802.11ac
BUYER'S GUIDE

802.11ac Wireless: The Time to Move is Now!

Higher Density and Higher Capacity for a Better Experience

802.11ac is the next generation in wireless and is 3x faster than 802.11n. The benefits of 802.11ac are real and the time to move is now.

Introduction

The explosive growth in mobile and BYOD devices is driving user demand for higher capacity and higher density wireless networks. Users today expect the wireless network to be simple to use, super-fast at delivering and receiving data, and smart enough to allow roaming at will regardless of device or application - video, voice, or data. The average user typically has 3 – 5 devices. Many only come with a wireless interface, with no Ethernet connection or even cellular connectivity. Wi-Fi has replaced wired as the connection method of choice for many users and increasingly, in organizations.

The proliferation of wireless devices has gone well beyond smartphones, tablets and laptops. The Internet of Things has arrived with sensors, wearable devices like watches and glasses driving further demands for wireless capacity and density.

802.11ac is the next generation of wireless, specifically designed to provide the higher capacity and density that users and organizations demand. As you install a new wireless infrastructure, or upgrade or expand your existing wireless network, you now have the opportunity to better meet user needs now and prepare your network for continued growth in devices and demand. The time to move to 802.11ac is now, with Wave 1 implementations providing 3x the performance of 802.11n. The benefits for 802.11ac are real - today.

This paper will provide information on planning for the move to 802.11ac wireless. Topics discussed will include:

- **Deployment** – Deploying 802.11ac Wave 1 today
- **Upfront network planning** - Considerations for planning when making the move to 802.11ac
- **Infrastructure and design** - Whether or not your selected 802.11ac solution requires upgrades to your existing wired infrastructure, channel planning, capacity and density planning
- **Clients** – 802.11ac clients will be required in order to achieve the full performance gains to be had with an 802.11ac Wi-Fi installation
- **Network management** – Things like a unified wired/wireless management, distributed policy controls, and zero touch APs will make IT's job easier and create a great experience for users

Overview of the 802.11ac Standard

802.11ac wireless provides significantly higher data rates, client capacity, and density than 802.11n.

802.11ac is the next phase in delivering wired-like performance for wireless and has evolved from the 802.11n standard. 802.11ac provides significantly higher data rates, client capacity, and density than 802.11n and directly addresses the user demands generated by the explosion of mobile and BYOD devices.

802.11ac is being delivered in two implementation Waves: "Wave 1" and "Wave 2." 802.11ac Wave 1 is available now with all major wireless vendors having access points that support the protocol. 802.11ac Wave 2 is targeted to be available around Q2 of 2015.

802.11ac Wave 1 provides significant performance gains over 802.11n through two evolved techniques:

- A denser modulation scheme, 256-QAM, providing up to a 33% increase over 64-QAM used with 802.11n
- An increase in the number of bonded channels from two with 802.11n to four with 802.11ac Wave 1, and the use of 80MHz channel widths
- With these evolved techniques, 802.11ac Wave 1 delivers up to 3 times the performance over the 802.11n standard

Wave 2 will further increase performances by introducing multi-user MIMO (MU-MIMO), increasing the number of spatial streams and increasing the possible bonded channels from 80 MHz in Wave 1 to 160MHz in Wave 2.

Theoretical throughput for 802.11ac Wave 1 increases to 1.3Gbps per radio versus 450Mbps per radio available with 802.11n wireless.

A closer look at the gains of 802.11ac Wave 1 over 802.11n:

- Bonding two 20MHz channels for a total of 40MHz in 802.11n can provide 150Mbps of theoretical throughput per spatial stream. Therefore an access point supporting 3 spatial streams could deliver up to 450Mbps of theoretical throughput per radio.
- Now take a look at **802.11ac**. By using 256-QAM and bonding 4 x 20MHz channels for a total of 80MHz in 802.11ac can provide 433Mbps of theoretical throughput per spatial stream. Therefore an access point supporting 3 spatial streams could deliver up to 1.3Gbps of theoretical throughput per radio.

Note that 802.11ac only supports the 5GHz band.

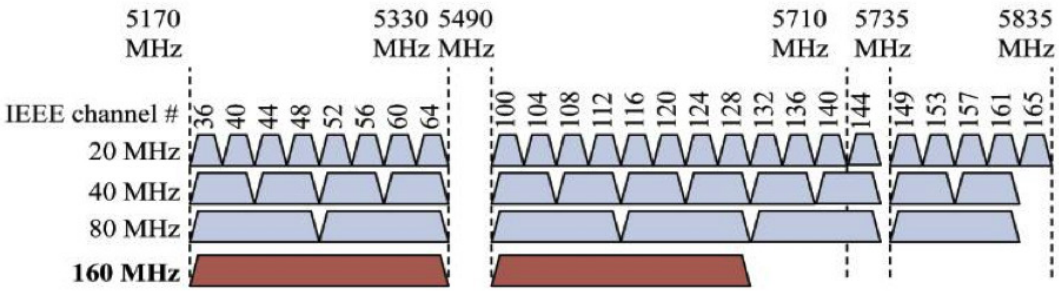

Figure 1 shows channel plan for 5GHz spectrum with 20, 40, 80, and 160MHz (not available until 802.11ac Wave 2) channel widths

Deploy 802.11ac Today for:

Deploy 802.11ac Wave 1 wireless today if you are installing a new wireless network, expanding an existing wireless network or upgrading an older wireless network.

1. **New wireless installations** - If you are installing a wireless network into a new building or a new location within an existing campus or building, then 802.11ac is recommended.
2. **Expansion of existing wireless network** - If you are expanding an existing 802.11a/b/g/n wireless network and are looking for additional coverage and capacity, 802.11ac should be seriously considered as an overlay to the existing network.

   This will allow you to start a migration towards a full 802.11ac network as well as establishing placement of APs for a full 5GHz wireless network deployment. 802.11ac is also backwards compatible 802.11n APs. Additionally a good enterprise AP will have dual radios providing support for both 802.11ac and legacy 802.11a/b/g/n client's simultaneously, thereby enabling you to upgrade the wireless infrastructure without disrupting the current wireless client base. Based on this 802.11ac should be seriously considered.
3. **Upgrading existing wireless network** – If you are looking to upgrade an older network to newer and faster wireless technology then moving to 802.11ac would be the recommended choice.

Upfront Planning

Installing or upgrading a wireless network is not a plug-and-play project – it requires upfront planning for a smooth running project and a great outcome. Things to consider:

Upfront planning prior to installing a new wireless network will insure a great outcome.

1. **Site survey** - Perform a detailed site survey of the existing wireless network if you are replacing or upgrading an existing wireless network. This will provide a baseline for things like dead spots in the network, channel usage, and so forth. Also keep in mind that in order to gain the full performance benefits of 802.11ac, access points will need to be located closer together.
2. **Floor plan** - Use a site planning tool such as Ekahau to create a detailed site plan using a floor plan of the building to determine placement of the access points. Many factors can affect RF therefore taking things like makeup of the building will be important – concrete versus sheetrock, how much metal is used in building construction, cubicle farms versus open spaces and so forth.
3. **Devices and BYOD** - How many devices will be connecting to the wireless network? Look at the number of devices versus just the number of people as many employees will have more than one device. On average the number of wireless devices per employee is between 3 and 5 which would include employees bringing their own device (BYOD).
   a. When planning for devices look at where device numbers will be in 1, 3 and 5 years in order to plan for wireless network growth and expansion.
4. **Density of users** – As part of your planning try to get a feel for the density of people in a given area in order to determine the best number of APs for the area. For instance an auditorium or stadium will have a much denser user concentration than a lobby or office area. Also keep in mind that density might change with the time of day. For instance an auditorium in a school might have an event in the evening where students and parents are invited, which could drive increased user density than during the course of a normal day.

802.11ac APs that maintain support for PoE power (with full functionality) versus going to PoE+ will save money on your power budget.

5. **Wired network** - Perform a wired audit to make sure that you have adequate Ethernet drops to support newly deployed access points. Keep in mind that 802.11ac access points may be equipped with multiple Ethernet ports to offload the increased amount of RF traffic. Additionally take an inventory of switch ports and power. Minimally switch ports will need to have 1Gbps ports to support the increased data rates of 802.11ac and many (not all) access points will require increased power using PoE+ (802.3at) versus PoE (802.3af).
    a. Make sure the access point has at least 2 Ethernet ports and checkout the power requirements. Staying with PoE saves money on your power budget and may save you from needing to upgrade switches. APs with Dual Ethernet ports provide a distinct advantage offering link aggregation and/or power redundancy.
6. **Applications** - What applications are running on the wireless network? Application traffic and patterns hitting the APs can greatly affect the wired infrastructure and must be accounted for. Users expect the wireless network to perform as well as the wired network and demand that applications are accessible throughout the wireless network without service interruption or degraded performance. Knowing what is going on with applications will help in planning the wireless network. Things to consider here:
    a. Applications that are latency sensitive like VoIP and video.
    b. Application bandwidth and usage including access to popular content streaming sites (youtube, netflix, hulu, etc...)?
    c. Where are applications servers located? They could be centralized within the datacenter, distributed across a campus, hosted in the cloud, or distributed across multiple regions.
        i. Additionally when looking at this consider upstream versus downstream application usage. It may be heavier in one direction or the other.
    d. As with devices also look at where application growth will be in 1, 3 and 5 years in order to plan for wireless network growth and expansion.
7. **A vendor with experience** - Work with a vendor or installer that knows what they are doing, has years of experience implementing complex wired/wireless networks, can provide references, and who will be there for you down the road.

When the 802.11ac installation is complete perform a post-site survey to establish a baseline for future wireless growth and insure the network is performing to plan.

8. **Post-site survey** – Once you are done with your 802.11ac installation make sure you perform another site survey to insure that you have the full coverage that you expect and planned for and so that you have an established baseline for future installations or network changes.

Infrastructure and Design

Infrastructure and design considerations to fully benefit from an 802.11ac deployment:

1. **Ethernet switches/cabling** – You must have at least 1Gbps Ethernet ports on the edge switches for 802.11ac. As mentioned earlier, 802.11ac Wave 1 has the ability to drive 1.3Gbits of traffic per radio through the access point's (AP) Ethernet ports. Typically today's AP will have a radio dedicated for 5Ghz 802.11ac and a radio dedicated for 2.4GHz 802.11a/b/g/n with a theoretical maximum traffic rate of 1.75Gbits per AP. In reality the AP will only drive a little over a Gig of traffic through the Ethernet ports and even at that it is unlikely that it would sustain this level for an extended period of time. Additionally quality enterprise grade APs will have dual Ethernet ports that will allow you to aggregate the AP traffic

You will need 2 x 1Gbp switch ports for the new 802.11ac AP in order to off-load wireless traffic to the wired network at full traffic rates.

to 2 x 1Gig switch ports therefore you will have more than enough bandwidth to support the data rates of 802.11ac Wave 1. Without 2 x 1Gig switch ports you will not get the full traffic rates out of a dual radio access point.

a. Make sure that the 802.11ac AP has dual Ethernet ports.

b. You may need to run a second Ethernet cable to the 802.11ac AP if you are replacing an existing 802.11n AP in order to support link aggregation (LAG) and/or power redundancy.

c. 802.11ac Wave 1 will not require upgrading the edge switch to 10Gig access ports.

d. You can repurpose older 10/100 edge switches for 10/100/1000 edge switches to handle the increased Ethernet traffic generated by 802.11ac APs.

It should be noted that once 802.11ac Wave 2 becomes commercially available 10/100/1000 edge switches may need to be repurposed as Wave 2 will be able to drive between 1.7Gbps and 3.5Gbps of traffic to the switch ports. You may however, not need to upgrade all the way to 10Gig edge switches as 2.5Gig switches are becoming available. Either way new access switches will be required for 802.11ac Wave 2. It should be noted that older switches will still work with 802.11ac Wave 2 APs but may rate limit the throughput of the AP.

2. **Power over Ethernet (PoE or PoE+)** – Make sure that your switch supports the correct level of power to support the 802.11ac AP. There are two standards for switch power – PoE providing 12.9W of DC power at the AP (802.3af) or PoE+ providing 25.5W of DC power at the AP (802.3at). Some 802.11ac APs may require 802.3at power, therefore may not run on existing switch ports even if there are 802.11a/b/g/n APs currently plugged into these existing switch ports.

   a. Make sure edge switches can supply appropriate power to the 802.11ac AP.

   b. Select an AP vendor that can provide full functionality with just PoE. Choosing a vendor that truly supports PoE with full functionality can preserve existing edge switch infrastructure and save on power budgets.

   c. Many vendors have had to move to PoE+ to power their APs with full functionality. This is really an area to be careful of due to many vendors claiming to support the lower powered PoE however, if you read the fine print they are limiting functionality when running on PoE.

   d. An alternative to powering the AP via the switch would be to use a power injector.

Plan for a dense AP deployment in order to achieve the high capacity that users demand today.

3. **Plan for dense AP deployments** – Moving to 802.11ac will likely require more APs than what were deployed with existing 802.11a/b/g/n APs. This is due to several factors:

   a. 256-QAM modulation requires higher signal quality to work which means that it works at a shorter range than 64-QAM modulation. In fact in order to get the maximum traffic rates of 802.11ac it is a good idea to figure on clients being within an average of 30 to50 feet of the AP for optimum performance. Outside of this distance APs will basically fall to 802.11n traffic rates.

   b. Secondly users are demanding more and more capacity. Designing a network for high capacity usage for today and looking towards the future will also drive a denser AP deployment.

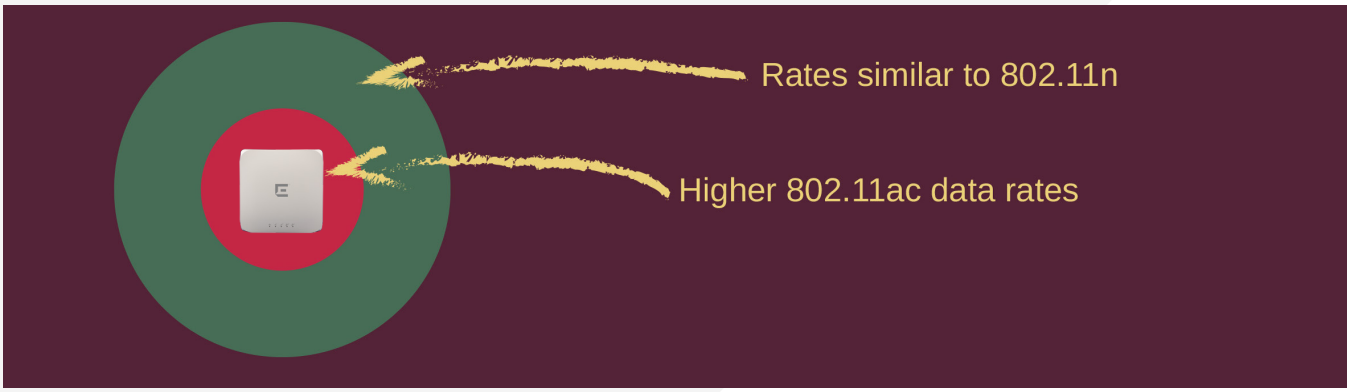

Figure 2 shows data rate differences verses distances between 802.11n and 802.11ac

802.11ac allows for increased traffic rates so make sure that not only the access switches can handle the increase but also the rest of the network - distribution, datacenter, and application servers.

c. You may want to plan for even denser AP installations in areas such as stadiums, auditoriums or other large public areas to handle the capacity that these types of scenarios would demand.

d. If this is a wireless upgrade identify areas that have had performance complaints and plan for additional APs to increase the capacity.

4. **Overall network capacity** – We have discussed making sure that the edge switches can handle the increased traffic that 802.11ac will drive however this increased traffic will propagate throughout the network. Additionally planning for increased capacity driven by denser AP deployments allows more clients to connect, which will also increase traffic. Typically the traffic will go from the network edge to distribution, core and datacenter therefore you need to make sure that the rest of your network will also handle increased traffic, including application servers.

5. **Application planning** – Look at applications being used, how they are being used and where they are being used. Things like where the application is being hosted – in the datacenter versus the public cloud will affect traffic loads across the network as multiple users access these from multiple locations. Simultaneous application usage could drive infrastructure requirements. Also things like video distribution or VoIP usage will also drive additional traffic and may require traffic prioritization.

6. **Channel planning** – In order to gain the full performance gains of 802.11ac you must deploy APs in 80MHz mode. A new channel plan based on a site survey will need to be conducted if you are migrating from an existing wireless network to ensure interference free transmission over the 5GHz band. Additionally when dynamic frequency (DFS) is taken into consideration there are only 2 non-overlapping channels with an 80MHz channel width (Wave 1) and no non-overlapping channels if you were to use a 160MHz channel width (when Wave 2 is available).

   Several channels in the 5GHz band are also used by emergency services, military and first responders and therefore requires DFS support. If the access point detects that one of these are in use the AP is required to back off and not use this channel for at least 30 minutes. As part of the channel planning try to determine if one of these emergency services, military or first responders is nearby and in use and then plan your installation around this so as not to have the interference.

802.11ac only runs on the 5GHz band however the 2.4GHz band will still be required for years to come. Make sure the new AP has dual radios to support both of theses bands.

a. If the client devices used in the wireless network do not support 80MHz channel widths 40MHz widths will still work until upgraded but will not achieve full data rates offered by 802.11ac.

   i. Additionally make sure that the clients you will be deploying support DFS.

b. You probably still need to plan for 2.4GHz devices for the next several years. Since 802.11ac is 5GHz only make sure that the 802.11ac access point has a second radio that supports the 2.4GHz band. If you are migrating you might also decide to keep existing wireless network in place as an overlay to support the 2.4GHz band until all client devices support 5GHz.

c. You may also need to re-plan the 2.4GHz channel plan as well when using a dual radio 802.11ac AP where one radio is now handling the 2.4GHz RF traffic. This is because you are installing the APs much closer together for a dense 802.11ac deployment which will cause the 2.4GHz radios to be to close. Therefore you may need to power down some of the 2.4GHz radios.

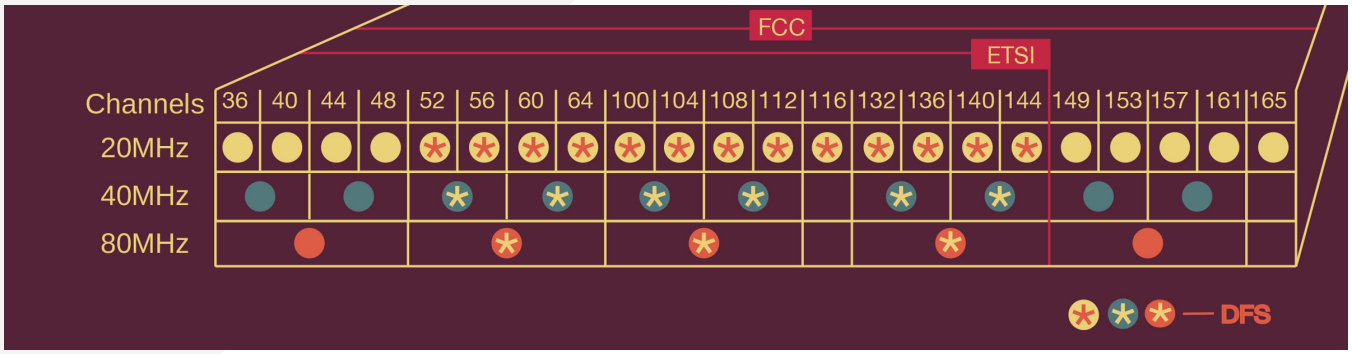

Figure 2 shows 5GHz spectrum with DFS channels

Wireless Clients

When moving to 802.11ac do not forget to make sure you have client support for 802.11ac.

Wireless clients are often overlooked when planning for a new or upgraded wireless network. There are no performance gains to be had if the wireless client does not also support 802.11ac along with the AP. Fortunately many clients do support 802.11ac. Most new laptops, many smartphones and some tablets currently support 802.11ac Wave 1. You should check online to see if your device of choice provides support. The Wi-Fi Alliance provides a good list of device clients that provide support. This list grows every day. As mentioned the 5GHz band has less range than the 2.4GHz band but has a greater data rate which allows you to locate APs closer together for a much denser deployment. Things to consider:

1. **802.11ac capable clients** - Before purchasing new devices check to make sure that they are 802.11ac capable. Make sure the device supports functionality like DFS (described above), 80Mhz channel widths, and 256-QAM.
2. **Clients and spatial streams** – Keep in mind that all client devices are not equal. As the table below shows smaller devices do not support the same number of spatial streams as larger devices. This will also determine RF data rates.
3. **Extended battery life** - The higher data rates available with 802.11ac help to extend battery life because it takes less time to transmit a given amount of data.
4. **Run 802.11n clients on 5GHz** - You may also want to move 802.11n dual-band

	802.11n		802.11ac		
Mobile Device/Streams	**20 MHz.**	**40 MHz.**	**20 MHz.**	**40 MHz.**	**80 MHz.**
Smartphone (one stream)	72.2	150.0	86.7	200.0	433.3
Tablet (two streams)	144.4	300.0	173.3	400.0	866.7
Notebook (three streams)	216.7	450.0	288.9	600.0	1300.0

clients onto 5GHz which can improve the connection quality and user experience for these clients as you migrate to 802.11ac. Functionality such as band steering and/or load balancing techniques can be employed here to automate this and force 2.4GHz clients to the 5GHz band.

Zero touch APs reduce management complexity.

Network Management

Network Management (NMS) in of itself is a topic for careful consideration we will just touch on a few key points to consider here:

1. **Zero touch APs** – Due to size and complexity of wireless networks the APs should be able to take their configurations from a centralized location so that APs do not need to be configured individually.
    a. Additionally APs with dynamic power and channel detection will make deployment easier.
2. **Policy** – A policy management system allows IT to centrally define a set of rules that use context such as time-of-day, location, device type, user name and so forth to dynamically and transparently control what users and devices can or cannot do on the network. A policy should be able to follow the user and/or device as they roam across the network and change dynamically based on context. Based on this the policy management system should then be able to push policy out to a single AP, groups of APs, or all APs from a central location then allowing policy decisions to be made at the AP. Policy should not have to be tied to a VLAN or require a VLAN for enforcement.
3. **Unified wired/wireless NMS** – Many wireless vendors do not have the ability to manage anything beyond their own wireless infrastructure. This may work in some case however in larger more complex wireless networks there are huge advantages for IT, the business, and the users of having an NMS that can provide management, analytics and control over the entire wired and wireless network.
    a. With that said it is equally important that the wireless solution can also be managed within itself and/or be managed by third party management systems via open standards such as SNMP.
4. **Ease-of-use** – NMS should make things easier by providing automation, intuitive dashboards, point-and-click configuration, troubleshooting and so forth.
5. **Holistic 802.11a/b/g/n/ac management** – If you are sticking with the same vendor and migrating from 802.11a/b/g/n wireless to 802.11ac wireless make sure that both old and new APs are seamlessly managed through the same NMS.

A unified wired/wireless NMS reduces complexity and provides huge advantages for IT, the business and the users.

802.11ac Wave 1 is commercially available now and the advantages are huge. If you are planning a new wireless implementation move to 802.11ac Wave 1 today.

Do Not Wait for 802.11ac Wave 2

802.11ac Wave 2 will not become commercially available Q2 2015. 802.11ac Wave 1 is here now and provides real benefits today. Users want speed, applications want speed and 802.11ac Wave 1 is 3 times faster than 802.11n. As we discussed above if you are increasing the size of your wireless network, installing new locations or replacing your wireless network you want to go with the higher performing 802.11ac standard.

1. **Switches** – As stated above in the infrastructure and design section, access layer switches will need to be upgraded to 2.5Gig or 10Gig switches in order to handle 802.11ac Wave 2 traffic.
2. **Clients** – Clients for 802.11ac Wave 1 are readily available on almost all new devices therefore they will be best served by using 802.11ac APs.
    a. Clients for 802.11ac Wave 2 will not be readily available for well over a year, probably closer to 2 years.
3. **160MHz channel width more for consumers than enterprise** – 802.11ac Wave 2 will increase the channel width to 160MHz which will be of great interest in the consumer market but may have limited application for commercial usage due to the lack of non-overlapping channels available when using a 160MHz bonded channel width. Additionally 160MHz channel widths will be optional and will not be enforced. Note refer to figure 1 above for channel widths.
    a. Many vendors will also claim 3.5Gbps performance with 802.11ac Wave 2 but this will also require 160MHz channel width. In reality enterprises will not be using a single 160 MHz channel since this will not allow for non-overlapping channels. Additionally this will require 4 spatial streams to achieve this rate which most clients will not have support for.
4. **Density versus coverage** – Wireless deployments today are no longer about coverage it is about density and scalability. 802.11ac Wave 1 will provide the density and scalability to handle the increased demand of today's users and applications.
5. **Higher RF performance** – The higher performance that comes with 802.11ac further optimizes the usage of valuable RF. Devices do not have to be connected as long to transfer their data due to the higher performance of 802.11ac.
    a. Less connection time also extends the devices battery life.
    b. Both of these will make the user more efficient and thus happier.
6. **Multi User MIMO (MU-MIMO)** - MU-MIMO available in Wave 2 has the ability to interact with several clients simultaneously and will increase wireless data rates and therefore drive up up-link utilization which will need to be considered for back-end infrastructure.

Quality customer support and years of networking experience should be a top priority when selecting a vendor or partner.

Customer care

Quality customer care comes from a combination of experience, the number of years in business, and a deep commitment that there is nothing more important than the customer. This involves much more than providing a phone number to call when something is not working properly. Truly ensuring customer success requires a partnership with a wide range of offerings from professional services for network design and installation to customized technical training; and yes immediate problem resolution in the event of a network issue.

Things to consider:

1. **Customer care** – Is customer care a key component to the vendor's business or is it outsourced to a third-party clearinghouse?
2. **Years of experience** – Many vendors are relatively new to wireless and have only been involved for a short time. How many years of customer care experience does the vendor have with the products and/or the services that they provide?
3. **Partner ecosystem** – Does the vendor have a large partner base that can help design, deploy and optimize even the most complex networks?
4. **Support plans** - Does the vendor offer a full range of support plans designed to provide the right service for your individual business needs?

Summary

802.11ac is the way to go if you are planning a brand new wireless installation, expanding an existing wireless network, or upgrading an older wireless network. 802.11ac Wave 1 delivers real performance gains and is available now.

In this paper we have looked at several areas that should be carefully considered when planning for your installation. Before you even start the actual installation make sure you have a plan in place to insure a great outcome. Things to consider in your plan should include; pre and post site surveys, floor plans, device types and use, AP density, the wired network and application usage. We also discussed infrastructure and design considerations to insure that the wired network is ready for 802.11ac, client ready planning for 802.11ac, and considerations for network management to increase IT efficiencies and user satisfaction.

For questions or help in planning your 802.11ac installation please contact your Extreme Networks representative and we will be happy to help.

Figure [1] from Wikipedia (http://en.wikipedia.org/wiki/List_of_WLAN_channels)

Extreme networks

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