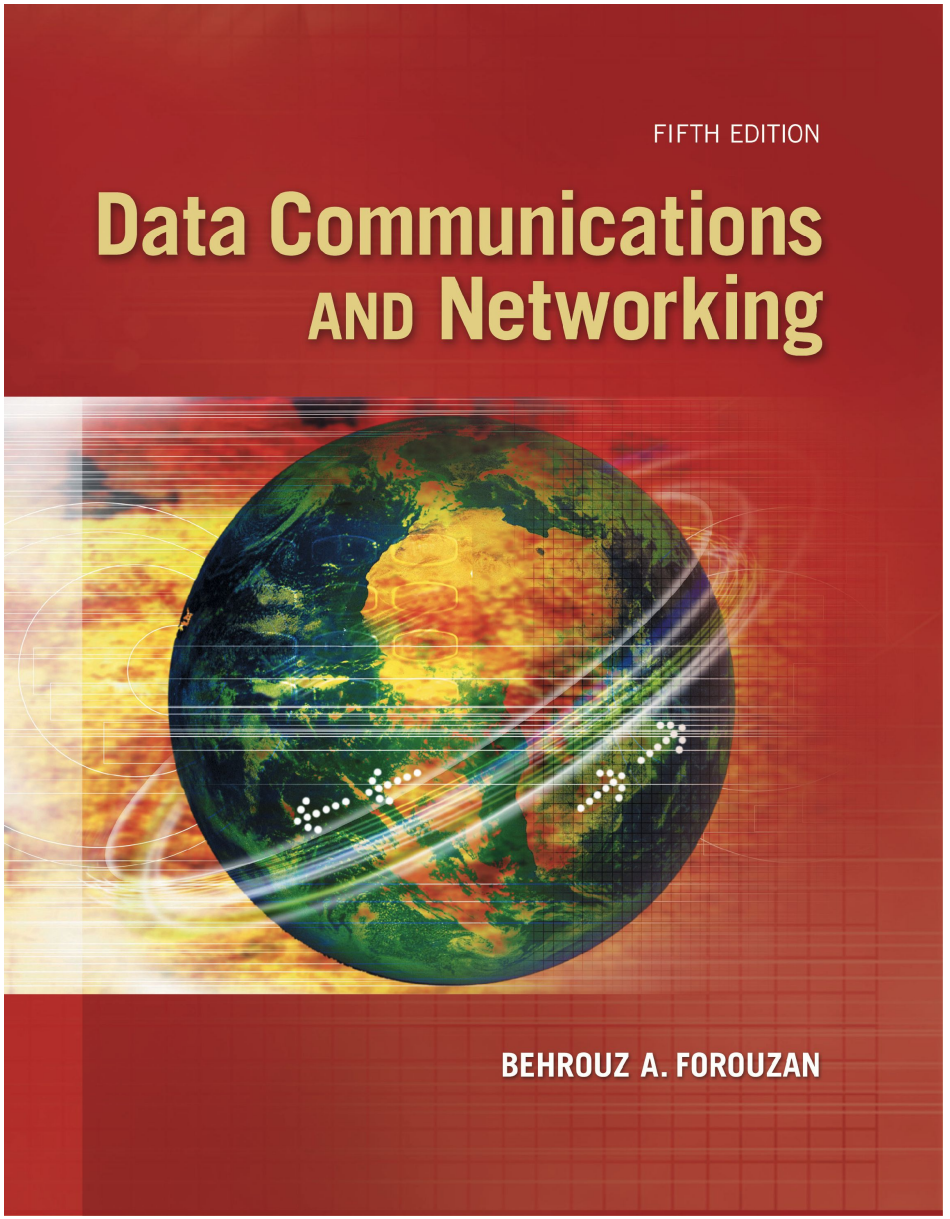
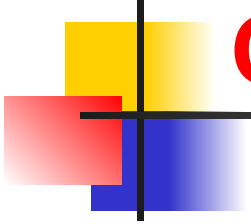
Chapter 15

Wireless LANs





Chapter6: Outline

15.1 INTRODUCTION

15.2 IEEE 802.11 PROJECT

15.3 BLUETOOTH

Chapter 15: Objective

- *The first section introduces the general issues behind wireless LANs and compares wired and wireless networks. The section describes the characteristics of the wireless networks and the way access is controlled in these types of networks.*
- *The second section discusses a wireless LAN defined by the IEEE 802.11 Project. This section defines the architecture of this type of LAN and describes the MAC sublayer.*
- *The third section discusses the Bluetooth technology as a personal area network (PAN). The section describes the architecture of the network, the addressing mechanism, and the packet format. Different layers used in this protocol are also briefly described and compared with the ones in the other wired and wireless LANs.*

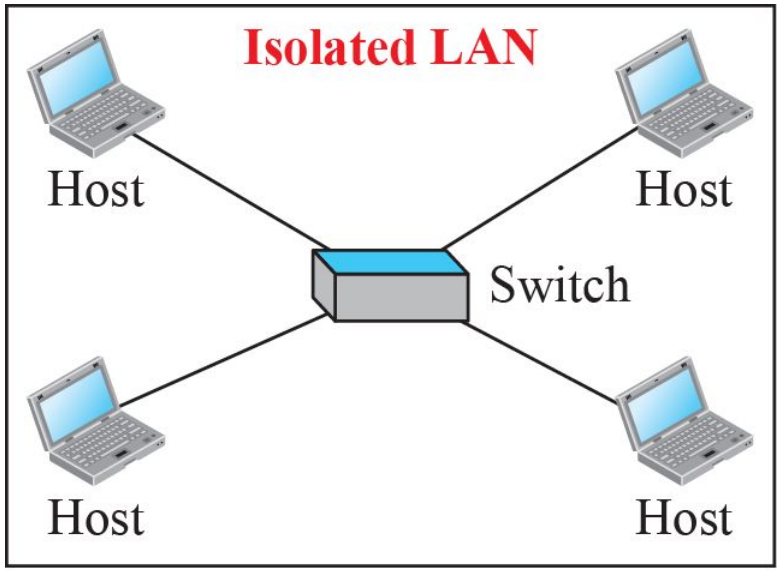
15-1 INTRODUCTION

Wireless communication is one of the fastest-growing technologies. The demand for connecting devices without the use of cables is increasing everywhere. Wireless LANs can be found on college campuses, in office buildings, and in many public areas. Before we discuss a specific protocol related to wireless LANs, let us talk about them in general.

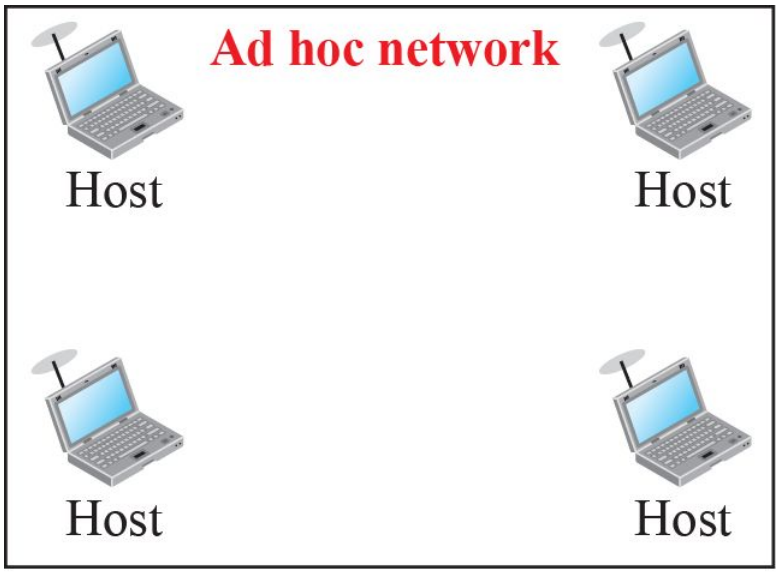
15.15.1 Architectural Comparison

Let us first compare the architecture of wired and wireless LANs to give some idea of what we need to look for when we study wireless LANs.

Figure 15.1: ***Isolated LANs: wired versus wireless***

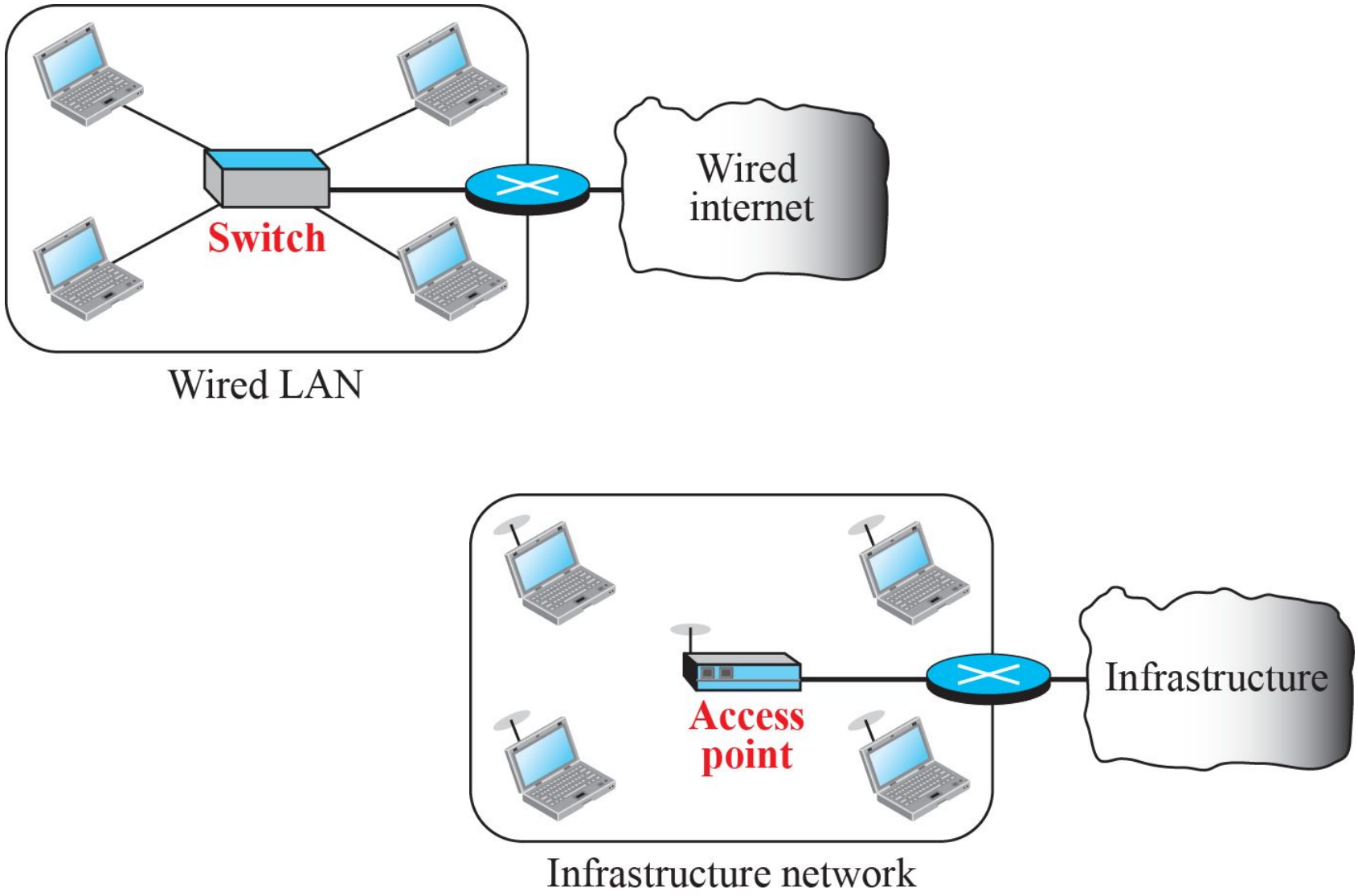


Wired



Wireless

Figure 15.2: ***Connection of a wired LAN and a wireless LAN to other networks***



15.15.2 Characteristics

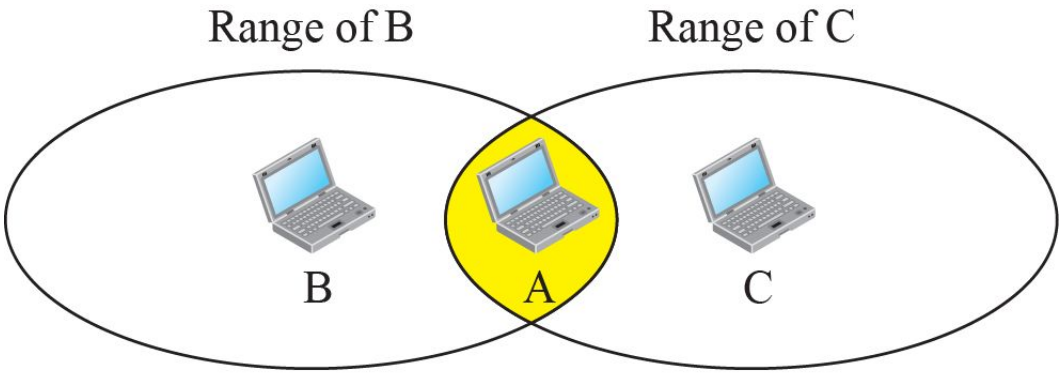
There are several characteristics of wireless LANs that either do not apply to wired LANs or the existence of which is negligible and can be ignored. We discuss some of these characteristics here to pave the way for discussing wireless LAN protocols.

15.15.3 Access Control

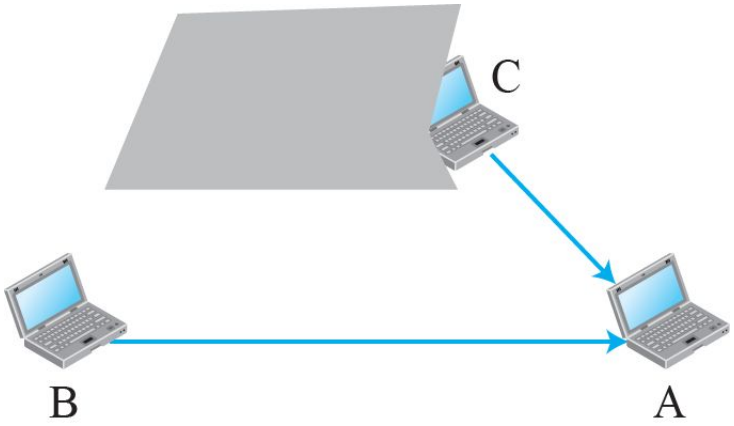
Maybe the most important issue we need to discuss in a wireless LAN is access control—how a wireless host can get access to the shared medium (air). The CSMA/CD algorithm does not work in wireless LANs for three reasons:

1. *Wireless hosts do not have enough power to send and receive at the same time.*
2. *The hidden station problem prevents collision detection*
3. *The distance between stations can be great.*

Figure 15.3: Hidden station problem



a. Stations B and C are not in each other's range.



b. Stations B and C are hidden from each other.

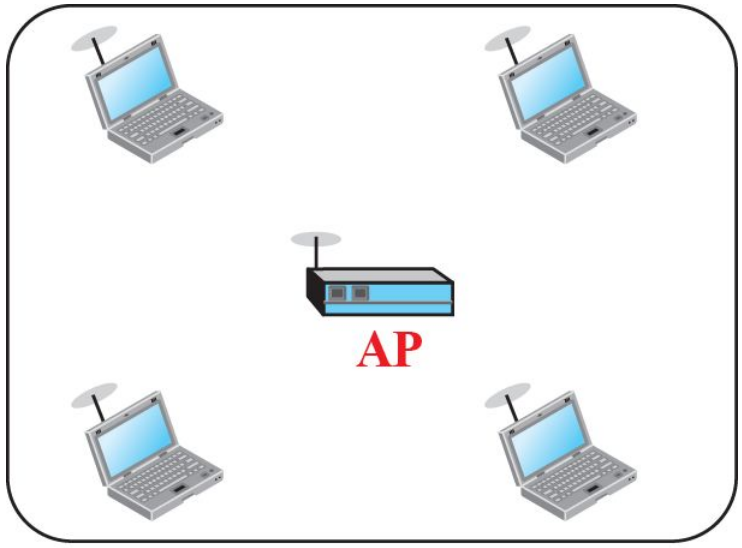
15-2 IEEE 802.11 PROJECT

IEEE has defined the specifications for a wireless LAN, called IEEE 802.11, which covers the physical and data-link layers. It is sometimes called wireless Ethernet. In some countries, including the United States, the public uses the term WiFi (short for wireless fidelity) as a synonym for wireless LAN. WiFi, however, is a wireless LAN that is certified by the WiFi Alliance.

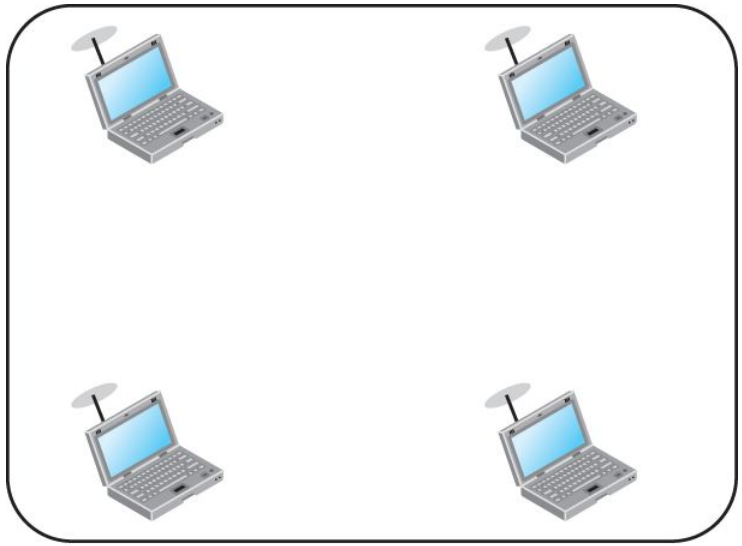
15.2.1 Architecture

The standard defines two kinds of services: the basic service set (BSS) and the extended service set (ESS).

Figure 15.4: Basic service sets (BSSs)

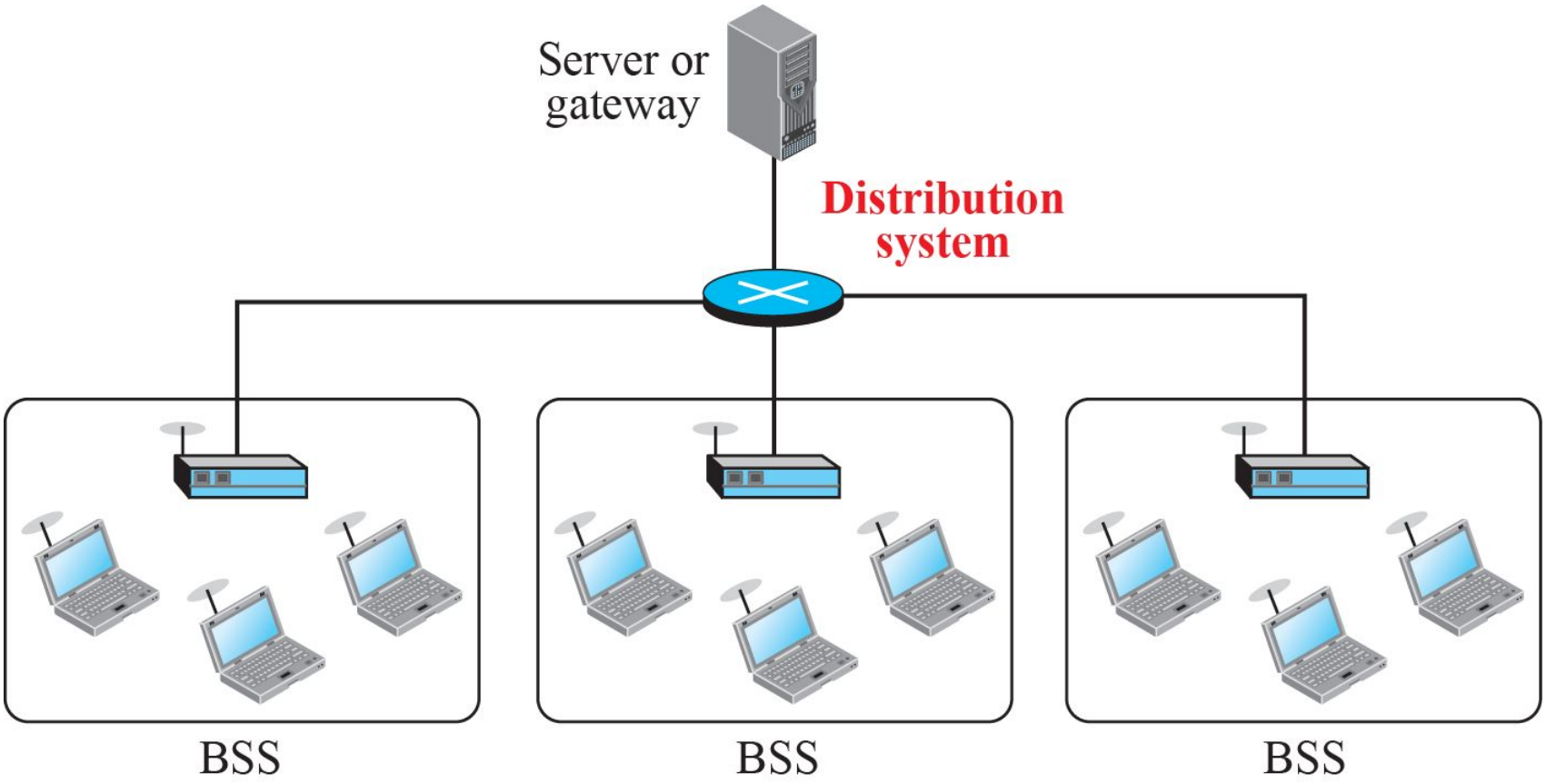


Infrastructure BSS



Ad hoc BSS

Figure 15.6: ***Extended service set (ESS)***



15.2.2 MAC Sublayer

IEEE 802.11 defines two MAC sublayers: the distributed coordination function (DCF) and point coordination function (PCF). Figure 15.6 shows the relationship between the two MAC sublayers, the LLC sublayer, and the physical layer. We discuss the physical layer implementations later in the chapter and will now concentrate on the MAC sublayer.

Figure 15.6: MAC layers in IEEE 802.11 standard

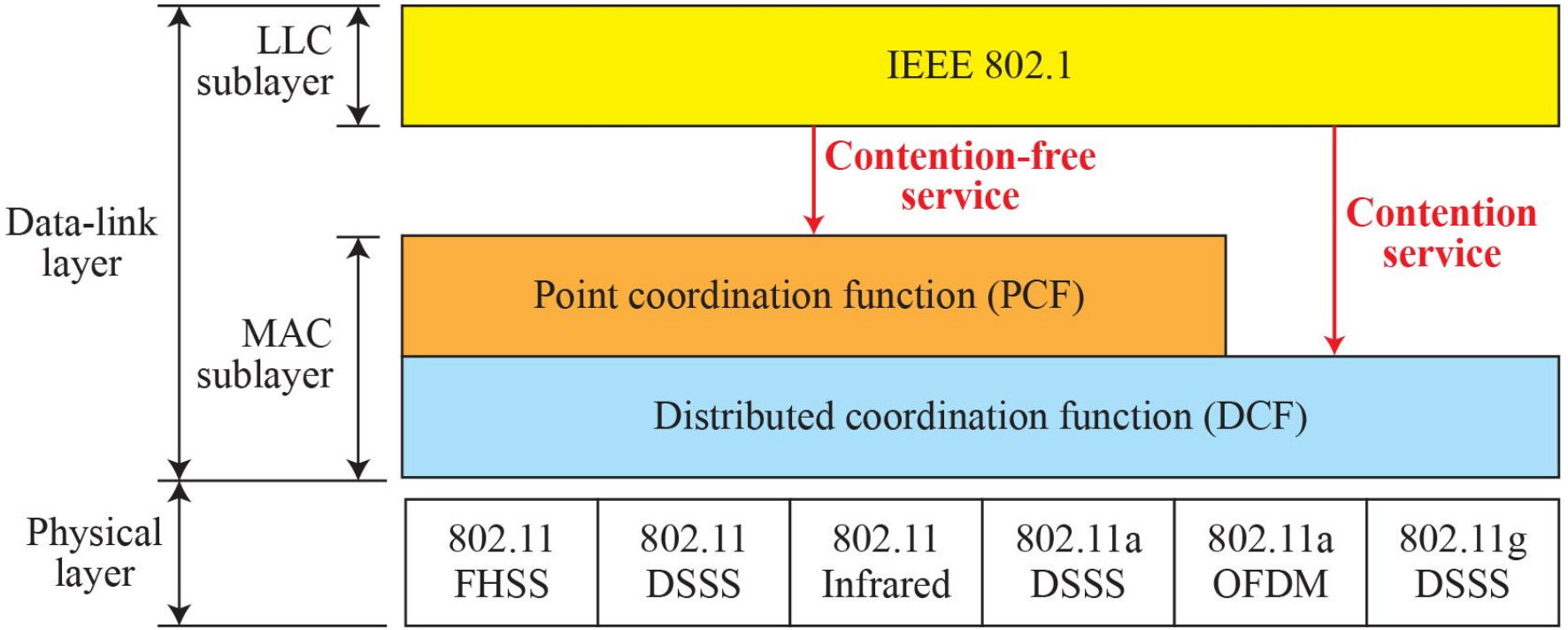


Figure 15.7: ***CSMA/CA and NAV***

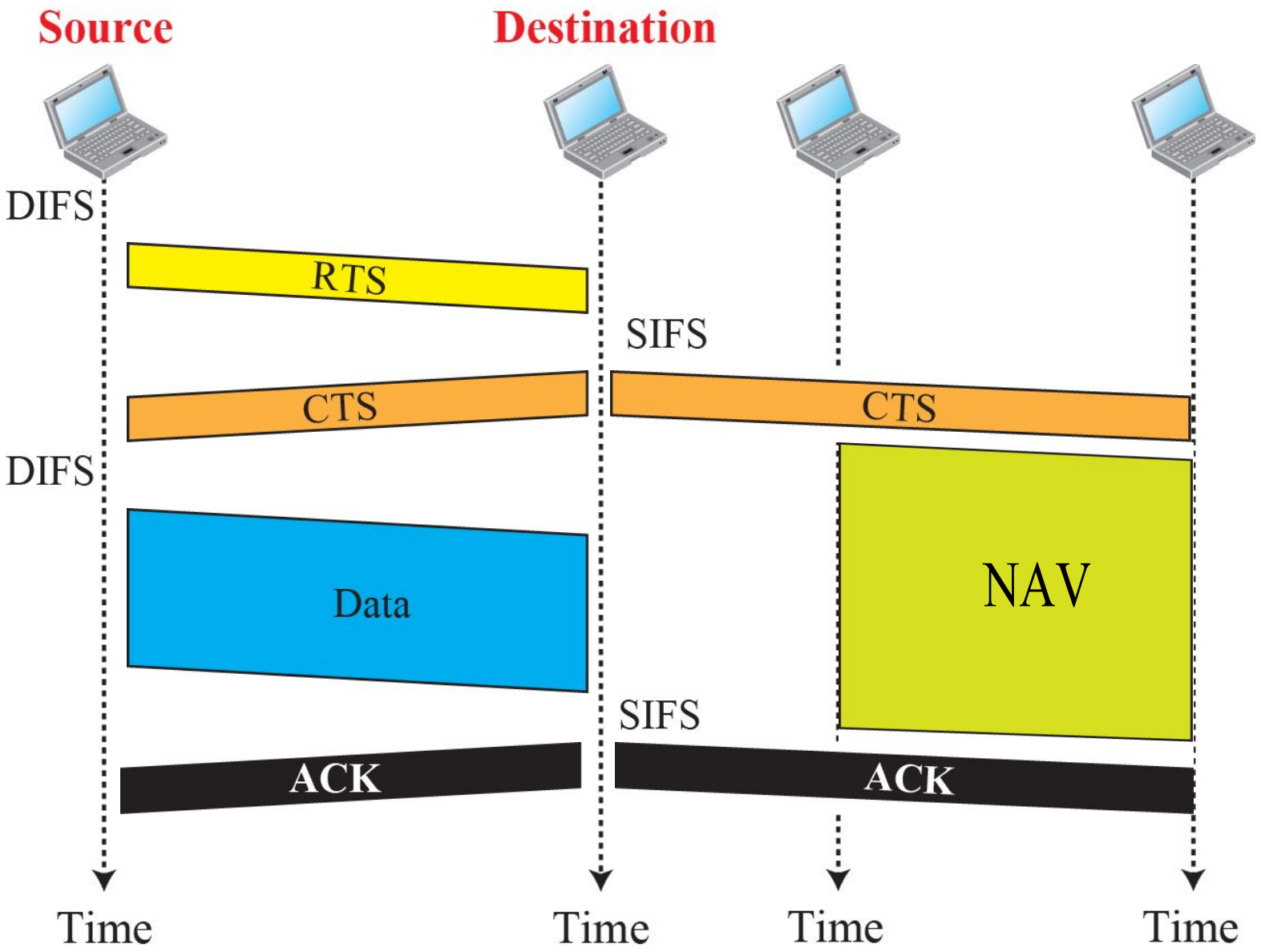


Figure 15.8: Example of repetition interval

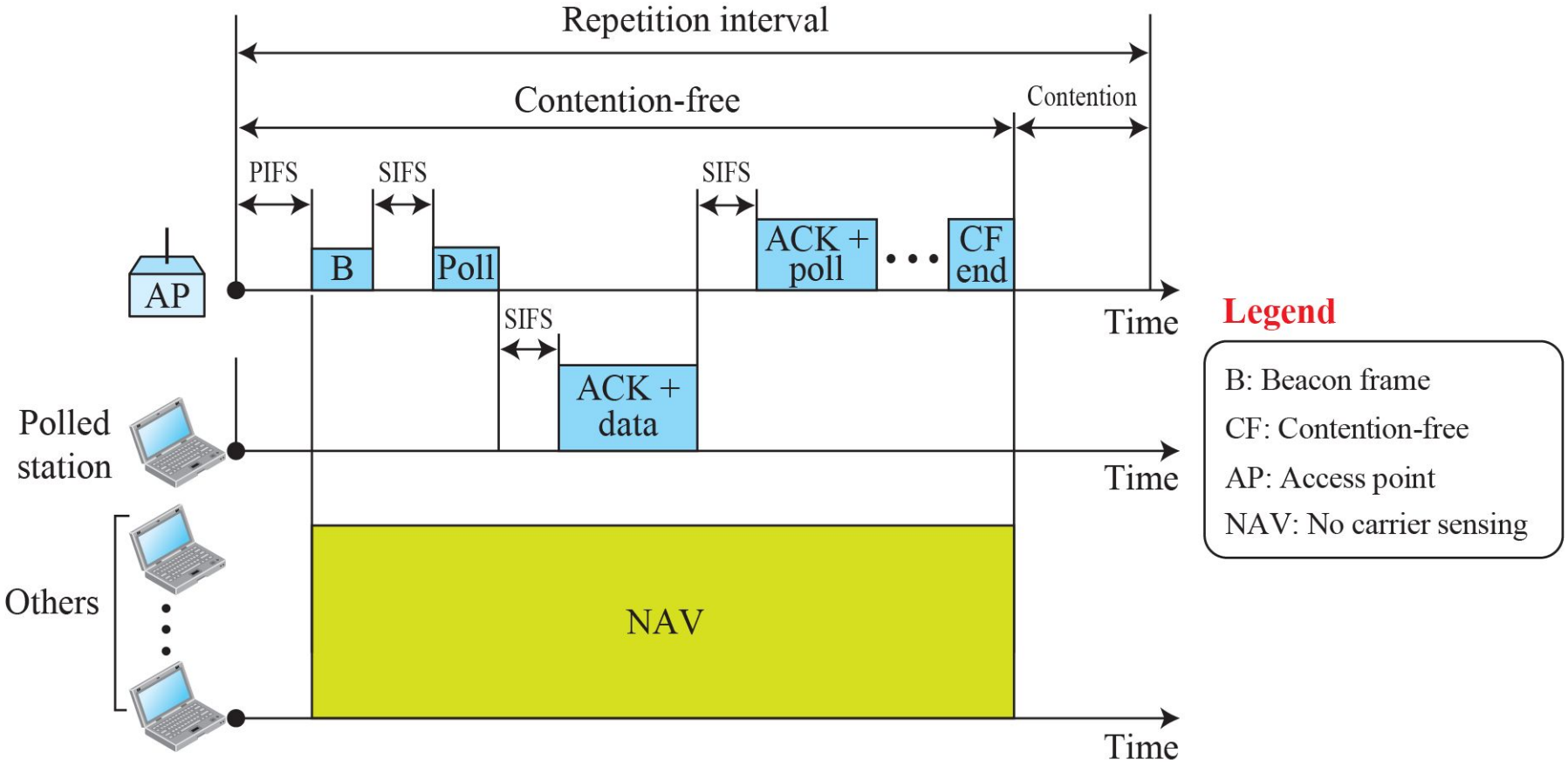


Figure 15.9: Frame format

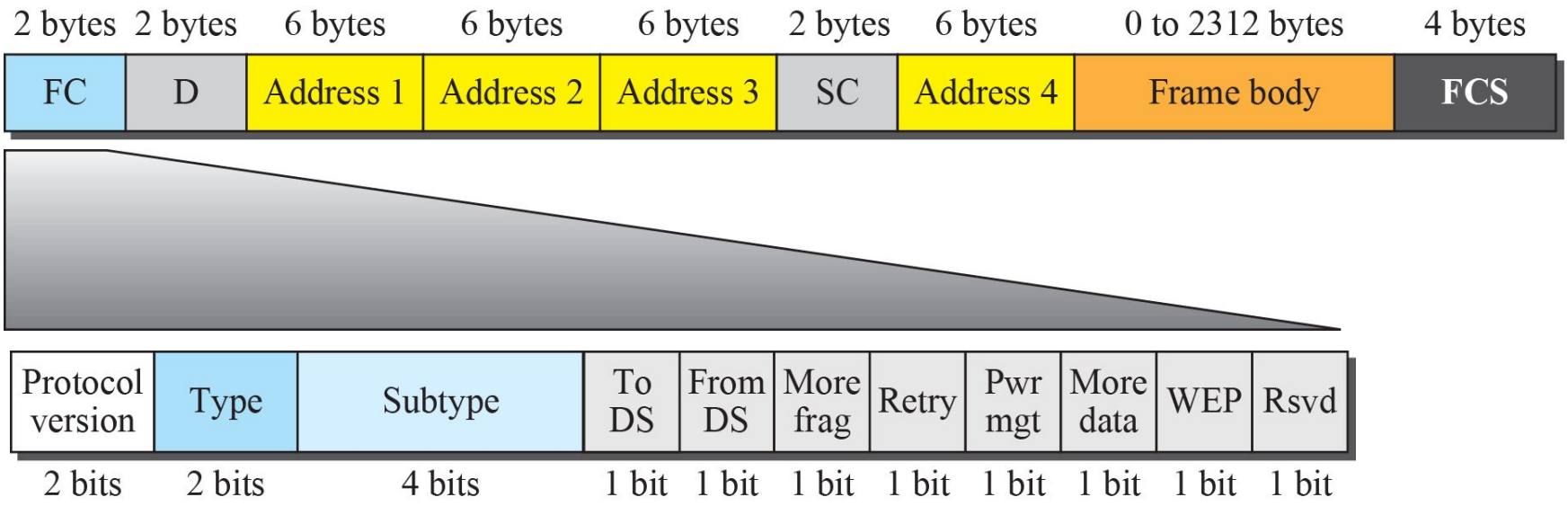
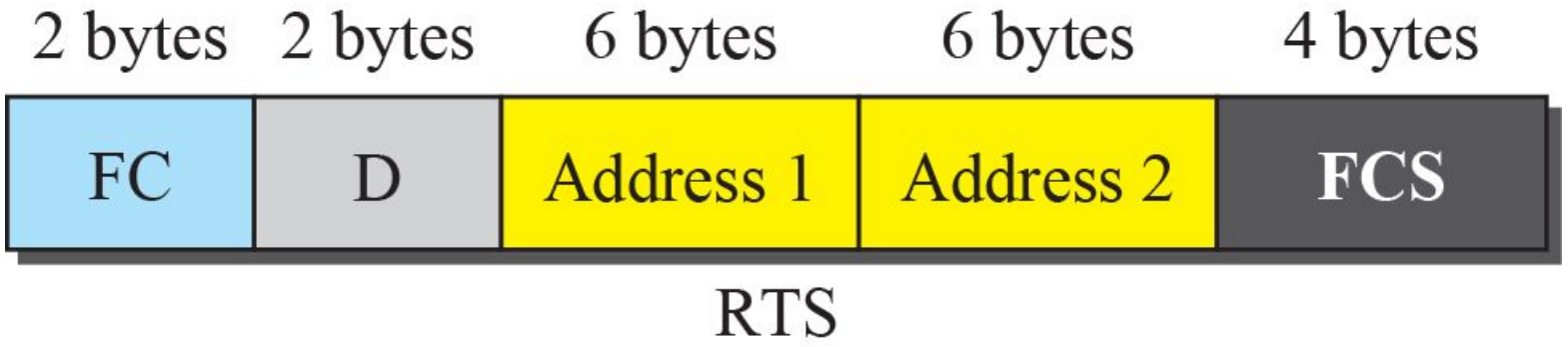


Table 15.1: Subfields in FC field

Field	*Explanation*
Version	Current version is 0
Type	Type of information: management (00), control (01), or data (10)
Subtype	Subtype of each type (see Table 6.2)
To DS	Defined later
From DS	Defined later
More flag	When set to 1, means more fragments
Retry	When set to 1, means retransmitted frame
Pwr mgt	When set to 1, means station is in power management mode
More data	When set to 1, means station has more data to send
WEP	Wired equivalent privacy (encryption implemented)
Rsvd	Reserved

Figure 15.10: ***Control frames***



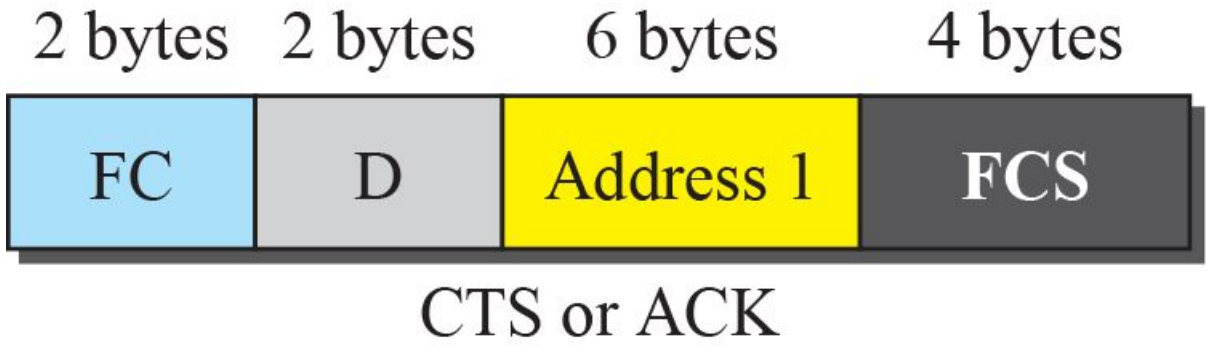


Table 15.2: Values of subfields in control frames

Subtype	*Meaning*
1011	Request to send (RTS)
1100	Clear to send (CTS)
1101	Acknowledgment (ACK)

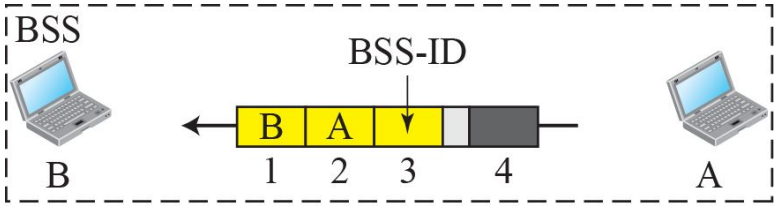
15.2.3 Addressing Mechanism

The IEEE 802.11 addressing mechanism specifies four cases, defined by the value of the two flags in the FC field, To DS and From DS. Each flag can be either 0 or 1, resulting in four different situations. The interpretation of the four addresses (address 1 to address 4) in the MAC frame depends on the value of these flags, as shown in Table 15.3.

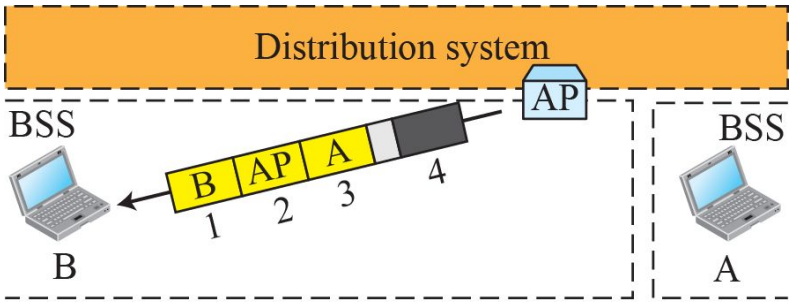
Table 15.3: Addresses

To DS	*From DS*	*Address 1*	*Address 2*	*Address 3*	*Address 4*
0	0	Destination	Source	BSS ID	N/A
0	1	Destination	Sending AP	Source	N/A
1	0	Receiving AP	Source	Destination	N/A
1	1	Receiving AP	Sending AP	Destination	Source

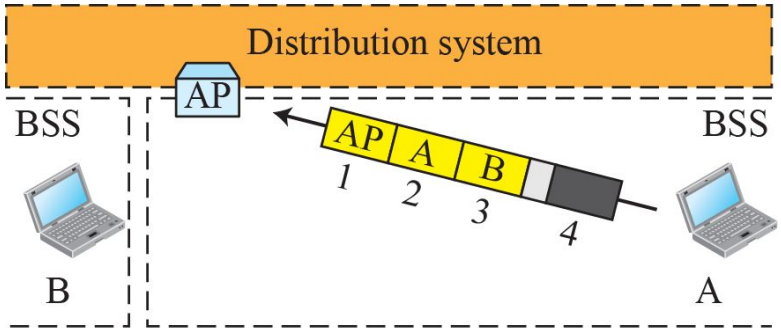
Figure 15.11: Addressing mechanisms



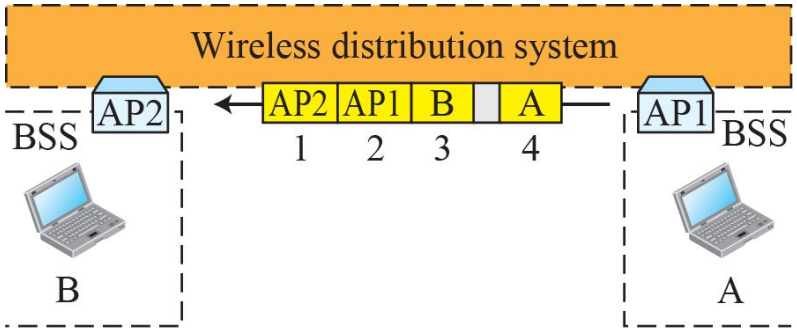
a. Case 1



b. Case 2

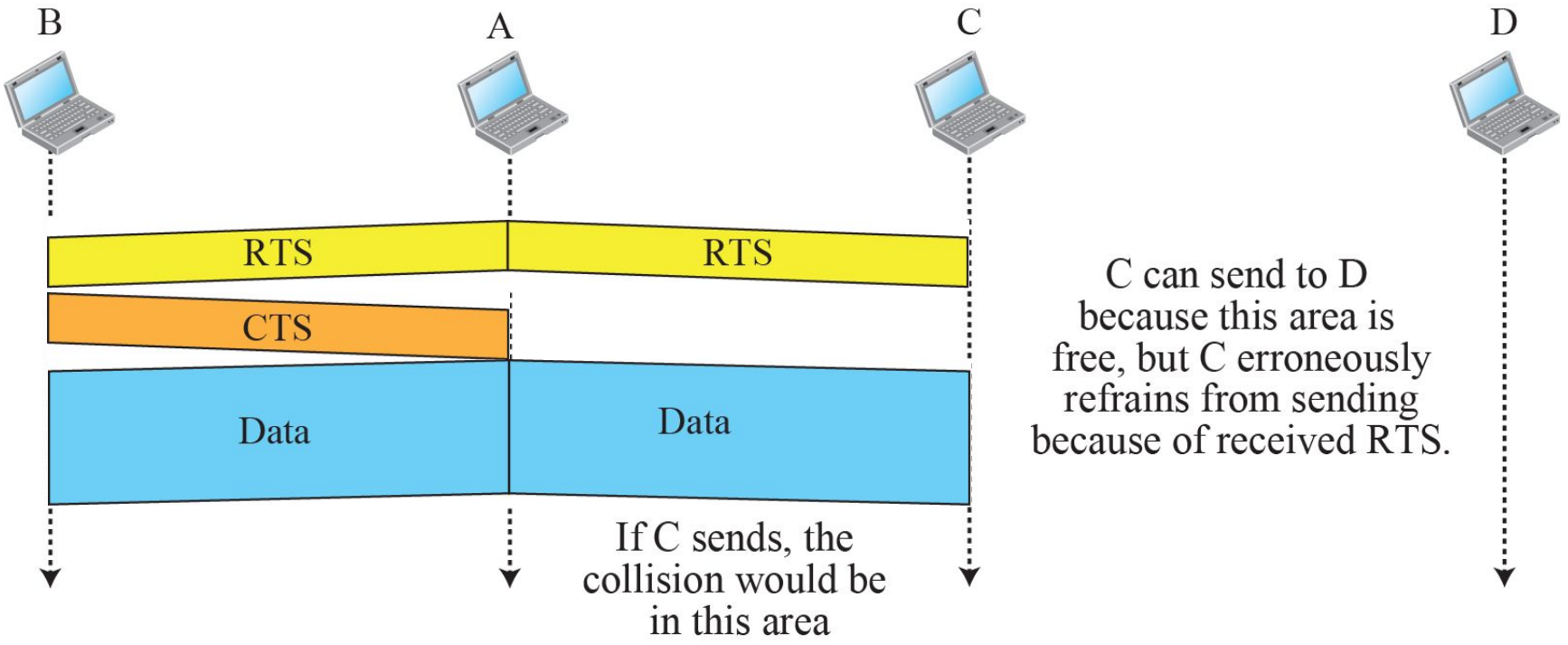


c. Case 3



d. Case 4

Figure 15.12: Exposed station problem



15.2.4 Physical Layer

We discuss six specifications, as shown in Table 15.4. All implementations, except the infrared, operate in the industrial, scientific, and medical (ISM) band, which defines three unlicensed bands in the three ranges 902–928 MHz, 2.400–4.835 GHz, and 5.725–5.850 GHz.

Table 15.4: Specifications

IEEE	*Technique*	*Band*	*Modulation*	*Rate (Mbps)*
802.11	FHSS	2.400–4.835 GHz	FSK	1 and 2
	DSSS	2.400–4.835 GHz	PSK	1 and 2
	None	Infrared	PPM	1 and 2
802.11a	OFDM	5.725–5.850 GHz	PSK or QAM	6 to 54
802.11b	DSSS	2.400–4.835 GHz	PSK	5.5 and 11
802.11g	OFDM	2.400–4.835 GHz	Different	22 and 54
802.11n	OFDM	5.725–5.850 GHz	Different	600

Figure 15.13: ***Physical layer of IEEE 802.11 FHSS***

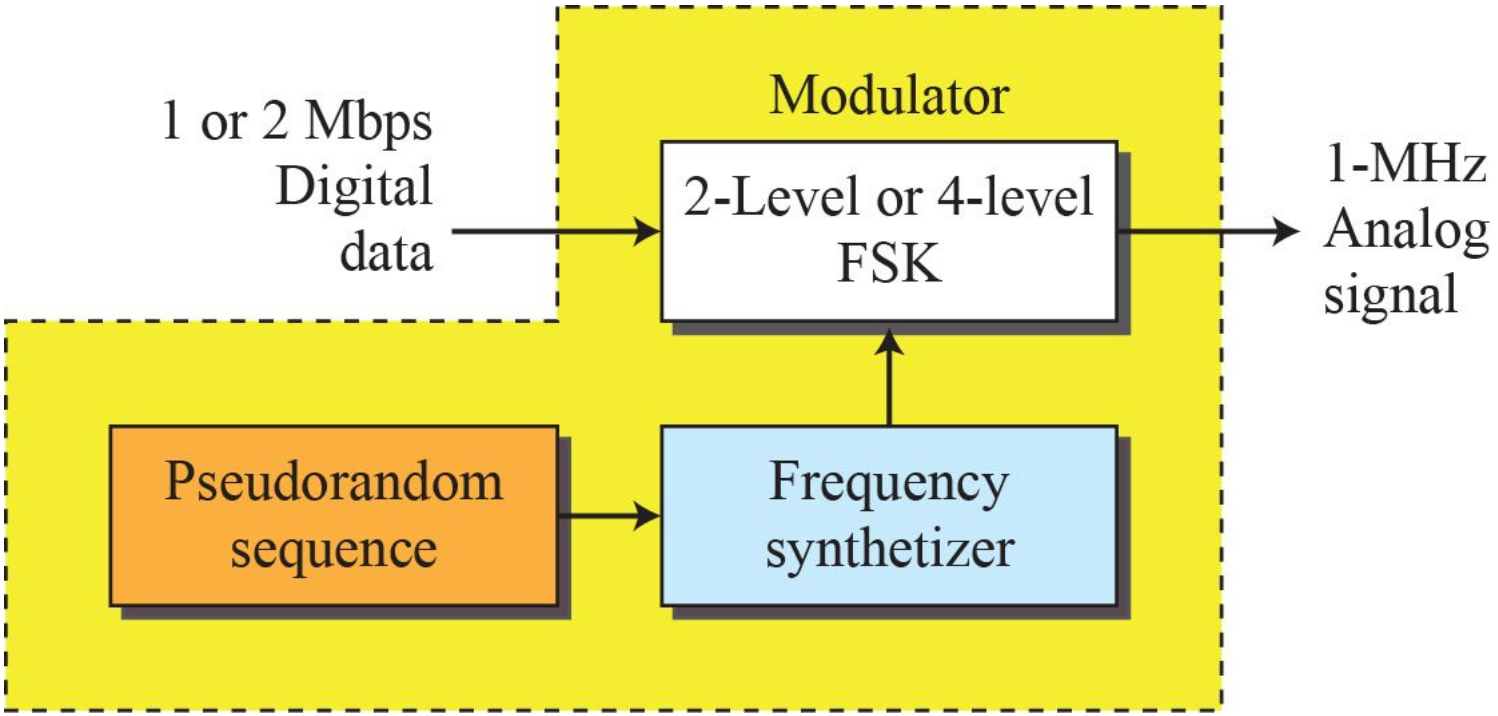


Figure 15.14: Physical layer of IEEE 802.11 DSSS

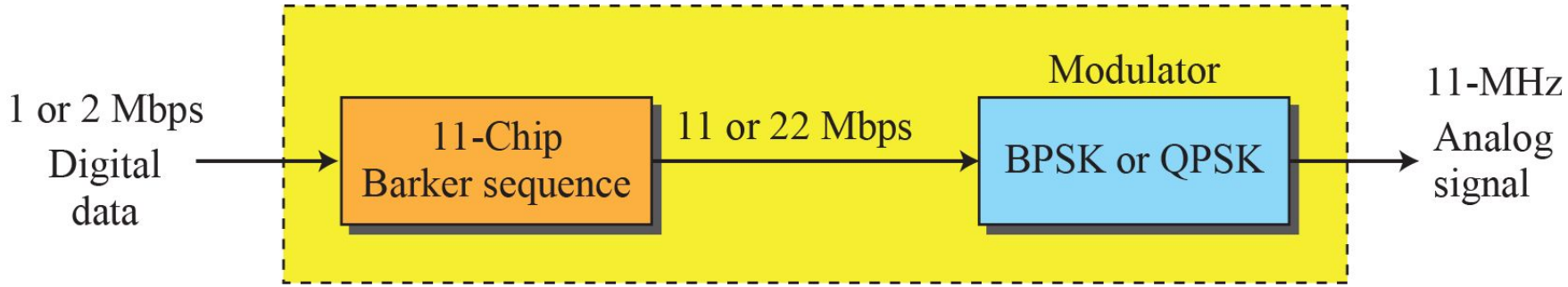


Figure 15.15: Physical layer of IEEE 802.11 infrared

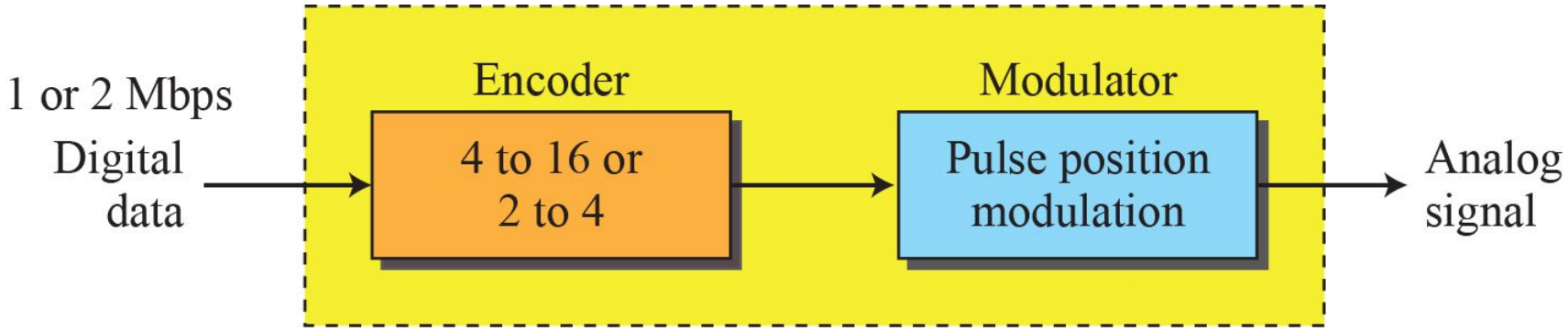
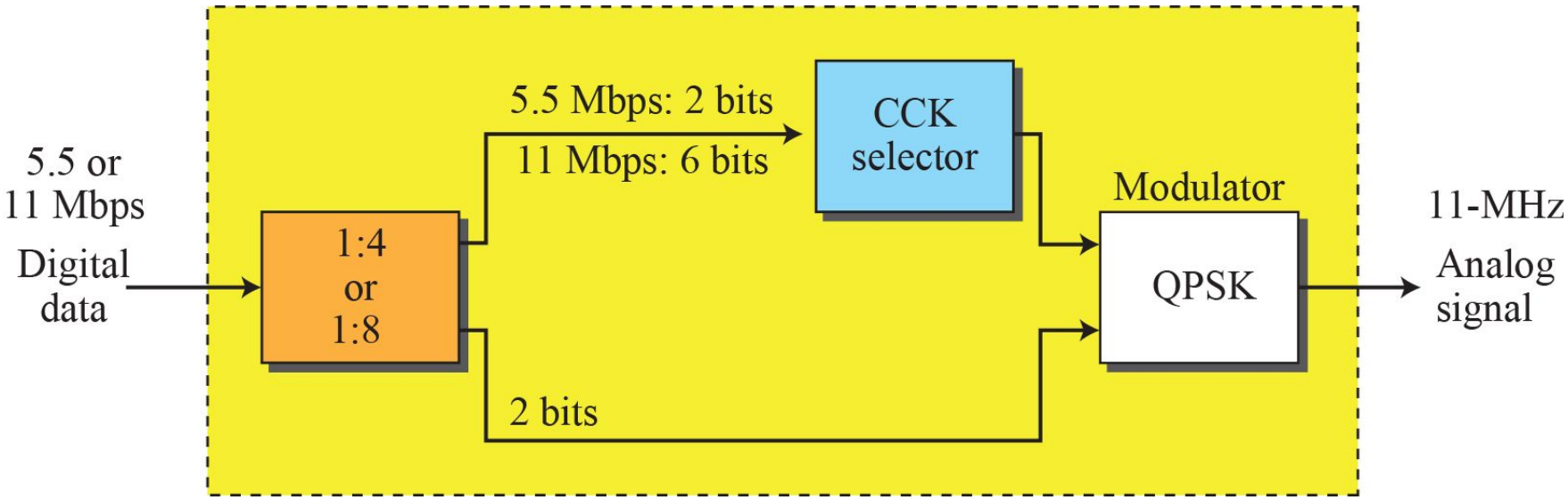


Figure 15.16: ***Physical layer of IEEE 802.11b***



15-3 BLUETOOTH

Bluetooth is a wireless LAN technology designed to connect devices of different functions when they are at a short distance from each other. A Bluetooth LAN is an ad hoc network. The devices, sometimes called gadgets, find each other and make a network called a piconet.

15.3.1 Architecture

Bluetooth defines two types of networks: piconet and scatternet.

Figure 6.17: ***Piconet***

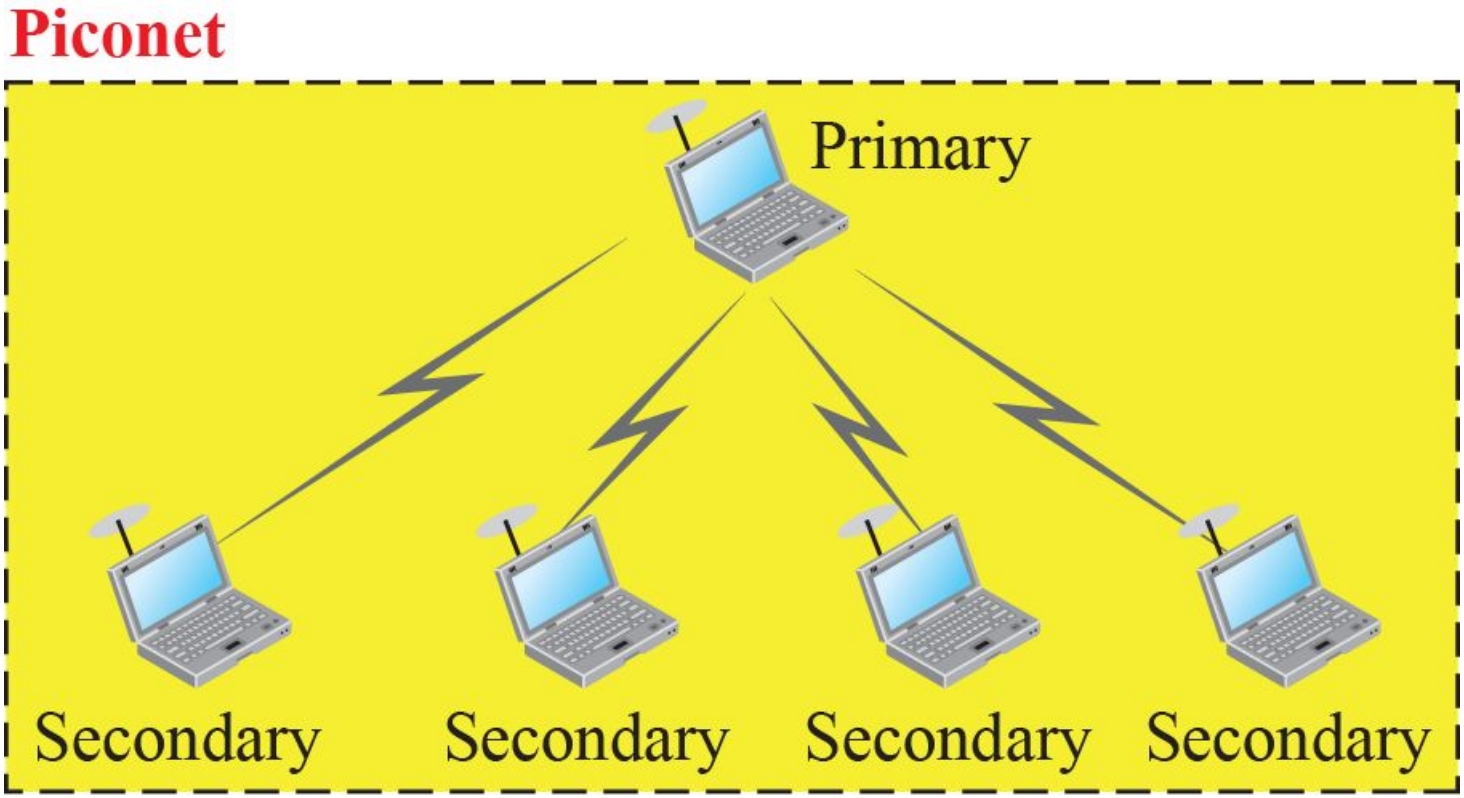
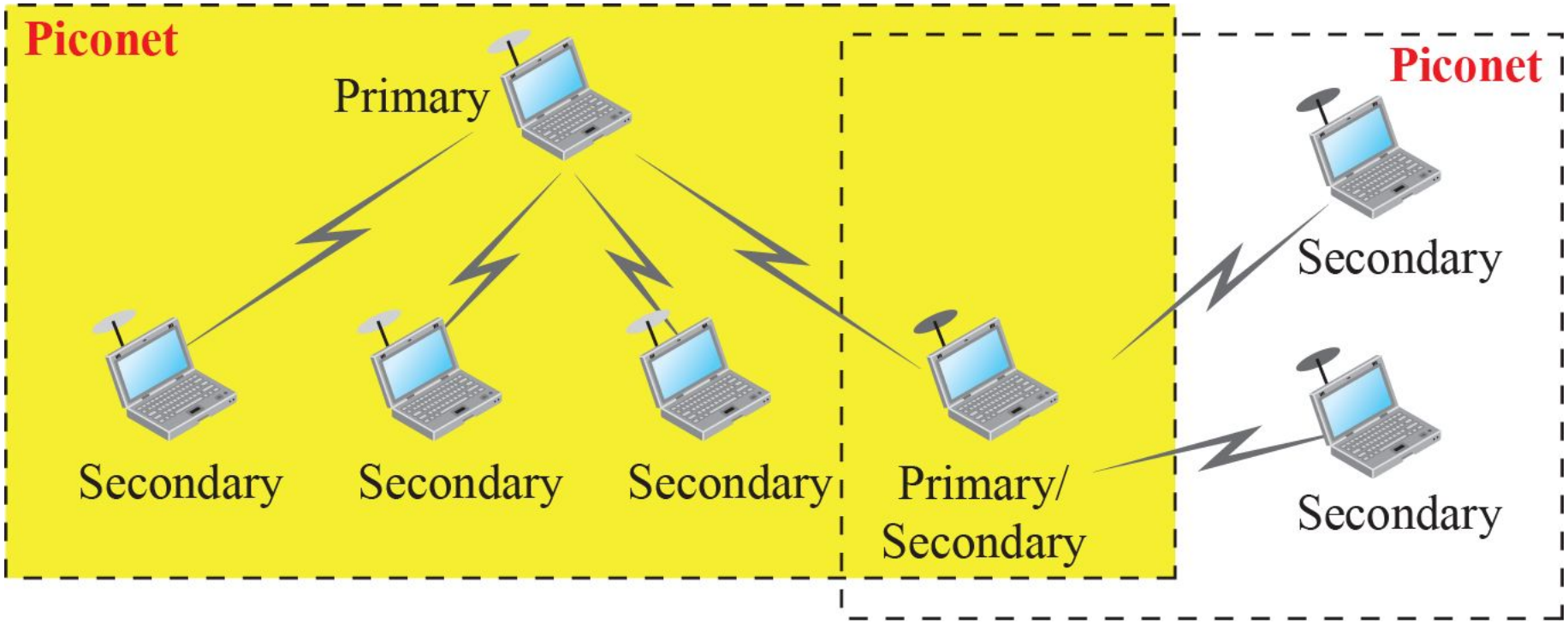


Figure 15.18: ***Scatternet***



15.3.2 Bluetooth Layers

Bluetooth uses several layers that do not exactly match those of the Internet model we have defined in this book. Figure 15.19 shows these layers.

Figure 15.19: ***Bluetooth layers***

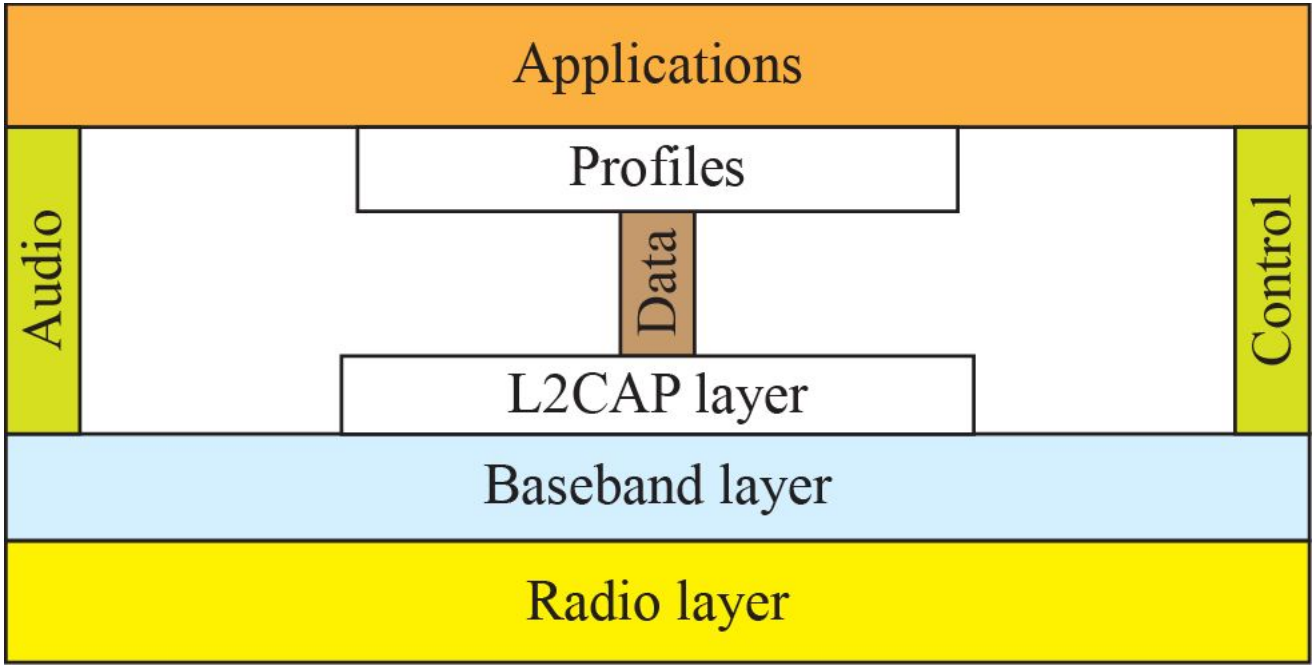


Figure 15.20: L2CAP data packet format

Figure 6.21: Single-secondary communication

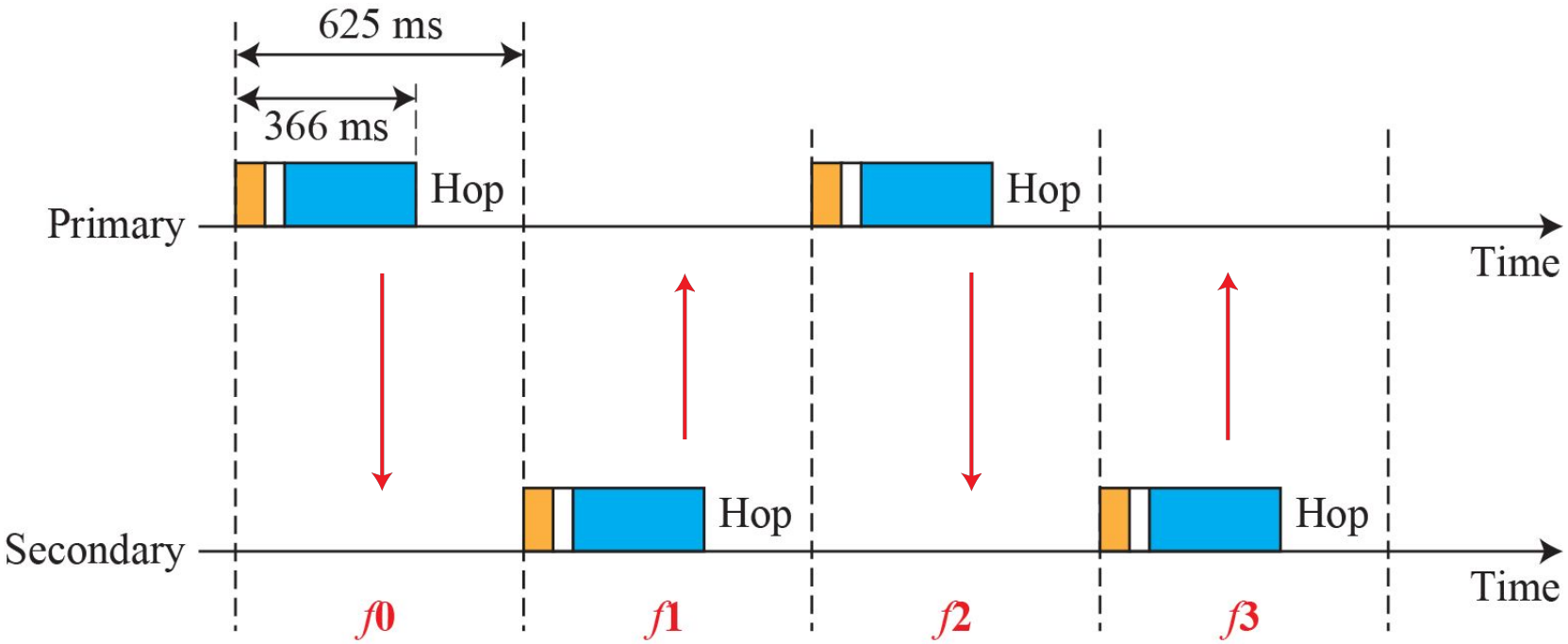


Figure 6.22: Multiple-secondary communication

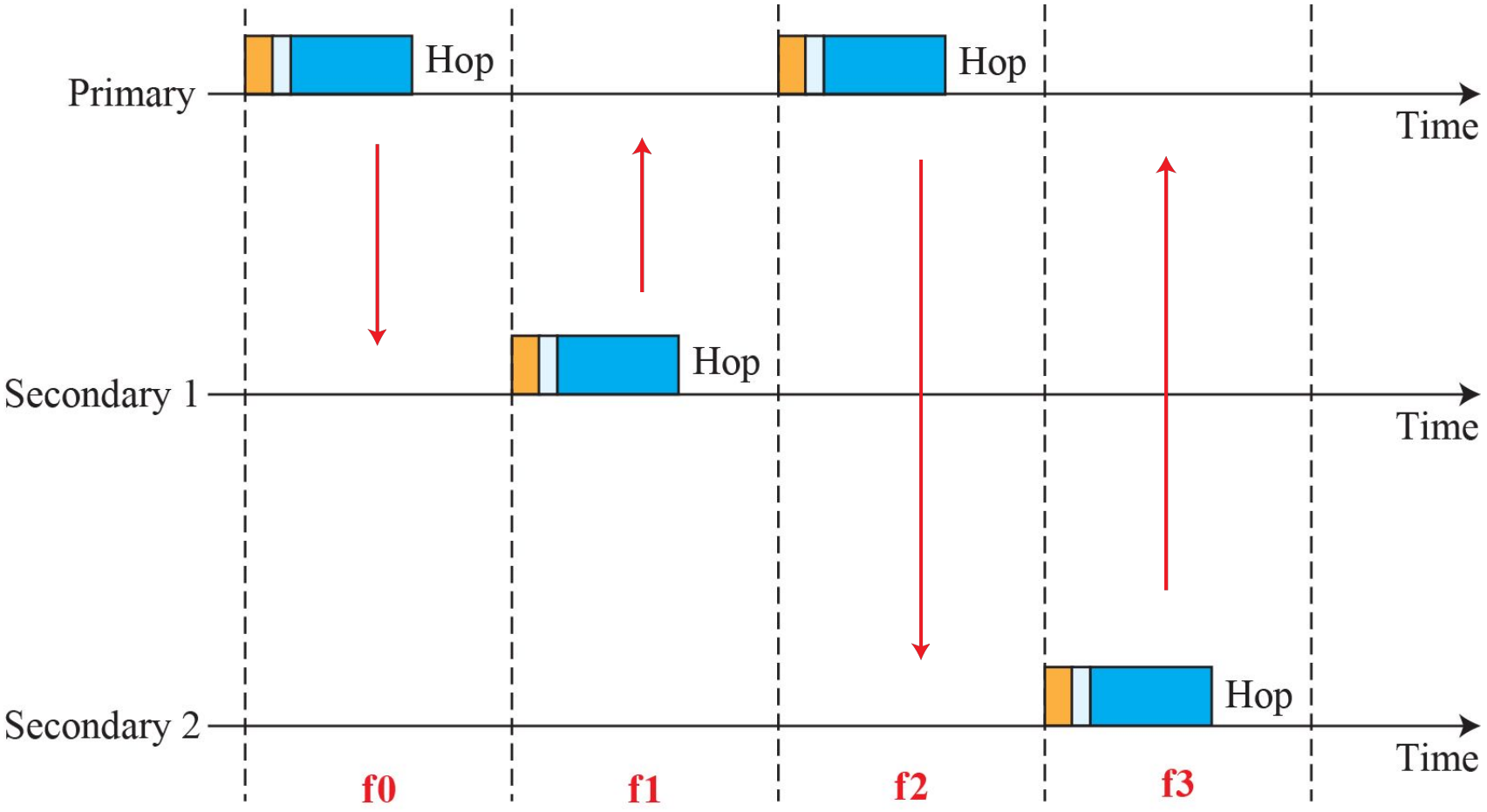
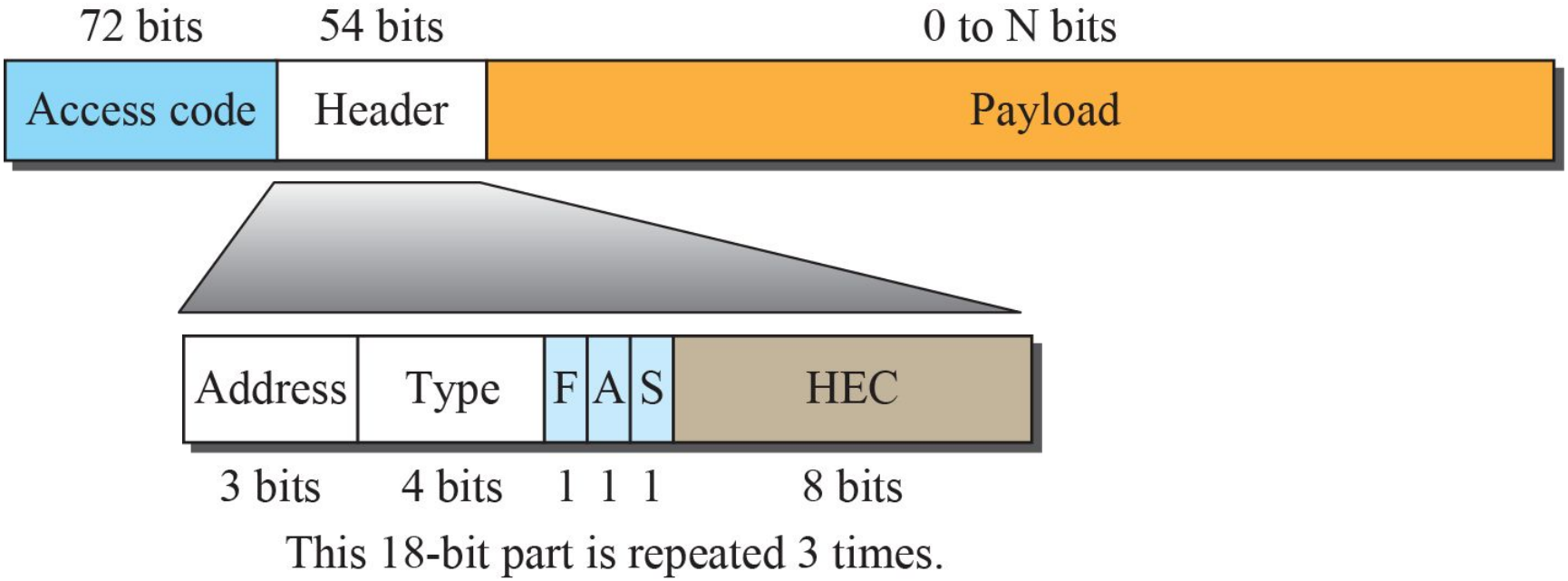


Figure 6.23: Frame format types



N = 240 for 1-slot frame

N = 1490 for 3-slot frame

N = 2740 for 5-slot frame