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A Perspective on Multi-Access Edge Computing

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Overview

The convergence of the Internet and telecommunication networks is igniting a debate on how to cost effectively meet the performance requirements of different services. Edge Computing, which places compute and storage resources at the edge of the network, is a technology at the heart of this debate. It promises to bring many benefits to end users, but its implementation in mobile networks has to overcome a number of challenges.

The interest in Edge Computing is enforced by the emergence of 5G wireless access technology with applications in varied vertical markets such as automotive, health, energy, education and many others. This widens the addressable market for service providers beyond the traditional consumer-centric business model. This is a fundamental shift that affects many aspects of business operations.

Key Takeaways

1. Edge Computing is necessary to meet the requirements of 5G applications and allows service providers to address the needs of vertical markets.

2. Implementation of Multi-access Edge Computing is coupled with a compelling business case that is absent today as service providers develop their strategy on how to best address vertical markets.

3. Equipment vendors must remain flexible on how to implement MEC in order to meet a range of potential applications with varying requirements and market potential.

In our analysis of Multi-access Edge Compute (MEC) – the implementation of Edge Computing in wireless networks – we conclude that mobile network operators (MNOs) are still debating which approach to take. Some view MEC as integral part of 5G networks where it would be coupled with a new network architecture. Others view MEC as a tactical expediency in certain applications. A strategic view of MEC and its role in the network is missing to date, largely due to the multitude of applications and beneficiaries.

Equipment vendors are making provisions for MEC in the design and architecture of their solutions. Vendors have embraced a flexible network architecture that centralizes specific functions of the radio access network to improve performance of heterogeneous networks. This is coupled with steady progress in network virtualization that will facilitate the implementation of MEC. Nevertheless, vendors have a major challenge in getting the value proposition of MEC fully exposed, due to the existence of a large number of use cases and stakeholders of MEC.

The applications for MEC correlate closely with vertical markets, which have different service requirements. As a result, the implementation of MEC could accelerate with market adoption of these applications and technologies: IoT connectivity, small cells, new spectrum regimes, and technologies such as virtualization and network slicing. Such technologies raise the opportunity for third parties to deploy MEC in private networks, independent of the mobile network operators. Hence, MEC becomes an integral part of a service offering that differentiates from that provided by MNOs. Therein lies an opportunity for new entrants to leverage flexible business models.

MEC Definition

MEC moves compute and storage functions closer to the end user at the edge of the network and away from the core (Figure 1). This improves the response time of applications (reduces latency) and reduces the amount of data traversing the transport network between the core and the MEC server location. Distributing compute and storage results in additional cost to the service provider. Consequently, the location and sizing of compute and storage elements are key design factors that need to be carefully balanced.

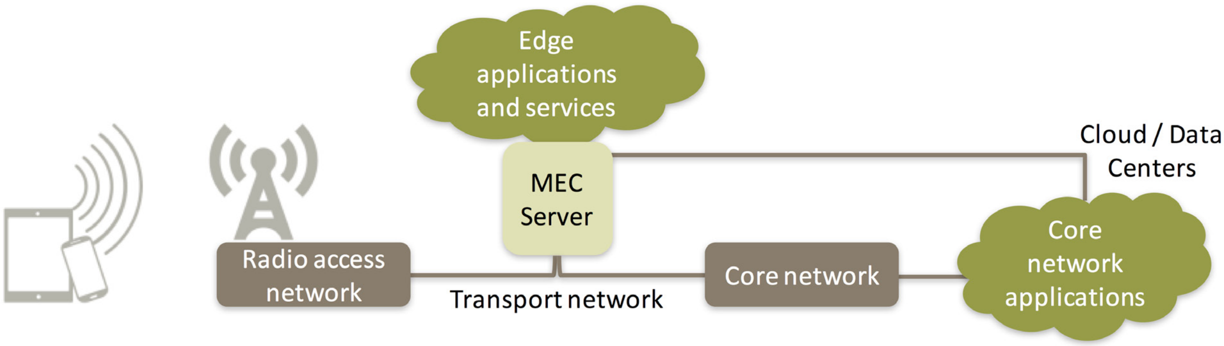

Figure 1: MEC architecture overview.

MEC impacts the architecture of the mobile network, which centralizes important functions such as billing and legal intercept. Having compute and storage capability at the edge entails a non-trivial expansion of these functions to the network edge, particularly within the framework of today's highly distributed LTE networks.

The Applications

Applications that benefit from MEC include those with one or more of the following requirements:

- High responsiveness, low latency and near real-time operation
- Data caching
- Context-aware services
- Location-aware services
- Heavy computation applications
- Data transformation and transcoding
- Extended battery operation

This includes the following applications:

- Enterprise applications including asset tracking, video surveillance and analytics, local voice and data routing.
- Augmented and virtual reality.

- Multimedia content delivery where video can specifically benefit from caching and transcoding.
- Retail services including ad delivery and footprint analysis in shopping malls among other applications.
- IoT applications which can be divided into two categories:

a) Massive IoT connectivity where MEC streamlines device connectivity with the core network to reduce overhead communications and improves response time.

b) High-responsiveness applications where low latency is critical. This includes smart grid switching of power and alternative energy supplies, and fault detection applications.

- Critical communications: this category includes multiple applications in various sectors

a) Traffic safety and control systems.

b) Precision farming using autonomous vehicles and real-time analytics.

c) Industrial IoT applications for monitoring and time-critical process control.

d) Automotive applications related to hazard warning and cooperative autonomous driving.

e) Healthcare applications requiring high responsiveness.

Many of the above applications can only be implemented with MEC, the only way to provide sub 1 msec compute to the network edge.

MEC Drivers and Dependencies

MEC integrates with a number of technologies leading to a scenario of mutually enforcing adoption. Thus, the greater traction these technologies attain in the market, the more relevant MEC would be over and beyond its baseline. The following technologies help define the future for MEC:

1) **Network virtualization:** network function virtualization (NFV) and software defined networking (SDN) are two key technologies whose implementation significantly reduces the barriers to entry for MEC. Specifically, the application of NFV in the radio access network (RAN) is important. The major vendors have embarked on a process of redefining their RAN solution architecture to incorporate NFV and to readily provide a platform for MEC implementation.

2) **Small cells and heterogeneous networks:** MEC allows customized services in various use cases such as enterprise and venue applications (e.g. shopping malls, stadiums, and airports). The emergence of shared spectrum regimes such as the 3.5 GHz Citizen Broadband Radio Service (CBRS) provides a market opportunity for small cell networks to ramp up. Similar scenario can be expected with unlicensed band LTE technology (MuLTEfire). Small cell networks in shared and unlicensed spectrum need not be deployed by the MNOs, but can be deployed by private enterprises thus creating an opportunity to offer differentiating services.

3) **IoT connectivity:** Applications in the Industrial Internet is a major potential driver for MEC as it allows support for lower cost devices that packs less processing than otherwise required (i.e. thin devices). This results in lower latency and faster response. Applications in Industrial Internet have specific requirements related to latency, location, processing, etc. that MEC could fulfil effectively.

4) **Network Slicing:** This is a 5G technology that relates to provisioning instances or personalities of the network to serve applications with specific performance criteria. Network slicing leverages network virtualization concepts to create or remove network slices based on demand. While the full implementation of this technology is still a few years away, it integrates well with MEC where both technologies contribute to meeting the quality of service and experience subscribed to by the user.

The MEC Ecosystem & Business Case

Unlike other technologies, MEC opens up the possibility to change the telecom value chain by inserting new players including the MEC service provider and application developers (Figure 2). It also offers the potential to change how content providers and OTT players deliver their services. MEC allows service providers to capitalize on new business opportunities, such as applications catering to vertical market requirements, which leads to new business dynamics among players in the value chain.

For instance, MEC allows OTT and content providers to offer better service to end users, but the cost of the MEC infrastructure is borne by the service provider. How the future relationship between OTTs and content providers with telecom and MEC service providers will shape up is an open issue with multiple possible outcomes depending on the application.

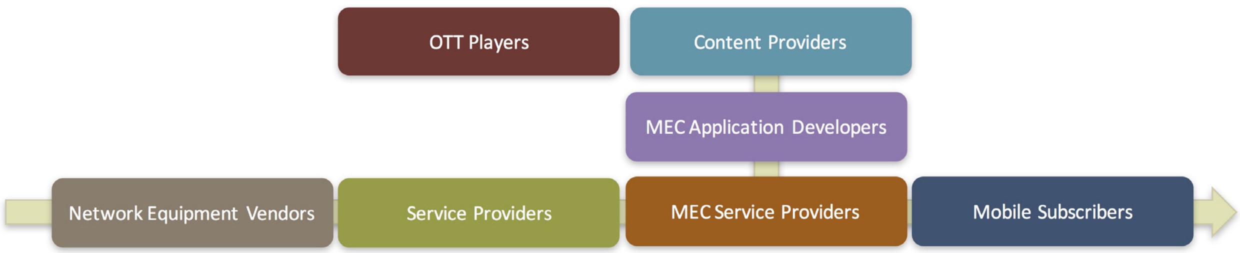

Figure 2: MEC value chain.

The business case for MEC has high variance where, in addition to the wide range of possibilities on the revenue side, there is a wide variance in cost. The major factor for cost for MEC is the proximity of MEC servers to the network edge. More servers located at the network edge will result in increased performance, and cost. On one extreme, MEC servers can be placed at every base station. But this leads to the highest cost of deployment while leaving the number of users benefiting from MEC limited to those served by that base station. To address this, 5G networks are being architected to support multiple hierarchies whereby the MEC servers can be placed at an aggregation point between the core and the base station. Such an architecture captures the benefits from central offices that some service providers have, and is the central premise behind project such as Central

Office Re-architected as Data Center (CORD) and Mobile-CORD (M-CORD). Alternatively, it is possible to leverage the small cell gateway or controllers in heterogeneous network deployments (Figure 3).

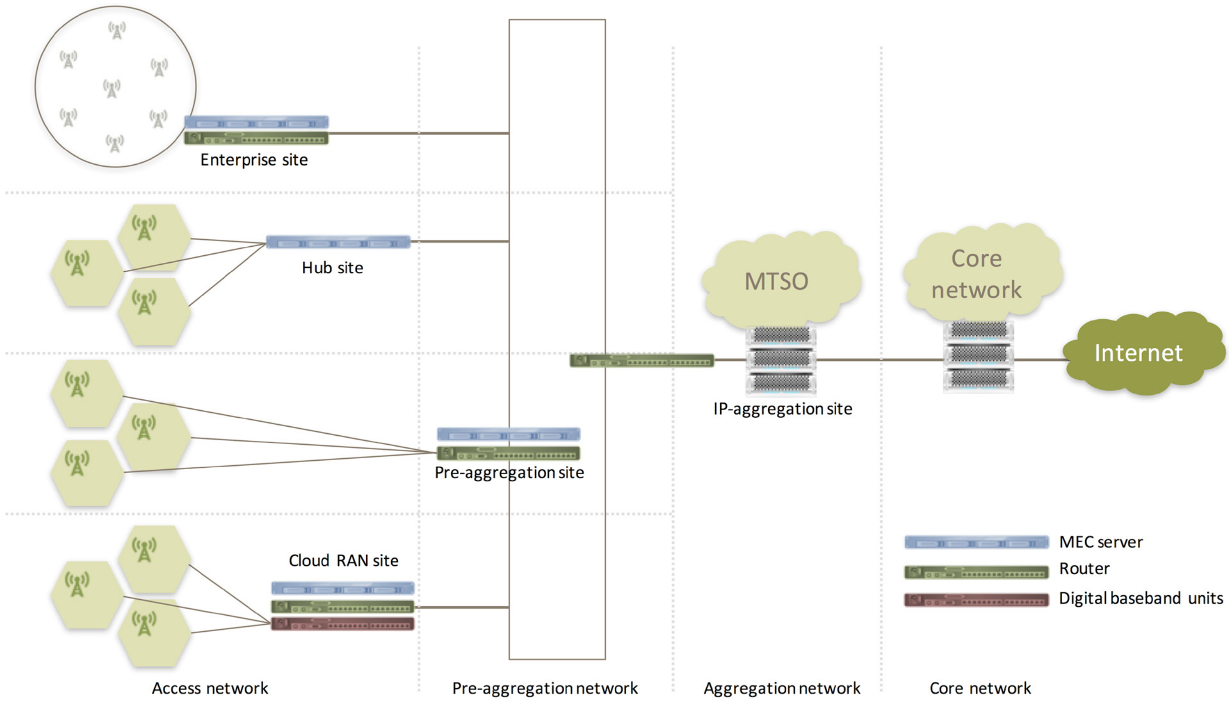

Figure 3: MEC deployment scenarios.

Challenges to MEC Implementation

There are a few commercial and technical challenges to implementing MEC. Of the technology challenges, we note specifically:

1) Technical compatibility with the current network architecture. For instance, functions such as billing and legal intercept are located in the core network. However, MEC fractures that architecture as data flow does concentrates at the edge and does not reach the core. The question is then how existing networks would be re-architected to leverage the benefits of MEC?

2) Ensuring security and network integrity in order to provides an open environment for third party application developers to run services on the telecom service provider infrastructure.

3) Maintaining service over a number of radio access technologies that characterizes heterogeneous networks, such as LTE, Wi-Fi and future 5G technologies.

As for commercial challenges, the issues today concentrate on highlighting the business case for an open MEC environment to both service providers and potential beneficiaries of MEC such as enterprises. This cannot be done in isolation of the application on hand and is specific to different vertical players which makes the market evolution of MEC very selective. Another issue relates to the handling of content including digital rights and content access management, and encryption and storage of the content within the network.

Conclusions

Edge Computing is a necessary architecture to meet 5G requirements, and enables service providers to enter vertical markets. This makes Edge Computing a cornerstone architecture for any service provider with plans to serve vertical markets. MEC, which represent the implementation of Edge Computing in wireless networks, is an evolving architecture that benefits existing 4G networks as well. While equipment vendors develop solutions that accommodate Edge Computing, service providers remain undecided on their approach to MEC. A chief reason for this is the absence of validated applications and a compelling value proposition for prospective customers. Virtualization of the wireless networks will positively impact the implementation of MEC as it reduces the barrier to entry. Moreover, the advent of applications such as private networks will play a positive role in accelerating the adoption of MEC.

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