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Private 5G, Edge Compute and AR/VR: Opportunities Unlimited for Enterprises to Boost Productivity

WHITEPAPER

Abstract

This white paper explores about game-changing potential of private 5G network, edge computing, and augmented reality/virtual reality (AR/VR) technologies. Together these technologies provide limitless opportunities for enterprises to boost productivity, improve business processes and elevate human-machine interaction. Global augmented reality market is set to soar with a projected CAGR of 50.7% by the year 20301 and the deployment of private 5G networks will be the key to unleash its full potential. Multi-access edge compute (MEC) brings data processing close to end users with increasing access, added security, and reduced latency. Private 5G and edge computing will revolutionize and facilitate seamless implementation of AR/VR for enterprises.

Key Takeaways

01

Introduction To Augmented Reality (AR), Virtual Reality (VR), And Their Synergy with Private 5G Digital Solutions.

02

A Brief Overview of Private 5G Networks and Multi-Access Edge Compute (MEC).

03

Underscoring The Crucial Role Played by Private 5G And Edge Computing in Enhancing AR/VR Experiences.

04

An Overview of The Architectural Framework Enabling AR Through Private 5G Technology.

05

Merits Of Utilizing Private 5G Networks For AR/VR Applications.

06

Illustrating Specific Scenarios Where AR/VR Experiences Are Enriched by Combining Private 5G And Multi-Access Edge Compute (MEC).

07

Industries Leveraging Private 5G Networks in Conjunction With AR/VR Technologies.

Introduction

Enterprises are demanding innovative digital solutions to augment their business processes, boost productivity, further improve human machine interaction and so on so forth.

Augmented reality/ virtual reality (AR/VR) technology has been in foray for past few years. Capability of these technologies to address enterprise requirement is already proven. However, as enterprises are demanding more from the existing use cases, technology advancements are also happening at rapid pace. Consequently, the usage of AR/VR technology for various use cases would be requiring high bandwidth and low latency for better performance management.

Private cellular network (aka 5G) is designed to provide ultra-low latency and high bandwidth is crucial in enabling these use cases of future. In this whitepaper, we will explore role of 5G in widespread adoption of AR/VR for various industry verticals.

Private 5G Network and Edge Computing: An Overview

Non-public network (NPN) aka private 5G network, per 3GPP, is about speed, latency, and sensor density.

What's Special About 5G ?

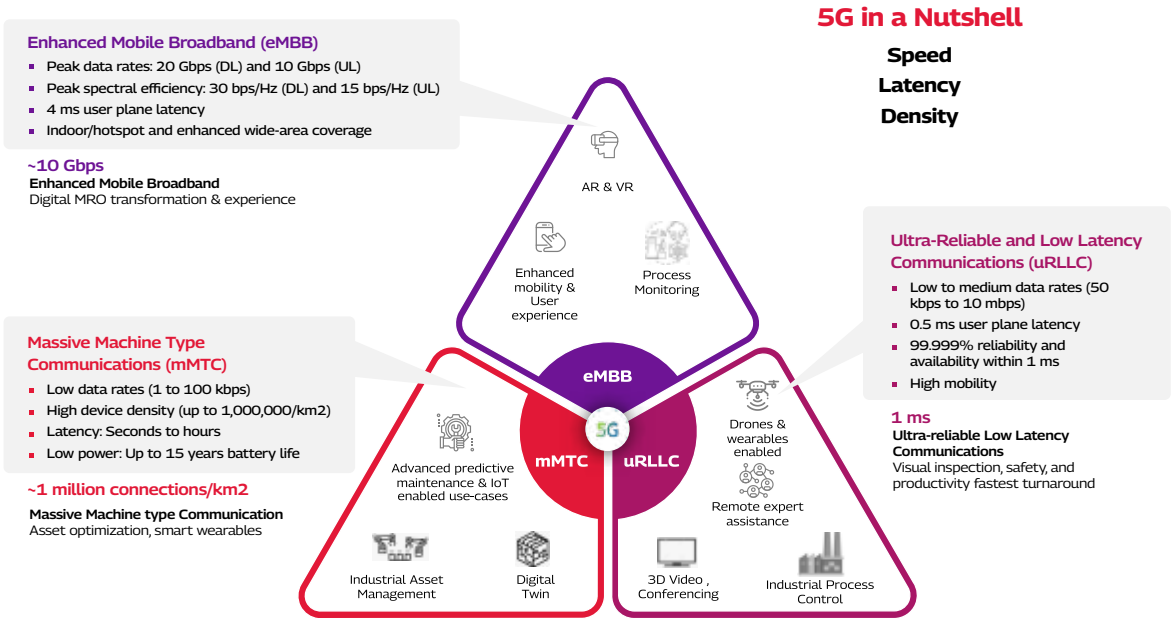


Figure 1: Impact and capabilities of 5G network

Any conversation involving exciting 5G use cases requiring real time data insights, leads to multi-access edge compute (MEC). Multi-access edge computing is an ETSI-defined network architecture model positioned at the network edge -cellular and other setups. It creates an IT service environment on the network edge and enables cloud computing capabilities.

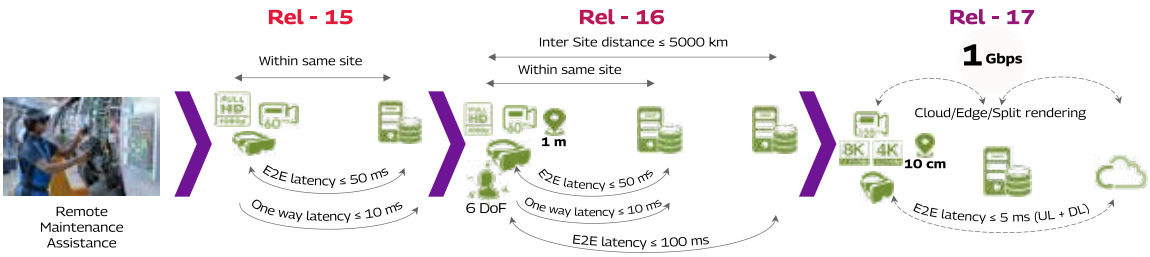
MEC brings data closer to its end-users where action is happening, increasing ease of access, security and reducing latency. Only the required data is sent to the cloud while the rest of the data gets processed locally, saving bandwidth, and enhancing response times.

While 5G promises never-seen-before to peak mobile broadband speed of up to 10GBps, the combination of 5G and edge computing is what will open doors to new ways of working. With a ten times greater speed than the current LTE networks and ultra-reliable low latency of 1ms with 10^ (-9) that enables processing massive data in real-time, these two technologies are intricately linked to each other. It has the power to significantly transform applications and data analytics by making way for new revenue streams and use cases.

Importance of Private 5G and MEC for AR/VR

Enterprises are demanding more and more from cutting technologies like AR/VR. From simple workflow downloading to heavy files upload on one hand to crucial maintenance of mission critical assets in hazardous plant locations where movement must happen in 3 dimensions, bandwidth requirement is increasing in leaps and bounds. Below mentioned dia. shows how 3GPP releases aim to cater to bandwidth need of such use cases.

AR Assisted Remote Maintenance: Scale up with 5G



Richer Visual Content

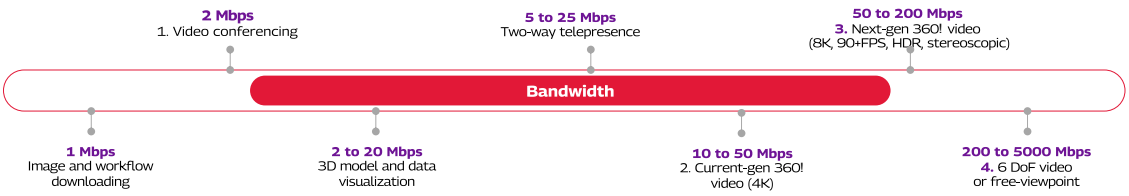


Figure 2: 5G made possible AR/VR use case deployment anywhere

Similarly, according to STL partners the latency requirement for some of the crucial use cases have also been very demanding as mentioned in below diagram.[2]

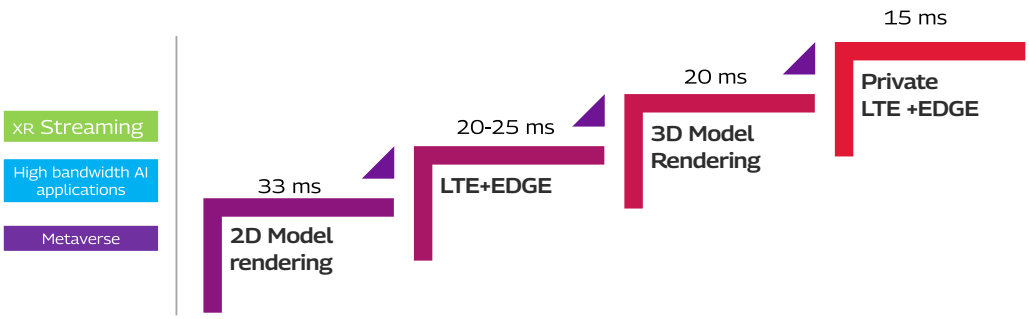


Figure 3: Latency requirements for AR/VR

AR/VR use cases enabled by edge computing technology powered by Private cellular network help in achieving the requirements and provide desired benefits.

High Level Architecture of 5G Enabled AR Use Cases

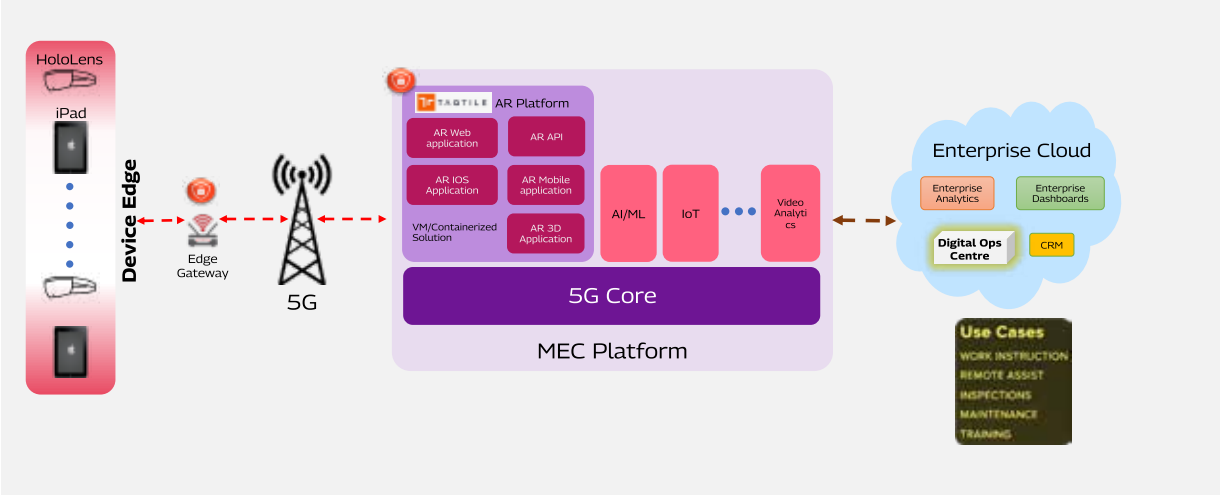


Figure 3: Latency requirements for AR/VR

Benefits of Private 5G Enabled AR/VR Use Cases:

- The capabilities of AR/VR applications can significantly be enhanced by Private 5G networks. The low latency and high throughput of Private 5G enable real-time, seamless, immersive experiences with minimal lag, improved quality of response. This improvement in responsiveness will be particularly crucial for applications such as gaming and remote collaboration, where real-time interaction is essential for a satisfying user experience.
- Private 5G networks offer greater scalability and flexibility compared to traditional networks. With network slicing capabilities, organizations can allocate dedicated network resources for AR/VR applications, ensuring consistent and reliable performance even in crowded environments without worrying about degraded performance.
- Private 5G networks provide enhanced security features, including data encryption, authentication, and access controls. This is particularly important

for AR/VR applications that may involve sensitive data or confidential information.

- Location based AR experiences will be fueled by increased accuracy and speed of 5G network, creating highly accurate digital overlays over real world. Users can access relevant information based on their precise location details.

Tech Mahindra brings the private 5G powered AR/VR solutions inference over MEC in a consortium mode and has partnered with leading device providers and platform players to alleviate pains in enterprise domain.

Below mentioned are selected few use cases where potential to craft new solutions are endless:

AR Work Instructions – AR work instructions are enhanced with augmented reality, 3D models, audio, video, and PDF manuals making them an invaluable on-the-job aid for completing complex tasks accurately and consistently. The AR work instructions were designed to work on smart glasses like HoloLens worn by technicians on the production floor. It's also supporting Apple iPad. These wearables displayed relevant information, step-by-step instructions, and visual aids directly in the user's field of view, eliminating the need to constantly refer to manuals or diagrams. With this AR powered work instructions, it's easier to understand complex assembly processes, reducing the likelihood of errors. The real-time integration of data allowed for immediate feedback on quality control, enabling technicians to spot and rectify issues swiftly. All these artifacts like 3D models, audio, video, PDF manuals and other sensor data are stored at the Enterprise Edge storage and served to the AR enabled devices via high speed private 5G network.

Remote Assistance – Remote assistance helps workers get jobs done faster and more accurately when work is shared and coordinated across teams. workers can get help from experts whenever and wherever they need it.

For example, there is a critical issue with a state-of-the-art production line and Enterprise was experiencing a significant delay in the production, resulting in considerable financial losses. Traveling to the remote location was not feasible on such short notice for the expert who is attending a different issue in a different location, but the problem demanded immediate attention. This is where AR remote assistance comes into play. By leveraging this cutting-edge AR Platform experts can remotely assist on-site technicians using AR wearables like HoloLens and a high-speed communication network like private 5G within the enterprise locations.

AR For Inspections – With AR assistance workforce Can perform inspections, audits, compliance, and quality checks more accurately and efficiently.

For example, a chiller unit is a critical part of an Enterprise and whose downtime will affect the production process. So, a periodic inspection of the chiller unit is required to ensure its normal and optimal working condition. Here AR can be a valuable tool to enhance the efficiency and accuracy of the inspection process. AR overlays digital information onto the real-world environment, allowing inspectors to access relevant data like inlet and outlet water temperature fed from the IoT sensors in Realtime, assisting the technician in inspecting the oil level and visualize

other potential issues in real-time. Here private 5G forms a communication backbone connecting the AR Wearables/handhelds to the Enterprise edge compute there by enabling a two-way high-speed datalink transferring the Realtime overlay data required for inspection and sending the evidence for successful inspections or faults Identified back to the Edge compute storage. Also, the low latency, high throughout and high capacity Private 5G network makes it possible to offload some of the computing tasks back to the edge compute there by making the wearables lighter.

AR For Training – AR powered training will get less experienced workers up to speed and productive faster.

Immersive Learning: AR enables employees to experience realistic scenarios and simulations, enhancing their learning process. For example, a 1:1 scale of Chiller unit can be overlayed along with the instruction how to operate the machinery will give an immersive learning experience along with a new level of realism to learning there by reducing the requirement of additional manpower.

On-the-Job Training (OJT): AR-based training allows employees to learn directly on the job without disrupting regular operations. With the help of AR an employee can train himself on how to inspect a chiller unit with step-by-step guidance along with videos/manuals/notes transmitted in real-time to his wearable from the edge via the Enterprise Private 5G network and also completing the inspection work on the physical machinery simultaneously.

Remote Training and Collaboration: With the rise of remote work and teams being distributed, AR bridges the physical distance gap. Employees can attend virtual training sessions, workshops, and meetings from anywhere, as if they were present in the same room. AR also facilitates real-time collaboration, enabling remote employees to interact, share ideas, and work on projects together.

Safety Training: AR is particularly valuable for high-risk industries where safety is paramount. Employees can undergo safety training in AR environments that simulate potential hazards without exposing them to actual risks.

AR For Maintenance – Unplanned/unfamiliar maintenance activities can be carried out with minimal delay.

AR can provide step by step visual instructions overlaid on physical equipment. Right tools and procedures appropriate for the maintenance activity will be highlighted. If required technician can pull in remote expert for real-time collaboration and can show the problem area in the machinery in a “what I see you see” concept and can complete the maintenance activity with minimum delay.

Industry Verticals Use Cases with Private 5G With AR/VR

The industry verticals where Private 5G coupled with AR/VR makes a significant impact:

Manufacturing: AR coupled with Private 5G is used to greatly accelerate the time it takes new workers to reach productivity, take experienced workers through annual certifications as well as offer 'just in time' training to experiences workers completing infrequent tasks while on the job. AR Digital work instructions can be propagated across factory floors to workers engaged in complex maintenance job. Real time collaboration employing "see what I see" concept with augmented guidance is a key use case. VR can be used to simulated a manufacturing, assembly and disassembly processes in an Industry.

Oil and Gas: In oil and gas industry Edge powered Private 5G along with AR can improve productivity and reducing equipment breakdown/downtime by enabling AR work instructions, Job execution, Remote expert assistance and maintenance, AR powered inspections. AR powered on job training for new recruits to make them productive at a shorter time span.

Defence: AR assisted Manufacturing and Maintenance can be a boon for Defence industries. VR can be used to visualise a Defence equipment in real scale even during conceptualization or design stage. Critical maintenance of defence equipment and weapons at base level can be done with the help of AR digital work instructions, AR Maintenance procedure and AR Remote guidance beamed straight in to the ARVR devices like HoloLens.

Retail: 5G and AR/VR is changing the consumers shopping experiences by offering immersive experiences of products like furniture and TVs how they will look like in their living space from the comfort of their home. Also, in Inventory Management of retail warehouses 5G coupled with AR technology can be used for warehouse planning, Inventory management and order picking.

Healthcare: Private 5G can be used in hospitals to transmit important high resolution and data heavy test reports from one part of the facility straight to the physician's wearable. Paramedics can use AR devices coupled with private 5G to pull out and verify patient records in real-time while performing an emergency procedure. With 5G network slicing capabilities critical medical AR/VR data transmission can be prioritised over non-critical traffic like entertainment in the hospitals.

Sports and Entertainment: AR/VR gaming require expensive and powerful hardware to process the huge amount of data. With 5G and edge computing the processing task can be offloaded to the edge and games can be streamed in high speed and low latency to the AR/VR devices. The ultimate immersive sports viewing experience delivered over 5G and powered by edge cloud compute GPU facilities, enabling a photoreal real-time game viewing suite rendered and streamed to a viewer's smartphone, tablet, or AR headset with interactive leader boards for example.

The same way ever expanding private 5G powered AR/VR use cases can be a gamechanger for various industry verticals that are not covered here like aerospace, mining, ports, utilities, education, and training.

AR/VR use cases with Taqtile Manifest: Tech Mahindra along with one of its partners Taqtile presents a plethora of use cases that can be applicable to diverse sectors like manufacturing, healthcare, oil and gas, defence.

Conclusion

Tech Mahindra, a prominent worldwide provider of technology solutions, has been at the forefront of leveraging private 5G networks, MEC and AR/VR (Augmented Reality/Virtual Reality) technologies to deliver innovative solutions to enterprises. Tech Mahindra deploys private 5G network and multi access edge compute for enterprises which are crucial for enabling AR/VR based use cases. Tech Mahindra collaborates with partners and platform providers, such as Taqtile, to develop and implement a wide range of AR/VR use cases. These use cases include AR work instructions, remote assistance, AR for inspections, training, and maintenance. Private 5G, edge computing, and AR/VR are going to transform various industries by enabling new applications and use cases that can improve productivity and reduce costs.

References:

1. STL Partners. (2023, March 31). 5G and AR/VR: Transformative Use Cases with Edge Computing. https://stlpartners.com/articles/edge-computing/5g-edge-ar-vr-use-cases/