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Multi-access Edge Computing (MEC); Study on MEC Support for V2X Use Cases

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Foreword

This Group Report (GR) has been produced by ETSI Industry Specification Group (ISG) Multi-access Edge Computing (MEC).

Modal verbs terminology

In the present document "**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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1 Scope

The present document focuses on identifying the MEC features to support V2X applications. It collects and analyses the relevant V2X use cases (including the findings from external organizations), evaluates the gaps from the defined MEC features and functions, and identifies the new requirements including new features and functions. When necessary, this may include identifying new multi-access edge services or interfaces, as well as changes to existing MEC services or interfaces, data models, application rules and requirements. It will also recommend the necessary normative work to close these gaps if identified.

2 References

2.1 Normative references

Normative references are not applicable in the present document.

2.2 Informative 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.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

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.

[i.1] National Highway Traffic Safety Administration (NHTSA) / Department of Transportation (DOT), "Federal Motor Vehicle Safety Standards; V2V Communications".

NOTE: Available at: https://www.gpo.gov/fdsys/granule/FR-2017-01-12/2016-31059

[i.2] ETSI TR 102 638: "Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Definitions".

[i.3] 3GPP TR 22.885: "Study on LTE support for Vehicle to Everything (V2X) services".

[i.4] ETSI GS MEC 012: "Mobile Edge Computing (MEC); Radio Network Information API".

[i.5] ETSI GS MEC 013: "Mobile Edge Computing (MEC); Location API".

[i.6] ETSI GR MEC 018: "Mobile Edge Computing (MEC); End to End Mobility Aspects".

[i.7] 5G Automotive Association (5GAA) White Paper: "Toward fully connected vehicles: Edge computing for advanced automotive communications".

NOTE: Available at http://5gaa.org/wp-content/uploads/2017/12/5GAA_T-170219-whitepaper-EdgeComputing_5GAA.pdf.

[i.8] ETSI GS MEC 001: "Multi-access Edge Computing (MEC); Terminology".

[i.9] ETSI GS MEC 002: "Multi-access Edge Computing (MEC); Phase 2: Use Cases and Requirements".

[i.10] ETSI TS 123 285: "Universal Mobile Telecommunications System (UMTS); LTE; Architecture enhancements for V2X services (3GPP TS 23.285)".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in ETSI GS MEC 001 [i.8].

3.2 Abbreviations

For the purposes of the present document, the abbreviations given in ETSI GS MEC 001 [i.8] and the following apply:

5G	Fifth Generation
API	Application Programming Interface
IMA	Intersection Movement Assist
LS	Location Service
MNO	Mobile Network Operator
OEM	Original Equipment Manufacturer
OSS	Operational Support System
PER	Packet Error Rate
PLMN	Public Land Mobile Network
QoE	Quality of Experience
QoS	Quality of Service
QW	Queue Warning
RAB	Radio Access Bearer
RAN	Radio Access Network
RAT	Radio Access Technology
RNI	Radio Network Information
RNIS	Radio Network Information Service
TNL	Transport Network Layer
V2I	Vehicle-to-Infrastructure
V2V	Vehicle-to-Vehicle
V2X	Vehicle-to-Everything
VRU	Vulnerable Road User
WLAN	Wireless Local Area Network

4 Overview

The present document identifies the MEC features in order to enable the necessary support for V2X applications.

Clause 5 collects and analyses the relevant V2X use cases (including the findings from external organizations). The recommendations on the services and features are identified for each use case. Evaluation is provided for each recommendation to identify the issues to be solved.

Clause 6 discusses the key issues and the corresponding solutions and further identifies the gaps from the existing MEC functions and features.

Clause 7 concludes the study with the prioritized V2X use cases to be supported in this phase, and the consolidated recommendations. The recommendations for necessary normative work are provided in order to close the identified gaps.

5 Use cases

5.1 Introduction

This clause discusses four use case groups that are commonly known to the V2X communities [i.7], namely "safety", "convenience", "advanced driving assistance" and "vulnerable road user".

5.2 V2X use case group "safety"

5.2.1 Description

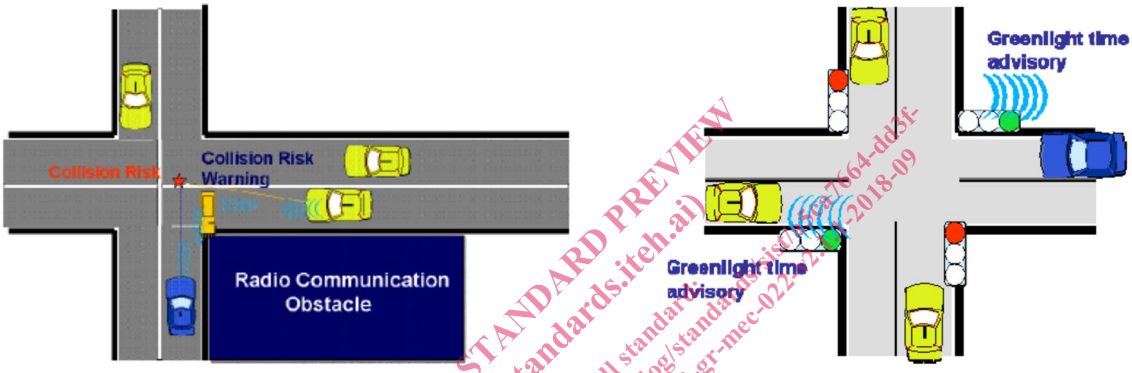
The V2X use case group "Safety" includes several different types of use cases (relevant to MEC) to support road safety using the vehicle-to-infrastructure (V2I) communication in addition to the vehicle-to-vehicle (V2V).

Intersection Movement Assist (IMA)

This type of use cases was specifically listed in the US DOT NHTSA publication 2016-0126 [i.1], and ETSI TR 102 638 [i.2]. The main purpose of IMA is to warn drivers of vehicles approaching from a lateral direction at an intersection. IMA is designed to avoid intersection crossing crashes, the most severe crashes based on the fatality counts. Intersection crashes include intersection, intersection-related, driveway/alley, and driveway access related crashes. Figure 5.2.1-1 illustrates two typical scenarios:

a) intersection collision warning, and

b) intersection management.



a) intersection collision warning b) intersection management

Figure 5.2.1-1: V2X "safety" use cases

Queue Warning (QW) [i.3**]**

In a lot of situations, a queue of vehicles on the road may pose a potential danger and cause delay of traffic, e.g. when a turning queue extends to other lanes. Using the V2I service, the queue information can be made available to other drivers beforehand. This minimizes the likelihood of crashes and allows for mitigation actions.

5.2.2 Recommendations

This group of V2X use cases requires the support of roadside infrastructure for the V2V and V2I communications. In the case that the Multi-access Edge Computing system is used to provide the V2X support, the related recommendations on the services and features enabled in the system include:

[R-5.2.2-1] It is recommended that the MEC system provides feedback information from the network to the vehicle in support of V2X functions, predicting whether a communication channel is currently reliable or not (e.g. in terms of fulfilling latency requirements and 100 % packet arrival).

[R-5.2.2-2] It is recommended that the MEC system provides interoperability by supporting V2X information exchange among road users connected through different access technologies or networks or mobile operators.

[R-5.2.2-3] It is recommended that the MEC system enables multi-operator operation for V2X mobiles/users to provide service continuity across access network coverage nationwide and across borders of different operators' networks.

[R-5.2.2-4] It is recommended that the MEC systems provide interoperability in a multi-operator scenario, enabling MEC apps in different systems to communicate securely with each other, in order to enable synchronization in multi-operator systems also in absence of cellular coverage (outside of 3GPP™ domain).

[R-5.2.2-5] It is recommended that the MEC system provides interoperability in a multi-operator scenario, enabling MEC apps to communicate securely with the V2X-related 3GPP™ core network logical functions (e.g. V2X control function) and gathering PC5 [i.10] V2X relevant information (e.g. PC5 configuration parameters) from 3GPP™ network.

5.2.3 Evaluation

[R-5.2.2-1] In current MEC system, the RNI API can provide up-to-date radio network information to the service consumer, i.e. the V2X functions. However, current QoS-related information in RNI API is not sufficient in order to allow necessary prediction regarding the QoS performance (e.g. latency, throughput, reliability). Therefore, potential enhancements on RNI API for the prediction should be considered including both relevant measurements in RAN or processed results for the prediction. This enhanced service could also be provided by a new API.

[R-5.2.2-2] In current MEC definition, MEC system includes not only 3GPP™ access, but also other non-3GPP™ access. Therefore the MEC system is RAT agnostic and will be enhanced for multi-access if needed. There is no need to consider the different access networks within an operator's system in this study. Moreover, the information exchange among MEC system from different operators may require potential enhancement on the horizontal communication for the MEC system.

[R-5.2.2-3] The operator network is normally region specific or country specific. The V2X service requires a seamless coverage of the communication, and unified service regardless the subscription of the users. In previous experience, network sharing and roaming agreement could help to achieve this. However, each of them have its own limitations, which may not meet the requirements. Normally the MEC system could be shared by operators, but the interaction with the underlying networks from different operators may need more efforts in business coordination rather than technical obstacles. It is also possible that the MEC system could also be operator-specific, thus the horizontal communication enhancements among different operators may be considered to provide a sort of "MEC platform as a service" paradigm.

[R-5.2.2-4] The MEC system can be a preferred environment for hosting V2X application server functions in charge of the authorization for the usage of V2X services. Thus, in order to ensure alignment across different operators' domains (also in absence of cellular coverage), the MEC system hosts V2X application functions (with at least one MEC Host for each operator domain hosting such functions). In order to ensure interoperability, the MEC apps should communicate securely with 3GPP™ core network in order to gather relevant information from 3GPP™ network (i.e. the list of authorized UEs, the relevant information about the authorization based on the UE subscription and the relevant PC5 configuration parameters).

5.3 V2X use case group "convenience"

5.3.1 Description

Software updates and other telematics use cases are typically included in this group, which can technically be implemented with existing access technology and are partly already supported by car manufacturers.

5.3.2 Recommendations

This group of V2X use cases requires cost effective communication to be enabled between the vehicles and the backend server (e.g. car OEM's server). In the case that the Multi-access Edge Computing system is used, the related recommendations on the services and features enabled in the system include:

[R-5.3.2-1] It is recommended that the MEC system enables multi-operator operation for V2X mobiles/users to provide service continuity across access network coverage nationwide and across borders of different operators' networks.

5.3.3 Evaluation

[R-5.3.2-1] The operator network is normally region specific or country specific. The V2X service requires a seamless coverage of the communication, and unified service regardless the subscription of the users. In previous experience, network sharing and roaming agreement could help to achieve this. However, each of them have its own limitations, which may not meet the requirements. Normally the MEC system could be shared by operators, but the interaction with the underlying networks from different operators may need more efforts in business coordination rather than technical obstacles. It is also possible that the MEC system could also be operator-specific, thus the horizontal communication enhancements among different operators may be considered to provide a sort of "MEC platform as a service" paradigm.

5.4 V2X use case group "advanced driving assistance"

5.4.1 Description

Advanced driving assistance represented by the two use cases (related to MEC) collects the most challenging requirements for V2X. It can require distribution of a relative large amount of data with high reliability and low latency in parallel. Additionally, the advanced driving use cases would benefit from predictive reliability. This means that vehicles moving along should have the possibility to receive a prediction of the network availability to plan ahead.

Real Time Situational Awareness & High Definition (Local) Maps

Real time situational awareness is essential for autonomous vehicles especially at critical road segments in cases of changing road conditions (e.g. new traffic cone detected by another vehicle some time ago). In addition, the relevant high definition local maps need to be made available via downloading from a backend server.

The use case for real time situational awareness and High Definition (Local) Maps should not only be seen as a case to distribute information on relatively slow changing road conditions. The case should be extended to distribute and aggregate locally available information in real time to the traffic participants via road side units.

See-Through (or High Definition Sensor Sharing)

In this type of use cases vehicles such as trucks, minivans, cars in platoons are required to share camera images of road conditions ahead of them to vehicles behind them.

5.4.2 Recommendations

In the case that the Multi-access Edge Computing system is used, the related recommendations on the services and features enabled in the system include:

[R-5.4.2-1] It is recommended that the MEC system enables the support for locally aggregating the real-time information from the connected nodes with very low latency.

[R-5.4.2-2] It is recommended that the MEC system enables the support for locally distributing the real-time information to the connected nodes with very low latency.

NOTE: Examples of connected nodes are base stations in a mobile network or access points in a WLAN, which are connected to the MEC system.

[R-5.4.2-3] It is recommended that the MEC system provides predictive quality related information to the vehicle when the various connectivity parameters (like Latency, PER, signal-strength …) are going to change.

[R-5.4.2-4] It is recommended that the MEC system provides interoperability by supporting V2X information exchange among road users connected through different access technologies or networks or mobile operators.

[R-5.4.2-5] It is recommended that the MEC system enables multi-operator operation for V2X mobiles/users to provide service continuity across access network coverage nationwide and across borders of different operators' networks.