

# Antenna Considerations for Wi-Fi 6



# Introduction

As we all know, the degree to which we are all wirelessly connected around the world continues to increase. According to Internet World Stats, almost 57% (officially more than half) of the world population is now connected to the internet. As wireless technologies continue to develop and evolve, this trend will only grow. Not only is the number of connected people increasing, the sophistication and complexity of wireless technologies also deepens.

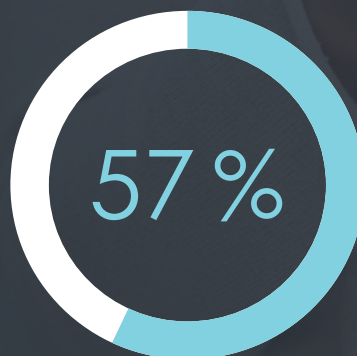
With the increasing number of our world population becoming connected via the internet and with the ever-increasing development of new wireless technologies, the need for faster speeds and increased bandwidth also looms.

To mitigate these technological needs, the Wi-Fi Alliance has introduced the newest generation of Wi-Fi technology - Wi-Fi 6 (also known as or based upon the IEEE 802.11ax standard).

This application brief discusses how antennas and antenna systems must evolve and/or perform to function successfully in a Wi-Fi 6 world.



Don't confuse Wi-Fi 6 with the emerging 5G technology. Although both are intended to increase the speed and bandwidth of wireless networks, they are two different things. Whereas Wi-Fi 6 is the sixth generation of Wi-Fi, 5G is the fifth/latest generation of mobile network or cellular technology.



Almost **57%** (officially more than half) of the world population is now connected to the internet.

# What is Wi-Fi 6

First of all, it's important to explain what Wi-Fi 6 entails. Like we've already stated, Wi-Fi 6 (or 802.11ax) is the next generation of wireless technology. The following sections outline three main goals that the Wi-Fi Alliance intends to achieve with this technology.

## Increased Speeds/ Higher Throughput

Wi-Fi 6 is expected to deliver a 40%-higher speed increase compared to Wi-Fi 5 (802.11ac). According to **Cisco Visual Networking Index: Forecast and Trends**, the total amount of internet traffic in five years (2017-2022) will be higher than the previous combined total years since the internet's inception. In addition, during the same time period, 4K video is expected to increase from 3% to 22% of all IP traffic. And, to throw in one more statistic, the OECD (Organization for Economic Cooperation and Development) estimates that each household with at least two teenagers will own approximately fifty IoT and other internet-connected devices. There is little doubt that the increased speed of Wi-Fi 6 is necessary.

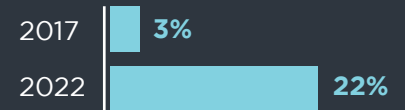
## Extended Battery Life

Despite the fact that wireless and other technologies have advanced and sky-rocketed, the technologies surrounding Wi-Fi connectivity power consumption and battery life have not demonstrated much advancement. With the introduction of Wi-Fi 6, the Wi-Fi Alliance hopes to change this fact. Using Target Wake Time (TWT), a new feature that enables access points to set up a schedule for sending data packets while allowing the devices to "nap" or enter a lower power mode between transmissions, devices could use far less power (**67% lower power consumption**) than they achieved prior to Wi-Fi 6.

## Better Performance in an Increasingly- Congested Wi-Fi Environment

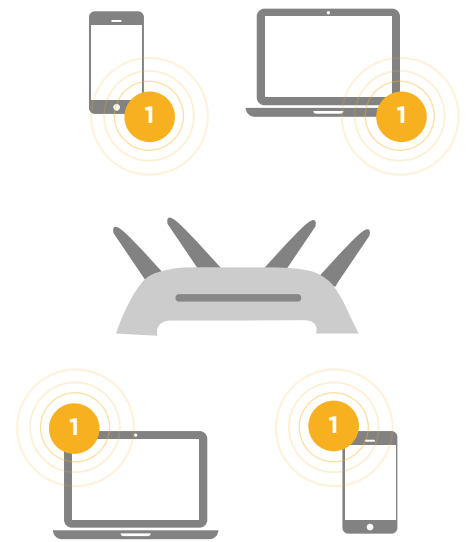
It's quite obvious that the use of smartphones and a myriad of other connected devices continues to escalate. In addition, more and more public places are setting up their environments for wireless coverage. Added to these two factors is the fact that devices, like we mentioned earlier, are using increasingly data-heavy applications. All of this combines into an extremely congested Wi-Fi environment which often leads to slow, ineffective wireless service. To combat this, Wi-Fi 6 incorporates several technologies that help decrease interference between devices and more-efficiently transmit data packets. With these technologies in place, consumers are able to achieve fast speeds and quality performance despite the continued increase in wireless devices.

4K video is expected to increase from **3% to 22%** of all IP traffic.



Each household with at least two teenagers will own approximately 50 IoT and other internet-connected devices by 2020.





Multi-User MIMO

# Antenna Considerations for Successful Wi-Fi 6 Performance

## Challenges for Antennas

It's true that the arrival of Wi-Fi 6 brings many important and needed enhancements. But, due to these new features, there are some challenges that accompany them. The majority of these enhancements require a higher degree of organization between devices, access points, and other parts of the system in order to function successfully. Because every part of the system is so interrelated, the tighter radio frequency (RF) specifications that accompany Wi-Fi 6 means that every aspect of an RF system design becomes more complicated.

These challenges certainly apply to antennas as well. Due to the increased complexity and higher performance expectations involved with Wi-Fi 6, antennas must be optimized to meet these higher levels of performance.

Some of the challenges facing optimized antenna performance include:

- The need for additional antennas
- The increasingly-smaller enclosure size of current devices
- The fact that multiple technologies must co-exist (and function) inside a single device enclosure
- The need for additional ports in a single footprint which also means a wider variety of connectors.

## Understanding MU-MIMO

First, let's briefly discuss one key technology that is integral to Wi-Fi 6 - MU-MIMO or Multi-User, Multiple Input, Multiple Output. MU-MIMO helps mitigate the challenges involved with our current and increasingly-congested Wi-Fi environment. It achieves this by adding uplink support for concurrent upstream and downstream client data transmissions.

For effective performance, MU-MIMO uses a feature called beamforming. Beamforming, rather than randomly scattering a signal in all directions, points signals directly towards the intended device or devices. Because these signals are used more efficiently,

the range and speed of Wi-Fi are enhanced; a targeted signal is stronger than a scattered one. With MU-MIMO, antennas are more fully utilized; various antennas can communicate (both uplink and downlink transmissions) independently with different devices at the same time.

For optimal performance of a Wi-Fi 6 device, more antennas are required. Traditionally, the majority of smaller Wi-Fi devices, such as consumer electronics or home automation devices, may have only included one antenna. Now, access points and user devices incorporating up to 8 antenna ports will become part of the new standard, but not without increased complication. Whether working with embedded or external antennas, accommodating additional radios (and thus antennas) requires more space and increased power. The need for additional space and increased power lead to extra cost and more of a battery drain.

This new MU-MIMO technology uses even more complex antenna sets in order to cover both 2.4 GHz and 5 GHz bands. For effective functionality of MU-MIMO technology on both the uplink and downlink, up to 8 spacial streams (involving eight antennas) is ideal.

# Antenna Installation for Optimized Performance

## Handling a Smaller Enclosure Size or Less Space in General

Whether you're using embedded MIMO antennas or external antennas, increasing the number of antennas can add complication to your setup. But it is especially complicated with embedded antennas. As our connected devices become smaller and more compact, the space allotted for RF equipment also decreases. In other words, real estate becomes an issue. Considering the fact that eight antennas, for example, are ideal for optimal Wi-Fi 6 performance, the challenge arises of fitting additional embedded antennas within or providing connectors for the additional external antennas given the smaller enclosure size.

## Installation is a Tricky Thing

Antenna installation, whether it's embedded antennas or external antennas is a tricky thing. How the antennas are situated within the device or outside the device is critical - if the placement isn't exact, connectivity can be adversely affected. Antennas must be optimized to limit interactions or interference with other antennas. The more isolated each antenna is, the better the performance.

## Increase Space Between Antennas

One way to increase isolation is to increase the physical space between antennas. Antennas must be the correct distance apart (at least a 1/4 of a wavelength) - which is especially complicated when you're trying to fit multiple embedded antennas

in a small space. Antennas also require the correct orientation for optimal performance. For example, placing two antennas at a 90-degree angle to each other is typical for a 2x2 MIMO antenna arrangement. Considering more than a typical 2x2 MIMO scenario is required for effective MU-MIMO, there's even a higher degree of complication.

## Minimize Antenna Pattern Correlation

In addition to spacing, minimizing the antenna pattern correlation and dual polarization also must be considered for successful antenna installation, especially in small portable devices.

Minimizing the antenna pattern correlation is a task which is especially difficult in a small enclosure. Antenna pattern correlation, simply put, is the amount of similarities (or dissimilarities) between multiple antennas' radiation patterns. To gain the most advantage of an antenna array, the device RF receiver must be able to distinguish between different antenna spatial streams. You can create these dissimilarities through separation and orientation of the antennas.

Dual polarization diversity in antennas also helps with the isolation optimization. Dual polarization involves packaging two antennas (one that is horizontally polarized and another that is vertically polarized) together in a single housing or radome. When installed properly, a dual-polarized antenna housing

(two antennas in a single radome) isn't limited to communicating with one type of polarization but rather can transmit to and from both vertically- and horizontally-polarized antennas. Basically, you have two antennas in one package which, aside from helping with isolation and correlation, it saves space and cost and provides a dual port in a single footprint.

## Dual-Band Antenna Arrays

Whereas the 802.11 ac standard (Wi-Fi 5) only functioned on the 5 GHz band, Wi-Fi 6 incorporates both the 2.4 GHz and the 5 GHz frequency bands. As the number of wireless technologies and devices continues to evolve, congestion in both of these bands will continue to increase, negatively

Minimizing the antenna pattern correlation and dual polarization also must be considered for successful antenna installation, especially in small portable devices.

impacting both Wi-Fi speeds and bandwidth. Any devices or other hardware that expects optimal Wi-Fi 6 performance, including antennas, must be capable of effectively



handling both frequency bands despite the high level of congestion.

To add to this complication, in October of 2018, the FCC (U.S. Federal Communications Commission) released a notice of proposed rulemaking to potentially open the 6 GHz band to unlicensed use. This band contains up to 1,200 MHz of new spectrum (5.925 GHz to 7.125 GHz). In order to meet performance expectations for the next generation of Wi-Fi, this additional unlicensed spectrum is essential. The introduction of the 6 GHz band is certainly good news for Wi-Fi, but it also increases the degree of difficulty that accompanies the optimization of antenna performance in this expanded environment.

## Conclusion

The anticipated performance of Wi-Fi 6 has the potential to meet the growing needs for faster speeds and increased bandwidth as our wireless connectivity around the globe skyrockets. But with this increased performance comes increased complexity and challenges for wireless devices, access points, and all other aspects of wireless systems. Antennas and antenna systems are not immune to these challenges. As part of a wireless connectivity system, antennas must also be optimized to meet the performance standards of Wi-Fi 6. The need for additional antennas, the decreased size of devices and therefore antenna enclosures, and the co-existence of multiple technologies in a single device, for example, extend the complexity of Wi-Fi 6 to these antenna systems.

# About Laird Connectivity's Wi-Fi 6 Antennas

Laird Connectivity offers a large variety of antennas for Wi-Fi 6, including antennas suitable for both indoor and outdoor locations including:

- Omnidirectional, multi-port canister antennas
- Directional, multi-port panel antennas
  - Featuring various gain configurations
  - Offering various combinations of vertical and horizontal polarizations
- Omni single-port antennas

Laird Connectivity also offers single and multi-port omnidirectional antennas designed for in-building ceiling mount applications. Lastly, the Wi-Fi 6 antenna portfolio includes an extensive offering of embedded antennas for both network and subscriber devices.

**Note:** Wi-Fi 6 WLAN antennas are currently in development. Please contact Laird Connectivity to discuss how we can address your requirements.

For more information, visit [lairdconnect.com/rf-antennas/wi-fi-antennas](https://lairdconnect.com/rf-antennas/wi-fi-antennas)



## About Laird Connectivity:

Laird Connectivity simplifies the enablement of wireless technologies with market-leading wireless modules and antennas, integrated sensor and gateway platforms, and customer-specific wireless solutions. Our best-in-class support and comprehensive engineering services help reduce risk and improve time-to-market. When you need unmatched wireless performance to connect electronics with security and confidence, Laird Connectivity delivers — no matter what.

Learn more at [lairdconnect.com](https://lairdconnect.com)