SNS COLLEGE OF ENGINEERING

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Department of Information Technology

Course Name – 19IT401 Computer Networks

II Year / IV Semester

Unit 2 – Link Layer

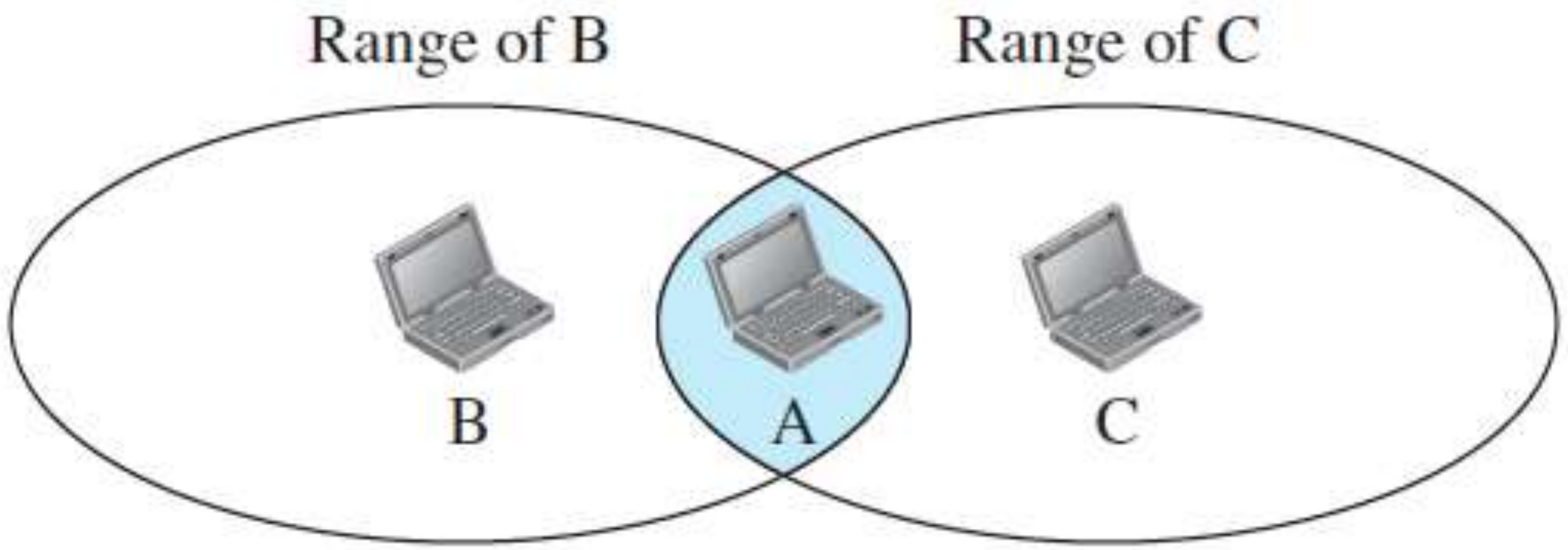
Topic 8- Wireless LAN 802.11

Wireless LAN – IEEE 802.11

CSMA/CD does not work with Wireless Because

1. To detect a collision, a host needs to send and receive at the same time in Full Duplex Mode. Wireless hosts do not have enough power to do so. They can only send or receive at one time.
2. Because of the hidden station problem, in which a station may not be aware of another station's transmission due to some obstacles or range problems, collision may occur but not be detected.
3. The distance between stations can be great. Signal fading could prevent a station at one end from hearing a collision at the other end.

To avoid these problems CSMA/CA was invented.



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

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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.

Architecture

The standard defines two kinds of services:

- the basic service set (BSS) and
- the extended service set (ESS).

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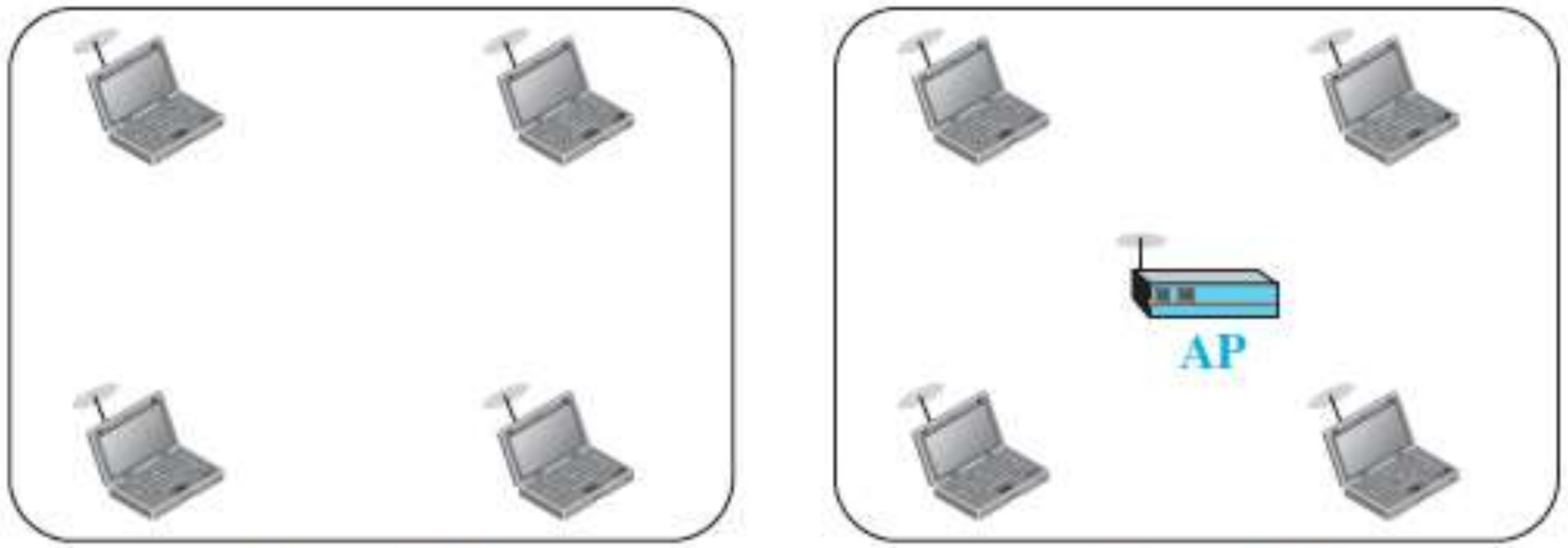
Basic Service Set

- A basic service set is made of stationary or mobile wireless stations and an optional central base station, known as the access point.
- The BSS without an AP is a stand-alone network and cannot send data to other BSSs.
- It is called an ad hoc architecture . In this architecture, stations can form a network without the need of an AP; they can locate one another and agree to be part of a BSS.
- A BSS with an AP is sometimes referred to as an infrastructure BSS .



Ad hoc BSS   Infrastructure BSS

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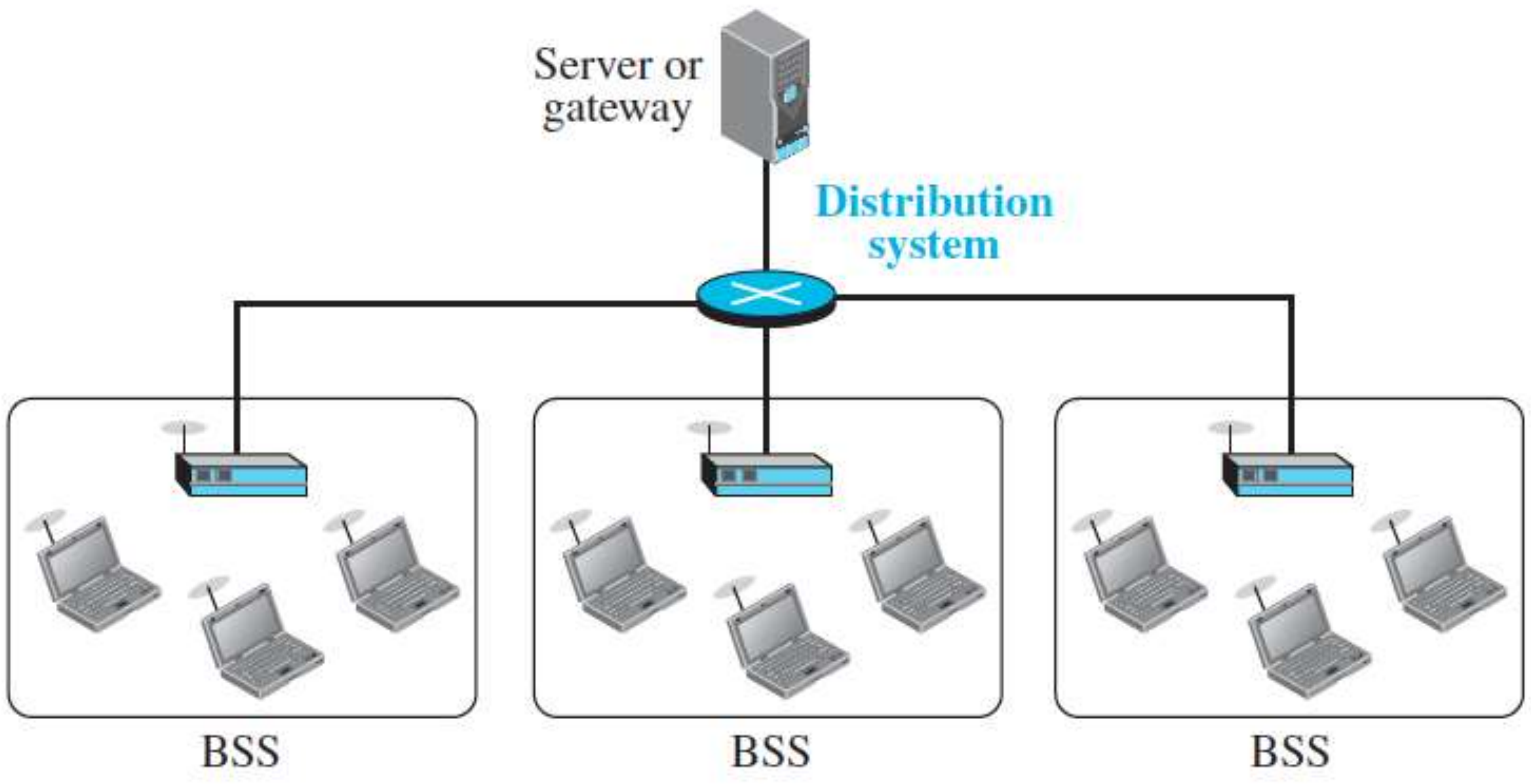
Extended Service Set

- An extended service set (ESS) is made up of two or more BSSs with APs.

- In this case, the BSSs are connected through a distribution system, which is a wired or a wireless network. The distribution system connects the APs in the BSSs



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Station Types

IEEE 802.11 defines three types of stations based on their mobility in a wireless LAN:

- no-transition,
- BSS-transition, and
- ESS-transition mobility.

- A station with no-transition mobility is either stationary (not moving) or moving only inside a BSS.

- A station with BSS-transition mobility can move from one BSS to another, but the movement is confined inside one ESS.

- A station with ESS-transition mobility can move from one ESS to another.

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MAC Sublayer

IEEE 802.11 defines two MAC sublayers: the distributed coordination function (DCF) and point coordination function (PCF).

Distributed Coordination Function

DCF uses CSMA/CA as the access method.

Frame Exchange Time Line

1. Before sending a frame, the source station senses the medium by checking the energy level at the carrier frequency.
    a. The channel uses a persistence strategy with backoff until the channel is idle.
    b. After the station is found to be idle, the station waits for a period of time called the **distributed interframe space (DIFS);** then the station sends a control frame called the request to send (RTS) .

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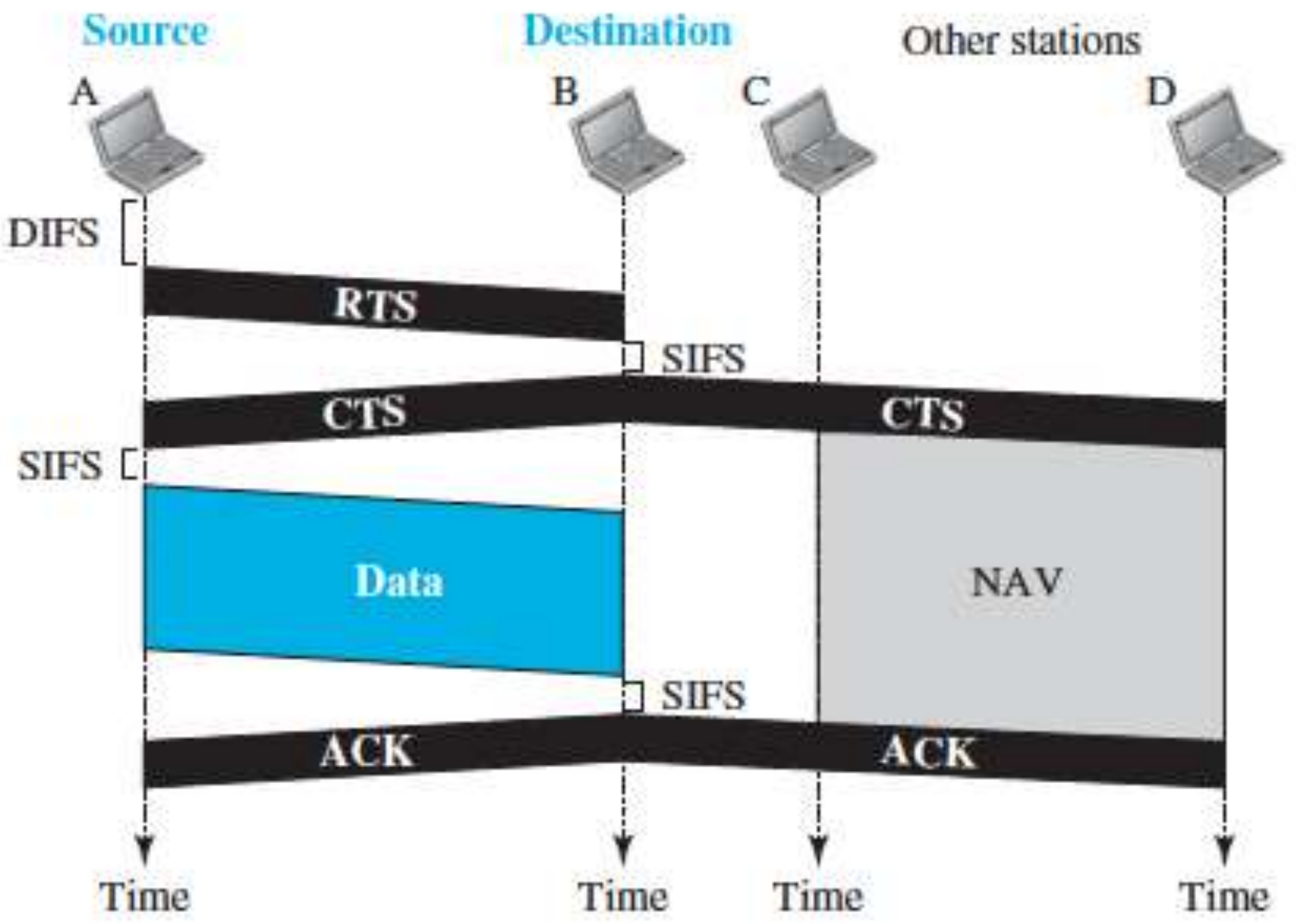
2. After receiving the RTS and waiting a period of time called the **short interframe space (SIFS)**, the destination station sends a control frame, called the clear to send (CTS), to the source station.

This control frame indicates that the destination station is ready to receive data.

3. The source station sends data after waiting an amount of time equal to SIFS.

4. The destination station, after waiting an amount of time equal to SIFS, sends an acknowledgment to show that the frame has been received.

Network allocation vector (NAV)
It is a timer that shows how much time must pass before other stations are allowed to check the channel for idleness.



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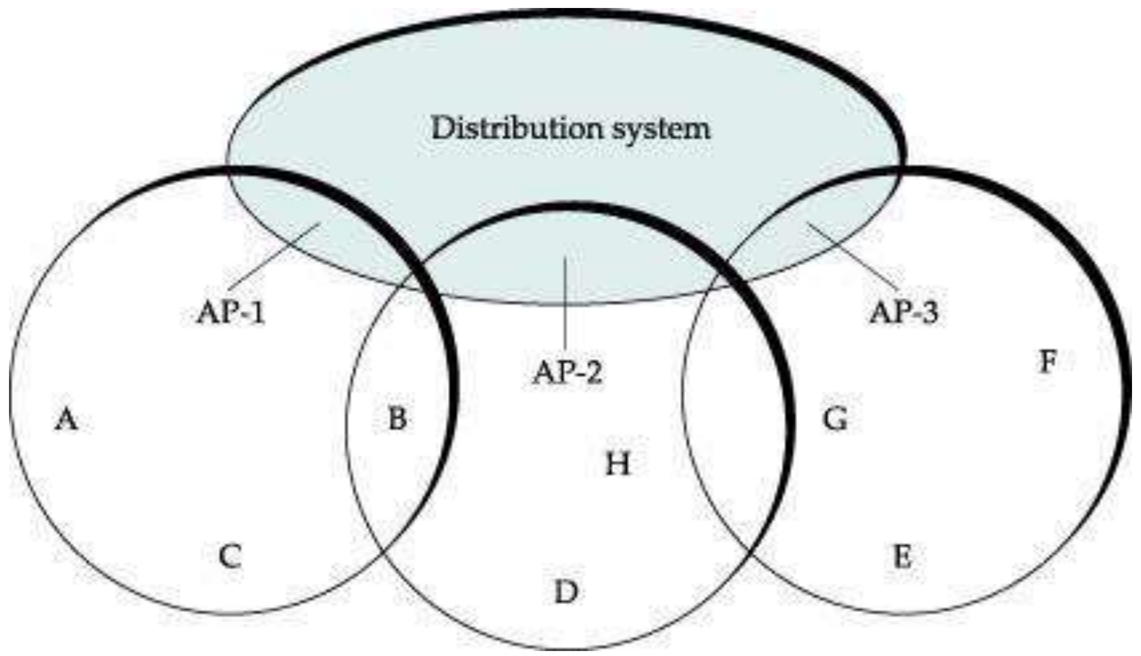
Point Coordination Function (PCF)
The point coordination function (PCF) is an optional access method that can be implemented in an infrastructure network.

Active Scanning
The technique for selecting an AP is called active scanning as follows:

- The node sends a Probe frame.
- All APs within reach reply with a Probe Response frame.
- The node selects one of the access points and sends that AP an Association Request frame.
- The AP replies with an Association Response frame

Passive Scanning
APs also periodically send a Beacon frame that advertises its features such as transmission rate.
This is known as passive scanning



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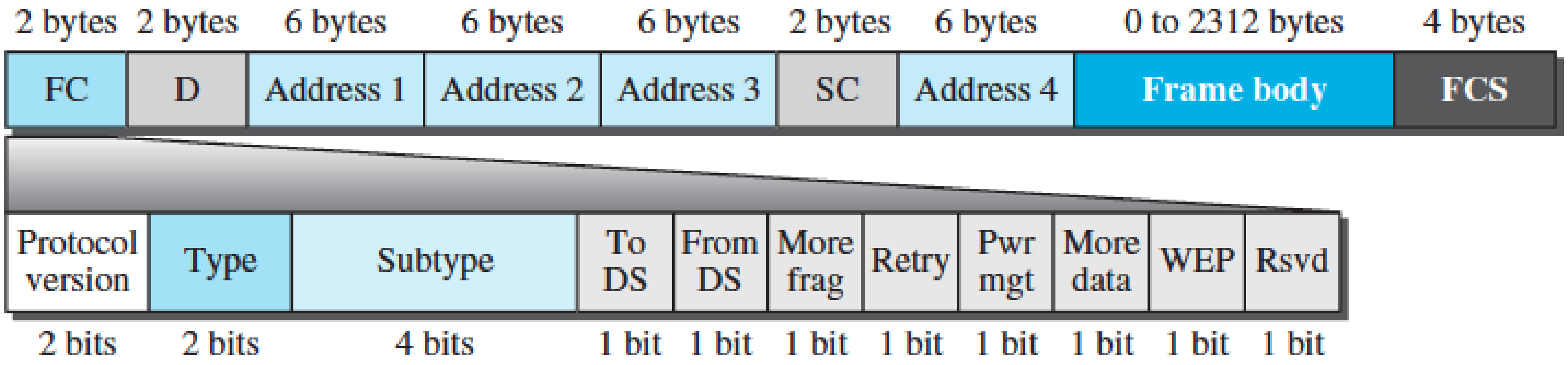
Frame Format



Frame control (FC). The FC field is 2 bytes long and defines the type of frame and some control information.

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Frame Format

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 15.2)
To DS	Defined later
From DS	Defined later
More frag	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

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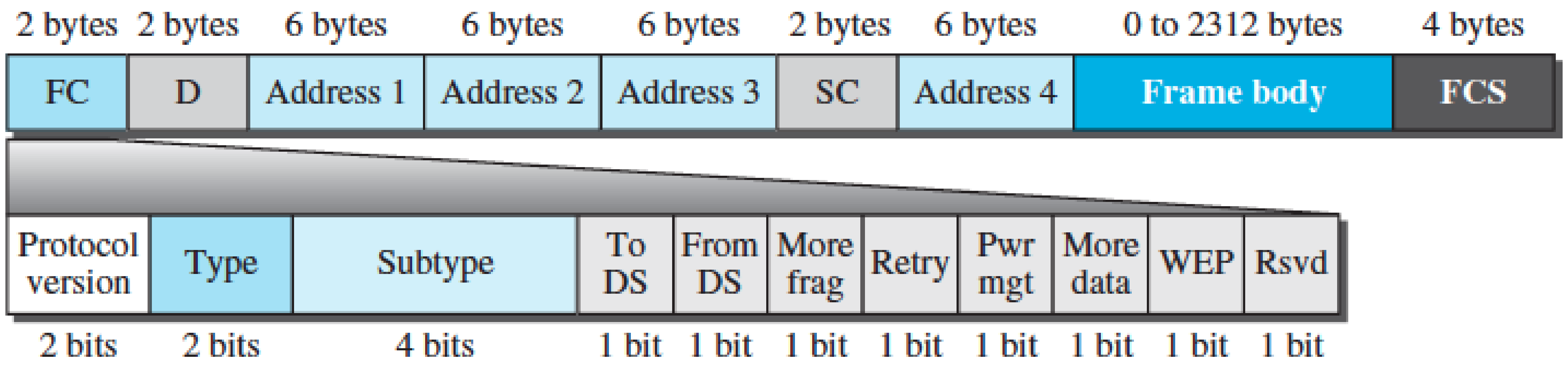
Frame Format



D - This field defines the duration of the transmission that is used to set the value of NAV. In one control frame, it defines the ID of the frame.

Addresses - There are four address fields, each 6 bytes long. The meaning of each address field depends on the value of the To DS and From DS subfields.

- When one node is sending directly to another, both the **DS bits are 0**, Addr1 identifies the target node, and Addr2 identifies the source node
- When both **DS bits are set to 1**, the message went from a node onto the distribution system, and then from the distribution system to another node.
- Addr1 identifies the ultimate destination, Addr2 identifies the immediate sender, Addr3 identifies the intermediate destination and Addr4 identifies the original source

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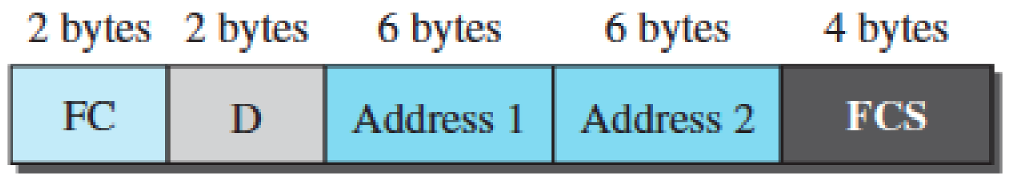
Frame Format

- Sequence control - This field, often called the SC field, defines a 16-bit value. The first four bits define the fragment number; the last 12 bits define the sequence number, which is the same in all fragments.
- Frame body - This field, which can be between 0 and 2312 bytes, contains information based on the type and the subtype defined in the FC field.
- FCS - The FCS field is 4 bytes long and contains a CRC-32 error-detection sequence.

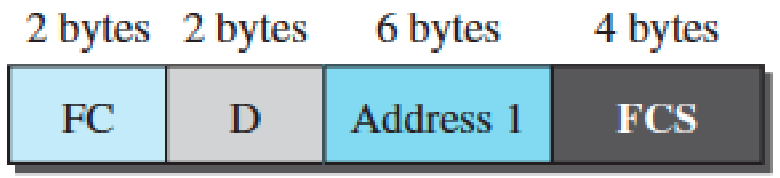
Frame Types

A wireless LAN defined by IEEE 802.11 has three categories of frames:

- Management frames - initial communication between stations and AP. Ex probe, probe response etc.
- Control frames - used for accessing the channel and acknowledging frames. Ex – RTS, CTS, ACK
- Data frames - used for carrying data and control information



RTS



CTS or ACK

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

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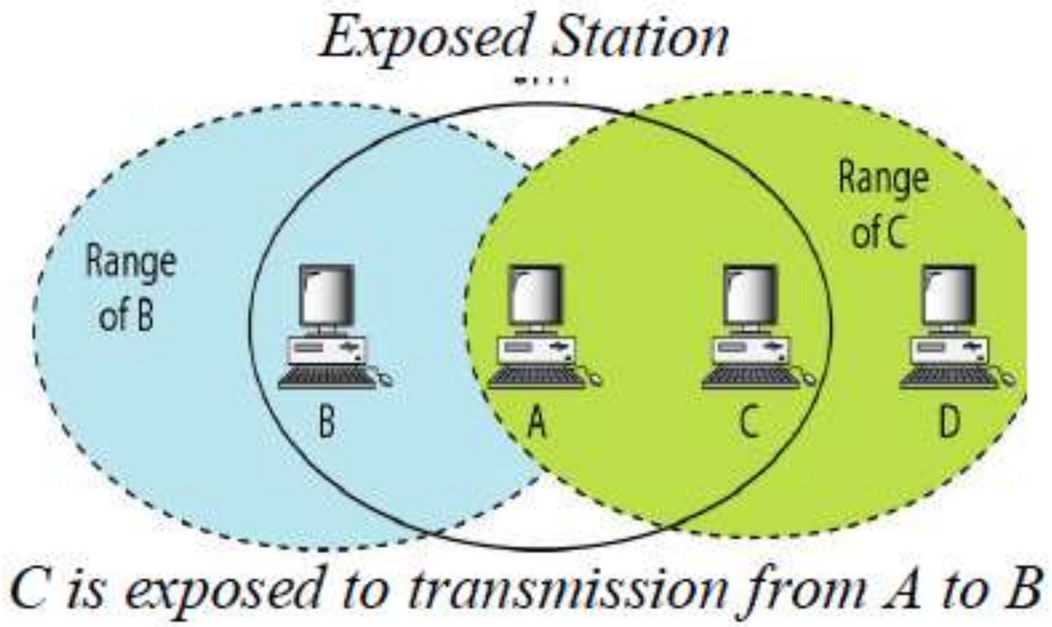
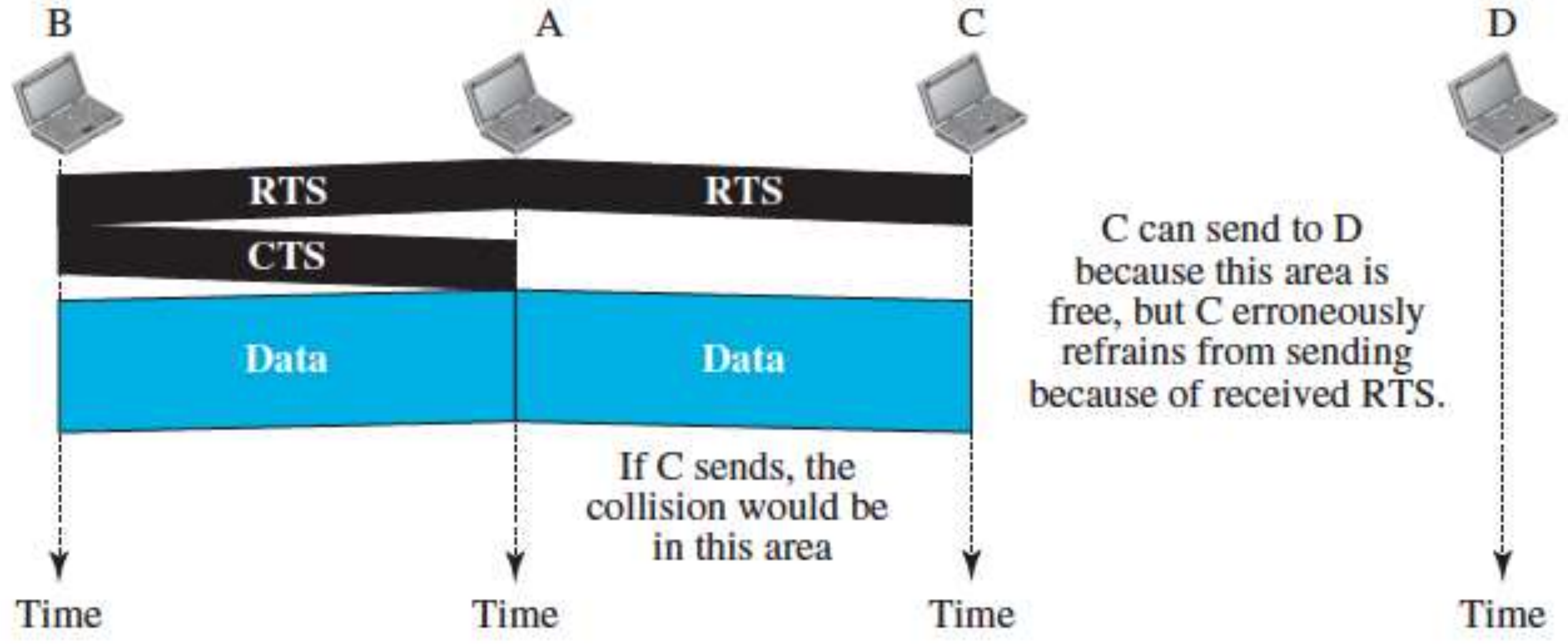
Exposed Station Problem

- A is transmitting to station B.
- Station C has some data to send to station D, which can be sent without interfering with the transmission from A to B.
- However, station C is exposed to transmission from A; it hears what A is sending and thus refrains from sending.
- In other words, C is too conservative and wastes the capacity of the channel.





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Physical Layer

802.11 was designed to run over three different physical media namely FHSS, DSSS and infrared. The data rate for spread spectrum currently is 11 Mbps.

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

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Physical Layer

IEEE 802.11 FHSS

- IEEE 802.11 FHSS uses the frequency-hopping spread spectrum (FHSS) method.
- FHSS uses the 2.400–4.835 GHz ISM band.
- The band is divided into 79 subbands of 1 MHz (and some guard bands).
- A pseudorandom number generator selects the hopping sequence.
- The modulation technique in this specification is either **two-level FSK** or four-level FSK with 1 or 2 bits/baud, which results in a data rate of 1 or 2 Mbps.

IEEE 802.11 DSSS

- IEEE 802.11 DSSS uses the direct-sequence spread spectrum (DSSS)
- DSSS uses the 2.400–4.835 GHz ISM band.
- The modulation technique in this specification is **PSK** at 1 Mbaud/s.
- The system allows 1 or 2 bits/baud (BPSK or QPSK), which results in a data rate of 1 or 2 Mbps

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Physical Layer

IEEE 802.11 Infrared

- IEEE 802.11 infrared uses infrared light in the range of 800 to 950 nm.
- The modulation technique is called **pulse position modulation** (PPM).
- For a 1-Mbps data rate, a 4-bit sequence is first mapped into a 16-bit sequence in which only one bit is set to 1 and the rest are set to 0.
- For a 2-Mbps data rate, a 2-bit sequence is first mapped into a 4-bit sequence in which only one bit is set to 1 and the rest are set to 0.
- The mapped sequences are then converted to optical signals; the presence of light specifies 1, the absence of light specifies 0.

IEEE 802.11a OFDM

- IEEE 802.11a OFDM describes the orthogonal frequency-division multiplexing (OFDM) method for signal generation in a 5.725–5.850 GHz ISM band.
- The band is divided into 52 subbands, with 48 subbands for sending 48 groups of bits at a time and 4 subbands for control information.
- OFDM uses PSK and QAM for modulation. The common data rates are 18 Mbps (PSK) and 54 Mbps (QAM).

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Physical Layer

IEEE 802.11b DSSS

- IEEE 802.11b DSSS describes the high-rate direct-sequence spread spectrum (HRDSSS) method for signal generation in the 2.400–4.835 GHz ISM band.
- HR-DSSS is similar to DSSS except for the encoding method, which is called **complementary code keying** (CCK). CCK encodes 4 or 8 bits to one CCK symbol.
- To be backward compatible with DSSS, HR-DSSS defines four data rates: 1, 2, 5.5, and 11 Mbps.
- The first two use the same modulation techniques as DSSS.
- The 5.5-Mbps version uses BPSK and transmits at 1.375 Mbaud/s with 4-bit CCK encoding.
- The 11-Mbps version uses QPSK and transmits at 1.375 Mbps with 8-bit CCK encoding.

IEEE 802.11g

- This new specification defines forward error correction and OFDM using the 2.400– 4.835 GHz ISM band. The modulation technique achieves a 22- or 54-Mbps data rate.
- It is backward-compatible with 802.11b, but the modulation technique is OFDM.

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Physical Layer

IEEE 802.11n

- An upgrade to the 802.11 project is called 802.11n (the next generation of wireless LAN).
- The goal is to increase the throughput of 802.11 wireless LANs.
- The new standard emphasizes not only the higher bit rate but also eliminating some unnecessary
- overhead.
- The standard uses what is called MIMO (multiple-input multiple-output antenna) to overcome the noise problem in wireless LANs.
- Some implementations of this project have reached up to 600 Mbps data rate.