



# Best Practices for Wi-Fi 6 Migration

by The Tolly Group

The goal of this paper is to provide a concise summary of important considerations and options for successful Wi-Fi 6 deployments.

## Executive Summary

Wi-Fi has long gone from being “nice to have” to being a business necessity. With the rapid rise of IoT combined with the abundance of personal wireless devices the number of devices has skyrocketed and the demand for bandwidth has increased along with it.

Wi-Fi 6 is the latest generation technology that brings with it significant efficiency improvements in both individual device and overall system throughput. Importantly, it also brings some new features that will allow battery-powered clients - almost all WLAN devices - to make much more efficient use of the battery when communicating via Wi-Fi. Wi-Fi 6 is here now. You need to have a plan for migration so that your business can reap the benefits ASAP.

The Wi-Fi 6 upgrade, fortunately, is not necessarily a “forklift” upgrade where everything needs to be replaced at once. Wi-Fi 6 gear is backward compatible with existing Wi-Fi standards and can be put into place in existing networks. You will, however, need and want a strategy for coordinating all the the elements of Wi-Fi 6 in your environment: Access Points (APs), client devices (laptops, phones, tablets, IoT devices, etc) and your upstream wired LAN switching and cable infrastructure.

So, where to begin? This document will attempt to take structured approach on how to begin integration of Wi-Fi 6 into your existing WLAN environment.

The best practice is to implement a Wi-Fi 6 migration that addresses the performance concerns most relevant to your company’s needs. In these pages, Tolly will outline elements for consideration in building that strategy.

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## Concept-in-a-Nutshell

Wireless local area networks (WLANs) are not only ubiquitous but essential elements of business networking. As application demands grow, the WLAN vendor community responds with enhanced technology. It is important to understand these new developments and plan an effective migration.

## Scope

This document aims to provide practical, strategic guidance to

enable network planners to recognize benefits of the new WLAN technology to see how best to leverage it in their networks both in the short and longer terms.

This document is not a step-by-step cookbook for implementing Wi-Fi 6. Tolly provides consulting services that can assist organizations in realizing specific design and implementation needs.

## Business Goals

Before any discussion of migration specifics the team should spend the required time to understand the business priority of each application and Wi-Fi service. Only with that knowledge can one effectively design a relevant and meaningful migration plan.

## Wi-Fi 6 Benefits

This document is not concerned with discussing the benefits of Wi-Fi 6. Each generation of Wi-Fi has been focused on addressing concerns and limitations of the

### About The Tolly Group

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## LANCOM Systems

LANCOM Systems is the leading European manufacturer of secure, reliable and future-proof networking (WAN, LAN, WLAN) and firewall solutions for the public and private sectors. The company combines hardware business with virtual network components and Cloud-based software-defined networking (SDN). The result is a unique portfolio of on-premises and Cloud solutions with a central platform for SD-WAN, SD-LAN, SD-WLAN & SD-Security.

LANCOM stands for "Made in Germany" quality. Solutions from LANCOM operate reliably in customer networks over many years. The product ranges excel with long life cycles and professional management. Free security and functional updates provide sustainable investment protection and ensure important competitive advantages for customers. Technical support and services are offered by LANCOM's own in-house Support Center.

Furthermore, as a leading manufacturer in the German market, LANCOM incorporates the latest technological trends in its products. In line with the upcoming Wi-Fi 6 standard, the company offers four completely new portfolio components: an integrated service gateway, a PoE-capable switch, and two ax-enabled access points. The Wi-Fi 6 product line reinforces LANCOM's unique selling points: holistic network solutions from one source, state-of-the-art technology and premium class hardware. The portfolio additions provide reliable and secure Wi-Fi – as fast as Wi-Fi 6 can be.



## Wi-Fi 6: Some Key Enhancements and Practical Benefits

Tech Enhancement	Acronym/ Reference	Purpose	Practical Benefit
Orthogonal Frequency Division Multiple Access	OFDMA	Subdivide channel	Improve performance with smaller data sizes (e.g. VoIP).OFDMA brings reliability to Wi-Fi operation. With AP scheduling clients, access to medium is regulated and thereby reliable.
Spatial Reuse (Overlapping Basic Service Set)	SR and OBSS aka "coloring"	Enables decentralized cooperation	Enables channel reuse, better spectrum use in dense deployments
Target Wake Time	TWT	Allow client wake times to be scheduled (i.e. "longer sleep time")	Improve battery life especially for IoT and handhelds
1024 Quadrature Amplitude Modulation	1024 QAM	More advanced modulation technique	Efficient transmissions. Transmit 25% more data, improves channel availability
Multi-User Multiple Input Multiple Output	MU-MIMO	Simultaneous transmissions. Extended to include uplinks	Improve throughput for multi-antenna stations

Table 1

prior generation. Wi-Fi vendors can provide details of the technology benefits and offer a variety of educational resources.

Table 1 lists some of the key technology enhancements that will be available in Wi-Fi 6 along with a note on the practical benefits.

### Triggers for Wi-Fi 6

The massive popularity and growth of Wi-Fi eventually showed the limitations of existing technology.

In recent years, the density of Wi-Fi users has generally increased along with the increase of Wi-Fi capable devices. These include

laptops, tablets, phones, watches, video cameras, sensors and other "Internet of Things" (IoT) devices.

Voice over IP (VoIP) traffic has increased dramatically as well. In contrast to prior applications such as file downloads and video streaming that was carried via large packets/frames, VoIP traffic



is delivered using small packets/frames.

Existing technology (i.e. Wi-Fi 5 and earlier) required that for each transmission a channel would be dedicated to a single client. This resulted in wasted spectrum/inefficient use of bandwidth.

Most of the mobile phone vendors have started to release their first Wi-Fi 6 devices and it is assumed that within a short period of time, all are to be released as Wi-Fi 6 only.

The above provided performance challenges to existing WLAN technology and were focal points for updates in Wi-Fi 6.

## Best Practices Goals

Identify how best to provide high-performance Wi-Fi to your business while leveraging existing Wi-Fi and wired LAN infrastructure.

## Role of Standards Group

For many years, wireless LAN technology has been standardized by the IEEE under the auspices of its 802.11 working group. Hence, every standard begins with 802.11.

Thus, core WLAN technology can generally assumed to be standards based.

## Role of Wi-Fi Alliance (WFA) & Certification

In tandem with the standards committee work, vendors formed an alliance focused on consumer

and marketing issues. The group created the designation Wi-Fi to refer to compatible WLAN products. Significantly, this group set up interoperability and certification standards for products so that buyers could be assured of compatibility and interoperability with the various standards.

The Wi-Fi Alliance has created a program for Wi-Fi 6 certification called “Wi-Fi CERTIFIED 6.” Tolly recommends that this certification be a requirement for any Wi-Fi 6 gear that you plan to use. Be aware that some early gear might have been developed prior to the certification criteria being finalized and might not pass certification. While not officially certified, some of these devices are interoperable in an 802.11ax ecosystem and should be noted as such.

Wi-Fi alliance certification is a prerequisite, but it alone is not sufficient as the focus is mainly on interoperability. For high density and high performance deployments, it's necessary to ask for performance test data and to benchmark key performance indicators (KPIs) from the WLAN vendor.

## Wi-Fi Terminology

Since its earliest days, significant WLAN standards have been identified using the IEEE designation of the standard. Thus, one of the early Wi-Fi standards was known as 802.11b and the very latest data rate version available is known as 802.11ax.

The suffix letters indicate the order that each task group was begun but not necessarily the order of ratification. (After the committees exhausted a-z, they began with aa, ab, etc. aa-az have also been exhausted and current standards work is up to “be”.)

In an attempt to make Wi-Fi technology more manageable for general users, the Wi-Fi Alliance introduced a simplified naming structure with which to refer to each generation of Wi-Fi.

This document is primarily focused on Wi-Fi 6 which is the alternate name used to refer to technology implementing IEEE 802.11ax. The two terms are synonymous and can be used interchangeably. This document will use the shorter and more descriptive Wi-Fi 6 designation.

## Wi-Fi 5

The previous generation technology (sensibly) is called Wi-Fi 5 and is synonymous with the standards found in IEEE 802.11ac. This document will reference Wi-Fi 5 with respect to various differences between the the generations as well as any considerations for integrating the two environments.

## Wi-Fi 6 Waves

Various vendors rolled out Wi-Fi 5 in two “waves” or releases. The WFA will be standardizing Wave 1 and Wave 2 for Wi-Fi 6 and vendors will certify to each.



While the WFA does not publish specifics of what features are mandatory and optional in each wave, WFA vendor members have this information and generally make it available upon request.

The notes on waves that follow should be considered informational only as it was not possible to confirm it with the WFA.

Wave 1 will include: UL/DL OFMDA, DL MU-MIMO, 1024 QAM, TWT, 160MHz channels and 8x8.

Only UL and DL OFMDA are mandatory.

DL MU-MIMO is mandatory on APs only if the AP supports four or more spatial streams. Target Wake Time is optional for clients but mandatory on APs. 1024-QAM (and 256-QAM) are optional. 8x8 is optional.

Although not finalized as of Q4 2019, features anticipated in Wave 2 include: UL MU-MIMO and BSS Coloring (Spatial Reuse). Possibly combining MU-MIMO/TxBF and OFDMA. (Note that BSS coloring is a component of, but not synonymous with, spatial reuse.)

The Wi-Fi industry works closely with the national regulators to acquire more spectrum in the 6GHz band. When this occurs another wave of hardware will be needed.

### General Interoperability

For many years, WLAN technology has been based on standards and that continues to be the case with

Wi-Fi 6. Thus, as noted elsewhere, it is generally safe to assume that core functions will interoperate.

Various vendors may extend their offering with network management and other mechanisms that are not defined by the standards groups and, thus, are not likely to be interoperable.

### Wi-Fi 6 Interoperability

As noted earlier, the primary concern should be with early Wi-Fi 6 products that might have been finalized prior to the finalization of certification requirements for the Wi-Fi Alliance's "Wi-Fi CERTIFIED 6" program. The WFA WPA3 certification and others may be prerequisites for the Wi-Fi 6 program.

### Wi-Fi 6 Backward Compatibility

Wi-Fi 6 is the new high performance technology, but it is backward compatible with all prior technologies 802.11 a/b/g/n/ac. Additionally unlike the prior Wi-Fi 5 technology all the new improvements being delivered with Wi-Fi 6 will be available to both 2.4GHz and 5GHz radio bands.

This means you don't have to refresh your entire Wi-Fi 5 infrastructure to benefit from Wi-Fi 6 technology. Depending on use case you can either refresh your network completely or selectively.

### Feature Availability

Not all vendors will support all features beyond those mandated for certification. Some vendors might not believe that certain features are appropriate to implement for certain markets or a given feature may not yet be implemented but still on a vendor roadmap.

### Vendor Lock-In

Vendor lock-in is not typically an issue with WLAN technology as being standards-based one can generally mix-and-match gear from multiple vendors.

As noted elsewhere, though, management and administration elements are beyond the scope of the standards group work. Thus, these will vary across vendors and will usually only work with the primary vendor's gear.

## WLAN

### Performance & Efficiency

This is not designed to be a detailed or technical discussion of Wi-Fi 6 technology. Rather, its purpose is to provide an understanding the practical benefits available with Wi-Fi 6 in each area.





## VoIP and Small Packet Efficiency

With prior versions of Wi-Fi, a given spectrum was dedicated to a single client for the albeit brief duration of a single transmission. For certain types of traffic and clients, this was wasteful as there was excess bandwidth that remained idle.

Wi-Fi 6 introduces a concept known as resource units (RUs) as a way to multiplex and share among eight or more clients the same bandwidth that previously was available only to a single client at one time.

Depending upon the traffic profile, this new multiplexing technique could increase both bandwidth efficiency and client performance.

Although Wi-Fi 6 introduces OFDMA and RU concept, the limiting factor will be AP hardware and scheduler.

Some APs will be better at handling multiple simultaneous clients than others. Before committing to a large scale deployment, it would be prudent to measure and understand any potential performance bottlenecks. One KPI to track - maximum simultaneous RUs, this indicates how many clients the AP can handle simultaneous in uplink and downlink.

## Dense Environments

By dense we mean many APs near other put in place to handle large numbers of users. Environments such as sports venues, universities, hospitals, multi-unit dwellings (apartments) and shopping malls are among the environments that would likely fall into this category.

In Wi-Fi 5, the primary inefficiency is that the overhead for a single station to acquire the channel under CSMA/CA, and to perform acknowledgements of received data is very large compared to the time required to transmit the actual payload. So with escalating numbers of stations (STAs) there is an escalating amount of network overhead. OFDMA addresses this by multiplexing many such overheads into a single transmission time block (TXOP).

Wi-Fi 6 also introduces an additional tag that allows Wi-Fi 6 devices to ascertain exactly which AP they are “hearing.” The technical term is spatial reuse but generally called “coloring” provides a method for the AP and client to confirm whether they are part of the same basic service set and eliminate confusion and wasted wait time. BSS coloring is not a Wave 1 feature. The color signaling field is included (because it is part of the MAC layer). But nobody can do anything else with it in Wave 1. BSS Color manipulation will come in Wave 2.

## More MU-MIMO

Multi-User Multiple Input Multiple Output is another multi-radio multiplexing technique introduced in earlier Wi-Fi upgrades. Previously, the technique was limited to downlinks only and maxed out at 4x4 radios. With Wi-Fi 6, both downlink and uplinks with up to 8x8 radios are supported.

With OFDMA, feedback and acknowledgments from multiple clients can now be delivered in parallel making MU-MIMO more efficient. These new updates are meant to make MU-MIMO more practical in deployments.

It is important to note that most clients today are 2x2. But it is with 1x1 and 2x2 clients where the potential 8x8 MU-MIMO AP benefits are the highest. The reason for 8x8 APs is that a single AP can communicate simultaneously with up to four 2 spatial stream (SS) stations, or up to eight 1SS stations.

## Client Power Efficiency

Wi-Fi 6 brings another feature that improves client efficiency by allowing clients to determine how frequently the AP should communicate with them.

As constant “wake ups” deplete batteries more quickly, the new “Target Wake Time” allows each Wi-Fi 6 client so specify a custom wake up time thus allowing the client to determine the most



efficient communication interval and avoid depleting its battery needlessly.

This is a significant benefit to vendors of phones, tablets and other handheld devices as well as for IoT device vendors. Thus, industry analysts expect the adoption rate of Wi-Fi 6 to be more rapid than that of Wi-Fi 5 for client devices.

### Other Tech Enhancements

Modulation techniques have been updated, longer OFDM symbols and frame preamble updates were made that can further add to efficiency and performance.

## Access Point Power

To make full use of Wi-Fi 6 AP features and functions, the APs with more than four spatial streams will need additional electrical power.

Industry vendors say that Type 2 or Class 4 POE (25.5 W of power available to the device, 30W from the source) should be considered the minimum for Wi-Fi 6.

Some newer APs will accept two wired uplinks and accept PoE on both of them. While this requires that you have two cables run to your AP, this could be an effective option to increase power to the AP as well as uplink speed (discussed next).

Higher density models (8x8, for example) will require the latest released 802.3bt power over Ethernet capabilities. Type 3 can be class 5 (45W/40W) or class 6 (60W/51W).

Many APs also accept external power. Having to run building power to individual APs can be logistically complex and expensive, however.

## AP-Switch Uplink Speed

One can expect all Wi-Fi 6 APs to support existing Gigabit Ethernet uplinks, that is not an issue.

The uplink bandwidth could become an issue when the majority of clients are migrated to Wi-Fi 6. This is because Wi-Fi 6 systems can generate WLAN traffic in excess of one Gigabit per second, enough to make a Gigabit Ethernet uplink a bottleneck (given that much of the traffic will likely be directed through the uplink out of the local WLAN environment.)

The uplink loading depends on how the wireless system is configured. In particular the channel bandwidth that is used. When using 40MHz channels, a Gigabit Ethernet interface is unlikely to become a bottleneck.

Critical as well is if the AP has more than the traditional two radios (2.4GHz and 5GHz). Possibly a second 5GHz radio, or in the future

and additional 6GHz radio (which is more likely to operate with 80MHz or even 160MHz channels).

In any case, serious consideration needs to be given to how you can provide additional uplink bandwidth going forward.

To solve this bandwidth bottleneck between switches, the link aggregation (LAG) protocol has been developed (and generally works across vendors). This allows incremental bandwidth increases between switches. Instead of either one GbE or 10 GbE, two or more GbE links can be combined to create a single logical link of higher bandwidth between switches.

While LAG is frequently used between wired switches, it is often not a practical option for WLAN because of the expensive of the cable installation and switch ports.

Most Wi-Fi 6 APs support multiple uplinks. If your current switching environment consists of copper-based Gigabit Ethernet ports, then this is likely your only near-term option. This, of course, requires that you run a second Ethernet cable from your LAN switch to your AP.

Going forward, you will want to look at switches that support newer “multi-gigabit” options (802.3bz standard): 2.5, 5 and 10G-Base-T. These switching options will provide greater bandwidth and, being copper based, also support provision of power over the Ethernet cable.



Many vendors note that for optimal support of multi-gigabit uplinks, wiring should be upgraded to Cat6A structured cabling.

However, others state that 2.5Gbps runs fine over full-length (100m) CAT5E. And even 5Gbps can be supported on those cables when within 70m.

Thus for a majority of Wi-Fi 6 deployments, there may be no need to upgrade existing CAT5E cabling. For new installs, CAT6A is indeed recommended.

Some vendors offer GbE switches with several of the multi-gigabit ports. Other vendors, offer switches composed primarily or completely of the multi-gigabit links. Presumably, these switches are designed to serve as aggregation switches for high-speed APs and will, no doubt, have 40GbE or 100GbE uplinks into the site switching fabric as 10GbE uplinks might be a bottleneck.

## Further Considerations.

### Future AP Deployment Strategy

Wi-Fi 6 enhances high-density performance. Thus, it is important to re-evaluate your AP deployment/density strategy going forward to make sure that future deployments are optimized for Wi-Fi 6 capabilities.

### Wave 2 Equipment Availability

Not all vendors will deliver Wave 2 capabilities simultaneously. If Wave 2 capabilities are critical for your business, get a timetable from your vendor for certified products to be available.

## Next Steps/ Follow-On Work

This document should assist in identifying core Wi-Fi 6 migration concerns and options.

Tolly recommends checking with your primary LAN switch provider to determine how they plan to support Wi-Fi 6 APs that can require greater than Gigabit Ethernet uplink bandwidth.





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