WiFi 6, 6E and 7
What Is It, How Does it Work, and the good, bad and ugly of it

Presented by Bob Primak
For The Lexington Computers and Technology Users Group (LCTG)
Wed., Dec. 10, 2025
At the Lexington, MA Community Center (LCC)

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Table provided by Gemini AI.

Generation	IEEE Standard	Adopted Year	Frequency Bands	Theoretical Max Speed	Upstream Speed
Wi-Fi 7	802.11be	2024	2.4 GHz, 5 GHz, 6 GHz	~46 Gbps	~46 Gbps
Wi-Fi 6E	802.11ax	2021	2.4 GHz, 5 GHz, 6 GHz	9.6 Gbps	9.6 Gbps
Wi-Fi 6	802.11ax	2019	2.4 GHz, 5 GHz	9.6 Gbps	9.6 Gbps
Wi-Fi 5	802.11ac	2013	5 GHz	~3.5 Gbps	~3.5 Gbps
Wi-Fi 4	802.11n	2009	2.4 GHz, 5 GHz	600 Mbps	600 Mbps
Wi-Fi 3	802.11g	2003	2.4 GHz	54 Mbps	54 Mbps
Wi-Fi 2	802.11a	1999	5 GHz	54 Mbps	~11 Mbps
Wi-Fi 1	802.11b	1999	2.4 GHz	11 Mbps	~2 Mbps

Note: The Wi-Fi Alliance introduced the simplified, consumer-friendly generation numbering system (Wi-Fi 4, 5, 6, etc.) starting in 2018, retroactively applying numbers to earlier standards. Wi-Fi 7 was officially launched in January 2024.

Note: These upstream speeds are not indicative of what an actual ISP will offer when connecting to the Internet. That is an entirely different question from the upstream speed possible within a WiFi local network (LAN).

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Intel infographic

Wi-Fi generations at a glance

	Wi-Fi 5 (802.11ac)	Wi-Fi 6 (802.11ax)	Wi-Fi 6E (802.11ax)	Wi-Fi 7 (802.11be)
Frequency	5 GHz	Dual-band (2.4 GHz, 5 GHz)	Tri-band (2.4, 5, **6 GHz**)	
Bandwidths (Channels)	20, 40 , 80, 80+80, 160 MHz			20, 40 , 80, 80+80, 160, **320 MHz**
Max data rate	~7 Gbps	~9.6 Gbps		**~36 Gbps***
Access (Multiplexing)	OFDM	OFDMA		
Modulation	254 QAM	1024 QAM		**4096 QAM**
Antenna	DL MU-MIMO (4 x 4)	DL + UL MU-MIMO (8 x 8)		
Security	WPA2	WPA3		**WPA3, including updates**
Key innovations	40 MHz mandatory	TWT, BSS coloring, Beamforming		**Multi Link Operation (MLO), Multi-RU, Puncturing, Deterministic Latency**

* Theoretical maximum data rates based on the latest draft of the IEEE 802.11be standard.
** ">5 Gbps Wi-Fi 7 2x2 client speed" - is based on the current draft of the 802.11be specification which specifies the theoretical maximum data rate for a 2x2 device that supports 320 MHz channels, 4096 QAM, and Multi-Link Operation is 5.76 Gbps. Based on an industry-standard assumption of 90% efficiency for new Wi-Fi products operating in the exclusive 6 GHz band, the resulting estimated maximum over the air 2x2 client speed would be 5.19 Gbps.

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Key WiFi Terms (See previous table)

OFDM (Orthogonal Frequency Division Multiplexing)

OFDMA (Orthogonal Frequency Division Multiple Access)

MU-MIMO (Multi-User Multiple Input, Multiple Output)

QAM (Quadrature Amplitude Modulation)

MLO (Multi-Link Operation) is part of WiFi 7 only.
(Time does not allow me to go into details about these technologies.)

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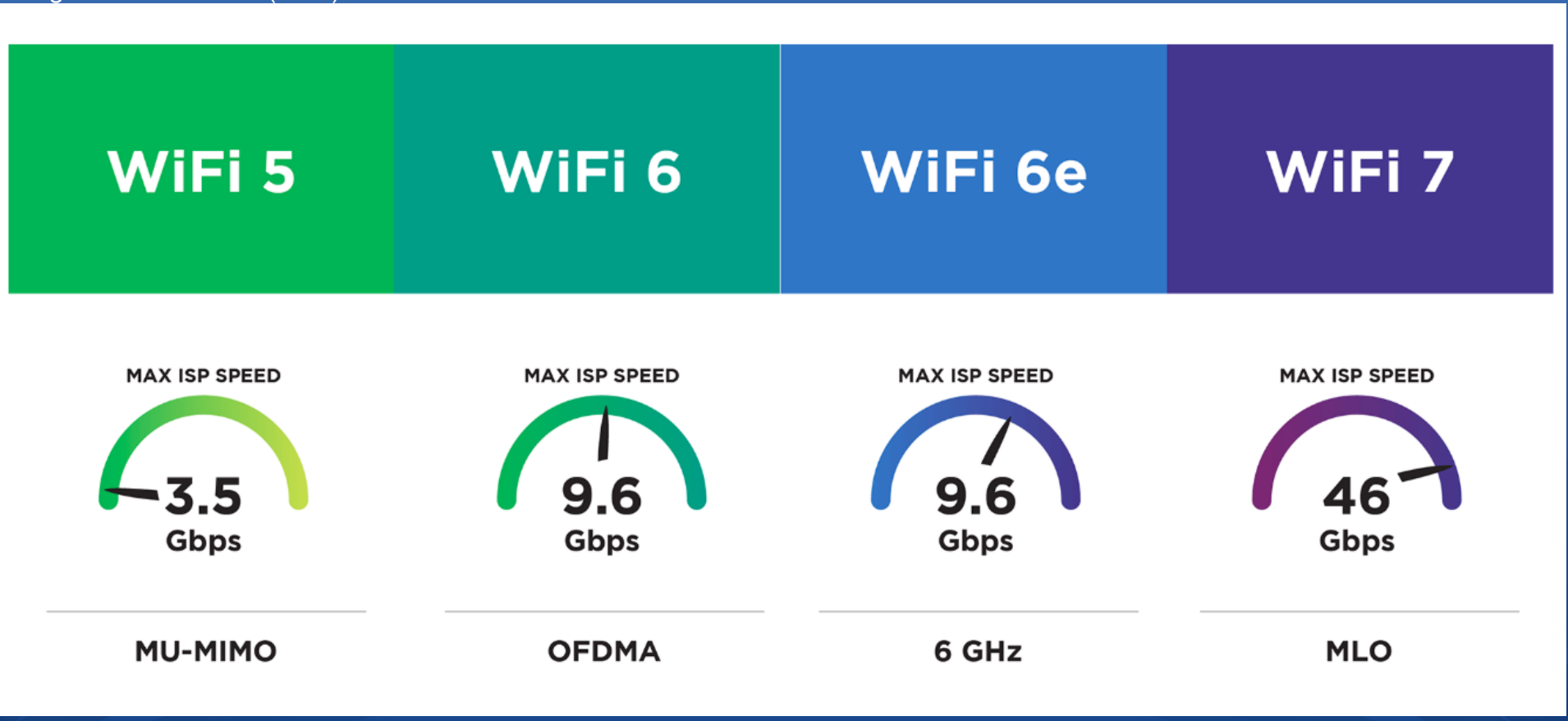
Image Credit: Astound (RCN) web site.



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Wireless security cheat sheet

ENCRYPTION STANDARD	FAST FACTS	HOW IT WORKS	SHOULD YOU USE IT?
Wired Equivalent Privacy (WEP)	First 802.11 security standard. Easily hacked due to its 24-bit initialization vector (IV) and weak authentication.	Uses RC4 stream cipher and 64- or 128-bit keys. Static master key must be manually entered into each device.	No
Wi-Fi Protected Access (WPA)	An interim standard to address major WEP flaws. Backward-compatible with WEP devices.	Retains use of RC4 but adds longer IVs and 256-bit keys. Each client gets new keys with TKIP. Enterprise mode: Stronger authentication via 802.1x and EAP.	No
WPA2	Upgraded hardware ensured advanced encryption didn't affect performance.	Replaces RC4 and TKIP with CCMP and AES algorithm for stronger authentication and encryption.	If WPA3 is not available
WPA3	Current standard. New authentication method helps thwart KRACK and offline dictionary attacks.	Replaces PSK four-way handshake with SAE. Enterprise mode has optional 192-bit encryption and a 48-bit IV.	Yes

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Equipment for WiFi

Gateway or Modem plus Router

I won't deal with separate modems, as the landscape is changing rapidly for these devices.

DOCSIS is a standard which determines (among other things) your cable modem's security and speed limits. DOCSIS only applies to Cable Modems, not to Fiber Optic systems.

Let's look at the DOCSIS standards in use now, then the gateways I am familiar with (Comcast's Xfinity/xFi series).

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DOCSIS Generations (per Brian Livingston, AskWoody Newsletter, Dec. 8, 2025.)

Year introduced	Name	Throughput (theoretical)	Main Features
1997	DOCSIS 1.0	40Mbps down 10Mbps up	Standardized downstream speeds Used coax cable
1999	DOCSIS 1.1	40Mbps down 10Mbps up	Voice over IP 56-bit DES encryption
2001	DOCSIS 2.0	40Mbps down 30Mbps up	increased upstream data rates
2006	DOCSIS 3.0	1Gbps down 200Mbps up	strong 128-bit AES encryption
2013	DOCSIS 3.1	10Gbps down 1Gbps up	requires AES (ending weak DES)
2020	DOCSIS 4.0	10Gbps down 6Gbps up Symmetrical down/up	Extended Spectrum Spectrum Flexibility Symmetry Focus

Brian goes on to explain how and why your ISP provided original Gateway is likely out of date and isn't getting timely security patches (firmware updates).

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DOCSIS 3.0, 3.1 and 4.0 specifications

(Cnet:) https://www.cnet.com/home/internet/comparing-modems-docsis-3-0-vs-docsis-3-1-vs-docsis-4-0/

Device	Max download speed	Max upload speed	Price range	Specification issued
DOCSIS 3.0	1Gbps	100Mbps	$50-$150	2006
DOCSIS 3.1	10Gbps	1Gbps	$150-$250	2013
DOCSIS 4.0	10Gbps	6Gbps	N/A	2019

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How much speed do you need? (Brian Livingston, AskWoody Newsletter, Dec. 8, 2025)

Consider how little downstream bandwidth some popular Internet services really suck up:

- Standard-definition video (480p): 3 Mbps per stream
- High-definition video (720p/1080p): 5Mbps per stream, peaking at 10Mbps
- 4K/ultra-high-definition video: 15Mbps to 25Mbps from Netflix and similar services
- “High-quality” videoconferencing (480p): 1Mbps to 2Mbps for Zoom et al.
- High-definition videoconferencing (1080p): 3Mbps to 4Mbps
- Group high-definition videoconferencing: 3Mbps per participant
- Multiplayer gaming: 3Mbps to 8Mbps per gaming device
- “Premium experience” gaming: 15Mbps to 25Mbps, if there’s voice traffic
- Music streaming: 0.3Mbps to 1Mbps at various tiers of Spotify and others

Only if your location engages in super-competitive gaming — or you have a handful of heavy “influencers” who constantly upload videos to social media — do you need more than the estimates shown [here].

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DOCSIS 3.0 vs. 3.1 vs. 4.0: What are the differences?

(Cnet:) https://www.cnet.com/home/internet/comparing-modems-docsis-3-0-vs-docsis-3-1-vs-docsis-4-0/

DOCSIS 3.1 modem advantages

- Speed: DOCSIS 3.1 cable modems support faster speeds than DOCSIS 3.0 modems and are thus better suited for high-speed plans, especially those with gig speeds or higher.
- Security: DOCSIS 3.1 modems may offer better online security than 3.0 models, especially if you purchase a modem-router combo device.

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DOCSIS 3.0 vs. 3.1 vs. 4.0: What are the differences?

(Cnet:) https://www.cnet.com/home/internet/comparing-modems-docsis-3-0-vs-docsis-3-1-vs-docsis-4-0/

DOCSIS 4.0 modem advantages

- Upload speeds: DOCSIS 4.0 is designed to "significantly increase upstream capacity," according to CableLabs, the organization that sets and tests DOCSIS specifications.
- Future proof: DOCSIS 3.1 is the current standard, but 3.0 is still in use, nearly two decades after its introduction in 2006. It’s safe to assume that 4.0 modems will be useful for many years to come.

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Equipment: Modem, in this case, Gateway:

Comcast/Xfinity/Xfi Gateways:

Xfinity Wireless Gateway (Original Version, WiFi 5 generation)

The Xfinity Wireless Gateway offers the speed, coverage, WiFi management tools, parental controls and Xfinity WiFi Extender (excluding DPC3939) for extended coverage.

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Model XB3

Dual-band WiFi option: Yes

2.4 GHz connected client limit: 30

5 GHz connected client limit: 30

Maximum data throughput: 600 Mbps

Does not support WPA 3 or WiFi 6

DOCSIS Version may be out of date

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XB6, current base model

- Dual-band WiFi option: Yes
  - 2.4 GHz connected client limit: 30
  - 5 GHz connected client limit: 75
  - Maximum data throughput: 1 Gbps
- Not capable of WPA 3
- DOCSIS version is current
- Basically, a good WiFi 5 gateway

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XB7 model: Upgrade but being phased out

- Dual-band WiFi option: Yes
  - 2.4 GHz connected client limit: 75
  - 5 GHz connected client limit: 75
  - Maximum data throughput: 2.5 Gbps
- Otherwise similar to XB6
- A slightly better WiFi 5 gateway

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XB8 My Choice. Upgrade for WiFi 6 and 6E

Tri-band WiFi option: Yes

2.4 GHz connected client limit: 100

5 GHz connected client Limit: 100

6 GHz connected client limit: 100

Maximum data throughput: 2.5 Gbps

WPA 3 capable

Still supports major features of VOIP phone line, including battery backup.

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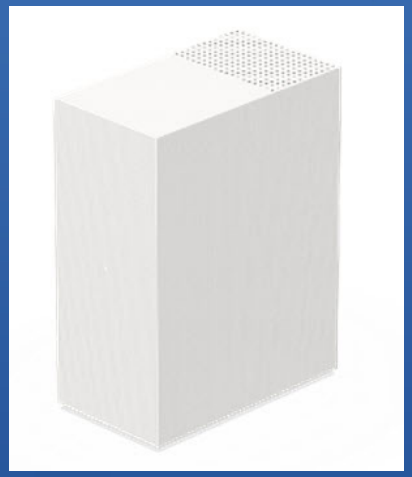

XB10 A leap forward, but beyond my needs

Tri-band WiFi option: Yes

2.4 GHz connected client limit: 100

5 GHz connected client limit: 100

6 GHz connected client limit: 100

Maximum data throughput: 10 Gbps

Supports all WiFi 7 features

Moves from landline VOIP phone to in home cellular hotspot. Uses 5G Cell service.

Comcast requires their mobile services plan. Not cheap when used this way

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XER10 Future WiFi gateway

Only available where there's fiber to the home

1 Gb Ethernet ports: 3

10 Gb Ethernet ports:

2 (1 WAN & 1 LAN)

Tri-band WiFi option: Yes

2.4 GHz connected client limit: 100

5 GHz connected client limit: 100

6 GHz connected client limit: 100

Maximum data throughput: 10 Gbps

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XB10 and XER10 are the only ones which have DOCSIS 4.0 now.

My choice (XB8) has DOCSIS 3.1.

It is WPA 3 and WiFi 6E capable.

The speed I have on my plan (Internet) is 1 Gbps.

Network speed depends on a lot of other factors.

Fast enough for Zoom meetings and all my online activities, including streaming video.

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The upgrade from the base model (XB6) was free with current equipment return.

Now on to the final piece of a WiFi upgrade:

WiFi cards and dongles

Individual PCs, other devices on your network and a host of other factors will influence your own choices.

I had to consider my extensive use of Linux, while some people will need to consider Windows 10, which does not support WiFi 6E or the 6 GHz band. I run Windows 11 Pro.

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My choices are based on my own WiFi environment

(institutional, crowded 2.4 and 5 GHz bands)

What I had:

Comcast Xfinity Xfi Gateway (XB 6)

(See above for details)

Computer #1: Intel NUC mini-PC, 11th Gen Intel Core-i5

Intel NUC 11 (PAKi5) 11th Gen Intel Core i5-1135G7 with Iris Xe Graphics

- 16 GB RAM
- AX-200 WiFi card
- Can handle WiFi 6, WPA 3, 2.4 GHz and 5 GHz bands
- Limited MU-MIMO capabilities

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What I had: (continued)

Computer #2: Powerspec (Micro Center) model B685 Tower

- Motherboard: ASUS PRIME H610M-E D4
- Intel 12th Gen Core-i5 processor with Intel Iris XE Graphics
- 16 GB RAM
- Qualcomm Atheros QCA6174 802.11ac Wireless Network Adapter
- WiFi 5 capable, not WiFi 6 capable, 2.4 GHz and 5 GHz bands
- Limited MU-MIMO capabilities

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My Upgrades:

Comcast Xfinity Xfi Gateway (XB 8)

(See above for details)

Qualcomm WiFi Card to internal WiFi Card

- This upgrade worked with Windows 11 Pro, but not with LMDE Linux. I could not find a driver for the upgraded card. At that point I looked only at cards or USB dongles which have known Linux compatibility.
- Your choice of WiFi card upgrades or WiFi dongles depends on your hardware, your operating system(s) and other factors.

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What did work:

Powerspec and NUC upgrades to a USB 3.0/3.1 dongle:

Due to my Linux experience, I went with a

Netgear Nighthawk A 8000 USB 3.0/3.1 dongle

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Dongle Specs: Netgear AXE3000 USB 3.0 WiFi Adapter (A8000)

Linux compatible, where the OS actually will support the WiFi 6/6E features.

Windows 11 but not Windows 10 compatible.

WPA 2 and WPA 3 supported.

2.4 GHz, 5 GHz and 6 GHz bands supported.

Not meant for MU-MIMO or multichannel enhancements.

Fits my needs in my apartment.

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Cost for both PCs:

(Best Buy Burlington, MA pricing)

$73.00 (tax included) x 2 = $146.00 for 2 PCs.

This was actually my main expense in upgrading my network.

The rest of the “cost” was in reconfiguring my computers and creating new WiFi profiles.

I also had to learn how to manage 2 WiFi devices on each PC.

Windows 11 makes this fairly straightforward, but in Linux, configuration is much more DIY.

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So how did it all go?

I am happy with the upgrades. I don't do anything which maxes out my Internet speed at the gateway, and I don't tax the capacity of my in-home network. So I can't put a value of any stress-testing of the new standards.

I can say that for Zoom meetings, the video rendering is flawless now (and it wasn't bad before). And I haven't had issues with slowness, choppy transmissions or poor quality meeting experiences. No crashes which could be attributed to the dongles, the gateway or my Comcast services.

The cost was not super-cheap, but very affordable. I think so far, I have gotten good value for my investment for two reasons:

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Reason 1:

The 6 GHz channels have little or no interference or channel competition so far. By far most of my neighbors at Brookhaven at Lexington have not upgraded to WiFi 6, so I'm pretty much in the clear for now. Microwave and electric/electronics interference, which can be an issue in the 5 GHz band, are not an issue in the 6 GHz band. I have no problem getting the signal through one interior wall, between my dongles and my gateway. YMMV, depending on building materials and any wiring, ductwork, etc. inside your walls.

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Reason 2:

I like the added security of WPA 3. I specify it for all my Internet connections except my phone and my converted Linux-powered Chromebook now. In the 6 GHz band, I can turn off WPA and WPA 2 at the gateway for better security. (But I don't usually do this.) I can't report on MU-MIMO or multichannel features, as I don't actively try to use them.

So, what does everyone think of WiFi 6, 6E and 7 so far?

Anyone thinking of upgrading? Why? Or, Why Not?

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Corrections and updates, Wed., Dec. 10, 2025

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