ECCS-3631
Networks and Data Communications

Module 8-1
Wireless Networks

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Wireless Networks

Most popular wireless Internet access technologies today. Compare and contrast them.

(1) Wireless LAN:

In a wireless LAN, wireless users transmit/receive packets to/from a base station (i.e., wireless access point) within a radius of 200 to 300 ft. The base station is typically connected to the wired Internet and thus serves to connect wireless users to the wired network. Wi-Fi does not provide high-speed mobility.

(2) Mobile Data Networks:

In these systems, packets are transmitted over the same wireless infrastructure used for cellular telephony, with the base station thus being managed by a telecommunications provider. This provides wireless access to users within a radius of tens of miles of the base station. Cellular network provide high-speed mobility.

Comparison of Wireless Networks

Wireless LAN

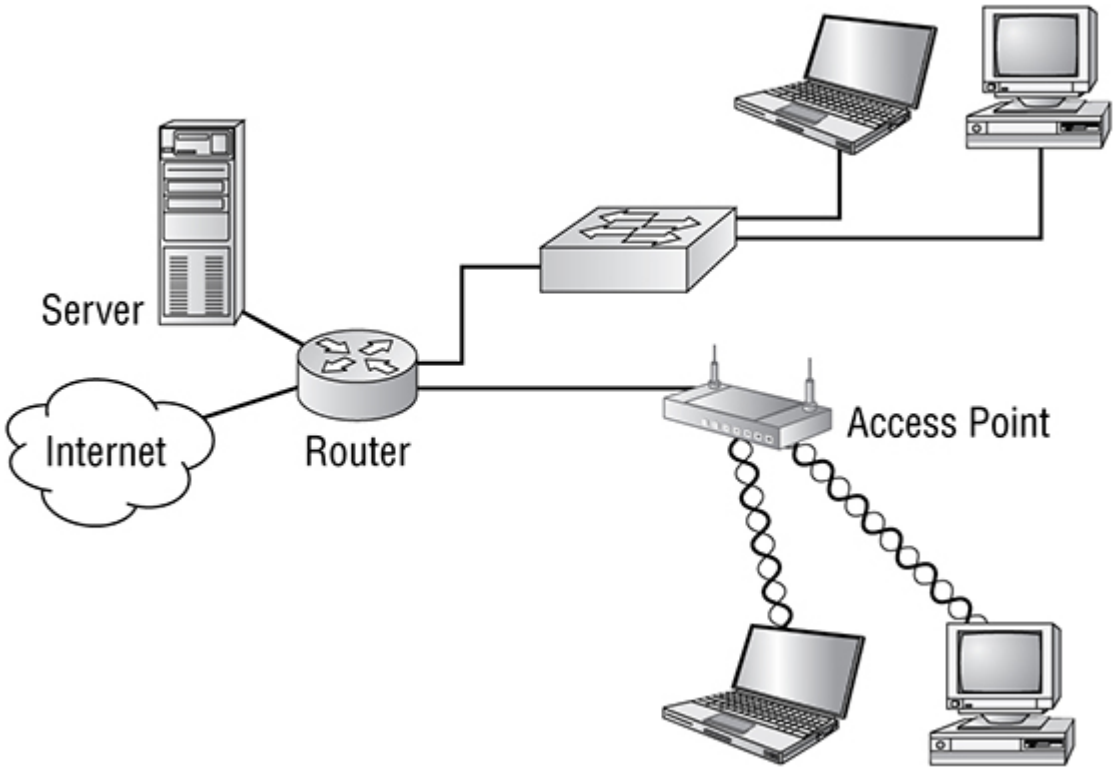
- Limited range, about 200 to 300 ft
- Set up yourself in-home or offered by ISP
- No limit for the amount of usage
- Use Free ISM band including 2.4 GHz, 5 GHz, 6 GHz)
- Does not provide hand over
- No mobility

Mobile Networks (Wireless Wide Area Network, WWAN)

- Long distances, typically 1000 to 2000 ft.
- Offered by mobile carriers (AT&T, Verizon, Sprint, T-Mobile, etc.)
- Buy plans based on usage
- Cellular frequencies are allocated by the US Federal Communications Commission (FCC). Examples: 1.7 GHz, 1.9 GHz, 2.1 GHz, 2.3 GHz, 2.5 GHz, etc.
- Provides hand over
- High mobility, remain connected while moving at a high speed

Wireless Networks

- An extension of an existing LAN
- Provides wireless connectivity to computer and end devices.



Basic Wireless Devices – AP

- Wireless Access Point (AP) is a Central Component like a hub or switch to connect hosts and allow them to communicate.
- Wireless APs have at least one antenna.
- AP has half-duplex nature. A wireless device cannot send and receive simultaneously.
- APs come in two types: Stand-alone AP or the Wireless Router.

Wireless Network Interface Card

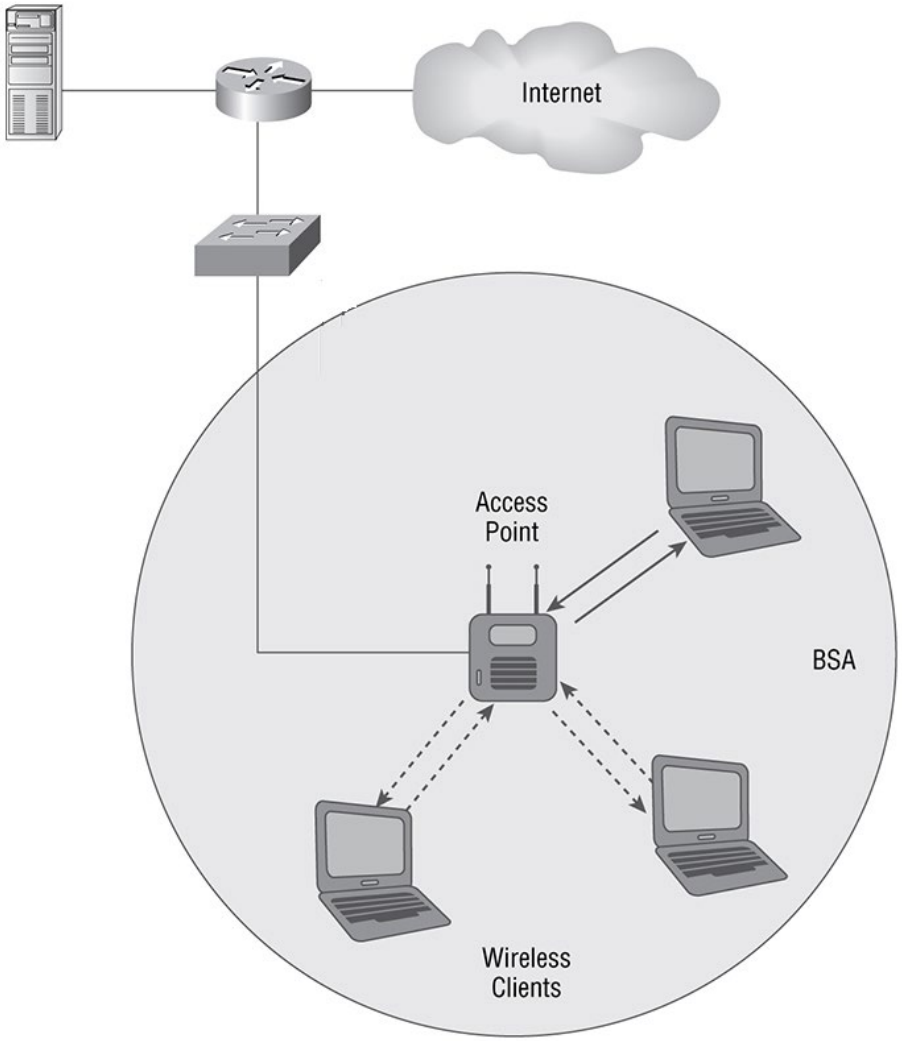
- A host needs a Wireless Network Interface Card to connect to a wireless network.
- A Wireless NIC does the same job as a traditional NIC
- The Wireless NIC has a radio antenna.

Wireless Antenna

- Wireless Antennas work with both transmitters and receivers.
- Two broad classes of antennas:
  - Omni-directional (or point-to-multipoint)
  - Directional (point-to-point)

Basic Service Set (BSS) or Basic Service Area (BSA)

- A Basic Service Set (BSS) is the area, or cell, defined by the wireless signal served by the AP.
- It can also be called a Basic Service Area (BSA).
- BSS is the most common term that's used to define the cell area.

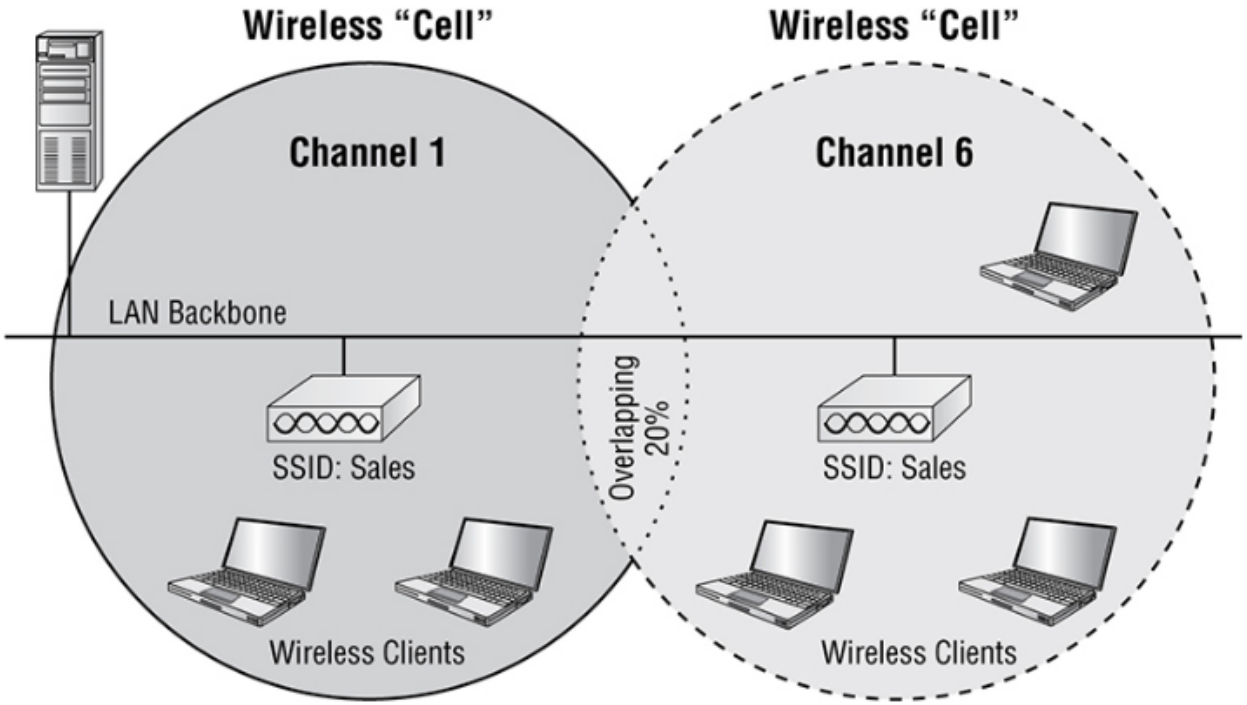


Service Set ID (SSID)

- An SSID is a basic name that defines the Basic Service Area (BSA) transmitted from the AP.
- This is the name the AP transmits out to identify which WLAN the client station can associate with.
- The SSID can be up to 32 characters long
- SSID can be either broadcasted to the outside world or hidden.

Extended Service Set

- If you set all access points to the same SSID, wireless clients can roam around freely within the same network.
- A most common wireless network design in today's corporate settings.

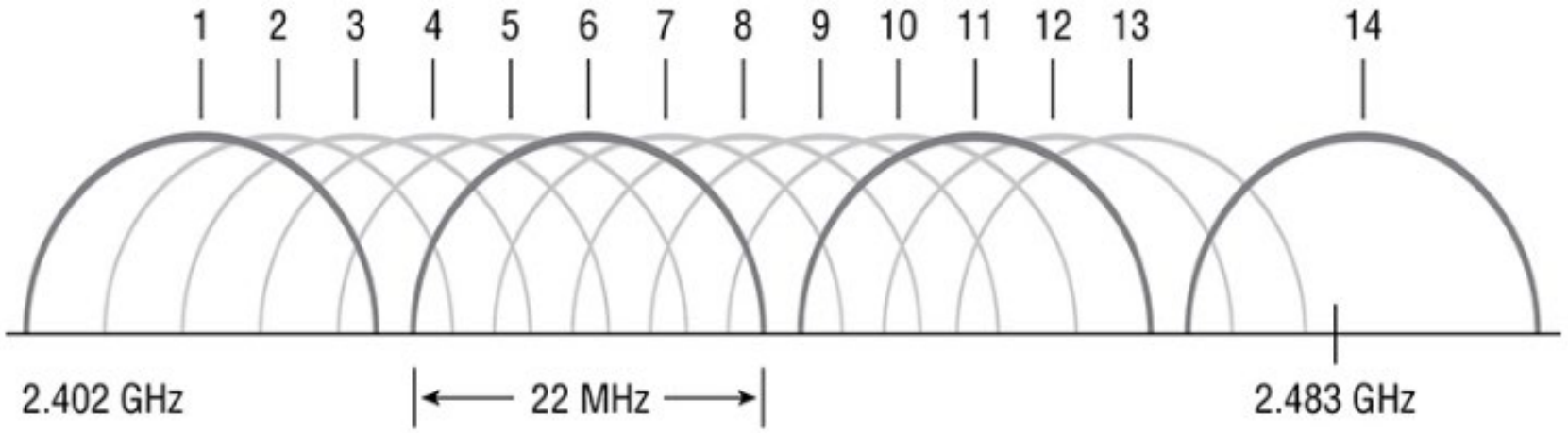


Wi-Fi Channels

- ISM radio bands are reserved for Industrial, Scientific, and Medical purposes except telecommunications.
- Wi-Fi Frequency Bands: 2.4 to 2.5 GHz
  5.15 GHz to 5.35 GHz
  5.925 GHz to 6.425 GHz
- IEEE 802.11b/g/n uses 2.4 to 2.5 GHz
- IEEE 802.11ac uses 5.15 GHz to 5.35 GHz
- IEEE 802.11ax uses 5.925 GHz to 6.425 GHz

2.4 GHz Band

- Within the 2.4GHz (ISM) band are 11 channels approved for use in the United States, 13 in Europe, and 14 in Japan.
- Each channel is defined by its center frequency, but remember, that signal is spread across 22MHz.
- There is 11MHz on one side of the center frequency and 11MHz on the other side, so each channel encroaches on the channel next to it
- This means that consequently, within the United States, only channels 1, 6, and 11 are considered nonoverlapping.



IEEE 802.11 Standards

- IEEE 802.11a, year 1997, 1-2 Mbps data rate, 2.4 GHz
- IEEE 802.11b, year 2000, 11 Mbps data rate, 2.4 GHz
- IEEE 802.11g, year 2003, 54 Mbps data rate, 2.4 GHz
- IEEE 802.11n, year 2009, 600 Mbps data rate, uses MIMO, 2.4 GHz
- IEEE 802.11ac, year 2013, 6.9 Gbps data rate, 5 GHz
- IEEE 802.11ax, year 2021, 9.6 Gbps data rate, 2.4/5/6 GHz

2.4 GHz Channel Allocations

Channel	Center Frequency (MHz)	Frequency Range (MHz)
1	2412	2401–2423
2	2417	2406–2428
3	2422	2411–2433
4	2427	2416–2438
5	2432	2421–2443
6	2437	2426–2448
7	2442	2431–2453
8	2447	2436–2458
9	2452	2441–2463
10	2457	2446–2468
11	2462	2451–2473

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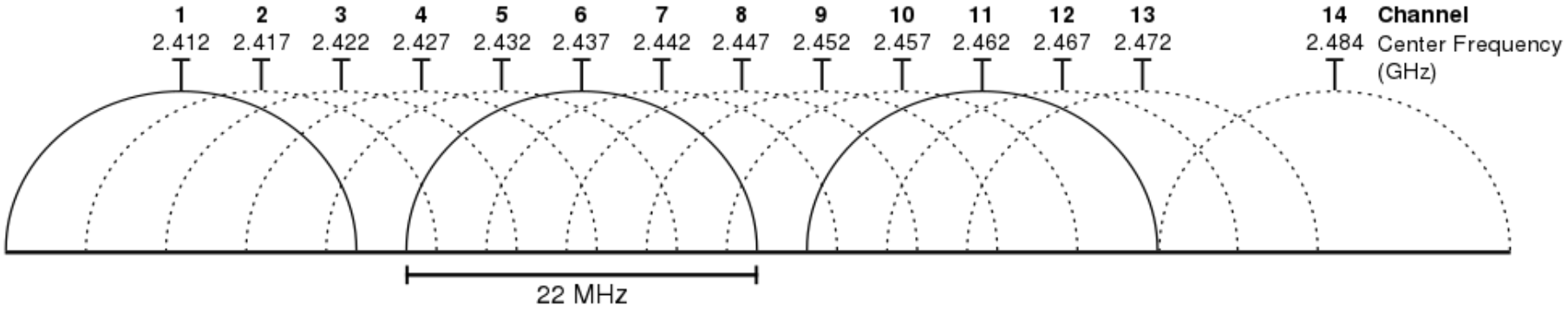
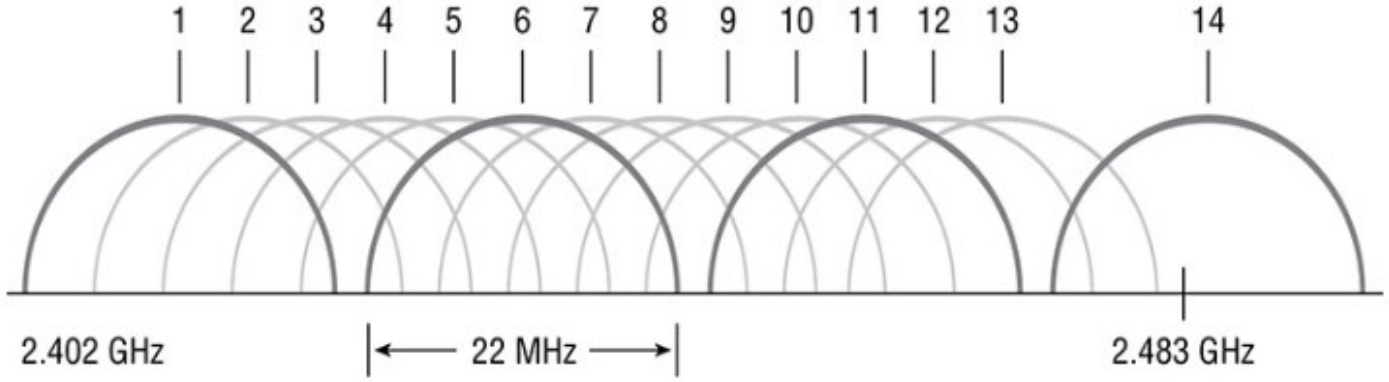


Wi-Fi Overlapping Channels

- When APs are on the same channel, they will hear each other and defer to one another when transmitting. This is due to information sent in the header of each wireless packet that instructs all stations in the area (including any APs) to refrain from transmitting until the current transmission is received. The APs perform this duty based partially on the duration field. Anyway, the end result is that both networks will be slower because they'll be dividing their transmission into windows of opportunity to transmit between them.
- When the APs are only one or two channels apart, things get a little tricky, because in this case, they may not be able to hear each clearly enough to read the duration field. The ugly result of this is that they'll transmit at the same time, causing collisions that cause retransmissions and can seriously slow down your throughput—ugh! Therefore, although the two behaviors are different within these two scenarios, the end result is the same: greatly lowered throughput.



Wi-Fi Channel Overlap Techniques

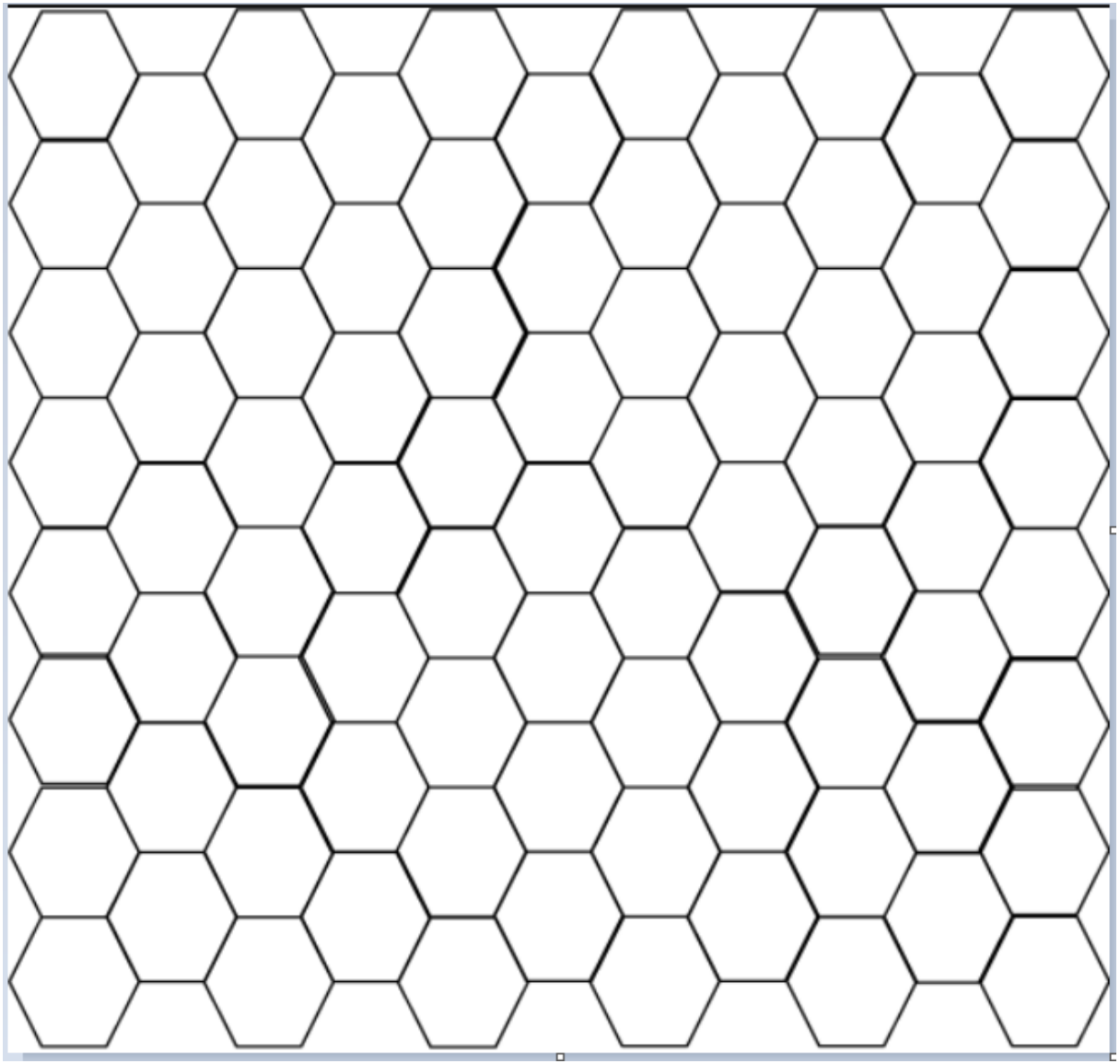
Sometimes it becomes necessary to deploy multiple APs, and here are two scenarios that certainly scream for doing this:

- You have a large number of users in a relatively small area. Considering the nature of the contention method used by WLANs the more users associated with a particular access point, the slower the performance. By placing multiple access points in the same area on different channels, the station-to-AP ratio improves, and performance improves accordingly.
- The area to be covered exceeds the range of a single AP and you would like to enable seamless roaming between the APs when users move around in the area.

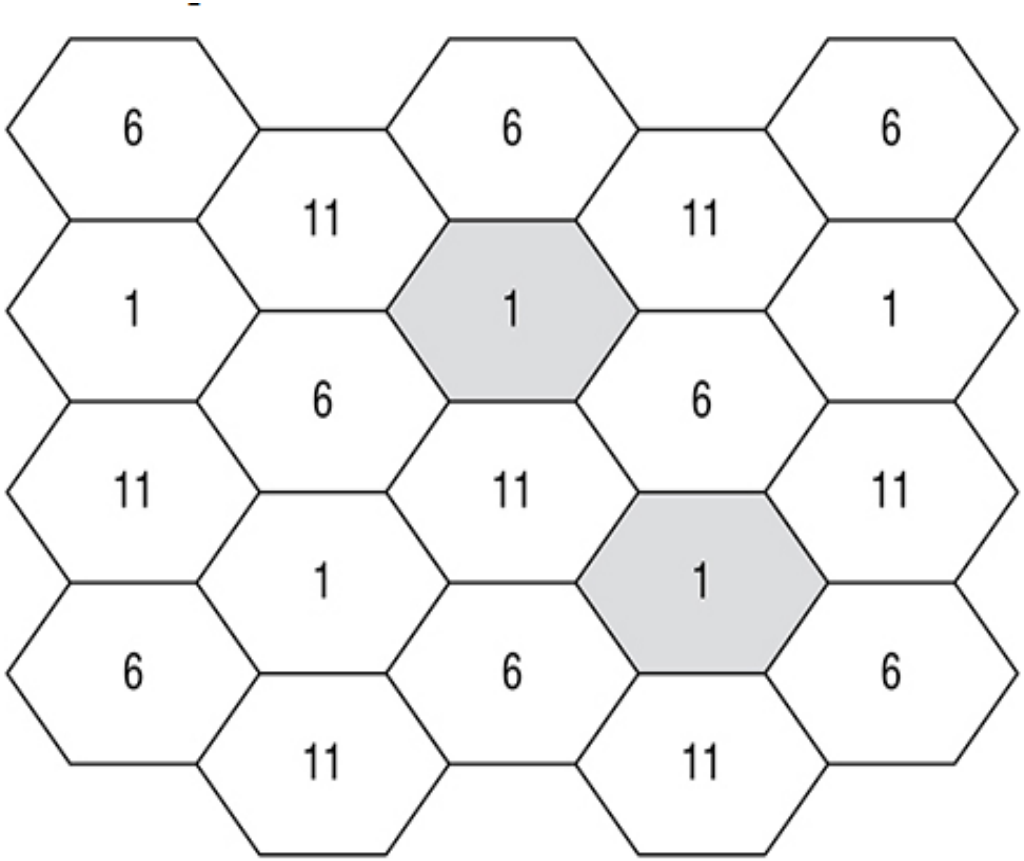
Multiple APs in the same Area for 2.4 GHz

- When deploying multiple APs in the same area, you need to choose channels that don't overlap.
- With the 2.4GHz band, ***the channels must have at least four channels' space between them***, and remember—only 1, 6, and 11 are non-overlapping.
- When choosing channels in a wide area, they can be reused if there's enough space between each channel's usage area or cell.

WiFi 2.4 GHz Planning

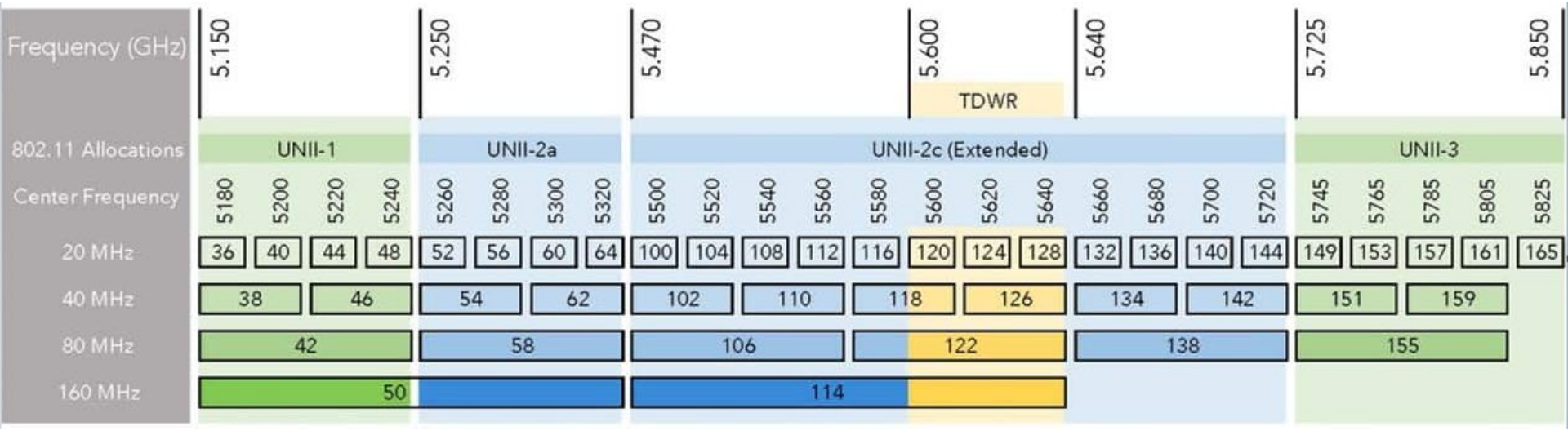


WiFi 2.4 GHz Planning



5 GHz Channel Allocations

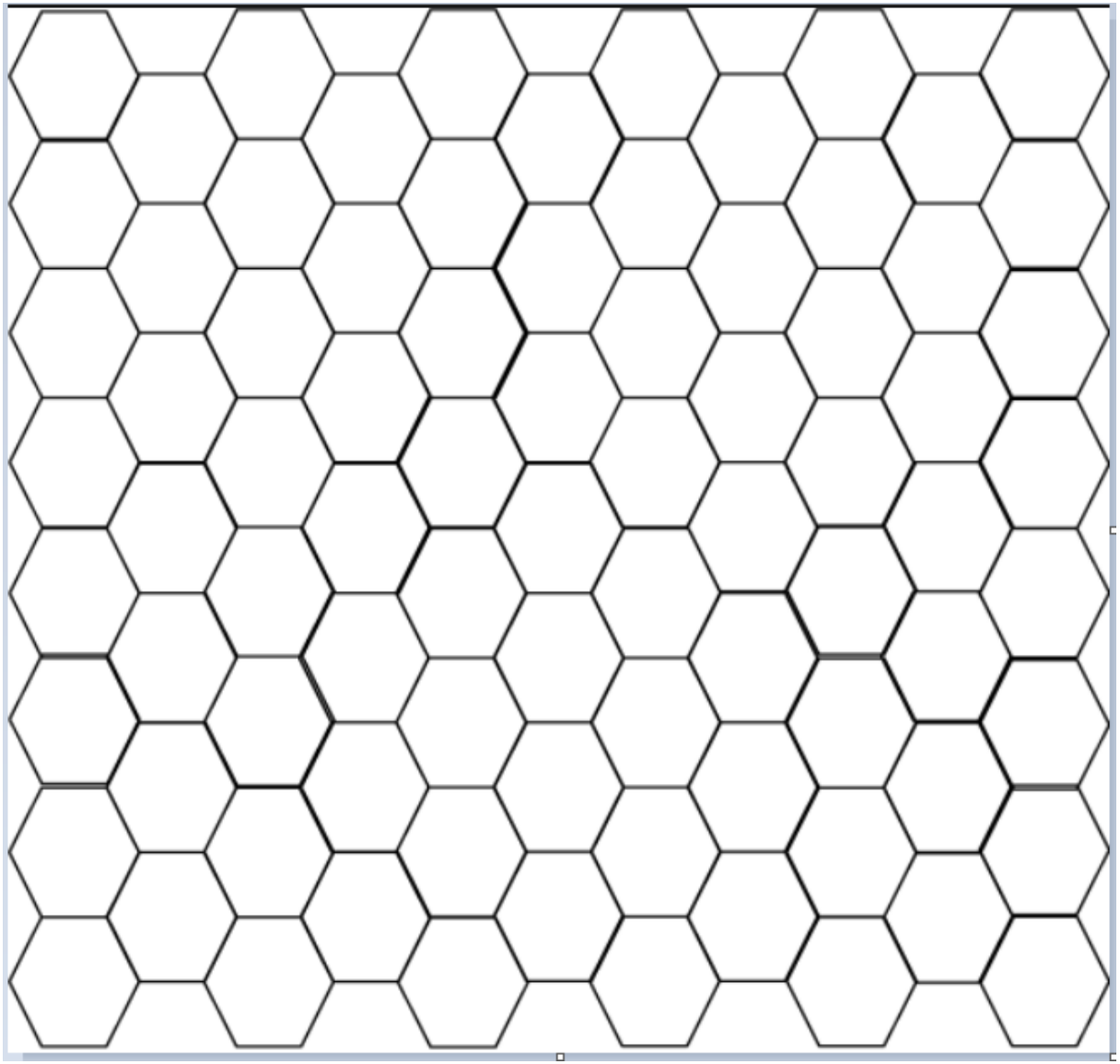
- Within the 2.4GHz (ISM) band are 11 channels approved for use in the United States, 13 in Europe, and 14 in Japan.
- 5GHz frequency is divided into three unlicensed bands called the Unlicensed National Information Infrastructure (UNII) bands. These bands are known as UNII-1, UNII-2, and UNII-3—the lower, middle, and upper UNII bands.
- In the lower UNII band the center points are 10MHz apart, and in the other two the center frequencies are 20MHz apart.



Multiple APs in the same Area for 5 GHz

- When deploying APs in the 5GHz band (802.11a), ***the space between the channels can be two channels***, given that there's no overlap.

WiFi 5 GHz Planning



WiFi 5 GHz Planning