Lecture 24: Wireless and Mobile Networks I

2019. 6. 3.

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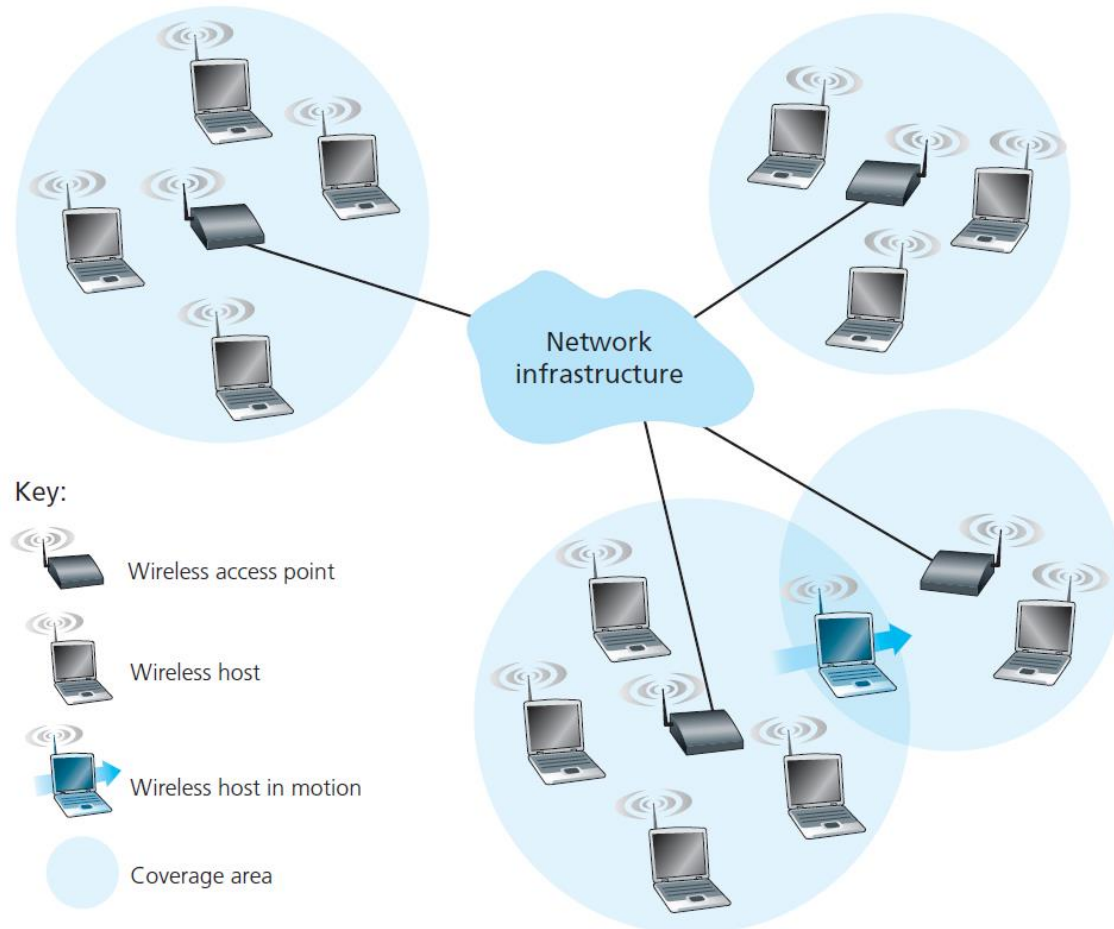
- Wireless and mobility: Impact on higher-layer protocols

Introduction

◈ **Elements of a wireless network**

　◆　Access point (AP): Link-layer device

Network infrastructure

Key:

Wireless access point

Wireless host

Wireless host in motion

Coverage area

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Introduction

◈ **Classification of wireless networks**

- Single-hop, infrastructure-based

  - 802.11 networks, 4G LTE data networks

- Single-hop, infrastructure-less

  - Bluetooth networks

- Multi-hop, infrastructure-based

  - Some wireless sensor networks

- Multi-hop, infrastructure-less

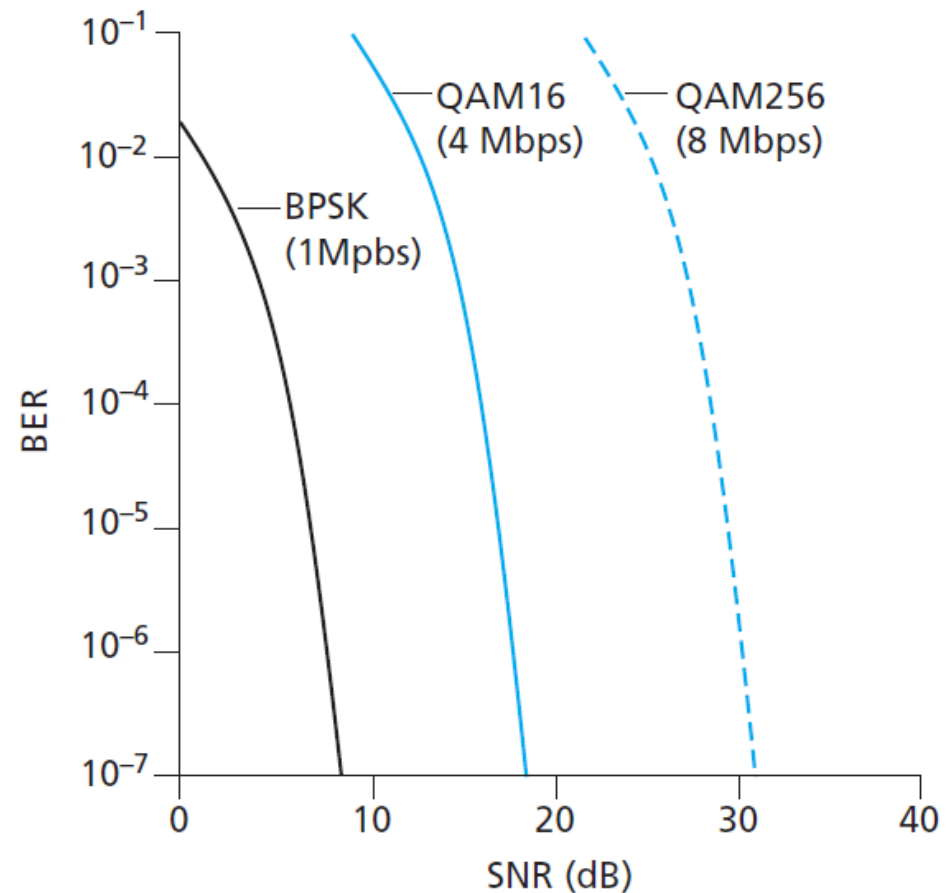 - Mobile ad hoc network (MANET)

  - Vehicular ad hoc network (VANET)

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Wireless Links and Network Characteristics

◈ **Wireless link characteristics**

- ◆ Decreasing signal strength

- ◆ Interference from other sources

- ◆ Multipath propagation

◈ **Signal-to-noise ratio (SNR)**

- ◆ A relative measure of the strength of the received signal and the noise

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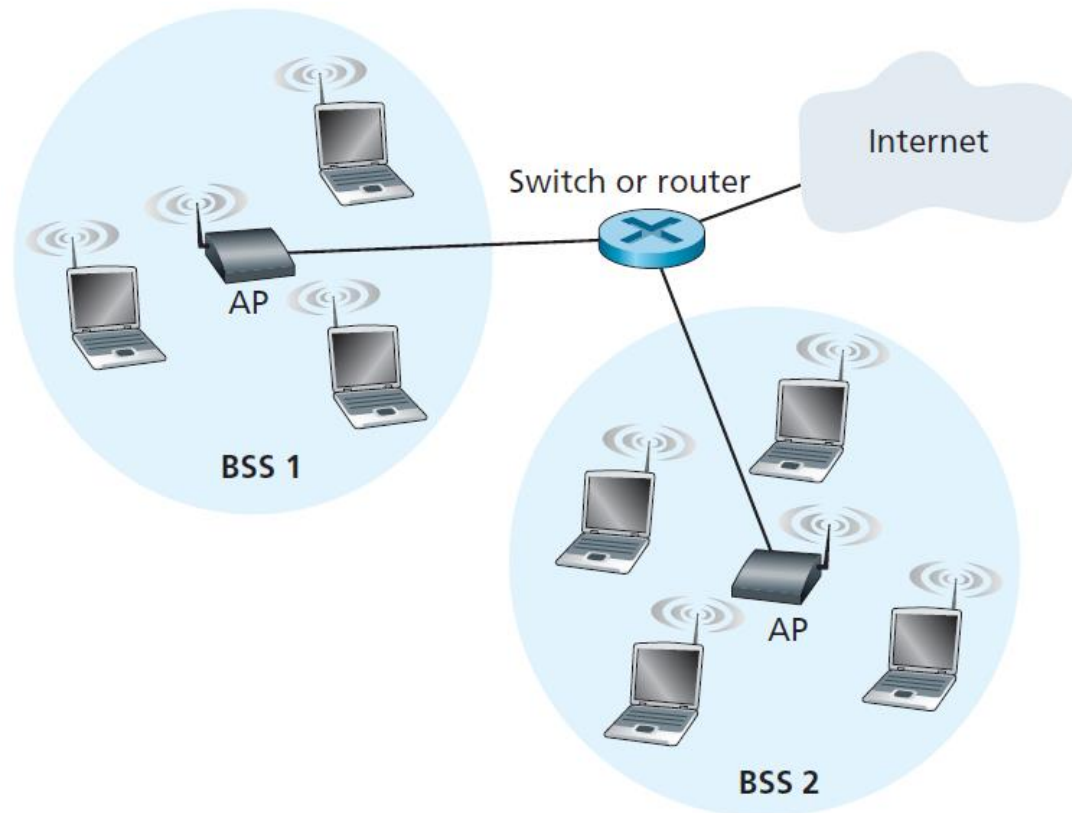
WiFi: 802.11 Wireless LANs

◈ **IEEE 802.11 wireless LAN standards**

Standard	Frequency Range	Data Rate	Technologies
802.11b	2.4 GHz	up to 11 Mbps	DSSS
802.11a	5 GHz	Up to 54 Mbps	OFDM
802.11g	2.4 GHz	Up to 54 Mbps	OFDM, DSSS
802.11n	2.5 GHz, 5 GHz	Up to 450 Mbps	OFDM, MIMO
802.11ac	5 GHz	Up to 1300 Mbps	Beamforming

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DSSS: Direct-sequence spread spectrum
OFDM: Orthogonal frequency division multiplexing

WiFi: 802.11 Wireless LANs

◈ **The 802.11 architecture**

  ◆ Basic service set (BSS): One AP and other wireless stations

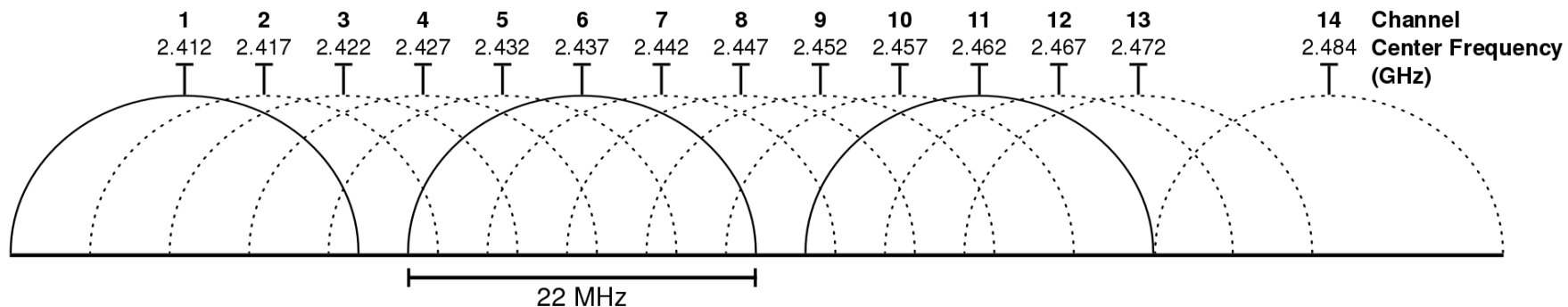# WiFi: 802.11 Wireless LANs

◈ **Channels**

- 802.11b

  - Channels can vary across regions.

|														
1	2	3	4	5	6	7	8	9	10	11	12	13	14	**Channel**
2.412	2.417	2.422	2.427	2.432	2.437	2.442	2.447	2.452	2.457	2.462	2.467	2.472	2.484	**Center Frequency (GHz)**

22 MHz

◈ **Association**

- A device creates a virtual wire between itself and the AP.

  - Association request/response frames

- The data frames can be exchanged between a device and its associated AP only.
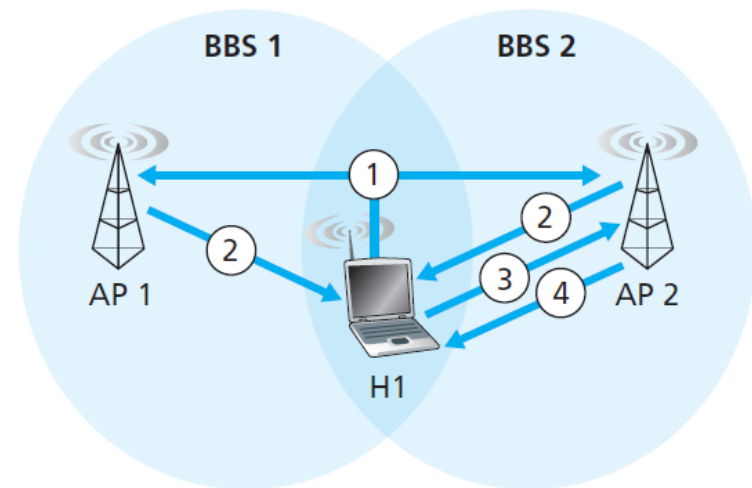
WiFi: 802.11 Wireless LANs

◈ **Scanning for Aps**

◆ A beacon frame includes the AP's Service Set Identifier (SSID) and MAC address.
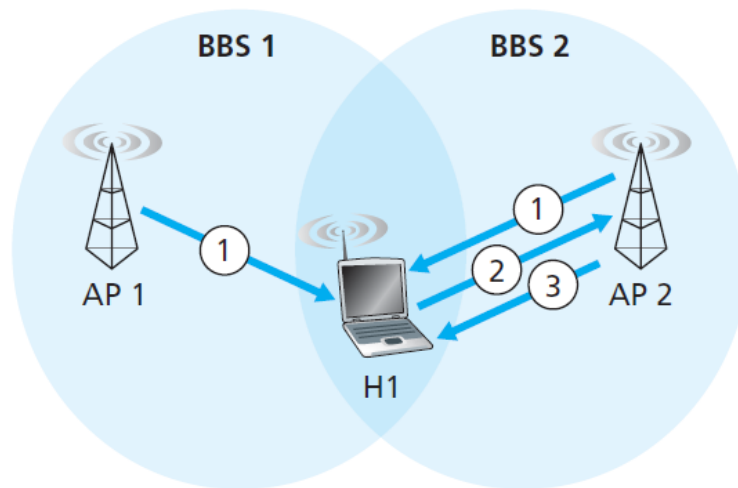
a. Passive scanning
  1. Beacon frames sent from APs
  2. Association Request frame sent:
     H1 to selected AP
  3. Association Response frame sent:
     Selected AP to H1

a. Active scanning
  1. Probe Request frame broadcast from H1
  2. Probes Response frame sent from APs
  3. Association Request frame sent:
     H1 to selected AP
  4. Association Response frame sent:
   Selected AP to H1

WiFi: 802.11 Wireless LANs

- ◈ **The 802.11 MAC protocol**

  - ◆ CSMA with collision avoidance (CSMA/CA)

    - ◆ Step 1) If the channel is idle, the station transmits its frame after DIFS.

    - ◆ Step 2) If the channel is busy, the station chooses a random backoff value using the binary exponential backoff.

      - ◆ Decrease the counter value if the channel is idle.

      - ◆ Hold the counter value if the channel is busy.

    - ◆ Step 3) When the counter reaches zero, the station transmits the frame and then waits for an ACK.

    - ◆ Step 4) If an ACK is received and the station has another frame to send, goes to Step 2. If the ACK is not received, the station reenters the backoff phase with the random value chose from a *larger* interval.
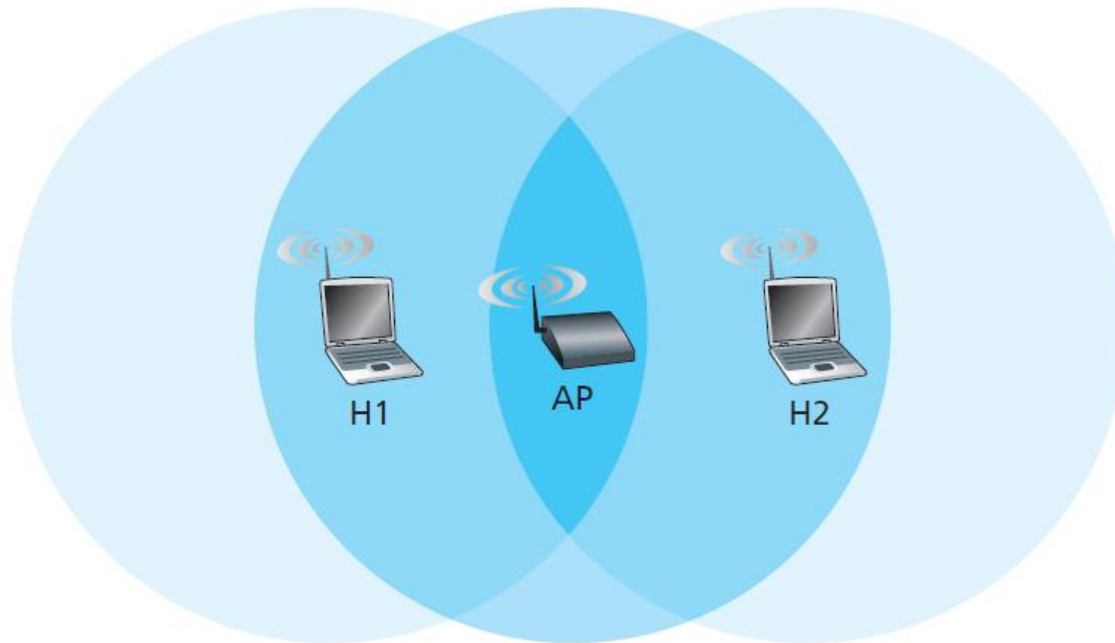
SEJONG UNIVERSITY   DIFS: Distributed inter-frame space

WiFi: 802.11 Wireless LANs

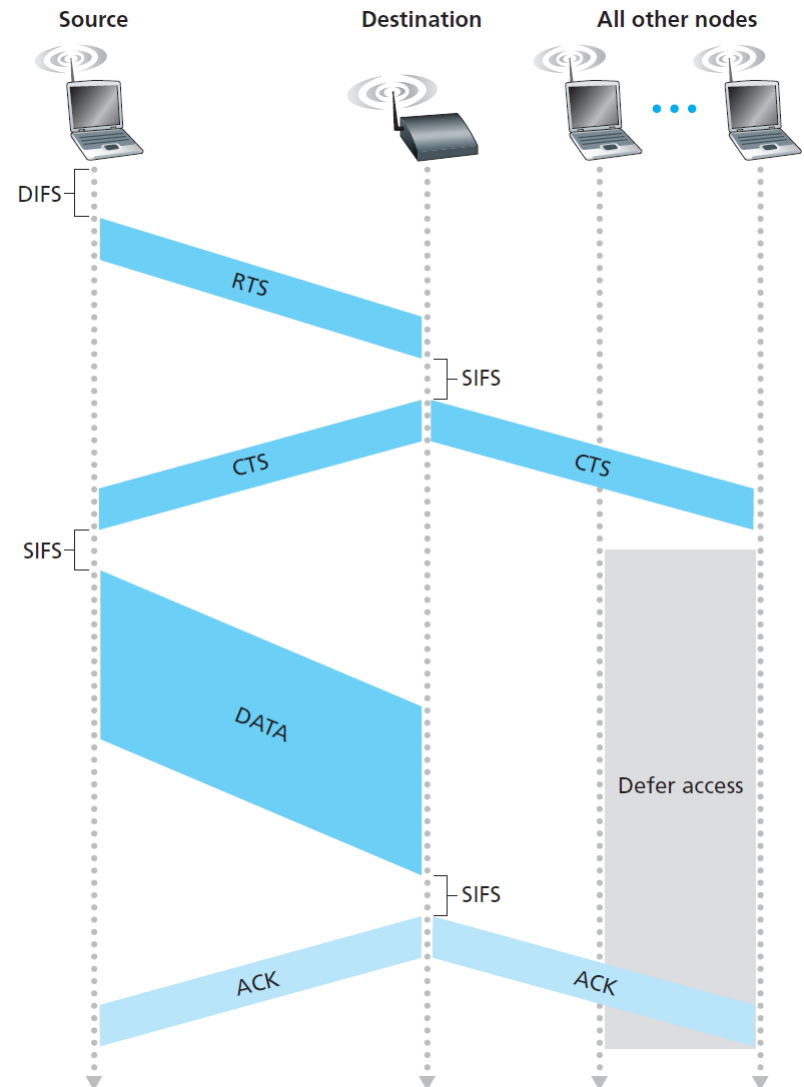◈ **The 802.11 MAC protocol**

♦ Link-layer acknowledgements
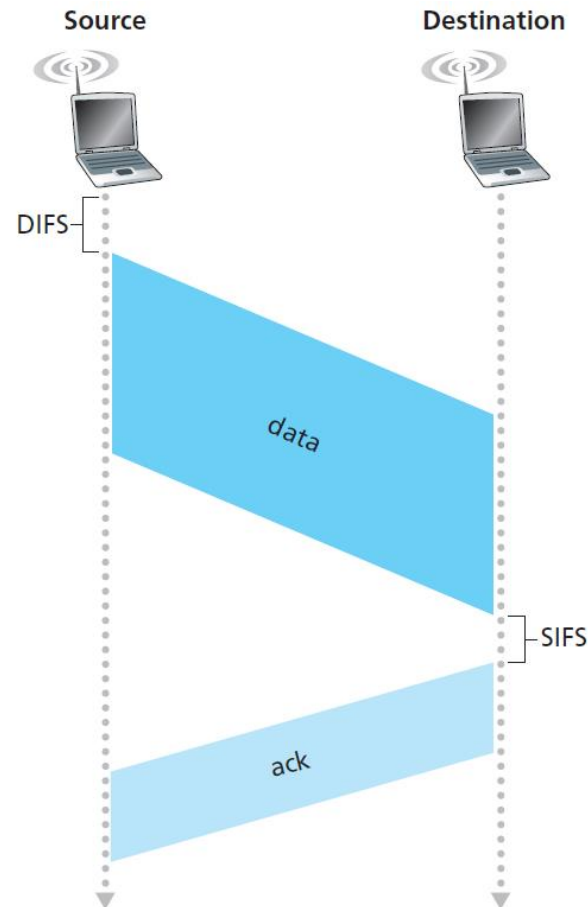
WiFi: 802.11 Wireless LANs

◈ **Hidden terminal problem**

 ◆ H1 is hidden from H2, and vice versa.

WiFi: 802.11 Wireless LANs

◈ **Dealing with hidden terminals**

- Request to send (RTS) control frame

- Clear to send (CTS) control frame

WiFi: 802.11 Wireless LANs

Frame (numbers indicate field length in bytes):

2	2	6	6	6	2	6	0-2312	4
Frame control	Duration	Address 1	Address 2	Address 3	Seq control	Address 4	Payload	CRC

◇ **The fields in a frame**

- ◆ Payload and CRC fields

  - ◆ The payload size is typically fewer than 1,500 bytes.

- ◆ Address fields

  - ◆ Address 2: The MAC address of the station that transmits a frame

  - ◆ Address 1: The MAC address of the station that receives the frame

  - ◆ Address 3: The MAC address of the router interface

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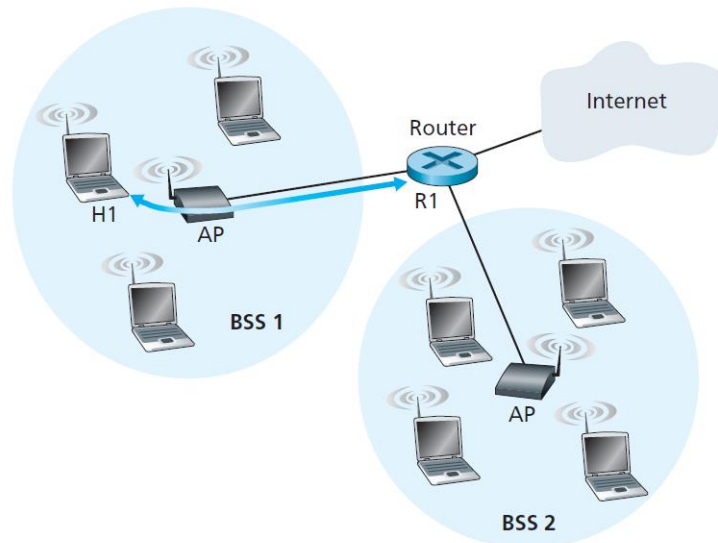
WiFi: 802.11 Wireless LANs

◈ **Mobility in the same IP subnet**

  ◆ As H1 moves away from AP1, H1 detects a weakening signal from AP1 and starts to scan for a stronger signal.

  ◆ H1 receives beacon frames from AP2.

  ◆ H1 then disassociates with AP1 and associates with AP2, while keeping its IP address and maintaining its ongoing TCP sessions.
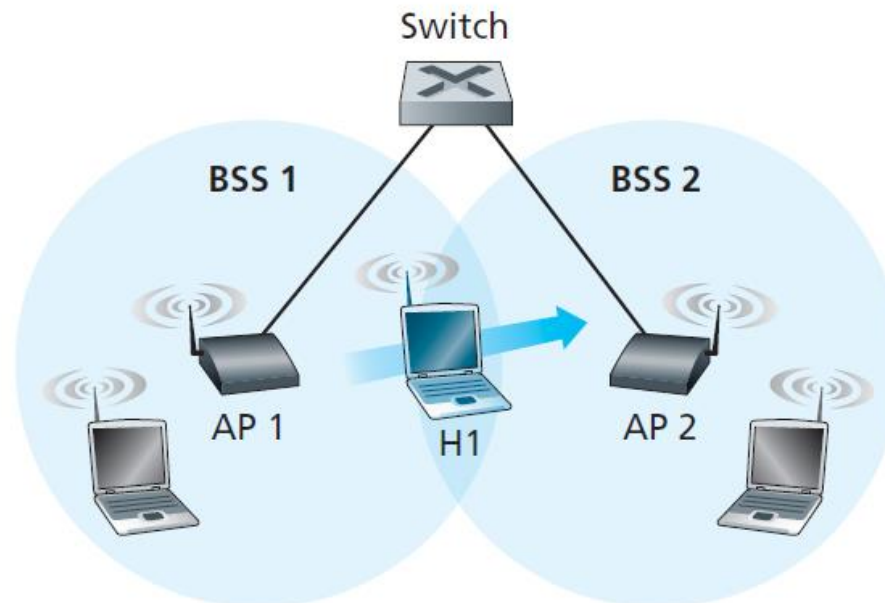
WiFi: 802.11 Wireless LANs

◈ **Advanced features in 802.11**

- ◆ Rate adaptation

  - ◆ The transmission rate is controlled according to the channel state.

- ◆ Power management

  - ◆ Alternate between sleep and wake states

  - ◆ A node goes to sleep state and will wake up just before the AP sends a beacon frame, and quickly enter the fully active state.

  - ◆ The beacon frames sent out by the AP contain a list of nodes whose frames have been buffered at the AP.