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WiFi 6 Accelerates a Path to a

HYPER-CONNECTED WORLD

WHITE PAPER

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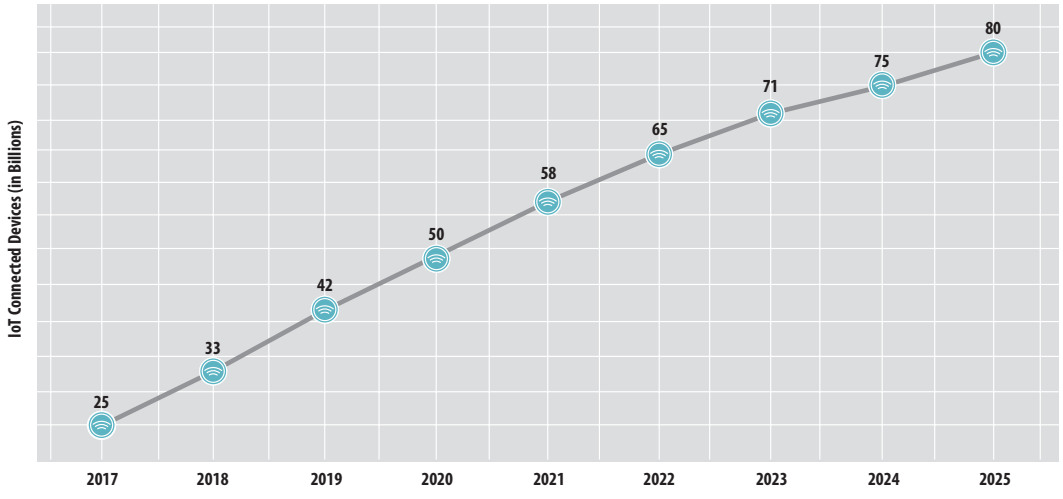
INTRODUCTION: DIGITAL TRANSFORMATION SUCCESS REQUIRES WIFI EVOLUTION

Digital transformation has become a top priority for almost all businesses today. Organizations are looking to harness the power of digital technologies to improve customer service, lower costs and increase employee collaboration. Companies that are able to do this will leapfrog their competition and become market leaders, while those that cannot will struggle to survive—with many going out of business. In fact, since the year 2000, 55% of companies in the Fortune 2000 have disappeared.

Becoming a digital company is an evolutionary leap that requires several new initiatives such as cloud computing, virtual reality (VR) and augmented reality (AR), 4K video, artificial intelligence (AI) and mobile devices. Although all these technologies may seem unrelated, they do have one thing in common—they are all network centric. This means the success or failure of digital initiatives can often hinge on the network—particularly WiFi, as it is the first point of connectivity for Internet of Things (IoT) devices and other devices. Over the next several years, the number of IoT devices is set to explode (Exhibit 1), further increasing the value of WiFi.

For example, ZK Research recently interviewed a high-end retail store in Europe that implemented a tablet program to provide in-store staff with faster access to customer information, which should improve the customer experience. This is important, as Walker and Gartner both predict that the customer experience will overtake all other factors and become the top brand differentiator by 2020. However, the retail store did not upgrade its WiFi network as part of the digital project, resulting in poor network performance. ZK Research interviewed many in-store personnel, and they stated that the slow response time of the mobile application frustrated customers to the point where they left the store. The digital transformation project was designed to increase customer loyalty, but the poor WiFi network actually decreased it.

Exhibit 1: Internet of Things Devices Are Set to Explode



ZK Research 2017 IoT Device Forecast

ABOUT THE AUTHOR

Zeus Kerravala is the founder and principal analyst with ZK Research. Kerravala provides tactical advice and strategic guidance to help his clients in both the current business climate and the long term. He delivers research and insight to the following constituents: end-user IT and network managers; vendors of IT hardware, software and services; and members of the financial community looking to invest in the companies that he covers.

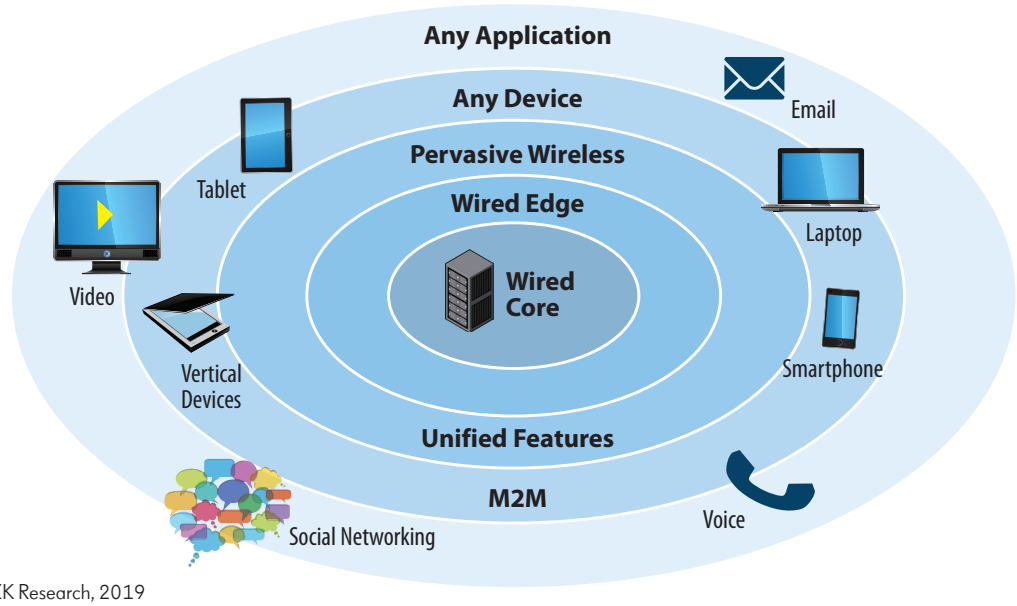
Another example of a digital transformation project that failed because of poor WiFi is a U.S.-based hospital where messages were sent to clinicians' mobile devices when patient alarms were triggered. Prior to the project, the only way the medical staff would know of an issue was to hear an alarm and then react. The project was implemented, but no change was made to the wireless network—which was in dire need of an upgrade. Many nurses reported that when an alarm was triggered, it would often take several minutes for the message to arrive at the mobile device. This made the devices unreliable and caused nurses to not trust them, as the delayed alarms were putting patients' lives at risk.

Digital transformation will impact all organizations including higher education, government organizations and general enterprises. The WiFi network should be considered a foundational technology, as it can deliver any application or content to any device regardless of the user's location (Exhibit 2). To meet the demands of digital transformation, businesses should consider upgrading to the latest version of wireless LAN, 802.11ax, also known as WiFi 6.

SECTION II: INTRODUCTION TO WIFI 6

WiFi has gone through five major releases since 1999, and it sits on the precipice of its most significant upgrade in history. WiFi 1 through 5 can be thought of as making incremental improvements to the original 802.11 standard. WiFi 6 is the first WiFi standard engineered specifically for a world where everything is connected all the time, and it assumes that upload and download speeds need to be symmetric. Older versions of WiFi assumed usage to be infrequent and casual, and they expected there would be significantly more downloading of data than uploading.

Exhibit 2: Pervasive WiFi Is Foundational to Digital Businesses



ZK Research, 2019

Exhibit 3: The Evolution of Wireless LAN

STANDARD		DATE	FREQUENCY (GHZ)	MAXIMUM DATA RATE
WiFi 1	802.11b	1999	2.4	11 Mbps
WiFi 2	802.11a	1999	5.0	54 Mbps
WiFi 3	802.11g	2003	2.4	54 Mbps
WiFi 4	802.11n	2009	2.4 / 5.0	600 Mbps
WiFi 5	802.11ac (Wave 1) 802.11ac (Wave 2)	2013 2015	5.0 5.0	1.73 Gbps 3.46 Gbps
WiFi 6	802.11ax	2018	2.4 / 5.0	9.60 Gbps

ZK Research, 2019

The "WiFi 6" terminology is new for the technology. Recently, the Wi-Fi Alliance issued new names for WiFi to make it simpler for the average person to understand. With this release, "WiFi 6" refers to the IEEE standard 802.11ax, "WiFi 5" is 802.11ac, etc. Exhibit 3 shows the evolution of wireless from WiFi 1 through WiFi 6.

WiFi 5 was a big leap forward in speed, but it was still built with legacy assumptions in mind. For example, it's common for WiFi to perform well in an arena, conference facility or other venue prior to an event. However, once the event starts, hundreds or even thousands of people post pictures, tweet or use other functions, and then the network becomes so slow that it's often unusable.

The issue isn't WiFi speeds, as 802.11n and later releases have more than enough bandwidth. The bigger problem with WiFi is how it handles congestion as the network becomes overcrowded. WiFi 6 solves many of the problems with traditional WiFi by completely redesigning how the technology works, and it takes many best practices from 4G/LTE networks.

The rest of this section discusses the major differences between WiFi 6 and older versions of WiFi.

WiFi 6 Is the Fastest Wireless to Date

WiFi 6 will be significantly faster than WiFi 5. The exact difference in speed depends on several factors including channel width and spatial streams, but the wider and multiple channels will greatly increase throughput. Exhibit 4 presents a sampling of various configurations comparing WiFi 5 and WiFi 6.

Exhibit 4: Comparing WiFi 5 to WiFi 6

	CHANNEL WIDTH	ONE SPATIAL STREAM	THREE SPATIAL STREAMS	FOUR SPATIAL STREAMS	EIGHT SPATIAL STREAMS
WiFi 5	80 MHz	433 Mbps	1.30 Gbps	1.73 Gbps	-
	160 MHz	867 Mbps	-	3.47 Gbps	-
WiFi 6	80 MHz	600 Mbps	1.80 Gbps	2.40 Gbps	4.80 Gbps
	160 MHz	1.20 Gbps	3.60 Gbps	4.80 Gbps	-

ZK Research, 2019

WiFi 6 Will Be Less Congested

One of the most significant innovations in LTE was a feature called Orthogonal Frequency Division Multiple Access (OFDMA). OFDMA is ideal for low-bandwidth applications and results in better frequency reuse, reduced latency and increased efficiency.

With previous versions of WiFi, channels were held open until the data transmission had finished. Think of a line at a store with only one cashier, so people have to queue up waiting to check out. With WiFi 5, multi-user multiple-input, multiple-output (MU-MIMO) was used to connect more users, but it provided only a marginal improvement. Continuing with the store analogy, using MU-MIMO means there can be four cashiers and four lines, but the customers still need to wait until the transaction ahead of them is completed to check out. With OFDMA, each channel is multiplexed into hundreds of smaller subchannels, each with a different frequency. The signals are then turned orthogonally so they can be stacked on top of each other and then de-multiplexed.

In the store analogy, imagine a cashier being able to handle multiple customers in the following way: customer 1 starts to write a check, which holds up the line. With OFDMA, the cashier can start ringing up customer 2's order while customer 1 is writing out the check. If customer 2 realizes that he/she forgot an item and needs to exit the line, the cashier can then start dealing with customer 3. The exact number of clients that can transmit simultaneously is dependent on channel width and the number of resource units (RUs), which are the number of subchannels created. A WiFi 6 access point (AP) can designate 26, 52, 106, 242, 484 and 996 subcarriers (the building blocks of RUs). Exhibit 5 shows the number of clients based on the number of subcarriers and the channel width.

From a user perspective, the network will seem much less congested with WiFi 6 than with WiFi 5. Another benefit is that the 2.4- and 5-GHz bands can be combined, creating even more channels for data. The WiFi 6 standard also includes 1024-QAM (quadrature amplitude modulation) encoding, which allows for more data to be transmitted per packet.

Exhibit 5: OFDMA Client Matrix

SUBCARRIERS	20-MHZ CHANNEL	40-MHZ CHANNEL	80-MHZ CHANNEL	160-MHZ CHANNEL
484	N/A	1 client	2 clients	4 clients
242	1 client	2 clients	4 clients	8 clients
106	2 clients	4 clients	8 clients	16 clients
52	4 clients	8 clients	16 clients	32 clients
26	9 clients	18 clients	37 clients	74 clients

ZK Research, 2019

WiFi 6 Has Better Client Battery Life

All new WiFi standards improve battery life because data can be transmitted further and faster, so the client isn't working as hard. However, WiFi 6 has a new feature called target wake time (TWT) that lets APs tell clients when to sleep and provides a schedule of when to wake. These are very short periods of time, but being able to sleep numerous short times will make a big difference on battery life.

SECTION III: UNDERSTANDING IF WIFI 6 IS RIGHT FOR YOUR BUSINESS

WiFi 6's speed and efficiency give it game-changing potential. Historically, for high-bandwidth applications such as real-time video and digital signage, businesses had to use a wired connection because older versions of WiFi could not deliver the necessary quality. WiFi 6 is the first wireless standard that will enable businesses to shift to an all-wireless workplace where all devices and applications connect via WiFi. As technologies such as 4K video, automated guided vehicles (AGVs) and VR/AR become mainstream, the need for WiFi 6 will further increase.

WiFi 6 is due to be ratified in early 2019, but there are commercial products available today. All businesses should eventually deploy WiFi 6, but many will not need to do so immediately. ZK Research has identified three types of companies that should look to deploy WiFi 6 right away:

Customers currently running WiFi 4 (802.11n): ZK Research estimates that up to 49% of all businesses are still running WiFi 4 somewhere in their organization. This technology is almost a decade old and can cause companies major problems with application performance or reliability. These customers should skip WiFi 5 (802.11ac) and deploy WiFi 6. Deploying

WiFi 6 can be left in place for at least five years.

WiFi 5 will likely result in the need to perform another upgrade in two to three years, while WiFi 6 can be left in place for at least five years.

Trailblazing businesses that are early adopters: Many businesses strive to stay ahead of the curve with respect to technology. WiFi 6 will provide the best possible experience for their customers and internal employees, and the technology should be a top consideration for these types of businesses. These companies are often found in highly competitive industries such as higher education, luxury retail and entertainment venues, and poorly performing wireless can quickly drive their customers to another brand. One proof point of this comes from ZK Research's finding that in 2017, two-thirds of millennials admitted to switching brand loyalties because of a single poor experience. Not all of these instances were due to WiFi, but this example does demonstrate the need to provide the best possible technology.

Companies that use high-bandwidth and immersive applications: Many businesses have integrated high-bandwidth applications into their business processes. For example, a furniture manufacturer in the United Kingdom uses VR headsets to create a virtual "sofa studio" to enable customers to see what a wide range of sofa models will look like. Another example is a high-end retail store in the United States that has created an entirely new approach to shopping by integrating technology into the in-store experience. All stores have been outfitted with interactive mirrors that greet shoppers and invite them to approach. Shoppers can tap the screen, choose merchandise, pick a beverage and even pay for items through the mirror. These are very high-bandwidth applications that will work significantly better over WiFi 6.

SECTION IV: HUAWEI—THE RIGHT TECHNOLOGY PARTNER FOR WIFI 6

Many options are available to businesses with respect to WiFi 6, and decision makers need to ensure they are making the best possible choice. China-based Huawei has been a pioneer in the technology, and the company has a highly differentiated solution currently available.

Huawei has been at the forefront of WiFi 6 since 2011. It has held one of the 16 board member positions for the Wi-Fi Alliance and three chair positions in the 13 standard task groups devoted to 802.11ax research. In addition, a Huawei expert served as the chairperson for the 802.11ax standards task force in 2014, and Huawei released the first prototype later that year. In 2017, Huawei become the world's first vendor to develop a WiFi 6 beta product, and its AP7060DN was the first commercially released product in 2018.

In addition to the standard features available with WiFi 6 specification, Huawei's WLAN SmartRadio provides several other intelligent features designed to improve the WiFi experience, including the following:

Intelligent roaming load balancing moves client connections to different APs when the signal gets weak. This feature can proactively optimize coverage for up to 80% of users.

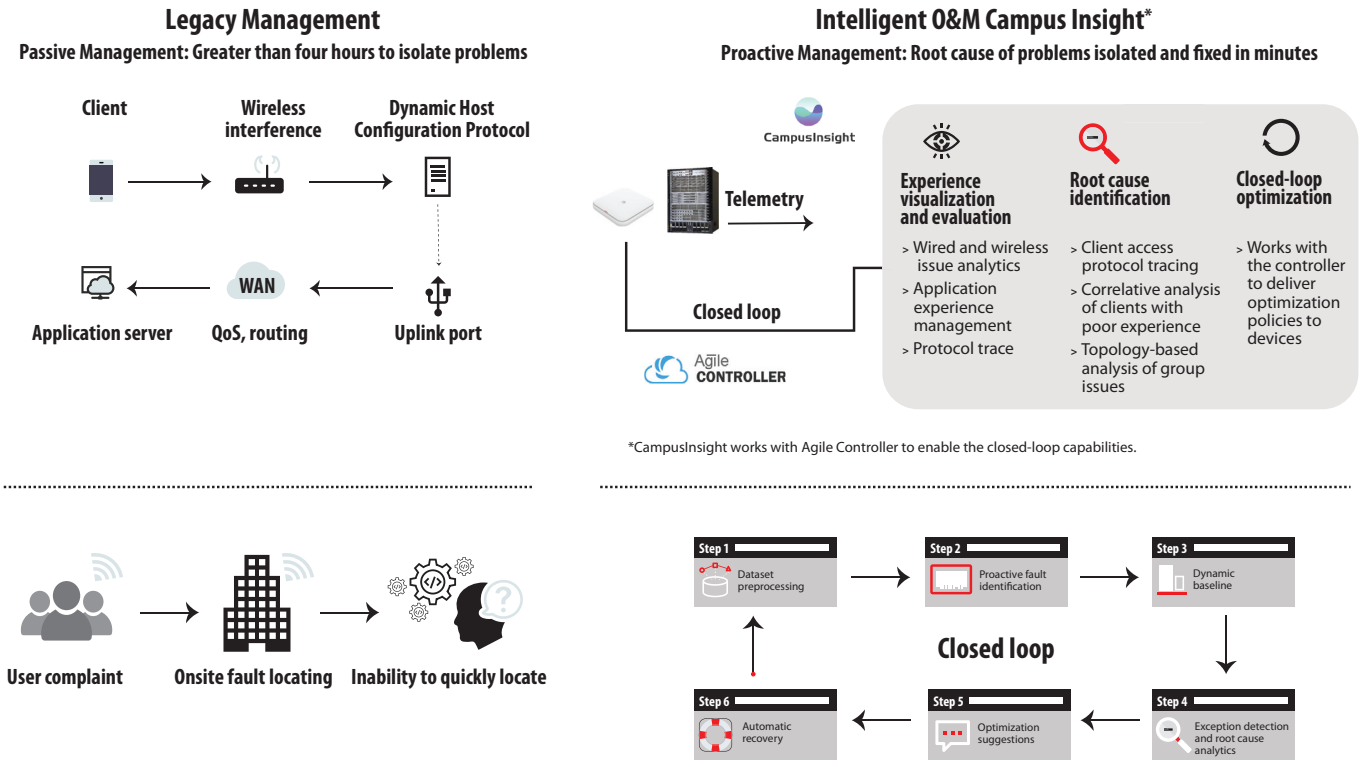
Dynamic frequency adjustment automates the process of finding the best frequency to connect to. The result is an AP capacity improvement of up to 30%.

Intelligent enhanced distributed channel access redistributes packets across channels to improve the performance of real-time traffic. This feature improves the voice and video experience by 15%.

These features are available in Huawei's newest WiFi 6 APs as well as WiFi 5 APs.

Huawei also offers a tool called CampusInsight that manages wireless and wired networks. The software uses network telemetry, machine learning and closed-loop automation to quickly identify the root cause of problems (Exhibit 6). With traditional management tools, WiFi troubleshooting can be very difficult, and it can often take hours to just isolate the problem. CampusInsight is part of Huawei's larger Intent-Driven Network vision, in which networks are autonomous and can secure and manage themselves—freeing up IT's time to focus on more strategic issues.

Exhibit 6: Huawei CampusInsight Proactively Fixes Network Problems



Huawei and ZK Research, 2019

Building a robust wireless network using WiFi 6 should be a top initiative for business and IT leaders.

CampusInsight is critical today, as the majority of IT resources are focused on managing day-to-day operations. This leaves only a small amount of budget and people time to dedicate to strategic initiatives. The ZK Research 2018 WiFi Troubleshooting Survey found that about one-third of network engineers spend at least one day per week doing nothing but WiFi troubleshooting. CampusInsight can eliminate that burden.

In addition to WiFi 6 APs, Huawei also provides a complete line of wired switches capable of supporting increased bandwidth from the access edge. The switches are designed with open standards in mind and can interface with third-party infrastructure and applications via application programming interfaces (APIs).

One of the early adopters of Huawei's WiFi 6 solution is i-Shanghai. The company has integrated APs into each of its digital kiosks, which people use to look up local information on a large digital display. The APs provide an aggregate of 10 Gbps of bandwidth and can deliver free WiFi to more than 1,000 connected devices, which is a 4x improvement over WiFi 5. The system is built with open data interfaces for the public security system in order to perform security analysis. Also, the data from WiFi can be used to analyze crowd flows.

SECTION V: CONCLUSION AND RECOMMENDATIONS

The digital business era has arrived, and all companies must now focus on building a strategy to capitalize on the new opportunities it brings. The first step in the evolution to a digital business is to become a connected enterprise that utilizes mobility as the centerpiece of its strategy.

The foundation of a connected business is the WiFi network. In the past, the wireless network in most organizations was treated as a tactical resource used to incrementally improve productivity by untethering an employee from his or her desk. In a connected business, WiFi is a strategic asset that can be used to create new business processes and change the way organizations interact with employees, customers and others. This will increase customer loyalty, enable the creation of new processes, lower costs and bring productivity to new heights.

Building a robust wireless network using WiFi 6 should be a top initiative for business and IT leaders. However, the market is evolving rapidly, and developing a strategy can be a challenge. To help organizations get started, ZK Research makes the following recommendations:

Expand the definition of "mobile first." WiFi 5 ushered in a new era of WiFi in which businesses could make the vision of "mobile first" a reality. Many of the innovations in WiFi 6 combined with Huawei's features, such as SmartRadio, expand the value of "mobile first," as it can support the explosion of IoT devices. Also, WiFi 6 enables a wide range of new use cases. IT leaders should change "mobile first" to "mobile experience first."

Understand that experience matters for digital success. The wireless network contains a wealth of information about those who are connected to it. This data should be collected and

analyzed to help companies better understand the behavior of individuals. Being mobile will create a competitive advantage today, and the data and analytics related to mobile users will enable digital businesses to maintain a leadership position over the long term.

Choose a network vendor based on today's needs. When choosing a technology vendor, it's often easiest to choose the incumbent supplier or the one with the most market share. This can be a sound strategy in legacy markets. However, when markets are in transition, it's important to choose a vendor that can meet your demands both today and in the future—and this vendor is often not the incumbent. Here are some of the criteria that should be considered:

- Robust and converged wired and wireless portfolio
- End-to-end management of network, devices and policies
- Extended network to include IoT devices
- Application experience assurance
- Open APIs to connect with third-party applications

ZK Research believes that Huawei is an example of a vendor that meets the above criteria.

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