TECHNOLOGY BRIEF

What is Wi-Fi 6E?

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Even as Wi-Fi 6 deployments continue to ramp up, the industry is preparing for the biggest Wi-Fi upgrade to date—Wi-Fi 6E. Here, we provide the backstory, details and specifications you need to get up to speed on the new standard.

What is Wi-Fi 6E?

On April 23, 2020, the US Federal Communications Commission (FCC) voted unanimously to allocate 1,200 megahertz (MHz) of spectrum for unlicensed use in the 5.925-7.125 GHz (6 GHz) band. At the same time, the Wi-Fi Alliance decided to extend the Wi-Fi 6 standard (802.11ax) to include the new 6 GHz band. The result is Wi-Fi 6 extended or Wi-Fi 6E[1]. Wi-Fi 6E is significant in that it represents the first ever expansion of Wi-Fi spectrum. In 2018, the economic value provided by Wi-Fi was nearly $2 trillion, and is expected to grow to almost $3.5 trillion by 2023.[2]

Why Wi-Fi 6E is needed

Since its introduction in 1997, Wi-Fi's allotted 600 MHz of unrestricted spectrum in the 2.4 GHz and 5 GHz bands has neither changed nor grown. Yet, the amount of traffic it must carry has. Demand for Wi-Fi is rising exponentially. By 2022, it is expected to carry 51 percent of all IP traffic.[3] As next generation technologies like 5G and IoT come online, the current 600 MHz of bandwidth will become increasingly strained, exacerbating the following problems:

- **Congestion:** Like cars on a highway, Wi-Fi devices must share the same digital highway, with each waiting its turn to transmit and receive data. As the number of connected Wi-Fi devices grows by 22% each year,[4] the congestion can degrade performance in even the best Wi-Fi networks. Traffic overloading is especially problematic in high-density venues like auditoriums and lecture halls. It is also an issue in apartment complexes and other multi-dwelling units, where uncoordinated access points (APs) interfere with each other. Triband extenders (2.4/5Lo/5Hi) within Wi-Fi 5 may bring some relief but may also worsen the experience.[5]
- **Legacy bottlenecks:** A key to Wi-Fi's success, backward compatibility, is also a big disadvantage. To ensure interoperability, slower, 802.11b/g/n devices are prioritized equally with faster Wi-Fi 6 devices. But when slotted ahead of a faster device, a slower device impedes overall throughput.
- **Constrained channel width:** Theoretically, wider channels translate into faster speeds; so, the 80 MHz and 160 MHz channels supported under current Wi-Fi standards should offer higher throughputs. In reality, many of the channels are non-contiguous, limiting the wide-channel advantage and constraining throughput.

Benefits of Wi-Fi 6E

The additional spectrum allocated to Wi-Fi 6E will address many of the current challenges.

- **Less Congestion:** Current Wi-Fi offers 27 non-overlapping 20 MHz channels, while Wi-Fi 6E will offer 59 new 20 MHz channels. The added channels will alleviate many of the congestion challenges and enable better support for more connected devices and device types.
- **Higher Speed:** 1,200 MHz of contiguous spectrum enables channel bonding of 80 MHz (14 new channels), and even 160 MHz (7 new channels). This is good news for high-density venues like convention centers and auditoriums. In the home, Wi-Fi and Wi-Fi 6E will deliver speeds to complement the multi-gigabit speeds of the latest fiber and DOCSIS 3.1 networks. By combining multiple 20 MHz channels into one wider, higher-throughput 80 MHz or 160 MHz channel, existing Wi-Fi 6 clients can reach their maximum speeds without the limits of operating in smaller channel widths. Wi-Fi 6E can also support more wired replacement applications like wireless point-to-point and indoor mesh backbone links.
- **Lower Latency:** Wi-Fi 6E will only support OFDMA, MU-MIMO, 1024 QAM, and 6 GHz capable devices. All other legacy Wi-Fi devices will be limited to the 2.4 GHz and 5 GHz bands. Separating the traffic ensures the speed that ultra-latency sensitive applications such as AR/VR, gaming, and real-time imaging require. New APs are expected to provide backward compatibility to support Wi-Fi 6E and legacy bands with the device.

As a result, Wi-Fi 6E will enable delivery of the deterministic, low-latency, highly reliable quality of service (QoS) required for next-generation wireless applications.

	Wi-Fi 5	Wi-Fi 6	Wi-Fi 6E
Operating bands	5 GHz	2.4 GHz, 5 GHz	6 GHz
Modulation scheme	OFDM	OFDMA	OFDMA
MIMO streams	Up to 8x8	Up to 8x8	Up to 8x8
MU-MIMO	Downlink MU-MIMO	Downlink and Uplink-MU-MIMO	Downlink and Uplink-MU-MIMO
Channel width	20 MHz, 40 MHz, 80 MHz, 160 MHz	20 MHz, 40 MHz, 80 MHz, 160 MHz	20 MHz, 40 MHz, 80 MHz, 160 MHz
Highest modulation	256-QAM	1024-QAM	1024-QAM
Target Wake Time (TWT)	No	Yes	Yes
BSS Coloring	No	Yes	Yes

Table 1: Key differences between Wi-Fi 5, Wi-Fi 6, and Wi-Fi 6E

What are the rules governing 6E?

- **AP Decides:** Unlike current Wi-Fi, in which end-user devices make uncoordinated roaming decisions that can lead to poor connectivity, devices operating in the 6 GHz band must obey the operating rules of the AP which has better visibility to make these decisions.
- **Coordination Requirements:** The biggest change within Wi-Fi 6E is the new requirement to enforce frequency coordination among standard power APs via Automated Frequency Coordination (AFC). Wi-Fi AFC provides a list of frequencies where the AP can operate safely without interfering with other incumbents like

There will be two classes of APs—standard power and low power indoor—each has their own set of operating rules:

AP Class	Standard Power	Low-Power Indoor
Environment	Indoor/Outdoor	Indoor
Automated Frequency Coordination (AFC)	Required	Not Required
Max. EIRP (up to 320 MHz channel)	36 dBm	30 dBm
Operating Bands	U-NII 5 U-NII 7	U-NII 5 U-NII 6 U-NII 7 U-NII 8

Table 2: Wi-Fi 6E AP Types

fixed microwave operators. Standard-power APs must connect to a cloud AFC database and report their position. The AFC then assigns a specific operating channel for the AP.[6] AFC is not required for low-power indoor APs.

- **Uncoordinated Operations:** While low-power indoor APs may operate within the 6 GHz band without AFC control, they are restricted from having weather-resistant enclosures, external antennas and battery-only operation. Such restrictions prevent equipment manufacturers from creating U-NII 6 and U-NII 8 band-supported APs, causing potential interference problems for existing microwave wireless operators.
- **11ax required:** Only 802.11ax devices will be able to operate within the 6 GHz band. With no need to support legacy devices, Wi-Fi 6E can operate at its intended maximum efficiency, while legacy devices can use 2.4 GHz and 5 GHz as normal.

Where and when will Wi-Fi 6E be available?

Beyond the US, the EU, UK, Korea, Singapore, Japan, Brazil, Canada and Mexico are evaluating Wi-Fi's expansion into 6 GHz for unlicensed use. Chipset manufacturers[7] have already announced that new 6 GHz-capable, low-power indoor APs could be ready as early as Q4 2020. Standard-power APs for enterprise use are expected beginning around the latter half of 2021. The lag between the two release dates is due to the additional requirements for AFC.

Biggest upgrade in 20 years

Seen as the biggest change to Wi-Fi in 20 years, the tech industry is excited about Wi-Fi 6E and the future of this once-humble technology. Stay tuned to CommScope. We'll keep you informed as things continue to develop.

Key differences between Wi-Fi 6 and 6E

Compared to Wi-Fi 6, 6E is not a new technology. The difference is that it operates in the 6 GHz band instead of 2.4/5 GHz for Wi-Fi 6, and has more bandwidth—1.2 GHz vs 600 MHz. This makes Wi-Fi 6E functionally different in a few key ways:

- Wi-Fi 6E mandates OFDMA which enables a more stable device-to-network connection.
- Because Wi-Fi 6E has the 6 GHz band to itself, no legacy devices, it can support much faster speed and lower latency.
- Due to its higher frequency spectrum, Wi-Fi 6E has less range than Wi-Fi 6.

Endnotes

1 https://www.wi-fi.org/news-events/newsroom/wi-fi-alliance-brings-wi-fi-6-into-6-ghz

2 https://www.wi-fi.org/value-of-wi-fi

3 https://www.networkworld.com/article/3341099/wi-fi-6-5g-play-big-in-ciscos-mobile-forecast.html

4 https://www.nctatechnicalpapers.com/Paper/2019/2019-the-promise-of-wifi-in-the-6-ghz-band/download

5 http://dynamicspectrumalliance.org/wp-content/uploads/2019/03/DSA-Event-Handout_Final.pdf

6 https://www.qualcomm.com/news/releases/2020/02/25/qualcomm-highlights-technology-leadership-industry-readies-wi-fi-6e

7 https://www.broadcom.com/company/news/product-releases/52926

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