Extreme networks

Wi-Fi 6/6E

BUYER'S GUIDE

EXIGENT

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Section I: Wi-Fi 6 Unlocks Business Innovation

The sixth generation of Wi-Fi (Wi-Fi 6/6E), technically known as 802.11ax, stands to be the biggest transformative shift in wireless technology since the invention of wireless LAN. The evolution of this technology is well-timed as it aligns with both current business and IT issues. From a business perspective, two underlying themes are driving infrastructure investments – the digitization of the business and hybrid work. This is causing organizations to modernize the underlying infrastructure.

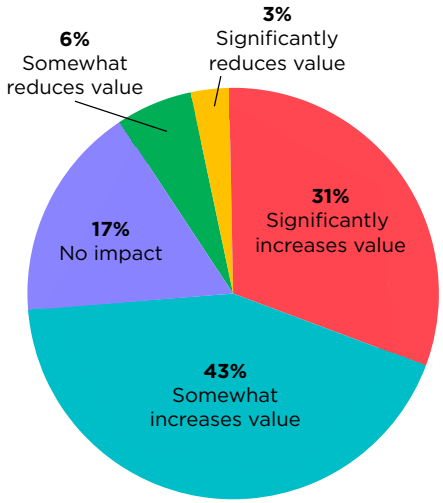
The pandemic has changed business operations and made things that were once an exception, the norm. For example, in retail, touchless payments are mandatory to help combat the spread of germs. Educational institutions are using tablets and video to create immersive learning experiences. Financial service firms and restaurants are using QR codes for patrons to look at menus, order food, and pay in a safe way.

For knowledge workers, the workplace-of-the-future will look significantly different as it must be safe, agile, and accommodate remote workers. Internet of Things (IoT) devices are being used to create a safe, flexible workplace. Businesses will use connected environmental sensors, temperature scanners, collaboration endpoints, and video systems to allow workers to work effectively but ensure safety protocols are being followed.

The creation of new, digital processes and the shift to hybrid work has changed business leaders' opinion of the network. In a recent study, ZK Research found that 74% of respondents believe the pandemic has increased the value of the network (Exhibit 1).

Exhibit 1: Networks are now critical to business operations

Source: 2021 ZK Research Hybrid Work Study



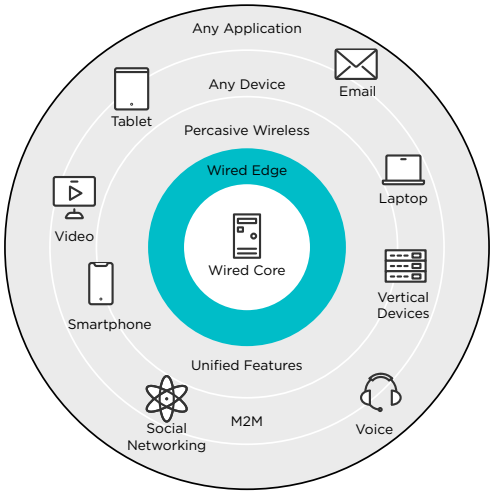
Looking ahead, the network, particularly the wireless network, will play a key role in the adoption of new technologies. Businesses will be looking to create new customer and employee experiences through the deployment of cloud computing, virtual reality (VR) and augmented reality (AR), 4K video, artificial 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 Wi-Fi.

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, improving the customer experience. This is important as customer experience is now the top brand differentiator. However, the retail store did not upgrade its Wi-Fi 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 Wi-Fi network actually decreased it.

The Wi-Fi 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, Wi-Fi 6/6E.

Exhibit 2: Pervasive Wi-Fi Is Foundational to Business Success

Source: ZK Research, 2021



Section II: Introduction to Wi-Fi 6 and 6E

Wi-Fi has gone through five major releases since 1999, and it sits on the precipice of its most significant upgrade in history. Wi-Fi 1 through 5 can be thought of as making incremental improvements to the original 802.11 standard. Wi-Fi 6 is the first Wi-Fi 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 Wi-Fi assumed usage to be infrequent and casual, and they expected there would be significantly more downloading of data than uploading.

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

Exhibit 3: The Evolution of Wireless LAN

Source: ZK Research, 2021

	Standard	Date	Frequency (GHz)	Maximum Data Rate (Mbps)
Wi-Fi 1	802.11b	1999	2.4	11
Wi-Fi 2	802.11a	1999	5.0	54
Wi-Fi 3	802.11g	2003	2.4	54
Wi-Fi 4	802.11n	2009	2.4/5.0	600
Wi-Fi 5	802.11ac (wave 1)	2013	5.0	1,730
	802.11ac (wave 2)	2015	5.0	3,460
Wi-Fi 6	802.11ax	2018	2.4/5.0	9,600
Wi-Fi 6E	802.11ax	2020	6.0	10,800

Wi-Fi 5 was a big leap forward in speed, but it was still built with legacy assumptions in mind. For example, it's common for Wi-Fi to perform well in an arena, conference facility or other venues 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 Wi-Fi speeds, as 802.11n and later releases have more than enough bandwidth. The bigger problem with Wi-Fi is how it handles congestion as the network becomes overcrowded. Wi-Fi 6 solves many of the problems with traditional Wi-Fi 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 Wi-Fi 6 and older versions of Wi-Fi.

Wi-Fi 6 Is the Fastest Wireless to Date

Wi-Fi 6 will be significantly faster than Wi-Fi 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 Wi-Fi 5 and Wi-Fi 6.

Wi-Fi 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 Wi-Fi, channels were busy until the data transmission had finished. Think of a line at a retail store with only one cashier, so people have to queue up waiting to check out. With Wi-Fi 5, multi-user multiple-input, multiple-output (MU-MIMO) was used to connect more users, but it only provided 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 handling 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 Wi-Fi 6 access point (AP) can designate 26, 52, 106, 242, 484, and 996 subcarriers (the building blocks of RUs). Exhibit 4 shows the number of clients based on the number of subcarriers and the channel width.

Exhibit 4: OFDMA Client Matrix

Source: ZK Research, 2021

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

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

Wi-Fi 6 Has Better Client Battery Life

All new Wi-Fi standards improve battery life because data can be transmitted further and faster, so the client isn't working as hard. However, Wi-Fi 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.

Introducing Wi-Fi 6E

Wi-Fi 6E builds on the existing Wi-Fi 6 (802.11ax) standard. Wi-Fi 6E offers all the cutting-edge features of Wi-Fi 6 and allows access to a new 6 GHz wireless band. This provides the following benefits:

- **Additional spectrum**. The 6 GHz band supports up to fourteen 80 MHz channels or seven 160 MHz channels. More available Wi-Fi channels means more available Wi-Fi spectrum and less overlap between networks in crowded areas like stadiums and high-density office buildings.

- **More high-bandwidth channels**. The 6 GHz band supports almost twice as many high-bandwidth (80 MHz, 160 MHz) channels as 5 GHz. More bandwidth channels mean more capacity for network heavy applications like video streaming, VR, and real time video collaboration.
- **No dynamic frequency selection (DFS) scanning required**. Unlike 160 MHz channels in the 5 GHz wireless band, devices operating in 6 GHz don't share the spectrum with radar devices or TV stations. As a result, people who cannot take advantage of 160 MHz channels because they live near places like airports or TV stations can benefit from vacant 160 MHz channels.
- **No legacy devices support**. The 6 GHz band is exclusive to Wi-Fi 6E so 6 GHz networks do not need to slow down to accommodate older devices. This means that Wi-Fi 6E devices can take full advantage of the bandwidth, spectrum, and speed improvements of 6 GHz without competing with any non-6E devices.

5G is Complementary

Although this paper is focused on Wi-Fi 6, it is important to understand 5G. Both technologies are built from the same foundation am provide higher data rates to support new applications and increased demand in capacity to connect more devices and things. 5G is often positioned as a replacement for Wi-Fi 6 but in actuality, they are complimentary and together can provide uninterrupted wireless access.

Consider a typical worker that starts their day operating at home. In the person's house, they will connect over the home Wi-Fi network. Once they leave and commute, the connection will flip to 5G. When the person arrives at the office, the connection will shift back to Wi-Fi. After the workday, the individual will use a combination of Wi-Fi and 5G depending on where the person is located. It's important to understand that Wi-Fi 6 will continue to be the access of choice for indoor settings where 5G is better for outdoor and the coming together of the two can make everyone's lives more consistently connected.

Section III: Is Wi-Fi 6 Right for You?

Wi-Fi 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 Wi-Fi could not deliver the necessary quality. Wi-Fi 6 is the first wireless standard that will enable businesses to shift to an all-wireless workplace where all devices and applications connect via Wi-Fi. As technologies such as 4K video, automated guided vehicles (AGVs) and VR/AR become mainstream, the need for Wi-Fi 6 will further increase.

All businesses should eventually deploy Wi-Fi 6, but many will not need to do so immediately. ZK Research has identified three types of companies that should look to deploy Wi-Fi 6 right away:

- **Customers currently running Wi-Fi 4 (802.11n)**: ZK Research estimates that half of all businesses are still running Wi-Fi 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 Wi-Fi 5 (802.11ac) and deploy Wi-Fi 6. Deploying Wi-Fi 5 will likely result in the need to perform another upgrade in two to three years, while Wi-Fi 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. Wi-Fi 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 two-thirds of millennials admitted to switching brand loyalties because of a single poor experience. Not all of these instances were due to Wi-Fi, 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.

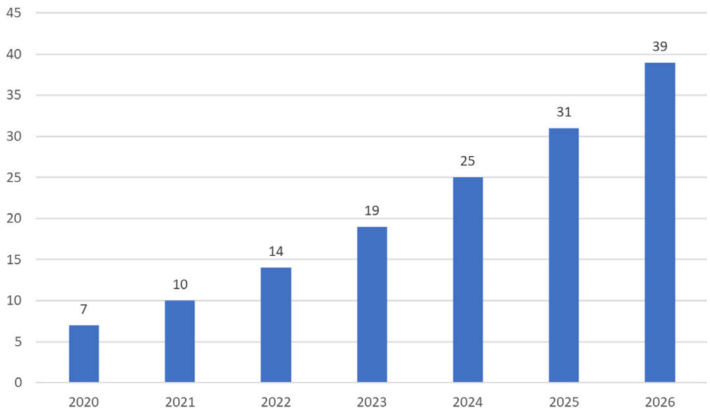
Section IV: Choosing the Right Wi-Fi Provider

Many options are available to businesses with respect to Wi-Fi 6, and decision makers need to ensure they are making the best possible choice. Below is a list of criteria that decision makers should evaluate the product on.

- **Cloud managed networks**. IT administrators are now tasked with managing access points in hundreds, if not thousands of locations, including workers' homes which require a rethinking of Wi-Fi management.
- The management tools should enable unified management with granular visibility.
- Work with a vendor or installer that has many years of experience and a proven track record of implementing complex, wired/wireless networks. Ultimately, that will be there for you in the future.
- **Robust wired portfolio**. Although access is shifting to a predominantly wireless model, the network still requires a strong wired backbone. The Wi-Fi vendor should offer a wide range of wired products that span the campus edge, campus core, and data center.
- **Secure connectivity**. As mentioned earlier, for many organizations, the wireless network has become their primary network. This means the wireless network needs to be always on and highly resilient, and it must provide excellent quality experience for even the most demanding applications. The network needs the ability to scale quickly to accommodate the rapid growth of mobile applications and other changes in the business climate. Also, security must be integrated into the network to protect its users and the organization from breaches.
- **Simple guest access**: Having guests connect to the wireless network is one of the keys to harnessing the potential of the connected enterprise. Guest access enables businesses to offer visitors Internet access without compromising the company's network. While the guest is connected to the network, the organization can extract a wealth of contextual information. But with many solutions, connecting to a guest network can be a complicated, multistep process that often requires the intervention of the IT department. Security must be a top consideration for guest access. Although enterprises secure employee Wi-Fi access with enterprise-grade authentication, they often default to the lowest common denomination of security for guests, such as a shared PSK-based guest access SSID.
- **AI based management tools**. Wi-Fi troubleshooting is extremely difficult for most network professionals as there are so many factors for providing consistent performance. Most Wi-Fi vendors offer exportable data, flow information, and telemetry to provide information that can be used for troubleshooting. The problem is that there is now too much data to be analyzed manually. AI-based management tools can quickly identify anomalies and inform the engineering team of any problems before they impact business operations. All businesses require AI-based tools to support the increasingly important Wi-Fi network.
- **Wi-Fi 6 and 6E products**. The two wireless standards are complementary and not competitive. For most companies, the benefits of Wi-Fi 6E will not be enough to justify an upgrade from Wi-Fi 6. Businesses should look to use Wi-Fi 6E in areas where device density, latency, or throughput are issues.
- **IoT connectivity**. As mentioned earlier, IoT devices are set to explode over the next five years. The 2021 ZK Research IoT Device forecast shows that the number of connected IoT endpoints will grow from 7B in 2020 to 39B in 2026. Many of these devices will connect using Wi-Fi, but some will use other protocols, such as Bluetooth. The Wi-Fi 6 vendor should offer support for all IoT endpoints.

Exhibit 5: IoT Devices on the Rise

(Connected endpoints (billions)



- **Flexible solutions**. Upgrading the wired and wireless networks can be highly disruptive to business operations. The network vendor should offer flexible solutions that enable the customer to start with what they need today but then upgrade, with minimal disruption when required.

- **Best in class customer service**. While network infrastructure is much simpler to deploy today than in years past, problems still occur. When this happens, given the business-critical nature of the network, the network vendor must offer fast and accurate customer service to minimize network downtime. Vendors that outsource their technical assistant centers (TACs) often create unnecessary risk as this introduces unnecessary delays in remediating any issue.

Section V: Extreme Brings Best in Class Wi-Fi With Flexibility

Extreme Networks has been a pioneer in networking for decades and was one of the first to embrace Wi-Fi 6. The company has invested heavily in its Wi-Fi portfolio and has a highly differentiated solution, which is why it is the product of choice for many demanding organizations such as the National Football League (NFL), Major League Baseball (MLB), and many Fortune 1000 companies. Below are a number of Extreme's key differentiators.

ExtremeCloud™ IQ

Wired and Wireless Network Management powered by Machine Learning (ML) and Artificial Intelligence (AI) with intuitive configuration workflows, real-time historical monitoring, comprehensive troubleshooting and integrated network applications.

ExtremeCloudIQ is a revolutionary and industry leading approach to cloud-based networking that takes full advantage of Extremes end to end networking solutions. ExtremeCloudIQ manages wireless access points, switches, and routers in a uniform, full stack manner. It analyzes and interprets millions of networks and user data points from the network edge to the data center using cutting edge ML/AI technologies to provide actionable business and IT insights.

Exhibit 6 shows the difference in the various licensing tiers for ExtremeCloud IQ.

	ExtremeCloud™ IQ Connect	**ExtremeCloud™ IQ** Navigator	**ExtremeCloud™ IQ** Pilot*	**ExtremeCloud™ IQ** CoPilot*
Availability	**PUBLIC**	**PUBLIC**	**PUBLIC PRIVATE LOCAL**	**PUBLIC PRIVATE**
Feature Set	Free device management for access points, switches, and routers	**EVERYTHING IN CONNECT, PLUS:** Additional management functions for third party and non-native cloud devices	**EVERYTHING IN NAVIGATOR, PLUS:** Advanced infrastructure management, reporting, and remediation tools	**EVERYTHING IN PILOT, PLUS:** Explainable machine learning derived insights and intelligence. Algorithmically detected anomalies.
Unique Features	• Device onboarding • Guided Configuration • Centralized Management • Wi-Fi Planner • Basic Monitoring Tools • Essential Security	• Application Visibility • SSH Proxy • Web Proxy wo WiNG Controller • Web Proxy to Extreme Campus Controller	• Advanced Topology View • Troubleshootiing Heuristics • Contextualized Optimization • Rold Based Profiling • Advanced 360o Reporting • Comparative Analytics *Only available for cloud native devices	• PoE Stability • Wi-Fi Capacity • Wi-Fi Efficiency • Device Uplink Efficiency • Traffic Patterns • Radar Detection *Only available for cloud native devices

Universal Hardware

Business must frequently pick between several operating systems to boost capabilities, improve product usability, or simply extend the usable lifespan of their product in today's market. When it comes to older products, it usually means rip and replace. Extreme's universal platforms make the procedure easier.

Through Universal Hardware, customers can start with one software feature set and then switch or add capabilities when required. Licenses are pooled and made available in ExtremeCloud IQ enabling customers to make the software portable across products. Benefits of Universal Hardware include:

- Feature set is decoupled from hardware and can be changed.
- No rip and replace to evolve to a new technology/ use case.
- Simple, poolable and portable switch licensing.
- One license for any device.

Products supported under Universal Hardware include 5520 series of edge/aggregation switches, 5420 fixed form wiring closet and edge switches and Wi-Fi 6/6E APs

Private Preshared Key (PPSK) Wi-Fi Security

802.1X is the gold standard for Wi-Fi authentication, but it can be difficult to deploy and configure because it requires certificate management. It's also hard to troubleshoot when problems arise. There is an alternative standard, WPA2-Personal, based on shared keys, but this is far from enterprise-grade security as each device uses the same key. If one device is breached, all devices can be impacted.

Extreme offers PPSK, which provides the high security benefits of 802.1X, but with the ease of deployment of WPA2-Personal. With PPSK each user has a unique key, that be used to connect to the network. For the user, it looks like any other pre-shared key that would be used to connect to the network. However, the IT administrator has much more control over this. They can tie the key to a user identity or the MAC address that uses that key. This simplifies the process of assigning devices to VLANs, creating QoS policies, and tunnels while ensuring each users identity is unique.

Management Solutions for IoT Devices

Extreme offers its IoT Defender adapter that is an inline security device that can be used to connect and secure devices that do not have native capabilities. Policies can be pushed to the adapter, which acts as a bridge to the company network. This is a simple, low-cost method of connecting traditionally unconnectable devices.

Extreme Technical Assistance Center

It doesn't seem to matter the age, if it was an accident or there was a network threat, all networking equipment will eventually need some maintenance. The longer your network is down, the more it can financially affect your operations sometimes with disastrous outcomes. Extreme's Global Technical Assistance Center (GTAC) has got you covered. At Extreme Networks, our experienced team is 100% insourced and we make sure your challenge is resolved as quickly and seamlessly as possible. Our methods only involve two levels of support to speed up the resolution time, not 5 levels going back and forth. In addition to GTAC's 24/7 technical assistance, we also offer customers access to the GTAC Knowledge Base where users can search for answers to commonly asked questions provided by trained Extreme Networks' engineers.

Section VI: Conclusion and Recommendations

Businesses leaders and IT pros are under more pressure than ever before. All companies must now focus on building a strategy to capitalize on the new digital era opportunities but also redesign the workplace for hybrid work. The first step in the evolution is to ensure a modernized wireless network as Wi-Fi has become the primary access method for people and devices.

In the past, the wireless network in most organizations was treated as a tactical resource used to incrementally improve productivity by untethering employees from their desks. In a connected business, Wi-Fi 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 Wi-Fi 6/6E 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 mobility**. Wi-Fi 5 ushered in a new era of Wi-Fi in which businesses could make the vision of mobile everywhere a reality. Many of the innovations in Wi-Fi 6/6E expand the value proposition of mobility as it can support the explosion of IoT devices and high-density environments. Wi-Fi 6/6E enables a wide range of new use cases, and IT leaders should no longer be concerned with choosing between the performance of wired and convenience of mobility. Wi-Fi 6/6E provides both.

- **Understand that experience matters for business 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
  - AI based management capabilities
  - Extended network to include IoT devices
  - Application experience assurance
  - Best in class customer experience

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

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