MEC support for V2X

Technical overview on MEC V2X API

Antonio Consoli
(Huawei, ETSI MEC delegate, 5GAA delegate)

ETSI MEC / CCSA joint workshop on V2X

January 25th, 2023

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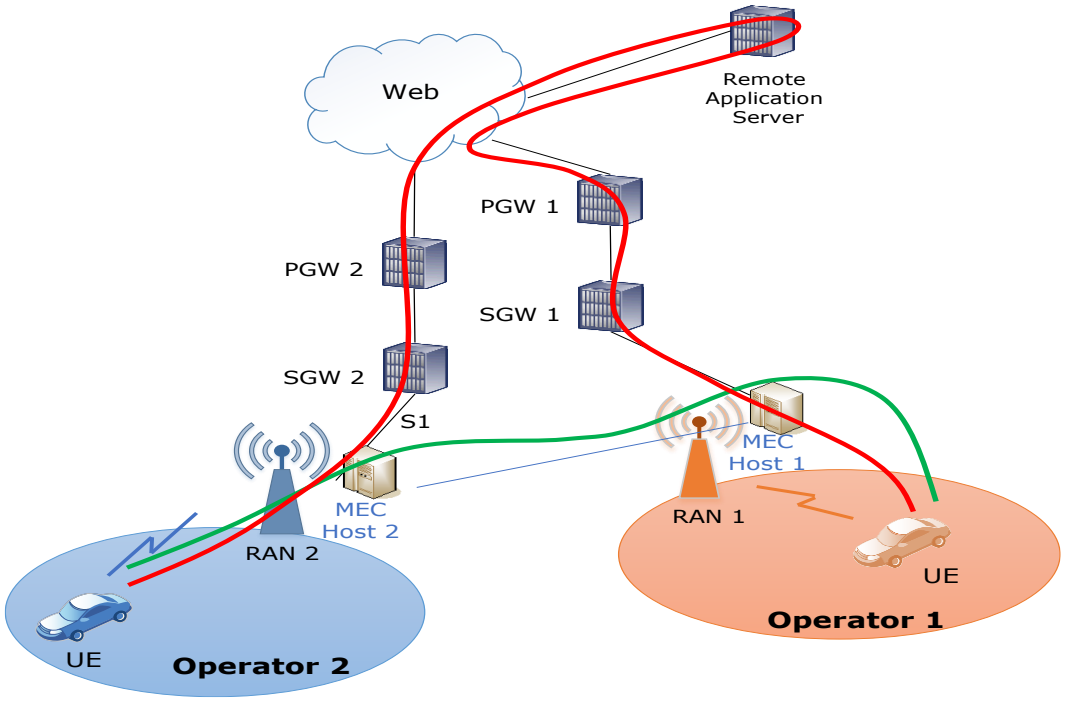
ETSI GS MEC 030 V2X Information Services API

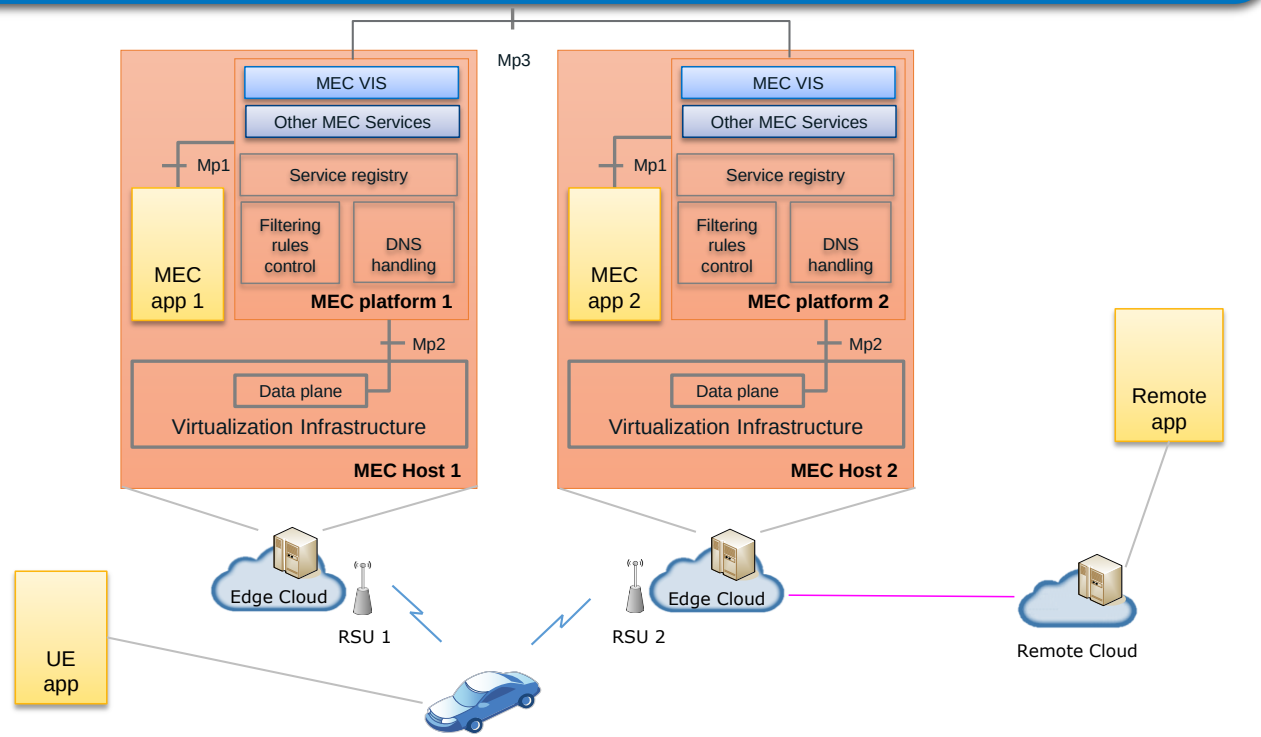
ETSI GS MEC 030: V2X API overview

ETSI MEC GS 030 (MEC V2X Information Services API)

- The introduction of this V2X Information Services (VIS) is aimed at helping the ecosystem adopt MEC for automotive use cases.
- Goal is to facilitate **V2X interoperability in a multi-vendor, multi-network and multi-access environment**.



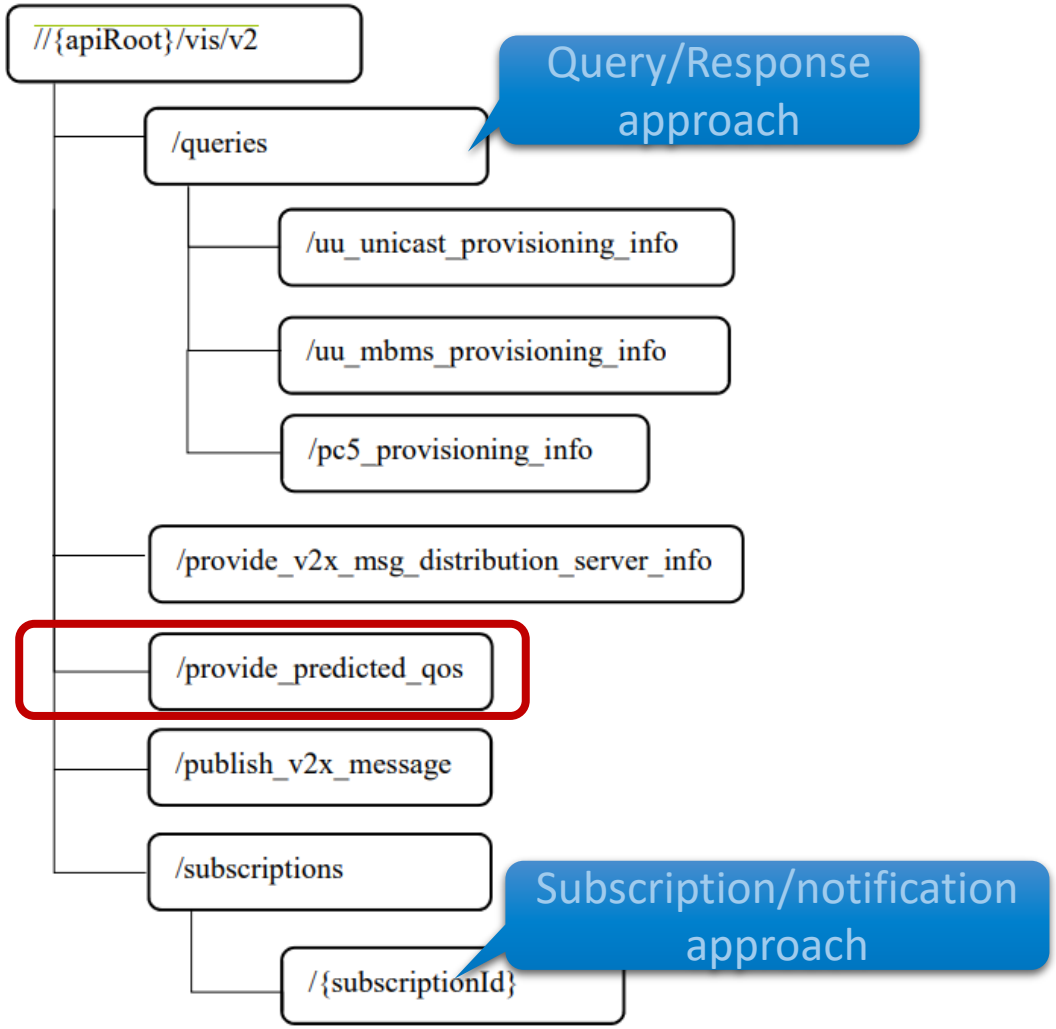
Multi-operator scenarios and V2X services: Example of path for data exchange without the VIS service (in **red**) and with the VIS service (in **green**)



Example of application instances in a V2X service with VIS API: In presence of multiple MEC hosts, the VIS permits to expose information between MEC applications running on different MEC hosts.

- The VIS service may be produced by the MEC platform or by the MEC app.

ETSI GS MEC 030: V2X API resource URI structure and Data types



Resource name	Resource URI	HTTP method	Meaning
Uu unicast provisioning information	/queries/uu_unicast_provisioning_info	GET	Retrieve provisioning information required for V2X communication over Uu unicast.
Uu MBMS provisioning information	/queries/uu_mbms_provisioning_info	GET	Retrieve provisioning information required for V2X communication over Uu MBMS.
PC5 provisioning information	/queries/pc5_provisioning_info	GET	Retrieve provisioning information required for V2X communication over PC5.
Provide V2X Message Distribution Server information	/provide_v2x_msg_distribution_server_info	POST	Provide V2X Message Distribution Servers information required for direct connection with a service consumer.
Provide predicted QoS task	/provide_predicted_qos	POST	Provide predicted QoS based on route information.
Publish V2X message task	/publish_v2x_message	POST	Publish a V2X message to VIS.
All subscriptions for a subscriber	/subscriptions	GET	Retrieve a list of active subscriptions for this subscriber.
		POST	Create a new subscription.
Existing subscription	/subscriptions/{subscriptionId}	GET	Retrieve information on current specific subscription.
		PUT	Modify existing subscription by sending a new data structure.
		DELETE	Cancel the existing subscription.
Notification callback	Client provided callback reference	POST	Send a notification.

Note: the role of the MEC V2X API is to **deliver** the P-QoS info (generated by some Prediction Functions in the network and/or at UE side) to V2X Application instances (which are the consumers of this info)

Suggested reading: MEC V2X Information Service API, https://docbox.etsi.org/isg/mec/open/MEC030%20V2XAPI%20drafts/MEC030v321/gs_mec030V2XAPIv314_Final%20draft.pdf

MEC V2X API – moving toward Phase 3

- Phase 2 published (maintenance)
- Phase 3 closing (new features)
  - V.3.2.1 final draft addressing observations and issues in the specification

Phase 2 deliverable published in May 2022 ***** Ready *****

ETSI GS MEC 030 V2.2.1

https://www.etsi.org/deliver/etsi_gs/MEC/001_099/030/02.02.01_60/gs_MEC030v020201p.pdf

Main goals of v2.2.1:

- aligns with latest MEC 009 & MEC 011 security considerations;
- implements the WebSocket pattern to V2X Information Service (VIS) subscription data types
- fixes errors identified in previous GS MEC 030 v2.1.1 and adds missing referenced structured data types per ETSI TTF T012 feedback

Main goals of v3.2.1:

Latest draft of ETSI GS MEC 030 V.3.2.1

https://docbox.etsi.org/isg/mec/open/MEC030%20V2XAPI%20drafts/MEC030v321

- Add Notification Data Type for *PredQosNotification*, as well as to fix the bugs in the related data types.
- Update the VIS API accordingly.

***** Currently under finalization *****

Phase 3 deliverable published in March 2023 ***** Ready *****

ETSI GS MEC 030 V3.1.1

https://www.etsi.org/deliver/etsi_gs/MEC/001_099/030/03.01.01_60/gs_mec030v030101p.pdf

Main goals of v3.1.1:

- Addressed the necessary changes to enhance Vehicular-to-Everything (V2X) MEC services in order to facilitate interoperability in a multi-vendor, multi-network and multi-access environment, considering the relevant work of other industry bodies relating to V2X communication (e.g., ETSI ITS, 5GAA), with focus on **analytics interoperability**: **Predictive QoS in multi-vendor MEC deployments**

VIS Changes introduced by 5GAA in Phase 3

Brief History:

- 20 Oct 2021 - LS from 5GAA to ETSI MEC on Enhancements on ETSI MEC 030 to Support end to end Predictive Edge Analytics
- 04 Jan 2022 - LS reply from ETSI MEC to 5GAA on Enhancements on ETSI MEC 030 to Support end to end Predictive Edge Analytics
- 30 Mar 2022 - LS from 5GAA to ETSI MEC on potential enhancements to MEC VIS API
- 05 May 2022 - LS Reply from ETSI MEC to confirms this technical topic is within the scope of MEC 030 WI
- 07 Jun 2022 - 5GAA sends input to ETSI MEC with proposed changes to VIS API
- 22 Mar 2023 - Publications of ETSI MEC Specifications

Several sections of VIS specifications were modified/enhanced:

- Inputs related to a new section 5.4.6, following the existing section 5.4.5 (this way, the suggestion is to insert the new section, and then shifting the existing 5.4.6 and 5.4.7 to 5.4.7 and 5.4.8
- Inputs and changes related to section 5.5.5
- Inputs and changes related to section 6.2.6
- Inputs and changes related to section 7.7

What is Predictive QoS and how is it used?

ETSI GS MEC 030: Overview on Predictive QoS

- 5G Automotive Association (5GAA) has developed the concept of predictive Quality of Service (QoS), which is a mechanism enabling mobile networks to provide advance notifications about predicted QoS changes to interested consumers.
- This makes it possible to adjust application behavior before the predicted QoS change takes effect, which is important to certain automotive use cases, such as remote and autonomous driving.
- QoS predictions may also be exposed to the V2X Application through a **MEC service API**

Use Case	QoS KPIs to be Predicted	Examples of Potential Application Reactions
Tele-Operated Driving	Data rate, Latency, Reliability	Change route, Park vehicle, Handover to nearby driver, Change sensor set/properties, Change teleoperation mode (e.g., from manoeuvring to trajectory provision)
High-Density Platooning	Latency, Reliability	Change inter-vehicle distance, Handover to driver, Change platoon speed or length, Terminate platoon
Hazardous Location Warning	Reliability	Inform user about availability of warning service, Change speed, Change route
Lane Merge	Latency, Reliability	Change speed of merging attempt, Abort lane merge
Software Update	Data rate	Reschedule, Stop or resume download
Infotainment	Data rate	Change video quality

Work Item **MEC 030** introduced the support for service exposure and communication across participating V2X applications in different MEC systems

Suggested reading: 5GAA White Paper on "Making 5G Proactive and Predictive for the Automotive Industry"
https://5gaa.org/wp-content/uploads/2020/01/5GAA_White-Paper_Proactive-and-Predictive_v04_8-Jan.-2020-003.pdf

Predictive QoS in automotive

Predictive QoS: A feature that allows the mobile network to provide notifications about ***predicted QoS changes*** to enable **in-advance adjustment** of the application behavior.

"QoS could drop in x seconds and degradation may last for y seconds"

IQN

Tele-Operating driver

4 **Network QoS degradation takes effect; necessary action has already been taken**

5 **Network QoS is back to normal; application may revert countermeasures**

Vehicle speed: 50 km/h

3 **Application receives In-Advance QoS Notification (IQN) of potential network quality degradation**

2 **Application takes appropriate action / countermeasure (e.g. decrease speed, change lane)**

1 **Connected vehicle is being driven through tele-operation**

QoS parameters for Tele-Operated Driving:

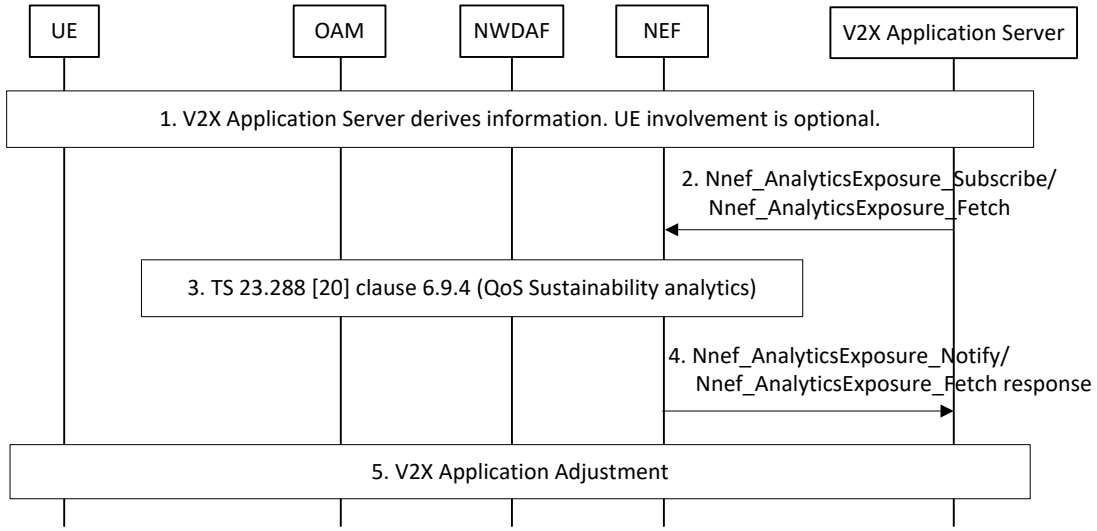
Application class	5QI	5QI features
Video and audio	2	Resource type: GBR PDB: 150 ms PER: 10^{-3} UL GFBR: **44 Mbps**
Vehicle command	83	Resource type: Delay Critical GBR PDB: 10 ms PER: 10^{-4}
Status information	4	Resource type: GBR PDB: 300 ms PER: 10^{-6} UL GFBR: 4 Mbps
Conversational voice	1	Resource type: GBR PDB: 100 ms PER: 10^{-2}

Predicted QoS change

Source: 5GAA and Huawei

QoS prediction in the 3GPP System

Notification on QoS Sustainability Analytics to the V2X Application Server

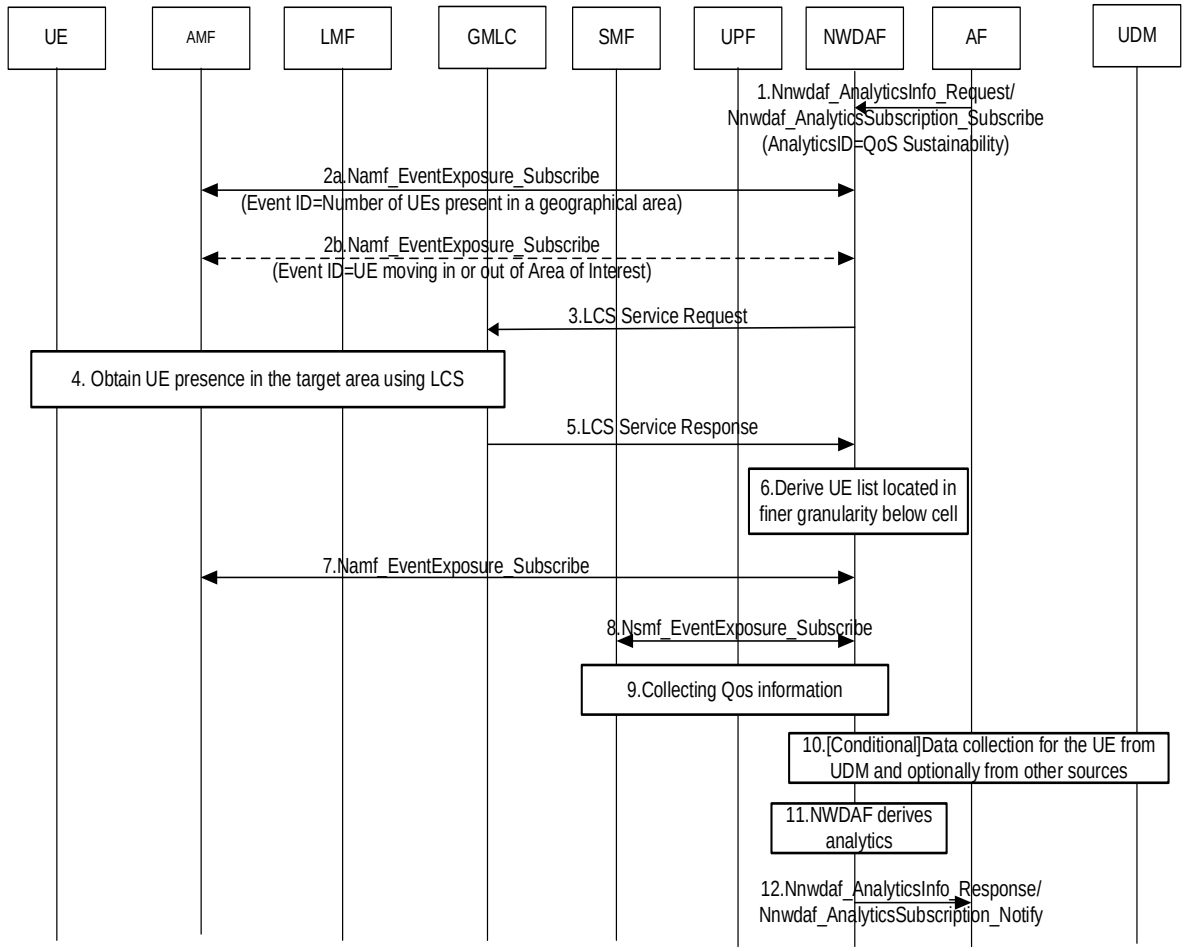


Source: 3GPP TS 23.287

- QoS Sustainability analytics was introduced in 3GPP Release 16
- A V2X Application Server may request notifications on QoS Sustainability Analytics for an indicated geographic area and time interval in order to adjust the application behaviour in advance with potential QoS change.
- The V2X Application Server may include multiple sets of parameters in order to provide different combinations of "Location information" and "Analytics Target Period" when requesting notification on QoS Sustainability Analytics.
- The request made by the V2X Application Server does not have to be per UE. In order to make a request for multiple UEs, the V2X Application Server can perform mapping between individual UE path requests and subscription to notification per path/road segment.
- Whether a request is generated for a UE or multiple UEs, and how to set the parameters included in the request and triggers for such request are up to the V2X Application Server implementation

QoS prediction in the 3GPP System

Procedure for QoS Sustainability in a fine granularity area



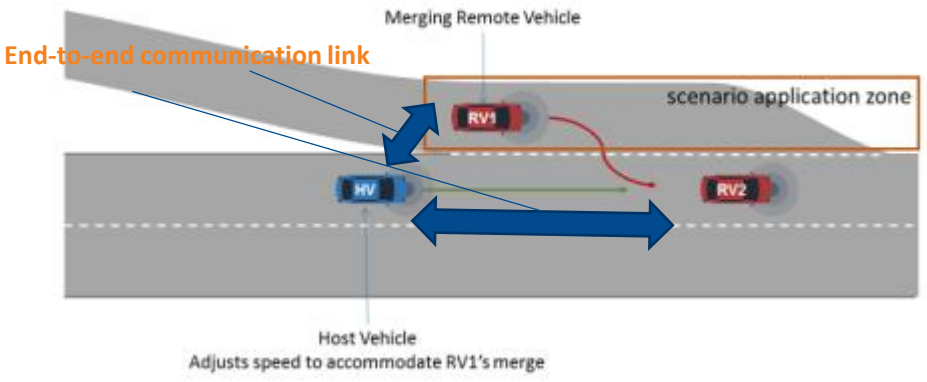
Source: 3GPP TS 23.288

- 3GPP has introduced **great improvements** in QoS sustainability analytics **in Release 18**, with the support of a new procedure for **fine granularity**.
- The consumer of QoS Sustainability analytics may request the NWDAF analytics information regarding the QoS change statistics for an Analytics target period in the past in a certain area or the likelihood of a QoS change for an Analytics target period in the future in a certain area (smaller than a cell).
- The consumer can request either to subscribe to notifications (i.e. a Subscribe-Notify model) or to a single notification (i.e. a Request-Response model).
- The service consumer may be a NF (e.g. AF).
- Thanks to additional input collected from the core network, the **NWDAF may provide analytics with much higher precision** (taking into account the specifics of the UE in question) **and related to areas smaller than a network cell.**

Predictive QoS in real MEC scenarios

Predictive analytics in inter-MNO edge scenarios

Example: Cooperative Lane Merge/Change (using Uu)



Source: 5GAA [1]

Cooperative Lane Merge/Change (using Uu) is an example of use case that can benefit of MEC nodes [2]:

- involves **vehicles exchanging data** (e.g. their intended trajectories to coordinate their lateral (steering) and longitudinal controls (acceleration/deceleration)) **to ensure a smooth manoeuvre**[3]
- several messages need to be exchanged over a **certain period of time** amongst the involved vehicles and **SLRs should be supported during the whole lane merge/change operation**
- **predicted QoS notifications of the end-to-end communication link**, during the time of the maneuver, **may determine different actions** in the involved vehicles (e.g. abort maneuver or switch to a different communication mode).

NOTE – The Cooperative Lane Merge/Change example has been chosen as representative for the scenario of two vehicles needing to exchange information with a specific set of SLRs over a certain period of time. Other use cases may also fit such scenario.
NOTE – Predicted QoS has been chosen as representative of more generic predictive edge analytics. Other examples of analytics include observed service experience, network or network slice load, etc.

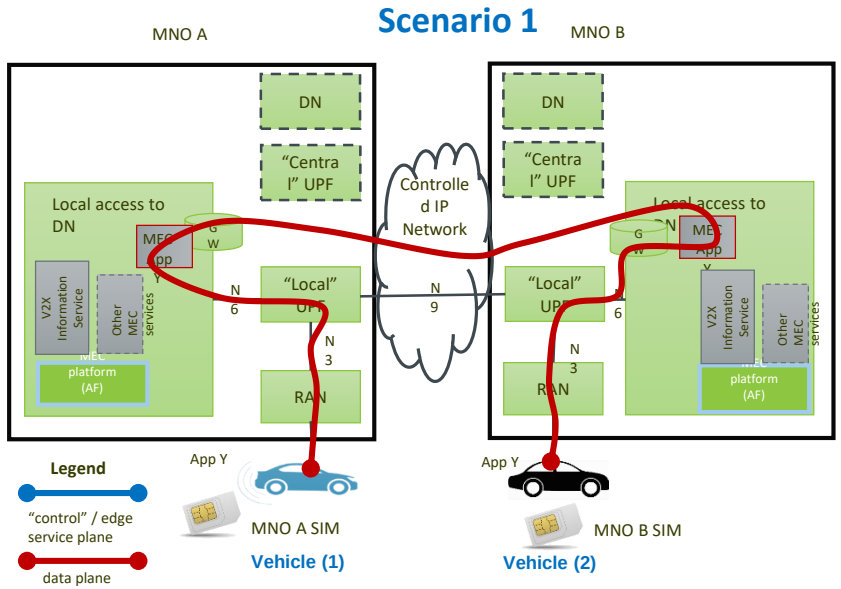
[1] 5GAA_T-190032_Use Case Description Cooperative Lane Merge_v1.1
[2] MEC4AUTO Technical Report Use Cases and initial test specifications review

Predictive analytics in inter-MNO edge scenarios

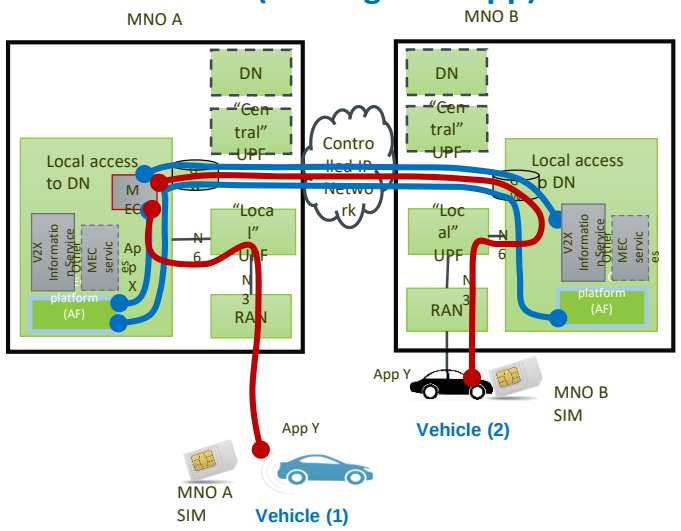
Three different scenarios

Requirement: each of the MEC applications running in the vehicles shall be capable of receiving the predicted QoS notifications for the end-to-end communication link of the user plane between the two vehicles.
NOTE – such notifications may trigger specific reaction in the application (e.g. abort manoeuvre)

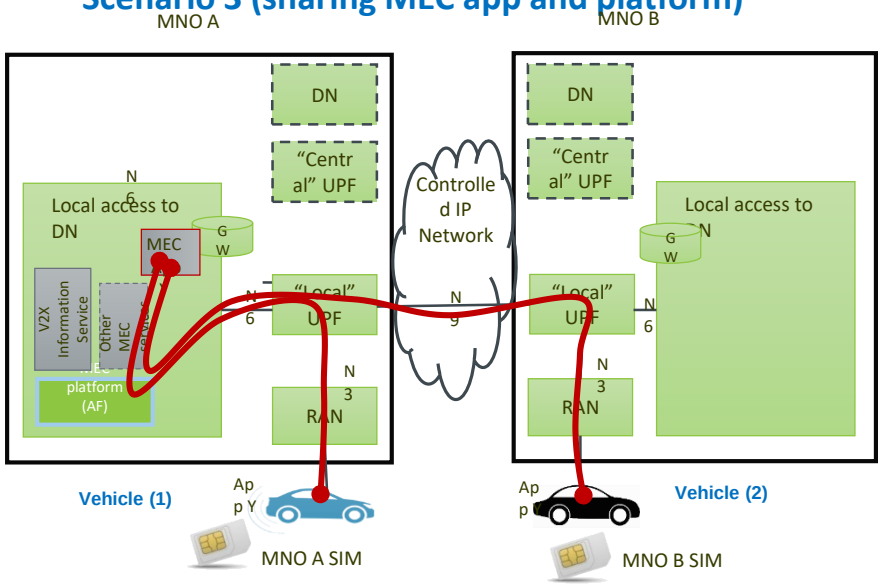
Scenario 1



Scenario 2 (sharing MEC app)



Scenario 3 (sharing MEC app and platform)



NOTEs:

- MEC4AUTO assumed vehicles having global SIM, here we assume each vehicle has SIM card provided by the operator it is connecting to
- MEC4AUTO did not include the end-to-end user plane link between the two vehicles
- Shown only Scenario 3A, similar consideration in case of Scenario 3B (N9)

Observation:

- In the scenarios studied in MEC4AUTO TR, the end-to-end communication link includes network segments in **multiple MNO networks** and potentially also **outside MNO networks**.
- There is a **need to determine the PQoS of network segments across multiple operator networks**.

Source: 5GAA

Why do we need end-to-end QoS prediction?

Example V2N2V scenario

If the communication link does not support the required QoS, the application may decide to make different actions than what planned when QoS is supported (e.g. abort operation)

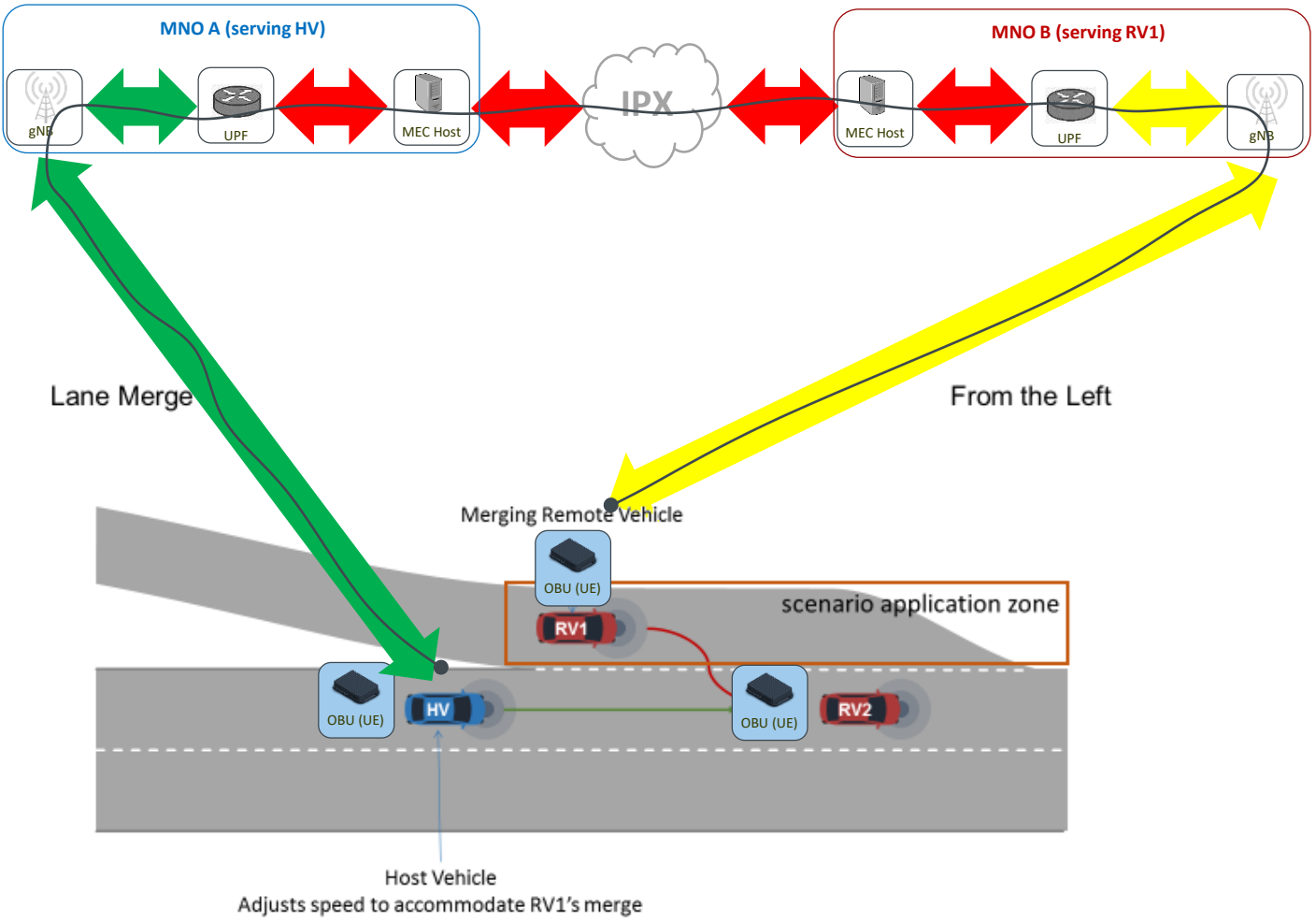
Existing 3GPP R16 (and R18) considers the QoS prediction limited to the "3GPP domain", that is the network segment between the UE and UPF node (Radio and Core network).

It does not consider potential QoS issues in the following network segments:

- the network containing the MEC host (Data Network)
- the network segment of IP interconnect between MNOs
- the network segment of the operator serving the remote vehicle (which can be different from the MNO serving the host vehicle)

The need for end-to-end QoS prediction (in V2N2V, multi MNO)

Perspective of HV: which prediction information is available today?



end-to-end user plane link between two V2N2V application instances

QoS prediction **available** for the network segment via standard 3GPP interface(*)

QoS prediction **not available** for the network segment not currently available via standard interface (*).

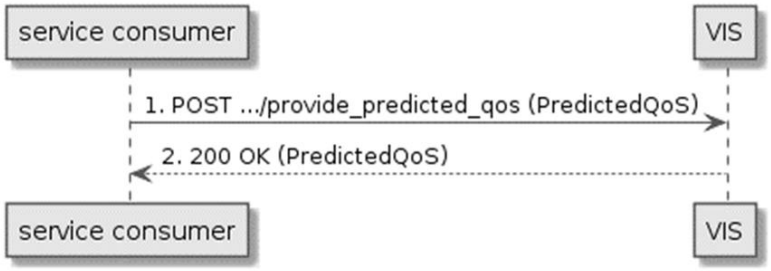
QoS prediction **may be available** for the network segment via standard 3GPP interface for the RV1 vehicle but **currently not available** for the HV vehicle via standard interface (**).

(*) 3GPP R16 solution "QoS Sustainability analytics" supports QoS prediction between the UE and the UPF node, for details please check TS 23.288 cl. 6.9. No enhancements planned for R18 on this issue.
(**) RV1 vehicle may share the QoS prediction with HV via user plane connection, no standard currently specifies this.
(***) Describing MEC4AUTO scenario 1. Other deployment options may be possible, with MEC host also in other network domains, and different configurations for the end-to-end user plane link

ETSI MEC 030 VIS API solves this issue with v3

New functionality in MEC VIS API: end-to-end QoS prediction

VIS support for journey-specific QoS predictions



The Figure shows a scenario where, the service consumer (e.g. a V2X application) sends a POST request to VIS to receive the predicted QoS correspondent to potential routes of a vehicular UE. The response contains the required information.

In v3, service has been enhanced to provide support for multi-domain E2E predictive QoS notifications:

- VIS may now enable support for predictive QoS notifications in multi-domain MEC deployments by collecting and distributing analytics from external Prediction Functions (PFs) located in the different network domains (MNOs, Service Providers, RTAs, IPX, etc.).
- The sourcing of analytics from external PFs, such as the Network Data Analytics Function (NWDAF) in the 3GPP network domains may help in providing more accurate QoS predictions to the service consumers.

Support for analytics subscription

Figure 5.5.6.1-1: Flow of subscribing to the V2X information event notifications

Attribute name	Data type	Cardinality	Description
subscriptionType	String	1	Shall be set to "PredQosSubscription".
callbackReference	Uri	0..1	URI exposed by the client on which to receive notifications via HTTP. See note.
requestTestNotification	Boolean	0..1	Shall be set to TRUE by the service consumer to request a test notification via HTTP on the callbackReference URI, as described in ETSI GS MEC 009 [9], clause 6.12a. Default: FALSE.
websockNotifConfig	WebsockNotifConfig	0..1	Provides details to negotiate and signal the use of a Websocket connection between VIS and the service consumer for notifications. See note.
_links	Structure (inlined)	0..1	Hyperlink related to the resource. This shall be only included in the HTTP responses and in HTTP PUT requests.
>self	LinkType	1	Self-referring URI. The URI shall be unique within the VIS API as it acts as an ID for the subscription.
filterCriteria	QosPredFilterCriteria	1	List of filtering criteria aimed to filter QoS predictions at the reception. Any filtering criteria included in the request, shall also be included in the response.
expiryDeadline	TimeStamp	0..1	Time stamp.
NOTE: At least one of callbackReference and websockNotifConfig shall be provided by the service consumer. If both are provided, it is up to VIS to choose an alternative and return only that alternative in the response, as described in ETSI GS MEC 009 [9], clause 6.12a.			

Table 6.3.6-1: Attributes of the PredQosSubscription

- In addition to the request/response interaction, VIS can now use **subscription/notification** interactions with the service consumers that ensures more flexibility.
- The service consumer may subscribe to the multi-domain E2E predictive QoS notification when the vehicle enters a specific road traffic scenario (e.g. approaching an intersection, starting a lane merge operation, etc.) and **VIS may continuously provide in-advance predictions on relevant events along the route**, as such information becomes available.
- A **new data type to support the subscription to Predictive QoS** has been added in Section 6.3.6

Changes to the type PredictedQoS (1 of 2)

Name	Data type	Cardinality	Remarks
timeGranularity	TimeStamp	0..1	Time granularity of visiting a location.
locationGranularity	String	1	Granularity of visited location. Measured in metres.
Routes	Structure (inlined)	1..N	Information relating to the potential routes of a vehicular UE.
>routeInfo	Structure (inlined)	2..N	Information relating to a specific route. The first structure shall relate to the route origin and the last to the route destination. Intermediate waypoint locations may also be provided.
>>location	LocationInfo	1	Vehicular UE location.
>>time	TimeStamp	0..1	Estimated time at the location.
>>rsrp	Uint8	0..1	Reference Signal Received Power as defined in ETSI TS 136 214 Shall only be included in the response.
>>rsrq	Uint8	0..1	Reference signal received quality as defined in ETSI TS 136 214 Shall only be included in the response.
Note: The data type of locationGranularity is a string which indicates the granularity of a visited location by means of latitudinal and longitudinal margins.			

Type: PredictedQos (v2)

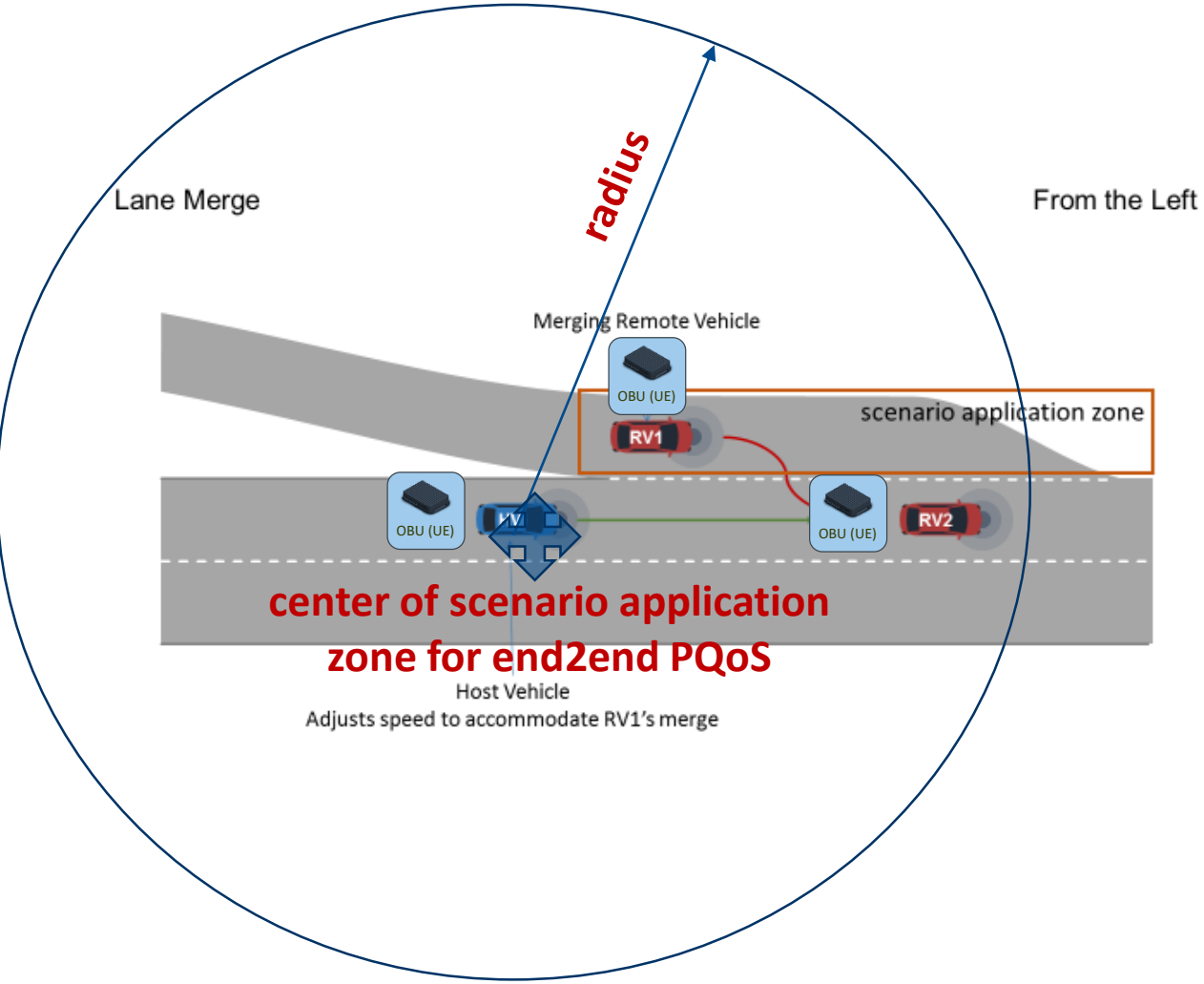
- In order to support the new type of end-to-end QoS prediction, the type **PredictedQoS has been modified.**
- Introduced a **target type**:
  - SINGLE_UE_PREDICTION - The predicted QoS is to be intended as journey-specific for a requesting vehicular UE.
  - E2E_APPLICATION_INSTANCE_PREDICTION: The E2E user plane link between two V2X application instances
- Instead of radio specific information, more **high level KPIs related to the QoS** have been introduced.
- Introduced the support of **notice period/time horizon**, which is defined as the minimum time interval required for the consumer to receive the notification before theevent happens (time of the prediction).
- Introduced support of the **threshold model**, which is requested in subscription/notification in order to define the triggering conditions and allow the consumer to be notified any time one or more predicted KPI falls within or outside of a predefined range.
- Support for **confidence**, or the confidence of a specific prediction.

Changes to the type PredictedQoS (2 of 2)

Name	Data type	Cardinality	Remarks
predictionTarget	Enum (inlined)	1	Indicates target of QoS prediction. Valid values: 1. SINGLE_UE_PREDICTION: The predicted QoS is to be intended as journey-specific for a requesting vehicular UE. 1. E2E_APPLICATION_INSTANCE_PREDICTION: The E2E user plane link between two V2X application instances, where one instance relates to a single vehicular UE and the other instance to an application instance within another network, i.e. either another vehicular UE as in the V2N2V case, or an infrastructure element as in the V2N2I case. Shall only be included in the request.
timeGranularity	TimeStamp	0..1	Time granularity of visiting a location.
locationGranularity	String	1	Granularity of visited location. Measured in meters.
noticePeriod	TimeStamp	0..1	Information on when the predicted QoS is needed at the service consumer interface. The value of the notice period depends on the application reaction that has to be triggered by the service consumer. The value of the notice period shall be equal or a multiple of the timeGranularity, if it is present. If present, it shall only be included in the request.
predictionArea	Structure (inlined)	0..1	Geographical area including the two ends of the user plane link between two V2X application instances. It shall only be present when "predictionTarget" = "E2E_APPLICATION_INSTANCE_PREDICTION".
>center	LocationInfo	1	Center of geographical area including the two ends of the user plane link between two V2X application instances.
>radius	String	1	Radius of geographical area including the two ends of the user plane link between two V2X application instances. Measured in meters.
routes	Structure (inlined)	0..N	Information relating to the potential routes of a vehicular UE. Shall only be present when "predictionTarget" = "SINGLE_UE_PREDICTION".

Name	Data type	Cardinality	Remarks
>routeInfo	Structure (inlined)	1..N	Information relating to a specific route. The first structure shall relate to the route origin and the last to the route destination. Intermediate waypoint locations may also be provided.
>>location	LocationInfo	1	Vehicular UE location.
>>time	TimeStamp	0..1	Estimated time at the location.
qos	Structure (inlined)	1	Predicted QoS at the related time and vehicular UE location. Shall only be included in the response.
>stream	Structure (inlined)	1..N	Predicted QoS at the related time and vehicular UE location for the specific data stream. In case of 3GPP network, this is mapped to a QoS flow.
>>streamId	String	1	The identifier of a specific data stream. In case of 3GPP network, this is mapped to a QoS flow.
>>qosKpi	Structure (inlined)	1..N	This structure contains the prediction for a specific QoS KPI related to a given data stream.
>>>kpiName	String	1	The name of the KPI (e.g. latency, UL bitrate, etc.). It can be included in the request and in the response.
>>>kpiValue	String	1	Information on the predicted value for the specific QoS KPI. It can be in different forms, such as upper bound and lower bound, CDF, actual value, etc. Shall only be included in the response.
>>>confidence	String	0..1	Confidence of the prediction, as returned by the relevant domain PF. The value and the measurement of the confidence depends on the SLA. Shall only be included in the response.
NOTE: The data type of locationGranularity is a string which indicates the granularity of a visited location by means of latitudinal and longitudinal margins.			

Requesting end-to-end QoS prediction



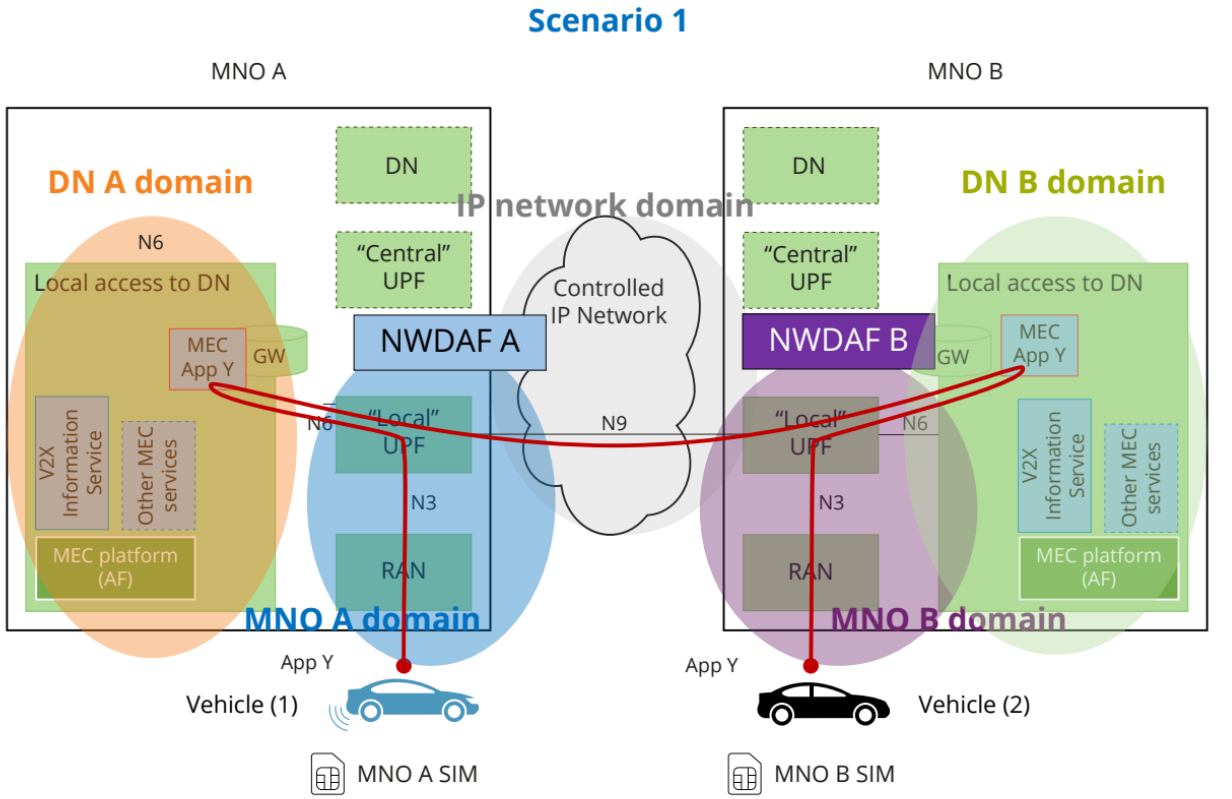
How can the service consumer tell VIS which end-to-end QoS prediction are needed?

- New APIs use a **center** and **radius** mechanism
- In the example, the radius centered in the HV: in this case, end2end PQoS is needed for all of the vehicles in the circle, which means:
  - e2e PQoS between HV and RV1
  - e2e PQoS between HV and RV2

- NOTE that each segment may have different MEC resource sharing scenario and different sets of end-to-end domains

Putting it all together: a real example

Scenario 1: Both MNO A and MNO B have MEC platform and MEC application X

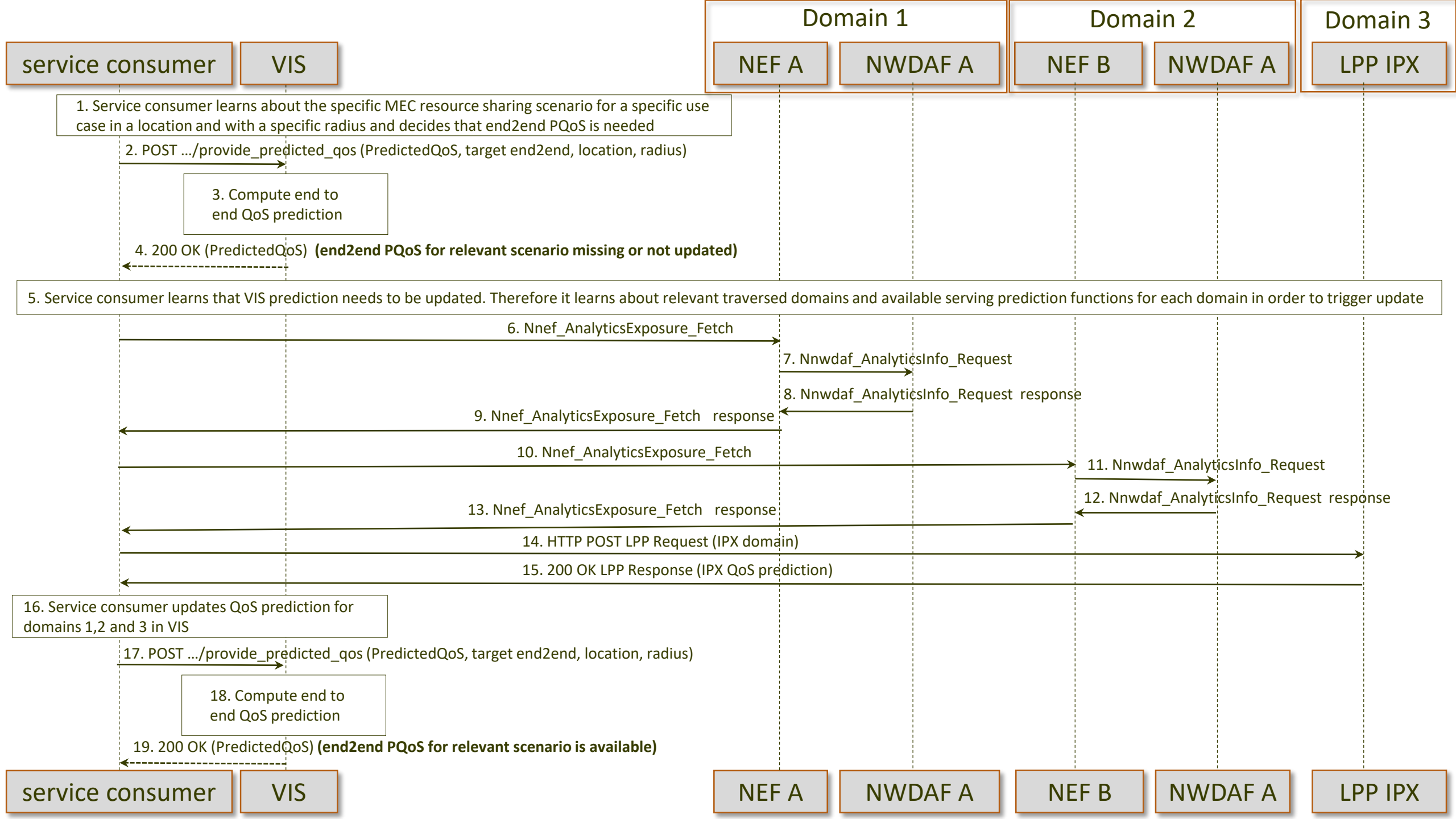


Presence of MEC application	vehicle (1): MNO A	vehicle (2): MNO B
Presence of MEC platform	vehicle (1): MNO A	vehicle (2): MNO B
Vehicle subscriptions	vehicle (1): MNO A	vehicle (2): MNO B
Available interconnection between MNOs	N9	
Roaming	No	

It is possible to identify at least five network domains traversed by the end-to-end user plane link for which QoS prediction could be advisable:

1. MNO A RAN, core network and central DN domains
2. MNO A edge DN domain
3. MNO B RAN, core network and central DN domains
4. MNO B edge DN domain
5. IP interconnect domain between MNO A and MNO B

The next slide shows how a service consumer can use VIS to know the end-to-end QoS prediction for the user plane link across the multiple domain, assuming that there are providers for the QoS prediction of each single domain


Domain 1
Domain 2
Domain 3
service consumer
VIS
NEF A
NWDAF A
NEF B
NWDAF A
LPP IPX
1. Service consumer learns about the specific MEC resource sharing scenario for a specific use case in a location and with a specific radius and decides that end2end PQoS is needed
2. POST …/provide_predicted_qos (PredictedQoS, target end2end, location, radius)
3. Compute end to end QoS prediction
4. 200 OK (PredictedQoS) (end2end PQoS for relevant scenario missing or not updated)
5. Service consumer learns that VIS prediction needs to be updated. Therefore it learns about relevant traversed domains and available serving prediction functions for each domain in order to trigger update
6. Nnef_AnalyticsExposure_Fetch
7. Nnwdaf_AnalyticsInfo_Request
8. Nnwdaf_AnalyticsInfo_Request response
9. Nnef_AnalyticsExposure_Fetch response
10. Nnef_AnalyticsExposure_Fetch
11. Nnwdaf_AnalyticsInfo_Request
12. Nnwdaf_AnalyticsInfo_Request response
13. Nnef_AnalyticsExposure_Fetch response
14. HTTP POST LPP Request (IPX domain)
15. 200 OK LPP Response (IPX QoS prediction)
16. Service consumer updates QoS prediction for domains 1,2 and 3 in VIS
17. POST …/provide_predicted_qos (PredictedQoS, target end2end, location, radius)
18. Compute end to end QoS prediction
19. 200 OK (PredictedQoS) (end2end PQoS for relevant scenario is available)
service consumer
VIS
NEF A
NWDAF A
NEF B
NWDAF A
LPP IPX

Conclusions

A few takeaways …

- MEC deployments may fall into **different architecture scenarios**. In case of multi-domain, there are specific requirements on the analytics
- MEC V2X APIs can provide support for **end-to-end analytics** in the context of **multi-domain MEC deployments**
- **5GAA and ETSI MEC have been working together** to improve MEC V2X APIs to support **new real-world scenarios**

For more information …

- 5GAA gMEC4AUTO Task 3 TR - Predictive Edge Analytics and Network Slicing Enabling Mobility-as-a-Service in Global MEC Scenarios – link
- 5GAA PRESA TR – Predictive QoS and V2X Service Adaptations - link
- ETSI GS MEC 030 V3.1.4 (2024-01) - Multi-access Edge Computing (MEC);V2X Information Services API - link
- 3GPP TS 23.287 Architecture enhancements for 5G System (5GS) to support Vehicle-to-Everything (V2X) services (Release 18) - link
- 3GPP TS 23.288 Architecture enhancements for 5G System (5GS) to support network data analytics services (Release 18) - link
- 3GPP TS 29.520 Network Data Analytics Services;Stage 3 (Release 18) - link

Thank you!

Antonio.Consoli@huawei.com