

Chapter 14

Wireless LANs

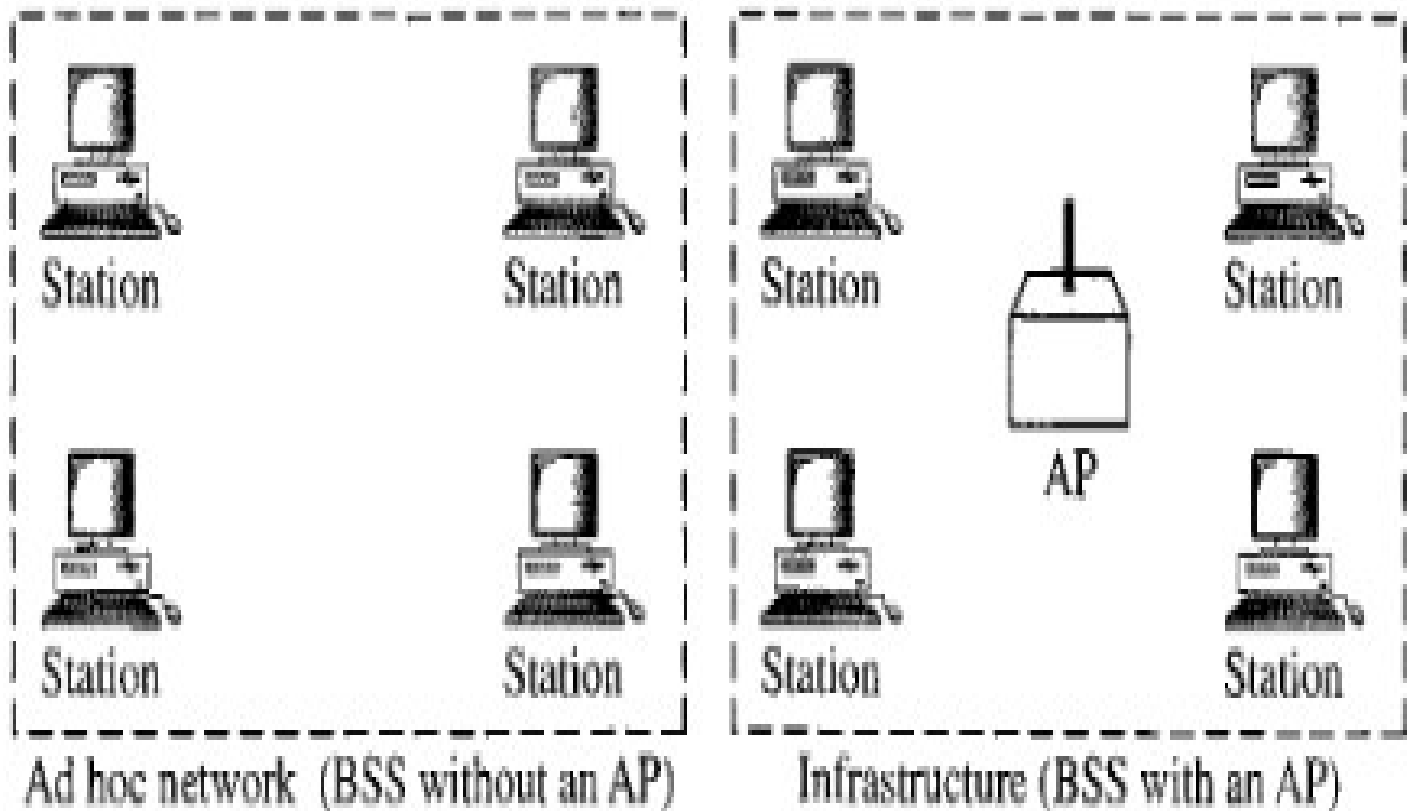
IEEE 802.11

- Basic Services: Basic Service Set (BSS) and the Extended Service Set (ESS)
- BSS – building block of a wireless LAN
 - Made up of stationary or mobile wireless stations and an optional central base station, access point (AP)
 - Ad hoc – BSS without AP
 - Infrastructure – BSS with AP

IEEE 802.11

BSS: Basic service set

AP: Access point



IEEE 802.11

- **ESS** – made up of two or more BSSs with APs; BSS are connected through a **distribution system**, usually a wired LAN
- Mobile or stationary stations

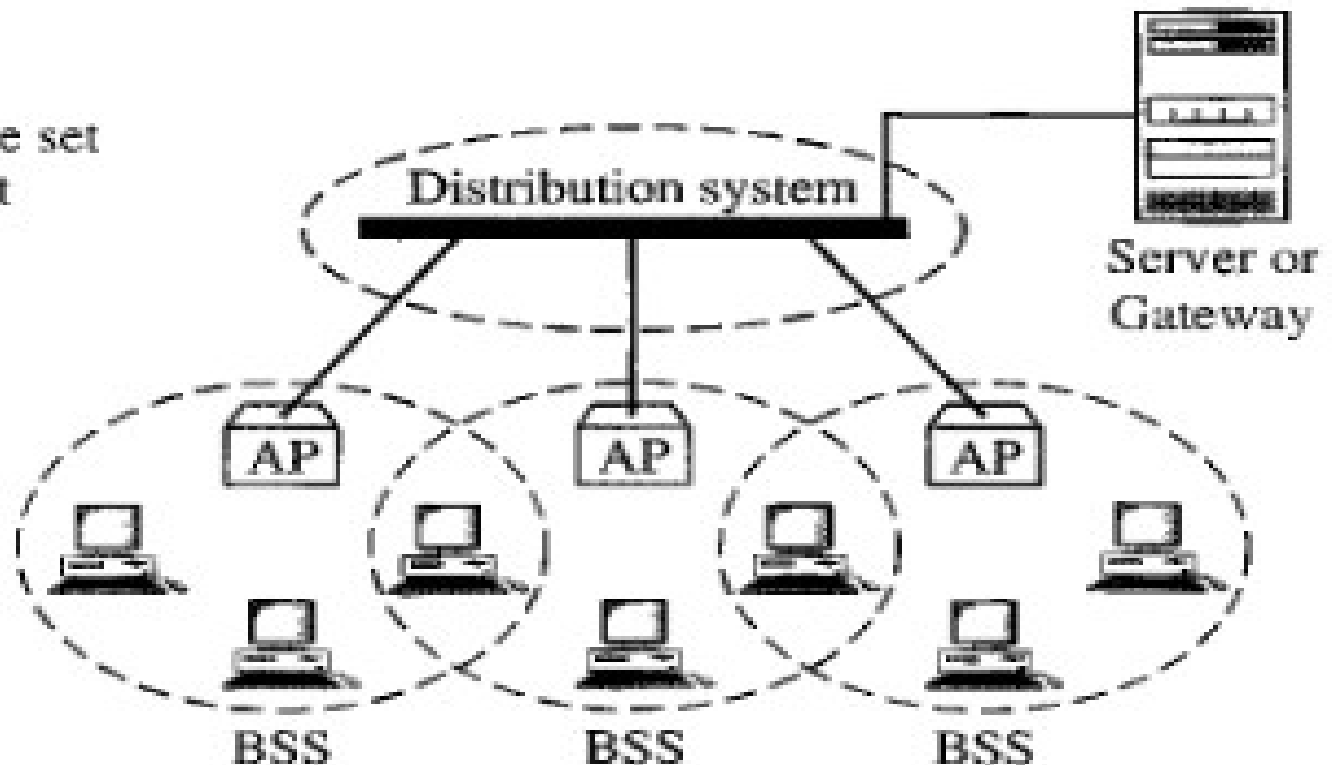
IEEE 802.11

- ESS

ESS: Extended service set

BSS: Basic service set

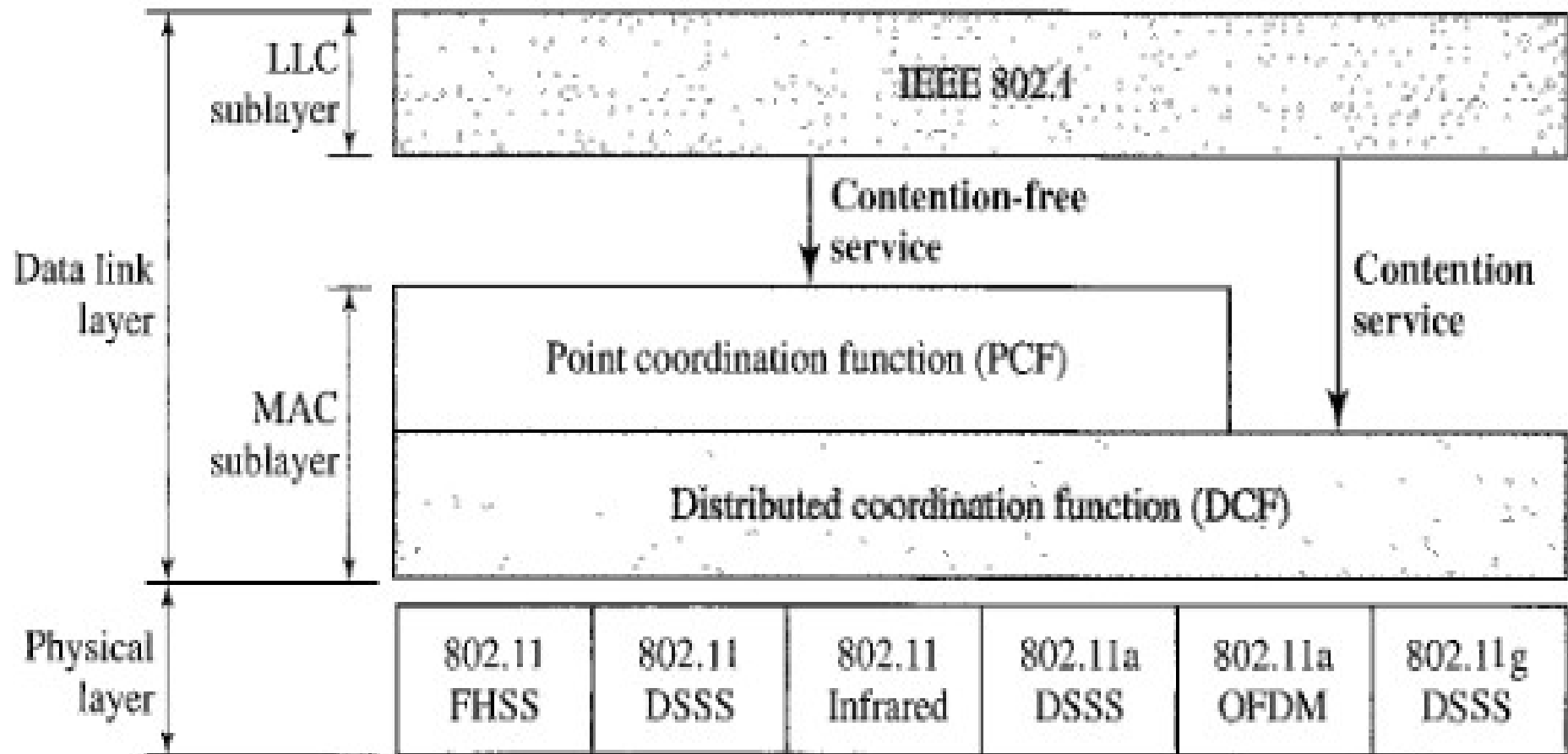
AP: Access point



IEEE 802.11

- Station Types:
 - No-transition – stationary or moving only inside a BSS
 - BSS-transition – station can move from one BSS to another confined inside one ESS
 - ESS-transition mobility – station can move from one ESS to another
- IEEE does not guarantee that communication is continuous

IEEE 802.11 MAC



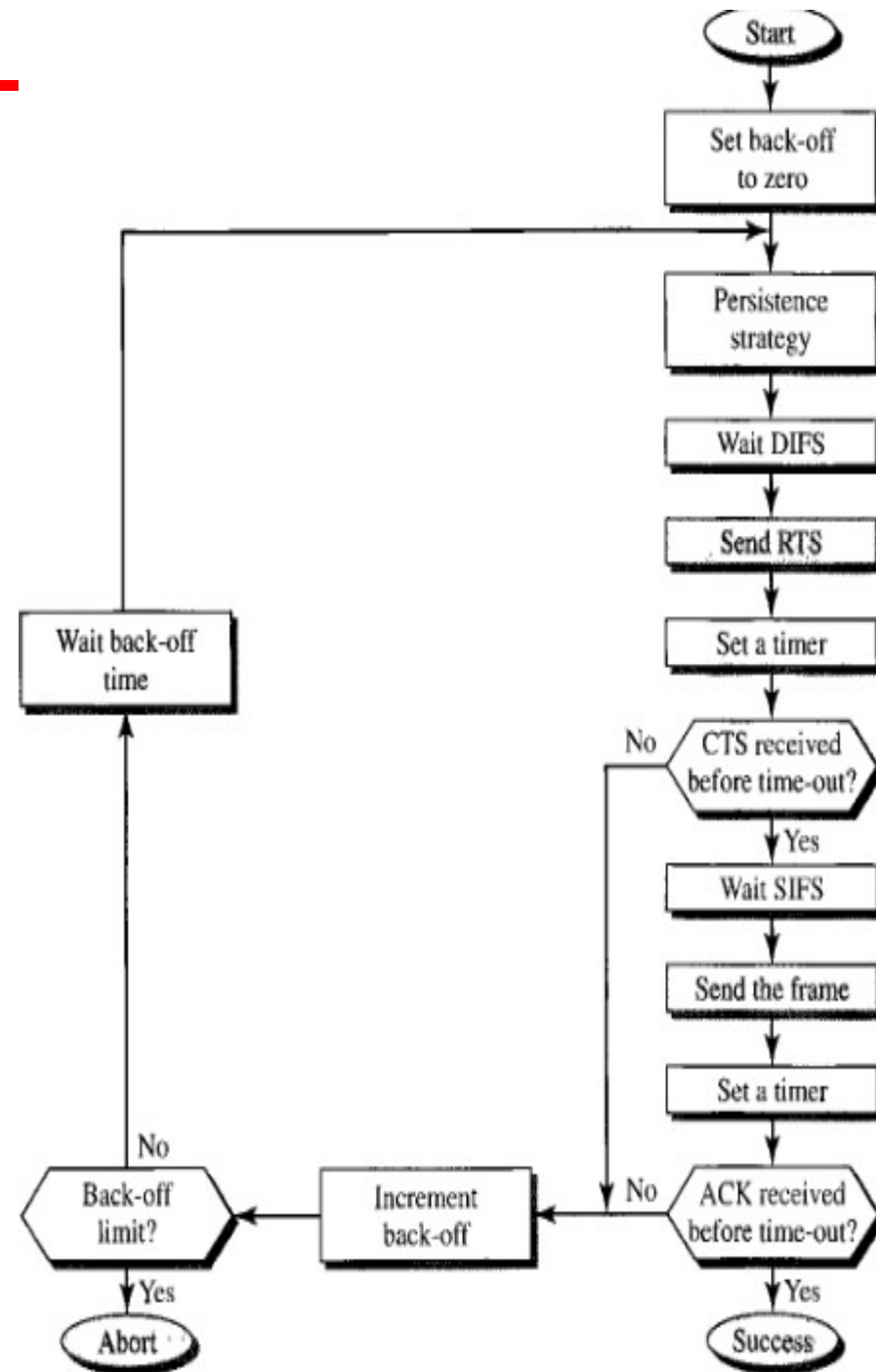
Distributed Coordination Function

- Distributed Coordination Function (DCF)
- Uses CSMA/CA
- Cannot use CSMA/CD because:
 - Station must send and receive at the same time; costly
 - Collision may not be detected because of hidden station problem
 - Distance between stations may be great

Distributed Coordination Function

- Abbreviations
 - **DIFS** – distributed interframe space
 - **RTS** – request to send
 - **SIFS** – short interframe space
 - **CTS** – clear to send

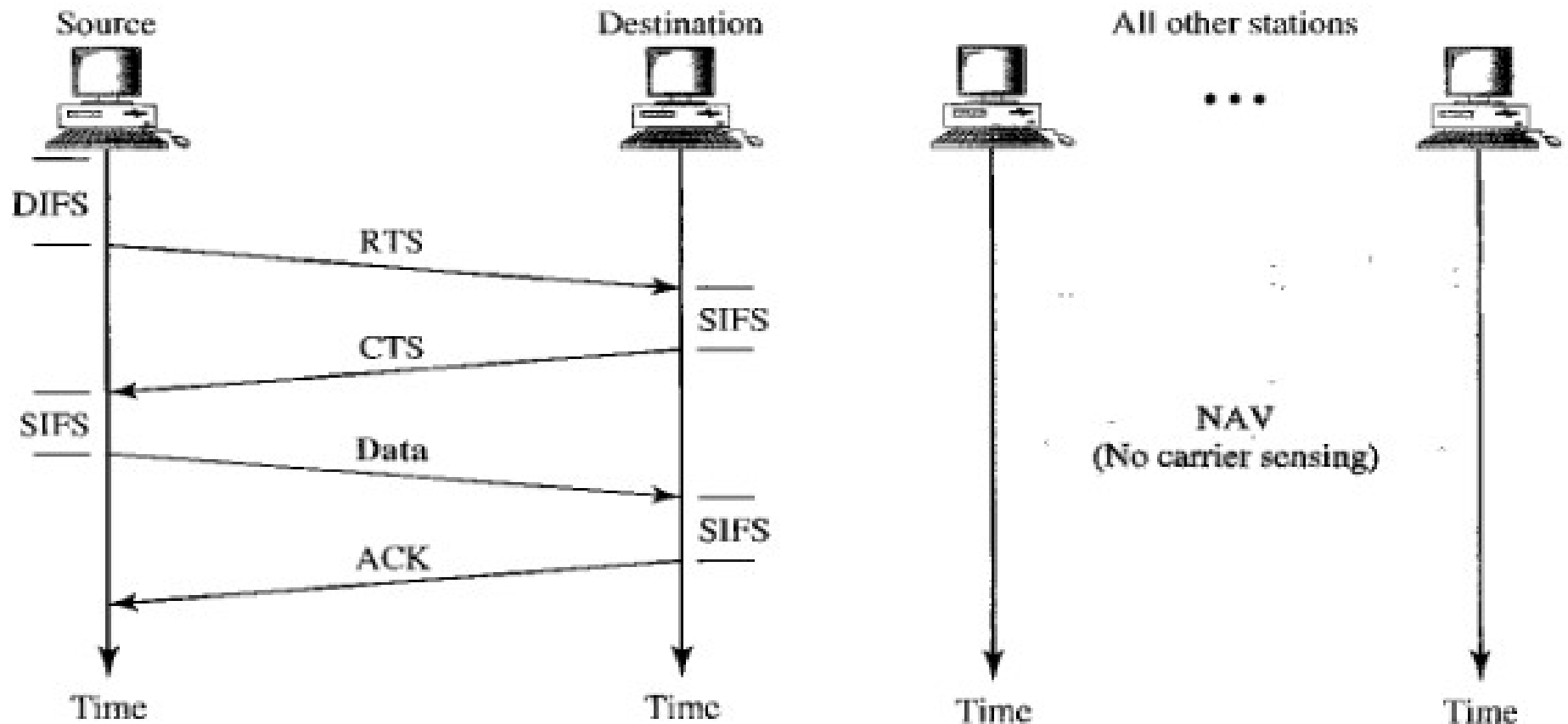
CSMA/CA Flow-chart



Network Allocation Vector

- How other stations defer sending their data if one station acquires access?
 - When a station sends an **RTS** frame, it includes the duration of time it needs to occupy the channel
 - Station affected by the transmission creates a timer called **NAV**
- Each station, before sensing the physical medium to see if it is idle, first checks to see its NAV to see if it has expired
- During handshaking – no **CTS** means collision

CSMA/CA and NAV

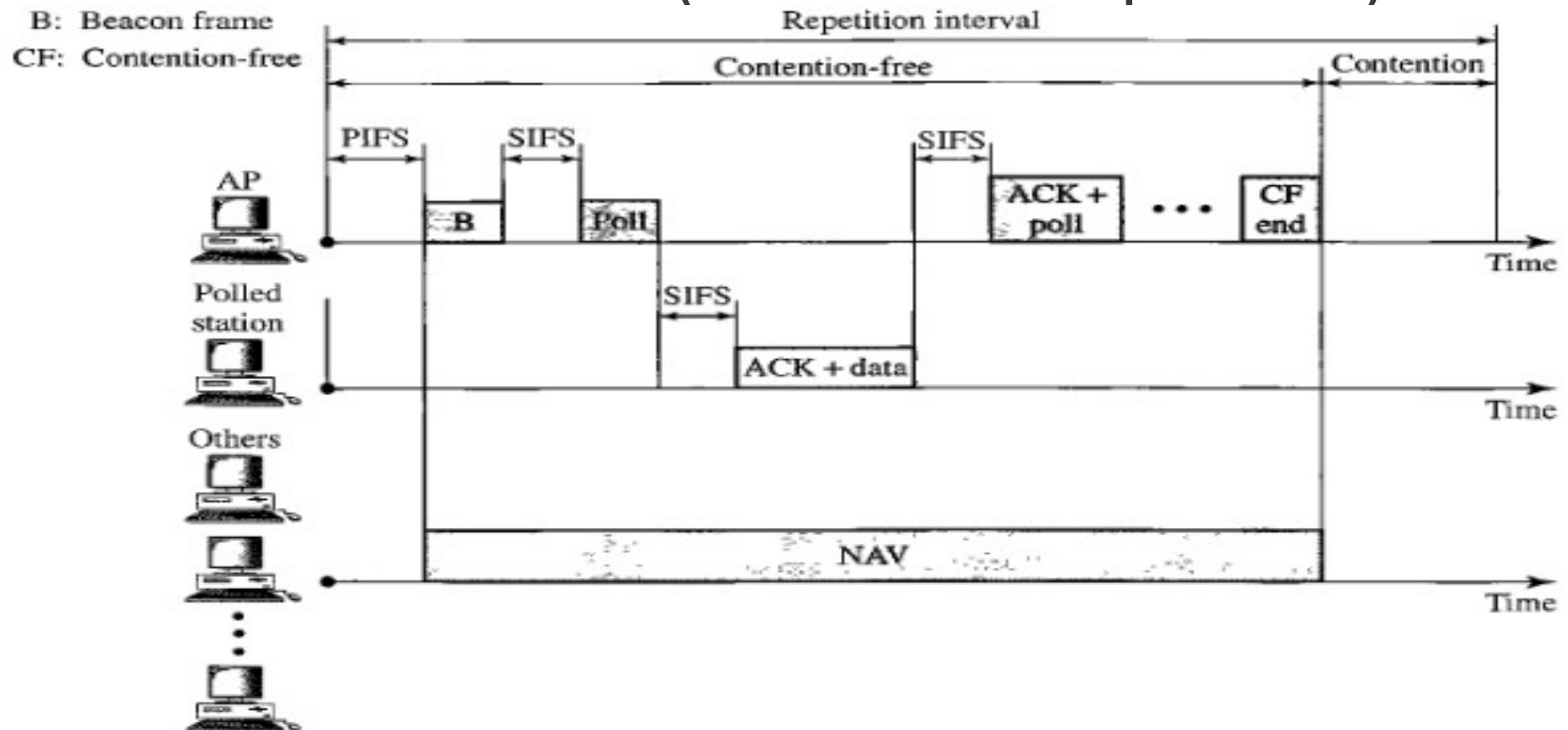


Point Coordination Function

- Optional access method for time-sensitive transmission
- Can be implemented in an infrastructure network only
- Centralized, contention-free polling access method
- **PIFS** and **SIFS**, **PIFS** shorter than DIFS (gives higher priority to PCF over DCF)

Point Coordination Function

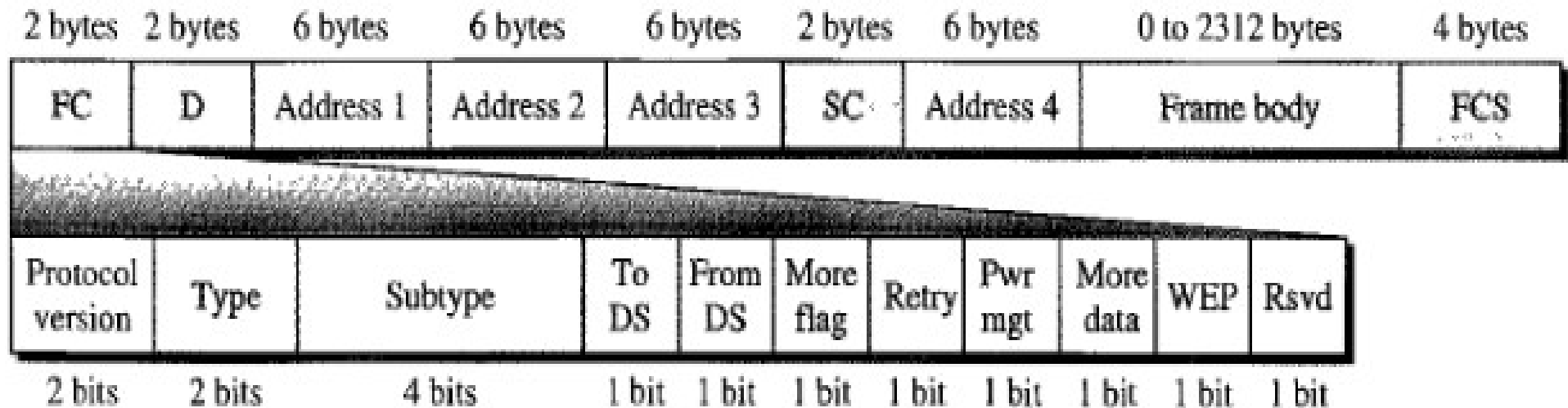
- **Repetition interval** - allow DCF stations to access the medium (when PCF is present)



Fragmentation

- Wireless environment is very noisy
- Corrupted frames must be retransmitted
- More efficient to resend small frames than a large one

Frame Format



Frame Format

- **Frame Control (FC)** – defines the type of frame and some control information

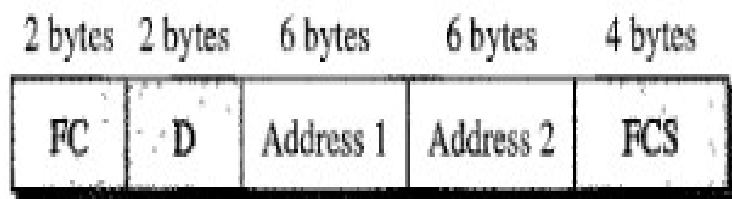
<i>Field</i>	<i>Explanation</i>
Version	Current version is 0
Type	Type of information: management (00), control (01), or data (10)
Subtype	Subtype of each type (see Table 14.2)
To DS	Defined later
From DS	Defined later
More flag	When set to 1, means more fragments
Retry	When set to 1, means retransmitted 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

Frame Format

- **D** – duration of the transmission that is used to set the value of NAV
- **Addresses** – four 6-byte addresses (depends on the value of TO DS and FROM DS)
- **Sequence control** – sequence number of the frame to be used in flow control
- **Frame body** – can be between 0 and 2312 bytes; info depends on the type and subtype in FC
- **FCS** - CRC-32

Frame Types

- **Management Frames** – initial communication
- **Data Frames** - data
- **Control Frames** –accessing the channel and acknowledging frames; type field: 01



RTS



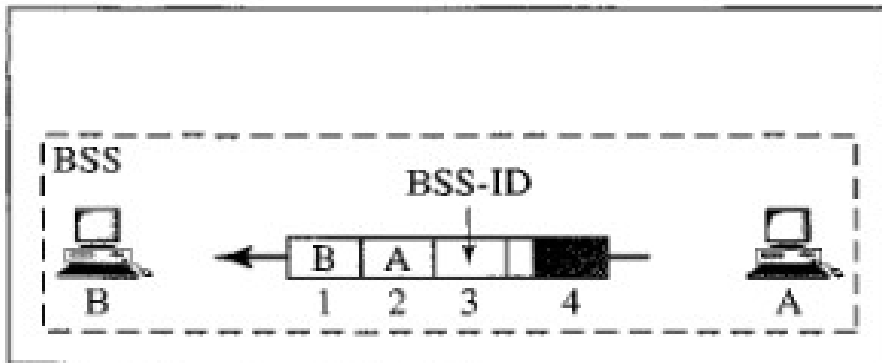
CTS or ACK

<i>Subtype</i>	<i>Meaning</i>
1011	Request to send (RTS)
1100	Clear to send (CTS)
1101	Acknowledgment (ACK)

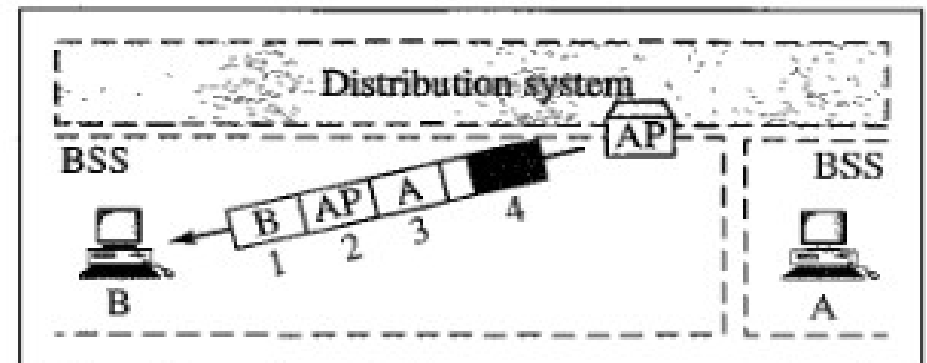
Addressing Mechanisms

<i>To DS</i>	<i>From DS</i>	<i>Address 1</i>	<i>Address 2</i>	<i>Address 3</i>	<i>Address 4</i>
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

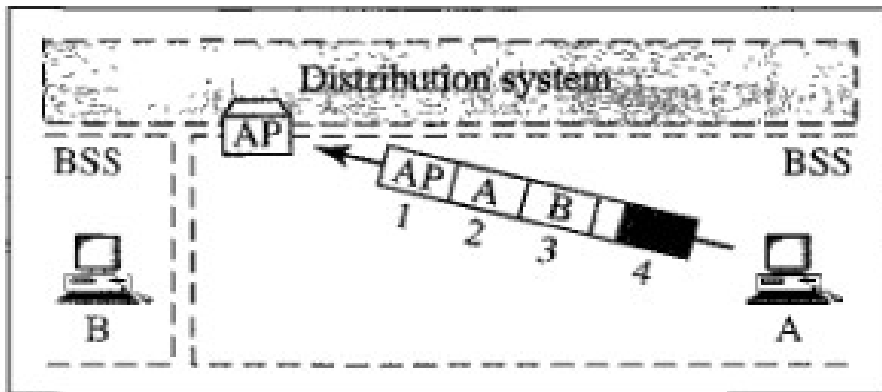
Addressing Mechanisms



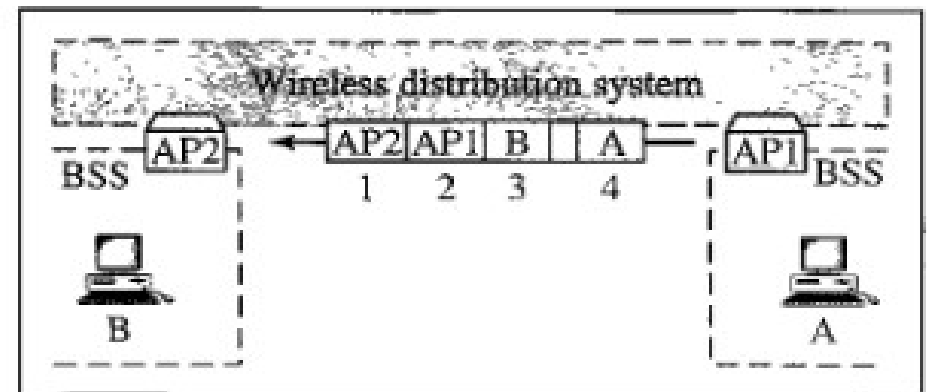
a. Case 1



b. Case 2



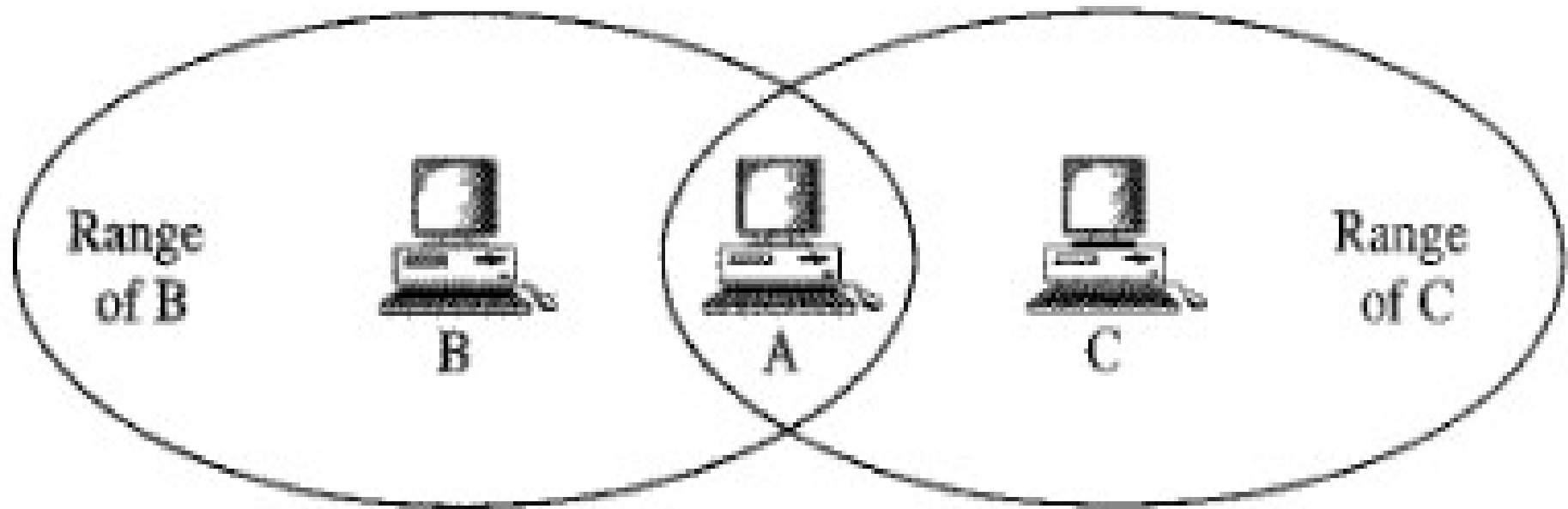
c. Case 3



d. Case 4

Hidden Station Problem

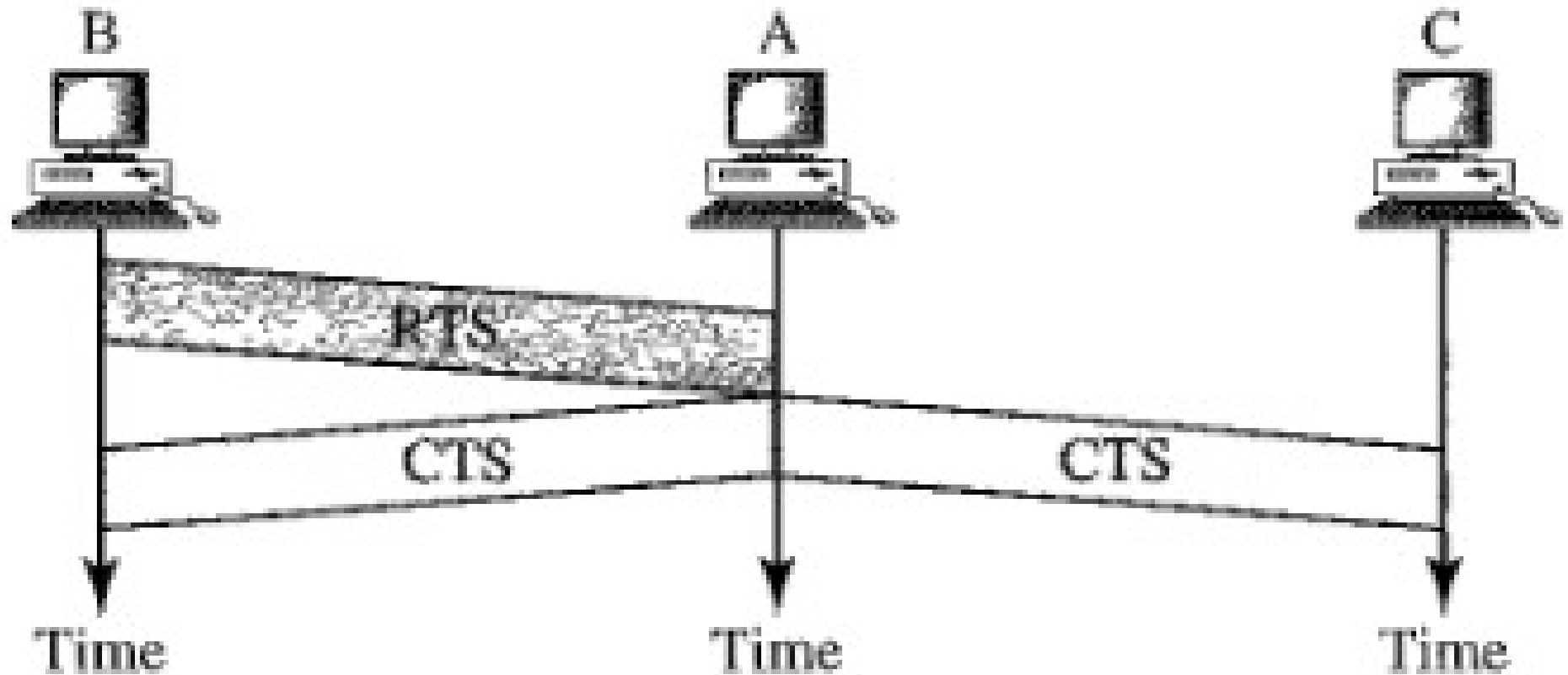
- Can reduce the capacity of the network because of collision



B and C are hidden from each other with respect to A.

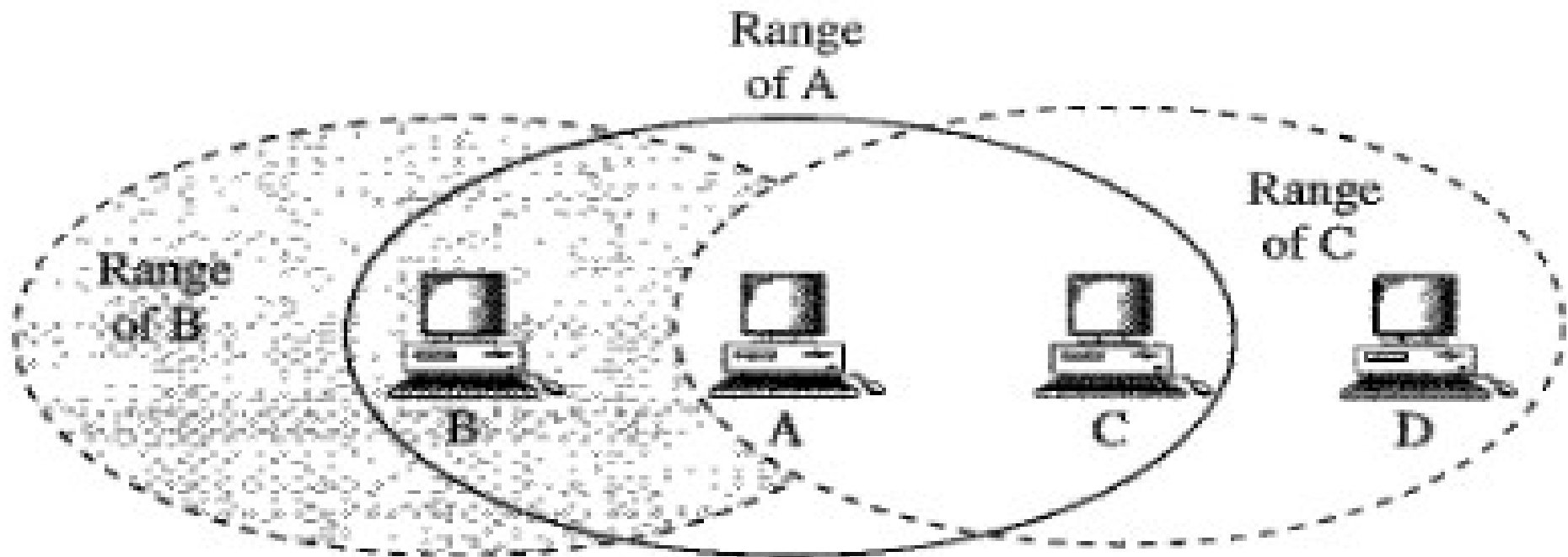
Hidden Station Problem

- Handshaking to solve HSP



Exposed Station Problem

- Station refrains from using the channel even when it is available



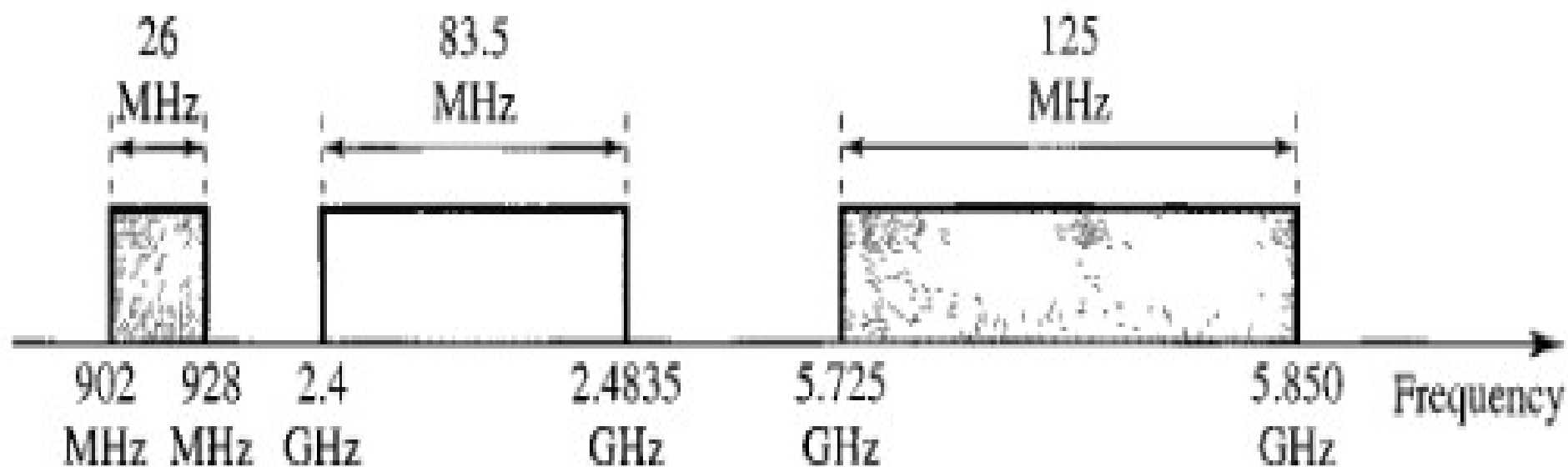
C is exposed to transmission from A to B.

Physical Layer

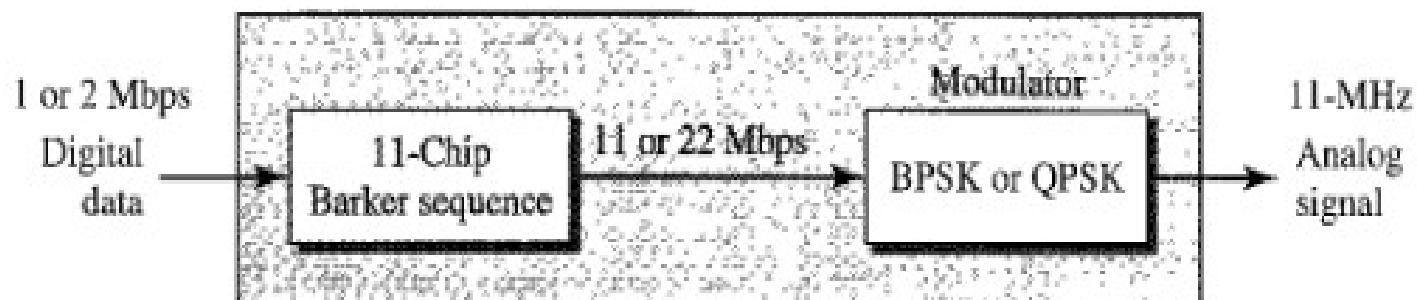
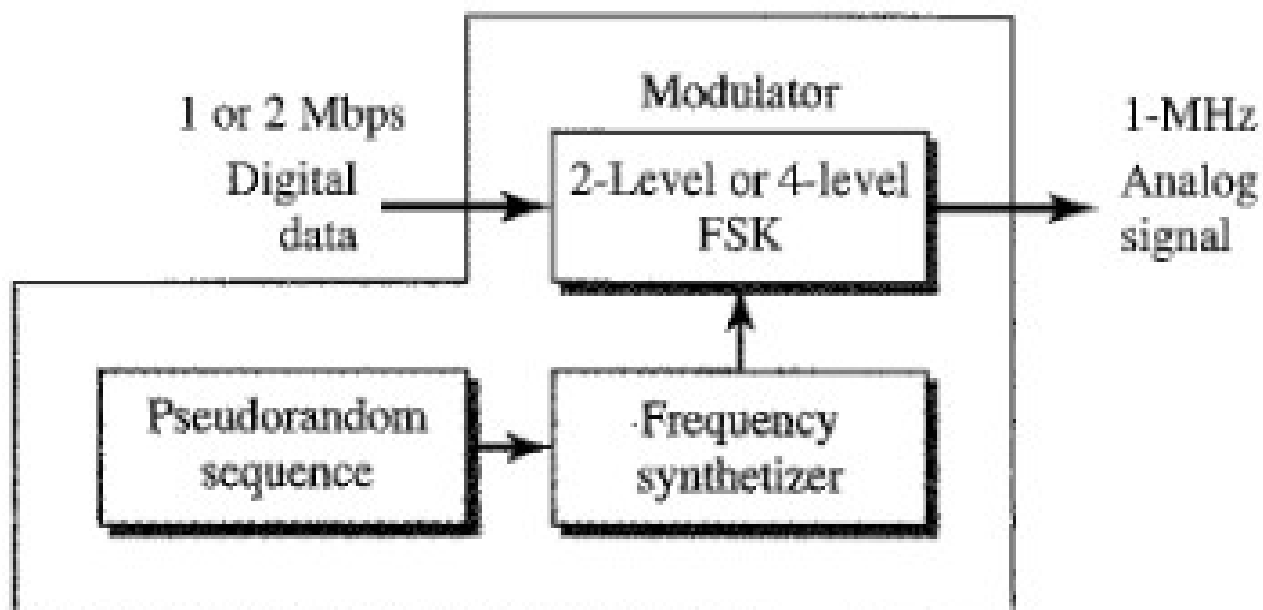
<i>IEEE</i>	<i>Technique</i>	<i>Band</i>	<i>Modulation</i>	<i>Rate (Mbps)</i>
802.11	FHSS	2.4 GHz	FSK	1 and 2
	DSSS	2.4 GHz	PSK	1 and 2
		Infrared	PPM	1 and 2
802.11a	OFDM	5.725 GHz	PSK or QAM	6 to 54
802.11b	DSSS	2.4 GHz	PSK	5.5 and 11
802.11g	OFDM	2.4 GHz	Different	22 and 54

Physical Layer

- ISM band



Physical Layer

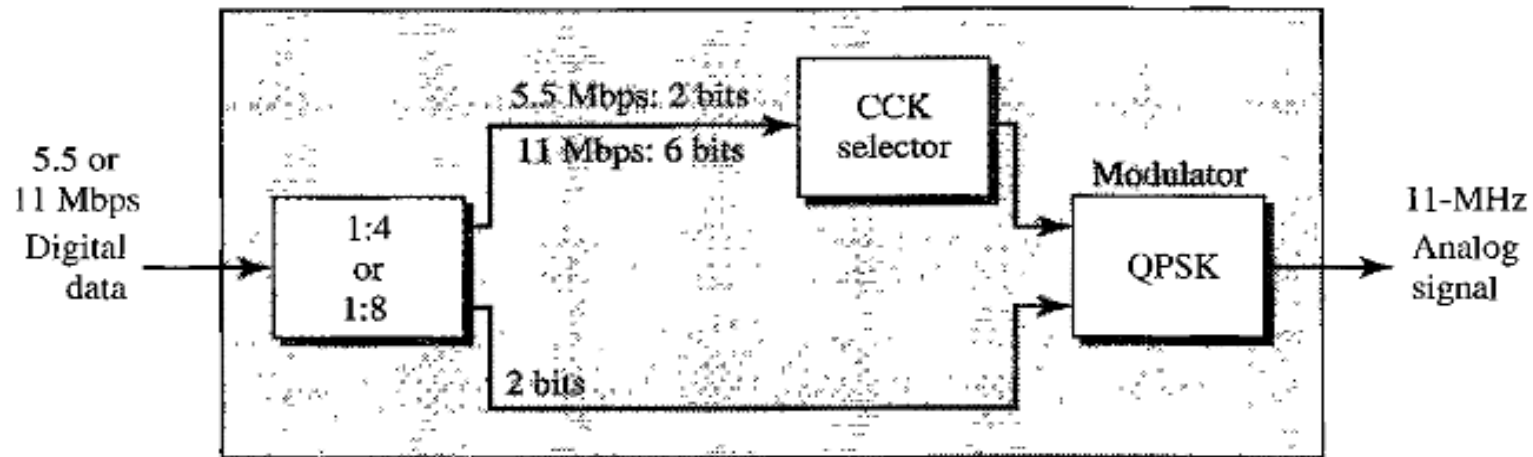


IEEE 802.11a OFDM

- Orthogonal frequency-division multiplexing (OFDM) same as FDM except all sub bands are used by one source at a given time
- Band is divided into 52 subbands with 48 groups of bits at a time and 4 subbands for control information
- Uses PSK (18 Mbps) and QAM (54 Mbps)

IEEE 802.11b DSSS

- High-rate direct sequence spread spectrum (HR-DSSS)
- 2.4-GHz ISM
- Uses complementary code keying (CCK)
- Encode 4 or 8 bits to one CCK symbol



IEEE 802.11g

- OFDM
- 2.4-GHz ISM band
- 22- or 54-Mbps data rate

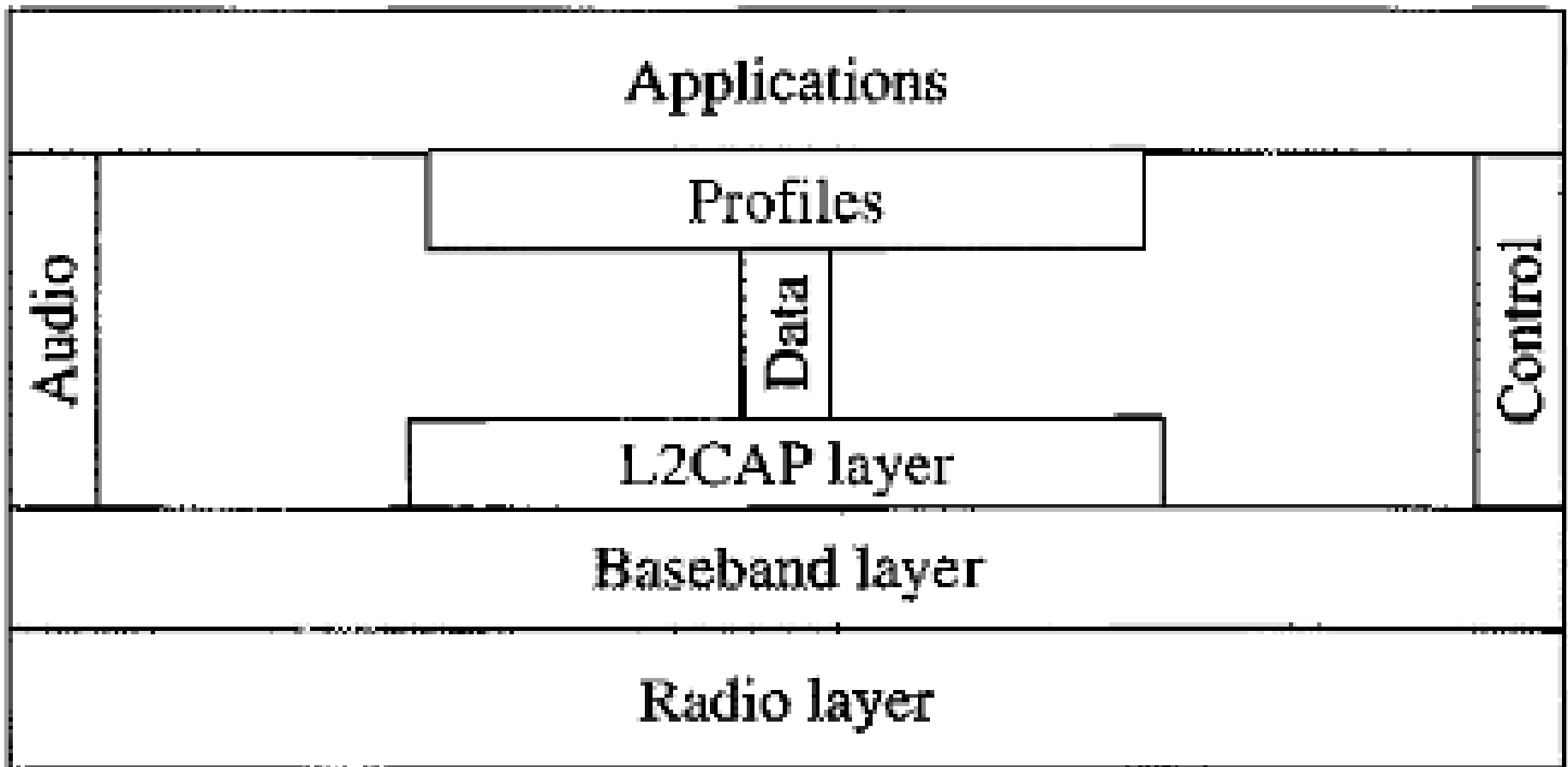
Bluetooth

- Wireless LAN technology designed to connect devices of different functions such as telephones, notebooks, computers (desktop and laptop), cameras, etc.
- An ad hoc network - **piconet**
- Network cannot be large
- Started as a project by the Ericsson Company
- From the word “Blaatand”

Bluetooth

- Piconet
 - May have up to 8 nodes; one primary others secondary
- Scatternet
 - Combination of Piconets
 - A secondary station in one piconet can be the primary in another
 - A station can be a member of two piconets
- Current data rate of 1Mbps with 2.4 GHz bandwidth – can cause interference with 802.11b

Layers



Radio Layer

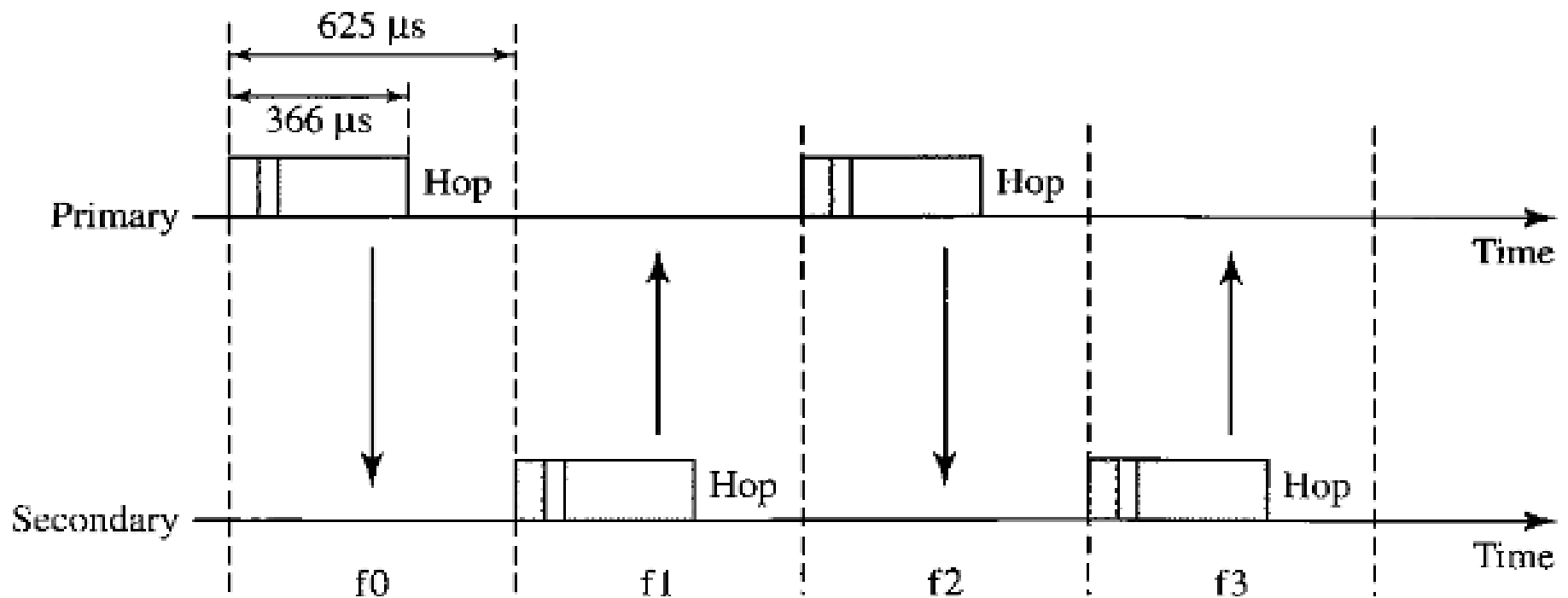
- Equivalent to the physical layer
- Range of 10m
- 2.4-GHz ISM band divided into 79 channels of 1 MHz each
- FHSS – hops 1600 times per second
- Uses Gaussian FSK for modulation

Baseband Layer

- Equivalent to the MAC sublayer
- Uses Time-Division Duplex TDMA
- Communication is between primary and secondaries only
- If there is one secondary, time slot is divided into 625 micro seconds with the primary using even-numbered slots and secondary using odd-numbered slots

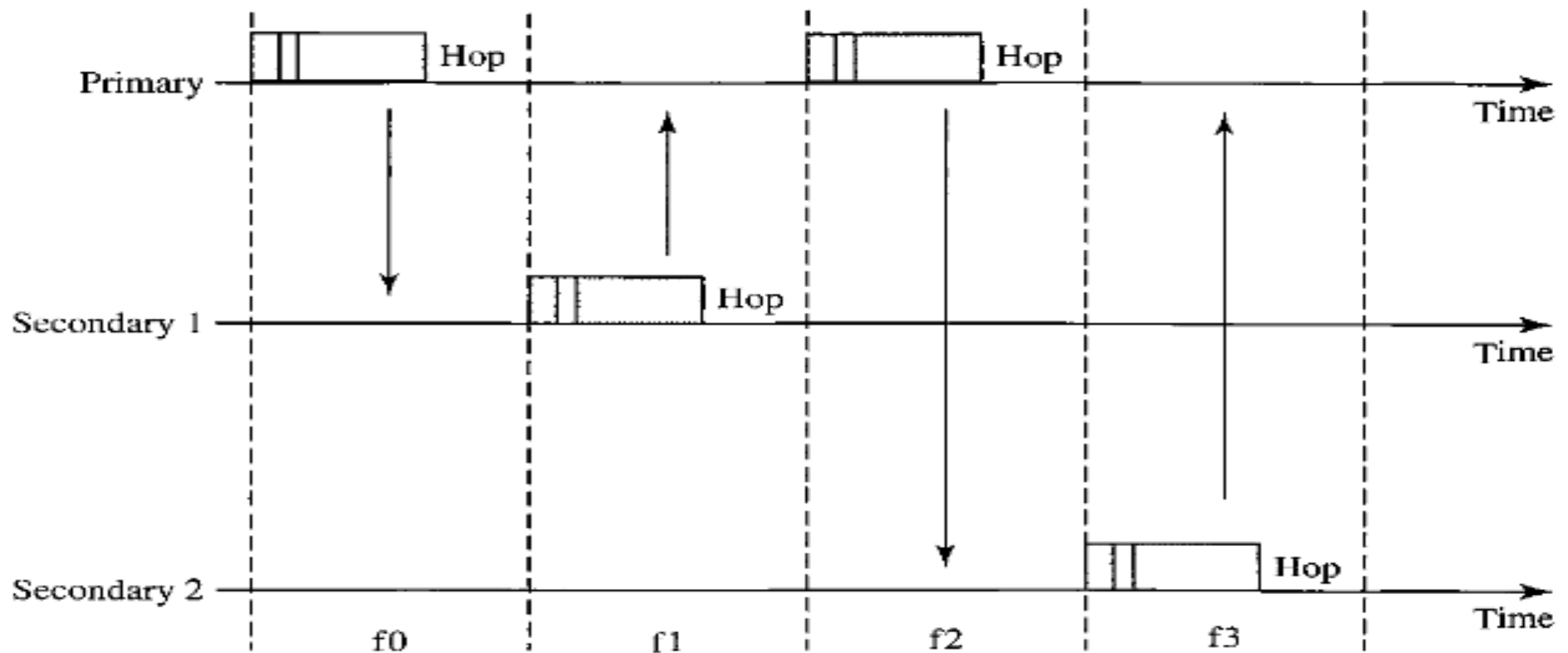
Baseband Layer

- Single secondary communication; primary uses even numbered slots



Baseband Layer

- Multiple-secondary communication; similar to poll/select with reservations



Physical Links

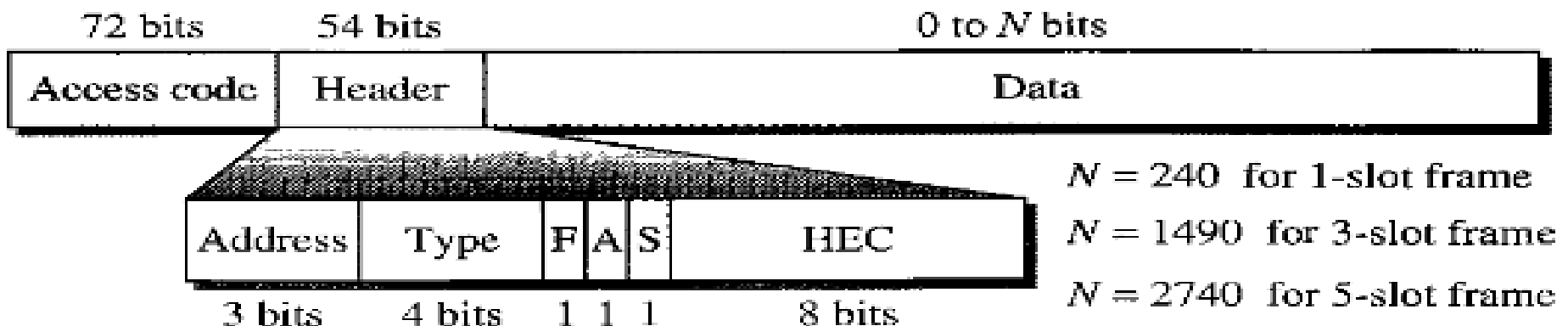
- **Synchronous connection-oriented (SCO)** – used when avoiding latency is more important than integrity; no retransmission
 - Reserves two slots at regular intervals
 - Used in real-time audio
- **Asynchronous connectionless link (ACL)** – used when data integrity is more important than latency; with retransmission

Frame Format (Baseband Layer)

- Three types: one-slot, three-slot, five-slot
- A slot is 625 microseconds
- **One-slot**: with 1-MHz bandwidth and 1 bit/Hz, size is 366 bits
- **Three-slot**: size is 1616 bits
- **Five-slot**: size is 2866 bits

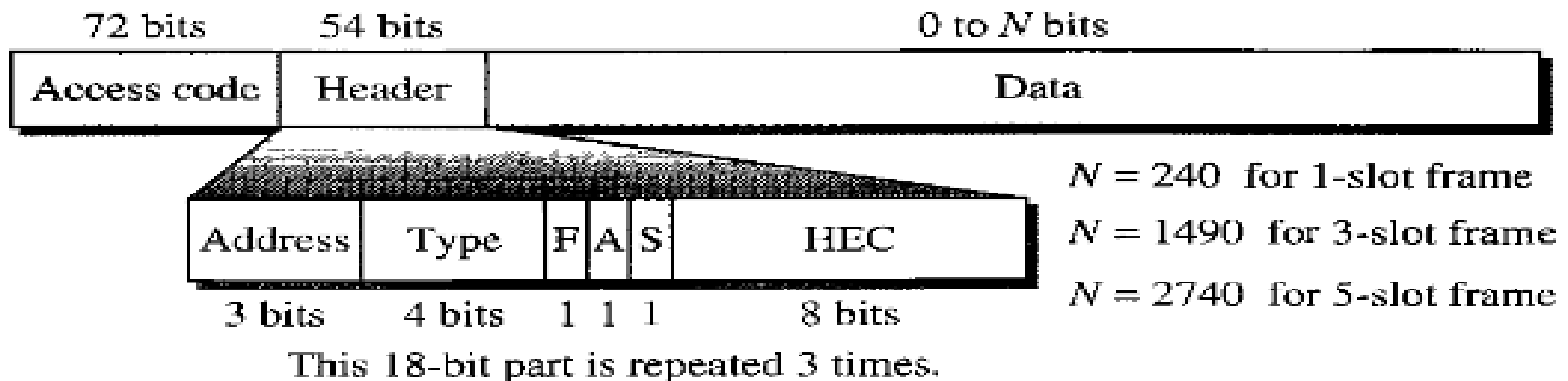
Frame Format

- **Access code** – 72-bits; sync bits; primary id
- **Header** – 54 bits in a repeated 18-bit pattern
 - **Address** – secondaries id
 - **Type** – type of data
 - **F** – flow control, **A** – ACK, **S** – seq #, **HEC** – checksum



Frame Format (Baseband Layer)

- **Payload** – 0 to 2740 bits



L2CAP

- Logical Link Control and Adaptation Protocol (L2CAP)
- Used for exchange in ACL link
- Allows multiplexing, segmentation and reassembly, QoS, and Group Management



Enjoy! :)