Wi-Fi 6 Industry Impact Report

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Transition? Or Transformation?

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in association with Qualcomm Technologies, Inc.

Executive Summary

To hear technologists describe it, Wi-Fi 6 is about to transform connectivity. The next-generation Wi-Fi connectivity technology – along with the emerging 5G cellular generation – will shake up the way we connect with each other. The ability of Wi-Fi 6, or 802.11ax, to instantly route traffic – even to devices on the far reaches of very crowded networks – will also change the way we interact with our smart devices. It will even rework the way smart devices communicate with each other.

But from what we've seen thus far, Wi-Fi 6 is emerging on the scene in much the same manner as previous generations of wireless technology: integrated inside the latest smartphones and laptops. And in new routers and access points that promise faster, more reliable connectivity for more devices.

Which, on the eve of Wi-Fi 6-certified products coming to market, begs the question: is Wi-Fi 6 really revolutionary? Or is it evolutionary?

The unequivocal answer is yes. It is both.

To be sure, Wi-Fi 6 is providing faster, more reliable connections. Its ability to handle much more traffic at once comes at a critical time, as more laptops, smartphones, cameras, smart speakers, displays and other personal and IoT devices crowd networks with massive new data flows. And for the next couple of years, that is much of what you'll come to see out of the next-generation Wi-Fi: better, faster and more reliable Wi-Fi connectivity. Decidedly evolutionary, yet important, improvements.

But while it may not seem evident at first, revolution is destined to follow the evolution, with new applications sprouting up to take advantage of Wi-Fi 6's bankable responsiveness, even in the face of challenging conditions that would choke today's wireless networks. Some of those applications are already coming into view. Consider, for example:

- Rich virtual assistants like Amazon Alexa, Apple's Siri and Google Home will migrate into Wi-Fi 6 routers from speakers and other smart devices. That will expand the assistants' reach, enabling them to converse from smart TVs, stereos and other microphone-equipped devices on the network. Wi-Fi 6 also will help make them far more responsive, private and secure.

So as the assistants prove their mettle, consumers will find themselves tapping them for far more than weather reports, cooking timers and other simple command-and-control tasks they're mostly used for today.

- With real-time access to security cameras across airports and other crowded venues, security teams will be able to find and track suspects using a mix of AI, streaming video and human observation. That's simply not possible now, due to inevitable lags that plague older Wi-Fi networks.

- Automobile dealers will be able to connect wirelessly to vehicles' on-board diagnostics, and identify problems before drivers pull into the service bay. So mechanics could spot problems early and provide estimates for repairs even before owners head off to the waiting area for coffee.

But the blockbuster new applications that pop up to take advantage of Wi-Fi 6 will take us all by surprise when they appear – just as it has been with each new leap in network capability. Like, for example:

- A quarter century ago, when Amazon appeared on the scene to take advantage of early internet connectivity, transforming the network of universities and government research bodies into a channel for interstate commerce, or

- Fifteen years ago, when 21st-century infrastructure made possible social media sites like Myspace, Facebook and Twitter, or

- The past decade, when the emergence of LTE cellular connectivity brought us ride-sharing apps like Uber and Lyft.

Produced in association with wireless pioneer Qualcomm Technologies' Inc., which has been instrumental in bringing leading-edge wireless connectivity innovations to both cellular and Wi-Fi, this FeibusTech Industry Impact Report is designed to give the reader an appreciation for Wi-Fi 6, and what new capabilities to expect. The Brief details those enhancements, and explores the short- and long-term impact on four market segments: the home, the enterprise, public spaces and automotive.

Background: Under the Hood

A number of critical new features give Wi-Fi 6 networks and devices the ability to handle much more traffic, more efficiently. The first two, in fact, are multiuser technologies – one with origins in boosting PC connectivity and the other from the cellular world – that together lay the foundation for Wi-Fi 6: MU-MIMO and OFDMA. MU-MIMO is designed to boost traffic for more complex data from smartphones and laptops, and OFDMA is tailor-made for IoT, voice and other so-called "small-data" applications:

MU-MIMO: Multiuser, multiple-input multiple-output communication, or MU-MIMO, dramatically expands an ability introduced with 802.11ac, or what is now called Wi-Fi 5. The last-generation MU-MIMO could handle no more than four spatial streams – and only downstream data. And only on the 5GHz band. Wi-Fi 6 MU-MIMO is much more capable, handling up to 12 streams of both upstream and downstream data – on both 2.4GHz and 5GHz bands.

Single-user MIMO dramatically improves speed and reliability – provided newer laptops and smartphones also are capable. But because earlier-generation routers can only communicate with just one client at a time, it only takes one older device to bog down an entire network.

With MU-MIMO, the network can devote a channel to the older device without forcing the other devices to wait. Further, the more MIMO devices the router can serve simultaneously, the more devices can connect to the network without the risk of delays. The Qualcomm Networking Pro 1200 platform is one of the first router platforms to support 8x8 MU-MIMO – both upstream as well as downstream.

On the client side, connected devices don't need eight antennas to get the best benefit from an 8x8 router – provided they are equipped with 8x8 sounding capability. With eight-stream sounding, in fact, clients with as few as two antennas can extract the best performance from the network.

OFDMA: Orthogonal Frequency Division Multiple Access, or OFDMA, is one of the most important new features in Wi-Fi 6. It enables the router and client device to handle communications between multiple devices at once and uses the available spectrum much more efficiently by splitting signals between different devices based on how much of the resource they need. So a light bulb, for example, would get a much smaller slice of the resources than, say, a tablet streaming 4K video. Indeed, OFDMA is a critical addition to Wi-Fi technology. It paves the way for hundreds and hundreds of devices to coexist on a single access point.

Together, OFDMA and MU-MIMO make possible both a huge jump in capacity the network can deliver while, at the same time, much more efficiently deliver that capacity to all the devices relying on it. This reality will help Wi-Fi networks handle the coming explosion of IoT devices. As of this writing, the Qualcomm Networking Pro Series platformsare likely the only Wi-Fi 6 router platforms that use OFDMA to support up to 37 simultaneous devices in a single 80Mhz channel, the maximum specified in the standard. As mentioned, it is also one of the first to offer 8x8 MU-MIMO. Combined with leading-edge scheduling and planning and silicon architecture to support, the Pro Series platforms can effectively manage up to 1,500 connective devices at once.

Target Wake Time: Target Wake Time, or TWT, is a very effective technique for orchestrating network traffic and minimizing unnecessary chatter. Rather than forcing a light bulb, with its simple, infrequent communication needs, to check in with the router at the same pace as, say, a game console, the light bulb can negotiate a much lower rate. This not only reduces contention. It also dramatically reduces power requirements. Which means that more IoT devices will be able to run on battery power for longer. And smartphones will hold a charge significantly longer, without sacrificing performance.

BSS Coloring: Basic Service Set Coloring, or BSS Coloring, is a great way to improve reliability in very dense environments. The technique prioritizes – or colors – traffic, and effectively shuts out and ignores traffic on the same frequencies that is likely communicating on another network.

1024 QAM: Quadrature amplitude modulation, or QAM, is a technique for packing digital bits into radio signals. The higher the number, the more packed the bits. 1024 QAM in Wi-Fi 6 yields as much as a 35-percent increase in data rate over Wi-Fi 5, which employs a 256-QAM scheme.

Wi-Fi 6 isn't 5G!
It is important to note that some of these features are the same or similar as what the emerging 5G cellular standard employs to achieve much the same improvements in speed, capacity and latency. That, as well as the fact that both are hitting the market at more or less the same time, has caused some to believe that Wi-Fi 6 and 5G is an either-or proposition. It is not. Though both standards employ some of the same techniques to improve radio communications, they are very different technologies built for very different uses.

There are a few, minor market segments where the technologies might compete. For example, it might be difficult for managers of small, scattered outdoor IoT deployments to decide whether to link the devices with a Wi-Fi network or simply outfit each device with 5G cellular. But by and large, these wide-area and local-area network technologies are complementary, especially over the next few years as 5G infrastructure takes hold.

Most smartphones soon will ship with Wi-Fi 6 built in and, once carrier deployments are widespread, 5G as well. In some cases, like sports stadiums packed with tens of thousands of people with smartphones, plus surveillance cameras, point-of-sale terminals, environmental sensors and other IoT devices, Wi-Fi 6 and 5G will join forces to handle the intense load.

In the meantime, demand is high for Wi-Fi 6 in public venues like stadiums, campuses, high-density apartment complexes and subway interchanges, which are in line to experience some of the first deployments of the new standard. As well, consumers in households with multiple streaming devices, security cameras, smart thermostats and other IoT devices can also benefit from Wi-Fi 6 – this year, if they choose.

One pleasant consequence of Wi-Fi 6's mix of capabilities is that some benefit all connected clients, not just Wi-Fi 6-enabled devices. Which means everyone on an upgraded network will notice immediate improvement, even with older devices. And, as people upgrade to laptops and smartphones with Wi-Fi 6, those devices will do more on the network in a fraction of the time – so overall network performance will continue to improve over time.

Market Segment Analysis

Wi-Fi 6, or 802.11ax, is about to set Wi-Fi connectivity free. The new standard enables more client devices – and many times more IoT devices – to operate unimpeded on the network. It enables more audio, video and other real-time data. Taken together, it means the wireless network is available for myriad new real-time applications. And as we'll explain, some of those new duties are already coming into view.

Unquestionably, the segment that will enjoy the greatest near-term benefit is public Wi-Fi: large venues, busy campuses and congested mass-transit hubs. In terms of rapid acceleration, however, the public segment may be eclipsed by the home market, which is already beginning to see Wi-Fi 6 routers appear on store shelves. As well, the home segment may be the first to see revolutionary new use cases, as Wi-Fi 6 gives a foundational capability needed to catapult new IoT devices and applications into the mainstream.

The automotive market will take more time to develop – but it may be the most purely revolutionary segment in view today.

Public Wi-Fi
If there is a segment with a crying need for Wi-Fi 6 it is Public Wi-Fi. And if you've ever tried to post a video clip at a football game, carry on a video chat through a busy subway station or stream a HD video on the quad of a bustling college campus, then you already know why. Wi-Fi in high-density environments like these comes at a premium, and the networks struggle to keep network traffic moving.

For many of these applications, it is more than just the raw number of clients clamoring for attention on the network. It is also the radio noise from nearby networks, and from other devices on competing frequencies. This is particularly true on the 2.4 GHz band, where many appliances – as well as devices on competing wireless protocols like Bluetooth and ZigBee – conspire to pollute the spectrum for Wi-Fi.

Wi-Fi 6 is poised to help greatly in that regard. Because unlike Wi-Fi 5, which focused improvements solely on the 5 GHz band, Wi-Fi 6 brings the latest communication and contention techniques to 2.4 GHz as well.

But while the capacity and efficiency will free up personal device connectivity in the short term, venues and providers recognize the transformational potential of Wi-Fi 6, and are already working on next-generation applications.

Boingo Wireless, for example, is conducting pilot projects with the administration staff at the John Wayne Airport in Orange County, Calif., developing applications to take advantage of Wi-Fi 6. The group is creating work-orders on location and in real-time, something that was not possible with previous Wi-Fi generations due to incessant lag and spotty coverage between buildings.

The airport is also starting to outfit the passenger network in strategic spots around the airport with Wi-Fi 6, which – unlike 5G – is compatible with existing backhaul. That means managers can roll out Wi-Fi 6 piecemeal, which airport officials believe is more budget-friendly and far less risky than a wholesale upgrade.

One pain point that Wi-Fi 6 already is beginning to address in pilot deployments at stadium settings is transaction execution. Spotty connectivity at point-of-sale terminals can be frustrating for vendors and consumers alike. Staff often blames the terminals for delays that can depress sales during breaks in the action, which are critical times for food-and-beverage activity. Wi-Fi 6 promises instant transactions, which can keep lines shorter, and boost sales by luring more buyers into the queue.

Airport authorities are also eyeing another application for Wi-Fi 6: security cameras. When there is an incident on-site, commanding real-time access to the cameras can mean the difference between quickly resolving an incident with minimum disruption and costly delays, cancellations and – in the worst of circumstances – unspeakable tragedy.

Video calling is growing rapidly in popularity, though conducting a call while on the move at an airport can be an exercise in futility. Wi-Fi 6 helps ensure that calls are smooth and continue without buffering – even when passengers are racing between concourses to catch connections.

Home
Another segment poised for early Wi-Fi 6 deployments is the home market, with routers already beginning to appear on store shelves. The routers will improve wireless performance for many situations, including homes with:

- Older devices slowing the network
- Streaming difficulties at longer distances from the router,
- Smart home devices, like thermostats and security cams, and
- Many neighbors in close proximity – all with their own routers and collections of devices.

Executives at managed-Wi-Fi-as-a-service provider Plume say Wi-Fi 6 is arriving just in time to prevent home networks from getting overwhelmed by the number of devices all clamoring for connectivity. The number of households Plume manages that 50 or more connected devices is growing quickly, they said.

For its part, Netgear this fall will release a new generation of its high-performance mesh network platform: a Wi-Fi 6-upgrade for Orbi. With the new Orbi platform, Netgear is promising multi-gigabit speeds even to the far corners of the home.

The home is arguably the segment that will find the biggest benefit from Wi-Fi 6's enhancements in the 2.4-GHz band, because many households are peppered with appliances like microwave ovens, baby monitors and garage door openers clogging the network. As a result, people with older or lower-cost Wi-Fi devices, which are commonly relegated to 2.4-GHz communication, should expect to see a marked improvement in network performance. But even for those with more modern networks and double-digit devices, the improvement in 2.4-GHz band available noticeably ease congestion.

FeibusTech forecasts that Wi-Fi 6 will spark a revolution in the smart home, which thus far has been unfolding slowly – primarily due to the limitations of existing networks. Connections to the devices are inevitably choppy, often with an unacceptably annoying lag. Even simple tasks like turning off the lights with a voice assistant can take a few seconds as communications bounce up into cloud services before executing the command.

Voice is tremendously inefficient on today's networks, because it takes up far more capacity than it needs to. In fact, the same is true for most smart home devices, many of which grab a significant chunk of available bandwidth for their transmissions even though they typically send and receive small, simple packets – like "turn down the temperature," for example.

Wi-Fi 6 will also facilitate the rearchitecting of voice assistants, which will help make them the cornerstone of the smart home – as they were envisioned. Virtual assistants like Amazon Alexa and Google Voice are currently tied to discrete devices like speakers and displays, which can dramatically limit their capability. By migrating into the home network, new assistants will have far more processing power and storage available. This will give them the ability to handle many requests locally at the edge, without ever tapping the cloud. That will not only make them quicker and more private. It will also make them smarter.

By living in the network instead of a smart device, the voice assistant will have at its disposable myriad devices – like smart TVs, consoles, and stereo speakers.So the assistant could answer a request to turn off the lights from the bedroom TV as a cue to darken only that room.

Enterprise
The transition to Wi-Fi 6 in so-called "carpeted" enterprise deployments is more of an evolutionary story – at least for end users. For enterprise buyers, CIOs and other IT decision-makers, however, Wi-Fi 6 is about to rock their world.

Buyers who opt for full-spec Wi-Fi 6 solutions like Qualcomm's Pro platform can plan for up to 1,500 devices connecting effortlessly on a single access point. That is an order of magnitude more than what's possible today. Executives see opportunity, and are trying to get their arms around what this breakout advance in connectivity means for planning and budgets.

On the client side, there are pockets of application development for some verticals that also could prove to be revolutionary down the road.

In the meantime, enterprise IT managers are making plans in earnest to migrate to the latest technology, now that access points are coming to market with Wi-Fi 6 certification. And due to the hefty leap in capability, FeibusTech expects a more rapid transition than for past generations.

Once client devices are deployed in earnest next year, performance will improve steadily for Wi-Fi 6 networks. As administrators see that bump in performance – especially out to the far corners of the network – FeibusTech expects the trend toward the wireless office and the ongoing disappearance of ethernet connections to accelerate.

Enterprise network provider Arista expects the proliferation of Wi-Fi 6 – and its ability to handle real-time data types – to be the last nail in the coffin of VoIP phone systems, a market that has been in decline for more than a decade. With Wi-Fi 6 in place, cloud-based applications like Skype and WebEx running on laptop and smartphone apps will drive out discrete phones from the desktop.

Ruckus, another leading enterprise network provider, sees a couple of new use cases emerging as a result of Wi-Fi 6. For example, new regulations in cities like Chicago, Miami and Seattle mandate that staff in hotels and other hospitality establishments wear panic buttons. This IoT application is made practical – if not possible – by Wi-Fi 6 – with pervasive connectivity everywhere in a building.

And in education, Ruckus and Lenovo are making possible applications for students using VR goggles, where Wi-Fi 6 will be a game changer.

Automotive

The automotive market may turn out to be as close as there is to a purely revolutionary segment for Wi-Fi 6.

The segment, in fact, has already been in revolutionary mode as it prepares to introduce the first vehicles with integrated 5G cellular with the 2022 model year. The industry is hard at work on new uses for 5G – most notably V2X, shorthand for vehicle-to-just-about-anything-else communication. For self-driving cars, for example, vehicle-to-vehicle communication will be invaluable for preventing accidents and speeding stop-and-go traffic. Likewise, vehicle-to-infrastructure can help cut energy-wasting waits and improve traffic flow at stop lights.

Increased cellular connectivity is giving rise to two in-vehicle Wi-Fi access points, each with very different purposes: one for inside the cabin, primarily for streaming entertainment and internet connectivity, and a second for diagnostics, over-the-air upgrades and other telematics applications.

Wi-Fi 6 will help most in areas of dense office and residential complexes – which, during rush hour, will also have scores of in-auto networks vying for spectrum in stop-and-go traffic.

In-car entertainment is a nascent segment that will get a big boost from Wi-Fi 6 and 5G, as the combination will offer real-time responsiveness needed for A/V streaming, inside the vehicle and out.

And on the telematics front, automobile dealers are excited about the prospects for connecting wirelessly to vehicles' on-board diagnostics as they pull up to the service area. This wasn't possible before Wi-Fi 6, due to the sheer volume of on-board diagnostic data along with the lack of a high-capacity, low-latency network to capture it fast enough.

In just the time the vehicle pulls into the service area, reps would now be able to approach with a list of issues along with a repair estimate. That will cut wait times and increase the capacity of the service department – a win-win for customers and the dealership.

Conclusions

By now, it should be clear that Wi-Fi 6 will bring with it immediate benefits in network speed, capacity and responsiveness to the broad market – benefits that will improve over time as more Wi-Fi 6-capable devices that can make the most of the technologies' many capabilities replace systems with older-generation connectivity.

Perhaps more importantly, Wi-Fi 6 brings network performance up to a level that will enable revolutionary new applications in virtually every segment. Some of those applications are already apparent. But many won't arise for several years, until there is a critical mass of Wi-Fi 6 connectivity.

To best leverage the many benefits of Wi-Fi 6 connectivity – today, and in the future – buyers would be wise to choose the best technology available for their deployments. And the obvious choice is Qualcomm's Networking Pro, which is the only platform available today that supports 8x8 MU-MIMO and OFDMA with up to 37 simultaneous users, both spec maximums. As well, the Networking Pro's internal scheduling architecture – which is fully compatible with the standard – is ready for the demands of tomorrow's networks, with 100s of devices connecting simultaneously.