



# Accelerating enterprise innovation and transformation with 5G and Wi-Fi 6

Deloitte's Study of Advanced Wireless Adoption,  
Global Edition

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# Introduction

IN OUR HYPERCONNECTED era, the number of networked devices may reach 29.3 billion by 2023—more than three devices for every human being on the planet.<sup>1</sup> Next-generation wireless technologies such as 5G and Wi-Fi 6 are poised to become a crucial part of the networks that link machines and people. By offering significant performance improvements—such as faster speeds, increased data capacity, lower latency, greater device density, and precise location sensing—these new wireless technologies are already enabling novel solutions, including autonomous vehicles, precision automation and robotics, telemedicine and telesurgery, immersive retail and entertainment experiences, and augmented-reality workplace collaborations.

Innovative solutions such as these are why leaders across industries see advanced wireless networks as increasingly essential to their strategies. And rising urgency is accelerating a shift in focus to 5G and Wi-Fi 6, far faster than what executives forecast less than a year ago.

In early 2020, Deloitte surveyed US-based networking executives to understand how US enterprises are approaching advanced wireless technologies and how they expect to benefit from the new capabilities.<sup>2</sup> Shortly after that survey wrapped, the COVID-19 pandemic plunged the world into a time of extraordinary disruption, spurring a global recession with substantial workforce and IT implications.<sup>3</sup> To obtain a global perspective on advanced wireless adoption and assess attitudes during the crisis, we extended our survey in Q4 2020 to 437 networking executives from nine additional countries, representing organizations with plans to adopt 5G and/or Wi-Fi 6 (see sidebar, “Methodology”).

We uncovered key insights about *how* and *why* organizations around the world plan to adopt advanced wireless:

## **The pandemic has accelerated the shift in focus to advanced wireless.**

The COVID-19 pandemic has catalyzed a shift in priorities: Remarkably, half the global networking executives we surveyed report that the crisis has spurred their organization to *accelerate investment* in wireless networking. They’re focusing on newer technologies such as 5G and Wi-Fi 6, which they view as a way to bolster their ability to address current and future disruptions, as well as an opportunity to create new solutions. Our earlier survey indicated that executives planned to take up to three years to shift their attention to 5G and Wi-Fi 6 from older wireless technologies, but priorities have changed much faster than anticipated.

## **Advanced wireless is foundational to innovation and transformation.**

As the latest in a decades-long evolution of wireless technologies, 5G and Wi-Fi 6 promise performance and operational improvements over previous generations. More significantly, they enable innovative usage scenarios that aren’t merely incremental advances.<sup>4</sup> Indeed, networking executives expect next-gen wireless to be integral to their business success and transformational for both their enterprises and industries, representing an opportunity to change how they operate, innovate, and sell. Leaders view advanced wireless technologies as foundational to their efforts to implement innovative technologies at the heart of their digital transformation efforts, including big data analytics, artificial intelligence (AI), Internet of Things (IoT), cloud, and edge computing. More

than ever, these technologies are converging in enterprise innovation initiatives, with advanced wireless at the core.

**The ecosystem is complex and evolving.**

Adopters engage with myriad telecom and technology vendors (for example, application providers, cloud companies, wireless carriers, network equipment providers, component vendors,

and consulting firms/integrators) and often with multiple vendors of each type. Two-thirds of adopters prefer to purchase best-of-breed components, and many seek help with integration. With seven in 10 adopters indicating they're open to exploring new relationships, it will become increasingly important for vendors to carve out and solidify their position.

## METHODOLOGY

To understand how enterprises around the world are adopting advanced wireless technologies, including motivations, challenges, and preferences, Deloitte in Q4 2020 (during the COVID-19 pandemic) surveyed 437 IT and line-of-business (LoB) executives in nine countries, who are responsible for connectivity at organizations in the process of adopting 5G and/or Wi-Fi 6 or planning to adopt either technology within the next three years. The countries represented: Australia (51 respondents), Brazil (51 respondents), China (50 respondents), Germany (50 respondents), India (51 respondents), Japan (51 respondents), Netherlands (50 respondents), Portugal (29 respondents), and United Kingdom (54 respondents). Eight in 10 executives decide networking investments; 7 in 10 manage implementations.

Seventy-one percent of respondents are IT executives; the rest are LoB executives. Fifty-nine percent are C-level executives, including CIOs and CTOs (48%) and CEOs, presidents, and owners (10%); 22% are senior VPs/VPs/business unit heads; and the remaining 19% are senior directors/directors. In terms of company size, 15% have an annual revenue of US\$50 million to US\$500 million; 20% have revenues of US\$500 million to US\$1 billion; 34% have revenues of US\$1 billion to US\$5 billion; and 31% have revenues of US\$5 billion or more. Six industries are represented in the survey: consumer, retail, and automotive (25%); technology, media and telecom (19%); energy, resources and industrials (19%); financial services (22%); life sciences and health care (8%); and education (6%).

Note: Our prior survey of 415 US networking executives<sup>5</sup> was conducted in Q1 2020, before the effects of the COVID-19 pandemic were felt in the United States. Both surveys have similar respondent profiles.

# Networking executives have rapidly shifted their focus to advanced wireless

**D**ELOITTE'S EARLY 2020 study found that US-based networking executives still viewed 4G/Long Term Evolution (LTE) and current (or previous) versions of Wi-Fi as the most critical wireless technologies for their businesses. Most viewed 5G and Wi-Fi 6 as up-and-coming over the next few years.<sup>6</sup>

years, as physical 5G infrastructure is built out and 5G devices become more available, leaders expect the new technologies to become even more significant.<sup>7</sup> It's worth noting that executives now see 5G and Wi-Fi 6 as higher priorities than 4G LTE and Wi-Fi 5 (and older versions) in nearly all the countries we studied.<sup>8</sup>

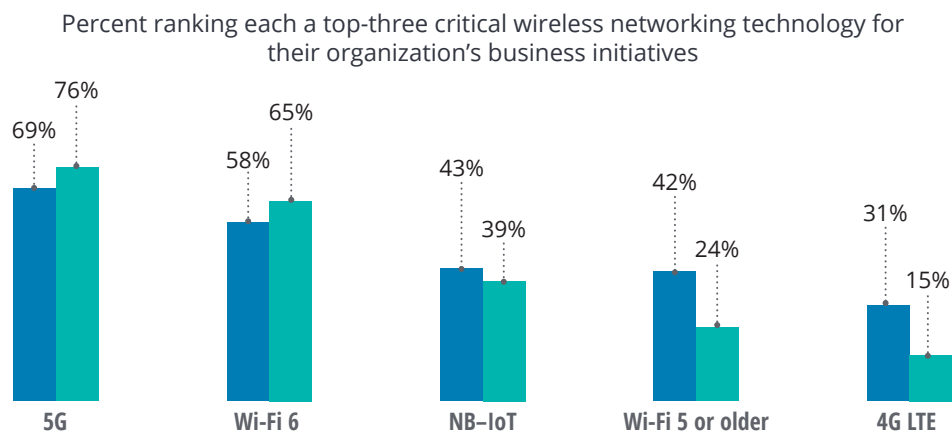
Attitudes shifted quickly: Nine months later, global networking decision-makers regard 5G and Wi-Fi 6 as the most critical wireless technologies for their business initiatives (figure 1). And in the next three

About two in five executives ranked Narrowband IoT (NB-IoT) in their top-three most important wireless technologies, although enthusiasm varies considerably by country—in China and India, three

FIGURE 1

## Networking executives already regard 5G and Wi-Fi 6 as the most critical wireless technologies for their business initiatives—and their importance will continue to grow

■ Today ■ In three years



Note: N=437 global networking executives.

Source: Deloitte's Study of Advanced Wireless Adoption, Global Edition, 2021.

in five networking executives ranked it within their top three, reflecting higher uptake in those countries.<sup>9</sup> As part of the upcoming 3GPP Release-17 5G specification, NB-IoT can play a role in organizations' 5G IoT evolution strategy.<sup>10</sup>

## The COVID-19 pandemic is accelerating wireless investment

Why has leaders' focus shifted toward advanced networking technologies much faster than our 2020 study suggested? For several reasons that the world saw play out in real time over the nine months that separated our two surveys. The COVID-19 pandemic caused surging demand for better connectivity to support remote working, online learning, and automation. The crisis vividly underscored organizations' need for ubiquitous, secure, high-quality connectivity to reduce onsite personnel, maintain business operations, and support virtual employee interaction and customer engagement. And it highlighted the value of virtualization and automation capabilities that enable more flexible, remote management of enterprise operations.

Others have noted the extent to which the pandemic has catalyzed change in the technology, media, and telecommunications industry, compressing what was expected to be years of gradual change into several intense months.<sup>11</sup> Our study findings corroborate this: Half the networking executives we surveyed expect to boost their wireless networking investment due to the pandemic (15% report they'll invest significantly more), while less than a quarter report pullbacks (figure 2).

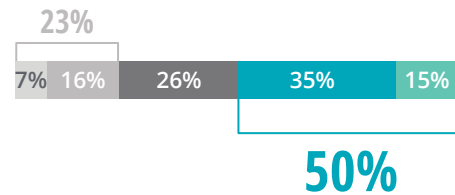
The primary stated reason for escalating wireless investment is resilience—augmenting an organization's ability to address current and future business disruptions (figure 3). After all, the pandemic will surely not be the last crisis

FIGURE 2

### Half the networking executives expect to boost their investment due to the pandemic

Compared to our planned wireless networking investments before the pandemic, the COVID-19 crisis is causing our organization to invest . . .

- Significantly less
- Somewhat less
- No change
- Somewhat more
- Significantly more



Note: N=437 global networking executives.

Source: Deloitte's Study of Advanced Wireless Adoption, Global Edition, 2021.

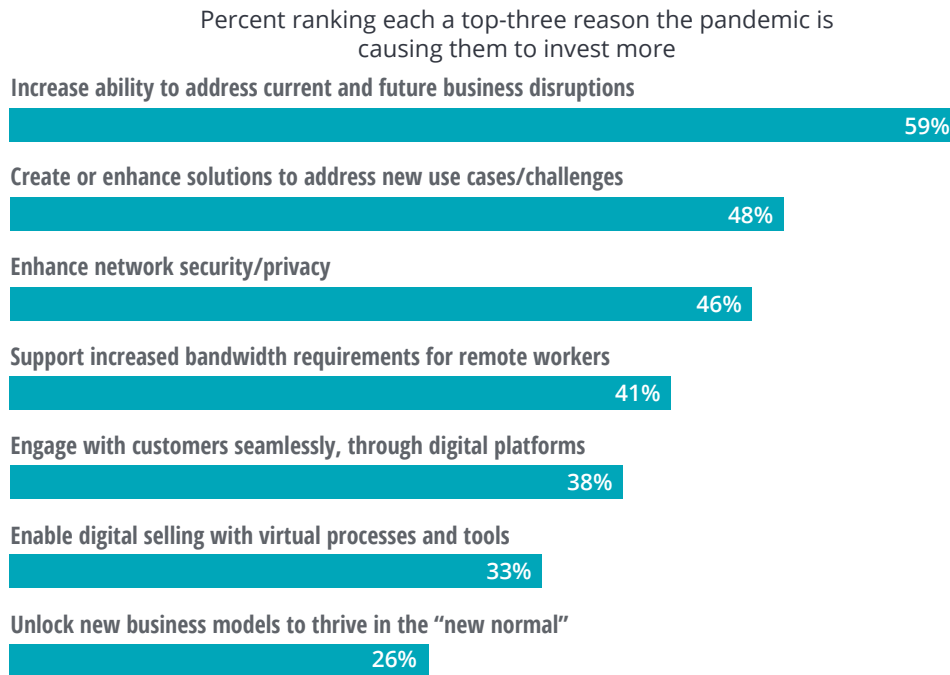
companies face in the next several years.

Consider the example of a major telecommunications company that deployed a private 5G network on a factory production floor to address pandemic-related challenges: Leaders were able to rapidly deploy safety use cases, such as scanning employees for face masks and monitoring smart badges to ensure that workers weren't in close proximity for too long.<sup>12</sup> And instead of flying in specialists to repair robots, managers outfitted local employees with "mixed reality" headsets so that remote technicians could guide them. A number of companies have been rolling out new wireless applications and services designed to keep personnel safe in the workplace, including solutions that use Wi-Fi to sense when devices enter building areas and real-time analytics to flag occupancy issues.<sup>13</sup>

The pandemic may well be accelerating demand for novel products and services that rely on a more robust and powerful network infrastructure. Indeed, the number-two reason cited for increasing wireless investment is to create or enhance solutions that address new use cases. As a case in

FIGURE 3

## Networking executives who are increasing wireless spending due to the pandemic cite wireless's ability to help them address disruption, create solutions to address new use cases, and enhance network security



Note: N=220 global networking executives who indicated their organization is increasing wireless investment due to the pandemic.

Source: Deloitte's Study of Advanced Wireless Adoption, Global Edition, 2021.

point, enterprises in China have utilized 5G in a variety of crisis-related solutions aimed at limiting personal interactions, including hospital robots that performed disinfection and medicine deliveries and driverless vehicles that delivered food and medical supplies to quarantined individuals.<sup>14</sup> Companies have also leveraged the high bandwidth and low latency of 5G networks for telehealth, including remote medical consultation and diagnosis of COVID-19 and remote, robot-controlled ultrasounds.

The number-three motivator for increased spending relates to a desire for better network security and data privacy. As the pandemic pushed

more workers and their devices offsite, leaders may have realized they needed to invest more in protecting devices and data.

### Strategic importance and adoption are on the rise

Networking executives recognize the importance of advanced wireless for their business success today and believe it will be essential to thriving in the postpandemic era. Four in five currently see advanced wireless technologies as *very* or *critically* important for their business—and the same number expect to hold that view in three years.



Adoption is set to take on more urgency: One-fifth of networking executives view the technologies as critically important for their enterprise today; one-third say they will be critically important in three years.

Backing up their strategic view, these executives are planning significant wireless networking investment over the next three years. Considering all the wireless technologies (such as 4G, 5G, various types of Wi-Fi) they expect to use over this period and the cost of devices (such as 5G smartphones), hardware/equipment, software, installation, and operations services (but not including costs for spectrum), our respondent organizations estimate their three-year spending at US\$149.7 million on average. In our earlier study, US networking executives reported they would spend an average of US\$115.7 million on their wireless investments over a three-year time frame.

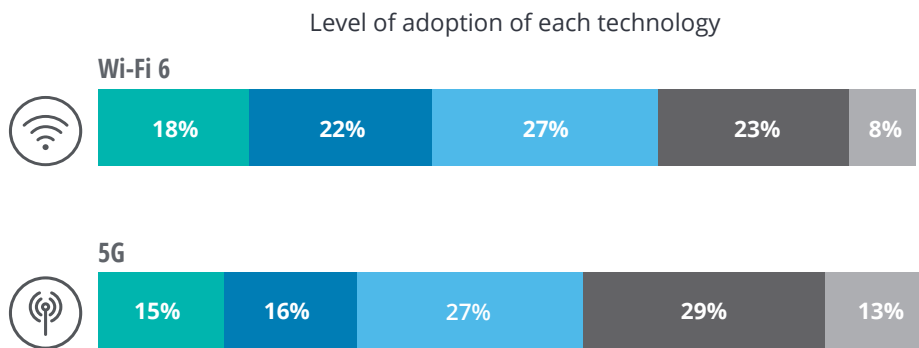
The higher spending estimate outside the US likely reflects the passage of nine months between surveys, as well as the catalyzing effects of the pandemic.

The surveyed organizations are going all-in when it comes to adopting advanced wireless technologies. By design, our survey included respondents from organizations that are in the process of adopting 5G and/or Wi-Fi 6 or plan to adopt either technology within the next three years. In practice, we found that adoption is well past the planning stage: Two-thirds of respondents' organizations are either running pilots or deploying Wi-Fi 6 solutions, while 58% are doing the same with 5G (figure 4). Roughly another quarter are in the process of actively "preparing to use" each technology—for example, acquiring devices/ infrastructure or identifying potential providers and partners.

FIGURE 4

### 67% of respondents' organizations are either running pilots or deploying Wi-Fi 6 solutions; 58% are doing the same with 5G

- Deploying enterprisewide ■ Deploying in many departments
- Started pilots/experiments in several departments ■ Preparing to use
- Planning to use in two to three years



Note: N=437 global networking executives. Numbers may not total 100%, due to a small number who reported "no plans to use."

Source: Deloitte's Study of Advanced Wireless Adoption, Global Edition, 2021.

## Enterprises pursue a variety of usage scenarios

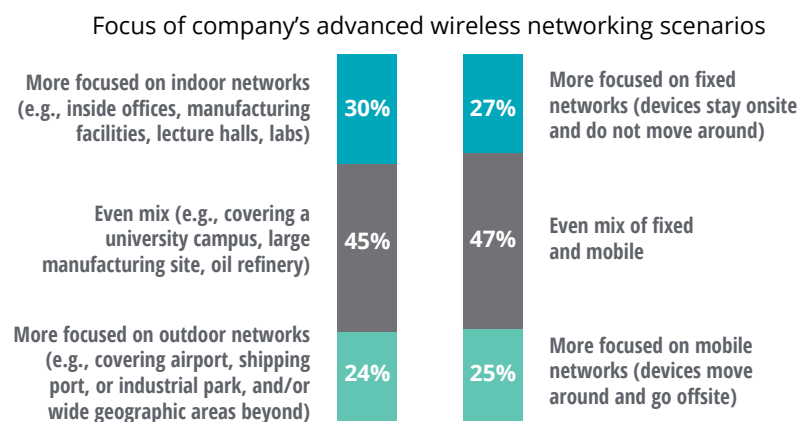
To leverage the capabilities of advanced wireless, adopters tend to target a blend of indoor and outdoor usage scenarios, and a blend of fixed and mobile networks (figure 5). Organizations use advanced wireless networks to connect employees, machines, and customers. When it comes to employee connectivity—both inside and outside the office—the top two use cases involve enhancing workplace communication and collaboration (figure 6). For example, organizations can use Wi-Fi 6 to increase the speed of voice and video, untethering workers from desktop phones and wired connections.<sup>15</sup> And with so many professionals working remotely during the pandemic, 5G may enable new ways to improve collaboration and productivity, such as high-resolution, multiperson videoconferencing, interactive digital whiteboards, and immersive collaboration experiences enriched by virtual reality (VR)/augmented reality (AR) technologies.<sup>16</sup>

The third-most-cited use case for employee connectivity relates to IT administration and remote troubleshooting. For example, 5G is poised to play a role in remote management of workers’ mobile devices, enabling IT professionals to rapidly push data-intensive updates to a large number of devices.<sup>17</sup> Companies are already using 5G technology to connect remote 3D designers and video editors to their high-end workstations back at the office, providing 4K-quality streaming and allowing them to perform CPU-intensive tasks from afar.<sup>18</sup> A UK water company has been using a private 5G network to enable a “remote expertise” use case: As newly hired technicians encounter issues with equipment in the field, AR headsets relay the situation to experienced colleagues who guide the troubleshooting remotely.<sup>19</sup>

Advanced networking also enables many new applications for machine connectivity—inside facilities, on campuses, and in broader areas such as shipping ports and international airports. For example, video surveillance in factories can allow human operators (or AI systems) to remotely supervise equipment in real time,

FIGURE 5

### Advanced wireless adopters tend to say they’re focusing on usage scenarios involving both indoor/outdoor networks and fixed/mobile devices



Note: N=437 global networking executives. Numbers may not total 100%, due to a small number who reported “Don’t know.”

Source: Deloitte’s Study of Advanced Wireless Adoption, Global Edition, 2021.

and 5G can deliver the ultrareliable, low-latency communication needed to drive maintenance via robots. Augmenting a smart-factory floor with wirelessly linked IoT sensors enables massive streams of data about the performance and health

of equipment, and analytics can predict problems before they occur.<sup>20</sup> Companies are also using wireless technologies to connect machines directly to other machines—for example, in vehicle-to-vehicle safety systems.<sup>21</sup>

FIGURE 6

## Enterprises are targeting a wide range of usage scenarios with advanced networking

	 <b>Employee networking</b>	 <b>Machine networking</b>	 <b>Customer networking</b>
<b>#1</b>	<b>Workplace communication</b> Faster and seamless upload/download of files from cloud, remote document sharing, messaging, accessing internet	<b>Remote monitoring/control</b> Video surveillance, connected assembly lines for production processes, telemedicine	<b>Advanced customer experiences</b> Cloud-based mobile apps, autonomous stores, immersive AR/VR/3D features, entertainment, video-based checkups
<b>#2</b>	<b>Advanced collaboration tools</b> Mobile video conferences, AR/VR/3D experiences, remote workplaces	<b>Machine-to-machine communications</b> Vehicle communications and safety systems, assembly/production line	<b>Security and fraud prevention</b> Biometric checks, geolocation transactions, smart contracts/blockchain
<b>#3</b>	<b>IT administration</b> Remote troubleshooting, managing workstations/servers/mobile devices	<b>Advanced analytics</b> Insights on sensor-generated data, edge computing	<b>Advanced analytics</b> Insights on shopping patterns or on-floor movement, pricing, forecasting, recommendations, geofencing-based notifications
<b>#4</b>	<b>Network management</b> Software-defined WAN, network slicing	<b>Asset tracking</b> Inventory management, sensors in containers/goods/machines, geofencing, blockchain/smart contracts	<b>Enhanced customer support</b> Remote diagnostics, video chats, 3D consultations
<b>#5</b>	<b>Advanced analytics</b> Device usage, cloud usage	<b>Automation</b> Autonomous vehicles, remote-controlled robots or drones, delivery robots	<b>Digital payments</b> Mobile wallets, in-car payments, connected commerce

Note: N=437 global networking executives.

Source: Deloitte's Study of Advanced Wireless Adoption, Global Edition, 2021.

Wireless technologies are also powering enhanced customer experiences. Municipalities are already employing a combination of Wi-Fi 6 and 5G to drive smart-city solutions that improve public services, including real-time traffic monitoring/optimization and geofencing applications that can deliver personalized alerts to anyone within a predetermined geographic area.<sup>22</sup> In health care, next-generation wireless initiatives enable real-time remote patient monitoring, high-definition video consultations, and even remote medical

procedures using robots—the need for which grew more urgent during the pandemic.<sup>23</sup> Sports organizations are using 5G and Wi-Fi 6 to deliver more engaging, immersive stadium experiences. And retail companies are combining advanced wireless with IoT sensors and analytics to support smart inventory systems, optimize product pricing, and personalize shopping experiences.<sup>24</sup>

## Enterprises adopt Wi-Fi 6 and 5G in parallel

The huge amount of attention advertisers and news editors have lavished on 5G has undeniably overshadowed Wi-Fi 6. But both will have a significant role to play in the future of wireless. Unlike past generations of wireless, 5G cellular and Wi-Fi 6 networks will be able to interoperate seamlessly with one another and are widely regarded as complementary technologies in the wireless ecosystem.<sup>25</sup> Standards bodies and wireless alliances continue to propose solutions for the remaining technical challenges around seamless interoperability.<sup>26</sup>

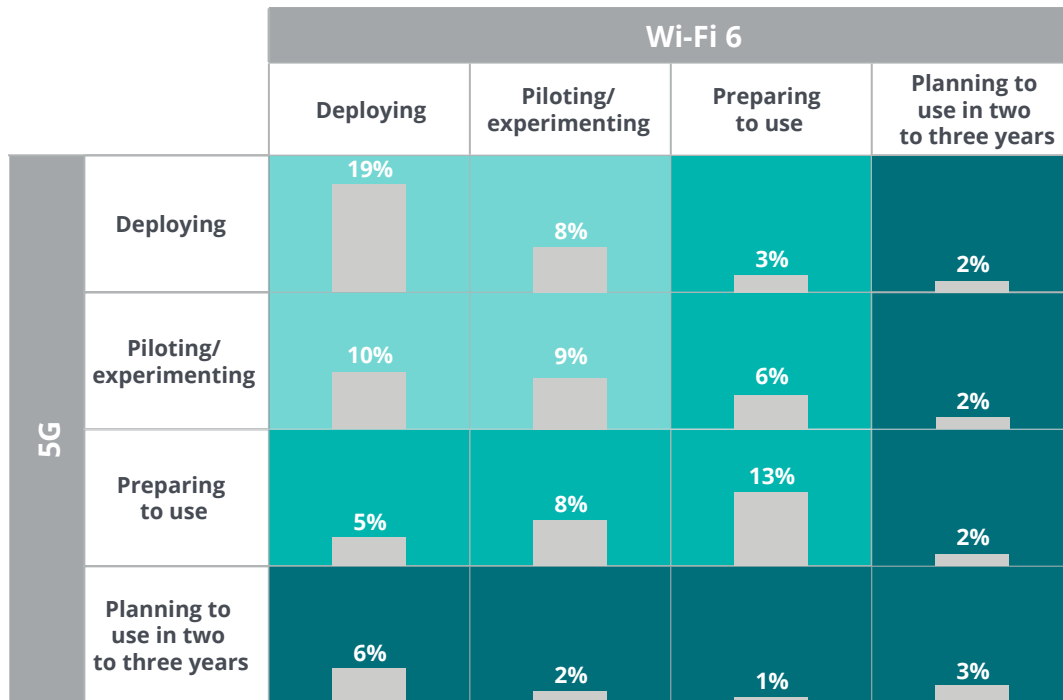
Networking executives report their enterprises are adopting both technologies for their wireless initiatives, indicating they prefer Wi-Fi 6 for indoor, on-campus, and fixed network situations and 5G for outdoor, off-campus, and mobile network environments. Adopting the technologies in parallel makes sense. Fully 45% are already deploying both Wi-Fi 6 and 5G in their business or piloting/experimenting with them, with another 35% actively preparing to use both—for example, acquiring devices/infrastructure and identifying providers (figure 7). Nearly all expect their organization to be using both 5G and Wi-Fi 6 within the next two to three years. Projected investment reflects coadoption as well: Over the next three years, these organizations expect to split their wireless spending fairly evenly between Wi-Fi (48%) and cellular technologies (52%).



FIGURE 7

### Organizations are adopting Wi-Fi 6 and 5G in parallel to meet the needs of their advanced wireless initiatives

- 45% are already deploying or piloting both 5G and Wi-Fi 6
- 80% are deploying, piloting, or preparing to use both 5G and Wi-Fi 6
- 98% believe they'll be using both technologies within two to three years



Note: N=437 global networking executives.

Source: Deloitte's Study of Advanced Wireless Adoption, Global Edition, 2021.

Parallel adoption of 5G and Wi-Fi 6 is also apparent when we take a deeper look by country (figure 8). In all geographies studied, more than half the networking executives report their organization deploys or pilots Wi-Fi 6, and in Germany, Brazil, the United Kingdom, China, and Australia, the adoption percentage reaches 70% or higher. These countries also report the highest levels of 5G deployments/pilots.

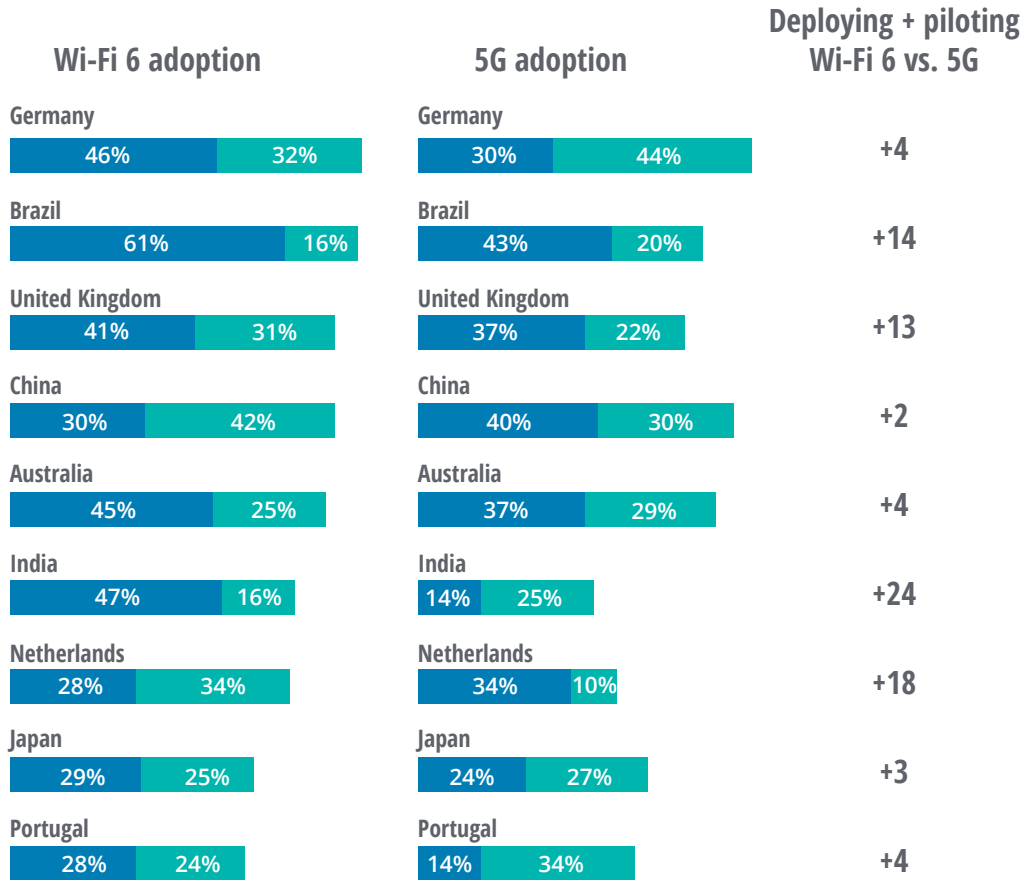
Wi-Fi 6 has an adoption lead over 5G in all countries studied, but double-digit gaps are apparent in India, the Netherlands, Brazil, and the United Kingdom. Spectrum availability is likely a contributor to the comparatively slower pace of 5G

adoption: While Wi-Fi 6 uses unlicensed spectrum (and therefore has a lower-cost path of entry), 5G initiatives generally require that government regulators auction or allocate spectrum suitable for 5G services, and some auctions have faced delays. The Netherlands didn't complete its first 5G spectrum auction until mid-2020.<sup>27</sup> Both India and Brazil had targeted 2020 for auctions, but the pandemic postponed those plans.<sup>28</sup> It's no surprise that the three countries with the highest levels of 5G adoption—Germany, China, Australia—all had 5G spectrum auctions in 2018 or 2019, giving their commercial rollouts of 5G a head start before COVID-19 hit.<sup>29</sup>

FIGURE 8

**Deployments/pilots of Wi-Fi 6 currently surpass deployments/pilots of 5G in all countries we studied, with the biggest deltas occurring in India, the Netherlands, Brazil, and the United Kingdom**

■ Deploying ■ Piloting/experimenting



Note: N=437 global networking executives.

Source: Deloitte's Study of Advanced Wireless Adoption, Global Edition, 2021.

# Advanced wireless is foundational to innovation and transformation

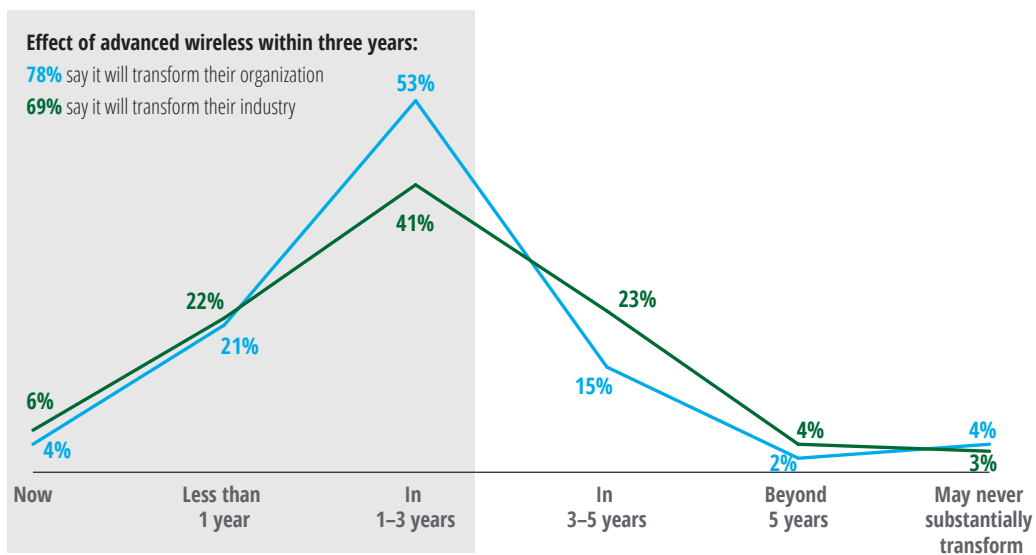
**A**N OVERWHELMING MAJORITY of networking executives expect advanced wireless technologies to transform both their enterprises and industries in the near term—especially remarkable considering that 5G and Wi-Fi 6 are the latest generations of technologies that have been evolving for decades. Four in five believe advanced wireless will *substantially*

transform their organization within three years, and nearly as many say the same about the effect on their industry (figure 9). Because their industry peers will be transforming nearly as fast as their own organizations, many of these executives are likely feeling enormous competitive pressure to quickly realize benefits.

FIGURE 9

## Networking executives overwhelmingly believe advanced wireless will transform their organizations and industries within three years

- Advanced wireless networking will transform our company
- Advanced wireless networking will transform our industry



Note: N=437 global networking executives. Percentages may not total 100%, due to a small number who reported "Don't know."

Source: Deloitte's Study of Advanced Wireless Adoption, Global Edition, 2021.

## Fueling innovation

Advanced networking is becoming an essential part of organizations' innovation architecture. Rather than merely representing the latest-and-greatest improvements in wireless technologies, next-gen connectivity is becoming an integral part of how companies are innovating and transforming—changing how they operate, develop new products and business models, and engage with customers. Indeed, three-quarters of networking decision-makers believe their organization can create *significant competitive advantage* by leveraging advanced networking technologies and four in five believe advanced connectivity will be critically important for enhancing customer interactions within three years.

A majority of survey respondents (56%) see their company's current networking infrastructure as preventing them from addressing the innovative

use cases they want to target—and that drive to innovate is motivating them to adopt next-gen networking. In fact, the desire to take advantage of new technologies, such as AI, big data analytics, and edge computing is a top driver for advanced wireless adoption, tied with improving efficiency (figure 10). Enhancing customer interactions rounds out the top three sought-after benefits. It's worth noting that, in our early 2020 study, improving efficiency was solidly in the top spot, while taking advantage of new technologies placed third. The latter has now risen to first place. Another innovation activity—creating new business models—has also moved up several rungs. Leaders cited improved performance and operational characteristics of advanced wireless—such as faster data speeds, improved coverage, lower latency, enhanced security, better reliability, and interoperability—as important attributes for achieving the benefits of advanced wireless.



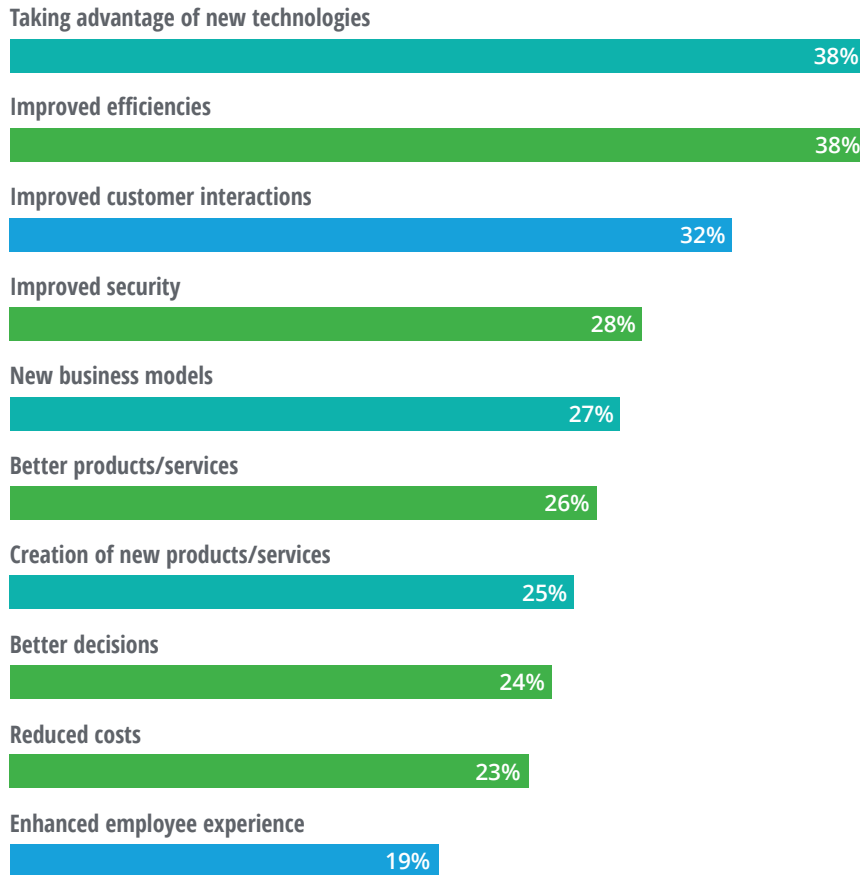


FIGURE 10

## Motivations for adopting advanced wireless include innovating, improving operations and products, and enhancing interactions with customers and employees

■ Innovating ■ Improving ■ Enhancing interactions

Percent ranking each a top-three benefit their organization is aiming to achieve with advanced wireless



Note: N=437 global networking executives.

Source: Deloitte's Study of Advanced Wireless Adoption, Global Edition, 2021.

Taking a closer look at countries, the top three overall motivators—taking advantage of new technologies, improving efficiency, and improving customer interactions—generally resonate in most geographies (figure 11). However, some countries place high emphasis on certain objectives outside

these three—for example, new business models (Japan, Netherlands, Portugal), better products/services (Germany, Portugal), creation of new products/services (China, Australia), and reduced costs (Brazil).

FIGURE 11

**Some countries have top objectives outside the overall most popular, such as “reduced costs” in Brazil, “new business models” in Portugal, Japan, and the Netherlands**

■ #1 objective ■ #2 objective ■ #3 objective

Percent ranking each a top-three benefit their organization is aiming to achieve with advanced wireless

	All	Australia	Brazil	China	Germany	India	Japan	Netherlands	Portugal	United Kingdom
Taking advantage of new technologies	38%	43%	31%	44%	22%	59%	35%	40%	21%	43%
Improved efficiencies	38%	39%	37%	42%	44%	35%	35%	28%	24%	52%
Improved customer interactions	32%	39%	31%	18%	30%	51%	22%	22%	45%	37%
Improved security	28%	27%	31%	24%	36%	33%	25%	14%	28%	33%
New business models	27%	24%	24%	28%	20%	18%	31%	34%	52%	22%
Better products/services	26%	20%	16%	34%	32%	25%	27%	26%	34%	20%
Creation of new products/services	25%	37%	25%	48%	20%	18%	12%	22%	17%	22%
Better decisions	24%	22%	22%	24%	26%	20%	31%	20%	34%	24%
Reduced costs	23%	22%	39%	20%	28%	22%	16%	30%	14%	11%
Enhanced employee experience	19%	24%	20%	6%	16%	20%	20%	32%	10%	24%

Note: Networking executives based in Australia (N=51), Brazil (N=51), China (N=50), Germany (N=50), India (N=51), Japan (N=51), Netherlands (N=50), Portugal (N=29), and United Kingdom (N=54).

Source: Deloitte’s Study of Advanced Wireless Adoption, Global Edition, 2021.

## Advanced networking at the core

Networking executives resoundingly view advanced wireless as integral to their efforts to deploy innovative technologies at the heart of their digital transformation efforts, including big data analytics, cloud computing, edge computing, AI, and IoT. Remarkably, 99% of our respondents said their companies are pursuing each of these technologies in the coming year, despite it not being a requirement for survey participation. Four in five networking executives consider advanced wireless very/extremely important to their

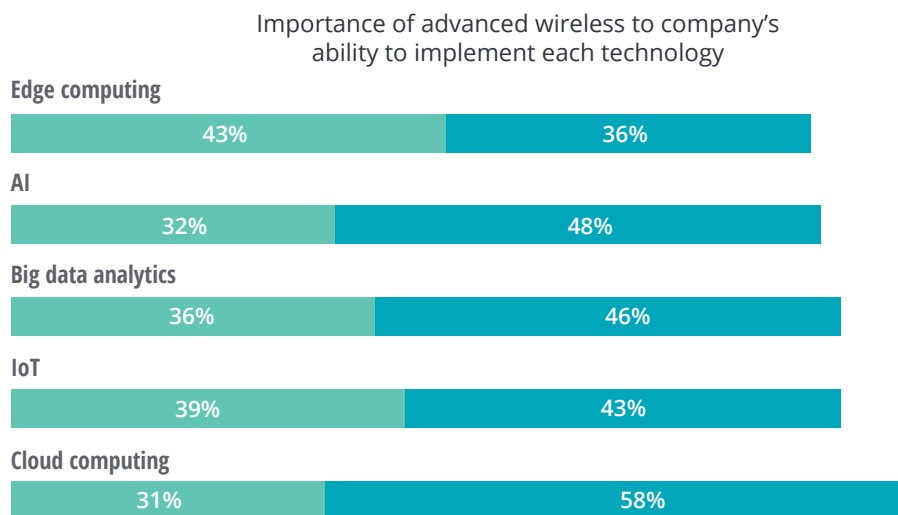
organization's ability to implement IoT, big data analytics, AI, and edge computing—and even more say the same for cloud computing (figure 12).

More than ever, these technologies are intertwined and converging in enterprise innovation initiatives (see sidebar, “Innovating globally with advanced connectivity”). With advanced networking becoming intrinsic, how organizations adopt and architect their advanced wireless solutions is no longer a separate decision from how they implement other innovative technologies: Leaders should increasingly consider advanced networking a key component of an organization's end-to-end enterprise architecture.

FIGURE 12

### Executives see advanced wireless networks (including 5G and Wi-Fi 6) as foundational to taking advantage of other advanced technologies

■ Very important ■ Extremely important



Note: N=437 global networking executives.

Source: Deloitte's Study of Advanced Wireless Adoption, Global Edition, 2021.

## INNOVATING GLOBALLY WITH ADVANCED CONNECTIVITY

**Private 5G networks enable smart factories.** Germany's telecommunications regulator awarded licenses for deploying "private 5G" networks, which are initially expected to support industrial IoT.<sup>30</sup> The characteristics offered by 5G—ultrahigh reliability, submillisecond latency, availability, and high security—are seen as a good fit for critical industrial applications that require real-time control, such as robot and machine mobility and industrial automation.

Industrial conglomerate Robert Bosch GmbH, together with Nokia, has rolled out a private 5G network at its lead plant for Industry 4.0 in Germany—a step toward its vision of a highly efficient "factory of the future."<sup>31</sup> The factory has an automated transport system consisting of 5G-connected automated guided vehicles that are able to move and deliver loads throughout the facility while safely avoiding other vehicles, objects, and people.

Bosch Rexroth AG—a Bavaria-based division focused on manufacturing equipment—has outfitted a production floor with a private 5G network that connects machines, robots, and precision power tools.<sup>32</sup> The network, along with predictive analytics and AI, allows the company to coordinate and optimize production operations.

**Next-gen connectivity powers immersive experiences.** The Olympics has long been a place to showcase innovative technologies, and the 2021 summer games planned for Tokyo<sup>33</sup> promise to carry on that tradition. Intel expects to run a VR experience over a 5G network at the games: A multitude of cameras installed around an arena will collect live video, and viewers around the world with VR headsets will be able to look around the venues and experience the sporting events as if they're right next to the athletes.<sup>34</sup> Nippon Telegraph and Telephone Corp. is piloting a hologram system that captures ultrahigh-definition 8K video of athletes and creates holograms that mirror their moves; the speed and low latency of 5G networks can enable spectators in other locations to watch the holograms in real time.

In Brazil, a partnership between Claro and Ericsson has already demonstrated the use of 5G technology for a real-time holographic experience: In October 2019, a musician played at the Claro Brasil offices, and the audience in a 5G-connected stadium 17km away was able to experience his performance as a hologram.<sup>35</sup> High-definition video was also set up between the orchestra and its conductor, and attendees with 5G-equipped VR devices were able to watch the real-time movements of the musicians as an immersive experience.

**IoT, AI, and 5G meet at the intelligent edge for automated inspections.** Haier, a global household appliance manufacturer headquartered in China, has developed a system to automatically inspect new stainless steel refrigerators in a production line, using high-definition, 5G-connected industrial cameras, edge computing servers equipped with machine-vision image-processing capabilities, and offsite servers performing AI-based training.<sup>36</sup> Conventional production involved time-consuming manual inspection of new refrigerators for scratches, dents, or other imperfections. In the new solution, cameras along the production line capture real-time video of each appliance and send it via 5G to an edge computing platform. On the edge server, machine-vision algorithms perform near-real-time image analysis to detect defects—and the results are used to increase the accuracy of the AI model over time. The system has improved both production performance and product quality monitoring.

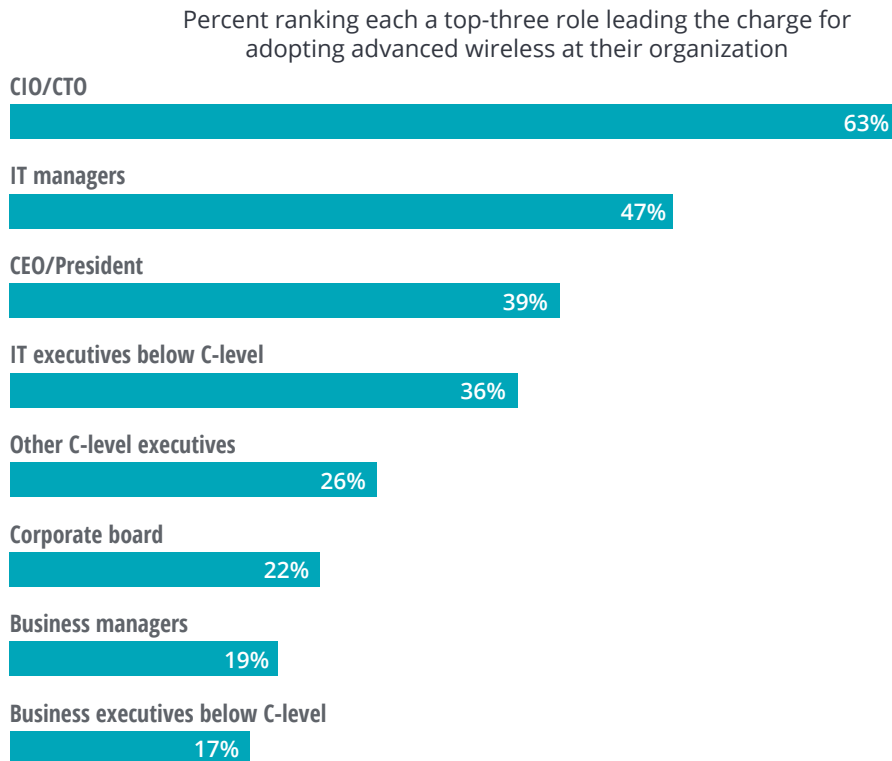
# How adoption of advanced wireless is unfolding

**O**RGANIZATIONS ARE APPROACHING advanced wireless adoption as a strategic technology initiative, led by technologists both inside and outside the enterprise. The IT function—both C-level executives and practitioners—leads the charge to adopt, followed by C-level business executives (figure 13).

When it comes to influencing an organization's decisions around advanced wireless, IT staff and technology vendors hold the most sway, followed by wireless carriers and the company's executives (figure 14).

FIGURE 13

## Within organizations, IT executives and practitioners lead the charge to adopt advanced wireless

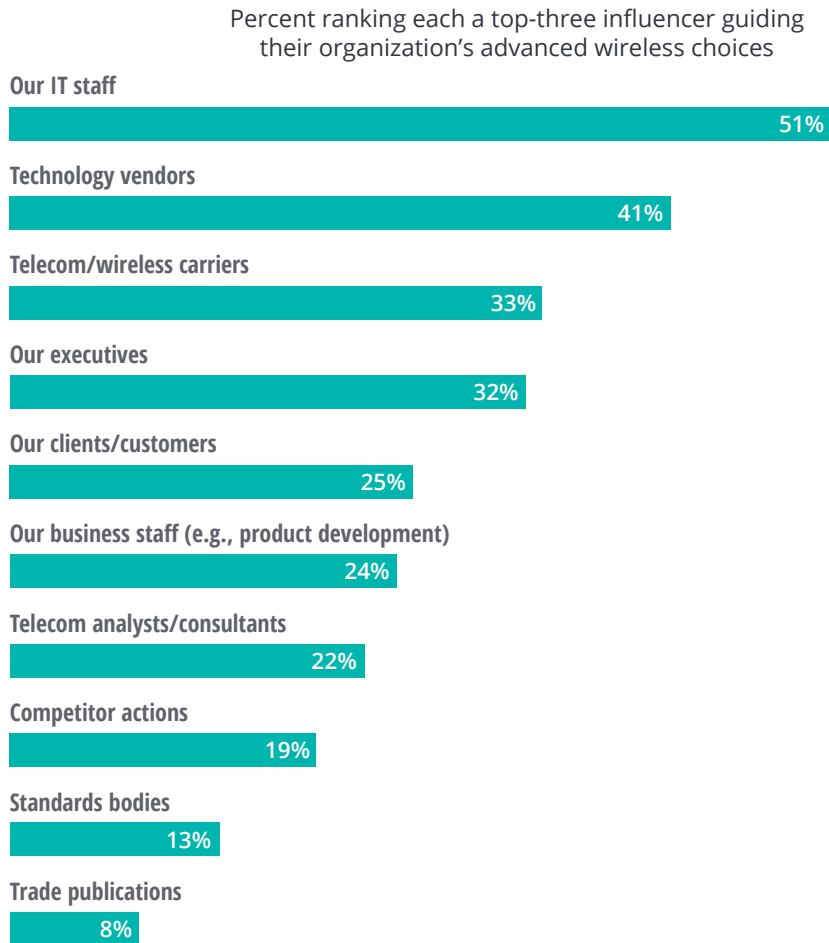


Note: N=437 global networking executives.

Source: Deloitte's Study of Advanced Wireless Adoption, Global Edition, 2021.

FIGURE 14

### IT staff and technology vendors have the most influence on organizations' advanced wireless choices.



Note: N=437 global networking executives.

Source: Deloitte's Study of Advanced Wireless Adoption, Global Edition, 2021.

## Complex and evolving ecosystem

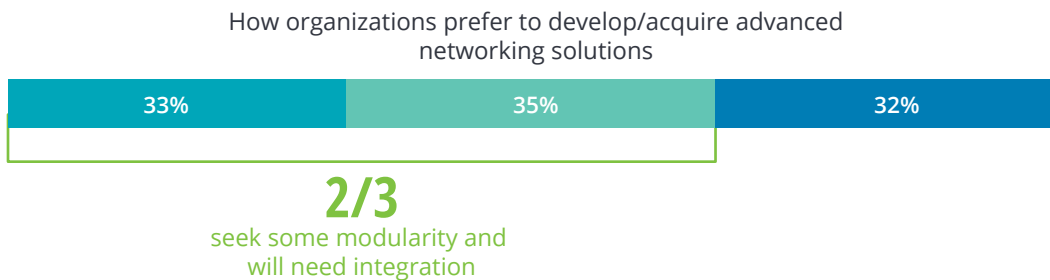
Fulfilling the promise of advanced wireless initiatives, particularly those involving 5G, involves a complex ecosystem of players, including application and cloud providers, wireless carriers, consultants and integrators, equipment manufacturers, and infrastructure providers. About one-third of the networking executives we surveyed prefer to purchase full end-to-end advanced wireless solutions, but the other two-thirds prefer to acquire best-of-breed components or a blend of components and full solutions, offering more of an opportunity to customize and control (figure 15).

In order to assemble complete solutions, organizations generally bring together capabilities and technologies from a range of players (figure 16). On average, advanced wireless adopters engage with about eight of the nine listed types of vendors. Moreover, when it comes to cloud providers, application providers, component providers, consulting firms/integrators, and network equipment providers, about half of enterprises engage with two or more vendors of each type. The relationships are evolving: For each type of vendor in the ecosystem, at most three in 10 adopters prefer to keep engaging with their current vendors; the remainder are open to exploring new ones.

FIGURE 15

### Two-thirds of advanced wireless adopters prefer to purchase best-of-breed components, or a blend of components and end-to-end solutions

- Prefer to acquire best-of-breed components and integrate them
- Prefer blend of individual components and end-to-end solutions
- Prefer to buy end-to-end solutions



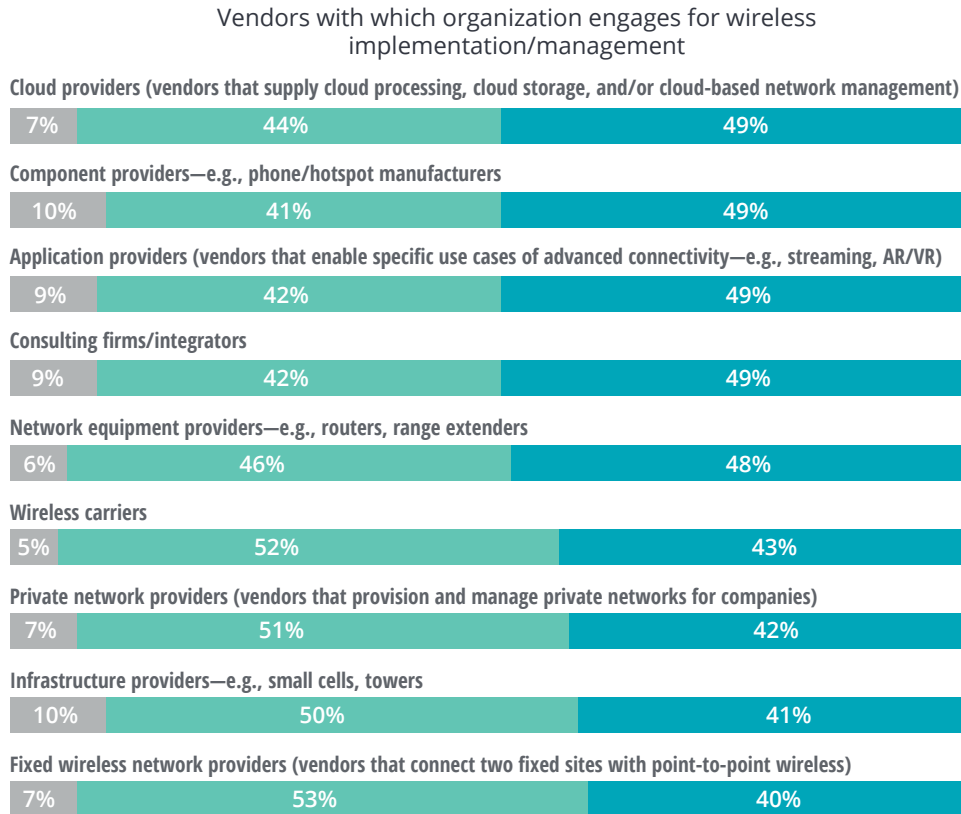
Note: N=437 global networking executives.

Source: Deloitte's Study of Advanced Wireless Adoption, Global Edition, 2021.

FIGURE 16

## Organizations engage with myriad vendors to implement and manage their wireless initiatives, including technology companies, telecom firms, and consultants/integrators

■ None/don't know ■ One ■ Two or more



Note: N=437 global networking executives.

Source: Deloitte's Study of Advanced Wireless Adoption, Global Edition, 2021.

Enterprises choosing best-of-breed solutions face a great deal of complexity and need to coordinate the efforts of multiple parties. Beside their own in-house teams, they're looking to cloud providers (such as the hyperscalers), network technology vendors, consultants/system integrators, and wireless carriers to help them weave together and orchestrate the pieces. Even when adopters choose integrated solutions, the vendor handles a great deal of behind-the-scenes complexity. Today's reality is that no single vendor can offer full-stack, end-to-end solutions on its own. While some may

already have the vast majority of the required components and capabilities, they still need to partner with others to acquire and integrate additional pieces to create complete solutions.

The architecture of 5G networks is expected to become more virtualized, open, and programmable, allowing best-of-breed components to proliferate.<sup>37</sup> The role of orchestrators that assemble all the pieces is likely to become increasingly important, whether that role is assumed by telecom providers, tech providers, or system integrators.



## Challenges to adoption

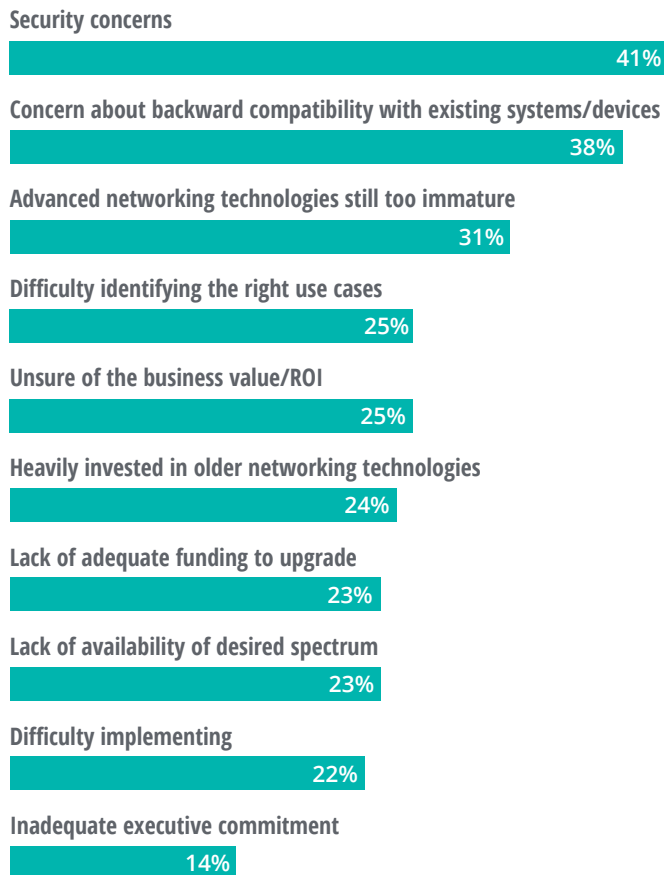
One way vendors can up their game is by helping customers address their networking challenges. With advanced wireless enabling a hyperconnected world, leaders recognize that there are many more potential network entry points that need to be protected, and security tops their list of concerns (figure 17). At the same time, next-gen wireless

technologies promise better security. Wi-Fi 6 improves data protection by ensuring that all certified devices support the latest generation of security (WPA3), which offers more robust encryption and key management.<sup>38</sup> And 5G slicing supports unique security policies per slice—a boost to security as long as slices are configured and managed properly.<sup>39</sup>

FIGURE 17

### Security and backward compatibility with existing systems are the top concerns in adopting advanced wireless

Percent ranking each a top-three challenge for organization's adoption of advanced wireless



Note: N=437 global networking executives.

Source: Deloitte's Study of Advanced Wireless Adoption, Global Edition, 2021.

Another top concern of adopters is backward compatibility with existing systems and devices. Vendors have an opportunity here to show how their components can work well with others, and to go above-and-beyond by offering integration services. When we look at the country level (figure 18), it's clear that some adopters are still struggling to get out of the starting gate, heavily invested in older technologies (a top-three challenge in Germany), unsure of the business value of advanced networking (a top-three challenge in China, Germany, Japan, the Netherlands, and Portugal), or having difficulty identifying the right use cases to target (a top-three challenge in Australia and Japan). Once again, these difficulties represent an opportunity for vendors to demonstrate the business value of their solutions and the usage scenarios they enable—perhaps by engaging customers in pilot programs.

## Cloud and edge in the spotlight

Seven in 10 networking executives revealed that they expect to primarily deploy and manage their wireless networking applications and services on public or private clouds in the next two to three years (figure 19). Remarkably, those who expect to use mainly private clouds are twice as likely to trust traditional cloud technology firms the most to manage their data in the private clouds (56%) than to look first to their own IT department (28%).

Moreover, executives reported relying on technology companies—namely, application providers and cloud providers—the most to help design their advanced wireless network architectures. And enterprises are keenly aware that their networks can't merely connect their

devices but must also connect to clouds, collecting data from machines and sensors, and meshing it with the company's cloud-based operational data.

Another area that bears watching is the proportion of adopters (16%) that expect to chiefly deploy and manage their wireless networking applications and services on the edge in the near future. This represents a jump from 9% of executives in our US study and points to a growing awareness of the significance and utility of edge computing.<sup>40</sup> Consider that, with 5G, the time for device or sensor data to arrive at a cell tower may be just 2–3 milliseconds, but the time for it to travel to a distant data center for processing (for example, by cloud-based analytics services) could still take hundreds of milliseconds, presenting a problem for applications for which low latency is critical.<sup>41</sup> Moving data processing, storage, and AI-driven analytics to the edge—closer to where the data is collected—can enable applications that require fast response times, such as drones that visually inspect rail lines or bridges to spot possible problems, telehealth systems that capture and analyze video to monitor patient health in real time, choreographed robots on a factory floor, or automated traffic management systems.<sup>42</sup>

As providers of next-generation networking products and services jockey for competitive position and race to deliver complete solutions, the enterprise networking space is seeing the formation of many innovative collaborations and alliances among technology firms and telecom vendors—even among parties once considered competitors. Edge computing is an especially dynamic area for emerging partnerships, and the large public cloud providers are all rolling out edge computing capabilities.<sup>43</sup> Amazon, for example, has

FIGURE 18

### Executives in some countries have other top concerns, such as uncertainty about business value, difficulty identifying the right use cases, and lack of spectrum

■ #1 challenge ■ #2 challenge ■ #3 challenge

Percent ranking each a top-three challenge for organization's adoption of advanced wireless

	All	Australia	Brazil	China	Germany	India	Japan	Netherlands	Portugal	United Kingdom
Security concerns	41%	39%	45%	44%	30%	45%	31%	28%	59%	57%
Concern about backward compatibility with existing systems/devices	38%	33%	43%	54%	26%	39%	29%	40%	28%	43%
Advanced networking technologies still too immature	31%	31%	31%	28%	28%	35%	20%	34%	38%	33%
Difficulty identifying the right use cases	25%	33%	24%	22%	26%	31%	31%	24%	7%	22%
Unsure of the business value/ROI	25%	20%	12%	30%	28%	16%	39%	34%	34%	20%
Heavily invested in older networking technologies	24%	25%	18%	28%	32%	24%	16%	24%	21%	26%
Lack of adequate funding to upgrade	23%	29%	29%	20%	16%	22%	27%	28%	21%	17%
Lack of availability of desired spectrum	23%	18%	16%	20%	30%	37%	31%	12%	21%	19%
Difficulty implementing	22%	27%	24%	8%	28%	14%	25%	24%	28%	22%
Inadequate executive commitment	14%	27%	12%	10%	16%	12%	8%	16%	14%	11%

Note: Networking executives based in Australia (N=51), Brazil (N=51), China (N=50), Germany (N=50), India (N=51), Japan (N=51), Netherlands (N=50), Portugal (N=29), and United Kingdom (N=54).

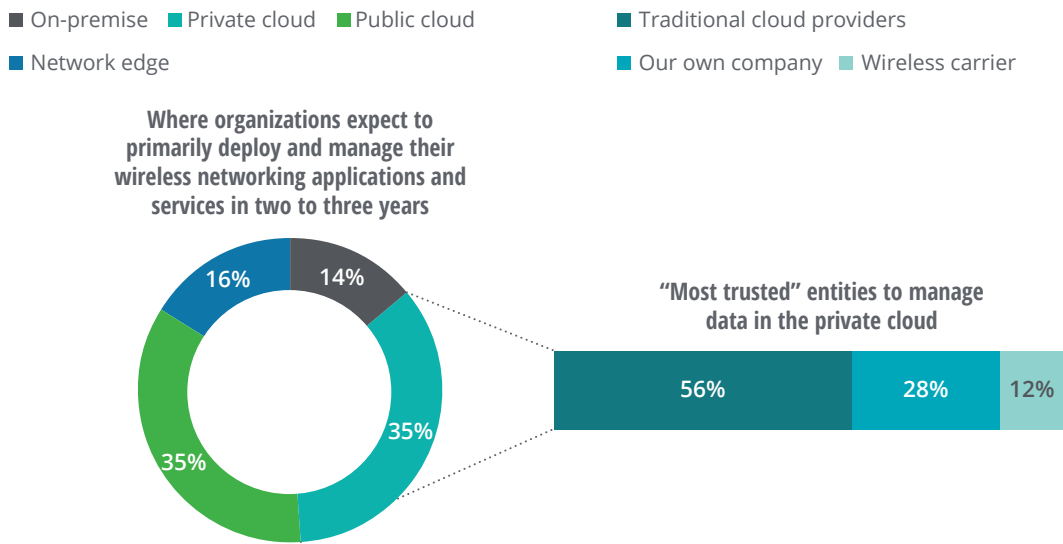
Source: Deloitte's Study of Advanced Wireless Adoption, Global Edition, 2021.

been partnering with telcos (such as Telstra in Australia) to embed Amazon compute and storage services at the edge—in base stations or the network operators’ data centers—and customers can continue to use the cloud APIs and functionality with which they’re already familiar, without worrying about the complexity of establishing an edge presence themselves.<sup>44</sup> Google

Cloud is partnering with AT&T in the United States to bring edge compute services (such as cloud-based artificial intelligence and machine learning) to the network edge.<sup>45</sup> In India, Bharti Airtel has teamed with IBM in an initiative to bring 5G, hybrid cloud, and edge capabilities to its customers.<sup>46</sup>

FIGURE 19

### Enterprises have very high levels of interest and trust in using cloud services to deploy and manage their wireless networking applications



Note: For the pie chart, N=437 global networking executives. For the bar chart, N=154 executives who reported their organization will primarily deploy on private cloud. Percentages may not total 100%, due to a small number who reported “Don’t know”.

Source: Deloitte’s Study of Advanced Wireless Adoption, Global Edition, 2021.

# Considerations for networking decision-makers

**A**LTHOUGH IT'S STILL early days of rolling out advanced connectivity, leaders already recognize the potential benefits. Adopters strongly believe in next-gen wireless networking technologies' ability to deliver competitive advantage, unlock the power of other emerging technologies, and rapidly transform both their organization and industry. The strategic decisions that wireless adopters make today may affect their future positions, and organizations may want to take the following considerations into account:

- *End goal in mind.* Adopters should consider the usage scenarios they want to achieve and determine which wireless technology (or technologies) would be the best choice in different situations. The most successful adopters are likely to be those with the skills to deploy multiple technologies and make diverse networks interoperate as needed.
- *Data strategies.* When massive volumes of data flow from connected machines and sensors, organizations need thoughtful strategies and policies on how to store, secure, and analyze it. Depending on the requirements of various usage scenarios, some data may need to be stored and analyzed in clouds, with other data processed at the intelligent edge.
- *Innovation infrastructure.* Given that leaders see next-gen wireless technologies as a significant enabler of other pivotal technologies such as AI, IoT, and edge, wireless will likely become intrinsic to every innovation initiative. Enterprises should regard next-gen wireless as a core part of their innovation infrastructure

and strategy, not as a discrete consideration or afterthought. Imagine how advanced wireless may enable new products, services, and business models—and enhanced interaction with customers and employees.

- *Integration and network management.* Adopters are interacting with a complex ecosystem and a multitude of vendors. With the propensity to acquire best-of-breed components, organizations should decide whether to tackle the complexity of integration themselves or seek out partners. They should assess their organization's ability to manage, authenticate, and secure networks with thousands of devices. Given that security is the number-one adoption concern, leaders would be wise not to underestimate the level of risk, cost, and effort in shouldering these responsibilities, and may want to engage partners for help.



The advanced wireless ecosystem is complex and competitive, with the overwhelming majority of adopters willing to reconsider their vendors for wireless implementation and management. Suppliers of next-gen networking products and services may wish to consider the following:

- *Challenges as opportunities.* Adopters cited security and backward compatibility as top challenges to adoption. And, depending on country, there are difficulties around understanding business value or identifying the right use cases. All of these are areas of opportunity for savvy vendors to demonstrate their expertise and value.
- *Ecosystem positioning.* Evaluate where you can add the most value and carve out your position. Consider whether you can offer expertise in

architecting solutions and integrating components—areas where adopters of advanced wireless are likely to seek help. Think about teaming up with other vendors to offer more complete solutions and a more attractive value proposition to adopters.

- *Innovation partnerships.* Vendors that see next-gen connectivity as adding merely incremental value may miss out on opportunities. Savvy vendors should go beyond offering connectivity products and services and seek to become trusted partners for innovation and transformation.

Both adopters and providers may be able to unlock enormous opportunities as advanced wireless networks become widespread over the next few years.

## Endnotes

1. Kelly Hill, "Connected devices will be 3x the global population by 2023, Cisco says," *RCN Wireless*, February 18, 2020.
2. Dan Littmann et al., *Enterprises building their future with 5G and Wi-Fi 6: Deloitte's Study of Advanced Wireless Adoption*, Deloitte Insights, June 1, 2020.
3. Ira Kalish, *Weekly global economic update: January 2021*, Deloitte Insights, January 4, 2021; Melanie Wolkoff Wachsman, "Research: How COVID-19 will affect 2021 IT budgets," *ZDNet*, September 1, 2020; Louis Columbus, "Covid-19's impact on the future of IT budgets," *Forbes*, August 9, 2020.
4. Deloitte, *Will 5G remake the world, or just make it a little faster?*, 2018; Bainbridge IT Staffing, "From 1G to 5G: A brief history of the evolution of mobile standards," accessed February 24, 2021; Chioma Azeh, "What is Wi-Fi 6 and why does it matter?," *Cordcutting*, September 10, 2020.
5. Littmann et al., *Enterprises building their future with 5G and Wi-Fi 6*.
6. In our prepandemic survey of US networking executives in January 2020, 75% ranked 4G as one of their business's top-three critical wireless technologies and 65% ranked Wi-Fi 5 (and below) in the top three. Those percentages were expected to drop to 33% and 26%, respectively, within three years. Twenty-nine percent and 31% ranked 5G and Wi-Fi 6 in their top three, respectively. By 2023, 76% expected 5G to be a top-three most critical wireless technology for their business, and 70% expected the same for Wi-Fi 6. During the same time frame, 4G and older Wi-Fi technologies were expected to diminish in importance.
7. The near-term future views of US and non-US networking executives are closely aligned. By 2023, 76% of both non-US and US networking executives expect 5G to be a top-three most critical wireless technology for their business; 65% of non-US executives and 70% of US executives expect Wi-Fi 6 to be in the top three.
8. This observation holds for all countries except Germany, where the networking executives surveyed still rank "Wi-Fi 5 and older" as the most critical wireless technologies for their efforts right now—followed by 5G and Wi-Fi 6. Within three years, these executives expect to place the greatest emphasis on 5G, followed by Wi-Fi 6. Note that for at least the new few years, infrastructure and device limitations mean 4G and 5G networks are expected to coexist; in fact, some early 5G deployments make use of existing 4G infrastructure. See Connor Craven, "What is 5G network infrastructure?," *sdxcentral*, January 5, 2020; OmniSci, "5G Infrastructure," accessed February 24, 2021; Mori Eliav, "How 4G and 5G can coexist while you prepare for the future," Oracle Communications Blog, October 2, 2020.
9. Dan Jones, "Vodafone Idea readies NB-IoT services in India," *Light Reading*, November 5, 2019; Ethan Qi, "NB-IoT is poised to lead the IoT connection growth in China," *Counterpoint*, April 1, 2020.
10. Dan Jones, "NB-IoT expected to be part of 5G by June 2022," *Light Reading*, January 28, 2020; GSMA, *Mobile IoT in the 5G future*, May 2018.
11. Deloitte Insights, *TMT Predictions 2021*, 2020.
12. Martha DeGrasse, "Ericsson 5G private network helps its factory during pandemic," *Fierce Wireless*, January 29, 2021.
13. Michael Cooney, "Wireless upgrades from Cisco, Aruba, Juniper aim at helping businesses reopen safely," *Network World*, June 1, 2020.
14. Julber Osio, "Coronavirus crisis brings new 5G use cases into action," *S&P Global*, April 1, 2020.
15. Mike Feibus, "3 ways WiFi 6 can revolutionize your network," *CIO*, September 6, 2019.

16. Fingent, "From remote work to virtual work, 5G is reinventing the way we work," July 31, 2020.
17. US Cellular Business, "Make sure your data stays safe, no matter what," accessed January 31, 2021.
18. AIT News Desk, "Splashtop, the fastest remote desktop solution, just got even faster," *AiThORITY*, April 28, 2020.
19. Daphne Leprince-Ringuet, "Using 5G and AR to create the future of remote support," *ZDNet*, June 3, 2020.
20. GSMA, *Factory efficiency*, November 2020; GSMA, *5G for smart manufacturing*, April 16, 2020.
21. Keith Mallinson, "How C-V2X in 5G will transform cars and save lives," *RCR Wireless News*, February 6, 2020.
22. Mark Montierth, "Better together: 5G and Wi-Fi 6 enable smart cities," NXP, March 24, 2020.
23. William G. Wong, "Pandemic-driven telehealth needs a 5G remedy," *Machine Design*, August 6, 2020.
24. Ernest Sampera, "How retailers can lay the groundwork for 5G applications now," vXchnge, August 5, 2020.
25. TechPower IT Solutions, "5G and Wi-Fi 6—friends or foes?," accessed February 24, 2021; Rowell Dionicio, "How 5G and Wi-Fi 6 will work together," Hewlett Packard Enterprise, November 5, 2020.
26. RealWire, "Wireless broadband alliance releases blueprint for 5G and Wi-Fi 6 convergence," press release, January 26, 2021.
27. Juan Pedro Tomás, "Dutch operators secure 5G spectrum," *RCR Wireless News*, July 23, 2020.
28. Research and Markets, *5G market in India 2020*, May 2020; Comms Update, "Brazilian 5G auction delayed to Q1 2021 at earliest," June 26, 2020.
29. China and Australia both completed 5G spectrum auctions in December 2018; Germany completed an auction in June 2019. everythingRF, "5G frequency spectrum in China," July 22, 2020; Kavita Majithia, "Australia 3.6GHz auction raises \$615M," *Mobile World Live*, December 10, 2018; Juan Pedro Tomás, "Germany completes 5G spectrum auction," *RCR Wireless News*, June 14, 2019. The United Kingdom is a bit of an outlier: Its first 5G spectrum auction was completed in April 2018, yet their Wi-Fi 6 adoption appears to outpace 5G adoption.
30. Alan Weissberger, "German telecom regulator awards 5G private network licenses in the 3.7GHz to 3.8GHz band," IEEE ComSoc Technology Blog, September 25, 2020; Catherine Stupp, "German industrial firms plan to build private 5G networks," *Wall Street Journal*, April 6, 2020.
31. everythingRF, "Bosch's Industry 4.0 plant in Germany is powered by a private 5G campus network," December 7, 2020.
32. Will Knight, "These factory robots may point the way to 5G's future," *Wired*, November 5, 2020.
33. Eamon Barrett, "Are the Tokyo Olympics actually going to happen?," *Fortune*, February 20, 2021.
34. River Davis, "The 2021 Olympics will be going 5G," *Wall Street Journal*, April 12, 2020.
35. Carmen Nery, "How carriers are preparing for the arrival of 5G in Brazil," *Labs News*, February 21, 2020.
36. GSMA, "Haier: Optimising manufacturing performance through 5G, edge computing and machine vision," February 2020.
37. Leonardo Bonati et al., "Open, programmable, and virtualized 5G networks: State-of-the-art and the road ahead," *Computer Networks* 182, (2020).
38. Larry Lunetta, "Protecting mobile users: Why Wi-Fi 6 offers robust security and enhanced usability," *InfoSecurity Magazine*, June 30, 2020; Monica Allevan, "Wi-Fi Alliance makes WPA3 mandatory for device certification," *Fierce Wireless*, July 27, 2020; Wi-Fi Alliance, "Discover Wi-Fi security," accessed February 6, 2021.
39. GSMA, *5G security issues*, November 2019; Ericsson, *A guide to 5G network security*, 2018.



40. Deloitte predicts that the global market for the intelligent edge will reach US\$12 billion in 2021, continuing a compound annual growth rate of about 35%. Chris Arkenberg et al., *Gaining an intelligent edge: Edge computing and intelligence could propel tech and telecom growth*, Deloitte Insights, December 7, 2020.
41. Keith Shaw, "Edge computing and 5G give business apps a boost," *Computerworld*, September 14, 2020.
42. Ibid.; Stephen Lawson, "Edge computing set for big role in 5G vehicle automation," *Light Reading*, December 10, 2019.
43. Paul Gillin, "Out on the edge: The new cloud battleground isn't in the cloud at all," *SiliconANGLE*, December 1, 2020.
44. *Computer Business Review*, "AWS Wavelength: The cloud comes to your 5G network," December 9, 2019; Aaron Tan, "AWS and Telstra team up on 5G," *Computer Weekly*, February 4, 2021.
45. Kelly Hill, "Google Cloud jumps into 5G and telco edge computing with a 'GMEC' vision," *RCR Wireless News*, March 5, 2020.
46. *Economic Times*, "Airtel drives Open Hybrid Cloud Network deployment with IBM, Red Hat," December 8, 2020.

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