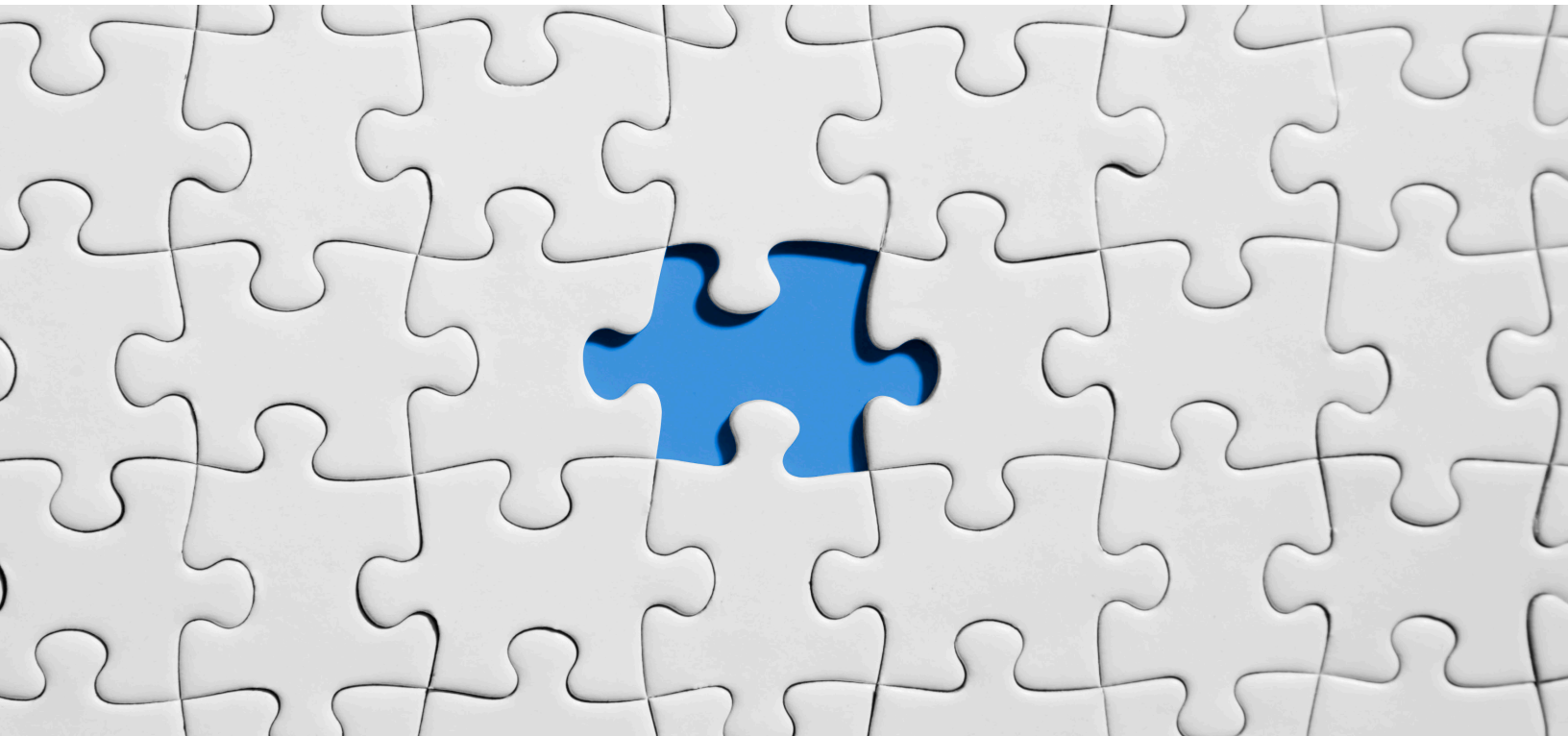


IMPACT OF 5G AND DIGITAL TRANSFORMATION ON STORAGE



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Abstract

The arrival of 5G is expected to bring a dramatic increase in speeds, low latencies, and an unforeseen level of network capabilities. This will set the stage for even more advanced and novel applications enabling everything to be more connected, in real-time, all the time.

5G is set to revolutionize the network and communications industry by providing ultra-fast transmission rates; as much as 100 times faster than existing 4G or previous networks. Today we are generating a massive amount of data, and to process effectively, there is a need to leverage a big data set that can make these data actionable.

This article will focus on how from the data center to the edge, 5G and high-speed flash storage are enabling emerging Internet of Things (IoT) use cases from CDNs, connected and autonomous vehicles, Industry 4.0, video surveillance, cloud-based gaming, and telemedicine. 5G use cases that will be affected, and the role of storage in making them happen will also be discussed.

Many industries will benefit from what 5G has to offer. From healthcare and automotive to smart homes and smart cities, the capabilities of 5G can alter the entire landscape, enabling several applications that 4G just couldn't handle.

With the increase in potential industries, both tech and non-tech, there will be greater need for cloud services. Wearable devices, for instance, that lack enough internal storage typically rely on synced larger devices like smartphones. These devices will be able to function independently using the cloud through 5G's low to zero latency.

We will also look into how 5G will drive cloud computing to the next level and how with 5G technology, cloud computing will eventually be able to fully capitalize on augmented reality (AR) through the highly anticipated AR Cloud that will completely change our interaction with the physical world and create a new immersive scenario. Moreover, 5G holds the promise of reducing bandwidth wastelands and freeing businesses to leverage the cloud. Also, another aspect is how 5G technology can affect the economic growth. When 5G's full economic benefit is realized across the globe, a broad range of industries – from retail to education, transportation to entertainment, and everything in between – could produce trillions of dollar's worth of goods and services enabled by 5G technology.

5G will be an enabler of digital transformation and have a significant impact on where data is stored and processed. The impact on storage will be seen primarily in the overall compute and software architecture needed to serve these use cases, and it appears that today's storage technologies will stand up well to the challenges ahead.

Introduction

Fifth-generation (5G) technology is expected to bring a dramatic increase in speeds, low latencies, and an unforeseen level of network capabilities. This will set the stage for even more advanced and novel applications enabling everything to be more connected, in real time, all the time.

At the heart of what it means to be human is the way we interact with one another. We have built a mobile environment as we have evolved, and now, more than ever, mobile communication really feeds human needs. And as more and more information is provided, the capacity to connect and communicate is also enriched. 5G has three essential promises that power communication: fast speeds of broadband, near zero latency, and high density of devices. First, we'll take you through the development of wireless networks.

In the 80s, 1G began the dawn of communication via data transmission. 1G was a radio network capable of transmitting our voices through analog radio waves. It was big, like a phone, sometimes a big backpack.

We had 2G, pioneering digital communication from analog radio waves about 10 years later. It was the 1990s that brought worldwide cell phone ownership and, most importantly, the birth of texting.

We welcomed 3G over the next 10 years, and introduced mobile broadband. Users were able to access data from nearly anywhere in the world in the 2000s, increasing data transfer capabilities leading to services such as video conferencing, aka Skype. This led to the launch of the first iPhone in 2007, a major technological advancement we're all pretty familiar with.

Now, we have achieved what we have and are using today, 4G. What largely distinguishes 4G is its speed, which is almost 5 times faster than the previous network. In turn, 4G networks have provided businesses and individual consumers the ability to remain linked in a less restrictive way. The way we use mobile internet really changed its introduction, from streaming HD videos to online gaming, 4G effectively turned our smartphones into modern age computers.

Now this is where things get really interesting, joining the mobile network of the fifth generation. Any progress we've seen over the past four decades has been a pioneer for a new form of network. By 2035, a network with maximum economic advantage is projected to hit \$12 trillion as 5G transforms mobile technology from connecting people to people to connecting people to all.

This article provides a brief overview of how modern businesses and technologies are or will be able to leverage 5G to transform user experience like never before. We take you through some of the most indulging topics such as digital transformation with 5G, various 5G industrial use-cases, taking 5G to the cloud and finally, the impact of 5G on the economy.

Digital Transformation with 5G



Figure 1

Enterprises are embarking on their turnkey initiatives of digital transformation that improve customer experience, deliver massive operational productivity and generate new revenue streams. These programs are driven by a tectonic technological transition that began with SMAC (Social, Mobility, Analytics and Cloud) to DARQ (Distributed Leader Technology (DLT), Artificial Intelligence (AI), Extended Reality (XR) and Quantum Computing in the modern era.

Today, with next generation wireless technology for digital cellular networks, i.e. 5G, will bring 10x speed with 50x lower latency, massive Internet of Things (IoT) for Machine-to-Machine (M2M) connectivity and network edge compute to facilitate hyper localization. Wireless networks have evolved over generations. As technology continues to evolve, 5G is the first digital native standard that takes internet data speed and low network latencies to a completely new level. Built and enabled by digital technologies including cloud virtualization (SDN and NFV), network slicing, mobile edge computing and service-based architecture, it will enrich business use cases for digital transformation. Key functional attributes of a 5G network are Enhanced Mobile Broadband (eMBB), Massive Machine Type Communications (mMTC), Ultra-reliable and low latency (URLLC) communications and Mobile Edge Computing (MEC).

While these business use cases and technology drivers will empower the digital transformation in Med-tech and Healthcare, challenges will surface during the change. Here are certain challenges and possible solutions that will streamline the process: –

5G technology has had an impact on the digital transformation of enterprises across different verticals, notably Medical and Healthcare technology (Med-tech), and Communication Service Providers (CSPs).

In regard to 5G for Digital Transformation in MedTech and Healthcare, some of the market cases and main technology drivers such as NextGen Med-Tech devices, Telemedicine and Remote Surgery can enable the industry to concentrate on live data, remote diagnosis and treatment, provide emergency response and dramatically boost safe remote interventions.

While these business use cases and key technology drivers will empower digital transformation of Med-tech and Healthcare, key challenges that will emerge during the transition. Here are some of the challenges and potential solutions that will streamline the operation.

Challenges	Solutions
Meeting Medical-Grade Security Standards	End to End Data Encryption
Probability of Medical errors/Medical diagnosis if improper processing or data loss	Stringent Security Assurance Methodology FDA, HIPAA, ISO13485
Penetration varies widely from urban to rural settings	Carriers plan to deploy “small cells”, which are cellular antennas the size of a backpack
Cost factors could be challenging due to demographic location, technology penetration, and infrastructure required	Cost can be reduced by using network sharing

The medical technology industry has compelling use cases with significant impact on patient outcomes. They have started investing in these transformations programs and have set up dedicated R&D teams in a Med-tech start-up to expedite the study of product viability.

In regard to 5G for Digital Transformation for Communication Service Providers (CSPs), market cases and key technology drivers include Industry Vertical Alliances, IoT App, B2B FWA/Private Business Networks and Three Way/Four Way/Smart Home Services, all of which will enable native CSPs and other leading CSPs to collaborate with industry leaders in putting forward their revolutionary business models, provide scalable SaaS IoT platform for business to register, manage and build data analytics on their IoT devices, and provide TV, Broadband Internet, Smart Home and cellular services with an all-in-one customer connection.

While digital transformation in CSPs will empower these business use-cases and key technology drivers, there will be key challenges that will emerge during the transition. Here are some problems and solutions that will streamline the operation.

Challenges	Solutions
Service Management of these new services	Partnering with digital technology providers with a strong consultative approach and service capabilities to ensure a better chance for successful deployments
Enable billions-odd IoT devices with and without SIM	Build strong security authentication mechanism which cuts across various types of devices
Significant cost involved to set up new networks with no accurate clarity on revenues or return on investments	Cost can be reduced by using network sharing through network virtualization

To ride the 5G wave, CSPs will undergo major changes in their business models and IT infrastructure. The key is to develop strategic business relationships to build, configure and service these new services for industry vertical offerings and for digital tech providers. Large upfront costs will also be involved; however, early adopters and first movers will have the advantage to capture cash-rich markets.

With 5G bringing a revolution across various industries, companies should invest in early 5G prototypes that will be network ready. Companies often wait for competitors to succeed/fail before investing in and adapting new technology. They should, however, identify their digital tech partner to begin building their early proof of concept (PoC)/prototypes in order to become the market leader. The lines between industry verticals are blurring, given the amount of digital tech disruption along with 5G adaptation. Therefore, when defining business use cases, look at how the business can grow in the ecosystem.

5G Use Cases

The theoretical performance improvements of 5G suggest possible network latency of one millisecond, at speeds from 1Gbs to 10Gbps. That’s a 10-100x improvement over 4G and LTE (4.5G).

So, the next big question is: What does that unlock?

The most popular 5G use cases to discuss are topics like IoT and AI/ML initiatives, and those are exciting advancements.



Figure 2

Surveillance Cameras

An increasingly common storage use case is the surveillance camera. Surveillance footage is only as valuable as it is usable, which requires:

1. Better resolution to be able to recognize enough detail to be useful
2. Better connectivity to get it to where it needs to be for human or machine evaluation
3. Scalable and low-cost storage to keep it for both immediate analyses, and for long-term archives

Fixed Wireless Access

Fixed wireless access can enable homes and small businesses to enjoy media-rich applications with low latency, using 5G wireless home broadband. With 5G comes fixed-grade services, so mobile operators can compete head-to-head with fixed broadband services, and converged operators have a new tool for connecting homes at gigabit speeds.

Mobile service providers can use 5G to deepen their customer relationships and extend into the home and workplace:

- 5G enables home broadband fast enough for gaming and high-definition video streaming
- 5G can also connect small and medium sized businesses, giving them guaranteed reliability for their business-critical applications

5G IoT Applications in Industrial Automation

The key benefits of 5G in the industrial automation space are wireless flexibility, reduced costs and the viability of applications that are not possible with current wireless technology. Today these applications require cables, as Wi-Fi does not provide the range, mobility and quality of service (QoS) required for industrial control, and the latency of today's cellular technology is too high. With 5G, industrial automation applications can cut the cord and go fully wireless, enabling more efficient smart factories.

eHealth

As the foundation of a modern healthcare service, 5G can help to save lives. High-resolution video consultations, assistance robots and smart wearables all help increase efficiency and effectiveness of treatments. Of everything we are and everything we have, our health is the most valuable. Using connected healthcare technologies, it is possible for doctors to help more patients, with more targeted care, and more timely interventions. As video consultations, hospital robotics, and smart wearables become increasingly popular, 5G will be vital. Of course, with more clarity of videos, robotics and more data generated, there will be a need for the storage to be transformed in such a way so as to accommodate this surge of 5G advancements.

Cloud Robotics and Automation

Using the edge cloud, robots can be controlled and re-programmed to assist everywhere from hospitals to factories. Now that the processing is outside the robots, they can be less complex.

Robots will develop greater autonomy as time-sensitive networking in 5G connects them to intelligence in the edge cloud. This will open more opportunity for them to undertake hazardous and repetitive tasks. Sensors can gather data to create 'digital twins', used to optimize every process.

Here are some ways that Artificial intelligence will play a key role:

- By offering highly reliable and low-latency networks, service providers can enable the robots of tomorrow.
- On production lines, robots can undertake multiple tasks with remote reconfiguration of the Programmable Logic Controllers (PLCs).
- In industrial processes, automation systems can help with quality control, using vision processing and machine learning in the cloud.

Taking 5G to the cloud

The world is now heading towards 5G network connection, which is set to revolutionize the network and communications industry by providing ultra-fast transmission rates. This can be as much as 100 times faster than the existing 4G or previous networks. Today we are generating a massive amount of data and processing these effectively requires a big data set that can make these data actionable. This is where Cloud Computing comes in, delivering a large data storage option to businesses.

However, this large storage service needs faster connectivity as the amount of data is continuously growing. 5G is expected to usher in vast changes to cloud services. Since mobile devices are rapidly replacing desktop computers in the user's preference thanks to their accessibility and technological

advancements, the cloud will have a great responsibility in the transmission of data at higher speeds; 5G will be its main ally.



Figure 3

The 5G Impact

Having high frequency and bandwidth, 5G has the potential to enable smartphones to transmit and receive information 10 times faster than the current speed with 4G. This faster bandwidth will also transform the use of other technologies alongside cloud computing. Some tech experts are calling for 5G to light edge computing on fire and take share away from the public clouds.

When it comes to the real world, many industries will benefit from what 5G has to offer. From healthcare and automotive to smart homes and smart cities, the capabilities of 5G can alter the entire landscape, enabling several applications that 4G just couldn't handle.

With the increase in potential industries, both tech and non-tech, there will be an greater need for cloud services. Wearable devices, for instance, that lack enough internal storage, typically rely on synced larger devices such as smartphones. These devices will be able to function independently by using the cloud through 5G's low to zero latency.

Cloud Computing Influenced by 5G

According to reports, the speed of 5G will be comparable to LAN speeds. This will significantly benefit client-server architectures such as cloud computing. Indeed, it is also said that 5G frequency will be

higher than the LAN. if this becomes reality, the world will have much more advanced and sophisticated mobile applications.

With 5G technology, cloud computing will eventually be able to fully capitalize on augmented reality (AR) through the highly anticipated AR Cloud that will completely change our interaction with the physical world and create a new immersive scenario. Moreover, 5G holds the promise of reducing bandwidth wastelands and freeing businesses to leverage the cloud.

Thus, with the widespread rollout of 5G technology, more mobile cloud applications across industries will be widely adopted. And as everyday mobile apps become more reliant on cloud computing, they will improve with the given availability of 5G's low latency capabilities.

5G Economic Impact



Figure 4

The march toward 5G continues what has been a natural progression of cellular technology innovation dating back to the early 1980s. But the economic impact that comes with the promise of 5G is what makes this evolution most significant.

We are just over a year into actual 5G deployments and so far these networks have made substantial progress. Some operators even claim “nationwide” 5G coverage, which is impressive unless you look at just what “nationwide” means and how wide a country really is.

According to reports, more than 17.7 million 5G connections were established at the end of 2020, including a 329% surge during the final three months of 2019. It is predicted that 91 million 5G connections will be made by the end of 2021. 5G ecosystem is already swimming in financial might.

While past technology evolutions primarily targeted the consumer market, the spend and return on 5G has a larger focus on the broader enterprise space. This includes connecting not just traditional enterprise workers and their respective mobile devices but connecting all electronic devices. This will involve a broader push toward edge deployments that can serve what are expected to be billions of connected and IoT devices.

With greater reliability and data speeds that will surpass those of 4G networks, a combination of 5G and local edge compute will pave the way for new business value.

It is reported that 5G IoT connections will surge from \$525 million in operator-billed revenues this year to \$8 billion in 2024. Also, automotive and smart cities sectors would be the key growth drivers for 5G adoption over the next 5 years.

This opportunity will also be a boon for vendors that will supply most of the hardware for these deployments, though the real benefit will be for those that can also adapt those platforms to take advantage of true 5G capabilities.

The implications for solution providers such as Ericsson, Huawei, Nokia, and ZTE are that they must enhance their 'value add' by complementing their deep technical expertise with business expertise including vertical industry knowledge, new functional expertise (sales, marketing, and accounting), and solution design and consulting expertise tailored for niche use cases.

5G Economic Impact From COVID-19

Of course, the COVID-19 pandemic could throw a wrench into many of the 5G economic predictions and plans. Global supply chains will be interrupted because of the social impact the virus is having on the workforce and this in turn will delay availability of equipment.

A recent survey conducted found that 79% of organizations said that the pandemic is having a negative impact on overall operations. Major business disruptions in organizational supply chains, IT resources, human capital, and strategic planning are contributing causes of the reported negative impact.

Vendors and operators have so far provided limited commentary on the expected impact from the pandemic that has created a crippling effect, not only on service industries but also on manufacturing enterprises, including 5G infrastructure vendors.

Many groups are delaying adoption of a pair of critical releases for 5G specifications because of changes in how the members will be able to conduct meetings. The releases are tied to more advanced 5G features that should not impact the ongoing initial roll outs but could impact plans for enterprises.

5G coverage is just picking up in many regions. As such, even if Release 16 was not delayed, many enterprises who wish to work with carriers to begin 5G trials and pre-commercial deployments would still need to wait for coverage to start.

Conclusion

“5G is the fundamental platform for the fourth industrial revolution and will become an integral part of societies and civil infrastructures, just like roads, energy and transportation.”

This article highlighted how 5G will bring in a new dawn of transformation in the digital era and how an effective storage system is a must to fully embrace this advancement. There is no aspect of our daily lives that will not be affected by this boom. As the 4G chapter closes, a new era begins which requires networking technology to evolve and be ready for next-generation services and demand. We not only need to evolve legacy system to be more competitive, we also require new disruptive ideas to secure the 5G market and foster growth for the future. Indeed, we need to adopt a proactive stance to be ready for the 5G story.

The cloud infrastructure will be completely changed once 5G hits the cloud space. Cloud Computing will see a new high and it will fully capitalize on augmented reality through the AR Cloud. The impact on storage will be seen primarily in overall compute and software architecture needed to serve these use cases. All we have to do is ensure that today’s storage technologies will stand up to this new boom of 5G and its accompanying challenges.

Despite the negative effects the Covid-19 pandemic has had on essential equipment production, distribution, implementation and device availability, 5G prospects remain bright and are likely to experience little lasting damage going forward. However, besides the spectrum, 5G will require a fundamental change to the core architecture of the communication system. Simply upgrading the existing Long-Term Evolution (LTE) core will not be able to support the various requirements of all 5G use cases.

Regardless, as the 5G future takes shape, you can see the technology is much more than just enabling faster connections for smartphones. 5G quite literally has the potential to transform not only internet broadband service, but also enable new applications and use cases, from connected smart devices in IoT, to autonomous vehicles, smart cities and connected factories; the list goes on. The word “disruptive,” in the case of 5G, is an understatement.

Clearly, 5G will lead to one of the biggest technological transformation of our lifetime, with unlimited possibilities.

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