

Enabling applications at the edge of the 5G network

White Paper

Multi-access Edge Computing (MEC) is rapidly becoming established as an essential mobile network technology for improving the customer experience and supporting new business opportunities, especially under the Internet of Things.

Placing cloud computing capabilities at the edge of the network, close to the users, enables the delivery of ultra-low latency, very high throughput services. MEC is an essential component of future 5G networks and the 3GPP has already defined key enablers. This white paper looks at how these enablers can be used to integrate MEC into 5G architecture.

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1. Executive Summary

Multi-access Edge Computing (MEC) is a key enabler of future 5G networks which will help operators to address a much wider range of use cases and business opportunities than ever before. Even today, ahead of the deployment of 5G networks, a growing number of operators are deploying MEC to provide ultra-responsive, high bandwidth, locally-relevant and highly personalized services to their customers.

In a sports stadium, for example, augmented reality or virtual reality services showing the action on the pitch in new ways and high-resolution video replays can be provided to spectators, differentiating the customer experience and generating new revenue for the operator. MEC will also be a vital technology in supporting demanding Internet of Things (IoT) applications in industrial settings and across smart cities.

The 3GPP has already defined many of the key enablers of the MEC architecture, built around the fully software-based approach of 5G.

This white paper describes some of the key use cases that can be addressed by MEC, describes how MEC is integrated in 5G architecture and how to use the enablers specified by 3GPP in its Next Generation work.

2. MEC creates revenue and customer experience opportunities

MEC is widely seen as a powerful technology that can improve the mobile communications experience, cost-effectively support demanding IoT applications and provide new ways to maintain network performance and the customer experience.

The customer experience is greatly improved by MEC's ability to deliver real-time mobile services that use context information and location awareness to create a high degree of personalization. These services can also be more responsive because of the ultra-low latency achieved by locating computing resources near to the point of use. Popular and locally-relevant content can be delivered from exactly where users consume it.

The reduced latency, high bandwidth and local context can also support the needs of critical communications and IoT applications that demand robust and highly responsive connectivity.

Meanwhile, access to a real-time network and context information, supported by real-time analytics, can be used to optimize network and service operation and proactively maintain the customer experience. The network operator can also benefit from IT economies of scale that enable proximity, context, agility and speed to be used for wider innovation, creating further value and revenue generation.

MEC is already being deployed by many operators on today's 4G networks to deliver new services to multiple sectors and create innovative business opportunities. It opens

opportunities for collaboration and is proving to be a powerful catalyst for innovation.

2.1 MEC is a foundation technology for 5G

The coming 5G era provides another compelling reason to deploy MEC today. 5G takes a full software approach that will transform networks into programmable, software-driven networks capable of supporting extremely diverse use cases. It will use technology enablers, such as Network Functions Virtualization (NFV) and Software-defined Networking (SDN), to enable the efficient and scalable distribution of network functions, splitting the user from the control planes.

MEC is a key enabler and architectural concept for 5G, helping to satisfy 5G throughput, latency, scalability and automation targets. It offers additional privacy and security and ensures significant cost efficiency. Several 5G use cases can already be enabled with MEC. Integrating MEC into 5G architecture will create added value, ensuring efficient network operation, service delivery and a highly personalized customer experience.

3. The basic building blocks of MEC

MEC implements cloud-computing and IT capabilities at the edge of the network, close to users, thus becoming the “cloud” for real-time and personalized mobile services.

The MEC system comprises MEC Application Enablement, Application Programming Interfaces (APIs) and management capabilities to run applications as software-only entities within a network or part of a network.

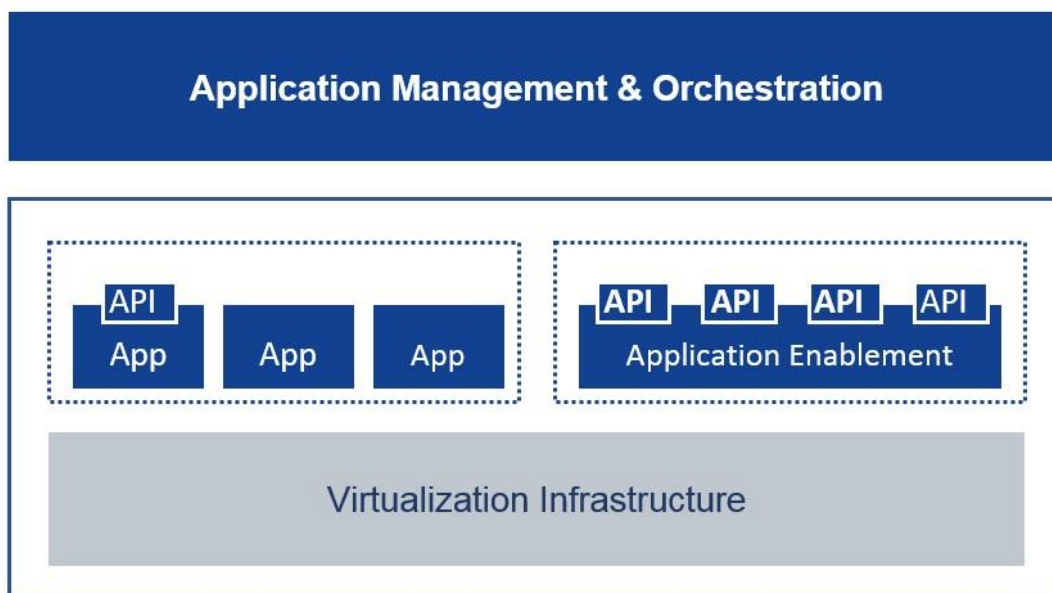


Figure 1: the MEC application enablement framework

MEC Application Enablement enables authorized applications to access the operator network, lets them run within the network and consume network and context information via the APIs. It can run on an add-on network element, sharing the virtualization resources with other network functions or applications, or on a standalone host with virtualization resources dedicated to MEC.

The flexible, efficient, multi-tenant, run-time hosting environment comprises hardware resources and a virtualization infrastructure that provides virtual compute, storage and network resources to run the applications.

MEC Application Enablement provides the following functions:

- Registration, announcement, discovery and notification of services
- Authentication and authorization of applications that provide and use services
- Communication support for services (query/response and notifications).

3.1 The role of APIs

A few service-related APIs have already been specified and published, including Radio Network Information (RNI) ([Link to GS MEC 012](#)), Location Information ([Link to GS MEC 013](#)), MEC Bandwidth Management and User Equipment (UE) identity.

The RNI API is used by applications to optimize the network and service operation and proactively maintain the customer experience. RNI data can also be used, for example, when a UE mobility event occurs that requires application relocation. The information is then used to optimize the application relocation process.

Location information can help to locate UEs and provide insight into how crowds are distributed. It can be used by smart-city applications, for example optimizing transportation or for utility planning. Advertising can also intelligently use location services. Geo-fencing can use location information to provide a service available only in a specified geographical area.

The MEC management and orchestration functions aid the running of applications at the correct location at the right time, based on technical and business requirements.

The architecture supports flexible deployment of MEC according to the needs of the application, such as the required latency, available virtualized resources, the features required to run the application, connectivity requirements, geographic reach, UE support, mobility and service continuity. Commercial demands, such as cost and business models, can also influence the decision on where to deploy MEC.

4. Deploying MEC to support different use cases

MEC can be deployed as required to meet the network operator's business objectives.

Some of the many opportunities for deploying MEC include:

- At hotspots to support special services in stadiums, exhibitions, malls and enterprise campuses.
- At metro-aggregation sites and baseband hotels to support city-wide applications
- At distributed data centers or in specific deployment patterns, as well as in a centralized data center to support network-wide applications.

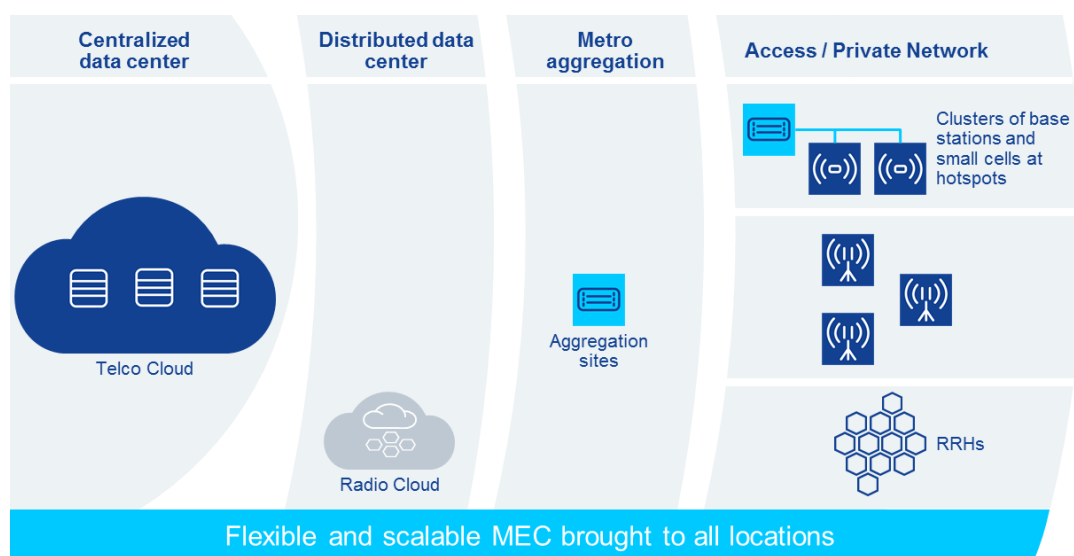


Figure 2: MEC has a wide range of deployment options

4.1 City edge MEC deployment

Applications that need coverage across a whole city can be supported by MEC deployed at a higher tier in the network topology, for example at a traffic aggregation point or at a site where baseband capacity is pooled. City-wide applications could include video analytics used across the city, or an IoT application to monitor smart city infrastructure.

City edge distributed MEC is expected to be one of the main deployment scenarios for 5G networks. At the city edge, MEC can support low latency services, for example car-to-X to improve safety and support autonomous driving within a city area. MEC can also support smart city functions by connecting numerous IoT devices as an IoT gateway. In addition, MEC content caching can support the efficient and fast delivery of advanced content, like 4/8K video streaming or augmented reality to many 5G users while reducing the impact of heavy data traffic on the external transport network.



Figure 3. Distributed MEC city edge deployment to provide high availability, support many simultaneous users (potentially millions), transfer large amounts of data and support ultra-low latency services

4.2 Centralized MEC

Network-wide applications include network probing and traffic optimization, which can be supported by MEC deployed at a higher network tier for broad coverage with lower deployment and operational costs.

Centralized MEC is located relatively far from the radio access point and thus delivers services that do not have strict latency requirements or require local context. These include video or health services, and favorite content caching, such as Google accelerator, which avoids the frequent transfer of content over a long distance. Centralized MEC can be deployed at core sites which also host the User Plane Function (UPF) and provide peering points to the internet.

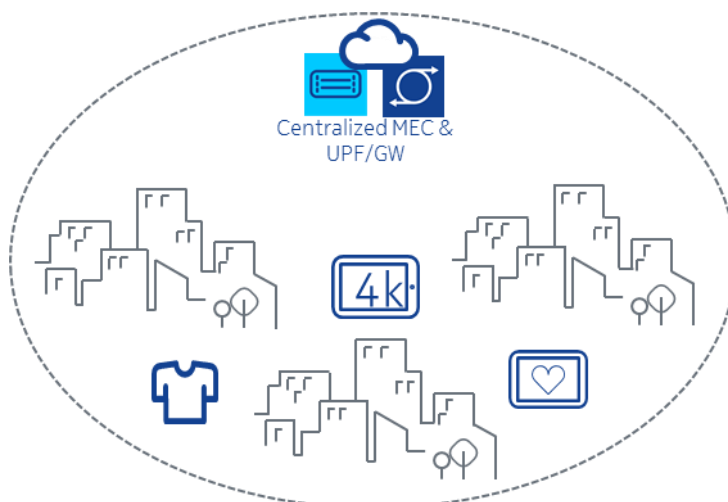


Figure 4: Centralized MEC deployed at a peering point to serve a defined geographical area with high availability, support for a very large number of simultaneous users (up to tens of millions) and to support very high data traffic volume

4.3 Enterprise and local venues

Where a high degree of locality is needed, including services in stadiums, exhibition halls, malls, transportation hubs and enterprise campuses, MEC applications are best deployed close to the small cells, macro cells or Wi-Fi access points near to or within a venue or site. Small scale distributed MEC provides locally-relevant services to enterprises and venues. For example, a sports stadium could use MEC to provide high quality video clips from the event to spectators. An airport could use MEC for advertising, location and virtual reality. An industrial plant could use MEC for video surveillance and as an IoT gateway for connecting IoT devices. A campus or conference center could offer local services to residents and visitors. Distributed MEC is deployed close to the actual venue and within the venue, for example, an enterprise or stadium.

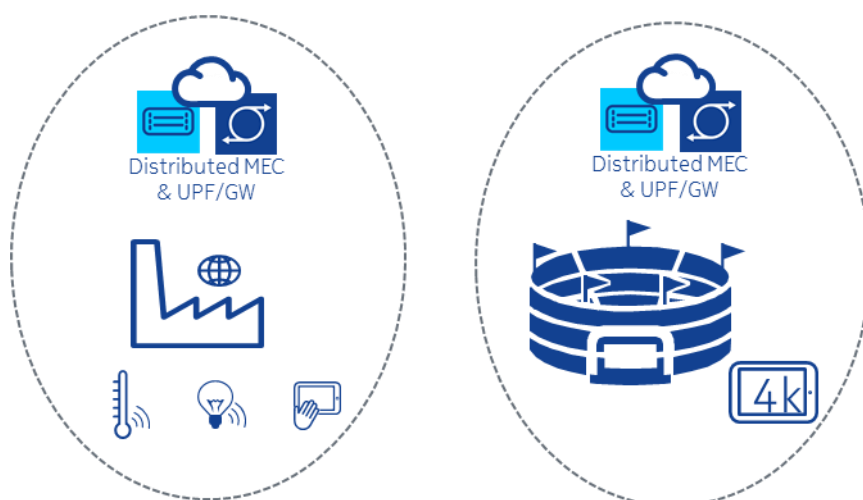


Figure 5: Distributed MEC deployed at a local venue to focus on local content requiring high availability, with a moderate number of simultaneous users (from hundreds up to 100,000), carrying moderate to large amounts of data traffic, possibly delivering ultra-low latency, and easy interworking with local content provider solutions

Public transport, like air and rail travel, may also benefit from MEC deployment as enterprise cases with special requirements. For example, caching favorite content (news, video clips) to users or providing ultra-high quality in-flight movies to passengers on inter-continental flights.

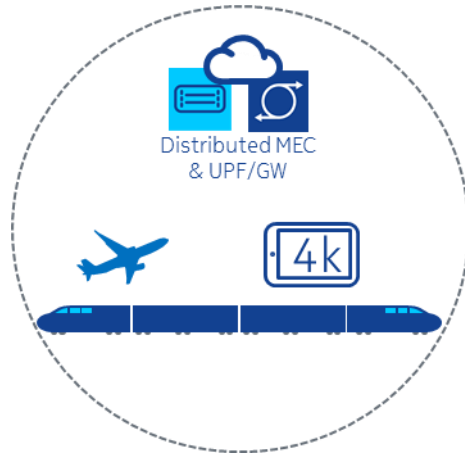


Figure 6: Distributed/local MEC for public transport to support a moderate number of users and traffic (e.g. a 'jumbo' jet with 500 users), offering railway grade hardware (as defined in EN 50155), with high availability and hosted on the same platform as 5G / WLAN Controller for a compact installation

5. 3GPP specifies the key enablers of MEC for 5G

As a core component of the future 5G system, 3GPP is working to integrate it into the next generation architecture.

3GPP has selected a generic approach and defined an Application Function (AF) that uses various capabilities of other 3GPP network functions. MEC as an AF would be able to use all the capabilities it needs.

The 3GPP 5G architecture locates MEC at the Edge Cloud. The first UPF steers the traffic intended for the local Data Network (DN) according to configured traffic rules. On the control plane, the MEC application enablement platform uses the APIs offered by 3GPP network functions.

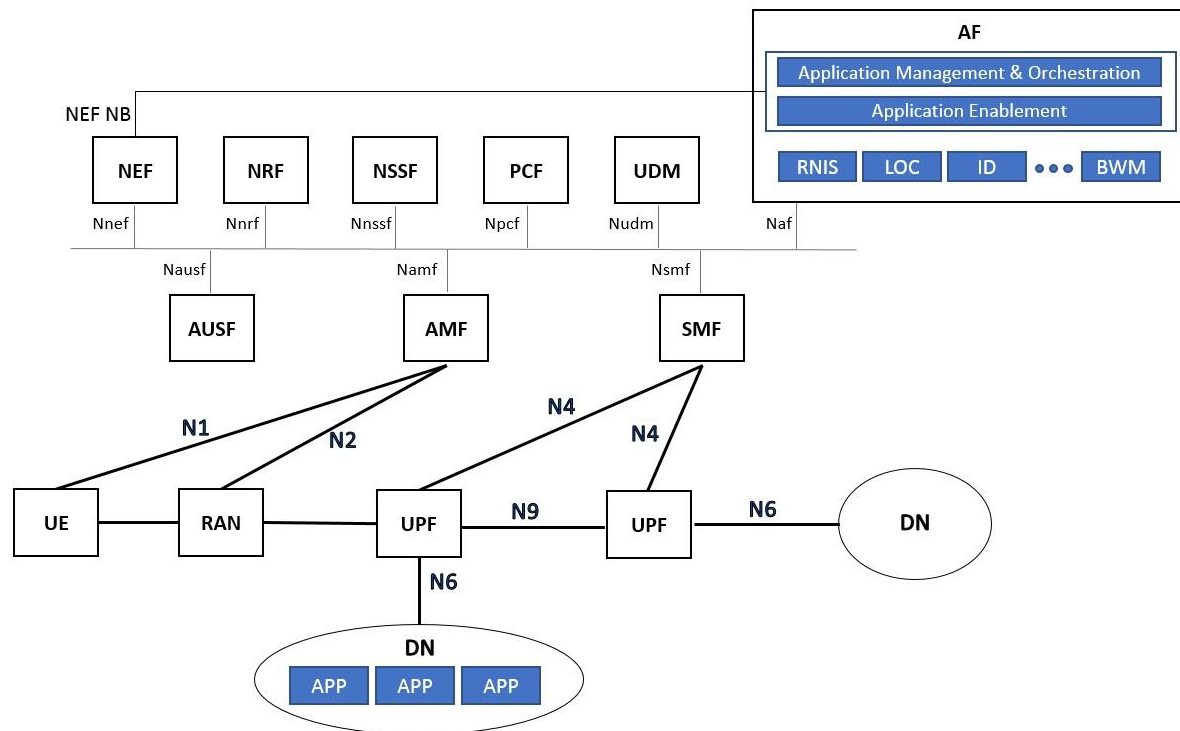


Figure 7: MEC in 5G Architecture

Another way to illustrate MEC integration in 5G is shown in the high-level overview of MEC in 5G in Figure 8. Here, MEC is deployed in Edge and Central clouds and uses APIs offered by core functions and the Network Exposure Function (NEF).

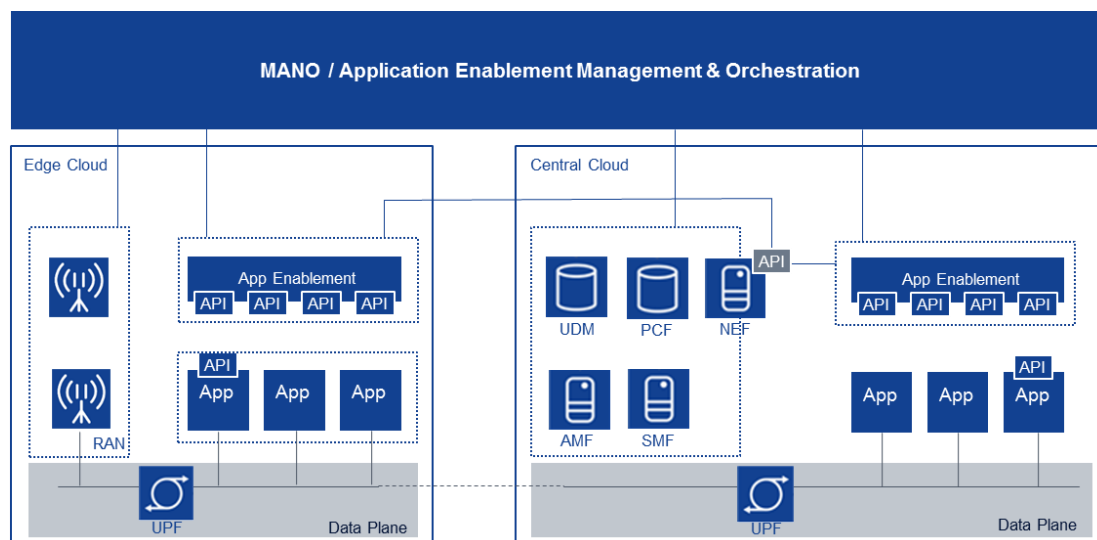


Figure 8: MEC in 5G distributed cloud

However, defining MEC simply as an Application Function is not sufficient, because many different functions are needed. Thus, 3GPP specification TS 23.501 on 5G system architecture defines the following functions needed to enable a flexible and efficient MEC solution:

- Concurrent access to Local DN and Central DN in a single Packet Data Unit (PDU) session
- Session Management Function (SMF) sending the traffic handling rules to UPFs
- Selection of UPF for a PDU session close to the UE
- Selection of a new UPF based on UE mobility events
- MEC can request traffic steering locally for a single UE or a group of UEs
- Network capability exposure to allow MEC to request information about UE or request actions towards the UE
- Mobility event triggers from SMF to MEC
- Charging support for locally steered traffic
- Location Information support for locally steered traffic
- Indication to UEs about Local Access Data Network (LADN) availability for MEC services offered in specific locations

Many services offered over MEC are configured from the network and therefore transparent to the user. To access data services, the user has a single PDU session that needs to have concurrent access to the local DN and central DN to enable MEC. This is achieved by placing an additional UPF close to the UE's point of attachment. The user plane data traffic that needs to be routed to a local DN can then be configured to the local UPF by the Session Management Function (SMF).

MEC as an AF can request configuration of the traffic routing either via the Policy Control Function (PCF) or directly from the SMF, based on the policy enforced. The configuration request can be either for a single user (UE) or group of UEs.

Service continuity is essential for users and involves actions from both the mobile network and the MEC system. When a user moves out of a UPF service area, a new UPF needs to be allocated and configured for the UE. The MEC can request information about UEs from the Network Exposure Function (NEF) and, based on received information, request further actions towards the UEs. In addition, the SMF may send indications about mobility events to the MEC system, which can then trigger procedures to reconfigure traffic routing or to relocate applications to a new DN.

Some MEC services may be offered only in specific locations, for example in sports stadia and arenas. Such services can be offered from the local DN over a dedicated PDU session. The 5G system architecture will support visibility of local services by indicating LADN availability to users in the service area.

6. Conclusion

MEC has been identified as critical building block in 5G architecture as it can satisfy the demanding throughput, latency, scalability and automation requirements expected for the 5G era. MEC enables applications to be hosted in a distributed cloud and offers a framework for Service Based Architecture (SBA).

With MEC, services can be both offered and consumed in the most appropriate locations within the network, both in the edge cloud and central cloud. MEC also offers a framework for managing and orchestrating apps in the required locations based on technical and business parameters.

While MEC can already be used with existing networks, 5G architecture is being designed to support MEC. The approach taken by 3GPP focuses on specifying the necessary enablers that allow application functions such as MEC to use the services offered by the system. In this way, MEC can be fully integrated into the 5G system.

Abbreviations

3GPP	3rd Generation Partnership Project
AF	Application Function
API	Application Programming Interface
DN	Data Network
IoT	Internet of Things
LADN	Local Access Data Network
MEC	Multi-access Edge Computing
NEF	Network Exposure Function
NFV	Network Functions Virtualization
PCF	Policy Control Function
PDU	Packet Data Unit
RAN	Radio Access Network
RNI	Radio Network Information
SBA	Service Based Architecture
SDN	Software Defined Networking
SMF	Session Management Function
UE	User Equipment
UPF	User Plane Function



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