Figure 3.1 Network types

	Range	*Bandwidth (Mbps)*	*Latency (ms)*
LAN	1–2 kms	10–1000	1–10
WAN	worldwide	0.010–600	100–500
MAN	2–50 kms	1–150	10
Wireless LAN	0.15–1.5 km	2–11	5–20
Wireless WAN	worldwide	0.010–2	100-500
Internet	worldwide	0.010–2	100–500

Figure 3.2 Conceptual layering of protocol software

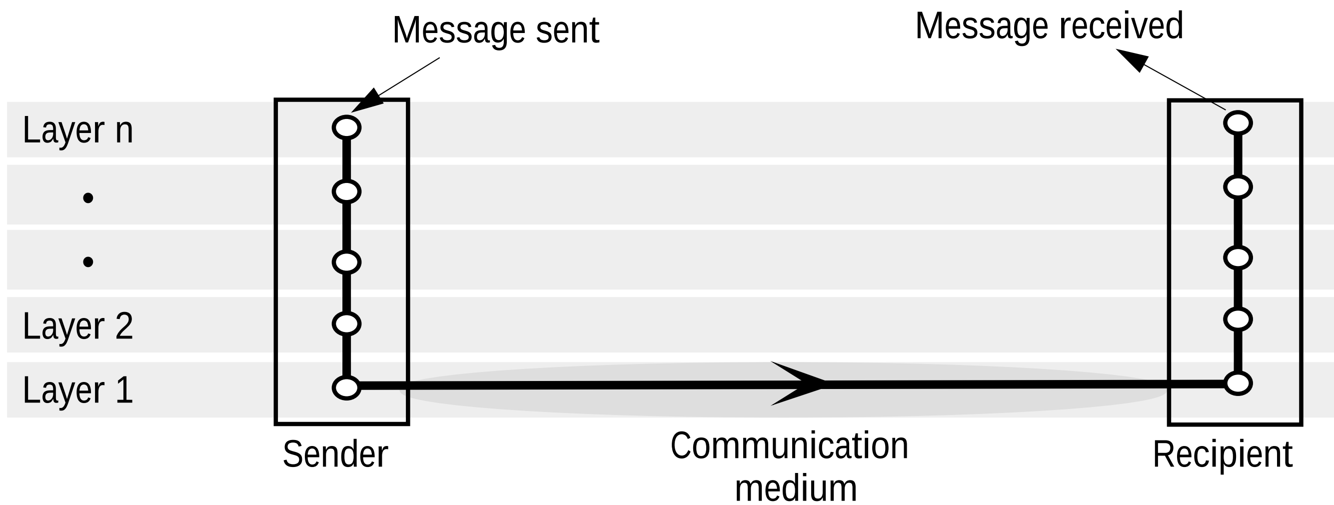

Figure 3.3 Encapsulation as it is applied in layered protocols

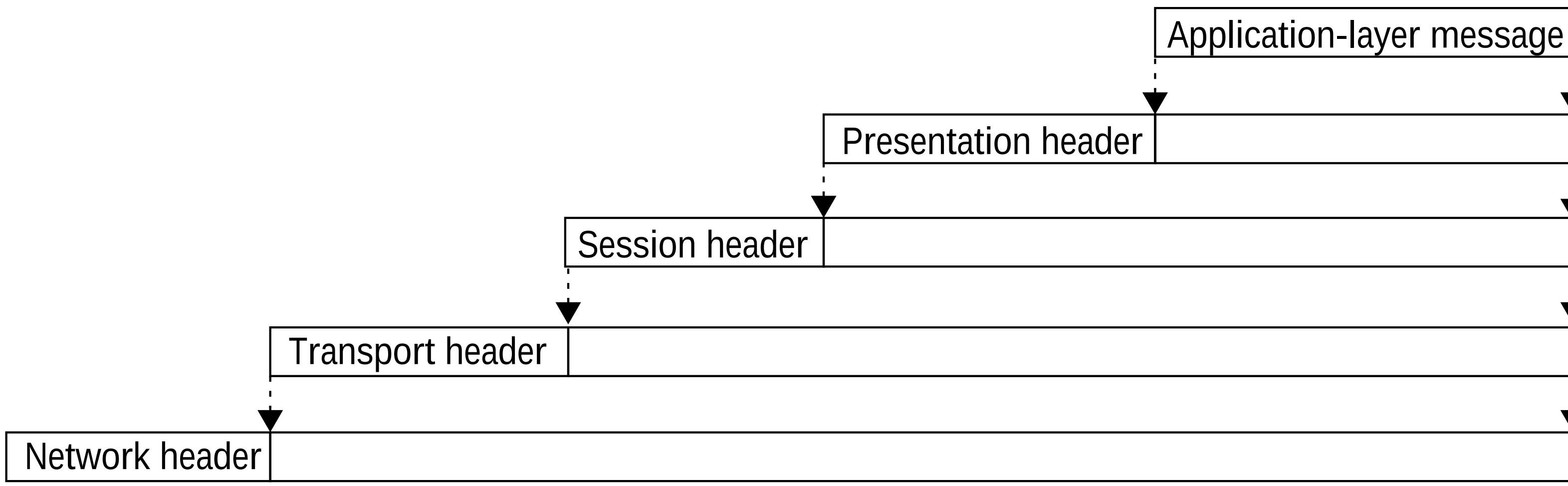

Figure 3.4 Protocol layers in the ISO *Open Systems Interconnection (OSI)* protocol model

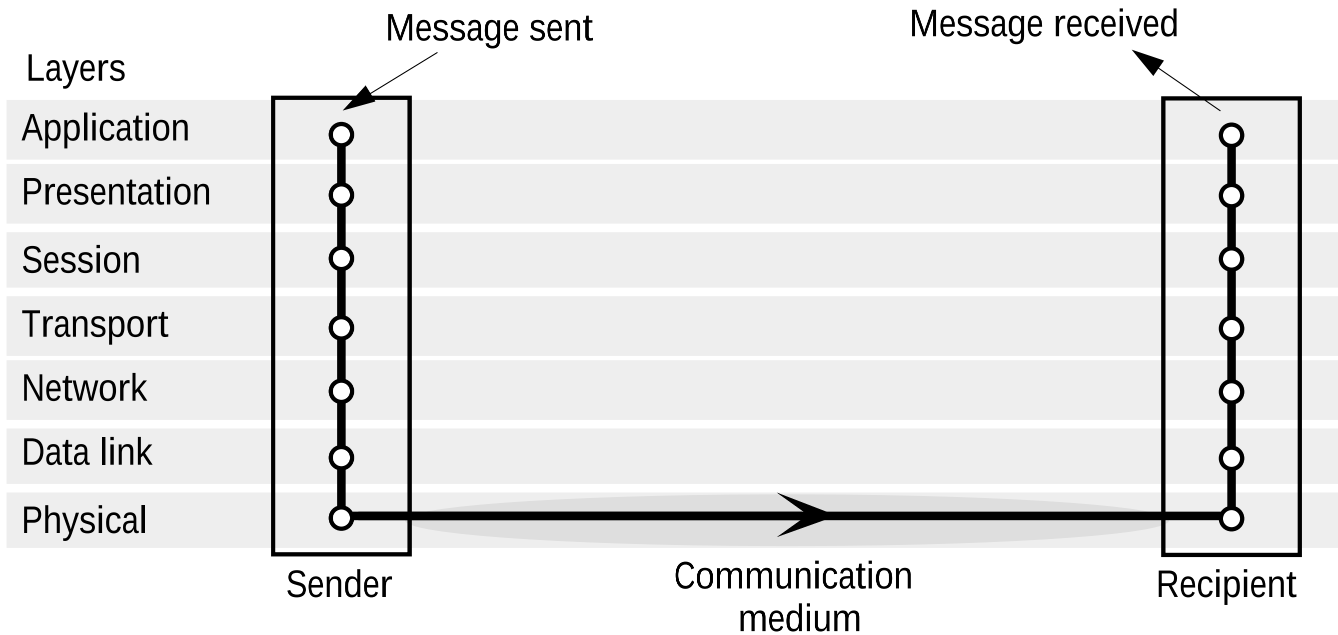

Figure 3.5 OSI protocol summary

Layer	*Description*	*Examples*
Application	Protocols that are designed to meet the communication requirements of specific applications, often defining the interface to a service.	HTTP, FTP, SMTP, CORBA IIOP
Presentation	Protocols at this level transmit data in a network representation that is independent of the representations used in individual computers, which may differ. Encryption is also performed in this layer, if required.	Secure Sockets (SSL),CORBA Data Rep.
Session	At this level reliability and adaptation are performed, such as detection of failures and automatic recovery.	
Transport	This is the lowest level at which messages (rather than packets) are handled. Messages are addressed to communication ports attached to processes, Protocols in this layer may be connection-oriented or connectionless.	TCP, UDP
Network	Transfers data packets between computers in a specific network. In a WAN or an internetwork this involves the generation of a route passing through routers. In a single LAN no routing is required.	IP, ATM virtual circuits
Data link	Responsible for transmission of packets between nodes that are directly connected by a physical link. In a WAN transmission is between pairs of routers or between routers and hosts. In a LAN it is between any pair of hosts.	Ethernet MAC, ATM cell transfer, PPP
Physical	The circuits and hardware that drive the network. It transmits sequences of binary data by analogue signalling, using amplitude or frequency modulation of electrical signals (on cable circuits), light signals (on fibre optic circuits) or other electromagnetic signals (on radio and microwave circuits).	Ethernet base-band signalling, ISDN

Figure 3.6 Internetwork layers

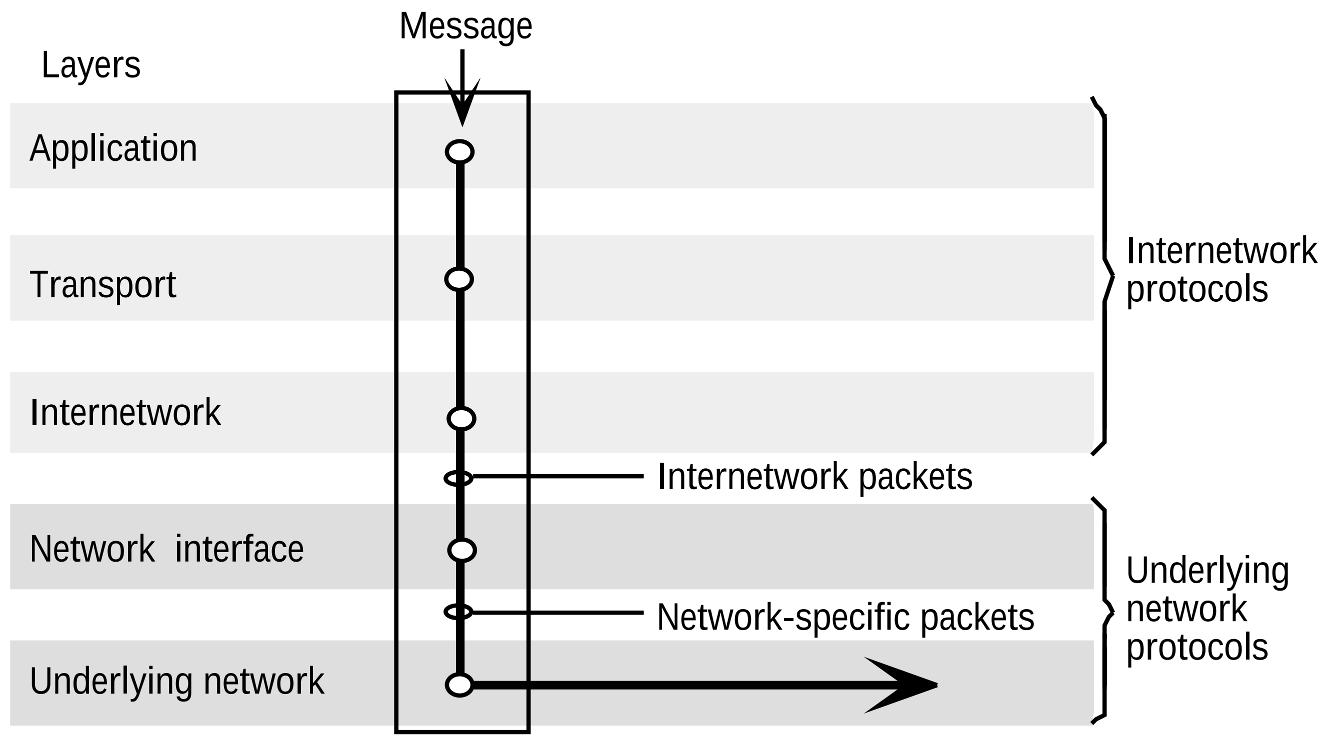

Figure 3.7 Routing in a wide area network

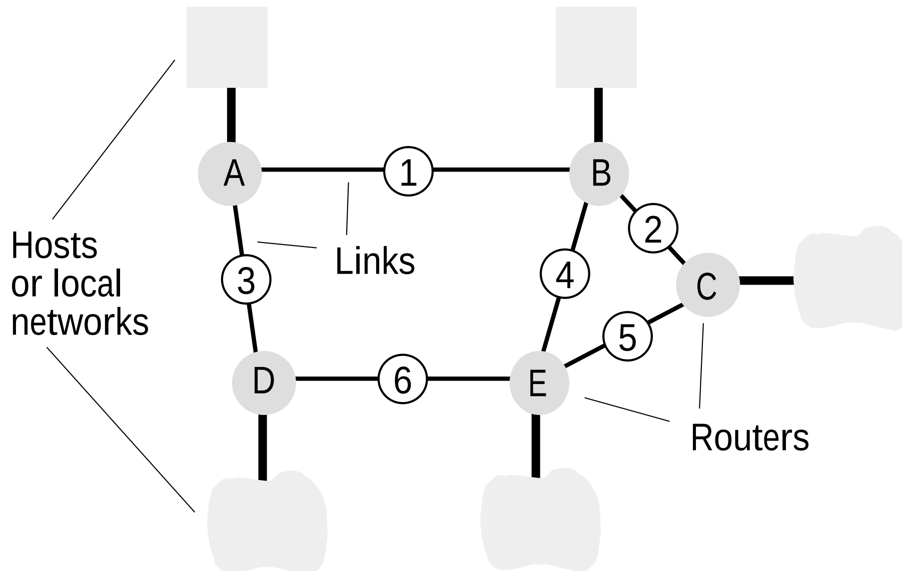

Figure 3.8 Routing tables for the network in Figure 3.7

Routings from A		
To	*Link*	*Cost*
A	local	0
B	1	1
C	1	2
D	3	1
E	1	2

Routings from B		
To	*Link*	*Cost*
A	1	1
B	local	0
C	2	1
D	1	2
E	4	1

Routings from C		
To	*Link*	*Cost*
A	2	2
B	2	1
C	local	0
D	5	2
E	5	1

Routings from D		
To	*Link*	*Cost*
A	3	1
B	3	2
C	6	2
D	local	0
E	6	1

Routings from E		
To	*Link*	*Cost*
A	4	2
B	4	1
C	5	1
D	6	1
E	local	0

Figure 3.9 Pseudo-code for RIP routing algorithm

Send: Each *t* seconds or when *Tl* changes, send *Tl* on each non-faulty outgoing link.

Receive: Whenever a routing table *Tr* is received on link *n*:

```
for all rows Rr in Tr {
    if (Rr.link ≠ n) {
        Rr.cost = Rr.cost + 1;
        Rr.link = n;
        if (Rr.destination is not in Tl) add Rr to Tl;    // add new destination to Tl
        else for all rows Rl in Tl {
            if (Rr.destination = Rl.destination and
                (Rr.cost < Rl.cost or Rl.link = n)) Rl = Rr;
                // Rr.cost < Rl.cost : remote node has better route
                // Rl.link = n : remote node is more authoritative
        }
    }
}
```

Figure 3.10 Simplified view of the QMW Computer Science network

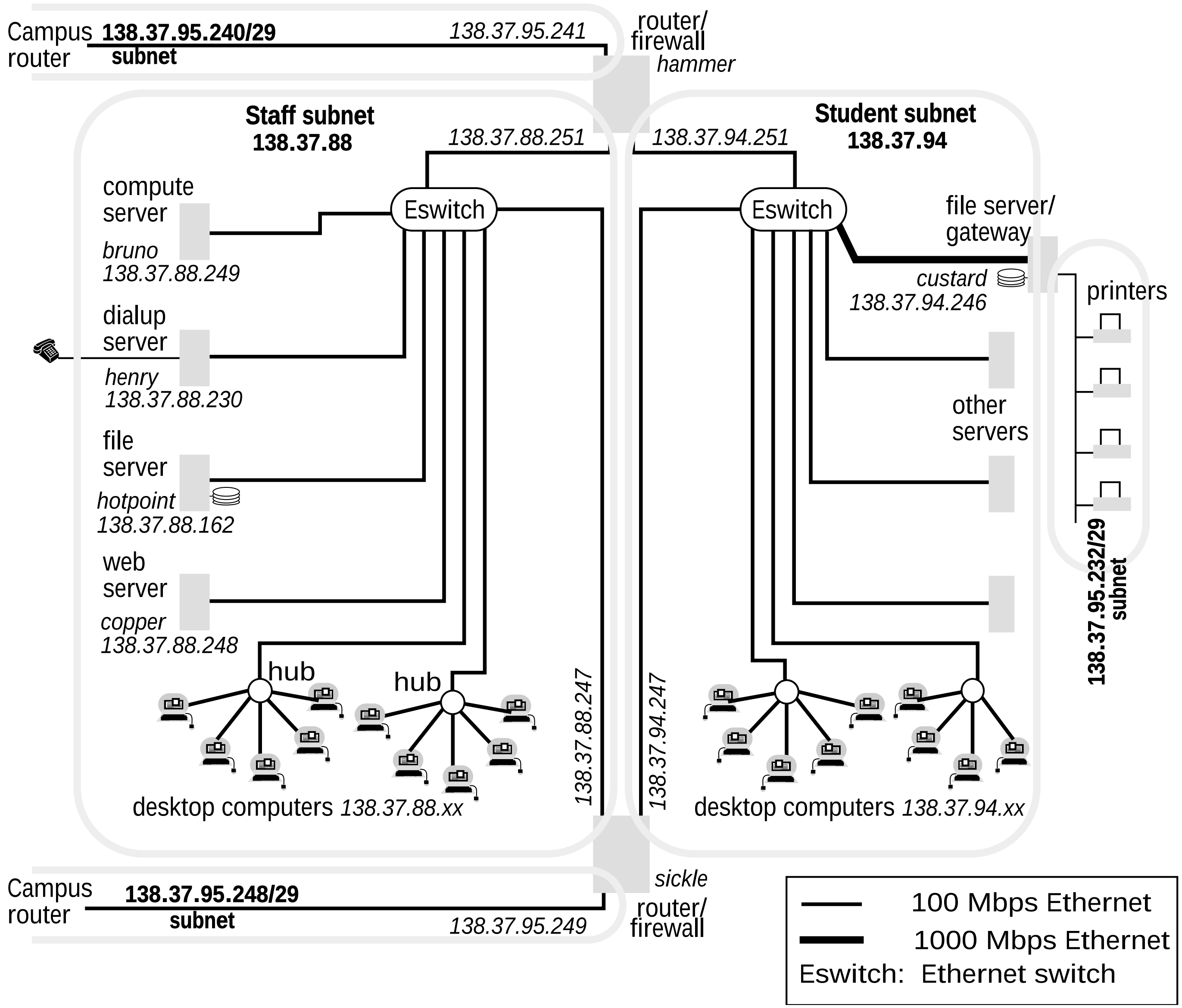

Figure 3.11 Tunnelling for IPv6 migration

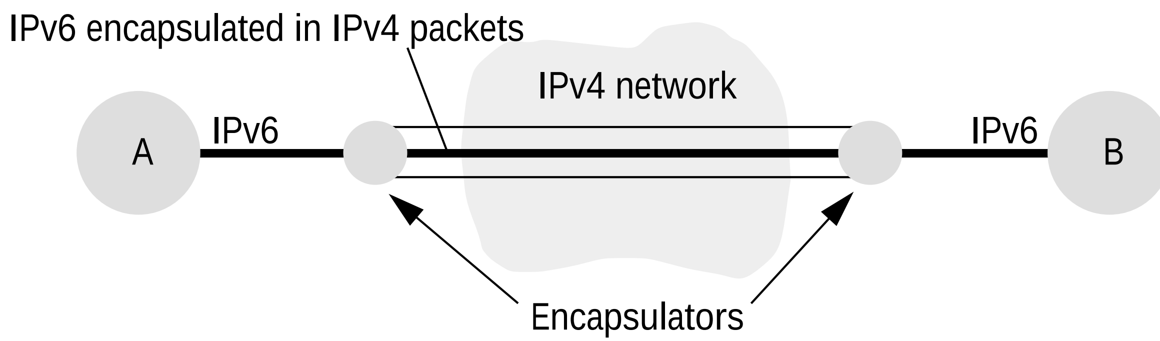

Figure 3.12 TCP/IP layers

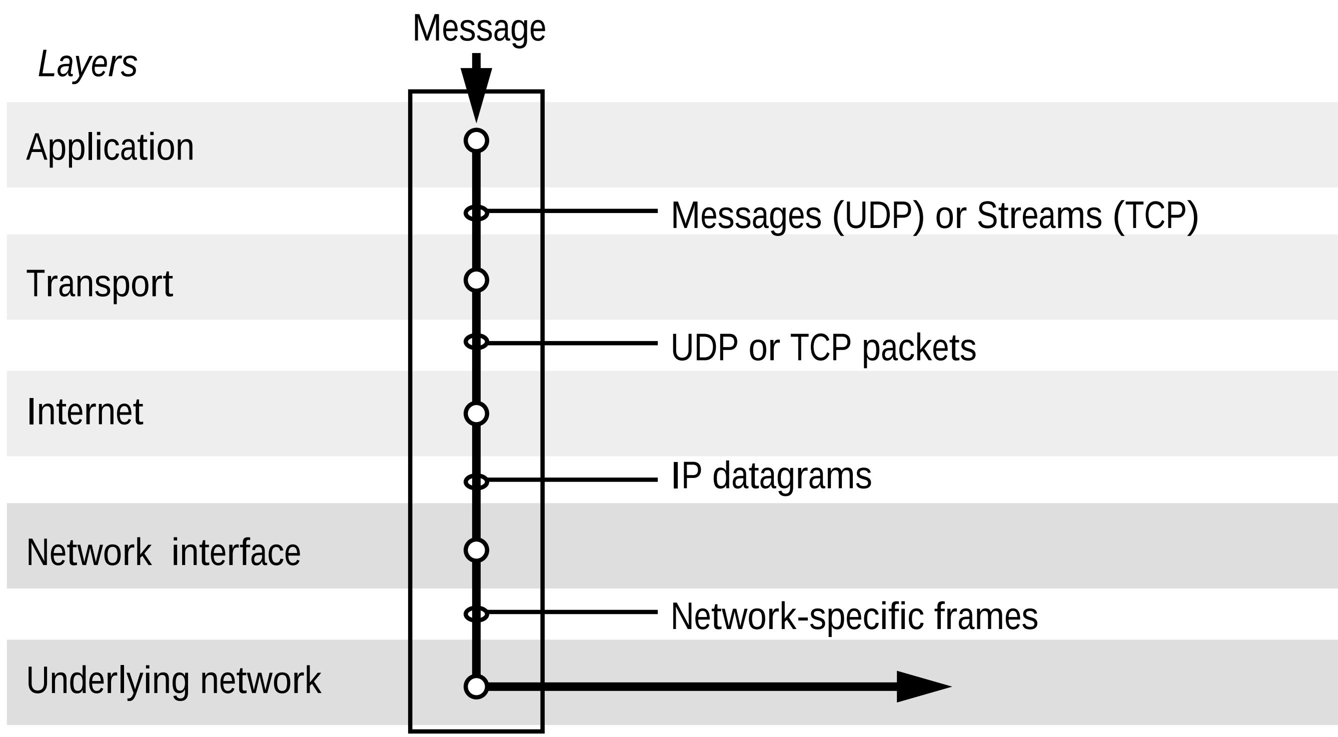

Figure 3.13 Encapsulation as it occurs when a message is transmitted via TCP over an Ethernet

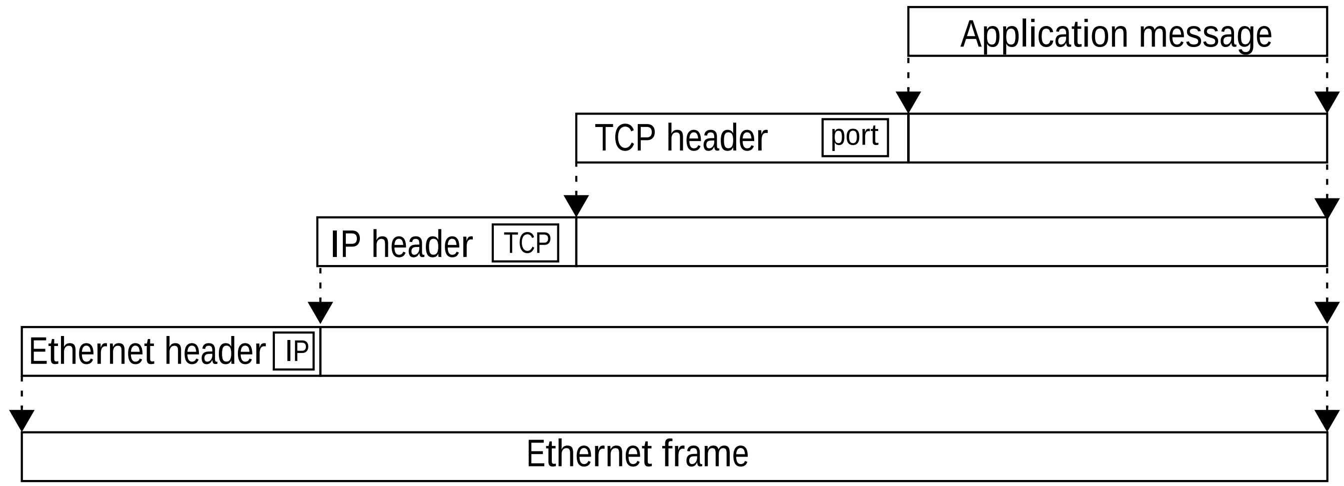

Figure 3.14 The programmer's conceptual view of a TCP/IP Internet

Figure 3.15 Internet address structure, showing field sizes in bits

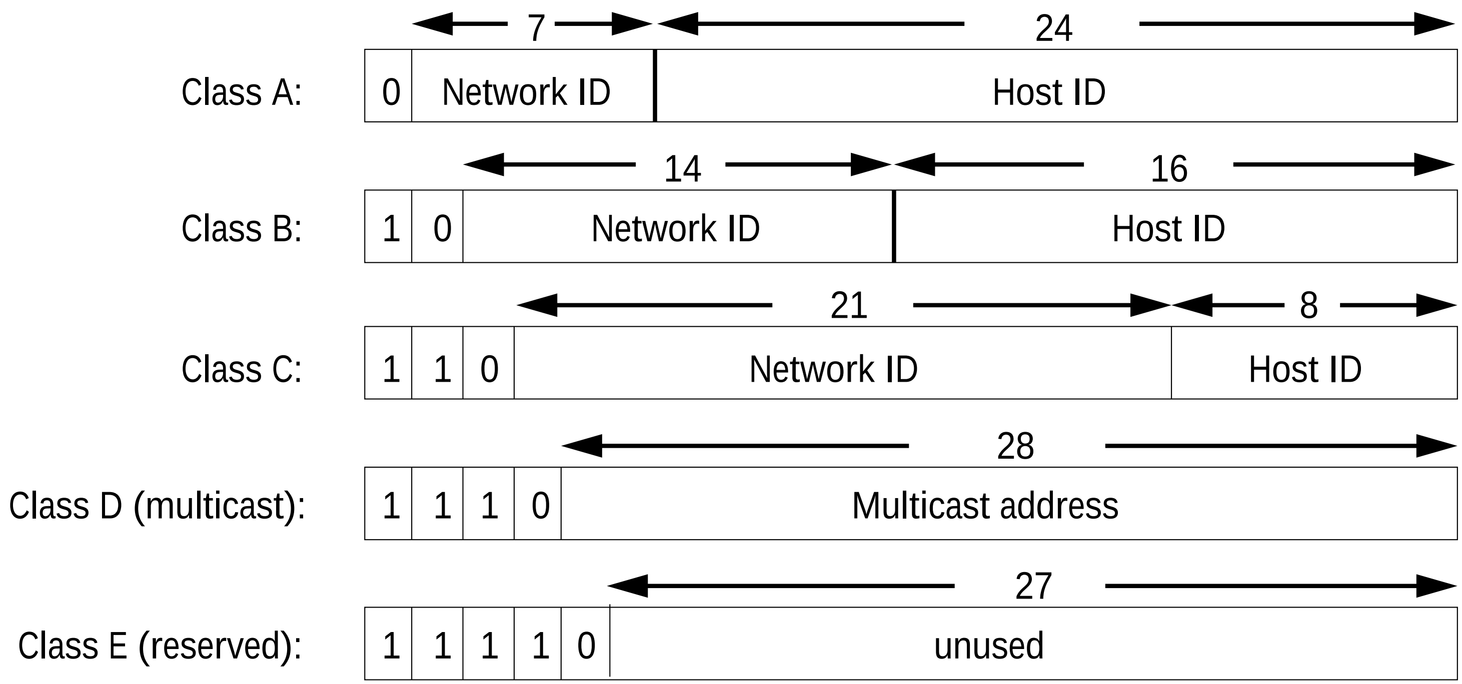

Figure 3.16 Decimal representation of Internet addresses

	octet 1	*octet 2*	*octet 3*		*Range of addresses*
	Network ID	*Host ID*			
Class A:	1 to 127	0 to 255	0 to 255	0 to 255	1.0.0.0 to 127.255.255.255
	Network ID		*Host ID*		
Class B:	128 to 191	0 to 255	0 to 255	0 to 255	128.0.0.0 to 191.255.255.255
	Network ID			*Host ID*	
Class C:	192 to 223	0 to 255	0 to 255	1 to 254	192.0.0.0 to 223.255.255.255
	Multicast address				
Class D (multicast):	224 to 239	0 to 255	0 to 255	1 to 254	224.0.0.0 to 239.255.255.255
Class E (reserved):	240 to 255	0 to 255	0 to 255	1 to 254	240.0.0.0 to 255.255.255.255

Figure 3.17 IP packet layout

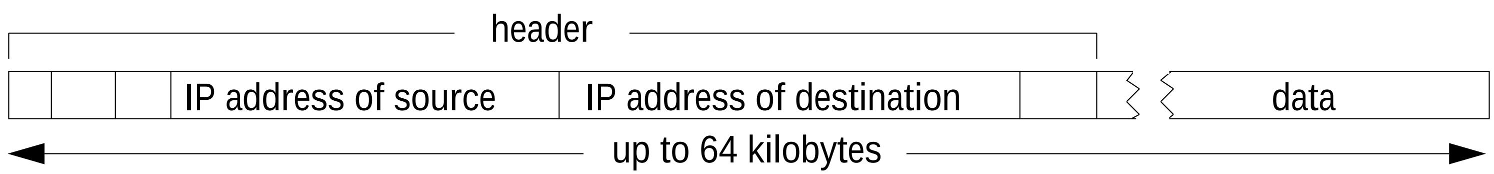

Figure 3.18 IPv6 header layout

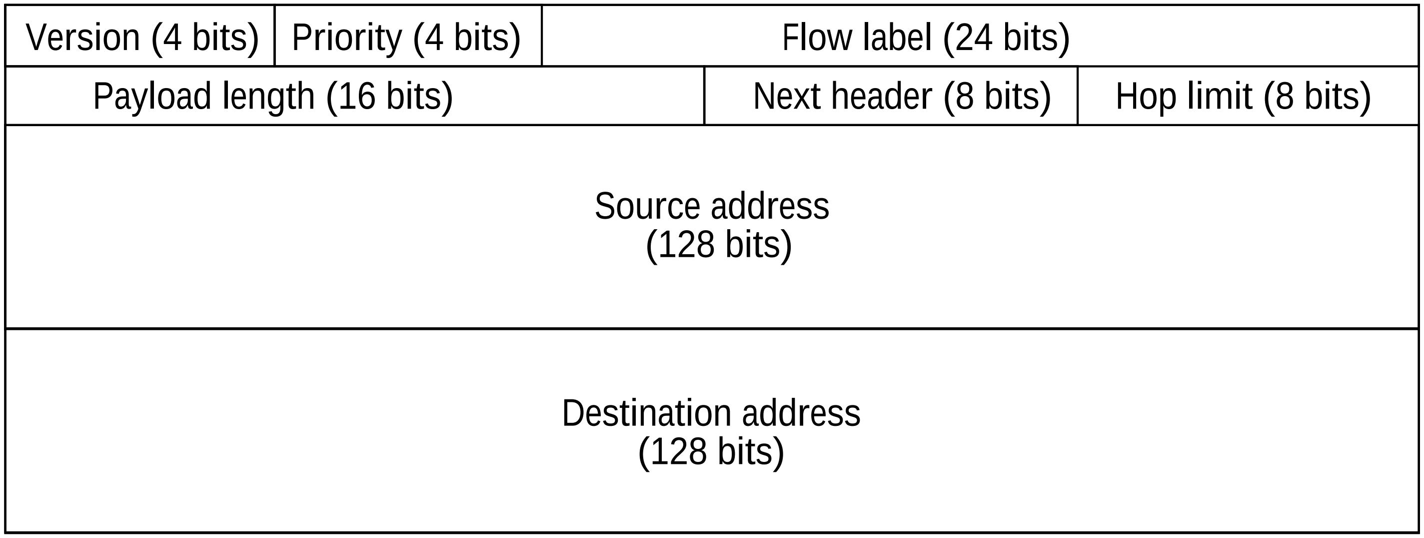

Figure 3.19 The MobileIP routing mechanism

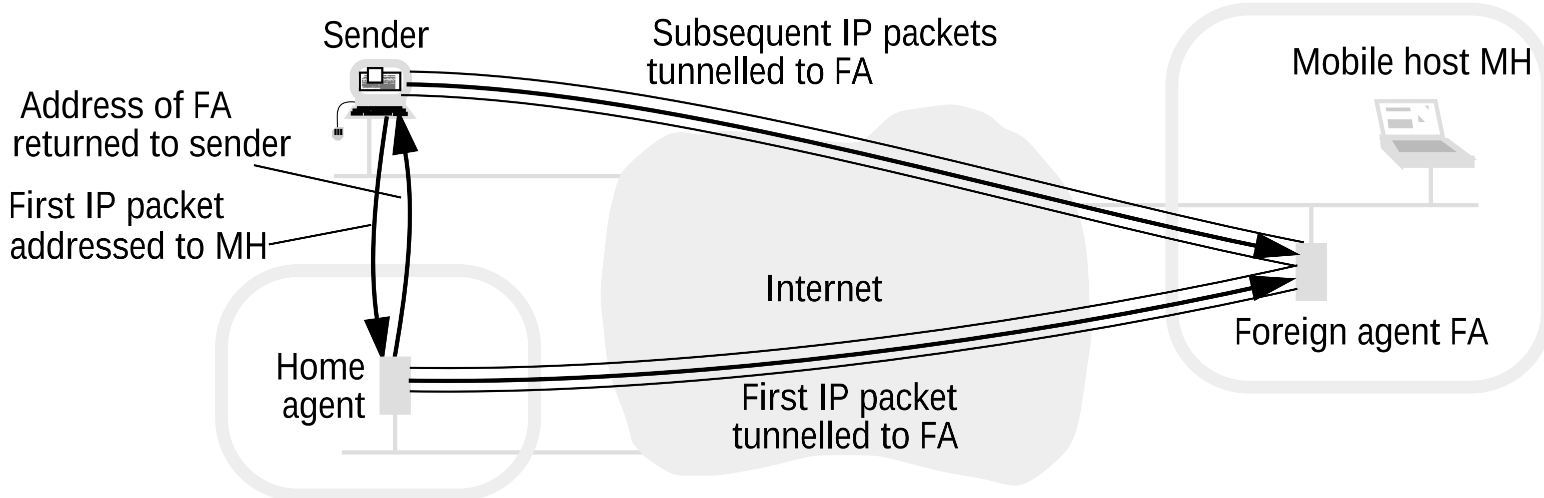

Figure 3.20 Firewall configurations

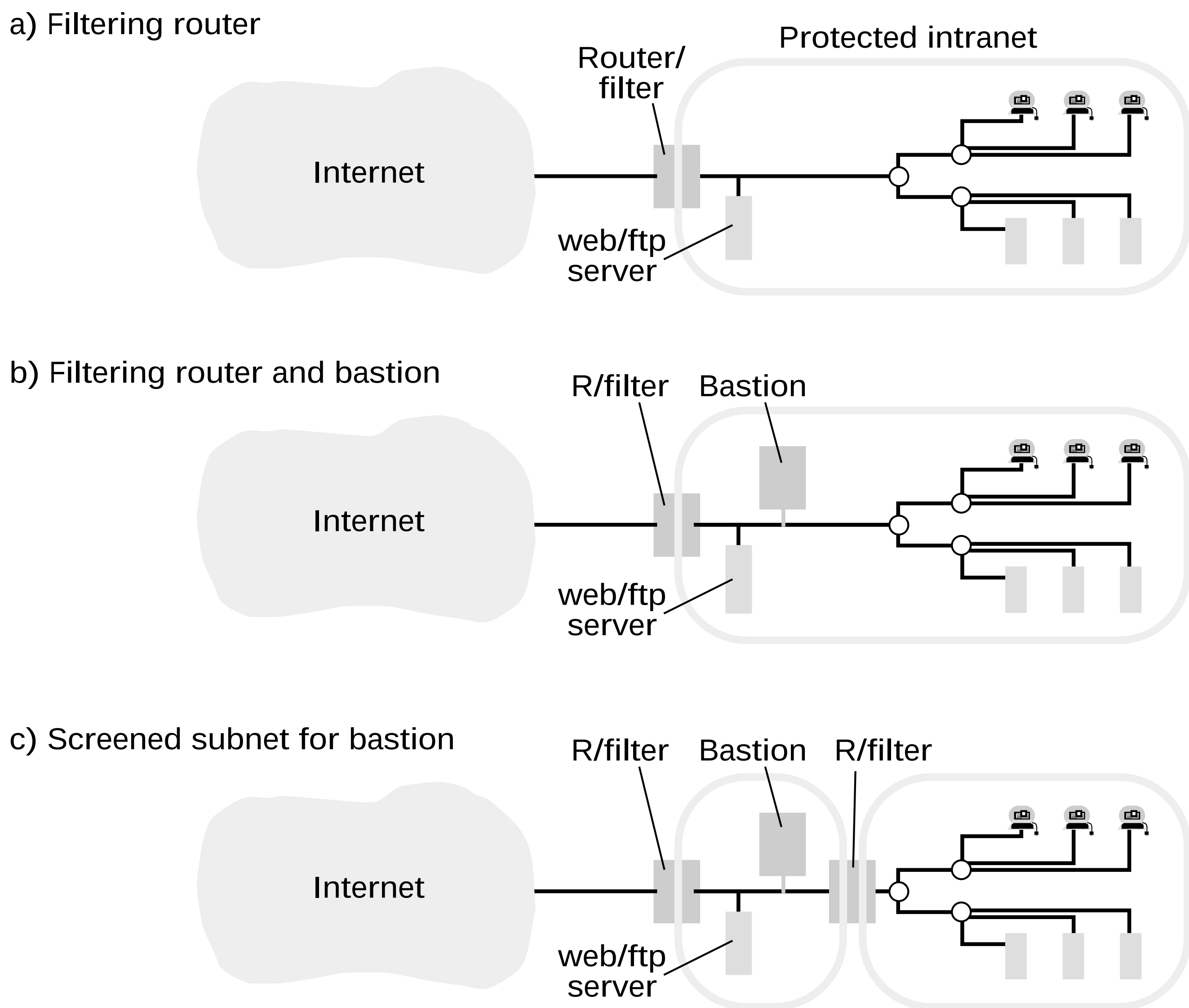

Figure 3.21 IEEE 802 network standards

IEEE No.	*Title*	*Reference*
802.3	CSMA/CD Networks (Ethernet)	[IEEE 1985a]
802.4	Token Bus Networks	[IEEE 1985b]
802.5	Token Ring Networks	[IEEE 1985c]
802.6	Metropolitan Area Networks	[IEEE 1994]
802.11	Wireless Local Area Networks	[IEEE 1999]

Figure 3.22 Wireless LAN configuration

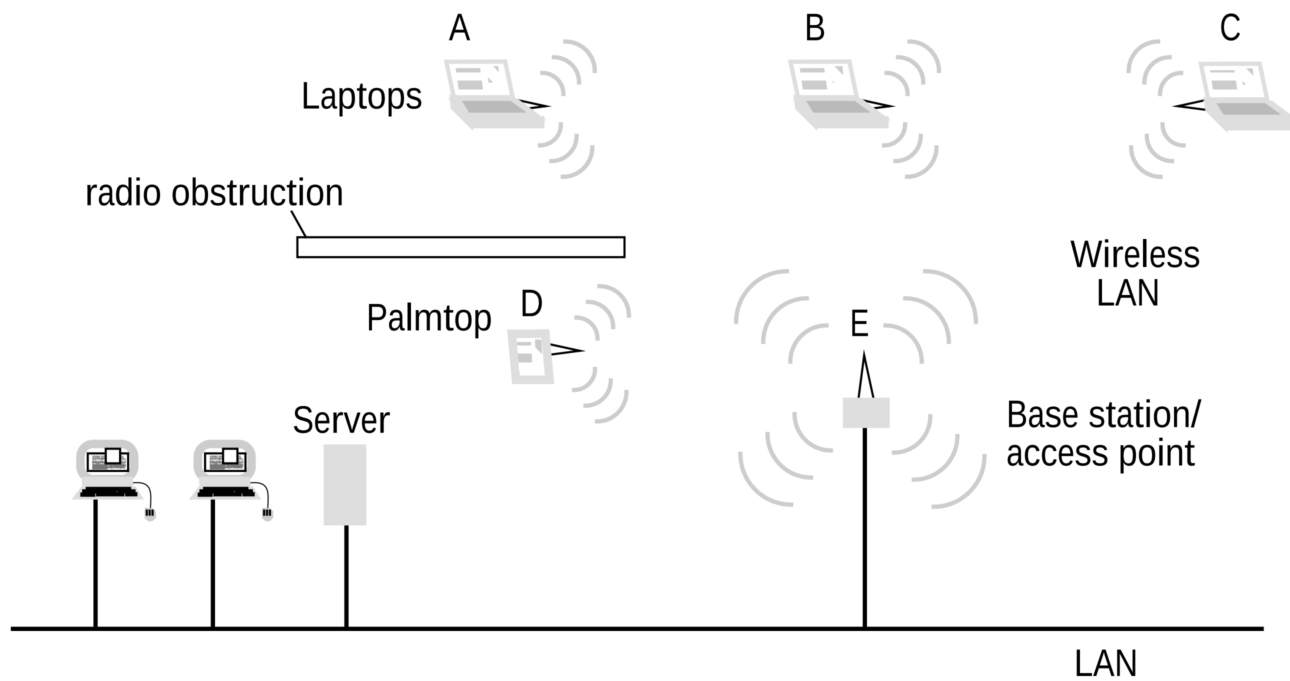

Figure 3.23 ATM protocol layers

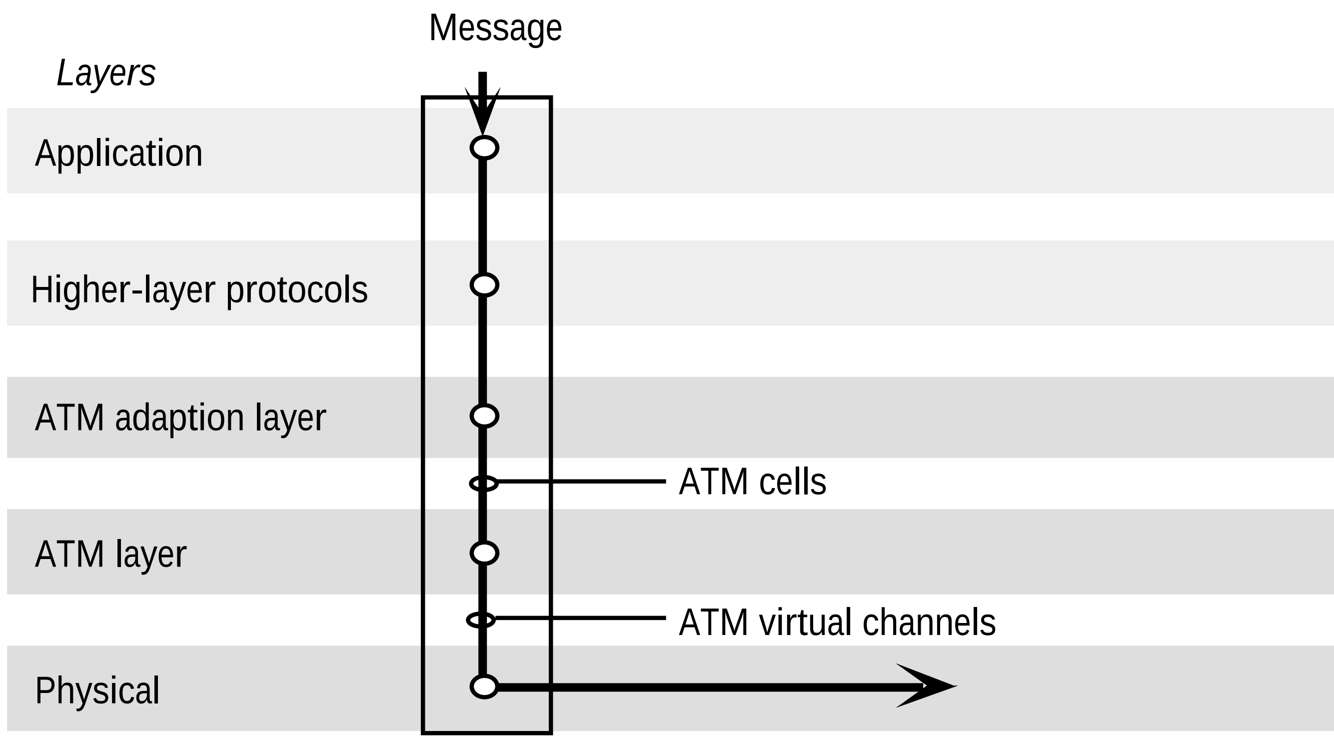

Figure 3.24 ATM cell layout

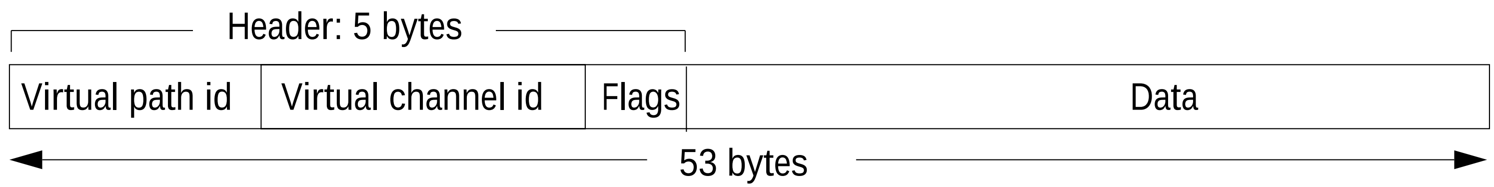

Figure 3.25 Switching virtual paths in an ATM network