MIGRATION GUIDE

802.11ac Migration Guide

Migrating to the AP832

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Introduction

There have been many 802.11 standards that have emerged over the past few years, such as 802.11k, r, v, and w, but the one new standard that has gotten the most attention is 802.11ac. This should not come as a surprise to anyone following the evolution of Wi-Fi, or anyone who uses Wi-Fi (and who doesn't use Wi-Fi?), as 11ac will improve Wi-Fi performance and enable new media-rich applications even in high client density environments.

11ac is all about increasing throughput capacity, scaling client density, and improving Wi-Fi reliability. 11ac can increase throughput capacity by enabling a higher per-client throughput for a given number of clients, or it can allow for higher client density by enabling support for more clients, for a given per-client throughput, or for a specific service level agreement (SLA). All this is made possible by improvements on many of the features that showed up first with 802.11n, such as wider channels, higher modulation schemes, frame aggregation, and MIMO.

This guide was written for network designers and implementers, and the assumption is that the reader has knowledge of Wi-Fi and has worked with 802.11a/b/g/n networks in the past. This guide provides an overview of 802.11ac features, introduces the 11ac-capable AP832, and discusses a number of important 11ac migration-specific considerations, such as channel width, SNR requirements, security profiles, AP density, switching infrastructure, and so on.

802.11ac Overview

802.11ac builds upon the success of 802.11n, which, for the time being, is still the predominant WLAN standard in the market. 802.11ac operates only in the 5 GHz band, and increases performance utilizing various techniques, some of which are outlined in Table 1 below.

Table 1 – 802.11ac Major Features Enhancements

802.11ac Features	Customer Benefits
Wider channels	Higher data rates – 1.3 Gbps and higher
Higher encoding density	Higher bit density per packet
Increased number of spatial streams	Higher data rates per AP/client link
Beamforming	Greater AP/client link reliability
Multi-user MIMO (MU-MIMO)	Greater capacity and efficient use of spectrum
Larger frame aggregations supported	Greater efficiency and throughput

While some 11ac network designers may opt to deploy 40 MHz channels, particularly where DFS channels are not available, 80 MHz channels are likely to be common. Table 2 below shows a theoretical throughput for common 11ac-enabled devices using 80 MHz channels.

Table 2 – Data Rates for Common 802.11ac Clients

Devices	Antennas	Modulation/ Channel Width	Data Rate
Smartphones	1x1:1	256-QAM / 80 MHz	433 Mbps
PCs / Tablets	2x2:2	256-QAM / 80 MHz	867 Mbps
PCs	3x3:3	256-QAM / 80 MHz	1.3 Gbps

Table 3 below shows data rates of 11ac-enabled devices for different numbers of spatial streams, for a given channel width.

Table 3 – Subset 802.11ac Data Rates by Channel Width

# Spatial Streams	Channel Width		
	20 MHz	**40 MHz**	**80 MHz**
1	86 Mbps	200 Mbps	433 Mbps
2	173 Mbps	400 Mbps	866 Mbps
3	288.9 Mbps	600 Mbps	1.3 Gbps

11ac's arrival will enable new applications by delivering higher data throughput and greater link reliability, all made possible by sophisticated RF architectural enhancements that include:

- **Wider channel support**: 11ac mandates support of 80 MHz wide channels, with optional 160 MHz wide channels. Wider channels of 11ac provide much higher data throughput rates than are possible with 802.11n. Most Wave 1 products will not include support for 160 MHz channels. *The Meru AP832 supports up to 80 MHz channels.*

Table 4 below lists the number of 40, 80, and 160 MHz channels available in Australia, Europe, and the United States.

Table 4 – Available 802.11ac Channels by Channel Width

Channel Width	Including DFS		Excluding DFS	
	US/Australia	**EUROPE**	**US/Australia**	**EUROPE**
40 MHz	10	9	4	**2**
80 MHz	5	5	**2**	**1**
160 MHz	**1**	**2**	**---**	**---**

- **Higher encoding density:** 256-QAM is four times denser than the maximum encoding of 64-QAM used in 802.11n, further increasing the bit rate achieved by 802.11ac. For Wave 1 products, both MCS-8 and MCS-9 are optional. Both MCS-8 and MCS-9 use 256-QAM. *The AP832 supports MCS-8 and MCS-9.*

- **More spatial streams**: 11ac supports up to eight spatial streams, further increasing the data rate for each radio. First wave products will likely support up to three spatial streams. *The AP832 supports up to 3 spatial streams on both radios.*

- **Transmit Beamforming (TxBF):** This increases signal strength and improves effective data rates. TxBF is going to be approximately 7 dBm for a 1x1:1 client and up to 3 dBm gain for a 2x2:2 client, assuming that the AP is 3x3:3, as with the AP832, and TxBF is enabled on the client and the AP. TxBF is optional in Wave 1, but many vendors have opted to support this feature. *The AP832 currently does not support TxBF*.*

- **Downlink MU-MIMO**: This feature supports simultaneous transmissions to multiple clients connected to a single AP radio and maximizes channel utilization. Up to four distinct clients can receive data simultaneously from a single AP radio. This feature is optional for Wave 1. Most vendors will not support MU-MIMO on their Wave 1 products. *The AP832 does not support MU-MIMO.*

*TxBF is expected for the AP832 in a subsequent release.

- **Larger frame aggregations:** 11ac provides a drastic increase in the maximum frame aggregation size compared to what is available in 11n. Larger frame aggregation improves MAC layer efficiencies. *The AP832 supports aggregation lengths up to 1 MB.*

AP832

The Meru AP832 is a dual-radio, dual-band 802.11ac access point that supports one radio configured for 2.4 GHz operation and one radio configured for 5 GHz 11ac operation, or two 5 GHz 11ac radios. The AP832 supports multiple wireless channel architecture deployment options, such as single-channel architecture (SCA), with or without Virtual Cell, SCA with channel layering, multi-channel architecture (MCA), or a hybrid of SCA and MCA. The AP832 is designed to meet the requirements for even the most challenging deployment scenarios.

The AP832 includes the following features:

Radio Capabilities:

- 3x3 MIMO, dual band capable
- 11ac MCS0 - MCS9 (1.3 Gbps max. data rate in 80 MHz channel for an 11ac station)
- 11an MCS0 - MCS23 (450 Mbps max. data rate for an 11n station)
- Legacy (802.11abg) backward compatible
- Hardware accelerated encryption/decryption
- 20 MHz, 40 MHz ,and 80 MHz channels

Default Radio Settings:

- Interface 1 defaults to 2.4 GHz 11bgn (channel 6, 20 MHz width)
- Interface 2 defaults to 5 GHz 11ac (channel 36, 80 MHz width)

Note: As mentioned previously, both radios can be configured as 5 GHz 11ac radios. More information on dual 5 GHz operation for the AP832 can be found in the “AP832 Dual 5 GHz Operation” section of this guide.

Ethernet Ports:

- Supports two Gig-E ports, labeled G1 and G2
- Auto-negotiation supported
- G1 is the uplink port with PoE support.
- G2 is for wired station or switch backhaul connectivity.

The AP832 supports both internal (AP832i) and external antennas (AP832e). For more information regarding antenna options for the AP832e, please follow the link below:

http://www.merunetworks.com/products/access-points/antennas/index.html

AP832 Models

The table below lists the currently available AP832 models.

Table 5 – AP832 Models

Model	Wireless	Wired	Antenna
AP832e	Dual Radio: 802.11ac/bgn - 3x3:3	2 interfaces: 10/100/1000	External
AP832i	Dual Radio: 802.11ac/bgn - 3x3:3	2 interfaces: 10/100/1000	Internal

802.11ac Deployment

The Meru AP832 is backward compatible with 802.11a/n and 802.11b/g/n clients, so you can upgrade your network today, and the existing client base will work with AP832s. It should be added that after numerous performance tests in Meru's labs as well as at customer sites, networks that were populated by mainly non-11ac clients typically performed 10–20 % better using the AP832, as compared to the network before upgrading to AP832s. However, to get the most out of the AP832, a client population consisting of a high percentage of 11ac clients is recommended.

Meru provides solutions for both single-channel architecture (SCA) and multi-channel architecture (MCA), or a mix of channel architectures, depending on the requirements for a particular customer's business and/or use case. Enterprises can add the AP832 to their existing network to support additional capacity as part of their existing deployment. However, there are recommended best practices for operating a network that includes both 11n and 11ac APs. The "Migrating to 11ac" section of this guide has more detail on this subject.

WLAN Controller

Customers are required to upgrade the controller software, System Director OS, to version 6.0-2-0 or later to support the AP832.

Meru supports two data plane modes, bridged and tunneled. In bridged mode, also known as the remote AP mode, the data traffic from the client is bridged locally at the access layer or edge switch. Control and AP management traffic is still sent between the AP and the controller in bridged mode. In tunneled mode, all data, AP management, and control traffic is passed through the controller.

> Note: If tunneled mode is the data plane mode selected, the recommendation is to have a 10 Gig uplink port for the controller, as two or three AP832s that are operating with high channel utilization could potentially oversubscribe a single Gigabit controller uplink.

RF Architecture Overview

One aspect of Meru's Mobile***FLEX*** architecture is the ability to choose the best deployment option to meet the requirements of customer use cases. Selecting the right access methodology is a significant early step in designing a WLAN network. Mobile***FLEX*** allows you to choose SCA, MCA, or some combination of both. As with any architecture, each of these options has its advantages and disadvantages. The key is to select the right architecture that meets all network requirements.

Single-Channel Architecture

SCA, in combination with Virtual Cell, provides simplified channel planning, infrastructure-controlled client roaming, seamless AP-to-AP hand-offs, and optimal (i.e., best data rate) client-to-AP associations.

SCA and Virtual Cell with channel layering and load balancing can be used to scale client and throughput capacity. For more information about channel layering and load balancing, please refer to the "Channel Layer Configuration Note" that can be downloaded from the Meru Support Portal.

CAL

SCA with context-aware layering (CAL): channel layers can be reserved for particular applications, devices, user groups, classes of service, etc.

Multi-Channel Architecture

MCA, in combination with Native Cell (i.e., no virtualization), can be used as a way to increase spectral diversity for environments that do not need the features available when implementing Virtual Cell.

SCA/MCA Hybrid

Another option is deploy a hybrid channel architecture, where SCA and MCA coexist in the same space: a single channel is reserved for the SCA layer, or part of the deployment is SCA and another part is MCA.

Choosing the best channel architecture starts with understanding the applications, client device types, client density, SLA, etc., for a given deployment. The AP832 supports all of the channel architectures and features described above.

Clients per AP832

The BYOD phenomenon has changed the enterprise network landscape and has forced IT managers to plan ahead for all types of user-owned mobile devices. BYOD typically means that client densities are escalating, as it is not unusual for users to carry two or three devices at a time. With BYOD, the client count per AP/radio has continued to rise, as one would expect. What follows are some general client density guidelines for the AP832.

Table 6 – Recommended Client Density*

AP832	CLIENTS PER RADIO	CLIENTS PER AP
Typical Client Density	30	60
High Client Density	80	160
Max Clients Supported	128	256

* These recommendations for AP832 are for both Native and Virtual Cell.

The actual number of clients recommended per radio depends on applications in use, SLAs, client types, etc. This subject is discussed in detail in the guide titled “BPG - High Density Design and Deployment,” which is available for download through Meru Customer Support.

Security Profiles

To ensure that you are benefiting from the VHT data rates available in 11ac, your security policies need to be configured to use WPA2 with CCMP. The CCMP requirement is part of the 11ac specification.

Signal Strength

The recommendation for 11n networks is typically that AP signal strength be -65 dBm or greater everywhere that Wi-Fi service is required, if support for voice or video is required. In addition, with the rise in acceptance of VoIP and video conferencing over Wi-Fi with applications like Skype, FaceTime, Lync, Adobe Connect, etc., it is probably a best practice to design networks for voice and video support, even if Wi-Fi VoIP handsets (e.g., Cisco 7925 and Ascom i75) aren’t expected to be used. This recommendation is influenced by the knowledge that to achieve the highest modulation rate of 64-QAM, a signal strength of approximately -65 dBm or greater is needed.

With 11ac, a higher signal strength is required to achieve the highest modulation rate of 256-QAM. This is because 256-QAM employs a much denser constellation than 64-QAM, which makes data corruption more likely at lower signal strength when using 256-QAM. How much higher signal strength is required depends mainly on channel width. Wider channels will require higher signal strengths to achieve 256-QAM rates.

At the extreme, a signal strength of approximately -49 dBm or greater will be required to support 256-QAM (MCS-9) for 160 MHz, or 80+80 MHz, channel widths.

For networks using 80 MHz channels, the widest channel width used in Wave 1 APs, a signal strength of approximately -52 dBm or greater is required to support 256-QAM. For 40 MHz channels, a signal strength of approximately -54 dBm or greater is required to support 256-QAM.

Table 6 below lists approximate signal strengths required to support modulation schemes for various channel widths.

Table 7 – Signal Strength Requirements for Modulation Schemes

MODULATION SCHEME	40 MHz	80 MHz	80+80 MHz	160 MHz
11n 64-QAM	-65 dBm	N/A	N/A	N/A
11ac 256-QAM	-54 dBm	-52 dBm	-49 dBm	-49 dBm

SNR

Another important metric to consider when building a wireless network is the signal to noise ratio (SNR). With 11n networks, an SNR of 25 or greater is often recommended, particularly if voice and/or video applications are present. Although this recommendation still applies for 11n clients running on 11ac networks, for 11ac clients to achieve their highest possible data rates, the SNR should be approximately 32–36.

Data Rates

With 11n networks, it is often a best practice to remove lower data rates, particularly when designing a network to support high client densities and/or high throughput capacity. The typical recommendation is to remove support for all data rates below 24 Mbps on 5 GHz and 2.4 GHz channels, assuming no support for 11b clients.

Removing lower data rates guarantees that clients do not operate below a certain data rate, ensures that management traffic is transmitted at higher data rates and prevents clients from associating to, or hanging on to APs that are relatively far away.

While it is still possible and often recommended to remove lower data rates for 11b/g/n and 11a/n clients when using the AP832 when operating a radio in non-11ac mode, if however, the AP832 radios are in 11ac mode then lower data rates cannot be removed. Per the 802.11ac specification, only higher data rates, specifically MSC-8 and MCS-9, can be disabled.

Note: Removing lower data rates for 11b/g/n and 11a/n clients can cause compatibility issues with some clients, so it is best to proceed with caution before removing data rates.

Switch and PoE Guidelines

In this section, we will provide recommendations for switching and PoE capabilities.

AP832

The recommendation is that each AP832 be connected via a single 1G Ethernet port, and that edge switches have a 10G uplink back to the distribution or core network switches. Following these recommendations will eliminate potential wired infrastructure bottlenecks.

Controller

As mentioned previously, if the data plane is configured for tunneled mode, a 10G uplink from the controller to the connecting switch is recommended, as all data plane traffic will need to pass through the controller's Ethernet port/s. A 10G uplink can be used for bridged mode deployments as well, but since all data plane traffic avoids passing through the controller's Ethernet port/s, a 1G controller uplink port will most often be more than adequate for bridged mode deployments.

PoE

The AP832 can be powered by 802.3af or 802.3at. Customers that currently have 802.3af power will not need to upgrade to 802.3at power unless they intend to use both 10/100/1000 Ethernet ports. Again, G1 is for uplink and PoE. G2 is for wired client or switch backhaul. G2 does not have support for PoE.

A summary of what is supported when powering the AP832 with an 802.3af or 802.3at power source can be seen below.

802.3af or 802.3at PoE supports the following:

- Both radios are enabled (in any mode).
- G1 is enabled.
- G2 is disabled.

A summary of what is supported when powering the AP832 with an 802.3at power source can be seen below.

802.3at PoE supports the following:

- Both radios are enabled (in any mode)
- Both Gig-E Ports are enabled.

Channel Width Planning

If the clients are predominantly 802.11ac, then selecting 80 MHz for all 11ac APs is generally the best approach in terms of throughput capacity. Network designers should consider using 40 MHz channels if any of the following apply:

- A majority of the clients are not expected to be 11ac capable for the near future.
- If MCA is to be used in a region, where only a single 80 MHz channel is available and DFS channels are not available.
- CAL is to be used, and 40 MHz channels layers are adequate or preferred for the specific traffic and/or clients assigned to each channel layer.

Channel Selection for SCA

RF environments change, so selecting the cleanest channel at the time of deployment does not guarantee interference-free channels forever. Hence, it is recommended to use E(z)RF® Spectrum Manager and Spectrum Sensors to determine the best channel/s to use, not just for the initial deployment, but also on an ongoing basis. The goal is to identify sources of Wi-Fi and non-Wi-Fi interference that may be present at the site/s and to use channels that have the least interference present.

By using E (z) RF Spectrum Manager continually, to monitor all channels (2.4 GHz and 5 GHz), channel quality reports can help determine the best channel/s to use. If, over time, channels that were once relatively free of interference experience more interference, it may be advisable to change to cleaner channels.

AP832 Dual 5 GHz Operation

As mentioned previously, the AP832 supports dual 5 GHz operation. One common use case for operating an AP832 with both radios configured to 5 GHz channels is when two AP832s are co-located, with AP832-1 providing both 2.4 GHz and 5 GHz service, and AP832-2 providing two more channels of 5 GHz service, with channel layering configured across the three 5 GHz channels. An example of how the configuration might look can be seen below.

Example Dual 5 GHz Configuration

AP832-1
Radio-1: Channel 1 / 20 MHz
Radio-2: Channel 36–48 / 80 MHz

AP832-2
Radio-1: Channel 100–112* / 80 MHz
Radio-2: Channel 149–161 / 80 MHz

*Channels 100 – 112 require DFS certification. DFS support is expected in subsequent release.

In the above example we can see that we have three unique 80 MHz wide 5 GHz channels configured, and that there is a great deal of spectrum isolation between each of the selected 5 GHz channels, as one channel is from UNII-1 (36–48), one is from UNII-2e (100–112), and one is from UNII-3 (149–161).

With dual 5 GHz operation, the recommendation is to select channels from different UNII bands, as this will ensure more than enough channel separation, thereby limiting the harmful effects of ACI.

When deploying the AP832 configured for dual 5 GHz operation, it is highly recommended that AP832e model APs and external antennas be used. While using external antennas is not mandatory, doing so can yield up to 100% more throughput than what is achievable using the AP832i built-in antennas.

By using the external antennas, it is possible to separate each antenna unit by approximately 6 feet, as each external antenna unit comes with three leads (one for each antenna) that are 3 feet long. Separating the antenna units by approximately 6 feet is recommended. It should be mentioned that APs that are co-located for the purpose of deploying load balancing also need to be separated by 7–10 feet. The purpose for these spacing recommendations is to limit the effects of ACI, as well as to provide similar coverage patterns for the channel layers configured.

AP Placement Plan

Developing an AP placement plan does not always require the use of a planning/survey tool such as Ekahau Site Survey. There will be installations where placing 11ac APs every 50–100 feet (depending on the signal strength, client density, and throughput capacity requirements) will be sufficient. These simple installations are characterized by a uniform structure where it is relatively trivial to predict coverage patterns of 11ac APs.

When coverage planning is required due to highly irregular building designs, contractual agreement, or some other reason, the recommendation is to use the planning tools available in Ekahau Site Survey.

A post-AP-installation site survey is generally recommended. The recommendation is to use a site survey tool like Ekahau Site Survey.

One-for-One AP Replacement

One question that is often asked related to migrating from non-11ac networks to 11ac networks is whether the network would work if a one-for-one swap is performed (i.e., replacing the 11n APs with 11ac APs). Assuming that the 11n network was designed to provide -65 dBm coverage or greater everywhere, the simple answer is yes. In addition, as mentioned previously, if the network is composed of mostly 11n clients, the network will likely perform even better with 11ac APs. Of course, the network will perform considerably better if the majority of clients are of the 11ac variety; however, if the network is to be optimized to deliver optimal performance for 11ac clients, higher AP densities will be required (as compared to a typical 11n network).

AP Density

A good rule of thumb when determining the optimal 11n AP density, from the perspective of a station, is that a station, no matter where it is located, should be able to hear from 2 to 3 APs. This recommendation would still hold true for 11ac networks if the design called for approximately -65 dBm signal strength or greater everywhere; however, in order to support the highest data rates available in 11ac, higher AP densities will very likely be required. Higher AP densities will allow a client to hear more APs. Therefore, the recommendation for 11ac networks optimized for peak 11ac client performance is that clients should be able to hear from 3–5 APs.

Another consideration is that supporting 256-QAM through a wall or some other signal attenuating obstruction is challenging, and therefore if you intend to optimize your network for 11ac performance, the recommendation is to put 11ac APs within line of sight of the intended coverage areas. Assuming line of site, 256-QAM rates are achievable up to distances between 25 and 30 feet.

AP Transmit Power

With higher AP densities, there will likely be a need to reduce AP transmit power to optimize channel re-use. This is true for high-AP-density SCA networks as well as MCA networks.

2.4 GHz vs. 5 GHz Signal Strength

Thus far, all of the discussions regarding signal strength and AP density have been focused on 11ac radios. As was already mentioned, performing one-for-one AP replacements is a valid approach if the network design requirements for signal strength are roughly the same as they were for the existing network (e.g., -65 dBm or >). If this is the case, the 2.4 GHz network coverage and signal strength will be comparable to what existed prior to performing the one-for-one AP swap to 11ac APs. If, however, higher AP densities are required to meet higher signal strength requirements (e.g., -52 dBm or >), then there is a strong likelihood that the new network will be over-provisioned in the 2.4 GHz band. If this is the case, the recommendation is to provision some of the 2.4 GHz radios as full-time spectrum sensors, and/or configure some of the 2.4 GHz radios to 5 GHz radios and enable channel layer load balancing across the 11ac channel layers for high client density areas. It should be mentioned that certain restrictions apply with channel layer load balancing.

> Note: At the time of this writing, the AP832 does not support the soft spectrum sensor functionality. It is anticipated that support will be available in a future release.

AP832 Mounting

The AP832i has six internal antennas. This AP can be mounted on the ceiling or a wall. The AP832i and AP832e are similar in many ways; one way they differ is in antenna patterns. The AP832e omni antennas (default) provide 360 degrees of coverage. The internal antennas of the AP832i provide approximately 190 degrees of coverage, radiating from the top of the AP. With the 190-degree coverage pattern of the AP832i, an AP mounted on the ceiling would provide strong coverage from the ceiling to the floor, and horizontally, but would not provide strong coverage for the floor above. Likewise, an AP832i mounted on a wall would provide good coverage for the room that it is mounted in, but it would not provide good coverage in the room on the other side of the wall on which the AP is mounted. Antenna coverage patterns must be considered when developing an AP placement plan.

The AP832 datasheet, available for download from the link below, includes antenna radiation patterns for both the AP832i and the AP832e.

http://www.merunetworks.com/products/access-points/antennas/index.html

For more information about mounting the AP832, please refer to the AP832 Installation Guide that can be downloaded from the Meru Support Portal.

11ac Migration

This section offers a series of pre-migration questions to help prepare for the migration, and it also provides guidelines for migrating a network to AP832s.

11ac Migration Planning Questions

When planning for an 11ac network migration, working from a list of questions such as the one below will help ensure that the migration goes well. This list can help network designers discover information about the requirements for the 11ac network. The data collected here will influence AP/antenna type, AP density, channel architecture, switch infrastructure, and so on.

Applications

Q: Which applications will be in use?

The objective here is to characterize the types of applications in use. It is important to understand throughput and latency requirements for each application currently in use or planned.

Q: Will video and/or voice applications be used?

Video and voice applications are typically the most demanding in terms of network performance. Networks that need to support either of these applications are typically designed to support a higher level of SNR.

Q: Will HD video be used, or used in combination with high client density?

High-definition video in combination with high client density environments is perhaps one of the most challenging combinations for Wi-Fi networks. Areas that need to support HD video and high numbers of clients need to be identified so that extra channel capacity (e.g., SCA w/channel layering or MCA) can be planned.

Clients

Q: What type of clients will be used?

If the client community is mainly a mix of 11n single-stream clients, like tablets, and laptops equipped with 2 spatial stream 11n clients, then channel capacity will be much lower than if most clients are three spatial stream 11ac laptops.

Q: What are the maximum data rates and channel widths supported by the various client types?

Knowing the mix of client types and data rates supported for the client community is critical when determining how much channel capacity is required to support customer use cases.

Q: Will all clients have support for DFS channels?

Much older clients may not have support for DFS channels. If some percentage of the client population lacks support for DFS channels, use of DFS channels is not recommended.

Coverage

Q: Will there be a one-to-one AP replacement?

Q: Will higher AP densities be required to optimize the network for 11ac client performance?

Again, a one-for-one replacement will work well in terms of coverage and will result in signal strength being comparable to what was in place with the previous network, but if the throughput requirements are considerably greater, higher AP density is one way to provide higher average data rates, thereby getting more capacity out of each channel deployed.

Capacity

Q: Are there any high-density areas, and if so, where are they located?

Client density requirements help network designers determine how many APs are required for a given area, as well as influence the choice of channel architecture (e.g., SCA with channel layering or MCA).

Q: What is the anticipated peak aggregate throughput requirement for each of the high-density areas?

Q: Will there be enough channels (spectrum) deployed to handle the throughput requirements for the types of clients expected to be present in the high-density areas?

Peak aggregate throughput is a product of application throughput and peak client density. Once peak aggregate throughput is determined, and average client data rates are factored in, the number of channels required for a given area of the network can be determined.

Architecture

Q: Which data plane model will be deployed—bridged or tunneled?

Knowing which data plane mode will be used will influence switching infrastructure requirements. In addition, while bridged mode may alleviate the need to upgrade the switching infrastructure, there are a number of features that are currently not supported in bridged mode (e.g., IGMP snooping).

Q: Which channel architecture will be used—SCA, MCA, or a combination of both?

For some networks, deciding which channel architecture to use is not that critical, as either would work; however, there are some environments where SCA is better suited to meet the network requirements. Choosing the right channel architecture up front will help save on cabling, implementation costs, etc., as well as provide a better end user experience for the life of the network.

Switching and Power

Q: Will each AP have a 1G uplink port?

It is strongly recommended that all AP Ethernet connections be 1G. This will prevent AP uplinks from being bottlenecks that could have the effect of limiting overall network performance.

Q: Will the edge switches have a 10G uplink back to the distribution or core network switches?

If edge switch uplinks are limited to 1G, they will likely become choke points if a number of AP832s connected to that switch are heavily utilized.

Q: Will the switches support 802.3af or 802.3at?

Since most AP832 configurations are fully supported with just an 802.3af PoE source, most customers will not be required to upgrade to 802.3at.

AP Model

Q: Will the AP832i, with built-in omni antennas, work for your network?

Q: Are there areas of the network where external high gain or directional antennas are currently in use?

Identify areas where the default omni antennas may not be optimal for coverage needs. The AP832e, with the appropriate external antennas, should be used for those areas.

Security

Q: Do any of the clients lack support for WPA2 with CCMP?

> Note: The 11ac specification does not support TKIP or WEP security.

Most clients support WPA2/CCMP these days; however, if there are some older clients (e.g., older handheld scanners) in use that do not support WPA2/CCMP, the recommendation is to create a separate WLAN for them in the 2.4 GHz band only.

Controller

Q: Will a HW-based controller be required, or would a virtual controller instance be preferable?

Q: Which controller model is best to support the number of APs and stations today, as well as for the next few years?

The popularity of virtual controllers has grown in recent years. Whether the plan is to use a virtual controller or a hardware-based controller, rightsizing the controller model to ensure that it will be able to handle the expected numbers of APs and stations is an important step.

Migrating to the AP832

The general recommendation when migrating from non-11ac APs to 11ac APs is to proceed with one floor or section of a building at a time. This recommendation holds true for SCA networks or MCA networks, although the reasons behind these recommendations differ.

Migrating from 11abgn MCA Networks to 11ac MCA Networks

For MCA networks, if 11ac APs were mixed with 11abgn APs in an area, clients that are moving through this area may prefer an 11ac 80 MHz channel to an 11an 40 MHz channel. This could potentially cause some clients to stick to 11ac APs while ignoring 11n APs that may offer better service. Therefore, the recommendation is to migrate floor-by-floor or wing-by-wing to avoid mixing 11ac and non-11ac APs in the same area of a building.

Migrating from 11abgn SCA/VCell Networks to 11ac SCA/VCell Networks

For SCA with VCell, it is recommended to avoid mixing AP model numbers for a given area, as VCell currently does not span across different AP model numbers. As with MCA networks, the general recommendation is to migrate floor-by-floor or wing-by-wing of a building.

> Note: VCell does work across AP832i and AP832e models.

A border area could be the floor above or below, as well as a section or wing of a building that is adjacent to the area where AP832s have just been installed. At the border where 11ac APs are adjacent to 11abgn APs, the recommendation is to configure the AP832s to use a different channel than the bordering non-AP832s. Following this recommendation will optimize performance.

Validating Coverage Post-Migration

Once the new AP832s have been installed, channels have been selected, AP transmit power levels have been set, and so on, the recommendation is to do a thorough coverage survey throughout the entire deployment. The main goals here are to validate that the network is in fact providing the designed signal strength and SNR, and in the case of MCA deployments, that there is a minimal amount of overlapping coverage for APs that are sharing the same channel. Ekahau's Site Survey suite has tools that can perform this task, whether the network was built using SCA or MCA.

If it is determined that there are areas where coverage does not meet the requirements, AP transmit power can be adjusted; or if external antennas are used, they may need to be adjusted. In some cases, additional APs may need to be deployed. The validation/adjustment process should be iterative until all areas of the deployment have the coverage specified in the design requirements.

Network Tuning

It is highly unlikely that any initial Wi-Fi deployment will be optimally tuned, even if extreme care was taken during the planning and implementation phases, as there are too many variables to account for when dealing with Wi-Fi. Although it is beyond the scope of this guide to delve deeply into the art and science of Wi-Fi network tuning, this section will touch on a number of things that should be checked and, if applicable, adjusted.

There are a number of statistics that should be monitored post-deployment to determine how well the network is running, such as client counts per radio, channel utilization rates, radio retry rates, client data rates, application performance, SLAs met, etc.

Monitoring channel utilization rates, for example, can help identify where capacity needs may be high enough to warrant adding channel capacity. If adding more channel capacity is not the preferred option to increase throughput capacity, another option could be to upgrade clients from the existing 11n set to 11ac.

Network monitoring and tuning should be an ongoing activity, as RF environments, client mixes, application requirements, etc., tend to change over the course of the life of a Wi-Fi network.

Migrating to AP832 in E(z)RF

In order to facilitate the AP832 migration within System Director and E(z)RF Network Manager, a guide that describes the process to swap out APs has been created. Once the swap process has been performed on the controller, AP832s automatically get updated in E(z)RF Network Manager. The “E(z)RF AP and Data Migration” guide can be downloaded from the Meru Support Portal.

Conclusion

Organizations should evaluate their WLAN migration strategy now for 802.11ac. 802.11ac provides many times more throughput and client capacity compared to 11n networks. The AP832 is fully compatible with 11a/n and 11b/g/n clients, and will likely improve performance for these clients. Many new devices are coming equipped with 11ac clients, such as Samsung Galaxy S4, HTC One, the new MacBook Air (2x2:2), and the new MacBook Pro (3x3:3), as well as numerous Windows 8 notebooks now available that utilize Intel’s 11ac 7260 (2x2:2) client. An 11ac network will be required in order for these clients to perform up to their potential.

Building an 11ac network is like building an 11n; however, there a few significant differences that network designers need to be cognizant of, such as:

- 11ac requires higher signal strength and SNR to support 256-QAM
- 11ac may require higher AP density when optimizing for 11ac client performance
- 1G ports for 11ac ports are required to benefit from 11ac throughput improvements
- 10G ports are required for edge switch uplink ports
- 10G port is required for controller (for tunneled mode)

The 11n to 11a migration process is similar to the process of going from 11abg to 11n. As with the migration from legacy to 11n, the general recommendations are to proceed with the migration floor-by-floor or wing-by-wing.

Moving from legacy networks to 11n networks enabled new customer use cases, such as HD video streaming, but even 11n struggled to deliver HD video streaming in high client density areas or where single-stream 11n devices, like tablets and smartphones, made up a large percentage of the client population.

802.11ac, with its ability to provide much better throughput capacity—especially for single-stream devices—is up for even the most challenging environments. Even if the majority of clients are not 11ac yet, network performance and reliability will likely improve by migrating to 11ac technology today. Migrating to 11ac now prepares the network for the next generation of Wi-Fi clients that is beginning to show up in big ways today.

Acronyms

ACI – Adjacent Channel Interference
BYOD – Bring Your Own Device
CAL – Context Aware Layering
CCI – Co-Channel Interference
CCMP – Counter Mode with Cipher Block Chaining Message Authentication Code Protocol
DFS – Dynamic Frequency Selection
DHCP – Dynamic Host Configuration Protocol
HT – High Throughput (802.11n)
IGMP – Internet Group Management Protocol
MAC – Medium Access Control
MCA – Multi-Channel Architecture
MCS – Modulation and Coding Scheme
MIMO – Multiple Input Multiple Output
MU-MIMO – Multi-User MIMO
QAM – Quadrature Amplitude Modulation
RADIUS – Remote Access Dial-In User Server
SCA – Single-Channel Architecture
SLA – Service Level Agreement
SNR – Signal to Noise Ratio
TxBF – Transmit Beamforming
VHT – Very High Throughput (802.11ac)
WPA2 – Wi-Fi Protected Access II

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