tmforum

# ENTERPRISE 5G

# THE ROLE OF THE TELCO

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# Contents

# The big picture

*For the first time, the mobile communications industry is prioritizing the enterprise market. Indeed, for more than 30 years, its main focus has been on serving individuals and consumers, but 5G is changing the target. Now mobile operators and their suppliers believe there is more potential for revenue growth in serving enterprises than consumers.*

Most "pure" mobile operators focus exclusively on the consumer market, and all have deployed coverage based on where people are and where they go, rather than on where businesses are located. As a result, many firms ranging from companies in office blocks to those with large campuses, such as ports or stadiums, have suffered from poor coverage.

In addition, mobile devices have been built for consumers, with the two dominant app stores, Google Play and Apple, catering to them. Operators have provided services on a "best effort" basis, while many enterprises need guaranteed quality of service and service level agreements. Even communications service providers (CSPs) with strong enterprise lines of business typically run their mobile networks as standalone businesses and have had little success in integrating mobile into their ICT service portfolios.

LTE has been a huge success in terms of delivering a great experience to consumers but a failure when judged on its ability to deliver new revenue. There is no reason to expect 5G to be any different in the consumer market. It's quite likely that the jump from 3G to 4G delivered greater benefits to consumers (who for the first time could stream video reliably) than the leap from 4G to 5G will.

## Reasons for optimism

So, why are mobile operators so bullish about 5G and the enterprise market? The answer lies in three trends:

Ever since work began on the 5G standard, operators have viewed it as the key to unlocking the IoT opportunity. Other network technologies such as NB-IoT, LTE-M or LoRA may meet requirements for a lot of IoT applications, but 5G is still viewed as the long-term solution for scaling IoT and enabling high-bandwidth and low-latency applications.

Along with other technologies such as AI and machine learning, blockchain, fintech, smart manufacturing, and IoT, 5G is seen as crucial to the Fourth Industrial Revolution or Second Digital Revolution, in which adoption of new technologies drives automation in manufacturing and industrial processes more broadly.

Adoption of cloud computing for IT and network functions will enable CSPs to take a more flexible approach to building new products and services, and to scale them more quickly than previously possible.

A fourth reason for 5G's enterprise focus doesn't necessarily benefit CSPs and could result in them losing some control of the market: New competitors including enterprises themselves see an opportunity to build their own mobile networks. Until now, the mobile industry has been shaped by national operators that have been the only companies awarded spectrum. But with 5G, the sector is becoming democratized, with regulators awarding spectrum not only to enterprises, but also to startup service providers with a focus on the B2B market.

## Vertical or horizontal?

There are two types of connectivity services and two types of ICT services CSPs can offer. On the connectivity side, they can deliver traditional communications services or connectivity-as-a-service (CaaS), which we'll define and discuss more in the next section. When it comes to ICT services, they can offer platform-based services and end-to-end solutions that may or may not use a platform model.

Traditional connectivity services comprise mobile voice and data via smartphones and fixed wireless access. The key issues in assessing the potential of 5G for delivering these services are:

Whether the characteristics and capabilities of 5G will result in any migration from fixed broadband and Wi-Fi to 5G

Whether 5G offers B2B users the opportunity for connectivity where currently there is none (for example, if the enterprise requires temporary connectivity, or the economics of 5G make it viable to deliver connectivity for the first time)

Platform services and end-to-end solutions cover a range of use cases across vertical sectors such as manufacturing, healthcare and transportation. If the operator provides an end-to-end solution, it acts as the single point of contact for customers and is responsible for bringing together and managing all the partners needed to deliver the solution.

Platform-based and end-to-end solutions require connectivity as an enabler, but a much bigger part of the value proposition focuses on specific applications. For example, a CSP might sell an end-to-end solution for lowering the cost of air conditioning in a building or set of buildings using IoT. Or they may offer a solution that enables an automotive company to transform its operations into a smart factory or one that reduces network infrastructure required by bank branches using 5G and edge computing.

> CSPs are most excited about 5G use cases that require end-to-end solutions, because they can capture a larger proportion of enterprise spending and own the customer relationship. But their success in exploiting these opportunities is by no means guaranteed.

Traditional connectivity and CaaS offer a far more realistic, achievable opportunity for CSPs, albeit one with less upside and less opportunity to expand their share of total enterprise spending on new use cases.

In this report we look at the types of business models CSPs are pursuing to target enterprises as 5G is deployed.

Read it to understand:

- Which services operators may be able to provide beyond connectivity
- Who CSPs' primary competitors are in selling IoT and ICT solutions that rely on 5G and why some are also potential partners
- What connectivity-as-a-service is
- Why platforms are important
- Whether 5G can command higher prices for connectivity
- How CSPs are positioning basic 5G services in the B2B market
- Why 5G is beneficial to enterprises and why some IoT use cases need 5G
- When 5G-enabled IoT services will become available
- What the most promising IoT use cases are for CSPs
- Which verticals CSPs are targeting and why
- Analysts' forecasts for 5G enterprise revenues
- Why enterprises are turning to mobile private networks and what that means for mobile operators

Section 1

# Assessing business models, competitors and partners

*Communications service providers (CSPs) like to "own" the customer. This is true for consumers and enterprises with only a few exceptions – for example, in the B2B market many operators use distributors, and in the consumer business they may use mobile virtual network operators. But these represent only a small proportion of their total businesses. In enterprise 5G deals, on the other hand, CSPs may not always be able to own the customer.*

As operators develop enterprise 5G strategies, they must reconsider how to serve customers. They face several choices and must ask themselves these questions:

What size companies should we target? Generally, the smaller the business, the less likely the operator will need to develop new skills and capabilities.

What kinds of products should we sell (either alone or with partners)?

With whom should we partner to expand our capabilities and reach?

Which use cases or verticals should we focus on?

What role should we play in the digital ecosystem? CSPs may play different roles based on the vertical and size of enterprise.

A natural starting point for CSPs is an assessment of the products and services they already offer and capabilities they already have. Most importantly, however, they need to assess their existing customer base. An operator that has strong relationships with B2B customers has a great opportunity to deliver new 5G-enabled products and services.

## Potential competitors

In targeting the enterprise 5G market, CSPs likely will face competition from other companies that are as well or even better positioned to deliver 5G ICT services. They include:

- **Vertical market specialists** – every vertical has its own specialist vendors. In telecoms, for example, Amdocs, Ericsson, Netcracker and Nokia specialize in hardware and software solutions aimed specifically at CSPs, and they have long-standing relationships with their customers. Companies like this in other sectors include John Deere (agricultural machinery), Alstom (transportation) and Maersk (shipping). Gartner defines these types of companies as operational technology (OT) vendors: "hardware and software that detects or causes a change, through the direct monitoring and/or control of industrial equipment, assets, processes and events."
- **Cloud providers** – in addition to providing cloud computing services, public cloud providers such as Alibaba, Amazon Web Services (AWS), Microsoft Azure and Google Cloud Platform offer access to large ecosystems of application.
- **Systems integrators and professional service firms** – companies like Accenture and IBM deliver complex systems of hardware and software components and ensure that they work together. They typically have deep knowledge of technology and vertical markets.
- **Enterprise IT and OT vendors** – these are global corporations that dominated the IT landscape before the advent of cloud computing. Most have either transitioned into software vendors leveraging cloud computing or hardware vendors. Examples include Bosch and Siemens.

- **Niche ICT or IoT service providers** – this group includes specialized service providers that have a technology- and vendor-agnostic approach and have acquired expertise in specific use cases. They often target markets such as IoT and may be global or specific to a certain country or region.
- **Enterprise application developers** – these are companies that develop software to help companies run their businesses. Some, like Salesforce, are cloud native, while others have migrated products and services to the cloud.
- **Device makers** – companies that manufacture new devices such as drones and robots may sell their devices plus related applications as a service.

## Ecosystem partners

It is much too early to tell who the winners and losers will be in delivering 5G-enabled services. The market likely will remain fluid for some time as companies seek to extend their roles and influence beyond their traditional markets.

Most solutions will require companies to join forces to deliver all the capabilities enterprises are looking for in 5G solutions. In jockeying for position, partners will have the opportunity to move up or down the value chain.

> A partner can secure a larger proportion of overall enterprise spending if they move higher in the value chain, and the higher a company goes, the greater their chance of owning the relationship with the enterprise – and the profit margin that goes with it.

### Drones-as-a-service shows potential roles for CSPs & partners

**Devices**
In some early proofs of concept, smartphones have been strapped into the drone. For full commercial deployments, 5G modules will need to be embedded into the electronics of the drone itself.

**Applications development**
Drones-as-a-service will likely involve the use of applications built on geographical information systems. These apps will need to be customized for sectors such as agriculture, utilities, and oil and gas production, and for segments within each vertical. For example, drone applications could be used to increase efficiency or improve security for utilities, or to monitor pest damage and identify growth in agriculture.

**Applications deployment & enablement platforms**
This role can be played by different types of companies, but it is often played by drone operators. Zipline, for example, specializes in delivery of medical supplies via drone.

**Connectivity**
Drones rely on wireless connectivity. Communication is needed for management to support authentication and authorization, while command and control communication is needed to fly the drone. Payload data transmission is also needed to support the applications onboard the drone, such as high bandwidth video streaming for news gathering. For collision avoidance, drones may require means to communicate with other nearby drones.

**Software infrastructure**
Drones can generate huge amounts of data based on the application and number of units deployed. Some of this may be extremely time sensitive and require immediate processing to generate real-time insights. Drone operations and data processing likely will take place in a public cloud to meet these objectives, ensure security and help applications scale.

**Hardware infrastructure**
Remote gateways to process, filter and upload real-time information to the cloud are needed, as well as a drone control station.

**Systems integration**
Today drone operators handle systems integration with help from specialist firms, but large global systems integrators are also beginning to build competence in this area. CSPs could partner or acquire expertise to offer management of drones-as-a-service.

## Opportunities for CSPs

Connectivity is where 5G operators are guaranteed to have a role, unless the deployment in question is a private network, in which case the enterprise may secure its own spectrum. The connectivity share of the total value of the solution will vary by application, but many of the people we interviewed estimate that it will be in the range of 10% of total enterprise spending.

The highest-value parts of the digital ecosystem lie in application development and services. While some operators still aspire to attract developers, most likely will not capture much of the value in this category, unless they make acquisitions in specific vertical markets.

The services category offers more opportunities. Many large operators are already increasing their systems integration and managed services capabilities, often through acquisitions. For example, in 2017 Orange Business Services acquired Business & Decision, an international consulting and systems integration group. As more use cases for 5G begin to emerge in different vertical sectors, the need for integration of systems will increase.

## Best business models

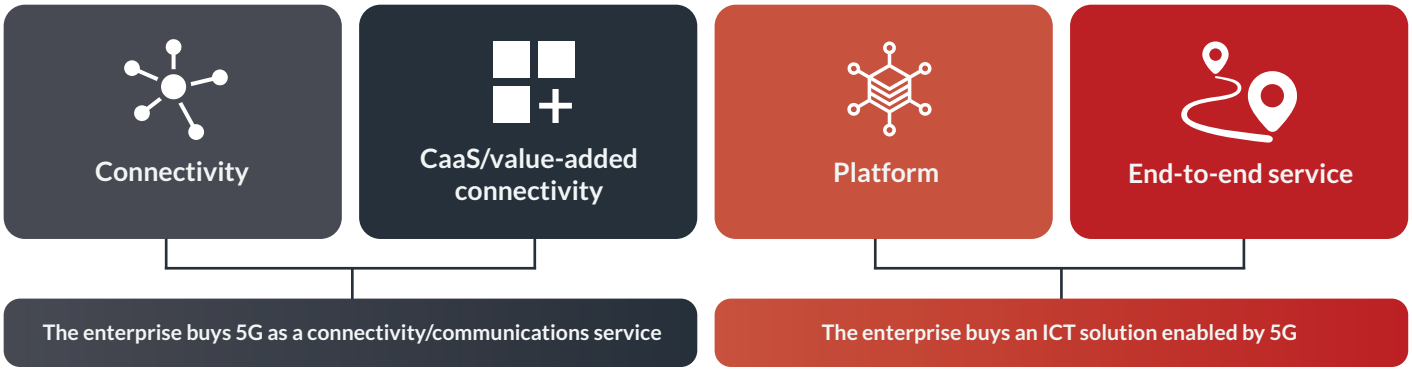
Realistically, the options for CSPs seeking to extend their role into other parts of the 5G ecosystem are limited. The main opportunities follow, and the graphic below illustrates potential business models.

**Edge computing** – operators may be able to capture a share of the software infrastructure market for solutions that use edge computing; many are deploying their own edge computing capabilities or partnering with hyperscale cloud providers and capturing a share of their revenues (in return CSPs are co-locating cloud providers' edge computing servers in telco data centers).

**Professional services** – operators could provide integration and consulting services, most likely in network rather than IT environments

**Full solution provider** – CSPs could provide full solutions and manage a complex partner ecosystem, ideally through a platform business model

### Roles for CSPs in delivering 5G services




- Operator sells standard 5G connectivity products (mobile and fixed) to full range of businesses
- Operator delivers customized connectivity offerings (using network slicing) to enterprises and third-party service providers
- Services are fully configurable and flexible using self-service digital tools
- Other solutions offered to enhance connectivity such as network security
- Operator participates in a platform business model as either the platform owner (with responsibility for going to market) or a platform participant
- In addition to connectivity, operator provides other enabling capabilities such as billing, location services, network analytics, hosting or security)
- Foundational services could include connectivity, CaaS or NaaS
- Operator is responsible for an end-to-end service, most likely delivered with the help of many partners

## What is CaaS?

The left half of the graphic on page 7 illustrates roles that confine CSPs to their current one as providers of connectivity, while the options on the right side offer them a much bigger role in delivery of 5G solutions. But the transition from a provider of connectivity to a provider of connectivity-as-a-service (CaaS) is ill-defined and imprecise.

No agreed definition exists for CaaS. Our own loose definition is: "the delivery of connectivity/IP presence solutions to meet the specific demands of different applications and users."

In some cases, an enterprise might also want its own dashboard to manage varying requirements. Today's connectivity solutions comprise a limited number of pricing options with little or no ability to configure the network and the service to meet the specific demands of different users.

Network slicing is a type of CaaS that CSPs could offer to give enterprise customers this type of control. Operators envision providing different types of connectivity (speed, coverage, latency, quality of service, etc.), although how they will do this remains unclear. For example, they have not determined whether to deploy a few network slices or many. Providing CaaS can also mean using whichever network technologies (5G, fiber, satellite, etc.) are best suited to meeting specific connectivity requirements.

As part of the Digital Ecosystem Management Project, TM Forum members are working on essential architectures and standards to position telecoms as the trusted partner for CaaS. This includes creating a playbook for how to deliver the services. To learn more, please contact Joann O'Brien.

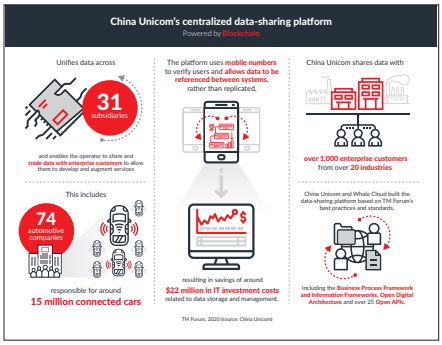
## Building platforms

Platform business models and the delivery of end-to-end solutions require CSPs to develop new capabilities beyond connectivity. Platform business models come in many different forms. Digital business model consultant Simon Torrance explains the advantages of platforms like this:

> "Rather than trying to design and build everything yourself – which is the default for most companies today – platform thinking encourages you to act as a coordinator or enabling intermediary between the needs of your customers, your own expertise and the expertise of others."

CSPs can deliver their core CaaS capabilities through an existing platform, or they can build their own platforms to offer connectivity and other network and technology components. A small number of Tier 1 operators including China Unicom, Orange and Vodafone Group are beginning to do this using TM Forum Open APIs and the Open Digital Architecture (ODA – see page 39). See the case study below for more about China Unicom's approach using blockchain to make data available to enterprise customers. An upcoming research report called How to lead in the Open API Economy will look in detail at using APIs in platform business models.

**Read about China Unicom's data monetization platform:**




## Full-service provider

End-to-end solutions represent the most ambitious strategy for CSPs, and they are potentially the most lucrative. However, examples of operators developing end-to-end solutions are sparse, and they typically have acquired companies. Verizon, for example, spent more than $3 billion to acquire Telogis and FleetMatics so that it could create Verizon Connect, which is now a leading global provider of telematics. Similarly, Vodafone has become a leading provider of IoT solutions through acquisitions and organic growth. The company acquired Cobra Automotive Technologies and South African IoT solutions provider IoT.nxt.

In the next section, we'll explain how spectrum allocation, standards and technologies such as network slicing and edge computing have a role to play in enterprise 5G.

Section 2

# Spectrum, standards and 5G-enabling technologies

*5G offers broader and more diverse capabilities than previous generations of mobile technology. Consequently, it can help communications service providers (CSPs) better meet the diverse requirements of business users. This section assesses which capabilities are most important for various use cases and explains when they will become viable by looking at progress on spectrum allocation, 5G standards, network slicing, edge computing, quality of service (QoS) and business support capabilities.*

## Spectrum

The liberalization of mobile spectrum means it is now available to enterprises and niche service providers targeting B2B segments. Both see an opportunity to build mobile networks that are tailored to specific business requirements.

On a more foundational level, liberalization is allowing enterprises to add mobile coverage where previously it was either patchy or non-existent. In most cases companies are adopting LTE because of the maturity of the technology and device ecosystem. However, 5G is starting to gain a foothold because of the flexibility it promises. The graphic below shows how regulators in some countries are enabling enterprises through spectrum allocation.

In many countries, regulators are enabling mobile private networks (MPNs) by allocating spectrum to enterprises.

For existing operators, regulators are allocating spectrum in three bands to support 5G applications:

- **Low-band 600MHz-900MHz** – this spectrum is most suited to enterprises that need coverage over a wide area such as emergency services. For example, AT&T is building an LTE-based network for US emergency service provider FirstNet in the spectrum range 758MHz to 793MHz.
- **Mid-band 3.5GHz to 3.8GHz** – most early 5G spectrum allocations to national mobile operators are in this spectrum band, and they will use it to serve main areas of population and major road arteries. Private network licenses are also being awarded in this spectrum band.
- **High-band above 6GHz** – this spectrum is suited to fixed wireless, and most early allocations have been in the 26GHz band.

In many countries, regulators are enabling mobile private networks (MPNs) by allocating spectrum to enterprises.

In the US, regulators require mobile operators to share CBRS (Citizens Broadband Radio Service) spectrum in the 3.55GHz to 3.7GHz band with other organizations including businesses.

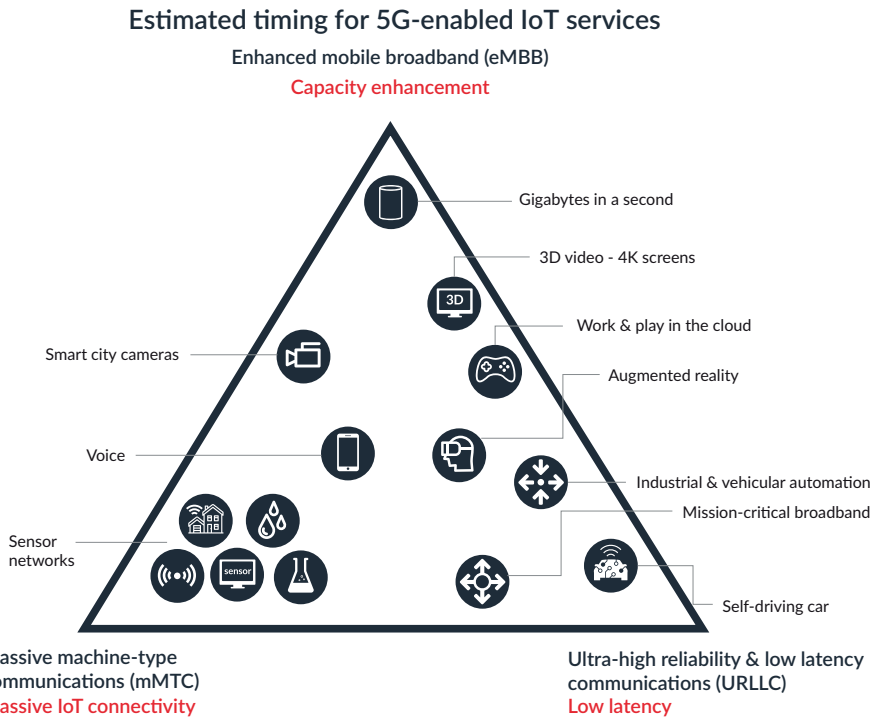
Licences are provided on a first-come first-serve basis for a nominal fee in the UK in the band operating at 3.8GHz to 4.2GHz.

France was the first country formally to open licences at 2.6GHz for private use in May 2019, with first licences going to airports and rail companies.

Licences are provided in Germany by direct application to the national regulator which has allocated 37GHz to 3.8GHz to private networks.

## Standards

The International Telecommunication Union (ITU) is standardizing 5G as part of its IMT [International Mobile Telecommunication system] for 2020 and beyond initiative, with specifications from 3GPP and contributions from other standards bodies like ETSI and NGMN. Specifically, 3GPP is defining Non-standalone 5G, which provides standards for new radio interfaces (Release 15) and Standalone 5G which includes a next-generation mobile core (Release 16). While some use cases such as improved mobile broadband are possible without a new core network, most depend on it. The graphic below shows the types of 5G use cases.




TM Forum, 2020 (based on ITU graphic)

The transition to new core networks is a bigger change for CSPs than deploying new radio technology in that they are transitioning from the old hardware-centric world to cloud computing, which offers many benefits in terms of agility, flexibility and scalability. To deploy new core technology, many operators will bring in new suppliers. For example, they may partner with a startup like Mavenir, which offers cloud native 5G solutions, or an IT giant such as Microsoft, which earlier this year acquired mobile core vendor Affirmed Networks. This deal combined with Microsoft's public cloud capabilities and aspirations in edge computing put the company in a strong position to help shape CSPs' 5G B2B services.

By deploying a new cloud native core network, CSPs will be able to centralize some IT workloads while at the same time disaggregating their networks by deploying capabilities at the edge, where they will be closer to customers and therefore can deliver superior quality of service (QoS).

However, there is no blueprint for building out a 5G core as cloud native technology has never been deployed in the network before. CSPs must figure out how to deploy the technology in a way that supports their vision for addressing the enterprise market. For example, based on the opportunities they see in edge computing, they may choose to take a distributed approach to their network core, which would be beneficial for use cases that requires low latency.

3GPP froze 5G Release 16 in July this year, and since then many operators have started testing 5G core capabilities with current and new vendors. Widespread rollout of commercial services, however, isn't likely until 2021 and 2022. CSPs are caught in a classic chicken-and-egg scenario: They want to see which use cases are most viable before committing to a full 5G core, but they may not be able to demonstrate key capabilities to enterprises until they have a 5G core in place.

## Network slicing

Mobile networks have always been built on the principle that all devices communicate using the same physical network infrastructure. This changes with 5G. Network functions can run as software on virtualized infrastructure, which makes it possible to spin network functions up and down without having to invest in expensive hardware.

The ability to take a multi-tenant architectural approach means that an operator can run separate networks over the same physical infrastructure using a concept called network slicing. A network slice allocates specific resources to an application, service, set of users or network. These resources can be dedicated to only one network slice or shared among many slices. We'll look at some TM Forum Catalyst proofs of concept in Section 5 that have been exploring network slicing.

In practice, developing a commercial strategy based on network slicing is extremely complex. While deployment of network functions virtualization (NFV) is a foundational requirement, other essential technologies include cloud native virtual network functions, containers, edge compute and service lifecycle automation. To support 5G network slicing, next-generation NFV infrastructure needs to be cloud native, vendor agnostic (to avoid vendor lock-in) and standards compliant to ensure network resource agility and scalability.

Furthermore, for CSPs to exploit the full benefits, network slicing needs to operate across the mobile core, the access network and the backhaul network. Suppliers such Ericsson, Huawei and Nokia are already touting solutions for network slicing which work across core and access networks. However, the ability to spin slices up and down across disparate networks is still some time away.

> "We don't have the standards," says Juan Carlos Garcia, Senior VP of Technology and Ecosystems at Telefónica. "There is no clear way of doing this. We are trying to make advances on slicing and how to orchestrate across various domains, but we are three to five years away from having slicing as a commercial service. You can however still offer small slices and experiences by controlling the experience."

## The network edge

Our recent report *How to build and operate at the edge* provides a full assessment of operators' edge strategies. Many CSPs are seeking to expand and decentralize 5G networks by deploying components at the edge so that they are closer to end customers. There are two inter-related reasons extensive edge deployments can help CSPs target enterprises:

- **Lower latency** – if components are located closer to end users, latency is lower. Enterprises need consistency, latency guarantees and absolute maximum levels of latency. In small countries, centralized computing without edge deployments may be sufficient to provide latency lower than 50 milliseconds, but in larger countries operators may need 50 or more edge locations to guarantee QoS. Our research has found that most CSPs believe 20- to 30-millisecond latency is good enough to meet the requirements of most enterprise applications, but emerging use cases such as drones and robotics will require latency in the single digits.
- **Ability to serve customers based on location** – CSPs are already segmenting enterprise sectors and opportunities, which will necessarily result in edge computing being deployed faster in some locations than others. An operator targeting retailers likely will prioritize deployment of edge computing close to retail parks, while one targeting financial services will prioritize financial districts.

See the panel on page 12 for more about edge computing.

## QoS and security

However compelling new 5G core capabilities may be, they are of little use to businesses unless QoS is guaranteed. Enterprises would much rather have guaranteed latency of 20-30 milliseconds than single-digit millisecond latency which is not guaranteed and occasionally increases to 50 milliseconds.

5G operators will rely on NFV, cloud computing and automation to ensure QoS in 5G networks, particularly for URLLC use cases. This requires network optimization and service assurance. Given that we are at the very start of the 5G era it will take some time for CSPs to settle on the best approaches to ensure network and service reliability.

The same is true of security. 5G standards enshrine encryption and protect the integrity of network traffic. However, approaches to ensuring other aspects of network security are not covered, so it will be up to each CSP to determine how to secure vulnerabilities between different network elements. For the enterprise itself, the task is securing not just the network but also the application.

## Gaining an edge on enterprise 5G

Edge computing holds the key to delivering ultra-low-latency services – one of the key benefits of 5G, particularly in B2B markets. CSPs that want to deliver URLCC services need to decide how, where and when to deploy edge computing capabilities.

They have a few options:

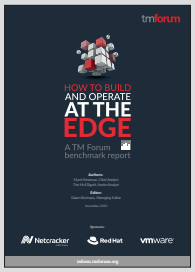
- Build a nationwide edge network to ensure that every device is in close proximity to a data center
- Deploy a small number of edge locations and test services with business customers before committing to further deployments
- Partner with hyperscale cloud providers, enabling them to develop edge computing capabilities that use the CSP's network

In November, we produced our first Benchmark Report on edge computing, *How to build and operate at the edge*. The report assesses CSPs' three options and explains which paths early adopters are taking. Most Tier 1 mobile operators we interviewed as part of the research are still in the planning phase, although a few have deployed edge facilities to test the market.

Overall, they are unsure about whether to go it alone or partner with cloud providers to deploy edge capabilities. Initially, most CSPs were planning to build their own edge computing networks, but over the last year Amazon Web Services, Google Cloud Platform and Microsoft Azure have forced them to re-evaluate as the cloud providers have begun implementing their own edge strategies, which include offering CSPs revenue-sharing deals for edge-enabled services.

This leads to more questions for CSPs to answer: should they partner with only one hyperscale cloud provider or multiple? And should they deploy their own edge computing facilities alongside their partners'?

**Read the report to learn more:**




## Support systems for 5G

Monetizing 5G is a dilemma for CSPs. They need to be able to monetize not only all the capabilities that exist in the network today, but also capabilities like network slicing which will be added. Flexibility and agility are key in systems of engagement and core commerce systems (also known as business support systems – BSS), given that the future is so unclear in terms of which 5G use cases will become viable. This is leading operators to move these customer-facing systems to the cloud and adopt architectures that rely on containerization and microservices. The result is a better digital experience for customers and increased ability for CSPs to be innovative.

As noted in Section 2, the ability to commercially manage complex digital ecosystems made up of many partners could become a key differentiator for 5G operators. But as they seek to empower business customers to manage their own connectivity requirements by implementing network-as-a-service (NaaS), they will be severely tested in terms of delivering simple, easy-to-use and real-time self-service systems.

However, the challenge of modernizing existing enterprise BSS should not be underestimated. Operators have focused more on modernizing consumer BSS in recent years, so many of them do not have the agility needed to respond to new opportunities in the enterprise market and manage complex ecosystems. Furthermore, many CSPs have created separate, standalone billing systems for their IoT lines of business, and such a separation of IoT from the core enterprise business could hinder the ability to seize new B2B and B2B2X opportunities.

We'll look at CSPs' pricing strategies for 5G connectivity in the next section.

Section 3

# Is 5G connectivity an enterprise opportunity or just more of the same?

*With all the excitement about enterprise 5G use cases that require capabilities such as low latency and high availability, it is easy to forget about the basic opportunity for communications service providers (CSPs) to deliver 5G as a connectivity service. The big questions are whether 5G capabilities warrant higher prices or enable operators to sell new subscriptions.*

Today's enterprise and consumer 5G services essentially are faster LTE connections that are provided in limited locations. In South Korea, the world's most mature 5G market, subscribers are able to use their devices on 5G about a third of the time in the country's three largest cities, according to data from Opensignal, a company that measures and reports mobile user experience on all major networks worldwide. Average download speed of the 5G connection in these cities is 310-375Mbps.

Our research into 5G operators' pricing plans suggests only half-hearted attempts to charge a premium over LTE. US telco Verizon, for example, was charging a $10 monthly premium for 5G but dropped it in August.

However, we do see an opportunity for CSPs to introduce new pricing structures, as evidenced by the following trends:

- **Bigger data buckets and more unlimited data pricing plans** – TIM, for example, offers three options that all include unlimited voice and SMS plus music content, but each includes a different amount of data. Data is unlimited with the premium plan (see table below).
- **Speed-based pricing** – for example, UK mobile operator Vodafone introduced speed-based (and unlimited data) pricing in July.
- **Bundled content and applications** – until now most content bundling has been in the consumer market, with operators offering video and gaming services that use augmented and virtual reality, but there is no reason they could not offer such services to enterprises.

**TIM's 4G and 5G monthly plans**

| PACKAGE | NETWORK | DATA INCLUDED | INCLUSIVE CONTENT | PRICE |
|---|---|---|---|---|
| TIM Advance 4.5G | 4G | 40GB | TIM Music | €19.99 |
| TIM Advance 5G | 5G | 50GB | TIM Music | €29.99 |
| TIM Advance 5G Unlimited | 5G | Unlimited | TIM Music | €39.99* |

*includes 250 international call minutes

TM Forum, 2020

## Upselling customers

Even though operators may be unable to increase prices with 5G, they may be able to upsell business users to plans with more inclusive or unlimited data. This will be driven by the transition away from voice telephony to video platforms such as Microsoft Teams and Zoom.

5G may also allow operators to simplify pricing plans for fixed and mobile broadband bundles. With 5G the speeds and capabilities of fixed and mobile subscriptions narrow. Operators can offer single bundles of fixed and mobile connectivity across multiple devices, all with unlimited data and guaranteed minimum speeds.

CSPs also may be able to sell more subscriptions by leveraging 5G capabilities to provide back-up or redundancy for fixed broadband connections and to deliver temporary connectivity.

> The lockdowns across the world resulting from the Covid-19 pandemic have increased dependence on the broadband connections of home workers, and the rapid adoption of video telephony platforms has resulted in a massive increase in traffic levels.

This has sparked demand for secondary broadband lines. For example, in June, UK telco BT launched a new service called Dedicated Connection which gives homes a second line to address rising demand.

Rather than using a fixed connection as a back-up line, operators could offer 5G. The service could be a dedicated fixed wireless access service if available, delivered either to a 5G router located inside the building or to an externally-mounted antenna. It could also be a connection to a public 5G network and accesses via a 5G home router. And future generations of home routers may embed fixed broadband and mobile/5G connectivity.

With no installation costs, CSPs that provide 5G fixed-wireless access (FWA) and mobile operators can offer prepaid or non-contract services. This could prove attractive for businesses with temporary or seasonal requirements. For example:

- Rental properties like student accommodations or holiday rentals
- Seasonal businesses in tourist destinations such as bars, cafes, restaurants and camp sites
- Sports stadiums, concert halls and outdoor music or religious festivals
- Other seasonal industries like agriculture

## New device market

In most cases businesses are interested in installing 5G connectivity on their premises to complement Wi-Fi and support IoT applications, but there is opportunity to connect other devices that typically use Wi-Fi, such as laptops.

When LTE was launched, there was an expectation that many laptop vendors would start embedding mobile connectivity, but this did not happen. However, there could be a stronger rationale for embedding 5G in laptops if the performance in terms of speed, handover, security, quality of service and latency matches or exceeds Wi-Fi's.

Lenovo has already introduced a 5G laptop called the Yoga 5G, which the company describes as "the world's first PC with revolutionary 5G connectivity." It's powered by Qualcomm Snapdragon 8cx processing.

Smartphone vendors are also investing more in B2B capabilities. Last month Apple and Verizon launched a new program called Fleet Swap which will allow businesses to trade in their entire fleet of smartphones – regardless of whether they are currently a Verizon customer – and move to the iPhone 12 with no upfront costs and no monthly fee in the case of the iPhone 12 mini or a low monthly cost for other models.

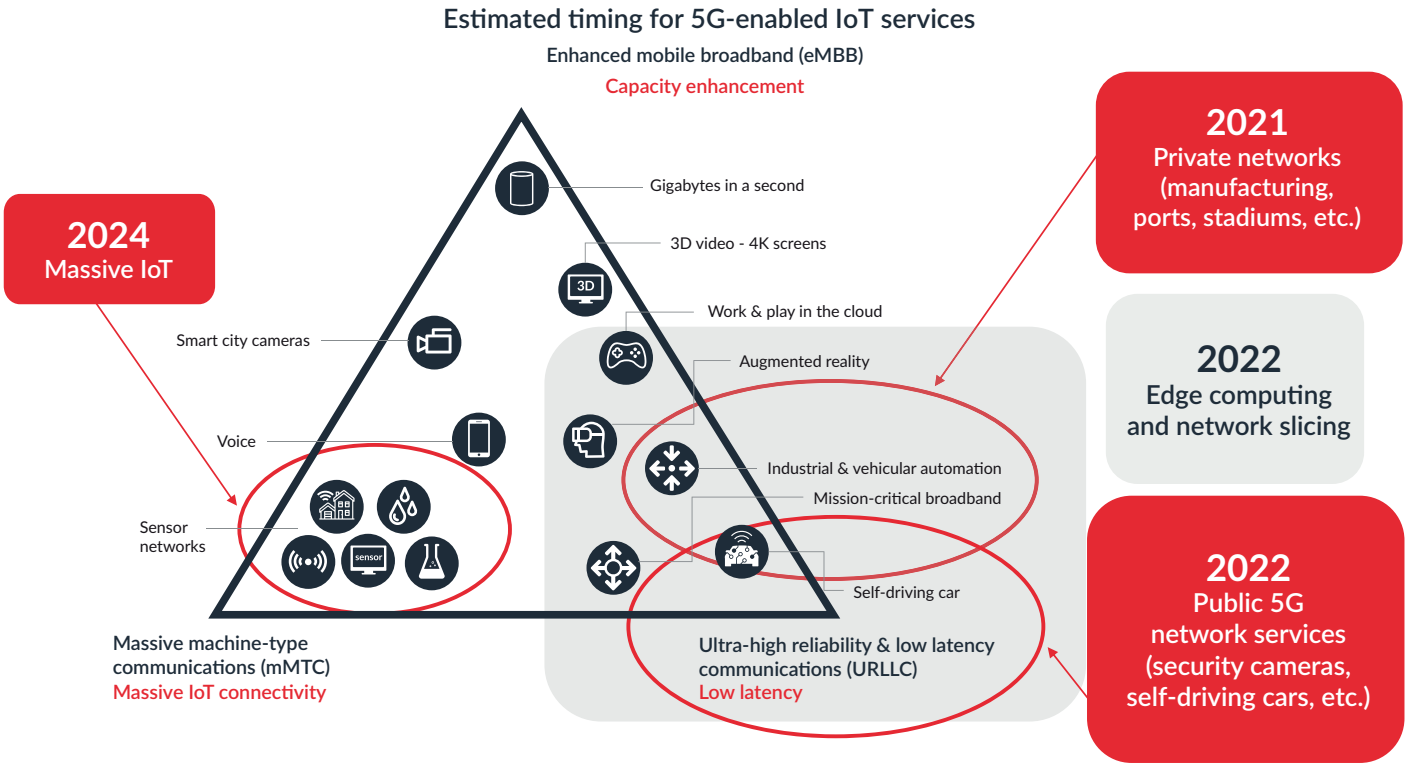
In the next section, we'll look at the relationship between IoT and 5G.

Section 4

# Does the IoT need 5G?

*When mobile operators and their suppliers began contemplating 5G about 10 years ago, they viewed it as key to unlocking the IoT's potential. Indeed, 5G became synonymous with IoT. But growth of the IoT has been much slower than expected, and emergence of other network technologies have delayed the need for 5G. In addition, the sheer scale and complexity of ecosystems for delivering future IoT services have made it clear that connectivity represents only a small part of the total value proposition. Nevertheless, IoT still offers the most important opportunity for communications service providers (CSPs) to find new sources of revenue.*

The graphic below is a modified version of the one in Section 3, which is based on the International Telecommunication Union's (ITU's) definition of 5G use cases. In this one, we offer predictions based on our research and analysis for when CSPs will begin delivering 5G-enabled IoT services.




TM Forum, 2020 (based on ITU graphic)

Two of the three types of 5G use cases – enhanced mobile broadband (eMBB) and ultra-low latency communications (URLLC) – require 5G, but massive machine-type communications (mMTC), which supports widespread deployment of IoT devices, can also be provided in the medium term using technologies such as low-power wide-area technologies (LPWA – see the next page).

## IoT without 5G

Demand for IoT services today is met using several technologies, some of which use unlicensed spectrum frequencies and others using licensed spectrum. For example, Wi-Fi, Bluetooth and dedicated LPWA technologies such as SigFox and LoRA use unlicensed spectrum, while LTE, GSM/GPRS, Narrowband IoT and LTE-M use licensed spectrum.

These networks are not under any sort of capacity pressure to migrate to 5G. Indeed, Japanese mobile operator NTT DoCoMo announced in March 2020 that it was shutting down its NB-IoT service, citing "the current business environment", which was being impacted by the start of the Covid-19 pandemic. So, it would seem that operators have plenty of options for IoT connectivity before they consider 5G.

However, CSPs that have not launched LPWA services yet may decide to go straight to the 5G mMTC standard rather face migration concerns. The specifications for mMTC are in Release 16 of 3GPP's standard, which was frozen in June 2020.

The downsides of going straight to 5G are the high cost of modules (new generation modules always command a significant premium) and the likelihood that coverage will not be as good as LTE for several years.

## It's about latency

With enhanced mobile broadband already offered and mMTC applications served for now by other network technologies, low-latency services are the primary focus for 5G and IoT across public and private networks. This is particularly true for applications that require ultra-low latency connectivity enabled by edge computing.

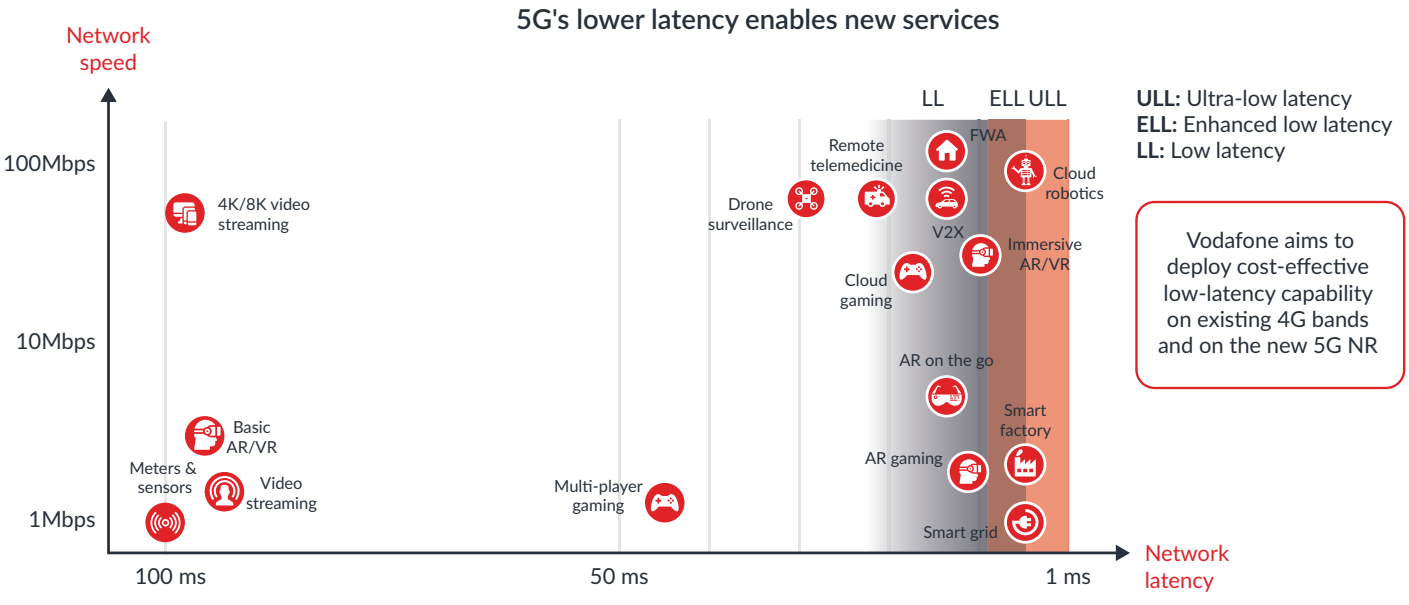
Edge applications mostly fall into one of the following three categories:

- Emerging devices such as robotics or drones
- Replacement for connectivity – for example, in a car manufacturing plant
- Applications that have never been connected until now such as video surveillance cameras

The graphic below which we featured in our recent TM Forum Benchmark report, *How to build and operate at the edge*, shows the latency demands that Vodafone Group expects for several 5G services.

None of the edge use cases represents a short-term opportunity for mobile operators. Robotics and drone connectivity are emerging applications, and sectors such as manufacturing, where there is strong early interest in 5G, will take time to go through the process of approvals and standardization. The process of embedding a new wireless technology needs to apply through the whole manufacturing supply chain.

Furthermore, the case for upgrading existing manufacturing plants to 5G will be extremely difficult to make until machinery needs to be upgraded. A more likely scenario is that




TM Forum, 2020 (based on Vodafone graphic)

manufacturers will seek to use 5G in new manufacturing plants rather than existing ones.

It is also unclear what role 5G operators have to play in sectors such as automotive manufacturing because many large companies are looking to build their own private mobile networks. We discuss this in more detail in the next section.

## Best use cases

The most promising 5G IoT use cases for CSPs are those that require coverage over a large area that is likely to already be part of the operator's existing or planned footprint. Sectors and businesses CSPs can target include:

**Emergency services** – local governments in the US, UK and France are already rolling out next-generation emergency services that use LTE technology. These could be upgraded to 5G so that emergency services providers could offer video calling or emergency healthcare solutions.

**Transportation** – mobile operators can enable navigation for connected and autonomous vehicles for businesses that are based on or depend on national transportation networks (for example, roads and railways). Vehicle-to-vehicle and vehicle-to-everything applications also are opportunities longer term.

**Retail** – bricks-and-mortar retailers need to improve shoppers' experiences and lower the costs to compete with online retailers. Improving customer experience could include offering new digital experiences using screens or advanced capabilities such as virtual and augmented reality. To reduce costs retailers may use technologies that reduce staff in stores, lower costs on heating, lighting and air conditioning, and replace in-store IT and computing requirements.

**Smart home** – CSPs are well positioned to enable connectivity and management of IoT devices in the home (for example, security monitoring or refuse collection).

## Sizing the opportunity

Some large CSPs have invested heavily in IoT and already operate sizeable IoT businesses. In many cases the companies are generating hundreds of millions of dollars in revenues even though the percentage of total revenue that comes from IoT is modest. The table below compares operators' IoT revenues for the specified year and shows year-on-year growth.

To build a robust IoT business, operators have had to add solutions capabilities on top of the network, but this has proved extremely challenging for mobile operators with little exposure to the B2B market. Furthermore, little progress has been made in "industrializing" IoT applications.

Service providers are finding that even within a vertical there can be hundreds of different use cases. They have a vision of building horizontal capabilities that can be applied to different verticals, but this still requires a solution-selling approach. For this reason, some CSPs have taken to acquiring existing IoT service providers that already have a niche expertise.

In the next section, we'll look at which vertical markets CSPs are targeting with 5G connectivity and other services.

**Comparison of CSPs' IoT revenues**

| Operator | IoT as % of total revenue | Year-on-year growth of IoT revenue |
|---|---|---|
| 中国移动 China Mobile | 1.40% (2019) | 40% |
| China unicom中国联通 | 0.80% (2018) | 45% |
| orange | 0.68% (2018) | Growth not reported publicly |
| T | 0.40% (2017) | 20% |
| Telefónica | Q1 2019 but percentage was not publicly disclosed | 53% |
| telenor | 0.63% (2018) | 24% |
| TELSTRA | 0.72% (2018) | 36% |
| verizon | 1.20% (2018) | 11% |
| vodafone | 0.98% (2017) | 12% |

TM Forum, 2020 (based on operators' publicly available financial disclosures)

Section 5

# Which vertical markets should CSPs target?

*Because 5G is driven by use cases, communications service providers (CSPs) necessarily must focus on a wide range of verticals, both in terms of product development and market focus. In some cases the two come together, as with autonomous vehicles. But not every operator is pursuing the same vertical market opportunities.*

CSPs often target specific markets based on the capabilities they have developed or acquired. Orange, for example, has acquired expertise in security solutions and mobile payments, so it targets financial services. Similarly, Vodafone Group specializes in automotive and insurance services. This does not mean that the companies ignore other verticals – merely that when it comes to delivering full solutions on top of connectivity, they have a clear focus.

CSPs are considering all kinds of vertically focused IoT and ICT services, not just 5G. And even when 5G is relevant to a particular market, it is unlikely to be the only connectivity option. Generally, operators are taking the view that LTE may meet an enterprise customer's initial requirements, but over time they will migrate to 5G for connectivity.

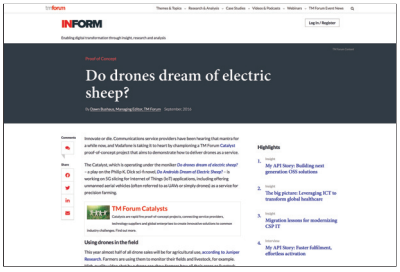
Some applications need 5G capabilities like broad coverage, high speed, low latency and quality of service (QoS) more than others. The table on this page shows the sectors we believe present the most attractive opportunity for CSPs to provide 5G services. An explanation of our analysis follows.

## Agriculture

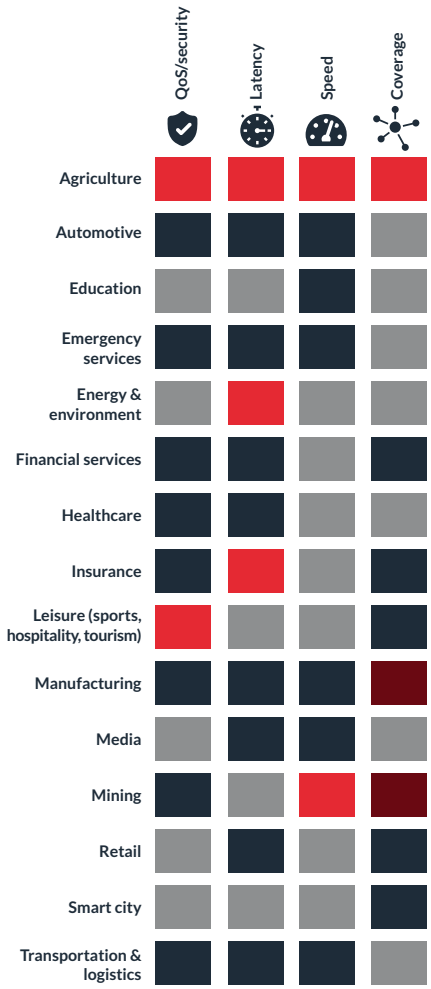
Farmers are interested in using 5G to monitor irrigation, disease and growth patterns. Indeed, some of the earliest drones-as-a-service initiatives have been in agriculture. Vodafone, for example, sponsored a TM Forum Catalyst proof of concept to show how such a service could work.

When it comes to 5G, coverage for farming applications may be an issue because there may not be any cellular coverage at all in some regions. But some applications like monitoring and asset tracking are unlikely to need 5G.

**Read more about the drones-as-a-service Catalyst project:**




### Which verticals are CSPs targeting?




- Vertical needs the services 5G operators are offering/will offer
- Vertical may need the services 5G operators are offering/will offer (some but not all use cases within this vertical will benefit from 5G)
- No clear need for 5G
- Use case best served by a 5G private network

TM Forum, 2020

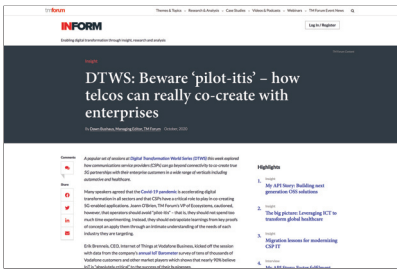
## Automotive

The automotive sector has generated perhaps the most interest from 5G operators and their suppliers. However, the slow progress of autonomous vehicles and the realization that vehicle manufacturers will be unlikely to leave critical security issues to a third-party service provider have resulted in a degree of caution when it comes to talking up 5G's prospects. Even so, the technology will have an important role to play once coverage levels improve enough for vehicle-to-vehicle applications.

Again, Vodafone is a leader in this vertical. The company is collaborating with Ford Motor Company and TM Forum in an important 5G IoT project called 5GEM (5G Enabled Manufacture). It is a 22-month project supported by a £3.9 million ($5.1 million) investment from the UK government. Other participants include ATS, HSSMI, Lancaster University, TWI and Vacuum Furnace Engineering.

The goal is to use 5G and AI in manufacturing to connect machines, allowing real-time feedback, control, analysis and remote expert support. TM Forum will contribute Open APIs for key purposes including IoT devices, ensuring portability and scalability of the solution across the globe, and management of connectivity through network as a service (NaaS).

**Read more about the collaboration between Vodafone and Ford:**

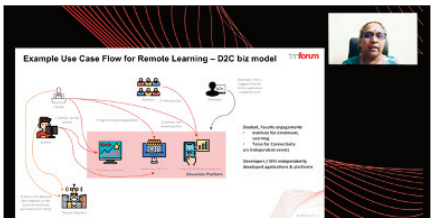



## Education

Schools and universities are already interested in how 5G can improve communication. This may be for R&D (in universities) but it could also be to provide basic connectivity into the classroom and campus areas more broadly. Mobile coverage offered by operators may be good enough for most facilities although larger, more rural campuses may need to invest in their own networks. Device support (laptops and tablets) would be needed if 5G is to capture any of the demand currently met by WiFi.

A TM Forum Catalyst proof of concept called *Developer is king!*, sponsored by Globe Telecom and KDDI, has been working to help CSPs monetize 5G and edge computing by looking at two sets of consuming stakeholders: enterprises or other organizations in verticals like education, automotive, healthcare and manufacturing, plus application developers. During a recent demonstration, the team illustrated a timely remote learning use case where a CSP provides the service enabled by 5G and edge to include live streaming and chats. In the demonstration, video quality is low for students but could be improved by a sponsor paying for reduced latency.

**Watch the video to learn more about the project:**




## Emergency services

US emergency services provider FirstNet is already delivering next-generation emergency services through a partnership with AT&T, which provides slicing of its LTE network. With 5G, organizations like FirstNet will be able to extend their capabilities and offer high-speed video and augmented and virtual reality capabilities. However, the lack of 5G coverage will limit its usefulness in the medium term. Indeed, in the UK where BT is delivering next-generation mobile services, the operator has had to increase its basic coverage to support the delivery of emergency services in remote areas.

Multiple TM Forum Catalysts have been exploring how to use 5G's unique capabilities to guarantee critical public safety services. You can learn more about two recent projects, *5G ride on!* and *The EDGE in automation*, by watching the videos below:



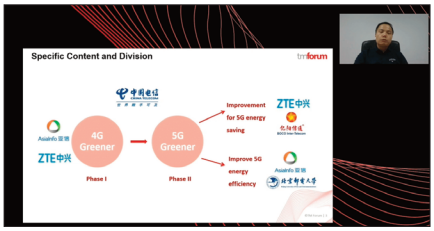
## Energy & environment

This is a broad segment covering the utilities sector (electricity and gas) and the usage of IoT to monitor pollution levels and the physical environment. It includes the potential for using 5G to improve the efficiency of smart grid operations. The requirements in this segment are diverse. For example, a private network may be preferable for facilities that generate gas and electricity, but power generation from renewables such as hydro, wind or solar is likely to need other types of connectivity. Speed and throughput will be less of a priority than latency and QoS.

CSPs may be able to apply learnings to this vertical from a Catalyst project addressing energy consumption in their own networks. The ongoing project called *AI for greener telco*, which is championed by China Telecom, has been looking at how to

create a sustainable 5G future when the increase in 5G base stations and deployment of large-scale multiple input multiple output (MIMO) technology are leading to a huge increase in power consumption – each 5G base station uses 2.5 to 3.5 times more energy than 4G base stations. As part of the demonstration, the team refined historical pattern recognition from different times to identify when and where energy could be saved. They also monitored users' perceptions of experience to enable immediate activation of base stations to improve poor experience.

**Watch the video to learn more:**




## Financial services

The requirements of the financial services sector go from trading floors, which require millisecond latency, to mobile payment services such as M-Pesa in Kenya. Perhaps surprisingly, there are relatively few use cases for 5G in financial services. One area worthy of exploration is the use of 5G to simplify network operations at individual bank branches and to provide more flexibility in terms of where to locate branches. The combination of 5G and AI also could enhance the security of banking operations.

## Healthcare

The potential for 5G in healthcare has sparked the imaginations of telecoms executives more than any other vertical, but CSPs have been attempting to innovate in healthcare for many years with little success. A handful of CSPs such as Orange and Telus in Canada have built ICT businesses in healthcare, but the sheer size, complexity and apparent unwillingness to embrace digital innovation have stymied most telco initiatives.

There are some signs of change, however. The Covid-19 pandemic is causing inter-governmental bodies and national administrations to prioritize and accelerate digitization of healthcare. Earlier this month Indian Prime Minister Narendra Modi called on mobile operators to help with the Covid-19 vaccination drive, and CSPs including AT&T, Lumen (formerly Century Link) and BT have started to talk publicly about 5G hospitals and 5G-connected ambulances.

Several recent TM Forum Catalyst proofs of concept have explored digital health. You can find more information about them here.

**Read this report for more about the role for CSPs in healthcare:**


## Leisure

CSPs are already delivering 5G connectivity to sporting venues. For example, Verizon has been partnering with the National Basketball Association and National Hockey League in the US to equip stadiums with 5G and explore future business models. 5G can provide the capacity and speed necessary to enhance spectators' experiences. Other examples in this vertical are holiday/vacation complexes and campsites, and temporary, "pop-up" cafes and bars that have seasonal requirements.

## Manufacturing

While vehicle manufacturing as described in the Vodafone example on page 19 has generated the most interest, all factories that use fiber connectivity to connect machinery represent opportunities for 5G. This represents an opportunity for CSPs, but many manufacturers are looking to deploy their own mobile private networks (MPNs) for the following reasons (we'll look at this in more detail in the next section):

- They need excellent indoor coverage that is unlikely to be part of a macro network.
- Their own security protocols may require them to retain control of and responsibility for maintaining the network.
- Many of the new capabilities that mobile operators are looking to offer such as network slicing will not be commercially available for two to three years.

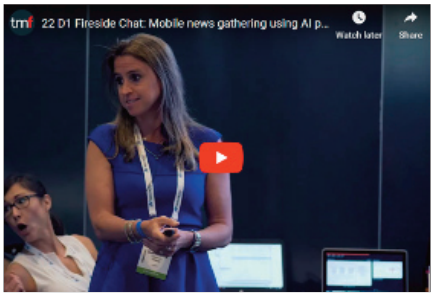
## Media

Using 5G signals to deliver media broadcasts from outdoor events is an early use case that can deliver significant costs savings compared with the use of satellite connectivity. Sporting events and news are good use cases so long as the sites have 5G coverage. Those operators which are investing in edge computing as part of their 5G roll-out may also seek partnerships with video and gaming companies to help them deliver a better, lower-latency experience to their customers.

Many TM Forum Catalysts have looked at how to use 5G to support media use cases. An early TM Forum 5G Catalyst used the Tour de France cycling event to demonstrate how to use network slicing to increase the volume of choice of content available to viewers; minimize the cost of deployment and operation; create new revenue streams; improve the

customer's/viewer's experience; create an immersive experience for fans; and ensure safety and security for competitors and spectators. Another more recent project brought together media and telecoms companies to improve the quality of broadcast content through using 5G and AI-powered compression.

**Watch the video to learn more:**




## Mining

Mining companies are investing in LTE-based MPNs to increase productivity and improve safety. Mining will likely remain an MPN business – there is no real business case for CSPs to extend their macro networks into mines. But as 5G matures and capabilities such as network slicing emerge, there will a case for upgrading from LTE.

## Retail

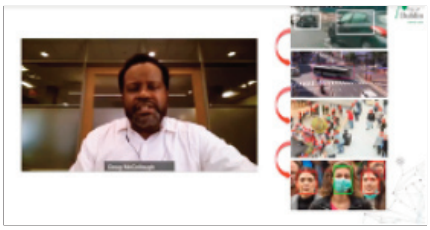
As retailers increase their digital capabilities to offer shoppers new services that use virtual and augmented reality (for example, allowing people to try clothes on virtually), there will be an opportunity for 5G because retailers will need low-latency, high-speed capabilities. Retail may be a vertical where CSPs choose partner with public cloud providers to deliver 5G-enabled services. When they partner to deploy edge computing capabilities, for example, they are likely to target shopping centers because there are lots of potential customers with similar requirements. Most will already be buying services from CSPs, so there is an opportunity to offer added value with computing services.

## Smart cities

While the smart city vision may be compelling, delivering IoT services with viable business cases is much more difficult. Connecting city bikes, delivering smart street lighting and putting sensors in refuse bins are among the services that are being deployed today but none rely on high-speed connectivity of low latency services. The biggest opportunity in the short-to-medium term for 5G is likely to be CCTV surveillance cameras. Indeed, Gartner forecasts that 70% of all 5G IoT endpoints in 2020 will be surveillance cameras. These have traditionally been connected by fixed broadband.

As part of the Smart City Forum, TM Forum members have developed many APIs and other assets to help smart city governments and CSPs that would like to target this market. Several TM Forum Catalyst proofs of concept have explored the use of 5G in smart cities. One called Connected citizens has developed an interoperable, commercial data platform to enable new business models for sustainable smart cities. Another more recent project called *Smart networks for smart cities* features an analytics application that is driven by AI and determines parking patterns in the City of Dublin, Ohio's historic district. The team used 5G network slicing to provide the service.

**Watch the video to learn more about the project with the City of Dublin:**



## Transport & logistics

Ports and airports are two early users of MPNs, although the applications that they use tend to be quite different. In the case of ports, 5G connectivity will increase efficiency through automation of freight operations. While there may already be reasonable mobile coverage in ports, QoS is an issue.

Airports, on the other hand, have advanced fiber and Wi-Fi networks. In the short term, 5G will provide complementary capabilities – for example, delivering connectivity to aircraft for maintenance purposes and for downloading and uploading flight data and entertainment services.

An ongoing Catalyst proof of concept called *The aviator*, championed by AT&T and BT, shows how 5G's network slicing capabilities can enable the aviation industry and its partners (airport operators, aircraft manufacturers, the airlines themselves, advertisers and others) to re-imagine the overall air travel experience, while also expanding the market opportunity for CSPs.

**Watch the video to learn more:**


In the next section, we'll look at 5G MPNs and the roles CSPs can play in them.

Section 6

# Mobile private networks are a growth opportunity for telecoms

*Five years ago, very few companies were even talking about mobile private networks (MPNs), let alone deploying them. A small number of mobile equipment vendors were delivering standalone networks for mission-critical enterprise services, but they were outliers in the global mobile communications business. Today, MPNs represent one of the most exciting opportunity for growth in telecoms.*

Every day seems to bring a new announcement from an enterprise that is trialing or deploying an MPN. The surge in interest has forced incumbent mobile network vendors and communications service providers (CSPs) to quickly develop strategies and add capabilities that will ensure they have a role as partners and suppliers in delivering these networks.

In some cases, enterprises will work closely with mobile operators to build MPNs, but in others, enterprises may bypass CSPs entirely or give them limited roles and responsibilities. These scenarios are playing out right now, and it is too early to state categorically that enterprises, which operate in a wide variety of verticals all over the world, will prefer one approach over another.

Mobile network vendor Nokia is building a significant MPN business. Says Jane Rygaard, the company's Head of Dedicated Wireless Networks and Edge Cloud:

"Last year [2019] was the first year that we saw enterprises asking, 'How can I do this? What do I need to know?'. In 2020 we see quite a lot happening: enterprises buying direct and operators understanding what they need to do to address the market, and systems integrators realizing what needs to be done if you want to enable enterprises [to deploy private networks]."

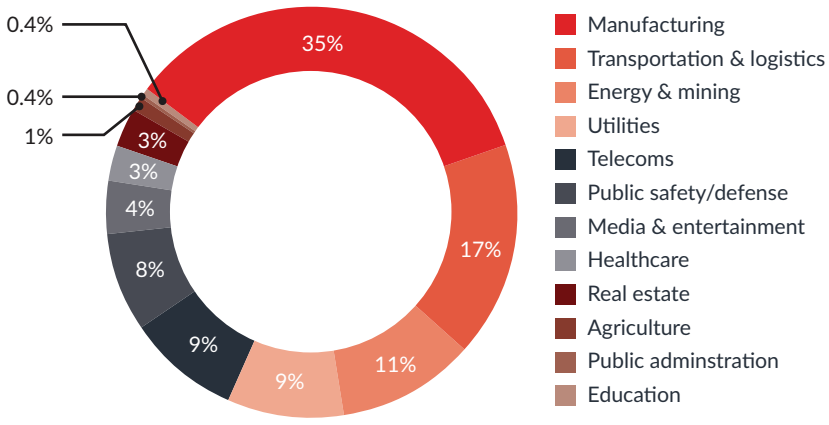
## Who's using MPNs?

Based on public announcements, research firm Omdia has identified nearly 100 MPN deployments around the world. (The actual figure is probably several times this number, as Nokia reported in November 2019 that it had already deployed more than 120 LTE-based MPNs.) The sectors with the most implementations are manufacturing, transport and logistics, and energy and mining.

The automotive industry has been the biggest adopter of MPNs in manufacturing, but it is by no means the only one. Other deployments or planned deployments tracked by Omdia include shipbuilders, engineering groups, and manufacturers of appliances/white goods.

In the transportation and logistics category, transport hubs such as ports and airports are early adopters. Indeed, there is so much interest from port authorities in deploying MPNs that it is poised to become a global phenomenon. Ports that have deployed or are in the process of

**Enterprise 5G announcements by sector**




TM Forum, 2020 (Source: Omdia)

implementing MPNs include Antwerp and Zeebrugge in Belgium, Belfast in Northern Ireland; Felixtowe in England; Rotterdam in the Netherlands; and the Finnish ports of Kokkola, Oulu and Hamina.

## MPN drivers

Most MPNs are deployed in locations that have poor or no mobile coverage. These typically are privately owned buildings or locations where mobile operators do not believe they would generate enough traffic to justify extending the public network.

But some enterprises are building MPNs even if they do have access to public network sites. There are several drivers for adoption:

**Adding mobility to private networks** – enterprises with private wireline networks often add Wi-Fi for mobility, but they are discovering that cellular connectivity can be a better option, such as when coverage needed is partially outdoors or when the network is fully loaded. And with the deployment 5G, enterprises are growing more excited about cellular technology as an enabler of Industry 4.0.

**Maturity of technology** – the first time a mining company used LTE in a mine was in 2012, and the first LTE-enabled truck appeared in 2015. But it wasn't until 2019 that an LTE network was fully deployed in a mine as part of the transition to autonomous mining operations. As cellular technology matures, companies are finding more reasons to use it, and this will increase as 5G is deployed.

**Merging of computing and telecoms** – CSPs are adopting the same software and cloud architectures for their networks and IT environments that enterprises are using. This means that network vendors and mobile operators can speak the same language as their enterprise customers, and most importantly they can articulate the benefits of combining cellular technology and enterprise IT.

**Availability of spectrum** – as explained in Section 2, until recently mobile licenses have been granted only to network operators prepared to commit to national rollouts and pay multi-billion-dollar licensing fees. This changed with the Citizens Broadband Radio Spectrum (CBRS) auction in the US. CBRS is spectrum that operators must share with other companies – for example, satellite operators. As part of these auctions, regulators awarded spectrum to organizations such as utilities, educational institutions and specialized B2B service providers. Other countries have followed the US in reserving spectrum for enterprises.

**Interest in IoT** – enterprises are keen to adopt IoT technology, but few telecoms operators have acquired the skills to sell or deliver IoT solutions using public networks. As such, do-it-yourself IoT is an attractive option for businesses such as manufacturing companies.

## Do MPNs need 5G?

Most MPNs use LTE technology, but the Standalone 5G standard completed this summer allows enterprises to use the new technology as an alternative. However, Nokia's Rygaard believes there is still work to be done on 5G to meet enterprises' requirements.

She points to a greater focus on the uplink, which has limitations in 5G because of its use of mid-band and high-band spectrum. In addition, as enterprises bring together IT and cloud environments with mobile networks and technologies, new orchestration capabilities will be needed to provide resilience in the IT stack.

Despite the relative immaturity of 5G, Lufthansa Industry Solutions, a division of the Lufthansa airline group, has already deployed private 5G networks to enable remote maintenance of its own planes and those belonging to other airlines. Company executives say the reason for adopting 5G rather than LTE is because of 5G's potential to deliver new capabilities in the future.

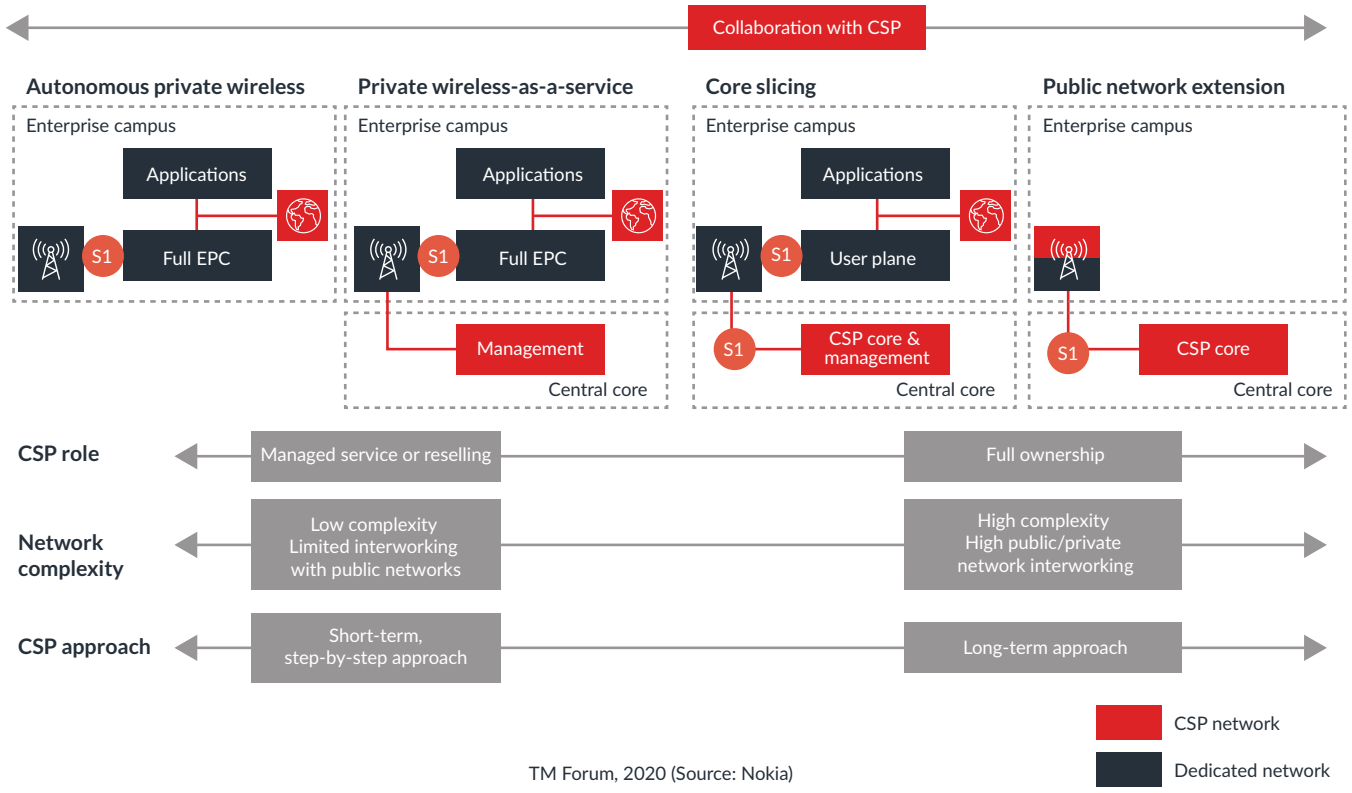
## Roles for CSPs

Early discussions around MPN seemed to pitch mobile operators into direct competition with network vendors such as Nokia. But Rygaard says characterizing the companies' roles as conflicting is misleading.

> "We seldom see a conflict," she says. "There is just a perceived conflict in the market."

Every large enterprise has its own requirements and existing relationships with suppliers, operators and systems integrators. These often determine the relative roles of the players. Nokia describes four roles for CSPs in MPNs as shown in the graphic below. The CSP's involvement increases in each scenario, moving from left to right. These models are based on Nokia's own network deployments and engagements with enterprises.

**Private wireless architecture options and roles for CSPs**




TM Forum, 2020 (Source: Nokia)

In each of the four scenarios above the enterprise has its own radio access network – either because there is no existing network coverage or because the coverage does not meet the requirements of the enterprise. The main difference in the four scenarios is ownership and operation of the core network. Those enterprises that are building their own access and core networks – and which may or may not be managed by an operator (the two models on the left) – have typically started with fairly small, uncomplicated networks for specific use cases. They will expand their networks over time as use cases are proven. The two models that involve collaboration with the CSP tend to be more complicated in nature, with the operator managing and owning part or all of the core.

- **Autonomous private wireless** – in this scenario, the enterprise procures its own hardware and software to build and manage an MPN on its premises. The radio access network (RAN) is connected through a 3GPP S1 interface to the evolved packet core (EPC), which is connected to internal applications and the cloud. Companies that build their own MPNs usually already

have network skills and capabilities, and a full grasp of what they want to achieve with a mobile network. Companies such as Bosch and Siemens fall into this category. However, even in this case there is a role for mobile operators to provide connectivity beyond the campus. For example, if a connected vehicle leaves a factory or campus, it needs to be able to roam on the public cellular network.

- **Private wireless-as-a-service** – this model is an evolution of autonomous private wireless, where infrastructure remains on the enterprise's premises, but management of the network is handed over to a CSP. In this case, the enterprise may not have the expertise needed to manage its own MPN or may not see the mobile network as core to its business. This may be attractive for companies that do not want to commit to buying their own core network (CapEx) or want to trial it first by paying a monthly as-a-service fee.
- **Core slicing** – this scenario comes into play when an enterprise wants to mix and match its own capabilities with those of a mobile operator, often to enhance security. For example, a company may want to keep applications within the enterprise but move core network functionality and management of the network to the cloud.
- **Public network extension** – this option is the most lucrative for CSPs because nearly all of the MPN in the public cellular network with only the RAN remaining on the customer's premises. But this is also the most challenging scenario for CSPs because they have to decide whether to manage the MPN as part of the core cellular network or create a separate, dedicated team. Often a dedicated team is needed to meet service level agreements and for end-to-end management.

## Assessing the models

It is still too early to determine which MPN approach will prove most popular and which types of companies are likely to choose one model over another. Considerations around security and control will be key. Many companies are concerned about the risk of other companies getting access to their data or operations through a thir- party core network.

> Enterprises' existing relationships with CSPs and systems integrators will also be a factor. A company that already has a strong relationship with an operator might want to leverage it to deploy an MPN.

Finally, simplicity is a consideration for most enterprises. An IT department may want to be able to operate the MPN in the same way as Wi-Fi systems and without having to worry about managing the core network.

In the next section, we'll look at how 5G enterprise services might impact CSPs' revenues.

Section 7

# How will 5G enterprise services impact CSPs' revenues?

*Communications service providers (CSPs) will generate two types of revenue from selling 5G services to enterprises: revenue from mobile broadband (smartphones/devices) and fixed wireless access services that will migrate from existing technologies to 5G; and revenue from new ICT services enabled by 5G. In this section, we look at a wide variety of market projections for 5G enterprise services and offer our own predictions based on some of the data about the potential value of 5G IoT connectivity to CSPs.*

Broadband 5G revenue could come from existing connections that migrate to 5G or new connections – for example, serving rural areas that did not have connectivity before or the addition of second or multiple lines for existing subscribers. Revenue from new ICT services enabled by 5G can also be broken down into to two categories: from connectivity required to enable new ICT services and from other parts of the value chain.

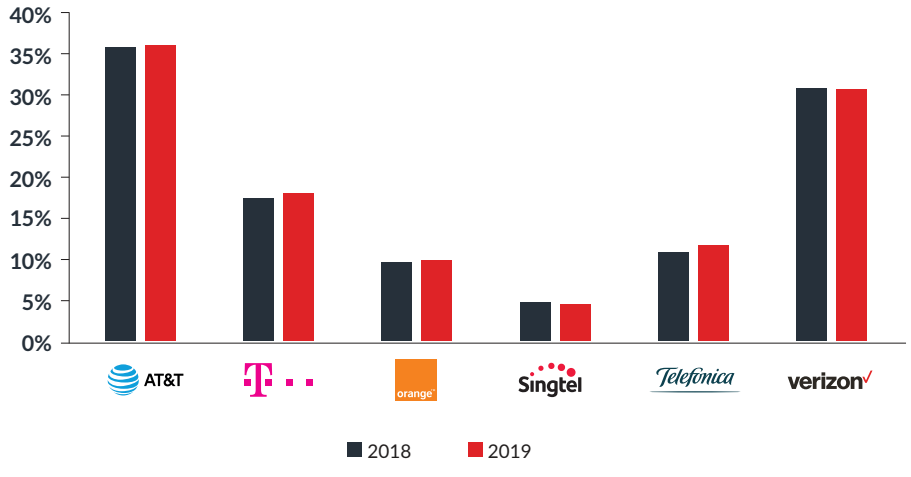
These breakdowns do not give the full picture about the impact or return on investment of 5G, however. Many new ICT services enabled by 5G could also be enabled by LTE. Indeed, in many cases enterprises will adopt a combination of LTE and 5G, and it may not be clear where to apportion revenue. As such, it may be easier to consider these new revenues as LTE-and-5G enabled rather than merely from 5G.

Another question is how to account for revenue generated (either directly or indirectly) from mobile operators' investments in deploying edge capabilities in their networks and investments in edge computing more broadly. CSPs may make these investments as part of an overall 5G strategy, but this does not mean that all revenues derived from edge computing will come from 5G. Other transmission facilities such as fiber may be used to connect enterprise locations to the network edge.

## Current revenue

The recent financial performance of large telecoms operator groups does little to suggest that the enterprise market is poised for strong growth. Enterprise revenues at six of the largest operator groups in Europe and North America plus Singtel in Asia – precisely the companies that would be expected to earn new B2B revenue from 5G – grew by only single-digit percentages in 2019, if they grew at all (see below). CSPs have managed to generate some new revenue from ICT services such as security, IoT and cloud, but it has merely compensated for the continuing decline in revenue from voice services such as roaming and international calling.

**Enterprise revenues of selected CSPs (in US$ billions)**




TM Forum, 2020

## Is 5G a game changer?

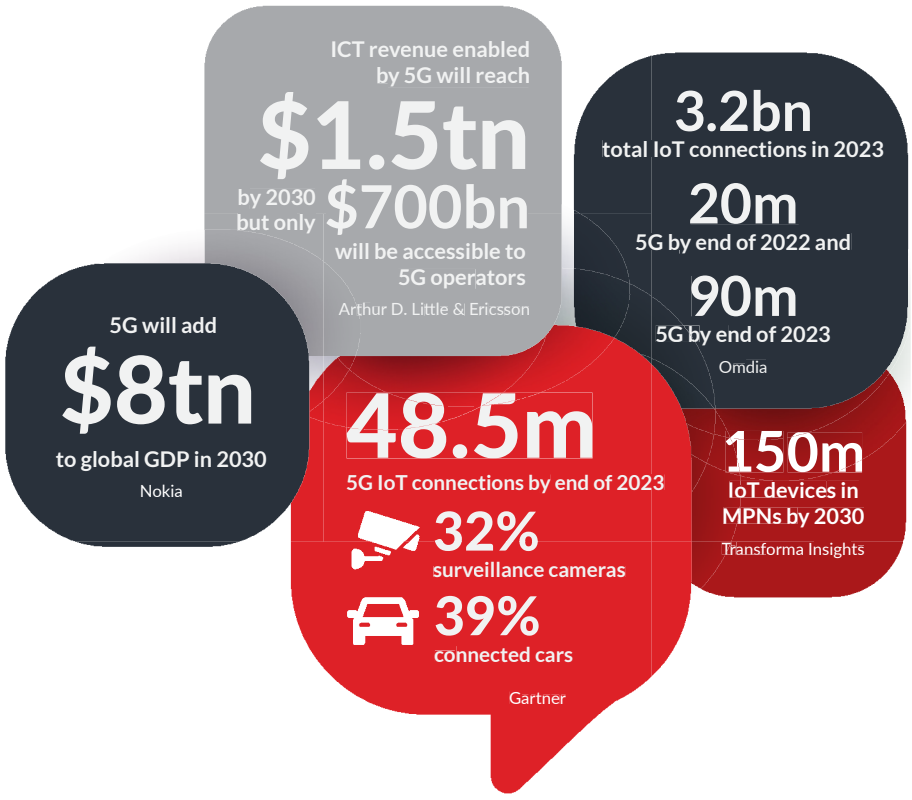
There is no shortage of market forecasts for 5G-enabled services, but they do not always compare like with like. A projection from network vendor Ericsson and management consultancy Arthur D. Little suggests that ICT revenue "enabled" by 5G will reach $1.5 trillion by 2030, but only $700 billion will be accessible to 5G operators because most comes from products and services that they do not have the ability to deliver.

IoT forecasts often include breakouts for 5G IoT specifically. For example, research firm Omdia forecasts that there will be 3.2 billion total IoT connections in 2023, 90 million of which will be 5G connections. The company forecasts 20 million 5G IoT connections by the end of 2022.

We can use this data to predict the value of the 5G IoT connectivity business to CSPs. Assuming average revenue per user (ARPU) of $1 for each IoT connection, the 5G IoT connectivity business will be worth $1.1 billion per year globally by the end of 2023. In reality, IoT ARPU ranges from around 10 cents to $5 per month, so the total could be slightly lower or significantly higher. The figure would also be lower if we were to use Gartner's forecast of just under 50 million 5G IoT connections by the end of 2023, which is about half Omdia's prediction.

Other forecasts seek to assess the value to society, or to businesses, of services that use 5G. Nokia, for example, projects that 5G will add $8 trillion to global GDP in 2030.

Bullish (and widely varying) projections for 5G & IoT




TM Forum, 2020

## What about MPNs?

The revenue potential for mobile private networks (MPNs) is perhaps the most difficult to forecast. A good starting point is to count the number of enterprises or organizations in each relevant sector (for example, ports or car-manufacturing plants) and then make assumptions about how many will build MPNs.

However, forecasting the size and scale of each MPN deployment is extremely difficult. While we did not find research quantifying the 5G MPN opportunity specifically, Transforma Insights does project the number of IoT devices in MPNs. The company predicts that there will be 150 million IoT devices in MPNs by 2030, up from 3 million at the end of 2019. More than three quarters of the devices will use 5G.

In the next section, we offer advice for CSPs and their partners to help them capitalize on the 5G enterprise opportunity.

Section 8

# Make it happen – Strategies for success in enterprise 5G

*Communications service providers (CSPs) may be tempted to jump headfirst into the enterprise 5G business, but they won't all be successful. In countries that have four or five national mobile operators, it is likely that only one or two will have enough experience serving enterprises to succeed. An operator whose business is 95% consumer today will find it difficult to build B2B capabilities that require different skills, experience and market access. For operators that do decide to target enterprises with 5G services, here are some important steps to take:*

## Consider connectivity

Many CSPs believe that to grow revenue they must develop new capabilities and offer services beyond connectivity. But 5G's ability to deliver low-latency connectivity and speeds that come close to those achieved over fiber mean there is a huge opportunity to grow basic connectivity. For small and medium-sized enterprises this could be as simple as selling 5G to provide resiliency or redundancy, or basic broadband connectivity for new or temporary sites.

But operators will have to improve the connectivity experience to be successful. This means offering the ability to customize or configure connectivity to meet the requirements of specific users or applications, and providing a fully digital experience that ideally puts the customer in control of managing their own connectivity requirements.

## Don't be a follower

Over the past 30 years, mobile operators around the world have built very similar networks using similar strategies in terms of deployment, services, pricing and support systems. But many CSPs will go their own way in developing networks and strategies to support the B2B market. They will focus on specific markets, particular customer bases, and they will develop business models that will work for them. As such, there will be no 5G enterprise blueprint, and operators will need to choose their own paths rather than following others.

## Weigh partnerships

The telecommunications industry has been talking about the value of partnerships for several years without always being clear about their commercial rationale. CSPs partner with over-the-top (OTT) providers to increase loyalty and customer lifetime value. They do not make a profit from the services that they resell, and the deals may even be loss-making.

When it comes to partnerships for 5G enterprise services, operators could take the same approach. Partnering with hyperscale cloud providers may be the best way to sell more 5G connections. On the other hand, CSPs may choose partnerships that will let them claim a bigger share in the sale of full, end-to-end solutions or that allow them to own the relationship with the enterprise customer.

## Let customers lead

CSPs have long adopted a "build it and they will come" model, but this approach will not work in the enterprise market where each customer has a specific set of requirements. Mobile operators are finding special rules, characteristics and approaches to deployment of technology in every vertical. Without engaging potential customers to work through these challenges, it will not be possible to decide which network capabilities to exploit or to develop, or which support systems will help them monetize the opportunity.

## Strike a balance

While operators will need to spend time investigating the requirements of verticals, they will not be able to build a profitable business if they have to customize every solution. CSPs should also focus on developing horizontal capabilities that are repeatable across sectors. For example, an operator could sell security-as-a-service to companies in all kinds of industries.

## Choose verticals wisely

Even the world's largest B2B telecoms operators are discovering that they may be able to serve only a few verticals with end-to-end ICT solutions. To become service providers of choice in those sectors, CSPs may need to acquire specialist ICT providers that already have expertise (and customers) in a given market. Vodafone is a good example of an operator that is using this approach as it has committed to serving business customers in the sometimes-overlapping automotive and insurance industries.

## Decide role in MPNs

The explosion of interest in mobile private networks (MPNs) has forced CSPs to quickly put together market propositions that meet the many and varied requirements of enterprises. Operators likely will focus on the same verticals in their MPN strategies as they do in selling 5G services more broadly. Forging strong partnerships with systems integrators and network equipment vendors will be essential for operators to participate in MPNs.

## Build for agility

5G gives mobile operators the opportunity to innovate and co-create with business customers. While customer centricity is essential, operators will also need flexible network and IT architectures. Slow, costly customization and integration will not work. Enterprises necessarily will take an experimental approach to exploiting 5G's capabilities, so mobile operators will need to adopt cloud native technology and move workloads to the public cloud in order to deliver flexible, scalable solutions.

TM Forum members are developing the Open Digital Architecture (ODA) as a blueprint for modular, cloud-based, open digital platforms that can be orchestrated using AI. ODA replaces traditional operational and business support systems (OSS/BSS) with a new approach to building software for the telecoms industry. To find out how ODA can help in targeting enterprise 5G, please contact George Glass, and for more information read the white paper below.

## Improve BSS

Today's enterprise BSS stacks are simply not designed to exploit the versatility of 5G, and it will be a while before operators understand fully which 5G capabilities are most relevant to the verticals they are targeting. It is clear, however, that 5G services will require CSPs to participate in digital ecosystems. In addition, enterprises expect control, self-service and real-time capabilities.

CSPs need to start deploying these capabilities today to ensure they are ready when enterprises move beyond experimenting with 5G. Again, the ODA can help operators reimagine their core commerce systems for agility. In addition, TM Forum members are working on a Business Capability Map and Business Architecture to help CSPs understand their unique capabilities and how to monetize 5G services. To learn more about this work, please contact Joann O'Brien.

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# How Telcos Will Enable 5G
## *And how enterprises will leverage it*

## Introduction

Enterprises are embarking on a journey to digitize their business models as they strive to determine how to take advantage of modern technology and business processes. 5G, machine learning, artificial intelligence, augmented reality, the Internet of Things, edge intelligence—these are just a few of the technological advances changing the foundation of data management in the telco space.

With the $40 billion-plus 5G market expected to grow at an annual clip of almost 40% through 2027, telcos are primed to be at the forefront of one of the biggest industrial pivots in modern history. However, 5G isn't exactly an easy technology to control or manage, as it involves an unprecedented level of data ingestion requiring totally new ways of storing and analyzing data.

> "One of the most important things telcos will do to enable enterprises on 5G is to create a 5G service-based architecture that supports open radio access networks (Open RAN).

To fully capitalize on 5G, telcos will need to first adopt their own new technologies and strategies to make 5G a reality, and then enterprises will need to properly use other new technologies and strategies to make 5G work. While it's not easy, all of these new technologies are in development and already being applied in real-word use cases.

The advantages of 5G include:

- Ultra-reliable low-latency communication (ie, < 1 millisecond)
- Massive bandwidth capable of < 10 Gbps peak rates
- The ability to handle 1 million connected devices per square kilometer
- The enablement of low-power machine-to-machine communication

All of the above will enable enterprises of all types, but especially those in IoT and financial services, to fight fraud and monetize real-time data, leading to billions of dollars in new ROI.

But certain steps need to be taken—on both the telco side and the enterprise side—to get there.

This report explains what telcos need to do to enable 5G for enterprises and then what enterprises will need to do to leverage 5G to the fullest.

## What Telcos Need to Enable 5G for Enterprises

Although things like small cells, mmWave, and fiber backhaul networks are table-stakes for 5G success, there are a few more capabilities telcos need to provide for enterprises to allow them to not just use but monetize the advantages of 5G.

### 1. Open RAN

One of the most important things telcos will do to enable enterprises on 5G is to create a 5G service-based architecture that supports open radio access networks (Open RAN).

Open RAN uses hardware and software components from multiple vendors operating over network interfaces that are open and interoperable, thus allowing communication service providers (CSPs) to avoid vendor lock-in and mix and match the best solutions possible.

A vital part of this approach is the RAN Intelligent Controller, which facilitates the integration of loosely coupled network functions through a database to provide a uniform view of network information and a message queue to orchestrate the interactions and service chaining.

### 2. Unified data management

A service-based 5G core will need to ensure data consistency between the various network functions that constitute the 5G core. This centralization requires a data platform that brings together structured and unstructured data to be available and utilized at scale while preserving low latency.

There's a twist to this, though. 5G networks will put the onus of call detail record (CDR) creation and persistence on the data platform. This shift requires the unified data management function's front end to be able not just to store and fetch data but also to add intelligence to manufacture CDRs and mediate their interactions to optimize monetization strategies.

### 3. Modern policy and charging

Charging and policy functions are quintessential business support service (BSS) functions for revenue assurance. There's already a recognized need to start running these functions in a federated manner closer to the subscriber universe. The subscribers can be human subscribers,

as in mobile phone users, or, more interestingly, networks of things in an enterprise or industrial setting.

> "There are two key technologies enterprises will need to use to take full advantage of Industry 4.0 - Digital twins and Multi-access edge computing (MEC).

Charging is moving from online and offline to usage-based charging, and policy functions are getting more complex, too. With LTE, locally stored operator policies, static data from subscriber profiles, and repository- and application-specific data were the things driving decisions. With 5G, the policy function gets continuous dynamic input from various network function interfaces and the network data analytics.

This increasing amount of dynamic data means the database supporting the new 5G policy functions needs to be easily scalable and adaptive in order to incorporate policy changes in a matter of milliseconds; it can't be an eventually consistent technology prone to data loss and inaccuracy.

## The Tools Enterprises Will Use to Capitalize on 5G

5G will be a key element of "Industry 4.0"—ie, the fourth industrial revolution, which is the automation of traditional manufacturing and business processes.

To incorporate these advances in automation, enterprises will need to go through a digital transformation. Unfortunately, instead of rethinking business processes and models to unshackle from the constraints of yesteryear technology choices, organizations end up replicating the same old tired processes but with the newer set of technologies. This unimaginative approach is counterproductive in two ways:

1. Organizations cannot use modern technology as intended.

2. Technology vendors get stifled to meet the arcane requirements just to make their revenue targets.

On the positive side, enterprises that recognize that digital transformation is an opportunity to introduce better efficiencies into their business processes see a plethora of options to achieve that goal.

When it comes to 5G, there are two key technologies enterprises will need to use to take full advantage of Industry 4.0.

### 1. Digital twins

To use the data appropriately, organizations need to create a digital representation of their people, processes, and systems. These can be broadly called "digital twins".

Digital twins historically were pure representative data collection systems. This data is then used for big data analytics to understand how the various business processes are operating and potentially used for dashboards in operation centers.

5G is changing this.

The ubiquitous connectivity of these systems, devices, and people within a business process helps enterprises imagine new ways to automate these business processes. Process automation requires a real-time control loop where physical assets provide current events' data. Simultaneously, the digital twin uses this data and the intelligence created in the machine-learning iterations to drive actions.

### 2. Multi-access edge computing

Making continuously integrated automation a reality requires ultra-low-latency communications and fast processing of the data to drive actions.

We can break this down as:

1. Ingest the data from the sources

2. Store the data

3. Aggregate to measure any key performance indicators (KPIs)

4. Apply business logic and rules to determine any deviation of the KPIs from the normal

5. Determine the outcome of these decisions

6. Invoke appropriate reactive/corrective actions

7. Notify or alert any downstream systems of these decisions and actions

The challenge is that all this needs to happen very quickly, which becomes an issue when you factor in things like built-in latencies and the complexity of tech stack management.

To accomplish all of the above steps quickly, enterprises need to rapidly process data at the edge via multi-access edge computing (MEC).

MEC, also known as mobile edge computing, started in 2016 and has since matured into a clear set of standards geared towards leveraging data and intelligence for real-time localized data services.

MEC nodes are typically used in:

- Customer premise edges, for applications that require operations to complete within five milliseconds; and
- Telco-operated network edges, for applications that use an external software provider for a broader set of customers.

In either case, one key element that comes into play with MEC is that compute nodes are limited compared to a central data center or data center cloud, which makes it extremely difficult to manage several applications running at the same time, which is where having a unified data layer and data platform comes in.

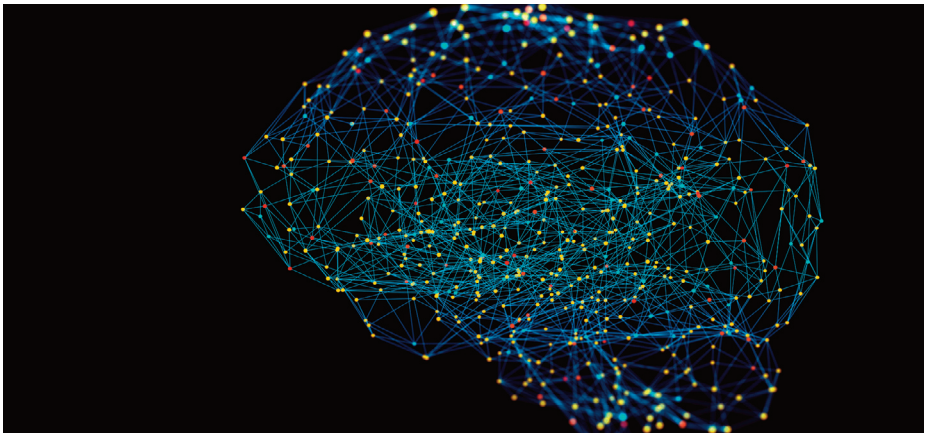
> "With Open RAN, unified data management, and modern policies and charging, telcos can set themselves up for 5G success.

## Conclusion

Provisioning services for enterprises on top of 5G is a great monetization area for CSPs, but this has to be done with the recognition of the fact that 5G is still in a "build it and they will come" stage.

To make 5G successful, CSPs need to provide edge services to enterprises, which will require some investment. Using a corner-cutting or patchwork approach to this process would likely prove disastrous in the context of 5G's low-latency demands.

A successful 5G journey means thinking holistically and investing in all the technologies that make 5G possible. With Open RAN, unified data management, and modern policies and charging, telcos can set themselves up for 5G success, and then let enterprises, in turn, set themselves up for 5G success via the use of digital twins and MEC.



# TM Forum Open Digital Framework

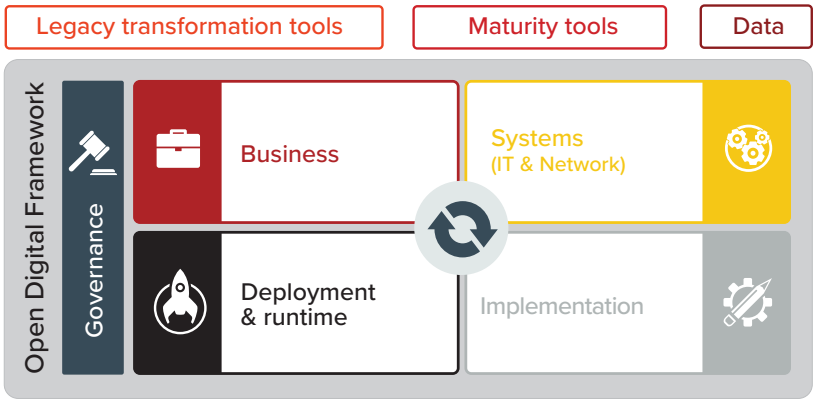
## A blueprint for intelligent operations fit for the 5G era

The TM Forum Open Digital Framework (ODF) provides a migration path from legacy IT systems and processes to modular, cloud native software orchestrated using AI.

The framework comprises tools, code, knowledge and standards (machine-readable assets, not just documents). It is delivering business value for TM Forum members today, accelerating concept-to-cash, eliminating IT & network costs, and enhancing digital customer experience.

Developed by TM Forum member organizations through our Collaboration Community and Catalyst proofs of concept, building on TM Forum's established standards, the Open Digital Framework is being used by leading service providers and software companies worldwide.

### Core elements of the Open Digital Framework




The framework comprises TM Forum's Open Digital Architecture (ODA), together with tools, models and data that guide the transformation to ODA from legacy IT systems and operations.

**Open Digital Architecture**

- Architecture framework, common language and design principles
- Open APIs exposing business services
- Standardized software components
- Reference implementation and test environment

**Transformation Tools**

- Guides to navigate digital transformation
- Tools to support the migration from legacy architecture to ODA

**Maturity Tools & Data**

- Maturity models and readiness checks to baseline digital capabilities
- Data for benchmarking progress and training AI

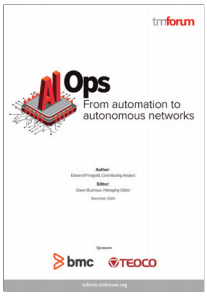
### Goals of the Open Digital Framework

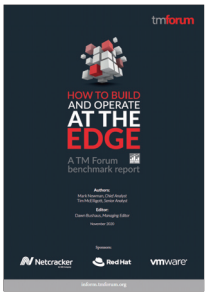
The aim is to transform business agility (accelerating concept-to-cash from 18 months to 18 days), enable simpler IT solutions that are easier and cheaper to deploy, integrate and upgrade, and to establish a standardized software model and market which benefits all parties (service providers, their suppliers and systems integrators).

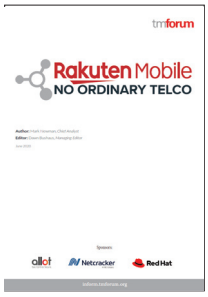
### Learn more about member collaboration

If you would like to learn more about the Open Digital Framework, or how to get involved in the TM Forum Collaboration Community, please contact George Glass.

# TM Forum research reports



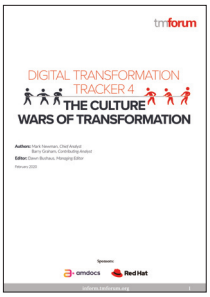























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