5G and edge computing

White paper

Together, these powerful technologies are bringing real time to the real world.

As the world grows ever more connected, the pace of business accelerates.

Fast is no longer fast enough. The growing expectation from consumers and organizations alike is for as-it-happens answers, response and experiences that feel like they are happening in real time.

Real-time answers. Real-time responses. Real-time experiences.

Make no mistake, this emerging era of practically instantaneous information delivery will bring great things, like faster, deeper and more actionable business intelligence; advanced imaging; smarter vehicles; better tools for anyone from first responders to artists; and so much more.

It will also leverage a new kind of network architecture. One that no longer relies on centralized, cloud-based computing, and instead utilizes the powers of 5G and edge computing to bring the real-time enterprise to life.

Cloud computing: What it gave us and where it's going

Few modern technologies have delivered as many business benefits and capabilities as the public cloud. It enables businesses to outsource infrastructure management and storage, and it's flexible, scalable and cost-e ective.

The cloud has been particularly beneficial for expanding the capabilities of programs focused on consolidated data storage, mobile productivity applications and modernizing enterprise systems like enterprise resource planning (ERP) and new or reengineered workloads that require flexibility and elasticity. It's also leveled the playing field across business segments by providing access to technologies previously out of reach for small and medium-sized businesses (SMBs), such as workflow management tools and customer relationship management (CRM) programs.

On an even larger scale, the cloud has enabled the development of the myriad of applications that we utilize on our smartphones, essentially transforming the way we use mobile devices. Devices that will soon be powered by the next-generation 5G network—and require next-gen cloud architecture to support new applications.

As ever-increasing numbers of mobile and Internet of Things (IoT) devices come online—and as demand for the ultra-responsive application environments promised by 5G grows—the cloud's latency could potentially become problematic.

Latency: Why does it matter?

Network latency is the time required for a packet of data to make the round trip between two points. More simply, it's the time between a user action—opening an app, clicking on a website—and the response to that action.

A number of factors can contribute to network latency, including the speed of and available bandwidth on the network; the number of hops the data has to make across switches, interconnections and other network equipment; and the size of the transmitted data packet. And, critically, the distance between the client device making the request and the servers responding to it.

Unfortunately, many data centers are built where land, electricity and water are the least expensive. That means when the typical urban mobile-device user clicks on an application or URL, they are accessing data that is likely stored hundreds or even thousands of miles away.

Why does that matter? Because latency is directly linked to the end-user experience. And end users don't like to wait. Generally, any online experience with a lag time of more than 100 ms no longer feels instantaneous.

One hundred milliseconds isn't a huge deal when you're checking email, accessing a spreadsheet or consulting with a coworker in another state. But it's a very big deal when you're wearing virtual reality goggles that aren't quite syncing with your movements, diagnosing medical emergencies remotely, operating a facility with autonomous manufacturing equipment, or working in public safety, where receiving intelligence practically in real time could profoundly impact safety, security and mission success.

That's why distributed computing architectures, like edge computing and multi-access edge computing (MEC)—along with 5G—could be essential for supporting functionality that feels like it's happening in real time.

Edge computing: Extending infrastructure to where business happens

The edge is a network architectural model that brings technology resources, including compute and related infrastructure, closer to the end user—or to where the data is generated. It's a decentralized extension of cellular networks where data is processed and stored at the edge, with only key information transmitted to centralized data networks like the cloud.

Edge computing doesn't replace the cloud; it simply puts the parts of the applications that need to be closer to the endpoints where they belong. It's a type of hybrid cloud, in which all data doesn't have to shuttle back and forth between far-away servers and user devices.

As Forrester highlights in a 2018 report,[1] edge computing arose to address a number of cloud-related challenges, including:

- An increasing need for low latency and high reliability
- The rapid expansion of the IoT
- An increasingly mobile and distributed workforce
- Bandwidth and connectivity limitations
- The high cost of data transit and storage
- Evolving data privacy requirements

By reducing the distance data has to travel, decreasing the number of hops it has to make across network equipment and consolidating information, edge computing can reduce latency, speed up processing and preserve bandwidth on the customer's existing network.

Computing at the edge enables localization of data, too, for organizations that require data localization for security or privacy reasons. And it can support business continuity by enabling regional o ces or sites to stay up and running when operations are disrupted at the primary site.

Edge computing has been steadily growing in popularity over the last few years as the performance benefits and e ciency of last-mile processing become increasingly clear.

On its own, edge computing enables faster, localized processing. Combine it with 5G and you have the architecture for a next-gen wireless network that could empower operations essentially in real time.

5G + edge = multi-access edge computing

5G, the fifth generation of cellular mobile communications, is expected to approach single-digit latency and provide data transfer rates many times faster than the blink of an eye, massive bandwidth, and greater connectivity and reliability.

MEC is a type of edge computing that uses cellular networks and 5G as its primary connectivity. A foundational technology for 5G, it provides both an IT service environment and cloud-computing capabilities at the edge of the mobile network, within the radio access network (RAN) and in close proximity to mobile subscribers.

5G is expected to be capable of supporting up to 1 million devices in a square kilometer[2] and is expected to spur a radical increase in the number of connected devices and systems, leading to the Massive IoT (MIoT). By 2020, some 20.4 billion devices are forecast to connect, and by 2025 that number could swell to 55 billion,[3] with everything from manufacturing equipment and smart cities applications to connected vehicles and wearables clamoring for increased bandwidth.

That's why the pairing of 5G and MEC is natural. Together, they could deliver the ultra-low latency and gigabits-per-second throughputs that are a precondition for applications that operate practically in real time, such as:

Autonomous and assisted-driving vehicles

A single autonomous test vehicle produces about 30 TB per day, which is 3,000 times the scope of Twitter's daily data.[4] The combination of 5G and MEC might well be the key to enabling widespread adoption of autonomous vehicles by enabling constant, near-instantaneous uploading, processing and downloading of massive amounts of data.

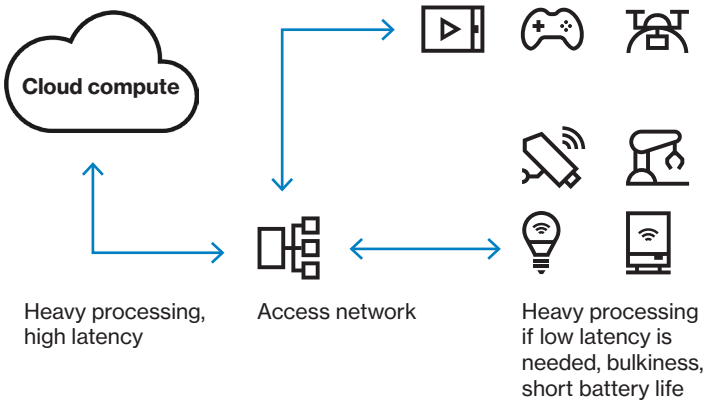
Immersive experiences

Augmented, virtual, mixed and extended reality (AR/VR/MR/XR) technologies require extremely high bandwidth and extremely low latency. Anything less creates experiences that are less immersive and more frustrating—or downright nauseating. With MEC and 5G, these technologies could enter the business world in a big way, potentially powering hyper-realistic training environments, advanced medical imaging, remote repair, immersive meetings, augmented retail and much more.

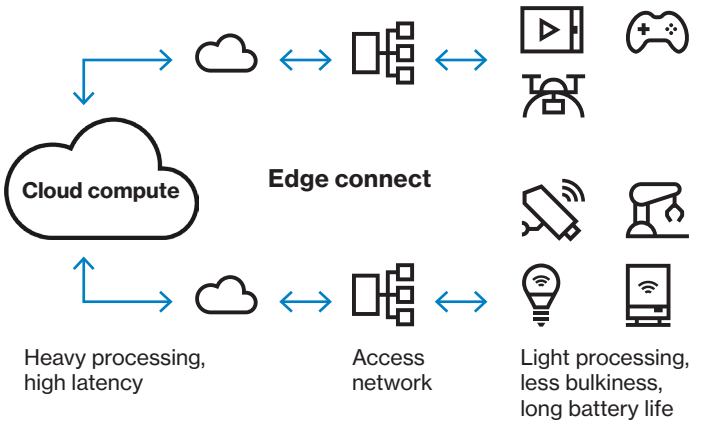
Wireless media delivery

5G, which has the capacity to enable faster data transfer to the editing floor, along with advances in wireless camera tech, is expected to disrupt the media and entertainment industry on multiple levels, enabling new immersive and interactive experiences. 5G will transform media business models. Intel predicts that with new network capabilities brought by 5G, annual mobile media revenues are expected to double in the next 10 years to $420 billion in 2028 ($124 billion in the U.S.).[5]

Traditional cloud



MEC



Digital marketing

Location-based, as-it-happens marketing should become more relevant to individual consumers, and analytics could allow marketers to tweak campaigns on the go. Faster connectivity could also enable higher-resolution and AR ads at the point of purchase (POP); mobile 4K and 8K video streaming; and relevant, omnichannel customer interactions through out-of-home (OOH) networks that feel like they're happening in real time.

Smart safety

A solution that combines computer vision and augmented reality to enable faster, safer navigation through smoke, dust or fog-filled environments and transmit visual point of view (POV), telemetry data and location to command and control is currently being tested at the Verizon 5G First Responder Lab, along with other solutions to improve responder safety and awareness.

Massive IoT

Organizations should be able to develop massive, scalable and valuable IoT capabilities known as MIoT. MIoT deployments could generate and harness huge amounts of data to drive advanced analytical and artificial intelligence (AI) programs and provide mission-critical services known as Ultra Reliable, Low Latency (URLL).

Precision manufacturing

Fully connected and automated factories could detect issues in near real time, potentially reducing error rates, increasing productivity and paving the way for real-time enterprise (RTE)—the holy grail of manufacturing technology.

Data-driven business intelligence

The ability to ingest and process vast amounts of data essentially in real time could empower organizations to rapidly respond to changing markets and demand.

Next-level logistics

5G and MEC could amplify three key technologies that will transform logistics: IoT performance tracking, robotics and distribution automation.

Smart communities

Communities that tap into the power of 5G and MEC could drive improvements in:

- Public safety (smart streetlights, remote security monitoring, as-it-happens response)
- Transit (intelligent rail, smart parking)
- Utilities (water treatment and management)
- Citizen engagement (public Wi-Fi access and emergency preparedness)

5G and MEC could also profoundly impact next-generation hardware by opening up the opportunity to rethink mobile devices. Smartphones could become more battery e cient, with much of the processing moving off f the device and to the edge.

Processing and capabilities currently reside on the device, making smartphones and other mobile devices expensive, complex and tough on batteries. Enabling near real-time operations on today's devices would require major improvements in battery life, as well as mobile chipsets for AI/machine learning (ML), computer vision and other complex processes.

Computing at the edge opens the door to low-cost, lightweight mobile devices with wide-ranging capabilities and long battery life. A single device, whether a smartphone, tablet, goggles, headset or biomedical monitor, could leverage a broad range of advanced capabilities located at the network edge.

And because MEC architecture can be deployed on RAN sites at the farthest edge of the network, 5G and MEC could also deliver localized compute services specific to an environment or industry, such as oil and mining operations, manufacturing plants, hospitals, universities, public safety and other government facilities, sports arenas, and business campuses.

The Verizon network: MEC built right

MEC is an essential aspect of Verizon's network architecture. It is, in fact, one of the four key elements—along with massive fiber resources, small cell deployment and critical millimeter wave (mmWave) spectrum holdings—that makes Verizon 5G Ultra Wideband unique.

Verizon operates thousands of C-RAN and SAP sites (Service Access Point or distribution switch locations) that can run MEC services and is currently integrating network and compute in areas throughout the network. Verizon engineers have successfully tested MEC on a live 5G network, cutting latency in half.[6]

As Adam Koeppe, Verizon Senior Vice President for Network Planning, recently noted, "To achieve near-zero latency, where data moves many times faster than the blink of an eye, having computing functions closer to the user is a vital step."

Verizon is conducting frequent 5G and MEC tests and simulations, and is working with everyone from NFL players to firefighters to race car drivers to test the boundaries of what the two technologies can do.

At the Verizon 5G Labs, located in New York, Los Angeles, Palo Alto, Waltham and Washington, D.C., innovators, start-ups and entrepreneurs are exploring the power and possibilities of 5G technology as they help grow the 5G ecosystem.

It's important to note, too, that low latency is far from the only benefit 5G and MEC could bring. We expect businesses and government agencies to also greatly benefit from the unprecedented increases in speed, bandwidth, throughput, reliability, agility, scalability, energy e ciency, privacy and security that these two technologies can deliver.[7]

Piloting new possibilities: What will real time do for you?

"Transformative" is a term that's thrown around frequently in the technology and business sectors, and it can be di cult to di erentiate the wheat from the cha —the truly transformative technologies from those that sound impressive but fail to deliver actual benefits.

MEC is an essential aspect of Verizon's network architecture. It is, in fact, one of the four key elements—along with massive fiber resources, small cell deployment and critical mmWave spectrum holdings—that makes Verizon 5G Ultra Wideband unique.

We believe that 5G and MEC are the real thing—and the key t o enabling the real-time era. By extending infrastructure to where business happens, these technologies could genuinely transform the way business gets done.

And we invite you—whatever your industry or business size—to imagine how 5G and MEC could help you do more, o er more, and work smarter or safer. Dream about all the new capabilities that gigabits-per-second throughputs and ultra-low latencies could bring to your organization. Visualize what real time could do for you.

And then, when you're ready to partner with a company that knows how to turn big ideas into powerful realities, let us know. We can help you develop a pilot project that harnesses the combined powers of 5G and MEC to transform your organization.

Be sure to dream big.

Getting on the path to real-time business

As with any major technology evolution, the better—and sooner—you prepare for 5G and MEC, the smoother the transition should go. And the quicker you could be able to take advantage of the benefits they'll bring. Following are steps you should take now.

Assess and baseline your environment, so you can develop an executable transformation plan.

Begin transitioning from traditional operating environments to programmable, on-demand, software-defined ones.

Deploy application-visibility solutions to gain insights into the performance of your applications.

Identify the business processes and applications that would most benefit from real-time responsiveness and ultra-low latency.

Partner with a company that can deliver hybrid connectivity—the right mix of private WAN, public WAN and wireless access.

Create a pilot project to appraise the value of 5G and MEC to your organization.

For applications requiring low latency, sending huge quantities of data to and from the centralized cloud is no longer practical; data processing and management need to take place closer to the user. MEC moves application processing, storage and management to the radio access network's edge.

Learn more:

To learn more, contact your business specialist.

verizon business ready

1 Edge Computing Will Radically Alter Your Infrastructure Strategy, Forrester, December 2018.
2 https://www.samsung.com/global/business/networks/insights/news/5g-is-now-part-1-2018-the-year-of-5g/
3 https://www.verizon.com/about/our-company/5g/internet-things-will-thrive-5g-technology
4 https://www.wardsauto.com/technology/storage-almost-full-driverless-cars-create-data-crunch
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