



Research Insights

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# Telecom's 5G future

Creating new revenue streams and services with 5G, edge computing, and AI

IBM Institute for  
Business Value



## How IBM can help

More than ever, communications service providers need to rely on the latest solutions related to 5G, (hybrid) cloud, artificial intelligence, edge computing, platform technology and blockchain to enable the digital transformation of the network needed to thrive in today's environment. IBM has an extensive global network of telecom solution labs, research labs and innovation centers to support its industry offerings. With more than 22,000 subject matter experts in the communications industry, we work with more than 200 major communications service providers across the globe. IBM continues to invest significantly in key acquisitions to add expertise and capabilities that enable clients in this industry.

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## Talking points

### **5G will enable new groundbreaking use cases in virtually every industry**

The congregation of 5G, edge computing, and artificial intelligence (AI) is expected to enable entirely new use cases in vertical industries and accelerate the adoption of Industry 4.0.

### **Consumers see value in 5G and would even switch providers for better video quality**

Consumers have high expectations for 5G, and many are willing to pay extra—even switch to a different provider—for a better mobile video experience and/or for future immersive media applications.

### **AI at the network edge will lay the foundation for ultra-low latency 5G applications**

Locating AI close to the edge is crucial for applications where near-real-time feedback and decision-making are a priority for applications. This will enable previously unimagined latency-dependent wireless solutions.

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## 5G: Creating an opportunity for CSPs to position for growth

Today, the telecommunications industry stands on the brink of a pivotal new era—one in which advances in multiple technological areas, specifically 5G, edge computing, and AI, are congregating to fundamentally change the world. These technologies have the potential to alter how consumers communicate, consume content, work together, and interact with the environment. As well, they are poised to shift the dynamics of industries, both inside and outside of telecommunications.

The focus of this IBM Institute for Business Value (IBV) Research Insights report is two-fold: it is designed to explain how new 5G technology will unlock entirely new groundbreaking applications simply not possible today,. Also, it will detail how communications service providers (CSPs) can use this technology to create value and enhance revenue in both the enterprise and consumer spaces.

From a broad perspective, 5G has the potential to empower people, societies, organizations, and enterprises. It is a game-changer, with the capacity to create huge opportunities for a wide range of industries. For telecommunications, 5G could open opportunities for much-needed new revenue streams. However, CSPs are proceeding with caution because of the high risks and investments involved in moving toward ubiquitous 5G networks.

For example, according to a report on 5G spending from Greensill, the world's biggest non-bank provider of working capital solutions, infrastructure upgrades will need global investment in the neighborhood of USD 1 trillion.<sup>1</sup> Rolling out 5G requires denser (than 4G) arrays of masts and small cells, an intensive fiber-optic backhaul, and many other new infrastructure elements. Furthermore, additional—mostly high-priced—5G-spectrum has to be acquired. And these are only the anticipated CSP investments. They don't include, for instance, upgrading Internet of Things (IoT) devices.



# 49%

of telecom leaders report that their companies will make large investments in 5G mobile technologies in the next two-to-three years



# 77%

of 5G early adopting consumers would opt for 5G when available if it resulted in a superior mobile video quality experience



# 94%

of telecom executives expect edge computing implementations to improve operational responsiveness in the next five years

Additionally, CSPs will need to make these large investments during a period of relatively flat revenue growth. In 2018, the annual year-over-year revenue growth was 1.4 percent—less than half of global GDP growth.<sup>2</sup> And after a small pick-up in 2019 and 2020, the growth is expected to slow to around 1 percent by 2025, according to the GSM Association (GSMA).<sup>3</sup>

Even more, CSPs still have to amortize their 4G core networks. 4G has made a gigantic leap in network capabilities, but substantial investment was required to accomplish this. The first 4G services came online in the early 2010s. Between 2010 and 2018, CSPs spent well over USD 1 trillion globally on upgrading their networks to 4G.<sup>4</sup> And many CSPs are still upgrading to cope with growing demand.

As a result, most CSPs will not prioritize the core network in the first stages of 5G deployment. Instead, “islands” of 5G New Radio (NR) coverage will be added to the 4G core, mainly to solve the capacity issue. This evolutionary approach will be the natural approach for most CSPs, allowing them to lessen initial investments with the revenue potential remaining small.

### **5G: Addressing today’s pain points of smartphone users**

There is a general agreement that the greatest potential for CSPs to generate revenue from 5G is in industry applications, including the IoT. However, that requires building networks in which 5G NR is paired with a 5G core and huge investments. A significant amount of work remains to upgrade technology, standards, support systems, and business models. It could be the middle of the decade before all of this is sufficiently accomplished.

Consequently, early 5G services will focus on addressing current pain points of smartphone users, particularly those related to the explosive growth in mobile video. Mobile video, according to Cisco, will account for 79 percent of total mobile data traffic by the end of 2022.<sup>5</sup>

## 5G is set to have the fastest global roll-out of any generation of mobile network technology.

The rise in the number of mobile devices used to watch streamed content has contributed to a rapid increase in video viewing time. And the amount of embedded video in social media and the evolution toward higher resolution are further increasing pressure on current networks, resulting in degraded video experiences. The previous mobile network transition from 3G to 4G offered significant improvements in video viewing, but it has not kept pace with the rapacious consumer appetite for high-resolution video content.

### Executing early commercial launches

5G is set to have the fastest global roll-out of any generation of mobile network technology. The number of 5G subscriptions is growing more quickly than expected. In 2018, Ericsson forecast 1.5 billion 5G subscriptions globally by the end of 2024, but rapid early momentum and consumer enthusiasm has led the company to adjust this figure in 2019 to 1.9 billion.<sup>6</sup> By 2024, 5G coverage is projected to reach 45 percent of the world's population, while 5G networks are forecast to carry 35 percent of the global mobile traffic.<sup>7</sup> The GSMA has a somewhat more conservative forecast, estimating 1.57 billion connections by 2025.<sup>8</sup>

Although it will take some time to hit critical mass, the race to 5G is clearly on. CSPs in several markets have gradually switched on 5G. Timing largely depends upon the availability of 5G-compatible smartphones and 5G spectrum allocation, with each country having a schedule for either reserving, auctioning, or making formal plans for 5G spectrum.

South Korea started its first 5G commercial networks on April 4, 2019, and surpassed the three million subscriber mark five months later. 5G coverage now reaches almost all of the country's population.<sup>9</sup> Data use has surged on South Korea's 5G networks as a result of ultra-high definition (UHD) 5G live broadcasting and entertainment applications such as augmented reality/virtual reality (AR/VR) gaming.<sup>10</sup>

In spring 2019, Verizon, AT&T, Sprint, and T-Mobile began rolling out networks in a number of US cities with 5G speeds and faster wireless connections. Verizon has also launched its new 5G network in sports venues—such as those of the NFL and NBA—across the US.<sup>11</sup> GSMA forecasts that 5G will account for almost half of all mobile communications in North America by 2025.<sup>12</sup>

China has invested heavily in the transition to 5G. Since November 1, 2019, China has had the largest 5G network available for commercial use, with the three major Chinese providers offering 5G services to users.<sup>13</sup> Their networks operate in 50 of China's major cities, with 12,000 active 5G base stations supporting coverage. By 2025, China is expected to account for more than 40 percent of the world's 5G connections.<sup>14</sup> In 2019, commercial 5G networks were also launched in—among others—Germany, Switzerland, and the UK.<sup>15</sup>

### Creating private 5G networks

To enable full deployment and commercialization of 5G, CSPs need sufficient spectrum within specific frequency ranges. Many of them are already involved in 5G spectrum auctions. However, CSPs can no longer be assumed to be the default connectivity providers. 5G could see explosive growth in private enterprise networks, according to a GSMA Intelligence report.<sup>16</sup>

This nascent movement toward allocating spectrum for enterprise—as opposed to operator—use will likely fuel demand within the next five years. Manufacturers, for instance, might opt to build private 5G networks for their in-factory applications.

The US Federal Communications Commission (FCC) has already approved initial commercial deployments for Citizens Broadband Radio Services (CBRS) in the 3.5 GHz mid-band spectrum for 5G.<sup>17</sup> Germany has carved out spectrum for private licenses in its 5G allocations, even without auctioning but instead assigning spectrum to applicants on request.<sup>18</sup> BMW, Volkswagen, and Daimler have already expressed interest in operating private 5G networks for their German plants.<sup>19</sup>

For operators, this means that infrastructure competition becomes harder and that “frenemy-style” partnerships with adjacent industries become the norm rather than the exception.

## Telstra: Collaborating on 5G in a working innovation lab<sup>22</sup>

Telstra's 5G Innovation Centre was opened in 2018 at the company's Southport Exchange on the Gold Coast to enable collaboration among 5G technology vendors, developers, start-ups, and enterprise customers from around the world. The lab was designed to test 5G and related technologies in the Australian environment and to help develop products and services that can take advantage of the latest telecommunications technology.

In this facility, Telstra designs, experiments, and collaborates to conduct 5G tests in real-world environments. The company's purpose is to advance the deployment of 5G as soon as new standards, spectrum, and 5G-capable devices become available. With all these building blocks in place, Telstra can roll out commercial 5G capabilities nationally to high-demand areas.

Telstra has evaluated a variety of use cases in its lab, including immersive media, augmented and virtual reality, 5G mobile gaming, and autonomous driving. As well, 5G smart drone technology has been applied to support surf lifesaving, and robotic arm technology to support a range of industrial applications that require precise control.

## 5G: Creating a bigger impact on enterprises than on consumers

The big win for CSPs will come from being able to address enterprise needs, not in being first to serve mass consumers. 5G can unlock a wealth of benefits for enterprises and industries in which the technology has a lot more to offer than just network performance enhancements. The most significant value of 5G will not come from connecting people, but from its ability to provide seamless connectivity to infrastructures, machines, and things.

5G is set to become the foundation platform for many new applications in industry verticals such as manufacturing, transportation, and healthcare. However, the capabilities and standards required to unlock a new world of enterprise services are still under development. Consequently, commercial 5G enterprise applications—such as Industry 4.0 factories, autonomous driving cars, and robotic surgeries—will become available in evolutionary stages and remain some time away.

For CSPs, industry verticals present the largest incremental revenue opportunity. But to create the potential for optimal profit from 5G, these organizations will need to alter their mindsets and abandon some past practices. It is imperative for CSPs to collaborate in ecosystems. CSPs can only help enterprises and industries unlock value from 5G if they are part of the digital fabric, provide open platforms to play on, and deliver solutions in partnership with their ecosystems.

Several CSPs are already partnering in 5G technology trials. Telefonica, for example, is working with Spanish automaker Seat on 5G-connected car use cases for safer driving in city environments.<sup>20</sup> NTT Docomo and electronics company Omron are conducting joint field trials using 5G at their plants and other production sites.<sup>21</sup> And Telstra has launched a 5G innovation center to enable collaboration among technology vendors, developers, start-ups, and enterprise customers, as well as to conduct 5G field trials (see sidebar: "Telstra: Collaborating on 5G in a working innovation lab").

The blending of 5G, edge computing, and AI provides a foundation to support new groundbreaking use cases in almost every industry.

## Blending a perfect fusion of technologies

5G technology can open up a new set of breakthrough use cases for consumers and businesses that use applications that depend on increased connection speeds, improved traffic capacity, very low latency, high reliability/security, and support for high density of devices. Consumers, for example, could benefit from enhanced entertainment options—sophisticated VR/AR, mixed reality, extended reality (XR), 360-degree video applications, and more—that will come with the establishment of full ubiquitous 5G networks.

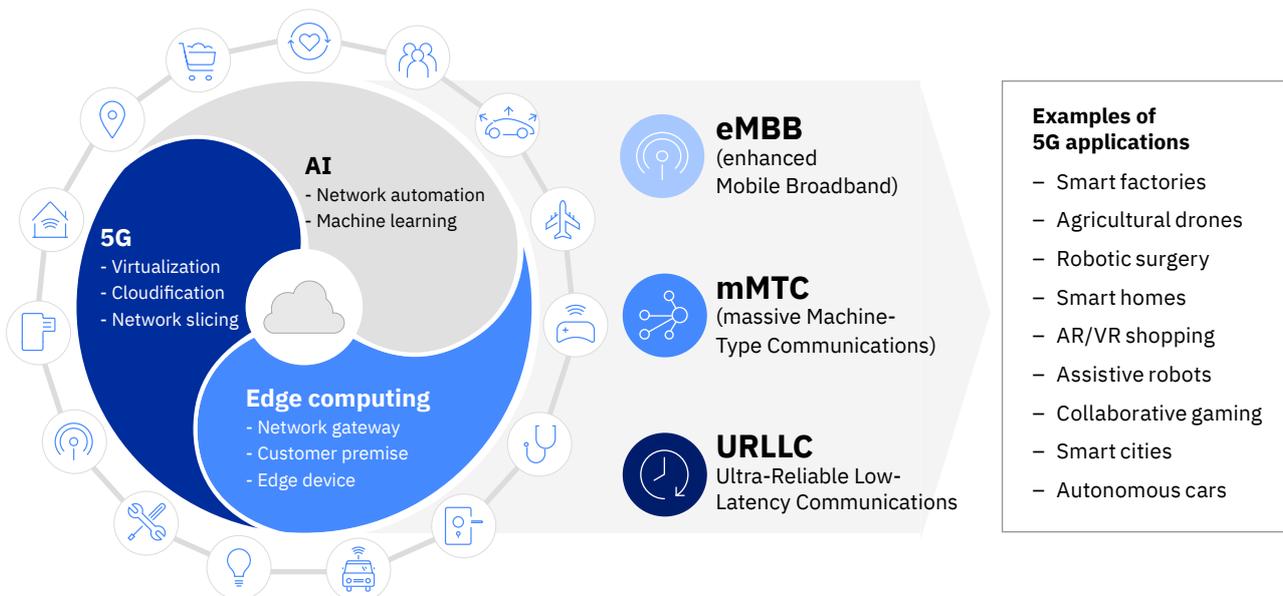
The blending of 5G, edge computing, and AI represents a unique foundation to support new groundbreaking use cases in almost every industry, from manufacturing and automotive to healthcare and agriculture (see Figure 1). These technologies also provide a potent opportunity for CSPs to create new enterprise revenue streams.

### Understanding that 5G is much more than just another G

While the transition from 1G (analog voice) to 2G, 3G, and 4G network technologies was all about digitization of mobile communications, use of data and apps, and increasing speed and throughput, 5G brings much more to the table.

**Figure 1**

The perfect confluence of technologies: 5G, edge computing and AI



Source: IBM Institute for Business Value.

In addition to enhancing mobile broadband (eMBB), it will enable massive machine-type communications (mMTC) to support mass adoption of IoT services across many industry verticals. Plus, it will offer ultra-reliable low-latency communications (URLLC) for mission-critical applications.

5G uses spectrum within three key frequency ranges (sub-1 GHz, 1-6 GHz, and above 6 GHz) to deliver widespread coverage across urban, suburban, and rural areas, as well as to support a large amount of IoT devices. CSPs need to make the best use of the performance characteristics (related to requirements such as peak data rates, traffic capacity, and latency) of each band to enable all envisioned use cases.

Realizing the full benefits of 5G requires a virtualized cloud-based network infrastructure that allows optimization through rapid scaling and descaling, resource sharing, and agility. Network virtualization and cloudification are fundamental to realizing 5G network services delivery aligned with customer and service provider expectations. It also allows for an unprecedented level of cognitive automation, enabling 5G networks to conduct intelligent, agile, responsive network and service operations.<sup>23</sup>

### **Teaming up: Edge computing and 5G**

5G is only one of a set of technologies coming together to kick off a new chapter in the history of telecommunications. Another essential technology that helps fundamentally transform telecommunications is edge computing, including multi-access edge computing (MEC) as defined by European standards organization ETSI.<sup>24</sup> Latency-dependent and time-sensitive applications, such as automated vehicle driving and telerobotics, will especially benefit from edge computing in combination with 5G network slicing.

Without edge computing, 5G applications and services will rely upon connecting through the core network to centralized cloud resources for storage and computing, losing much of the positive impact of the latency reduction enabled by 5G. The basic idea behind edge computing is that by storing/accessing data and performing high-demand processing tasks closer to the network edge—that is, closer to the end-users and devices—network congestion and latency are significantly reduced. These reductions are crucial for latency-critical applications dependent on continuous corrective actions.

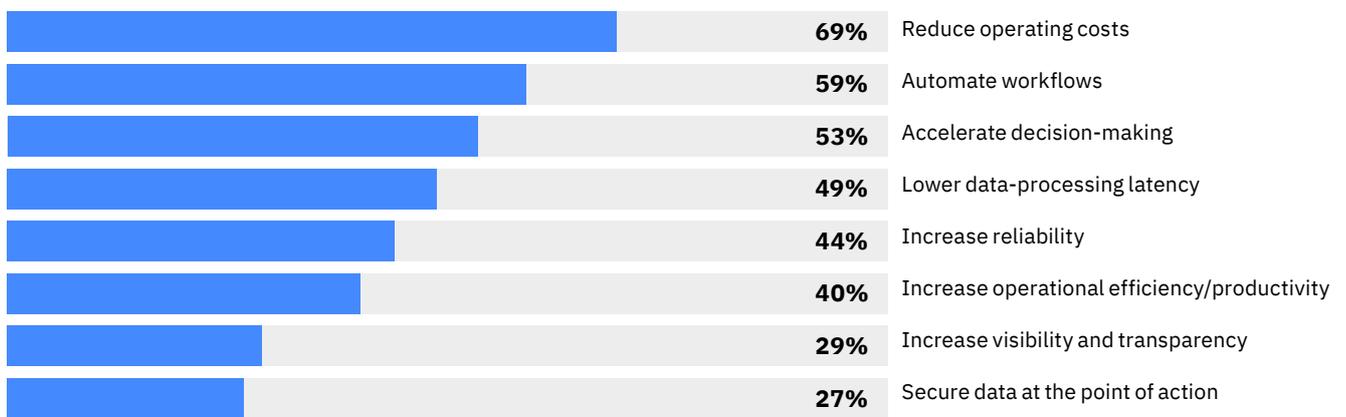
Edge computing is complementary to—rather than in competition with—cloud computing. In this way, benefits can be leveraged from both local (on the network gateway, customer premises, or edge devices) and cloud computing. Though edge computing can be used in a 4G environment, the combination with 5G optimizes throughput and latency—to the order of sub-10 milliseconds—thus laying the foundation for previously unimagined latency-dependent wireless solutions.

5G-based edge computing commercial applications are beyond the near-term horizon, but CSPs increasingly realize the importance of these applications and that they can play an integral role in their deployment. Fifty-six percent of CSP executives in IBM's edge computing survey reported they are already in the planning and proof-of-concept phase.<sup>25</sup> Among all CSP executives interviewed, 94 percent expect edge computing to have a positive impact on operational responsiveness within five years. They say the greatest impacts will then be on reducing operational costs, automating workflows, accelerating decision-making, and lowering data-processing latency (see Figure 2).

# AI has become the key driver for the adoption of edge computing.

**Figure 2**

Elements of operational responsiveness where edge computing is expected to have the greatest impact in five years



Source: 2020 IBM Edge Computing Study; n=70.

Many CSPs are already evaluating edge computing on 5G networks. For example, AT&T has been testing edge computing in a retail environment (see sidebar: “AT&T: connecting 6-foot-tall retail robots to 5G and edge computing”). As another example, Verizon is developing new 5G edge technology that could revolutionize mobility for VR, XR, and AR in enterprise applications.<sup>26</sup> And SK Telecom has launched a 5G edge computing open platform to third parties and enterprise customers.<sup>27</sup>

## Ramping up AI in 5G networks

Industry digitalization, the increasing number of connected devices, and the demand for immersive experiences will require more and more processing power at the edge of networks. Gartner predicts that, by 2022, more than half of enterprise-generated data will be created and processed outside of data centers, and that by 2025 about 75 percent of data will be analyzed and acted upon at the edge.<sup>29</sup>

AI has become the key driver for the adoption of edge computing. Edge computing brings AI closer to where the data is created and where actions need to be taken. AI can process large amounts of data in short periods and provide the insights to drive quick, local, data-informed decision making. Locating AI close to the edge is crucial for applications where near-real-time feedback and optimization are a priority for applications—such as machine control, equipment monitoring, and remote surgery.

Faster AI-based decision-making and responses at the edge also result in better user experiences—for instance, in the areas of AI-assisted driving and multi-player gaming. In addition, edge computing supports improved security because sensitive data can be analyzed at the edge and doesn’t need to be sent over the core network to a central cloud, in this way limiting the amount of data stored in any one location.

## AT&T: Connecting 6-foot-tall retail robots to 5G and edge computing<sup>28</sup>

AT&T Foundry in Plano, Texas, is working with robot manufacturer Badger Technologies to test robots in a combined 5G and multi-access edge computing (MEC) environment. Badger currently operates approximately 500 retail robots at grocery stores in the US owned by Dutch retailer Ahold Delhaize. The robots roam the aisles of the stores, checking for spills and other trip-and-fall hazards. They also monitor inventory levels.

Today, those robots are networked over Wi-Fi in the stores; data is processed by computers on the robots. In the new situation, an onsite MEC device at the foundry allows computers to be removed from the robots and to process data on the customers' premises. The trial aims to prove the benefits of 5G and MEC for robotics and other applications that require high speeds and low latencies. Processing data locally also gives Badger more control over what data travels outside of its stores and what data stays onsite to address privacy and security concerns.

## Empowering enterprises and industries with 5G

For CSPs, the real prize is in addressing enterprise needs. The most advanced 5G use cases—and those that offer the greatest revenue growth opportunities for CSPs—are found in the enterprise and industrial markets. 5G holds the potential to become the foundation for many new industrial applications and to support entirely new use cases not possible with current networks.

### **Embarking upon new technology; uncertainty remains**

5G is expected to reinvent entire industries. However, this “revolutionary” aspect of 5G remains beyond the near-term horizon. Though the technology strategy is fairly mature, it will still take years to migrate to a 5G environment that makes such a transformation possible. It depends on having a cloud-native 5G core network, leveraging extensive network virtualization, and implementing AI-based automation.<sup>30</sup> Most operators are still in the early phases of developing this envisioned ubiquitous 5G network infrastructure. A significant amount of work remains in standards, regulations, and, in particular, operational and business support systems.

Uncertainty about business cases and the expected return on investment is also delaying full-scale 5G deployment. Confidence in the technology is high, but the uncertainties around the strength of the business cases and the underlying economics make many operators hesitant to go full speed ahead with 5G investments. CSPs are also dealing with risks such as increased competition, fast arrival of new technologies, changing regulations, and access to finance.

## With a full-fledged 5G network available, CSPs can deliver services to specific verticals through network slicing.

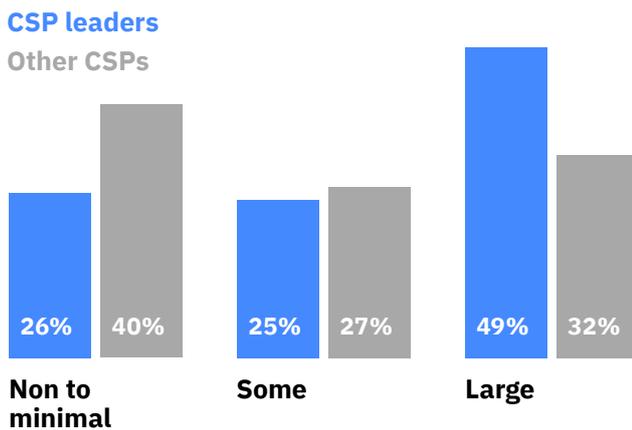
The results of our 2019 Global IBM Global C-suite Study, in which interviews were conducted with 730 telecom CxOs, revealed that only 15 percent of CSPs worldwide have made large investments in 5G technologies in the past two-to-three years.<sup>31</sup> However, CSPs increasingly realize that these investments are important to secure their future in industry verticals. Forty-nine percent of telecom leaders in the survey (those excelling in revenue growth, profitability, and innovation) say they plan to make large investments in the next two-to-three years (see Figure 3).

### Delivering the promise of network slicing

With a full-fledged 5G network available, CSPs can deliver services to specific verticals through network slicing, which provides the ability to deploy any number of virtual end-to-end networks on a single physical infrastructure, with each virtual network representing one slice.

**Figure 3**

Level of investment in 5G mobile technologies in the next 2-3 years



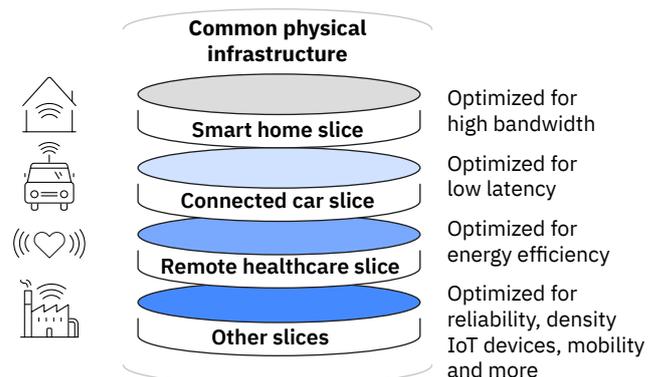
Source: 2019 IBM Global C-suite Study; n=730.

It enables telecom operators to reserve a slice for a specific customer or application at a guaranteed quality of service.<sup>32</sup> Network slicing allows operators to dynamically balance disparate requirements—such as availability/reliability, throughput, and latency—among different applications, such as those for remote healthcare and autonomous connected cars (see Figure 4).

Enterprise and industrial applications will especially benefit from 5G network slicing in combination with edge computing. Edge computing distributes storage, compute, and intelligence to multiple levels of the network, including to the extreme edge for very low-latency use cases. Thus, it delivers certain types of applications or services in dedicated slices closer to devices and end users. In addition to enabling ultra-low latency, it also helps enhance security and supports backhaul cost savings.

**Figure 4**

Network slicing



Source: IBM Institute for Business Value.

## Vodafone: Electric car factory boots production with 5G-fueled robots<sup>33</sup>

Automotive manufacturing production, enabled by 5G, network slicing, and edge computing, is now a reality for German electric microcar company e.GO Mobile AG at its Aachen complex. The solution helps deliver security-rich, near-real-time data networking across the production chain, from digital material management to autonomous vehicle control.

The optimized on-site network spans 36 antennas in the 8,500 square-meter facility, delivering gigabit bandwidth and latency of just a few milliseconds. The security-rich automatic identification and delivery of production materials to each specific vehicle as it goes through the assembly process increases operational speed and efficiency across the chain. This replaces the traditional production line that moves vehicles from station to station.

In the future, autonomous forklift trucks and small trains will also be used to transport material between warehouses and the production line. The assembly plant is an Industry 4.0 factory, fully networked in information technology. Connectivity links the physical and the digital worlds.

Deploying network slicing and edge computing in a 5G core network environment creates the possibility for previously unimagined latency-dependent wireless solutions, including those for connected autonomous vehicles and smart factories, among others. The concept of 5G with network slicing and edge computing is being evaluated by a number of CSPs—by Vodafone, for instance—for the German electric microcar company e.GO Mobile AG at its Aachen complex (see sidebar: “Vodafone: electric car factory boots production with 5G-fuelled robots”).

### **Assessing 5G-potential for IoT and industry verticals**

5G enterprise and industrial use cases are specifically centering on IoT. In fact, 5G has been designed with IoT use cases, which are extremely diverse, in mind. For instance, in the consumer IoT space, use cases range from connected homes and cars to personal electronics, such as wearables. In our 2019 Global Telecommunications Consumer Survey (which will be explored in detail in the second part of this report), 30 percent of consumers stated they are excited about 5G smart home applications, with only media and entertainment types of 5G applications ranking higher in relevancy to them.

Particularly in the enterprise IoT, the focus is on operations efficiency and effectiveness. For instance, 5G IoT-enabled enterprise resource planning (ERP) systems can couple sensors and other IoT devices to transmit data into the system in real-time without human intervention. In industrial IoT, 5G is the crucial element in the Industry 4.0 evolution toward increasingly smarter and more dynamic manufacturing.

## Industry 4.0 is completely changing the concept of manufacturing from massive production to massive customization.

5G IoT emerges as the lifeblood of most industries and will enable revolutionary capabilities for just about every industry (see Table 1). Ericsson analyzed ten industries and concluded that 5G-driven investments overall are expected to reach roughly USD 1.5 trillion in 2030, with nearly half of that addressable by CSPs.<sup>34</sup>

**Table 1**

Examples of 5G potential applications in industry verticals

Industry	Examples of potential 5G applications
Manufacturing	Smart factories, AR and remote expert, precision monitoring and control, collaborative robotics, advanced predictive maintenance
Automotive/ transportation	Autonomous driving, car infotainment, airborne taxis, fleet management and tracking
Entertainment	Collaborative gaming, consumer AR/VR, 3D calls/holograms, smart wearables
Healthcare	Remote patient monitoring, virtual consultations, remote diagnosis, robotic nursing, robotic surgery, fall detection
Energy and Utilities	Smart metering, smart grid automation, off-shore drilling operations, drone surveillance
Retail	AR/VR shopping, in-store experience, store operations, warehouse automation
Public sector	Smart streetlights, sensor networks, drones for public safety, smart parking management
Smart home industry	Access control, video surveillance, intrusion detection, appliance control, assistive robots
Agriculture	Smart farming equipment, AI-enabled farming drones, crop yield monitoring, soil/nutrient monitoring

But game-changing 5G use cases will not appear overnight. Fully autonomous vehicles will not become commercially available for many years. Remote surgery using robots is also in a nascent phase. Many of these potential applications will be dependent on the second phase of 5G.

### Industry 4.0: Moving from massive production to massive customization

Manufacturing is expected to be the largest beneficiary of 5G services. The combination of 5G, edge computing, and AI will be a driver of the next Industrial Revolution—Industry 4.0—with billions of machines, devices, and sensors just waiting to be wirelessly connected. This will become the backbone of manufacturing and related services in the future (see sidebar: “Insight: 5G and the Fourth Industrial Revolution”). It will be powered by robotics, AI, IoT, 3-D printing, AR, and cloud technologies, all of which will use 5G technology to allow machine-to-machine communication.

Industry 4.0 is completely changing the concept of manufacturing from massive production to massive customization. Industrial connectivity today mainly uses wired connections, which provide the high performance and reliability required for automation, but lack the flexibility to meet changing production demands. A flexible and programmable environment—based on high-speed, low-latency wireless 5G connections, the use of edge computing and AI—will link machines, processes, robots, and people. This environment sets up the opportunity for more flexible and dynamic production capabilities to meet rapidly evolving market needs and massive customization.

For the industry verticals of interest, CSPs have to clearly articulate the 5G value proposition by how they address enterprise pain points and needs.

## Insight: 5G and the Fourth Industrial Revolution

The manufacturing industry is set to reap considerable benefits from 5G. The unique attributes of the technology could unlock USD 740 billion of value in manufacturing by 2030.<sup>35</sup> 5G will be a key ingredient for Industry 4.0.

Industry 4.0 refers to the digital transformation occurring across manufacturing industries. It represents a fusion of emerging technologies, such as IoT, analytics, additive manufacturing, robotics, artificial intelligence, and augmented reality—all brought together with efficient enterprise-wide 5G connectivity.

5G will give manufacturers the ability to build smart factories. It can help them build fully integrated, collaborative manufacturing systems that respond in real time to meet changing demands and conditions in the factory, in the supply network, and in customer needs.

Potential advantages of 5G-enabled technology include:

- Easily configurable, highly flexible, and modular production systems that operate on demand
- Substantial increases in operations and resource efficiency
- Just-in-time servicing of machines or replacement of machine parts
- Zero-touch factory operations
- More efficient warehousing and supply chains
- The ability to use digital twins—virtual replicas of physical objects, processes, or products—to gain insights into performance and potential problems.

Industry 4.0 is no longer just a concept, and neither is it only about digital transformation. It's an entire technological revolution that encompasses 5G, network slicing, edge computing, and AI to create new opportunities and advantages that weren't previously available without the combination of these technologies.

### Changing business strategies to capture revenue

To benefit from the 5G revenue potential in the enterprise and industrial markets, CSPs need to make fundamental changes to their business strategies. In the revolutionary part of 5G, it is not just about providing connectivity, but is particularly about providing solutions to change how enterprises operate. It's about delivering value and outcomes that will help enterprises reinvent themselves.

CSPs will need to look into each industry to evaluate revenue growth possibilities as well as risks and barriers. For the industry verticals of interest, they have to clearly articulate the 5G value proposition by how they address enterprise pain points and needs.

It is vital for CSPs to engage deeply with industries and enterprise customers and jointly assess which use cases are viable, evaluate the maturity of other required innovations, and define a joint roadmap. Some CSPs, including Orange, are already part of ecosystems essential for the adoption of these emerging technologies in industry verticals.<sup>36</sup>

## Action guide

### *Empowering enterprises and industries with 5G*

To thrive in a 5G enterprise world and reap the benefits from 5G, network slicing, edge computing, and AI, CSPs should:

#### **1. Prepare for the true transformational power of 5G**

It will still take several years before we begin to see a significant uptake of 5G in the industry verticals. But to help create the potential for success, preparations have to start now.

- Drive network virtualization and cloudification. This will be essential to support advanced 5G services. Invest in related technologies such as network slicing, edge computing, and AI.
- Focus on updating or replacing operational and business support systems, essential to the management and monetization of new sophisticated 5G services.
- Explore new business models for generating entirely new enterprise revenue streams.

#### **2. Consider specialization**

Arguably, the scope of industries is too large for a single CSP to effectively address; it can't be all things to all customers and all industries. Therefore:

- Focus on certain verticals, or on offering horizontal capabilities, such as AR and VR, deployable in multiple verticals.
- Make sure you have the right knowledge and skills through acquisitions or partnerships with specialists or specialized companies.
- Build an ecosystem of innovation partners that add value to the core connectivity, open up new opportunities, and help expand the addressable market.

#### **3. Create the ability to rapidly prototype solutions**

5G advanced features will become available in many stages and configurations. Consider how to:

- Make comprehensive test environments available to rapidly prototype solutions for and with enterprise customers.
- Develop tools to effectively examine the operational aspects of new solutions with your enterprise customers.
- Be flexible and quick to work closely with both your customers and solution partners, especially in the feasibility and prototyping phases.

## Creating value in the 5G consumer space

Early 5G commercial deployments are driven by enhanced mobile broadband (eMBB) services—in fact elevating 4G Long Term Evolution (LTE) mobile broadband experiences to the next level—primarily connecting consumer smartphones and targeting consumer applications. These services represent an evolutionary approach for CSPs to meet the consumers’ insatiable appetite for faster and better mobile experiences.

To better understand consumer interests in 5G, the IBV surveyed nearly 12,500 consumers in 21 countries in mid-2019 to discover pain points with today’s mobile experiences and assess excitement about 5G. These countries represent 62 percent of the global population and 77 percent of global GDP.

### Consumers are excited about potential new experiences

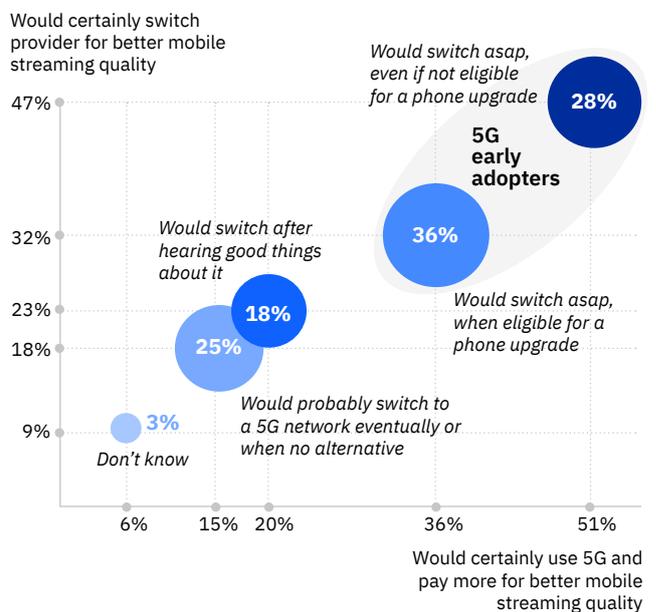
Almost two-thirds of respondents report awareness of 5G as a follow up to 4G/LTE. This awareness ranges from having some idea to being very familiar about 5G. Perhaps surprisingly, respondents in several emerging countries are more familiar with 5G than in mature countries, with the highest 5G awareness in China (82 percent).

Once educated about what 5G brings to the table, 81 percent of respondents surveyed in emerging countries and 49 percent in mature countries say they are very excited about the technology. People want the improved and new experiences promised by 5G. This is particularly true in emerging countries where the quality of current networks leaves much to be desired.

The challenge for CSPs preparing for 5G in the consumer space is to understand and keep up with the high expectations of early adopters. Our research revealed that 64 percent of respondents are likely to be early 5G adopters (see Figure 5). Twenty-eight percent said they would even switch to a 5G network if they are not yet eligible for a phone upgrade. The responses illustrate how important the smartphone has become in everyday life. Of course, actual 5G adoption is contingent upon the industry’s ability to deliver mid-range 5G smartphones and—especially in emerging countries—low-cost 5G devices.

**Figure 5**

5G early adopters would pay extra for 5G—or switch to another provider—for better mobile streaming video quality



Source: 2019 IBM Global Consumer Survey; n=12,431.

## The significant gains offered by 5G position home 5G WiFi as a serious alternative service to fixed broadband.

### Enhancing quality of video streaming could prompt provider change

Early 5G adopters understand the advantages realized by 5G. Eighty-three percent said 5G is very-to-extremely relevant for them. Close to two-thirds report they are willing to pay quite-to-significantly more for a 5G-enabled smartphone. In contrast, less than 30 percent of later adopters said they are prepared to pay a premium.

Early adopters also stated a willingness to pay more for a 5G data plan. However, previous mobile technology migrations reveal that consumers pay close to a similar amount as their previous plans, even though data speeds, data plans, and call allowances have increased. Data-plan tariffs are prone to level out through price competition. As a result, CSPs cannot expect enhanced 5G mobile broadband alone to create significant additional revenue.

The quality of video streaming is a main criterion that influences consumer satisfaction with provider networks. Four-out-of-five early adopters say video streaming quality is important. But load times, rebuffering, playback, picture quality, and synchronization on current networks are frustrating for many. More than three-quarters of early adopters say they would probably—or certainly—opt for 5G, when available, and pay extra if it results in a superior video streaming experience. More than three-quarters also say they would even switch to another provider if they can get there better quality mobile video streaming.

5G enables UHD video streaming. In the mid- to long-term, UHD video formats, such as 4K and 8K, will become common for videos on mobile devices. It is by far the most relevant 5G application for consumers, selected by 63 percent of early adopters. Companies such as AT&T and China Mobile are already test-streaming 4K high-dynamic range (HDR) video over 5G.<sup>37</sup> AT&T, for instance, tested streaming 4K video over 5G at the 2018 US Open golf tournament.<sup>38</sup>

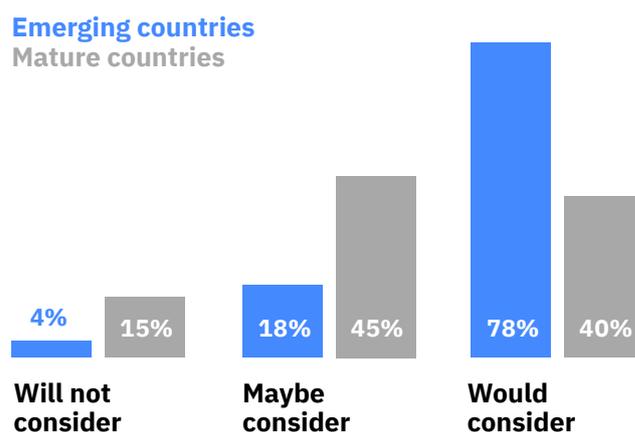
### Embracing 5G broadband for the home

For many CSPs, an additional focus in the first wave of 5G is on fixed-wireless-access (FWA). 5G can deliver Internet access to the home via a direct wireless connection (instead of via a wireline/cable connection), enabling a (WiFi) router to provide Internet service throughout a house.

The significant gains offered by 5G in capacity, latency, and throughput position home 5G WiFi as a serious alternative or complementary service to fixed broadband. As well, it could be an option in areas where fixed broadband service doesn't exist. Our research reveals consumers are open to the possibility of 5G home broadband. Seventy-one percent of respondents indicated they would subscribe to such a service if it becomes available, and another 23 percent might consider such an option (see Figure 6).

Figure 6

Subscribe to a home 5G WiFi service



Source: 2019 IBM Global Consumer Survey; n=12,431.

## Insight: Shifting VR to the next level with 5G

VR is all about putting people inside fully immersive computer-simulated environments, such as a stadium or rollercoaster, typically through the use of specially constructed headsets. Though the underlying technologies for VR have been in development for decades, VR applications are still in their infancy. The low-end headsets lack computing power, which limits graphics quality. The higher-end headsets are better but more expensive. And complex elements in the devices increase their weight. Usually, the headset requires a cable connection to a computer, limiting the player's mobility and, thus, the VR experience.

VR systems need very low latency—less than 20 milliseconds (ms)—for someone to feel as they are in a virtual environment. In fact, most users experience nausea when latency is over 20 ms. 5G and edge computing promise to deliver the ultra-fast speeds and low-latency connections crucial for VR. With 5G, much of the VR-intensive processing can be offloaded to the cloud (edge). Offloading means more computational power can be made available. It also means much smaller and more practical, energy-efficient, and less-expensive headsets that will be able to support wider VR adoption.

5G is critical to moving VR forward. Many industries will experience the advantages of using VR, such as entertainment, retail, and healthcare. According to the latest PwC Media and Entertainment Outlook, VR will be the fastest-growing media segment for the next five years.<sup>41</sup> But the road to fully immersive VR is not easy, which is illustrated by companies such as Google and BBC. Both organizations have scrapped several VR projects. We are still several years away from achieving the full benefits of 5G in VR. And it will be challenging for CSPs to make VR applications a profitable business in the future.

5G-based FWA might be interesting in countries with low fixed-broadband penetration, such as Indonesia and the Philippines, provided a clear business case exists. But this option can also be relevant in mature countries for CSPs that want to win market share by offering alternative 5G home broadband. Verizon, for example, has already launched 5G Home in select locations in the US and plans to deploy this service in every city.<sup>39</sup>

### Prompting revenue growth through immersive experiences

As indicated, enhanced mobile broadband alone might not result in higher charges for tariff plans. Price competition will likely level down data plan rates, resulting in flat revenue development. Therefore, the focus for CSPs must be on revenue generation from compelling new 5G applications that “wow” consumers. With the performance of 5G technology further improving speed, latency, throughput, and other characteristics, more transformational applications for consumers will become possible.

Future 5G-led applications will include immersive media encompassing deeply engaging, multisensory, digital experiences. But most of these transformational applications will take some time to become mature and commercially viable, which likely won't occur before the middle of the decade. Immersive and new media applications will scale significantly by 2028 and are forecast to generate more than USD 67 billion annually, according to Intel.<sup>40</sup>

Consumers are enthusiastic about future innovations in media and entertainment. For example, 45 percent of survey respondents indicated they're excited about more advanced VR entertainment applications, ranking VR second only to UHD video streaming (see sidebar: “Insight: Shifting VR to the next level with 5G”). Other 5G-immersive applications that spur consumer excitement include 3D-video movies (44 percent), AR (37 percent), 360-degree video, and 3D holographics (33 percent).

## The importance of 5G makes CSPs a vital component in gaming and eSports ecosystems.

### Gaming and eSports enthusiasts excited about 5G

5G-led innovation will also be important for mobile and VR gaming as well as for eSports, which refers to the world of competitive organized video games that are treated as a professional sport. The incredibly low latency is especially important to the gaming experience overall, and even more so for eSports. Indeed, 77 percent of the eSports enthusiasts among our survey respondents are energized about 5G, with 58 percent willing to pay significantly more for a 5G-enabled mobile device.

The importance of 5G makes CSPs a vital component in gaming and eSports ecosystems. South Korean operator KT, for instance, launched its 5G network with an AR “Avenger” game.<sup>42</sup> AT&T announced premium 5G plans for gaming.<sup>43</sup> And Deutsche Telekom is investing in eSports, intensifying its involvement in the gaming market (see sidebar: “Deutsche Telekom: Entering the eSports arena”). The group has acquired a 25 percent holding in leading eSports business SK Gaming. An increasing number of CSPs are also organizing eSports tournaments.<sup>44</sup>

### Deutsche Telekom: Entering the eSports arena<sup>45</sup>

In December 2019, Deutsche Telekom acquired a 25 percent stake in SK Gaming, claiming to be the first CSP to directly invest in an eSports organization. The acquisition underlines the importance and value that the company places on eSports and gaming. It intends to further develop the eSports sector, and in some ways to redefine it, using 5G and edge computing technologies, among others.

The acquisition illustrates the company’s commitment to eSports. Earlier the company became the main sponsor and technology partner for SK gaming, providing support for eSports professional teams including FIFA2020, Clash Royale, Hearthstone, and the famous League of Legends. The League of Legends has a huge fan base and is one of the most successful eSports games in the world.

Deutsche Telekom is heavily investing in eSports and gaming. In August 2019, the company launched its beta version of its new MagentaGaming service. The service allows players to stream games from the cloud rather than relying on the compute power of the player’s PC or console. As a result, even graphically demanding games will run on weaker hardware. In the near future, the company is planning to provide gaming in 4K resolution and 5.1 surround sound.

## Action guide

### *How to create value in the 5G consumer space*

5G is poised to unlock new opportunities in the consumer space. To improve your positioning and create the potential for increased market share, consider the following:

#### **1. Stand apart through higher-quality video streaming**

For the majority of consumers, the quality of video streaming is important, and they would switch for a better-quality experience elsewhere. Therefore:

- Make providing high-quality UHD mobile video experiences over 5G central to your consumer strategy.
- Explore the potential of network slicing, cloud, and edge computing as the foundational technologies for future video distribution.
- Collaborate with partners—among them media companies—to deliver high-profile streaming video content in UHD, including major sports events and music concerts.

#### **2. Prepare for consumer offerings that go beyond enhanced broadband**

The immersive market opportunity is still nascent, yet its ultimate promise is great, with AR and VR set to become mainstream drivers of consumer entertainment applications. Therefore:

- Drive greater awareness among consumers of the potential of 5G beyond high-quality video streaming. Explore how you can differentiate yourself in the next phase of 5G.
- Invest in emerging technologies—such as AR, VR, and 360-degree video—and in related skills to transform customer engagement. Innovate with new business models.
- Partner extensively. Partnering is crucial because creating immersive content is expensive and requires dedicated knowledge.

#### **3. Capitalize on the popularity of gaming, specifically eSports**

There are an estimated two billion gamers worldwide. The number of eSports participants is also quickly expanding. Many gamers use the latest generation of mobile devices, and 5G will be important for them. Therefore:

Explore the potential of gaming and eSports as part of your digital strategy—beyond the connectivity offering.

- Explore partnerships and evaluate roles to play. Consider which business models are most suitable.
- Make eSports a key element in your marketing strategies as a means to engage with the younger online audience.

## CSPs increasingly recognize AI's central role in automating the network.

### Enhancing tomorrow's 5G networks with AI

To prepare for the 5G future, CSPs are reinventing networks with cloud-based virtualized networking. In this environment, automation of operations is essential to support services delivery aligned with customer and service-provider expectations. Virtualization and cloudification allow for an unprecedented level of network automation—important in a world where workloads in mobile networks are becoming increasingly dynamic.

#### Automating 5G network operations with AI

CSPs increasingly recognize AI's central role in automating the network. A number of them have already implemented AI in their network operations. The National Broadband Network (NBN) in Australia updated its network management suite with AI capabilities to enable cognitive troubleshooting as well as automating processes to act on alarms that identify an actual, actionable problem in the network.<sup>46</sup> AI for network operations (AIOps) helps Nextel in Brazil predict and prevent network outages (see sidebar: "Nextel: Bringing AIOps to network operations").

AI facilitates faster decision making by capturing and processing network data and performance of key services in real time, and by automating network functions. It helps create a "living" 5G network that senses what is currently happening, anticipates changes, learns, and determines how to best make required changes. It allows for a new level of automation that results in a network that takes action based on a given situation.

AI systems can detect, predict, and localize irregularities in the 5G network and take steps to fix them before they impact customers. AI can be used to calculate future states based on various conditions and business policies, enabling zero-touch, automated, and optimized provisioning of network resources to help improve service. This capability is crucial in a world where an increasing number of IoT applications require very low latency.

### Nextel: Bringing AIOps to network operations<sup>47</sup>

Nextel is a Brazilian CSP that serves more than four million subscribers. Nextel aims to differentiate itself from other CSPs through excellent network reliability. With a nationwide network that is growing and becoming increasingly complex, the company needs advanced network operations technologies to monitor more than 25,000 network elements. It also needs to better understand the things that affect network performance to help maintain uptime and reduce outages.

Nextel has taken network operations from reactive to proactive to predictive by implementing AIOps. AI helps categorize incidents to get a better understanding of what is happening in the network, such as whether the outage is due to a utilities problem, and why the problem occurred. In this way, Nextel can group incidents together and focus on fixing problems at their source.

Nextel is also working with The Weather Company to predict weather-related incidents and prevent them from impacting service. With data from The Weather Company, Nextel can evaluate the chances of having problems with cell towers in particular regions and take precautionary actions.

AIOps, along with IBM Watson® and The Weather Company data, has helped Nextel take a more predictive approach to network operations. The company has achieved an 83 percent reduction in response time to network incidents. And Nextel can now do something about a potential incident before it actually happens, meaning that its customers, who depend on their mobile phones, are less likely to be without service.

## Living in an ever-growing global datasphere

According to IDC's ongoing global datasphere research, the average number of data interactions per connected person per day is expected to increase dramatically, from 601 interactions per day in 2020 to almost 5,000 by 2025.<sup>48</sup> This increase is the result of our homes, workplaces, appliances, vehicles, wearables, and implants becoming increasingly data enabled. Many of these interactions will be in the background as intelligent assistants, such as Google Assistant and intelligence built into cars, become part of the environment in which consumers interact every day.

An even bigger growth in data generation is expected to come from digital transformation and automation in various industries. The number of sensors and devices that make up the IoT continues to grow steadily. The total installed base of IoT-connected devices is projected by IDC to exceed 40 billion worldwide by 2025, generating 79.4 zettabytes (ZB) of data.<sup>49</sup> IoT increasingly becomes the fabric enabling the exchange of information from people, processes, and things. Data becomes the common denominator as it is captured, processed, and used to create value for industries, organizations, and consumers' lives.

## AI: Turning data into intelligence

Data is meaningless until value is extracted from it. It is all about using data smartly, turning it into intelligence. AI can help address the huge growth in the volume and velocity of data generated by all types of 5G devices and customers and create the insights needed for decision-making in a 5G environment. IoT data is simply impossible to use without AI. But using intelligence from data must protect customers' data and comply with privacy and security regulations.

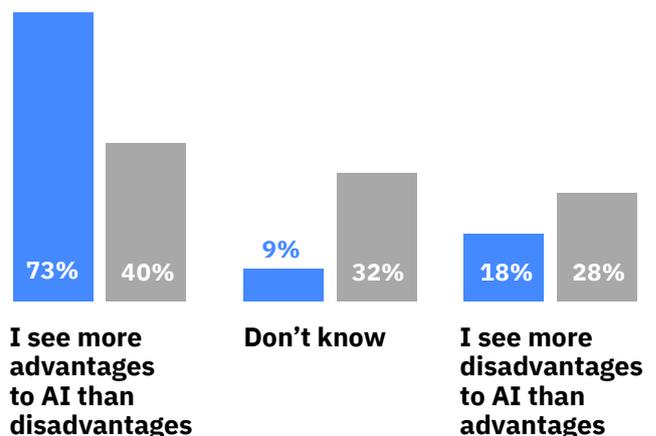
An increasing number of smartphones, wearables, sensors, and other devices in the IoT means that more data is created and collected in real time—often without user awareness—and accessed or shared by a potentially unlimited number of companies. Application of AI technology means creating more insights to improve customer experiences. But it can also lead to negative consequences—privacy concerns, for example—that could drive people away from the benefits of AI-supported IoT technologies.

Still, our consumer research revealed the number of respondents seeing more advantages to AI than disadvantages exceeds the number of respondents who see more disadvantages (see Figure 7). In emerging countries, using AI to provide better-personalized customer experiences is even more appreciated.

**Figure 7**

Position regarding using AI for better user experience/service

Emerging countries  
Mature countries



Source: 2019 IBM Global Consumer Survey; n=12,431.

AI at the edge creates a world of intelligent connectivity that positively impacts consumers, organizations, enterprises, and industries.

### Telco's trust advantage in managing data in ecosystems

The IoT is essentially meaningless if you can't integrate the data across partners in ecosystems and into logistics operations. Companies using smart devices to collect business and supply-chain data from a variety of sources and partners have to turn the data into decision-making drivers and do so easily. Data sharing across partner networks—a function of mutual trust—is a core challenge.

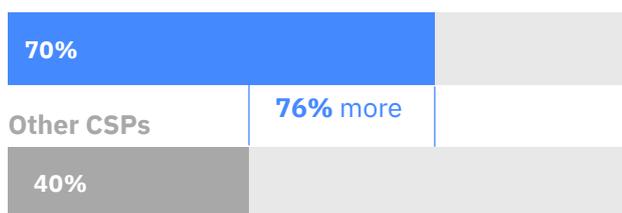
But it is also an opportunity for CSPs because they are seen as among the most trusted types of organizations, even topping banks and credit card companies in emerging countries.<sup>50</sup> This position enables CSPs to increase their roles in 5G ecosystems beyond just providing connectivity. They can become the hub for circulating IoT data across multiple parties and devices and using AI to deliver intelligence, not just rough data, to their ecosystem partners.

Becoming data-driven leads to important new opportunities for CSPs. The majority in our 2019 Global C-suite Study identified an enterprise strategy in which they drive value from data as one of their key focus areas.<sup>51</sup> As trusted enterprises, they can safeguard partner and customer data while also helping them monetize it. Seventy percent of CSP leaders in our survey told us they are pursuing data monetization strategies (see Figure 8).

### Figure 8

Integrating new modes of monetization into the data strategy

#### CSP leaders



Source: 2019 IBM Global C-suite Study; n=730.

### Boosting smart consumer and enterprise edge applications with AI at the edge

CSPs must be able to keep up with the speed and volume of changes that 5G services and applications demand of the network. The current approach focuses on transmitting the data from the point of creation to a central cloud or enterprise data center, slowing down response times.

Edge computing is delivering three essential capabilities—local data processing, filtered data transfer to the cloud (which helps reduce network traffic), and faster decision-making. As AI has emerged, its power to accelerate the detection of what is happening at the edge has been surprising. It has made edge devices extraordinarily smart, and they're getting smarter all the time. It's also allowing devices to provide insights and predictive analysis in real time, as well as drive local decision-making.

AI at the edge creates a world of intelligent connectivity that positively impacts consumers, organizations, enterprises, and industries. Examples of smart consumer edge applications are mainly focused on providing compelling user experiences. This includes improved streaming entertainment, light/powerful VR headsets, AR entertainment applications, multiplayer gaming, smart home automations, autonomous driving cars, and AR/VR shopping.

Smart enterprise edge applications include smart manufacturing, equipment monitoring, asset tracking, mining, fleet-vehicle diagnostics, autonomous delivery, patient monitoring, robot surgery, and farm monitoring. For instance, in smart factories, devices in an assembly line must communicate with control units with high reliability and very low latency to keep the assembly line moving. Combining low-latency and high-reliability communications with AI creates a factory where control by humans can be significantly optimized by technology.

## Action guide

### *Enhancing tomorrow's 5G networks with AI*

The advent of 5G creates a pivotal opportunity for CSPs to create new revenue streams, but it also introduces new challenges for them, in particular as mobile networks are becoming increasingly dynamic and many applications require fast decision-making. Incorporating AI into networks and applications can be one way to address these challenges. Consider the following:

#### **1. Start the journey to AI-enabled network operations**

To prosper in a 5G world and reap the benefits of the network cloud, it is necessary to pursue infrastructure agility. Therefore:

- Apply automation with AI to offload the need to determine and program every possible option for service-operations automation.
- Examine how AI can assist in 5G network slicing to automate the process of optimally assigning network slices among enterprise users and applications.
- Empower operations staff with AI to bring the information needed together so your operations can then be “as good as your best.”

#### **2. Take AI to the network edge where needed**

As more IoT devices are deployed, the need for AI at the edge grows exponentially. But it is still an emerging technology with relatively few real-world deployments. Therefore:

- Assess the potential of AI-enabled edge computing for your specific business cases and identify which use cases need edge AI for immediate decision making.
- Evaluate the costs of adopting edge AI against the benefit of real-time intelligence at the network edge.
- Examine how edge AI changes requirements for security, both physical and network.

#### **3. Obtain and maintain AI knowledge related to automating networks**

In the 5G environment, AI-enabled networking will be crucial to conduct intelligent, agile, responsive network, and service operations. CSPs should:

- Lead from the top. Put AI-enabled networking at the top of the C-suite's agenda.
- Invest in AI and AI-related tools, as well as in skills development, to help you keep up with the network requirements that 5G services demand.
- Use the machine learning and enablement of best practices—yours and those of others—with automation.

## Are you up to speed with 5G?

It is key for CSPs to do things differently from the past and to focus on the fundamental changes that are needed to optimally benefit from the 5G revolution. The following questions can help determine if you are ready to move forward with 5G:

- How are you preparing to provide your enterprise customers with solutions and capabilities—not just connectivity and SIM cards—to address their pain points, and to help them create business value in a 5G world?
- To what extent are you able to deliver insights, rather than rough data only, to help your customers improve operations and unlock the true potential of 5G? How are you leveraging AI?
- To what degree are you collaborating with partners in 5G ecosystems and open innovation platforms in which value is delivered in partnership with each other? How are you building and keeping trusted partnerships?
- What actions have you taken to transform the workforce to help make sure you have the skills crucial for playing a key role in the envisioned 5G environment?
- How do you see the breadth of 5G technological potential and benefits being translated into new revenue streams for your company?

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