Wireless LANs

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IEEE 802.11

IEEE has defined the specifications for a wireless LAN, called IEEE 802.11, which covers the physical and data link layers.

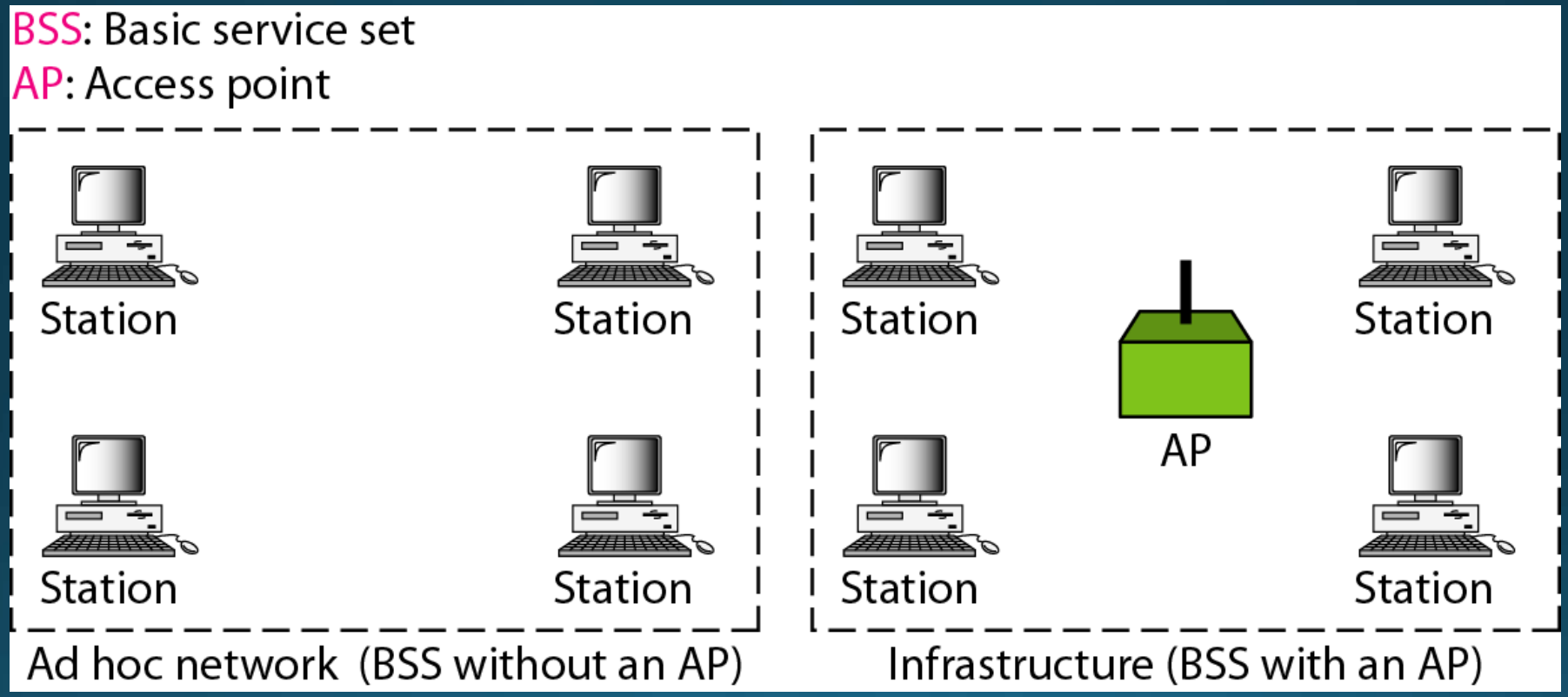
IEEE 802.x

- IEEE 802.1 Higher layer LAN protocols
- IEEE 802.2 Logical link control
- IEEE 802.3 Ethernet
- IEEE 802.4 Token bus
- IEEE 802.5 Token Ring
- IEEE 802.6 Metropolitan Area Networks
- IEEE 802.7 Broadband LAN using Coaxial Cable
- IEEE 802.8 Fiber Optic TAG (disbanded)
- IEEE 802.9 Integrated Services LAN
- IEEE 802.10 Interoperable LAN Security
- IEEE 802.11 Wireless LAN (Wi-Fi)
- IEEE 802.12 demand priority
- IEEE 802.13 (not used)

IEEE 802.x

IEEE 802.14	Cable modems
IEEE 802.15	Wireless PAN
IEEE 802.15.1	(Bluetooth)
IEEE 802.15.4	(ZigBee)
IEEE 802.16	Broadband Wireless Access (WiMAX)
IEEE 802.16e	(Mobile) Broadband Wireless Access
IEEE 802.17	Resilient packet ring
IEEE 802.18	Radio Regulatory TAG
IEEE 802.19	Coexistence TAG
IEEE 802.20	Mobile Broadband Wireless Access
IEEE 802.21	Media Independent Handoff
IEEE 802.22	Wireless Regional Area Network

Basic service sets (BSSs)



Note

A BSS without an AP is called an ad hoc network;
a BSS with an AP is called an infrastructure network.

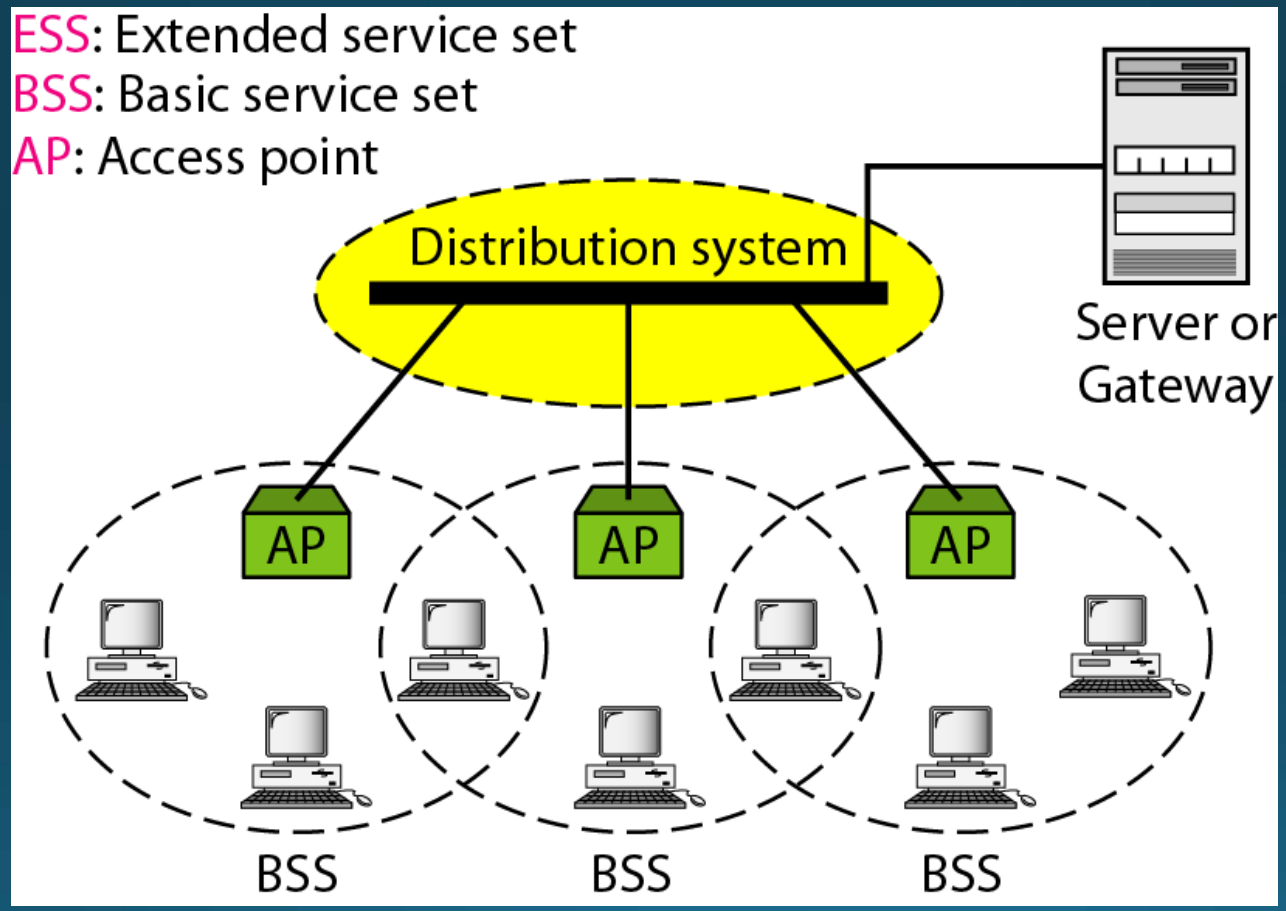
Wireless Benefits

- Limited installation time
- Solving wire problems
  - No connector
    - No maintenance
- Reconfiguration
- Flexibility of operation with in the radio coverage
- No previous planning required
- Allows design of small independent networks
- Robustness , can survive disasters like earth quakes

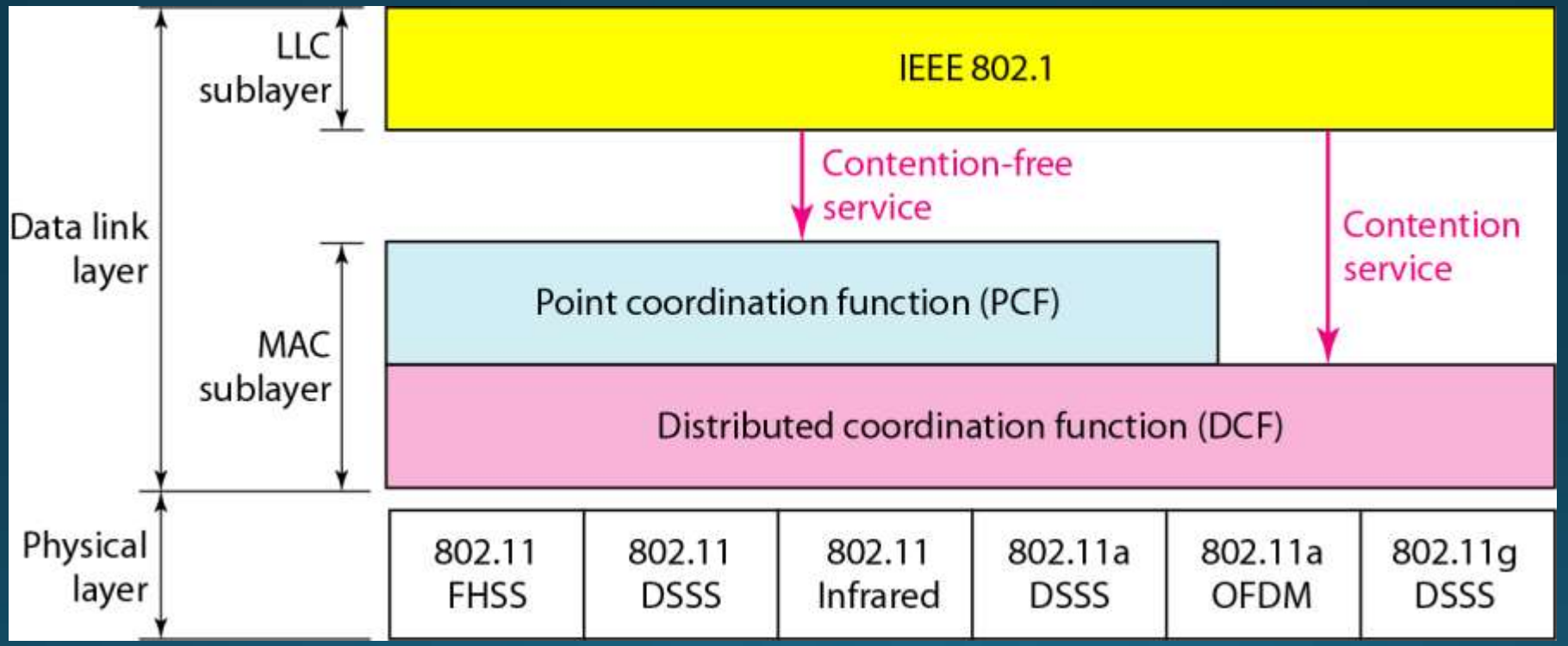
Wireless Disadvantages

- Low Quality of Service (10^{-4}), High delay
- Cost
- Proprietary Solutions
- Restrictions
- Safety and security

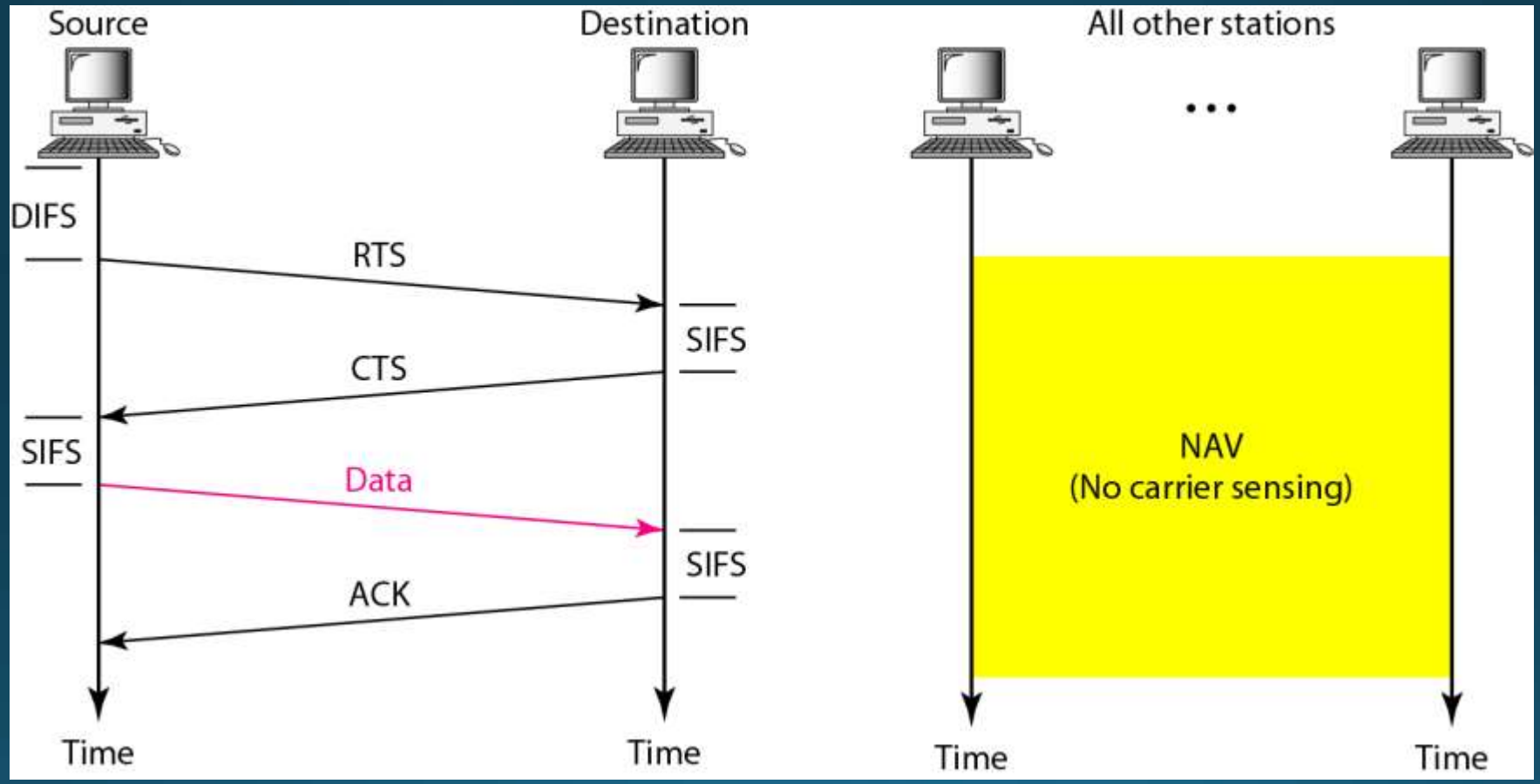
Extended service sets (ESSs)



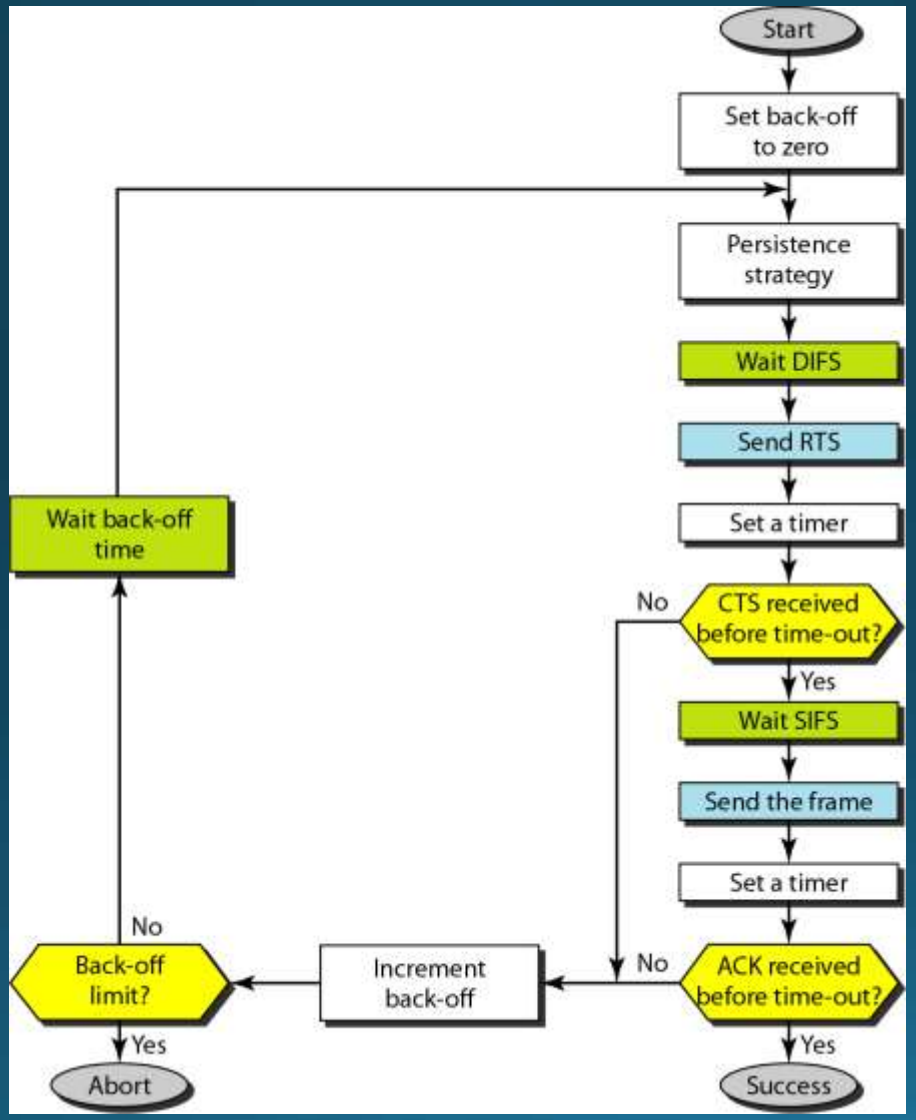
MAC layers in IEEE 802.11 standard



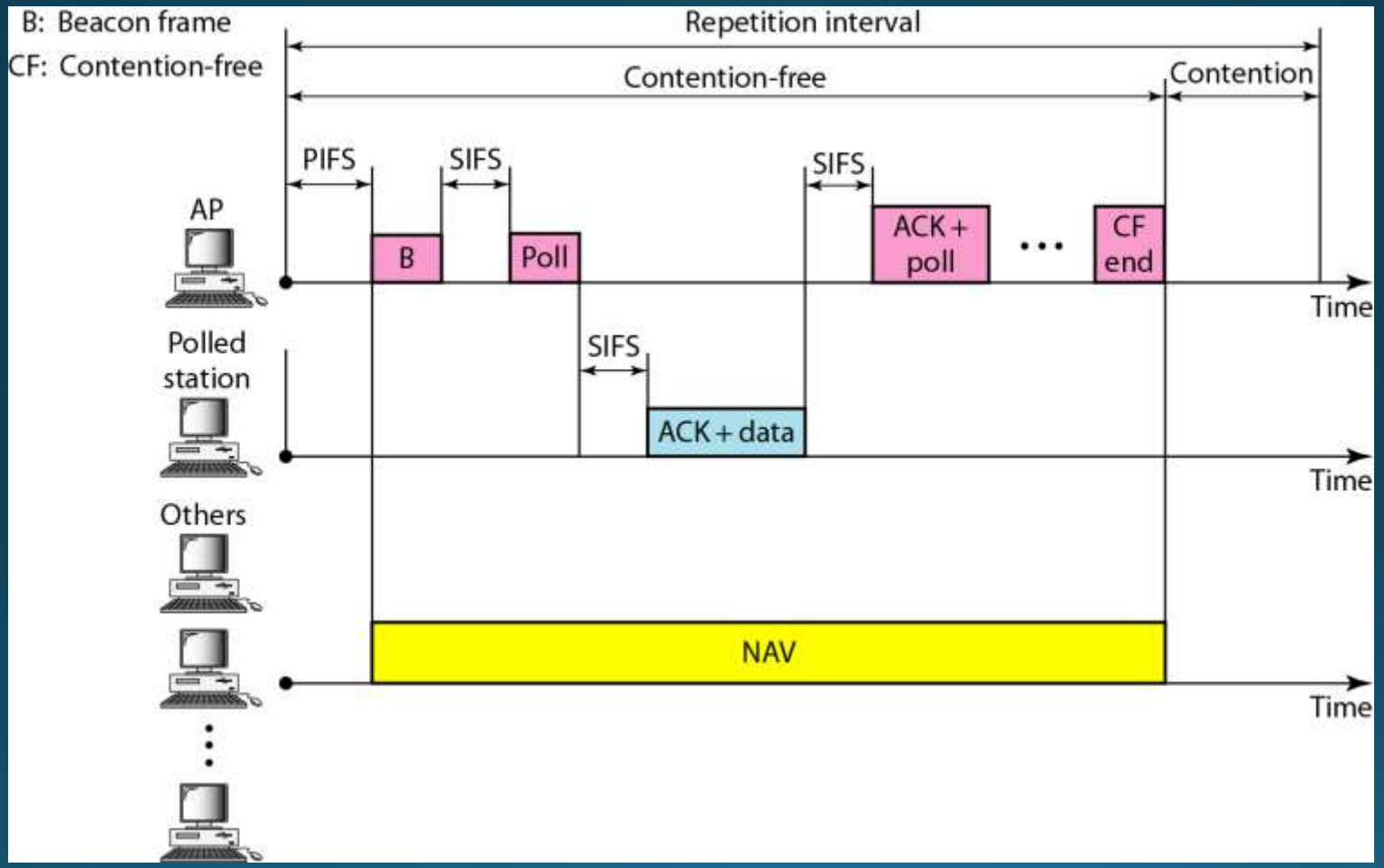
CSMA/CA and NAV



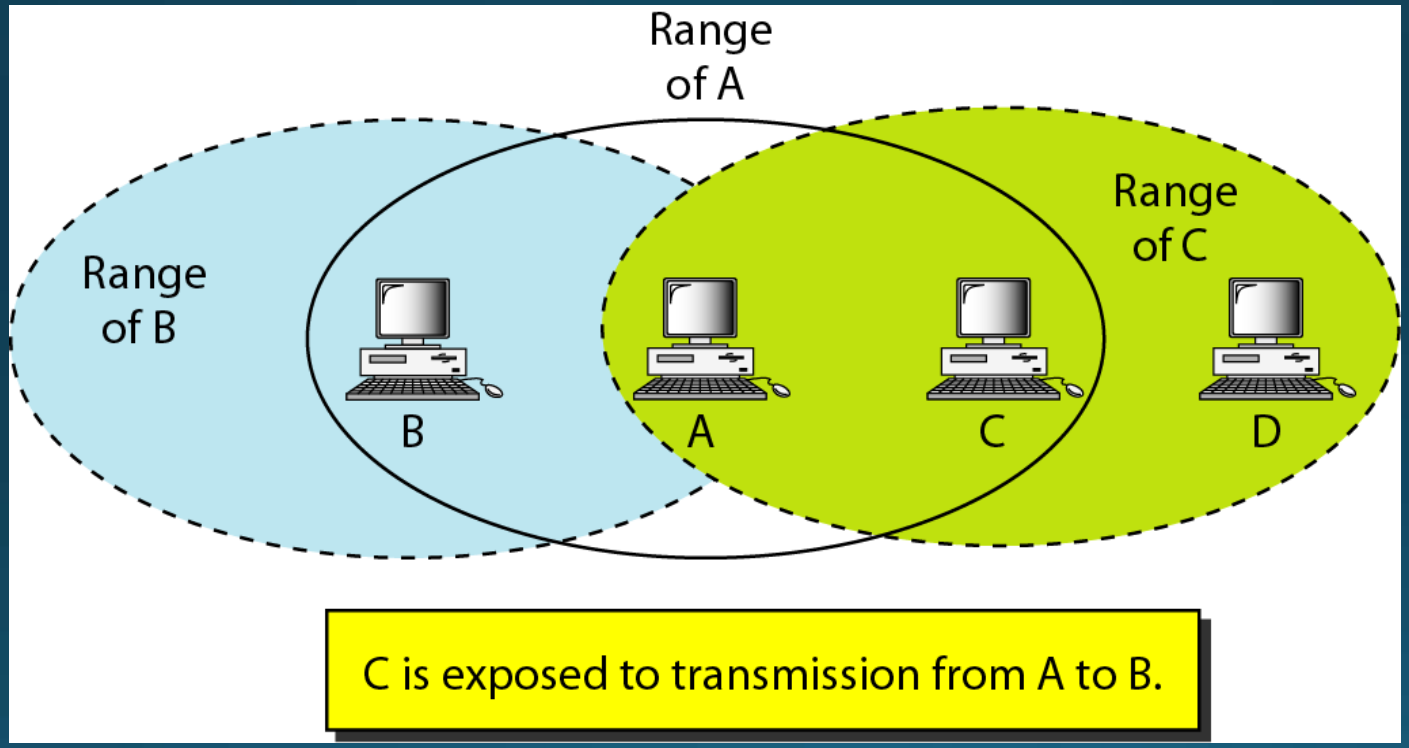
CSMA/CA flowchart



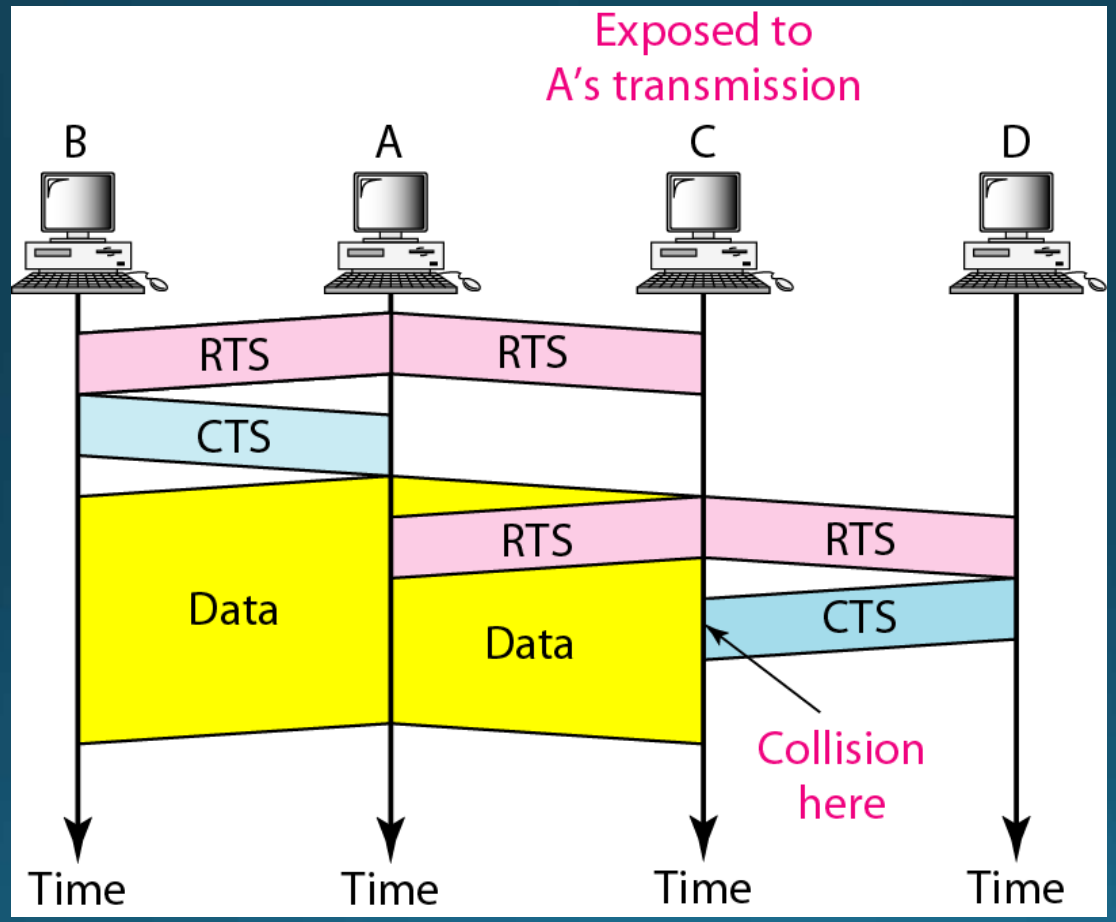
Example of repetition interval



Exposed station problem



Use of handshaking in exposed station problem



Physical layers

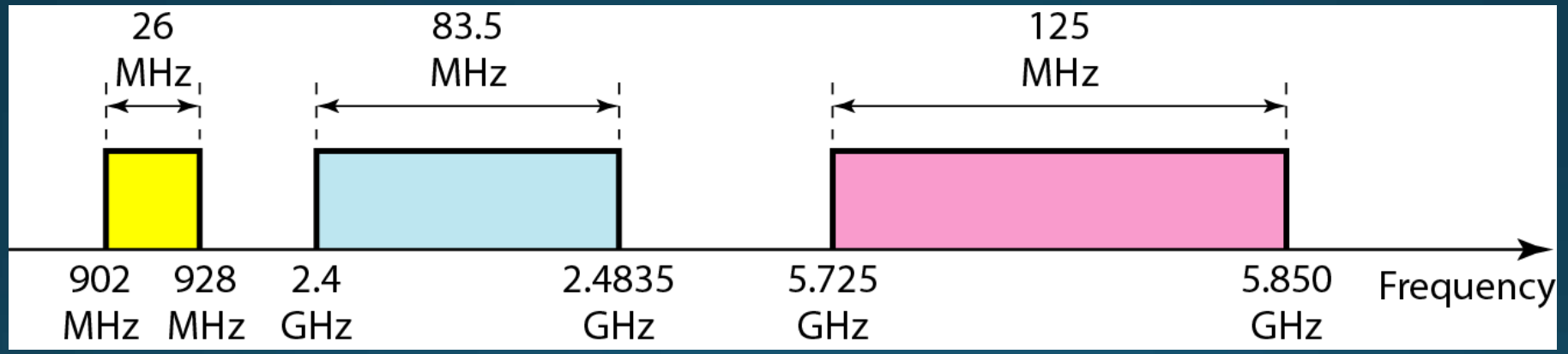
IEEE	*Technique*	*Band*	*Modulation*	*Rate (Mbps)*
802.11	FHSS	2.4 GHz	FSK	1 and 2
	DSSS	2.4 GHz	PSK	1 and 2
		Infrared	PPM	1 and 2
802.11a	OFDM	5.725 GHz	PSK or QAM	6 to 54
802.11b	DSSS	2.4 GHz	PSK	5.5 and 11
802.11g	OFDM	2.4 GHz	Different	22 and 54

ISM Bands

- 900 MHz band
- 1.8 GHz Band
- 2.4 GHz band
- 5.8 GHz band

Differ from country to another

Industrial, scientific, and medical (ISM) band



Challenges and solutions

- Industrial environment is Noisy
- Security problem

ISM + SS

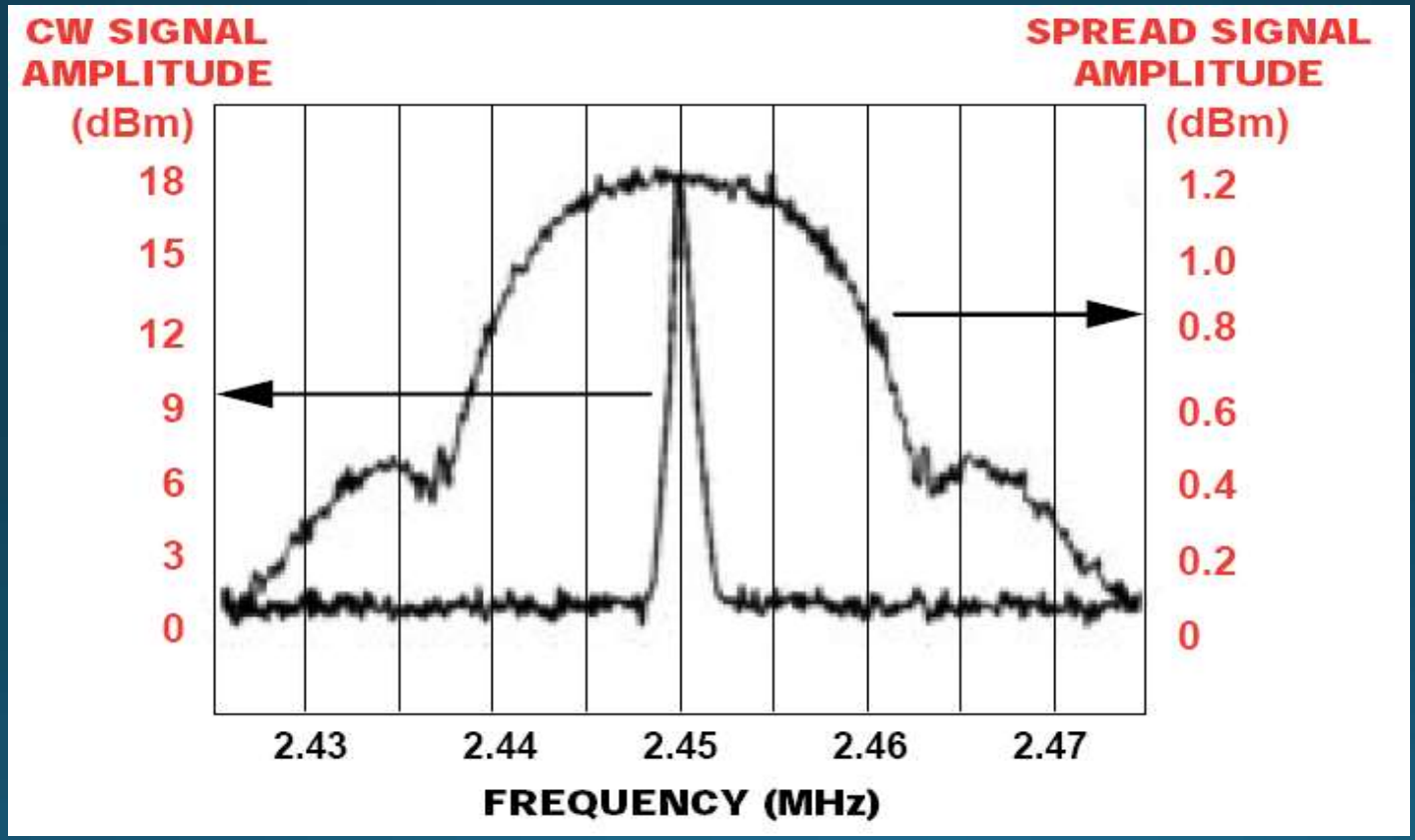
Spread Spectrum

- First existence 1940s
- Commercially 1980s

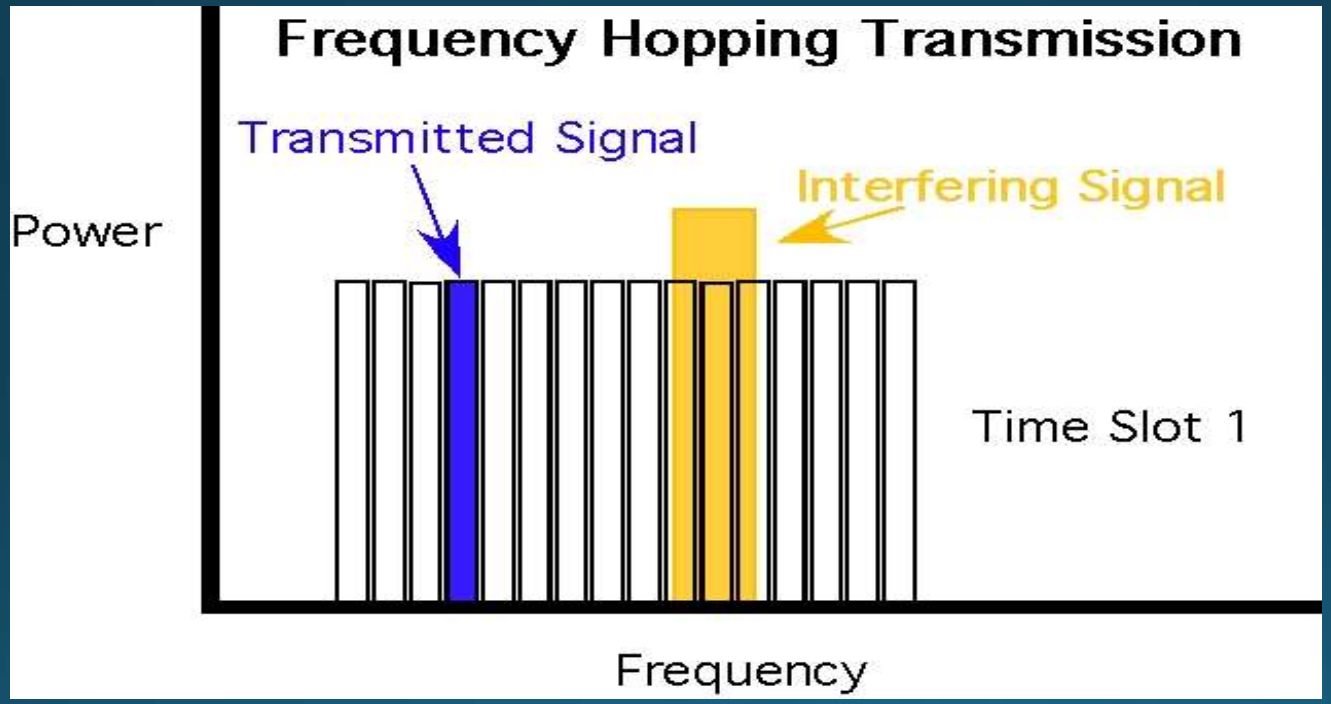
Advantages over fixed frequency transmission:

- increase resistance to natural interference
- Anti Jamming

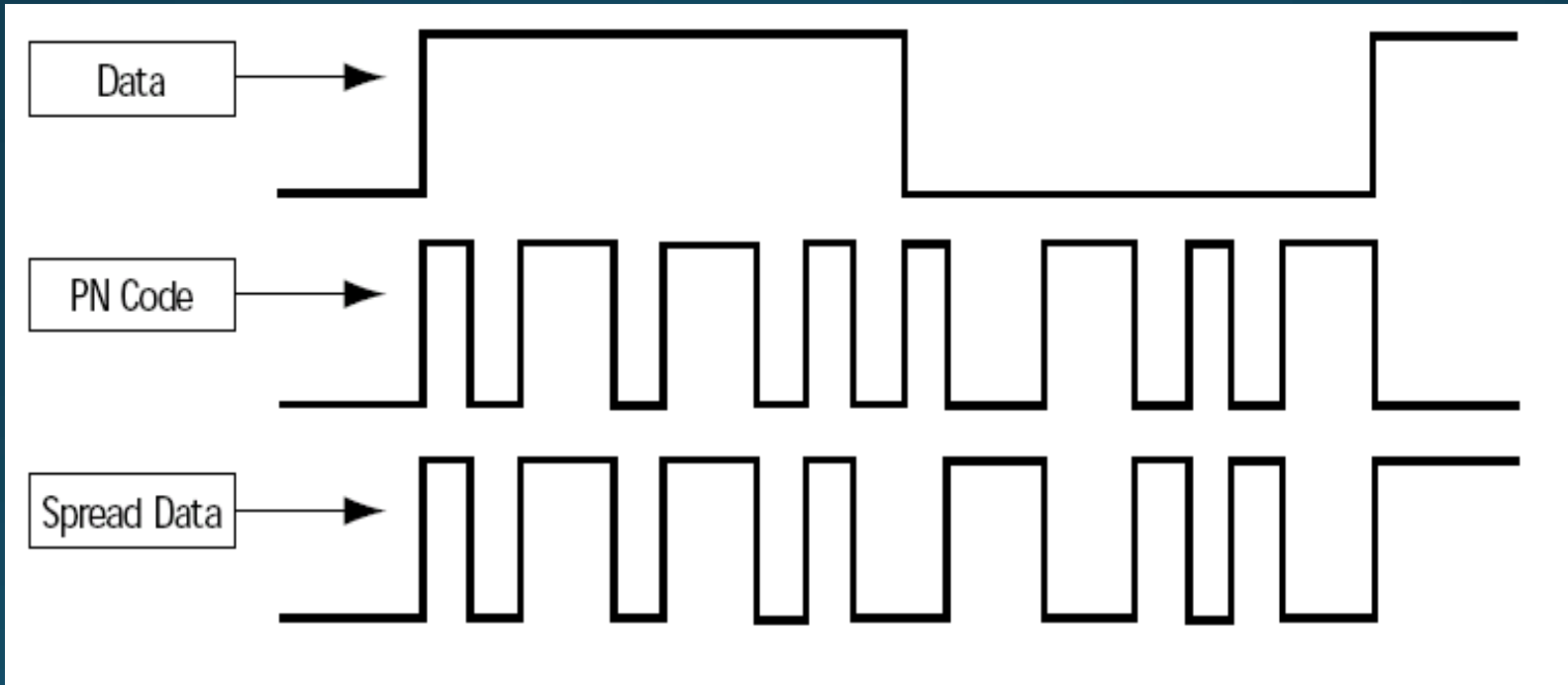
Spread Spectrum



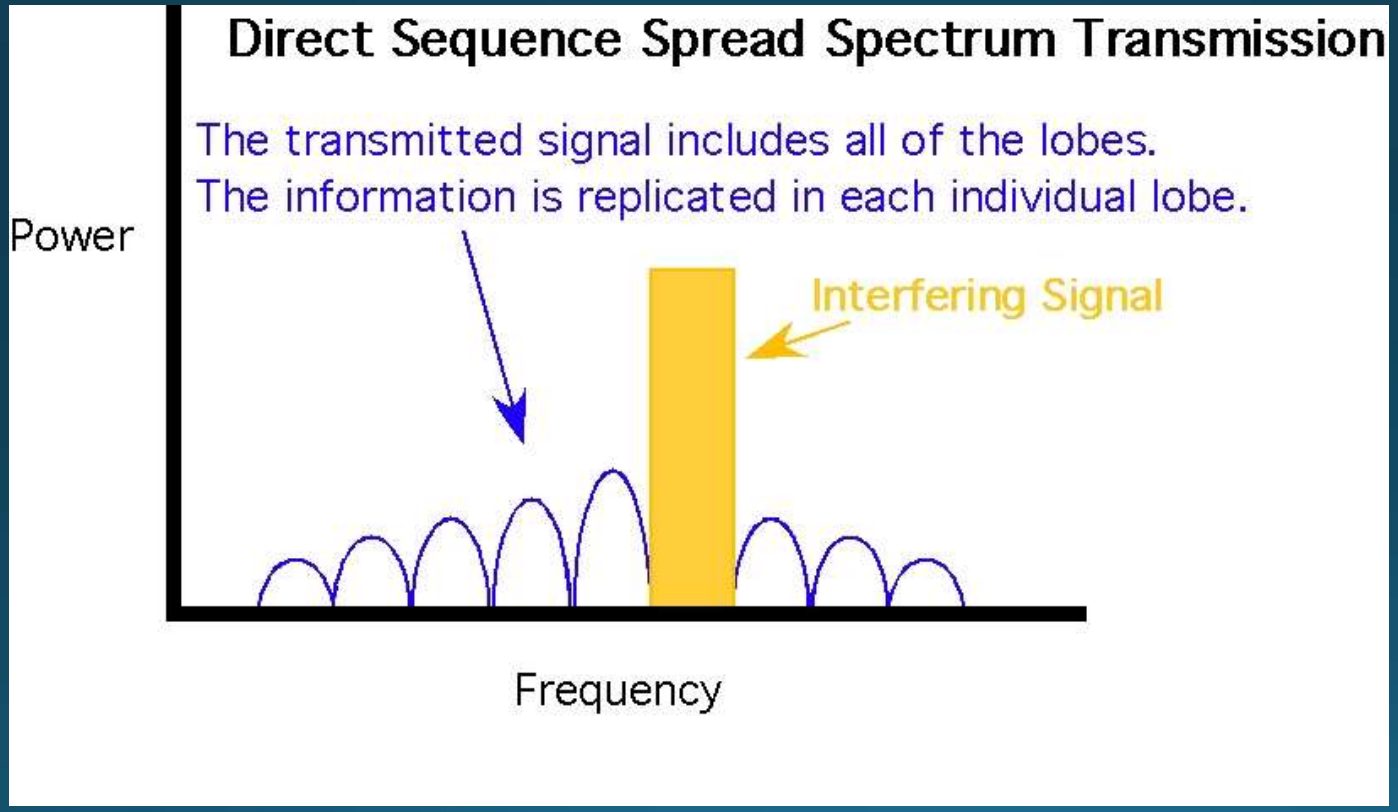
Frequency Hopping Spread spectrum (FHSS)



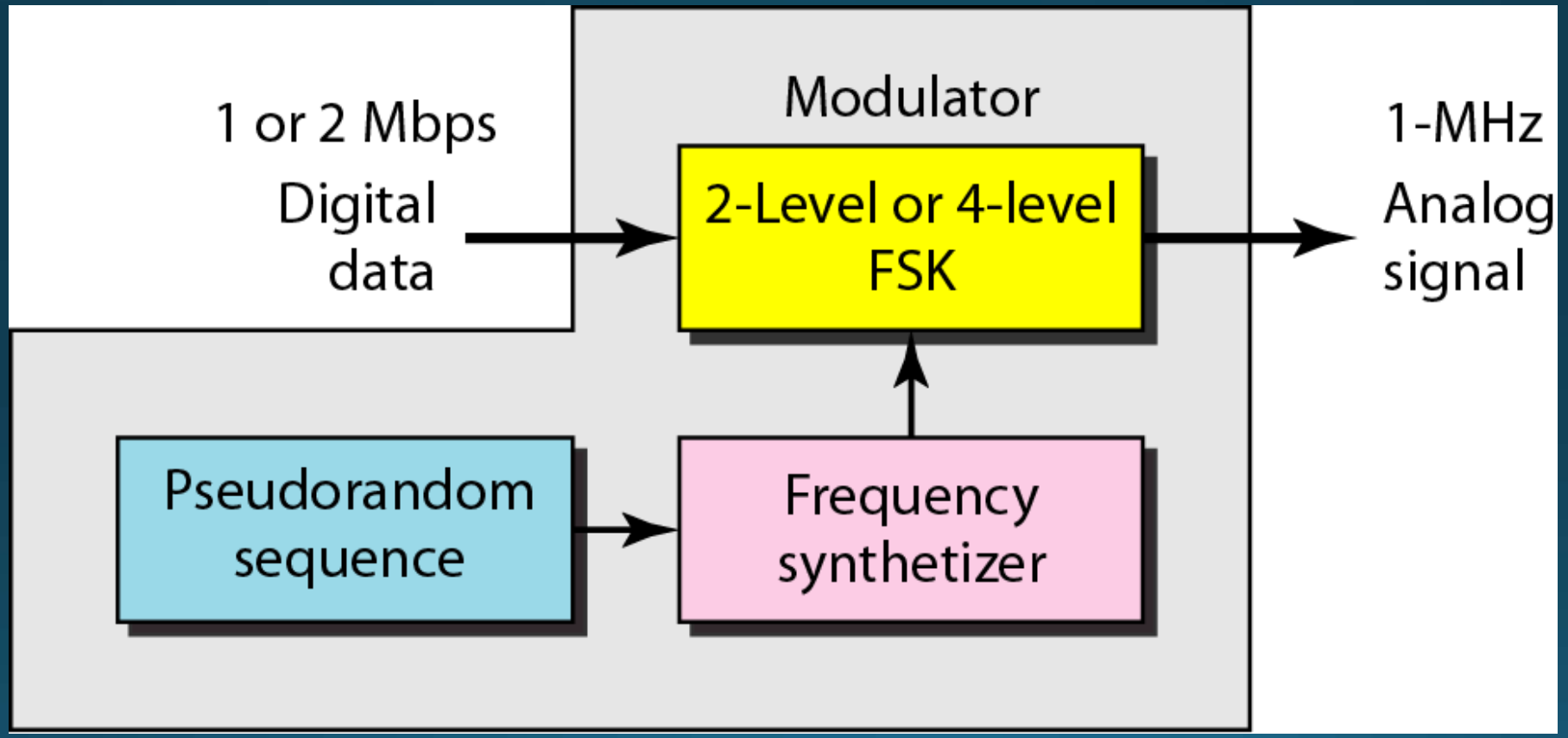
Direct Sequence Spread spectrum (DSSS)



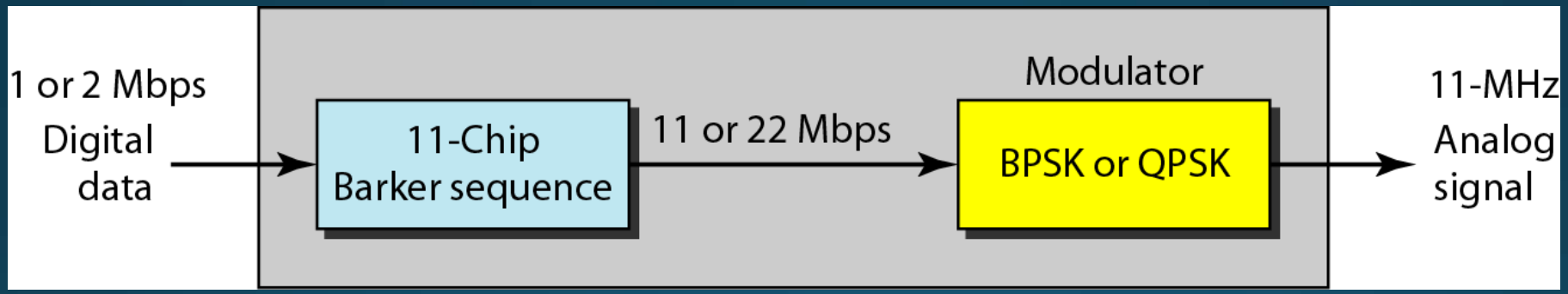
Direct Sequence Spread spectrum (DSSS)



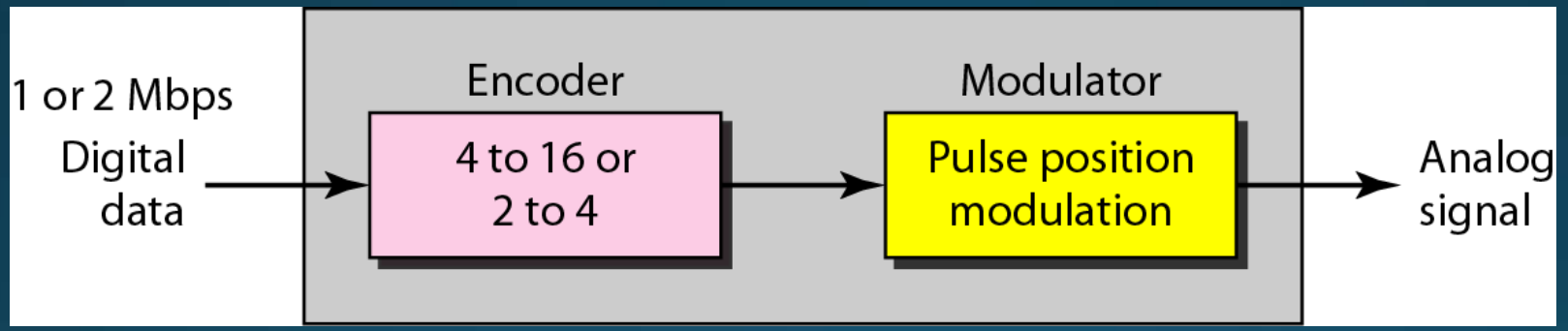
Physical layer of IEEE 802.11 FHSS



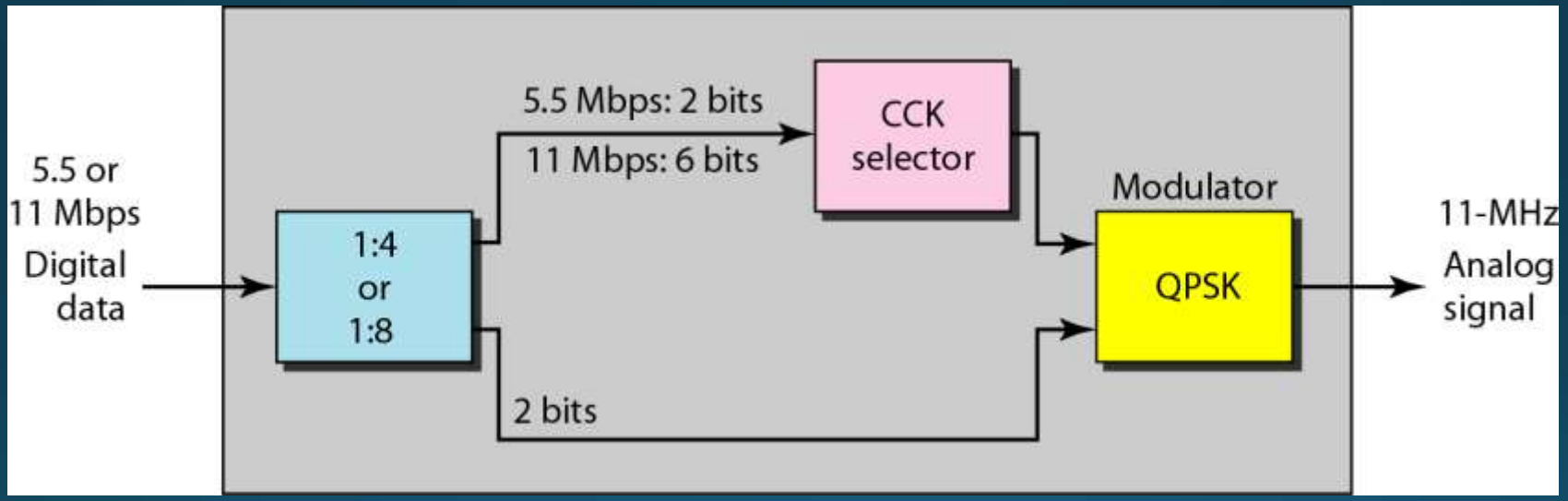
Physical layer of IEEE 802.11 DSSS



Physical layer of IEEE 802.11 infrared



Physical layer of IEEE 802.11b



Challenges and solutions

- Power consumption
- Latency

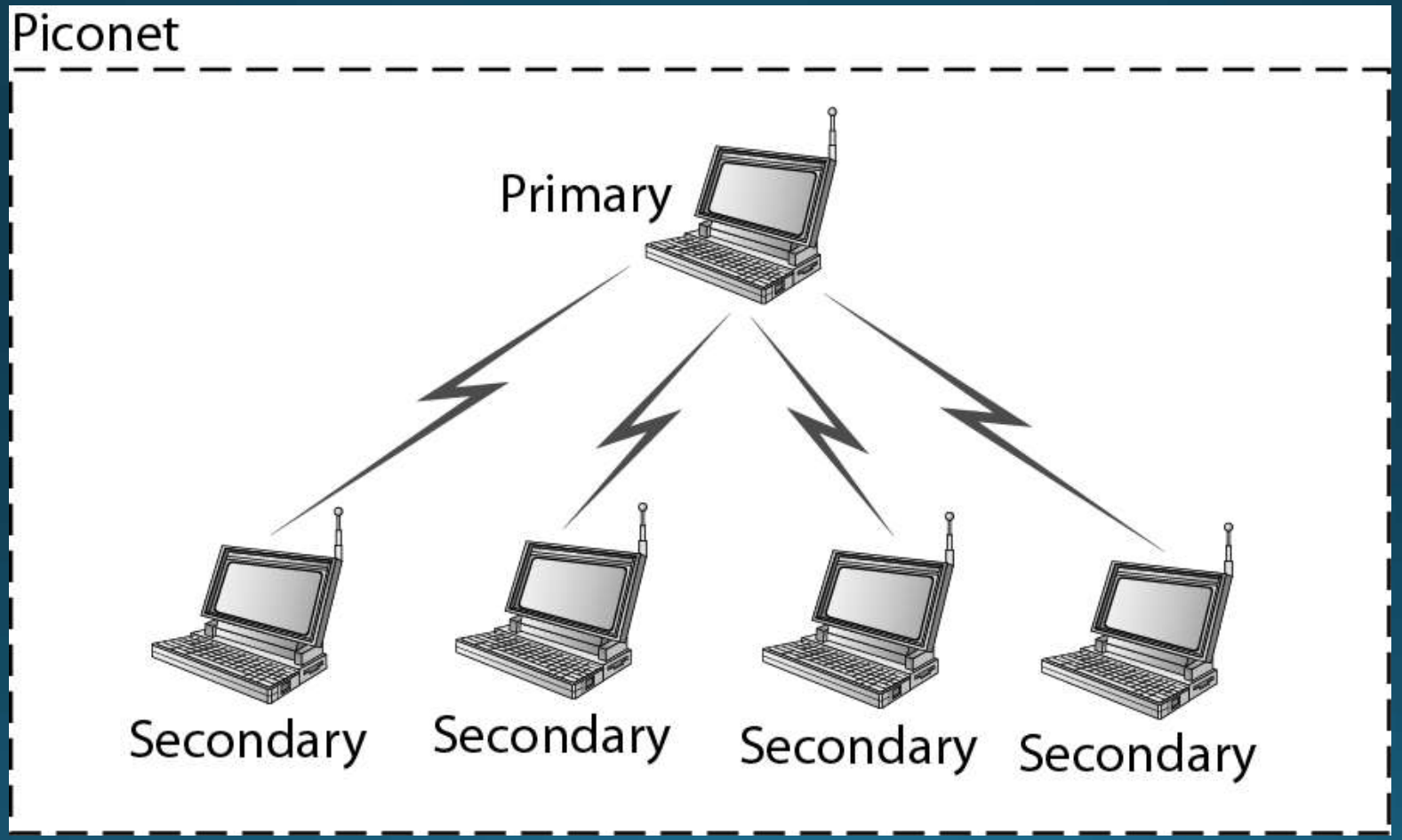
Power consumption

- Reduce average supply of the Radio link by:
  - Compression of data
  - Decrease duty cycle
  - Power management mechanisms (sleep mode)
  - Event-driven transmission strategy

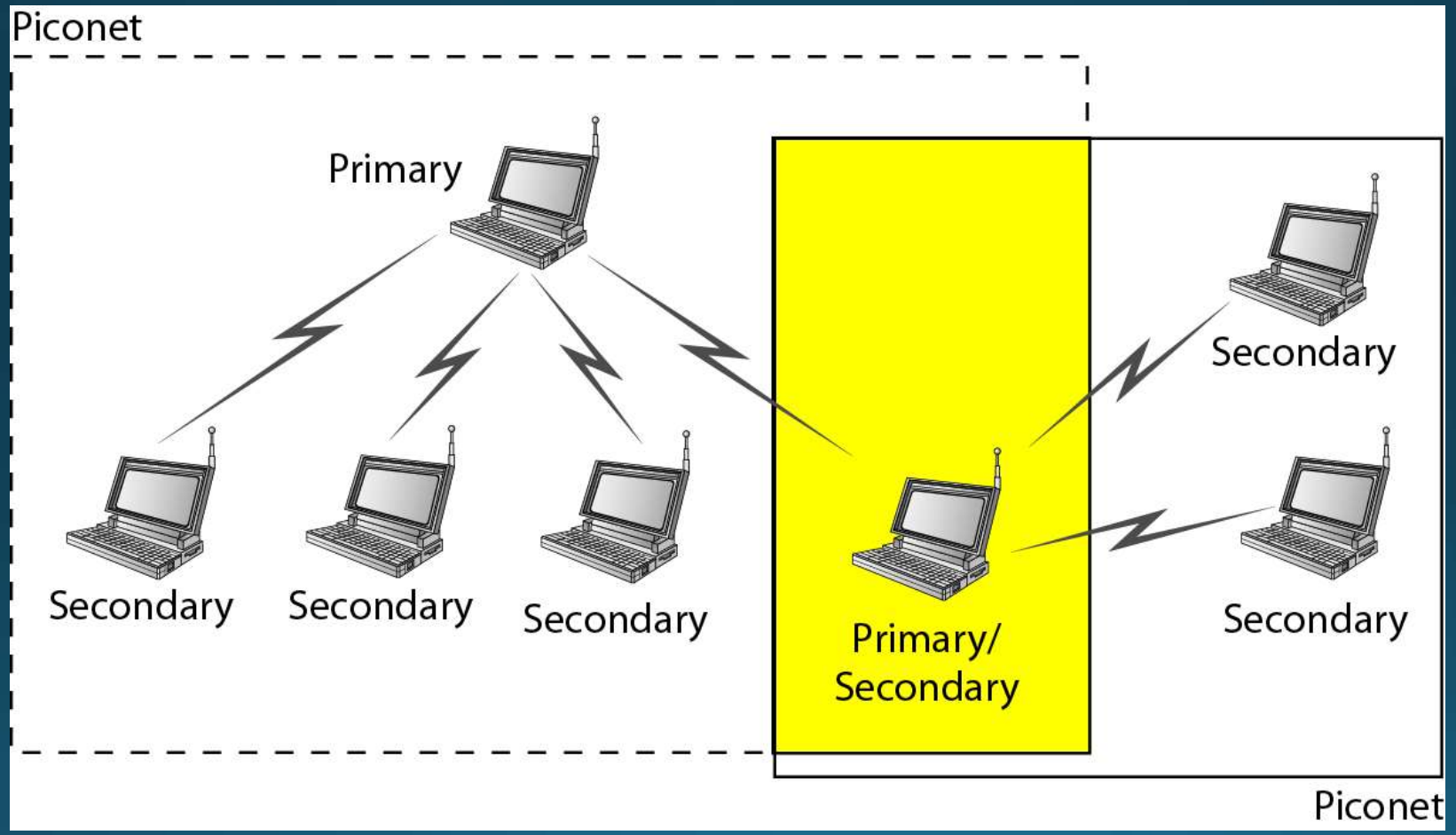
BLUETOOTH

Bluetooth *is a wireless LAN technology designed to connect devices of different functions such as telephones, notebooks, computers, cameras, printers, coffee makers, and so on. A Bluetooth LAN is an ad hoc network, which means that the network is formed spontaneously.*

Piconet


Piconet
Primary
Secondary
Secondary
Secondary
Secondary

Scatternet


Piconet
Primary
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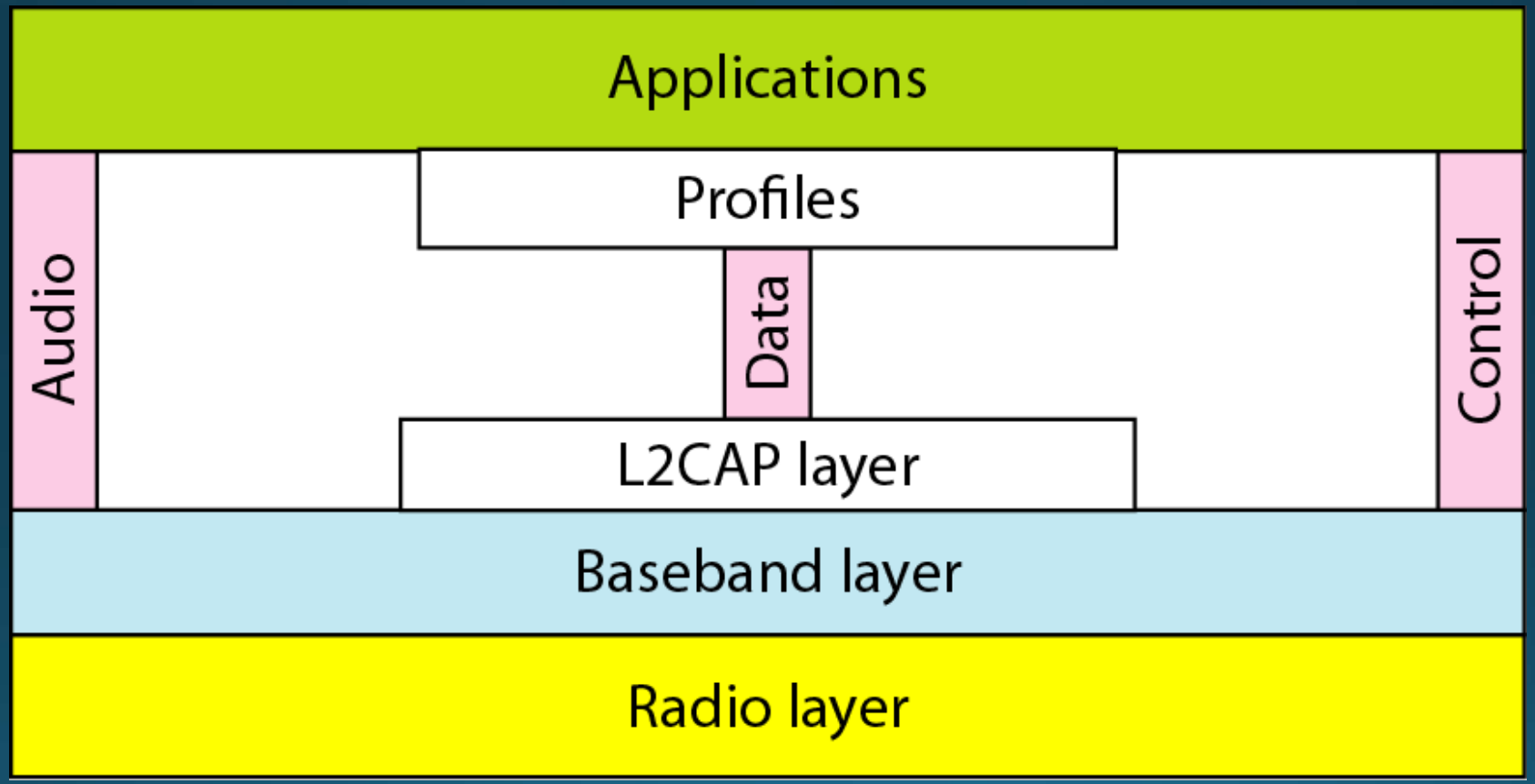
Secondary
Piconet

Bluetooth layers



Bluetooth

- IEEE802.15.1 & 2
- Low-power short-range radio technology
- Printers, keyboards, and mice
- Voice and data
- Operates in the unlicensed ISM at 2.4 GHz
- 79 channels between 2.402 GHz to 2.480 GHz
- Bluetooth channel is divided into time slots each 625 micro second in length

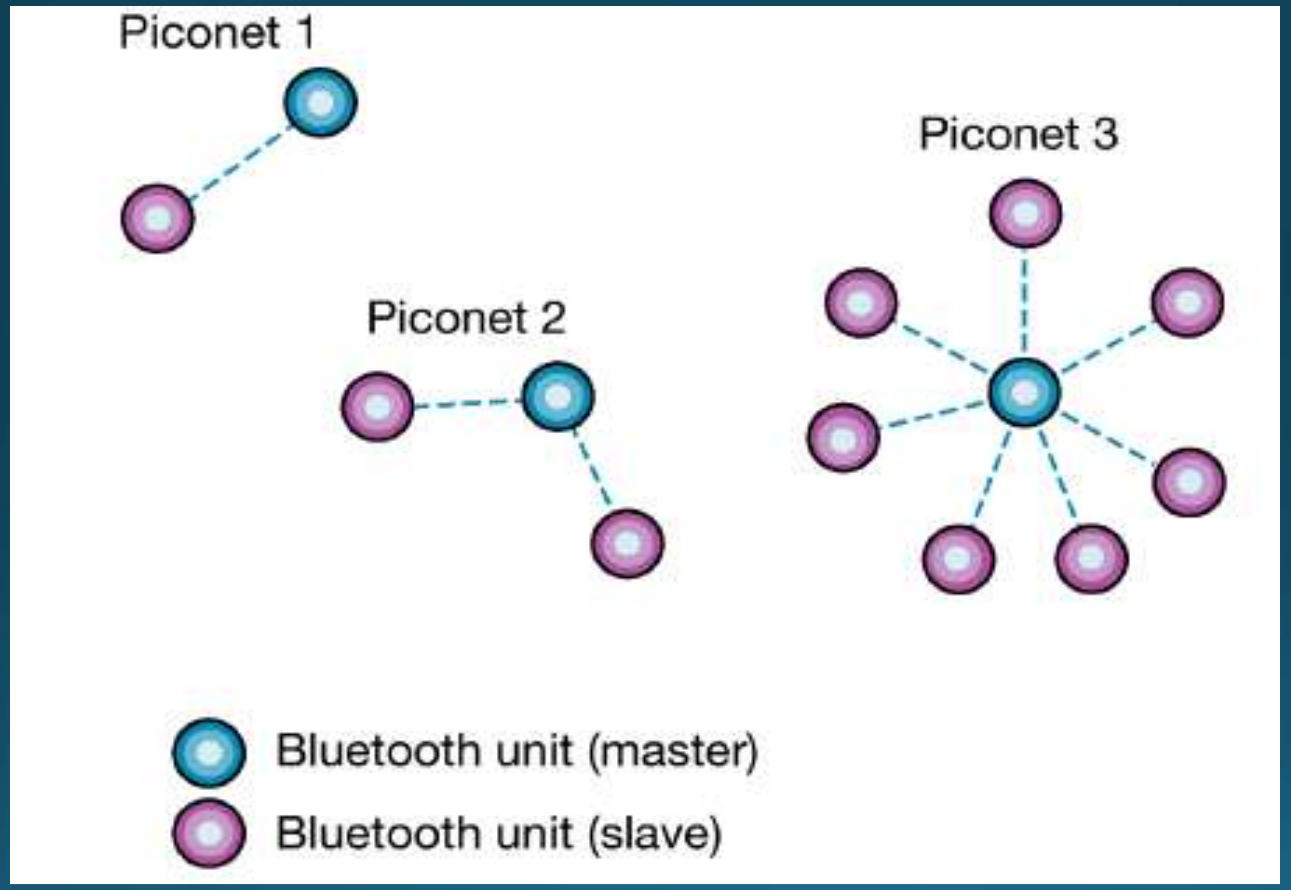
Bluetooth

- Bluetooth employs frequency hopping spread spectrum (FHSS)
- The devices hop through these timeslots making 1600 hops per second
- Bluetooth device can be a *master* or a *slave*
- All synchronize to the same hopping sequence.

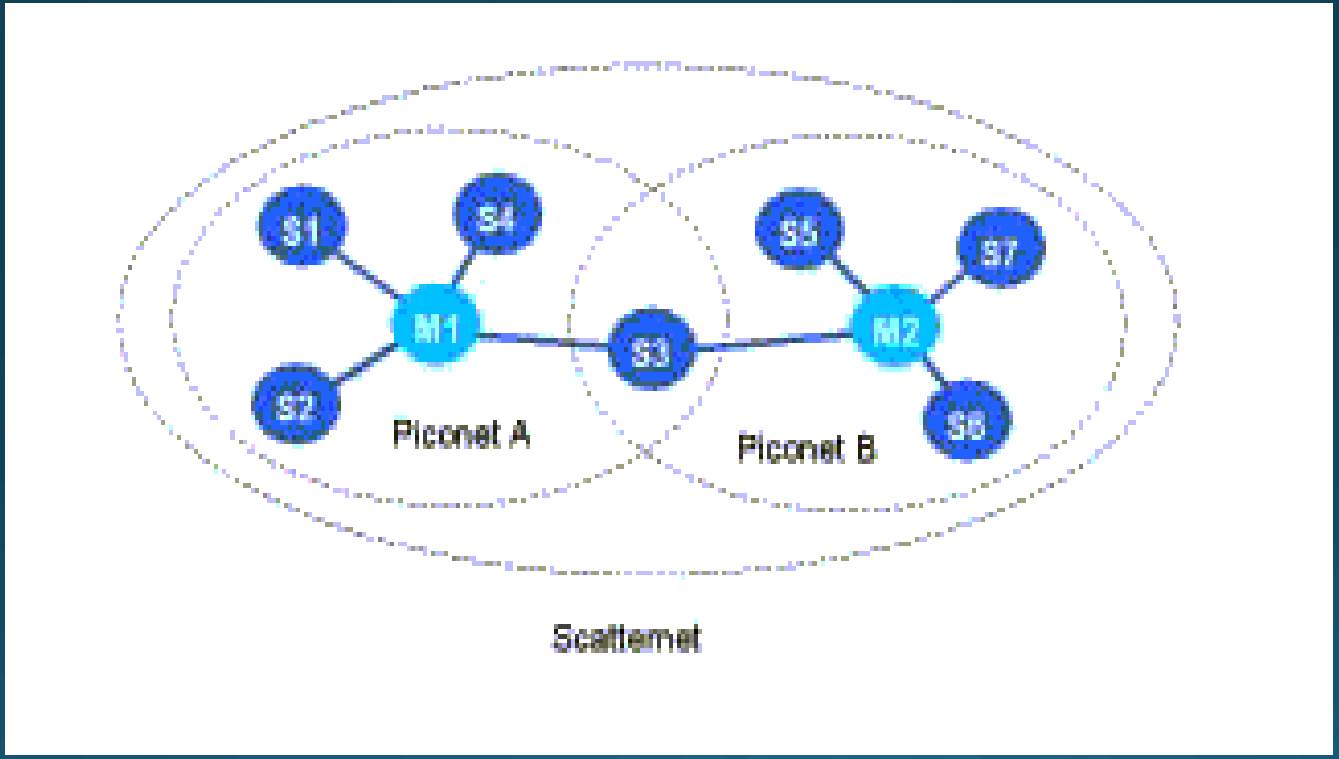
Bluetooth

- The master sets the hopping sequence
- slaves synchronize to the Master
- *piconet* is formed by a master and up to seven active slaves.
- Slaves in a piconet only communicate with the master.

Bluetooth piconet



Bluetooth scatter net



Bluetooth Disadvantages

- High power for short transmission range
- Long time of synchronization(sleep)
- MAC layer is complex

Zigbee Characteristics

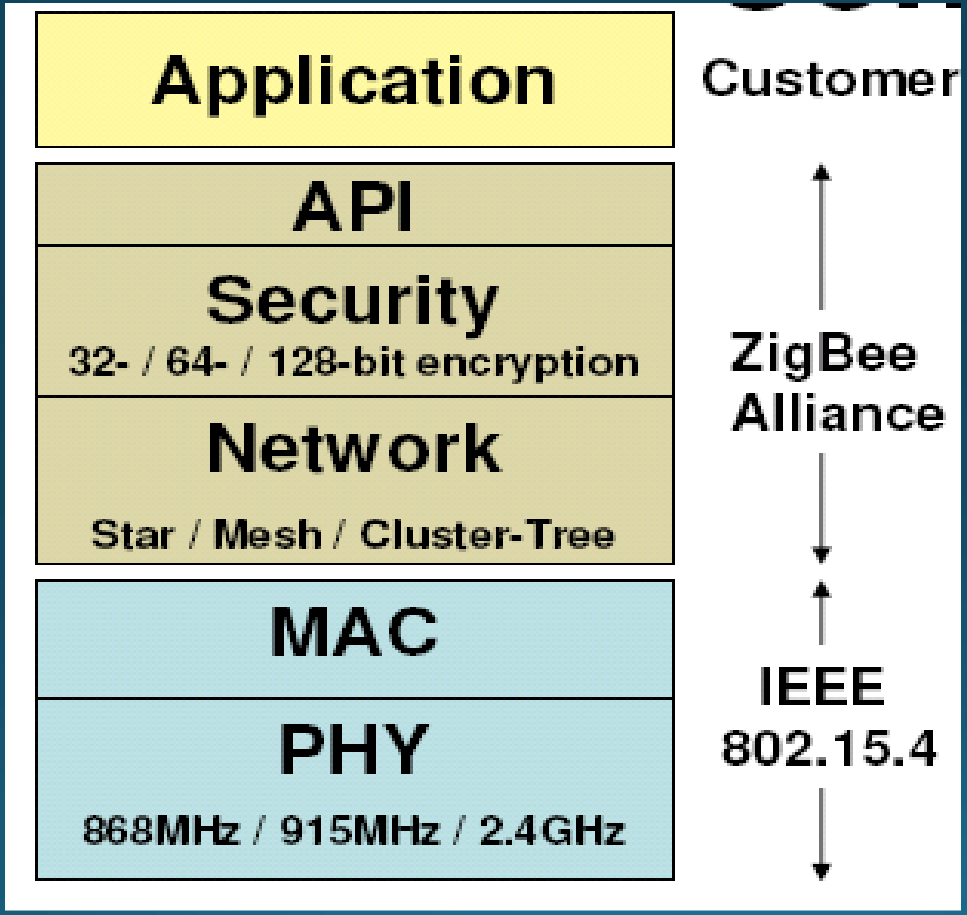
- WPAN (IEEE802.15.4)
- Zigbee devices have low data rates, consume very low power
- long battery life (months to years)
- Working in ISM
- Three bands

Zigbee Characteristics

- 2.4-2.4835 GHz (channels 11-26) Global
- 902-928 MHz (channels 1-10)
- 868-870 MHz (channels 0)
- Maximum data rates 250 kbps @2.4 GHz
  40 kbps @ 915 MHz
  20 kbps @868 MHz

Zigbee Characteristics

- Channel access using Carrier Sense Multiple Access with Collision Avoidance (CSMA - CA)
- 50m typical range


Application
API
Security
32- / 64- / 128-bit encryption
Network
Star / Mesh / Cluster-Tree
MAC
PHY
868MHz / 915MHz / 2.4GHz
Customer
ZigBee Alliance
IEEE 802.15.4

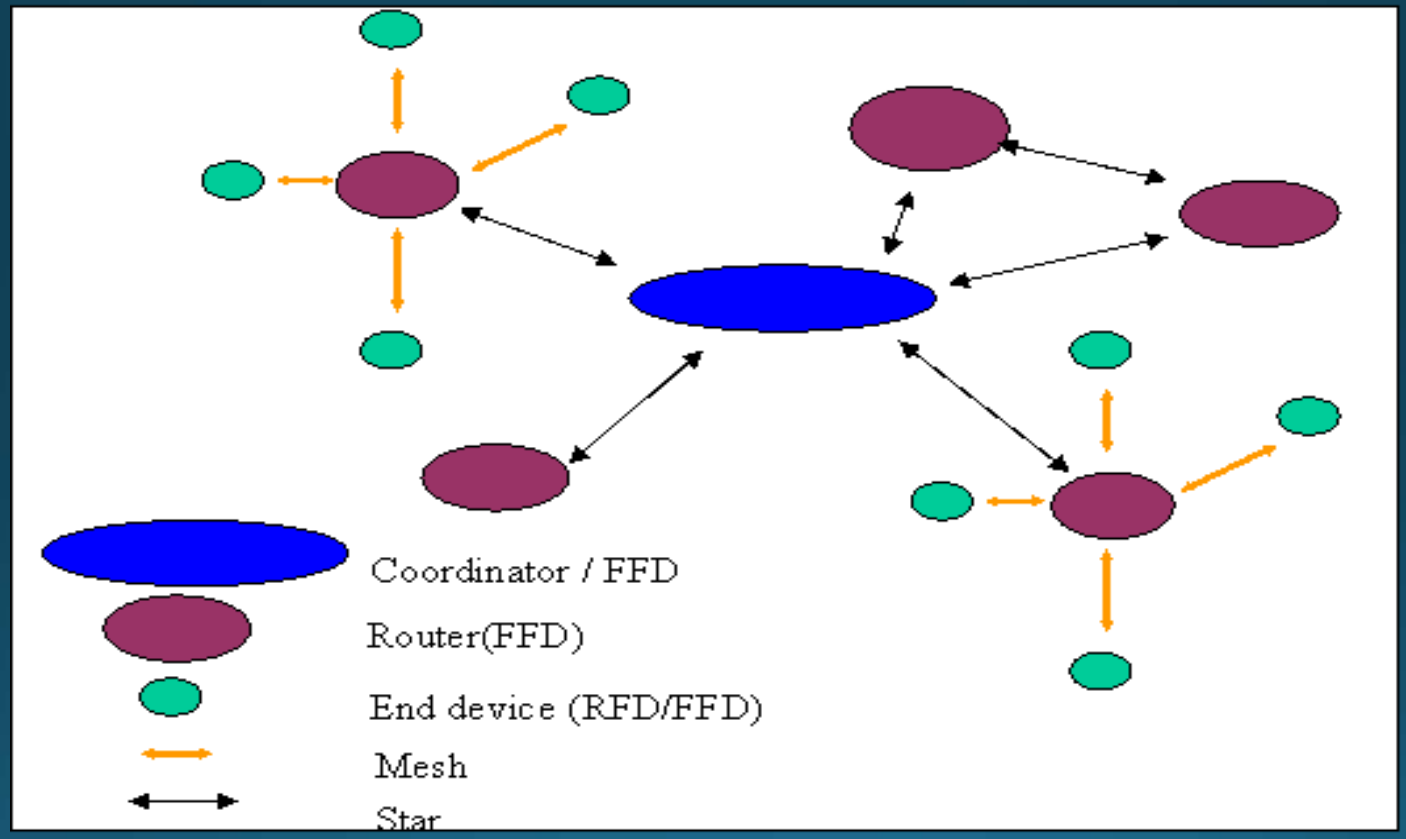
Zigbee Device Types

- Zigbee devices have 64-bit IEEE addresses
- To enable shorter addresses to reduce packet size
- The ZigBee coordinator node
- The full function device FFD
- The reduced function device RFD

Device Types
ZigBee coordinator node

- Only one in each network
- Act as the router to other networks
- Designed to store information about the network.

Device Types



Traffic Types

Data is *intermittent*

- The application, or other stimulus, determines the rate
- Device needs to connect to the network only when communication is necessitated
- Enables optimum saving on energy

Traffic Types

Data is *repetitive*

- Rate is fixed a priori
- Depending on allotted time slots GTS

ZigBee modes

Beacon mode

- Used when the coordinator runs on batteries
- Offers maximum power savings
- Device watches out for the coordinator's beacon that gets transmitted at periodically
- Looks for messages addressed to it

HYPERLAN/2

- The system will operate at the 5 GHz band. HIPERLAN/2 will provide data rates of up to 54 Mbps for short ranges,
- The bandwidth of one OFDM symbol IS equal to 20 MHz
- 64-point IFFT with a sub carrier spacing of 312.5 kHz.
- 52 sub carriers are used per channel. 48 sub carriers are meant for actual data and 4 sub carriers are pilots which facilitate phase tracking for coherent modulation.

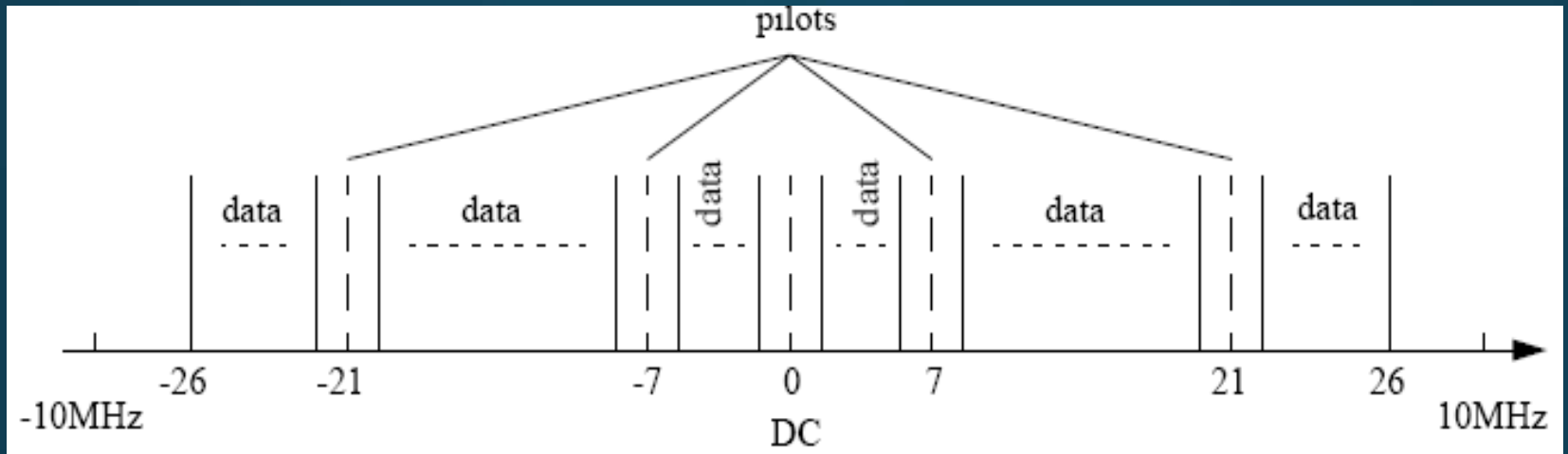


Figure 6.1 Sub carrier frequency allocation

The duration of the cyclic prefix is 800ns and the symbol duration is 3.2 ms.

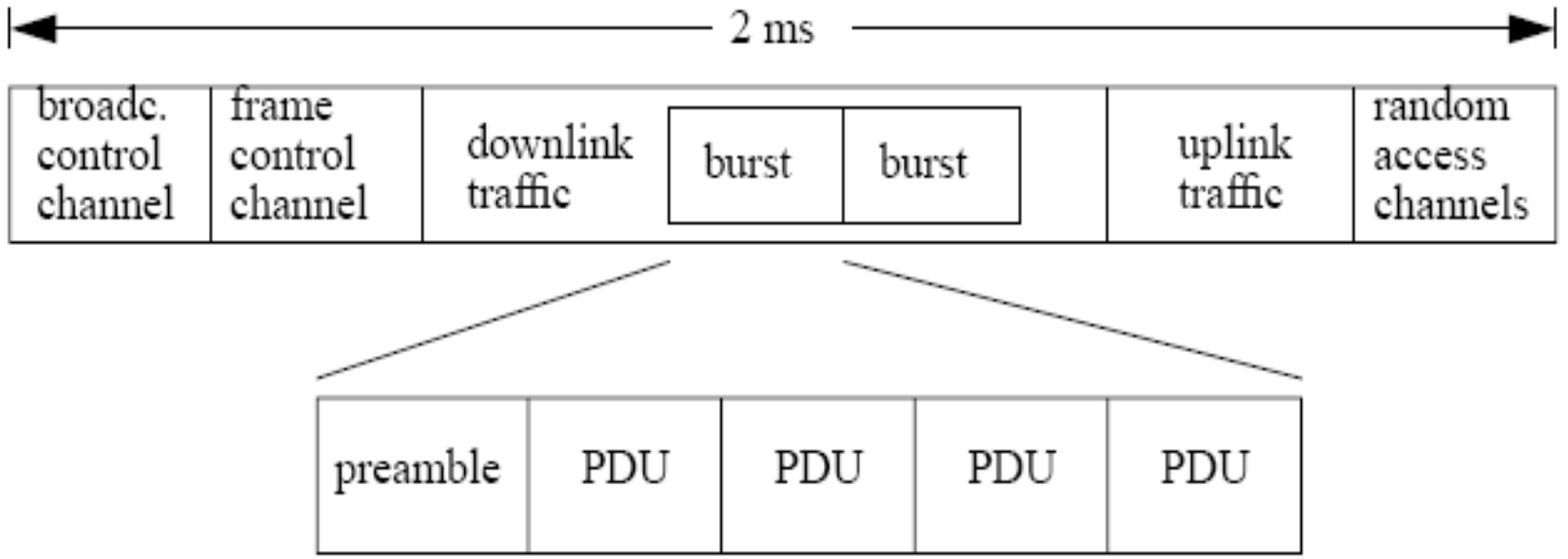


Figure 6.2 Frame structure of HIPERLAN/2