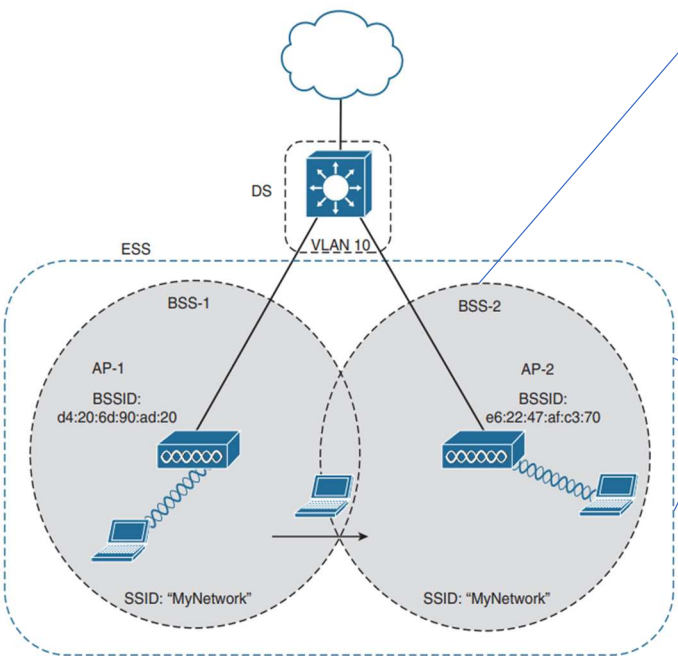


Wireless Fundamentals

- Wireless LANs are defined in 802.11.
- Operate in half duplex using CSMA/CA
- Wireless signals can be affected by **absorption, reflection, refraction, diffraction, and scattering**.
- Various aspects of waves can be measured, such as **amplitude, frequency, and period**.
- Frequency is measured in **hertz (Hz)**.
- Wireless LANs use two frequency ranges: the **2.4 GHz** band and **5 GHz** band.
 - Wi-Fi 6 (802.11ax) can use the **6 GHz** range too.
- Bands are divided into channels.
- 5 GHz band consists of non-overlapping channels.
- 2.4 GHz band channels overlap. To avoid overlapping, use channels 1, 6, and 11 (in North America).
- 802.11 standards (802.11b, 802.11a, etc) and their frequencies/theoretical max data rates.
- Service sets are groups of wireless devices. Three types:
 - Independent (**IBSS**, also called **ad hoc**)
 - Infrastructure (**BSS**, **ESS**)
 - *passing between APs in an ESS is called **roaming**.
 - Mesh (**MBSS**)
- Service sets are identified by an **SSID** (non-unique, human-readable) and **BSSID** (unique, MAC address of AP).
- The area around an AP where its signal is usable is called a **BSA**.
- The upstream wired network is called the **DS**.
- When multiple WLANs are used, each is mapped to a separate VLAN on the wired network.
- APs can also operate as a **repeater, workgroup bridge, or outdoor bridge**.

Standard	Frequencies	Max Data Rate (theoretical)	Alternate Name
802.11	2.4 GHz	2 Mbps	
802.11b	2.4 GHz	11 Mbps	
802.11a	5 GHz	54 Mbps	
802.11g	2.4 GHz	54 Mbps	
802.11n	2.4 / 5 GHz	600 Mbps	*Wi-Fi 4 (HT)
802.11ac	5 GHz	6.93 Gbps	*Wi-Fi 5 (VHT)
802.11ax	2.4 / 5 / 6 GHz	4*802.11ac	Wi-Fi 6



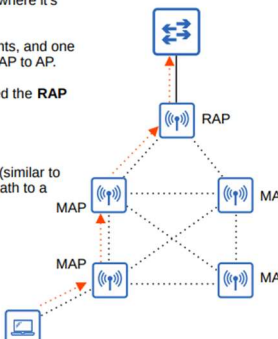
BSS (Basic Service Set) is a kind of Infrastructure Service Set in which clients connect to each other via an AP, but not directly to each other.

- A **BSSID (Basic Service Set ID)** is used to uniquely identify the AP.
 - Other APs can use the same SSID, but not the same BSSID
 - The BSSID is the MAC address of the AP's radio
- Wireless devices request to **associate** with the BSS.
- Wireless devices that have associated with the BSS are called 'clients' or 'stations'.
- *The area around an AP where its signal is usable is called a **BSA (Basic Service Area)**.
- *Clients must communicate via the AP, not directly with each other.

ESS (Extended Service Set)

- To create larger wireless LANs beyond the range of a single AP, we use an **ESS (Extended Service Set)**.
- APs with their own BSSs are connected by a wired network.
 - Each BSS uses the same SSID.
 - Each BSS has a unique BSSID.
 - Each BSS uses a different channel to avoid interference.
- Clients can pass between APs without having to reconnect, providing a seamless Wi-Fi experience when moving between APs.
 - This is called **roaming**.
- The BSAs should overlap about 10-15%.

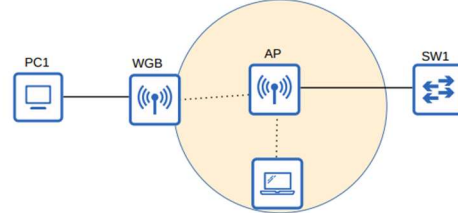
- An **MBSS (Mesh Basic Service Set)** can be used in situations where it's difficult to run an Ethernet connection to every AP.
- Mesh APs use two radios: one to provide a BSS to wireless clients, and one to form a 'backhaul network' which is used to bridge traffic from AP to AP.
- At least one AP is connected to the wired network, and it is called the **RAP (Root Access Point)**.
- The other APs are called **MAPs (Mesh Access Points)**.
- A protocol is used to determine the best path through the mesh (similar to how dynamic routing protocols are used to determine the best path to a destination).



- A **workgroup bridge (WGB)** operates as a wireless client of another AP, and can be used to connect wired devices to the wireless network.
- In the example below, PC1 does not have wireless capabilities, and also does not have access to a wired connection to SW1.
- PC1 has a wired connection to the WGB, which has a wireless connection to the AP.

There are two kinds of WGBs: **Universal WGB (uWGB)** is an 802.11 standard that allows one device to be bridged to the wireless network.

WGB is a Cisco-proprietary version of the 802.11 standard that allows multiple wired clients to be bridged to the wireless network.




An AP in **repeater mode** can be used to extend the range of a BSS.

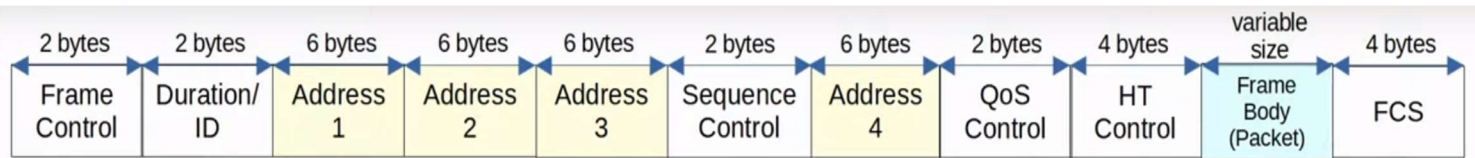
The repeater will simply retransmit any signal it receives from the AP

- Single radio repeater must operate on same channel as the AP, but can drastically reduce the overall throughput on the Ch by 50%.
- Two radio repeater can receive on one channel, and then retransmit on another channel.

- An **outdoor bridge** can be used to connect networks over long distances without a physical cable connecting them.
- The APs will use specialized antennas that focus most of the signal power in one direction, which allows the wireless connection to be made over longer distances than normally possible.
- The connection can be point-to-point as in the diagram below, or point-to-multipoint in which multiple sites connect to one central site.



802.11 Frame Format



- **Frame Control:** Provides information such as the message type and subtype.
 - **Duration/ID:** Depending on the message type, this field can indicate:
 - the time (in microseconds) the channel will be dedicated for transmission of the frame.
 - and identifier for the association (connection).
 - **Addresses:** Up to four addresses can be present in an 802.11 frame. Which addresses are present, and their order, depends on the message type.
 - Destination Address (DA): Final recipient of the frame
 - Source Address (SA): Original sender of the frame
 - Receiver Address (RA): Immediate recipient of the frame
 - Transmitter Address (TA): Immediate sender of the frame
 - **Sequence Control:** Used to reassemble fragments and eliminate duplicate frames.
 - **QoS Control:** Used in QoS to prioritize certain traffic.
 - **HT (High Throughput) Control:** Added in 802.11n to enable High Throughput operations.
 - 802.11n is also known as 'High Throughput' (HT) Wi-Fi
 - 802.11ac is also known as 'Very High Throughput' (VHT) Wi-Fi
 - **FCS (Frame Check Sequence):** Same as in an Ethernet frame, used to check for errors.
- 802.11 frames have a different format than 802.3 Ethernet frames.
 - For the CCNA, you don't have to learn it in as much detail as the Ethernet and IP headers.
 - Depending on the 802.11 version and the message type, some of the fields might not be present in the frame.
 - For example, not all messages use all 4 address fields.