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Multi-access Edge Computing (MEC); V2X Information Service API

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Reference

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Foreword

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

Modal verbs terminology

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1 Scope

The present document focuses on a MEC V2X Information Service (VIS), in order to facilitate V2X interoperability in a multi-vendor, multi-network and multi-access environment. It describes the V2X-related information flows, required information and operations. The present document also specifies the necessary API with the data model and data format.

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.

Referenced documents which are not found to be publicly available in the expected location might be found at https://docbox.etsi.org/Reference/.

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 necessary for the application of the present document.

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

[2] Void.

[3] IETF RFC 5246: "The Transport Layer Security (TLS) Protocol Version 1.2".

NOTE: Available at https://tools.ietf.org/html/rfc5246.

[4] IETF RFC 6749: "The OAuth 2.0 Authorization Framework".

NOTE: Available at https://tools.ietf.org/html/rfc6749.

[5] IETF RFC 6750: "The OAuth 2.0 Authorization Framework: Bearer Token Usage".

NOTE: Available at https://tools.ietf.org/html/rfc6750.

[6] ETSI TS 102 894-2: "Intelligent Transport Systems (ITS); Users and applications requirements; Part 2: Applications and facilities layer common data dictionary".

[7] IETF RFC 8446: "The Transport Layer Security (TLS) Protocol Version 1.3".

NOTE: Available at https://tools.ietf.org/html/rfc8446.

[8] ETSI TS 133 210: "Digital cellular telecommunications system (Phase 2+) (GSM); Universal Mobile Telecommunications System (UMTS); LTE; 5G; Network Domain Security (NDS); IP network layer security (3GPP TS 33.210)".

[9] ETSI GS MEC 009: "Multi-access Edge Computing (MEC); General principles, patterns and common aspects of MEC Service APIs".

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

[11] ETSI TS 136 300: "LTE; Evolved Universal Terrestrial Radio Access (E-UTRA) and Evolved Universal Terrestrial Radio Access Network (E-UTRAN); Overall description; Stage 2 (3GPP TS 36.300)".

[12] ETSI TS 136 423: "LTE; Evolved Universal Terrestrial Radio Access Network (E-UTRAN); X2 Application Protocol (X2AP) (3GPP TS 36.423)".

[13] ETSI TS 136 413: "LTE; Evolved Universal Terrestrial Radio Access Network (E-UTRAN); S1 Application Protocol (S1AP) (3GPP TS 36.413)".

[14] ETSI TS 136 331 (V14.16.0): "LTE; Evolved Universal Terrestrial Radio Access (E-UTRA); Radio Resource Control (RRC); Protocol specification (3GPP TS 36.331 version 14.16.0 Release 14)".

[15] ETSI TS 136 321: "LTE; Evolved Universal Terrestrial Radio Access (E-UTRA); Medium Access Control (MAC) protocol specification (3GPP TS 36.321)".

[16] ETSI TS 136 214: "LTE; Evolved Universal Terrestrial Radio Access (E-UTRA); Physical layer; Measurements (3GPP TS 36.214)".

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] Void.

[i.2] Void.

[i.3] OpenAPI™ Specification.

NOTE: Available at https://github.com/OAI/OpenAPI-Specification.

[i.4] ETSI GR MEC 022: "Multi-access Edge Computing (MEC); Study on MEC Support for V2X Use Cases".

[i.5] Void.

[i.6] ETSI TS 129 388: "LTE; V2X Control Function to Home Subscriber Server (HSS) aspects (V4); Stage 3 (3GPP TS 29.388)".

[i.7] ETSI TS 129 389: "LTE; Inter-V2X Control Function Signalling aspects (V6); Stage 3 (3GPP TS 29.389)".

[i.8] Void.

[i.9] Void.

[i.10] Void.

[i.11] Void.

[i.12] Void.

[i.13] Void.

[i.14] ETSI GS MEC 003: "Multi-access Edge Computing (MEC); Framework and Reference Architecture".

[i.15] ETSI GS MEC 012: "Multi-access Edge Computing (MEC); Radio Network Information API".

[i.16] ETSI GS MEC 013: "Multi-access Edge Computing (MEC); Location API".

[i.17] ETSI GS MEC 028: "Multi-access Edge Computing (MEC); WLAN Access Information API".

3 Definition of terms, symbols and abbreviations

3.1 Terms

For the purposes of the present document, the terms given in ETSI GS MEC 001 [1] apply.

3.2 Symbols

Void.

3.3 Abbreviations

For the purposes of the present document, the abbreviations given in ETSI GS MEC 001 [1] and the following apply:

CN	Core Network
C-V2X	Cellular V2X
DL	Downlink
E2E	End-to-End
eNB	evolved Node B
E-UTRAN	Evolved UMTS Terrestrial Radio Access Network
FDD	Frequency Division Duplex
FOTA	Firmware Over The Air
gNB	5G Node B
HSS	Home Subscriber Server
ITS	Intelligent Transport Systems
MBMS	Multimedia Broadcast Multicast Services
NF	Network Function
RSU	Road Side Unit
SDP	Session Description Protocol
SOTA	Software Over The Air
TDD	Time Division Duplex
UDP	User Datagram Protocol
UL	Uplink
VIS	V2X Information Service

4 Overview

The present document specifies the VIS API to facilitate V2X interoperability in a multi-vendor, multi-network and multi-access environment.

Clause 5 presents reference scenarios for the VIS service and lists the functionalities of the service. It also describes the information flows used for VIS.

The information that can be exchanged over the VIS API is described in clause 6 which provides detailed descriptions of all information elements that are used for VIS.

Clause 7 describes the actual VIS API providing detailed information of how information elements are mapped into a RESTful API design.

5 Description of the service (informative)

5.1 Reference scenarios for the VIS service

According to recommendations in ETSI GR MEC 022 [i.4], multi-access, multi-network and multi-operator scenarios are the reference assumptions motivating the need for MEC normative work on this area. Figure 5.1-1 shows all the scenarios applicable to V2X services. In particular:

- Some V2X services can be managed by OEMs (the so called "Vehicle OEMs scenario"), and, thus, it is reasonable to consider both single and multi-operator scenarios for such services. Note that V2X services are expected to be provided by different network operators in the same country and/or in different countries.
- Similarly, the same applies when the "ITS Operator scenario" is considered, that may additionally provide services for different vehicle OEMs. An ITS operator may need to provide a country-wide V2X service, by exploiting different operators' networks (deploying different MEC systems), and offering this service to vehicles belonging to different OEMs. Note that also in this case, V2X services are expected to be provided by different network operators in the same country and/or in different countries.

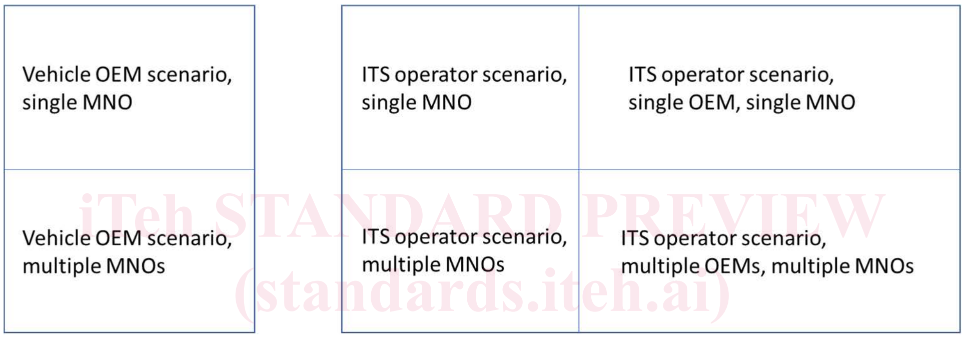

Figure 5.1-1: Reference scenarios relevant to the VIS service

As a consequence, in order to enable all use cases, the MEC V2X Information Service (VIS) should support C-V2X systems implemented in the most general scenarios. In particular, these scenarios should assume the presence of multiple MEC vendors and the need to enable interoperable data exchange between them. Moreover, multi-operator interoperability is a key aspect for ensuring service continuity, and it is described in clause 5.2.

5.2 Multi-operator scenarios and V2X services

The left hand side of figure 5.2-1 shows a typical multi-operator scenario, highlighting the case of temporary absence of radio coverage, e.g. in roaming situations. As showed in the right-hand side of figure 5.2-1, in a traditional V2X system (without the VIS service) the interconnection between MNOs is terminated at the remote side, with clear disadvantages in terms of high E2E latency; on the other hand, thanks to the exploitation of the VIS service (enabling also a "horizontal communication" between MEC systems), the interconnection between MNOs can be realized with low E2E latency.

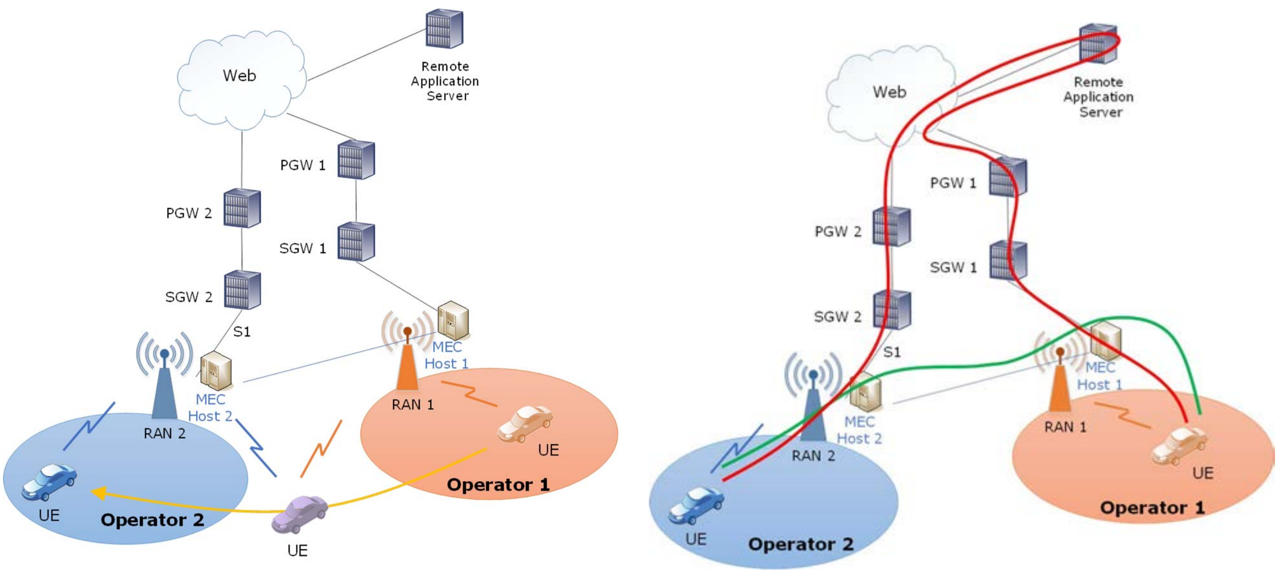

Figure 5.2-1: (left): Example of a multi-operator scenario for V2X services; (right): Example of path for data exchange without the VIS service (in red) and with the VIS service (in green)

V2X service needs to be provided across all the territory including both operators' coverage areas, as well as when leaving the coverage area of one operator and entering the coverage area of the other operator without any service disruption and guaranteeing E2E performance. For that purpose, VIS exposes information on PC5 configuration parameters and manages the multi-operator environment, especially when a UE is out of coverage.

5.3 V2X service continuity in multi-operator operation scenarios

5.3.1 Introduction

Wireless communication is a key enabling technology of co-operative intelligent transportation systems. Road users (including vehicles, cyclists, pedestrians) involved in the communication may use services provided by different operators.

A mobile operator network is typically region specific or country specific, which provides services directly to its own customers (subscribers), while providing communications to other operators' customers via the core network level interworking between two operators' networks. To maintain the V2X service continuity (often with low latency requirement) for road users becomes very challenging especially when such road users (e.g. vehicular UEs) move from one PLMN to another.

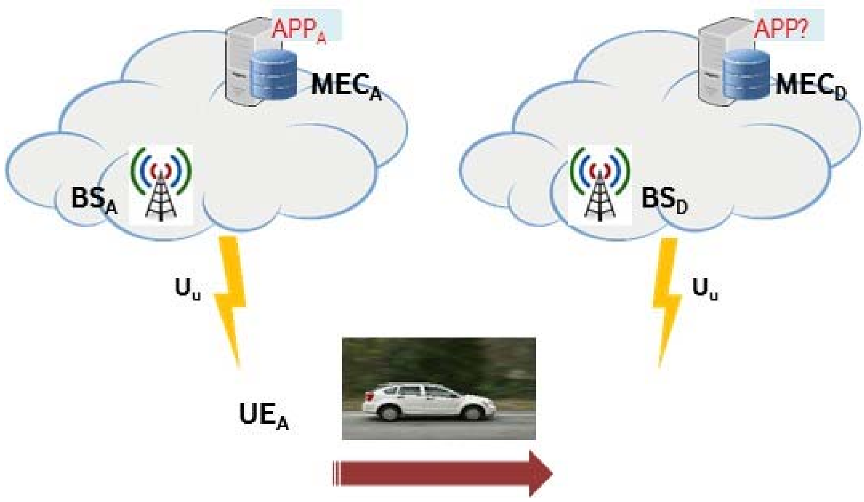

Figure 5.3.1-1: Example V2X use case: inter-PLMN service continuity

To enable service continuity in such use cases, mobile network level interworking among different PLMNs is necessary as specified in 3GPP specifications ETSI TS 123 285 [10], ETSI TS 129 388 [i.6] and ETSI TS 129 389 [i.7]. Furthermore, inter-MEC system coordination is also required to prepare in advance the UEs in transit (based on the agreements among operators, roam or handover to a new PLMN) and reduce the interruption time.

The service consumers communicate with VIS over the VIS API to get the necessary V2X service provisioning information for the visiting PLMN in support of inter-PLMN service continuity. Both the MEC applications and the MEC platform may consume the VIS; and both the MEC platform and the MEC applications may be the providers of the V2X information.

The VIS API supports both queries and subscriptions (pub/sub mechanism) that are used over the RESTful API or over alternative transports such as message bus. Alternative transports are not specified in detail in the present document. For RESTful architectural style, the present document defines the HTTP protocol bindings.

5.4 VIS functionalities

5.4.1 Overview

The MEC standards have been designed to facilitate V2X interoperability in a multi-vendor, multi-network and multi-access environment. The introduction of the VIS API is aimed at helping the ecosystem adopt MEC for automotive use cases. These use cases may involve different car makers, OEM suppliers, network infrastructure vendors, MEC vendors, application/content providers and other stakeholders. Therefore, it is critical that all MEC related interoperability reference points involving the potential stakeholders are fully specified.

In particular, the VIS defined in the present document will permit information exposure, pertinent to the support of automotive use cases, to MEC application instances. It will also permit a single ITS operator to offer a V2X service over a region that may span different countries and involve multiple network operators, MEC systems and MEC application providers.

For that purpose, the MEC VIS includes the following functionalities:

1) Gathering of PC5 V2X relevant information from the 3GPP network (e.g. the list of authorized UEs, the relevant information about the authorization based on the UE subscription and the relevant PC5 configuration parameters).

2) Exposure of this information to MEC apps (also potentially belonging to different MEC systems).

3) Enablement of MEC apps to communicate securely with the V2X-related 3GPP core network logical functions (e.g. V2X control function).

4) Enablement of MEC apps in different MEC systems to communicate securely with each other.

5) Possibly gathering and processing information available in other MEC APIs (e.g. RNI API, see ETSI GS MEC 012 [i.15], Location API, see ETSI GS MEC 013 [i.16], WLAN API, see ETSI GS MEC 028 [i.17], etc.) in order to predict radio network congestion and provide suitable notifications to the UE.

From that perspective, the VIS service is relevant to Mp1 and Mp3 reference points in the MEC architecture. In particular, the relevant information is exposed to MEC apps via the Mp1 reference point. Potential impacts on Mp3 reference point (e.g. enabling the possibility to transfer this information between different MEC platforms) are introduced in ETSI GS MEC 003 [i.14] and are out of the scope of the present document.

NOTE 1: The VIS API provides information to MEC applications in a standardized way; this is essential for interoperability in multi-vendor scenarios; nevertheless, it is acknowledged that MEC applications may communicate in a direct way (i.e. without the use of MEC platform).

NOTE 2: Inter-system communication may be realized between MEOs. As an alternative, or, in addition to that, possible Mp3 enhancements (or new reference points between MEC systems) may be defined. This is out of the scope of the present document.

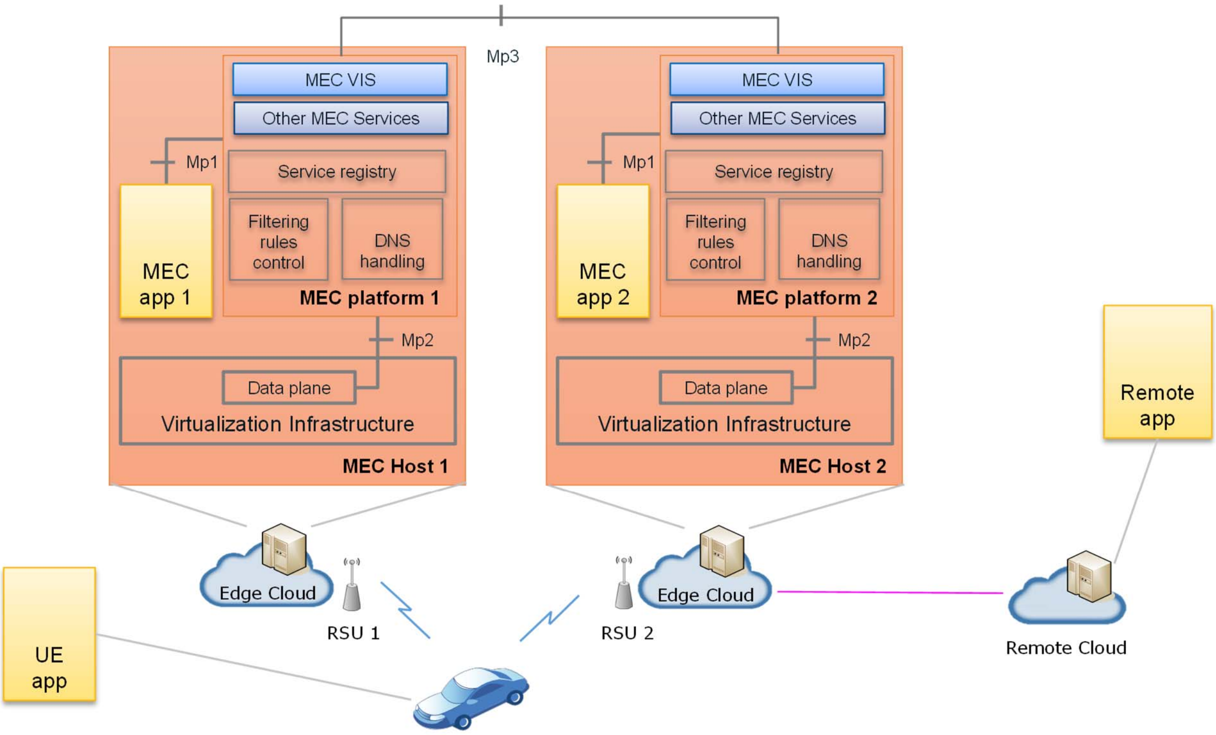

Figure 5.4.1-1: Example of application instances in a V2X service with VIS API

Figure 5.4.1-1 illustrates a typical V2X system involving multiple MEC hosts and the use of the VIS service. In the framework of V2X services, a car is hosting a client application, and is connected to a certain MEC host (and a related MEC application). In presence of multiple MEC hosts, the VIS permits to expose information between MEC applications running on different MEC hosts. In addition, other remote application server instances can be located somewhere else (e.g. private clouds owned by the operator or by the OEM). The VIS service may be produced by the MEC platform or by the MEC application.

5.4.2 Communication between V2X Control Function (3GPP) and VIS (MEC)

In a 3GPP network, V2X applications can be deployed on V2X Application Server. The V2X Control Function is the NF in core network part, which is used for network-related actions required for V2X. The HSS provides the list of the PLMNs, where the UE is authorized to perform V2X communication over PC5 reference point to the V2X Control Function, see ETSI TS 123 285 [10]. V2 is the reference point between the V2X Application Server and the V2X Control Function in the operator's network.

The VIS defined in MEC is used to facilitate V2X interoperability in a multi-vendor, multi-network and multi-access environment. Therefore, the VIS should obtain the UE's subscription data (e.g. PC5 based V2X communication allowed PLMN), from the V2X Control Function.

Because the V2X Application Server bears multiple V2X applications, it can, therefore, be deployed in MEC platform as a MEC application. The VIS can communicate with the V2X Application Server through Mp1, and it can obtain the UE's V2X subscription data from the V2X Control Function through the V2X Application Server.

NOTE: The VIS, or generic parts of it, can be deployed in the MEC Platform.

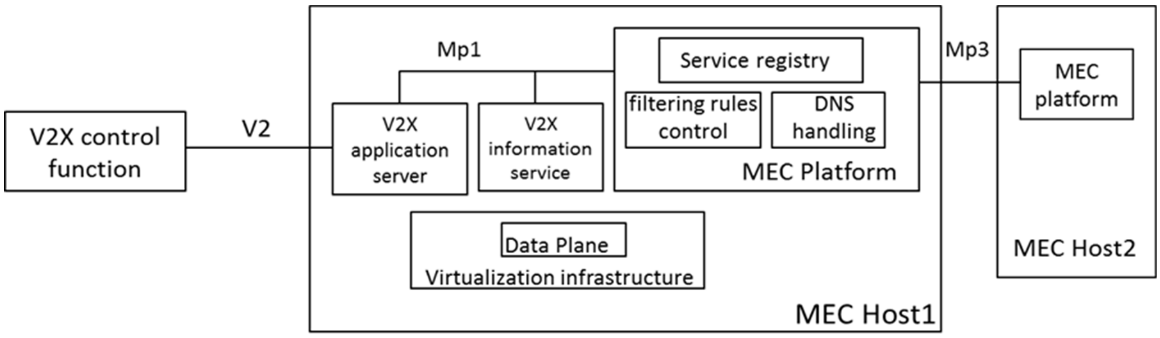

Figure 5.4.2-1: Example of architecture enabling the communication between the VIS and the V2X Control Function

5.4.3 Inter-MEC system V2X application communication

A V2X MEC application may be required to communicate with its peer applications in other MEC systems in order to fulfil the intended purpose of the application use case. The involved MEC systems need to enable the authorized applications in one MEC system to communicate with their peers in another MEC system.

The discovery of the application peers may be facilitated by the VIS API by exposing the available communication end point information for peer to peer connectivity. Alternatively, the configured traffic rules for the V2X MEC application together with the underlying inter-MEC system connectivity arrangements may support the application peers' communication. Lastly, the V2X MEC application may rely on non-MEC-specific means for its peer discovery and then rely on its authorized access to external interface for the communication.

The required arrangements between the involved MEC systems for realizing secure connectivity with the application specific requirements are deployment specific and beyond the scope of the present document.

5.4.4 Inter-MEC system service exposure

A V2X MEC application in one MEC system may be required to consume a service in another MEC system in order to fulfil the intended purpose of the application use case. The V2X MEC application discovers the service in question in the service registry in its local MEC host.

The required arrangements between the involved MEC systems for mapping a service produced in one MEC system to an endpoint in another MEC system are deployment specific and beyond the scope of the present document.

5.4.5 The VIS and its role in producing journey-specific QoS notifications

Accurate and timely predictions of the radio environment at locations planned to be visited by vehicles can either trigger, modify or postpone:

i) the application of certain V2X functionalities; and/or

ii) the download of content delivery/ software packages.

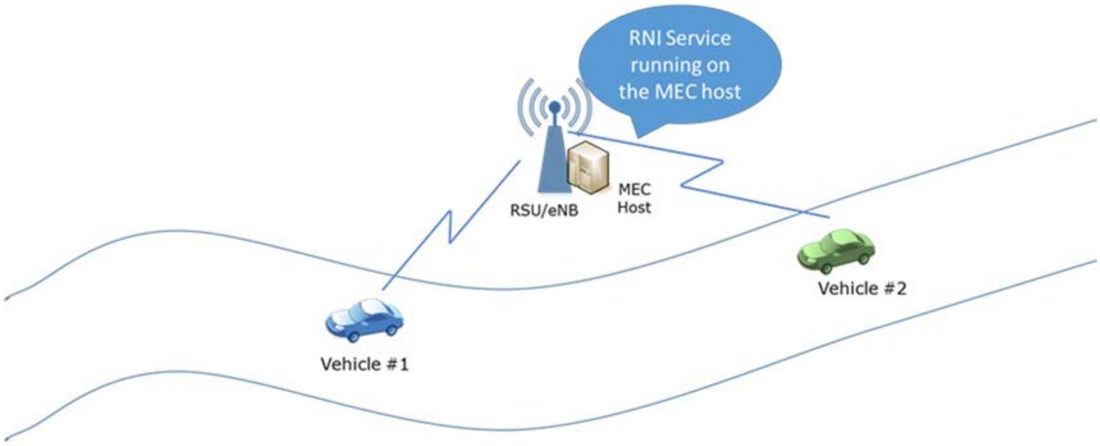

Figure 5.4.5-1: Exemplary V2X system scenario (see note)

However, focusing on V2X system scenarios characterized by high mobility and dynamic topology (as in figure 5.4.5-1), the accuracy and the timeliness of information (e.g. radio network, location information etc.) may be hampered by:

- the environmental situation, e.g. the occurrence of network congestion events when, for example, many vehicles attempt to provide radio measurements to the connected eNB/gNB, which is collocated with a MEC host, as well as by

- the deployment density of the cellular network, together with the capabilities of the deployed MEC infrastructure.

An example illustrating the impact of the above mentioned limitations on system performance is the one of a vehicle planning to follow a trajectory from location A to location B and a related MEC application which would need to be informed of radio conditions "en route", ahead of the vehicle's passing time, before reaching a decision. Decisions may consist in e.g. enabling/disabling autonomous driving features, downloading infotainment content, scheduling Software/Firmware Over-the-Air (SOTA/FOTA) updates, etc.

NOTE: Figure 5.4.5-1 illustrates an exemplary V2X system scenario, where the MEC host is deployed in collocation with a Roadside Unit (RSU)/ eNB providing coverage (V2X communication); the RNI Service (RNIS) is running at the MEC host - it is assumed that the planned trajectory of vehicle #1 and vehicle #2 is not known at the RSU.

To address such challenges, the VIS service may assist in implementing a framework for cooperative acquisition, partitioning and distribution of information for efficient, journey-specific QoS prediction. That is, the VIS service may be utilized to identify space/time correlations between radio quality data collected by different vehicles in a V2X system and a specific vehicle's planned journey for better prediction of the quality of the communication network along the designated route. As a consequence, the VIS may expose relevant (i.e. journey-specific) information about the QoS prediction to authorized UEs.

5.5 Sequence diagrams

5.5.1 Sending a request for provisioning information for V2X communication over Uu unicast

Figure 5.5.1-1 shows a scenario where the service consumer (e.g. a MEC application or a MEC platform) sends a request to receive the provisioning information for V2X communication over Uu unicast for a particular location. The response contains the required information.