Powering the All-Wireless Enterprise™

AP400 Deployment Guide

May 2012

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Introduction

The demands on 802.11 systems are already taxing the gains realized by moving from legacy networks to 802.11n. Smartphones and tablets are becoming ubiquitous in universities, hospitals, retail outlets, and hotels. The proliferation of mobile devices is dramatically driving up client density counts. When designing WLAN systems, two of the main challenges are accommodating higher client density and achieving higher throughput.

The iPhone launch at the Moscone Center in San Francisco in 2010 showed how higher client density can cause problems. The demonstration did not go as planned because there were too many devices using the same spectrum as the iPhone being demonstrated.

This wireless meltdown illustrates that although 802.11n does deliver more throughput than legacy networks, the increased throughput is often not enough to accommodate increasing client density counts. Most observers of the 802.11 space agree that client density and throughput requirements are increasing rapidly.

According to the “Virtual WLANs: Making the All-Wireless Enterprise a Reality” report (October 2010) written by the Yankee Group:

> **“**Wireless device proliferation: Just a few years ago, corporate wireless devices were limited to laptops and a few custom-built devices for specific verticals. Over the past 24 months, however, wireless devices have exploded in number and now include laptops, tablets and vertically specific devices such as medical devices, surveillance cameras and dual-mode phones. As the number of wireless devices continues to grow, so does the importance of the corporate wireless network. Yankee Group forecasts the total number of mobile devices will grow to 1.51 billion by 2014, up from 1.14 billion at the end of 2009.”

While we wait for emerging standards, such as 802.11ac, WLAN system designers must strive to get the most out of the current 802.11n standard. Techniques such as airtime fairness and co-channel interference mitigation help with optimizing channel utilization. For many networks, more needs to be done to handle the higher throughput and/or client density requirements.

The AP400 was developed with these challenges in mind. The AP400 can be configured with three 3x3:3 802.11n radios. Each radio supports three spatial streams and is capable of data rates of 450 Mbps per radio with an aggregated data rate of 1,350 Mbps. If three channel layers are still inadequate to meet the demands of high density areas, more AP400s can be provisioned in an area to add capacity by adding channel layers.

The AP400 supports virtualization, which offers the ability to optimize client-to-AP associations, thereby ensuring that clients are always connected at the highest possible data rates. Virtualization has other benefits, such as seamless roaming and greater application performance and predictability.

The AP400 can be configured to support very high client density and/or high throughput environments. The AP400 can also be configured to support different applications, such as voice or video, on different channel layers. The AP400 can help with other challenges, such as a crowded RF environment, when one of its radios is a spectrum sensor.

This guide provides design examples that illustrate how the AP400 is up to the challenge of current and future 802.11 demands.

AP400 Platform

The AP400 product family consists of four models. Two models have integrated antennas, and two have external antennas. A spectrum sensor model is available in the external or internal antenna models. Table 1 lists the AP400 models.

Table 1: AP400 Models

AP400 Model	Radio Characteristics
AP433e	Three 3-stream 802.11n radios (3x3:3) with external antennas
AP433i	Three 3-stream 802.11n radios (3x3:3) with internal antennas
AP433is	Two 3-stream 802.11n radios (3x3:3), plus one spectrum sensor with internal antennas
OAP433es	Outdoor AP with three 3-stream 802.11n radios (3x3:3) with external antennas

Note: The AP433e model is supported by System Director Release 5.0 and higher. The AP433i, AP433is, and OAP433es models are supported by System Director Release 5.1 and higher.

Deployment Guidelines

When planning for deployment, consider the following guidelines:

- Supported Radio Combinations
- Coverage and Spacing Guidelines
- AP400 Mounting Recommendations
- Load-Balancing Guidelines
- Band Steering
- PoE Guidelines
- Guidelines for Deployment with Spectrum Sensors

Supported Radio Combinations

The AP400 can support two radios in the same band, which allows for greater flexibility when implementing channel-layer load-balancing or reserving a channel layer for a specific application.

This guide provides examples illustrating how using two radios in the same band can help meet system design requirements.

Consider the following recommendations when selecting which channels to configure from a single band on an AP400:

- In general, select channels that are spaced far apart in a spectrum when configuring 20 MHz channels.
- For 40 MHz channels, use channels from different UNII bands in the 5 GHz range.
- Two 40 MHz channels in the 2.4 GHz band are not supported on a single AP400, as the channels (for example, Ch 1+ and Ch 6+) would overlap. One 20 MHz channel and one 40 MHz channel in a 2.4 GHz band on a single AP400 are also not supported, as they cannot provide enough channel isolation.

The following lists two examples of recommended dual radio/same-band configurations:

- Example 1: Dual 2.4 GHz radios, single 5 GHz radio
  - Radio 1: Ch 1
  - Radio 2: Ch 11
  - Radio 3: Ch 36+
- Example 2: Single 2.4 GHz radio, dual 5 GHz radios
  - Radio 1: Ch 1
  - Radio 2: Ch 149+
  - Radio 3: Ch 36+

In Example 1, there are two 20 MHz channels (Ch 1 and Ch 11) in the 2.4 GHz band configured and a single 40 MHz channel (Ch 36+ or 36-40). Channels 1 and 11 are selected to allow for greater spacing between the channels, thereby minimizing the issue of adjacent channel interference.

In Example 2, there are two 40 MHz channels (Ch 149+ and Ch 36+) in the 5 GHz band configured and a single 20 MHz channel (Ch 1). Channels 149+ and 36+ are selected from different UNII bands to allow for greater spacing between the channels, thereby minimizing the issue of adjacent channel interference.

Configuring two 40 MHz channels from the same UNII band is not recommended, as the adjacent channel interference adversely impacts performance.

The following lists examples that are not recommended, as adjacent channel interference would be severe and negatively impact performance:

- Example 3: Dual 2.4 GHz radios, single 5 GHz radio
  - Radio 1: Ch 1
  - Radio 2: Ch 6
  - Radio 3: Ch 36+
- Example 4: Single 2.4 GHz radio, dual 5 GHz radios
  - Radio 1: Ch 1
  - Radio 2: Ch 44+
  - Radio 3: Ch 36+

Coverage and Spacing Guidelines

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 -65 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.

In this guide, we assume that we meet the design requirements when the AP locations are 80-100 feet apart, excluding high-density areas where APs are located near each other in pods of two or more APs to support additional channel layering.

AP400 Mounting Recommendations

The AP400e models, with their external antennas, can be mounted vertically (for example, walls or columns) and horizontally (for example, ceilings) as their omni antennas provide 360° of coverage. The AP400i has internal antennas, which provide 180° of coverage. For this reason, the recommendation is that AP400i models be mounted on ceilings.

> **Note:** If AP400i models are mounted on walls, the coverage in the room on the other side of the wall is minimal.

For more information, see the *AP400 Installation Guide*.

Load-Balancing Guidelines

Load-balancing can be used to accommodate moderate or high-density areas. The additional spectrum provided by additional channel layers is used to provide additional bandwidth, as well as allowing for higher client densities.

Load-balancing is accomplished by provisioning two or more channel layers in the same band for a given ESS profile. Note that load-balancing occurs within an ESS profile and not an SSID. This distinction, as we will see later, has profound implications in terms of system design.

The specific type of load-balancing that is described in this section refers to maximum stations per BSSID. A BSSID is unique to a channel layer for a given ESS profile. Therefore, load-balancing with maximum stations per BSSID is really a technique to evenly distribute stations across channel layers for a given ESS profile.

Load-balancing can be configured to work across multiple radios in the same band on a single AP400 or across multiple APs that are positioned near each other.

A group of APs that are positioned near each other for the purpose of load-balancing is commonly referred to as a pod. APs that make up a pod should be placed approximately 7-10 feet apart from one another. For example, if there are three APs in a pod, they can be arranged in a delta configuration (as seen in several use cases in this guide). This placement recommendation allows similar coverage patterns for each channel layer but avoids interference that results by placing the APs too close together.

Note: APs interfere with each other if they are too close together, even when they are on different channels.

Load-balancing works with the following configurations:

- Virtualization with Shared BSSID (not supported on the AP400)
- Per-Station BSSID (also known as Virtual Port)
- No virtualization (when there is only one radio per channel layer for a given ESS profile)

With Virtual Port, there is a "parent BSSID" that is shared by all radios on the same channel within the same ESS profile. The parent BSSID is used when determining the maximum client count of the load-balancing feature.

This guide provides examples for configurations using per-station BSSID (Virtual Port) and configurations in which there is no virtualization, as the AP400 does not support shared BSSID. For the purpose of this guide, load-balancing is enabled for all use cases except Use Case 8.

When designing systems that require load-balancing, consider the following:

- Load-balancing is a global configuration. When load-balancing is enabled, it is applicable for all ESS profiles configured on a controller.
- Load-balancing works within a band only. What happens in the 2.4 GHz band has no impact on what happens in the 5 GHz band.
- Load-balancing works within an ESS profile (also known as an ESSID). What happens in one ESSID has no impact on what happens in any other ESSID.
- Load-balancing works even when Virtual Cell and/or Virtual Port are disabled if there is only one radio per channel layer within a particular ESSID. This option works well for high-density areas that are small enough such that a single radio per channel layer provides good coverage (for example, -70 dBm for data-only networks or -65 dBm for networks that need to support voice or video)

For information about configuring load-balancing, see the Channel Layering Configuration Note.

Channel Layer Capacity

Table 2 offers guidelines for determining the number of channel layers required to accommodate a given number of clients for a range of expected average throughput (per client). A maximum channel count of 24 is used, as this is the total number of channels currently available in the US when DFS channels are enabled in the 5 GHz band. Of the 24 channels, 3 are in the 2.4 GHz band and 21 are in the 5 GHz band.

Note: The AP400 does not currently support DFS channels.

Table 2: Number of Channel Layers Required for Client Density

	Number of Clients									
Per-Client Throughput	100	200	300	400	500	600	700	800	900	1000
0-.5 Mbps	1	2	3	4	5	6	7	8	9	10
.5-1 Mbps	2	4	6	8	10	11	12	13	14	15
1-2 Mbps	4	8	12	16	20	22	24	n/a	n/a	n/a
2-4 Mbps	8	16	24	n/a	n/a	n/a	n/a	n/a	n/a	n/a
4-8 Mbps	16	24	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

For information about configuring load-balancing, see the Channel Layering Configuration Note.

Band Steering

When designing networks with channels available in the 2.4 GHz and 5 GHz bands, we recommend that band steering be enabled to ensure that the majority of dual-band clients use the more abundant 5 GHz channels. Band steering is configured at the ESS-profile level. This guide assumes that band steering is enabled for all ESS profiles.

PoE Guidelines

Although the AP400 can operate two radios with 802.3af power, 802.3at power is required to support the operation of all three radios.

Guidelines for Deployment with Spectrum Sensors

The Deployment Guidelines for Meru PSM3x RF Interference Monitoring Sensors document describes how three levels of monitoring support (Gold, Silver, and Bronze) can be achieved using the spectrum sensors. This guide focuses on providing Gold-level monitoring support. Gold-level support provides the best level of interference detection and identification for non-802.11 sources.

Deployment Design Examples

This guide presents eight use cases, each of which illustrates the power and flexibility of the AP400 in combination with other Meru high-density enabling technologies, such as channel-layer load-balancing:

- Use Case 1: Pervasive 3 Radios for Access with Load Balancing Across Two 5 GHz Radios
- Use Case 2: Pervasive 3 Radios for Access with One 5 GHz Channel Layer Exclusively for Voice
- Use Case 3: Moderate Density Areas with Virtual Port and High-Density Areas Without Virtual Port
- Use Case 4: Moderate Density Areas with Virtual Port and High Density Areas with Virtual Port
- Use Case 5: Pervasive Voice and Moderate Density Areas with Virtual Port and High Density Area Without Virtual Port

- Use Case 6: Two Radios for Access and One Spectrum Sensor
- Use Case 7: Deployment Using AP300s in Lower-Density Areas and AP400s in Higher Density Area
- Use Case 8: Pervasive 3 Radios for Access with Two Radios for Virtual Cell and One Radio for Multi-Channel

For each use case, the design requirements are defined and a floor plan is provided. For simplicity, the same floor plan is used for each use case. Based on the design requirements and floor plan, we can establish an AP placement plan and a channel-layering plan.

AP400 Common Examples

The following use cases are common examples of AP400 deployment:

- Use Case 1: Pervasive 3 Radios for Access with Load Balancing Across Two 5 GHz Radios
- Use Case 2: Pervasive 3 Radios for Access with One 5 GHz Channel Layer Exclusively for Voice
- Use Case 3: Moderate Density Areas with Virtual Port and High-Density Areas Without Virtual Port
- Use Case 4: Moderate Density Areas with Virtual Port and High Density Areas with Virtual Port
- Use Case 5: Pervasive Voice and Moderate Density Areas with Virtual Port and High Density Area Without Virtual Port

Use Case 1: Pervasive 3 Radios for Access with Load Balancing Across Two 5 GHz Radios

This use case shows how the AP400 can be deployed when two channel layers from the same band are used for channel layer load-balancing.

Design Requirements

- Client density and throughput requirements are expected to be moderate and uniform throughout the deployment.
- Maximum client density is expected to be 50-60 clients per interference region.
- The maximum throughput requirement for a single interference region is expected to be approximately 200 Mbps.
- Coverage is required in 2.4 GHz and 5 GHz bands.
- The 2.4 GHz and 5 GHz bands support a mix of voice, video, and data applications.
- There are two SSIDs: “guest” and “staff,” which are configured on the 2.4 GHz channel layer and 5 GHz channel layers on all APs.
- Load-balancing across the 5 GHz channel layers is required.
- The “guest” SSID has an open security profile, and the “staff” SSID uses WPA2PSK.
- The size of the deployment is approximately 44,000 square feet.

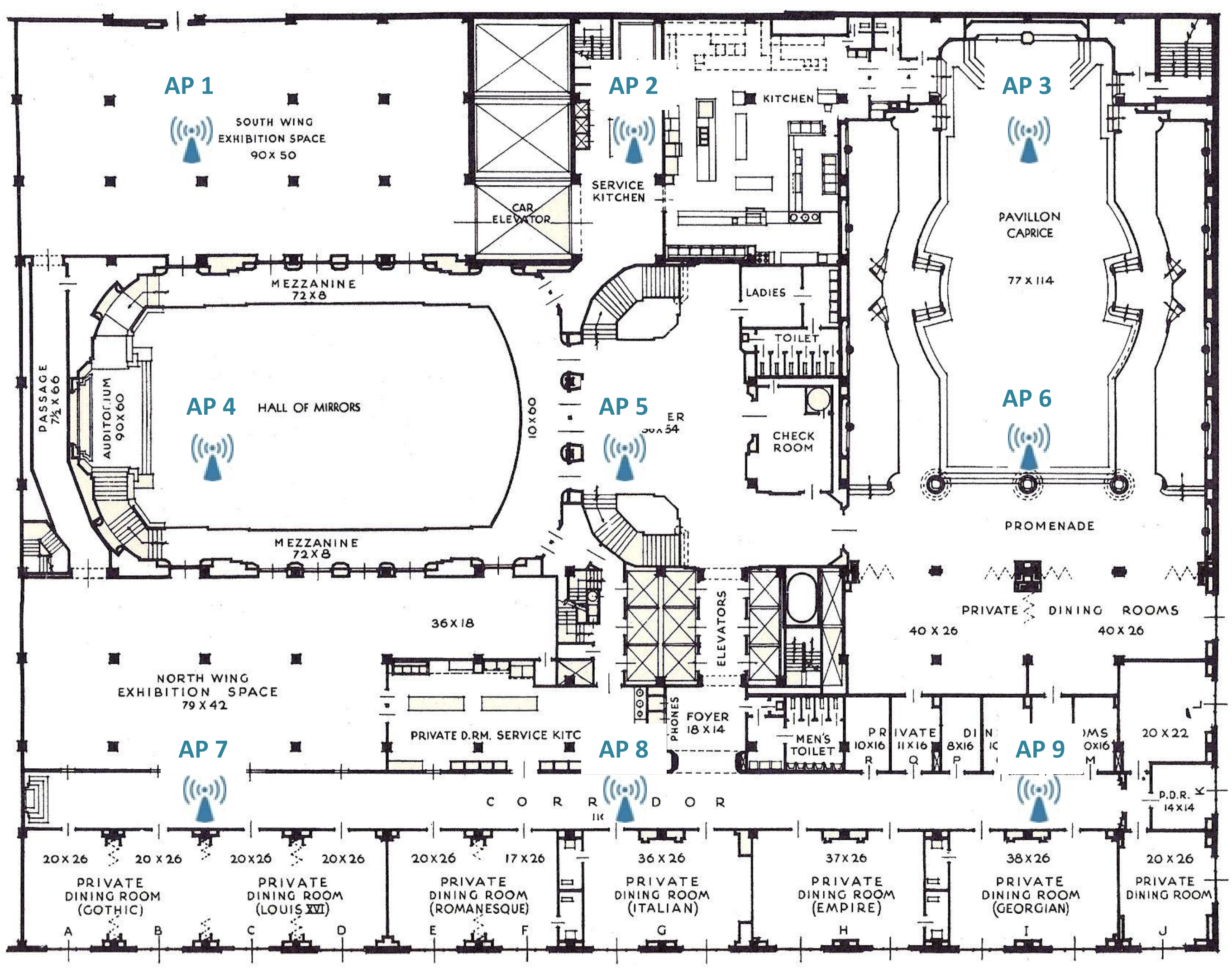
Floor Plan with AP Placement

Given that client density and throughput requirements are expected to be moderate and uniform, the APs are placed in a relatively even distribution. As throughput requirements are also expected to be moderate and uniform, there are no high-throughput areas that require additional channel layer load-balancing. A single AP400 in each location enables us to layer three channels pervasively.

AP-to-AP distances will vary, depending on the characteristics of an environment. For the purpose of this guide, we assume that we meet the requirements in Coverage and Spacing Guidelines when the AP locations are 80-100 feet apart.

Figure 1 shows the AP placement used to meet the design requirements of Use Case 1.

Figure 1: Hotel First Floor – AP Placement for Use Case 1



AP Radio Configurations

Table 3 lists the channels configured on each AP shown in Figure 1. The model AP433i is used in all locations for Use Case 1.

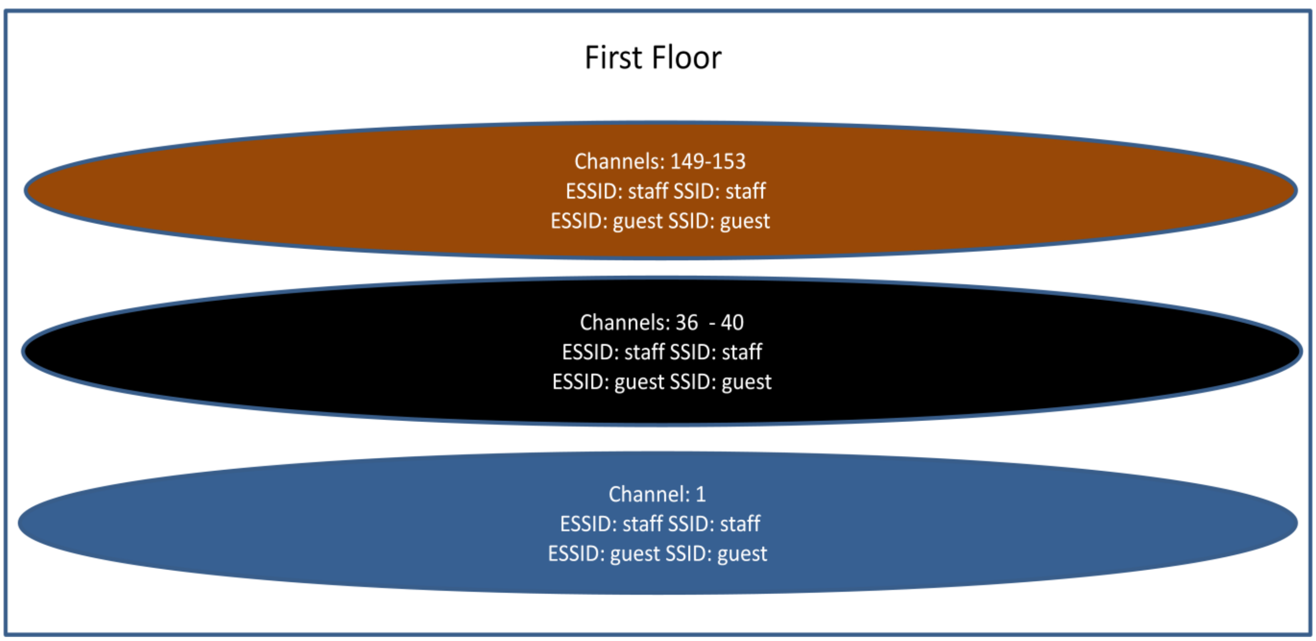
Virtual Port is enabled on all radios listed in Table 3.

Table 3: Use Case 1 AP Radio Configurations

AP ID	Radio 1	Radio 2	Radio 3
AP 1	Ch 1	Ch 36+	Ch 149+
AP 2	Ch 1	Ch 36+	Ch 149+
AP 3	Ch 1	Ch 36+	Ch 149+
AP 4	Ch 1	Ch 36+	Ch 149+
AP 5	Ch 1	Ch 36+	Ch 149+
AP 6	Ch 1	Ch 36+	Ch 149+
AP 7	Ch 1	Ch 36+	Ch 149+
AP 8	Ch 1	Ch 36+	Ch 149+
AP 9	Ch 1	Ch 36+	Ch 149+

Figure 2 shows the channel layers, as well as the SSIDs and ESSIDs assigned to them, for Use Case 1.

Figure 2: Hotel First Floor – Channel Layers for Use Case 1



There are three channel layers blanketing the first floor, two of which are 5 GHz (Ch 36+ and Ch 149+) and one is 2.4 GHz (Ch 1). The 5 GHz channels are 40 MHz wide, and the 2.4 GHz channel is 20 MHz wide. The “staff” and “guest” SSIDs are configured on all channels and on all APs/radios.

For this use case, load-balancing is enabled. As there are two channels in 5 GHz for the “staff” and “guest” ESSIDs, or ESS profile, clients joining either of those ESS profiles using the 5 GHz band are evenly distributed across the two 5 GHz channel layers.

Use Case 2: Pervasive 3 Radios for Access with One 5 GHz Channel Layer Exclusively for Voice

This use case is similar to Use Case 1. Instead of having two 5 GHz channel layers available for load-balancing, one of the 5 GHz channel layers is reserved exclusively for voice. Although we selected voice as the application that gets exclusive use of a 5 GHz channel layer in this example, the same design could apply for video, printing, or any other application. One of the chief advantages of the channel layer architecture is that it allows you to carve out channels for specific applications.

This use case shows how the AP400 can be deployed so that a channel layer is reserved for a particular application, such as voice, while still providing a channel in each band for other applications. This type of use case is an example of Meru’s “Application Segregation Mode.”

Design Requirements

- Client density and throughput requirements are expected to be moderate and uniform throughout the deployment.
- Maximum client density is expected to be 50-60 clients per interference region.
- The maximum throughput requirement for a single interference region is expected to be approximately 100 Mbps.
- Coverage is required in the 2.4 GHz and 5 GHz bands.
- The 2.4 GHz and 5 GHz bands support a mix of video and data applications.
- The “guest” and “staff” SSIDs are configured on the 2.4 GHz and one of the 5 GHz channel layers on all APs.
- The second 5 GHz channel layer is reserved for the “voice” SSID on all APs.
- The “guest” SSID has an open security profile, and the “staff” and “voice” SSIDs use WPA2PSK.
- The size of the deployment is approximately 44,000 square feet.

Floor Plan with AP Placement

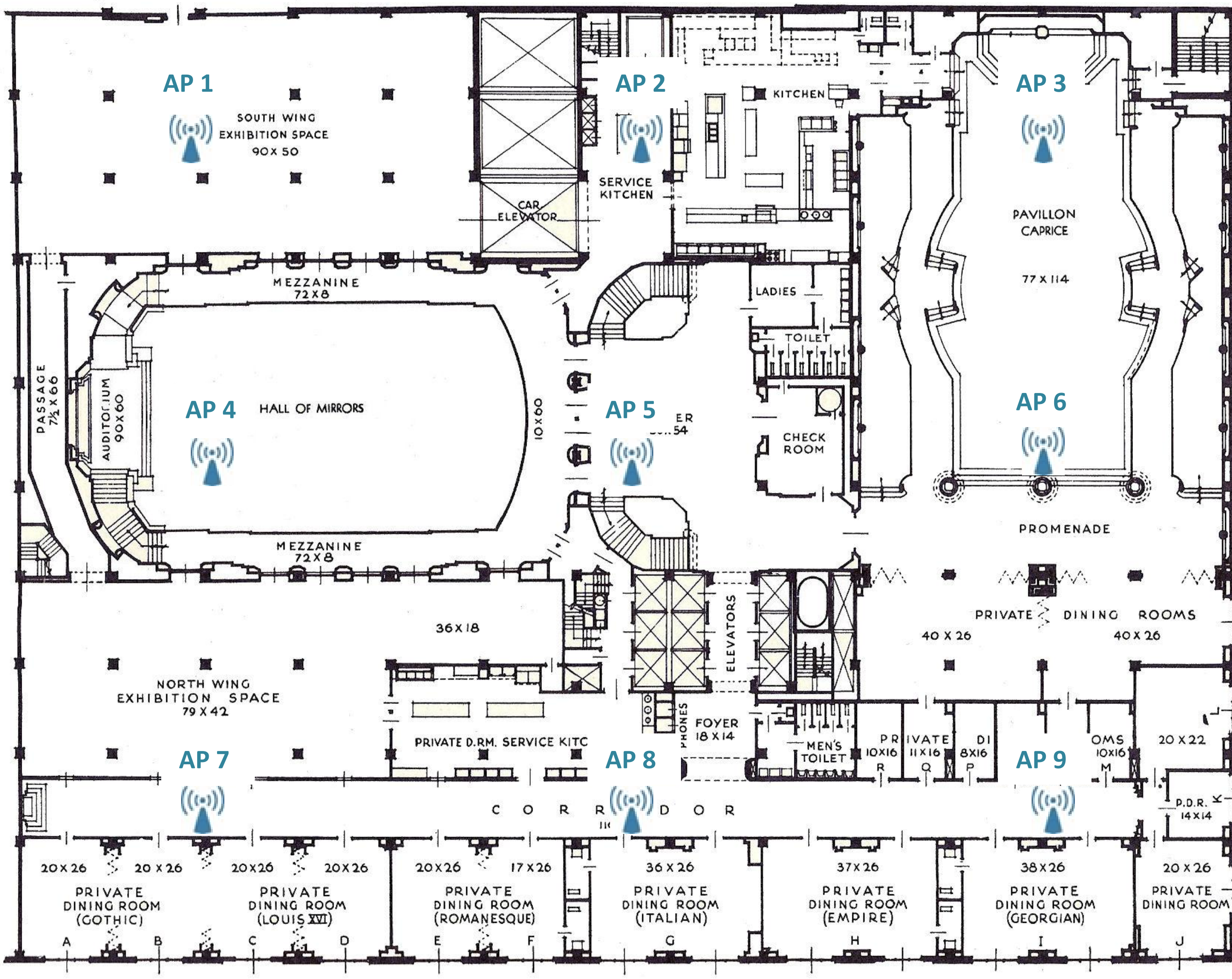
As with Use Case 1, client density and throughput requirements are expected to be moderate and uniform, so there is a relatively even distribution of APs. As throughput requirements are also expected to be moderate and uniform, there are no high throughput areas that require additional channel layers.

A single AP400 in each location enables us to provision two channels pervasively: one in the 2.4 GHz band and one in the 5 GHz band. A single AP400 in each location allows for two channel layers for a mix of video and data applications, as well as a single channel reserved for voice.

As in Use Case1, we assume that we meet the requirements stated in Coverage and Spacing Guidelines when the AP locations are 80-100 feet apart.

Figure 3 shows the AP placement used to meet the design requirements of Use Case 2.

Figure 3: Hotel First Floor – AP Placement for Use Case 2



AP Radio Configurations

Table 4 lists which channels are configured on each AP shown in Figure 3. The AP433i model is used in all locations for Use Case 2.

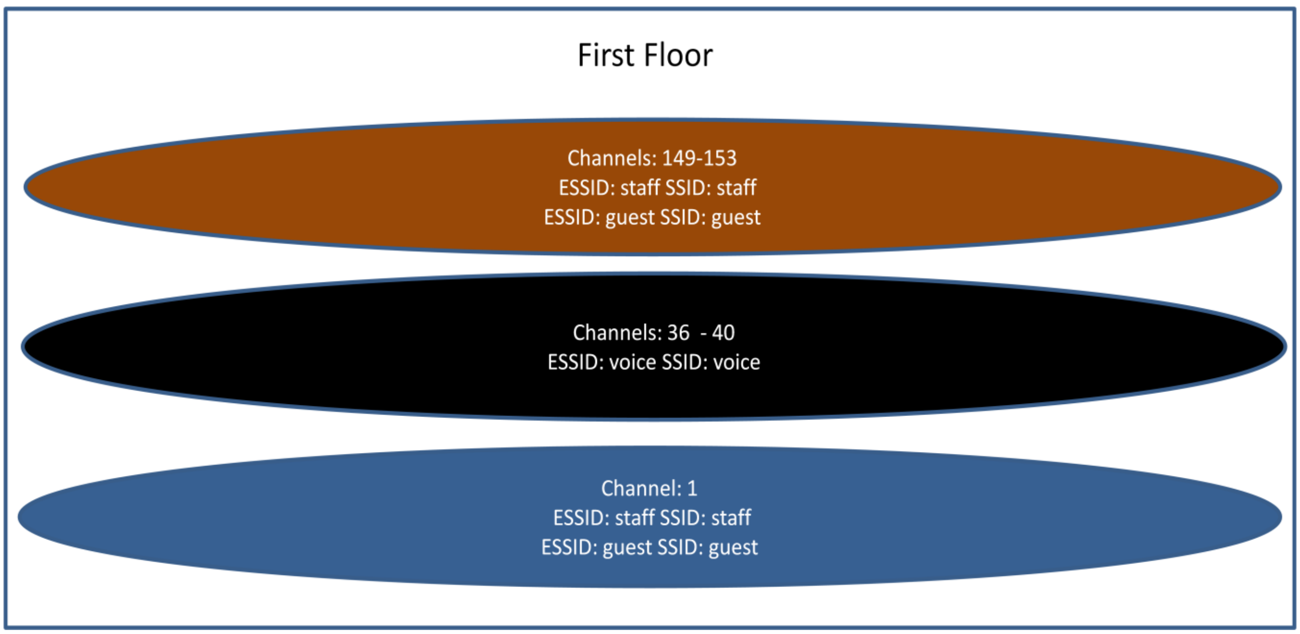
Table 4: Use Case 2 AP Radio Configurations

AP ID	Radio 1	Radio 2	Radio 3
AP 1	Ch 1	Ch 36+	Ch 149+
AP 2	Ch 1	Ch 36+	Ch 149+
AP 3	Ch 1	Ch 36+	Ch 149+
AP 4	Ch 1	Ch 36+	Ch 149+
AP 5	Ch 1	Ch 36+	Ch 149+
AP 6	Ch 1	Ch 36+	Ch 149+
AP 7	Ch 1	Ch 36+	Ch 149+
AP 8	Ch 1	Ch 36+	Ch 149+
AP 9	Ch 1	Ch 36+	Ch 149+

The radios that are reserved for voice are highlighted in gray in Table 4. Virtual Port is enabled on all radios.

Figure 4 shows the channel layers, as well as the SSIDs and ESSIDs assigned to them, for Use Case 2.

Figure 4: Hotel First Floor – Channel Layers for Use Case 2



As shown in Figure 4, there are three channel layers blanketing the first floor, two of which are 5 GHz (Ch 36+ and 149+) and one is 2.4 GHz (Ch 1). The 5 GHz are 40 MHz wide and the 2.4 GHz channel is 20 MHz wide. The “staff” and “guest” SSIDs are configured on the 2.4 GHz channel and one of the 5 GHz channel. The second 5 GHz (channel 36+) has only the single SSID “voice” configured on it.

Load-balancing is enabled; however, as neither band has two or more channel layers for a given ESS profile, no load-balancing occurs.

Use Case 3: Moderate Density Areas with Virtual Port and High-Density Areas Without Virtual Port

Unlike the previous two use cases, Use Case 3 has a high-density area. A single AP400 in each location, excluding the high client density area, enables us to provide three channels for access everywhere except for the high-density area.

In this use case, the high-density area is in the Hall of Mirrors auditorium. In this area, we need more channel layers to accommodate the anticipated higher client density and associated higher throughput demands. The Hall of Mirrors is approximately 5,400 square feet of open space. The Hall of Mirrors auditorium is small enough so that a single radio (per channel layer) can provide good coverage (for example, -65 dBm or greater) throughout.

Channel-layer load-balancing works with virtualization (Virtual Port) enabled or disabled if only one radio per channel is configured for an ESS profile. This is the case with the radios in the Hall of Mirrors. As each channel layer has just a single radio, the natural BSSID of the radio can be used when determining the maximum stations per BSSID.

This use case illustrates that channel-layer load-balancing can configured when virtualization is disabled. This type of use case is an example of Meru's "WLAN 500 Mode."

Design Requirements

- Client density and throughput requirements are expected to be moderate and uniform throughout the deployment excluding the Hall of Mirrors.
- Maximum client count is expected to be 50-60 clients per interference region in the moderate density areas.
- Maximum client count is expected to be 500 clients in the high density area.
- The maximum throughput requirement is expected to be approximately 200 Mbps per interference region in the moderate density areas.
- The maximum throughput requirement is expected to be approximately .5 Gbps in the high density area.
- Coverage is required in the 2.4 GHz and 5 GHz bands.
- The 2.4 GHz and 5 GHz bands support a mix of voice, video and data applications.
- There are two SSIDs: "guest" and "staff," which are configured on the 2.4 GHz channel layer and 5 GHz channel layers on all APs.
- Load-balancing across channel layers is required.
- The "guest" SSID has an open security profile, and the "staff" SSID uses WPA2PSK.
- The size of the Hall of Mirrors is approximately 5,400 square feet.
- The size of the deployment is approximately 44,000 square feet.

Floor Plan with AP Placement

Client density and throughput requirements are not expected to be uniform, as the Hall of Mirrors needs to support up to 500 clients. For the moderate density areas of the first floor, a relatively even distribution of APs is used, as with the previous two use cases.

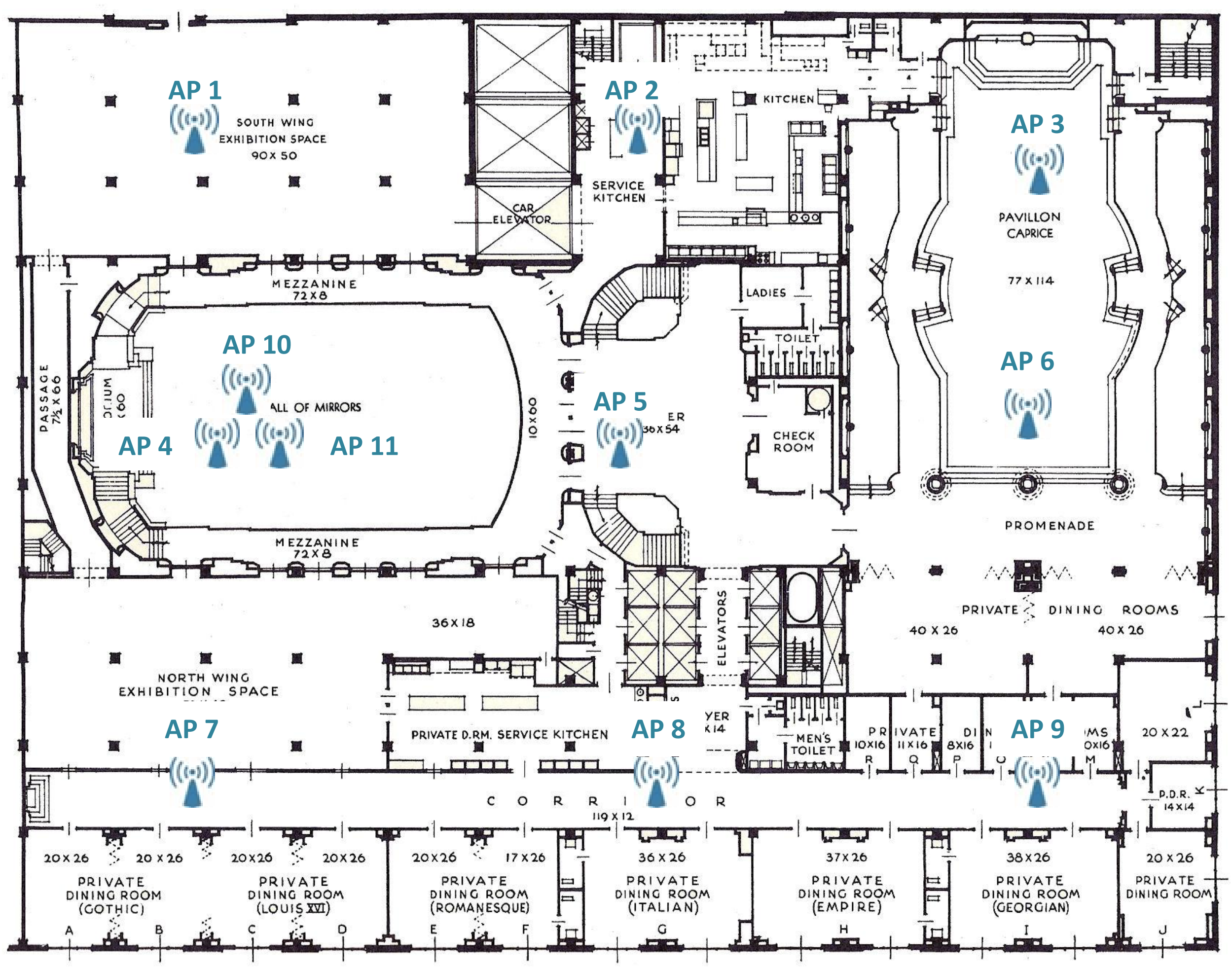
In the Hall of Mirrors, we need to add APs so that we can add channel layers to accommodate the additional clients and the associated increased throughput.

The requirements state the Hall of Mirrors has a maximum client density of 500, with an anticipated maximum aggregate throughput of .5 Gbps. Considering the expected client density and throughput requirements and referring to Table 2, the recommendation is to use three AP400s. Each AP has a single 2.4 GHz channel and two channels in the 5 GHz band, for a total of nine channel layers, all of which are 20 MHz.

As mentioned in Load-Balancing Guidelines, APs that make up a pod should be placed 7-10 feet apart from one another. For all APs not in the Hall of Mirrors, we use spacing for AP drops are 80-100 feet, as with the previous use cases.

Figure 5 shows the AP placement used to meet the requirements of Use Case 3.

Figure 5: Hotel First Floor – AP Placement for Use Case 3



AP Radio Configurations

The Hall of Mirror APs have each been configured with 20 MHz channels one of which is a 2.4 GHz channel, one from the UNII-1 of the 5 GHz band, and one from UNII-3 of the 5 GHz band.

Table 5 lists which channels are configured on each AP shown in Figure 5. The AP433i model is used in all locations for Use Case 3. The APs/radios that are in the Hall of Mirrors are highlighted in gray in Table 5. Virtual Port is enabled on all radios except for those highlighted in gray in Table 5.

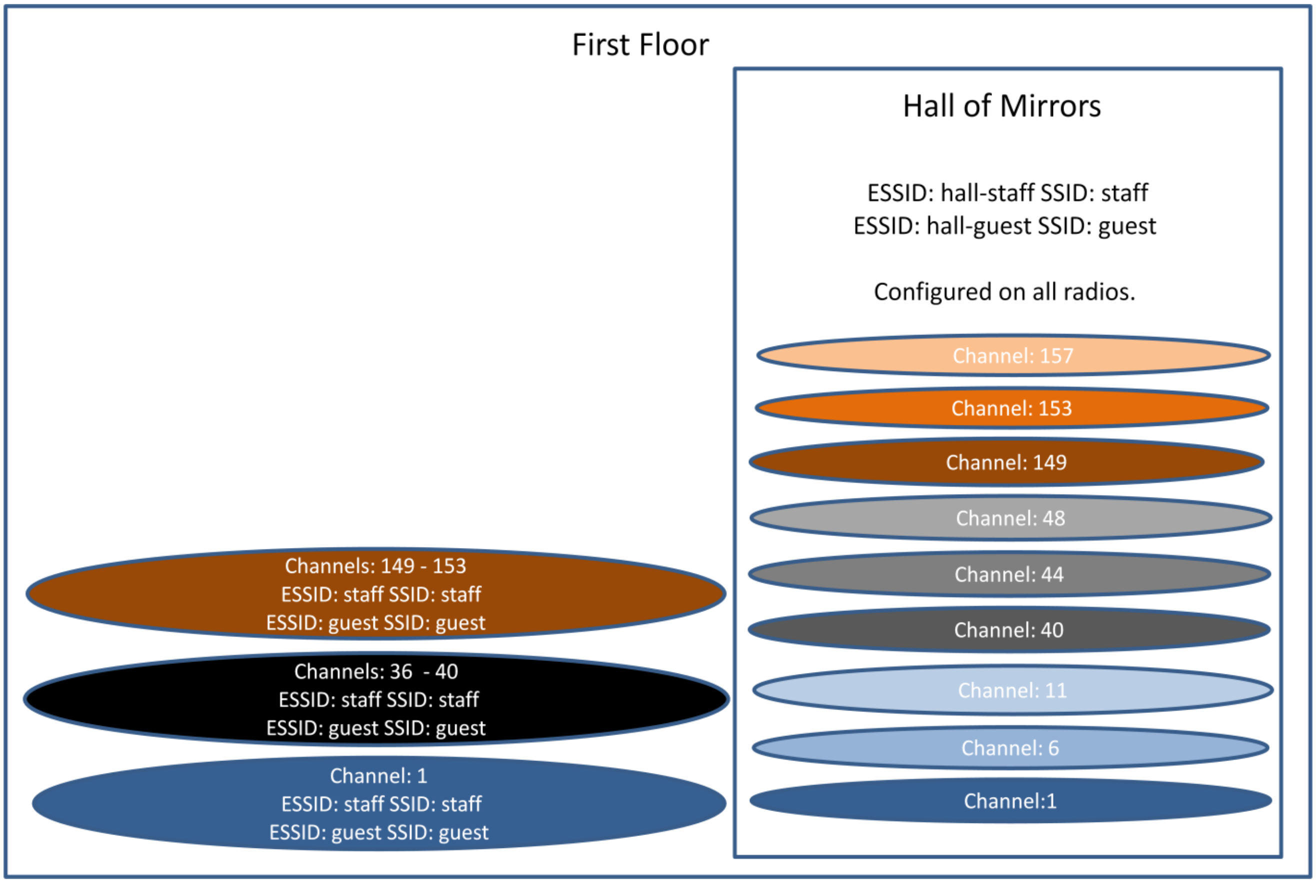
Table 5: Use Case 3 AP Radio Configurations

AP ID	Radio 1	Radio 2	Radio 3
AP 1	Ch 1	Ch 36+	Ch 149+
AP 2	Ch 1	Ch 36+	Ch 149+
AP 3	Ch 1	Ch 36+	Ch 149+
AP 4	Ch 1	Ch 40	Ch 149
AP 5	Ch 1	Ch 36+	Ch 149+
AP 6	Ch 1	Ch 36+	Ch 149+
AP 7	Ch 1	Ch 36+	Ch 149+
AP 8	Ch 1	Ch 36+	Ch 149+
AP 9	Ch 1	Ch 36+	Ch 149+
AP 10	Ch 6	Ch 44	Ch 153
AP 11	Ch 11	Ch 48	Ch 157

Figure 6 shows the channel layers, as well as the SSIDs and ESSIDs assigned to them, for Use Case 3.

There are three channels blanketing the first floor, excluding in the Hall of Mirrors, where there are nine channel layers. Of the APs not in the Hall of Mirrors, there are two 5 GHz (Ch 36+ and Ch 149+) and one 2.4 GHz (Ch 1) channels configured. The 5 GHz channels are 40 MHz wide and the 2.4 GHz channel is 20 MHz wide. The “staff” and “guest” SSIDs are configured on all APs/radios.

Figure 6: Hotel First Floor – Channel Layers for Use Case 3



The Hall of Mirror APs have each been configured with 20 MHz channels, one of which is a 2.4 GHz channel, one from the UNII-1 of the 5 GHz band and one from UNII-3 of the 5 GHz band. The total channel layer count in the Hall of Mirrors is nine, three of which are in the 2.4 GHz band and six from the 5 GHz spectrum.

Band steering moves dual-band capable clients to the 5 GHz bands, where clients are evenly distributed across the six 5 GHz channel layers in the Hall of Mirrors. The 2.4 GHz clients are evenly distributed across the three 2.4 GHz channels in the Hall of Mirrors.

The ESS profiles, or ESSIDs, applied to the moderate density area are not the same as the ESS profiles used in the high density area. As mentioned in Load-Balancing Guidelines, load-balancing occurs within an ESS profile. In this use case, we have distinct ESS profiles for the moderate density areas (for example, ESSID: staff) and the high density areas (for example, ESSID: hall-staff). By using different ESS profiles, we create independent load-balancing areas, or domains. What happens in one load-balancing domain has no impact on other load-balancing domains.

Although this use case has only one high-density area, if a network required more high-density areas, each of these areas would require a unique set of ESS profiles. The SSID remains constant throughout the network, so the use of multiple ESS profiles remains transparent to clients.

Use Case 4: Moderate Density Areas with Virtual Port and High-Density Areas with Virtual Port

Use Case 4 is similar to Use Case 3, as we deploy a single AP400 in each location, except in the high density area. The high-density area in this case is in the Pavillion Caprice. As with Use Case 3, we need more channel layers to accommodate the anticipated higher client density and throughput in the high-density area.

The Pavillion Caprice is approximately 8,800 square feet of open space. The Pavillion Caprice space is large enough so that a single radio (per channel layer) cannot provide good coverage (for example, -65 dBm or greater) throughout. Therefore, at least two radios per channel layer are required. As there is more than one radio per channel layer for this area, Virtual Port is enabled for the APs installed in the Pavillion Caprice.

This use case illustrates an example of how channel-layer load-balancing can configured when virtualization is enabled in a high-density area.

Design Requirements

- Client density and throughput requirements are expected to be moderate and uniform throughout the deployment excluding the Pavillion Caprice.
- Maximum client count is expected to be 50-60 clients per interference region in the moderate density areas.
- Maximum client count is expected to be 200 clients in the high density area.
- The maximum throughput requirement is expected to be approximately 200 Mbps per interference region in the moderate density areas.
- The maximum throughput requirement is expected to be approximately 300 Mbps in the high density area.
- 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 two SSIDs: “guest” and “staff,” which are configured on the 2.4 GHz and the 5 GHz channel layers on all APs.
- The “guest” SSID has an open security profile, and the “staff” SSID uses WPA2PSK.
- The size of the Pavillion Caprice is approximately 8,800 square feet.
- The size of the deployment is approximately 44,000 square feet.

Floor Plan with AP Placement

Client density and throughput are not expected to be uniform throughout the deployment, as the Pavillion Caprice needs to support up to 200 clients. For the moderate density areas of first floor, there is a relatively even distribution of APs, as with previous use cases.

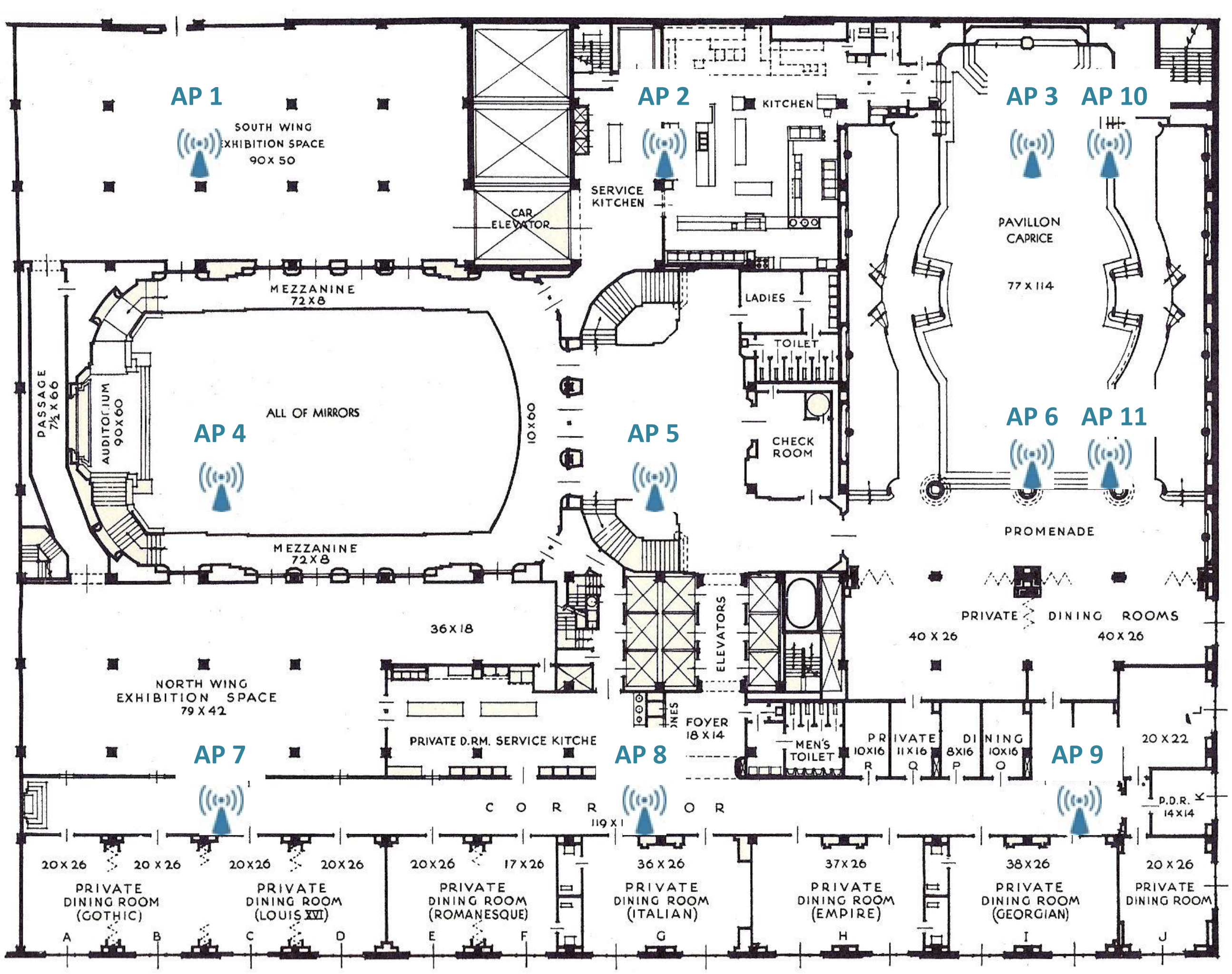
In the Pavillion Caprice, we need to add APs so that we can add channel layers to accommodate the additional clients and the associated increased throughput.

The requirements state that the Pavillion Caprice has a maximum client density of 200, with an anticipated maximum aggregate throughput of 300 Mbps. Considering the expected client density and throughput requirements and referring to Table 2, the recommendation is to use two AP400s in each pod. Each pod has three 20 MHz wide 2.4 GHz channels and three 40 MHz wide 5 GHz channels provisioned.

As mentioned in Load-Balancing Guidelines, APs that make up a pod should be placed 7-10 feet apart from one another. For all APs not in the Pavillion Caprice, we use spacing for AP drops are 80-100 feet, as with the previous use cases.

Figure 7 shows the AP placement used to meet the requirements of Use Case 4.

Figure 7: Hotel First Floor – AP Placement for Use Case 4



AP Radio Configurations

Table 6 lists the channels that are configured on each AP shown in Figure 7. The model AP433i is used in all locations for Use Case 4.

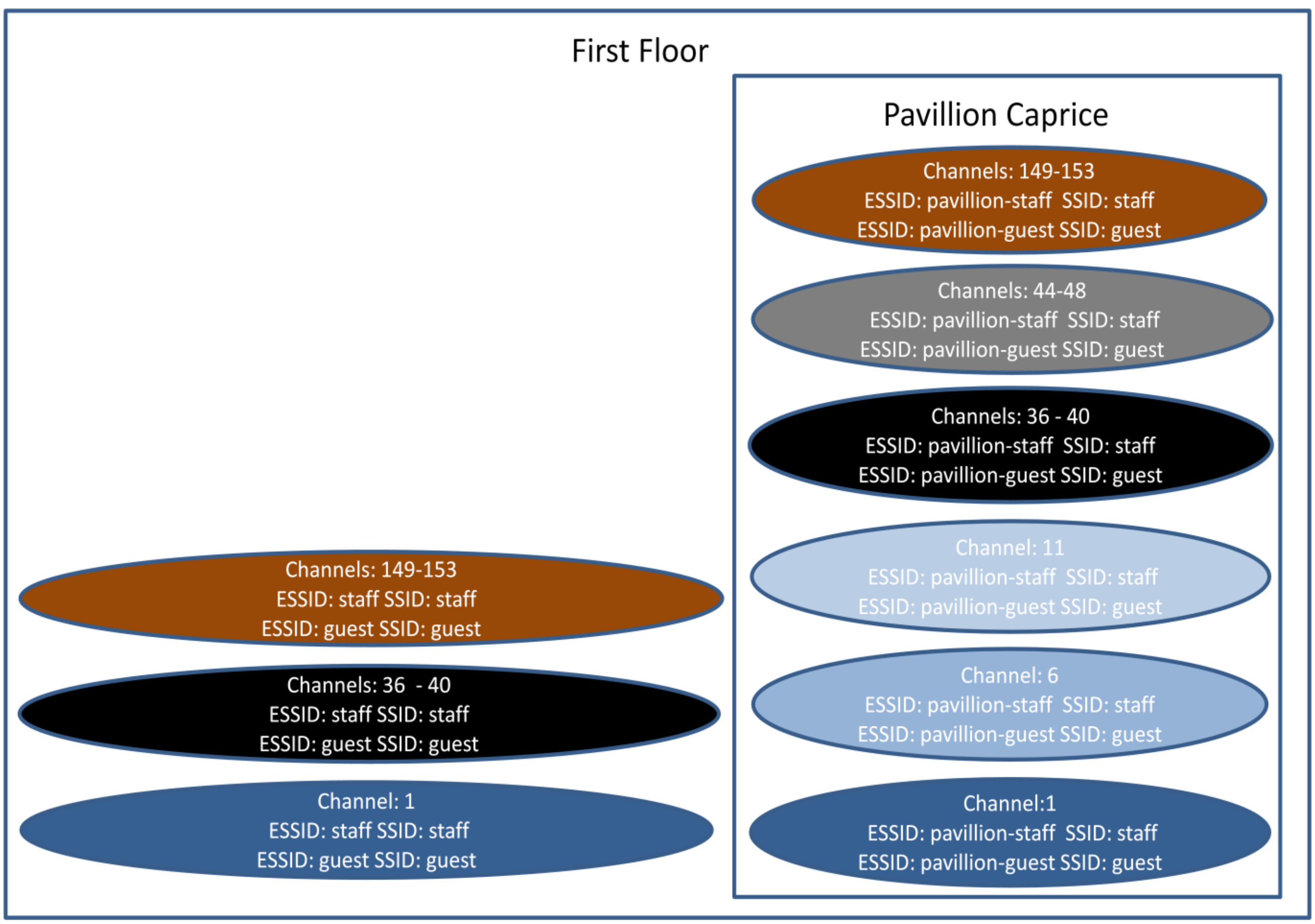
Table 6: Use Case 4 AP Radio Configurations

AP ID	Radio 1	Radio 2	Radio 3
AP 1	Ch 1	Ch 36+	Ch 149+
AP 2	Ch 1	Ch 36+	Ch 149+
AP 3	Ch 1	Ch 36+	Ch 11
AP 4	Ch 1	Ch 36+	Ch 149+
AP 5	Ch 1	Ch 36+	Ch 149+
AP 6	Ch 1	Ch 36+	Ch 11
AP 7	Ch 1	Ch 36+	Ch 149+
AP 8	Ch 1	Ch 36+	Ch 149+
AP 9	Ch 1	Ch 36+	Ch 149+
AP 10	Ch 6	Ch 44+	Ch 149+
AP 11	Ch 6	Ch 44+	Ch 149+

The APs/radios that are in the Pavillion Caprice are highlighted in gray in Table 5. Virtual Port is enabled on all radios.

Figure 8 shows the channel layers, as well as the SSIDs and ESSIDs assigned to them, for Use Case 4.

Figure 8: Hotel First Floor – Channel Layers for Use Case 4



There are three channels blanketing the first floor, except in the Pavillion Caprice, where there are six channel layers. Of the APs not in the Pavillion Caprice, there are two 5 GHz (Ch 36+ and Ch 149+) and one 2.4 GHz (Ch 1) channels configured. The 5 GHz are 40 MHz wide, and the 2.4 GHz channel is 20 MHz wide. The “staff” and “guest” SSIDs are configured on all channels and on all APs/radios. Clients joining either of those ESS profiles via the 5 GHz band are evenly distributed across the 5 GHz channel layers.

The Pavillion Caprice APs have been placed in two pods of two APs each. Each pod has three 20 MHz channels in the 2.4 GHz band and three 40 MHz channels in the 5 GHz band. The total channel layer count in the Pavillion Caprice is six.

Band steering moves dual-band capable clients to the 5 GHz bands, where clients are evenly distributed across the three 5 GHz channel layers in the Pavillion Caprice. The 2.4 GHz clients are evenly distributed across the three 2.4 GHz channels in the Pavillion Caprice.

ESS profiles, or ESSIDs, applied to the moderate density area are not the same as the ESS profiles used in the high density area. As mentioned in Load-Balancing Guidelines, load-balancing occurs within an ESS profile. In this use case, we have distinct ESS profiles for the moderate density areas (for example, ESSID: staff) and the high density areas (for example, ESSID: pavillion-staff). As with Use Case 3, by using different ESS profiles, we create independent load-balancing areas, or domains. What happens in one load-balancing domain has no impact on other load-balancing domains.

Use Case 5: Pervasive Voice and Moderate Density Areas with Virtual Port and High-Density Area Without Virtual Port

This use case can be thought of as a hybrid between Use Cases 2 and 3, as it includes a channel layer reserved for voice, as well as a high-density area where Virtual Port is disabled. The high-density area is the Hall of Mirrors auditorium.

As with Use Case 3, the high density area needs more channel layers to accommodate the anticipated higher client density and associated greater throughput. The Hall of Mirrors is approximately 5,400 square feet of open space. The Hall of Mirrors auditorium is small enough such that a single radio (per channel layer) can provide good coverage (for example, -65 dBm or greater) throughout. As in Use Case 3, there is only one radio per channel layer for this area. Therefore, Virtual Port can be enabled on the APs installed there, except the radio set to channel 36, as this channel has been reserved for voice throughout the entire first floor. All radios on all APs set to channel 36 have Virtual Port enabled.

This use case illustrates how load-balancing can work when virtualization is disabled in a high-density area while carving out a channel layer where virtualization is enabled for a specific application, such as voice.

Design Requirements

- Client density and throughput requirements are expected to be moderate and uniform throughout the deployment excluding the Hall of Mirrors.
- Maximum client count is expected to be 50-60 clients per interference region in the moderate density areas.
- Maximum client count is expected to be 300 clients in the high density area.
- The maximum throughput requirement is expected to be approximately 200 Mbps per interference region in the moderate density areas.

- The maximum throughput requirement is expected to be approximately 300 Mbps in the high density area.
- Coverage is required in the 2.4 GHz and 5 GHz bands.
- The 2.4 GHz and 5 GHz bands support video and data.
- SSIDs “guest” and “staff”, that are configured on the 2.4 GHz and one of the 5 GHz channel layers on all APs.
- A 5 GHz channel layer is reserved for the “voice” SSID.
- The “guest” SSID has an open security profile and the “staff” and “voice” SSIDs use WPA2PSK.
- The size of the Hall of Mirrors is approximately 5,400 square feet.
- The size of the deployment is approximately 44,000 square feet.

Floor Plan with AP Placement

Client density and throughput requirements are not expected to be uniform, as the Hall of Mirrors needs to support up to 300 clients. For the moderate density areas of first floor, a relatively even distribution of APs is used, as with the previous use cases.

As with Use Case 3, we need to add APs in the Hall of Mirrors so that we can add channel layers to accommodate the additional clients and associated increased throughput.

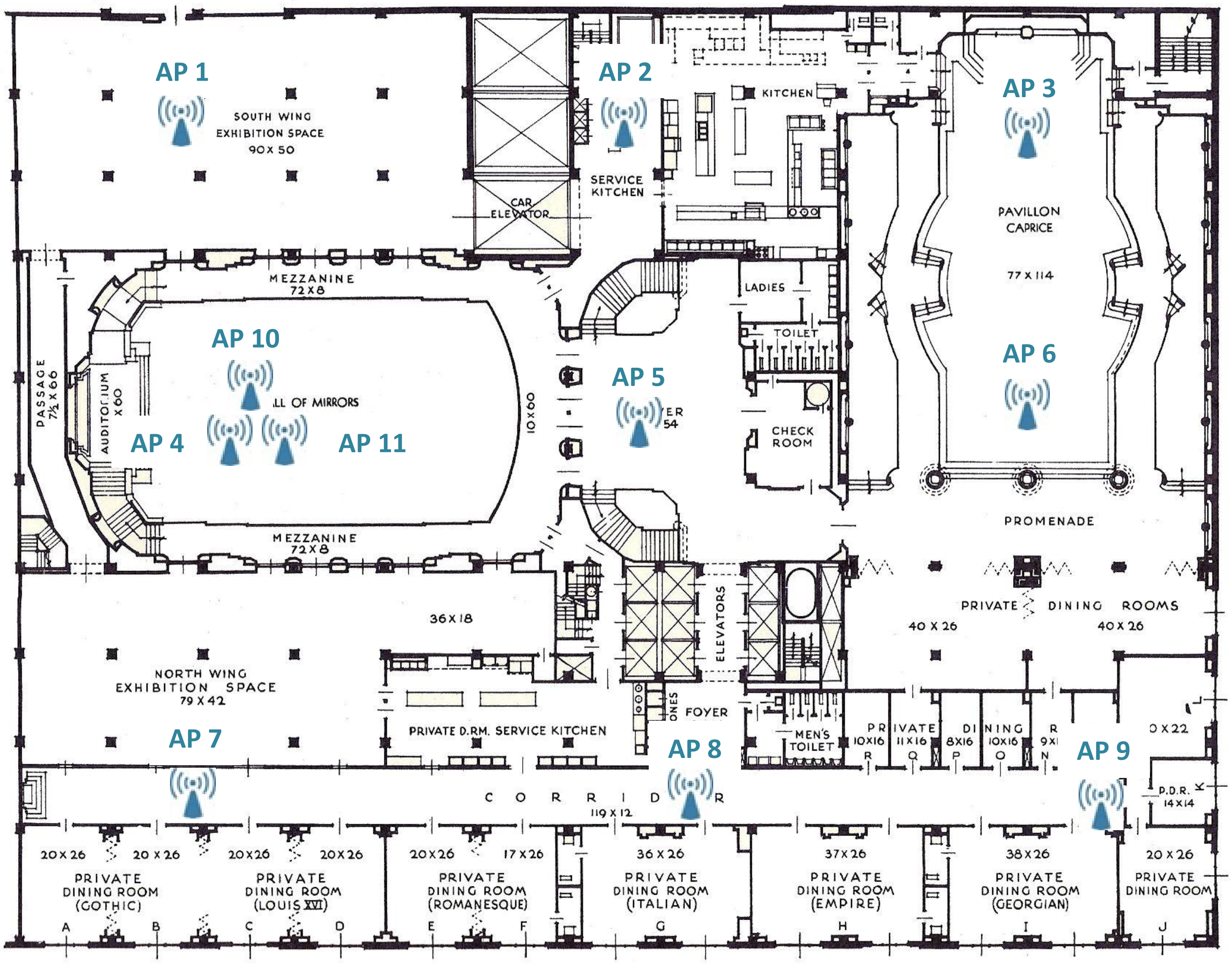
The Hall of Mirrors has a maximum client density of 300, with an anticipated maximum aggregate throughput of 300 Mbps. Considering the expected client density and throughput requirements and referring to Table 2, the recommendation is to use three AP400s. Each AP has a single 2.4 GHz channel and two channels in the 5 GHz band, for a total of nine channel layers in the Hall of Mirrors. All nine channel layers are 20 MHz.

In Use Case 3, all nine channels layers in the Hall or Mirrors were available for channel layering. In this use case, the channel 36 layer is not available for load-balancing, as it is reserved for voice.

As mentioned in Load-Balancing Guidelines, APs that make up a pod should be placed 7-10 feet apart from one another. For all APs not in the Hall of Mirrors, the spacing for AP drops is 80-100 feet as with the previous use cases.

Figure 9 shows the AP placement used to meet the requirements of Use Case 5.

Figure 9: Hotel First Floor – AP Placement for Use Case 5



AP Radio Configurations

Table 7 lists the channels that are configured on each AP shown in Figure 9. The AP433i model is used in all locations for Use Case 5.

Table 7: Use Case 5 AP Radio Configurations

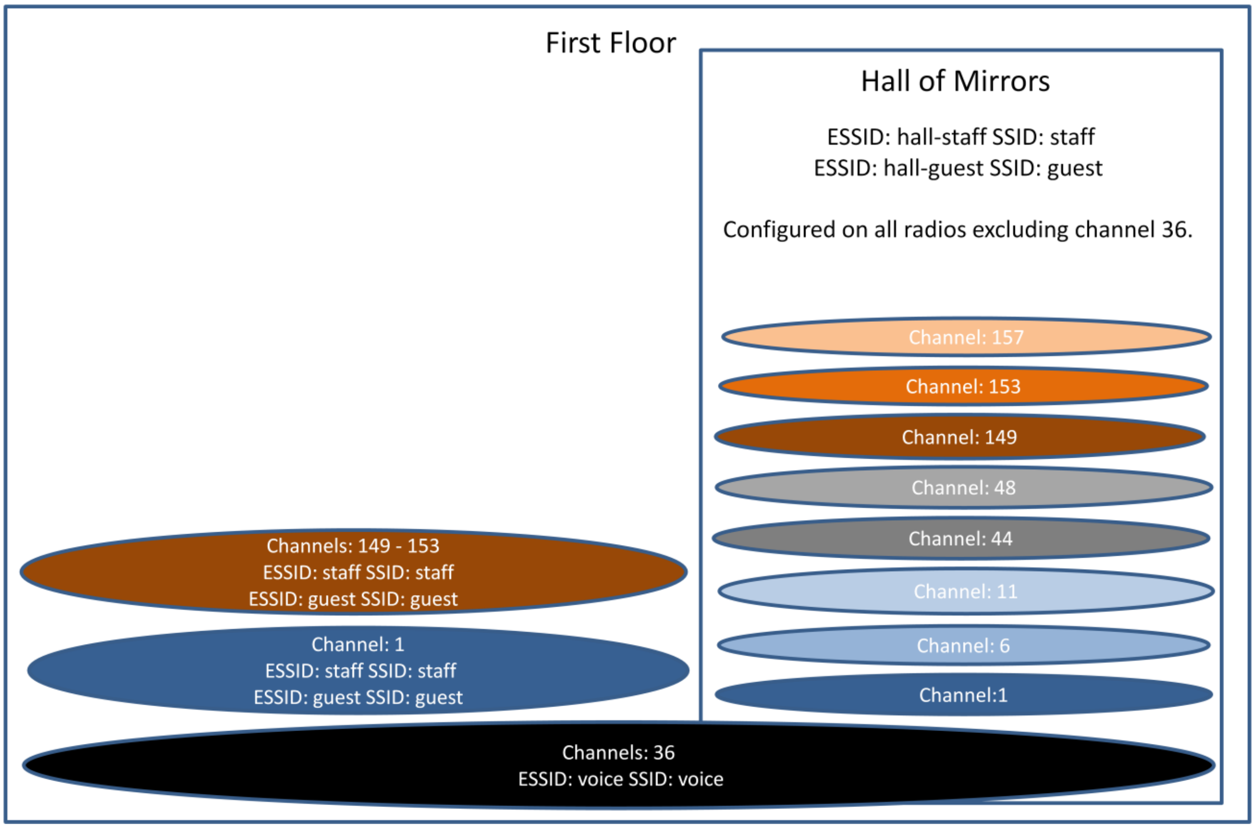
AP ID	Radio 1	Radio 2	Radio 3
AP 1	Ch 1	Ch 36	Ch 149+
AP 2	Ch 1	Ch 36	Ch 149+
AP 3	Ch 1	Ch 36	Ch 149+
AP 4	Ch 1	Ch 36	Ch 149
AP 5	Ch 1	Ch 36	Ch 149+
AP 6	Ch 1	Ch 36	Ch 149+
AP 7	Ch 1	Ch 36	Ch 149+
AP 8	Ch 1	Ch 36	Ch 149+
AP 9	Ch 1	Ch 36	Ch 149

AP ID	Radio 1	Radio 2	Radio 3
AP 10	Ch 6	Ch 44	Ch 153
AP 11	Ch 11	Ch 48	Ch 157

The radios that are in the Hall of Mirrors that are available for channel-layer load-balancing are highlighted in blue, and the channel reserved for voice is highlighted in gray in Table 6. Virtual Port is disabled on all radios highlighted in blue in Table 6.

Figure 10 shows the channel layers, as well as the SSIDs and ESSIDs assigned to them, for Use Case 5.

Figure 10: Hotel First Floor – Channel Layers for Use Case 5



As with Use Case 3, there are three channels blanketing the first floor, except in the Hall of Mirrors, where there are nine channel layers. Of the APs not in the Hall of Mirrors, there are two 5 GHz (Ch 36 and Ch 149+) and one 2.4 GHz (Ch 1) channels configured. One of the 5 GHz is 40 MHz (Ch 149+) and one is 20 MHz wide (Ch 36). The 2.4 GHz channel is 20 MHz wide. The “staff” and “guest” SSIDs are configured on all APs, but unlike in use case 3, channel 36 has only the “voice” SSID applied.

The three APs that make up the Hall of Mirrors pod have each been configured with 20 MHz channels, one of which is a 2.4 GHz channel, one from the UNII-1 of the 5 GHz band, and one from UNII-3 of the 5 GHz band. The total channel layer count in the Hall of Mirrors is nine, three of which are in the 2.4 GHz band and six from the 5 GHz band, one of which is reserved only for voice traffic.

Band steering moves dual-band capable clients to the 5 GHz bands, where clients are evenly distributed across five 5 GHz channel layers in the Hall of Mirrors. The 2.4 GHz clients are evenly distributed across the three 2.4 GHz channels in the Hall of Mirrors.

The ESS profiles, or ESSIDs, applied to the moderate density area are not the same as the ESS profiles used in the high density area. As mentioned in Load-Balancing Guidelines, load-balancing happens within an ESS profile. In this use case, we have distinct ESS profiles for the moderate density areas (for example, ESSID: staff) and the high density areas (for example, ESSID: hall-staff). By using different ESS profiles, we create independent load-balancing areas or domains. What happens in one load-balancing domain has no impact on other load-balancing domains.

Although this example has only one high density area, if a network required more high density areas, each of these areas would require a unique set of ESS profiles. The SSID remains constant throughout the network, so the use of multiple ESS profiles remains transparent to clients.

AP400 with Spectrum Example

Use Case 6 provides an example of an AP400 deployment that uses a spectrum sensor radio rather than one of the 5 GHz radios.

Use Case 6: Two Radios for Access and One Spectrum Sensor

This use case is similar to Use Case 1. Rather than having two 5 GHz channel layers configured for channel-layer load-balancing, one of the 5 GHz radios for each AP has been replaced with a spectrum sensor radio.

This use case shows how the AP400 can be deployed to support Gold-level spectrum analysis while still providing client access in both bands. This use case is an example of Meru's "Air Traffic Service Mode."

Design Requirements

- Client density and throughput requirements are expected to be moderate and uniform throughout the deployment.
- Maximum client density is expected to be 50-60 clients per interference region.
- The maximum throughput requirement is expected to be approximately 100 Mbps.
- Coverage is required in the 2.4 GHz and 5 GHz bands.
- The 2.4 GHz and 5 GHz bands need to support voice, video, and data.
- There are two SSIDs: "guest" and "staff," which are configured on the 2.4 GHz and on the 5 GHz channel layer on all APs.
- Gold-level spectrum analysis is required throughout the deployment.
- The "guest" SSID has an open security profile, and the "staff" SSID uses WPA2PSK.
- The size of the deployment is approximately 44,000 square feet.

Floor Plan with AP Placement

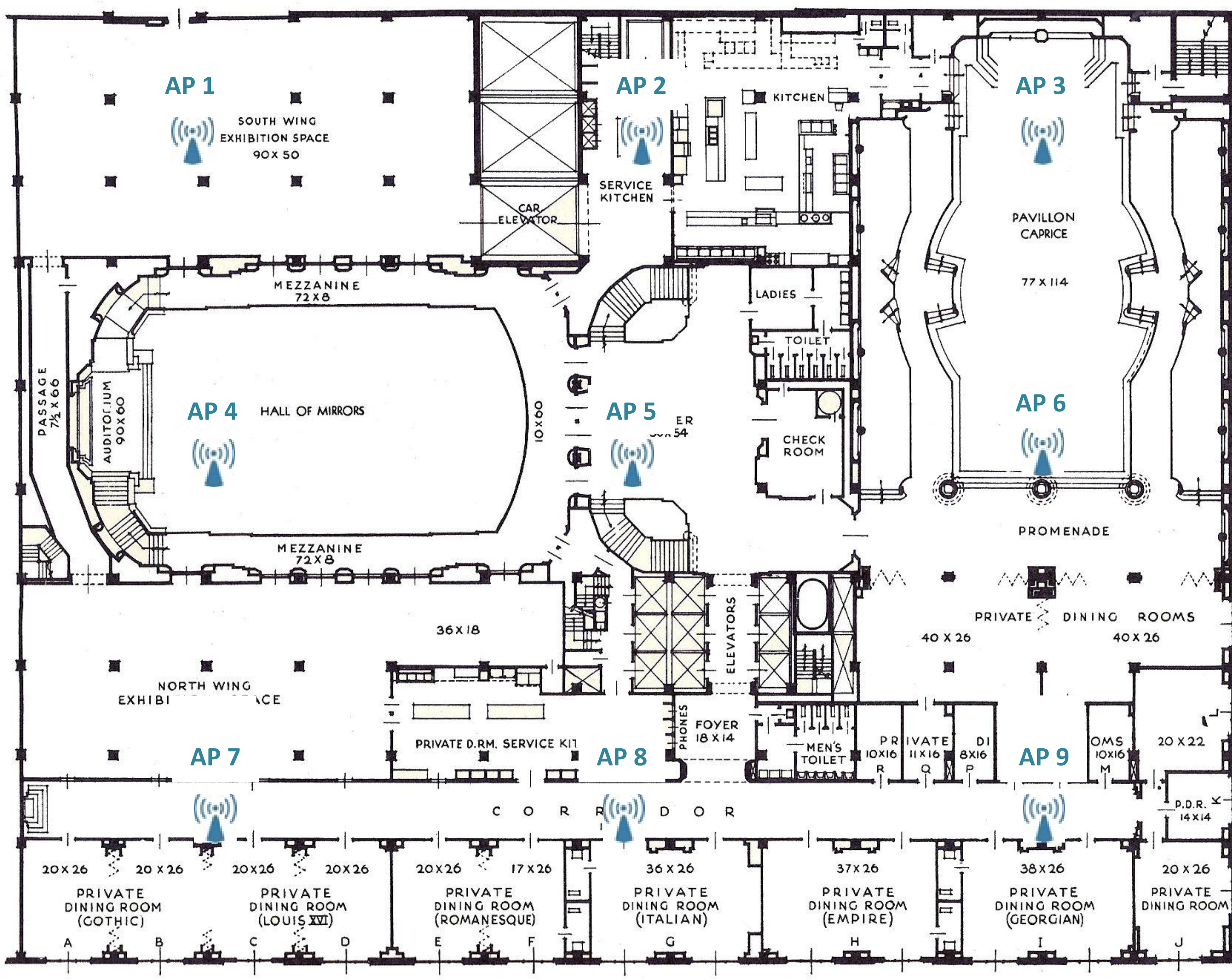
As client density and throughput requirements are expected to be uniform, we use a relatively even distribution of APs. As throughput requirements are also expected to be moderate and uniform, there are no high throughput areas that would require additional channel layering. Therefore, the AP placement is a single AP in each location.

The requirements also call for Gold-level spectrum analysis. This can be accomplished given the environment with a 1:1 AP-to-spectrum sensor ratio. For information about designing networks with spectrum analysis capabilities, see the Deployment Guidelines for Meru PSM3x RF Interference Monitoring Sensors document.

AP-to-AP distances will vary, depending on the characteristics of the environment. For the purpose of this guide, we assume that we meet the following requirements when the AP drops are 80-100 feet apart.

Figure 11 shows the AP placement used to meet the requirements of Use Case 6.

Figure 11: Hotel First Floor – AP Placement for Use Case 6



AP Radio Configurations

Table 8 lists the channels configured on each AP shown in Figure 11. The AP433 is model is used in all locations for Use Case 6.

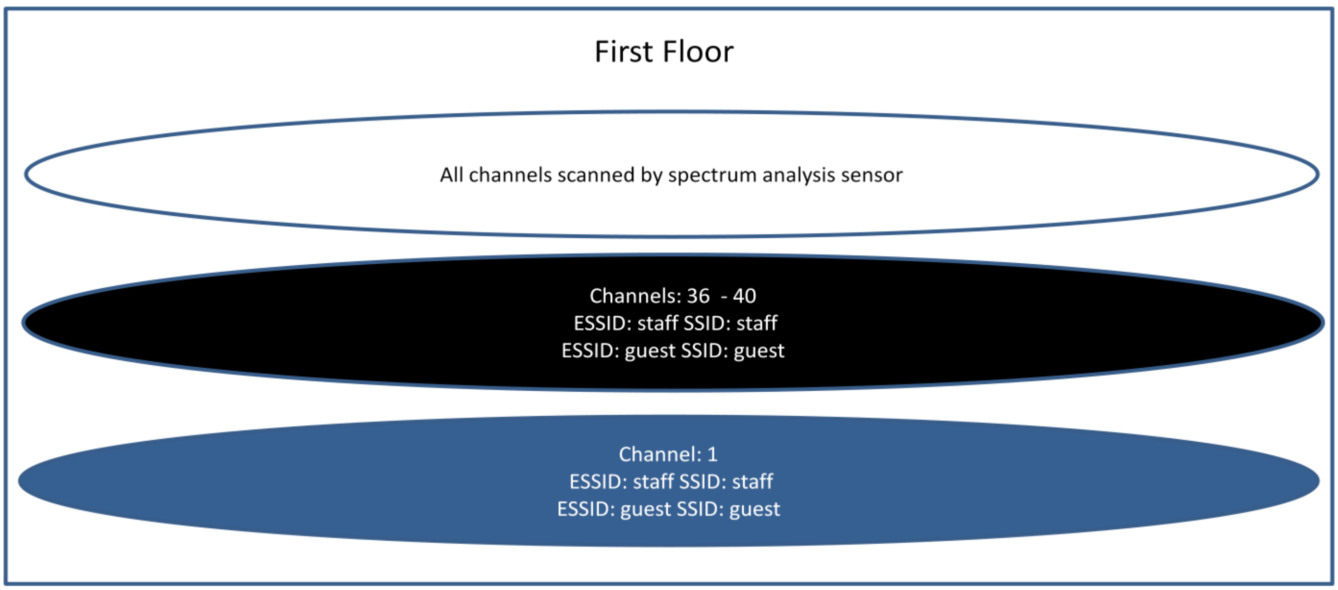
Table 8: Use Case 6 AP Radio Configurations

AP ID	Radio 1	Radio 2	Radio 3
AP 1	Ch 1	Ch 36+	Spectrum Sensor
AP 2	Ch 1	Ch 36+	Spectrum Sensor
AP 3	Ch 1	Ch 36+	Spectrum Sensor
AP 4	Ch 1	Ch 36+	Spectrum Sensor
AP 5	Ch 1	Ch 36+	Spectrum Sensor
AP 6	Ch 1	Ch 36+	Spectrum Sensor
AP 7	Ch 1	Ch 36+	Spectrum Sensor
AP 8	Ch 1	Ch 36+	Spectrum Sensor
AP 9	Ch 1	Ch 36+	Spectrum Sensor

Virtual Port is enabled on all radios listed in Table 8, except the spectrum sensor radios, which are non-client-servicing radios.

Figure 12 shows the channel layers, as well as the SSIDs and ESSIDs assigned to them, for Use Case 6.

Figure 12: Hotel First Floor – Channel Layers for Use Case 6



There are two channel layers blanketing the first floor, one 5 GHz (Ch 36+) and one 2.4 GHz (Ch 1). The 5 GHz channel is 40 MHz wide, and the 2.4 GHz channel is 20 MHz wide. The “staff” and “guest” SSIDs are configured on the 2.4 GHz channel and the 5 GHz channel. The third radio of each AP is a spectrum sensor.

Load-balancing is enabled; however, as neither band has two or more channel layers for a given ESS profile, no load-balancing occurs.

AP400 with AP300 (or AP1000) Example

Use Case 7 provides an example of a deployment that uses AP300 models in lower-density areas and AP400 models in higher-density areas. Depending on the low-intensity are requirements of a network, AP1000 models can be considered.

Use Case 7: Deployment Using AP300s in Lower-Density Areas and AP400s in Higher-Density Area

This use case is similar to Use Case 4, but instead of using AP400s throughout the deployment, AP300s are used for the lower-density areas. The high-density area in this use case is in the Pavillion Caprice. As with Use Case 4, we need more channel layers to accommodate the anticipated higher client density and throughput in this area.

The Pavillion Caprice is approximately 8,800 square feet of open space. The Pavillion Caprice space is large enough such that a single radio (per channel layer) cannot provide good coverage (for example, -65 dBm or greater) throughout. Therefore, at least two radios per channel layer are required. As with Use Case 4, there is more than one radio per channel layer for the high-density area, so Virtual Port is enabled for the APs installed there.

This use case shows how AP300s and AP400s can be deployed in the same network, with the AP400s used only in the high-density area. Although this example uses AP300s for the lower-density areas, you could use AP1000s, depending on the requirements of the low-density areas in a network.

Design Requirements

- Client density and throughput requirements are expected to be low (relatively speaking) and uniform throughout the deployment, except for the Pavillion Caprice.
- Maximum client count is expected to be 30-40 clients per interference region lower density areas.
- Maximum client count is expected to be 500 clients in the high density area.
- The maximum throughput requirement is expected to be approximately 100 Mbps per interference region in the lower density areas.
- The maximum throughput requirement is expected to be approximately .5 Gbps in the high density area.
- Coverage is required in the 2.4 GHz and 5 GHz bands.
- The 2.4 GHz and 5 GHz bands needs to support voice, video, and data.
- There are two SSIDs: “guest” and “staff,” which are configured on the 2.4 and one of the 5 GHz channel layers on all APs.
- The “guest” SSID has an open security profile, and the “staff” SSID uses WPA2PSK.
- The size of the Pavillion Caprice is approximately 8,800 square feet.
- The size of the deployment is approximately 44,000 square feet.

Floor Plan with AP Placement

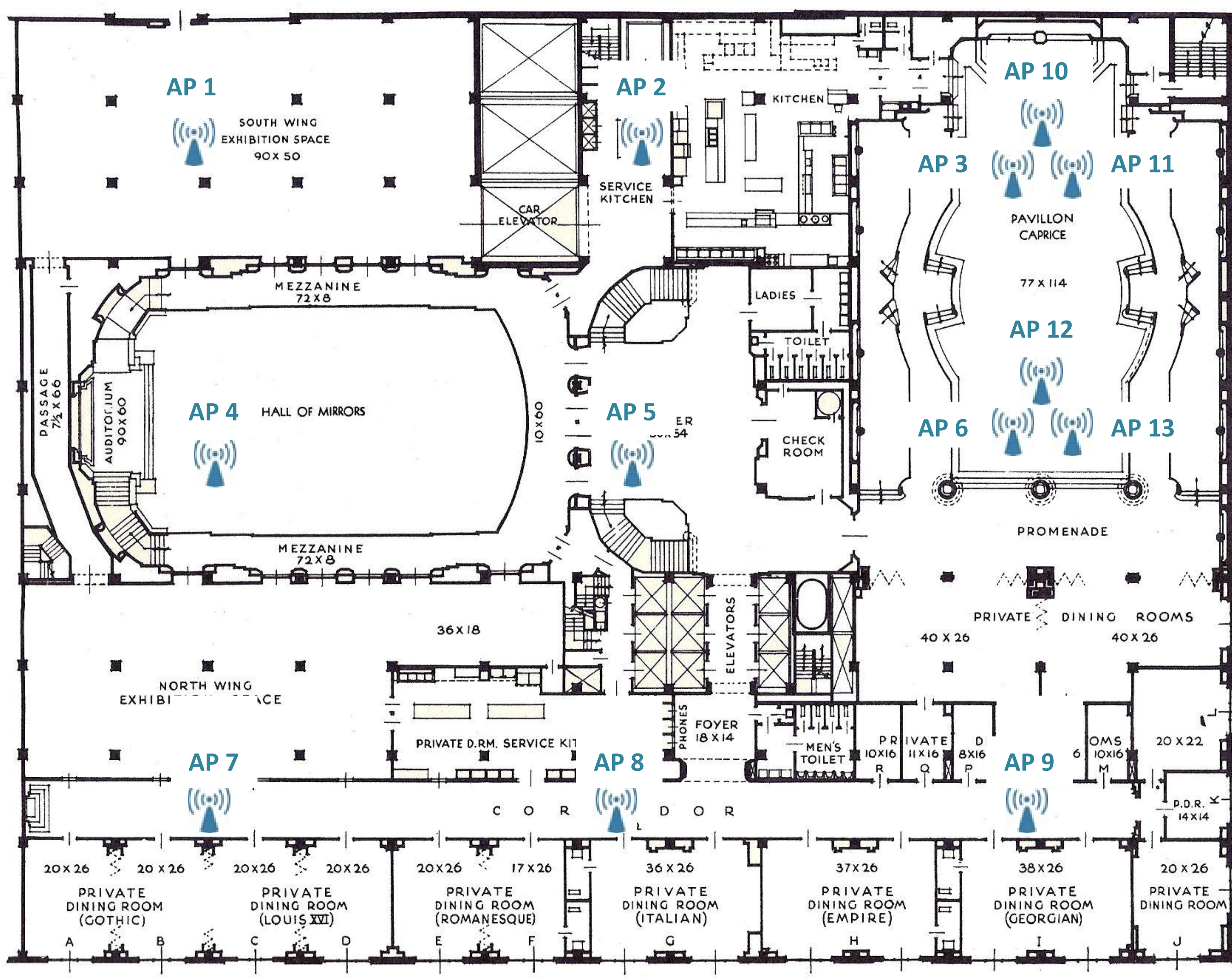
Client density and throughput requirements are not expected to be uniform, as the Pavillion Caprice needs to support up to 500 clients. For the lower density areas of first floor, we use a relatively even distribution of AP300s. In the Pavillion Caprice, we use AP400s so that we can add high numbers channel layers while using the fewest number of APs.

The Pavillion Caprice has a maximum client density of 500, with an anticipated maximum aggregate throughput of .5 Gbps. Considering the expected client density and throughput requirements and referring to Table 2, the recommendation is to use three AP400s in each pod. Each pod has three 20 MHz-wide 2.4 GHz channels and six 20 MHz-wide 5 GHz channels provisioned.

As mentioned in Load-Balancing Guidelines, APs that make up a pod should be placed 7-10 feet apart from one another. For all APs not in the Pavillion Caprice, spacing for AP drops is 80-100 feet as with the previous use cases.

Figure 13 shows the AP placement used to meet the requirements of Use Case 7.

Figure 13: Hotel First Floor – AP Placement for Use Case 7



AP Radio Configurations

Table 9 lists which channels are configured on each AP shown in Figure 13.

The AP433i model is used in the Pavillion Caprice (APs 3, 6, 10, 11, 12, and 13). The AP320i model is used in all other locations (APs 1, 2, 4, 5, 7, 8, and 9).

Table 9: Use Case 7 AP Radio Configurations

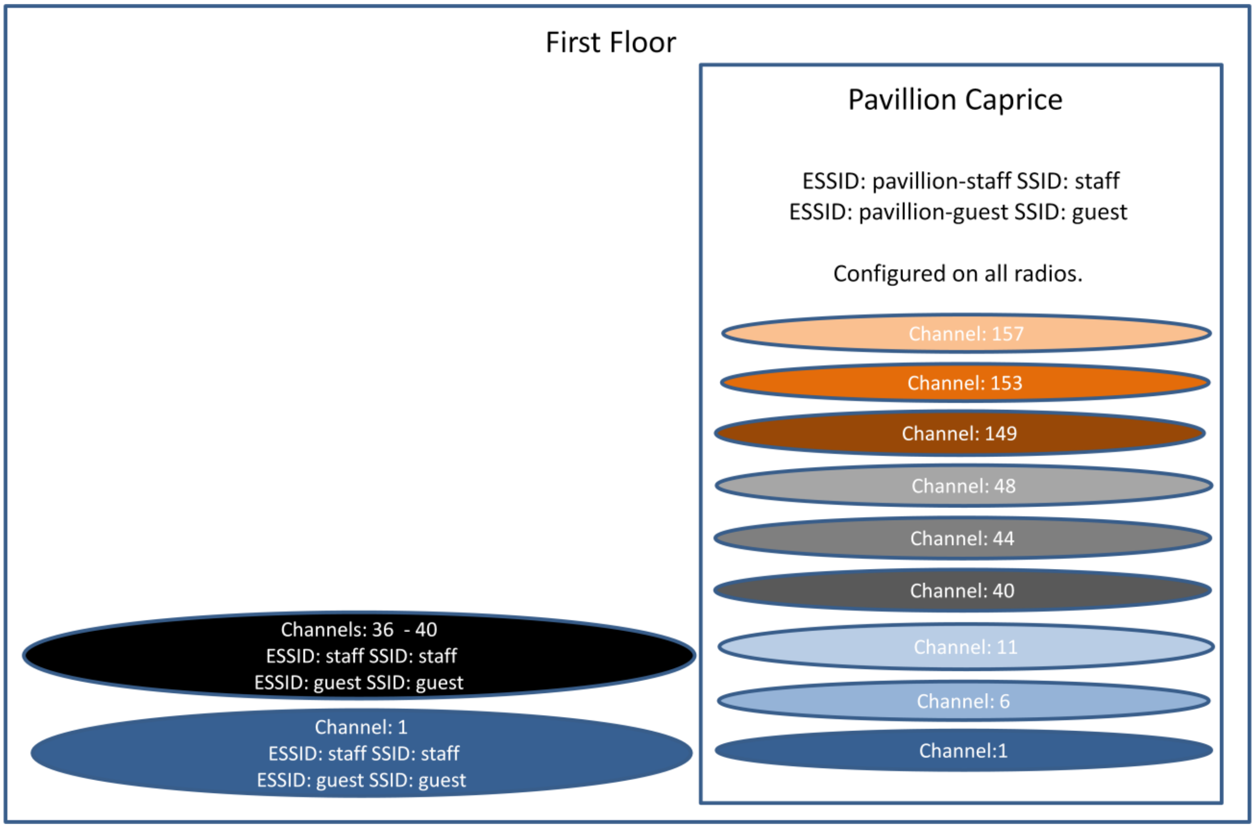
AP ID	Radio 1	Radio 2	Radio 3
AP 1	Ch 1	Ch 36+	n/a
AP 2	Ch 1	Ch 36+	n/a
AP 3	Ch 1	Ch 40	Ch 149
AP 4	Ch 1	Ch 36+	n/a
AP 5	Ch 1	Ch 36+	n/a
AP 6	Ch 1	Ch 40	Ch 149
AP 7	Ch 1	Ch 36+	n/a
AP 8	Ch 1	Ch 36+	n/a
AP 9	Ch 1	Ch 36+	n/a
AP 10	Ch 6	Ch 44	Ch 153
AP 11	Ch 11	Ch 48	Ch 157
AP 12	Ch 6	Ch 44	Ch 153
AP 13	Ch 11	Ch 48	Ch 157

The APs/radios that are in the Pavillion Caprice are highlighted in gray in Table 9. Virtual Port is enabled on all radios listed in Table 9.

Figure 14 shows the channel layers, as well as the SSIDs and ESSIDs assigned to them, for Use Case 7.

There are two channels blanketing the first floor, except in the Pavillion Caprice, where there are nine channel layers. Of the APs not in the Pavillion Caprice, there is one 5 GHz (Ch 36+) and one 2.4 GHz (Ch 1) channel configured. The 5 GHz channel is 40 MHz wide, and the 2.4 GHz channel is 20 MHz wide. The “staff” and “guest” SSIDs are configured on all channels and all APs/radios (except the APs located in the Pavillion Caprice). The “pavillion-staff” and “pavillion-guest” ESSIDs are configured on all channels and all APs/radios in the Pavillion Caprice.

Figure 14: Hotel First Floor – Channel Layers for Use Case 7



The Pavillion Caprice APs have been placed in two pods of three APs each. Each pod has three 20 MHz channels in the 2.4 GHz band and six 20 MHz channels in the 5 GHz band. The total layer count in the Pavillion Caprice is nine.

Band steering moves dual-band capable clients to the 5 GHz bands, where clients are evenly distributed across the six 5 GHz channel layers in the Pavillion Caprice. The 2.4 GHz clients are evenly distributed across the three 2.4 GHz channels in the Pavillion Caprice.

The ESS profiles, or ESSIDs, applied to the lower density area are not the same as the ESS profiles used in the high-density area. Load-balancing occurs within an ESS profile. In this use case, as with Use Case 4, we have distinct ESS profiles for the lower-density areas (for example, ESSID: staff) and the high density areas (for example, ESSID: pavillion-staff).

AP400 Virtual Cell and Multi-Channel Hybrid Example

Use Case 8 provides an example of a deployment in which the AP400 models use two radios in Virtual Cell mode and one radio in multi-channel model.

Use Case 8: Pervasive 3 Radios for Access with Two Radios for Virtual Cell and One Radio for Multi-Channel

This use case is unique, as the APs have two radios in Virtual Cell mode and one radio in multi-channel mode. Putting the third radio in multi-channel mode allows for greater spectral diversity, which helps improve aggregate available bandwidth.

Unlike the other use cases, load-balancing is disabled, as there are no areas in the deployment in which there are two or more channel layers within the same band for a given ESS profile.

Use Case 8 shows an AP400 deployment for which two channel layers from the different bands are used to provide seamless roaming, while the other 5 Ghz radios are configured to different channels to allow for greater throughput for applications that require a great deal of bandwidth (for example, HD video).

Design Requirements

- Client density and throughput requirements are expected to be moderate and uniform throughout the deployment.
- Maximum client density is expected to be 50-60 clients per interference region.
- The maximum throughput requirement for a single interference region is expected to be approximately 500 Mbps.
- Coverage is required in 2.4 GHz and 5 GHz bands.
- The 2.4 GHz and 5 GHz bands support a mix of voice, video, and data applications.
- Three SSIDs are used:
  - The “guest” and “staff” SSIDs are configured on radios 1 and 2 of all APs.
  - The “video” SSID is configured on radio 3 of all APs.
- Load-balancing is not required.
- The “guest” and “video” SSIDs have open security profiles, and the “staff” SSID uses WPA2PSK.
- The size of the deployment is approximately 44,000 square feet.

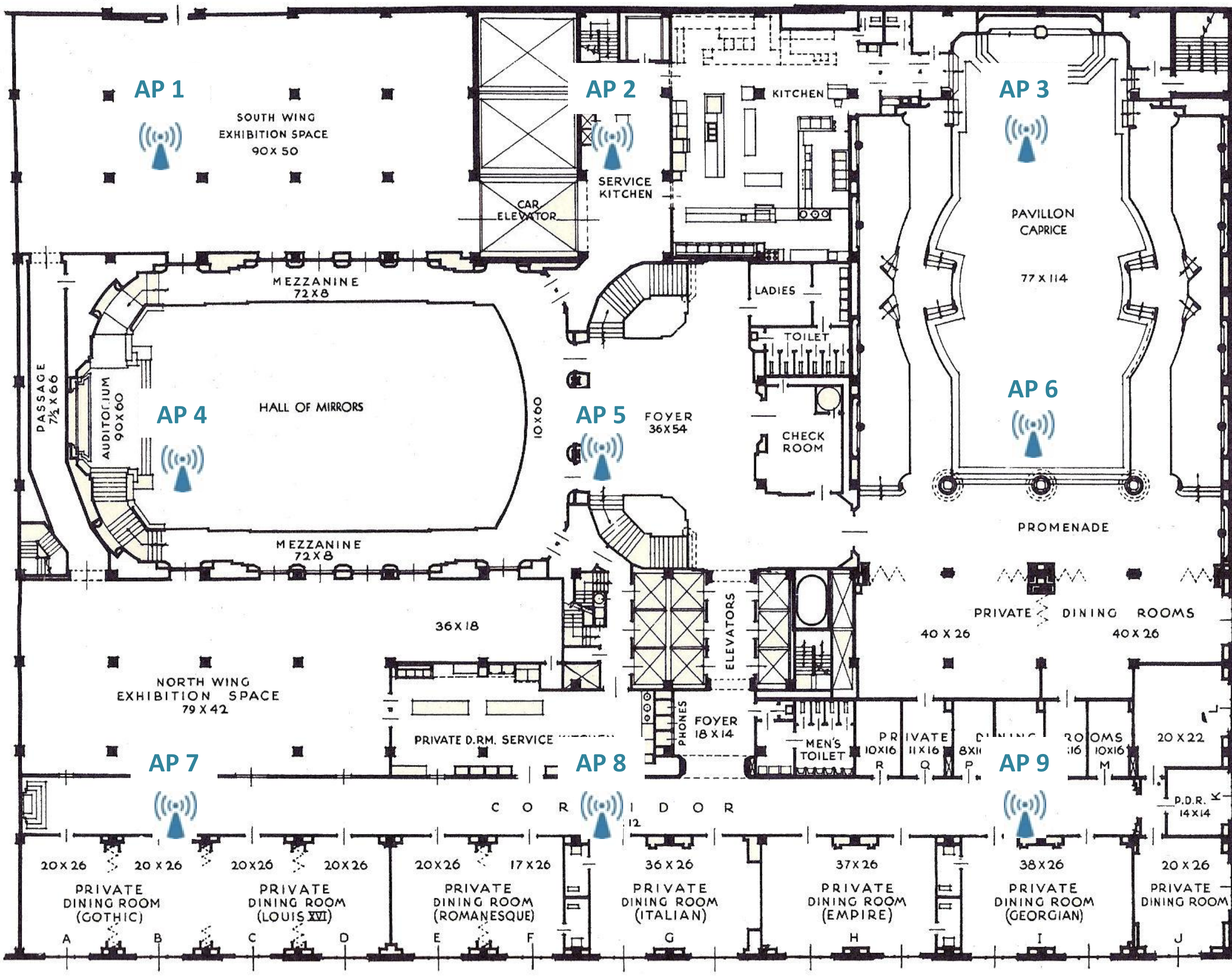
Floor Plan with AP Placement

Given that client density and throughput requirements are expected to be moderate and uniform, we use a relatively even distribution of APs. As throughput requirements are also expected to be moderate and uniform, there are no high throughput areas that require additional channel-layer load-balancing. A single AP400 in each location enables us to layer three channels pervasively.

AP-to-AP distances vary, depending on the characteristics of an environment. In this guide, we assume that we meet the requirements described in *Coverage and Spacing Guidelines* when the AP locations are 80-100 feet apart.

Figure 15 shows AP placement to meet the requirements of Use Case 8.

Figure 15: Hotel First Floor – AP Placement for Use Case 8



AP Radio Configurations

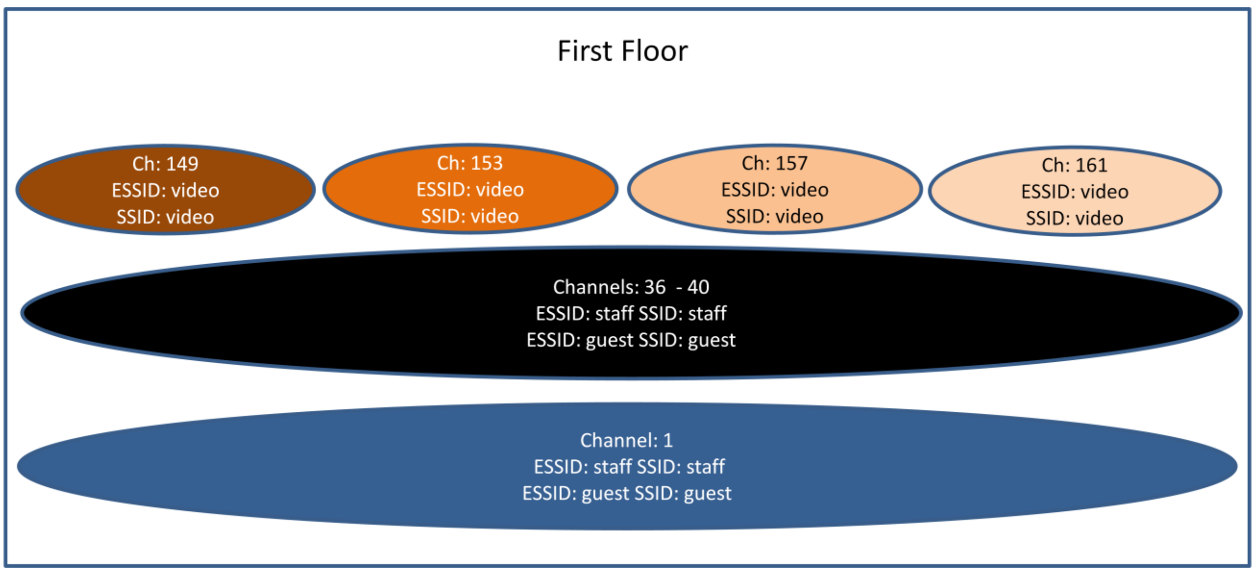
Table 10 lists the channels configured on each AP shown in Figure 15. The AP433i model is used in all locations for Use Case 8. Virtual Port is enabled on only radios 1 and 2, as listed in Table 10.

Table 10: Use Case 8 AP Radio Configurations

AP ID	Radio 1	Radio 2	Radio 3
AP 1	Ch 1	Ch 36+	Ch149
AP 2	Ch 1	Ch 36+	Ch 153
AP 3	Ch 1	Ch 36+	Ch 157
AP 4	Ch 1	Ch 36+	Ch 161
AP 5	Ch 1	Ch 36+	Ch 165
AP 6	Ch 1	Ch 36+	Ch 149
AP 7	Ch 1	Ch 36+	Ch 153
AP 8	Ch 1	Ch 36+	Ch 157
AP 9	Ch 1	Ch 36+	Ch 161

Figure 16 illustrates the channel layers, as well as the SSIDs and ESSIDs assigned to them, for Use Case 8.

Figure 16: Hotel First Floor – Channel Layers for Use Case 8



As shown in Figure 16, there are two channel layers blanketing the first floor, one of which is 5 GHz (Ch 36+) and the other is 2.4 GHz (Ch 1). The 5 GHz channel is 40 MHz wide, and the 2.4 GHz channel is 20 MHz wide. The “staff” and “guest” SSIDs are configured on channel 36+ and channel 1.

Only the “video” SSID/ESSID is applied to radio 3 of each AP. The third radio of each is configured to one of the following channels: 149, 153, 157, 161, or 165. All of these channels are 20 MHz wide.

Where to Find More Information

Refer to the following documents for additional information:

- Meru AP400 Installation Guide
- Channel Layering Configuration Note
- Deployment Guidelines for Meru PSM3x RF Interference Monitoring Sensors