Cisco Meraki

Channel Planning Best Practices

This article discusses channel planning best practices for an 802.11 wireless deployment.

APs should be deployed in such a manner that wireless clients experience minimal packet loss and choose the AP with the strongest signal when roaming. In order to achieve this, neighboring APs will need to be close enough so that their coverage cells have some overlap. When APs have overlapping coverage they should be set to different non-overlapping channels. This prevents the APs from causing an increase in channel utilization or interfering with each other.

The Cisco Meraki wireless system provides two features (auto channel selection and power reduction) that automatically adjust the channel settings and power levels of neighboring APs in the same network with the goal of providing strong wireless coverage while preventing an increase in channel utilization or causing interference. In certain high density deployments however, these features may not be aggressive enough. In these instances, a Dashboard administrator can use RF measurements from a site survey to perform manual channel and power selection to fine tune the wireless network.

The goal of using different non-overlapping channels is to avoid the affects caused by channel utilization and interference. The two sections below explain why this is important.

Channel utilization

APs and wireless clients on the same channel who are also within range of each other form a single broadcast domain, similar to an Ethernet hub. All devices can hear each other's transmissions and if any two devices transmit at the same time, their radio signals will collide and become garbled resulting in data corruption or complete frame loss. If there is an excessive amount of collisions, data would never be transmitted successfully and the wireless network would be unusable. To avoid collisions, 802.11 wireless devices use a listen before speaking approach when accessing the wireless medium. Specifically, devices perform a Clear Channel Assessment (CCA) by listening to see if another device is actively transmitting on the channel before attempting to send its own frames. When a device detects another transmission in progress, it will perform a random back-off for a short period of time after which it would perform another check before attempting to transmit again. If the channel is clear after a check, the device can access the channel and send some data. As the number of devices needing to transmit frames increase on the channel, congestion can occur to the point where devices spend more time receiving than sending. This results in slower speeds because devices have to wait longer to send data.

Interference

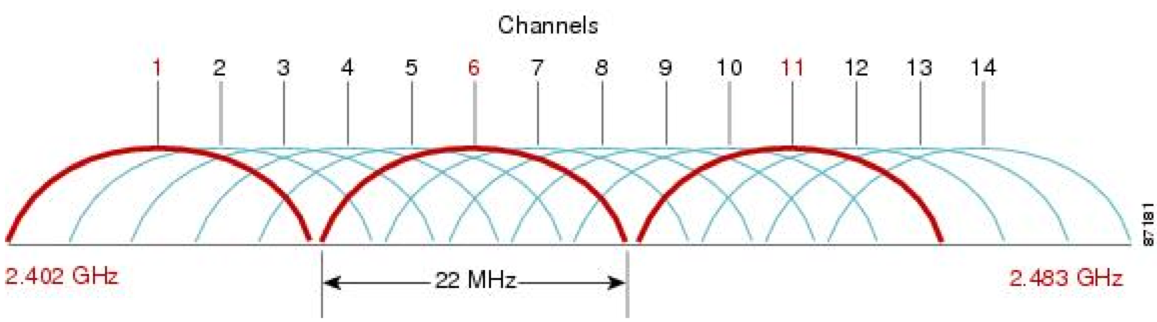
When two wireless devices transmit at the same time, their radio signals will collide and become garbled. 802.11 devices on the same channel use a CCA check to avoid these collisions. However, the CCA check may not detect a transmission occurring on a different channel that also has some frequency overlap on the channel the check is being performed on. In this case, two 802.11 devices on different channels that overlap may transmit at the same time causing a collision and possible data corruption or frame loss. This is called interference because one device's transmission interferes with another device's transmission. As the number of interfering devices increase, so does the potential for frame loss. The 802.11 standard uses a reliable transport mechanism where each sent data frame must be ACK'd by the receiver to ensure the frame was not lost in transit or corrupted. If a the sender does not receive an ACK, it must re-transmit the same frame until an ACK is received. Re-transmissions result slower speeds because it takes longer to successfully send a single frame.

802.11 RF Spectrum

2.4GHz

The 802.11 standard defines fourteen 20MHz wide channels in the 2.4GHz industrial, scientific, and medical (ISM) band. Wireless devices specified as 802.11b/g/n are capable of operating within this band. The channels available within different countries/regions is dictated by local governing authorities. In the United States, channels 1 through 11 are permitted. This provides three non-overlapping channels 1, 6 and 11. Because most of the channels overlap, 2.4GHz is not the best choice for high density 802.11 deployments. Below is a diagram showing the 2.4GHz channel plan.

2.4 GHz Channel Plan



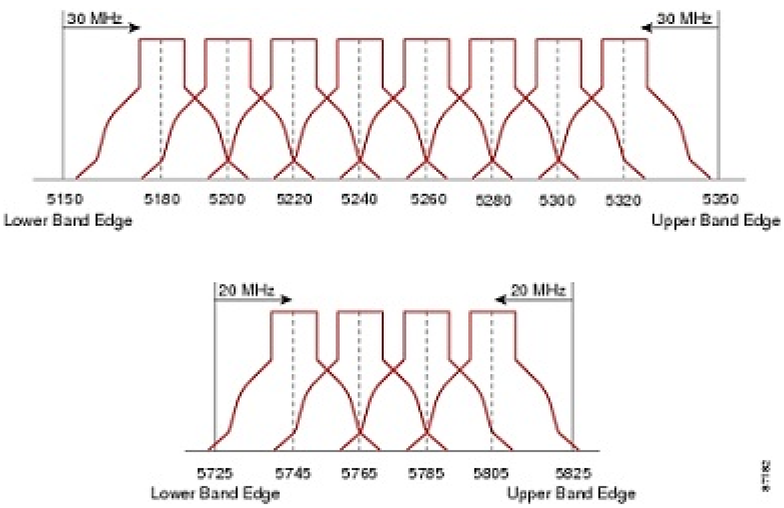
Enterprise Mobility 4.1, Design Guide WLAN Radio Frequency Design Considerations, Courtesy of Cisco Systems Inc.

5GHz

The 802.11 standard defines 23 20MHz wide channels in the 5GHz spectrum. Each channel is spaced 20MHz apart and separated into three Unlicensed National Information Infrastructure (UNII) bands. Wireless devices specified as 802.11a/n/ac are capable of operating within these bands. In the United States, UNII-1 (5.150 to 5.250 GHz) containing channels 36, 40, 44, and 48 and UNII-3 (5.725-5.825) containing channels 149, 153, 157, 161 are permitted. UNII-2 (5.250-5.350

GHz and 5.470-5.725GHz) which contains channels 52, 56, 60, 64, 100, 104, 108, 112, 116, 120, 124, 128, 132, 136, and 140 are permitted in the United States, but shared with radar systems. Therefore, APs operating on UNII-2 channels are required to use Dynamic Frequency Selection (DFS) to avoid interfering with radar signals. If an AP detects a radar signal, it must immediately stop using that channel and randomly pick a new channel. In the United States, even without the use of the UNII-2 band, 5GHz is well suited for high density deployments due to its greater number of non-overlaping channels. Below is a diagram showing the U.S. 5GHz channel plan.

U.S. 5 GHz Channel Plan



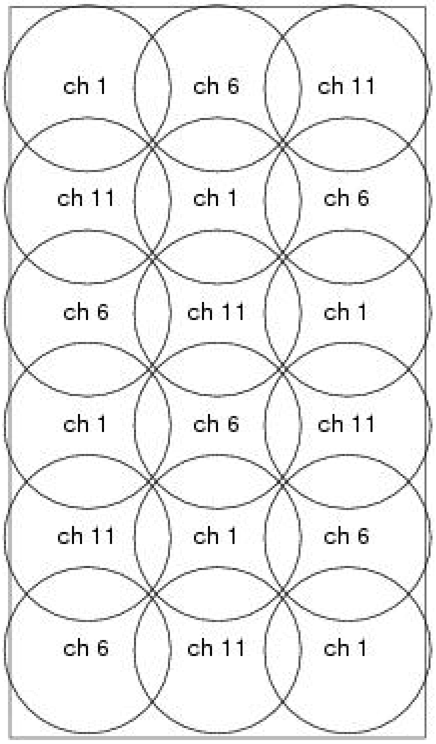
Service Provider Wi-Fi, Challenges of Unlicensed Wi-Fi Deployments,

A Practical Guide for Cable Operators, Courtesy of Cisco Systems Inc.

Note: 802.11n devices can operate on either band and are backwards compatible with older 802.11 standards.

Overlapping Coverage Cells

APs should be deployed with overlapping coverage cells. This prevents packet loss which can occurs if a wireless client hits a dead zone when roaming between AP coverage cells. However, APs with overlapping coverage cells should not be on the same channel, if possible, because this can lead to increased channel utilization. The diagram below shows APs on different channels wherever their coverage is overlapping:



Enterprise Mobility 4.1, Design Guide WLAN

Radio Frequency Design Considerations,

Courtesy of Cisco Systems Inc.

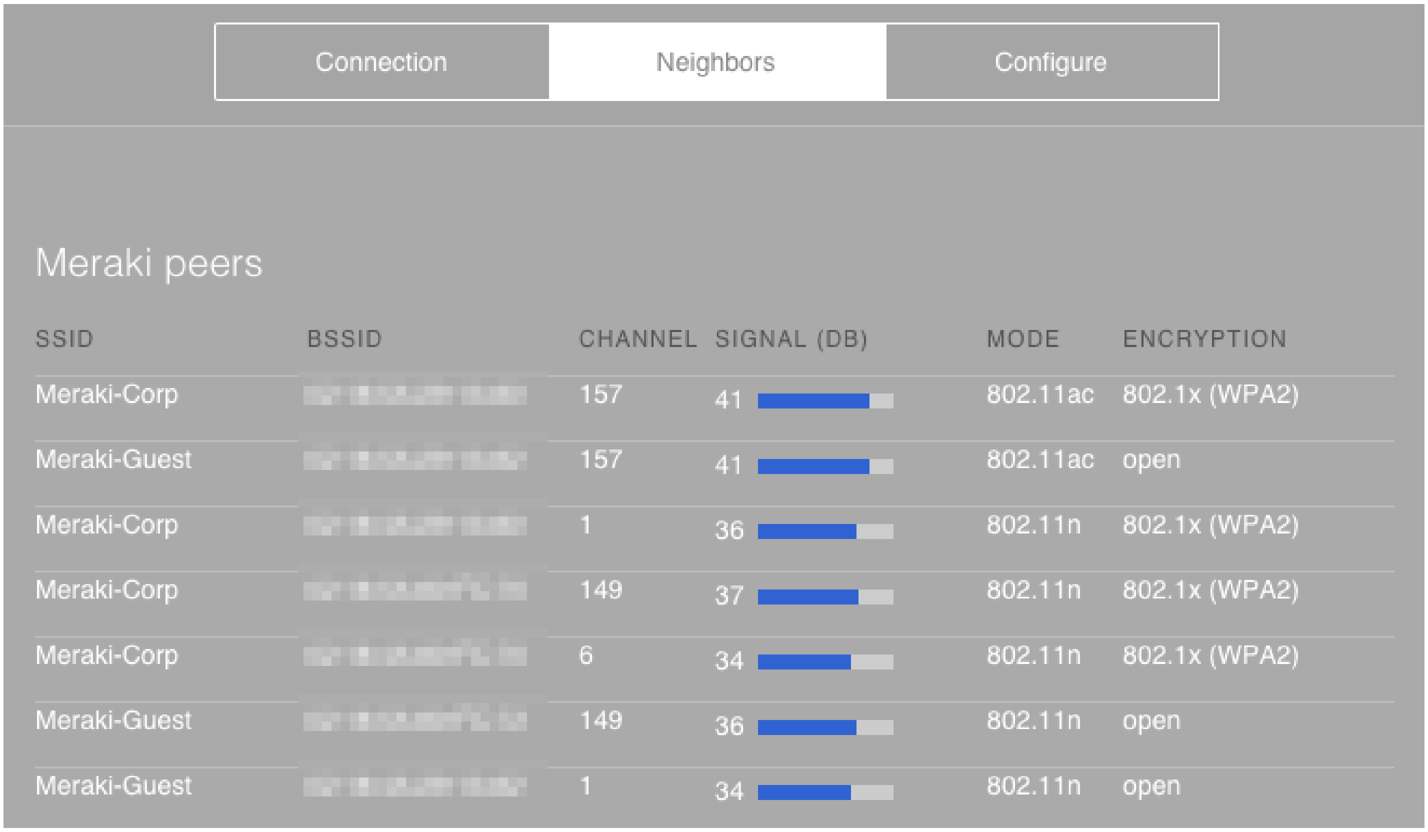
Below is a floor plan on the Radio Settings page in Dashboard. The channel selections and power levels of the APs were set manually based on RF measurements taken from a site survey on 2.4GHz. The result is wireless coverage on the entire floor with enough overlap for seamless roaming. Notice neighboring APs are never on the same channel:

Identify Neighboring AP

It is possible to determine which neighboring Cisco Meraki APs in a Dashboard network could attribute to higher channel utilization or interference. This information can be used as part of a site survey. Once possible neighbors have been located, channel selections and power levels can be adjusted accordingly.

Local Status Page

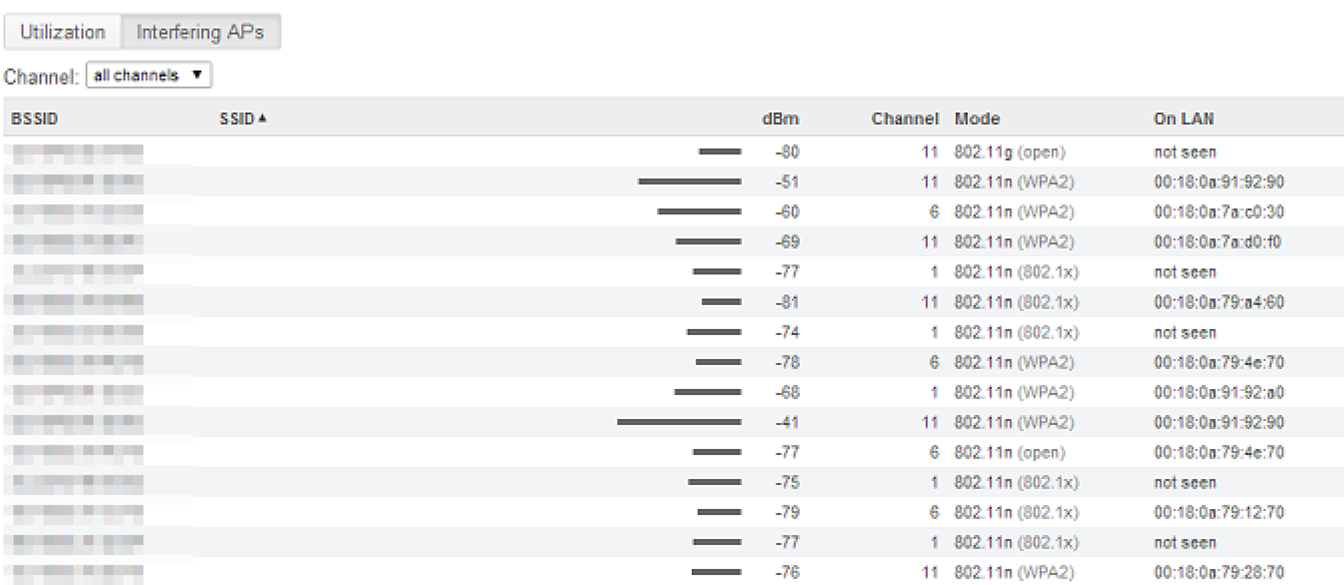
The Local Status Page on each AP has a Mesh Neighbors table. This page reports other Cisco Meraki APs within range in real-time. The channel and RSSI of the neighboring APs are reported. Ideally there would be no entries in this table. However if there is an entry the RSSI reported should be <10dB:



SSID	BSSID	CHANNEL	SIGNAL (DB)	MODE	ENCRYPTION
Meraki-Corp	[illegible]	157	41	802.11ac	802.1x (WPA2)
Meraki-Guest	[illegible]	157	41	802.11ac	open
Meraki-Corp	[illegible]	1	36	802.11n	802.1x (WPA2)
Meraki-Corp	[illegible]	149	37	802.11n	802.1x (WPA2)
Meraki-Corp	[illegible]	6	34	802.11n	802.1x (WPA2)
Meraki-Guest	[illegible]	149	36	802.11n	open
Meraki-Guest	[illegible]	1	34	802.11n	open

RF Spectrum Page

Cisco Meraki APs utilizing the dedicated Spectrum analysis radio have an Interfering APs list in Dashboard. This list is located on the details page of the AP under **Monitor>RF spectrum**. The list displays the BSSID (APs Wireless MAC), power level, channel and SSID name of APs operating within range. This information provides the ability to spot potential sources of congestion or interference.



BSSID	SSID ▲	dBm	Channel	Mode	On LAN
[illegible]		-80	11	802.11g (open)	not seen
[illegible]		-51	11	802.11n (WPA2)	00:18:0a:91:92:90
[illegible]		-60	6	802.11n (WPA2)	00:18:0a:7a:c0:30
[illegible]		-69	11	802.11n (WPA2)	00:18:0a:7a:d0:f0
[illegible]		-77	1	802.11n (802.1x)	not seen
[illegible]		-81	11	802.11n (802.1x)	00:18:0a:79:a4:60
[illegible]		-74	1	802.11n (802.1x)	not seen
[illegible]		-78	6	802.11n (WPA2)	00:18:0a:79:4e:70
[illegible]		-68	1	802.11n (WPA2)	00:18:0a:91:92:a0
[illegible]		-41	11	802.11n (WPA2)	00:18:0a:91:92:90
[illegible]		-77	6	802.11n (open)	00:18:0a:79:4e:70
[illegible]		-75	1	802.11n (802.1x)	not seen
[illegible]		-79	6	802.11n (802.1x)	00:18:0a:79:12:70
[illegible]		-77	1	802.11n (802.1x)	not seen
[illegible]		-76	11	802.11n (WPA2)	00:18:0a:79:28:70

Site Surveys

It is best practice for an implementation team to perform predictive and post-deployment site surveys (passive and active) of a wireless deployment. Site surveys are performed using professional grade toolkits such as those from Ekahau or Fluke networks (Air Magnet). Without the use of a professional site survey tool, it is virtually impossible to plan and implement a robust and reliable wireless system that extends beyond two or three APs in a small single floor area. The purpose of these surveys in regards to channel planning should be to ensure adequate coverage without causing additional channel utilization or interference. Below are some other considerations when surveying the network:

- It is important to note that 2.4GHz and 5GHz have different characteristics that must be taken into account when deploying dual-band APs (2.4GHz and 5GHz capable) access points. The 2.4GHz signal can travel further and has better penetration capabilities than 5GHz. Thus the radius of a coverage cell on 2.4GHz is longer than on 5GHz. This could lead to dead zones in 5GHz coverage if only 2.4GHz coverage is measured in a site survey, and will likely require different power settings for each radio to equalize coverage cells.
- In some deployments, multiple SSIDs are enabled on an a single AP. Some SSIDs may have legacy bit rates disabled which shortens the coverage radius on 2.4GHz or the SSID may only have 5GHz enabled. The site survey should measure the coverage cells of each SSID independently within the extended service set to determine if adequate coverage is met.
- For high-density deployments, manually tune 2.4 & 5.4GHz channels and power settings based off of site survey data.

Additional Resources

For more information about wireless best practices, please refer to the following articles:

- Multi-SSID Deployment Considerations
- Understanding Wireless Performance and Coverage