

Wi-Fi CERTIFIED WiGig™: Wi-Fi® expands to 60 GHz



October 2016

The following document and the information contained herein regarding Wi-Fi Alliance programs and expected dates of launch are subject to revision or removal at any time without notice. THIS DOCUMENT IS PROVIDED ON AN "AS IS", "AS AVAILABLE" AND "WITH ALL FAULTS" BASIS. WI-FI ALLIANCE MAKES NO REPRESENTATIONS, WARRANTIES, CONDITIONS OR GUARANTEES AS TO THE USEFULNESS, QUALITY, SUITABILITY, TRUTH, ACCURACY OR COMPLETENESS OF THIS DOCUMENT AND THE INFORMATION CONTAINED IN THIS DOCUMENT.

Wi-Fi® innovates to meet increasing digital demand

The widespread availability and use of digital multimedia content have led to the need for continuous innovations in wireless connectivity. Wi-Fi CERTIFIED WiGig™ devices offer a solution to growing Wi-Fi demands, adding more Wi-Fi capacity that specializes in handling the demanding needs of multimedia content and other bandwidth intensive applications.

Demand for faster speeds, higher capacity, and lower latency are the driving forces behind many Wi-Fi technologies entering the market. From the individual live streaming a video onto their tablet to the hotel providing internet service to guests, the need to wirelessly connect increases drastically year to year. Some applications, like virtual reality, require the ability to process massive amounts of data very quickly to provide a first-rate user experience. As Wi-Fi usage grows, the industry remains proactive in making advancements to meet expanding needs.

In mid-2016, Wi-Fi Alliance® announced enhancements to the [Wi-Fi CERTIFIED™ ac](#) program, providing data rates up to 4.5 gigabits per second (Gbps) using the 5 gigahertz (GHz) unlicensed spectrum. To complement the enhancements to Wi-Fi CERTIFIED ac, Wi-Fi Alliance has introduced Wi-Fi CERTIFIED WiGig to accelerate the commercial availability of WiGig® devices. Operating in the less crowded 60 GHz frequency band, WiGig enables extremely high performance, multi-gigabit connectivity and low latency for a range of applications, including wireless docking, augmented reality/virtual reality (AR/VR), multimedia streaming, gaming, and networking.

Use of Wi-Fi has increased immensely over the past decade, and Wi-Fi devices have become an important part of daily life. Nearly 2.8 billion Wi-Fi devices are projected to be sold in 2016 alone, with cumulative shipments expected to reach more than 32 billion by 2021.¹ The market for WiGig devices is already growing and expected to ramp to a cumulative 4.7 billion shipments by 2021.² Wi-Fi CERTIFIED WiGig offers a new opportunity to expand Wi-Fi use with devices that offer high performance and low latency, along with the same quality of interoperability, compatibility, and security delivered by Wi-Fi CERTIFIED devices.

The WiGig solution

Utilizing the wider, less congested 60 GHz unlicensed spectrum, WiGig is a directional, line-of-sight technology that provides for multi-gigabit data transfer capability, supporting data rates up to 8 Gbps. WiGig complements Wi-Fi CERTIFIED ac and increases network performance, resulting in better use of network resources and rivaling wired connections. Leveraging a new frequency band with WiGig technology allows for maximum throughput, low latency user experiences. The key benefits of WiGig are:

- **High performance:** Ultra-wide channels in the millimeter wave bands enable faster data rates up to 8 Gbps, offering extremely high transmission speeds at ranges up to 10 meters (32.8 feet).

¹ ABI Research, June 2016

² ABI Research, June 2016

- **Low latency:** The 60 GHz spectrum provides greater bandwidth to enable real-time data transfer.
- **Power efficiency:** Wide range of operating modes in 60 GHz provides flexibility between battery life and performance making it suitable for a wide array of usages, such as handsets and VR headsets.
- **Increased capacity:** Beamforming reduces link interference, using multiple antennas and directional communication to overcome signal decay and allow greater spectral reuse.
- **Dynamic session transfer:** Devices and applications dynamically switch between 2.4, 5, or 60 GHz depending on application and environmental conditions.

WiGig applications

The benefits of WiGig technology reach many market segments in both consumer and business applications. Mobile phone makers and service providers, computer, peripheral and consumer electronics vendors, airport, stadium, and hotel network managers can all give their customers the benefit of WiGig multi-gigabit connectivity for a variety of data-intensive applications.

Wireless docking

WiGig helps bring the wireless office closer to fruition, allowing a number of peripherals to be connected without wires and without compromising quality. Employees giving presentations can wirelessly connect their laptop or smartphone to the company's projection system, eliminating the need to use cumbersome wires and adapters. Individuals who want to show their photos on a larger screen can wirelessly connect their camera directly to their computer or tablet. WiGig not only provides connectivity between the PC and various high-performance peripherals such as monitors and hard disk drives (HDDs), it also delivers a high throughput networking link. Wireless docking over WiGig brings a high-performance computing environment that could be utilized by any PC, regardless of manufacturer, benefiting both enterprise and home environments.

Multimedia entertainment

WiGig advances the multimedia entertainment experience. Since most entertainment experiences like home theaters and gaming occur in the same room, WiGig is a perfect fit to give a high speed, low latency experience. Multi-player gaming with WiGig releases players from the standard client-server architecture and offers the opportunity to network directly with other players. Using WiGig, individuals can play together in the same room without perceived latency, which detracts from an immersive gaming experience. WiGig technology can deliver extremely high frame rates and uncompressed high definition (HD) streams for an unparalleled gaming or HD movie viewing experience. Players can see graphics and animations as intended, without latency.

Augmented and virtual reality

The augmented reality/virtual reality (AR/VR) industry is growing at a tremendous pace in a variety of markets. Though still evolving, most AR/VR applications today remain dependent on a wired connection to a PC or dependent on a smartphone's cellular connectivity. These applications require very low latency, high definition rendering of minimally compressed or uncompressed formats. WiGig can deliver the in-room performance required to untether these applications, giving a more immersive experience and helping to extend the AR/VR audience.

Public kiosks

Travelers can download movies before leaving the house or while rushing through the airport. WiGig opens new opportunities for public kiosk applications by allowing users to obtain products and services quickly, securely, and wirelessly. A WiGig-enabled movie kiosk at an airport could potentially serve several customers simultaneously, sending multiple 10-gigabyte movies in a manner of seconds.

Enterprise connectivity

Multi-band access point deployments that include 60 GHz support will dramatically increase Wi-Fi capacity within the enterprise. These deployments provide general connectivity to users, while also creating the ability to process high throughput for bandwidth intensive applications. Offloading multimedia streams and large file downloads creates a more efficient network throughout the enterprise.

How WiGig works

WiGig technology works by leveraging the 60 GHz unlicensed spectrum for short-range, multi-gigabit data transfer. Though local regulatory bodies determine regional spectrum allocation, WiGig is generally available in at least one band in all geographical areas (Figure A). In the United States, all six channels are fully available.

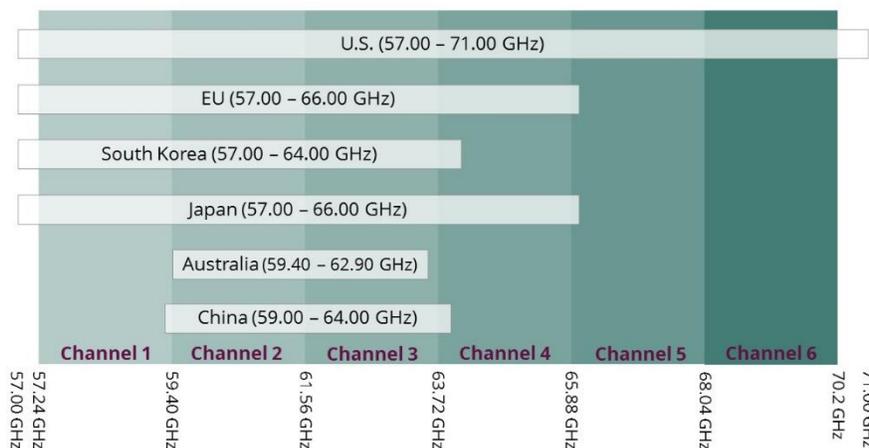


Figure A. 60 GHz spectrum allocation

Physical layer

The 60 GHz band has much more spectrum available than the 2.4 GHz and 5 GHz bands combined. Many regions provide at least 8 GHz of spectrum, and up to 14 GHz in the United States, compared with 83.5 MHz in the 2.4 GHz band. As with the 2.4 and 5 GHz bands, the 60 GHz spectrum is divided into multiple channels. At 60 GHz, each channel is 2.16 GHz wide – more than 10 times wider than the channels available in the most recent enhancements to 802.11ac.

Modulation & coding scheme

WiGig supports two types of modulation and coding schemes, which provide different benefits:

- Single Carrier mode supports the highest available data rates up to 8 Gbps.
- Low-power Single Carrier mode provides lowest possible power consumption, targeting mobile devices such as smartphones, up to 2.5 Gbps.

The two types of schemes share common elements such as preamble and channel coding. This reduces implementation complexity for manufacturers of WiGig devices.

Medium Access Control layer

At the MAC layer, WiGig includes new features that support advanced usage models, facilitate integration with Wi-Fi networks, reduce power consumption, and provide strong security.

Network architecture

WiGig supports both infrastructure and device-to-device operation. In infrastructure mode, WiGig operates in the same manner as existing Wi-Fi networks, with stations and access points interconnected to access a shared medium. In device-to-device operation, devices connect to each other to provide a means to send or receive data. In device-to-device mode, a Personal Basic Service Set (BSS) is configured when a device presents itself as a Personal BSS Control Point (PCP). Other stations are then able to connect to the PCP to exchange data.

Seamless multi-band operation

WiGig provides the ability for multi-band operation, allowing sessions to transfer from one Wi-Fi band to another seamlessly. A communication session can be rapidly and seamlessly transferred between a 60 GHz channel and any lower-frequency Wi-Fi channel (Figure B). This innovation enables seamless fallback to other bands if WiGig connectivity is not available.

Users with multi-band capable devices can maintain session links that might have been initiated on a 60 GHz channel, by automatically switching to another Wi-Fi band. For example, an

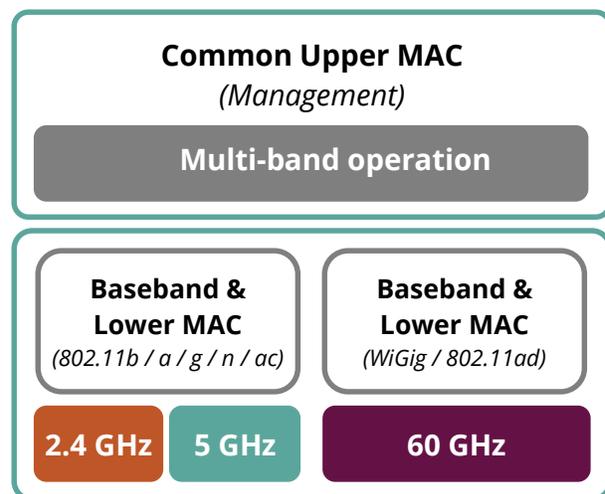


Figure B. WiGig architecture

HD streaming session initiated on WiGig might require the mobile device to switch to another Wi-Fi band as the user moves out of range of the original link. With dynamic band switching, the user does not have to intervene in this process and the device is able to maintain a consistent user experience.

Beamforming

Beamforming uses directional antennas to reduce interference and focus a signal between two devices into a concentrated “beam.” This allows for robust multi-gigabit communications. During the beamforming process, devices establish communication and then fine-tune their antenna settings to improve the quality of directional communication and minimize contention with adjacent communications, which maximizes link performance and overall system spectral efficiency.

Power management

WiGig provides flexibility in accessing the medium by incorporating two different channel access schemes. The first, contention-based access, is an enhanced access method defined in 802.11 (CSMA/CD), with additional optimizations to account for directional connections. Contention-based schemes are well suited for one-time, non-periodic data exchanges such as a large file transfer. Once granted access to the medium, the file transfer is completed quickly at the highest data rate available.

The second method is a schedule-based access scheme. This method allows two devices to schedule periods of data exchange, thereby allowing for potentially longer sleep periods. These longer sleep periods provide additional power saving, useful for mobile devices such as smart-phones. Additionally, scheduled access provides better quality of service for latency-sensitive applications, such as wireless display.

The combination of these access methods provides flexibility in tailoring the access method to the requirements of the data stream. Furthermore, providing flexible access methods increases the channel utilization.

Advanced security

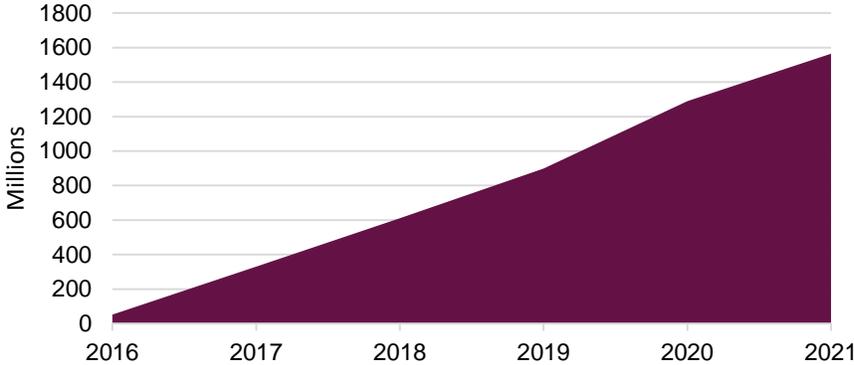
Wi-Fi CERTIFIED WiGig devices utilize WPA2™ (Wi-Fi Protected Access® 2) with the addition of Galois/Counter Mode Protocol (GCMP) for encryption. GCMP is a highly-efficient mode of encryption that is designed to support higher communication speeds by utilizing parallel processing in hardware.

The multi-band future of Wi-Fi

WiGig provides significant user benefits in a variety of ways, some of which are transformational in the very nature of how users will interact with WiGig-enabled devices. The benefits of using this technology span many markets, from mobile and PC to consumer electronics and service provider segments. WiGig is available worldwide in the unlicensed 60 GHz spectrum and increases bandwidth, throughput, and network capacity.

Expectations are that 2017 will see steady growth in commercially available WiGig devices, with more growth year over year (see chart). The use of multi-band devices is expected to rise and new applications for its utilization, which span multiple industries and market segments, will develop. By 2021, 4.7 billion cumulative WiGig devices will have been introduced into the market.

WiGig chipset shipment forecast
(ABI Research, June 2016)



Over the past 16 years, Wi-Fi has become an increasingly important part of people’s lives. The ever evolving wireless demands of individuals, families, business and governments require additional Wi-Fi space and functionality. Wi-Fi CERTIFIED WiGig provides maximum throughput and more efficient use of the 60 GHz unlicensed spectrum. WiGig’s features enhance existing Wi-Fi capabilities and help create new uses that are focused on low latency, high throughput, and increased capacity for both networking and device-to-device applications.

WiGig at-a-glance		
Spectrum: 60 GHz ♦ Speed: up to 8 Gbps ♦ Range: 10 m (32.8 ft)		
Feature	Benefit	Function
Ultra-wide channels	High performance	Ultra-wide channels enable data rates up to 8 Gbps for extremely high transmission speeds
High bandwidth 60 GHz spectrum	Low latency	Greater bandwidth enables real-time data transfer
Band switching support	Dynamic Session Transfer	Dynamically switch between 2.4, 5, and 60 GHz in multi-band devices
Beamforming	Increased capacity	Reduce link interference using multiple antennas and directional communication
Data rate optimization	Power efficiency	Modulation schemes provide flexibility between battery life and performance

Wi-Fi Alliance commitment

Wi-Fi Alliance is committed to providing the best user experience for all Wi-Fi CERTIFIED products. Our certification programs validate that products from different brands work well together and with older Wi-Fi devices, and we require that the latest industry-standard security mechanisms are in place in every product we certify. The Wi-Fi CERTIFIED logo means devices have been rigorously tested to meet expectations and the highest quality user experience.

Interoperability

Wi-Fi products are interoperable if they can communicate with each other, no matter what brand. Wi-Fi Alliance certification programs test devices from different manufacturers to ensure that they work well together. With more than 700 member companies, users can choose certified products from many different manufacturers and have confidence that they will work together.

Backward compatibility

Devices that are Wi-Fi CERTIFIED also are backward compatible with legacy devices. If you have an older Wi-Fi CERTIFIED device, it will work with multi-band WiGig devices.

Security

Wi-Fi CERTIFIED products have the very latest generation of security protections on board. WPA2 security is standards-based and uses very strong encryption, providing plenty of protection for a home Wi-Fi network. WPA2 is designed to help ensure that only authorized users can connect to the network, and then encrypts the data that travels over the Wi-Fi network so that privacy is maintained.

Consumers should always turn on the security features in any Wi-Fi product. Products that also feature the Wi-Fi Protected Setup™ certification have the very easiest setup of a protected home network that is supported by multiple vendors – making it possible to configure a security-enabled network at the push of a button or with a short Personal Identification Number (PIN).

Look for the Wi-Fi CERTIFIED logo

The Wi-Fi CERTIFIED logo is the best assurance of an interoperable, backward-compatible product with security protections in place. Users should always look for the logo on product packaging and should always buy Wi-Fi CERTIFIED products to be sure their devices operate together seamlessly, include the latest security features, and are good neighbors to other Wi-Fi equipment.



Learn more

An up-to-date list of certified products can be found in the [Wi-Fi Alliance's Product Finder](#). Users can search for Wi-Fi CERTIFIED equipment by multiple criteria, including product category, manufacturer, certification date and features supported, and can view the interoperability certificate for certified products.

For further information on Wi-Fi Alliance certification programs and for white papers on Wi-Fi-related topics, please visit www.wi-fi.org.

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 [certified more than 30,000 Wi-Fi products](#). 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 the adoption and evolution of Wi-Fi, which billions of people rely on every day.

Wi-Fi®, the Wi-Fi logo, the Wi-Fi CERTIFIED logo, Wi-Fi Protected Access® (WPA), WiGig®, the Wi-Fi Protected Setup logo, Wi-Fi Direct®, Wi-Fi Alliance®, WMM®, Miracast®, and Wi-Fi CERTIFIED Passpoint® are registered trademarks of Wi-Fi Alliance. Wi-Fi CERTIFIED™, Wi-Fi Protected Setup™, Wi-Fi Multimedia™, WPA2™, Passpoint™, Wi-Fi CERTIFIED Miracast™, Wi-Fi ZONE™, the Wi-Fi ZONE logo, Wi-Fi Aware™, Wi-Fi CERTIFIED Wi-Fi HaLow™, Wi-Fi HaLow™, Wi-Fi CERTIFIED WiGig™, and the Wi-Fi Alliance logo are trademarks of Wi-Fi Alliance.