



GROUP SPECIFICATION

Mobile-Edge Computing (MEC); Service Scenarios

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Reference

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Foreword

This Group Specification (GS) has been produced by ETSI Industry Specification Group (ISG) Mobile-Edge Computing (MEC).

Modal verbs terminology

In the present document "**shall**", "**shall not**", "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the [ETSI Drafting Rules](#) (Verbal forms for the expression of provisions).

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Introduction

Mobile-Edge Computing provides IT service environment and cloud-computing capabilities within the Radio Access Network (RAN) in close proximity to mobile device. MEC aims to reduce latency, ensure highly efficient network operation, service delivery and ultimate personal experience. The term "Edge" in this context means the radio base station itself (eNodeB, RNC, etc.), and servers within the radio network (e.g. at "aggregation points"). The presence of MEC server at the edge of the RAN allows exposure to real-time radio and network information (such as subscriber location, cell load, etc.) that can be leveraged by applications and services to offer context-related services; these services are capable of differentiating the mobile broadband experience.

The Mobile-Edge Computing environment creates a new value chain and an energized ecosystem, which in turn can create new opportunities for mobile operators, application and content providers whilst enabling them to play complementary and profitable roles. Based on innovation and business value, this value chain will allow all players to benefit from greater cooperation and better monetize the mobile broadband experience.

Mobile Operators can open up the radio network edge to third-party partners, allowing them to rapidly deploy innovative applications and services towards mobile subscribers, enterprises and other vertical segments.

For application developers and content providers, the RAN edge offers a service environment with ultra-low latency and high bandwidth as well as direct access to real-time radio and network information. Mobile-Edge Computing allows content, services and applications to be accelerated, increasing responsiveness from the edge. The customer experience can be proactively maintained through efficient network and service operations, based on insight into the radio and network conditions.

Network vendors and technology providers can provide RAN equipment and base stations enhanced with cloud-computing capabilities, by offering more powerful and flexible network elements able to satisfy the increasing needs of the communication world.

The goal of the present document is to describe some service scenarios that can be delivered through the use of Mobile-Edge Computing. These serve as examples of how MEC can stimulate innovative services and applications that would create a better quality of experience for the end user. MEC will enable a large number of new kinds of applications and services for multiple sectors (such as consumer, enterprise, health, etc.).

1 Scope

The present document introduces a number of service scenarios that would benefit from the introduction of Mobile-Edge Computing (MEC) technology. Mobile-Edge Computing enhances the Mobile Access Network with MEC servers that enable applications to run in the mobile edge. Due to the proximity of the server into the Access network, there is a latency reduction of delivering such applications or services. Such applications can expose information that can be used to optimize the network and services, reduce latency, and support creating personalized and contextualized services. Moreover, new and innovative analytics services enable the operator to monitor usage and service quality. Internet of Things (IoT) applications or enterprise communications can benefit greatly from MEC, as it allows service delivery in close proximity to the actual terminal devices.

The focus of the present document is to introduce or provide a non-exhaustive set of service scenarios. It is not the intent nor does the present document provide any requirements.

2 References

2.1 Normative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

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Not applicable.

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The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

Not applicable.

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

analytics: processing which makes use of data to provide actions, insights and/or inference

augmented reality: live direct or indirect view of a physical, real-world environment whose elements are enhanced, or supplemented, by computer-generated sensory

Internet of Things (IoT): device, machine or entity connected to any other device, machine or entity through a network

vehicle: human transport including automobile, car, truck, plane, train, motorcycle

3.2 Abbreviations

For the purposes of the present document, the following abbreviations apply:

DSRC	Dedicated Short Range Communications
IoT	Internet of Things
IP-PBX	Internet Protocol Private Branch Exchange
LAN	Local Area Network
LTE	Long Term Evolution
MEC	Mobile-Edge Computing
PBX	Private Branch Exchange
QoE	Quality of Experience
RAN	Radio Access Network
RNC	Radio Network Controller
TCP	Transmission Control Protocol
WLAN	Wireless Local Area Network

4 Service scenarios

4.1 Intelligent video acceleration service scenario

4.1.1 Description of scenario

Eliminating mobile content delivery inefficiencies by guiding sources as to real-time network capacity.

A Radio Analytics application located at the RAN provides the video server with an indication on the throughput estimated to be available at the radio downlink interface. The information can be used to assist TCP congestion control decisions and also to ensure that the application-level coding matches the estimated capacity at the radio downlink.

4.1.2 Motivation

Improve the end user's Quality of Experience (QoE) by reducing the content's time-to-start as well as video-stall occurrences, and guarantee maximum utilization of the radio network's resources.

4.1.3 Problem statement

The behaviour of the Transmission Control Protocol (TCP), which assumes that network congestion is the primary cause for packet loss and high delay, can lead to the inefficient use of a cellular network's resources and degrade application performance and user experience.

The root cause for this inefficiency lies in the fact that TCP has difficulty adapting to rapidly varying network conditions. In cellular networks, the bandwidth available for end devices can vary by an order of magnitude within a few seconds due to changes in the underlying radio channel conditions, caused by the movement of devices, as well as changes in system load when other devices enter and leave the network.

4.1.4 Relation to MEC

Figure 1 shows an example of the intelligent video acceleration service scenario. In this scenario, a Radio Analytics application, which resides in a MEC server, provides the video server with a near real-time indication on the throughput estimated to be available at the radio downlink interface.

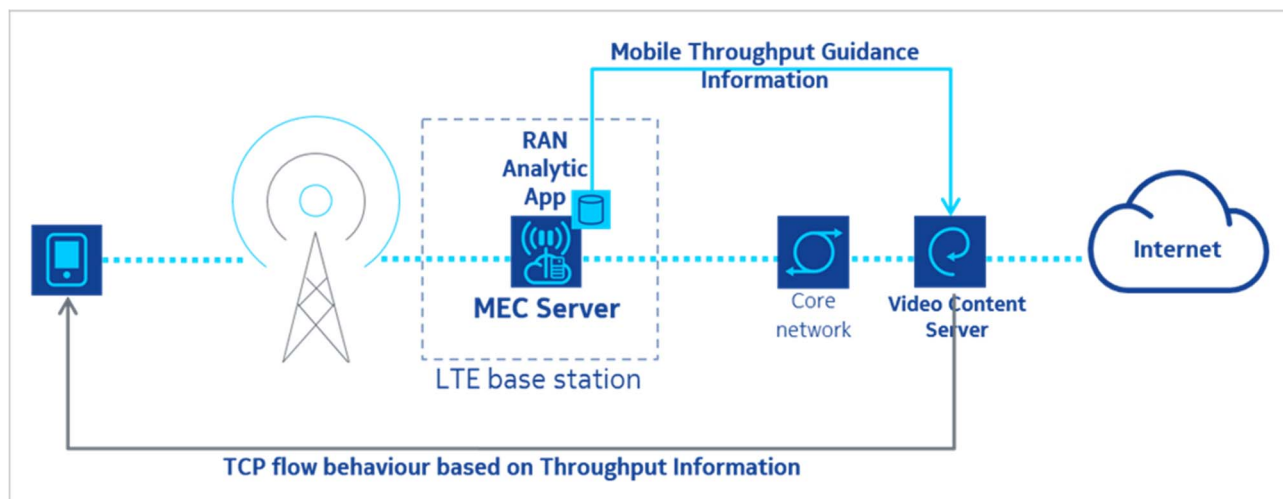


Figure 1: Intelligent Video Acceleration

The video server may use this information to assist TCP congestion control decisions, for example in selecting the initial window size, setting the value of the congestion window during the congestion avoidance phase, and adjusting the size of the congestion window when the conditions on the "radio link" deteriorate. In other words, with this additional information, TCP does not need to overload the network when probing for available resources, nor does it need to rely on heuristics to reduce its sending rate after a congestion episode.

This information may also be used to ensure that the application level coding matches the estimated capacity at the radio downlink. The aim of all of these improvements is to enhance the end user's quality of experience by reducing the content's time-to-start as well as video-stall occurrences, and to guarantee maximum utilization of the radio network's resources.

Mobile-edge Computing allows the Radio Analytics application to be deployed on top of platforms implemented by different vendors and across multi-operator networks. This ensures efficient utilization of the network resources in addition to enhanced quality of experience for the vast majority of end users.

4.2 Video stream analysis service scenario

4.2.1 Description of scenario

Consider a video based monitoring system such as vehicle license plate recognition for example to monitor vehicles entering and exiting an area of the city, car parks, for security purposes, etc. License plate information can be captured and sent to a cloud based monitoring service. It may be useful to extract other information from such video streams.

4.2.2 Motivation

Moving the video analysis away from the video camera reduces the cost of such cameras, especially when numerous cameras need to be deployed. Furthermore, performing the analysis locally, i.e. close to the mobile base station, mitigates the need to transmit high data video streams when only small pieces of information are required to be extracted from these video streams.

4.2.3 Problem statement

Currently, video based monitoring either requires video streams to be sent to a server or for video processing to be done at the same site as the camera. Both methods are costly and inefficient when compared to processing video data at a MEC server in order to extract meaningful data from video streams. The valuable data can then be transmitted to the application server without the need to transport high data rate video streams.

4.2.4 Relation to MEC

The use of a MEC server is highly advantageous in allowing flexibility on the analysis performed on video streams, especially compared with video processing done at source (at the camera site). Additionally, it saves from transporting potentially numerous high data video streams through the core network to cloud based services.

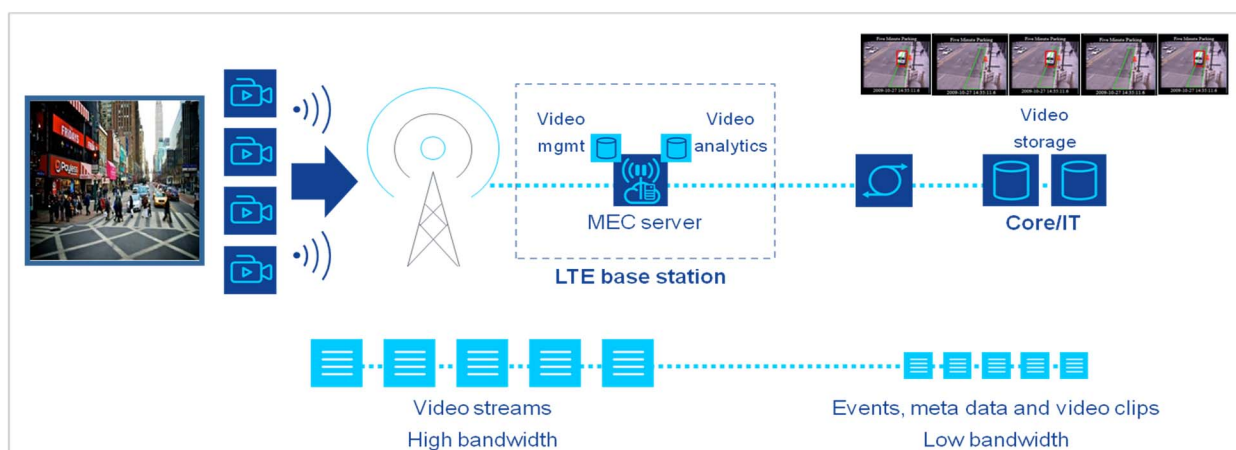


Figure 2: Video stream analysis

4.3 Augmented reality service scenario

4.3.1 Description of scenario

A visitor to a museum, art gallery, city monument, music or sports event holds their mobile device towards a particular point of interest with the application related to their visit activated (i.e. the museum application). The camera captures the point of interest and the application displays additional information related to what the visitor is viewing.

4.3.2 Motivation

Augmented reality can enhance the experience of a visitor to a museum or another point of interest. Augmented information pertaining to a point of interest is highly localized and thus hosting the information locally is advantageous compared with hosting in the cloud.

4.3.3 Problem statement

Augmented reality service requires an application to analyse the output from a device's camera and/or a precise location in order to supplement a user's experience when visiting a point of interest by providing additional information to the user about what they are currently experiencing. The application needs to be aware of a user's position and the direction they are facing, either through positioning techniques or through the camera view, or both. After analysing such information, the application can provide additional information in real-time to the user. If the user moves, the information needs to be updated.

4.3.4 Relation to MEC

The use of a MEC server is highly advantageous since augmented reality information is highly localized. Additionally, the processing of user location or camera view can be performed on a MEC server rather than on a more centralized server. There may be a need to update information at a fast rate, depending on how the user moves, and the context in which the augmented reality service is used (e.g. in an art gallery, exhibits are positioned only a few metres apart and each piece is supplemented with additional text on the artist, the interpretation of the artwork, etc.). In other words, augmented reality data requires low latency and a high rate of data processing in order to provide the correct information to the user's device depending on the location and orientation of the user.

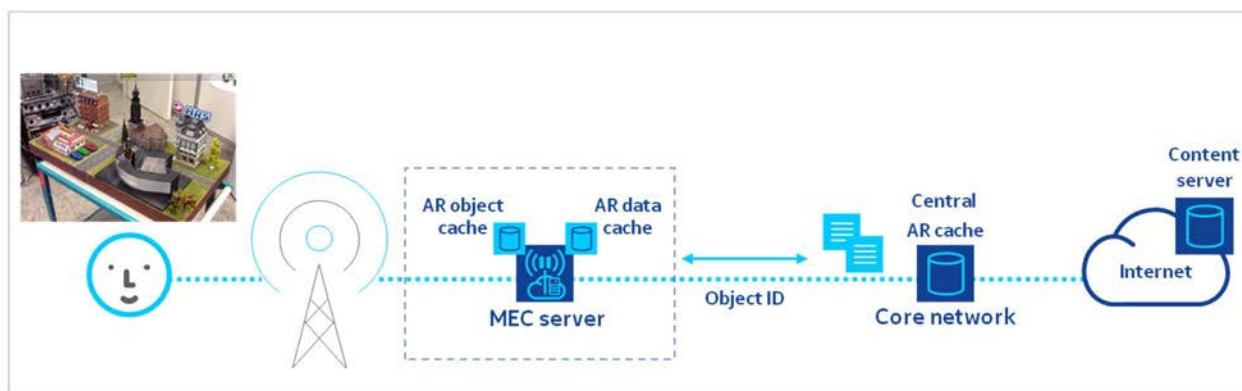


Figure 3: Augmented reality

4.4 Assistance for intensive computation

4.4.1 Description of scenario

In order to maximize battery life and simplify a device or sensor in order to make it low cost, intensive computation and decision making may be offloaded to the network. In some cases, such devices may also require information from other remote sources which is fed into the data processing required to do some decision making which is then fed back to the device. One example could be a robotic device that encounters an object and is required to perform image recognition. The image details are communicated to the server which returns a result. The robot might be instructed to perform an action on the object, e.g. if the object is a ball, kick it with your right leg. Gaming, environmental sensors and security applications could be other examples where offloading computations can be useful to enhance performance.

4.4.2 Motivation

Offload computationally intensive data processing which may require input from multiple sources. This can improve performance of a device with low processing power and also improve battery performance.

4.4.3 Problem statement

A device or sensor is made to be as low cost as possible but is required to remain operational for a long period of time. Such a device may also require further instruction or feedback based upon the information it feeds to the application or service. As a result of the low cost, computational power is often sacrificed. In some cases such computation requires input from other remote sources. Performing such computation off-board the device and within an entity where high performance processing is available can increase the battery life of remote devices and make them low-cost where such criteria is an important (e.g. sensors, meters, security systems where certain actions are taken based upon detected event). This type of computation offload may require applications to be redesigned to enable some features of the application to reside in the device and other aspects of the application to reside on a network resource. Some offloaded computation may require very low processing times with low latency to return back to the remote device the result of computation.

4.4.4 Relation to MEC

A MEC server can be used to host high performance computation capabilities which can take information from multiple sources. Such computation can be done in very short timescales, and the result fed back to remote devices which may require information to perform a further action. Such deployment reduces the need for a remote device to not only perform intensive data processing, but also reduces the need for a remote device to receive information from multiple sources in order to perform some meaningful computation.

4.5 Enterprise deployment of MEC

4.5.1 Description of scenario

As fixed communications hardware is replaced by mobile equipment, including smartphones, tablets and laptop computers, enterprise services are migrating to cloud based platforms to serve their mobile users. Increasingly, users are allowed to connect their own devices to the enterprise network. Integration of an IP-PBX with a MEC platform could provide seamless service between an Operator small cell deployment serving the enterprise area and the enterprise WLAN network.

4.5.2 Motivation

Enterprise users are becoming more mobile with many users also using their own devices to connect to the corporate network. Desktop services are migrating to cloud based enterprise services and tools to more effectively serve mobile users.

4.5.3 Problem statement

Enterprise networks are moving towards a true mobile office coupled with cloud based business tools integrated with mobile devices. Furthermore, small cell deployments serving enterprises and thus offering Unified Communications and services to mobile enterprise users are a significant market driver for Mobile Network Operators.

MEC platform-based breakout to an enterprise network, enables employees to connect directly to the Enterprise LAN via their smartphones/tablets, etc. (Bring Your Own Device). This requires an integration of the enterprise IT department with the mobile operator to work together on a service delivery strategy that removes the need to support fixed-line communications (e.g. desk phones and LAN cabling). As a result, authorized users are able to access the same services whether connected through the cellular network or enterprise WLAN. This also requires support for routing user plane traffic of enterprise users between the operator network and Enterprise network.

Within this mobile enterprise paradigm, there is a need to perform load balancing of users on the network, and thus assist with access network selection between small cells and WLAN. Furthermore, access control for different employees and guests needs to be carried out. This also involves providing different levels of services for different classes of end-user. The enterprise IT department would also need effective ways of managing user-owned devices, and easy provisioning of new services, devices and new access for new employees.

4.5.4 Relation to MEC

As part of MEC, a transparent breakout from within the RAN to the enterprise network may be supported to increase performance of IT connectivity of mobile devices accessing enterprise services, thus presenting a new class of mobile connectivity for enterprise deployments. The MEC platform is required to have integration with the enterprise network and the MEC Application manages access control subject to enterprise IT policies, implements enterprise-specific services (e.g. PBX integration) and ensures enterprise security. The MEC platform can assist with network selection, controlling which devices are connected via cellular access and which devices are connected over WLAN. The MEC platform provides capabilities to perform access control and integrate user/device authorization with the enterprise access control system; classify different levels of services per end-user within the Enterprise domain; and to provide for example, external Internet connectivity for guest access.

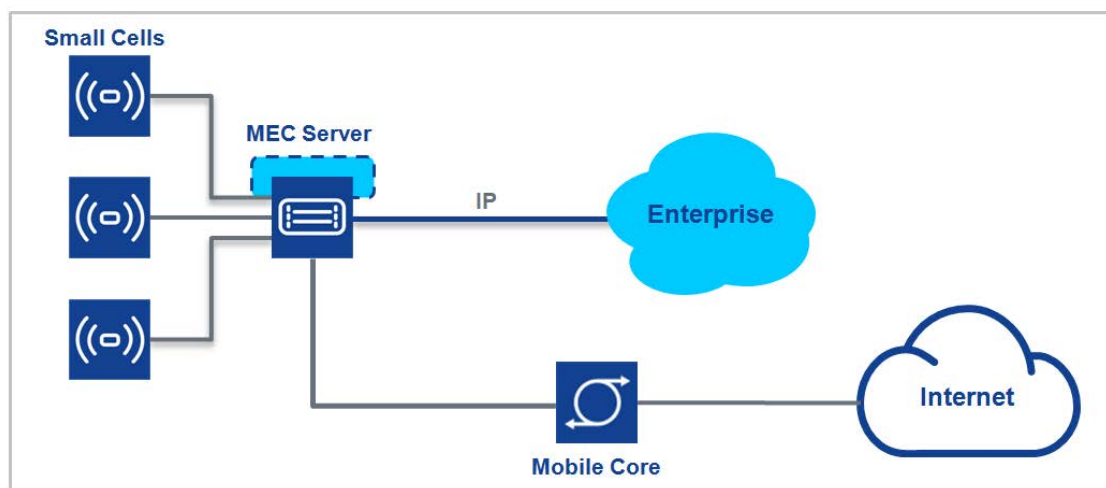


Figure 4: MEC platform with breakout to Enterprise network

4.6 Connected vehicles

4.6.1 Description of scenario

The number of cars and other vehicles becoming more 'connected' using technologies such as Dedicated Short Range Communications (DSRC) for short distance and Long Term Evolution (LTE) for long distance connectivity is increasing.

Communication of vehicles and roadside-sensors is intended to increase the safety, efficiency, and convenience of the transportation system, by the exchange of critical safety and operational data.

LTE can significantly accelerate the deployment of connected vehicles communications. LTE cells can provide out of line of sight visibility, i.e. beyond the range of direct communication between vehicles of 300 m to 500 m. LTE can satisfy the tight latency requirement of the connected vehicles communication, below 100 ms for some use cases, such as safety critical systems

Messages could be distributed in real time over LTE, eliminating the need to build a countrywide, costly DSRC network or retro fitting into vehicles (i.e. cars). Cars can leverage their increasingly inbuilt LTE connectivity. In deployments where DSRC exists, the LTE would be able complement it.

This scenario illustrates the use of 'Mobile-Edge Computing' to enhance the services for Connected Vehicles. It illustrates some potential uses of Mobile-Edge Computing in a vehicle context in order to bring the scenario to life.

4.6.2 Motivation

The number of Connected Vehicles is rapidly growing and will continue to do so over the coming years. Services provided that require Connected Vehicles is evolving and not yet near maturity, but the connectivity requirements for these needs to be available in order to provide a solid foundation. It is anticipated that this will generate a dramatic increase in the amount of data traffic transmitted from and too the sensors and processors in these Connected Vehicles. The characteristics of the connectivity needs may vary based on the service offered, including different tiers of latency, data proximity, computational cost and bandwidth availability.

4.6.3 Problem statement

Connected vehicles communication is used to increase safety by notifying of road hazards, reduce traffic congestion, sensing the vehicles behaviour, etc. It can also be used to provide value added services, such as car finder, parking location and to support entertainment services (e.g. video distribution).

As the number of Connected Vehicles increases and the situations where the use evolves, the volume of data will continue to increase along with the latency requirements. Whilst data stored and processed centrally may be adequate for some use cases, it can be unreliable and slow for all uses.

Mobile-Edge Computing (MEC) can be used to extend the connected car cloud into the highly distributed mobile base station environment. MEC applications can be run on MEC servers which are deployed at the LTE base station site, small cell sites or aggregated site locations, to provide the roadside functionality. MEC enables data and application to be housed close to the vehicles reducing the round trip time of data and enabling a layer of abstraction from both the core network and applications provided over the internet.

4.6.4 Relation to MEC

MEC offers a platform for a new class of applications that Connected Vehicles can rely upon. The data and applications remains in close proximity to the vehicles and roadside-sensors as they move and communicate with other connected devices and with a roadside unit. MEC provides the hosting services for the application, enabling lower latency for the applications and a layer of abstraction from the host services running across the internet.

MEC applications can run on MEC servers which are deployed at the wireless base station site to provide the roadside functionality. The MEC applications can receive local messages directly from the applications in the vehicles and the roadside sensors, analyze them and then propagate (with extremely low latency) hazard warnings and other latency-sensitive messages to other cars in the area (as depicted in figure 5). This enables a nearby car to receive data in a matter of milliseconds, allowing the driver to immediately react.

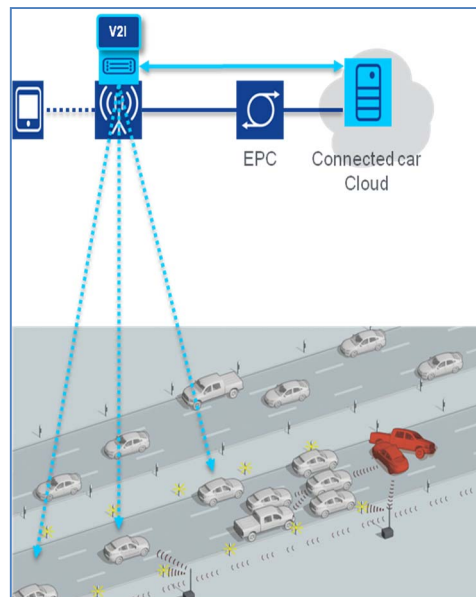


Figure 5: Connected vehicles

The roadside MEC application can inform adjacent Mobile-Edge Computing servers about the event(s) and in so doing, enable these servers to propagate hazard warnings to cars that are close to the affected area.

The roadside application can send local information to the applications at the connected car cloud for further centralized processing and reporting.

4.7 IoT gateway service scenario

4.7.1 Description of scenario

The Internet of Things is the cause for additional messaging and gateways to aggregate the messages and ensure low latency and security. Because of the nature of some of the devices being connected, a real time capability is required and a grouping of the sensors, devices is needed for efficient service.

4.7.2 Motivation

The various devices are getting connected over different forms of connectivity, such as 3G, LTE, Wi-Fi or other spectrum. In general the messages are small, encrypted and come in different forms of protocols. There is a need for a low latency aggregation point to manage the various protocols, distribution of messages and for the processing of analytics. The MEC Server provides the capability to resolve these challenges.

4.7.3 Problem statement

The huge amounts of traffic generated by IoT devices are resource constrained in terms of processor and memory capacity. There is a need to aggregate various IoT device messages connected thru the mobile network close to the devices. This will provide an analytics processing capability and a low latency response time.

4.7.4 Relationship to MEC

The MEC Server could provide some additional compute and memory and be utilized for the following:

- Aggregation and distribution services;
- Analytics of the device messages;
- Decision logic based on analytic results;
- Database logging;
- Remote provisioning and access control to the end devices.

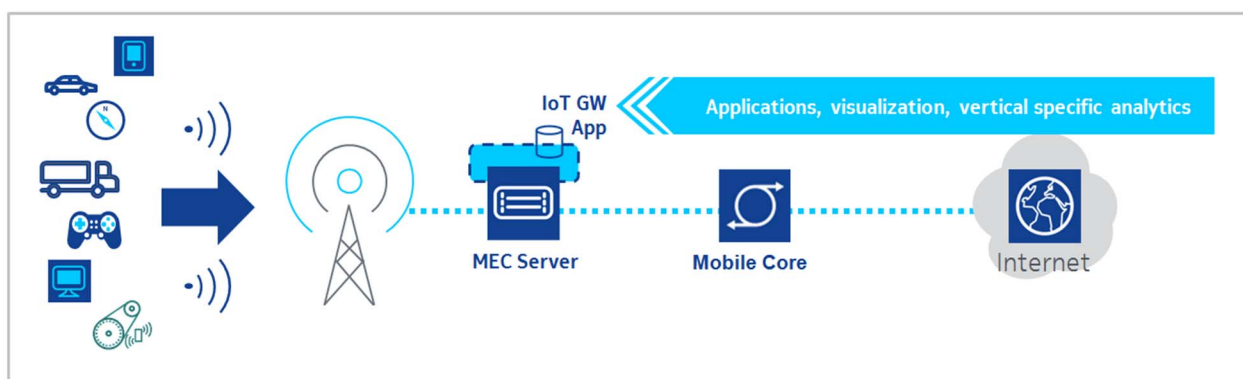


Figure 6: IoT gateway

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Annex B (informative): Bibliography

- ETSI GS MEC 002: "Mobile-Edge Computing (MEC) Technical Requirements".
- ETSI GS MEC 001: "Mobile-Edge Computing (MEC) Terminology".
- "Mobile-Edge Computing - Introductory Technical White Paper", Issue 1, September 2014.

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