The Evolution of Edge Computing

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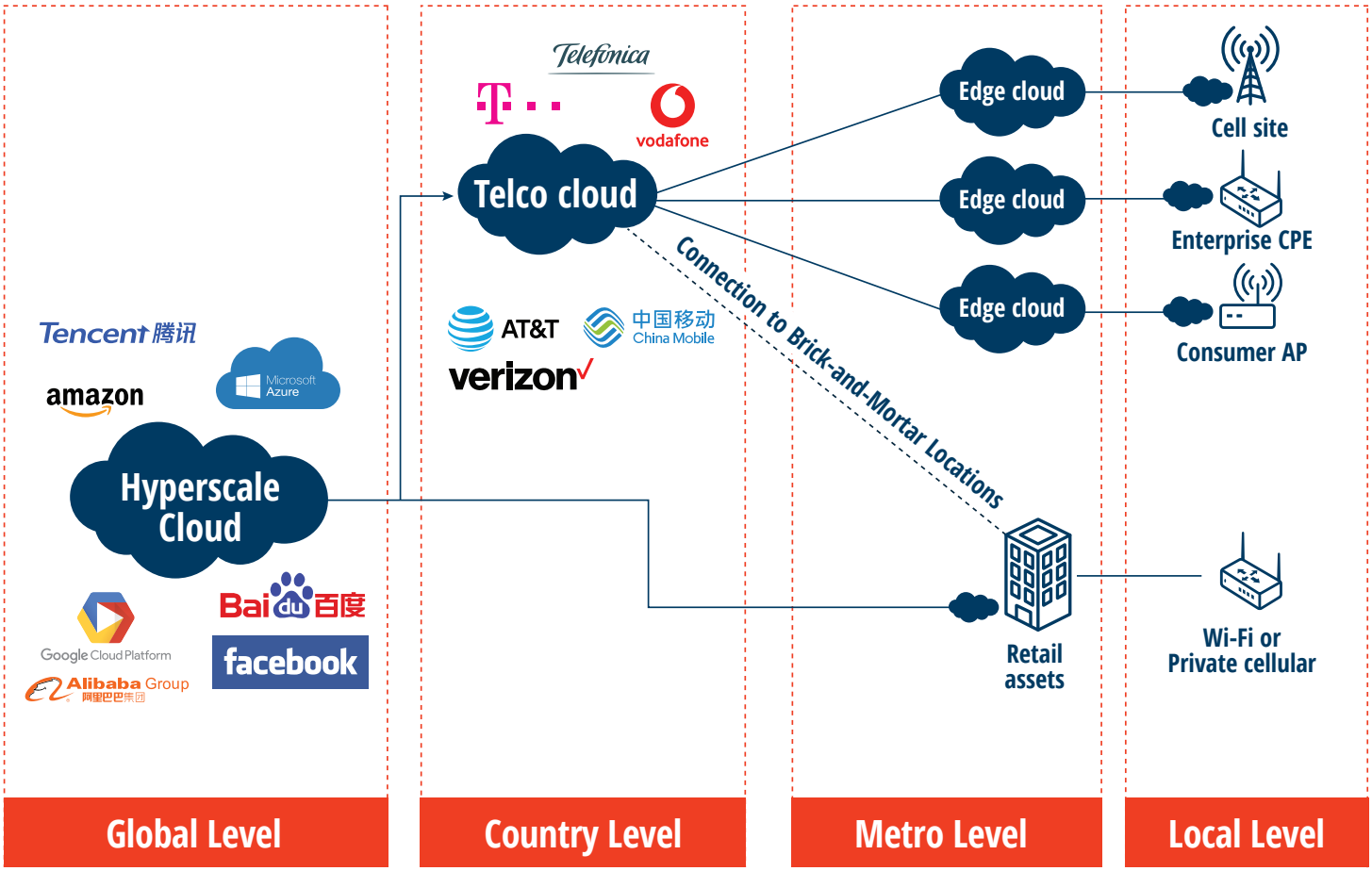
THE CHANGING NATURE OF EDGE COMPUTING

There has been no shortage of edge computing activities during 2017, in both the telco and web-scale domains. Several Tier One communication service providers (CSPs), including AT&T, China Mobile, and Deutsche Telecom (DT), have announced that edge computing will be a key component of their future network strategies and expect that several new use cases will be powered by edge servers. In the cloud domain, Amazon, Facebook, and Google are pushing further toward the edge of their own networks, creating more points of presence throughout the world. Amazon's acquisition of Whole Foods in the United States could also be interpreted as a first attempt to obtain real estate across the U.S. market that can be used for Amazon's edge servers. In fact, all major web-scale companies—Amazon, Google, and Microsoft—have announced edge computing services that are driven by IoT use cases.

Figure 1: Edge Computing in the Telco and Web-Scale Domain



Telcos own almost 100% of the last mile of consumer connectivity (with a few exceptions, *e.g.*, Google Fiber) and a large share of enterprise connectivity, whether this is spectrum or a fixed connection. This provides a unique advantage compared to web-scale companies, especially in the context of edge computing. By deploying edge servers in their network, telcos can provide significant value to end users and enterprises, well beyond their simple connectivity value proposition of today, and that is only the beginning. Edge computing will run on general-purpose hardware, allowing enterprises to use their own software and applications. Of course, as mentioned above, this depends on technical, economics, and use cases challenges to be addressed, but the presence of processing capability at the edge of any network is an undisputed advantage.

Licensed spectrum is not the only opportunity for edge computing. Private cellular is creating new use cases in enterprise segments hungry for carrier-grade network capabilities. The energy, manufacturing, and utilities segments are a few examples where digitization is creating the need for better connectivity throughout a factory floor, a solar energy sub-station, or a power plant. Unlicensed spectrum throughout the world and Citizens Broadband Radio Service (CBRS) in the United States are expected to create new opportunities and use cases for edge computing.

GETTING CLOSE TO THE END USER

It is no secret that the edge of the network, this precious location that lies closest to end users, devices, and enterprises, will be the next frontier for telcos and web-scale companies alike. Once the technology, economics, and deployment mechanisms of edge computing reach maturity, potential use cases and new applications introduce unique functionality that can create significant new service opportunities, particularly for telcos that own the last mile of network connectivity.

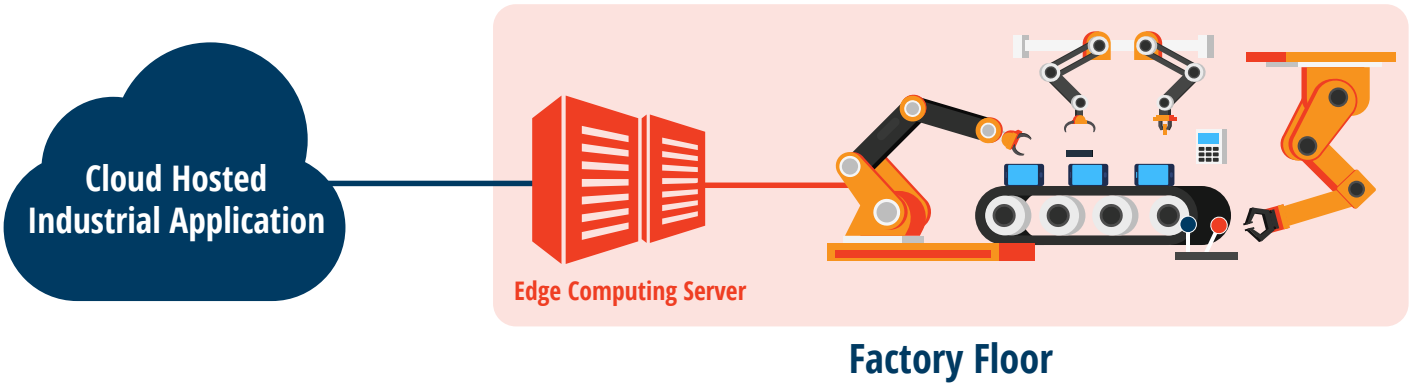
Enterprise digitization and the accelerating trend to merge operational technology (OT) with information technology (IT) will likely create vast amounts of data that need to be exchanged between enterprise locations. The largest companies are likely to own their own dark fiber and build their own networks, but almost all small, medium, and even large enterprises will rely on telcos to connect them to their points of presence and the Internet. On top of transferring these vast amounts of data, enterprises will also require data processing and analytics capabilities, which will saturate the current centralized cloud computing model deployed throughout the world. Moving these capabilities to the edge of the network will be the next wave of digitization, analytics, and the IoT.

Getting closer to the end user brings more advantages, including:

- **A Path to 5G**: Multi-Access Edge Computing (MEC) will be a foundational technology for 5G and learning about the deployment and management of these nodes before 5G is fully deployed will provide a competitive advantage for early adopters.
- **Localization**: Creation of services that are specific for an environment, *e.g.*, for manufacturing or transport. These applications may also be portable between different locations.
- **Security**: Fewer steps before sensor data are processed can increase security for IoT use cases. Also, the edge of the network now becomes an intelligent environment that can be active in securing the network and end users.

Figure 2 illustrates how edge computing can create business opportunities in a connected factory, a previously unexplored environment for telcos. An edge computing server, communicating with the factory control room or even an application hosted on the telco or private cloud can create new types of robotics use cases.

Figure 2: Concept of Edge Computing for Manufacturing **Source: ABI Research**

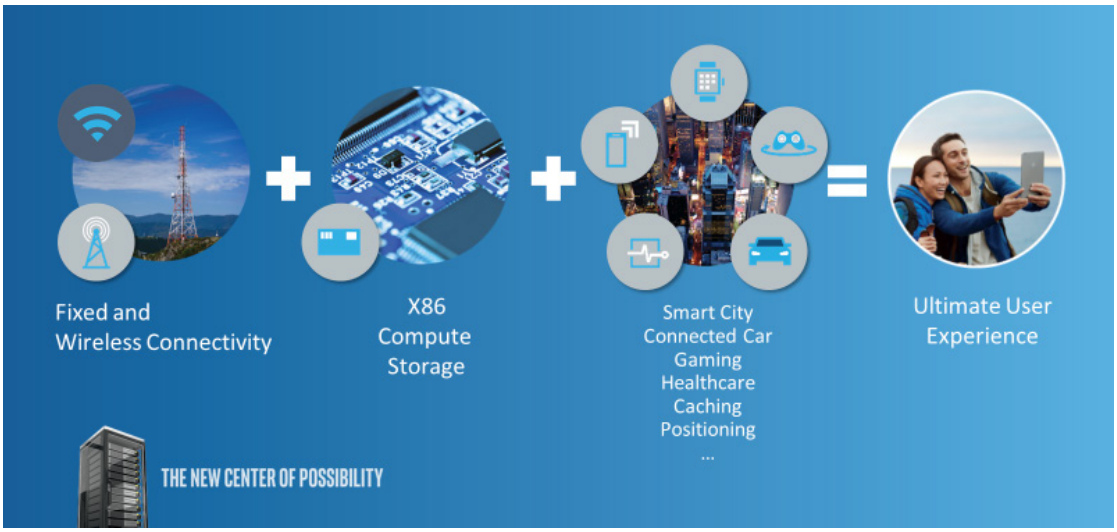


In the manufacturing market, collaborative robotics and digital twins are rapidly increasing efficiency. Robots are also becoming mobile, requiring carrier-grade, low-latency connectivity. Edge computing will be used to control these digital platforms and ensure that the factory floor is a safe, connected, and efficient environment.

EDGE COMPUTING REDEFINES APPS AND NETWORK DEPLOYMENT

The distribution of processing and storage capabilities will likely marry the cloud computing deployment model with the distributed nature of telcos, allowing new use cases. In this new environment, it is important to note that new capabilities are necessary, and that they do not necessarily align with previous expertise in telco networks. Today's networks are largely centralized and depend on application processing in either in the telco or web-scale cloud. On the other hand, tomorrow's networks are likely to be distributed and customized according to a specific use case, and the edge of the network becomes much more than a connectivity enabler, as illustrated in Figure 3 below.

Figure 3: 5G Extends the Cloud to the Multi-access edge **Source: Intel**



The edge of the network is now augmented by processing and storage capabilities, and when coupled with applications that are tailored for end markets, can create new types of value for consumers and enterprises. The applications or use cases that will be most successful are not clear to the industry today; the same way it was not clear that the Apple App Store would create vast network effects and increase the value of the iOS ecosystem exponentially. The same concept applies to edge computing. A common fabric of processing capability at the edge can enable a new development environment that developers can use to create location-based applications, end-market specific use cases, and much more. The possibilities that a common edge computing layer enables are endless and include:

1. **Edge Slicing**: The edge of the network can enable different use cases and offer different levels of service that require different network capabilities. This may be essential to justify large-scale 5G deployments that use edge computing as a foundational element.
2. **Machine Learning for IoT Sensor Collection**: Edge computing can be used to deploy machine learning algorithms at the edge of the network to collect, process, and validate IoT sensor data, before forwarding to the cloud for further processing and storage. This is quickly becoming a key challenge as sensor data increase rapidly.
3. **Vertical Applications**: Telcos can use edge computing to provide end markets with specific functionality that no other party can enable. For example, a telco can deploy an edge computing server on a factory floor, coupled with a private network to offer real-time remote control for robots.
4. **Network Efficiency**: Local caching, traffic optimization, and control and user plane separation (CUPS) are a few examples where edge computing can significantly increase network efficiency. Edge computing also reduces congestion in the core network.

Edge computing presents a foundational and structural evolution of the telco network, and monetizes the most precious asset of the telco: the last mile. Although there are some challenges to deploying edge computing on a large scale, the distribution of processing capabilities will create new opportunities and will pave the way for service innovation in an environment that is ripe for it.

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249 South Street
Oyster Bay, New York 11771 USA
Tel: +1 516-624-2500
www.abiresearch.com

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