Technical white paper

Design considerations for an IEEE 802.11ac network

Table of contents

Evolution of IEEE 802.11ac

Since its introduction in 1999, the IEEE 802.11 standard (Wi-Fi) has made a huge leap in capabilities, performance, and availability—from 11 Mbps of IEEE 802.11b to a staggering 1.3 Gbps with Wave 1 of IEEE 802.11ac. In mid 2015, IEEE 802.11ac Wave 2 devices were starting to show up on manufacturer's portfolios supporting up to four spatial streams and 80 MHz channel providing data rates of up to 1.7 Gbps on the 5 GHz band. In the future, support for eight spatial streams and 160 MHz channel providing data rates of up to 7 Gbps will be available.

In 1999, the IEEE 802.11b standard supported 20 MHz channels in the 2.4 GHz spectrum, with a single stream and four data rates per stream: 1, 2, 5.5, and 11 Mbps.

At the same time, ratification of IEEE 802.11a was completed supporting the following capabilities:

- 20 MHz channels
- 5 GHz spectrum
- Single stream
- Eight data rates: 6, 9, 12, 18, 24, 36, 48, and 54 Mbps

Both IEEE 802.11b and 802.11a standards support WEP for security and encryption.

In mid 2003, the IEEE 802.11g standard was ratified with backward compatibility for IEEE 802.11b.

The new IEEE 802.11g standard offered the same 20 MHz channel bandwidth and data rates similar to 802.11a, but in the 2.4 GHz band rather than the 5 GHz band.

Due to the simplicity and ease of breaking the WEP key, the IEEE created a group to develop a new security and encryption standard. This resulted in the introduction of WPA and WPA2 (Wi-Fi Protected Access). Also, understanding the limitation and vulnerability of WEP encryption caused the IEEE to come out with a temporary solution, WPA-personal TKIP, until the ratification of WPA2-personal AES.

In 2009, a new Wi-Fi standard, IEEE 802.11n high throughput with full backward compatibility to all previous standards. This new standard introduced support of both 20 and 40 MHz channels, multiple input/output streams (MIMO), and multiple types of explicit and implicit beamforming. Additionally, IEEE 802.11n supports both 2.4 and 5 GHZ bands, and higher data rates.

- 20 MHz channel data rates: 7.2, 14.4, 21.7, 28.9, 43.3, 57.8, 65, and 72.2 Mbps
- 40 MHz channel data rates: 15, 30, 45, 60, 90, 120, 135, and 150 Mbps

---

Note
These data rates represent theoretical rates for a single stream and do not represent actual throughput capabilities.

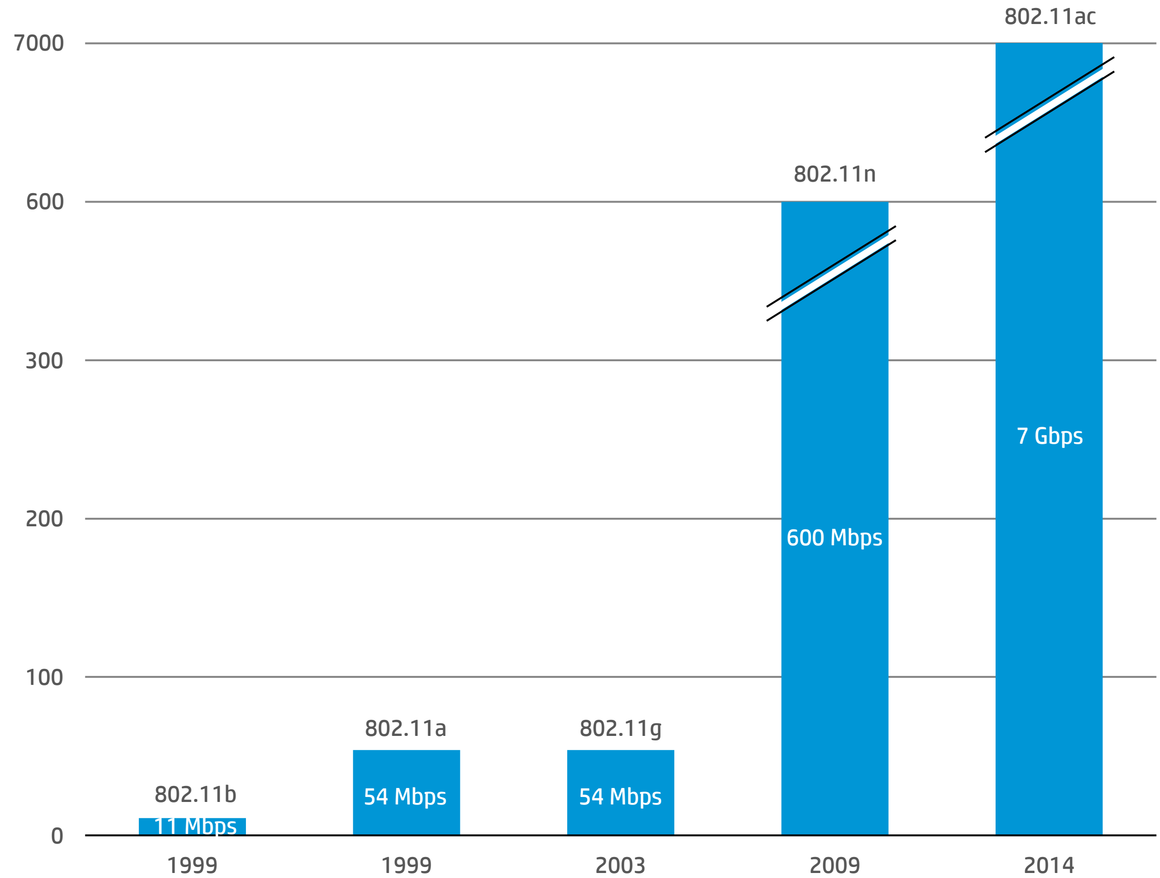
Although the IEEE 802.11n standard described supports up to four spatial streams, no more than three spatial streams have been implemented in a commercial Access Point (AP) or client to date. With the use of three spatial streams on a 40 MHz channel, the maximum theoretical throughput is 450 Mbps (150 Mbps per stream x Number of streams). On a 20 MHz channel, the maximum theoretical throughput is 216 Mbps (72 Mbps per stream x Number of streams).

At the end of 2013, the IEEE organization ratified the latest 802.11 standard: IEEE 802.11ac very high throughput. This standard operates in the 5 GHz spectrum only and was designed to deliver almost 4X the capacity compared with the IEEE 802.11n standard. In early 2015, we have seen multiple APs and clients that support a subset of the new standard called 802.11ac Wave 1.

The new IEEE 802.11ac standard supports a higher modulation level (256QAM compared to 64QAM with 802.11n) and dictates a single standard for beamforming—Null Data Packet (NDP). In addition, the allowed channel bandwidth was extended from 40 MHz to 80 MHz and 160 MHz, in order to enable delivery of "bandwidth-hungry" applications such as HDTV over the air while supporting multiple clients, and for setting the infrastructure for futuristic high-bandwidth demanding applications. In order to overcome the limitations of legacy standards, which allow a single client permission to access the medium at each point in time, the IEEE 802.11ac standard supports multiuser MIMO (MU-MIMO), which dramatically decreases the wait time between one transmission to another.

Since the device support of the new standard enhanced capabilities is divided into two waves, some of the final goals will only be achieved in the second wave.

Figure 1. Evolution of the IEEE 802.11 standard



Note
The maximum theoretical data rate for IEEE 802.11ac is 7 Gbps.

Understanding IEEE 802.11ac features

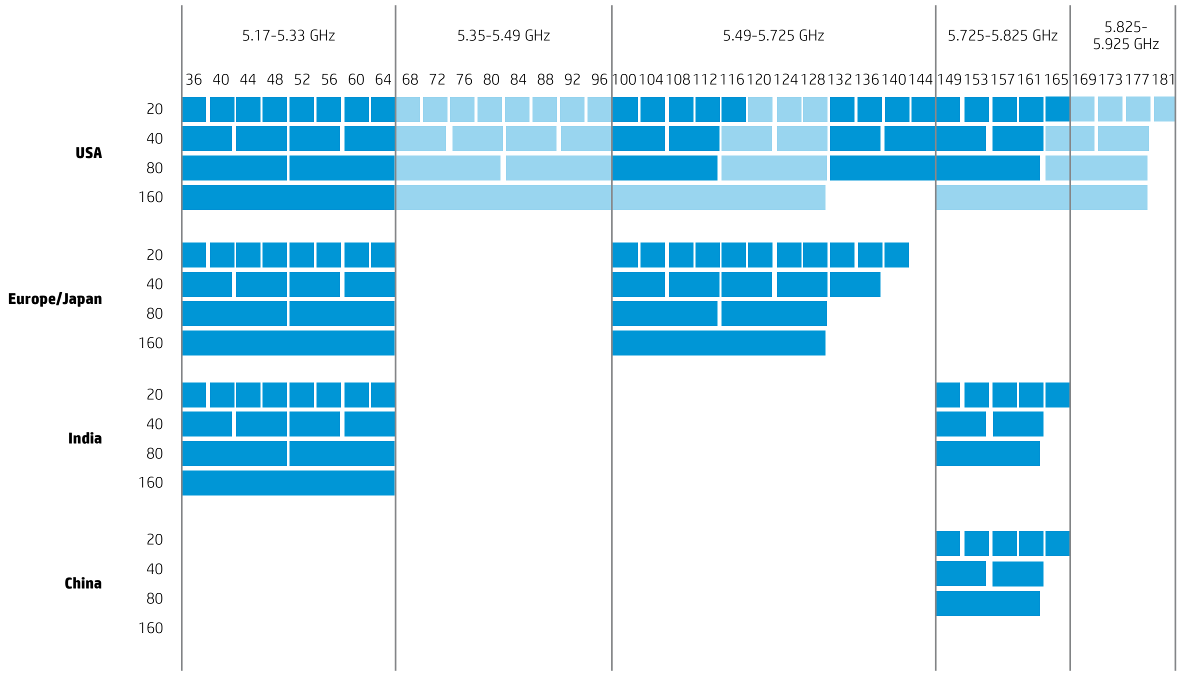
IEEE 802.11ac is all about addressing the increasing number of devices, handling much higher densities, and supporting higher speeds in order to improve overall performance. This standard, in Wave 1, supports up to 1.3 Gbps, when communicating with clients that support three spatial streams, and up to 1.7 Gbps, in the second wave, with clients that support four spatial streams. These throughputs represent a major leap from previous WLAN standards. The standard will benefit real-time application services such as VoIP, bandwidth hungry applications, high-density scenarios, and jitter- and latency-sensitive applications, with the following new features and capabilities:

- Wider channel bandwidths
- Increase number of spatial streams
- Multiuser MIMO
- Higher modulation level

Wider channel bandwidths

IEEE 802.11ac supports 20, 40, and 80 MHz channels with optional support for contiguous 160 MHz channels or non-contiguous 80+80 MHz channels. The 80 MHz systems use fewer antennas than a 40 MHz system, while providing the same performance. Additionally, doubling the bandwidth from 40 MHz to 80 MHz allows each spatial stream to support roughly twice the number of bits per symbol. As a result, it takes a single-stream 80 MHz transmission to provide the same performance as a two-stream 40 MHz transmission. Although increased bandwidth might sound exciting, in reality HP does not recommend the deployment of an 80 or 160 MHz channels in a commercial/enterprise environment. As these are usually high-density deployments, the dramatic reduction in available channels results in a high rate of channel reuse, which decreases the network performance due to co-channel interference.

Figure 2. Channel bandwidth supported by IEEE 802.11ac



MIMO spatial streams

IEEE 802.11ac standard dictates the support of one spatial stream and 20 and 40 MHz channels. It also described an option that supports up to 8 spatial streams plus 80 and 160 MHz channels; with each spatial stream supporting up to 433 Mbps, on 80 MHz channels. In the first wave of IEEE 802.11ac, we did not see the APs supporting more than three streams. In fact, mobile clients will most likely keep supporting up to two streams, as the support of each additional stream consumes large amount of battery power, which is limited on mobile devices. What is seen today in the market are devices with a single stream that support the 80 MHz channel to enable increased throughput rather than implementing support for a second stream. Another strategy taken by manufacturers is installing a chipset that will support three streams, but the software will enable the support of only two streams to conserve battery power.

MU-MIMO

MU-MIMO provides ability to serve multiple clients at the same time and offers a radical increase in capabilities, which allows an increase of VoIP calls, video streams, and other jitter- and latency-sensitive applications. It is most suitable for organizations using medium-to-high density deployments and/or those who have a deployment of client devices with a smaller number of spatial streams compared with their access points.

Since the client can only process a portion of the spatial streams available on the access point, the access point has some streams that are not utilized. With MU-MIMO, those streams can be made available for use by another client simultaneously.

Instead of allocating all spatial streams to a single client, providing the client with all the bandwidth (in most cases without a real need from the client perspective), the AP divides the spatial streams according to client's need. Where in the past a single client would receive all the three streams, it is now possible to allocate one stream per user and serve three different clients at the same time, providing each client sufficient bandwidth for their needs.

The key benefit of deploying IEEE 802.11ac Wave 2 clients and APs is the ability of the technology to handle moderate to very high throughput with low jitter and delay. With multimedia usage becoming more and more each day, MU-MIMO will be a feature that should be considered prior to deploying Wave 1 of the IEEE 802.11ac standard.

With the ability to utilize MU-MIMO, organizations face a set of new requirements and considerations.

MU-MIMO must be supported by client devices too and the fact that the AP supports MU-MIMO is not be sufficient.

AP placement

With previous IEEE 802.11 standards, all clients could face the AP from one direction and performance would not suffer. With MU-MIMO, AP placement plays a much more vital role in order to serve multiple clients.

The clients should obtain the greatest spread possible and should surround the AP from all angles. In the example of a 4x4 AP, the fourth transmitting element will emit an inverse signal to the three streams servicing clients. This reduces the interference on each clients' stream that is produced by the other two streams.

This masking signal is similar to the signal generated by noise cancelation algorithms and will emit an inverse sinus that will cancel the incoming signal. Since the AP will only have a single transmitting element to try and cancel three different streams (signals), the best scenario will be a reduction of 33 percent for each of the unwanted signals being received. The greater the physical separation between the participating clients, the easier it is to generate the masking signal. The closer the clients are, the harder it is to generate a signal that will successfully cancel the unwanted streams.

Number of supported clients

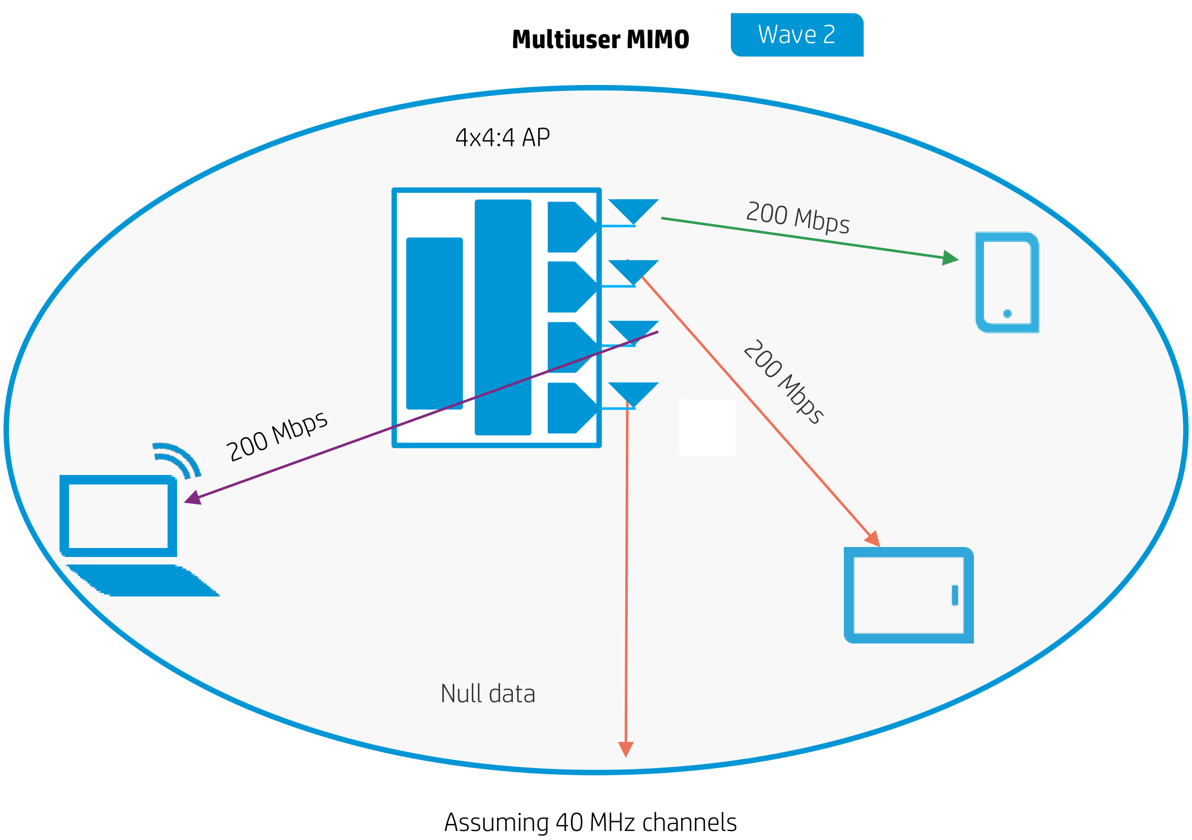
The number of supported clients is calculated based on the following formula:

n-1=(# of served clients)—where "n" represent the number of TX elements

Currently, vendors are not manufacturing APs with more than four TX elements; meaning that up to three clients can be served simultaneously (n=4)

The essence of MU-MIMO is shown in figure 3

Figure 3. Single user MIMO and multiuser MIMO



Modulation

IEEE 802.11ac uses orthogonal-frequency-division multiplexing (OFDM) to modulate bits for transmission. While the modulation method is the same as that used in IEEE 802.11n, IEEE 802.11ac optionally allows the use of 256QAM. This increases the number of bits per sub-carrier from six to eight, resulting in up to a 33 percent increase in the physical data rate. The ability to transmit more data per transmission plays a huge role when it comes to enabling "bandwidth-hungry" application on the WLAN—this will translate to better end user experience especially in high-density deployments.

5 GHz wireless spectrum

IEEE 802.11ac operates only in the less congested 5 GHz wireless spectrum. The 5 GHz spectrum, which is less prone to interference, offers up to 23 (varies by country) non-overlapping 20 MHz channels versus the three non-overlapping 20 MHz channels in the 2.4 GHz spectrum. By using the 5 GHz spectrum, IEEE 802.11ac becomes more suitable for applications sensitive to packet loss and delay, and those requiring high performance and throughput, such as voice and video.

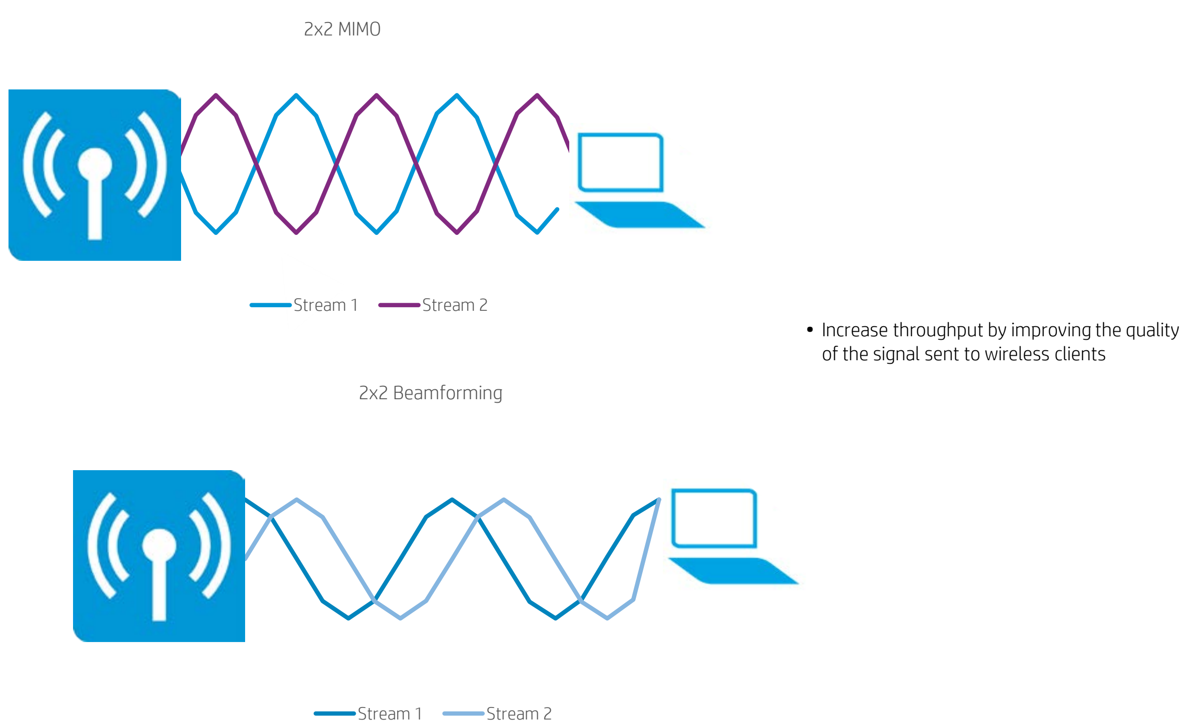
Although IEEE 802.11ac enables the use of wider than before channels (80 MHz and 160 MHz) the limitation that comes with using 80 and 160 MHz channels is the dramatic reduction of the number of available channels (depending on region the number of channels is between 2–5). This, in turn, brings back the channel selection limitation that is seen with the 2.4 GHz spectrum and might degrade the network performance due to co-channel interference.

Beamforming

TX beamforming can be used to increase throughput by improving the quality of the signal sent to wireless clients. When this option is enabled, access points use beamforming techniques to optimize the signal strength for each individual wireless client station. Beamforming works by changing the characteristics of the transmitter to create a focused beam that can be more optimally received by a wireless station. To achieve this the standard calls for two entities, the beamformer—the entity who transmits, and the beamformee—the entity who receives the transmission.

By applying a well-calibrated time shift on each of the different TX elements, the beamformer transmits the same signal from different TX elements, resulting in a state where all signals arrive at the same time to the beamformee. Since all signals are the same and arrive at the same time, the effect on the beamformee is an increase of received signal strength—usually by 2–3 dBm. Beamforming will become valuable in environments where the RF condition is "noisy" and clients are having hard time maintaining good and stable link to the AP while trying to run bandwidth-hungry application or jitter- and latency-sensitive applications such as VoIP or live video.

Figure 4. Beamforming



Beamforming, however, doesn't come without a price. Whenever beamforming is active, the AP will not be able to use MIMO to the same client and will revert to a single stream mode.

Notes

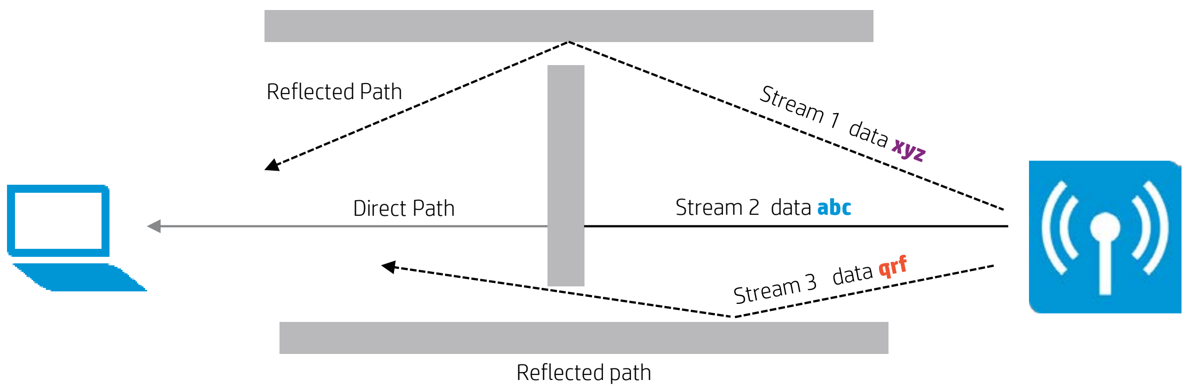
1. It is important to remember that both AP and client need to support beamforming technology.
2. APs are able to use both beamforming and MIMO when communicating in MU-MIMO mode (when serving multiple clients), meaning that one client can be allocated two streams for beamforming and another client can be allocated to the third stream with being affected.

The difference between MIMO and Beamforming can be seen in figures 4 and 5.

Figure 5. MIMO

Limitation: As signal strength weakens, AP will lower number of streams being used

Benefit: Each stream increases the throughput by 1/# of streams.

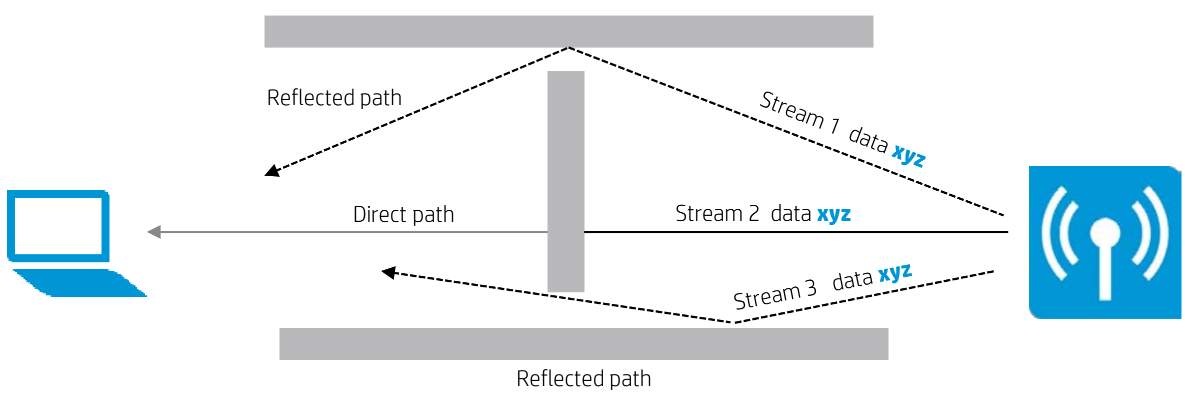


Each data stream contains a different set of data, each stream reaches the client at a different point in time and the client compiles all streams to one set of data

Figure 6. Beamforming

Limitation: All streams are carrying the same data, reducing the throughput capability

Benefit: By making all 3 streams arrive at the client at the same time, the signal strength is increased by 2-3 db



Each data stream contains the same set of data, each stream reaches the client at the same point in time, and the client receives a "single" stream

IEEE 802.11n and 802.11ac comparison

The following tables provide the primary differences between IEEE 802.11n and 802.11ac. Additionally, any differences between wave 1 and wave 2 implementations of IEEE 802.11ac are identified.

Table 1. 802.11n/ac differences

Item	802.11n	802.11ac Wave 1	802.11ac Wave 2
Channel bandwidth in MHz	20, 40	20, 40, 80	20, 40, 80, 160
Frequency in GHz	2.4, 5	5	5
Modulation levels	BPSK, QPSK, 16QAM, and 64QAM	BPSK, QPSK, 16QAM, 64QAM, and 256QAM	BPSK, QPSK, 16QAM, 64QAM, and 256QAM
Beamforming support	Supports multiple types	Supports only NDP Explicit beamforming	Supports only NDP Explicit beamforming
Spatial stream	Up to 4 spatial streams	Up to 8 spatial streams	Up to 8 spatial streams
Client support	Support a single client at any given moment	Support a single client at any given moment	Support up to 4 clients at any given moment

Table 2. Performance comparison based on single stream with different channel bandwidth

	IEEE 802.11n	IEEE 802.11ac Wave 1	IEEE 802.11ac Wave 2
40 MHz channels	150 Mbps	200 Mbps	433 Mbps
80 MHz channels	N/A	433 Mbps	1.3 Gbps
160 MHz channels	N/A	N/A	2.6 Gbps

Table 3. IEEE 802.11n and IEEE 802.11ac spatial stream comparisons

Spatial streams	IEEE 802.11n max-40 MHz	IEEE 802.11ac max-40 MHz	IEEE 802.11ac max-80 MHz	11ac max-160 MHz (Wave 2)
1	150 Mbps	200 Mbps	433 Mbps	866 Mbps
2	300 Mbps	400 Mbps	866 Mbps	1.73 Gbps
3	450 Mbps	600 Mbps	1.3 Gbps	2.34 Gbps
4	600 Mbps	800 Mbps	1.7 Gbps	3.46 Gbps

Considerations

Cabling requirements

Due to the new high speeds and increased throughput capabilities, the backhaul infrastructure might need to be upgraded in preparation for supporting 802.11ac deployments. Although 802.11ac Wave 1 clients are capable of delivering theoretically 1.3 Gbps, most APs today are equipped with 1 Gbps ports, which ties the maximum throughput of the AP to the port limitation rather than to the AP's capabilities. Furthermore, the conditions in which the AP performs at such high speed are very limited and involve a single client, capable of 3x3:3, accessing the medium; these type of clients are limited and the chance of this exact scenario is very low.

It is recommended to deploy cat5e or cat6 Ethernet cables for 802.11ac Wave 1 APs and connecting them to 1 Gbps ports on the switch side. Where in the past 1 Gbps to 4 Gbps uplinks were sufficient on the edge switch, with IEEE 802.11ac it is recommended to prepare for 10 to 40 Gbps uplinks to the core of the network from the edge switch.

When considering deploying 802.11ac Wave 2 APs, the link speed between the APs and the switch should be reviewed. The introduction of MU-MIMO and the ability to support 80 and 160 MHz channel alongside the additional fourth stream brings the reality of surpassing 1 Gbps speeds from each AP. HP Smart Rate multigigabit ports, capable of up to 10 Gbps, will be available on HP 802.11ac Wave 2 APs, and should be connected to HP Smart Rate multigigabit ports on the switch side. This will help ensure sufficient bandwidth availability for the APs, and mitigate bottlenecks at the edge. For 802.11ac Wave 2 AP, HP recommends deploying cat6 Ethernet cables, which are designed to sustain high throughput and multigigabit rates.

Cabling for the 2.5 Gbps Smart Rate mode is not defined by a standard today. HP Research and Development (R&D) testing has shown that the 2.5 Gbps mode performs as well as 1000 BASE-T and operates robustly on any structured cabling that meets the requirements for 1000 BASE-T operation. Put simply, if the cabling works reliably for 1000 BASE-T, it should work for 2.5 Gbps. The two modes are close in terms of robustness, which can be attributed to three main factors:

1. 2.5 Gbps Smart Rate uses a coding and modulation technique that is leveraged from 10G BASE-T. This technique is more advanced than what is used by 1000 BASE-T and has significantly more powerful error correction capability to deal with errors caused by cable impairments and external noise.
2. 2.5 Gbps Smart Rate operates on 100 MHz bandwidth. This happens to also be the channel bandwidth that cat5e cabling is specified, designed, and tested to. Cat6 extends that bandwidth to 250 MHz.
3. At 100 MHz, the electromagnetic coupling between adjacent cables in a tight bundle of cables is fairly minimal.

What this means is that cabling in the field that is certified for 1000 BASE-T operation has enough channel bandwidth to support 2.5 Gbps Smart Rate operation. While 2.5 Gbps operates at a higher frequency (100 MHz) than 1000 BASE-T (62.5 MHz), its coding, modulation, and error correction technique compensates for the additional performance impairments.

Most importantly, the 100 MHz frequency of operation results in minimal impact from external noise. This is key because the majority of older cat5e and cat6 installations give no consideration to mitigating alien crosstalk, minimizing how tightly multiple cables are bundled together, using shielded twisted-pair cables, and/or taking care to avoid routing cables through noisy environments. In fact, in an effort to keep cable installations easy to work with when routing through conduits and cable trays, most cable installers have gotten into the habit of "grooming" the cable bundles for 1000 BASE-T applications to keep them neat and tidy. This creates significant amounts of alien crosstalk between the cables due to the tight bundling. Fortunately, this electromagnetic coupling is frequency dependent, and at 100 MHz it is fairly minimal.

In general terms, 2.5 Gbps Smart Rate supports up to 100 m of cat5e or better, unshielded or shielded twisted-pair cabling. In technical terms, cabling for 2.5 Gbps Smart Rate must meet the requirements for cat5e described in ANSI/TIA/EIA-568-B.2.

This is identical to the requirements for 1000 BASE-T. It keeps the cabling guidelines simple and consistent, helps ensure quality cabling continues to be installed/deployed in the field, and should provide a positive experience when customers drop 2.5 Gbps Smart Rate into their environment and it just works.

5 Gigabit Ethernet (5G Smart Rate)

This is where things get really tricky. Of the four speeds (10/100 Mbps, 1 Gbps, 2.5 Gbps, 5 Gbps, and 10 Gbps) 5 Gbps Smart Rate is the most technically challenging, particularly when deployed on cat5e cabling. There are two main reasons for this.

First, 5 Gbps mode operates on 200 MHz bandwidth. In reality, most decent quality cat5e cabling has acceptable performance in the 100–200 MHz range to support 5 Gbps operation. However, cat5e cable quality varies greatly between cable vendors, so it is virtually guaranteed that a certain percentage of existing cat5e installations that meet 1000 BASE-T operation will have insufficient performance in the 100–200 MHz range to support reliable 5 Gbps operation. Moving to cat6 solves this issue since cat6 is specified and tested to 250 MHz.

Second, and more importantly, the 200 MHz operating bandwidth used by 5 Gbps falls into a frequency range where electromagnetic coupling between cables in a tight cable bundle can be significant. This makes the Alien noise issue much more significant. Because most legacy cat5e and cat6 cable plants were installed without regard to alien crosstalk mitigation, the potential for noise degradation at 5 Gbps on legacy cabling is very real.

This makes 5 Gbps deployment in existing cable installation difficult since it involves a trade-off between the cabling loss and noise. With shorter cables, the link has greater signal-to-noise ratio (SNR) and can tolerate more noise. With longer cables, the link has less SNR and can tolerate less noise. For example, HP lab testing has shown that 5 Gbps link with a 100 m of reach can only tolerate about 40 m worth of coupled noise in a 6-around-1 cable bundle configuration. If that same link were shortened to 60 m, it could tolerate the entire 60 m worth of coupled noise in the same 6-around-1 configuration.

Figure 7. HP Smart Rate multigigabit and cable throughput capabilities

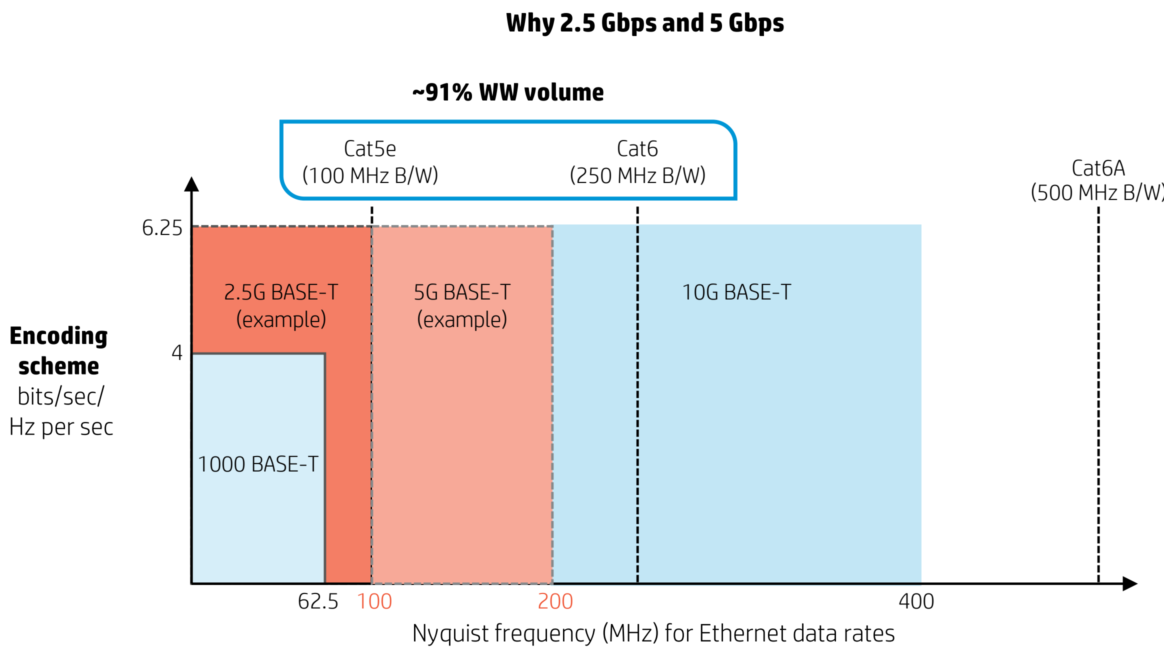


Table 4. Speeds, cabling, and reach for proposed twisted pair physical layers

Cabling type	1000 BASE-T	2.5G BASE-T	5G BASE-T	10G BASE-T
Cat5e	100m + 4PPoE	**100m + 4PPoE**	**Up to 100m + 4PPoE**	No support
Cat6	100m + 4PPoE	**100m + 4PPoE**	**100m + 4PPoE**	55m + 4PPoE
Cat6A	100m + 4PPoE	**100m + 4PPoE**	**100m + 4PPoE**	100m + 4PPoE

Note
For more information on HP Smart Rate multigigabit, cabling, and the HP Smart Rate multigigabit technology refer to the following document: HP Smart Rate technology TWP.

Power requirements

HP IEEE 802.11ac Wave 1 Access Points can operate on IEEE 802.3af PoE. This means that edge switches does not need to be upgraded to support IEEE 802.3at PoE+. However, the following limitations of using IEEE 802.3af PoE should be taken into consideration:

- The 2.4 GHz radio is reduced from three streams down to two streams.
- The HP 802.11ac walljacks are unable to supply power to IEEE 802.11af (POE) devices from the POE out port.

HP IEEE 802ac Wave 2 Access Points will require IEEE 802.3at PoE+, drawing up to 20+ Watts, and will be equipped with 2.5 Gbps smart rate ports.

HP recommends that network architects closely look at their existing edge infrastructure to determine whether the power requirements for IEEE 802.11ac access points can be met. If the limitations listed above for Wave 1 access points is not acceptable, or if Wave 2 access points will be installed, the edge will need to support IEEE 802.3at PoE+. Ensure that the switch can provide the necessary power for the number of access points that will be connected to it.

Channel usage

Is there truly a need to deploy 80 MHz channels? Are there any “bandwidth-hungry” applications on the network that 40 MHz channel throughput is not sufficient for? Depending on regional limitation the number of 80 MHz channels vary from 4 to 6 non overlapping channels. This puts a hard limitation when designing an RF plan while trying to avoid/minimize co-channel interference and channel overlapping.

Unlike IEEE 802.11n, where 5 GHz channel allocation was almost a non-issue, in IEEE 802.11ac there are at most five non-overlapping 80 MHz channels available in most regulatory regions—and potentially fewer if dynamic-frequency- selection (DFS) channels need to be avoided. The limited number of none overlapping channels places a premium on companies who can deliver access points with proven antenna capabilities that will minimize the “bleeding” of RF signal to neighboring channels.

Simply put, 80 MHz channels, 160 MHz channel, or non-contiguous 80+80 MHz channels, are not recommended in high density deployments. In an enterprise environment, they should typically only be used in select, low-density locations or areas of a building.

AP positioning

As previously mentioned, with the introduction of MU-MIMO, AP positioning is becoming much more important than ever before. For MU-MIMO to operate effectively, the AP needs to be installed in a location where the clients are surrounding it from 360 degrees to obtain the greatest separation between concurrent served clients. As with any AP upgrade, it is recommended to perform a site survey—at minimum, a passive site survey to determine the best AP coverage for your environment.

HP IEEE 802.11ac network design guidance

When designing a wireless network that utilizes IEEE 802.11ac APs, one should design the cell edges to overlap at -59 dBm to maintain the support of high modulation levels offered by the new standard (compared to -65 dBm which was used with the previous IEEE 802.11n standard).

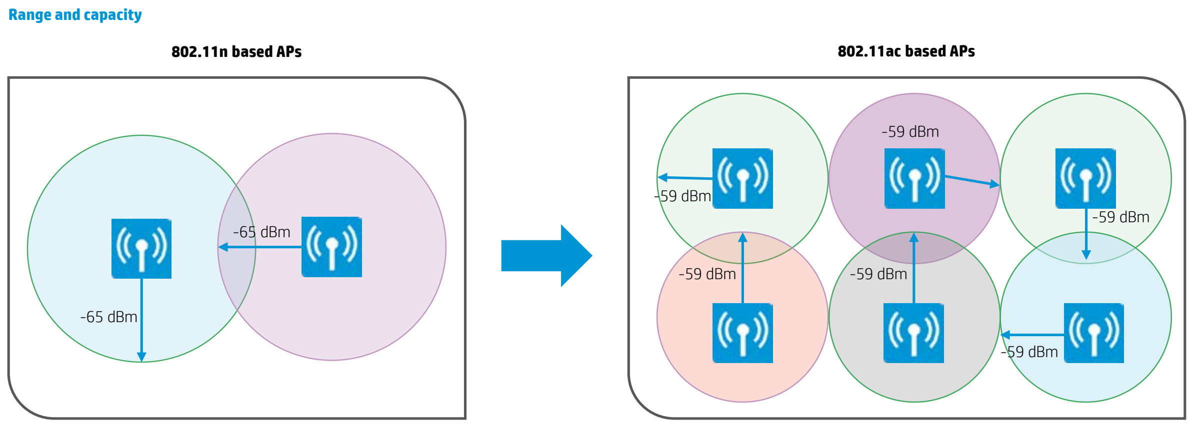
As a result of this requirement, the cell size of each AP will shrink when compared with an 802.11n AP. It will require more APs to cover the same area as before, but will offer much higher performance. Another point to be taken under consideration is: 802.11ac is only supported on the 5 GHz band, therefore, the 2.4 GHz radio on the HP access points will continue to work in 802.11n mode—only in a much denser environment than before. Considering that 2.4 GHz has a much larger footprint than the 5 GHz frequency, and far fewer non-overlapping channels (3) available, more co-channel interference is bound to be introduced. It is recommended that organizations consider shutting down a portion of the 2.4 GHz radios all together or setting the 2.4 GHz radios to work in IDS/scanning mode and adjust the transmit power on the remaining 2.4 GHz radios to shrink the 2.4 GHz RF footprint. An alternative option is to deploy a mix of single radio APs and dual radio APs to reduce cost.

Note

The values provided here should be treated with caution as each environment is different and an RF survey is required to determine the optimal value for each deployment.

APs that support IEEE 802.11ac can be used to replace legacy standard APs in a ratio of 1:1; however, in most cases doing so will create pockets of high-speed connectivity rather than a unified high-speed connectivity coverage.

Figure 8. RF and performance considerations for deploying 802.11ac



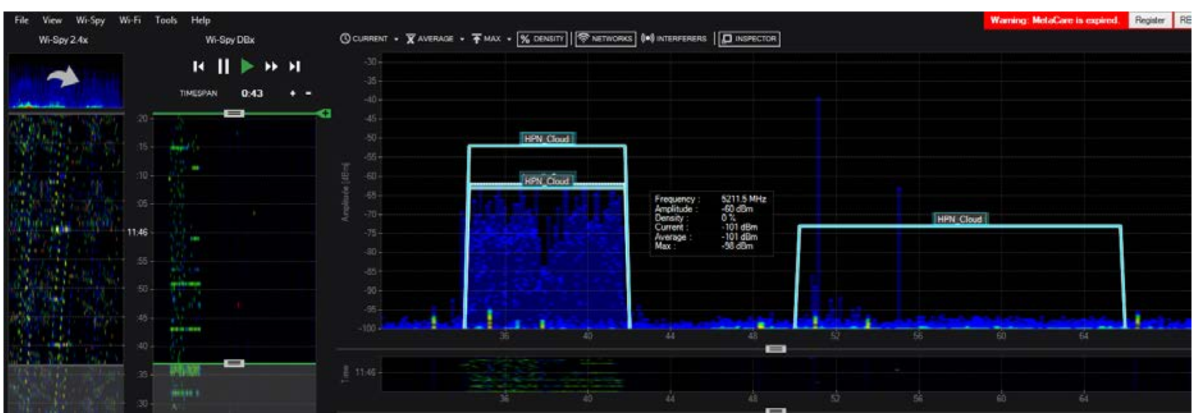
Site survey and spectrum analysis

To insure best performance, minimize interferences, and outages it is highly recommended to conduct a site survey and spectrum analysis prior to designing and launching the network. During the site survey and spectrum analysis of the venue, the network architect must be aware of currently utilized channels and RF interferences that are constant in the air.

Since both 2.4 GHz and the 5 GHz are unlicensed channels they are available to use by the public, hence it is very likely to find other SSIDs "bleeding" and utilizing channels that can affect the "quality of the air". It is a good practice to show courtesy and approach neighboring network administrators to ask them to reduce transmit power for the benefit of all neighboring wireless networks.

Once the survey is completed and information is gathered regarding which channels should not be used, the network architect can move forward with designing the network and channel assignments. When approaching the task of setting the maximum transmit power, the architect should plan around -60 dBm at the cell edge. Since prediction models are not able to predict the RF behavior at 100 percent accuracy, a second survey should be done to fine tune and adjust the power levels and RF propagation.

Figure 9. RF survey and analysis sample



Client compatibility and legacy standards

The vast majority of clients (cell phones, tablets, laptops, etc.) are capable of supporting 1x1:1 and 2x2:2; and do not fully utilize the benefits of technologies such as MU-MIMO and beamforming, and we see a similar situation when we look at the laptops segment. As a result, administrators may see no real benefit in deploying 3X3:3 APs, or APs capable of these features. However, it is important to remember that the penetration of new IEEE 802.11ac clients is at its beginning and will increase as time progresses, while legacy standard clients will be de-commissioned. Networks being built today will be in service for the next 3-5 years and should take the evolution of IEEE 802.11ac clients into consideration when determining the equipment and design of the WLAN. As time progress, it is anticipated that the utilization and performance of the network will increase as clients capable of beamforming and MU-MIMO are introduced.

Note
IEEE 802.11ac support full backward compatibility so legacy clients will still be able to utilize the network and organizations will not lose the investment made in legacy assets.

.

Learn more at
hp.com/networking

Sign up for updates
hp.com/go/getupdated

Share with colleagues

Rate this document

4AA5-8774ENW, June 2015