5G and edge computing

White paper

Unleashing the power of real time

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

Low latency is no longer good 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.

Make no mistake, this emerging era of practically instantaneous information delivery should 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 extends cloud compute resources to the edge of the mobile network and 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-effective.

The cloud has been particularly beneficial for expanding the capabilities of programs focused on consolidated data storage; mobile productivity applications; 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 ultraresponsive application environments promised by 5G grows—the cloud's latency could potentially become problematic.

Latency: Why does it matter?

Round-trip 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.

Round-trip latency also includes the processing time required within the compute environment. What we are improving in this schema is the network latency. This is done by decreasing the distance between the end user and the application at the edge, while also optimizing routing to ensure the shortest route between the end user and the edge compute environment. 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 cloud-compute extension of cellular networks where data is processed and stored at the edge, with only key information transmitted back to the centralized cloud for backend services support.

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 represents a merging of the environments, i.e., cloud compute and networking, in which all data doesn't have to shuttle back and forth between far-away servers and user devices.

As Forrester noted in the report in the report "Edge Computing Will Radically Alter Your Infrastructure Strategy,"[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 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 round-trip 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 offices 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 efficiency 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.

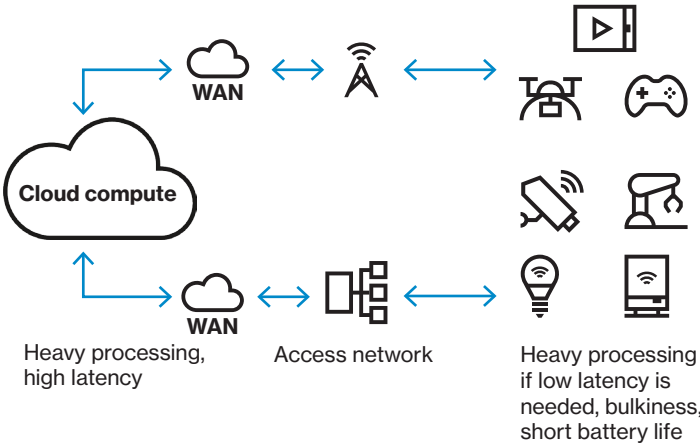
5G + edge = mobile edge computing

5G, the fifth generation of cellular mobile communications is expected to be optimized for services that are latency sensitive, and should provide massive bandwidth, data transfer rates many times faster than the blink of an eye, and greater connectivity and reliability than 4G LTE.

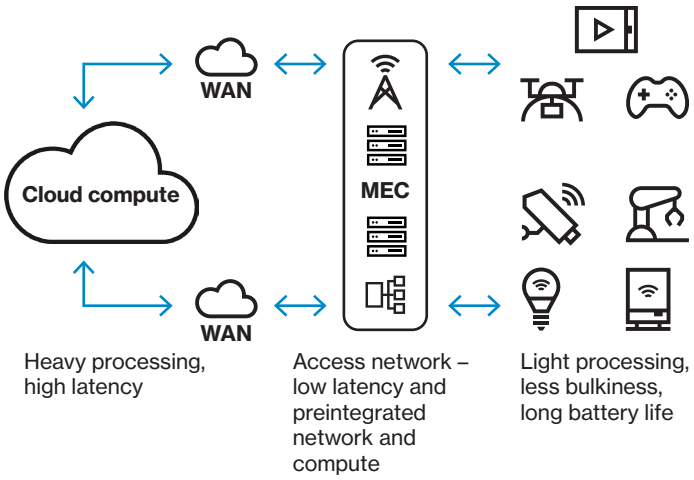
MEC is the widely-accepted standard of edge computing that places compute and storage resources at the edge of the network, close to end users. A complementary technology for 5G, it provides both an IT service environment and cloud-computing capabilities at the edge of the mobile network, within the radio access network (RAN) and in close proximity to mobile subscribers, enterprises and other organizations—all with a range of networking and computing needs.

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 2025, some 38.6 billion

Traditional cloud



Distributed cloud



devices are forecast to be connected worldwide, and by 2030 it's projected that there will be 50 billion.[3] Everything from manufacturing equipment and smart cities applications to connected vehicles and wearables will be clamoring for increased bandwidth.

That's why the pairing of 5G and MEC is natural. Together, they could eventually deliver the ultralow latency and gigabits-per-second throughputs that are a precondition for applications that operate practically in real time, such as:[4]

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.[5] 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 hyperrealistic 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 is expected to 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.).[6]

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

5G is expected to help public safety organizations rapidly ingest, analyze and deliver information gathered from 911 call systems and other data sources to improve safety and better manage planned and unplanned events. It could also enable hyperrealistic virtualized training for emergency and disaster response, and other paradigm-shifting capabilities 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 that require Ultra Reliable Low Latency Communication (URLLC) services.

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 – to enable just-in-time production and improve tracking, delivery and package movement.

Smart communities

5G and MEC-powered solutions could enable communities to:

Capture, analyze and distribute video content in real time.

Provide hyperaccurate area mapping to aid with delivery services and emergency response.

Remotely control miniature robots that may aid in disaster response citizen engagement (public Wi-Fi access and emergency preparedness).

Aggregate data from deployed personnel, body-attached or unattended sensors, and autonomous agents to assist in search and rescue or disaster response.

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

Verizon 5G Edge is designed to help enable the development of large-scale, latency-sensitive applications.

Verizon 5G Edge: The right edge computing platform

MEC is an essential aspect of Verizon's network architecture. It is one of the four key elements—along with massive fiber resources, small cell deployment and critical millimeter-wave (mmWave) spectrum holdings—that help make the Verizon 5G network a powerful tool for transformation.

In fact, Verizon is building MEC right into its 5G network to help enable the development of large-scale, latency-sensitive applications.

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 increases in speed, bandwidth, throughput, reliability, agility, scalability, energy efficiency, 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 difficult to differentiate the wheat from the chaff—the truly transformative technologies from those that sound impressive but fail to deliver actual benefits.

We believe that 5G and MEC are the key to enabling the real-time era. By extending infrastructure to where business happens, these technologies could radically transform the way business gets done. That's why we're building the power of the cloud right into the Verizon 5G network with Verizon 5G Edge.

And we invite you—whatever your industry or business size—to imagine how 5G and MEC could help you do more, offer more, and work smarter or safer. Dream about all the new capabilities that gigabits-per-second throughputs and ultralow 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 Verizon 5G Edge 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 ultralow 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.

Learn more:

To learn more, contact your Verizon Wireless business specialist.

verizon

1 "Edge Computing Will Radically Alter Your Infrastructure Strategy," Forrester, December 2018.

2 https://www.samsung.com/global/business/networks/insights/blog/5g-is-now-part-1-2018-the-year-of-5g/

3 "Internet of Things (IoT) in the U.S.," Statistica, 2020

4 These use cases reflect potential uses of MEC, ranging from applications available near-term that use current technologies, to more advanced uses that leverage the expected full benefits of future 5G- and MEC-critical capabilities. They should not be seen as current or committed solutions—there is no guarantee that Verizon nor anyone else will develop and launch these solutions.

5 https://www.wardsauto.com/technology/storage-almost-full-driverless-cars-create-data-crunch

6 https://newsroom.intel.com/wp-content/uploads/sites/11/2018/10/ovum–intel–5g–ebook.pdf

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