Enterprise 5G: Guide to planning, architecture and benefits

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This enterprise 5G guide explains how the cellular technology works, its architecture options, emerging use cases, how it compares to 4G and Wi-Fi 6, and more.

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Enterprise 5G: Guide to planning, architecture and benefits

CHUCK MOOZAKIS; SANDRA GITTLEN

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In the coming years, enterprise use cases will outweigh consumer use cases, making it essential for organizations to thoroughly understand 5G's benefits and challenges now and to begin evaluating how the technology could affect the way they do business.

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WHAT IS 5G?

5G is the fifth generation of cellular communications technology. Initially released in 2017 after years of development, the standard greatly increases the capacity and versatility of wireless connectivity.

5G's potential speed of 20 Gbps is a significant draw, but its low latency -- ultimately two milliseconds or less -- is even more attractive for enterprise applications that encompass augmented reality, IoT, location awareness and branch connectivity. 5G is engineered to be more secure than its cellular service predecessors, thanks to more comprehensive transport security algorithms and other safeguards.

HOW DOES 5G WORK?

5G uses a vast network of small cell stations located on light poles and building roofs, among other locations, to transmit signals via the millimeter wave spectrum (30 GHz to 300 GHz). With its shorter wavelength, a millimeter wave can only travel short distances and is susceptible to weather and obstacles, such as buildings, walls, coated windows and foliage. Millimeter wave technology works best in densely populated areas or open venues, such as in factories or stadiums, which can be blanketed with low-powered small cell stations to properly gain line of sight and boost radio signals.

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In addition to small cells, 5G networks can be connected and distributed via macrocells and femtocells.

5G isn't monolithic. Enterprises can also take advantage of the standard through the use of lower frequency bands -- low-band and midband -- with the tradeoff being support for fewer devices at potentially lower speeds and greater latency. For now, many organizations concentrate their enterprise 5G efforts in dense areas or open venues to take optimal advantage of 5G's capabilities.

Two other 5G options are standalone 5G and non-standalone 5G. Both are valid ways to build 5G networks and provide roadmaps that enterprises can follow when migrating to the 5G standard.

The 3rd Generation Partnership Project (3GPP) is working on 5G standards -- such as 5G New Radio (5G NR), a replacement for the long-term evolution (LTE) standard -- so enterprises need to pay close attention to its work. 5G NR supports the growth of wireless communication by enhancing electromagnetic radiation spectrum efficiency.

This new generation of cellular technology has its own lingo, so make sure to brush up on the 5G terms you need to know.

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THE DIFFERENCES BETWEEN 5G AND 4G

4G cellular service has been instrumental in powering the mobile workforce, but 5G will likely be better known for improving enterprise operations and making possible the delivery of new applications and services.

4G LTE is limited by its spectrum, which only reaches to 6 GHz. 5G's millimeter wave operates between 30 GHz and 300 GHz, which means the wider channels can transmit more data. 4G's use of lower-frequency bands impedes latency, speed and capacity, even though its signals can travel farther between radios or tall cell towers. Compared to 4G networks, some 5G networks might be able to support from 10 to 100 times more users and devices per square kilometer.

5G requires organizations to invest in new core infrastructure that includes base stations and antennas, as well as onboard radios for devices and sensors. 5G's shorter travel distances also demand more infrastructure -- namely, more small cell stations, about the size of a pizza box -- to get signals from one point to another without interference.

5G ushers in a whole new set of capabilities. Among them is network slicing, a technique that lets businesses program network segments to safely and cost-effectively share 5G connectivity.

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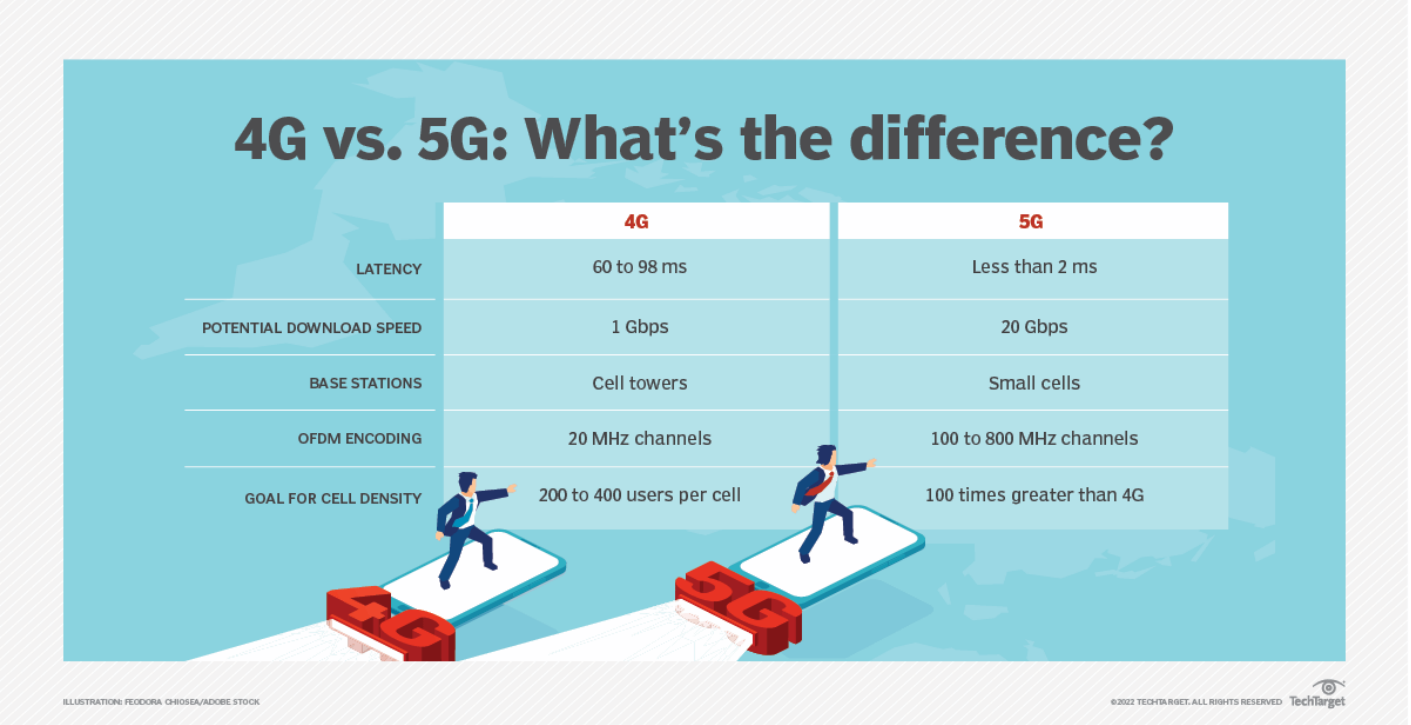

BUSINESS BENEFITS OF ENTERPRISE 5G

Organizations have long wanted a flexible and secure connectivity option for the enterprise, and the features of 5G meet that need. 5G is expected to benefit businesses in several key ways, including the following:

1. **Automation.** Increased speed and lower latency make cellular technology a viable option to bring automation to branch offices.

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2. **Flexible alternatives to dedicated links.** 5G services provide less costly and more flexible alternatives to MPLS and other dedicated lines primarily used for latency-sensitive applications.
3. **More users and devices.** Thanks to its increased capacity, 5G supports more users and devices connected in the same physical area without affecting availability.
4. **Power savings.** 5G can cut the power consumed by devices by up to 90%, making 5G a compelling IoT use case, as some IoT devices could experience a 10-year remote battery life.
5. **Augmented security.** Additional security features, including key management services, make 5G a more trusted option than 4G for IoT, branch and other enterprise traffic.

Providers, manufacturers and the U.S. government overall are working to make 5G a secure technology. Newer security tactics, such as zero trust, take advantage of 5G's programmability and can ensure only validated users get access. Notably, 5G uses 256-bit encryption, doubling the 128-bit standard used in 4G.

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5G ARCHITECTURE AND FEATURES

5G architecture better supports machine-to-machine communication than its predecessors because it features the ability to transmit large data streams, supports real-time decision-making and fosters automation. 5G's programmability makes it easier to connect with more data sources, including resources stored in the cloud.

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Finally, 5G is backward compatible with other wireless technologies, including 3G, 4G and Wi-Fi, enabling enterprises to aggregate the standard with other communications systems.

PRIVATE 5G NETWORK ARCHITECTURE

5G networks can either be public or private. To better secure their operations, many large enterprises build private 5G networks as an alternative to procuring network capacity from 5G providers. While private networks can be more costly, they enable enterprises to customize their 5G buildouts to meet application requirements, more finely manage infrastructure and secure data on premises.

When enterprises consider building private 5G networks, they should ask and answer some key questions:

1. Do you need ubiquitous coverage for devices or a new type of wireless backhaul?
2. Despite 5G's ability to support higher speeds, are you willing to trade larger cells and lower frequencies for speeds that might not meet expectations?
3. Will most of your traffic stay within your enterprise network or head out to the internet?
4. What device types, capabilities and density will be involved?

Typically, a private 5G network design includes small cell hardware and upstream connectivity to the LAN. Private 5G networks are not one-size-fits-all, however.

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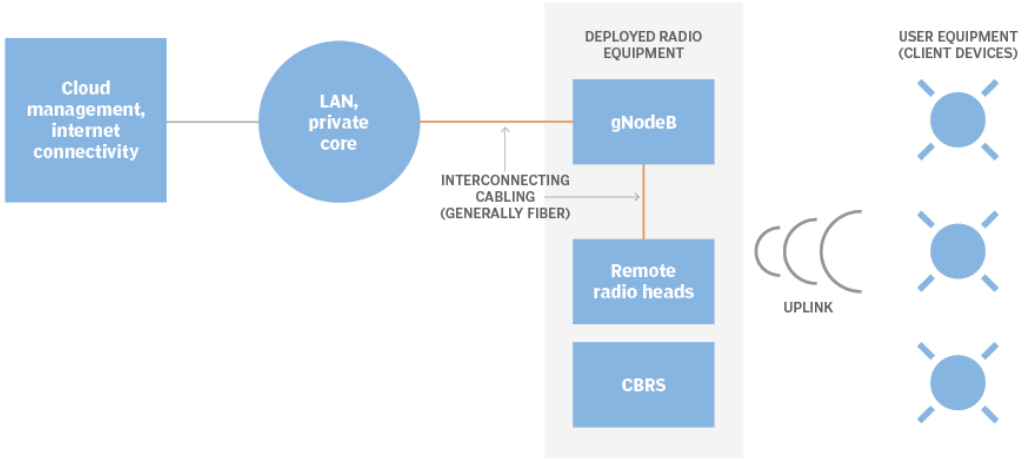
Private 5G network architecture

While this diagram simplifies a private 5G network design, these types of architectures can be quite complicated. Small cell hardware—such as gNodeB devices and remote radio heads and their associated cabling—form the access edge of the network. These devices need strong upstream connectivity to the LAN. Clients access the network as 5G radio devices. Ultimately, though, each organization's respective requirements will dictate the network design.



SOURCE: WIRELESS NETWORK ENGINEER LEE BADMAN

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5G AND WI-FI 6

The intersection of 5G and Wi-Fi 6 (802.11ax) presents some intriguing options for enterprises. For instance, Wi-Fi 6 might be better suited for congested spaces that have obstacles and little line of sight, while 5G works well in open spaces that require high speeds and low latency. Seamless handoffs between Wi-Fi and 5G networks mean the two technologies can be used together to support a growing remote workforce.

5G and Wi-Fi 6 both have powerful signal modulation, authentication and security features. In addition, each can help companies reduce their power consumption, either by design or through power-saving functions that can reduce the load on access points.

Typically, one main difference between cellular and Wi-Fi technology has been how they operate in licensed vs. unlicensed frequency bands -- but 5G changes that. Experts warn that using 5G in an unlicensed band could create interference with Wi-Fi, so businesses should carefully map out their coverage.

Also, Wi-Fi can't transfer sessions between access points. This limitation comes into play if a company wants to use Wi-Fi to track movement of products. By contrast, 5G can handle those transfers with ease.

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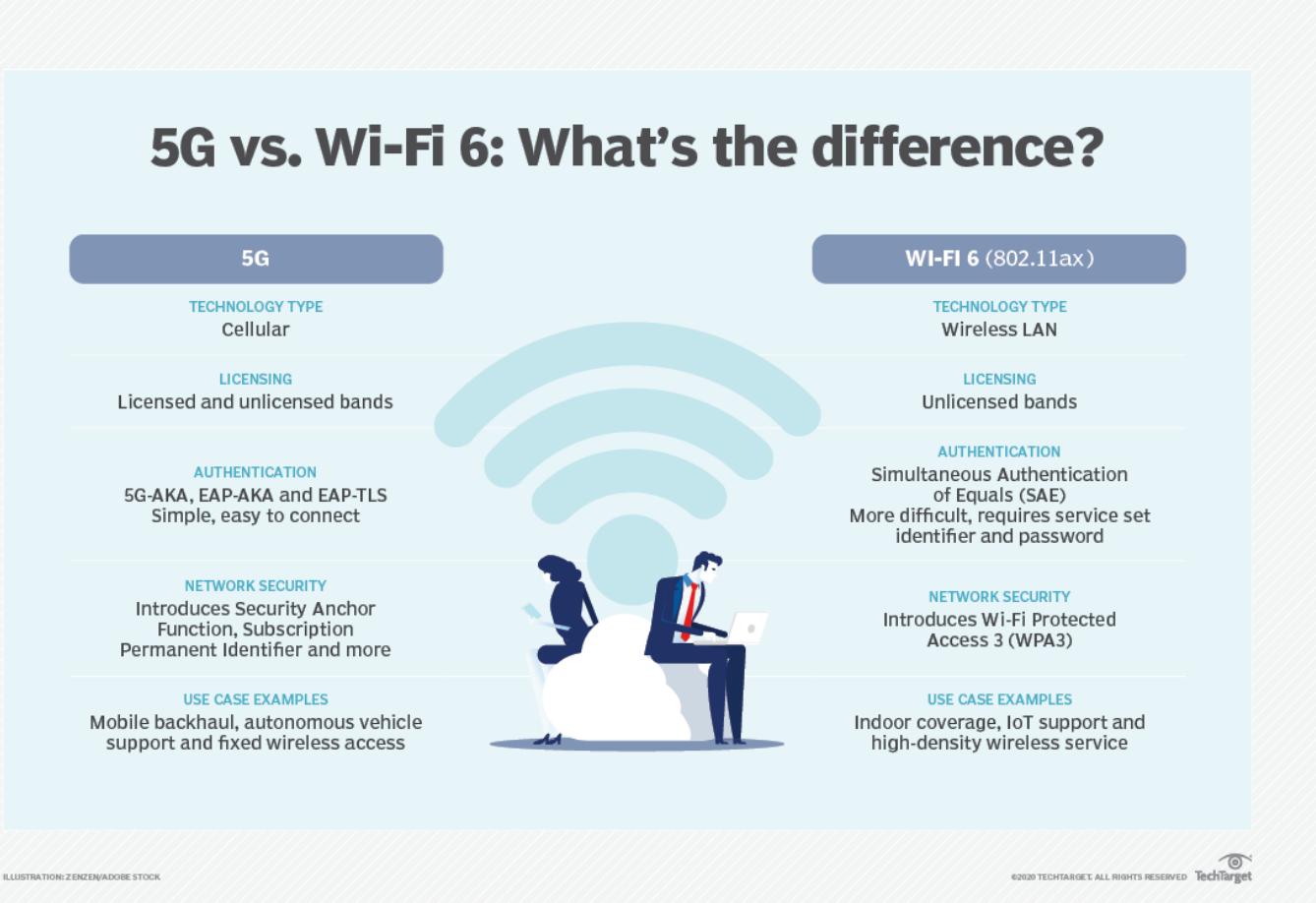

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5G, IOT AND EDGE COMPUTING

IoT and edge computing have distinct demands for high speed and low latency. In many cases, sensors are sending mission-critical information to edge or cloud-based devices to be aggregated, analyzed and acted upon. For example, consider self-driving vehicles, assembly line equipment and city surveillance cameras that constantly send and receive data.

5G's low-power requirements extend battery life, making it a perfect match for IoT networks. This capability enables enterprises to be innovative in their architecture designs, as devices won't have to be tied to a power source.

Experts recommend enterprises use an application's requirements to select the best wireless connectivity option -- understanding that 5G might be overkill in meeting the application's demands.

5G AND SD-WAN

Organizations can pair 5G and SD-WAN to manage wired and wireless connections to remote offices as well as home offices. The combination redefines WAN deployment strategies, offering organizations significant benefits as they determine how best to connect distributed workforces.

SD-WAN could also be useful in helping sites toggle between 4G and 5G connections, automatically selecting the appropriate link for the demands of the

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application and traffic conditions. Some industries, including retail, could employ SD-WAN to provision 5G as a primary option for pop-up locations, with secondary links via MPLS and broadband.

ENTERPRISE 5G USE CASES

Use cases for enterprise 5G are expanding rapidly as businesses evaluate where the cellular technology could improve their operations. Below are five examples of 5G use cases:

1. **Retail.** 5G fixed wireless can replace broadband connections, enabling faster connectivity and more flexible management. Using SD-WAN, companies could provision and manage hundreds of locations.
2. **Healthcare.** The healthcare sector is using technology to make greater use of limited resources, including surgical staff. 5G's low latency could enable surgeons to operate remotely via robotic applications. Hospitals also plan to use 5G to transmit critical diagnostic data and images that can be shared among the ER, ambulances and field teams to provide faster and more comprehensive care.
3. **Sports venues.** Sports organizations -- among them the National Football League, the National Hockey League, Major League Baseball, the National Basketball Association and NASCAR -- have deployed 5G to enrich the fan experience through real-time access to video highlights, such as instant replay and more immersive applications.

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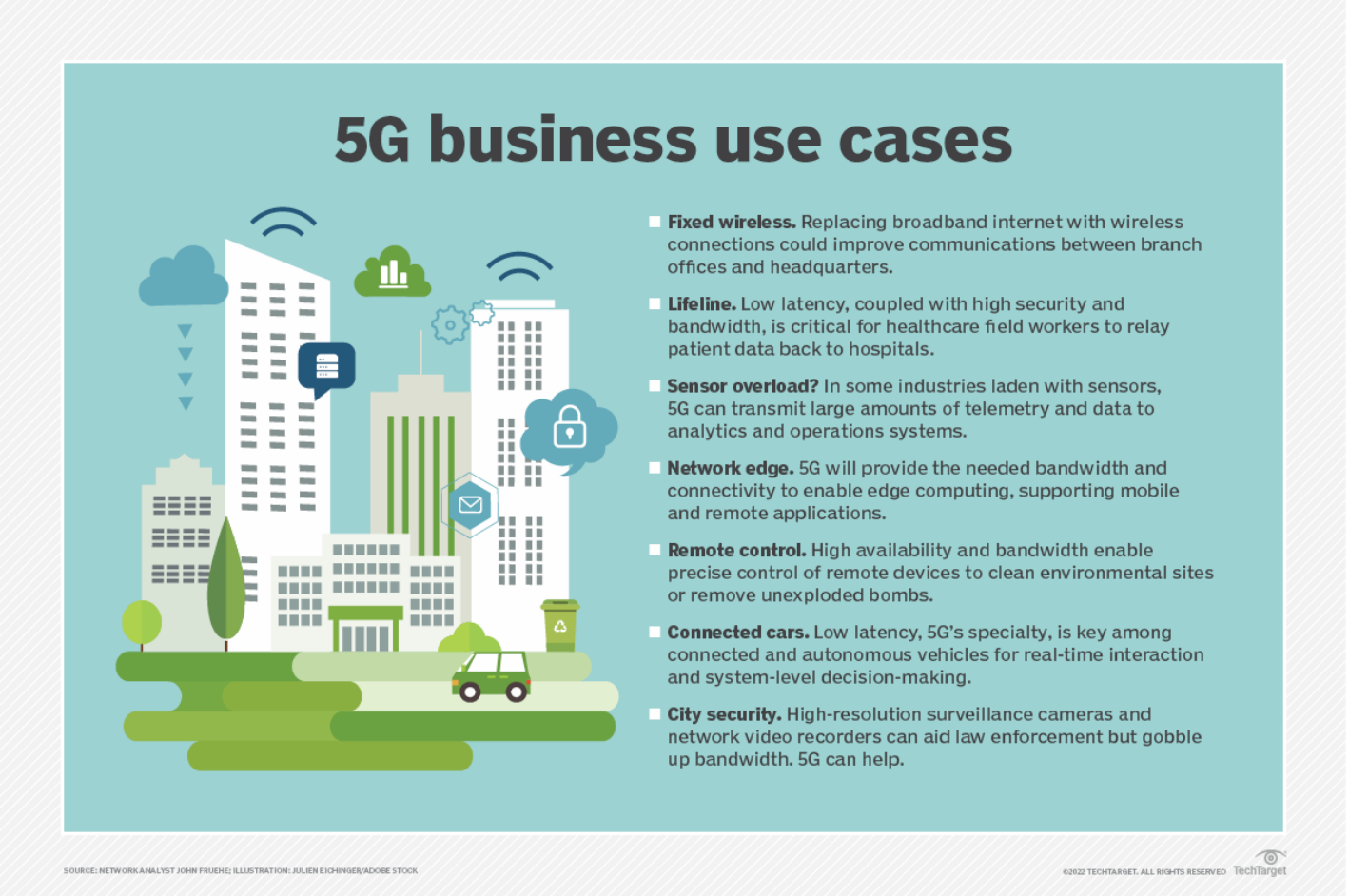

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4. **Manufacturing.** Companies can use 5G to speed connectivity from IoT sensors on machines to the cloud for more complex real-time analytics. The speed and low latency 5G provides means information extracted from the analytics can be put to use for real-time decision-making that could improve operations on the factory floor.
5. **Smart cities and autonomous vehicles.** Again, the low latency, capacity and throughput of 5G make it a prime candidate for innovation in city management and transportation. Streetlights, signals and other public safety applications can benefit from the wireless technology, enabling changes in patterns based on real-time events or AI models. Autonomous vehicles, which use AI along with machine learning and analytics to process information in real time, can communicate through 5G to automatically adjust speeds due to road conditions or increased traffic.

5G ENTERPRISE CHALLENGES

For all of 5G's benefits, enterprises should carefully consider its challenges when abandoning current wireless and wired infrastructure.

NETWORK SECURITY CONCERNS

The fact that 5G can simultaneously support more connected users and devices than previous cellular technology equates to many more vectors of exposure that need to be carefully assessed and monitored. Also, 5G requires far more infrastructure that must be protected from threats. Experts warn that hackers could use a 5G network to

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exploit existing vulnerabilities or to develop new modes of attack. Finally, the 5G standard itself does not support end-to-end encryption, and that gap early in the connection process can leave enterprises potentially open to attack.

STAFFING AND TRAINING

As with any evolving technology, finding qualified IT staff to integrate 5G will be an ongoing challenge for most enterprises. IT staff have to be specifically skilled to oversee a network that seamlessly shifts between wired and wireless connectivity. Personnel must also be able to troubleshoot myriad technical issues as well as manage 5G-enabled network components that range from simple IoT sensors to complicated machinery.

COST

5G requires a hefty investment to reap its full reward. Legacy network components have to be swapped out with those that are 5G compatible. Companies also have to buy new wireless gear to ensure adequate coverage.

SIGNAL INTERFERENCE

Perhaps more than any other wireless technology, 5G requires network teams to pay close attention to site surveys. The easiest use cases are venues with open spaces all under one roof. A site survey can reveal the extent of signal penetration challenges -- specially coated windows, walls, etc. -- and radio dead spots, as well as

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how much effort would be needed to mitigate them either with a facility redesign or additional equipment, such as antennas.

Although enterprises might face some indoor coverage challenges with 5G, small cell technology can help.

AVAILABILITY OF 5G

Companies that want to take full advantage of 5G enterprise-wide must first determine whether the cellular technology has been launched at all their locations.

Service providers are still in the process of rolling out their 5G services, with most of their attention focused on densely populated areas, such as major metropolitan cities. Although use cases for agriculture and mining are plentiful in rural areas, deployment of 5G in those locations might not be cost-effective for carriers, which could delay its availability.

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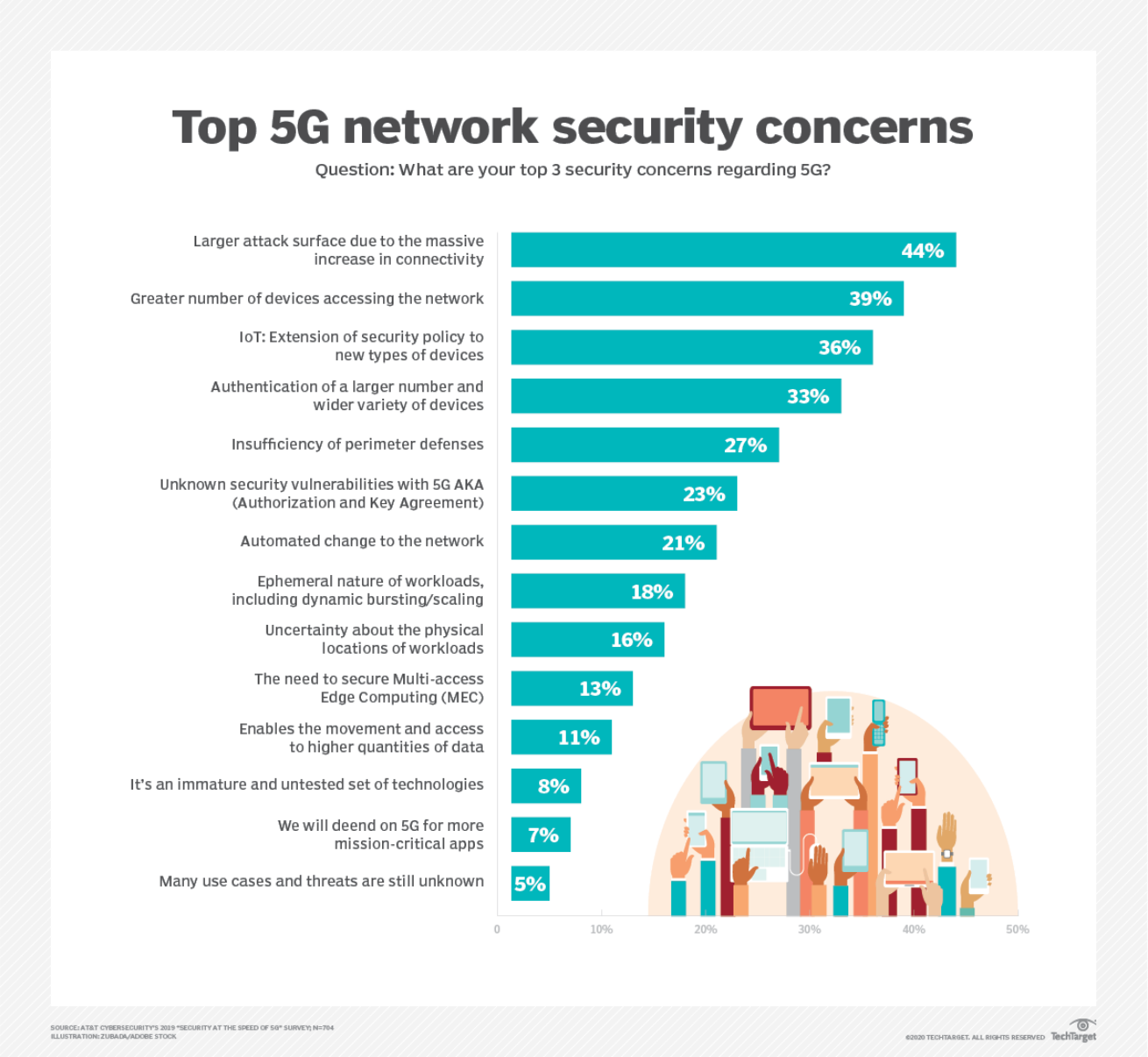

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HOW TO FIND PARTNERS AND BUY 5G

5G service is only as good as the devices and applications using it, so organizations should chart a roadmap for when enterprise equipment and applications will be available to support 5G. From that, they can create a timeline for procuring 5G services.

Businesses have to decide whether to buy, lease or build a 5G network. With those three options, enterprises could buy public 5G services from a mobile operator, lease a 5G network slice or build a private 5G network.

Enterprises that want to build their own private 5G network should partner with an integrator, vendor or service provider to help with some of the more nuanced aspects of 5G. For example, 5G can significantly increase traffic, so organizations must assess if other parts of the network -- such as the VPN -- can handle the load.

Enterprises that choose to build their own 5G networks should consider the following four factors:

1. Spectrum for the radio network.
2. 5G infrastructure to provide the required features and interfaces.
3. Small cells or microcells to transmit and receive.
4. Interconnected facilities to link the private 5G network to the public mobile network if required.

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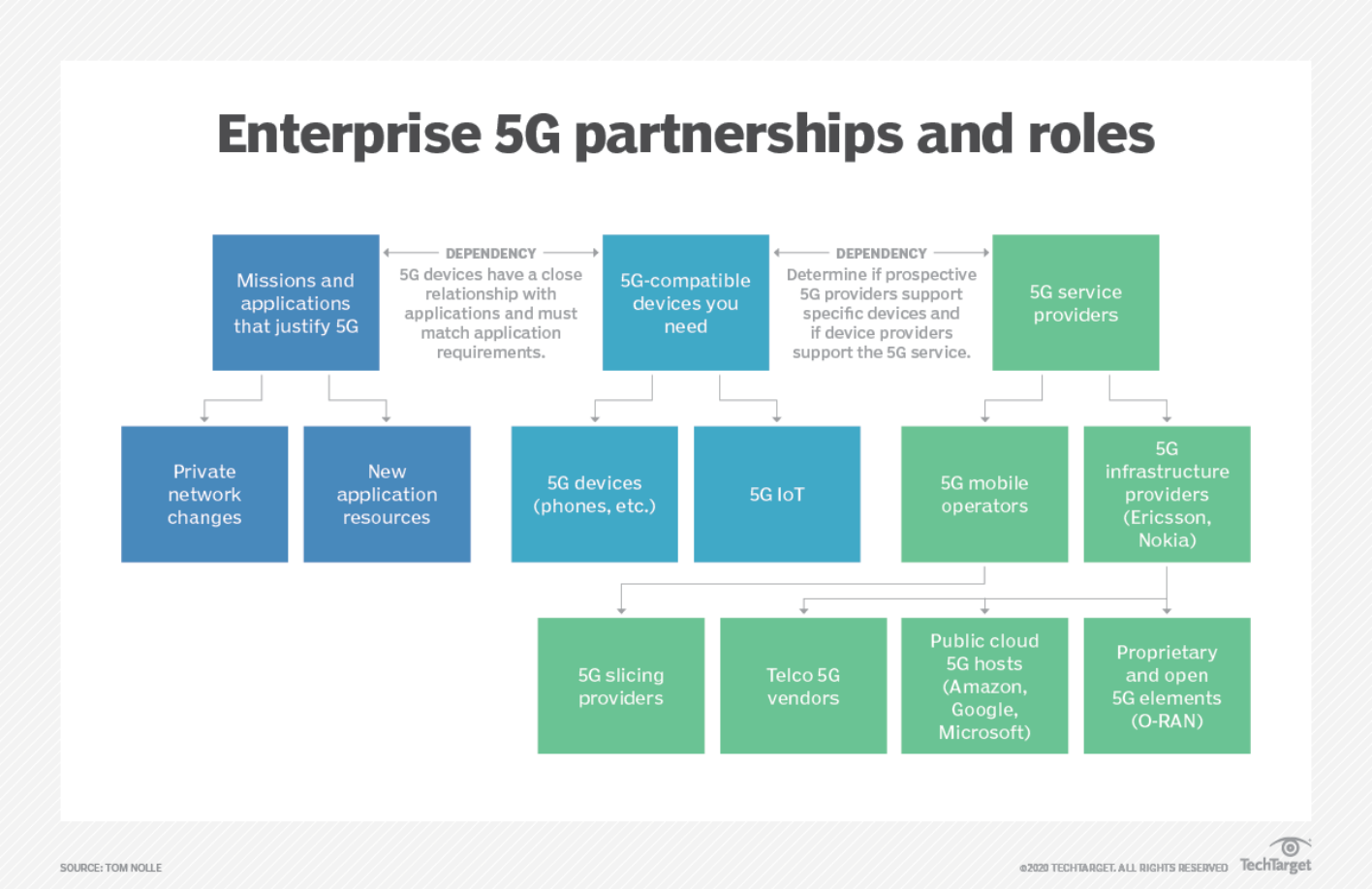

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THE FUTURE OF ENTERPRISE 5G

Enterprise 5G is all about innovation and applications. What comes next depends on how effectively enterprises take advantage of 5G's speed, low latency and capacity to push AI, machine learning, real-time analytics and other advancements deeper into their operations.

New iterations of 5G are also waiting in the wings. The 5G Advanced standard is pegged for release in 2024, according to a timetable released by the 3GPP. Among other capabilities, 5G Advanced will support extended reality communications, which builds on existing augmented and virtual reality applications. Read more about what might happen with 5G in the coming years.

At the same time, the wireless industry is already working on 6G technology, which is expected to begin launching commercially in 2030 and support data rates of 1 TB per second. 6G will build on 5G's capabilities for applications, such as imaging, presence technology and location awareness. 6G technology will be able to selectively use different frequencies to measure electromagnetic absorption rates and adjust frequencies accordingly. Industries such as government, healthcare and transportation will benefit greatly from 6G.

Chuck Moozakis is editor at large of the Networking, Security and Infrastructure group at TechTarget.

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Sandra Gittlen is former editor at large for TechTarget's Networking and Security Media Group.

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- **Top use cases for 5G augmented and virtual reality**
- **What 5G skills are most in demand?**