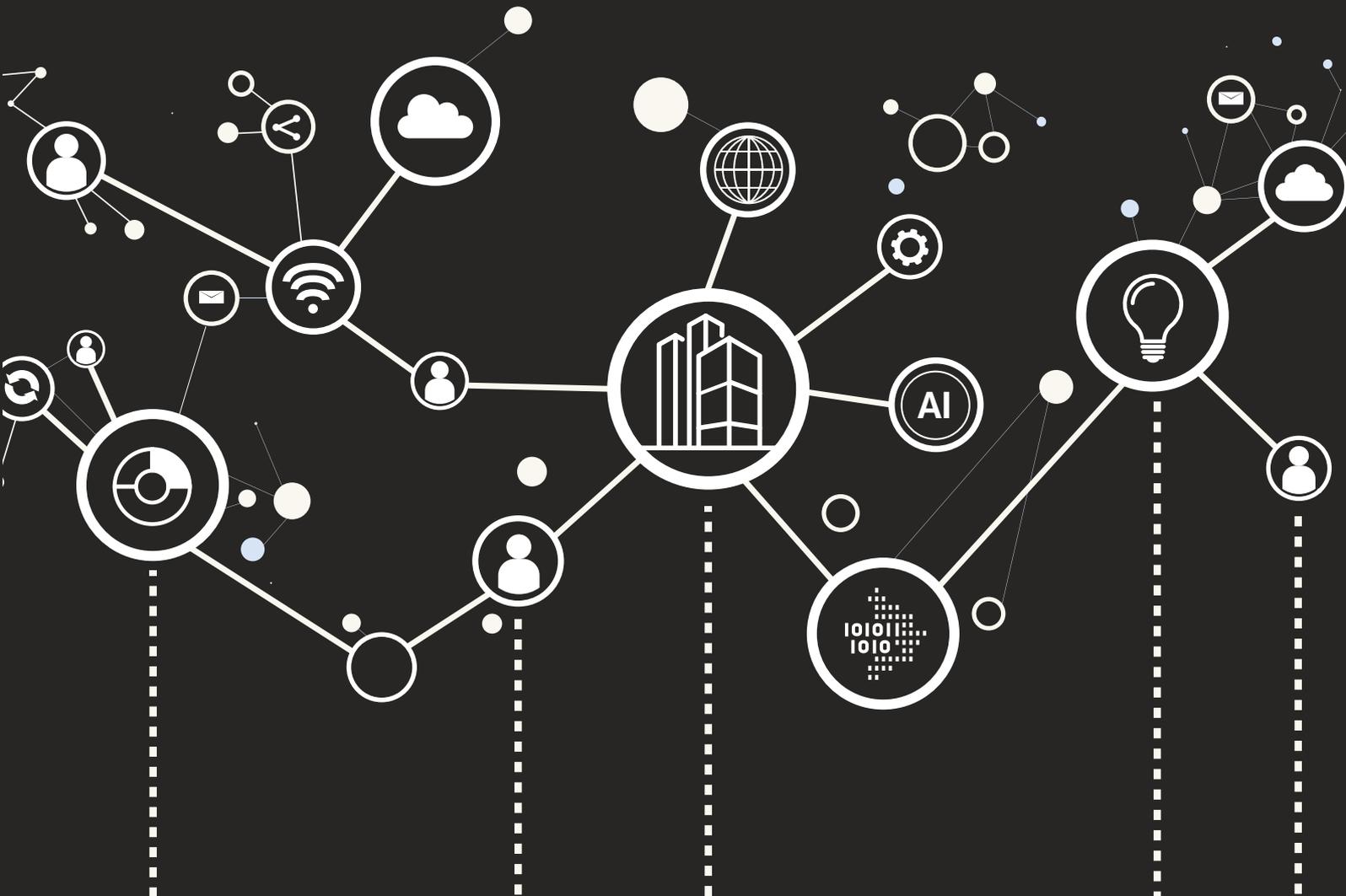
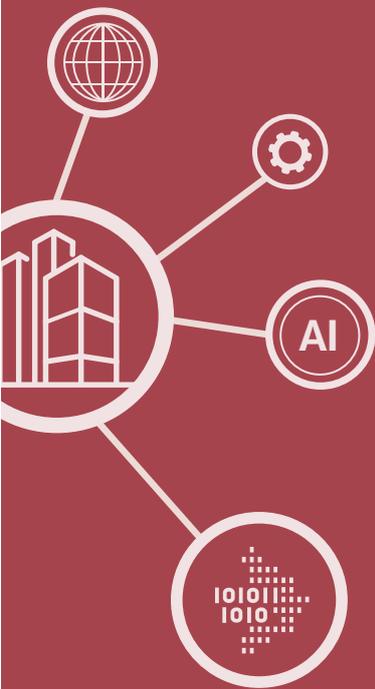


5G and the enterprise opportunity





Preface

“5G and the enterprise opportunity: How leading operators are developing ecosystem, cloud, and AI strategies for winning in 5G” is an MIT Technology Review Insights report sponsored by Ericsson. The report was produced through interviews with heads of IT, 5G business solutions, and platform innovation at telecommunications operators worldwide, conducted in July and August 2020. It examines how operators are transforming their business and technology environments to deliver 5G enterprise services, particularly focusing on cloud, automation, and the ecosystems that are emerging to drive digital transformation across industries. Ross O’Brien authored this report, Claire Beatty edited it, and Nicola Crepaldi was the publisher. The research is editorially independent, and the views expressed are those of MIT Technology Review Insights.

We would like to thank the following individuals for their time and insights:

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Byoung-Hyu Yoon, Vice President of Mobile Enterprise Business, Korea Telecom (KT), South Korea

Foreword

Welcome to this MIT Technology Review Insights report.

It is well established that 5G, IoT, cloud, and the new enterprise services they deliver are an incredible opportunity for telecommunications operators. Capturing these new revenues requires operators to build new service capabilities and transform their technology environments.

This report showcases real initiatives, strategies, and case studies of how operators are delivering 5G and innovative enterprise solutions, working with a broad ecosystem of partners, and leveraging OSS, BSS, cloud technology, and AI.

This is a time of exciting change and transformation, but the case studies also provide a glimpse into the new world of operational complexity that lies ahead. A world where operators have hundreds of APIs interacting with partners to deliver critical use cases in areas such as health care, manufacturing, and mining; where the variety of services, partners, and devices make AI and automation non-negotiable; where a microservices-based architecture is the only way to efficiently deliver stringent service-level agreements across large numbers of enterprise customers, each with differing demands.

Operators cannot compromise on operational efficiency, customer experience, or agility in this new era. As this report points out, while much work to meet these challenging objectives has already been done, there are still many unknowns. The need for an intelligent way to operate the network, IT, and multiple clouds, while managing partner relationships effectively, will be key.

At Ericsson, we have a proud history as a trusted partner to operators in managing large-scale IT and cloud operations intelligently and efficiently. As we step into the 5G arena, we are leading the way, driving the ecosystem and service innovations that are critical to monetizing 5G.

We sincerely thank the executives who contributed their insights and hope that you enjoy reading this report.

Peter Michelson
Head of Service Area Managed Services IT & ADM

Ericsson
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01 Executive summary

Unlike previous generations of network technology that paved the way for innovations like smartphones and wireless broadband, 5G's tremendous improvements in terms of lower latency, faster transmission speeds, and vastly increased network capacity are throwing open the doors to large-scale enterprise digital transformation. For operators, 5G represents yet another investment cycle—one where monetization requires making strategic bets on technology, platforms, business models, and partners. Leading operators are playing to their strengths and understand that delivering transformational enterprise solutions involves working in ecosystems of complementary capabilities.

Against this backdrop there are several imperatives for operators in the way they are developing industry verticals, approaching ecosystem development, and driving the major accelerations in cloud computing, automation, and AI that will enable them to scale 5G. There are also many unknowns and future challenges for the cloud and IT, as ecosystem and enterprise service complexity grows exponentially. The key findings of the report are as follows:

- **Operators are transforming from connectivity provider to enterprise service creator.** Delivering 5G enterprise services requires in-depth knowledge of customers' physical and digital environments in a way that far exceeds what was needed in the 3G and 4G eras. Across smart factories, autonomous vehicles, automated mines, and smart cities, operators are delivering much more than connectivity; IoT, software-defined wide area networks (SD-WAN), cloud, automation, and multi-access edge computing (MEC) are playing critical roles in customer value chains. This creates a huge (and complex) playing field. Leading 5G operators are developing standardized solutions and open platforms

so that, in future, the majority of enterprise services will become “off-the-shelf” rather than customized.

- **Ecosystems are critical for enterprise 5G success.**

Collaboration and co-creation with ecosystem partners have become table stakes for operators in delivering enterprise services, and they are building strategic alliances with systems integrators, cloud service providers, network technology players, and many more. This requires a technological and cultural transformation for operators, shifting from a closed monolithic network to one with open platforms, architecture, and application programming interfaces (APIs). The journey is still in its early days, and operators are finding several strategic decisions need to be made. These include how to be open and collaborative while maintaining prominence in customer value chains, monetizing effectively, and which partnerships to prioritize.

- **5G creates a new strategic imperative for cloud.** In the past, the key benefit of migrating network and IT functions to the cloud was for cost savings. With 5G, cloud technologies are taking center stage for different reasons. Cloud is critical to the working of ecosystem partnerships, to deliver enterprise services such as MEC and SD-WAN, and to support the platforms that allow developers to scale services up and down through API-exposed network functions. The cloud facilitates automation and AI, advances that help manage network performance and generate the data that comprise much of 5G's intrinsic value. Leading 5G operators report having more than half of network and IT workloads in the cloud, but that systems migration is always subject to cost-benefit scrutiny. Operators are prioritizing the applications and functions that are most essential for delivering 5G.

- **Enterprise service complexity is a leading driver for automation and AI.** The explosion of enterprise services is ushering in a new era of complexity for operators, both in the network and IT operations. This stems from the number of customers, devices, partners, service-level agreements (SLAs), APIs, cloud configurations, security requirements, and other factors—many of which are still emerging. Operators view automation, real-time data, and AI as essential tools for managing this complexity, now and in the future, to remove manual processes and develop increasingly predictive capabilities.

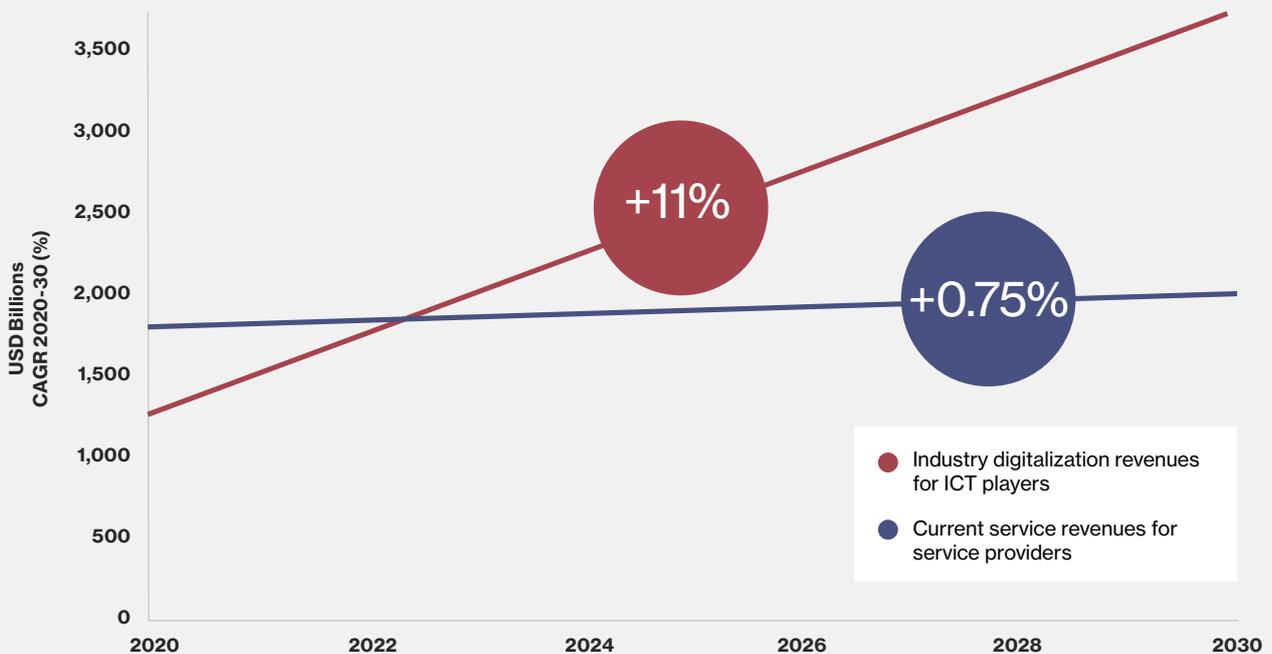
Enterprise services: the new revenue opportunity

The rise of 5G networks represents a new generation of mobile technology and a door to real enterprise digital transformation through a host of new services, technologies, and ecosystems. This massive technological shift requires infrastructure investments as significant as in previous generations, yet newly minted 5G networks are being launched into markets where the traditional connectivity business is stagnating.

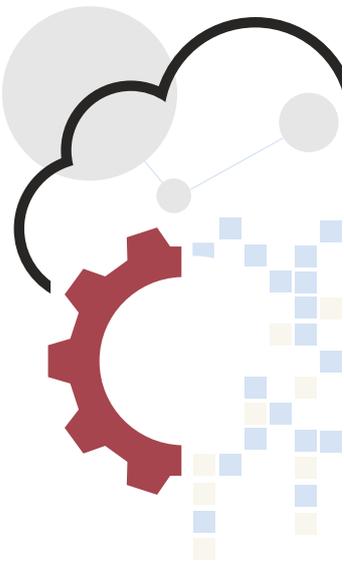
While much of this connectivity commodification relates to saturated consumer markets, traditional enterprise connectivity is also growing slowly. Research by Ericsson and Arthur D. Little forecasts revenue from basic connectivity to grow at 0.75% annually through 2030. The same research finds that the bright spot, the source of new revenue, will be value-added digital services—expected to grow 11% annually over the next decade (See Figure 1).¹ It is these more broadly defined digital services that operators aim to capture with 5G, amounting to an additional revenue opportunity of \$700 billion.²

Executives interviewed for this report argue that the most compelling market opportunities for 5G are in enterprise and public sector digitalization programs. These involve drawing on 5G’s powerful capabilities around throughput, mobility, reliability, latency, and data volume to host and manage a rich set of applications and technology

Figure 1: The service provider growth opportunity from industry digitalization



Source: Ericsson and Arthur D. Little, 2020



Building a winning 5G ecosystem requires operators to undergo a holistic digital transformation, with fully digital, increasingly virtual IT and network capabilities with cloud-based, software-defined, and process-automated service platforms.

functions across an exploding set of potential uses in sectors such as health care, manufacturing, construction and engineering, mining, agriculture, retail, events and public spaces, transportation, smart cities, and resource management. Yet delivering these capabilities, particularly at scale, requires an enormous shift for operators in terms of culture and skills, business model, architecture, and technical capabilities.

Not just another G

“5G is not just another G. It’s definitely not ‘4G plus one.’ It’s the foundation for the new real-time economy,” says Alexander Brock, senior vice president of technology strategy, innovation, and partnerships at Rogers

“The value of 5G is in assisting companies in their digital transformation, helping enterprises create digital representations of their real-world operations, and in turn helping them better understand their own customers, especially in industrial environments.”

Ryan van der Bergh
Head of Technology Architecture
Vodacom

Communications in Canada. “For the first time there are new capabilities in wireless that are truly transformational, such as variable bit rate capabilities, differential latency on demand, the ability to push transactions to the edge, and to spin up customized services through capabilities like network slicing. These are more likely to see the light of day in the enterprise market than they are in the consumer market, at least initially.” The challenges in this migration, says Brock, are technical as well as operational—taking networks and IT systems that were largely homogenous to ones that are fully customizable.

“5G-based enterprise services are probably going to be the biggest new revenue stream, because they’re the most disruptive,” says Ryan van den Bergh, head of technology architecture at Vodacom in South Africa. “The value of 5G,” he says, “is in assisting companies in their digital transformation, helping enterprises create digital representations of their real-world operations, and in turn helping them better understand their own customers, especially in industrial environments.”

Heading deeper into customer value chains

Like many of the operators interviewed for this report, Vodacom’s enterprise business development teams are structured in industry verticals to provide standard offerings such as virtual private networks, hosted private branch exchange, and SD-WAN, as well as customized solutions for specific industrial use cases. Vodacom has also acquired a majority stake in IoT.nxt, a South African IoT company that develops edge gateways for mining, agriculture, retail, and oil and gas verticals.

Becoming a digital transformation partner is taking operators deeper than ever before into their customers’

businesses—the digital and the physical. Customer solutioning involves exploring customer requirements and use cases, then learning what the actual operating environment looks like. “Funnily enough, the second one is actually often harder than the first,” says van den Bergh, particularly in mining environments that might be underground and have various physical or technological obstacles.

SmarTone in Hong Kong developed a number of industry verticals when it launched 5G in May of this year, focusing on the construction, hospitality, and property sectors—Hong Kong’s largest industry opportunities. “Over the last two years, we’ve spent quite a bit of time with construction site managers, having them walk us through their journey and having them identify needs, such as enhancing workplace safety, or their particular technology interests,” says Chief Technology Officer Steven Chau. He emphasizes the importance of discussing value over products in enterprise solution design. “We may be selling smart helmets or water sensors, but we don’t talk (to customers) about IoT. We talk about their user experience or their operational climate. At the end of the day, customers are not looking for a sensor here and there—they’re looking for a solution that can help them with their pain points.”

While some level of industry alignment is emerging organically within operators’ enterprise business divisions, becoming too deeply focused on verticals at this time can

be limiting, says Yoon Kim, chief technology officer at SK Telecom. “There are strategic verticals that we want to focus more on,” such as health care and manufacturing, “but we don’t want to be constrained by a ‘vertical-by-vertical’ approach.” The risk, he says, is missing out on 5G applications with broader industry appeal and potential.

From homogeneity to heterogeneity

Abdurazak (Abdu) Mudesir, senior vice president of service and platform at Deutsche Telekom, notes the difficulty of providing customized offers to numerous different vertical industries. “The heterogeneity of client requirements is a challenge: you have completely different verticals, and while there are some commonalities, there are also huge differences. For a service industry like ours that tries to develop mass-market offerings, this much customization is not easy. To offer dedicated enterprise networks in a cost-effective way, you need to work with many different and specialized partners.”

Rogers Communications in Canada is building specific expertise around IoT applications such as automotive, natural resources, fleet management, smart cities, and asset management, but generally the strategy is also to build a solution-neutral enterprise service delivery organization, based on servicing multi-cloud requirements and through open APIs. Focusing too much on specific use cases could become a distraction, particularly an over-emphasis on individual use cases, says Brock. Rather, he says, “We are making the investments in

SK Telecom’s 5G and AI vision

For SK Telecom, 5G is key to repositioning the company as a digital platform player with business lines spanning the media, security, e-commerce (its 11th Street business is one of Korea’s largest e-commerce destinations), mobility, music, and e-sports.

“There are two big technology pillars that this company is betting on,” says the company’s chief technology officer, Yoon Kim. “One is 5G, and the hyper-connectivity it enables, and the other is AI. 5G will change the world because it will blur the boundaries between the physical world that we live in, and the digital world. And AI will serve as the

mediator between the two worlds.” This blurring, says Kim, will create boundless opportunities for enterprise as well as consumer sectors.

To bolster its capabilities, SK Telecom has made several big bets, including the acquisition of security firm ADT Caps, making SK Telecom South Korea’s second-largest enterprise security player and providing solutions that can be integrated with 5G industrial applications. The operator has also recently made a \$25m investment in Israeli health-care company Nanox to launch affordable AI-powered medical imaging and diagnostics in South Korea and Vietnam.

platforms and IT systems to create the ‘network as a platform.’” This means having most customer requests as ready-to-go, off-the-shelf solutions, he says, and helping customers plug in and innovate. “It’s about building a series of foundational capabilities and allowing applications to flourish on the network. We are not going to be the experts in every vertical—what we need is to be experts in having an exposed set of capabilities to allow those verticals to plug into us.”

Operators aim to deliver about 80% of enterprise requests through off-the-shelf solutions, leaving just 20% in need of a customized response.

Rightsizing enterprise opportunities

The hype around 5G has opened the door to unprecedented collaboration and solutioning, which is a cultural transformation for many operators. Customers ask for an explanation of 5G and proof-of-concepts around what could be achieved. Navigating these expectations is challenging, says van den Bergh, because they fall into two extremes: “You either have enterprise customers who think you can do everything including flying cars, or you get the customers who are not quite sure whether anything can be done at all.” Focusing on value is where operators are coming into their own, showing customers what can be achieved even with 4G technology for increasing the connectivity of their operations. This then becomes a gateway for “moving them up the stack,” into capabilities that allow them to better understand their operating environments.

“It’s not about 4G or 5G, it’s more a question about what type of value do we enable to the customer in their digital journey.”

Lars Klasson
5G Program Manager
Telia Company

“It’s not about 4G or 5G, it’s more a question about what type of value do we enable to the customer in their digital journey,” says Lars Klasson, 5G program manager at Telia, the largest fixed-line, mobile, and broadband operator in Scandinavia and the Nordic countries.

Over the coming decade, 5G, IoT, MEC, and real-time AI will offer many avenues for profitable growth for operators. However, the exact scale and pace of enterprise demand is still emerging. To avoid being stretched too thin or distracted with niche use cases, operators must determine the right mix between standardized, plug-and-play services, and more customized solutioning. They will also need to work within a robust ecosystem of partners to fully monetize their 5G army.

Key takeaways

1

5G is the gateway to digital transformation: 5G is opening the doors, encouraging enterprises to ask operators to show them what is possible. Whether the required value comes from 4G or 5G capabilities, operators are becoming key partners in enterprise digital transformation.

2

Enterprise 5G requires a skills and culture transformation: Becoming more deeply integrated in customers’ value chains, existing infrastructure, applications, and ecosystems is a big shift for operators. Building a flexible startup-style culture is vital to succeed. Operators also need to make strategic choices about where to focus and how deeply to specialize.

3

Leading operators are building for scale: Although industry expertise is essential for working with enterprise customers, leading 5G operators are also looking ahead at how to achieve scale. This involves building IT platforms and systems with open architecture and APIs that industry verticals can plug into. In future, up to 80% of enterprise solutions will be off-the-shelf.

OS

Partnerships and the 5G ecosystem

Addressing the seemingly infinite number of enterprise opportunities, with all of their hardware and software complexities, means that operators cannot go it alone. A central feature of the shift to 5G is the partnerships and ecosystems that are evolving to meet customers' unique and complex goals for digital transformation (see box).

It takes a village

Operators need to be aware of their own strengths, assets, and skills and bring in partners where necessary. Chau at SmarTone says that if they don't have a technology solution, or it is not considered a real strength, they invite third parties to help identify the best way to address customer interests. "Through this process," he says, "we integrate all different pieces together to offer a single point of contact with the customer. So, in effect we are a project manager, doing systems integration work—coordinating the inputs of different partners around us to serve specific domains in-depth, and integrate as end-to-end applications."

This is a significant shift in roles for most operators. In days gone by, enterprise sales teams sold subscriptions to connectivity services. Now, says Chau, "They need to understand the entire customer journey, and how to meet all their IT and communication network requirements. This is quite different from what a telco used to be." Doing it alone is no longer an option, and success for operators in the 5G era increasingly depends on the strength and range of their ecosystem partners that they are working with.

Justin Shields, chief technology officer, platforms and solutions at Vodafone Business, whose team is currently working on hundreds of enterprise opportunities, notes

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Stephen Chau
Chief Technology Officer
SmarTone

The 5G universe



Reflecting the complexity of 5G and the degree to which those services extend deeply into the value chains of enterprise customers, there are a large number of players participating in 5G ecosystems.

These participants span infrastructure, data, software, and devices, and can include systems integrators, applications developers, network technology providers, public cloud service players (including hyperscalers such as Amazon Web Services, Microsoft Azure and Google Cloud that offer servers, storage, databases, software, and analytics), MEC platform and integration service companies, IoT solutions and device manufacturers, data center providers, cybersecurity companies, industry associations, and the enterprise's own technology partners.

that the sheer breadth of components within 5G enterprise services requires operators to work within in an ecosystem. “Managing this ecosystem is probably the thing which requires the most thought and management. One of the biggest challenges is the huge number and variety of customer requests that are coming through. It is exciting, but it also stretches any single carrier’s ability to manage the volume.” The complexity of the requests comes from the fact that they cut across devices (with security implications), applications that are often running at the edge, business processes, and on top of that, many require change management on the customer’s side.

5G operators globally are pursuing multiple ecosystem development strategies, just as they have in building up their vertical industry expertise. One way has been to find fellow travelers on the road to 5G: “We maintain and expand partnerships with technology firms that themselves specialize in 5G networks, devices, and applied services,” says Byoung-Hyu Yoon, vice president of Mobile Enterprise Business at Korea Telecom (KT). These include a partnership with Neuromeka, a provider of smart factory “cobots,” and Cognex, a US-based producer of machine-vision systems used in automated manufacturing to detect defects.

KT has two sandbox innovation programs, one at the Institute of Convergence Technology in Seoul, the other at the 5G Open Lab in Pangyo, a tech cluster outside Seoul, that leverage its KT Cloud platform for working with MEC developers. Rogers has a number of 5G innovation partnerships with universities and municipalities, including smart campus programs at the University of British Columbia (UBC), that includes a focus on edge computing, and the University of Waterloo, Ontario, as well as a C\$30m (US\$ 22.7m) Cybersecurity Catalyst innovation center at Ryerson University in Toronto. Together with UBC, Rogers launched a 5G pilot program that uses wireless sensors to collect anonymous data on vehicle and foot traffic patterns to improve road and pedestrian safety in the city of Kelowna, British Columbia—Canada’s first smart city solution.

APIs and the path to monetization

Telecommunications operators have traditionally had “mostly closed, monolithic architectures,” says Abdu Mudesir at Deutsche Telekom, while 5G ecosystems—and indeed monetizing 5G—can only be accomplished with a disaggregated architecture and open interfaces. Van den Bergh at Vodacom agrees, adding that with a whole suite



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Justin Shields
CTO Platforms and Solutions
Vodafone Business

of new 5G capabilities, the question becomes “How do we expose them best, in order to monetize the network? Standardized APIs, external API gateways, making sure that the architecture is completely open—these are fundamental requirements.”

At Rogers this has led to a “services factory” approach for developing standardized services and API interfaces exposed through common platforms to enable easy consumption for enterprise customers, allowing them to plug into the network. IT systems must also be as simple as possible, with a playbook, as opposed to everything being custom.

The clarity of the platform, the specifications, and access to the APIs is critical, says Shields at Vodafone Business, “Otherwise, you end up spending huge amounts of time trying to educate them [ecosystem partners] on what they need to do to take advantage of the technology.”

Operators interviewed for this report say that monetization and the division of value between partners are still agreed on a case-by-case basis.

Ecosystem investments, choices, and trade-offs

As 5G ecosystems evolve and mature, there are a number of choices and trade-offs that operators need to make. A key learning at Telia, says Klasson, is the importance of working within customers' own ecosystems. "What system integrators do they already use? What type of application providers or hardware providers do they use? You can try to speculate what type of ecosystem or partnership you need, but then when you are hands-on in the deal with the customer, they come to the table with their preferred partners already."

When Telia began its 5G journey two or three years ago, it started building up a large network to show companies what was possible with 5G. This strategy bore less fruit than was anticipated. Now, says Klasson, Telia has partnerships with a few application companies and systems integrators, "but that's it. The smaller companies developing application or hardware based on four or five years of experience probably learned more from us than we learned from them in hands-on customer cases."

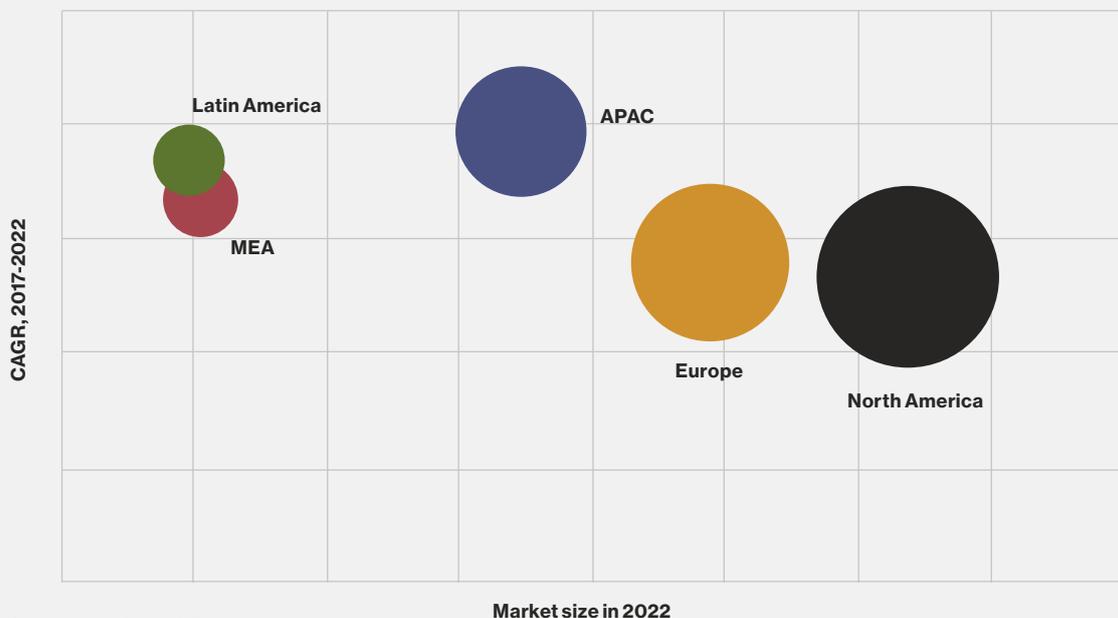
Another choice is in how much to rely on the technical or platform capabilities of partners versus building them in-house. In addition to cultivating mutually beneficial relationships with public cloud hyperscalers, says Kim, SK

"There are not too many operators that have all the ingredients—the connectivity, the edge offering, and also the IT services. It is actually quite unique to have these three capabilities, and that's one of the challenges for the industry."

Abdu Mudesir
Senior Vice President of Service and Platform
Deutsche Telekom

Telecom has invested in a joint venture with HP Enterprise to develop its own MEC platform with software and hardware that can be offered to operators in Southeast Asia that are just starting out on their 5G journeys.

Figure 2: MEC market size and growth rate, 2017-2022



Source: Marketsandmarkets, 2017

“We see this as an interesting mobile operator play where, in addition to partnering with hyperscalers, which we are doing actively, we can also build an ecosystem of our own, based on our 5G network, partnerships with third-party solution providers, robot makers, smart factories, and other device players to make a valid and viable new ecosystem,” says Kim. Indeed, the MEC market is estimated to be growing at 35.2% annually according to Markets and Markets, with Asia growing the fastest.

With MEC being a key market opportunity, Vodafone Business is also building up both its own platform and ecosystem partnerships. Through a strategic alliance with AWS Wavelength (the 5G service arm of Amazon Web Services), Vodafone Business can offer sub-10 millisecond latency for edge services. This, says Shields, creates “the same developer environment as if you were developing on a native public cloud, enabling developers to build low-latency applications that run on the edge.” The partnership radically expands both companies’ developer ecosystems. To expand its universe even further, Vodafone Business is building dedicated, private MEC edge zones that work with mobile private networks using Microsoft Azure.

Having all of these capabilities is what can make an operator really unique, says Abdu Mudesir. “There are not too many operators that have all the ingredients—the connectivity, the edge offering, and also the IT services.” Deutsche Telekom is also developing all three. This allows customers to run their networks in isolation if necessary and enables Deutsche Telekom to layer on managed IT services. Automotive is a leading industry segment, and Deutsche Telekom has partners with deep expertise—particularly EK Automation, InSystems Automation, and ASTI Mobile Robotics, companies with specialist technology for automated guided vehicles. Smaller, more niche ecosystem players can access and test the platform through the operator’s hub:raum tech incubator program.

Managing these complex ecosystems, creating platforms that enable them to flourish, and developing the technical capabilities and infrastructure that will give operators a competitive edge within them will continue to be key priorities for the telecoms industry as enterprise 5G begins to scale.

Key takeaways

- 1 **Innovation happens within 5G ecosystems:** Complex solutioning for enterprise services requires operators to collaborate and co-create with partners. Leading operators are setting up 5G innovation zones with strategic customers and sandboxes for collaboration with smaller developers. These efforts are critical for having a seat at the top table with enterprise customers and really understanding the applications and services they require.
- 2 **Open APIs are the path to monetization:** Operators are best able to expose, and therefore monetize, their 5G capabilities through open platforms and external APIs gateways. These are also essential for fueling the innovation ecosystem. The challenge is in ensuring these gateways and APIs are easy to use, accessible, and relevant.
- 3 **Navigating ecosystem strategy requires choices and trade-offs:** There are many challenges for operators in developing a clear ecosystem strategy. These include how to create a culture of openness and collaboration while maintaining prominence in the customer value chain, monetizing effectively, and choosing which partnerships to prioritize. As well as joining forces with ecosystem participants, leading operators are making big bets with regard to cloud, MEC, IoT, and high-value verticals to grow their technical capabilities and build ecosystems of their own.

5G provides a new impetus for the cloud

Over the past few years, operators have been reducing cost and simplifying legacy network infrastructure and operational processes by moving applications into the cloud. With 5G opening the door to closer collaboration with enterprise customers and broader ecosystem innovation, cloud takes on a whole new level of importance. Indeed, cloud is at the center of operator strategy for enterprise 5G.

Cloud-based resources are critical to the working of ecosystem partnerships, for delivering enterprise services such as MEC and SD-WAN, and for supporting the platforms that allow developers to scale services up and down through API-exposed network functions. The speed, flexibility, and openness of cloud architecture enable operators to more simply manage their IT operations and network services. Cloud also facilitates access to automation and AI tools, advances that drive performance in IT operations and network management and generate the data that comprise much of 5G's intrinsic enterprise value.

"A customized, scalable, and secure network, which is also lean to operate, must be cloudified," says Abdu Mudesir. "We have shaped our entire network strategy around disaggregated, microservices-type offerings, with automated and cloudified network architecture."

Operators interviewed for this report state that their "cloud-first" strategies cover the network, IT operations, and also internal IT systems, although these are at different stages of migration. They agree that the end goal is to move as many network and IT functions to the

cloud as possible. However, there are different streams, priorities within those, and a fully 100% cloud-native environment may not be achievable or desirable.

Cloud first, but not necessarily native?

"Cloud native consists of three dimensions," says Kim at SK Telecom. "The first is internal: using cloud-based capabilities for the 'operating systems' of your company—development processes, decision-making, or training." The second is "to use the cloud, either as a platform or as an infrastructure, to build products and services to provide directly to your customers." The third dimension is using cloud as an innovation space with ecosystem partners, essentially using cloud as "a tool for extremely close strategic collaboration for business value creation," he says.

In this third dimension, SK Telecom has achieved a cloud-native environment, says Kim. All new enterprise services developed by SK Telecom or its partners begin in the cloud. But on the first dimension—internal

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Deutsche Telekom

operations—the company is still on a journey. The company’s CEO has set a goal for 100% of internal IT to be public cloud-based by 2025.

“We rely on the cloud to deliver all of our technologies—we absolutely need cloud technology to give us the scale and the flexibility we need to deal with these solutions,” says Shields at Vodafone Business, pointing out that access to the cloud is also an increasingly pervasive requirement for their enterprise customers. Yet, selecting a particular cloud service should be a function of the cost, performance, or footprint required for each application. “Whether it’s on a public cloud or our own private cloud, it’s just a question of ‘Is it running right?’ The application doesn’t care whether it’s running on an AWS cloud, a Google Cloud Platform cloud, an Azure cloud, or our own extensive cloud resources.”

Getting to cloud native may not be possible given specific technical parameters, says Shields. “We operate in a hybrid world: sometimes using physical, on-premise, traditional infrastructure, and sometimes cloud native running in our private cloud, and then other times running

natively in the public cloud.” Over the past five years, Vodafone has migrated 50% of its EU network and 65% of IT applications into the cloud. The migration path has been to move applications that are least risky first, and with cloud technology rapidly maturing they have been able to accelerate these efforts.

Private and public clouds

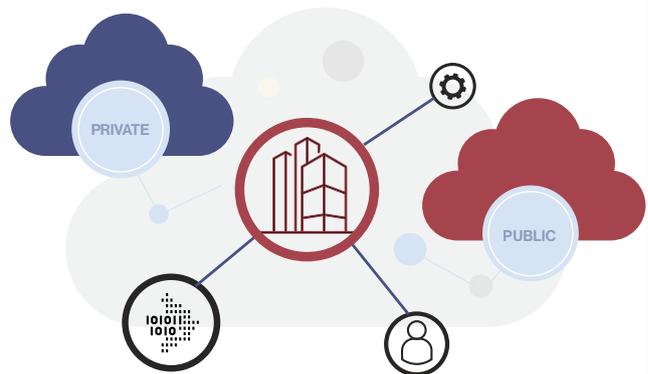
IT and network workloads have different requirements, and to meet them operators are adopting multi-cloud strategies. “Telco cloud” network capabilities, particularly network function virtualization, increasingly require low latency and high network availability. IT workloads, by contrast, have higher computer storage requirements, and cost-effectiveness is an even more important driver.

“The core has become a lot more complex because of the capabilities inherent in the new currencies that 5G brings,” says Brock. “We have 10 million customers today and hopefully hundreds of millions of devices connected to the network in the future. This means we need to make network investments to provision and manage them all efficiently, whatever their requirements, whether it be

Private and public clouds at AT&T

Cloud computing offers a solution for rationalizing and simplifying operators’ legacy infrastructure. “You acquire a lot of different systems and assets over the years, which builds up quite a bit of technology ‘debt,’” says Andre Fuetsch, chief technology officer and president of AT&T Labs. AT&T has “cloud-first” strategies for IT and network workloads to reduce costs and maximize performance. “We want to take advantage of the most cost-efficient, effective, and flexible technology solutions out there—most of which are typically found in cloud-native architectures,” says Fuetsch. “The goal is to move as many as possible; there are going to be some that we don’t move to the cloud, but those will be few and far between.”

On the IT side, AT&T is rapidly moving workloads to the public cloud—mainly for cost, but also to have much more efficient technology life cycles, allowing the company to decommission 22 of its 28 data centers. Network workloads are predominately hosted



in AT&T’s private cloud. “We have very robust and stringent performance requirements and frankly, the public cloud is not quite up to those requirements yet.” This is likely to change over the coming years, says Fuetsch. “Public cloud players will be in a unique position to run some of these workloads for us, and we’re very encouraged of that, because we look to get the best economics for cloud wherever possible.”

low-latency services, variable bit-rate services, or low-power devices,” and on the IT side, an open playbook of APIs and services to facilitate working with third parties. The two sets of operator requirements—a plug-and-play network, and ultra-simple IT systems—means they must have access to “both a common cloud and a hybrid cloud,” adding that this multi-cloud environment engenders many other operational benefits: “We can also drive network and IT cost optimization, enable network agility, and minimize our real estate footprint.”

Telia’s telco cloud journey started several years ago, says Klasson, with moving all of its information management system functions to the cloud, followed with the migration of its packet core two years later. “We decided then we should have a separate telco cloud, run in its own data center, and not mix it with our internal IT cloud: we want to have control, security, and the option to operate by ourselves—we think that’s important.” Looking ahead, operations support systems (OSS) is an area that Klasson has in his sights, he says, which will be resolved as more standardized applications emerge; Telia will adopt a mix of services and take a country-by-country approach to migrating the legacy OSS.

Determining cloud priorities

AT&T’s cloud migration plan has categories for all network and IT functions that help determine the speed at which they will be moved to the cloud. The first category includes enterprise functions that need to be retired. The second includes non-latency-dependent applications that

can be moved to one of the operator’s six remaining data centers. The third and fourth categories are applications that can be virtualized and containerized, respectively. The fifth category is applications that can be moved to a fully cloud-native state: microservice-based, data-driven, and fully automated.

When evaluating these categories, says Sorabh Saxena, executive vice president, customer service and operations at AT&T Business, “First and foremost, everything has to have a business rationale. The decision to take a function to cloud native has to be based on what’s most important for the business.” This requires close collaboration between the relevant business unit and technology leaders. Among the more challenging are “chatty applications” (with high intersystem dependency) that produce and exchange persistent data across multiple cloud zones or geographic nodes. These can consume more cloud resources and drive up expenditure on public cloud services.

Managing cloud complexity

The current challenges around cloud migration focus on application readiness, risk of destabilizing the legacy environment, cost implications, and security implications of different cloud technologies. As a result, operators are being pragmatic, developing hybrid-cloud environments and managing multiple clouds. It is possible that in the future delivering enterprise services across this cloud environment will become a source of complexity for operators, and they may look to further best practices in how to manage cloud resources and optimize their operations.

Key takeaways

1

Cloud first, but not quite native: The term “cloud native” is applicable for specific tranches of network and IT infrastructure, but not for operators’ technology environments overall. Some technologies will remain hosted on-premises for reasons including cost, stability, and security. The imperative for operators, then, is to develop a clear cloud strategy and push the most important capabilities for ecosystem partnerships and enterprise service delivery first. Given the importance of cloud for monetizing 5G, a lag in cloud could become a barrier to growth.

2

Managing parallel clouds: Contrary to conventional wisdom, 5G operators interviewed for this report do not argue that telco clouds and IT clouds must converge in order to reduce operational complexity. These goals can actually be achieved by developing telco cloud and IT clouds separately in a multi-cloud environment. In the long term, operators may find that parallel clouds become a source of complexity, requiring them to seek additional best-practice for optimizing operations.

05 Getting ahead of operational complexity in enterprise services

Even prior to the 5G era, complexity management was a key driver for trends such as automation and outsourcing. 5G and the accompanying surge in enterprise connectivity is rapidly accelerating this trend. Neither the network nor the IT operations can be managed without almost full automation, say leading operators.

“Automation is everywhere; coupled with AI, it is critical to everything that we do, given the scale and complexity of our network and operations,” says Fuetsch at AT&T. “The industry is developing far more distributed computing environments—the mobile packet core becomes far more distributed than in previous generations. And when you’re dealing with so many different functions that you have to manage on a higher and more-distributed scale, you have to have automation built in.”

Automation provided the agility for AT&T to scale effectively during the coronavirus pandemic. In March 2020, the huge shift to remote working led to a 25% spike in enterprise call volumes over home WiFi networks. A traffic management crisis was averted because automated network functions and components were able to spin up in a matter of hours.

AI also plays a critical part in AT&T’s operational efficiency. Examples include energy management, where AI dynamically powers down parts of the network not in use, and an AI-driven scheduling system that dispatches AT&T’s 35,000-strong team of repair technicians, factoring in variables such as road and weather conditions, inventory levels, and human resource policies.

“Automation is everywhere; coupled with AI, it is critical to everything that we do, given the scale and complexity of our network and operations.”

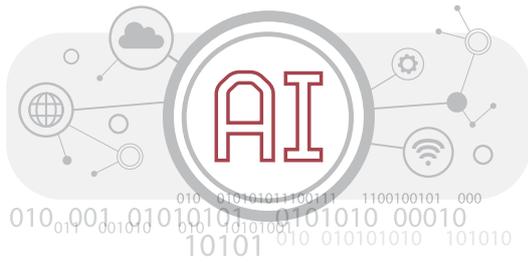
Andre Fuetsch
Chief Technology Officer and President
of AT&T Labs
AT&T

“This is a giant optimization problem we solve—every minute that you can be more efficient leads to significant productivity improvements.” The speed and responsiveness that operators are developing through AI and automation will also stand them in good stead for the future growth of enterprise services and 5G.

Automation, AI, and enterprise SLAs

SLA requirements around reliability and latency will require operators to have a high degree of control over service quality to resolve issues in close to real time. This is critical because, as Abdu Mudesir at Deutsche Telekom points out, smart factories and other Industry 4.0 enterprise services are reliant on high-performance computing and analytics that drive up customer service expectations. “Availability KPIs [key performance indicators] for 5G are really much higher than our network

AI as a service



For SK Telecom, AI is a source of competitive advantage, says Kim. The operator is developing “AI as a service” with use cases such as predictive maintenance, big data analytics, and anomaly detection for smart factories through its Metatron Grandview product. “Customers can go to our cloud and get all of the technical elements they need, upload their own data, and make sure that their virtual world—their digital twin—coincides with their physical world.” Particular applications, such as smart factories, will run in the cloud with customers being able to access services and solutions along whichever service metrics they require, says Kim.

KPIs today, and those or other SLAs cannot be managed manually. You need to fully automate incident management and root-cause analysis,” as it would be unworkable to do these tasks by going through incidents log-by-log. Automated root-cause analysis allows operators to shift toward predictive, proactive

SLA management, meaning the detection and prevention of anomalies before they happen.

Saxena at AT&T describes how their AI analytics platform capabilities are used for the enterprise customer experience. The AI platform has been in development over the past year and seeks to track performance against the “top moments that matter” for enterprises and even extends to industrial IoT. By understanding the customer’s experience and satisfaction with service elements such as ordering, contracting, and pricing, says Saxena, “we can analyze when a customer’s SLA is potentially not being met.” The system then proactively recommends next-best actions for resuming SLA compliance, as well as “preventing the slide of the customer from a promoter to a detractor.”

Another way to manage complexity at AT&T has been to increase internal collaboration through a way of working that is known there as “OpsDev,” which breaks down the layers between operations, IT, and the customer. With IT looking over the operations team’s shoulder, solving problems and developing solutions together, AT&T has been able to build platforms with much greater efficacy than before. More importantly, says Saxena, this allows everyone to see the customer’s point of view.

Efforts to understand what is happening within the enterprise experience—not just whether the overall service level is being met, but how the different components are performing—are where AI can provide real value for operators, allowing them to build additional credibility and demonstrate a genuine partnership with enterprise customers.

Key takeaways

1

Complexity, meet automation: The explosion of enterprise service volume is ushering in a new era of complexity for operators both in the network and IT operations. This stems from the number of customers, devices, ecosystem partners, stringent SLAs, APIs, cloud configurations, security requirements, and many other factors. Operators view automation, real-time data, and AI as essential tools for managing this complexity, now and in the future, to remove manual processes and develop increasingly predictive capabilities.

2

Many challenges are still unknown: As a partner to enterprises on a path toward digital transformation, there are still many areas that operators are learning about, and new challenges to manage. Building a customer mindset across operations and IT teams and aligning them around common goals will help with anticipating new challenges and proactively solving them.

Conclusion: 5G's simply complex future

Just a year after it was first introduced (and much of that dominated by a global pandemic), the telecommunications industry's hesitation around the potential use cases and monetization strategy for 5G is fading away. Whether or not enterprise customers actually need all of 5G's advanced capabilities right now, the hype around it is opening the door to deeper collaboration with customers, a strategic seat at the table with ecosystem partners, and an avenue for deriving value from innovation. The findings of the report are as follows:

- **Enterprise service strategy will occupy the greatest amount of CIO mindshare.** The questions of “where to play” and “how to play” will remain critical for operator CIOs and enterprise business heads. These questions will shape many decisions about which partnerships to form, which technical capabilities to build or acquire, and how to capture the most value from enterprise services. Operators must decide how much they want to focus on standard versus customized solutions, and how much vertical expertise or application development expertise they want to build up, as opposed to relying on partners. Being an innovation partner as well as a connectivity partner is a fundamental requirement to stay prominent in 5G ecosystems.
- **Cloud is the platform for 5G.** Operators with serious ambitions for 5G have a cloud-first strategy for their network and IT. Indeed, the ease of working in operators' cloud environments is a key differentiator for enterprises, developers, and other ecosystem participants. Yet the mix of cloud technologies is continually evolving as operators look to optimize the balance of public and private clouds, taking advantage of the best available technology while also carefully evaluating the cost and risk factors. For some of these reasons, a fully cloud-native environment may remain out of reach. An emerging challenge will be to manage all of the different cloud components and ensure a seamless experience across different clouds, to avoid silos building up again.
- **Reach for simplicity, prepare for complexity.** While some challenges in the 5G journey are known, others are yet to emerge. The full impact on operations is not known yet—the real challenge of delivering “five-nines” SLAs or the complexity that will emerge from having hundreds of APIs. Leading operators view automation and AI as central to managing operations efficiently, cost effectively, and at scale. DevOps principles can also allow for faster solution-development and can build a mindset around customer service. Operators must give thought to the types of challenges that they will face once 5G enterprise services really scale and prepare their environment for that future.

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Footnotes

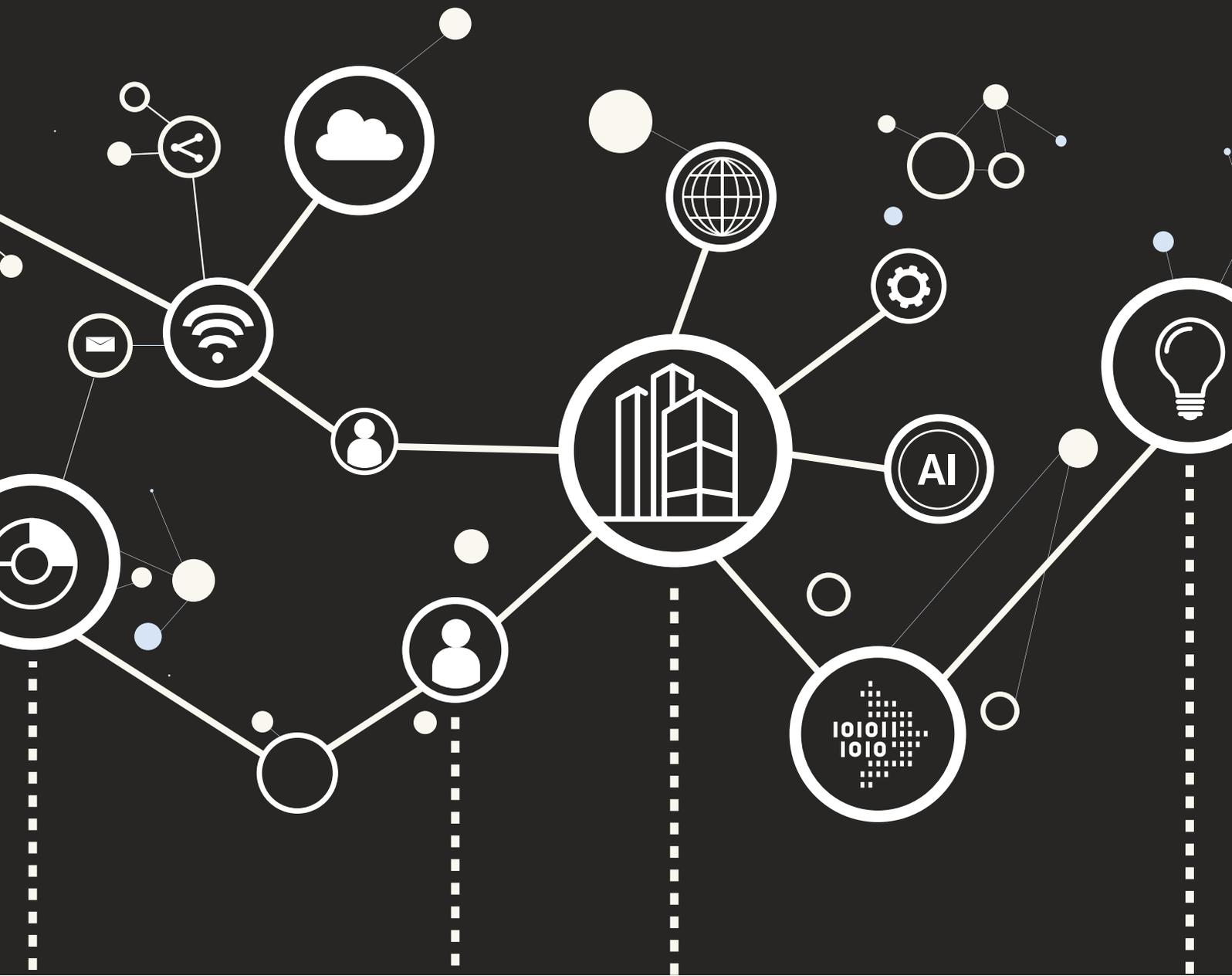
1,2 "Capturing business opportunities beyond mobile broadband," Ericsson, May 2020 (pdf, p.4)

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