










Wi-Fi HaLow

Sub-GHz Wi-Fi

IEEE 802.11ah offering long range, low power, high data rate and high node count for next-generation IoT applications

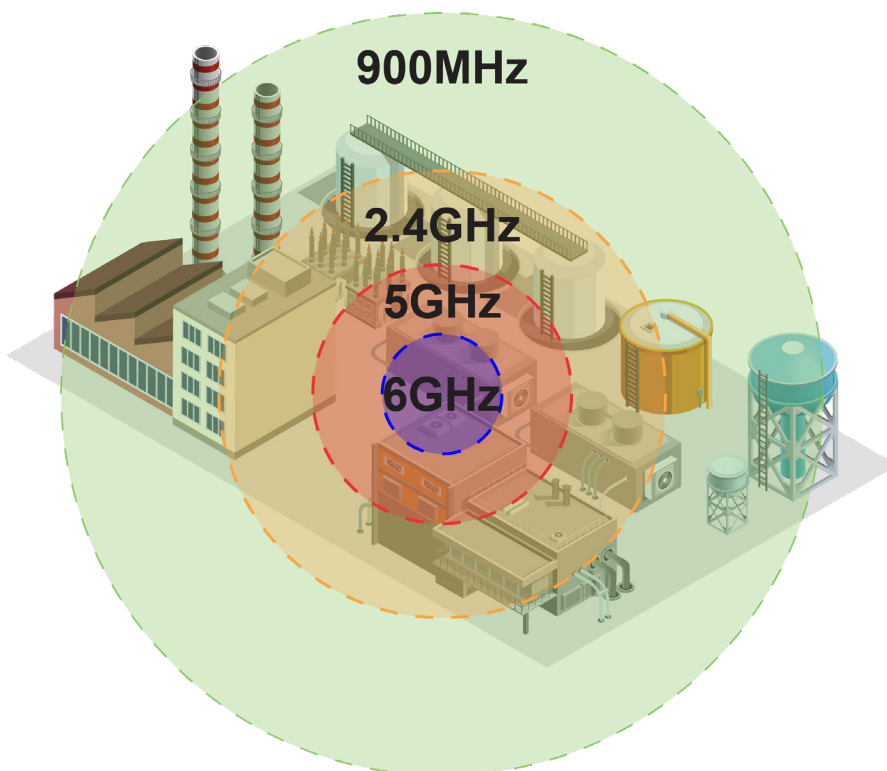
As traditional Wi-Fi has progressed from 5 to 6 and now to 7, it has gone higher in frequency and bandwidth to get higher and higher data throughput. Wi-Fi HaLow has done the opposite and gone lower in frequency and data throughput to get better range.

Wi-Fi CERTIFIED HaLow™ for IoT	
Features	Benefits
 Sub-1 GHz spectrum operation	 Long range: approximately 1 km
 Narrow band OFDM channels	 Penetration through walls and other obstacles
 Several device power saving modes	 Supports coin cell battery devices for months or years
 Native IP support	 No need for proprietary hubs or gateways
 Latest Wi-Fi® security	

Source: Wi-Fi Alliance®

The 802.11ah specification or Wi-Fi HaLow, was released by the Wi-Fi Alliance in 2017. It is best described as “sub-GHz long-range Wi-Fi”. It takes the features that have made Wi-Fi one of the most successful wireless protocols and brings it into lower frequency bands. It fills a gap by offering much better range than Bluetooth and IEEE 802.15.4 radios and much better data throughput than protocols like ZigBee, Thread, and LoRa. This allows it to offer several distinct advantages.

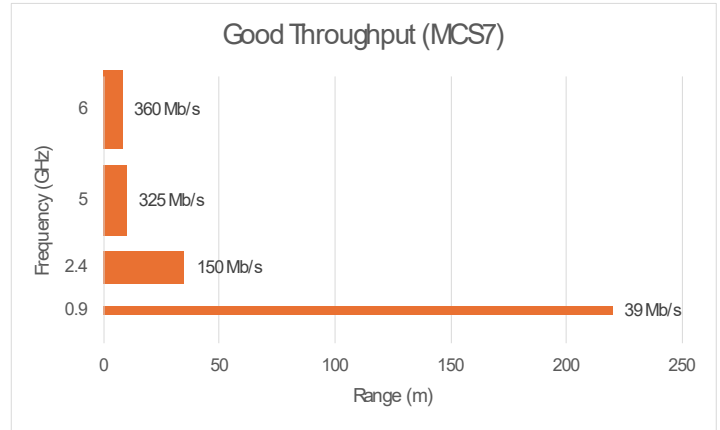
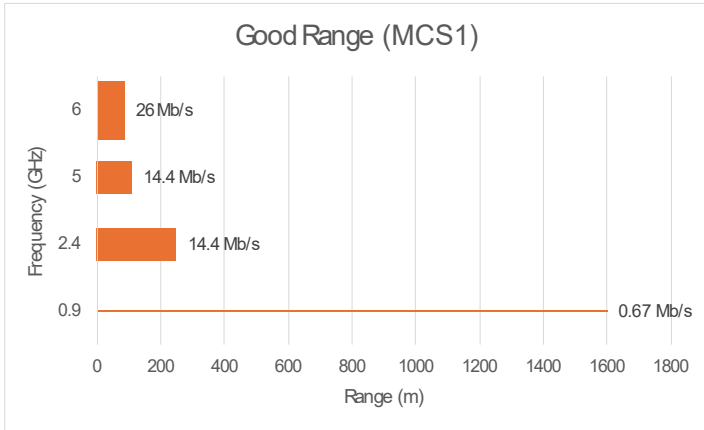
Range – Lower frequencies offer better range and signal penetration through obstructions in the environment. By moving into the 800MHz and 900MHz bands, HaLow offers more than twice the range of traditional 2.4GHz systems as well as newer 5GHz and 6GHz systems.



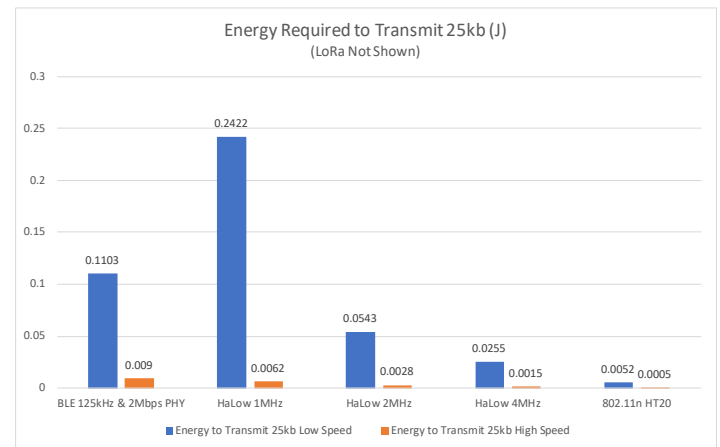
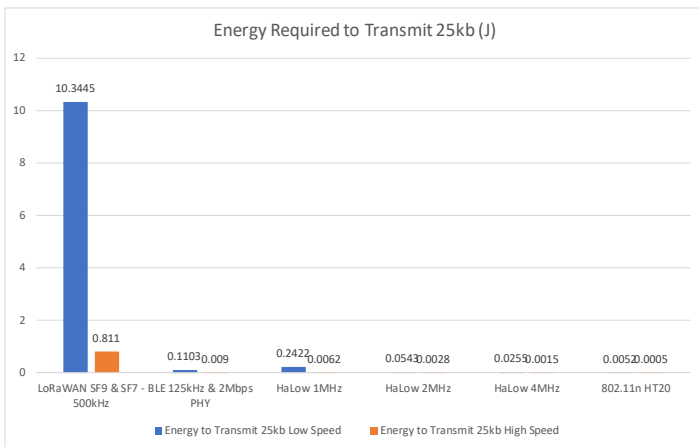
Scalability – HaLow can support over 8,000 nodes and has been tested at over 1,000 nodes on one Access Point. Most IoT systems can intelligently manage 250 to 350 nodes in a single network.

Security – Wi-Fi has led advances in security over the years and HaLow benefits from this experience. Wi-Fi HaLow uses WPA3 and Wi-Fi Enhanced Open, the highest level of security developed for the latest Wi-Fi generation.

Data Throughput – The first-generation Wi-Fi HaLow chipsets can push data at almost 40Mbps, which is significantly faster than protocols like Bluetooth, ZigBee, Thread, and LoRa. While this is lower than other Wi-Fi standards, HaLow achieves longer range and better signal penetration than the other Wi-Fi standards. The graphs below compare HaLow (802.11ah) to Wi-Fi 5 (802.11ac), Wi-Fi 6 and 6E (802.11ax) and Wi-Fi 7 (802.11be) frequency, range, and data throughput.

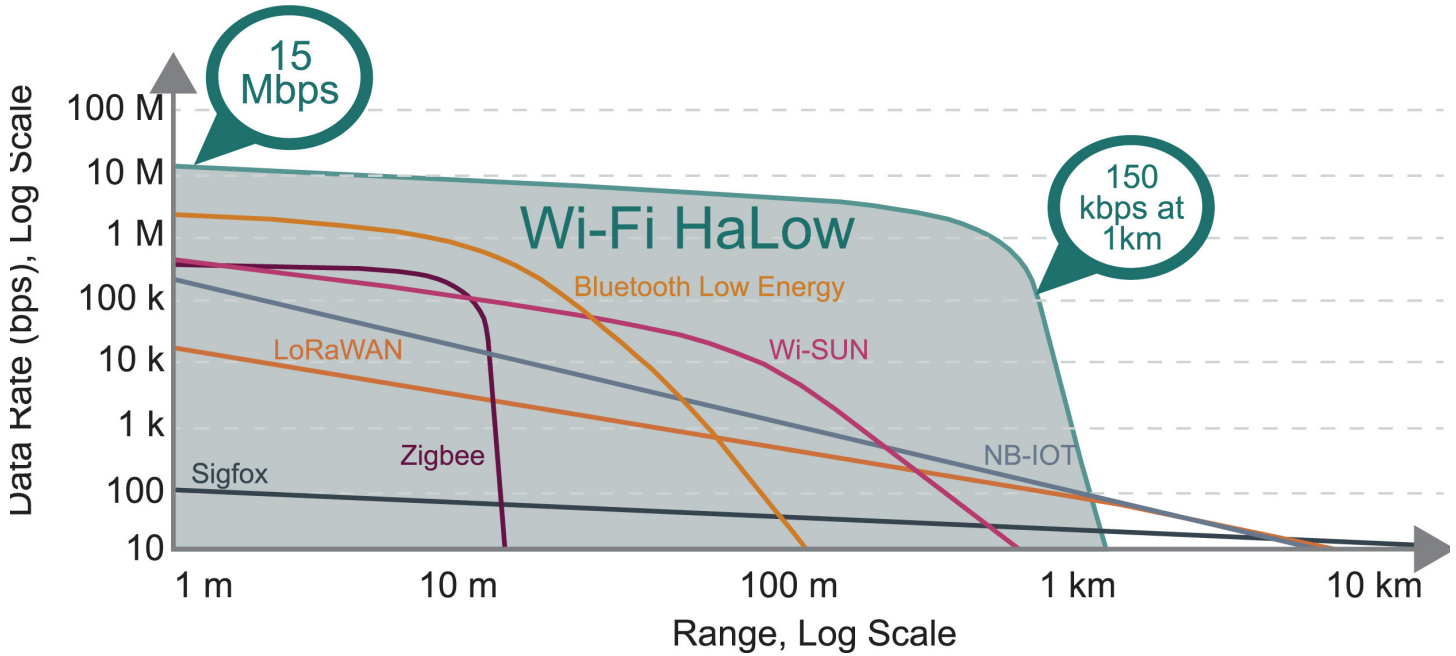


Power Consumption – Power is critical in battery powered IoT products. The peak power of Wi-Fi HaLow is higher than other radios, but because its throughput is much higher, its total on time is much shorter. This puts HaLow's power per bit efficiency higher than any of the other popular IoT protocols. Add into that new Wi-Fi features like Targeted Wake Time (TWT) and Restricted Access Window (RAW) and nodes can sleep for as long as months without being disassociated from the network. This lets them sleep for much longer periods, conserving battery power.



IoT Radio Comparison

Traditionally, Wi-Fi has not had a large share of the IoT market due to the high power requirements. HaLow changes that. It offers higher data throughput at a longer range than the most common IoT radio solutions while including low-power features. See the comparisons below.

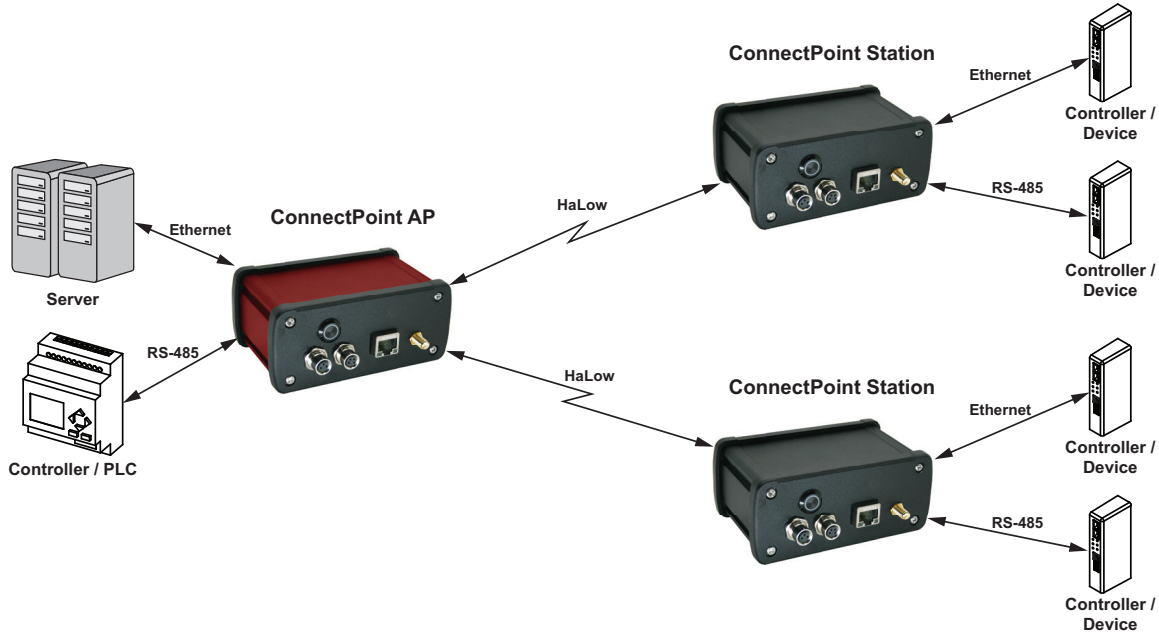


Attributes	Wi-Fi HaLow	Bluetooth Low Energy	Z-Wave	Zigbee	Thread	Wi-SUN	Sigfox	LoRaWAN	CAT-M1	NB-IoT
Frequency	Sub-1 GHz	2.4 GHz	Sub-1 GHz	2.4 GHz / Sub-1 GHz	2.4 GHz	Sub-1 GHz	Sub-1 GHz	Sub-1 GHz	Licensed	Licensed
Data rate (bps)	150 k – 86.7 M	125 k – 2 M	9.6 k – 100 k	250 k	250 k	6.25 k – 800 k	100 or 600	300 – 27 k	588 k – 1,119 k	20 k – 127 k
Range (m)	> 1 k	< 100	< 30	< 20	< 20	< 1 k	< 40 k	< 10 k	< 10 k	< 10 k
Modulation	OFDM over BPSK, QPSK, 16/64/256 QAM	GFSK	GFSK	BPAK/ OQPSK	BPAK/ OQPSK	MR-FSK / MR-OFDM / MR-OQPSK	DBPSK/ GFSK	CSS	QPSK	QPSK
Battery life	Years	Years	Years	Years	Years	Years	Years	Years	Years	Years
Security	WPA3™	128-bit AES in CCMMode	Security 2 (S2)	128-bit AES in CCMMode	EC-JPAKE	IEEE 802.1X	Session-level security	128-bit AES in CCMMode	3GPP security	3GPP security
OTA firmware updates	Supports	Supports	-	Supports	Supports	-	-	-	Supports	-
Subscription required	No	No	No	No	No	No	Yes	Yes	Yes	Yes
TCP/IP (internet)	Supports	-	-	-	Supports, 6LowPAN	-	-	-	Supports	-
Network topology	Star / Relays	P2P / Mesh	Mesh	Mesh	Mesh	Mesh	Star	Star	Star	Star
Open standard	IEEE 802.11ah	Bluetooth SIG	Proprietary	IEEE 802.15.4	IEEE 802.15.4	IEEE 802.15.4g	Proprietary	Proprietary	3GPP LTE Cat-M1	3GPP LTE Cat-B



ConnectPoint Products

ConnectPoint products create a Wi-Fi HaLow to Ethernet and RS-485 bridge. They extend and replace communications cables with a long-range wireless link. They use Wi-Fi HaLow to extend Ethernet and RS-485 networks up to 1 mile (depending on data rate and antennas). This eliminates the cost of running cables over long distances or to hard-to-reach locations. Communication is local, with no cloud connectivity or recurring charges.



The Nexus System

The Nexus System consists of a central industrial cellular gateway and a variety of nodes connected over a long-range Wi-Fi HaLow network. The number and variety of nodes can be selected to suit the application, making the system highly flexible. The gateway communicates with cloud servers over a CAT-1 cellular modem with plenty of bandwidth for live monitoring.

