Max speed wireless ac

Faster Wi-Fi: It's something we all crave. Fortunately, it's also something we can have, even on a budget. It's not just about fast Internet speeds to and from your service provider. It's also about transferring files between devices in your home or office, streaming video from a network-attached drive to a television, and gaming with the lowest network latencies possible. If you're looking for faster Wi-Fi performance, you want 802.11ac — it's that simple.In essence, 802.11ac is a supercharged version of 802.11n. 802.11ac is dozens of times faster, and delivers speeds ranging from 433 Mbps (megabits per second) up to several gigabits per second. To achieve that kind of throughput, 802.11ac works exclusively in the 5GHz band, uses plenty of bandwidth (80 or 160MHz), operates in up to eight spatial streams (MIMO), and employs a kind of technology called beamforming that sends signal directly to client devices.If you're currently using an 802.11n router — or an even older 802.11b/g model, like the perennial favorite Linksys WRT54G — and are thinking of upgrading to 802.11ac, here's what you need to know.How 802.11ac worksYears ago, 802.11n introduced some exciting technologies that brought massive speed boosts over 802.11b and g. 802.11ac does something similar compared with 802.11n. For example, 802.11n supported four spatial streams (4×4 MIMO) and a channel width of 40MHz. But 802.11ac can utilize eight spatial streams and has channels up to 80MHz wide — which can then be combined to make 160MHz channels. Even if everything else remained the same (and it doesn't), this means 802.11ac has 8x160MHz of spectral bandwidth to play with versus 4x40MHz — a huge difference that allows 802.11ac to squeeze vast amounts of data across the airwaves.To boost throughput further, 802.11ac also introduces 256-QAM modulation (up from 64-QAM in 802.11n), which squeezes 256 different signals over the same frequency by shifting and twisting each into a slightly different phase. In theory, that quadruples the spectral efficiency of 802.11ac over 802.11n. Spectral efficiency measures how well a given wireless protocol or multiplexing technique uses the bandwidth available to it. In the 5GHz band, where channels are fairly wide (20MHz+), spectral efficiency isn't so important. In cellular bands, though, channels are often only 5MHz wide, which makes spectral efficiency very important.802.11ac also introduces standardized beamforming (802.11n had it, but it wasn't standardized, which made interoperability an issue). Beamforming transmits radio signals in such a way that they're directed at a specific device. This can increase overall throughput and make it more consistent, as well as reduce power consumption. Beamforming can be done with smart antennae that physically move to track a device, or by modulating the amplitude and phase of the signals so that they destructively interfere with each other, leaving just a narrow, interference-free beam. The older 802.11n uses this second method, which can be implemented by both routers and mobile devices.Finally, 802.11ac, like 802.11 versions before it, is fully backwards compatible — so you can buy an 802.11ac router today, and it should work just fine with your older 802.11n and 802.11g Wi-Fi devices.How fast is 802.11ac?In theory, on the 5GHz band and using beamforming, 802.11ac should have the same or better range than 802.11n (without beamforming). The 5GHz band, thanks to less penetration power, doesn't have quite the same range as 2.4GHz (802.11b/g). But that's the trade-off we have to make: There simply isn't enough spectral bandwidth in the massively overused 2.4GHz band to allow for 802.11ac's gigabit-level speeds. As long as your router is well-positioned, or you have multiple routers, it shouldn't matter much. The more important factors will be the transmission power and antenna quality of your devices.And finally, the question everyone wants to know: Just how fast is Wi-Fi 802.11ac? As always, there are two answers: the theoretical max speed that can be achieved in the lab, and the practical maximum speed you'll most likely receive at home in the real world, surrounded by lots of signal-attenuating obstacles.The theoretical max speed of 802.11ac is eight 160MHz 256-QAM channels, each of which are capable of 866.7Mbps, for a total of 6,933Mbps, or just shy of 7Gbps. That's a transfer rate of 900 megabytes per second — more than you can squeeze down a SATA 3 link. In the real world, thanks to channel contention, you probably won't get more than two or three 160MHz channels, so the max speed comes down to somewhere between 1.7Gbps and 2.5Gbps. Compare this with 802.11n's max theoretical speed, which is 600Mbps.In situations where you don't need the maximum performance and reliability of wired gigabit Ethernet — still a good option for situations requiring the highest performance — 802.11ac is certainly compelling. Instead of cluttering up your living room by running an Ethernet cable to the home theater PC under your TV, 802.11ac now has enough bandwidth to wirelessly stream the highest-definition content to your game console, set top box, or home theater PC. For all but the most demanding use cases, 802.11ac is a viable alternative to Ethernet.The future of 802.11ac802.11ac will only get faster, too. As we mentioned earlier, the theoretical max speed of 802.11ac is just shy of 7Gbps — and while you'll never hit that in a real-world scenario, we wouldn't be surprised to see link speeds of 2Gbps or more in the next few years. At 2Gbps, you'll get a transfer rate of 256MB/sec, and suddenly Ethernet serves less and less purpose if that happens. To reach such speeds, chipset and device makers will need to implement four or more 802.11ac streams, both in terms of software and hardware.We imagine Broadcom, Qualcomm, MediaTek, Marvell, and Intel are already well on their way to implementing four- and eight-stream 802.11ac solutions for integration in the latest routers, access points, and mobile devices — but until the 802.11ac spec is finalized, second-wave chipsets and devices are unlikely to emerge. Chipset and device manufacturers have plenty of work ahead to ensure advanced features, such as beamforming, comply with the standard and are inter-operable with other 802.11ac devices.Now read: How to boost your Wi-Fi speed by choosing the right channel.Sebastian Anthony wrote the original version of this article. It has since been updated with new information.Check out our ExtremeTech Explains series for more in-depth coverage of today's hottest tech topics. Wireless networking is the most convenient way of accessing the internet. Every year the number of users and devices accessing the internet increases. As a result, many people experience speed slow-downs and unreliable wireless connections. To reduce those challenges and improve your wireless experience, the WiFi-Alliance established a new WiFi standard - 802.11ac. What is 802.11ac? The 802.11ac standard, also known as WiFi 5 and Gigabit WiFi, is the 5th generation of WiFi. It's an upgrade from IEEE 802.11n, or WiFi 4. WiFi 5 was designed to deliver improved speeds, WiFi performance, and better range to keep up with the growing number of users, devices, and data consumption. A Short History of the 802.11ac Standard The purpose of WiFi standards (IEEE 802.11) is to improve the wireless local area network (WLAN or Wireless LAN) user experience. New wireless standards are developed to fill gaps in the existing standards and to account for new technology. The 4th WiFi generation (IEEE 802.11n) saw a dramatic increase in the number of users and devices requiring wireless internet. This resulted in speed slowdowns and increased latency. To improve the 802.11n standard, the Institute of Electrical and Electronic Engineering developed the IEEE 802.11ac standard from 2008 to 2013. The improvements would result in a better WLAN experience - faster speeds, more bandwidth, and less latency. The updated standard was published in December 2013. Two waves of products were launched using the 802.11ac standard. The first wave was introduced in 2013 and the second in 2015. The difference between these product waves will be discussed later in this article. How Fast is the 802.11ac Standard? Maximum internet speeds are theoretical. They are based on optimal conditions - potential interference is not factored in. 802.11ac has a theoretical maximum speed of 1,300 Mbps (1.3 Gbps) - 2,300 Mbps (2.3 Gbps). It was the first WiFi standard developed that could theoretically achieve gigabit speeds opposed to megabit speeds. In contrast, 802.11n had a theoretical speed of 450 Mbps (0.45 Gbps). This meant WiFi 5 could be up to 3x faster than the previous WiFi generation under optimal conditions. In the real-world, data rates are susceptible to change due to the environment. Obstacles like building material, walls, doors, floors, and furniture can interfere with the signal strength, resulting in the speed slowing down. Forbes states that the fastest real-world 802.11ac speeds recorded are around 720 Mbps (0.72 Gbps). In contrast, the maximum speed recorded for 802.11n was 240 Mbps (0.24 Gbps). While it's true that WiFi 5 is 3x faster than WiFi 4, the speeds are much lower than the theoretical ones. 802.11ac Key Features 802.11ac built on the features offered by 802.11n to improve throughput, bandwidth, and speed. Wider WiFi Channels There are two GHz frequency bands that routers and wireless devices use to communicate with each other – 2.4 GHz and 5 GHz. Most WiFi devices are dual-band, meaning that they can use both frequency bands. The difference between the two bands is their range, speed, and bandwidth. The 2.4 GHz band provides more coverage but slower speeds. On the other hand, the 5GHz band provides faster speeds but less coverage. Within those frequency bands, there are smaller bands that represent WiFi channels. A WiFi channel is what wireless devices use to send and receive data. The width (measured in MHz) dictates how much data can pass through the channel and at what speed. The traditional channel width is 20 MHz, and channel bonding is used to increase the channel widths. Wider channels tend to be associated with more data transfer and faster speeds – as long as the channel is not crowded and experiencing interferences. To better explain this, think of a channel as a road. Channel bonding is like adding lanes to it, allowing for a greater capacity of cars and faster overall speed. The 802.11n standard only supported 20 MHz and 40 MHz channels (bonds two 20 MHz channels). The first 802.11ac product wave supported a maximum of 80 MHz channel bandwidth. To improve on the first wave, the second wave of products took channel width to a different level. Wave 2 supports up to 160 MHz channel bandwidth. The 160 MHz channel improvement was achieved by bonding adjacent channels or non-adjacent 80 MHz channels (to create the 80+80 MHz channel). As a result, it improved throughput significantly. MIMO – Multiple-Input Multiple-Output MIMO technology uses multiple transmitters and receivers (antennas) to send data to multiple WiFi devices simultaneously. Originally, 802.11n routers used SU-MIMO (Single-User Multiple-Input Multiple-Output), meaning that the router could only communicate with one connected device at a time. When 802.11ac Wave 1 was launched, there had not been any improvements done to the SU-MIMO technology. Wave 2 saw these improvements come to light. Wave 2 802.11ac routers adopted MU-MIMO (Multi-User Multiple-Input Multiple-Output). Routers could now transmit information to multiple devices at the same time. The new technology only supported downlink (communication from the router to wireless devices) MU-MIMO, they could only transmit data to the client devices simultaneously. The information packets being sent to the wireless router (uplink) could only be sent one by one. This new technology improved speeds and supported more connected devices. Spatial Streams All routers and wireless devices have antennas, the number of antennas determines the number of spatial streams (data signals) that can be sent and received at the same time. Spatial streams are represented as 1x1, 2x2, 3x3, 4x4, etc. For example, a 2x2 spatial stream represents two antennas supporting two data streams. Both 802.11n and 802.11ac devices had this technology, the difference was the number of spatial streams they supported. WiFi 4 had a maximum of 4 spatial streams and the first wave of WiFi 5 had 3. How does spatial streaming work if they used Single-User MIMO and could only communicate with one client at a time? Mobile devices can support a certain number of streams. Many smartphones only support 1x1 spatial streams, some higher-end smartphones and laptops support 2x2 spatial streams, some computers support 3x3 spatial streams, and there aren't many devices that support 4x4 spatial streams. Let's say you have an 802.11n router with three antennas. This router has three spatial streams, and can only allocate them to one device at a time. If an iPhone (1x1) and a Mac (2x2) are requesting information at the same time, they will have to stand in line to receive it. The router will use one of its antennas to talk to the iPhone. After finishing with the phone, the router will use two of its antennas to talk to the Mac. Multiple spatial streams can be used to communicate with one client at a time, never with multiple devices. Your three-antenna router wasn't able to make use of its potential due to only being able to interact with one device at a time. To help improve the communication process and speeds, 802.11ac Wave 2 routers supported 4 spatial streams (later, up to 8). With the help of Multi-User MIMO, the clients requesting information did not have to wait in line. The router could allocate one antenna to the iPhone and two to the Mac at the same time. More information could be transmitted and received simultaneously. In addition, since the signal is being allocated more efficiently, power consumption is reduced which improves the battery life on the connected devices. Beamforming Before beamforming was used, the antennas on the routers would transmit signal in all directions. In a sense, this would cause the signal to go to waste because it was being transmitted into unnecessary areas. Therefore, the wireless signal had less range and was more susceptible to speed slowdowns and interferences. Beamforming is used to improve the wireless signal between the WiFi router and the connected devices. It focuses the signal (known as smart signal) in the direction of the connected devices rather than transmitting it into every direction. Beamforming helps improve the range, speed, and reduce interference. Beamforming technology existed when 802.11n was developed, but had not yet been standardized. There were numerous different beamforming versions available. In order for beamforming to work, the router and the clients needed to share the same beamforming technology. Unfortunately, with so many beamforming versions, not all WiFi 4 manufacturers implemented the same one. WiFi 5 standardized explicit beamforming. With the new standards, all manufacturers incorporated the same version. Both waves of WiFi 5 products support what's called "explicit" beamforming. More Data Transfer with 256-QAM Wireless devices use sound frequencies to communicate with each other. When a device transmits data via sound waves, it modulates the frequency of a specific radio channel. The sound wave is made up of bits of binary code (a series of 0s and 1s). The receiving device decodes the sound waves to understand what is being said. This is how all wireless internet data is transferred. For example, let's say you open Google. The transmitting signal modulates the frequency of your radio channel to communicate with the router. The router decodes the 0s and 1s to understand your request. After the information is gathered, the same process will send the information to your computer. When your computer decodes the 0s and 1s, the Google homepage will be displayed on your screen. This process is known as quadrature amplitude modulation (QAM). WiFi 4 used 64-QAM, meaning that devices sending information could only send 6 bits at a time. The QAM technology was improved for WiFi 5. WiFi 5 uses 256-QAM; it allows devices to send 8 bits of binary code at once. This upgrade improved WiFi speeds by 20% - 33%. Both 802.11ac waves supported 256-QAM. WiFi Frequency Bands As mentioned earlier, the two frequency bands used to send and receive information are 2.4 GHz and 5 GHz. WiFi 4 supported both frequency bands. However, WiFi 5 was developed to only use the 5GHz frequency. This would reduce the amount of interferences within the 2.4 GHz frequency. Signal interference is caused by multiple devices operating under the same frequency. There are a variety of devices that operate on the 2.4 GHz band - Bluetooth headsets, microwaves, baby monitors, home phones, etc. All of these clog up the band, slowing data. Most of us have experienced this. In order to use the 2.4 GHz band, WiFi 4 technology had to be incorporated into the development of WiFi 5. WiFi 5 devices using the 5GHz frequency can take full advantage of all the features offered by the new WiFi upgrade. But, WiFi 5 devices using the 2.4 GHz frequency can only tap into the WiFi 4 technology. Differences Between 802.11ac Wave 1 and Wave 2 The following chart is an overview of the two types of 802.11ac compatible products: 802.11ac Key Features: Wave 1 Wave 2 WiFi Channel Bandwidth 20, 40, and 80 MHz 20, 40, 80, 80+80, 160 MHz MIMO SU-MIMO MU-MIMO Spatial Streams 3 4 Beamforming Explicit Beamforming Only Explicit Beamforming Only QAM 256-QAM 256-QAM Frequency Bands 5 GHz 5 GHz For more information visit Cisco's white paper, 802.11ac: The Fifth Generation of WiFi. Difference Between 802.11ac and 802.11n The following chart is an overview of the differences between the 802.11ac and 802.11n standards: 802.11ac Key Features: 802.11ac 802.11n Theoretical Speed 1,300-2,300 Mbps 450 Mbps WiFi Channel Bandwidth 20, 40, 80, 80+80, 160 MHz 20, 40 MHz MIMO MU-MIMO SU-MIMO Spatial Streams Up to 8 Up to 4 Beamforming Explicit Beamforming Only Many Beamforming Versions QAM 256-QAM 64-QAM Frequency Bands 5GHz (2.4 GHz with 802.11n technology) 2.4 GHz and 5 GHz Is 802.11ac Backwards Compatible with Older WiFi Generations? Short answer: Yes. Backward compatibility is possible due to WiFi 5 using 802.11n technology to tap into the 2.4 GHz frequency. If WiFi 5 devices were only able to use the 5 GHz band, it would not be backward compatible with all previous WiFi generations. However, the speed at which the devices operate depends on which WiFi generation they are using. If you have a WiFi 5 computer connected to a WiFi 4 router, the computer can only operate at the speeds offered by the router. The same thing will happen if you have a WiFi 4 computer connected to a WiFi 5 router. To take advantage of everything WiFi 5 offers, all of the connected devices, and the router will need to have the 802.11ac standard built into them. How Much Area can WiFi 5 Cover? Coverage area varies based on the frequency band and WiFi blocking materials (walls, furniture, and building material). The 2.4 GHz frequency is able to travel farther and penetrate obstructions better than the 5 GHz frequency. Lifewire states that WiFi routers operating on the 2.4 GHz band can cover up to 150 feet indoors and 300 feet outdoors. Typically, the range will be 10 to 15 feet shorter when using the 5 GHz band. To improve on the range of the router, devices like WiFi extenders and mesh networks have been developed. WiFi extenders are wireless or wired gadgets that connect to the router and are plugged into a power source to extend the WiFi range. They should be placed in an area that is close enough to the router to get a strong signal, but far enough away to broadcast the signal into the needed areas. After the extender is connected, it's almost like having two access points. The extender will have its own network name (SSID) and its own password. When you move around your house, you will manually have to change your network connection between your router and the WiFi extender. They tend to work best in small homes and apartments. Mesh network systems are designed to blanket your entire home with WiFi coverage. They are made up of multiple mesh nodes that work together to extend the WiFi range. One node will be directly connected to the modem using an ethernet cable (fast ethernet or gigabit ethernet), and the other nodes will be stationed around your home. They create one large seamless wireless network. With a mesh network, you will only have one WiFi network name (SSID) and password. As you roam around your house, your phone will automatically connect to the node that is closest to it. Mesh systems tend to work best in medium to large homes, offices, and large buildings. What Devices Support WiFi 5? Since it's been a few years since WiFi 5 was released, most WiFi devices such as phones, tablets, computers, and router, have the 802.11ac chipsets implemented in their hardware. You can get wireless-ac routers and clients at your local electronic store, phone store, or directly from the manufactures (Apple, Samsung, ASUS, Netgear, etc). What Will Come After 802.11ac? WiFi standards are always evolving to improve the WLAN experience for all IoT (internet of things) devices. 802.11ax, or WiFi 6, is the next generation of WiFi. It builds on, and improves, the WiFi technology WiFi 5 offers - faster wireless speeds, high throughput, lower latency, and more bandwidth.

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