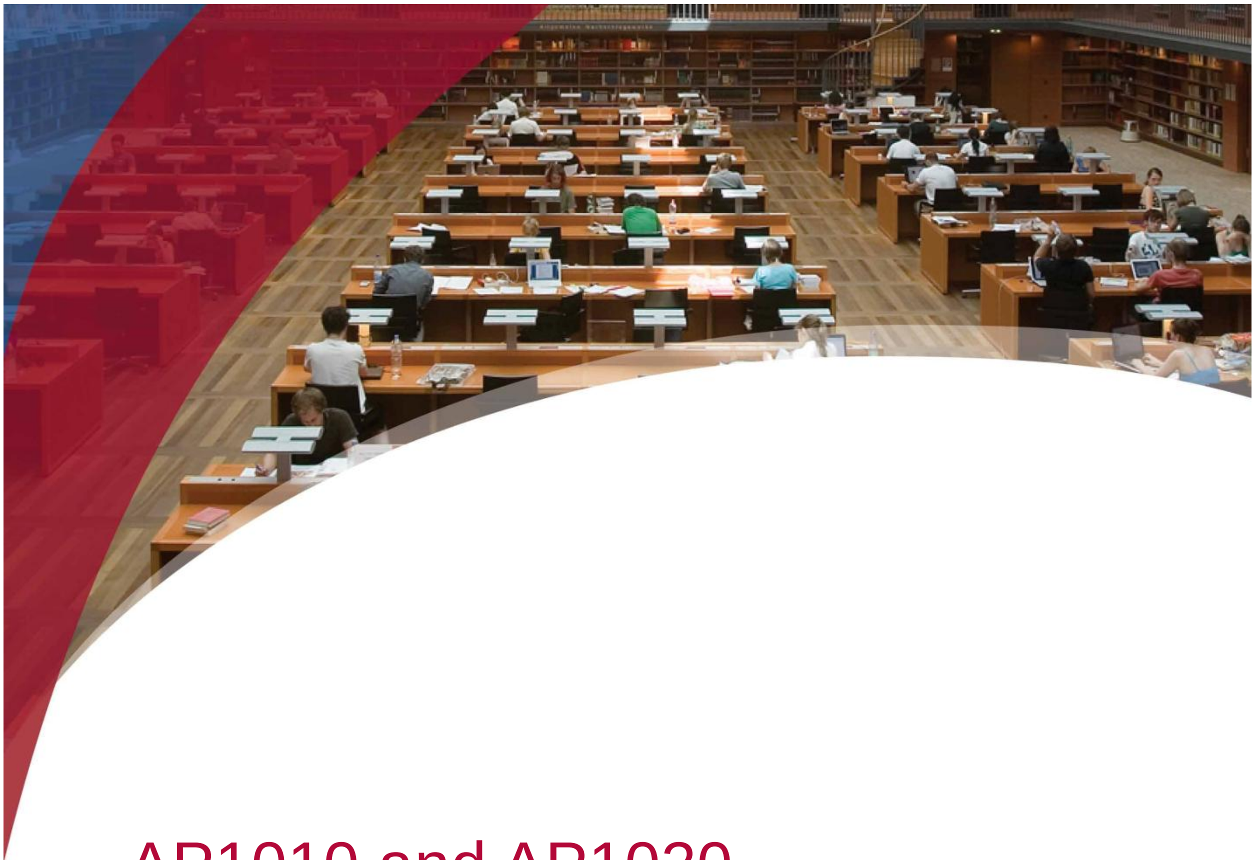


AP1010 and AP1020 Deployment Guide

January 2013

Contents

Introduction

The AP1010 and AP1020 are cost-effective access points for low- to medium-density deployments, with value-add features supporting enterprise mesh, point-to-point bridging for building-to-building connectivity, and built-in support for RTLS functionality. As with other Meru access points, the AP1010 and AP1020 support virtualization (Virtual Cell and Virtual Port).

The AP1010 and AP1020 radios are 802.11n-capable and support 2x2 MIMO with two spatial streams. The AP1010 and AP1020 allow for throughput of up to 300 Mbps per radio and support an 802.11n network, as well as legacy Wi-Fi clients.

The AP1010 and AP1020 access points are supported for System Director Release 4.1 or later. Certain capabilities and features (discussed later in this guide) are supported in System Director Release 5.2 or later.

What's New in this Document

The following lists additions to this document:

- Table 2 was added in VLANs.
- Figure 5 was added in Mesh Performance.
- Implementing a Weatherized Solution was added.
- Geographical Channel Regulations for Outdoor Deployments was added.

What's Changed in this Document

The enclosure list in Enclosures for Outdoor Deployments was updated.

About the AP1010 and AP1020

This section contains the following information about the AP1010 and AP1020:

- AP1010 and AP1020 Models
- Key Features
- AP1010 and AP1020 Deployment

AP1010 and AP1020 Models

There are two models of the AP1010 and two models of the AP1020. Two models have integrated antennas, and the other two models have external antennas. Table 1 lists the models and their radio characteristics.

Table 1: AP1010 and AP1020 Models

Model	Radio Characteristics
AP1010i	Single dual-band 2-stream 802.11n radio (2x2:2) with internal antennas
AP1020i	Two dual-band 2-stream 802.11n radios (2x2:2) with internal antennas
AP1010e	Single dual-band 2-stream 802.11n radio (2x2:2) with external antennas
AP1020e	Two dual-band 2-stream 802.11n radios (2x2:2) with external antennas

Key Features

The AP1010 and AP1020 include the following features:

- Virtualization Support
- Mesh
- Real-Time Location Systems (RTLS)

Virtualization Support

The AP1010 and AP1020 support virtualization, which offers the ability to optimize client-to-AP associations. Virtualization ensures that clients are always connected at the highest possible data rates and offers other benefits, such as seamless roaming and greater application performance and predictability.

The major advantage of virtualization is that each client device thinks that it is connected to the same AP, regardless of where the device is located or how often it roams between multiple APs. This takes away the decision-making capabilities of the client device when making inter-AP roaming decisions, which centralizes all control to the WLAN. The WLAN makes decisions about connectivity for client devices and allows users to change locations without disruptive handoffs.

The AP1010 and AP1020 support two types of virtualization:

- Virtual Cell (also known as shared BSSID)

  In this mode of virtualization, all APs advertising a particular SSID broadcast the same BSSID across the WLAN for that SSID. Different client chipset vendors incorporate different calculation methodologies for deciding when to roam from one AP to another.

  From a network perspective, this situation leads to inconsistency among various client devices and their behavior when it comes to roaming between two APs. This scenario is typical of why legacy microcell WLAN architectures have problems, especially in a BYOD environment.

- Virtual Port (also known as per-station BSSID)

  In this mode, a common parent BSSID (PBSSID) is broadcast for a particular SSID by all APs advertising that SSID. In Virtual Port, all clients receive a unique beacon and a unique broadcast/multicast key, making them invulnerable to certain types of key attacks. Each client is assigned its own BSSID. The BSSID remains the same for this particular client regardless of which AP the client is connected to.

When a client device probes and attempts to join that network, a unique CSSID (client SSID) is generated for that particular client, and all further communication between the client and the WLAN is made possible only using the assigned CSSID. After a client joins the network, the relevant CSSID is used across the WLAN for that client, so the roaming decisions continue to be made by the WLAN infrastructure, resulting in greater application performance and predictability, as opposed to leaving these decisions to the client itself.

Mesh

The mesh capability allows the WLAN to be extended beyond the wired enterprise to an all-wireless enterprise by untethering the APs. The APs are able to communicate with the rest of the network by using wireless backhaul links rather than wired Ethernet.

The mesh feature is supported in System Director Release 5.2 or later.

Some features of the mesh include:

- Simple setup and configuration
- Wireless backhaul connectivity from the APs to the controller
- Single-hop and multi-hop architectures
- Encrypted backhaul links using WPA2-PSK (re-encrypted at every hop)
- Automatic discovery and recovery of backhaul links

Note: Mesh licensing is required to allow APs to establish wireless backhaul connectivity to the controller.

Real-Time Location Systems (RTLS)

The AP1010 and AP1020 fully support Real-Time Location Systems (RTLS). RTLS includes the ability to track and locate all 802.11 wireless devices in a WLAN, such as tags, phones, laptops, and so on. The two RTLS platforms supported are AeroScout and Ekahau, which allow for device tracking/location accuracy of about 2 m (or less if additional hardware is installed). AeroScout and Ekahau use their own proprietary algorithms for calculating a device’s location.

More information can be found in the following interoperability guides:

- AeroScout Deployment Guide
- Ekahau RTLS Deployment Guide

AP1010 and AP1020 Deployments

The following are use cases, or deployment scenarios, in which the AP1010 or AP1020 should be implemented:

- Use Case 1: Low- to Medium-Density Coverage-Based Deployment
- Use Case 2: Point-to-Point Bridging
- Use Case 3: Enterprise Mesh
- Use Case 4: Real-Time Location Systems (RTLS) Support

There are other environments in which the AP1010 and AP1020 can be deployed. The previous examples illustrate how you can maximize the features of the AP1010 and AP1020.

Use Case 1: Low- to Medium-Density Coverage-Based Deployment

In typical deployments of the AP10210 and AP1020, the goals are ease of deployment, access, and high levels of reliability, along with other standard requirements, such as a high level of network security, detailed insight into network usage and statistics, and so on. Client density is usually low to medium, with potential designated areas in which high user density is anticipated. Deploying the AP1020 in a hotel is an ideal example. A hotel often has low- to medium-client density for most of the premises, except for designated areas that are expected to be high-density areas (for example, conference rooms).

For the design guidelines used in this use case, see Use Case 1 Design Example: Low- to Medium-Density Coverage-Based Deployment.

Use Case 2: Point-to-Point Bridging

Enterprise mesh is a useful deployment technique at sites in which wired Ethernet cabling is not present or feasible. Users at such sites still need the ability to connect to the WLAN to access local and online resources. Creating a point-to-point mesh network with the AP1020 is an effective method to provide network access to remote locations, such as a warehouse that is not physically located at headquarters.

For the design guidelines used in this use case, see Use Case 2 Design Example: Point-to-Point Bridging.

Use Case 3: Enterprise Mesh

Extending wireless coverage outdoors is a necessity in many environments, especially in education. In certain areas, the WLAN needs to span a garden, parking lot, outdoor stadium, or an entire campus. Using the mesh feature, wireless connectivity is easily introduced for an outdoor stadium with minimal effort and resource consumption.

For the design guidelines used in this use case, see Use Case 3 Design Example: Enterprise Mesh.

Use Case 4: Real-Time Location Systems (RTLS) Support

WLAN deployments in the healthcare industry are often considered critical for the smooth functioning of services provided by that healthcare institution. In addition, Real-Time Location Systems (RTLS) solutions are increasingly being deployed to allow for tracking and locating assets, recording data (for example, temperature control) and overall asset monitoring. Using the AP1020 and RTLS support in a veterinary clinic, doctors and pets are easily located. Information about pets is updated and uploaded to a database from anywhere in the clinic.

For the design guidelines used in this use case, see Use Case 4 Design Example: Real-Time Location Systems (RTLS) Support.

Design Guidelines

Consider the following when designing the WLAN:

- Virtualization
- Coverage
- Band Steering
- Scaling
- VLANs
- Mesh

Virtualization

The AP1010 and AP1020 support Virtual Cell and Virtual Port technologies. You choose the virtualization type based on the requirements of the proposed WLAN. The virtualization type is specified in the ESS profile, which allows for each defined SSID to use the technology appropriate for the station application.

In general, for most networks using AP1010 and AP1020 access points, the recommendation is to use Virtual Cell, which allows you get the best performance from the access points. Using Virtual Cell also helps improve performance as the client density in the WLAN environment increases, along with the growing trend of “Bring Your Own Device” (BYOD).

For information about virtualization modes, see the High Density Design and Deployment Best Practices Guide.

Coverage

When determining the optimal AP density, each station (no matter where the client is located) should be able to hear from two to four APs. For data-only networks, a minimum signal strength of -70 dBm should be “seen” everywhere. For networks that need to support voice and/or video, the recommendation is -67 to -70 dBm or greater everywhere.

Another important metric to consider when building a wireless network is the signal-to-noise ratio (SNR). The recommended SNR for data-only networks is 20 or greater. For networks that support voice and/or video, an SNR of 25 or greater is recommended.

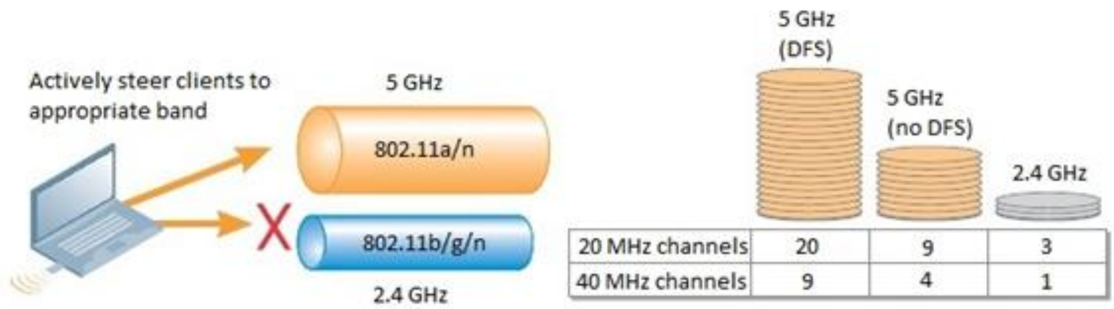
For location-based services (RTLS), the maximum effective distance between a tag and an access point is 200 ft. In most cases, the distance between a tag and an AP should not exceed 150 ft. At sites where thick concrete walls are present, this distance should be less than 100 ft for ideal performance.

Band Steering

On most dual-band capable client devices, the driver looks for a connection in the 2.4 GHz band before it looks for one in 5 GHz. Although the device can operate in both bands, 2.4 GHz is the most commonly available band, so the device searches for a connection in that band first. Clients might also see a stronger signal from 2.4 GHz when they are on the edge of the coverage range for the WLAN. The band steering function identifies the devices that are dual-band capable, and it responds to those devices only on the 5 GHz band. The band steering feature encourages devices to move to the 5 GHz band, which has more channels available, more bandwidth, and causes less interference for users.

Band steering requires symmetrical coverage in both bands to be effective. (In some situations, one way to get more symmetrical coverage is by using a channel in UNII-3 and increasing power. Use this method judiciously.) A larger 2.4 GHz coverage model can result in sub-optimal performance when band steering is used. When planning to use band steering, make sure to model RF signal propagation based on 5 GHz.

When designing networks with channels available in the 2.4 GHz and 5 GHz bands, band steering is recommended to offload the crowded 2.4 GHz spectrum. When Channel Layering is implemented, band steering should be enabled to ensure the 5 GHz spectrum is used to its fullest potential. Band steering is configured at the ESS-profile level.



Scaling

In environments where a high density of clients is expected, multiple channel layers can be introduced to boost performance. Because virtualization uses a single channel layer across all APs, additional layers can be easily configured to accommodate throughput-intensive applications and a highly dense client environment.

Although the AP1010 and AP1020 are ideal for low- to medium-density environments, adding additional channel layers can accommodate a higher number of devices, as is the case with other Meru access points. Note that for high-density environments, the AP320 or AP332 access points should be considered instead.

For information about Channel Layering, see the Channel Layering Configuration Note.

VLANs

VLANs are supported in tunnel mode for wired and wireless profiles. The traffic from the client is always untagged, and the controller maps the traffic to the correct VLAN. Multicast traffic can be optionally filtered. VLANs are also supported in wireless bridge profiles.

Table 2 lists the VLAN tagging support for Meru access points. For Meru APs with additional Ethernet ports, VLAN tags are not added to outgoing packets destined for wired clients on those Ethernet ports.

Table 2: VLAN Tagging Support

Profile Type	AP110	AP1014i	AP1010	AP1020	AP320	AP332	AP433
Wireless profile (tunneled)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Wireless profile (bridged)	No	No	Yes	Yes	Yes	Yes	Yes
Port profile (tunneled)	Yes	Yes	NA	NA	NA	Yes	NA
Port profile (bridged)	No	No	NA	NA	NA	No	NA

Mesh

The following provides some general information about a Meru mesh network implementation:

- Wireless backhaul link: A wireless connection over which an AP is connected to a controller. Backhaul links are encrypted on a per-hop basis using WPA2-PSK.
- Hop: A hop is when a connection passes over a wireless backhaul link. The mesh network supports a maximum of three (wireless) hops.
- Node: An AP participating in a mesh network.

  Any given node cannot be part of multiple mesh clouds. The maximum number of nodes supported in a mesh cloud is 16, and the maximum number of stations is 500.

  All nodes behind a wireless backhaul can only be connected to the same controller as the gateway AP.
- Mesh cloud: A group of mesh APs that can connect to each other to form a mesh. Only nodes that are in the same mesh cloud are able to establish mesh connections.

  Each mesh cloud has one pre-shared key (PSK). When a node comes online, it automatically downloads and installs the PSK.
- Virtual Cell and QoS parameters are supported over mesh links.

AP Roles

APs can operate in different roles in a mesh network, depending on their location in the network. APs can be in one of the following roles in a network.

Access Nodes

An access node is an AP that does not have any wireless backhaul connection (in other words, an AP that is not participating in the mesh setup).

Gateway Nodes

A gateway node is an AP that uses a wired backhaul connection to the controller and can support wireless backhaul connections from other nodes

Gateway nodes use beacons to advertise their backhaul capability over the air.

Mesh and Leaf Nodes

A mesh node is an AP that uses a wireless backhaul connection to the controller and can support wireless backhaul connections from other nodes.

A leaf node is an AP that uses a wireless backhaul to connect to the controller but does not support wireless backhaul from any other nodes.

Mesh and leaf nodes use beacons to advertise their backhaul capability over the air.

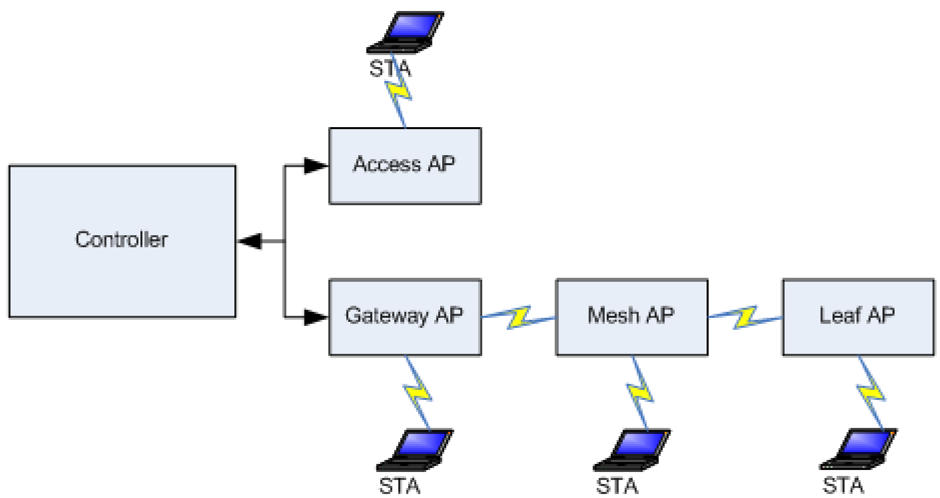
Mesh and leaf nodes provide only tunneled access. Bridged mode is currently not supported in a mesh environment. Mesh and leaf nodes cannot be part of ESS profiles configured for bridged mode.

Mesh and leaf APs automatically discover the best uplink node to connect to. The RSSI of the parent node is used as the primary gauge. If the RSSI values of multiple parent nodes are similar; the number of hops is used as the tiebreaker.

A mesh node monitors the uplink connection. In case of a link failure, if there is another parent node available, the mesh node automatically switches to the new parent node without losing connectivity to the controller and the stations associated to it.

The unused Ethernet port on a mesh node (mesh/leaf) can be used in a manner similar to an Ethernet switch port. Users can plug their devices into this port and gain access to the network.

Figure 1: Different Mesh Nodes



	Requires Wireless Backhaul	Provides Wireless Backhaul
Access AP	No	No
Gateway AP	No	Yes
Mesh AP	Yes	Yes
Leaf AP	Yes	No

In a mesh network, nodes have a parent/child relationship. How a node is identified depends on the relative position of the nodes in a mesh tree. For any two nodes with a mesh connection, the node closest to the gateway is the parent, and the other node is the child.

An uplink is the wireless connection to the parent AP (from the perspective of a mesh node). A downlink is the wireless connection (or set of connections) toward child mesh APs/nodes (from the perspective of a mesh node).

Characteristics of a Wireless Backhaul Connection

Nodes using a wireless backhaul connection can connect to the controller only using Layer 3. One controller can support multiple gateway nodes.

An uplink connection is always established using the highest numbered radio (radio1) on the AP. The downlink connection can be offered on any radio. The radio being used to provide wireless backhaul can also be used to provide service/access to clients. A node can provide downlink service on the same or different radio than the one being used to provide uplink service.

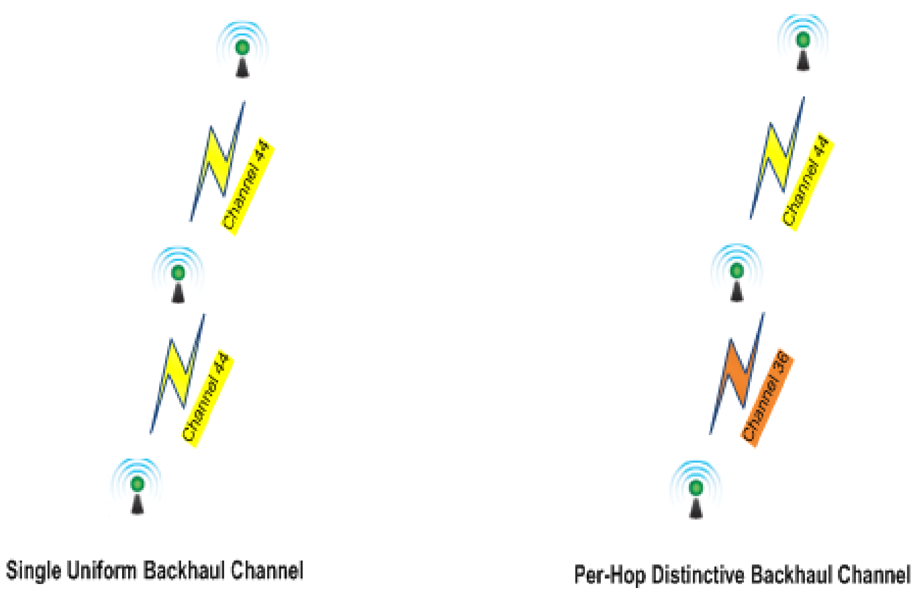
Although the backhaul uplink is always provided by the highest numbered radio on the AP, the channel usage on that radio can vary between two (or more) backhaul nodes, as shown in Figure 2.

There are no restrictions on the frequency band, channel, or channel-width for the radio being used for backhaul. For nodes that require wireless backhaul, channel parameters are inherited from the parent AP and are not configured independently on the child AP.

A radio that is participating in the mesh service will not change channels and only performs rogue detection/mitigation on the home channel.

When using a Per-Hop Distinctive Backhaul channel (shown in Figure 2), the second radio of the parent AP is used to exchange mesh information with the downlink radio (which itself might be the first or second radio of the child AP).

Figure 2: Backhaul Channel Establishment



Mesh Examples

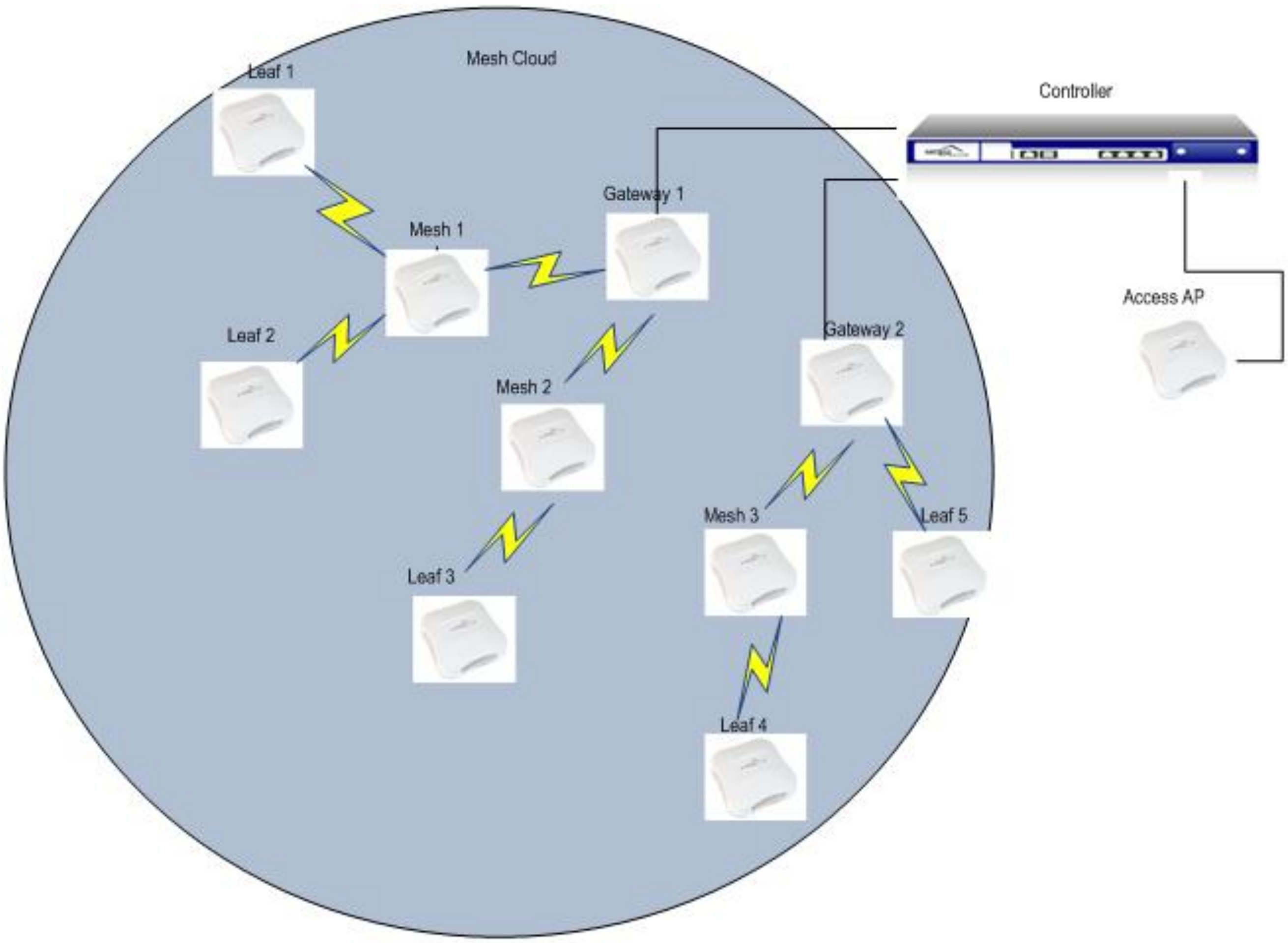
The following illustrates two mesh examples:

- Example 1: One Mesh Cloud
- Example 2: Two Mesh Clouds

Example 1: One Mesh Cloud

Figure 3 illustrates a mesh example with one mesh cloud, two gateway nodes, and three mesh nodes.

Figure 3: Mesh Example with One Mesh Cloud



In Example 1, consider the following scenarios:

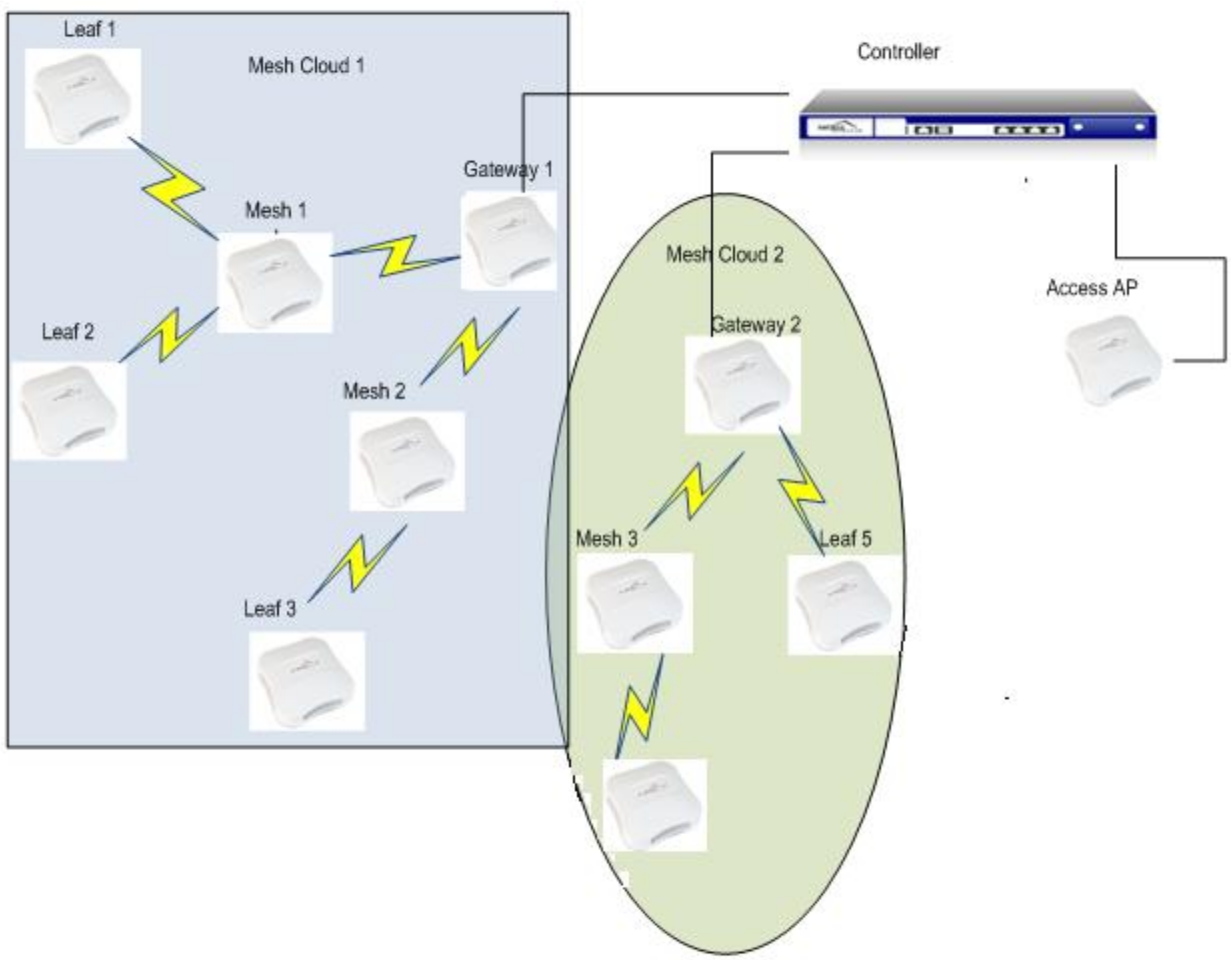
- Node “Mesh 1” goes down: Leaf 1 and Leaf 2 receive beacons from Gateway 1 and Mesh 2. The parent node is chosen based on the best RSSI.
- Node “Mesh 2” goes down: Leaf 3 receives beacons from Mesh 1 and Mesh 3. The parent node is chosen based on the best RSSI.

- Node “Mesh 3” goes down: Leaf 4 receives beacons from Mesh 2. The parent node is now Mesh 2.
- Node “Gateway 2” goes down: Mesh 3 and Leaf 5 receive beacons from Mesh 2 and Gateway 1. The parent node is chosen based on the best RSSI.

Example 2: Two Mesh Clouds

Figure 4 illustrates a mesh example with two mesh clouds: Mesh Cloud 1 and Mesh Cloud 2. Mesh Cloud 1 contains two mesh nodes and one gateway node. Mesh Cloud 2 contains one gateway node and one mesh node.

Figure 4: Mesh Example with Two Mesh Clouds



In Example 2, consider the following scenarios:

- Node “Mesh 1” goes down: Leaf 1 and Leaf 2 receive beacons from Gateway 1 and Mesh 2. The parent node is chosen based on best RSSI.
- Node “Mesh 2” goes down: Leaf 3 receives beacons from Mesh 1. Mesh 1 becomes the new Parent node.

- Node “Mesh 3” goes down: Leaf 4 receives no beacons (assuming Gateway 2 is too far) and is no longer available to service clients.
- Node “Gateway 2” goes down: Mesh 3, Leaf 5, and Leaf 4 become unavailable from a service perspective.

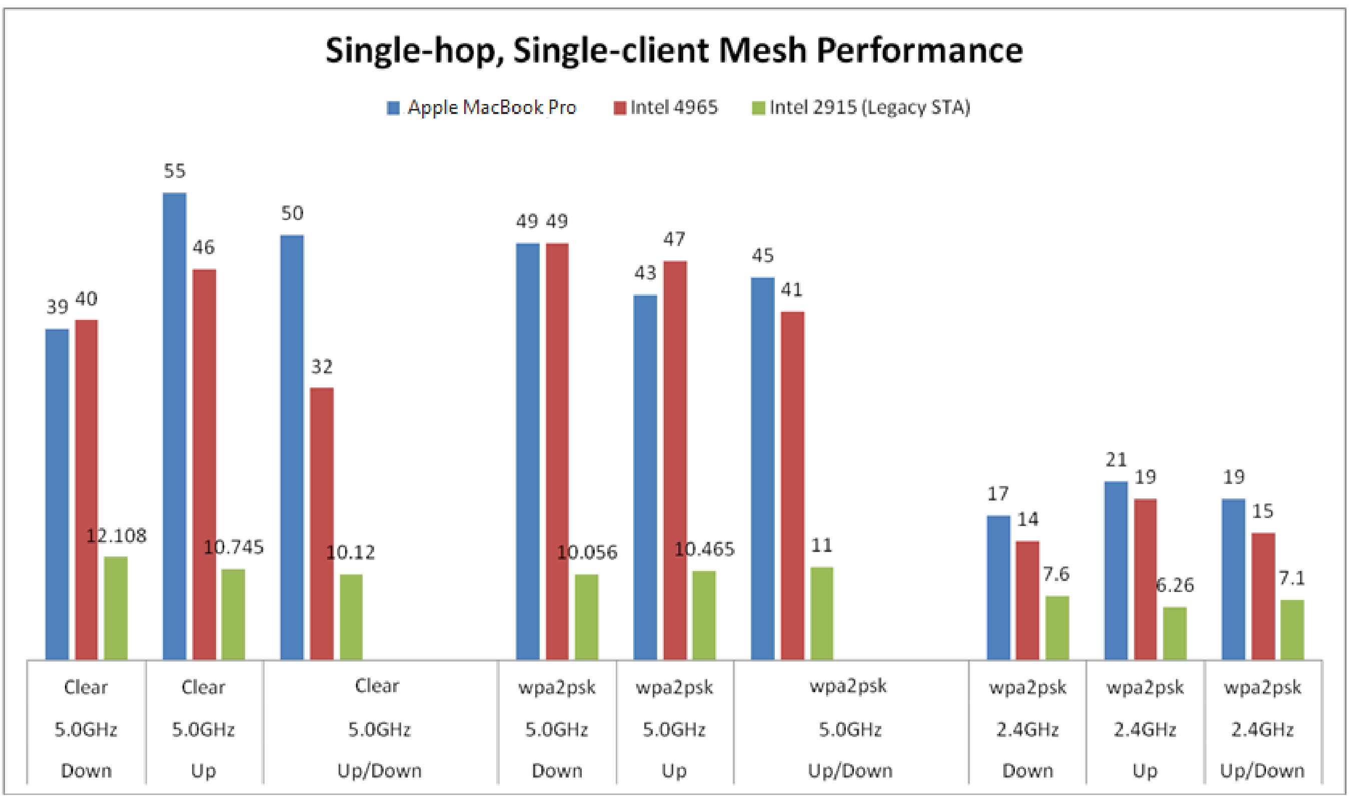
As seen in the previous examples, all entities/nodes in a particular mesh cloud interact only with each other. There can be no inter-mesh cloud communication.

In scenarios in which multiple mesh clouds are adjacent to each other, the recommendation is to assign different channels to each adjacent cloud to reduce the chance of collisions.

Mesh Performance

Figure 5 shows information about single-hop, single-client mesh performance. The rates (shown in Mbps) illustrate a scenario in which a client is connected to a radio that also provides backhaul connectivity.

Figure 5: Single-Hop, Single-Client Mesh Performance



Design Examples

The following use cases illustrate examples of AP1010 and AP1020 deployment:

- Use Case 1 Design Example: Low- to Medium-Density Coverage-Based Deployment
- Use Case 2 Design Example: Point-to-Point Bridging
- Use Case 3 Design Example: Enterprise Mesh
- Use Case 4 Design Example: Real-Time Location Systems (RTLS) Support

Use Case 1 Design Example: Low- to Medium-Density Coverage-Based Deployment

In this use case, a hotel environment has mostly low- to moderate-density of clients. Client density is expected to be low and moderate for rooms other than the Ballroom, which is expected to have a moderate density of clients. This use case deploys AP1020 access points with Virtual Cell enabled.

Design Requirements

- Client density is expected to be low and uniform throughout the deployment, except for the Ballroom where moderate client density is expected.
- Throughput requirements are expected to be moderate throughout the deployment.
- Maximum client count is expected to be 40-60 clients in the moderately dense areas (the Ballroom).
- Coverage is required in the 2.4 GHz and 5 GHz bands.
- The 2.4 GHz and 5 GHz bands support voice, video, and data.
- There are three SSIDs for the deployment “Guest,” “Staff,” and “Ballroom.”
- The “Guest” SSID has an open security profile. The “Staff” and “Ballroom” SSIDs use WPA2-PSK security.
- The size of the Ballroom is 5,000 sq feet.
- The size of the overall deployment is 60,000 sq feet.

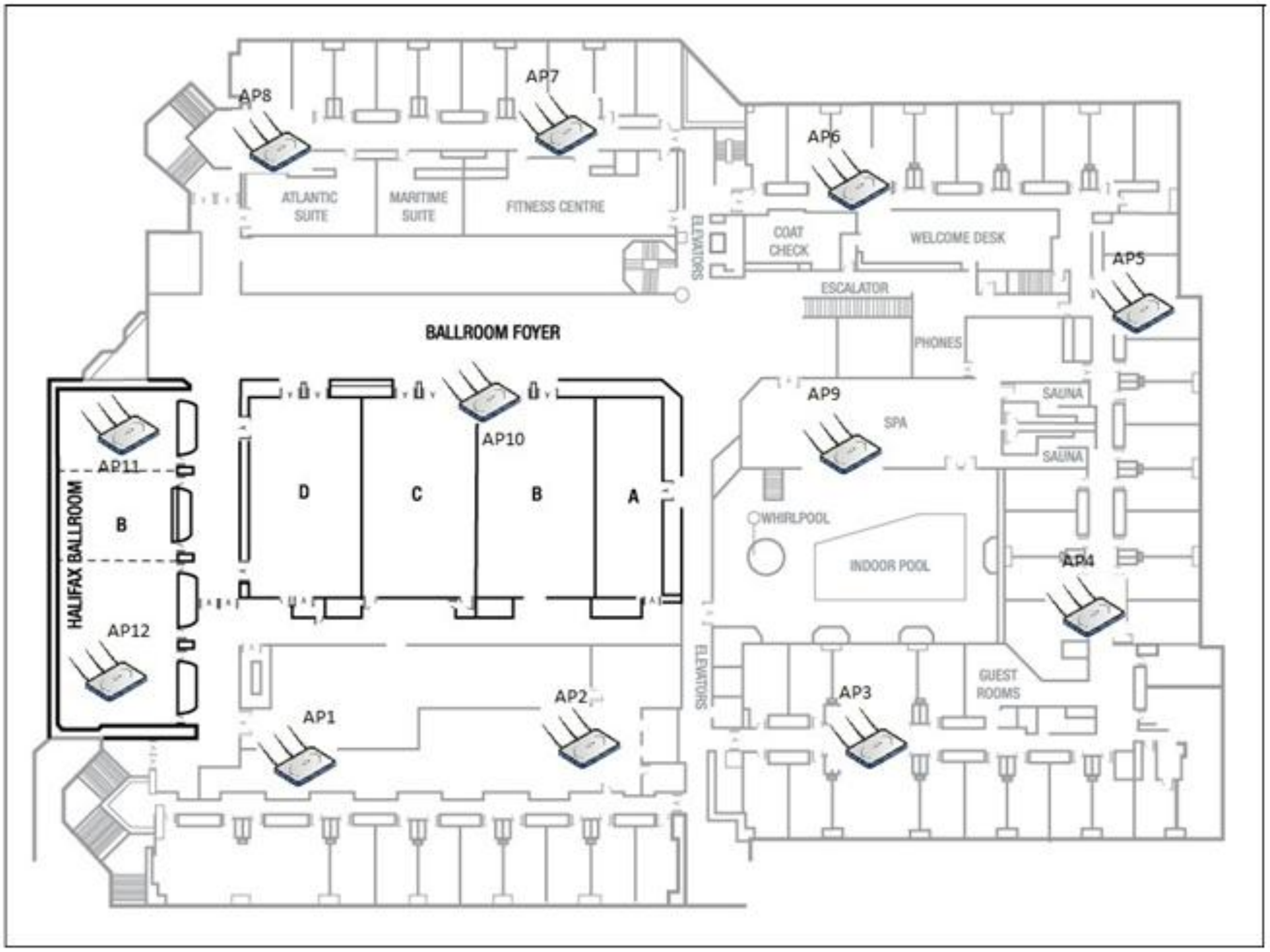
Floor Plan with AP Placement

Given the client density and throughput requirements, the AP placement is fairly uniform across the deployment, with the exception of the Ballroom where an additional AP has been introduced to handle the additional clients and boost throughput. AP placement for the floor plan is shown in Figure 6.

As per the requirements, the Ballroom can accommodate a maximum of 60 clients. Considering this, the two APs in the Ballroom each have one 20 MHz b/g/n interface and one 40 MHz a/n interface. These two APs broadcast the “Ballroom” SSID.

Similarly, all other APs in the deployment have one 20 MHz and one 40 MHz access channel. These APs (with the exception of the Ballroom APs) broadcast the "Guest" and "Staff" SSIDs on both bands.

Figure 6: Hotel Floor Plan with AP Placement



[Table 3](#) lists the radio configurations for all APs in this deployment.

Table 3: Use Case 1 AP Radio Configurations

AP ID	Radio 1 (2.4 GHz, 20 MHz)	Radio 2 (5 GHz, 40 MHz)	SSID (Radio1: Radio2)
1	Ch 6	Ch36+	Guest/Staff: Guest/Staff
2	Ch 6	Ch36+	Guest/Staff: Guest/Staff
3	Ch 6	Ch36+	Guest/Staff: Guest/Staff
4	Ch 6	Ch36+	Guest/Staff: Guest/Staff
5	Ch 6	Ch36+	Guest/Staff: Guest/Staff
6	Ch 6	Ch36+	Guest/Staff: Guest/Staff

AP ID	Radio 1 (2.4 GHz, 20 MHz)	Radio 2 (5 GHz, 40 MHz)	SSID (Radio1: Radio2)
7	Ch 6	Ch36+	Guest/Staff: Guest/Staff
8	Ch 6	Ch36+	Guest/Staff: Guest/Staff
9	Ch 6	Ch36+	Guest/Staff: Guest/Staff
10	Ch 6	Ch36+	Guest/Staff: Guest/Staff
11: Ballroom AP	Ch 1	Ch44+	Ballroom: Ballroom
12: Ballroom AP	Ch 1	Ch44+	Ballroom: Ballroom

All APs have Virtual Cell enabled, which means that all APs broadcast the same BSSIDs as long as they are on the same channel and advertise the same SSIDs. As an example, the BSSIDs broadcast by APs 1 through 10 on the b/g/n (2.4 GHz) radio would be xx:xx:xx:xx:xx:xx and yy:yy:yy:yy:yy:yy, for SSIDs Guest and Staff, respectively. Table 4 lists the example BSSIDs broadcast by all APs on both bands.

Table 4: BSSID Examples

AP ID	Radio 2.4 GHz BSSIDs	Radio 5 GHz BSSIDs
1 thru 10	Guest: xx:xx:xx:xx:xx:xx Staff: yy:yy:yy:yy:yy:yy	Guest: aa:aa:aa:aa:aa:aa Staff: bb:bb:bb:bb:bb:bb
11 and 12	Ballroom: 11:11:11:11:11:11	Ballroom: 22:22:22:22:22:22

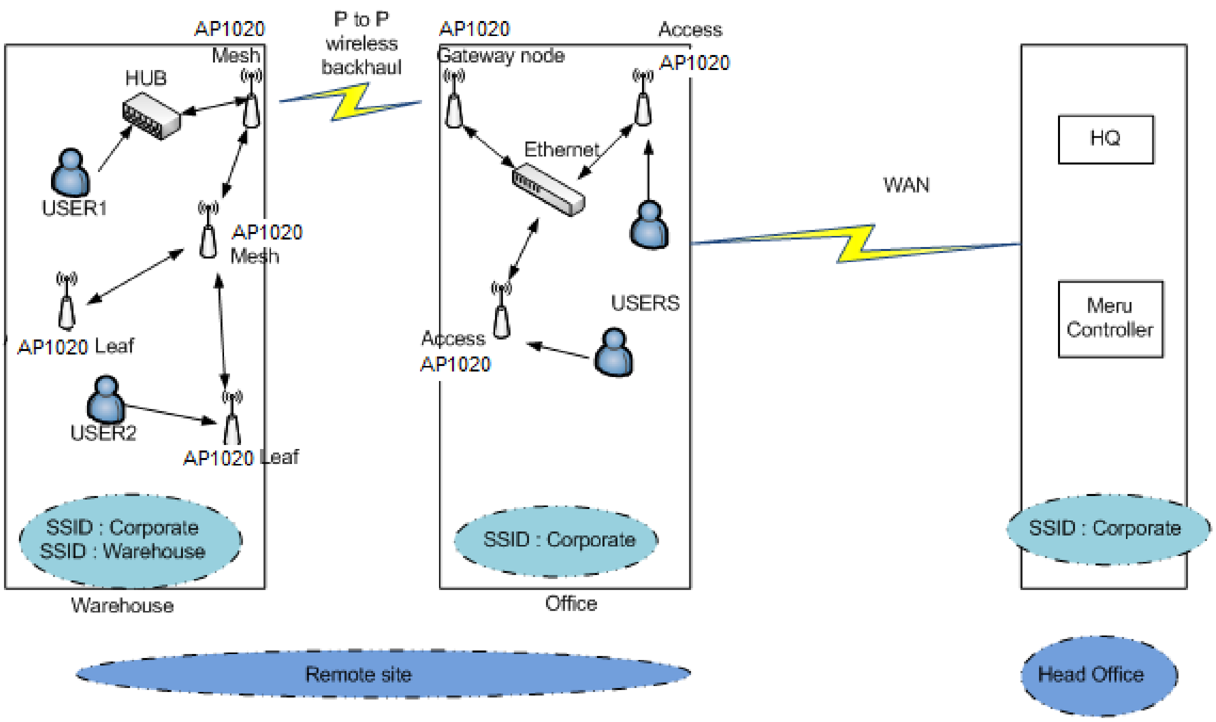
As clients connect and roam the site, they stay connected to the same BSSID regardless of their location (with the exception of the Ballroom). Clients are always connected to what they believe is the same AP and never know the true inter-AP roaming status. This allows for a seamless transition/handoff between APs. The only situations in which the BSSID changes are if the client attempts to connect to a different SSID and if the client switches from one radio band to another.

Use Case 2 Design Example: Point-to-Point Bridging

In this use case, a company has its headquarters in a different state or country, and the current remote site is expanding to include additional buildings and resources. The challenge is that although the primary building at the remote site has full wired and wireless connectivity, the new warehouse has no such accommodation. No Ethernet wiring has been laid, and the only resource available is power. The time and resources required to wire the new warehouse result in a non-optimal solution in terms of time and cost. Creating a point-to-point mesh network with AP1020 access points is an effective method to provide network access to the warehouse.

Using the mesh feature, wired and wireless connectivity can easily be introduced into a warehouse with minimal effort and resource consumption. Figure 7 shows a network diagram of the warehouse.

Figure 7: Warehouse at Remote Site Diagram



Design Requirements

- A WAN link (leased line) supports point-to-point connectivity between the head office and the remote office.
- The remote office has a full wired infrastructure, as well as wireless capabilities, and uses wireless via the AP1020 access points that have established communication with the controller at the head office.
- Ethernet switches at the remote office allow the APs to function in access mode (default mode of Meru APs). Users connect via wired and wireless as per their convenience.
- The “Corporate” SSID has a WPA2-PSK security profile and is accessed at the head office and remote office. The “Warehouse” SSID uses open security and is only broadcast in the warehouse.
- With the new warehouse being commissioned absent any Ethernet wiring and without the required hardware such as routers and switches, connectivity needs to be established to facilitate efficient productivity.
- Users need to have access to two SSIDs: “Corporate” and “Warehouse.”
- Dock stations use their wired Ethernet interface and devices such as handheld scanners need to use their wireless interface. In addition, users should have the freedom to access the corporate network from anywhere in the warehouse.

- In Figure 7, USER1 refers to all docking stations and other devices that require Ethernet connectivity. USER2 refers to all handheld scanners and other devices that use wireless connectivity.

Solution

Using the ability of the AP1020 access points to support mesh and allow for a wireless point-to-point connection between the remote office and the warehouse, users can immediately start working on their assigned tasks in the warehouse.

- An AP1020 gateway node is setup in the remote office. Its Ethernet port is wired into the switch.
- An AP1020 mesh node is setup in the warehouse, to complete the wireless backhaul link. Its Ethernet port is idle.
- Additional AP1020 mesh/leaf nodes are introduced in the warehouse to allow for full wireless coverage in the facility.
- A hub is plugged in to the Ethernet port of the mesh/leaf APs in the warehouse to accommodate the docking stations and other wired devices.
- USER1 is now able to access the network (Corporate or Warehouse, depending on the Ethernet port profile configuration for that AP) using the wired interface. USER2 can associate wirelessly to any of the two networks and switch between them at will.

In this use case, all SSIDs are tunneled. It is possible to configure “bridged” SSIDs; however, their broadcast boundary ends at the gateway node. (Mesh/leaf APs will not broadcast a bridged SSID.)

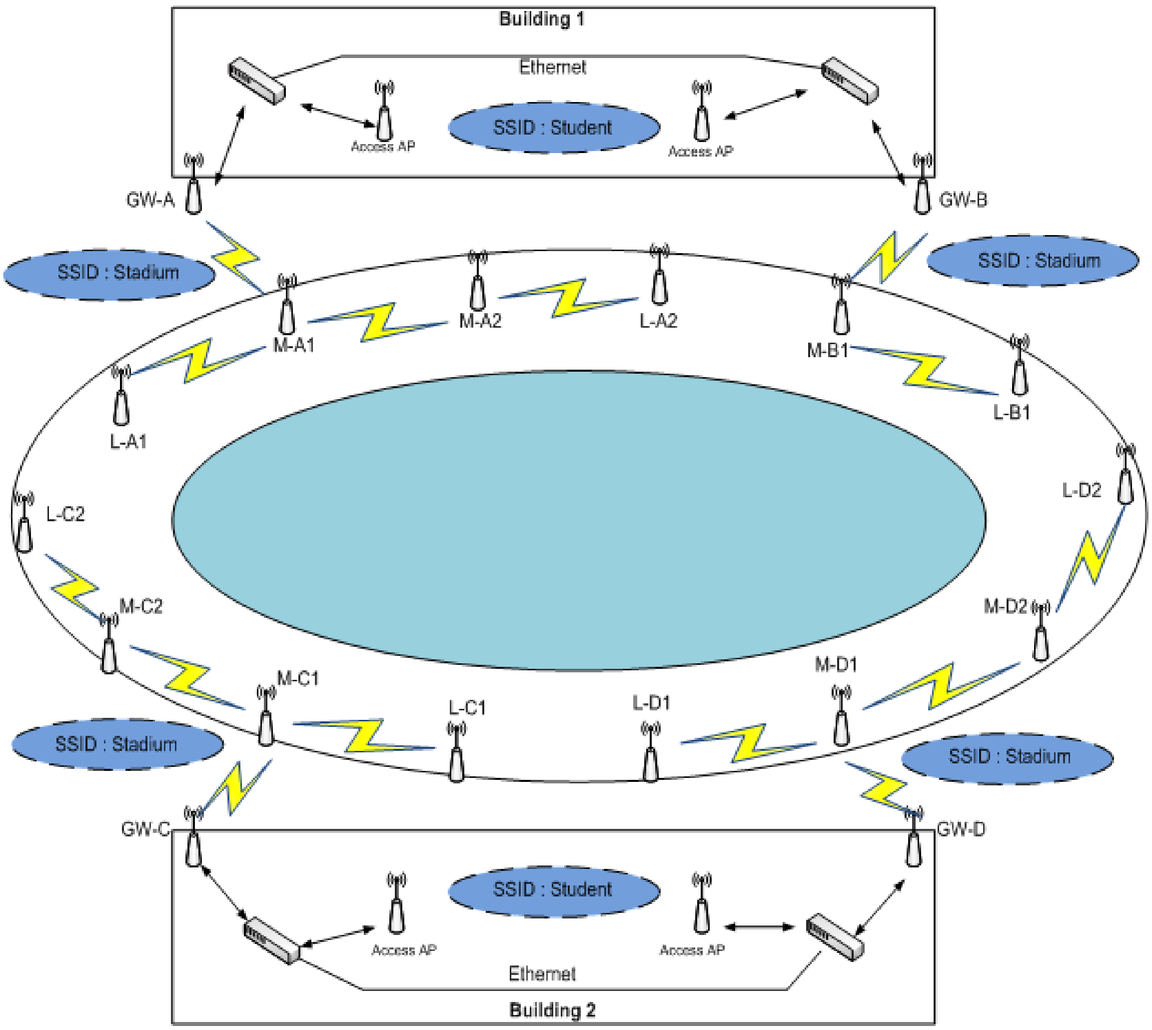
Use Case 3 Design Example: Enterprise Mesh

In this use case, a university has an outdoor track and field event stadium, and wireless coverage is required to create and update athletic records in real time. Although the stadium is surrounded on two sides by buildings that have indoor wireless coverage, the indoor APs in the building cannot meet the requirements for providing wireless service to the stadium.

The main challenge in this environment is to provide the required coverage, as there is no Ethernet wiring in place at the stadium.

Using the mesh feature, wireless connectivity is easily introduced in a stadium with minimal effort and resource consumption. Figure 8 illustrates the part of the campus and stadium that require wireless coverage.

Figure 8: Outdoor Stadium Diagram



Design

Building 1 and Building 2 are part of a university campus, and an outdoor stadium built in the 1950s is nearby. Both buildings have Ethernet and wireless (using access APs) connectivity. The controller is in a different building, and all university network APs tunnel back to the controller.

The buildings use the "Student" SSID for wireless connectivity, and the network uses WPA2-PSK security.

Requirements

- Users should be able to access a wireless network dedicated for the stadium itself.
- There is no Ethernet wiring in the stadium, nor is it deemed practical to extend the wired network into the stadium due to resource limitations (high cost, time consumption, and so on).
- At least 500 clients are expected to use the WLAN.

- An online database is to be updated in real time with athletic results and records.
- A secure SSID called "Stadium" needs to be created, and the authentication is WPA2-PSK.
- Users should be able to roam across the seating area without losing connectivity.

Solution

Using the mesh capability, the requirements can be met with minimal resource consumption.

- Because this is an outdoor stadium, the APs servicing the stadium are placed in enclosures for shielding against the elements of weather.
- In the diagram, the following entities are defined:
  - Access AP: Refers to APs in standard/default mode, whereby they provide wireless access to clients in both buildings.
  - Gateway nodes: GW-A, GW-B, GW-C, and GW-D are nodes configured as gateways.
  - Mesh nodes: M-A1, M-A2, M-B1, M-C1, M-C2, M-D1, and M-D2 are configured as mesh nodes that propagate the "Stadium" SSID using wireless backhaul to leaf nodes, as well as service clients in their vicinity.
  - Leaf nodes: L-A1, L-A2, L-B1, L-C1, L-C2, L-D1, and L-D2 are leaf nodes that broadcast the "Stadium" SSID to service clients in their vicinity.
- Four separate mesh clouds are defined to cover the entire stadium. These are broken up into clouds A, B, C and D. Each cloud has its corresponding mesh and leaf nodes.
- Mesh cloud A consists of M-A1, M-A2, L-A1 and L-A2. The letter M stands for mesh node, and the letter L stands for leaf node. Similarly, cloud B consists of M-B1 and L-B1. Cloud C consists of M-C1, M-C2, L-C1 and L-C2. Cloud D consists of M-D1, M-D2, L-D1 and L-D2.

As discussed in Mesh, entities/nodes belonging to one mesh cloud do not interact with nodes in a different mesh cloud.

Although the same goal could have been met by defining only two mesh clouds, the reason for additional clouds are as follows:

- Management overhead: The more nodes that participate in a single mesh cloud, the higher the management traffic overhead is. Gateway and mesh nodes advertise the SSID, along with their cloud participants in their beacons. Hence it is a good idea to logically break down the cloud into multiple clouds where possible.
- Client and node limit: As discussed earlier, each cloud can have a maximum of 16 mesh nodes and 500 clients. Keeping this in mind, and since there are expected to be more than 500 clients in the stadium, multiple mesh clouds are necessitated.

- Throughput: As a rule of thumb, as the number of wireless devices connected to a radio increase substantially, the expected throughput per client decreases. Also, in this particular scenario, with two clouds as compared to four, the backhaul links for the mesh and leaf nodes would be far more choked because twice the number of clients use the same backhaul links, when compared to four mesh clouds.

Any client that roams between two different mesh clouds still experiences a soft handoff, unlike other legacy WLAN vendors that use microcell technology. However, as mentioned earlier, the best practice recommendation is to use different channels on adjacent mesh clouds to minimize the chance of collisions.

Use Case 4 Design Example: Real-Time Location Systems (RTLS) Support

In this use case, a veterinarian clinic has a low- to moderate-density of clients. Clients include laptops, workstations, mobile devices, and asset tags. Using the AP1020 and RTLS support, doctors and pets are easily located in the clinic. Information about pets is updated and uploaded to a database from anywhere in the clinic. The AP1020 are deployed with Virtual Cell or Virtual Port enabled.

Design Requirements

- Client density is expected to be low to moderate. Throughput requirements are expected to be low.
- The majority of clients are asset tags, handheld scanners, and veterinarian equipment used to grade/assess a medical condition and automatically update an online database.
- Medical equipment used to assess and update the online database is placed on carts so that it can easily be wheeled to different rooms. This equipment authenticates to an online server, and it is crucial to maintain connectivity even if it is mobile.
- At a minimum, every client device needs to be tracked in real time and its location known to administrators. The accuracy of location tracking has to be within 2-3 m.
- Two SSIDs are used: “Staff” and “Visitor.” The Staff SSID uses WPA2-PSK, and the Visitor SSID is open.
- Asset tags are attached to pets undergoing treatment and medical supplies that require constant temperature control. The temperature control tags automatically update an online database with the medicine’s current temperature reading, along with the delta (if any) from normal.

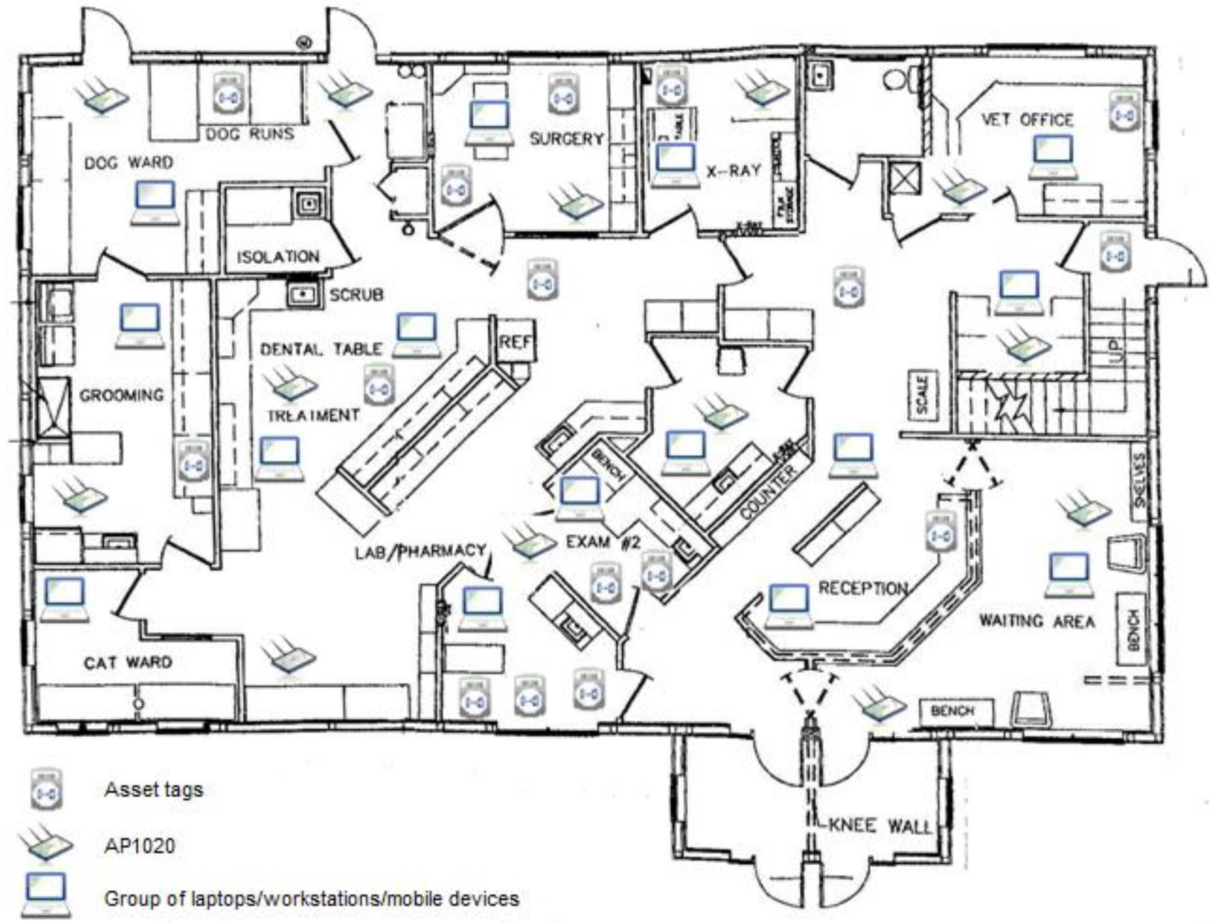
Floor Plan with AP Placement

Although the client density and throughput requirements are expected to be moderate at most, the APs are uniformly placed across the site with strong signal coverage everywhere. The primary reason for this is to allow for higher levels of location accuracy while tracking devices/tags. Figure 9 shows the AP placement for the clinic.

All APs broadcast the “Staff” and “Visitor” SSIDs on both radios (5 GHz and 2.4 GHz). The 5 GHz radios are configured for 40 MHz channel width to allow for higher throughput.

The challenge of ensuring that the mobile medical equipment stays authenticated with an online server, even while on the move, is easily overcome using Virtual Cell technology.

Figure 9: AP Placement for Veterinarian Clinic



As discussed earlier, in this particular deployment, the AP density might seem higher than expected, based on the client density and throughput requirements. However, due to the requirement of accurately tracking and pushing automated tag data to an online database, it is recommended that each device that is tracked should be heard by at least three APs. This principle is sometimes referred to as triangulation. Generally speaking, the more APs that hear a particular client, the more precise the tracking of that client is.

In this use case, asset tags containing basic ID information (for example, name and breed) are attached to pets that are waiting for or undergoing treatment. Temperature-monitoring tags are attached to medical supplies in the Lab/Pharmacy, which require constant temperature control. The front desk can inquire and find a pet's location using the online system without physically searching for that pet. Similarly, the location of each doctor is easily found, based on the laptop or handheld device that belongs to them. Motion-sensor tags are used to trigger automated alerts in the monitoring system, should a pet stray outside of a defined boundary designated to it. Doctors are able to update/upload a pet's diagnosis to the online database regardless of physical location.

The AP1010 and AP1020 have built-in support to allow for highly accurate location-based functionality. For indoor deployments, the APs gather a particular device's RSSI reading (and other information, such as channel, SSID, association state, and so on) and forward it to an external server to perform location calculations. Similar readings from multiple APs for the same device result in higher location accuracy.

Implementation Guidelines

Consider the following when implementing your WLAN:

- Enclosures for Outdoor Deployments
- Implementing a Weatherized Solution
- Geographical Channel Regulations for Outdoor Deployments
- Antennas
- Antenna Radiation Patterns
- Mounting Recommendations

Enclosures for Outdoor Deployments

Table 5 lists the TerraWave poly NEMA enclosures (14"x12"x6") that you can use for outdoor deployments.

There is little performance or signal impact when using enclosures with Meru APs and antennas enclosed inside the box. These enclosures are recommended for the AP1010 and AP1020. When using an enclosure, using AP models with integrated antennas is not recommended.

Table 5: TerraWave Enclosures

Part Number	Description	URL for More Information
V141206C60O4.25HC	14x12x6" heated and cooled enclosure with solid door and CAT60 lock, four holes for RPSMA jumpers	http://www.terra-wave.com/shop/14-x-12-x-6-heated-cooled-enclosure-with-solid-door-and-cat60-lock-four-holes-for-rpsma-jumpers-p-2175.html
V141206C60O2.25HC	14x12x6" heated and cooled enclosure with solid door and CAT60 lock, two holes for RPSMA jumpers	http://www.terra-wave.com/shop/14-x-12-x-6-heated-cooled-enclosure-with-solid-door-and-cat60-lock-two-holes-for-rpsma-jumpers-p-1343.html
V14126C60O4.25H	14x12x6" heated enclosure with solid door and CAT60 lock, four holes for RPSMA jumpers	http://www.terra-wave.com/shop/14-x-12-x-6-heated-enclosure-with-solid-door-and-cat60-lock-four-holes-for-rpsma-jumpers-p-2165.html

Implementing a Weatherized Solution

Use the following topics for information about implementing a weatherized solution:

- Access Point Preparation
- Weatherized Chassis Preparation
- Weatherized Chassis Installation

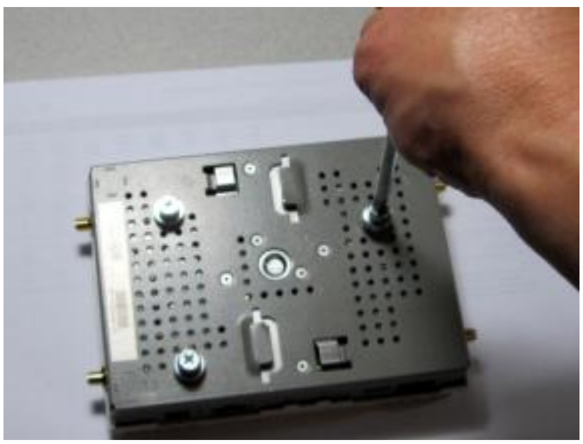
Access Point Preparation

This guide provides an example of a weatherized solution for the AP1020e. Installation of the AP1010e is slightly different, as it is a single-radio access point.

A shipment includes one wall mount bracket, three large screws (for attaching to the wall mount bracket), and four rubber feet (used when deploying on a horizontal surface).

Install the three mounting screws at the back of AP1020e, as shown in Figure 10.

Figure 10: Installing Mounting Screws on the AP

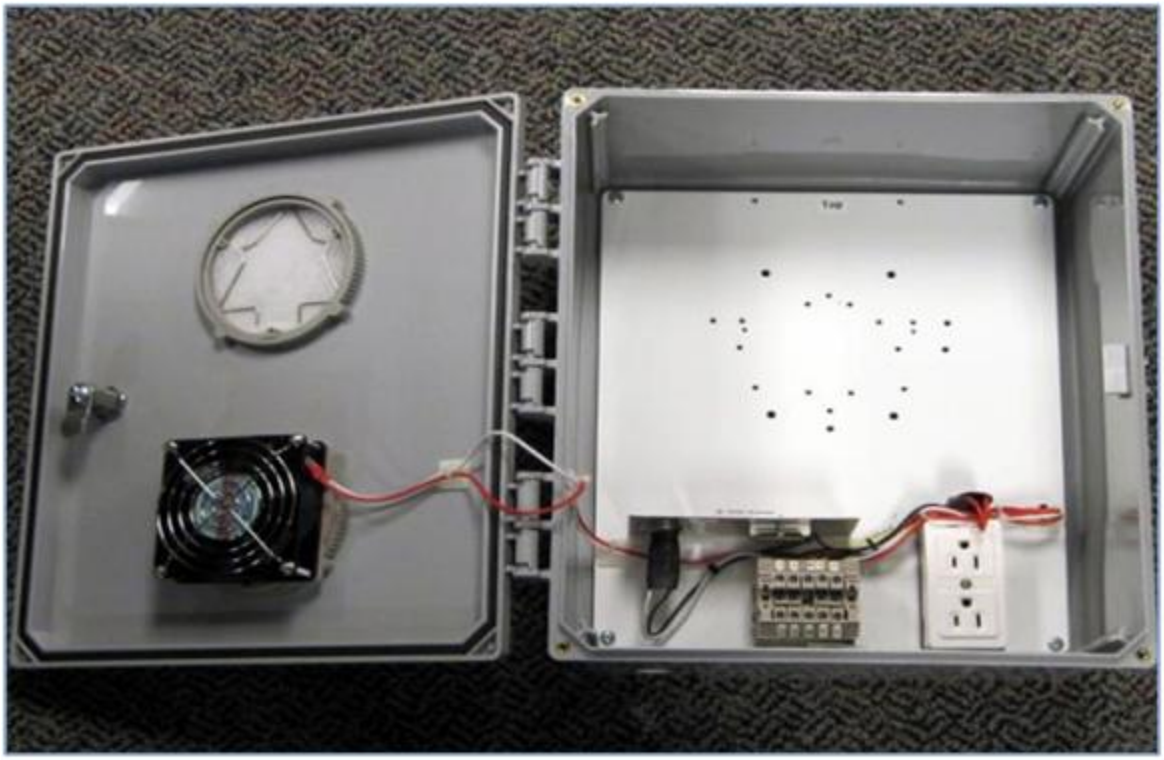


Weatherized Chassis Preparation

This AP1020e installation example uses a TerraWave poly NEMA enclosure (14" x 12" x 6"), as shown in Figure 11.

TerraWave offers different options and attachments to fit customized installations. See the TerraWave Web site to select the attachments that best meet your requirements. Our recommendation is to use the pole mount kit for TerraWave 14" wide polycarbonate enclosures (PMK-214).

Figure 11: TerraWave NEMA Enclosure



Accessories Included with Shipment

The following is an example of the accessories included with an enclosure shipment, as shown in Figure 12:

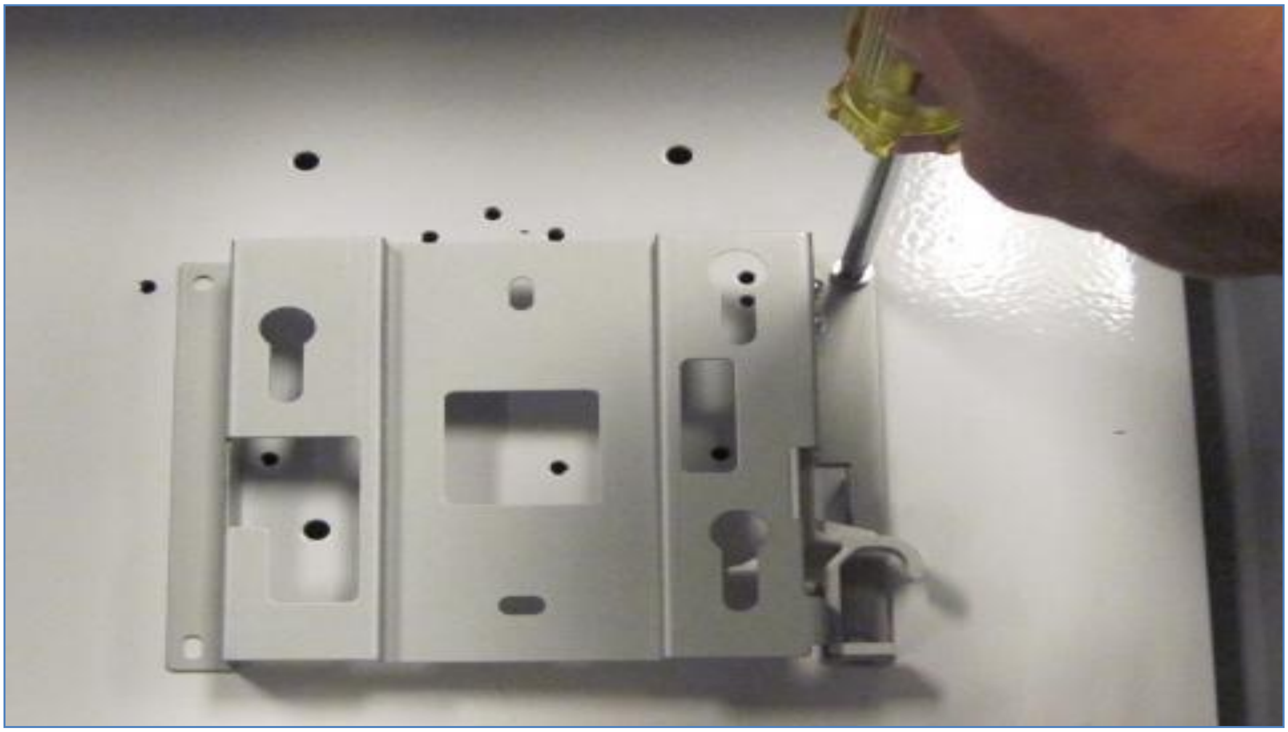
- Wall-mount brackets and screws
- Metal and plastic screws for plastic cover
- Cord caps
- Screws to fasten the AP and back panel together
- Lock key
- Fasteners for RF cable management
- Sealing cap

Figure 12: Enclosure Accessories

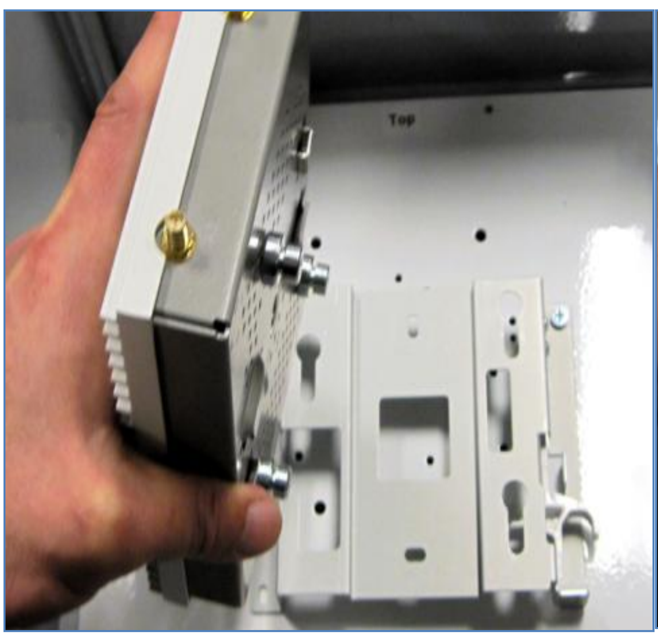
Weatherized Chassis Installation

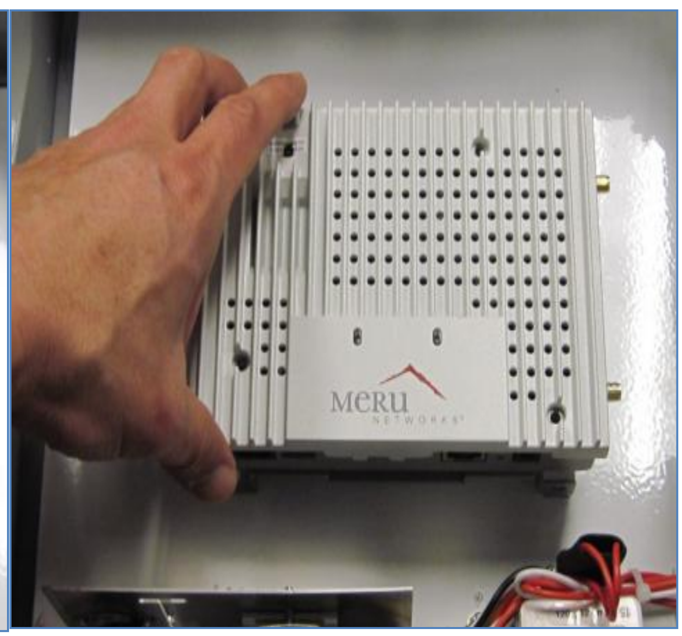
To install the weatherized chassis:

1. Attach the AP1020e wall-mount bracket over the back panel.

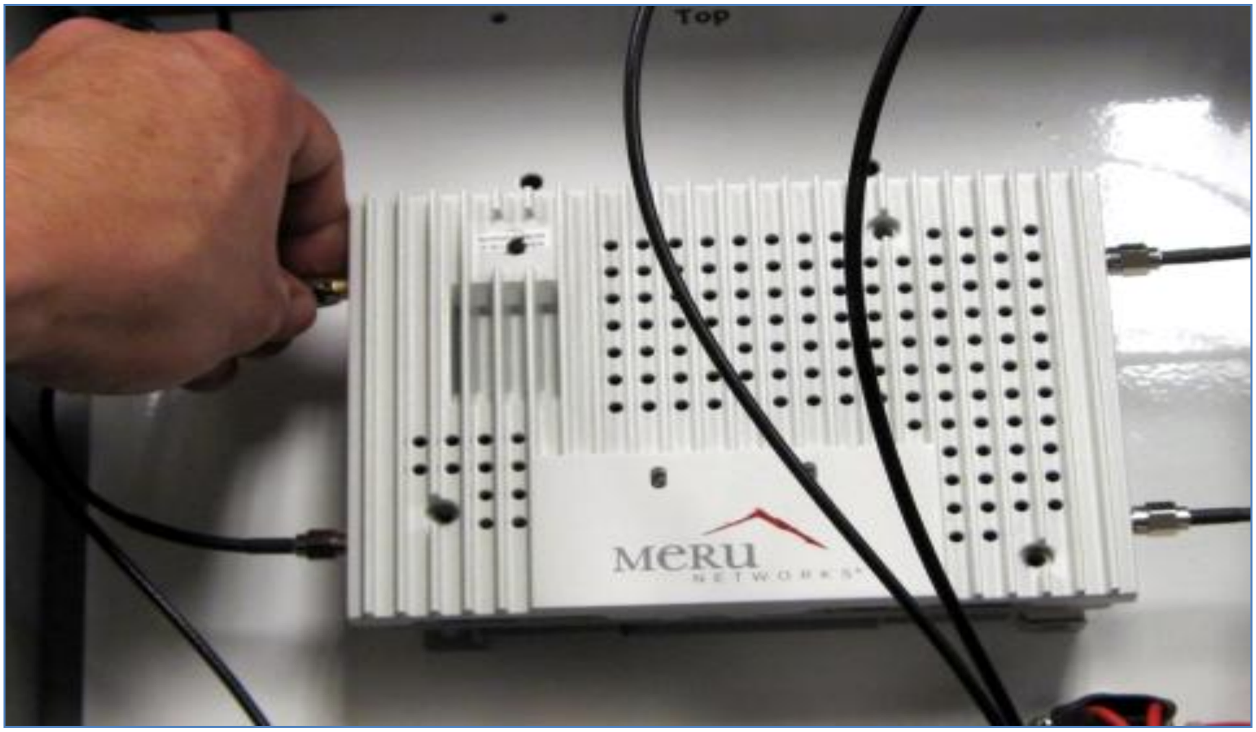


2. Mount the AP.



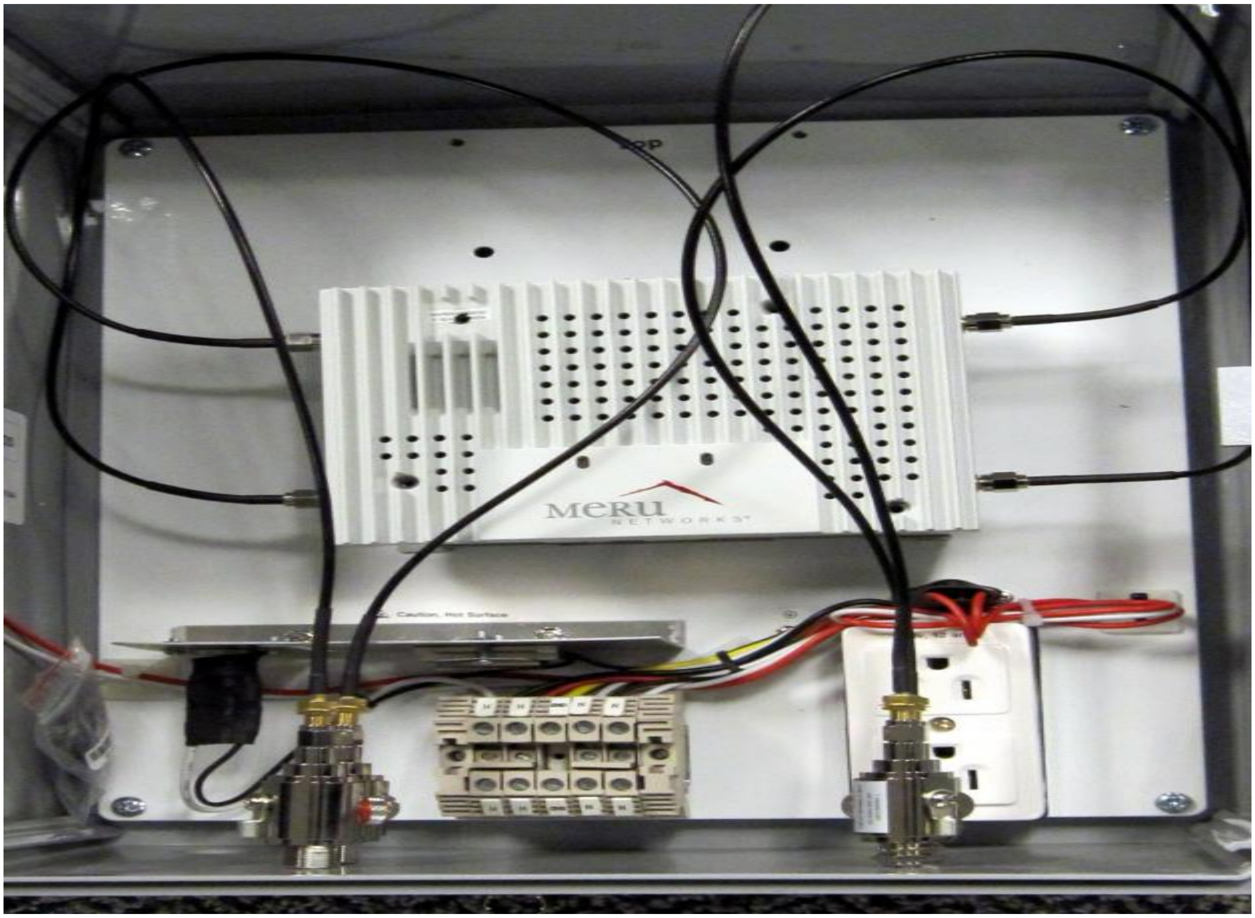


3. Install the RF coaxial cables (total of four). (You must obtain RF coaxial cables separately.)

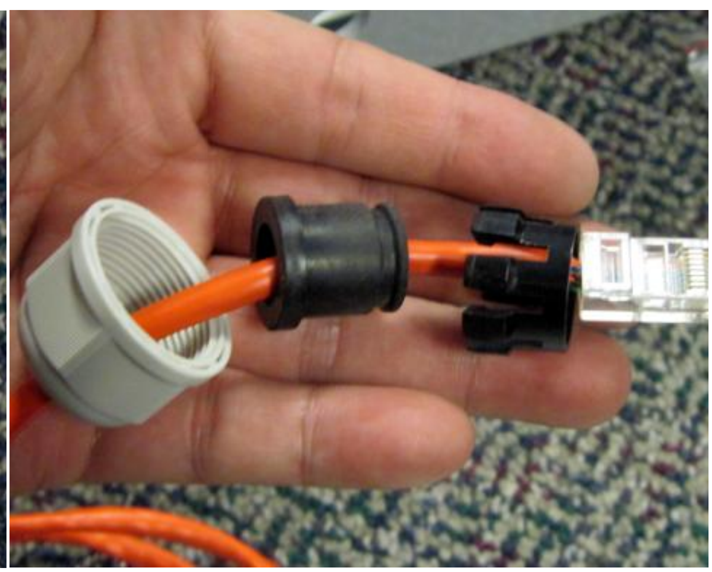


4. Install the lightning arrestors and lead RF jack outside of the NEMA chassis.

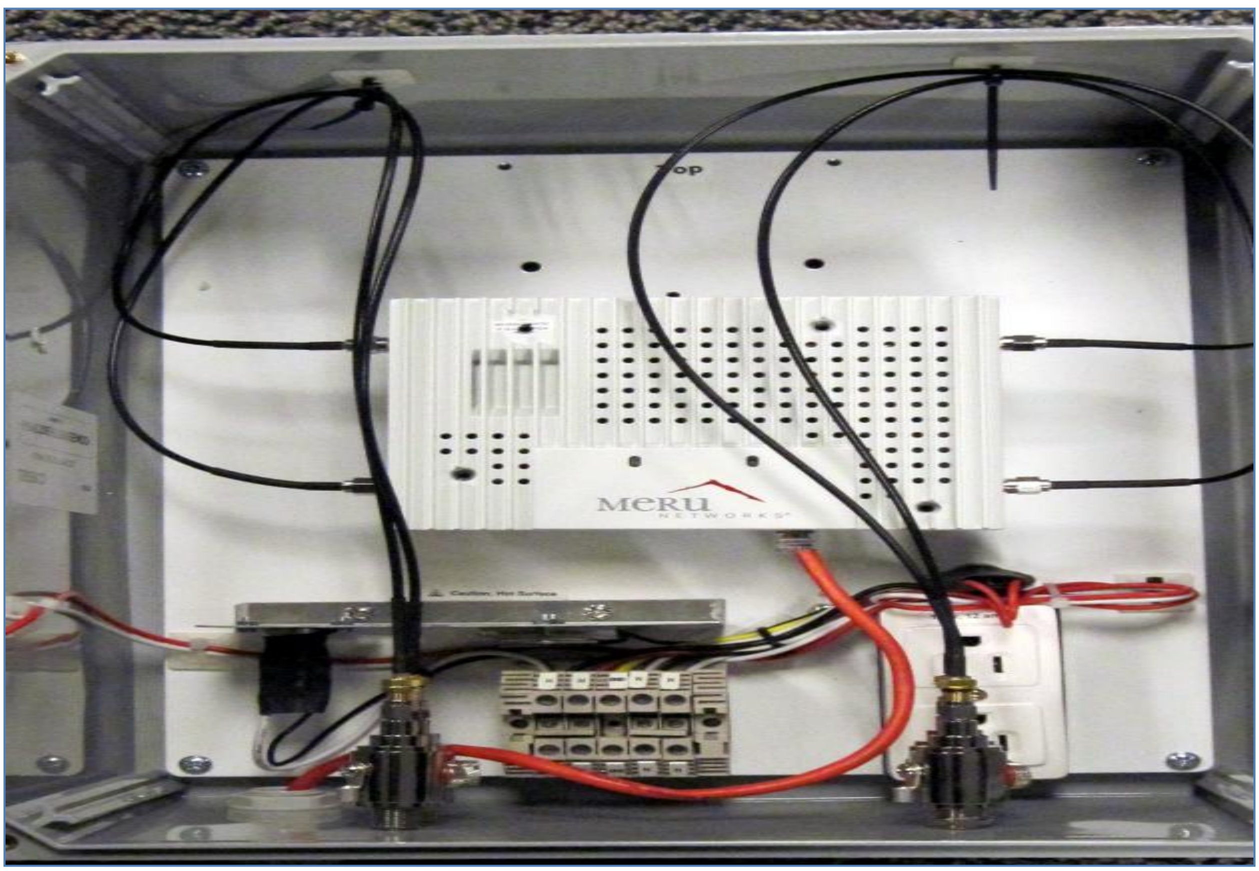
In this example, four are installed.



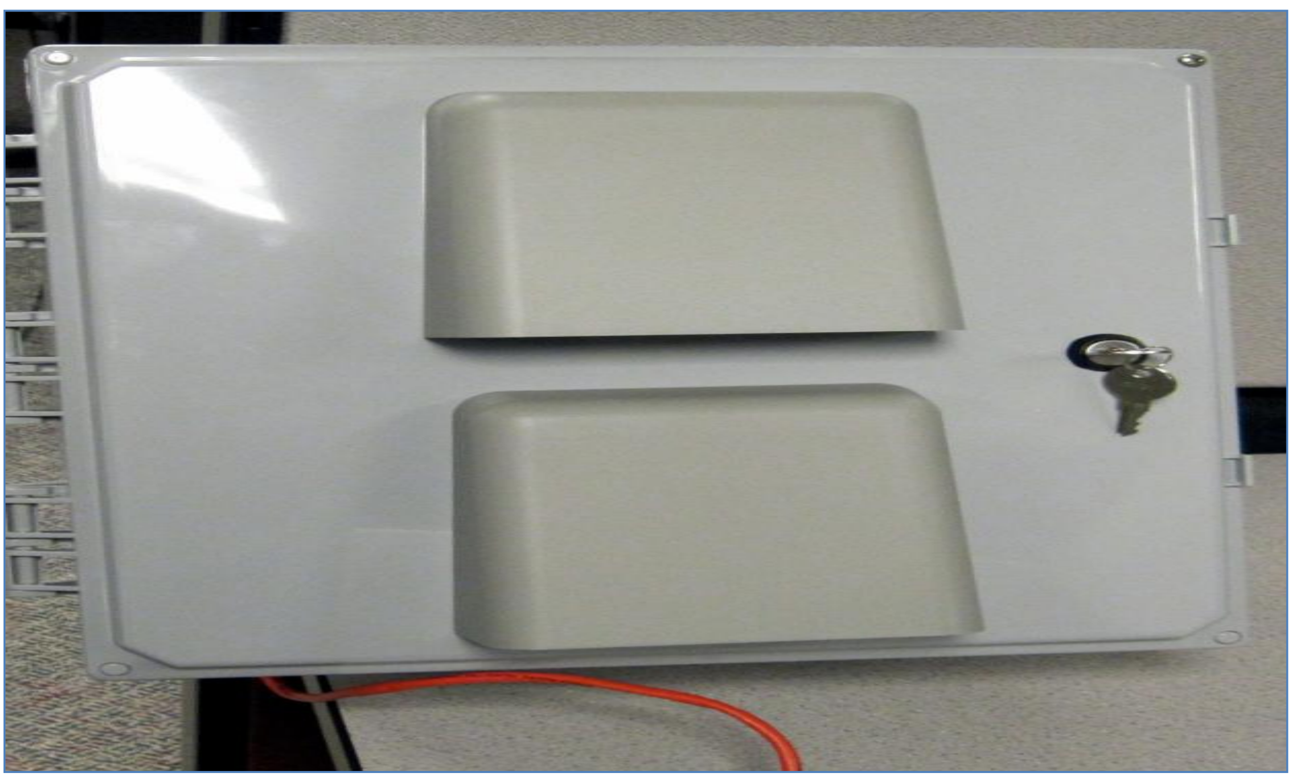
5. Extend the CAT5 cable for power and network connectivity.



The following illustrates the final assembly, with a network cable attached to the AP.



6. Fasten the cover by removing the plastic screws and replacing them with metal screws.



Geographical Channel Regulations for Outdoor Deployments

Table 6 lists channel regulations for outdoor deployments for common worldwide locations.

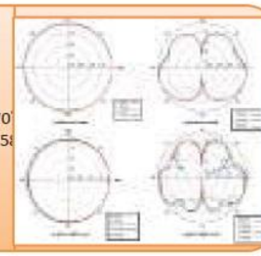
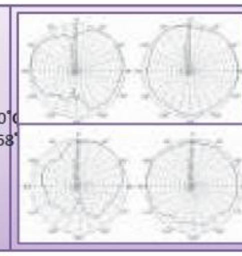
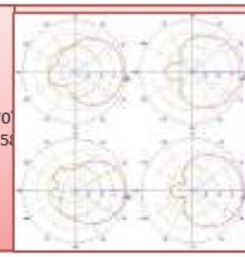
Table 6: Channel Regulations for Outdoor Deployments

Geographic Location	Radio 1 (2.4 GHz)	Radio 2 (5.x GHz)
Canada	No restrictions	Only channels 36–48 and 149–156 are allowed. DFS UNII-2 and UNII-2 extended bands are not allowed in outdoor environments.
United States	No restrictions	Only channels 36–48 and 149–156 are allowed. DFS UNII-2 and UNII-2 extended bands are not allowed in outdoor environments.
EU	No restrictions	Only channels 52–140 are allowed. UNII-1 and UNII-3 are not allowed.
Japan	No restrictions	Only channels 52–140 are allowed. UNII-1 and UNII-3 are not allowed.
Australia	No restrictions	Only channels 36–48 and 149–156 are allowed. DFS UNII-2 and UNII-2 extended bands are not allowed for in outdoor environments.
China	No restrictions	Only UNII-3 channels 149–165 at HT20 channel bonding are allowed. Use of other 5 GHz channels is prohibited.
Egypt	No restrictions	Only channels 52–140 are allowed. UNII-1 and UNII-3 are not allowed.
India	No restrictions	Only channels 52–140 are allowed. UNII-1 and UNII-3 are not allowed
Japan	No restrictions	Only channels 52–140 are allowed. UNII-1 and UNII-3 are not allowed.
Oman	No restrictions	Only channels 52–140 are allowed. UNII-1 and UNII-3 are not allowed.
Saudi Arabia	No restrictions	Only channels 52–140 are allowed. UNII-1 and UNII-3 are not allowed.
South Africa	No restrictions	Only channels 100–140 are allowed. UNII-1 in outdoor environments is not allowed. UNII-3 is not allowed.
UAE	No restrictions	Only channels 52–140 are allowed. UNII-1 and UNII-3 are not allowed.

Antennas

The antennas used in the AP1010 and AP1020 access points are shown in Figure 13. For information about the countries for which Meru products are certified, see http://salesportal.merunetworks.com/apps/f?p=1:10:2282153391451009::::PGID:793.

Figure 13: AP1010 and AP1020 Antennas

Model	Frequency Band	Gain	Polarization & Type	Beam width	Dimensions	Max Input Power	Operation Temperature	Antenna Pattern 2450 MHz and/or 5500MHz
ACC-ANT-ABGN230-W Omni directional rubber duct Dual-Band 	2.4 – 2.5 GHz	2.0 dBi	Vertical, Linear 1 x RP-SMA	E-Plane - 45º H-Plane - 360º	L = 5.1" Dia = 0.51 L = 13.0 Dia = 1.3 c	20 watts Impedance = 5 VSWR < 1.7:1	-30° C to +70 -22° F to +15	
	5.15 – 5.85 GH	2.0 dBi		E-Plane - 45º H-Plane - 360º				
ACC-ANT-I2ABGN-0304-O Ceiling mount Omni Dual-Band 2 x 2 MIMO 	2.4 – 2.5 GHz	3.0 dBi	Vertical, Linear 2x RP-SMA 2x 36" pigtail	E-Plane - 75º H-Plane - 360º	2.9" x 5.4" x 1.0" 7.36 x 13.7 x 2.54 c	2 watts Impedance = 5 VSWR < 1.7:1	-40° C to +70 -40° F to +158	
	5.15 – 5.85 GH	4.0 dBi		E-Plane - 90º H-Plane - 360º				
ACC-ANT-O4ABGN-0607-PT Wall mount Patch Dual-Band 2 X 2 MIMO 	2.4 – 2.5 GHz	6.0 dBi	Vertical, Linear 4x RP-SMA 4x 36" pigtail	E-Plane - 72º H-Plane - 82º	32.0" x 6.1" x 1.0" 44.5 x 13.7 x 2.54 c	50 watts Impedance = 5 VSWR < 1.7:1	-30° C to +70 -22° F to +15	
	5.15 – 5.85 GH	7.0 dBi		E-Plane - 60º H-Plane - 75º				

In addition to the standard antennas (ACC-ANT-ABGN230-W, OMNI-DIRECTIONAL RUBBER DUCT DUAL BAND ANTENNA, 2 dBi @ 2.4 GHz and 2 dBi @ 5.x GHz) equipped with the AP, you can also use the following antennas with the AP1010 and AP1020 to meet deployment requirements:

- ACC-ANT-I2ABGN-0304-0, CEILING MOUNT OMNI DUAL BAND MIMO ANTENNA, 3 dBi @ 2.4 GHz and 3 dBi @ 5.x GHz
- ACC-ANT-04ABGN-06-7-PT, WALLMOUNT PATCH DUAL BAND ANTENNA, 6 dBi @ 2.4 GHz and 7 dBi @ 5.x GHz

For additional information about antennas for the AP1010 and AP1020, see the following data sheets:

- Dual-Band Omni-Directional Antenna ACC-ANT-ABGN230-W data sheet
- ANT-04ABGN-0607-PT data sheet
- ANT- I2ABGN-0304-0 data sheet

You can order optional antennas from Meru.

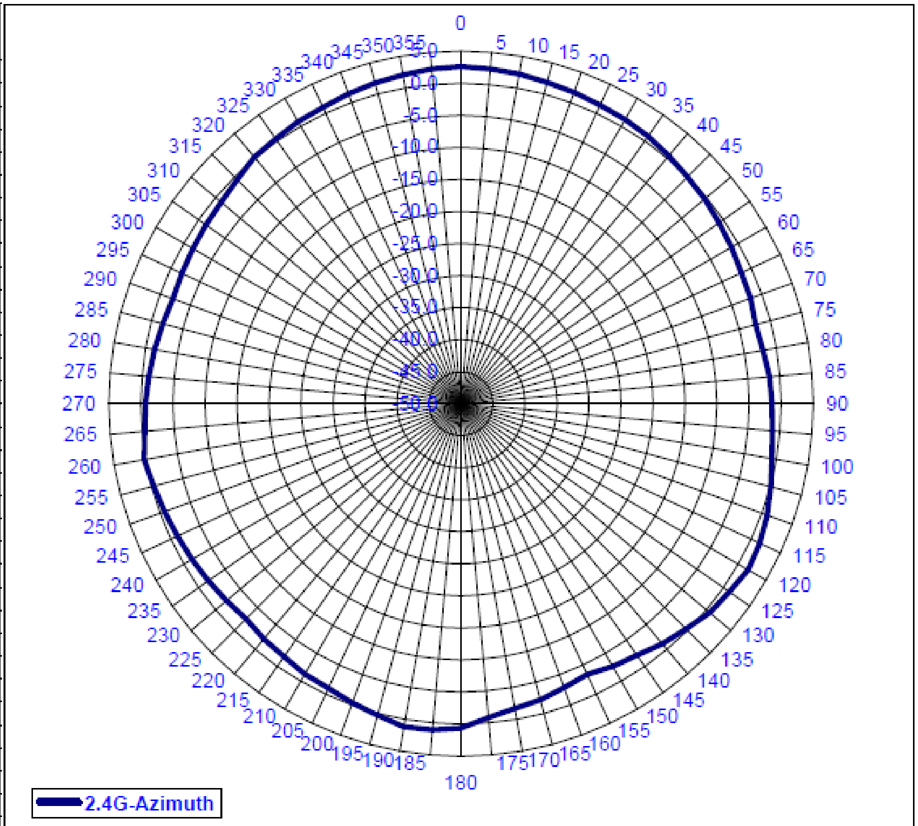
Antenna Radiation Patterns

Figure 14 shows the 2.4 GHz radiation pattern for the AP1000i. Figure 15 shows the 5.0 GHz radiation pattern for the AP1000i.

For radiation patterns for the AP1000e, see the data sheets listed on the Customer Support Portal.

Figure 14: 2.4 GHz Radiation Pattern for AP1000i

	2.4G Azimuth	2.4G Elevation
0	2.6	7.1
5	2.4	6.8
10	2.2	6.6
15	1.9	6.4
20	1.7	6.1
25	1.4	6.1
30	1.2	5.7
35	0.9	5.3
40	0.5	5.0
45	0.0	4.5
50	-0.4	4.1
55	-0.8	3.5
60	-1.2	2.8
65	-1.8	2.0
70	-1.9	1.1
75	-2.4	-0.4
80	-2.1	-2.0
85	-1.7	-3.8
90	-1.5	-6.3
95	-1.2	-9.2
100	-0.7	-15.4
105	0.1	-24.1
110	0.9	-22.6
115	1.5	-20.7
120	1.8	-18.9
125	1.2	-17.9
130	0.7	-16.6
135	-0.3	-15.6
140	-1.1	-14.9
145	-2.1	-15.2
150	-2.7	-16.1
155	-3.4	-17.4
160	-2.9	-18.4
165	-2.2	-21.3
170	-1.8	-24.8
175	-0.9	-26.9
180	0.6	-28.4
185	1.1	-30.9
190	1.2	-32.2
195	0.3	-29.1
200	-0.4	-24.8
205	-1.1	-20.4
210	-1.3	-17.5
215	-1.8	-14.1
220	-2.1	-10.6
225	-2.6	-7.8
230	-2.2	-4.7
235	-1.8	-2.2
240	-1.5	-0.2
245	-1.1	1.2
250	-0.7	2.1
255	-0.4	3.1
260	0.2	3.6
265	-0.4	4.3
270	-0.7	4.8
275	-1.1	5.2
280	-1.4	5.5
285	-1.8	5.7
290	-2.2	6.0
295	-1.9	6.5
300	-1.6	6.7
305	-1.3	7.0
310	-1.1	7.1
315	-0.6	7.3
320	0.2	7.6
325	0.4	7.8
330	0.8	7.7
335	1.0	7.5
340	1.4	7.6
345	1.8	7.5
350	2.1	7.3
355	2.4	7.1



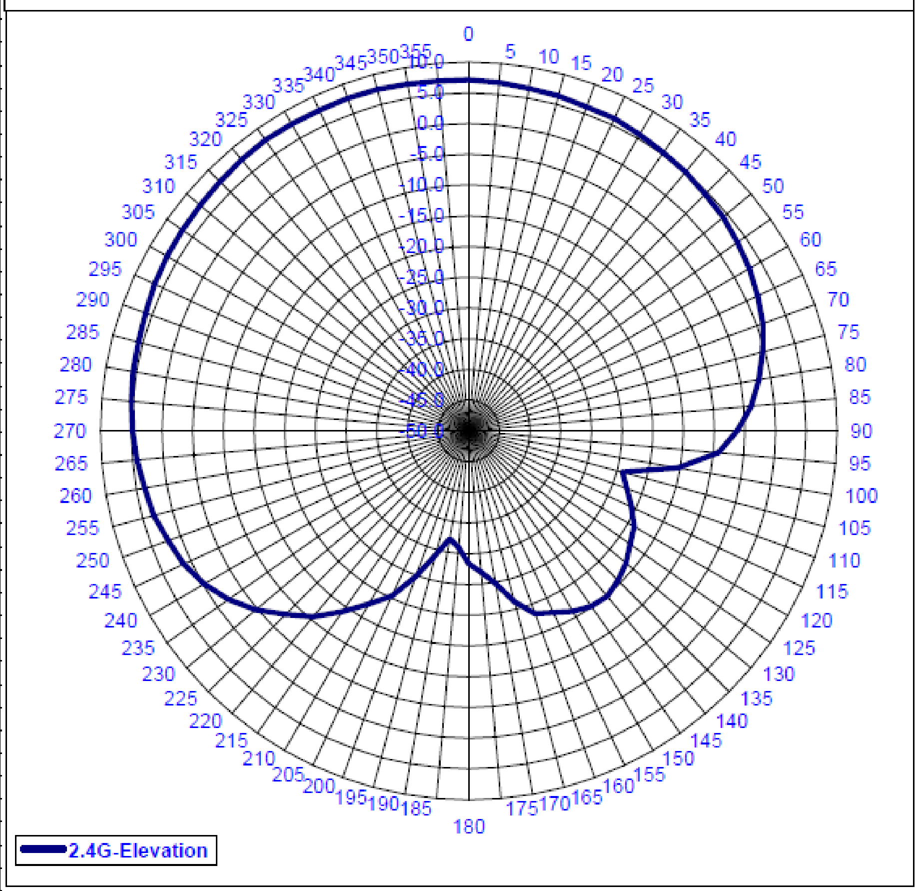
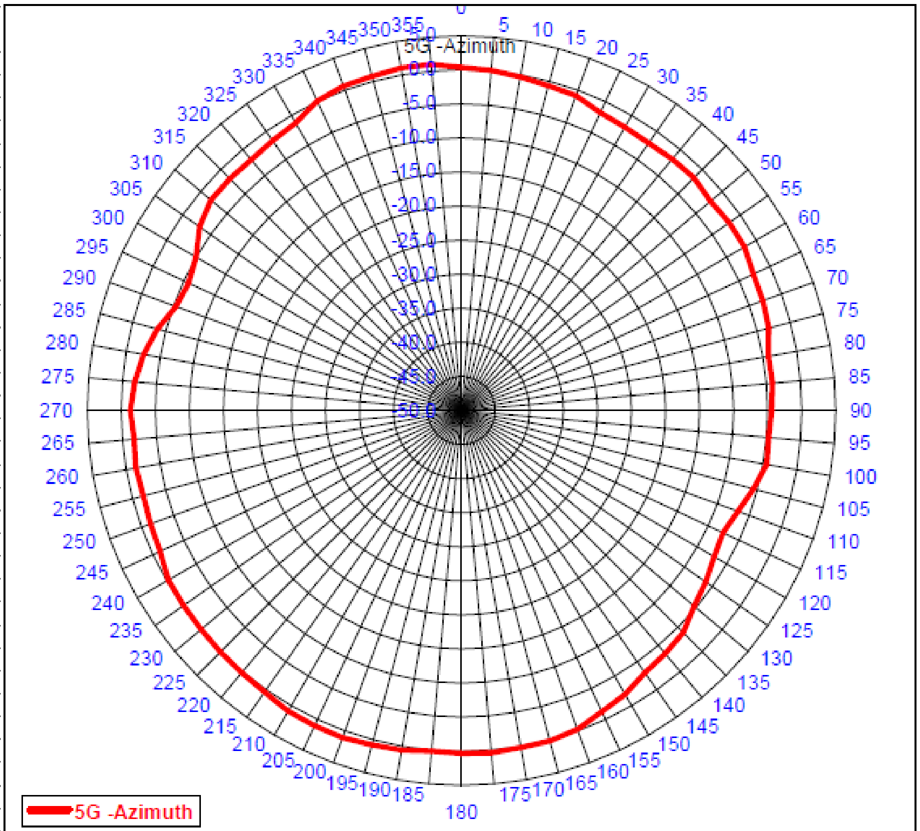
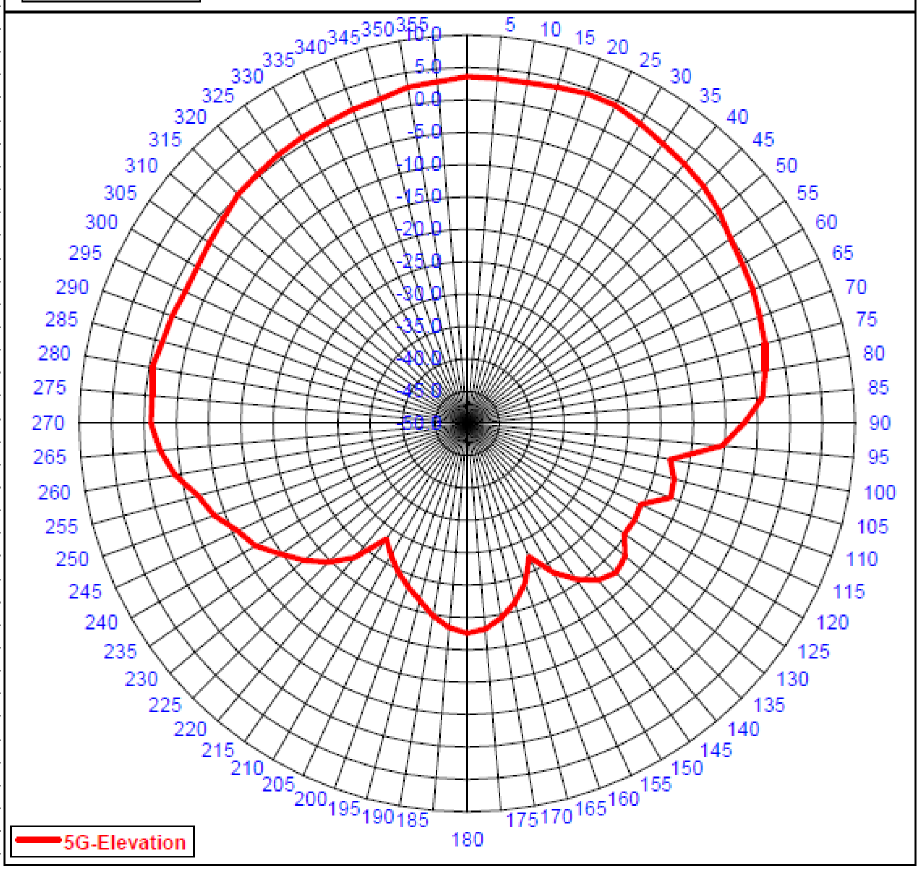


Figure 15: 5.0 GHz Radiation Pattern for AP1000i

	5G Azimuth	5G Elevation
0	0.3	3.6
5	0.1	3.5
10	-0.3	3.5
15	-0.7	3.8
20	-0.8	4.2
25	-1.8	4.2
30	-2.0	3.5
35	-2.1	2.7
40	-1.9	2.3
45	-1.7	1.8
50	-2.2	0.9
55	-2.0	-0.2
60	-2.0	-0.8
65	-2.7	-1.2
70	-2.9	-1.8
75	-3.3	-2.3
80	-4.2	-3.2
85	-4.2	-4.1
90	-4.5	-7.2
95	-4.7	-10.4
100	-4.5	-18.1
105	-5.6	-16.8
110	-6.8	-16.5
115	-7.6	-20.4
120	-7.2	-20.1
125	-6.2	-20.3
130	-5.4	-18.1
135	-3.9	-17.4
140	-3.5	-18.4
145	-3.1	-20.6
150	-2.0	-23.4
155	-1.3	-27.3
160	-0.3	-23.9
165	0.1	-21.4
170	0.2	-19.5
175	0.4	-18.1
180	0.3	-17.6
185	0.1	-18.3
190	0.6	-19.8
195	0.8	-21.7
200	1.1	-23.2
205	1.0	-24.7
210	0.9	-26.5
215	0.4	-28.2
220	0.2	-22.9
225	0.1	-19.7
230	-0.1	-17.1
235	-0.1	-14.8
240	-0.3	-12.2
245	-1.2	-10.8
250	-1.4	-8.4
255	-1.6	-6.9
260	-1.5	-4.1
265	-1.8	-2.3
270	-1.4	-1.1
275	-1.9	-1.1
280	-2.6	-0.6
285	-3.8	-1.2
290	-5.4	-1.4
295	-5.8	-1.8
300	-5.0	-1.8
305	-3.0	-1.3
310	-2.0	-0.8
315	-2.0	0.1
320	-2.0	0.3
325	-1.7	0.7
330	-1.3	1.0
335	0.1	1.2
340	0.6	1.6
345	0.8	1.9
350	1.0	2.7
355	0.9	3.0





Mounting Recommendations

The AP1000i models use integrated antennas that effectively allow for 180° signal propagation. We recommend that you do not mount these APs on walls, as the signal propagation behind the wall (on which the AP is mounted) is limited. Ideally, the AP1000i should be mounted on a ceiling.

In specific situations, you can mount an AP1000i on a wall to reduce the coverage behind it. For example, a boundary wall requires minimal signal propagation outside the wall, so you could mount an AP1000i on the boundary wall. Mounting an AP1000i this way is not standard and should be used judiciously.

The AP1000e models use external antennas and allow for full 360° signal propagation. These APs can be mounted on walls or ceilings, depending on the RF planning at the deployment site.

Where to Find More Information

For information about the AP1010 and AP1020, refer to the following documents:

- AP1000 Installation Guide
- Meru System Director Configuration Guide and Meru System Director Command Reference (On the Software Downloads & Documentation page, click the link for the release of System Director that you are using.)
- Best Practices Guide for High-Density Design and Deployment