Wi-Fi HaLow™:

Wi-Fi® for IoT applications

May 2020

Executive summary

Wi-Fi®, one of the most successful innovations of the high-technology era, enables a vast number of wireless connectivity uses. Carrying more than half of all internet traffic and shipping in nearly every mobile device type, it has replaced many wired local area networks (LANs) that use structured cabling in homes and businesses, and has given mobile service providers a reliable means to handle mobile network traffic. Wi-Fi leverages its inherent strengths to meet most connectivity uses, from standard computing to bandwidth intensive applications. However, Wi-Fi is capable of even more and has advanced to meet a wide array of Internet of Things (IoT) use cases with Wi-Fi HaLow™.

Wi-Fi HaLow builds upon Wi-Fi success, operating in the sub-1 gigahertz (GHz)[1] frequency band. Wi-Fi HaLow in sub-1 GHz provides long range, low power connectivity to handle challenging Wi-Fi environments, including those with obstructions such as walls. Wi-Fi HaLow can both match and improve upon many other IoT radio technology capabilities.

The IoT market is very broad, covering individual devices such as home appliances, thermostats, and surveillance cameras, to large factory sensor networks. IoT has its own set of requirements: very low power, longer range connections, penetration through building materials and other obstructions, and support for a greater number of client devices per access point (AP). To support these specific needs, Wi-Fi Alliance® introduced Wi-Fi HaLow. Based on the Institute of Electrical and Electronic Engineers (IEEE) 802.11ah standard, Wi-Fi HaLow augments existing Wi-Fi capability. By operating in the sub 1-GHz spectrum frequency band, Wi-Fi HaLow delivers the longer range connectivity and device energy savings required by many IoT applications, along with the latest security mechanisms available. The IEEE 802.11ah standard defines data rates for single stream devices ranging from 150 kilobits per second (kbps) to over 86 megabits per second (Mbps), making Wi-Fi HaLow uniquely equipped to meet the requirements for many IoT applications in a wide variety of environments.

Beyond increasing coverage, Wi-Fi HaLow provides the security, ease of use, and modulation techniques required to ensure reliable transmission rates. It uses spectrum more efficiently than competing IoT technologies, and its native internet protocol (IP) support streamlines data collection and analysis for IoT applications across a wide variety of use cases without requiring proprietary gateways. Because Wi-Fi HaLow is the first Wi-Fi technology to operate in the sub-1 GHz band, there are no backward compatibility requirements for Wi-Fi HaLow devices, which simplifies integrated circuit (IC) implementations for cost-sensitive sensor devices.

This paper discusses how Wi-Fi HaLow fits into the Wi-Fi portfolio and its ability to meet IoT connectivity requirements. It also addresses how other IoT technology options compare to Wi-Fi HaLow and provides an overview of use cases where Wi-Fi HaLow is the best connectivity choice. Readers will learn about Wi-Fi HaLow as a premier solution for a variety of IoT deployments.

Wi-Fi HaLow key benefits

- Long range: 1 kilometer (km)
- Robust connection in challenging environments; penetration through walls
- Significant battery power savings
- Streamlined access to internet and cloud-based applications: no need for proprietary hubs or gateways
- Latest Wi-Fi security protections

Wi-Fi HaLow key features

- Sub-1 GHz operation
- Narrow band OFDM channels
- Supports data rates from 150 kbps to 86.7 Mbps[2]
- Several power-saving modes
- Native IP support
- Wi-Fi CERTIFIED WPA3™ and Wi-Fi CERTIFIED Enhanced Open™ security

[1] Sub-1 GHz is defined as operation in frequency bands under 1 GHz, such as 902-928 MHz in the United States; actual frequencies vary by location

[2] 86.7 Mbps is possible using MCS 9, with 16 MHz channels and short guard intervals; results vary based on regulatory requirements and vendor implementation

Wi-Fi HaLow brings Wi-Fi to sub-1 GHz spectrum

Wi-Fi HaLow meets the IoT community's unique needs while providing the security and IP support that make Wi-Fi the trusted, ubiquitous, easy-to-use platform it is known to be.

No single technology can optimally meet the needs of every connectivity scenario. There are a variety of technology options available, each with its own benefits: wired connectivity may ensure fast transmission speeds, but users must bear the cost of installing wiring and sacrifice flexibility; other wireless technologies may provide reliable short range wireless communication, but signal quality fades prior to 100 meters; cellular technology provides long range coverage, but is expensive to deploy and maintain. While no technology will likely ever become the ultimate technology used for every situation, Wi-Fi HaLow capability in the sub-1 GHz frequency band allows Wi-Fi to meet more connectivity needs, including IoT uses in a variety of deployment scenarios.

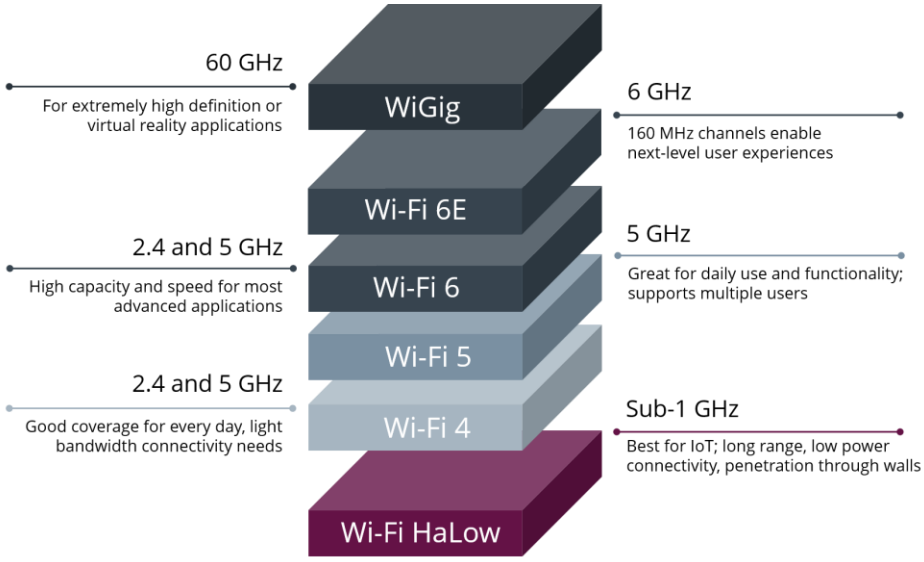

Figure 1. Wi-Fi spans several frequency bands and meets a variety of connectivity challenges.

Wi-Fi offers solutions to more coverage needs

Wi-Fi HaLow adds long range, low power connectivity ideal in IoT environments to the Wi-Fi portfolio. Sub-1 GHz operation and narrow band channels enable Wi-Fi HaLow to reach farther than other Wi-Fi versions—as well as many other IoT technology options—including better penetration through walls and other obstructions. Wi-Fi networks can be designed to leverage Wi-Fi in multiple frequency bands without the need for alternate radio technologies, which require special equipment or subscription-based solutions in licensed cellular bands. This flexibility makes Wi-Fi a prime solution for more coverage needs.

Figure 2 presents one example of how the Wi-Fi portfolio can meet coverage needs, showing Wi-Fi sample uses at a 6 Mbps data rate[3]. This rate is typically sufficient to operate smartphone applications, light and moderate web-based PC applications, and compressed video streaming applications. The image shows the Wi-Fi network

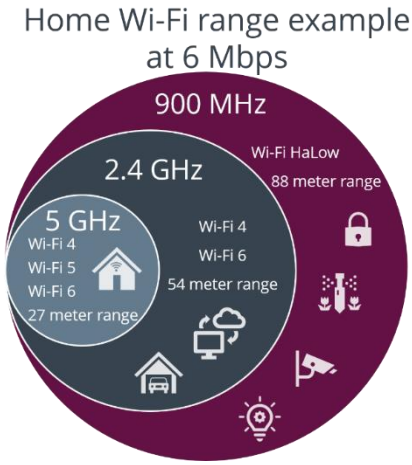

Figure 2. Wi-Fi coverage example at 6 Mbps shows how Wi-Fi HaLow significantly extends Wi-Fi range.

[3] *The U.S. has 26 MHz spectrum in 900 MHz available. Simulation assumptions: Minimum QoS 5 Mbps, Retail AP, 21 dBm/Tx chain Tx power, Indoor to outdoor (d^4) channel model, which is based on measurements conducted by Qualcomm. (Channel model has a slightly higher exponent comparing to the IEEE D NLOS path loss model.)*

coverage extension specific to a home environment. The low frequency and narrow band operation employed by Wi-Fi HaLow can enable lower data rate IoT connections at a one kilometer distance from an AP, depending on the transmit power allowed by the regulatory agency where the products operate. This enables
Wi-Fi HaLow to work well in not only home environments, but in agricultural and industrial environments as well.

Wi-Fi networks can be designed to leverage Wi-Fi in multiple frequency bands without the need for alternate radio technologies

Wi-Fi HaLow meets the broad and unique IoT requirements

Though the IoT market involves devices and solutions from smartwatches to home appliances, climate control systems, and remote sensors for industrial and agricultural environments, there are common requirements that span IoT applications: technical, wireless network operation, and customer adoption requirements.

Figure 3. Wi-Fi HaLow range is approximately one kilometer, a benefit to industrial and agricultural environments, logistics and transportation, smart city use cases, and more.

Technical requirements

Low power consumption

To enable battery-operated device usage, including devices that operate using coin-sized batteries, the wireless technology must offer options for low power and high energy efficiency. Wi-Fi HaLow operates using radio frequency signals of below 1 GHz to reach farther distances while using less transmit power than 2.4 GHz or 5 GHz technologies. Wi-Fi HaLow also implements new sleep and management modes to provide energy efficient, multi-year battery operation similar to—and in some cases better than—other IoT technology options.

Long range and robustness

IoT networks require effective range and robustness in a variety of environments. Wi-Fi HaLow uses a combination of sub-1 GHz radio frequency spectrum band and narrow band channels to provide ranges greater than one kilometer. Its range is greater than other personal area network (PAN) and wireless local area network (WLAN) technologies. Wi-Fi HaLow also penetrates through building materials better than 2.4 GHz radio frequency IoT technology options.

IP networking capability

IP networking capability is crucial to implementing effective IoT solutions. Devices and sensor networks may need to connect to the cloud for software upgrades and other IoT application management functions. Wi-Fi HaLow excels in this area when compared to other IoT technology options. Because Wi-Fi HaLow is Wi-Fi, it provides additional connectivity with native IP support—no proprietary gateways are needed, as is the case with many alternative technologies.

Data rates

Adequate data rates are required to satisfy many IoT applications. Some IoT devices need the ability to process tiny data packets occasionally and others need constant monitoring, using more data. Wi-Fi HaLow has a wide range of data rate capability, as low as 150 kbps and up to 86.7 Mbps[4], depending upon vendor implementation.

Security and privacy

Wi-Fi HaLow is underpinned by state-of-the-art security protocols, including Wi-Fi CERTIFIED WPA3™ and Wi-Fi CERTIFIED Enhanced Open™. These protocols encrypt potentially valuable and confidential data sent over the airwaves between IoT devices and the AP. Wi-Fi HaLow also offers higher data rates than other IoT technology options, providing headroom for additional security layers for tunneled IP traffic with trusted platforms in the cloud.

Wireless network operation requirements

Device variety

IoT devices come in a variety of shapes and sizes, with vastly different purposes. The communications solution should accommodate varied device types, usages, and throughput expectations. Wi-Fi HaLow is standards-based, meaning it enables efficient coexistence for a wide range of devices—from low data rate door locks to high definition video security cameras. Wi-Fi HaLow also provides higher data rates and network capacity than other PAN and wireless wide area network (WAN) IoT technologies.

Cost effectiveness

Operating and maintaining an IoT network environment should be cost effective. Just like other Wi-Fi versions, Wi-Fi HaLow operates in unlicensed spectrum without the added burden of monthly subscription fees or cellular carrier data plans. It enables individuals and businesses to use their own infrastructure in private, controlled networks. Wi-Fi HaLow also reduces the hardware costs of devices that would otherwise require multiple radios. For example, a device using LoRaWAN for long-distance connections at very low data rates might require a second radio utilizing another technology, such as Wi-Fi, to provide occasional firmware updates. A single Wi-Fi HaLow connection can accomplish both goals.

Network integration

Simple network integration is key to operating a streamlined IoT environment. Wi-Fi HaLow is easy to integrate with existing networking infrastructures because there is no need for protocol conversion boxes or gateways. Wi-Fi HaLow can be added into environments already using the crowded 2.4 GHz spectrum without increasing radio frequency (RF) interference. The simplest way to include IoT through Wi-Fi HaLow is to purchase a Wi-Fi HaLow enabled AP. The Wi-Fi HaLow signal reaches farther and removes the need, in many scenarios, for expensive meshes and repeaters required by other 2.4 GHz technologies.

Device capacity

In production environments such as farms and factories, large sensor and actuator networks monitor conditions and control machinery to attain desired outcomes. It is important that the IoT communications solution employed can support hundreds—or thousands—of connected devices per AP. Wi-Fi HaLow supports more client devices: up to 8,191 per service set identifier (SSID). Wi-Fi HaLow media access control (MAC) improvements also include features to segment device types into service classes, increasing the data capacity available for the required service.

Customer adoption-related requirements

Easy and secure installation

Ensuring IoT devices and environments are secure is a difficult task, and each available IoT technology has its own approach to security. Wi-Fi HaLow uses WPA3™ and Wi-Fi Enhanced Open™, the highest level of security developed for the latest Wi-Fi generation. Installation and device onboarding could also leverage Wi-Fi CERTIFIED Easy

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[4] 86.7 Mbps is possible using MCS 9, with 16 MHz channels and short guard intervals; results vary based on regulatory requirements and vendor implementation

Connect™[5], which enables quick and secure IoT device onboarding. The native IP connectivity enables IoT ecosystem companies to facilitate easy and secure installation.

Interoperability

The interoperability of a variety of device types from multiple vendors is important in an IoT environment. Wi-Fi HaLow continues the Wi-Fi tradition of ensuring multi-vendor interoperability. This tradition, and the fact that Wi-Fi HaLow is a standards-based technology, means Wi-Fi HaLow holds high potential for seamless interoperability between other Wi-Fi HaLow devices. It can also be readily incorporated with 2.4, 5 and potentially 6 GHz Wi-Fi radios into multiband APs without interference. Wi-Fi HaLow enables seamless connectivity with cloud-based services and other networked devices.

The table below summarizes how Wi-Fi HaLow meets common IoT connectivity requirements.

IoT requirement	Wi-Fi HaLow benefits
Technical	
Low power consumption	• Increased energy efficiency (bits per Joule) over other low power LAN/WAN technologies • Multi-year battery operation • Support for coin cell battery operation
Long range and robustness	• Sub-1 GHz narrow band signals that travel farther using less energy than 2.4 GHz signals • Minimum 10 decibel (dB) link budget[6] advantage over 2.4 GHz Wi-Fi • Greater than 1 km reach for higher amplified connections
IP networking capability	• Based on IEEE 802.11ah, international standard • Native IP support; no conversion gateways required • High data throughput supports User Datagram Protocol (UDP), Transmission Control Protocol/Internet Protocol (TCP/IP) and IP based discovery protocols
Data rates	• Supports 150 kbps to 86.7 Mbps[7]
Security and privacy	• WPA3™ required • Wi-Fi Enhanced Open™ required • Support for Wi-Fi Easy Connect™
Wireless network operation	
Device variety	• Standards-based features that enable efficient coexistent support of multiple usage models • Supports wide variety of devices, data rates, power, and range • Significantly higher data rates and network capacity than competing WAN/PAN technologies
Cost effectiveness	• Unlicensed spectrum operation; no monthly subscription fees • Supports private, controlled networks • Enables over-the-air firmware upgrades • Simplifies infrastructure without the need for complex meshes or repeaters
Network integration	• Native IP networking, including internet protocol version 6 (IPv6) • No need for gateways or conversion boxes; does not interfere with pre-existing networks • Easily integrates in Wi-Fi network APs
Device capacity	• Supports 8,191 devices per SSID

[5] At this date Wi-Fi Easy Connect™ does not include testing for Wi-Fi HaLow devices

[6] Link budget: an accounting of all the power gains and losses the signal experiences from transmitter to receiver

[7] 86.7 Mbps is possible using MCS 9, with 16 MHz channels and short guard intervals; results vary based on regulatory requirements and vendor implementation

Customer adoption	
Easy, secure installation	• Wi-Fi Easy Connect support • Native IP support simplifies connections for multiple cloud IoT ecosystems
Multivendor interoperability	• High potential for seamless interoperability at IP layer with 2.4 and 5 GHz Wi-Fi devices • Based on IEEE 802.11ah open standards-based technology

Wi-Fi HaLow not only meets IoT requirements, it provides for a full range of IoT capabilities operating in less congested sub-1 GHz spectrum. Wi-Fi HaLow can connect devices that run on coin-sized batteries with very low power consumption requirements. Its range can reach greater than one kilometer to provide extended range Wi-Fi and better penetration through building materials. Because Wi-Fi HaLow augments the overall Wi-Fi portfolio, it provides the streamlined, secure access to internet and cloud-based services with no need for proprietary hubs or gateways.

Wi-Fi HaLow advantages over other IoT technology options

Wi-Fi HaLow can scale in multiple ways for various environments, offering extended range, longer battery life, native IP support, and more data throughput from 150 kbps to more than 80 Mbps. In effect, Wi-Fi HaLow technology offers IoT technology capability (see Figure 4) that eclipses other solutions. Using Wi-Fi HaLow allows network owners to meet a wide variety of market needs via one flexible, internationally recognized standard.

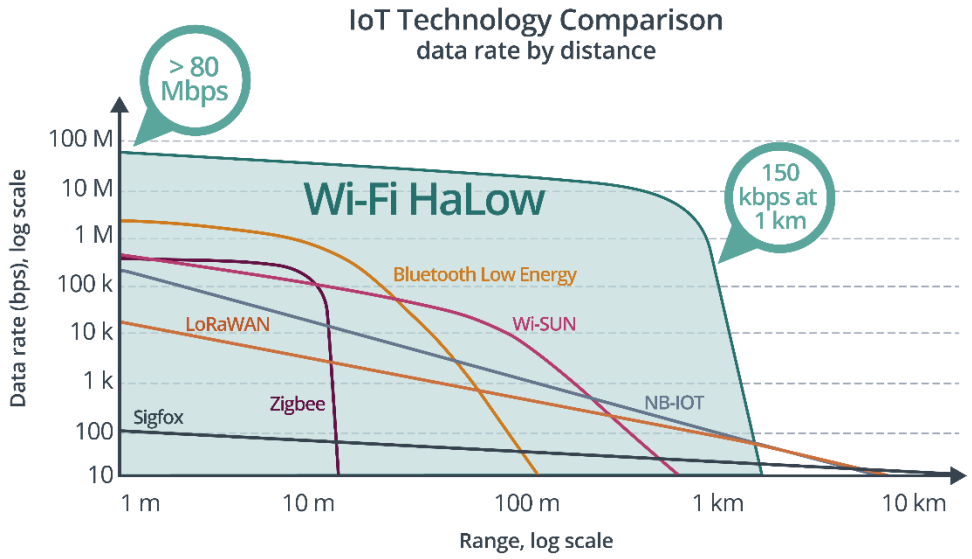

Figure 4. Approximations based on public information indicate that Wi-Fi HaLow allows higher data rates at longer distances than other IoT technology options. See IoT technology comparison at-a-glance table below.

Wi-Fi HaLow offers a single, open, industry standard technology that meets IoT demands, including speed, power, distance, density, penetration, and security. As a result, Wi-Fi HaLow offers a much wider breadth of IoT applications than other technology options. Other technologies, including Bluetooth Low Energy, Zigbee, Z-Wave, LoRaWAN, Sigfox, Narrowband IoT (NB-IoT), Long Term Evolution Category M1 (LTE-M), and other proprietary radio technologies have highlighted certain attributes, such as range or battery life. Wi-Fi HaLow represents a more comprehensive approach to IoT that enables it to handle a wider variety of IoT applications. These alternative wireless PAN and WAN solutions require extra layers of complexity, latency, and cost to achieve Wi-Fi simplicity and capability.

Range, data rate, and battery life

Operation in sub-1 GHz spectrum and narrow band channels makes Wi-Fi HaLow range significantly greater than several other technologies. Wi-Fi HaLow is capable of running low data rate agricultural sensor networks at greater than one kilometer, and can handle high data rate IoT use cases, such as outdoor video surveillance cameras or warehouse robots, at shorter distances—all on the same network. Wi-Fi HaLow also provides the low power and energy saving modes needed so that Wi-Fi sensors can last for years on one battery charge, such as for smart door locks and electronic shelf labels in grocery stores.

Topology, deployment, operating cost

Wi-Fi HaLow brings significant improvements to the simple star-oriented network architecture typically employed by Wi-Fi networks. Wi-Fi HaLow is standards-based and operates in unlicensed spectrum, so choosing Wi-Fi HaLow for IoT can result in a lower implementation cost for applications where devices are within one kilometer of an AP. For device clusters that require internet access, Wi-Fi HaLow is the optimal choice to aggregate their traffic, which can then be routed through a broadband or mobile service provider interface to the internet.

Subscriber-based network solutions rely on third-party service providers for building and managing infrastructure. Mobile network carriers utilizing licensed spectrum for LTE, LTE-M and NB-IoT usually charge fees per connected device and may require data plans for high-data rate applications. Some other system providers offering connectivity in the license-free spectrum, such as LoRaWAN and Sigfox services, also charge a recurring fee to use their network infrastructure. These latter, proprietary network technologies only provide very low data rates compared to Wi-Fi HaLow.

Wi-Fi HaLow implementation costs include the AP and client devices, plus the IT resources to configure the network. There are no recurring fees for using the customer-owned network resources. Wi-Fi HaLow can be easily added to existing infrastructure networks without negatively impacting other Wi-Fi frequency technologies. Wi-Fi HaLow can be implemented into a standalone AP specifically for IoT or a multiband AP as a comprehensive Wi-Fi solution.

Security, including during over-the-air updates

Wi-Fi HaLow devices support WPA3, the highest security level offered by Wi-Fi, to secure data between the AP and client devices. For system designers who must anticipate long-term improvements and security updates for devices in the field, Wi-Fi HaLow's high data rates support fast over-the-air (OTA) firmware updates when needed. Other technologies with very low data rates and lower levels of encryption cannot provide OTA firmware updates quickly and securely without suffering long periods of downtime and high energy consumption. Some may require the added costs of labor-intensive intervention on-site for each device. Wi-Fi HaLow minimizes the downtime required for OTA firmware updates, while providing multiple security layers.

IP-ready technology

Like other Wi-Fi versions, Wi-Fi HaLow enables transport for IPv4/IPv6 including UDP and TCP packets. A Wi-Fi HaLow enabled router can serve Wi-Fi HaLow client devices that send their data to and from cloud services. There are no proprietary gateway or hub controllers required to manage Wi-Fi HaLow clients. This simplifies the network architecture compared to non-IP client devices of other wireless technologies like Bluetooth Low Energy or Zigbee.

IoT technology comparison at-a-glance

The table below provides a high-level characterization of the main IoT technology options currently available. Wi-Fi HaLow is very energy efficient when measured in Joules of energy used to send and receive each bit, enables years of battery life, and offers many other advantages in reach and data throughput.

Attributes	Wi-Fi HaLow	Bluetooth Low Energy	Z-Wave	Zigbee	Wi-SUN	Sigfox	LoRaWAN	NB-IoT
Frequency	Sub-1 GHz	2.4 GHz	Sub-1 GHz	2.4 GHz / Sub-1 GHz	Sub-1 GHz	Sub-1 GHz	Sub-1 GHz	Licensed
Data rate (bps)	150 k - 86.7 M[8]	125 k - 2 M	9.6 k – 100 k	250 k	6.25 k – 800 k (50 k default)	100 or 600	300 – 27 k	20 k – 127 k
Range (m)	> 1 k	< 100	< 30	< 20	< 1 k	< 40 k	< 10 k	< 10 k
Modulation	OFDM over BPSK, QPSK, 16/64/256 QAM	GFSK	GFSK	BPAK/ OQPSK	MR-FSK / MR-OFDM / MR-OQPSK	DBPSK/ GFSK	CSS	QPSK
Battery life	Years	Years	Years	Years	Years	Years	Years	Years
Security	WPA3	128-bit AES in CCMode	Security 2 (S2)	128-bit AES in CCMode	IEEE 802.1X	Session-level security	128-bit AES in CCMode	3GPP security
OTA firmware updates	Supports	Supports	-	-	-	-	-	-
Subscription required	No	No	No	No	No	Yes	Yes	Yes
TCP/IP (internet)	Supports	-	-	-	-	-	-	-
Network topology	Star / Relays	P2P* / Mesh	Mesh	Mesh	Mesh	Star	Star	Star
Open standard	IEEE 802.11ah	Bluetooth SIG	Proprietary	IEEE 802.15.4	IEEE 802.15.4g	Proprietary	Proprietary	3GPP LTE Cat-NB1/NB2

** Peer-to-peer* *Source information used for this table is publicly available*

[8] *86.7 Mbps is possible using MCS 9, with 16 MHz channels and short guard intervals; results vary based on regulatory requirements and vendor implementation*

Studies comparing Wi-Fi HaLow to other IoT technology options

While empirical studies of Wi-Fi HaLow networks are few at this time, there are some studies and simulations that include it in competitive analyses of IoT technology options. Key findings in each study show that Wi-Fi HaLow outperforms other technologies in several areas, from range to energy efficiency and ease of use.

A Wi-Fi Alliance analysis of competing unlicensed low power WAN, PAN and LAN, and licensed WAN technologies covered various attributes, including data rate, range, battery life, ease of IP network integration, installation and operating cost efficiency, and scalability. In these comparisons, Wi-Fi HaLow excelled in all attributes except in WAN range. Wi-Fi HaLow was identified as stronger than other PAN networks for most attributes, and at least comparable to the other technologies. Wi-Fi HaLow is better in range and battery life than Wi-Fi running in 2.4 GHz. Figure 5 illustrates just one result from the analysis; more detailed information is available in the Wi-Fi HaLow Technology Overview.

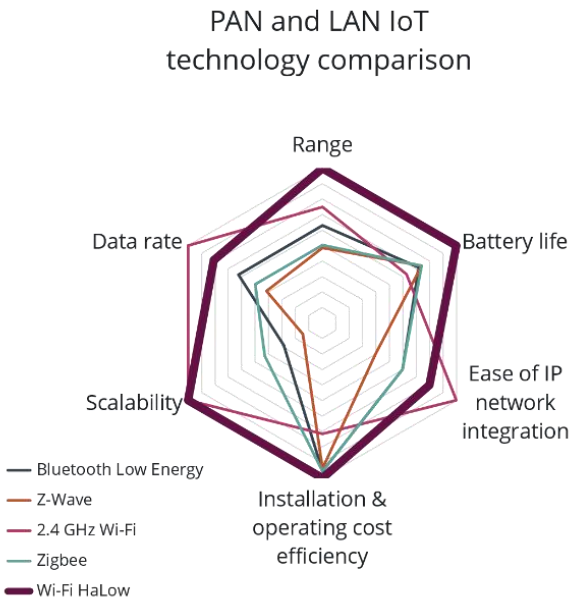

Figure 5. Wi-Fi HaLow meets most needs when compared to other IoT technology options.

A study by IMEC Research Group compared the energy consumption of several IoT technology options. The key takeaway showed that Wi-Fi HaLow can be more energy efficient than other IoT technologies.

The information detailed further in the Wi-Fi HaLow Technology Overview, shows that Wi-Fi HaLow has the range, data rates, and energy efficiency to be considered a premier IoT technology. The fact that it is underpinned by Wi-Fi security and deployment ease makes it worthy of consideration as the key technology for enterprises, industry, and more.

Use cases

Wi-Fi HaLow devices provide low power, long range connectivity, penetration through obstacles, and reliable data throughput that other IoT technology options offer, but with the added benefit of native IP support, easier network integration, and enhanced security. Wi-Fi HaLow represents a more well-rounded solution to many IoT needs, benefitting individuals in the home and farmers in the field. Wi-Fi HaLow devices are interoperable with each other regardless of vendor. Wi-Fi HaLow key use examples are described below.

Industrial automation

Real-time information gathered from sensors in an industrial automation system yields better control decisions to improve process yields. These decisions might be made at edge compute nodes or in the cloud. Critical session-based communications among the nodes may be needed, with no tolerance for congestion through busy meshes and gateways. For a factory or refinery using thousands of sensors and actuators spread across large distances, Wi-Fi HaLow has the capacity to connect these devices in a secure, low-latency network. Wi-Fi HaLow architecture is star-oriented to establish longer distance connections and wider choices in data rates than methods based on Zigbee meshes, which rely on some nodes which must repeat their neighbor's data. This adds delays and reduces the 250 kbps of total network throughput shared by devices in such a mesh architecture. System architects can rely on the advanced WPA3

security and native IPv6 support offered by Wi-Fi HaLow to protect critical communications for all devices, whether to an on-site controller or tunneled to a server in the cloud.

Agriculture

Smart farm operations require sensors and control point connectivity to care for crops and livestock across large areas. A single Wi-Fi HaLow AP that can reach or exceed a one kilometer radius supports internet access for more than 8,000 devices spread across 775 acres (over 310 hectares). Sensors that rely on batteries or solar power can stay in the field for years, measuring environmental conditions and crop and livestock health. Ventilation, heating, and irrigation can be automated without having to run power cables or signal wires for hard-to-reach sensors or controllers. Using Wi-Fi HaLow infrastructure to aggregate many local device connections saves the recurring costs that would otherwise be spent on data plans with mobile carriers or proprietary network service providers.

Home and building automation

Environmental, security, and safety systems in buildings from large office complexes and manufacturing facilities to single and multi-family homes can be simply and easily connected and automated with Wi-Fi HaLow. Wi-Fi HaLow delivers a low-power standard solution to connect door locks, cameras, heating, ventilation and air conditioning (HVAC) components, and appliances to each other and the internet without running additional signaling wires. Sub-1 GHz Wi-Fi HaLow penetrates through walls better than 2.4 GHz technologies. Smart lighting systems can be dynamically reconfigured to suit occupant needs in multi-tenant buildings. Access control systems can use W-Fi HaLow's high data throughput to add support for real-time video and biometric authentication schemes. Long battery life for Wi-Fi HaLow sensors reduces infrastructure and maintenance costs. Wi-Fi HaLow uses the latest WPA3 security and ensures protection against unauthorized system changes. Firmware updates can be implemented quickly and securely to trusted platforms in the cloud using over-the-air updates.

Logistics and transportation

The movement of goods from supplier to factory to warehouse to point of sale crosses many enterprise and wide area network boundaries. The real-time location and condition of the goods is used to help improve planning and efficiency. Sensors and asset trackers that implement Wi-Fi HaLow bring a global industry standard to logistics tracking. Battery-operated sensors can operate for years. The sub-1 GHz radio frequency signals penetrate through shipping materials to reach local APs in a warehouse or carrier vehicle. A freight or carrier service provider can offer mobile Wi-Fi HaLow IPv6 router connections, secured using WPA3 or Wi-Fi Enhanced Open, so that each customer can track their products during transport. Wi-Fi HaLow is also a superior network infrastructure for a cavernous warehouse due to its long range and signal penetration capabilities.

Smart cities

Municipal operations can benefit from Wi-Fi HaLow's ease of use and long-distance connections. Traffic monitors can add video inputs from Wi-Fi HaLow-connected cameras, without having to pull new cables. Traffic lights can be centrally controlled to manage traffic flow and in emergencies. Data from thousands of devices, such as parking lot meters, traffic monitors, and information signs, can be aggregated using Wi-Fi HaLow to provide feedback and control from a centralized location. After installing Wi-Fi HaLow networks, the municipality can avoid the recurring costs charged by services based on cellular carrier networks.

Wi-Fi HaLow can also be used to meet the IoT needs in environments such as retail stores and shopping malls, hotels and restaurants, medical practices employing patient monitoring devices, and anywhere that long range Wi-Fi is a necessity.

Summary

Wi-Fi HaLow offers a single, open, industry standard that can address many IoT applications in multiple industries. It combines the reach, robustness, scalability, and energy efficiency required by IoT systems, with the added benefits and capabilities of Wi-Fi. Operating in sub-1 GHz radio frequency spectrum and using narrower channels enables Wi-Fi HaLow to provide up to 100 times longer range than other IoT technology options. It can penetrate through building materials, ensuring successful home and building automation installations without costly meshes or repeaters, and connect devices approximately one kilometer or more from the AP while other IoT technologies were designed to only reach 10 meters. Wi-Fi HaLow uses several methods to achieve higher energy efficiency than most existing low power WANs and wireless PAN technologies. Using new MAC improvements and sleep modes, Wi-Fi HaLow supports devices powered by coin cell batteries; it can effectively handle sensor networks in varied environments, with increased capacity to support up to 8,191 devices per SSID.

Wi-Fi HaLow facilitates a more holistic approach to wireless connectivity. Because it is Wi-Fi, it is more easily integrated with existing Wi-Fi networks, supports native IP networking, and provides the latest in Wi-Fi security. High data throughput and low-latency architecture allow IoT devices to transfer secured data to cloud-based application servers. When field upgrades are necessary, Wi-Fi HaLow provides the capacity for efficient, secure over-the-air updates, minimizing device downtime. This can all be done without the need for proprietary gateways or hubs used by non-Wi-Fi network architectures commonly used in other IoT systems.

More information about Wi-Fi HaLow can be found at https://www.wi-fi.org/discover-wi-fi/wi-fi-halow and in the Wi-Fi HaLow Technology Overview.

About Wi-Fi Alliance®

www.wi-fi.org

Wi-Fi Alliance® is the worldwide network of companies that brings you Wi-Fi®. Members of our collaboration forum come together from across the Wi-Fi ecosystem with the shared vision to connect everyone and everything, everywhere, while providing the best possible user experience. Since 2000, Wi-Fi Alliance has completed more than 50,000 Wi-Fi certifications. The Wi-Fi CERTIFIED™ seal of approval designates products with proven interoperability, backward compatibility, and the highest industry-standard security protections in place. Today, Wi-Fi carries more than half of the internet's traffic in an ever-expanding variety of applications. Wi-Fi Alliance continues to drive Wi-Fi adoption and evolution, which billions of people rely on every day.