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Why 5G is Important for Enterprises

Content

Executive Summary

5G is an emerging technology that transforms underlying architecture in core networks and promotes virtualization, AI and automation. It changes the possibilities of networks, applications and underlying IT systems. It introduces new technologies such as edge compute and network slicing to enable the introduction and ubiquity of immersive solutions. These solutions are what will provide the tools for organizations – IT departments and lines of business – to transform digitally and create new business outcomes that have traditionally not been associated with IT.

From a technology view, 5G brings up to 10 Gbps of capacity – approximately 10 times of what is possible with 4G networks today. New technologies such as network slicing allow a business to create virtual networks that map to its IT needs, with specific policies applying uniquely to each. This can include low latency, high throughput and other performance traits such as added security. 5G brings network efficiency by dramatically reducing the cost of a mobile network. Businesses can start to consider 5G as the primary network, not just as a backup (i.e., how it is used today with 4G). In other scenarios, business can consider the case for wireless environments and eliminating office wiring. Enhanced mobile broadband can eliminate bottlenecks in the last mile, which can still be problematic in remote areas. With latency reduced to sub-milliseconds, businesses can start to consider the nexus between cloud, mobile and enterprise applications. More features and functionality can be extended to the mobile fleet and frontline employees. The use cases for ultra-low latency apps can be vertical specific. This can include the financial services for high-frequency trading, as well as mining and energy companies rolling out autonomous fleets that are highly responsive to their environments.

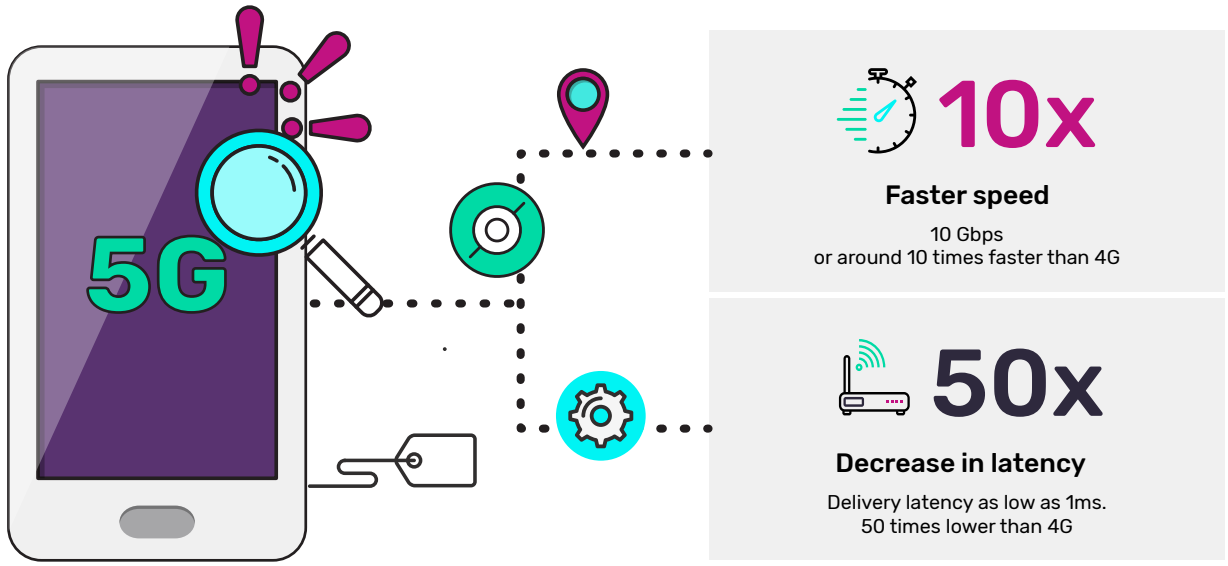
High-capacity solutions that are application-aware bring new possibilities in augmented and virtual reality (AR/VR) which can be transformative to the education sector through distance learning, to a real estate agent's ability to sell a house or in how remote assistance can be delivered through a contact center. In the latter, specialized engineers can help the frontline perform important tasks such as replacing a part working in parallel with Level 2 teams. Edge compute holds many possibilities for the Internet of Things (IoT) with data being processed and analyzed at both the core and edge locations. This opens up many additional use cases in location-based services, telemetry and preventative maintenance. In all instances, the user experience improves dramatically.

Industries in transformation are the likely first movers with the adoption of 5G solutions. Manufacturers, for example, are looking at ways to interconnect people, devices and objects, merging the physical and IT systems and using the latest technologies in robotics, AI and IoT to drive innovation. Healthcare providers are looking at 5G to enable patient monitoring and remote diagnosis through real-time imaging, as well as improving treatment capabilities in remote locations. Local governments are looking at ways IoT can improve operational efficiencies in a city, such as smart lighting and increased public safety through better surveillance. On a horizontal layer, facility managers, property owners and commercial developers are looking at smart and connected buildings to improve energy efficiency, user-centric designs, customization and visitor experience. The use of analytics can also improve health and safety as well as compliance.

This report discusses the opportunities and challenges for 5G in the enterprise. We consider the importance of the technology and what it can enable and highlight a few industry-specific uses cases. We contend that 5G is not just a technology, but a core component of what it will take for business to create IT environments that are virtualized, agile, software-defined and exceptionally responsive to user experiences. Modern IT environments need to balance the need for speed, flexibility and user experience with security and compliance. They will need a best-of-breed approach allowing the introduction of new technology over the lifecycle. Software and system integration will be important attributes to a successful 5G deployment.

Introduction

Why 5G?

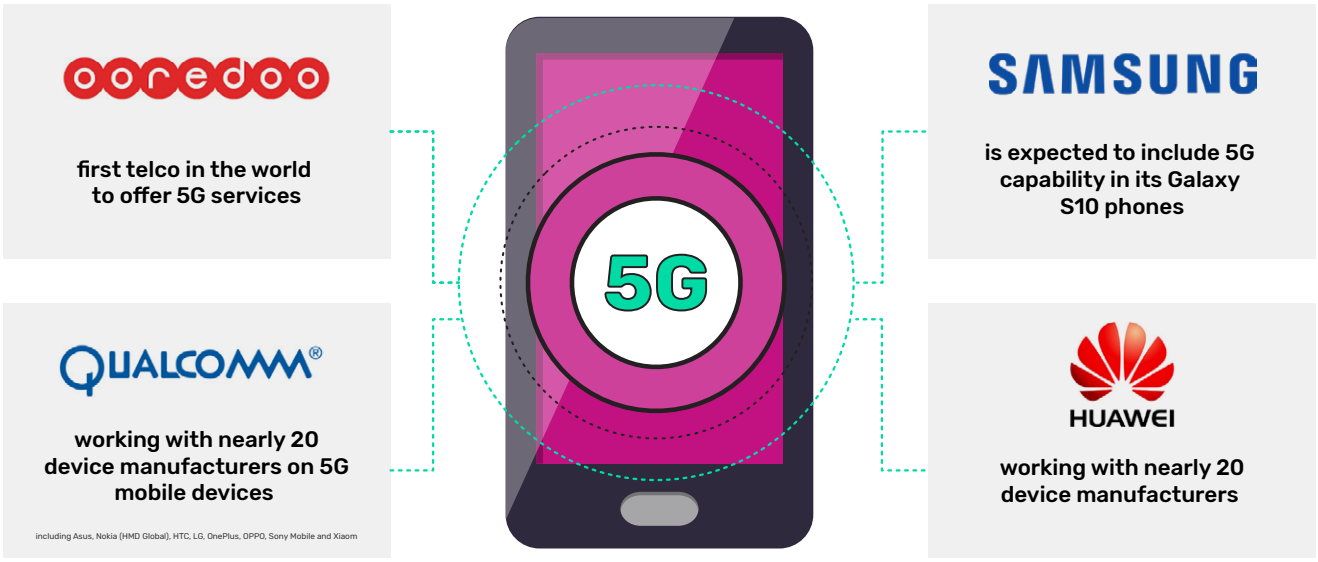


Since the first mobile communications network (1G) was launched 40 years ago, the technology has continuously evolved with new generations introduced about every 10 years. 2G has been available since 1991, replacing analogue with digital communications, while 3G came into the market 11 years after to offer a better mobile data experience. First launched in 2009, 4G – which is the most widely used mobile technology today – enables mobile apps and videos.

5G is now moving from the laboratory to the real world. The technology is not just about higher bandwidth and lower latency; it is also a wireless revolution that will enable robotics, automation, mixed reality and many more industry applications. 5G complements other emerging technologies such as AI/ML, robotics and IoT to further drive enterprise digital transformation both internally within an organization as well as externally in customer engagements.

5G's key technical attributes include faster speeds (10 Gbps, or around 10 times faster than 4G) and lower latency (1 ms, or around 50 times lower than 4G). 5G also comes alongside a number of emerging technologies such as network slicing, mobile edge computing, service-based architecture, SDN/NFV and cloud RAN to offer more agile and reliable infrastructure for addressing the new service requirements.

The 5G Era Has Begun



The 5G era has already begun. With a number of launches, demonstrations, trials and commitments from telcos, network vendors and device manufacturers globally, 5G has significantly evolved from hype to reality. Ooredoo Qatar took the lead by becoming the first telco in the world to offer 5G services in June 2018, a month after it launched the network. The momentum continued as a number of telcos in the Middle East, Europe, the US and South Korea launched their services later that year. However, current 5G services are only offered as home or mobile broadband and specialized enterprise services available to selected customers in limited markets, as 5G smartphones will only be available in 2019. These early 5G networks were launched mainly for the telcos' brand leadership rather than addressing the market needs. Most other telcos are already deploying the 5G network and trialing the technology, waiting for the spectrum to be ready and 5G smartphones to be widely available before offering their services commercially. The majority of commercial deployments are expected to be in the second half of 2019 and 2020.

On the device side, since Qualcomm unveiled its first 5G modem, Snapdragon X50, in 2016, the chipset manufacturer has announced several enhancements to its product. The company also announced that it is working with nearly 20 device manufacturers including Asus, Nokia (HMD Global), HTC, LG, OnePlus, OPPO, Sony Mobile and Xiaomi on 5G mobile devices, which are expected to be available later this year. Other chipset makers such as Intel, Huawei and Samsung have also been actively enhancing their products. Intel recently launched its 5G modem (XMM 8160), which will be available in the second half of this year. There are also a number of commitments from device manufacturers to launch 5G phones this year. Samsung is expected to include 5G capability in its Galaxy S10 phones, while OnePlus shared that it has been working on 5G phones since 2016 and indicated 5G support in the upcoming OnePlus 7 or 7T. Having launched 5G CPE in January, Huawei has confirmed its release of 5G foldable phones later this year. At the launch of the Mi MIX 3 in Beijing, the device manufacturer announced the availability of the 5G version in Q1 2019. The development of 5G appears to be on schedule. With the production of 5G hardware scaling up, the cost of the technology will fall, accelerating the development of enterprise solutions.

5G in Enterprise

'Digital transformation' has become a daily term in enterprises across different industries. Businesses are in various stages of implementing new technologies to develop new solutions, improve service delivery, increase operational efficiency, reduce cost, gain competitive advantage and meet rising customer expectation. 5G will soon make it into the list of technologies enterprise will consider for their roadmap.

Today's ICT solutions are not just about addressing the technical requirements such as capacity, SLAs, storage and compute power, but also enabling enterprises to achieve their business outcomes: for example, how cloud services can help enterprises to increase their employees' productivity, reduce operational cost, accelerate time-to-market and improve customers' satisfaction. As expectations around ICT solutions change from product features to business outcomes, lines of business (LoBs) are becoming more prominent in making an ICT decision. For example, in a smart office deployment, human resources and facility managers are often part of the decision as outcomes impact people, culture and physical building designs. A GlobalData study shows that a third of the 3,249 enterprises interviewed confirmed that the ICT spending from sales, marketing and customer relations has increased in 2018 compared to the previous year. The research also shows that the relative budgets are shifting out of IT to other LoB buying centers. Engaging more varied types of roles at enterprises in 5G discussion will be crucial for winning 5G enterprise contracts. 5G should not be viewed as a standalone solution. It will help to overcome the limitations of today's mobile technologies. Together with other areas such as cloud, IoT and mobile applications, 5G will enable new use cases.

Cloud

As businesses adopt new technologies as part of their digital transformation initiatives, cloud has become a foundation and is no longer optional for enterprises. While businesses move their existing workloads from on-premises to cloud, there are also a growing number of cloud-native platform providers' such as Salesforce and Pivotal available in the market. Webscale providers like AWS, Azure Google and Alibaba are also expanding their portfolio, offering wider ranges of cloud-based applications. According to a study by GlobalData, businesses can have up to 20 different cloud services in 2018. With wide bandwidth availability and enhanced security features via network slicing and edge computing, 5G will be a viable option for enterprise to connect to various clouds more cheaply than through MPLS and other fixed access technologies.

2

Mobility

At the same time, there are an increasing number of both internal and external users accessing cloud-based applications from mobile devices mainly through a public cellular network. The bandwidth needed for each application is growing due to richer application contents. While an enterprise mobility solution is able to manage devices and access, as well as providing some levels of protection, it is not enough to ensure end-to-end security and, more importantly, the user experience. The growing number of cloud-based applications accessed from mobile devices creates a gap that translates to a new requirement for businesses: secure, reliable and high-bandwidth wireless networks. 5G holds the answer to these business requirements of bridging cloud and mobility to enhance user experience and drive adoptions of applications such as AR/VR for meetings or field force.

3

IoT

The growth in IoT adoption is driving the total number of connected devices. According to a recent GlobalData study, about a third of 924 enterprises interviewed have more than 1,000 devices connected in their IoT deployments. Some IoT applications such as smart grid, smart building and location tracking that require large amount of sensors in a small area are reaching the maximum capabilities of existing wireless technologies. For example, most WiFi access points support only up to 250 devices. WiFi is also prone to interference from other networks and devices as it runs on unlicensed frequency bands. While 4G NB-IoT is designed to support large number of users, it has limitations on the bandwidth. These restrictions can be addressed by 5G features such as network slicing and service-based architecture where enterprise can dedicate different bandwidths across multiple services, while mMTC enables the network to support high-density IoT deployments.

4

Omnichannel

Today, many enterprises are already implementing an omnichannel strategy as part of their customer engagement initiatives to enhance customer and partner experience from awareness to the advocacy stage. While the traditional channels such as telephony and physical stores are still important, many enterprises are strengthening their mobile channel to address the rising demand from millennials. Most enterprises today have their own mobile applications that provide detailed information about products and services, buying experience and interactive customer support. Enterprises are also adopting new technologies such as AI for more efficient engagement and to gain a competitive edge.
Technologies such as AR and VR will further transform external engagement. For example, customers get to experience products remotely to help them in making purchasing decisions. The technologies will also enhance the technical resolution process by having the support team to experience the issues with mixed reality for more detailed information, accurate diagnosis and troubleshooting. However, AR/VR applications require bandwidth of at least 100 Mbps with latency less than 15 ms. This exceeds the limits of 4G and WiFi and requires 5G to ensure a seamless experience.

Use Cases

Enhancing the Network

Fiber Alternative – 5G offers fiber-like bandwidth and latency capabilities but with significantly shorter deployment time as there is no need to lay cables to the office/branch. With this advantage, 5G can be positioned as a comparable alternative to fiber for the enterprise data network, provisioned much faster and acting as the primary business-grade solution. It can also be used as a backup or hybrid to offer higher overall redundancy. 5G can even be used as primary connectivity for enterprises in their branch network, especially in cases where fiber deployment is challenging (e.g., rural areas). The technology can also enable enterprises to deploy an ad-hoc mobile branch for events or exhibitions within a short timeframe

SD-WAN Evolution – With the possibilities around 5G network slicing, there are other emerging areas for businesses, such as the ability to set bandwidth and throughput preferences as well as quality of services/class of service for a WAN through network slicing. This, alongside the ability to logically partition networks, creates new environments compared with what has been possible to date through any previous fixed or mobile-based capability. Networks can be purpose-built for the use case (e.g., ultra-low latency and security) to be more responsive to the application and IT environments they support. These networks can potentially work with existing SD-WAN solutions or overlay fixed networks.

Private Wireless Network – There are a growing number of enterprises deploying sensors and remote equipment in private wireless networks. These highly customized networks require a secure environment, high bandwidth and remote deployment. For example, mission-critical communications for public safety require a dedicated network to minimize cybersecurity threats; smart surveillance needs guaranteed high bandwidth for transmissions of HD videos; and mining requires coverage in remote and underground areas. These networks are usually provided by specialized players using standards such as 4G or TETRA. Going forward, 5G is expected to be the preferred option for enterprises for their private wireless network, especially to support future applications such as robotics and mixed reality. While a private 5G network may be more expensive than non-cellular standards (e.g., WiFi and TETRA), it offers superior advantages in capacity, latency, reliability and security. A number of mining companies, particularly in Western Australia, are actively considering 5G-based upgrades from private 4G networks to support use cases such as autonomous vehicles and equipment. Lower-latency solutions are more responsive. This can improve workplace health and safety by reducing the chances of an accident.

Manufacturing

Priorities	Challenges
Drive productivity	Competition
Increase efficiency	Shadow IT
Visibility in supply chain	Security

The industry priorities and challenges

Manufacturers are on the precipice of an industry-wide digital transformation, driven by the need to boost productivity, optimize operational efficiency and increase visibility across factory floor and supply chain operations. IT-OT (operational technology) integration, AI and agile infrastructure are the key components while 5G will be the heart of the transformation. The higher bandwidth, lower latency and mMTC offered by 5G will enable various new industrial applications such as robotics, big data analytics, IIoT and AR/VR in engineering and design, as well as new ways to provide remote support and training.

The role of 5G

One of the most discussed 5G applications in manufacturing is the use of AR and VR in remote support and training. The 'mixed reality' offers more efficient learning with virtual experience instead of lecture-based training. It also provides more accurate views and information for an issue in remote support. While not all equipment issues can be solved remotely with AR/VR, it is able to address the majority of common problems such as regular maintenance, remote repairs or minor component replacements. The sessions can also be saved for future reference if the same issue happens again.

5G addressing the priorities and challenges

Traditionally, equipment maintenance and troubleshooting are performed by the experts from manufacturers. The process could be costly and take many days due to the travels and logistics to bring in the equipment expert. The delay has significant impacts on production and hence the business. With AR/VR, the maintenance and troubleshooting tasks can be performed at any time. This could not only improve production efficiency, but also minimize business damage due to equipment malfunction and hence reduce operational cost.

5G vs. other technologies

Leading manufacturers such as Gabler are already deploying AR and VR technologies for equipment maintenance and training. HD AR/VR requires more than 100 Mbps for a smooth experience. While technically the required bandwidth can be addressed by fiber or WiFi, some remote sites/factories are not covered by fiber, while some issues can happen outside the corporate network (e.g., on the road). This is where 5G comes into the picture as the enabling technology for AR/VR in manufacturing.

Media

Priorities	Challenges
New business model	Reducing transmission costs
Meeting customer demand	Responding to threats from new players
Content distribution and user experience	Security and compliance

The industry priorities and challenges

Media is one of the industries heavily impacted by technology. The traditional media companies are transforming their business to compete with the new industry challengers such as OTT providers (e.g., Amazon, Apple, Facebook and Google) and virtual multichannel video programming distributors (MVPDs). The battle for content is also driving merger and acquisition in the industry. In 2018, AT&T completed its acquisition of Time Warner and Disney won the battle to acquire 21st Century Fox. Users' expectations are rapidly changing due to the advancement of device technologies. There is an increasing amount of content and live streaming accessed from mobile devices such as tablets and smartphones. 4K is becoming a common resolution for content and widely supported by media devices, while 8K TVs are beginning to enter the mass market.

The role of 5G

While 5G will increase mobile network capacity to ensure a smooth user experience, the driver for 5G in the media industry will not be from 4K or 8K content on smartphones. Technically, the human eye is not capable of noticing the difference between HD, 4K or any higher resolutions on smartphone screens. The main driver for 5G will be from new and immersive media experiences such as mobile gaming or, for example, AR/VR content and 360-degree videos from live events enabled by 5G-connected cameras and drones.

5G addressing the priorities and challenges

The new and immersive media experience will drive new revenue for content creators, broadcasters and event organizers. It will also offer a competitive advantage and set a new media trend in the mass market. For example, AT&T's plan to use 5G at AT&T Stadium will provide a new in-stadium experience where users have the opportunity to see a player's-eye view through VR or have 360-degree views of the event while not being in the stands. In-stadium experiences provide customers another reason to come to the game as opposed to staying at home and offer many in-app revenue opportunities.

5G vs. other technologies

AR/VR in media and gaming is not new. The content has been widely available since 2016. However, it is mainly designed to be accessed from fixed devices such as a Sony PlayStation or locally through download, not for mobile devices due to the high bandwidth requirements. While 4G networks can theoretically provide sufficient bandwidth for these applications, the network is often highly utilized by other users. Similarly, WiFi also has high theoretical peak speed, but the network runs on unlicensed frequency bands and is prone to interference. HD 360 videos for high-speed sports such as Formula 1, which require multiple wireless cameras to transmit real-time videos simultaneously, need very high bandwidth that can only be addressed by 5G.

Smart City

Priorities	Challenges
Increase operational efficiency	Deployment cost
Increase user experience	Technology readiness
Gain competitive edge	Security

The industry priorities and challenges

The advancements in digital technologies and sensors are driving cities to be more connected and smarter. While 'smart city' has a broad definition, the current deployments have been driven by local city councils and governments around traffic management systems, smart lighting, waste management, environmental monitoring and public transportation. These applications enable the government to minimize operational cost and increase user (citizen) experience and public safety.

Developers and building managers are also implementing smart building and smart parking to increase efficiency and minimize operational cost (energy bills) as well as to gain competitive edge in, for example, attracting property buyers, tenants and visitors. However, challenges such as deployment cost and technology availability (e.g., the capabilities of network to offer coverage and capacity) slow down smart city adoption.

The role of 5G

5G will enhance existing smart city applications, enable new use cases and accelerate deployments. The high bandwidth of 5G will accelerate remote surveillance deployments, as the cameras can be connected wirelessly instead of having to lay cables, which can be costly and take weeks while drones can be deployed instantly. The low latency and mMTC enable V2X and autonomous cars, while the network slicing feature logically separates the network from commercial traffic to provide a secure environment in a private wireless network.

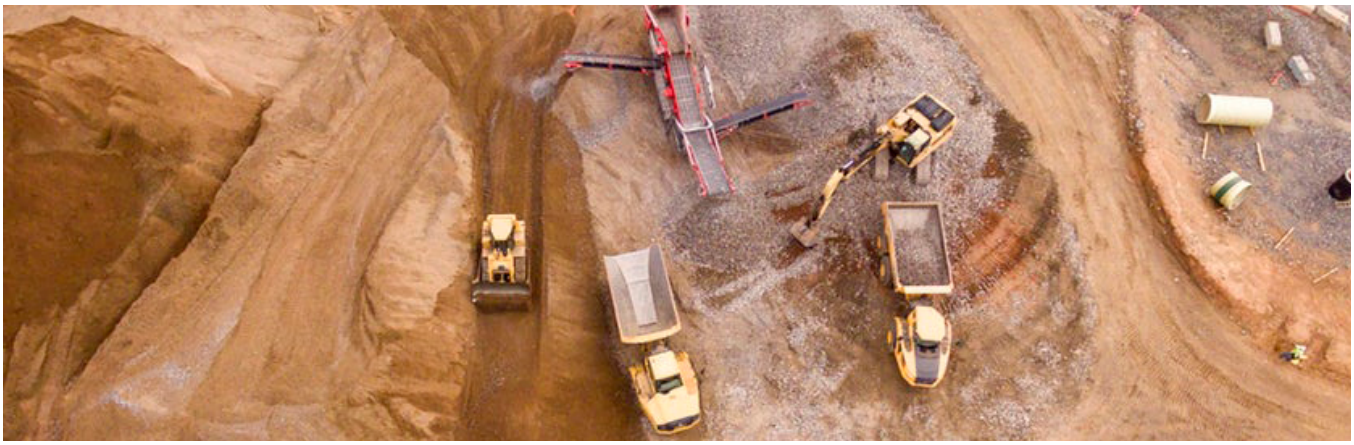
5G addressing the priorities and challenges

The shorter deployment time for surveillance translates to bigger cost savings in the hardware (cables and optical termination points), manpower and installation work (duct and cable installation) needed to lay cables. The V2X also helps the government to increase road safety with applications like real-time warning, platooning and collision warning, as well as enabling new sources of revenue such as advertising through V2X communications.

5G vs. other technologies

5G is not the only available V2X standard. C-V2X is natively defined in 5G, while IEEE 802.11p-based dedicated short range communications (DSRC) technology has long been used in the industry. While there is an ongoing debate concerning the two technologies, there has been growing momentum for C-V2X. Chipset manufacturers have committed to include C-V2X support in their future products, while network vendors and a number of vehicle manufacturers such as Audi, Ford and Ducati are developing and trialing C-V2X based systems. The mMTC and network slicing features make 5G an even better option compared to its predecessor to support thousands of vehicles and devices in a dedicated network.

Mining



Priorities	Challenges
Improve operational efficiency	Cost
Increase health and safety	Environmental impact
Improve access to capital	Volatile commodity price

The industry priorities and challenges

With a large amount of vehicles and equipment as well as operational safety challenges, the mining industry is transforming by adopting emerging technologies such as remote-controlled vehicles/trucks, equipment (e.g., drill rigs) and drones to increase operational safety and productivity. This will also enable mining companies to optimize cost, which is crucial in addressing the volatile commodity price.

The role of 5G

While the majority of mine sites are still using WiFi networks, many are adopting private 4G and considering 5G as an alternative due to the benefits of the cellular technologies over WiFi. 5G mMTC enables a large number of sensors to be connected, while URLLC provides true real-time information for remote operation of mining equipment such as trucks, drones and drilling machines. The higher bandwidth also enables AR/VR to provide equipment operators a better view to handle their trucks or machines remotely. While some early 5G deployments will use millimeter wave (over 24 GHz), 5G is also designed to run at lower frequency than WiFi (2.4 GHz and 5.8 GHz). Operating at lower frequency translates to stronger penetration capabilities to provide better underground coverage. Time division duplex (TDD) in 4G and 5G also offers asymmetrical bandwidth, which addresses the network requirements for mining, as the majority of traffic is uplink, from devices to the base stations/access points.

5G addressing the priorities and challenges

Having connected vehicles and machines equipped with HD cameras and AR/VR to assess a new underground area could minimize the need for real humans to be in high-risk areas, hence increasing operational safety. Deploying connected sensors also enables a mining company to collect a wider range of operational information, driving better decisions in process automation maintenance and hence increasing operational efficiency.

5G vs. other technologies

4G and WiFi have limited capabilities for some advanced applications, especially in high-bandwidth applications like AR/VR or with remote-control equipment that requires low-latency networks and high-density sensors. 5G is needed for these applications to ensure successful operations. The edge computing and ultra-reliable low-latency communication (URLLC) are important to ensure lag-free communications for remotely controlled vehicles, drones and drill rigs, while mMTC enables large numbers of sensors to be deployed to gain more environmental information. 5G will also enable live HD video or mixed reality streaming to assess difficult-to-reach areas (e.g., covered with hard rocks) from drones instead of putting human workers in hazardous environments.

Healthcare

Priorities	Challenges
Meet patient requirements	Rising cost
Increase operational efficiency	Regulatory
Increase revenue/market share	New technologies

The industry priorities and challenges

Like other industries, healthcare is also undergoing technology transformation. The dynamics of the three P's – healthcare providers, patients and payers (or the insurance companies) – is changing the industry landscape and driving healthcare providers to transform, especially in these four areas:

- Growing the margin with competitive advantage through innovations and enhanced operational efficiency;
- Meeting changing patient needs such as remote healthcare and digital engagement, as well as patient experience in the hospital facility;
- Getting the infrastructure ready to be more agile for electronics health records (EHR), external access and integration between platforms, while ensuring maximum protection from cybersecurity threats;
- Shifting from fee-for-service to value-based payment, which will change various processes such as the payment model, physician participants and patient engagement, in addition to improving the outcomes.

Various technologies are required by the healthcare providers to address these trends, but 5G will be the key enabler, especially in real-time EHR and remote healthcare.

The role of 5G

5G will enable AR/VR and 3D video for an immersive experience in remote diagnosis, thus providing doctors with better input to analyze patients. Apart from remote diagnosis, 5G will also enhance robotic tele-surgery. While it may sound too advanced, robotic tele-surgery developed by da Vinci Surgical System has been available since 2001, with the first operation done over an asynchronous transfer mode (ATM) network in the same year. With 5G, the application can be further enhanced: for example, to provide the surgeon more accurate depth perception and haptic feedback, which is very sensitive to time delay. 5G will also enable real-time and more efficient patient database management.

5G addressing the priorities and challenges

Telemedicine (remote diagnosis and robotic tele-surgery) enhances the patient experience, especially those in remote locations, as they are no longer required to travel and see the doctor physically to get consultation or treatment. The new 5G-enabled immersive experience in telemedicine also provides doctors with more detailed information for more accurate diagnosis/procedures. Real-time EHR management benefits patients, as patients can get faster treatment/ diagnosis based on the performed medical scans (CT, MRI, X-Ray) instead of waiting hours for the results to be delivered to doctors for analysis.

5G vs. other technologies

The mixed reality in remote telemedicine requires high bandwidth and low latency for information to be delivered accurately to doctors/medical staffs; for example, haptic feedbacks require latency of less than 5 ms. While this requirement can be addressed by fixed-line technology such as fiber, 5G is the only wireless technology that can offer similar capabilities. This is important for remote areas where fiber is not available. Patient databases which include medical images are usually very large and in gigabytes of size. Transmissions of such large sets of data for real-time applications require technologies like 5G to minimize delay.

Key Challenges

Technology Readiness

The 5G standard was only finalized in 2018. While most network vendors such as Ericsson, Nokia and Huawei already have their solutions ready, deployment is still limited. Major device manufacturers will only include 5G support in 2019. The network coverage will also be limited as carriers usually expand the coverage of new technology in stages and take two to three years to cover nationwide. Further complicating this is the fact that 5G uses a wide variety of spectrum bands, including mmWave, which includes spectrum over 24 GHz. This high frequency, which enables large bandwidth, has a very short range; as such, 5G networks will require a dense array of network sites using small cells. Securing the actual real estate needed to support this will be a challenge and it is already the source of some controversy, as the FCC in the United States made a critical decision in September 2018 mandating that cities and towns must approve or deny 5G cell site applications within 90 days, a departure from 4G, where local governments had more autonomy and authority. The limited coverage will restrict the implementation area and hence affect the overall business outcome. For example, HD surveillance installed on corporate vehicles will not work when the vehicle goes outside of 5G coverage areas. The integration with existing corporate networks may also be challenging, as service providers have limited or no deployment references. There are many more applications that are still in development, such as advanced robotics with human interactions and cognitive perception in tourism. There are also more applications yet to be discovered, as the technology is still not widely available in the market, especially to startups and developers, who are known for developing innovative applications leveraging new technologies.

Business Case and TCO/ROI

Whenever a new game-changing technology is introduced, it is not well understood and the impact is underestimated. The majority of 5G vertical use cases are still in the conceptual and developmental stage. These use cases are mainly driven by the network vendors and service providers to drive deployments and adoptions. While 5G will enable various industry applications, the real value to the end users remains unclear. For example, how much can a manufacturing company save with remote maintenance and training through AR/VR? How reliable is the technology to replace the existing process? Most service providers are also unable to guarantee measurable results, as there are very limited or no deployment references. This could also lead to longer implementation time and hence failure to achieve business outcomes within the required time. The cost of 5G devices and hardware is also expected to be high in the early deployments due to the low demand and scale, driving the overall TCO.

Professional Services

5G is not just a wireless network technology, but a key enabler for various vertical-specific solutions. 5G applications need to be developed and tailored for an industry or even for an enterprise's needs. Professional services play a very important role in ensuring successful implementation of 5G for enterprises. Business needs and challenges vary across verticals and geographical areas. Service providers need to understand the main concerns and objectives of enterprises as well as the local regulation. For example, security and data sovereignty are vitally important for banks, but not as much for manufacturing. As network and IT are converging, integration will be important as well. For example, the 5G-enabled AR/VR applications in manufacturing need to integrate with the other existing systems. Service management is equally important, especially in ensuring business outcomes. While the telcos are the main drivers for 5G today, not all of them are equipped with professional services capabilities. Partnering with 5G providers with a strong consultative approach and service capabilities will mean a better chance for successful deployments.

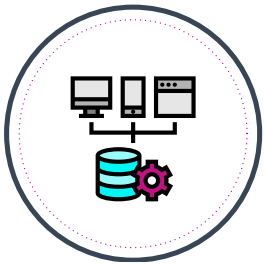
Security

Apart from the business case, security is another challenge that always appears as the top business concern in new technologies. 3GPP has defined 5G security standards, especially for the physical layer in identity management, such as USIM and Authentication and Key Agreement (AKA). As 5G will also enable various industry applications, the standardization body has also enhanced 5G security with Security Assurance Methodology (SECAM), adding assurance-based protection on top of the functional ones. However, the standard security may not be enough. The new benefits of 5G (e.g., service-based, agile) come with a cost. The open, flexible and programmable nature of SDN/NFV exposes 5G networks to bigger threats. The support for larger numbers of devices, especially in IoT deployment, and higher data rates also increases the probability of unauthorized access and threats like bots and DDoS. While high-end devices have additional protection embedded on the chipsets and sufficient compute power to run security applications (e.g., Qualcomm, Samsung, Huawei), the use of low-end devices with limited security and compute capabilities is expected to dominate IoT deployment due to cost. Integrating 5G applications with managed security services is also important to ensure end-to-end protection.

Recommendations for Enterprise

Solution Co-Creation

Most 5G applications are industry-specific that link closely to business outcomes and require professional services. Business priorities and challenges vary across industries and can be unique for some enterprises. Businesses should look for providers that have strong capabilities in professional services to help them throughout the deployment: from business case, solution development, implementation and service management to achieving business outcomes. Businesses should see their providers as partners to co-develop solutions and even in their go-to-market initiatives, instead of the traditional customer-supplier relationship. This is important to ensure successful deployments as well as to unlock new innovations.



Platforms to Manage Complexities Across Network Technologies

5G will be a key part of enterprises' networks. It is not just a cellular technology accessed from employees' mobile devices, but is also used as the underlying corporate network (such as SD-WAN and mobile branch) and as an enabler for new applications (e.g., AR/VR, omnichannel). The network management across different underlying technologies (e.g., IP VPN, Ethernet, 5G, broadband) will get more complicated. Businesses should look for an advanced network management platform with AI capabilities to ensure optimum reliability with minimum downtime and efficient use of resources across different network technologies.

First-Mover Advantage

Businesses should also use the 5G benefits to gain the first-mover advantage and an edge against competitors. Apart from the internal benefits such as enhanced internal operational efficiency and cost savings, businesses can also use 5G to enhance their customer engagement via applications such as AR/VR. As 5G is also available to the mass market, businesses can also leverage 5G to offer new applications such as mixed reality on mobile devices. This will provide marketing and brand advantage as well as attract new customers, especially the millennials and IT-savvy users.

Cross-Industry Collaboration

5G will enable various vertical applications across different industries. Businesses should look beyond their vertical and explore cross-industry collaborations. An example would be a reward-based medical insurance using activity tracking data and health conditions that requires collaboration between insurance and healthcare providers. While such an initiative already exists today, the data gathered by the insurance provider is limited to only fitness data obtained from wearables (e.g., number of daily steps). Collaboration between healthcare and insurance providers is needed for the deeper insights of health data such as body mass index and blood pressure to enable more accurate assessments and higher rewards. The collaboration can also minimize fraudulent insurance claims. These cross-industry collaborations are usually driven by the government, regulators and large service providers.

Providers Beyond Telcos

It is important for businesses to look for 5G providers beyond the traditional telcos. Traditionally, cellular network services are usually offered by carriers. While cellular network wholesale (e.g., MVNO, RAN sharing and domestic roaming) is not new, it has several limitations, especially in providing guaranteed bandwidth and security. Unlike other cellular technologies, 5G was developed with native supports for SDN/NFV, API and network slicing to enable service-based architecture. This will change the ecosystem value chain of 5G, as other non-telco providers are now able to lease a portion of telcos' 5G networks, integrate the capacity with their existing offerings and offer 5G-based services to enterprises.

About Infosys

Solution Co-Creation

Infosys believes that enterprises will drive 5G adoption and monetization and it will help them imagine new economies. Secure, low-latency and high-bandwidth connectivity is essential to transform their enterprise and get closer to their customers. 5G has the potential to further accelerate their digital transformation journey.

Infosys has developed technology tools and accelerators that can fast-track the 5G adoption journey for enterprises and communications service providers (CSP). These offerings will help enterprises imagine and create new economies with 5G technology, while simultaneously helping communication service providers accelerate and monetize their 5G network deployment.

Infosys Differentiation

- Infosys has expertise and a proven legacy of working across industry verticals and is a trusted partner for enterprise digital transformation in building IoT use cases powered by next-gen networks.
- Infosys, through its legacy of collaborating and partnering with network OEMs, CSPs and networking forums, has developed a reference architecture for edge and access networks.
- It provides offerings in areas of service orchestrator design and integration, helping speed up transformation by allowing customers to focus on business requirements.
- Infosys is committed to open source and white box solutions along with industry-leading players.
- It supports clients across industries to define, develop and integrate service offerings as an ecosystem integrator for 5G offerings.
- It has made an extensive investment in cloud, virtualization, AI/ML and DevSecOps and has deep experience in planning, design, assurance and operations.

How Infosys is enabling enterprises in this journey?

Infosys provides a unique proposition of enterprise domain expertise combined with technology capability in IT and network to bring use cases to life. Infosys accelerates enterprise adoption through the following ways:

- Enabling 'Private 5G in a Box': Providing an integrated cloud and open RAN-based 5G private network for enterprises flexible for any RAN hardware, Infosys partners with cloud mobility vendors and integrates with assurance and automation layers to provide a fully integrated solution.
- Building Vertically Integrated Use Cases: Infosys, with its rich enterprise knowledge, helps build industry-specific use cases (telemedicine, remote robotics, IoT) and also integrates with the network layer using intelligent software layers to provide best-in-class results. Infosys integration layers provide sufficient orchestration to make sure applications get the right network assurance from the 5G network slices.
- Infosys 5G Living Labs: An innovation hub for partners and clients, Infosys' globally distributed 5G Living Labs have been set up to address the following:
  - Defining business use cases and ROI
  - Co-creating and innovating solutions and use cases
  - Creating proofs of concept (PoCs) using its solution and accelerators along with technology providers and partners
  - Testing and validating the solutions
  - Act as a showcase ground for Infosys, partners and customers
- Accelerating the 5G Deployment and Operations: Infosys works with partners in developing, planning and monitoring solutions for 5G RF deployment, which optimizes the RF planning and monitoring effort, thereby reducing cycle times.

Infosys Use cases

Examples of use cases where Infosys has delivered value to clients:

- Industrial Manufacturing
  Predictive Maintenance of Critical and High-Value Assets: 5G-connected sensors can stream real-time information about assets' operating parameters that can be processed with machine learning algorithms at the edge supported by the network layer.

- Sports & Media
  Next-Gen Sporting Entertainment Experience: Infosys, as the Official Digital Innovation Partner of the Australian Open, will leverage its expertise in emerging technologies like big data and analytics, artificial intelligence as well as virtual and augmented reality, to provide unique, innovative and engaging experiences for fans. **Extended Stadium:** In 2019, at Melbourne Park, Infosys powered a live broadcast of Australian Open matches in virtual reality, a first-of-its-kind experience for tennis fans anywhere in the world.

- Logistics & Supply Chain
  Real-Time Shipment Rerouting: Transportation-related solutions will benefit significantly with 5G capability. Goods transported using 5G-enabled trucks that can transmit their locations, traffic patterns and local weather conditions will allow the logistics team to make real-time decisions on rerouting shipments and avoiding delays.

- Smart Communities/Campuses/Universities
  Providing Real-Time Response to Security Incidents: With a highly mobile population, ensuring the security of occupants of smart communities, campuses and universities is a critical and challenging requirement. Security solutions in the smart communities will leverage video analytics at the edge, resulting in real-time response and incident avoidance.

GlobalData

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