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5G Using Edge Computing Offers Low Latency, and Cost-Effective Innovation Opportunities

5G offers unprecedented mobile bandwidth and low latency. Hosting applications closer to the user can further cut latency and enable new use cases

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Executive Summary

Intel and AT&T are working together to test applications for edge computing.

This paper outlines the opportunity to use edge computing and 5G together, including use cases drawn from the media, retail, banking, security and manufacturing industries.

AT&T's work on edge computing is being carried out alongside its project to virtualize 75 percent of its network by 2020, and in preparation for its launch of 5G.

Business Challenge: Reducing Latency in 5G

5G is expected to bring unprecedented low latency and high bandwidth to the mobile network. This will accelerate existing applications and use cases, and can also make new types of applications viable for the first time. Autonomous vehicles, for example, could generate as much as 3.6 terabytes of data per hour[1] and would benefit from a network that could support the rapid processing of huge volumes of data.

Similarly, augmented reality and virtual reality (AR/VR) applications may require latency of less than 10 milliseconds to offer users a seamless experience[2]. If the visual display fails to keep up with head movements in VR, users can feel nauseous. The graphics-intensive processing required for high-end AR/VR cannot be carried out on a mobile device itself, so the speed with which data can be exchanged with the cloud is crucial for a smooth experience.

5G cuts the over-the-air latency between the device and the network, but transferring the data across the network, between a cloud data center and the end user's device, takes time. This can make some data-intensive applications unviable in the cloud even with the performance of 5G.

Solution Overview: Edge Computing

AT&T is on a journey to virtualize its network, replacing fixed-function network appliances with virtualized network functions running on general purpose servers, based on Intel® processors. Virtualizing the network gives AT&T the freedom to scale the network resources in line with demand, and an easier process for deploying new network functions. The virtualized network will be better able to meet the traffic demands of 5G, and is making it easier for AT&T to innovate in the network today. AT&T is on track to virtualize three quarters of its network functions by 2020, and achieved 55 percent in 2017.

As a result of the virtualization work, general purpose servers sit throughout the network. These servers can be used to host application workloads closer to the user, in the network, alongside the virtual network functions. This is similar to a Content Delivery Network (CDN), which hosts content close to the user to cut latency, but with the compelling advantage that new data can be computed, processed, analyzed or created for each user.

Edge computing allows for a continuum of deployment locations, ranging from on-premise for lowest latency; macro towers and small cells which might be a few miles from the customer, through sites such as central offices; to the core network. As the edge location gets closer to the user, the latency is lower. However, the processing power and storage capacity available may become more limited because of physical space and environmental constraints. Dimensioning and placement of the workloads need to be dynamic to accommodate physical constraints and still take advantage of edge computing. In some cases, data that is processed at the edge will also be transferred to the data center for further data analysis and archiving.

Applications can be hosted at different locations, depending on their tolerance for roundtrip latency. In some cases, edge computing will be used together with on-premise and cloud processing, such as in an autonomous driving application. Safety-critical applications require the fastest processing, and should be hosted on the vehicle itself to minimize latency. Applications such as real-time traffic updates or route planning can be hosted on an edge compute node to deliver low latency updates, and benefit from the enhanced compute power available at the edge. Data analytics for proactive maintenance could be hosted in the edge, with the possibility that applications at the edge are used to filter data to avoid backhauling all of it across the network.

Edge computing can be used today to cut latency in mobile applications, and combined with the high bandwidth of 5G, it will enable new use cases. AR/VR, for example, becomes viable for the first time using 5G and edge computing together. AT&T is already seeing latencies below 10 milliseconds in fixed 5G trials[3], which meets the latency requirements for a smooth VR experience. The graphics-intensive processing required for high-end AR/VR on current mobile devices is challenging and would in any case soon deplete the battery. However, hosting the processing close to the edge of the network means that the device can offload the processing and still achieve the latency required.

5G and Edge Computing: Better Together

Edge computing can be deployed to enhance a wide range of applications. Connected devices in factories can generate huge amounts of data, for example. Processing at the edge of the network can be used to analyze it, both to enable a rapid response to anything requiring intervention and to reduce backhaul across the network. In entertainment venues, edge computing can be used to deliver near real-time interactive video streams.

For innovative application developers, businesses and Communications Service Providers, the edge represents an immediate opportunity. Edge computing can be deployed using today's technologies. AT&T's Edge Computing Test Zone in Silicon Valley is using a 4G LTE connection until the final standards and equipment are available for 5G.

Communications service providers can prepare their networks for improved 5G performance by implementing edge computing infrastructures today.

Use Cases for Edge Computing

Intel and AT&T are working together to research and demonstrate how 5G wireless communications can be enhanced with edge computing. This is part of a long-term collaboration between the companies. Together, they launched what AT&T believes was the first 5G business customer trial at Intel's Austin, Texas, facility in 2016[4].

Through the companies' research and trials, a number of use cases, spanning a range of industries, has been identified.

In the media industry, one of the challenges is that video might be captured in 4K+ and must currently be transmitted using wired cameras. The wiring is costly and difficult to implement in many environments, increasing the time required for set-up and tear-down. Intel, AT&T and Ericsson worked with Fox Sports to stream live golf action from the 2018 US Open over a 5G link. Video was transmitted from the cameras over 5G to a media encoder/decoder based on Intel® architecture which was positioned at the edge of the network (see Figure 1). Decoding the camera feed at the edge of the network creates the potential for video to

be shown to athletes and audience members on site, and in the future could be enhanced with AR or multi-camera stitching. Content in the pilot was also shared with golf fans on DIRECTV*, AT&T's broadcast satellite service.

Figure 1. A remote 4K video camera connected to the Fox Sports network over a 5G link using spectrum provided by AT&T. Ericsson's 28GHz radio and antenna are located at the tower seen in the distance.

In the retail sector, AT&T has a 5G trial established at Magnolia Market in Waco, Texas, and is exploring possible use cases for edge computing. Magnolia Market sells furniture, and one possible use case would be to use AR/VR to help customers to see how products would look in their homes. Edge computing can also accelerate and streamline business applications for inventory management and wireless point of sale. Some retailers use a dedicated line to manage credit and debit card payments, but this can be consolidated into a virtualized edge application alongside other applications, reducing the complexity of the store infrastructure. Training content can be hosted at the edge too, reducing the latency and increasing the engagement for new employees. The customer experience can be enhanced by using the mobile network to recognize the identity and location of customers in the store, on an opt-in basis. Store assistants can then offer more tailored advice, based on a fuller picture of the customer that spans their online and in-store activities.

In banking, future mobile edge applications could be used to enhance the security of mobile ATMs deployed in the event of disaster or a branch outage. Facial recognition or fingerprint verification could be carried out using the edge compute node, with 5G used to enable a wireless connection and reduce latency in communications with the bank.

AT&T has been researching security and surveillance at its innovation center in Atlanta, Georgia. Videos can be analyzed to study the pattern of crowd and vehicle movements to identify chaotic, crowded or other potentially problematic scenarios. The combination of high quality video and artificial intelligence is a good fit for the bandwidth and speed offered by 5G and edge computing.

In factory environments, it can be costly or impractical to use cabling to gather information from the many machines on the factory floor. A reliable 5G connection can instead be used to collect data wirelessly, which can be processed at the edge of the network, to quickly identify anomalies that might point to a machine fault or safety issue.

The entertainment industry also stands to be transformed by edge computing. Gaming presents unique challenges, because of the need for a rapid response and constant interactivity to ensure the game is fair and engaging. Mobile gaming is currently limited by the processing power of handheld devices, but offloading the processing to the cloud can enable more sophisticated game experiences, and help to prolong battery life on the mobile device. The edge can help to deliver the performance required, as AT&T showed at the 2018 E3 gaming convention in Los Angeles with its Holo-Station. The demonstration enabled delegates to use a Microsoft HoloLens* viewer to interact with people who were in another room. The people who took part in the demo were scanned in 3D and their avatar was sent over a 5G connection, to be stitched together for viewing and interaction in the AR viewer.

Building the Software Stack for Edge Computing

Intel and AT&T are contributing to an open source project to accelerate the development of a standardized edge computing infrastructure, targeting carrier, provider and Internet of Things (IoT) networks. The Akraino* Edge Stack will be hosted by the Linux Foundation*. AT&T's contribution is designed for carrier-scale edge computing applications running in virtual machines and containers to support reliability and performance requirements.

Conclusion

Edge computing can be used with today's network technologies to increase the responsiveness of applications, and to prepare for tomorrow's 5G network. With the arrival of 5G, the huge increase in bandwidth and decrease in latency will enable much more data-intensive applications to be created. While 5G and edge computing can be used independently, they are stronger when used together to minimize latency and enhance application performance. Intel and AT&T are working closely on network transformation and 5G proofs of concept, with a shared vision for delivering highly performant wireless applications to consumers and enterprise users.

Learn More

- Akraino*
- AT&T Foundry*
- Intel 5G Technology at the US Open
- Intel® Network Edge Virtualization SDK (Intel® NEV SDK)
- Intel® Xeon® Scalable processors
- Intel® Network Builders
- AT&T Launches 5G Trial with Magnolia at the Silos
- Forbes: Fox Sports To Use 5G To Deliver 4K HDR US Open Golf Coverage To DirecTV Customers

Find the solution that is right for your organization. Contact your Intel representative or visit **http://networkbuilders.intel.com/**

Solution Provided By:

[1] http://about.att.com/story/reinventing_the_cloud_through_edge_computing.html

[2] http://about.att.com/innovationblog/5g_for_ai_and_vr

[3] http://about.att.com/innovationblog/5g_for_ai_and_vr

[4] https://newsroom.intel.com/news/intel-att-ericsson-5g-trial/

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