Verizon MEC

A high-level introduction

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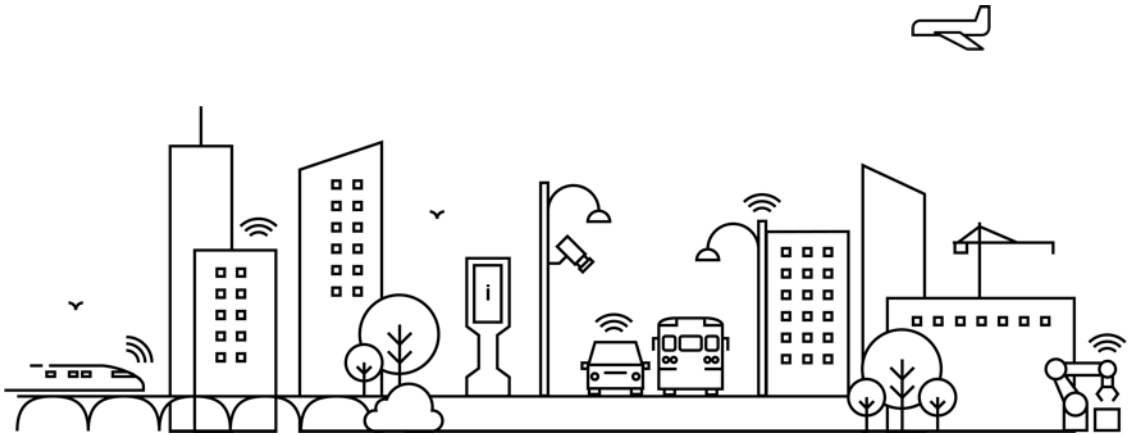
Digital transformation and the real-time enterprise

New demands and opportunities are driving organizations to implement technologies that support real-time enterprise (RTE) operations, such as:

- Internet of Things (IoT) applications and massive IoT connectivity
- Deep network and edge applications integration
- Low latency, automated operational intelligence



Drivers of the RTE[1]

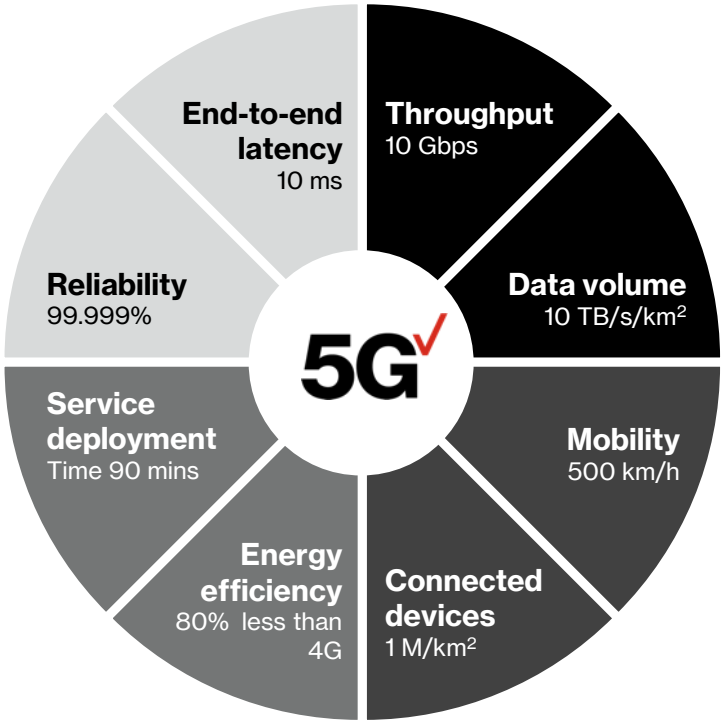
Industries	Retail	Manufacturing	Healthcare
Market catalyst	• Supply-chain simplification • E-commerce disruption • Rapid home delivery • Changing consumption patterns	• Flexible factories and 3D printing • Robotics intensifying productivity • Supply chain globalization	• Rising healthcare costs • Real-time patient analytics • Physician shortage
Use cases	• In-store operational visibility • Multimedia stores • Sensor-based inventory management	• Automated production • Remote control of heavy machinery • Smart supply chain solutions	• Telemedicine • Remote patient monitoring • Inventory management
Emerging technologies	 Massive IoT sensors	 Video analytics	 Robotics and automation	 Artificial intelligence/ machine learning (AI/ML)	 Augmented reality/virtual reality (AR/VR)
Foundational technologies	 Software-defined networking (SDN)	 IoT	 Video	 Security	 Telematics

1 RTE is a combination of 5G, MEC and IoT across all segments.

The Eight Currencies of 5G

Latency
Reliability

Speed
Throughput



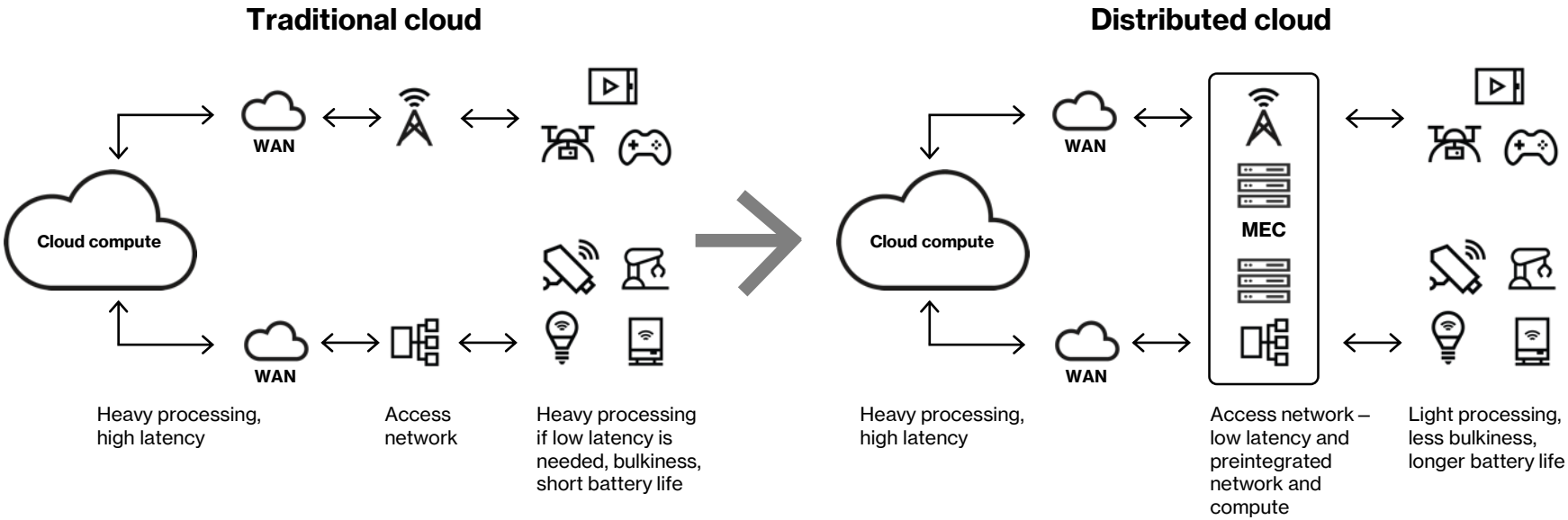
Service deployment
Energy efficiency

Mobility
Connected devices

What is MEC?

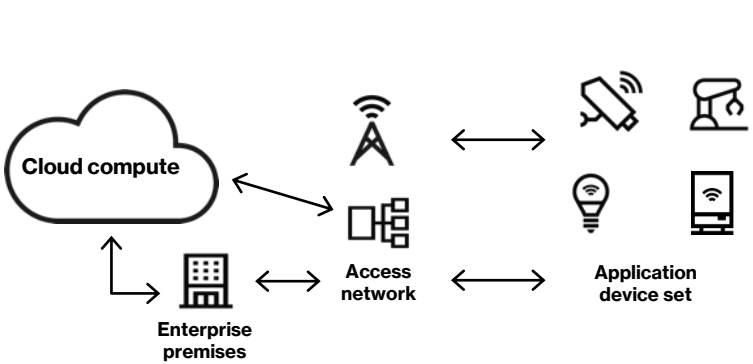
Computing on the edge

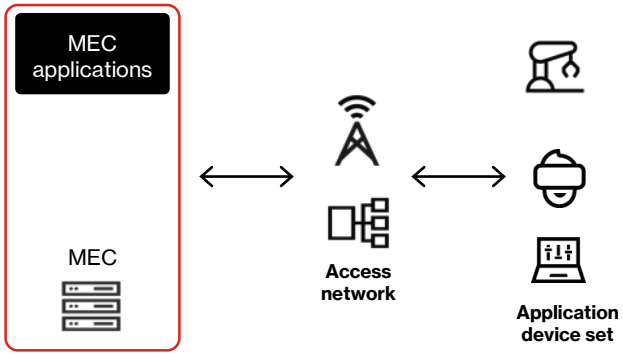
Multi-access edge computing (MEC) enables cloud servers to run closer to endpoints, reducing latency and speeding local processing.



How MEC is evolving the cloud environment

The integration of compute services and network services provides a uniform end-to-end application environment for development and management, while enabling proximity to end users.





Current mode of operation:

- Developers work in a segregated environment to provision connectivity and networking and procure compute resources
- Increasing challenges with growing data-processing volume and unreliable latency are affecting application performance

Future mode of operation:

- Preintegration of networking and compute services enables developers to leverage end-to-end services to easily configure, optimize and manage the life cycle of the application
- Service level agreement (SLA) enables reliable and secure connectivity and deterministic application performance

What can MEC help deliver?

MEC can help support the transformation to real time by delivering:

A fully converged enterprise access and compute environment

Ease in performing data analytics locally and deterministically

Consistently low latency for workloads and applications (closed-loop control systems, autonomous machines, robotics, AR/VR, etc.)

Data and application sovereignty to support security and compliance requirements

The ability to remove backhaul as point of failure in the application path and to reduce bandwidth demand on backhaul

Edge storage providing content delivery network (CDN) services for caching data on the network edge closest to the client element

Private MEC and public MEC architectures

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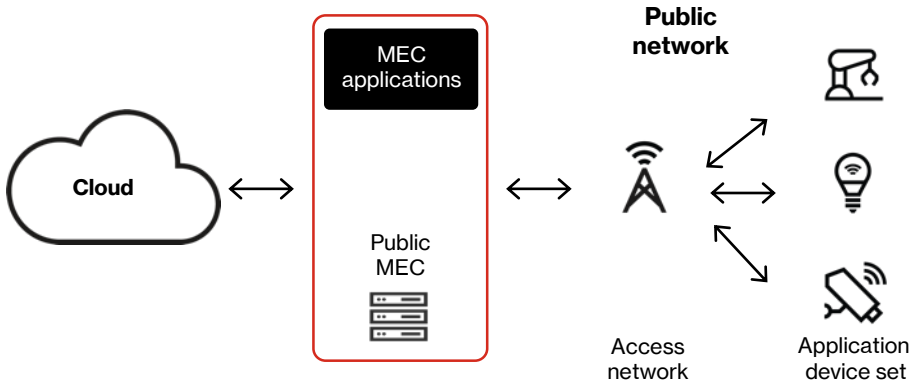
Public MEC high-level architecture

Key highlights:

- Multitenancy
- Platform-as-a-service/software-as-a-service (PaaS/SaaS) applications accessible to all devices on public mobile network

Use cases: gaming, supply chain, media, advertising, digital objects and more

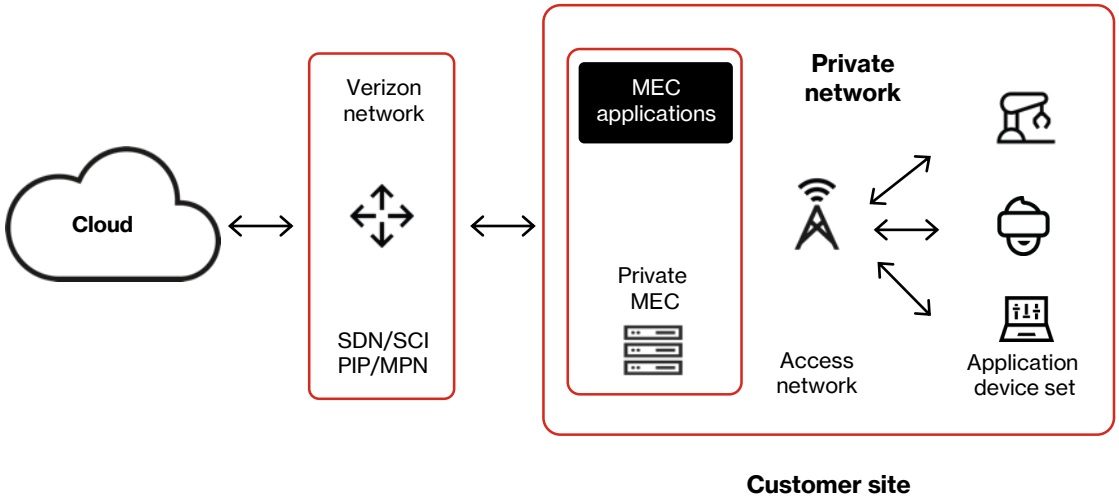


Private MEC high-level architecture

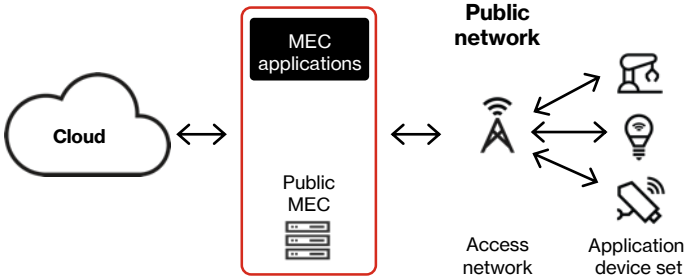
Key highlights:

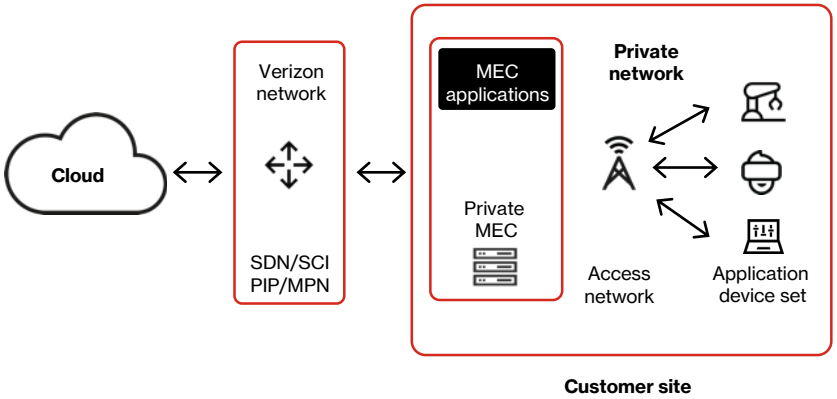
- Single tenant phase 1/ multilocation phase 2
- Mission-critical vertical PaaS/SaaS with restricted/controlled access and performance requirements
- Private network

Use cases: telemedicine, patient monitoring, real-time production control and automation, intelligent logistics, predictive maintenance, smart-store experiences, and more.



Public MEC vs Private MEC





Public MEC

Multitenant customer support from publicly situated network/compute infrastructure

- Locations at select SAP and C-RAN locations
- Latency in the 7 to 20 ms range at the C-RAN or 20 to 80 ms range at the SAP
- Access connectivity via public 4G/5G radio access network (RAN)
- Enterprise-level performance and security

Private MEC

Onsite at and dedicated to a single enterprise (single tenant)

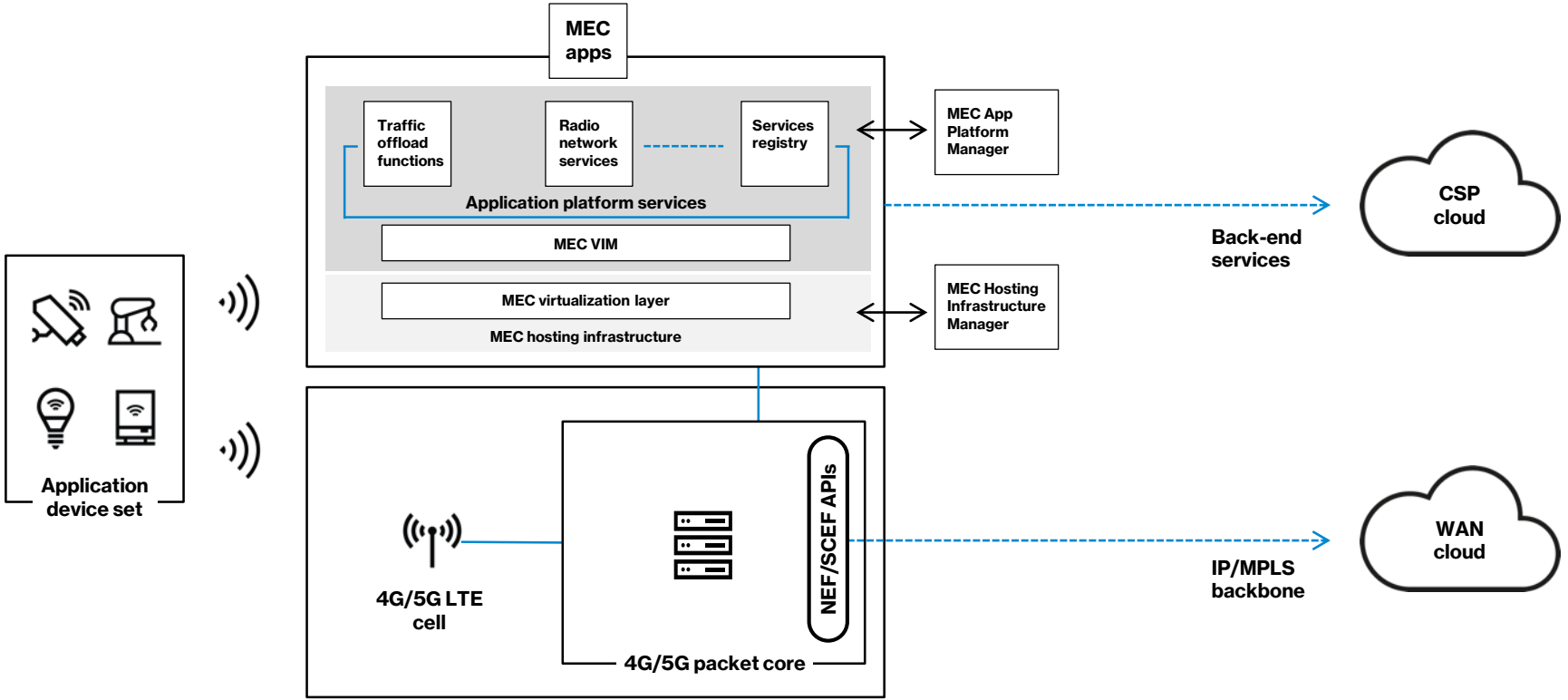
- Access connectivity via private 4G/5G network
- Ultralow latency in the sub-10 ms range

MEC comparison matrix

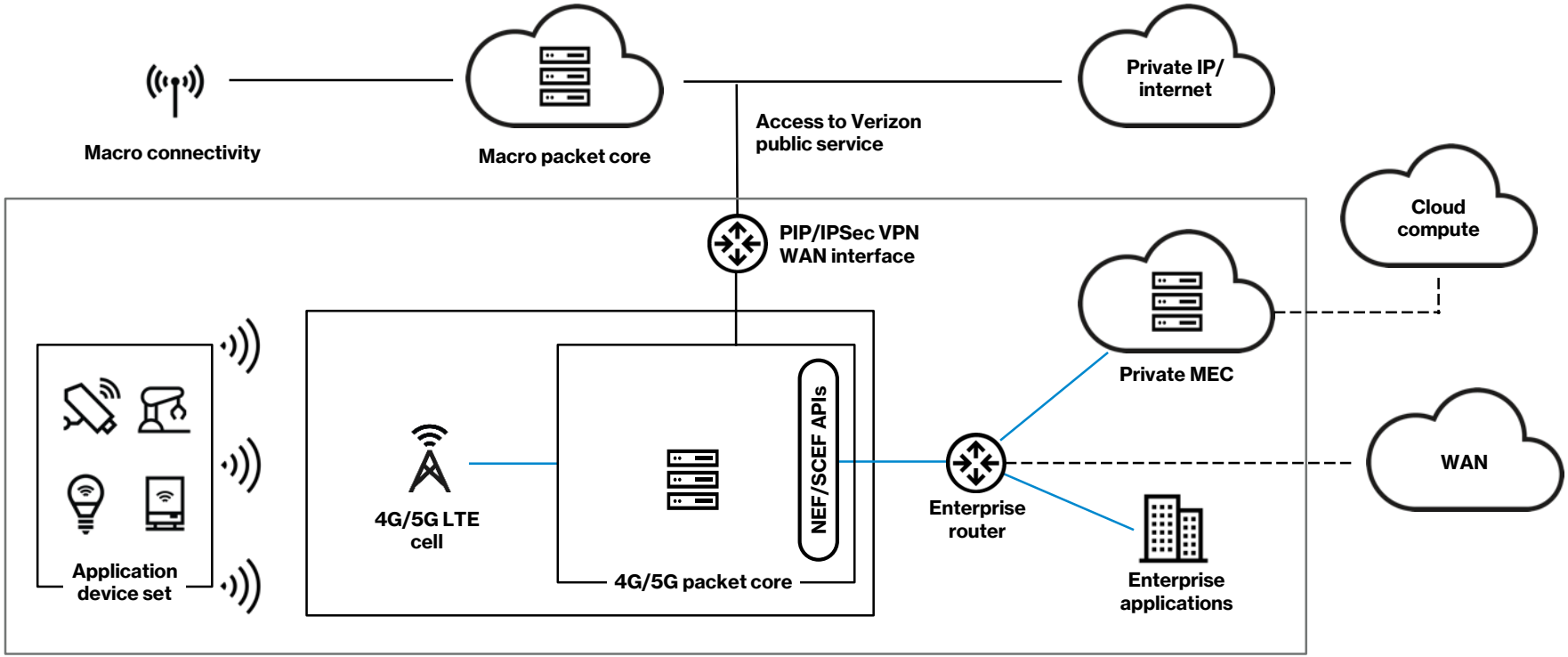
MEC type	Location	Tenancy	Mobile access	Operational scope	Latency	Security/ sovereignty	Use cases
Public	• SAP • C-RAN	Multitenant	4G/5G	Public domain	• SAP (20 to 80 ms) • C-RAN (7 to 20 ms)	Carrier grade	Gaming, supply chain, media, advertising, digital objects, etc.
Private	Enterprise • HQ • Branch	Single tenant	4G/5G	Enterprise domain	<10ms	• High data sovereignty • Bespoke security	Telemedicine, automated guided vehicles, shelf inventory management, theft/loss prevention, etc.

Private MEC deployment example

Public network-based MEC



Private MEC 4G/5G enterprise



Private and public MEC use cases

Immersive collaboration—telepresence

Potential use case
For discussion purposes only

5G essential

Challenges

- Enable remote face-to-face conversational experiences
- Allow participants to share content and interact as if they're in a face-to-face meeting
- Reduce the need to travel, and save costs through more immersive collaboration experiences

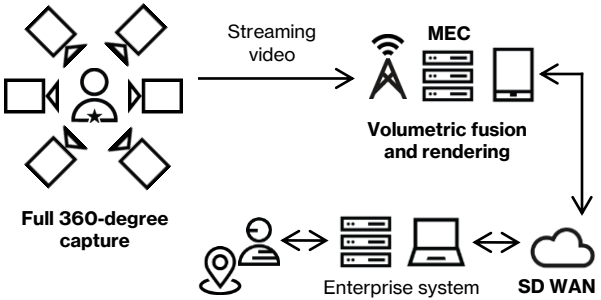
Solution

- Creates near real-time rendering of 3D volumetric video capture through the 5G and MEC platform
- Projects video rendering to a remote location and immerses it contextually in a business meeting room or medical consultation scenario at a clinic, a hospital or even a remote training location

Benefits

- Enable new levels of business collaboration – including telemedicine, 3D collaboration, training and education, and other business collaboration applications – providing significant potential to reduce travel costs
- Collaborate as if the remote subject were there
- Doctors can meet with and diagnose patients
- Engineers can collaborate on designs in 3D
- Hazardous training can be conducted remotely and in a virtual environment where safety is a consideration

Enhance remote meetings through immersive video capabilities. And offer similar real-life engagement and productivity to live meetings, reducing the need to travel.



SD WAN: software-defined WAN

Remote assisted surgery

Potential use case
For discussion purposes only

5G essential

Challenges

- Reduce high readmission cost
- Improve access to top surgeons
- Better control surgery costs for hospitals and patients
- Manage cost of training, certification and travel
- Enhance surgeon knowledge sharing and collaboration

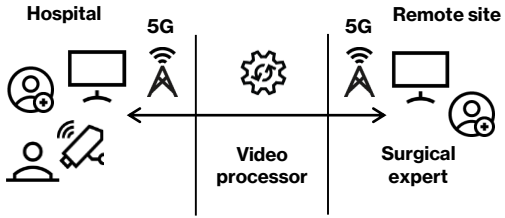
Solutions

- Hospitals access experts from virtually anywhere in the world through live immersive video collaboration tools supported by multi-access edge computing (MEC) to participate in surgery

Drive increased patient choice and control operating costs through remote access to surgical experts using cameras and augmented reality (AR).

Benefits

- Low-latency video communication to bring experts virtually anywhere in the world to the operating room and assist in surgery
- Immersive overlays of imaging and guidance from experts to orchestrate surgical operations and post-operative care
- Robust video analytics with high-definition (HD) cameras to provide feedback to surgeons and device certification agencies
- Haptic surgery assistance can share surgical sensor information with remote experts to assist surgery
- Remote robotics control to enable doctors to perform surgeries from a centralized location



Telemedicine

Potential use case
For discussion purposes only

5G essential

Challenges

- Increase access to healthcare for patients outside of metro areas and those seeking faster access to specialists and urgent care
- Improve provider operations efficiency
- Improve doctor/patient interaction and level of care with high-quality imaging to help diagnose conditions in dermatology and behavioral health

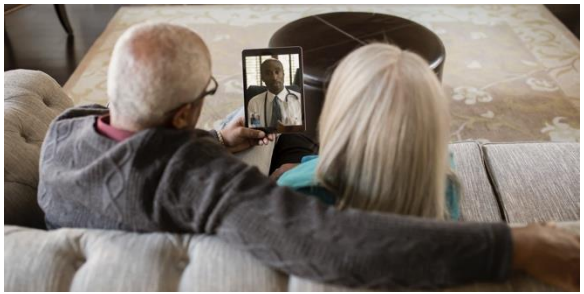
Solutions

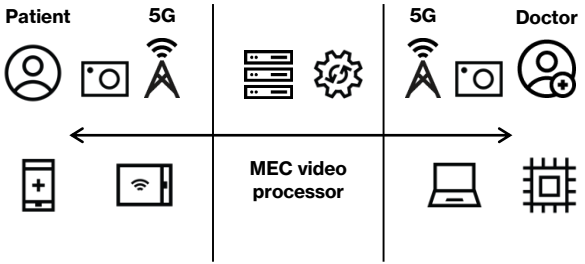
- Improves patient access to clinical care teams using 4K video at home or in a small clinic powered by 5G and MEC capabilities
- Shares sensor data and medical records in near real time
- Uses video analytics to assist with diagnostics

Benefits

- Allow patients to communicate with care teams, including nurses, pharmacists and doctors, via low-latency 4K video
- Use near real-time video analytics with MEC to assist in diagnosis, such as dermatology and eye exams, and movement analysis
- Provide near real-time health data to the care team with cameras, heart-rate monitors and blood-pressure devices
- Route and manage video calls in a call center among care providers in multiple locations
- Access patient mobile app, video calling client, medical records, appointment scheduling and office location information, all on the go

Video streaming and analytics could help increase patient access to quality healthcare and potentially reduce costs.





Drone automation in hazardous environments

Potential use case
For discussion purposes only

5G essential

Challenges

- Scarcity of workers with the skills required to work in extreme conditions
- Worksite safety concerns such as falls, injuries and electrocution
- More than 900 construction fatalities in 2017 in the U.S.[1]
- Estimated value of construction equipment stolen each year is between $300 M and $1 B[2]

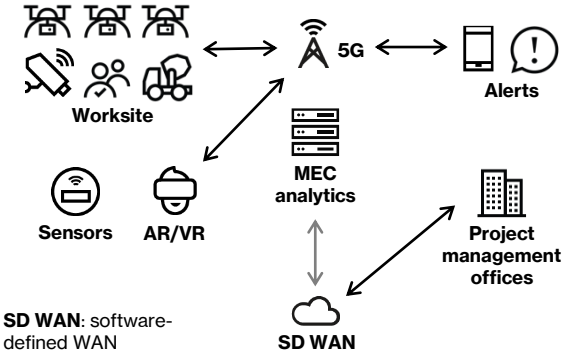
Solutions

- Enhances the safety and productivity of workers in hazardous environments through the use of drones and 4G LTE/5G connectivity, combined with MEC

Benefits

- Remotely monitor and manage equipment and parts via maintenance alerts and location tracking
- Extend drone battery life by offloading compute and storage to the MEC-based solution
- Enable drones to communicate in near real time using computer vision (CV) capabilities
- Optimize drone use and management with data analytics
- Integrate AR/VR capabilities for onsite workers to monitor drones and machinery

Using drones to monitor machinery and workers in potentially hazardous environments could improve worksite efficiency and management.



SD WAN: software-defined WAN

1 https://wwwn.cdc.gov/NIOSH-WHC/chart/bls-fw/injury?T=O&V=C&S=N00&D=RANGE&Y1=2017&Y2=2017&Y=
2 https://www.constructconnect.com/blog/high-cost-construction-equipment-theft

Remote patient monitoring

Potential use case
For discussion purposes only

Add 5G as needed

Challenges

- Continuously monitor patient data for trends and problem alerts
- Diagnose conditions remotely without requiring a doctor visit
- Better engage with patients and achieve medication compliance

Solutions

- Enable the continuous monitoring and analysis of patient conditions with few location constraints
- Doctors can remotely diagnose patients visually and by vital signs using the system's AI tools to help augment diagnosis
- Doctors can direct first aid as well as more advanced treatment via emergency medical services
- Heads-up glasses can help direct precise delivery of treatment
- 5G Ultra Wideband network provides reliable connectivity

Benefits

- Empowers live communications with specialists that can help medical professionals improve access to and quality of care
- Provides intelligent analysis and diagnosis with notifications
- Improves patient care efficiency and logistics via connectivity and MEC analytics
- Notifies and engages the right team of medical professionals with intelligent communications and AI

Automated guided vehicles

Potential use case
For discussion purposes only

5G essential

Challenges

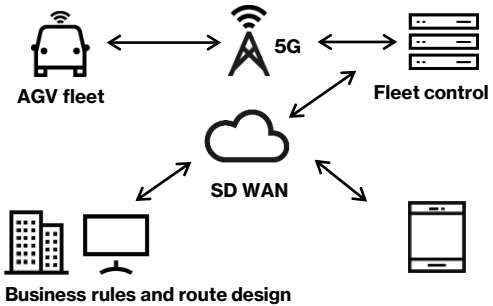
- Limited business gains due to inflexibility of current automated guided vehicle (AGV) deployment – particularly their physical guidance systems
- Infrastructureless AGV systems lack scalability and flexibility
- Need for manufacturing to become intelligent, not just automated

Solutions

- Tasking of AGVs using 5G, MEC and computer vision
- Monitoring and control of machines and processes
- Programmable logic controller (PLC) integration to support critical rerouting due to safety or factory-floor demand needs
- Navigation and/or operation commands sent to AGVs to perform time-sensitive tasks

Benefits

- AGV paths adapted in near real time based on production needs
- Integration with manufacturing execution system (MES) and enterprise resource planning (ERP) systems to drive AGV task management. One solution vendor found that automation of forklifts can increase productivity by up to 25%[1]
- Control of AGVs and monitoring of plant can enhance security, reducing risks of collisions and accidents with AGVs



Logistics automation improves productivity and safety in the movement of materials between manufacturing lines and buildings using AGVs.

SD WAN: software-defined WAN

1 http://www.mwpvl.com/html/full_case_picking.html

Marketing with collectibles

Potential use case
For discussion purposes only

5G essential

Challenges

- Increase connection of brands with customers, artists, fans, friends, families and global gamers through collectibles
- Increase fan engagement rates
- Offer multiple engagement models for creative generation of contextualized digital objects
- Improve campaign insights and performance optimization

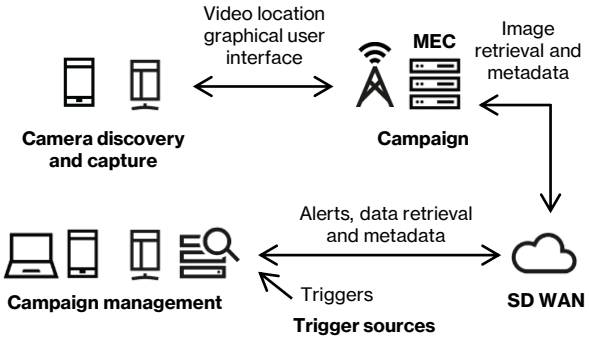
Solution

- Provides a platform where unique, policy-controlled smart objects can be traded, shared, collected, triggered, combined, redeemed and nurtured
- Creates digital collectables using current and historical content
- Designs smart objects for discovery so they can be dropped into a map; captured in AR or from digital signage; and stored, shared or redeemed

Benefits

- Offer a digital object platform to create paid media campaigns
- Help marketers to provide a novel experience for fans who can search for, discover, capture, trade and redeem unique digital objects
- Provide campaign management and analytics to drive object drops and policy, and to gain insights into engagements by number, type of interactions, shares and more

Create greater engagement with target audiences by offering large-scale AR and context-aware digital objects for games, coupons and tradeable collectibles.



SD WAN: software-defined WAN

Use cases

A library of additional use cases in manufacturing, retail, healthcare, transportation and more are available for your use, to help you customize your presentation.

They can help you initiate discussions with your customers and other external audiences on the benefits and applications of MEC, 5G and other cutting-edge technologies like AI and augmented reality.

https://solutionslab.vzw.com/presentation/mec-1-page-use-cases

Note: Please delete this slide once you have copied over the use cases you plan to present.