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Technical Report

3rd Generation Partnership Project;

Technical Specification Group Services and System Aspects;

Study on architecture enhancements for the

Evolved Packet System (EPS) and the 5G System (5GS)

to support advanced V2X services

(Release 16)

** 

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# Foreword

This Technical Report has been produced by the 3rd Generation Partnership Project (3GPP).

The contents of the present document are subject to continuing work within the TSG and may change following formal TSG approval. Should the TSG modify the contents of the present document, it will be re-released by the TSG with an identifying change of release date and an increase in version number as follows:

Version x.y.z

where:

x the first digit:

1 presented to TSG for information;

2 presented to TSG for approval;

3 or greater indicates TSG approved document under change control.

y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.

z the third digit is incremented when editorial only changes have been incorporated in the document.

# 1 Scope

The objective of this Technical Report is to identify and evaluate potential architecture enhancements of EPS and 5G System design needed to support advanced V2X services identified in TR 22.886 [2], based on vehicular services requirements defined in TS 22.185 [3] and TS 22.186 [4] and determine which of the solutions can proceed to normative specifications.

In Rel-15, the study focuses on EPS.

# 2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non‑specific.

- For a specific reference, subsequent revisions do not apply.

- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

[1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

[2] 3GPP TR 22.886: "Study on enhancement of 3GPP Support for 5G V2X Services".

[3] 3GPP TS 22.185: "Service requirements for V2X services; Stage 1".

[4] 3GPP TS 22.186: "Enhancement of 3GPP support for V2X scenarios; Stage 1".

[5] 3GPP TS 23.285: "Architecture enhancements for V2X services".

[6] 3GPP TS 22.278: "Service requirements for the Evolved Packet System (EPS)".

[7] 3GPP TS 23.501: "System Architecture for the 5G System; Stage 2".

[8] 3GPP TS 23.303: "Proximity-based Services (ProSe); Stage 2".

[9] 3GPP TS 23.502: "Procedures for the 5G System; Stage 2".

[10] 3GPP TS 23.503: "Policy and Charging Control Framework for the 5G System; Stage 2".

[11] 3GPP TS 33.303: "Proximity-based Services (ProSe); Security aspects".

[12] 3GPP TS 23.203: "Policy and charging control architecture".

[13] 3GPP TS 24.334: "Proximity-services (ProSe) User Equipment (UE) to ProSe function protocol aspects; Stage 3".

[14] 3GPP TS 36.440: "General aspects and principles for interfaces supporting Multimedia Broadcast Multicast Service (MBMS) within E-UTRAN".

[15] 3GPP TR 23.724: "Study on Cellular IoT support and evolution for the 5G System".

[16] 3GPP TS 23.246: "Multimedia Broadcast/Multicast Service (MBMS); Architecture and functional description".

[17] 3GPP TS 26.346: "Multimedia Broadcast/Multicast Service (MBMS); Protocols and codecs".

[18] 3GPP TS 25.446: "MBMS synchronisation protocol (SYNC)".

[19] Void.

[20] Void.

[21] 3GPP TS 23.222: "Functional architecture and information flows to support Common API Framework for 3GPP Northbound APIs; Stage 2".

[22] 3GPP TS 22.261: "Service requirements for next generation new services and markets".

[23] 3GPP TS 23.288: "Architecture enhancements for 5G System (5GS) to support network data analytics services".

[24] 3GPP TS 28.552: "Management and orchestration; 5G performance measurements".

# 3 Definitions and abbreviations

## 3.1 Definitions

For the purposes of the present document, the terms and definitions given in TR 21.905 [1], TS 23.285 [5] and TS 23.501 [7] apply.

## 3.2 Abbreviations

For the purposes of the present document, the abbreviations given in TR 21.905 [1], TS 23.285 [5], TS 23.501 [7] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in TR 21.905 [1].

CoR Categories of Requirements

LoA Level of Automation

RN Rank Notification

V2X AS V2X Application Server

V2XCF V2X Control Function

VQI V2X 5QI

# 4 Architectural Assumptions and Requirements

## 4.1 Architectural Assumptions

### 4.1.1 General

- Architecture reference models defined in TS 23.285 [5] (i.e. PC5 and LTE-Uu based V2X architecture reference model and MBMS for LTE-Uu based V2X architecture reference model) are used as basis architecture for supporting eV2X services in EPS.

- For EPS based enhancement, it is assumed that AS layer impact for solutions in this TR should be avoided as much as possible.

- eV2X Groups are handled within the V2X application which is out of scope of 3GPP.

- Architecture reference models defined in TS 23.501 [7] are used as baseline architecture for supporting eV2X services in 5GS.

- For V2X configuration of parameters known as Service Authorization and Provisioning of the UE, the architecture is based on Alternative #1 (V2XCF as part of the PCF) of Annex A.1 and parameters are provided by the PCF to the UE via the AMF based on procedure in TS 23.502 [9] clause 4.2.4.3 'UE Configuration Update procedure for transparent UE Policy delivery'.

- The provisioning mechanism also includes pre-configuration in the UE (via UICC or ME) and, either via V1 directly or via AF/PCF, parameter provisioning to the UE from the V2X Application Server.

Editor's Note: This requires Stage 3 changes, e.g., to include the NR parameters in the management objects.

### 4.1.2 PC5 and NG-RAN Uu based V2X architecture reference model

The high-level view of the non-roaming, roaming and inter-PLMN 5G System architecture for PC5 and Uu based V2X communication are depicted in Figure A.1.1.3-1, Figure A.1.1.3-2 and Figure A.1.1.3-3, respectively.

## 4.2 Architectural Requirements

Editor's note: This clause will define the architectural requirements based on the normative stage-1 requirements defined in TS 22.185 [3], TS 22.186 [4] and TS 22.278 [6].

# 5 Key Issues

Editor's note: This clause will describe the key issues for architecture enhancements of EPS and 5G System to support advanced V2X services.

## 5.1 Key Issue #1: Support of eV2X Group Communication

### 5.1.1 General description

One of the main use cases for eV2X is Vehicle Platooning where vehicles of the same platoon are involved in sharing the necessary information required to support the platoon operations (for example, distance between vehicles, relative speed, updates from RSU, etc.). Similar requirements apply also for the Extended Sensor use case where UEs exchange data gathered through local sensors or live video data among vehicles, Road Site Units, devices of pedestrians and V2X application servers.

For both cases such sharing of information is supported by creating a specific eV2X Group within a V2X application.

This key issue addresses how eV2X communication for these group of UEs will be supported by the 3GPP system. In particular, the following aspects are required to be studied:

- Whether and how the 3GPP system is required to be aware of an eV2X Group within the V2X application.

- Whether and how the 3GPP system is required to be aware of the number of UEs within an eV2X Group of a V2X application.

NOTE: It is assumed that eV2X Group discovery is supported within the V2X application.

- How 3GPP layer communication between UEs of the same eV2X Group is carried out.

## 5.2 Key Issue #2: 3GPP PC5 RAT selection for a V2X application

### 5.2.1 General description

A UE may support multiple radio access technologies (RATs) over PC5 interface, including LTE and NR. For such UE, the most suitable 3GPP PC5 RAT(s) for V2X applications should be selected based on various criteria. For example, for the V2X application requiring low latency, the PC5 RAT that meets the required latency should be selected.

To support the proper selection of 3GPP PC5 RAT to use for a V2X application, the following aspects need to be studied:

- What parameters should be considered as input to 3GPP PC5 RAT selection for each V2X application, e.g. QoS parameters, RAN related parameters such as expected range of a RAT, operator policy, preferences for each V2X application, peer UE capabilities, etc.?

- When and how the 3GPP PC5 RAT selection is performed? Is the 3GPP PC5 RAT selected before sending/receiving each V2X message, or is the 3GPP PC5 RAT selected based on static configuration for each V2X application?

- How can 3GPP system support the 3GPP PC5 RAT selection for the V2X application?

In addition, if the UE supports multiple (e)V2X applications and the UE is in scheduled mode operation, the UE may be required to change cell when a V2X application that requires to send a V2X message, has an operating carrier frequency, or resource configuration for a PC5 RAT that is not supported by the cell the UE is currently camped on. In such a case the following issues may arise and need to be studied:

- An active V2X application will be interrupted in case the new cell does not support its operating carrier frequency or resource configuration for the PC5 RAT selected.

- A UE may select a cell only supporting E-UTRA radio interrupting V2X applications that require to send V2X messages over NR Uu.

When studying the above aspects, the following need to be considered:

- When the UE is non-roaming and when the UE is roaming;

- When the UE is in coverage and when the UE is out of coverage.

Editor's note: When necessary, RAN WGs should be involved during the study of this key issue.

## 5.3 Key Issue #3: QoS Support for eV2X over Uu interface

### 5.3.1 General description

Rel-14 handles QoS for V2X communications as specified in TS 23.285 [5] clause 4.4.5, defining QoS handling for V2X communication over PC5 and over LTE-Uu reference points.

TS 22.186 [4] specifies service requirements to enhance 3GPP support for V2X scenarios in the 3GPP systems, both for safety (e.g., automated driving, vehicle platooning etc.) and non-safety (e.g., mobile high data rate entertainment, mobile hotspot/office/home, dynamic digital map update etc.) V2X scenarios.

In particular, TS 22.186 [4] defines five Categories of Requirements (CoR) to support eV2X scenarios: General Aspects, Vehicle Platooning, Advanced Driving, Extended Sensors and Remote Driving. Additionally, it defines six Level of Automation (LoA), reflecting the functional aspects of the technology and affecting the system performance requirements. The five level of automation defined are: No Automation (0), Driver Assistance (1), Partial Automation (2), Conditional Automation (3), High Automation (4), Full Automation (5). For each CoR and each LoA, requirements are specified in terms of Payload (from 50 to 12000 bytes), Transmission Rate (from 2 to 50 message/sec), Maximum end-to-end latency (from 3 to 500 ms), Reliability (from 90% to 99.999%), Data rate (from 0.5 to 1000 Mbps) and minimum required communication range (from 50 to 1000 meters).

To ensure the support eV2X scenarios in 5GS, including all CoRs and LoAs (including, e.g., URLLC), according to requirements specified in TS 22.186 [4], the following issues need to be studied:

- Investigating if the 5G QoS Characteristics defined in TS 23.501 [7] clause 5.7.4 (i.e., Resource Type, Priority Level, Packet Delay Budget, Packet Error Rate, Default Maximum Data Burst Volume, Default Averaging Window) are sufficient to represent the QoS profiles required by V2X services, or if additional QoS Characteristics need to be defined;

- Investigating if the standardised 5QI values defined in TS 23.501 [7] clause 5.7.4 are sufficient to support all CoRs and LoAs defined in TS 22.186 [4], or if additional standardised 5QI values need to be defined;

- Investigating possible enhancements of the 5GS QoS framework to support improved RAN QoS monitoring and control;

Editor's note: This aspect has RAN dependency and needs coordination with RAN WGs.

- Investigating possible enhancements to the 5GS QoS framework to allow the AF to influence QoS for eV2X applications.

## 5.4 Key Issue #4: Support of PC5 QoS framework enhancement for eV2X

### 5.4.1 General description

In Rel-14 V2X as documented in TS 23.285 [5], the QoS over PC5 is supported with the ProSe Per-Packet Priority (PPPP). Application layer is allowed to mark the packets with the PPPP, which indicates the required QoS level. Certain enhancement was added, e.g. by allowing deriving of PDB from the PPPP.

The new QoS requirements for eV2X are captured in TS 22.186 [4]. Various new KPIs are captured in clauses 5.2 to 5.5. These have a variety of new QoS parameter ranges, e.g. the latency (PDB) range from 100ms in advanced driving to 3ms in Emergency trajectory alignment. Message rate range from 10 message/second to 50 message/second, and with some burst traffic types, e.g. in extended sensor information sharing. In addition, the reliability requirement also varies, e.g. 90% to 99.999%.

The existing PPPP mechanism with 8 levels may not be sufficient to support the QoS differentiation. Therefore, enhancement may be required to allow the new QoS requirements of the V2X traffic to be conveyed from application layer to the AS layer.

This key issue will study the following aspects:

- Whether existing PC5 QoS framework (e.g. PPPP) is sufficient to support eV2X QoS requirements;

- What the QoS parameters for an application are and how such information can be passed to the AS layer to enforce.

This key issue also addresses the support of URLLC traffic.

## 5.5 Key Issue #5: Service Authorization and Provisioning to UE for eV2X communications over PC5 reference point

### 5.5.1 General description

In order to enable the UE to use eV2X Service in 5G system, service authorization and provisioning for eV2X communication over PC5 reference point is needed, following aspects need to be studied:

- Whether current authorization and provisioning mechanism over V2X control function defined in clause 4.4.1.1 of TS 23.285 [5] can be reused;

- Justification for introducing a new solution and overall solution description;

- Policy and parameters provisioned to UE;

- Principles for applying parameters for V2X communications over PC5 reference point;

- How to revoke the service authorization and provisioning to UE.

## 5.6 Key Issue #6: Service Authorization to NG-RAN for eV2X communications over PC5 reference point

### 5.6.1 General description

In order to provide eV2X service authorization information to NG-RAN (i.e. assisting NG-RAN to operate in Mode 3 or 4) for eV2X communication over PC5 reference point, following aspects need to be studied:

- When and how the UE indicates its eV2X capability to network;

- When and how 5GC provides to NG-RAN the authorization information on whether UE is authorized to use V2X communication over PC5 reference point;

- How to revoke the service authorization to NG-RAN.

## 5.7 Key Issue #7: Network Slicing for eV2X Services

### 5.7.1 General description

For 5GS, the Network Slicing feature, introduced in Release 15 (see TS 23.501 [7]), allows to deploy separate networks for dedicated purposes. Network slicing offers network deployment options, which can be exploited to support various eV2X services and scenarios. To make use of the 5G slicing framework for eV2X services, the following issues need to be studied:

- Which eV2X features, supported by Rel-15 5GS features or requiring enhancements to the 5GS architecture (e.g., side-link communication, multicast-broadcast communication, group communication etc.), would require or benefit from explicit network slicing support;

- The relationship between the 5GS features required to support eV2X services and network slicing, including:

- Whether new SST value(s) needs to be standardised, or if such features will be supported by existing SST values;

- Which 5GS features required to support eV2X services are supported by certain SST values.

## 5.8 Key Issue #8: Support of edge computing

### 5.8.1 General description

Edge computing is considered one of the key technologies to support V2X services. The edge computing for V2X services can be characterized by edge computing system located at the edge of the mobile network to support collecting and processing of time critical information from vehicle UEs, pedestrian UEs and/or RSUs, and providing information to vehicle UEs, pedestrian UEs and/or RSUs.



Figure 5.8.1-1: High level view of edge computing for V2X services

The ability to steer traffic to a specific local DN depending on the DNN/S-NSSAI/etc. and support for edge computing are already defined in Rel-15, e.g. in clause 5.6.7 'Application Function influence on traffic routing' and clause 5.13 'Support for Edge Computing' of TS 23.501 [7].

This key issue will study that the existing mechanisms specified in TS 23.501 [7] can be reused for V2X purposes and whether any enhancement is needed to support specific needs for V2X, e.g. local routing to/from V2X Application Server(s) in a local DN close to NG-RAN.

This key issue will also study how to support the session and service continuity requirement of V2X when the edge computing is utilized.

Solutions for this key issue should leverage those developed in FS\_5G\_URLLC and focus on aspects specific to V2X.

## 5.9 Key Issue #9: Support of unicast/multicast for sensor sharing over PC5

### 5.9.1 General description

In TS 22.186 [4], there are new requirements captured for supporting higher data rate information sharing between vehicles, e.g. that for the support of Extended Sensor use case in clause 5.4. The KPIs include those that can be still supported using broadcast mechanism, and those that cannot be supported with broadcast mechanism over the available ITS spectrum, especially, when there are multiple vehicles performing broadcast based information sharing in the proximity

Therefore, besides the broadcast mechanism, eV2X also needs to support a new interactive delivery mechanism to handle high data rate data sharing between vehicles, e.g. using unicast and/or multicast.

This key issue will study:

- How an interactive, e.g. request and response based, data delivery mechanism can assist the efficient delivery of data to satisfy eV2X use cases.

- If any V2X layer signalling is required.

- What information needs to be exchanged to enable the AS layer to configure the corresponding transmission and reception.

- How to prevent privacy issues related to long duration unicast/multicast session e.g. source L2 ID tracking.

NOTE: Coordination with RAN regarding the unicast/multicast support is needed.

## 5.10 Key Issue #10: eV2X message transmission and reception

### 5.10.1 General description

Transmission of a V2X message e.g. for V2V Service and V2P Service can be triggered periodically or based on a certain event. The V2X message can be exchanged when the UE is served by operator network, or when the UE is not served by operator network. The V2X message can be exchanged when the UE is non-roaming and roaming. The V2X message can be IP based or non-IP based.

When architectural requirements are identified in Release 16 to accommodate V2X messages transmission via PC5/Uu interfaces, then impacts on the eV2X message transmission will be addressed in this key issue.

## 5.11 Key Issue #11: Service Authorization and Provisioning to UE over NG-Uu reference point

### 5.11.1 General description

In order to enable the UE to use eV2X Service in 5G system, service authorization and provisioning for eV2X communication over NG-Uu reference point is needed, following aspects need to be studied:

- Whether current authorization and provisioning mechanism can be reused if V2X control function defined in clause 4.4.1.1 of TS 23.285 [5] shall be used;

- Justification for introducing a new solution and overall solution description;

- Policy and parameters provisioned to UE for unicast over NG-Uu;

- Principles for applying parameters for V2X communications over NG-Uu reference point;

- How to revoke the service authorization and provisioning to UE.

## 5.12 Key Issue #12: System migration and interworking for eV2X

### 5.12.1 General description

The eV2X system needs to support both the V2X requirements as specified in TS 22.185 [3], and the eV2X requirements as specified in TS 22.186 [4]. Therefore, the system needs to handle all types of V2X UEs, e.g. UE with EPS V2X capabilities, and UE with 5GS V2X capabilities.

The 5GS V2X capable UE needs to also support the services available via the EPS V2X system, and may need to interact with the EPS V2X capable UEs. This means that interworking towards V2X services via EPS needs to be investigated in order to support same V2X applications running over 5GS V2X and EPS V2X, e.g. any potential new QoS mechanism should also be able to handle QoS based on PPPP.

In addition, the eV2X system based on 5GC defined in TS 23.501 [7] need also be able to interwork with the EPC based V2X system, as one V2X UE may be roaming between the two systems.

For this key issue, the following aspects should be addressed:

- For PC5, how to support a 5GS V2X capable UE's communication with EPS V2X capable UE for the common services, e.g. basic safety related V2X services. This includes for example the selection of the PC5 RAT and features to use such that the 5GS V2X capable UE's message can be properly received by EPS V2X capable UEs;

Editor's note: This aspect has RAN dependency and needs coordination with RAN WGs.

- How to operate a 5GS V2X capable UE when it is under a V2X system based on EPS, and how to operate an EPS V2X capable UE when it is under a V2X system based on 5GS, with the understanding that current 5GS interworking principles as defined in clause 5.17 of TS 23.501 [7] are also applied to V2X;

- How to support roaming/interworking operation of the V2X UE between a V2X system based on EPC and that based on 5GC, e.g. how to handle the V2X policy/parameters from V2X Control Function via EPS and those delivered via 5GS.

## 5.13 Key Issue #13: Support NR based PC5 communication when UE connects to EPC

### 5.13.1 General description

When the UE connects to EPC, the UE may be allowed to use NR based PC5 communication.

The following aspects need to be studied to support NR based PC5 communication when UE connects to EPC:

- Whether and how the UE indicates its NR PC5 capability to the network;

- Whether and how the MME authorizes to use V2X service operation for NR PC5;

- Whether and which V2X policy and parameters need to be provisioned for NR based PC5 communication in the UE.

Editor's note: This key issue has RAN dependency and needs alignment with outcome of RAN work.

## 5.14 Key Issue #14: Support of broadcast over NG-Uu

### 5.14.1 General description

According to TS 22.185 [3], "the 3GPP system shall be able to distribute information in a resource efficient way to large numbers of UEs supporting V2X application". Additionally, TS 22.186 [4] includes requirements related to group message transmission. Such requirements encompass the support for message transfer for group management operations and message transfer among a group of UEs supporting V2X application.

As a result, in addition to the current NG-Uu based unicast mechanism, eV2X also needs to support the broadcast delivery mechanism in order to efficiently handle message transfers for groups of UEs.

This key issue will study the following aspects for the broadcast service for eV2X:

- How to support broadcast transmission that can satisfy the eV2X use cases (e.g., assist efficient delivery of data to large numbers of UEs).

- What information needs to be provided to the UE and how to provide such information (e.g., broadcast area).

- Whether and how to enhance the current architecture and/or NFs (e.g., SMF, UPF) to accommodate the broadcast service.

- How to support interworking with EPS based V2X broadcast.

NOTE 1: NR broadcast is out of scope of this key issue.

NOTE 2: Potential impacts on RAN, including RAN architecture, are to be analysed by and coordinated with the relevant RAN WGs.

Editor's note: Consistency with FS\_CIoT\_5G SI regarding broadcast support is to be ensured.

## 5.15 Key Issue #15: Enhancements to assist Application Adjustment

### 5.15.1 General description

Each eV2X service, as defined in TS 22.186 [4], may be provided with different application configurations, such as Levels of Automation, inter-vehicle gap, etc. Each application configuration may have a different QoS requirement. As a consequence, the application may have to adjust its configuration in case of QoS change according to the new QoS that can be delivered.

Considering the requirements of eV2X services, it may be important for some application(s) to be notified about a potential change in the delivered QoS in advance, in order to be able to dynamically adjust its configuration. The notification may consider the locations in which the UE is likely to be driving for a given time period.

This key issue aims at studying 5GS enhancements to assist application adjustments for eV2X services, according to notifications about potential change in the delivered QoS.

This Key issue applies only to UEs connected via Uu.

This key issue addresses the following aspects:

- what information is required as input to enable the assessment of a potential change in QoS in given areas by the 5GS;

- how the 5GS may determine that a notification about potential change in delivered QoS is necessary;

- how the 5GS may communicate such information to the application in the AF and/or the UE.

# 6 Solutions

Editor's note: This clause is intended to document the agreed architecture solutions. Each solution should clearly describe which of the key issues it covers and how.

## 6.1 Solution #1: Solution for Group Communication for eV2X

### 6.1.1 Functional Description

For eV2X, group communication can be supported based on the existing PC5 based V2X Communication as defined in TS 23.285 [5].

With this solution, the 3GPP system is not required to be aware of any eV2X group within the V2X application. The group management, including controlling the number of UEs within the group, is expected to be performed at application layer, which is out of scope of 3GPP.

In addition, the discovery of the group and group maintenance are also expected to be handled at application layer based on the V2X messages. Such application layer messages are to be defined by other SDOs responsible for upper layers, e.g. SAE, ETSI-ITS.

For the communication between UEs of the same eV2X group, existing V2X communication can be used as defined in TS 23.285 [5].

If desired, e.g. for optimized operations, separation of the traffic from different groups could be also achieved with the use of different destination L2 IDs. These destination L2 IDs could be negotiated among group members at application layer or obtained from V2X AS at application layer. For such operations, the application layer would decide the L2 ID and pass it down together with the packets down to 3GPP layer. In this case, PSID to L2 ID mapping is not used in deciding on the destination L2 ID.

NOTE: Any potential clash of "Group" L2 IDs assigned by different V2X applications is resolved within the application.

For eV2X group communication, no bearer level security is required. Security protection, including integrity (and confidentiality if required), is provided at application layer based on application requirements.

### 6.1.2 Procedures

No change to the existing procedures is required.

### 6.1.3 Impact on existing entities and interfaces

Potentially the 3GPP layer can be enhanced to support receiving destination L2 ID from application layer to use for group communication. If destination L2 ID is provided, the PSID to L2 ID mapping is not used.

### 6.1.4 Topics for further study

None is identified.

### 6.1.5 Conclusions

The eV2X Group Communication can be supported with existing PC5-based V2X communication mechanism and application layer group management. Uu-based V2X communication mechanism can also be used for eV2X group communications e.g. platooning. No normative change is needed.

## 6.2 Solution #2: QoS Support for eV2X over Uu interface

### 6.2.1 Functional Description

#### 6.2.1.1 General description

This solution addresses Key Issue #3 (QoS Support for eV2X over Uu interface) and it is twofold. In its first part, it is addressed if any new QoS characteristics for Uu interface are needed, while in the second part it is addressed if new standardized 5QI values are needed.

#### 6.2.1.2 Necessary QoS Characteristics for Uu Interface

eV2X is a distinctive family of services which may cover ultra-reliable and low latency scenarios, while at the same time it may require high data rates. TS 22.186 [4] specifies service requirements to enhance 3GPP support for V2X scenarios in the 3GPP systems. Requirements include support for both safety and non-safety V2X scenarios:

- Safety-related V2X scenarios: e.g. automated driving, vehicle platooning, etc.;

- Non-safety-related V2X scenarios: e.g., mobile high data rate entertainment, mobile hotspot/office/home, dynamic digital map update etc.

Notably, **Categories of Requirements** (CoR) are defined to support eV2X scenarios. Five CoRs are defined: General Aspects, Vehicle Platooning, Advanced Driving, Extended Sensors and Remote Driving.

Additionally, the concept of **Level of Automation** (LoA) is defined, which reflects the functional aspects of the technology and affects the system performance requirements. The defined LoAs are: No Automation (0), Driver Assistance (1), Partial Automation (2), Conditional Automation (3), High Automation (4), Full Automation (5).

According to the TS 22.186 [4], for each CoR and each LoA, performance requirements are specified in terms of:

- Payload (Bytes);

- Transmission rate (Message/Sec);

- Maximum end-to-end latency (ms);

- Reliability (%);

- Data rate (Mbps);

- Minimum required communication range (meters).

The above requirements are covered by the 5G QoS characteristics associated with 5QI (TS 23.501 [7]).

- The Payload can be linked to the Maximum Data Burst Volume (which can be defined to be equal to the maximum required payload for the CoR & LoA+ protocol overhead),

- the Maximum end-to-end latency (ms) is similar to the Packet Delay Budget (PDB), while the Reliability is calculated by using jointly the PDB and the Packet Error Rate (PER). Precisely, reliability (%) is defined as the success probability of transmitting X byte within a certain delay, which is the time it takes to deliver a small data packet from the radio protocol layer 2/3 SDU ingress point to the radio protocol layer 2/3 SDU egress point of the radio interface.

- The Data Rate is equal to the guaranteed flow bit rate (GBR QoS Flows) or the non-guaranteed bit rate (non-GBR). The Minimum required communication range is not considered as QoS characteristics.

Consequently, referring to V2X communication over Uu, no new QoS characteristics on top of those already defined in TS 23.501 [7] are necessary.

#### 6.2.1.3 Necessary 5QI values

Some eV2X scenarios, based on their QoS attributes (as defined in TS 22.186 [4]), can be mapped to already existing Delay Critical GBR 5QI Values (see TS 23.501 [7], Table 5.7.4-1). In particular:

- *Remote Driving* service should be mapped to the specified Delay Critical GBR 5QI Value 85;

- *Platooning (low Level of Automation - LoA)* and *Cooperative Lane Change (low LoA)* services should be mapped to the specified Delay Critical GBR 5QI value 83.

However, if not updated, the current standardized 5QI Values do not seem sufficient to match all eV2X Services based on their QoS requirements. More precisely, *Platooning (high LoA)* and *Cooperative Lane Change (high LoA)* services necessitate very low PDB (PDB=*5ms*) and at the same time PER equal to *10-4*, while the Default Maximum Data Burst Volume can vary from low (50B) to high (1354B).

Table 6.2.1.3-1: Proposed Standardized 5QIs to QoS characteristics mapping for Delay Critical GBR (*changes with respect to TS 23.501 [7] in Bold-Italic text*)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 5QI  Value | Resource Type | Default Priority Level | Packet Delay Budget | Packet Error  Rate | Default Maximum Data Burst Volume | Default  Averaging Window | Example Services |
| 82 | Delay Critical GBR | 19 | 10 ms (NOTE 4) | 10-4 | 255 bytes | 2000 ms | Discrete Automation (see TS 22.261 [22]) |
| 83 | 22 | 10 ms (NOTE 4) | 10-4 | 1354 bytes  (NOTE 3) | 2000 ms | Discrete Automation (see TS 22.261 [22]), ***eV2X Messages (Platooning, Cooperative Lane Change with low LoA; see TS 22.186 [4])*** |
| 84 | 24 | 30 ms  (NOTE 6) | 10-5 | 1354 bytes | 2000 ms | Intelligent transport systems (see TS 22.261 [22]) |
| 85 | 21 | 5 ms  (NOTE 5) | 10-5 | 255 bytes | 2000 ms | Electricity Distribution- high voltage (see TS 22.261 [22]), ***Remote Driving (see TS 22.186 [4])*** |
| ***New Value*** | ***18*** | ***5 ms*** | ***10-4*** | ***1354 bytes*** | ***2000 ms*** | ***eV2X messages (Collision Avoidance, Platooning with high LoA (see TS 22.186 [4])*** |

The PDB value for the new 5QI Value refers to half of the maximum end-to-end delay defined in TS 22.186 [4]. The priority level for the new 5QI Value is set as higher than 5QI 82, due to the more critical delay requirement under the same PER and higher than 5QI 85 to reflect high LoA.

NOTE 1: Whether a new standardized 5QI Value is needed or not is to be discussed together with RAN WG2.

NOTE 2: Whether a new standardized 5QI Value with ultra-low PDB ~1.5 ms, PER=10-5 for high reliability and big payload ~1300 B is feasible for V2X services, e.g. Emergency Trajectory Alignment and Sensors information Sharing with high LoA, needs feedback from RAN WG2.

## 6.3 Solution #3: Service Authorization and Provisioning to UE for eV2X communications over PC5 and NG-Uu reference points

### 6.3.1 Functional Description

This solution addresses Key Issue #5 and Key Issue #11.

This solution applies to the architecture option Alternative#1 in Annex A.

In 5GS, the service authorization parameters for V2X PC5 and V2X NG-Uu communication can be made available in the UE in different ways, i.e.

- pre-configured in the ME, or

- configured in the UICC, or

- preconfigured in the ME and configured in the UICC, or

- provided/updated by the V2X AS via PCF, or

- provided/updated by the PCF to the UE

When the service authorization parameters for V2X PC5 and NG-Uu communication are provided by the PCF, the existing procedures will be used:

- When the UE performs initial Registration as defined in clause 4.2.2 "Registration Management procedures" in TS 23.502 [9], the UE indicates to AMF the V2X capability, so that the AMF discovers the PCF supporting V2X by utilizing the NRF or local configuration in the AMF. If the UE supports V2X communication and it doesn't have valid V2X communication Policy/Parameter, the UE includes in the Registration Request message the UE Policy Container with indicating the V2X Policy Provisioning request. Based on the indication in the UE Policy Container, the PCF determines whether to provision the eV2X PC5 and eV2X NG-Uu service authorization parameters to the UE using procedures as defined clause 4.2.4.3 "UE Configuration Update procedure for transparent UE Policy delivery" in TS 23.502 [9] and clause 6.1.2 "Non-session management related policy control" in TS 23.503 [10].

- During mobility, e.g. UE moves from one PLMN to another PLMN, the PCF may update the UE with new service authorization parameters.

- When there is a subscription change in the list of PLMNs where the UE is authorized to perform V2X communication service over PC5 and/or NG-Uu reference point, the PCF may need to update the policy/parameters to the UE. If the serving PLMN is removed from the list when the UE is authorized to perform V2X communication service over PC5 and/or NG-Uu, it means the service authorization is revoked in the UE.

- When the user is roaming, the subscription change resulting in updates of V2X policy/parameters will be transferred by H-PCF via V-PCF.

- If the V2X configuration parameters is located in a database external to the UDR the V2X configuration parameters will be transferred to the PCF via the AF (i.e. the external database interacts like a 3rd Party AS).

NOTE 1: Update of provisioning information directly to the UE (i.e. V1 reference point) is available in this option as well.

NOTE 2: The UE provisioning is controlled by the PCF and in this solution no UE triggered provisioning update is needed. If the UE, due to a failure case or of some other reason, see a need to update the provisioning, the UE has to perform initial registration in the network. The solution assumes this registration trigger is very rare occurrence since the UE can be kept up to date by the PCF if any change in configuration is to occur. If UE triggered policy provisioning is adopted in general (see clause 6.3.2a), then such procedure can be also applied for V2X policy update from the UE.

NOTE 3: Deployment of PCF for the purposes of supporting UE policies for V2X via AMF does not depend on deployment of PCF for Session based PCC.

NOTE 4: In order to avoid multiple policy associations to the UE for both V2X and non-Session based PCC, it is assumed that the PCF for V2X supports also non-Session based PCC.

### 6.3.2 Procedures

Procedure for UE policy update can be reused:

- Clause 4.2.4.3 "UE Configuration Update procedure for transparent UE Policy delivery" in TS 23.502 [9].

- Clause 6.1.2 "Non-session management related policy control" in TS 23.503 [10].

### 6.3.2a Option of UE triggered V2X Policy provisioning procedure

The procedure is initiated when the UE determines the V2X Policy is invalid in following cases:

- if the parameter is outdated (e.g. the validity timer for the eV2X communication policy/parameter expires),

- if there are no valid parameters for current area, or

- parameters lost or deleted locally by abnormal situation.

This procedure, if agreed to be adopted for general UE triggered policy provisioning then it can also be applied for V2X.



Figure 6.3.2a-1: UE triggered V2X Policy provisioning procedure

1. UE sends UE Policy provisioning request including UE Policy container (Indication of V2X Policy provisioning request) to AMF.

2. The AMF sends Npcf\_UEPolicyControl\_Update request to the PCF to establish an AM policy control association with the PCF included the UE Policy container received from UE.

3. The UE Policy delivery procedure defined in clause 4.2.4.3 of TS 23.502 [9] is triggered.

NOTE: Steps 2 and 3 reuse existing messages.

### 6.3.3 Impact on existing entities and interfaces

Impacts on existing entities, interfaces and procedures are limited to adding new policies/parameters, no new functionality is introduced. Below are the impacted entities and interfaces listed:

- UDR for subscription change in the list of PLMNs where the UE is authorized to perform V2X communication service over PC5 reference point

- PCF handles service authorization and provisioning of parameters for V2X PC5 and V2X NG-Uu communication based on the the Indication of V2X Policy provisioning request in the UE Policy Container.

- UE handles the policy/parameters for service authorization using existing 5GC procedures with supporting UE triggered V2X Policy provisioning procedure if available. UE decides whether to include the Indication of V2X Policy provisioning request in the UE Policy Container in the initial Registration procedure or UE triggered V2X Policy provisioning procedure.

- AMF transferring the policy/parameters to the UE using existing procedures. AMF requests to create UE Policy Association to the PCF for V2X communication, based on the V2X capability indication in the Registration Request message.

- Impacted interfaces: N1, N8, N15, N24.

To perform the UE provisioning the user plane set-up is not needed.

### 6.3.4 Topics for further study

None is identified.

### 6.3.5 Conclusions

TBD.

## 6.4 Solution #4: Reusing solution of TS 23.285 [5] for Key Issue #5

### 6.4.1 Functional Description

This solution corresponds to the Key Issue #5 "Service Authorization and Provisioning to UE for eV2X communications over PC5 reference point" based on the architecture documented in Annex A, clause A.2.

The proposed solution reuses clause 4.4.1.1 'Authorization and provisioning for V2X communications over PC5 reference point' of TS 23.285 [5]. Therefore, the followings apply for Service Authorization and Provisioning to UE for eV2X communications over PC5 reference point:

- Pre-configuration in the UE;

- Service Authorization and Provisioning to UE from V2X Control Function;

- Parameter provisioning to UE from V2X Application Server.

### 6.4.2 Procedures

Same with clause 4.4.1.1 'Authorization and provisioning for V2X communications over PC5 reference point' of TS 23.285 [5].

The V2X policy/parameters provisioned by the V2X Control Function contain the complete set of information for the UE's operation of V2X in EPS and 5GS, regardless of the UE's current connection (e.g. via EPS or 5GS).

NOTE 1: The parameters provisioned needs to take care of the compatibility issue, as the UE may not be 5GS capable.

When the UE accesses the 5GS, it follows existing procedure as defined in TS 23.501 [7]. For the PDU Session that is used for the provisioning, a V2X related S-NSSAI should be used for the PDU Session.

If a dedicated DNN is configured to be used for the provisioning, the network ensures the access to the V2X Control Function at HPLMN is possible from all PDU Sessions using this DNN and associated with V2X related S-NSSAI. If no specific DNN is configured to the UE for the provisioning, the network ensures the access to the V2X Control Function for any PDU Sessions allowed for this slice regardless of the DNN used. In case the PDU Session is local breakout, the VPLMN needs to have a V2X Control Function proxy to support the access of the V2X Control Function in HPLMN, same as the V2X Control Function proxy defined in TS 23.285 [5] for EPS.

NOTE 2: This V2X Control Function proxy is not required if UE is configured to use a DNN for home routed PDU Session. The configuration for the DNN used for provisioning follows the mechanism in the same way as the configuration for the APN specified in TS 23.285 [5] for EPS.

Editor's note: It is FFS how the V2X Control Function and HSS interactions from EPS is mapped in 5GS, i.e. interactions with UDM.

### 6.4.3 Impact on existing entities and interfaces

UE:

- The UE gets authorization information (see clause 4.4.1.1.2 of TS 23.285 [5]) to use V2X communications over PC5 reference point on a per PLMN basis in the serving PLMN by the V2X Control Function in the HPLMN.

V2X Control Function:

- The V2X Control Function in the HPLMN requests authorization information from the V2X Control Function of the serving PLMN.

- The V2X Control Function in the HPLMN merges authorization information from home and serving PLMNs and informs the UE of the final authorization information (see clause 4.4.1.1.2 of TS 23.285 [5]).

- The V2X Control Function in the VPLMN or HPLMN may revoke the authorization at any time. The V2X Control Function in the HPLMN is notified when authorization is revoked by the VPLMN.

### 6.4.4 Topics for further study

No.

### 6.4.5 Conclusions

Editor's note: Conclusions will be collected for this particular functionality.

## 6.5 Solution #5: Service Provisioning to UE for eV2X communications over PC5 and NG-Uu reference points

### 6.5.1 General Description

This solution addresses Key Issues #5 and #11. In order to enable the UE to use eV2X Service in 5G System, service authorization and provisioning for eV2X communication over PC5 and NG-Uu reference point are needed. As a pre-assumption, the V2XCF is a Control Plane NF (i.e. option b in Annex A, clause A.0 is considered as the architecture).

The eV2X Communication Parameters for V2X PC5 and V2X NG-Uu communication can be pre-configured in the UE or provided by the V2XCF. In the latter case, the V2XCF shall provide the eV2X Communication Parameters to UE via the UE Configuration Update Command. When the eV2X Communication Parameters need to be updated (e.g., due to UE mobility, subscription change, V2X AS update), the UE or the V2XCF is triggered to update the eV2X Communication Parameters to UE via AMF.

Editor's note: the solution description for the roaming case is FFS.

### 6.5.2 Initial Provisioning of eV2X Communication Parameters



Figure 6.5.2-1: Initial provisioning of eV2X communication parameters

1. UE sends the Registration Request message. If the UE does not have available the eV2X Communication Parameters, the UE includes the "eV2X Communication Parameters Indication" in the N1 container for V2XCF in the registration request message.

2. AMF retrieves UE subscription data from UDM. If the UE's subscription data authorizes the UE to make V2X communication, the AMF should select a V2XCF for the UE.

3. If the message in Step 1 contains the N1 container for V2XCF, the AMF includes the N1 container for V2XCF received from UE in the message sending to V2XCF.

4. The V2XCF determines whether to provide V2X parameters to the UE, e.g. based on "eV2X Communication Parameters Indication" (indicated in Step 1), the information subscription data, local policy, etc.

5. If V2XCF determines that V2X communication parameters need to be provisioned to the UE then V2XCF includes the V2X communication parameters in the V2X Parameter Response message.

6. AMF sends the Registration Accept message to UE.

NOTE: Steps 3 and 6 can be executed in parallel.

7. AMF delivers the provisioned eV2X Communication Parameters to UE via a dedicated message (see step 2 of Figure 4.2.4.3-1 in TS 23.502 [9]).

8. UE replies with the result of the delivery of eV2X Communication Parameters (see step 3 of Figure 4.2.4.3-1 in TS 23.502 [9]).

### 6.5.3 Update of eV2X Communication Parameters

#### 6.5.3.0 General

After the UE retrieves and stores the eV2X Communication Parameters, the network may find the need to update the eV2X Communication Parameters, due to the occurrence of any of the following events:

- UE mobility, i.e., location change: The V2XCF may subscribe to location change notifications from AMF (via Namf\_EventExposure\_Subscribe) and trigger the update procedure if needed, i.e. if V2XCF determines that V2X parameters need to be updated. These events should result in the update of V2X provisioning parameters at the UE. V2XCF sends the updated parameters to AMF in a transparent container. The AMF then delivers the updated parameters to the UE.

- UE's V2X subscription has changed: The V2XCF may subscribe to UE's subscriber data update notification for V2X specific data type (via Nudm\_SDM\_Subscribe) and determine whether to provide updated V2X parameters to the UE.

- V2X AS configures new V2X parameters at the V2XCF: The V2XCF receives the new V2X parameters from the V2X AS via V2 interface thus the update procedure may be initiated.

- Notification from AMF of UE entering an Area of Interest.

- Notification from V2X AF/ V2X AS of updated parameter provisioning (see TS 23.285 [5]).

In addition, after UE retrieves and stores the eV2X Communication Parameters, UE itself may find the need to update the eV2X Communication Parameters, due to the occurrence of any of the following events:

- UE mobility, i.e., location change: if the associating available area of the eV2X Communication Parameters is provided to the UE.

- Notification from the AF/V2X AS to UE via the application layer.

- Expiration of a Validity Timer associated with the eV2X Communication Parameters; for example, if the UE is out-of-coverage when the timer expires, it shall request new parameters when it is back in-coverage.

- Parameters lost or deleted in some abnormal cases.

In the cases above, the V2XCF shall provide the updated service provisioning parameters to UE via AMF by the UE Configuration Update Command. If the UE is in CM-IDLE state, the AMF shall initiate paging UE firstly. In the cases above, UE can initiate the registration request with the "eV2X Communication Parameters Indication" to retrieve the new eV2X Communication Parameters.

#### 6.5.3.1 UE triggered update of eV2X Communication Parameters

Option A: The UE triggered update of eV2X Communication Parameters requires the Registration procedure and is same as described in clause 6.5.2.

Option B: The UE triggered update of eV2X Communication Parameters using procedure other than Registration.



Figure 6.5.3.1-1: UE triggered V2X Policy provisioning procedure

1. UE sends V2X Parameter provisioning request including the "eV2X Communication Parameters Indication" in the N1 container to AMF.

2. The AMF includes the N1 container for V2XCF received from UE in the message sending to V2X CF.

3. The V2X Parameter delivery procedure defined in clause 6.5.3.2 is triggered.

During AMF relocation, the target AMF may receive a V2XCF id from the source AMF to enable the usage of the same V2XCF by the target AMF, and the target AMF may decide based on operator policy either to use the same V2XCF or select a new V2XCF.

#### 6.5.3.2 Network triggered update of eV2X Communication Parameters



Figure 6.5.3.2-1: Network triggered update of eV2X Communication Parameters

1. After UE registers to the Network, the V2XCF maintains the UE's current V2X Communication Parameters. The network (i.e., V2XCF) can detect that the eV2X Service provisioning Parameters need to be updated due to:

- Notification from AMF of UE entering an Area of Interest;

- Notification from V2X AF/ V2X AS of updated parameter provisioning (see TS 23.285 [5]).

2. The V2XCF generates the updated eV2X Communication Parameters for the UE. During this step, V2XCF may interact with AMF, AF. If Step 1 is triggered by the AMF, then the V2XCF may check with the AF for restrictions/conditions relating to the area of interests to determine new parameters. If Step 1 is triggered by the AF, then the V2XCF may request info on UE location to the AMF to determine new parameters.

3. V2XCF delivers the updated eV2X Communication Parameters to UE via the AMF by sending the eV2X Communication Parameter Update message to AMF.

4. AMF sends the V2X provision parameters to UE via the UE configuration update command (see step 2 of Figure 4.2.4.3-1 in TS 23.502 [9]).

5. UE responds with the result of the delivery of eV2X Communication Parameters (see step 3 of Figure 4.2.4.3-1 in TS 23.502 [9]).

### 6.5.4 Impact on existing entities and interfaces

AMF:

- Obtains V2X subscription data from the UDM by means of the Nudm\_SDM\_Get operation;

- Executes V2X authorization check;

- Retrieves V2X parameters from the V2XCF by means of new or existing operations;

- Provides V2X parameters to UE via UCU message.

- Transparently sends the N1 container for V2XCF.

UDM:

- Stores and provides V2X subscription data to the AMF by means of the Nudm\_SDM\_Get operation.

V2XCF:

- Provides the services for associating with AMF and conveying the V2X parameters to the AMF.

- Subscribes to location change notifications.

- Subscribes to subscriber data update notifications for V2X data type.

UE:

- Performs Registration Procedure or Procedure other than Registration, including eV2X Communication Parameters Indication, when it finds the need to update the eV2X Communication Parameters.

### 6.5.5 Conclusions

TBD.

## 6.6 Solution #6: eV2X impacts to 5GC procedures

### 6.6.1 Functional Description

This solution corresponds to the Key Issue #6 "Service Authorization to NG-RAN for eV2X communications over PC5 reference point" and based on TS 23.285 [5] clause 5.5 'V2X impacts to EPC procedures' that describes the required EPC procedures for Service Authorization to E-UTRAN for V2X communications over PC5 reference point.

This solution applies to all options for eV2X architecture.

### 6.6.2 Procedures

#### 6.6.2.1 Registration procedure for UE

The Registration procedure for UE is performed as defined in TS 23.502 [9] with the following additions:

- The UE includes the V2X capability indication as part of the "5GMM capability" in the Registration Request message. The AMF stores this information for V2X operation. The V2X capability can indicate whether the UE is capable of supporting V2X communication over PC5 reference point.

- If the UE indicated V2X capability, and the UE is authorized to use V2X communication over PC5 reference point based on the subscription data, then the AMF shall include a "V2X services authorized" indication in the NGAP message, indicating the UE is authorized to use V2X communication over PC5 reference point as Vehicle UE, Pedestrian UE or both.

- The AMF obtains the UE-PC5-AMBR, and cross-RAT PC5 control authorization from the UDM as part of the subscription data and includes it in the NGAP message to the NG-RAN, which use it in resource management of UE's PC5 transmission for V2X services in network scheduled mode.

#### 6.6.2.2 Service Request procedures for UE

The Service Request procedures for UE in CM-IDLE state are performed as defined in TS 23.502 [9] with the following additions:

- If the UE is V2X capable, and the UE is authorized to use V2X communication over PC5 reference point based on the subscription data, then the AMF shall include a "V2X services authorized" indication in the NGAP message, indicating the UE is authorized to use V2X communication over PC5 reference point as Vehicle UE, Pedestrian UE or both.

- The AMF includes the UE-PC5-AMBR, and cross-RAT PC5 control authorization in the NGAP message to the NG-RAN which stores it as part of the UE context and may use it in resource management of UE's PC5 transmission for V2X services in network scheduled mode.

#### 6.6.2.3 N2 Handover procedures for UE

The N2 based handover or the Inter-RAT to NG-RAN handover procedures for UE are performed as defined in TS 23.502 [9] with the following additions:

- If the UE is V2X capable, and the UE is authorized to use V2X communication over PC5 reference point based on the subscription data, then the target AMF shall send the "V2X services authorized" indication, UE-PC5-AMBR and cross-RAT PC5 control authorization to the target NG-RAN as follows:

- For the intra AMF handover, the "V2X services authorized" indication, UE-PC5-AMBR and cross-RAT PC5 control authorization are included in the NGAP Handover Request message. If after the handover procedure, the "V2X services authorized" indication, or the UE-PC5-AMBR, or cross-RAT PC5 control authorization, or any combination are changed, the updated "V2X services authorized" indication, or the updated UE-PC5-AMBR, or cross-RAT PC5 control authorization or all are included in the NGAP UE Context Modification Request message sent to the target NG-RAN.

- For the inter AMF handover or Inter-RAT handover to NG-RAN, the "V2X services authorized" indication, UE-PC5-AMBR and cross-RAT PC5 control authorization are included in the NGAP UE Context Modification Request message sent to the target NG-RAN after the handover procedure.

The "V2X services authorized" indication sent to target NG-RAN denotes the UE is authorized to use V2X communication over PC5 reference point as Vehicle UE, Pedestrian UE or both.

The UE-PC5-AMBR and cross-RAT PC5 control authorization are sent to target NG-RAN for the resources management of UE's PC5 transmission in V2X communication.

#### 6.6.2.4 Xn Handover procedures for UE

The Xn based handover procedures for UE are performed as defined in TS 23.502 [9] with the following additions:

- If the source NG-RAN is V2X-enabled and the "V2X services authorized" indication is included in the UE context, then the source NG-RAN shall include a "V2X services authorized" indication, UE-PC5-AMBR and cross-RAT PC5 control authorization in the XnAP Handover Request message to the target NG-RAN.

- If the UE is V2X capable, and the UE is authorized to use V2X communication over PC5 reference point based on the subscription data, then the AMF shall send the "V2X services authorized" indication, the UE-PC5-AMBR and cross-RAT PC5 control authorization to the target NG-RAN in the Path Switch Request Acknowledge message. If, after the handover procedure, the "V2X services authorized" indication, or the UE-PC5-AMBR, or cross-RAT PC5 control authorization or any combination are changed, the updated "V2X services authorized" indication, or the updated UE-PC5-AMBR, or cross-RAT PC5 control authorization or all are included in the NGAP UE Context Modification Request message sent to the target NG-RAN.

The "V2X services authorized" indication sent to target NG-RAN denotes the UE is authorized to use V2X communication over PC5 reference point as Vehicle UE, Pedestrian UE or both.

The UE-PC5-AMBR and cross-RAT PC5 control authorization are sent to target NG-RAN for the resources management of UE's PC5 transmission in V2X communication.

#### 6.6.2.5 Nudm\_SDM\_UpdateNotification procedure for UE

The Nudm\_SDM\_UpdateNotification procedures for UE are performed as defined in TS 23.502 [9] with the following additions:

- If the "V2X services authorized" indication or the UE-PC5-AMBR, or cross-RAT PC5 control authorization or any combination need to be changed due to the changed subscription data and the UE is in CM-CONNECTED state, then the AMF shall notify the NG-RAN the updated "V2X services authorized" indication, or the UE-PC5-AMBR, or cross-RAT PC5 control authorization or all via the NGAP UE Context Modification Request message.

#### 6.6.2.6 V2X capability indication and V2X related information per PC5 RAT

A UE may support multiple radio access technologies (RATs) over PC5 reference point, including LTE and NR. For such UE, the V2X capability indication and V2X related information can be per PC5 RAT as below:

- The V2X capability indication sent by the UE described in clause 6.6.2.1 is per PC5 RAT. The V2X capability per PC5 RAT indicates whether the UE is capable of supporting V2X communication over PC5 reference point, i.e. over LTE PC5, over NR PC5 or over both.

- The "V2X services authorized" indication sent to NG-RAN described in clause 6.6.2.1 to clause 6.6.2.5 is per PC5 RAT.

- The UE-PC5-AMBR sent to NG-RAN described in clause 6.6.2.1 to clause 6.6.2.5 is per PC5 RAT.

- The cross-RAT PC5 control authorization sent to the NG-RAN described in clause 6.6.2.1 to clause 6.6.2.5 is per PC5 RAT.

NOTE 1: For V2X capability indication and V2X related information per PC5 RAT, coordination with RAN WGs is needed.

NOTE 2: Stage 3 will decide if an explicit cross-RAT PC5 control authorization IE is needed for the signaling over N2, or it can be indicated in an implicit manner.

NOTE 3: The cross-RAT PC5 control authorization indicates whether LTE Uu controls LTE and/or NR sidelink from the cellular network, and whether NR Uu controls LTE and/or NR sidelink from the cellular network. RAN WGs will decide if all combinations are needed.

### 6.6.3 Impact on existing entities and interfaces

UE:

- UE includes its V2X capability indicating whether the UE is capable of supporting V2X communication over PC5 reference point as a part of the "5GMM capability" in the Registration Request message.

AMF:

- AMF determines if the UE is authorized to use V2X communication over PC5 reference point based on the subscription data.

- AMF includes a "V2X services authorized" indication in the N2 message sent to NG-RAN denoting that the UE is authorized to use V2X communication over PC5 reference point as Vehicle UE, Pedestrian UE or both.

- AMF includes UE-PC5-AMBR and cross-RAT PC5 control authorization in the N2 message sent to NG-RAN.

NG-RAN:

- NG-RAN needs to handle the "V2X services authorized" indication and UE-PC5-AMBR.

- The source NG-RAN includes a "V2X services authorized" indication, UE-PC5-AMBR and cross-RAT PC5 control authorization in the XnAP Handover Request message to the target NG-RAN.

UDM (or maybe also UDR):

- UDM (or maybe also UDR) handles subscription parameters for eV2X.

### 6.6.4 Topics for further study

None.

### 6.6.5 Conclusions

For Key Issue #6, it is concluded to take Solution #6 for normative work.

## 6.7 Solution #7: Solution for Network Slicing for eV2X services

### 6.7.1 Functional Description

This solution addresses the Key Issue #7 in the perspective of Network Slicing for eV2X Services.

The eV2X services require certain level of service requirements, e.g. the latency (PDB) range from 100ms in advanced driving to 3ms in Emergency trajectory alignment. Message rate range from 10 message/second to 50 message/second, and with some burst traffic types, e.g. in extended sensor information sharing. In addition, the reliability requirement also varies, e.g. 90% to 99.999%.

To support certain level of service requirements described above, the eV2X services require certain network features, e.g. eV2X communications using side-link communication, multicast-broadcast communication or group communication, service authorization and parameters provisioning, etc.

Therefore, this solution proposes to define a specific SST for eV2X services. This approach follows the slicing framework and procedures defined in TS 23.501 [7] and TS 23.502 [9].

A Slice/Service Type can be a standard or non-standard value. One of the reasons to assign a standard value is to facilitate roaming support. In case of vehicle communications, it can be expected that vehicles move fast and cross over to different countries/PLMNs often while connected to the networks.

Therefore, this solution proposes to define a specific SST for eV2X services as a standard value.

### 6.7.2 Procedures

Editor's note: This clause describes procedures to support Network Slicing by this solution.

### 6.7.3 Impact on existing entities and interfaces

- Define a specific SST for eV2X services as a standard value

### 6.7.4 Topics for further study

Editor's note: This clause describes topics for further study.

### 6.7.5 Conclusions

Editor's note: This clause provides conclusions of the solution.

## 6.8 Solution #8: Application Function influence based edge computing for V2X

### 6.8.1 Functional Description

This solution corresponds to the Key Issue #8 "Support of edge computing".

The proposed solution is based on clause 5.6.7 'Application Function influence on traffic routing' of TS 23.501 [7] and describes how the Application Function (AF) influence on traffic routing feature can be applied to support edge computing for V2X.

According to clause 5.6.7 of TS 23.501 [7], an AF may send requests to influence SMF routing decisions for traffic of PDU Session and the AF requests may influence UPF (re)selection to allow routing user traffic via a local access in a Data Network identified by a DNAI (DN Access Identifier). Such AF requests for influencing SMF routing decisions may contain at least:

1) Information to identify the traffic to be routed.

2) Information about the N6 traffic routing requirements for traffic identified as defined in 1).

3) Potential locations of applications towards which the traffic routing should apply.

4) Information on the UE(s) whose traffic is to be routed.

- Identities of individual UEs.

- Groups of UEs identified by an External Group Identifier when the AF interacts via the NEF, or Internal-Group Identifier when the AF interacts directly with the PCF.

- Any UE the request applies to any UE accessing the combination of DNN, S-NSSAI and DNAI(s).

5) Indication of application relocation possibility.

6) Temporal validity condition indicating when the traffic routing is to apply.

7) Spatial validity condition on the UE(s) location indicating that the request applies only to the traffic of UE(s) located in the specified location.

8) An AF transaction identifier referring to the AF request.

9) Information on AF subscription to corresponding SMF events.

To route V2X messages or any traffic for V2X purposes to/from V2X Application Server(s) in a local DN close to NG-RAN, AF (i.e. V2X Application Server) operated by e.g. operators, OEMs, road authorities, can use the Application Function influence on traffic routing feature.

### 6.8.2 Procedures

Figure 6.8.2-1 shows a high-level procedure regarding an edge computing scenario to route V2X messages of any V2X UE located in a certain location (e.g. intersection area) to/from a V2X Application Server in a local DN. This procedure is not exhaustive to just show how the Application Function influence on traffic routing feature can achieve the support of edge computing for V2X.



Figure 6.8.2-1: High-level procedure for AF influence based edge computing for V2X

1. An AF sends an AF request containing the following information to a NEF.

- An AF transaction identifier referring to the AF request.

- Spatial validity condition indicating the certain location, e.g. a list of geographic zone identifier(s).

- Information on the target UE set to any UE accessing the combination of DNN, S-NSSAI and DNAI related to V2X. For example, DNN is for V2X Services, S-NSSAI is comprised of an SST with a standardized SST value for V2X Services and DNAI represents an identifier of a user plane access to a local DN where the V2X Application Server is deployed.

- Information on the traffic to be routed including DNN and S-NSSAI related to V2X.

- Information about the N6 traffic routing requirements including in the form of a list of DNAIs and associated N6 traffic routing information.

2. The NEF sends the AF request to PCF(s) related to the PDU Session for UE(s) corresponding to the AF request. Regarding spatial validity condition, the NEF maps the information from the AF to areas of validity based on pre-configuration and provides the areas of validity to the PCF(s).

NOTE: AF can also determine whether the UE has entered, or left area of interest based on subscribing to UE location information from the SMF (i.e. presence reporting area) or from the AMF via NEF.

3. The PCF received the AF request identifies which traffic in the PDU Session of the UE is corresponding to the AF request. Regarding the spatial validity condition, the PCF subscribes to the SMF to receive notifications about change of UE location in an area of interest. Therefore, the PCF can be notified by the SMF about UE location in or out of the subscribed area of interest.

4. When the PCF is notified that the UE entered the area of interest, the PCF provides to the SMF the PCC rules generated based on the AF request by triggering a PDU Session modification.

5. When the PCC rules are activated, the SMF may, based on local policies, take the information in the PCC rules into account to (re)select UPF(s) for PDU Sessions, or activate mechanisms for traffic multi-homing or enforcement of an UL Classifier (UL CL).

As a result, the traffic corresponding to the AF request for the UE located in the area of validity can be locally routed to/from the V2X Application Server relevant to the area.

6. When the PCF is notified the UE left the area of interest, the PCF provides to the SMF updated PCC rules by triggering a PDU Session modification.

7. The SMF may take appropriate actions to reconfigure the User Plane of the PDU Session.

As a result, the traffic corresponding to the AF request for the UE left the area of validity is not routed to/from the V2X Application Server relevant to the area anymore.

The AF that sends the AF request for AF influence based edge computing for V2X and the V2X Application Server that the traffic is routed to/from can be same or different.

### 6.8.3 Impact on existing entities and interfaces

No additional impact compared to impact on existing entities and interfaces described in TS 23.501 [7].

### 6.8.4 Topics for further study

None.

### 6.8.5 Conclusions

This solution has no normative impacts but can be documented in potential specification generated for eV2X, if needed.

## 6.9 Solution #9: Interworking for eV2X

### 6.9.1 Introduction

In the Key Issue #12 there are three aspects listed to be addressed and in this contribution one of this is put in focus:

- How to support roaming/interworking operation of the V2X UE between a V2X system based on EPC and that based on 5GC, e.g. how to handle the V2X policy/parameters from V2X Control Function via EPS and those delivered via 5GS.

The analyses are based on the use of the architecture shown in Annex A, clause A.1.

NOTE: Additional provisioning/configuration as supported via UICC, ME or directly from V2X Application Server is independent of the interworking with EPC.

### 6.9.2 Functional Description

V2X capable UEs not supporting 5GC NAS will only be connected to EPC and be provisioned using the V2X Control Function in EPC over the V3 reference point. These UEs will never be connected to 5GC.

V2X capable UEs both supporting EPC NAS and 5GC NAS can be connected to either EPC or 5GC. The radio parameters provisioned in the UE for PC5 communication may be the same in EPS and 5GS. The service parameters to be provisioned in the UE may be the same but there will probably also be differences if connected to 5GS or EPS e.g. some services can only be used if accessing via 5G.

The V2X policy/parameters are not session parameters (e.g. session type) that needs to be mapped between PDN connection and PDU session when UE moves between EPC and 5GC, and there is no need for V2X Control Function and PCF in Annex A, clause A.1 to interact when UE moves between EPC and 5GC.

The V2X Control Function can be seen as a container keeping a set of static configuration parameters. By this the V2X Control Function cannot be compared and do not have the requirements as the dynamic interworking functionality specified in TS 23.501 [7] clause 4.3 e.g. PCF.

To avoid adding complexity to 5GC it is proposed to handle the "interworking" between EPC and 5GC as follows, see also Figure 6.9.2-1:

1. A UE connecting to EPC will be provisioned via the V2X Control Function over V3.

2. A UE connecting to 5GC will be provisioned via the existing 'UE Configuration Update procedure for transparent UE Policy delivery'.



Figure 6.9.2-1: Local breakout roaming architecture for interworking between 5GS and EPC/E-UTRAN incl. V2X Control Function

NOTE: Alternative#4 in Annex A provides additional details on the provisioning via PCF when the configuration data is held in V2X Application Server.

### 6.9.3 Procedures

UE connected to EPC the existing procedures for V2X provisioning is used as specified in TS 23.285 [5].

UE connected to 5GC the existing

- Clause 4.2.4.3 UE Configuration Update procedure for transparent UE Policy delivery in TS 23.502 [9].

- Clause 6.1.2 Non-session management related policy control in TS 23.503 [10].

### 6.9.4 Impacts on existing entities and interfaces

No impacts on the EPC or 5GC as existing functionality is used.

### 6.9.5 Evaluation

The solution is with the following properties:

- Based on the use of the architecture shown in Annex A, clause A.1;

- It is assumed there is no need for the PCF and V2X Control Function to interact when UE moves between EPC and 5GC;

- When the UE moves from 5GS to EPS, the UE may obtain the V2X parameters if no valid parameters after system change.

### 6.9.6 Conclusions

This solutions addresses Key Issue #12 (System migration and interworking for eV2X) and it is proposed to take it as baseline for the normative phase.

## 6.10 Solution #10: Interworking solution based on Architecture in A.2

### 6.10.1 Introduction

This solution addresses following aspect of Key Issue #12 based on the architecture in A.2:

- How to support roaming/interworking operation of the V2X UE between a V2X system based on EPC and that based on 5GC, e.g. how to handle the V2X policy/parameters from V2X Control Function via EPS and those delivered via 5GS.

### 6.10.2 Functional Description

Figure 6.10.2-1 shows Local breakout roaming architecture for V2X interworking between 5GS and EPS. The proposed solution is also applied to non-roaming and Home Routed roaming scenarios. Support of N26 interface in the network is optional for interworking as described in TS 23.501 [7].



Figure 6.10.2-1: Local breakout roaming architecture for V2X interworking between 5GS and EPS

Based on the above architecture figure, we can see:

- Both EPS V2X CF and 5GS V2X CF are collocated;

- When the UE is accessing to EPS, the UE is provisioned with V2X related parameters/policy by the EPS h-V2X CF via user plane in EPS;

- When the UE is accessing to 5GS, the UE is provisioned with V2X related parameters/policy by the 5GS h-V2X CF via user plane in 5GS.

### 6.10.3 Procedures

When the UE connects to EPS, the existing procedures for V2X parameter/policy provisioning are used as specified in TS 23.285 [5], i.e. the U-plane based provisioning over PDN connection.

When the UE connects to 5GS, the existing procedures for V2X parameter/policy provisioning can be used as specified in TS 23.285 [5], i.e. the U-plane based provisioning over PDU session.

V2X Control Function provisions V2X parameter/policy for both EPS (if available) and 5GS (if available) to UE via U-plane based provisioning when UE accesses to either EPS or 5GS.

NOTE: How to handle the received V2X parameter/policy for 5GS in the UE only supporting EPS is up to UE implementation.

### 6.10.4 Impact on existing entities and interfaces

EPS V2X CF needs to be upgraded to support 5GS V2X CF.

Same impacts on 5GS as described in clause 6.4.3.

### 6.10.5 Conclusions

Editor's note: Conclusions will be collected for this particular functionality.

## 6.11 Solution #11: Solution for unicast or multicast for eV2X communication over PC5 reference point

### 6.11.1 Functional Description

This solution addresses Key Issue #1 on the support of eV2X Group Communication, Key Issue #9 on the support of the unicast/multicast communication over PC5 and Key Issue #4 on the support of PC5 QoS framework enhancement for eV2X, focusing on the following aspects:

- Identifiers for the unicast communication, e.g. L2 ID;

- Signalling protocol to support unicast/multicast communication;

- QoS support and AS layer configurations;

- Security associations;

- Procedures for the link establishment and maintenance.

### 6.11.2 Solution description

#### 6.11.2.1 Identifiers for the unicast communication

##### 6.11.2.1.1 Separate L2 ID address space for unicast and multicast from those for broadcast

One of the essential identifiers for the unicast/multicast communication is the L2 ID. As of the ProSe design in TS 23.303 [8], the destination L2 ID address space for one-to-one communication and one-to-many communications are separate with AS layer mechanism, i.e. MAC layer version number. This is done to avoid conflicts of the address used that may cause harm to one-to-one communications. In a similar manner, V2X unicast should also use the separate L2 IDs than that for the broadcast and multicast.

This separation applies to both destination L2 ID and source L2 ID. For a UE that has both broadcast and unicast/multicast traffic, different L2 IDs should be used with corresponding formats. The source L2 ID will be used by peer UE as the destination L2 ID in unicast communication. Details of the related L2 ID management for unicast/multicast is described in following clauses.

The UE may use distinct source L2 ID for different unicast one to one communication link e.g. when different unicast links are associated with different upper layer indentifiers.

##### 6.11.2.1.2 Deciding the Destination L2 ID to use for unicast/multicast communication

6.11.2.1.2.1 Option A

In TS 23.285 [5], the Destination L2 ID is decided by the UE based on a configured mapping between PSID/ITS-AID to the L2 ID. This suites for broadcast traffic, but does not work for unicast or multicast traffic. In unicast or multicast, destination L2 ID would not be decided based on PSID/ITS-AID. A V2X UE should be allowed to have multiple unicast connections or multicast groups supported simultaneously for a particular service (PSID/ITS-AID). Therefore, the destination L2 ID information in this case should come from the upper layer. This means that the interface between the V2X layer and upper layer needs to be enhanced to allow such information to be passed down together with the data packet.

It is expected that the actual V2X applications do not understand the notion of L2 ID, as the applications can be built for cross technology or platforms. Therefore, some mid-ware layer within the UE has to translate the identifier used by the application layer, e.g. Station ID, to the V2X L2 ID. It means such mid-ware layer needs to maintain the mapping of application layer destination identifiers and L2 IDs. Since this mid-ware layer is out of scope of SA2, in the specification it can be noted as "upper layer" in general, and the assumption that this "upper layer" maintains the mapping and provides the L2 ID for unicast or multicast communication should be documented.

6.11.2.1.2.2 Option B

An alternative to the above solution is for the V2X layer to manage such unicast link/multicast group to L2 ID mapping. In that case, the unicast link/multicast group can be allocated with a flow identifier at the time of establishment. Corresponding connection profile information, e.g. L2 IDs, transmission settings, QoS parameters, etc., could be associated with it. In such a case, the upper layer only needs to use the flow identifier to indicate the destination and pass it down with the data packet. V2X layer will apply the associated profile information, including the L2 IDs, for the transmission. This would allow the reuse the Uu link handling mechanisms, e.g. similar to that of the QoS Flows, and be more extensible. Again, the translation of the application layer identifiers, e.g. Station ID, to this flow identifier has to be done by this mid-ware layer, i.e. the "upper layer".

#### 6.11.2.2 Signalling protocol to support unicast/multicast communication

For unicast or multicast communication, there is a need for some control message exchanged between the UEs involved in order to establish the link or group. Therefore, some signalling protocol is required.

In ProSe one-to-one communication defined in TS 23.303 [8], a PC5 Signalling Protocol (clause 5.1.1.5.2) was introduced, which runs over PDCP layer. Although it is defined for ProSe use, the messages could be extended in order to be used for V2X communication. The detailed protocol design needs to be reviewed based on the actual unicast operation procedures.

Another alternative approach is to run RRC over PC5. As PC5 Signalling Protocol is used over PDCP anyway, RRC protocol can be used to replace it. Although not all RRC features are required for PC5 operation, those selected V2X relevant RRC messages can be extended and used, e.g. SidelinkUEInformation, etc. The advantage of that is the potential unification of control signalling protocols for Uu and PC5.

Therefore, in this solution a signalling protocol over PC5 for the unicast/multicast communication management is introduced.

#### 6.11.2.3 QoS support and AS layer configurations

It is desirable that QoS can be support over the unicast and multicast communication as well.

In TS 23.285 [5], the QoS model for V2X communication is based on the per packet model, e.g. PPPP and PPPR. With unicast or multicast communication, it should be discussed whether a connection-oriented QoS model similar to that of Uu connection should be supported as well.

As also discussed in Key Issue #4 "Support of PC5 QoS framework enhancement for eV2X", something more than existing PPPP and PPPR is expected be required.

Specifically for unicast or multicast, due to the link or group involved, most packets sent over the same unicast link between a pair of peers should have the same QoS characteristics. This is closer to the Uu connection model, rather than the normal broadcast based traffic. Therefore, Uu type of QoS management concept can be reused here. This allow a unified model for Uu and PC5.

In addition, there could be different AS layer features that may be optional or not backward compatible. Therefore, when setting up the unicast link, such configuration could be also negotiated and configured together with/or as part of the QoS profile.

NOTE: The QoS Model for unicast described in Solution #19 (clause 6.19) is used.

#### 6.11.2.4 Security associations

The unicast or multicast communication may need protection at link layer as well. The ProSe one-to-one communication supports secure L2 link establishment, as defined in TS 33.303 [11].

However, within V2X communication context, each UE has the corresponding certificates for the security protection. Therefore, there may be a need to enhancement or adjust the existing L2 secure link establishment protocol in order to support the use of such security associations.

The exact security handling should be analysed and decided by SA3. SA2 design needs to be aligned with those decisions when available.

#### 6.11.2.5 Procedures for the link establishment and maintenance

TS 23.303 [8] has defined the procedures for the establishment and maintenance of secure L2 link over PC5, as in clause 5.4.5. These procedures can be enhanced and adapted for the V2X use, subject to the decisions above regarding signalling protocol choice, security handling, etc.

Some addition considerations for the V2X for the link/group handling is required though. For V2X communication, not all UEs will be supporting or use unicast communication. In addition, not all services may be run over the same channel or RAT (e.g. LTE V2X vs. NR V2X). With V2X, there is no discovery channel like that of ProSe (i.e. PC5-D), and there is no assumption on the configuration from network as that of Public Safety use. Therefore, in order to support the link establishment, there is a need for service announcement in order to inform the peer of the existence of the UE and the capability of the UE for the unicast communication, e.g. channel to operate, or the services supported, etc.

Such a service announcement should be made accessible to all the UEs that are interested in using the service. For example, such announcement could be either configured to send over a dedicate channel, similar to how WAVE Service Advertisement (WSA) is handled, or to be piggybacked on the periodical messages from the supporting UEs.

NOTE 1: Service announcement is handled by upper layer and out of scope of SA2.

For layer 2 link maintenance, keep-alive functionality is needed to detect that when the UEs are not in direct communication range, so that they can proceed with implicit layer 2 link release.

NOTE 2: It is left to Stage 3 to determine how keep-alive functionality is supported.

### 6.11.3 Procedures

#### 6.11.3.1 Establishment of layer 2 link over PC5

Layer-2 link establishment procedure as defined in TS 23.303 [8] clause 5.4.5.2 can be reused for the eV2X unicast link establishment, with the following adaptations:

- The messages may be converted to RRC signaling message instead of PC5 signaling message, depends on RAN WG's decision.

- "UE oriented layer 2 link establishment" operates as below and Figure 6.11.3.1-1 shows the procedure:

- The Direct Communication Request message can be sent by UE-1 with broadcast mechanism, i.e. to a broadcast address associated with the application instead of the L2 ID of UE-2. The upper identifier of UE-2 is included in the Direct Communication Request message to allow UE-2 to decide on if to respond to the request. The Source L2 ID of this message should be the unicast L2 ID of the UE-1.

- The Direct Communication Request message should be transmitted using default AS layer setting e.g. broadcast setting, that can be understood by UE-2.

- UE-2 uses the source L2 ID of the received Direct Communication Request message as destination L2 ID in the subsequent signalling to UE-1, and uses its own unicast L2 ID as the source L2 ID. UE-1 obtains UE-2's L2 ID for future communication, for signalling and data traffic.



Figure 6.11.3.1-1: UE oriented layer 2 link establishment procedure

- "V2X Service oriented layer 2 link establishment" operates same to the "UE oriented layer 2 link establishment" with the following differences and Figure 6.11.3.1-2 shows the procedure:

- The information about V2X Service requesting L2 link establishment, i.e. information about the announced V2X Service is included in the Direct Communication Request message to allow other UEs to decide on if to respond to the request.

- The UEs that are interested in using the V2X Service announced by the Direct Communication Request message can respond to the request (UE-2 and UE-4 in Figure 6.11.3.1-2).

- After establishing layer 2 link with other UE(s) as described above, new UE(s) can enter proximity with UE-1, i.e. UE-1's direct communication range. In this case, UE-1 may initiate V2X Service oriented layer 2 link establishment procedure as it is aware of new UE(s) from Application Layer messages sent by the UE(s). Or the new UE may initiate V2X Service oriented layer 2 link establishment procedure. Therefore, UE-1 does not have to keep sending a Direct Communication Request message periodically to announce the V2X Service it wants to establish L2 link with other UE for unicast.



Figure 6.11.3.1-2: V2X Service oriented layer 2 link establishment procedure

The layer 2 link supports the non-IP traffic. No IP address negotiation and allocation procedure would be carried out.

#### 6.11.3.2 Contents of the signalling message for link establishment

The information carried in Direct Communication Request message defined in TS 24.334 [13] requires at least the following updates:

- For "UE oriented layer 2 link establishment",

- The User Info needs to include the target UE's ID (UE-2's upper layer ID), besides the initiating UE's ID (UE-1's upper layer ID).

NOTE: Stage 3 can decide if these IDs can be carried in the same IE or separate IEs, for example, the Station ID/Vehicle Temp ID only needs to be 4 octets.

- For "V2X Service oriented layer 2 link establishment",

- The Announced V2X Service Info needs to include the information about V2X Service requesting L2 link establishment, e.g. PSID or ITS-AIDs of the V2X application. Sensor Sharing, and etc can be the case for the V2X Service.

- The IP Address Config, which is specified as mandatory for ProSe, should allow an indication that no IP is to be used, such that the receiving UE (e.g. UE-2) would not start any IP configuration procedure for this particular link.

- The IEs dedicated for security need to be reviewed by SA3, as the security mechanism for eV2X may be different and requires different IEs.

- Additional configuraiton information regarding the link, e.g. when RRC message is used there may be AS layer configurations.

#### 6.11.3.3 Link identifier update procedure for privacy protection of unicast communication



Figure 6.11.3.3-1: Layer-2 link identifier update procedure

This procedure is used to update the peer in the unicast communication of the impending change of the identifiers used for this link. Due to the privacy requirements, in eV2X use, UE should frequently change its identifiers in order to avoiding being trackable by 3rd party. When the identifier change happens, all identifiers across all the layers, i.e. from application layer ID to L2 ID, need to be changed. This signaling is required before the identifier changes happen, to prevent service interruptions.

1. UE-1 decides the change of identifiers, e.g. due to the upper layer identifier change or a timer, and includes the new identifiers to use (including the new upper layer identifiers, new IP address/prefix if application, new L2 IDs) in the Link Identifier Update Request message, and send to UE-2 before it changes the identifiers. The new identifiers to use should be cyphered to protect privacy.

NOTE 1: The timer is running on a per Source L2 ID.

2. UE-2 respond with a Link Identifier Update Response message. Upon reception of the message, UE-1 and UE-2 can start to use the new identifiers for the data traffic. UE-1 shall receive traffic on its old L2 ID until it receives the Link Id Update Response from UE-2.

NOTE 2: If there are multiple links from UE-1 using the same upper layer identifiers or L2 IDs, UE-1 needs to perform the update procedure over each of the link and for each link needs to keep receiving traffic on its old L2 ID for that specific link until it receives the Link Id Update Response.

#### 6.11.3.4 Security aspects for layer 2 link

As the eV2X applications have associated security certificates, the unicast link can reuse those to derive the security association for protecting the signalling or data of the unicast link.

### 6.11.4 Impact on existing entities and interfaces

Editor's note: Impacts on existing nodes or functionality will be added.

### 6.11.5 Topics for further study

None.

### 6.11.6 Conclusions

Solution documented in clauses 6.11.1 to 6.11.4 addressed all the aspects of Key Issue #9 Support of unicast/multicast for sensor sharing over PC5, and should move to normative phase. Following aspects will be further updated based on feedbacks from other Working Groups:

- the signalling message definition for unicast link establishment and management, e.g. if and how RRC signalling is used for unicast link;

- the choice of per packet QoS model or bearer based QoS model for broadcast, groupcast, and unicast based on RAN decisions;

- signal to the base station regarding the service used when network scheduled mode is used;

- the potential security related procedure updates for unicast communication over PC5.

NOTE: The application layer may use unicast or groupcast communication mechanism for different applications, e.g. platooning applications.

## 6.12 Solution #12: 3GPP PC5 RAT selection for a V2X application

### 6.12.1 Functional Description

This solution corresponds to the Key Issue #2 "3GPP PC5 RAT selection for a V2X application".

If a V2X services need to be made available to LTE PC5 (resp. NR PC5) V2X capable UEs, the corresponding packets shall be transmitted at least over LTE PC5 (resp. NR PC5). This aspect is also related to the Key Issue #2 because this key issue can be interpreted that for V2X services requiring availability to LTE PC5 V2X capable UEs, NR PC5 V2X capable UEs supporting LTE PC5 should use at least LTE PC5 as a 3GPP PC5 RAT to transmit the corresponding V2X messages.

In Rel-15 (for RAN WI "LTE\_eV2X-Core"), there is the backward-compatibility issue with Rel-14 V2X regarding LTE PC5 transmission of V2X messages. This backward-compatibility issue mainly happens because Rel-15 LTE PC5 PHY format (modulation and TBS size) is incompatible with the Rel-14 LTE PC5 PHY format which means when a Rel-15 UE transmits V2X message by using Rel-15 LTE PC5 PHY format, Rel-14 UEs cannot decode the V2X message. Similarly, it is expected that when NR PC5 V2X capable UE transmits V2X message by using NR PC5 format, LTE PC5 V2X capable UEs not supporting NR PC5 cannot decode the V2X message.

Since Rel-14 LTE PC5 V2X capable UEs support the basic safety V2X services/messages, it is expected that to satisfy legacy support, the NR PC5 V2X capable UE supporting Rel-14 LTE PC5 should at least select the Rel-14 LTE PC5 RAT, unless it is specifically configured not to use them.

To resolve the backward-compatibility issue with Rel-14 LTE PC5 V2X, "Tx Profiles" based approach is considered as a potential approach for broadcast.

In this solution, it is proposed to use the "Tx Profiles" approach to solve the Key Issue #2 on 3GPP PC5 RAT selection for a V2X application by extending "Tx Profiles" to cover NR PC5 transmission mechanisms. Contents of Tx Profile can be defined by the AS layer while configuration of "Tx Profiles" associated with the V2X services, e.g. PSID or ITS-AIDs of the V2X applications, needs to be defined by the V2X layer.

Editor's note: Whether this solution is suitable is depending on design of NR PC5 that will be developed in RAN WGs.s introduced when developing contextge to the networkto transmit and receive non-IP based V2X message over Uu in 5GS000000000

### 6.12.2 Procedures

- The "Tx Profiles" are configured in the UE and associated with the V2X services, e.g. PSID or ITS-AIDs of the V2X applications.

- The V2X layer checks the V2X service of a packet from the upper layer (e.g. based on PSID or ITS-AID and/or QoS parameters) and locates the corresponding "Tx Profile(s)".

- The V2X layer passes the packet to the applicable LTE and/or NR PC5 AS layer(s) in accordance with the "Tx Profile(s)" for transmission.

NOTE: Any V2X packet passed to a PC5 AS layer is expected to be transmitted according to applicable RRM requirements (e.g. interference, resource scheduling etc).

### 6.12.3 Impact on existing entities and interfaces

Editor's note: Impacts on existing nodes or functionality will be added.

### 6.12.4 Topics for further study

Editor's note: Topics for FFS will be collected for this particular functionality.

### 6.12.5 Conclusions

Editor's note: Conclusions will be collected for this particular functionality.

## 6.13 Solution #13: Solution for PC5 RAT selection

### 6.13.1 Functional Description

This solution addresses the Key Issue #2 in the perspective of 3GPP PC5 RAT selection for a V2X application.

This solution applies to the all architecture options in Annex A.

Considering vehicle communications environment, it would be expected that various types of vehicles with different capabilities and with different subscription to different PLMNs are on the same road and need to communicate each other. So, it is hardly possible to know peer UE capabilities in advance.

In addition, the LTE RAT and NR RAT may provide different characteristics in terms of data rate, latency and message transfer range, etc. So, it is possible to decide which RAT type is the most suitable PC5 RAT to meet the service requirement of a certain V2X application in advance.

Therefore, this solution proposes to define a mapping of PC5 RAT type and the V2X services, e.g. PSID or ITS-AIDs of the V2X application. The UE is provisioned with the mapping information and is able to select a PC5 RAT type when sending V2X messages over PC5.

If a V2X service identified by e.g. PSID or ITS-AID is required to transfer V2X messages over LTE PC5, the V2X layer provides to AS layer the "Tx profile" associated with the same PSID or ITS-AID if available.

Editor's note: Whether this solution is suitable is depending on design of NR PC5 that will be developed in RAN WGs.

### 6.13.2 Procedures

The mapping of PC5 RAT type and V2X services (e.g. PSID or ITS-AIDs) is provided to the UE when the V2X service parameters are provisioned to the UE. How the service authorization and provisioning for eV2X communications over PC5 is provided to the UE will be studied under Key Issue #5 and architecture options in Annex A. Therefore, no further effort is required here.

### 6.13.3 Impact on existing entities and interfaces

UE:

- The UE stores the mapping of PC5 RAT type and V2X services and uses the mapping information to select a PC5 RAT type when sending V2X messages over PC5.

PCF, V2X Control Function and/or V2X AS:

- The entity who is in charge of managing V2X service provisioning parameters, i.e. PCF, V2X Control Function, and/or V2X AS, depending on which architecture reference model is selected, manages the mapping of PC5 RAT type and V2X services, and provides the mapping information to the UE.

### 6.13.4 Topics for further study

Editor's note: This clause describes topics for further study.

### 6.13.5 Conclusions

Editor's note: This clause provides conclusions of the solution.

## 6.14 Solution #14: Solution for eV2X system migration

### 6.14.1 Functional Description

#### 6.14.1.1 General description

This solution addresses Key Issue #12 (System migration and interworking for eV2X). The use cases described in the key issue are considered separately for PC5 based operation and Uu based operation.

#### 6.14.1.2 PC5 based V2X communication considerations

Depends on regional regulation and deployment choices, there may be following different types of UEs:

- Type 1: UE with LTE PC5 interface only;

- Type 2: UE with LTE PC5 and NR PC5 interfaces;

- Type 3: UE with NR PC5 interface only.

To address Key Issue #12 (system migration and interworking), the following situations should be considered:

- Depends on regional regulations and deployment, Type 1 UE may be deployed in a particular Geo-Area. In this case, when Type 2 UE or Type 3 UEs are made available later, all the UEs must be configured properly with the association of service (identified by PSID/ITS-AID) and RAT types, such that the service running on different types of UEs can interwork. The configuration data structure should support the following possibilities:

- Map a service type (PSID/ITS-AID) to one RAT type (e.g. LTE PC5 or NR PC5). For example, for basic safety services (e.g. BSM 0x20) is associated with LTE PC5, and Traveler information and roadside signage service (e.g. TIM 0x83) is associated with NR PC5. This way:

- Type 1 UE sends and receives BSM messages over LTE PC5, and indicates to upper layer that TIM is not supported.

- Type 2 UE sends and receives BSM messages over LTE PC5, and sends and receives TIM message over NR PC5.

- Type 3 UE sends and receives TIM messages over NR PC5, and informs upper layer that BSM is not supported (so that upper layer may decide to use other radio technology for such service).

- In some region, there may be no Type 1 UE deployment (or it was phased out after a long period), there may be Type 2 and Type 3 UEs. In this case, correct configuration should also point correctly the RAT type to allow the service running on different types of UEs to interwork. The configuration data structure should support the following possibilities:

- Map all service type (PSID/ITS-AID) to one RAT type (e.g. NR PC5). This way:

- Type 2 UE sends and receives all V2X messages over NR PC5.

- Type 3 UE sends and receives all V2X messages over NR PC5.

NOTE: Use of non-3GPP access technology for the V2X message transmission is handled at upper layer, and is out of scope of 3GPP.

In order to support the above operation, the different types of UEs need to have consistent configurations at least regarding:

- Radio resources to use for the specific PC5 interface in a particular region;

- Policy and parameters for the operation, e.g. service identifier mapping to the Tx Profile and QoS requirements.

Similar to existing definition in TS 23.285 [5], such configurations could be pre-configured (on the ME or UICC), or provisioned (via mechanism selected as described in Annex A, or via V1 from the V2X Application Server). The provisioning approach depends on the architecture options described in Annex A.

- For a EPS V2X Capable UE, the provisioning method is as defined in TS 23.285 [5] clause 5.2 (which in turn uses procedure of TS 23.303 [8] clause 5.2.1 and clause 5.2.2). When such a UE moves under the coverage of a 5GS system, it is expected that configuration from EPS will continued to be used, as it cannot access 5GS provisioning methods.

- For a 5GS V2X Capable UE, the provisioning can happen in EPS or 5GS. Therefore, there is a need to ensure that consistent configuration information is provided to the UE, and also avoid double provisioning of the configuration when UE moves between EPS and 5GS.

#### 6.14.1.3 Additional consideration for PC5 Mode 3 operations

For PC5 Mode 3 operation, network support is required. The assumed operation is as following:

Therefore, a 5GS V2X UE can operates Mode 3 when it is under the coverage of a NG-RAN that supports scheduling of 5GS V2X PC5 (i.e. NR V2X PC5). In such a case, the EPS V2X PC5 of the same UE (i.e. LTE V2X PC5) can operate in Mode 3 if the same serving NG-RAN node also supports scheduling of EPS V2X PC5. Otherwise, it can fall back to Mode 4. When the 5GS V2X UE is under the coverage of an EPS system, it can operate in Mode 3 of the EPS V2X PC5 (i.e. LTE V2X PC5) if the E-UTRAN supports it. The 5GS V2X PC5 (i.e. NR V2X PC5) will operate in Mode 4.

Editor's note: The Mode 3 operation details and the falling back to Mode 4 requires RAN's confirmation.

For an EPS V2X UE, obviously, it only operates in Mode 3 when it is connected to an EPS system.

#### 6.14.1.4 Uu based V2X communication considerations

There are two types of Uu based V2X communication defined in TS 23.285 [5], i.e. Uu unicast based, and Uu MBMS based.

For Uu unicast based V2X communication, it is possible for the UE to have the same service supported in EPS and 5GS, as long as architecture requirements as defined in TS 23.501 [7], e.g. clause 4.3, clause 5.17, can be met. Certain services may be only supported in 5GS, due to for example QoS requirements. Those services will not be considered for interworking.

### 6.14.2 Procedures

TBD.

Editor's note: This will be defined after the confirmation of the eV2X system architecture option.

### 6.14.3 Impact on existing entities and interfaces

TBD.

### 6.14.4 Topics for further study

Interaction between EPS and 5GS in configuration parameter provisioning based on eV2X system architecture option selection.

Assumptions and solutions have dependency on RAN design on V2X for 5G and need to be coordinated with RAN.

### 6.14.5 Conclusions

Principles documented in clause 6.14.1.2 to 6.14.1.3 provided examples regarding how proper configurations at the UE can support migration and interworking of V2X services on different types of UEs.

## 6.15 Solution #15: Network-controlled QoS mechanism for PC5 communication

### 6.15.1 General Description

This solution addresses Key Issues #4.Current QoS framework for V2X communication over PC5 is based on PPPP (ProSe Per Packet Priority) and PPPR (ProSe Per Packet Reliability) mechanisms which can be found in TS 23.285 [5]. It is proposed to use a new mechanism for:

- Making use of the similar QoS parameters for PC5 as the one for Uu;

- Delivering the QoS information from network side: the network provides the QoS rules of PC5 communication to the UE, i.e., Core Network-controlled QoS parameters provisioning procedure.

### 6.15.2 Proposed QoS model for PC5 communication

In clause 6.2.1.2 of Solution #2, it demonstrates that performance requirements in each CoR and LoA can be interpreted by the 5G QoS characteristics associated with 5QI (note that the original idea of Solution #2 is for Uu interface). As a result, similar QoS parameters can be used for PC5 communication, e.g. the Data Rate, Payload, Reliability and Maximum end-to-end latency can be represented by GBR QoS Flows or Non-GBR QoS Flows, Maximum Data Burst Volume, the combination of PDB and the Packet Error Rate (PER), and PDB, respectively. Such QoS parameters for QoS flow relevant to the PC5 communication will be associated to a certain PC5 link, to guarantee PC5 communication.

Editor's note: It is FFS what other parameters are needed to support QoS control to PC5, e.g. for satisfying "Transmission rate", and "Minimum required communication range" requirements in CoR and LoA, why these new parameters are needed, and how UE uses these new parameters for PC5 communication.

Editor's note: It is FFS whether and how NG-RAN enforces the QoS parameters for network schedule mode for PC5 communication.

Editor's note: It is FFS whether the QoS framework can be applied only to unicast/multicast or also to broadcast.

Editor's note: It is FFS that how does UE operate on network scheduling mode (mode 3) and autonomous communication mode (mode 4).

### 6.15.3 Procedures

NOTE: How to provide QoS parameters for PC5 communication by the CN is based on the Architecture decision.

### 6.15.4 Impact on existing entities and interfaces

V2XCF:

- The Network Function in the 5GC that will provide QoS parameters for PC5 communication to the AMF.

UE:

- Obtains QoS parameters for PC5 communication from the CN.

### 6.15.5 Conclusions

TBD

## 6.16 Solution #16: Solution for QoS Support for eV2X over Uu Interface - Enhancements for QoS Monitoring and Control

### 6.16.1 Functional Description

This solution addresses Key Issue #3 (QoS Support for eV2X over Uu interface) and it is based on enhancing the 5GS QoS model.

This solution defines two alternative options:

- Option 1 – RAN based multi-QoS profile;

- Option 2 – CN based multi-QoS profile.

To enable enhanced QoS Monitoring and Control the following steps should be executed. The steps apply to both options unless otherwise indicated.

1. An eV2X Application Function (AF), possibly from 3rd party, influences the QoS of the eV2X service, by offering a set of possible QoS levels to the PCF.

For examples, the AF indicates QoS levels 1, 2 and 3 which, based on SLA, are mapped on different QoS parameters sets.

2. To support eV2X services, a new type of PCC rule with multiple QoS parameter sets (each consists of a rank, 5QI, and optionally Rank notification (RN), GBR and MBR) should be introduced. The PCF generates such a PCC rule for the eV2X service and maps the QoS levels provided by the AF to different QoS parameter sets. This PCC rule is then provided to the SMF.

The new type of PCC rule includes, e.g.:

Parameter set 1 = {Rank 1: 5QI value = x1, RN, GBR = y1, MBR = z1} (i.e., highest QoS level);

Parameter set 2 = {Rank 2: 5QI value = x2, RN, GBR = y2, MBR = z2} (i.e. medium QoS level);

Parameter set 3 = {Rank 3: 5QI value = x3, RN, GBR = y3, MBR = z3} (i.e. lowest QoS level).

3. To support eV2X services, a new type of QoS flow that can be associated with multiple QoS profiles should be introduced. When the SMF receives a PCC rule with multiple QoS parameter sets, it establishes such a QoS flow and provides a QoS profile per QoS parameter set.

The new type of QoS Flow includes, e.g.:

QoS profile 1 = {Rank 1: 5QI value = x1, RN, GBR = y1, MBR = z1} (i.e., highest QoS level);

QoS profile 2 = {Rank 2: 5QI value = x2, RN, GBR = y2, MBR = z2} (i.e. medium QoS level);

QoS profile 3 = {Rank 3: 5QI value = x3, RN, GBR = y3, MBR = z3} (i.e. lowest QoS level).

4. (This step applies to Option 1 only) When the RAN receives a QoS flow establishment request which contains multiple QoS profiles, it treats this QoS flow according to the QoS profile with the highest rank (i.e. with the most demanding QoS parameter values).

NOTE 1: The ranking of the different QoS profiles is based on the application's input.

5a. (This step applies to Option 1 only) If later the current QoS profile cannot be fulfilled for the QoS flow, the RAN should try to fulfil the QoS of one of the other QoS profiles associated to the QoS flow. If this is successful, the RAN will indicate the rank of the now supported QoS profile in the notification to the network that the current QoS can no longer be fulfilled.

NOTE 2: RAN can optionally send a notification to the UE on the next level of QoS to be adjusted if specified by the PCF/SMF.

5b. (This step applies to Option 2 only) If the QoS profile cannot be fulfilled for the QoS flow, the RAN triggers a PDU session modification to notify the 5GC of the QoS failure (see TS 23.502 [9], clause 4.3.3.2 step 1a). The 5GC modifies the PDU session to fulfil the QoS of one of the other QoS profiles associated to the QoS flow.

NOTE 3: RAN can optionally send a notification to the UE on the unfulfilment of the QoS profile if specified by the PCF/SMF.

6. The AF and/or UE is notified by the PCF whenever a QoS level change occurs and can adjust the eV2X service accordingly. The notification indicates the supported QoS level following the change.

Depending on the use case (e.g., in case of latency constrains, the notification should be sent directly to the UE), the AF may indicate in the notification request message whether the notification should be sent to the UE, AF or both.

7. (This step applies to Option 1 only) If later the RAN recognizes that a higher rank QoS profile can be fulfilled, the QoS flow will be treated accordingly and a notification to the network is sent that a new QoS profile can now be fulfilled.

8. The AF and/or UE is notified by the PCF whenever a QoS level change occurs and can adjust the eV2X service accordingly. The notification indicates the supported QoS level following the change.

NOTE 4: Steps 5+6 and/or 7+8 can occur several times depending on the number of QoS profiles that are associated to the QoS flow.

### 6.16.2 Procedures

#### 6.16.2.1 Application Function Request to Influence eV2X QoS

The procedure for the application function request to influence eV2X QoS follows the principles specified in TS 23.503 [10] clause 6.2.3. The AF shall invoke (either directly of via the NEF) the Npcf\_PolicyAuthorization\_Create/Update Request service operation.

The Npcf\_PolicyAuthorization\_Create/Update Request service operation is extended by:

- The set of possible QoS Levels to associate to specific eV2X services;

- An preferred/default QoS Level to specific eV2X services;

- QoS level change policy in case the preferred/default QoS Level could not be fulfilled;

NOTE: Details on the content of the service operation are FFS.

The PCF shall notify (either directly of via the NEF) the AF the Success or the Failure of the request, along with the supported QoS Levels.

#### 6.16.2.2 Application Function Request of QoS Level Change Notification

The procedure for the application function request of QoS Level Change Notification follows the principles specified in in TS 23.502 [9] clause 4.3.6.3.

The AF shall invoke (either directly of via the NEF) the Npcf\_PolicyAuthorization\_Subscribe service operation. The service operation (AF request) may contain at least:

- Type of the notification (e.g. notified NFs or UE);

- Other information, e.g. as described in TS 23.501 [7] clause 5.6.7

NOTE: Details on the content of the service operation are FFS.

In case the AF shall be notified, the PCF shall notify either directly of via the NEF the AF the successful subscription to the QoS Level Change Notification event.

In case the UE shall be notified, PCF decides which NF should notify the UE (e.g., RAN, SMF or PCF).

#### 6.16.2.3 eV2X Service Session QoS Level Change and AF Notification

##### 6.16.2.3.1 Option 1 - (R)AN based multi-QoS profile

Figure 6.16.2.3.1-1 represents a high level description of how the QoS level change and related AF/UE notification work.



Figure 6.16.2.3.1-1: QoS Level Change and Notification (Option 1)

0. PCF/SMF gets the RAN capability on multi QoS profile support (e.g., via OAM configuration).

1. PDU session context establishment and authentication/authorization as described in TS 23.502 [9] clause 4.3.2.2.

2. Session Management Policy Establishment/Modification.

2a) The Application Function Request to Influence eV2X QoS procedure is executed as described in clause 6.16.2.1.

2b) The Application Function Request of QoS Level Change Notification procedure is executed as described in clause 6.16.2.2.

3. eV2X Service Session establishment with Multi QoS profiles QoS Flow according to the correspondent Multi QoS Level PCC rule.

4. When the RAN decides, e.g., that the QoS targets of the active QoS profile of the QoS Flow cannot be fulfilled, it triggers a PDU Session modification towards the SMF as described in TS 23.502 [9] clause 4.3.3.2, step 1e, and informs the SMF and, optionally the UE, about the new rank of the QoS profile. The SMF forwards the notification to the PCF.

The SMF continues the PDU Session modification to inform the UE about the currently active QoS profile (as described in clause 6.16.1 step 5). If specified by the PCF, the SMF may notify the UE without modification of the current PDU session.

NOTE: How RAN sends the notification to UE is pending RAN WGs' feedback.

5. The PCF notifies the AF of the QoS Level Change by sending the Npcf\_QoS\_Level\_Change\_Notification, after the completion of the PDU Session Modification if configured in step 2. The notification message may contain at least:

- eV2X session, UE ID, time, location, QoS Level and AF transaction identifier information.

The UE may also be notified of the QoS Level Change via NAS message, if not done at step 4.

6. The AF notifies the UE of the adjustment of V2X application according to the new QoS Level and/or vice versa. The notification may also include information on the QoS Level Change, if not previously notified in step 4 or step 5.

##### 6.16.2.3.2 Option 2 - CN based multi-QoS profile



Figure 6.16.2.3.2-1: QoS Level Change and Notification (Option 2)

1-3. As steps 1 to 3 of clause 6.16.2.3.1.

4. The RAN notifies the SMF of a QoS failure. The SMF triggers the PDU session modification asking for another QoS profile in Multi QoS profiles (e.g., according to the rules specified by PCF).

The SMF continues the PDU Session modification to inform the UE about the currently active QoS profile (as described in clause 6.16.1 step 5). If specified by the PCF, SMF may notify the UE without modification of the current PDU session.

5-6. As steps 5 to 6 of clause 6.16.2.3.1.

### 6.16.3 Impact on existing entities and interfaces

The solution has the following impacts:

**Option 1 - (R)AN based multi-level QoS profile**

QoS model

- The 5G QoS model should support a new type a QoS Flow associated to multiple QoS profiles.

AF

- The AF shall be able to invoke PCF services:

- To request multiple QoS levels for eV2X services;

- To request the QoS level change notification.

PCF

- The PCF shall extend existing services:

- To allow AF to request multiple QoS levels for eV2X services;

- To allow AF to request the QoS level change notification;

- To send AF notifications of QoS Level changes.

- The PCF shall define a new type of PCC rule with multiple QoS parameter sets (each consists of a rank, 5QI, and optionally Rank notification (RN), GBR and MBR) to support multiple QoS Levels eV2X services.

- The PCF shall identify ANs which support and not support multi QoS profiles.

SMF

- The SMF shall support the type of PCC rule with multiple QoS parameter sets;

- The SMF shall identify ANs which support and not support multi QoS profiles.

RAN

- The RAN should support multi QoS profiles bearers;

- The RAN should support the notification of a QoS profile change for multi QoS profile bearers towards the 5GC and/or the UE.

UE

- The UE should support multi QoS profiles.

**Option 2 - CN based multi-level QoS profile**

Same as for Option 1, with the following differences:

- no impacts on RAN.

### 6.16.4 Topics for further study

### 6.16.5 Solution evaluation

Solution #16 addresses Key Issue #3 "QoS Support for eV2X over Uu interface" and, in particular, the Requirements to support vehicle quality of service (see clause 5.6 of TS 22.186 [4]). The solution requires extending the current QoS framework and has some impact on the AF and 5GS. The main benefits are:

- It allows the eV2X AF to better adjust to the currently applied QoS (e.g., in case of QoS failure, instead of downgrading to the lowest possible QoS level, the V2X application can still operate at a higher QoS level, even if not at the highest one).

- It reduces the signalling load by avoiding QoS re-negotiations between V2X AF and 5GC and between PCF and SMF.

- The support of Multi QoS profile flows enables controlled QoS adjustments (i.e. upgrade or downgrade) according to the needs of the V2X application.

- It reduces discontinuity of eV2X applications.

### 6.16.6 Conclusions

Editor's note: Conclusions are FFS.

## 6.17 Solution #17: Solution for QoS Support for eV2X over Uu Interface

### 6.17.1 Functional Description

This solution addresses Key Issue #3 (QoS Support for eV2X over Uu interface) and it **reuses** the 5GS QoS model specified in TS 23.501 [7] and TS 23.503 [10] with necessary enhancement as follows.

1. An eV2X Application Function (AF), possibly from 3rd party, influences the QoS of the eV2X service, by providing service info to the PCF (via NEF if 3rd party AF) as specified in TS 23.503 [10] (and TS 23.203 [12]).

The V2X Application Function may require that the AN notify the UE of the QoS target unfulfilment/re-fulfillment.

2. PCF authorize the service info from the AF, translates it into PCC rule with QoS parameters such as 5QI, ARP, GBR/MBR, and optionally PL and notification control and then sends the PCC rule to the SMF.

The PCF passes the AN-to-UE notification control if requested by the V2X AF.

3. The SMF performs QoS Flow binding and creates a new QoS Flow if no existing QoS Flow can fulfil the service requirement. The SMF also derives the QoS rules and QoS Flow level parameters to the UE, as well as QoS profile to the AN.

The SMF may also indicate that AN need to notify the UE based on the information in PCC rule.

4. The AN receives a QoS flow establishment request which contains the QoS profile. Per TS 23.501 [7], in the QoS profile,

- The GFBR is recommended as the lowest acceptable service bitrate where the service will survive, and MFBR>GFBR can be provided to the RAN. The bit rates above the GFBR value and up to the MFBR value may be provided with relative priority determined by the Priority level of the QoS Flows.

- The PDB for GBR QoS Flows with GBR resource type shall be interpreted as a maximum delay with a confidence level of 98 percent if the QoS flow is not exceeding the GFBR. The PDB for delay critical GBR resource type may be exceeded for at most PER packets, that is, a packet delayed more than PDB is counted as lost if the transmitted data burst is less than MDBV within the period of PDB and the QoS Flow is not exceeding the GFBR.

- The Packet Error Rate (PER) defines an upper bound for the rate of PDUs (e.g. IP packets) that have been processed by the sender of a link layer protocol but that are not successfully delivered by the corresponding receiver to the upper layer, i.e. the PER defines an upper bound for a rate of non-congestion related packet losses. For GBR QoS Flows with Delay critical GBR resource type, a packet which is delayed more than PDB is counted as lost, and included in the PER unless the data burst is exceeding the MDBV within the period of PDB or the QoS Flow is exceeding the GFBR.

5. If the (R)AN cannot fulfil the GFBR requirement, and/or the PDB requirement and/or the PER requirement, it notifies the 5GC what QoS characteristics cannot be fulfilled using the procedure as specified in clause 5.7.2.4 of TS 23.501 [7] and then to the AF if notification is required so that the AF can take proper action.

When radio condition changes, and the requirement of GFBR, PDB and PER can be fulfilled again, the NG-RAN notifies the 5GC using the procedure as specified in clause 5.7.2.4 of TS 23.501 [7] and then to the V2X application. The V2X Application then takes proper action based on information provided by the 3GPP system and maybe other sources.

NOTE 1: A non-GBR Flow may use the bit rate up to the value of the session AMBR which can be very high, and consequently the non-GBR QoS Flow may take unreasonably large amount of resources and starve resource for other flows, therefore it's considered unrealistic to apply Notification Control for the non-GBR QoS Flow unless a bit rate parameter is also introduced for non-GBR Flow which means a major change to the QoS model.

In addition, (R)AN may also notify to the UE of the QoS target fulfilment/unfulfillment based on request from 5GC.

In addition to notify the V2X AF that the QoS targets cannot be fulfilled, the NG-RAN may also include the currently 'QoS requirements that are guaranteed' (GFBR, PDB and/or PER), so that the V2X application can take this information into account.

NOTE 2: The format of the 'QoS requirements that are guaranteed' between PCF and AF can be decided in the normative phase.

NOTE 3: It's assumed that (R)AN does not notify the UE frequently, e.g. every few milliseconds.

NOTE 4: How the NG-RAN decides that the PDB and/or PER cannot be fulfilled is implementation specific.

NOTE 5: The details on how the RAN notifies the UE of the QoS unfulfillment or re-fulfillment require coordination with RAN WGs. Whether RAN can provide PDB and/or PER information needs to be coordinated with RAN WG2.

NOTE 6: Whether the notification enhancement applies to V2X application only and up to the operator policy.

### 6.17.2 Procedures

Existing procedures can be reused with the following enhancement:

(1) That the RAN can also notify the unfulfillment/re-fulfilment of the QoS characteristics PDB and PER to the 5GC, and then to the Application Function.

(2) AF may request via 5GC that RAN notifies the UE of the unfulfillment/re-fulfilment of the QoS characteristics and proposes the bit rate between GFBR and MFBR to be used.

### 6.17.3 Impact on existing entities and interfaces

The following entities are impacted to support Notification Control of PDB and PER.

- RAN should be able to notify the UE and provide 'QoS requirements that are guaranteed' to 5GC.

- SMF/PCF shall support sending additional trigger to enable notification at (R)AN and transfer the currently 'QoS requirements that are guaranteed'.

- AF shall be able to specify the destination of the notification (UE and/or AF) during the subscription to the PCF notification services and receive the 'QoS requirements that are guaranteed' from the PCF.

- UE

- Receiving notification from the RAN.

### 6.17.4 Topics for further study

### 6.17.5 Solution evaluation

This solution supports RAN notification directly to UE for time critical application.

This solution reuses the existing QoS model and PCC framework as defined in 3GPP Rel-15 with some enhancement, therefore the impact on the system is minimized.

QoS modification triggered by the RAN notification is decided by one entity, therefore the chance of race condition in 5GC is minimized, and the risk of unstable system is minimized.

The solution enables the application to directly react/adjust to the changing conditions thus the control stays end to end on the application.

### 6.17.6 Conclusions

Editor's note: Conclusions are FFS.

## 6.18 Solution #18: Non-IP based V2X message transmission and reception over Uu reference point in 5GS

### 6.18.1 Functional Description

This solution corresponds to the Key Issue #10 "eV2X message transmission and reception", in particular related to how for a UE to transmit and receive non-IP based V2X message over Uu reference point in 5GS. That is, the proposed solution focuses only on non-IP based V2X message transmission and reception over Uu reference point in 5GS while other aspects regarding Key Issue #10 is out of scope of the solution.

**(1) IP encapsulation**

According to clause 4.4.3.2 of TS 23.285 [5], the UE uses IP type PDN connection to transmit and receive non-IP based V2X messages over LTE-Uu reference point in EPS which means the UE encapsulates non-IP based V2X message into IP packet before sending the V2X message to a V2X Application Server.

Therefore, in 5GS, same mechanism can be considered to transmit and receive non-IP based V2X message over Uu reference point specified in TS 23.285 [5] in 5GS which means IP type PDU Session is used to transmit and receive non-IP based V2X message over Uu reference point.

Different than EPS approach as defined in TS 23.285 [5], the 5G solution should be agnostic towards Transport Layer protocols for unicast communication. Unicast Uplink operation for the UE can be unified with this limit (e.g. restriction to UDP only) removed.

NOTE 1: Removing transport layer restrictions in 3GPP will allow application developers and/or other standardization organizations to determine the appropriate ones for their applications.

**(2) Unstructured PDU Session type**

In 5GS, Unstructured PDU Session type has been specified (see TS 23.501 [7] and TS 23.502 [9]). Unstructured PDU Session type can be considered to transmit and receive non-IP based V2X message over Uu reference point. Regarding interworking with EPS, Unstructured PDU Session type is transferred to EPC as non-IP PDN type when non-IP PDN type is supported by UE and network.

NOTE 2: Unstructured PDU Session type supports a maximum of one 5G QoS Flow per PDU Session and does not support SSC mode 3.

The UE determines which method between (1) and (2) is used for non-IP based V2X messages based on configuration. Regarding the configuration, two options can be considered as below:

- Option#1: V2X parameter based option

In this option, for the UE to route non-IP based V2X messages via an IP type PDU Session or an Unstructured type PDU Session, the following parameters for V2X Communication over NG-Uu can be provisioned in the UE.

- Mapping of the V2X services, e.g. PSID or ITS-AIDs of the V2X application to:

- PDU Session Type (IP type or Unstructured type).

- For IP type PDU Session, V2X Application Server address (consisting of IP address/FQDN and transport layer port#) for unicast.

- V2X Application Server address information.

- List of FQDNs or IP addresses of the V2X Application Servers, associated with served geographical area information and list of PLMNs that the configuration applies to.

- Option#2: URSP based option

In this option, for the UE to route non-IP based V2X messages via an IP type PDU Session or an Unstructured type PDU Session, URSP rules and the following parameters for V2X Communication over NG-Uu can be provisioned in the UE. Currently Application descriptor consists of OSId and OSAppId(s), so this does not cover PSID or ITS-AIDs of the V2X application. Therefore, new Application descriptor for V2X services needs to be defined as a Traffic descriptor or existing Application descriptor needs to be extended.

- URSP rules in order to cover the following:

- Mapping of the V2X services, e.g. PSID or ITS-AIDs of the V2X application to PDU Session Type (IP type or Unstructured type).

- Parameters for V2X Communication over NG-Uu:

- For IP type PDU Session, mapping of the V2X services, e.g. PSID or ITS-AIDs of the V2X application to V2X Application Server address (consisting of IP address/FQDN and transport layer port#) for unicast.

- V2X Application Server address information.

- List of FQDNs or IP addresses of the V2X Application Servers, associated with served geographical area information and list of PLMNs that the configuration applies to.

Option#1 requires only V2X parameters while Option#2 requires URSP as well as V2X parameters. In any case, V2X parameters will be defined to support V2X services, e.g. V2X parameters for V2X communication over PC5. Therefore, only using V2X parameters is considered efficient. In this regards, it is proposed to take Option#1 for the UE to decide whether non-IP based V2X messages are routed via an IP type PDU Session or an Unstructured type PDU Session. The V2X parameters are pre-configured or provisioned to the UE using the solution defined for Key Issue #11.

### 6.18.2 Impact on existing entities and interfaces

UE:

- For "(1) IP encapsulation", no additional impact compared to impact on non-IP based V2X message transmission/reception over Uu reference point defined in TS 23.285 [5] except there is no restriction on the Transport Layer Protocols use in 5GS (e.g. UDP, TCP etc.). It is recommended that this applies to UEs starting from Rel-16 independent of whether it is connected via EPS or 5GS.

- Regarding UDP or TCP, UE may learn from V2X Application Server or it may be configured if explicitly a transport protocol needs to be used (e.g. TCP, UDP) or no restriction imposed by configuration.

- For "(2) Unstructured PDU Session type", no additional impact compared to impact on non-IP based V2X message transmission/reception over Uu reference point defined in TS 23.501 [7] and TS 23.502 [9].

- UE determines which method between (1) and (2) is used for non-IP based V2X messages based on configuration.

5GC:

- 5GC handles configuration for the UE to determine which method between (1) and (2) is used for non-IP based V2X messages.

NG-RAN:

- No impact.

### 6.18.3 Topics for further study

None.

### 6.18.4 Conclusions

It is proposed to adopt Solution #18 with Option#1 (V2X parameter based option) for normative work for 5GS. In addition, it is proposed to adopt the principle related to IP encapsulation for EPS as well.

## 6.19 Solution #19: QoS Support for eV2X communication over PC5 interface

### 6.19.1 Functional Description

#### 6.19.1.1 General description

This solution addresses Key Issue#4 (clause 5.4) Support of PC5 QoS framework enhancement for eV2X. The QoS requirements for eV2X are different from that of the EPS V2X, and the previous defined PPPP/ PPPR in TS 23.285 [5] are considered not to satisfy the needs. Specifically, there are much more QoS parameters to consider for the eV2X services. This solution proposes to use 5QI for eV2X communication over PC5 interface. This allows a unified QoS model for eV2X services over different links.

#### 6.19.1.2 Solution description

The new service requirements were captured in TS 22.186 [4]. The new performances KPIs were specified with the following parameters:

- Payload (Bytes);

- Transmission rate (Message/Sec);

- Maximum end-to-end latency (ms);

- Reliability (%);

- Data rate (Mbps);

- Minimum required communication range (meters).

Note that the same set of service requirements apply to both PC5 based V2X communication and Uu based V2X communication. As analysed in Solution #2 (clause 6.2), these QoS characteristics could be well represented with 5QI defined in TS 23.501 [7].

It is therefore possible to have a unified QoS model for PC5 and Uu, i.e. also use 5QIs for V2X communication over PC5, such that the application layer can have a consistent way of indicating QoS requirements regardless of the link used. This does not prevent the AS layer from implementing different mechanisms over PC5 and Uu to achieve the QoS requirements.

Considering the 5GS V2X capable UEs, there are three different types of traffic: broadcast, multicast, and unicast.

The UE-PC5-AMBR is applied to all types of traffic and is used for the RAN for capping the UE PC5 transmission in the resources management.

For unicast type of traffic, it is clear that the same QoS Model as that of Uu can be utilized, i.e. each of the unicast link could be treated as a bearer, and QoS flows could be associated with it. All the QoS characteristics defined in 5QI and the additional parameter of data rate could apply. In addition, the Minimum required communication range could be treated as an additional parameter specifically for PC5 use.

For broadcast traffic, there is no bearer concept. Therefore, each of the message may have different characteristics according to the application requirements. The 5QI should then be used in the similar manner as that of the PPPP/PPPR, i.e. to be tagged with each of the packet. 5QI is able to represent all the characteristics needed for the PC5 broadcast operation, e.g. latency, priority, reliability, etc. A group of V2X broadcast specific 5QIs (i.e. VQIs) could be defined for PC5 use.

NOTE 1: The 5QI used for PC5 may be different from that used for Uu even for the same V2X service, e.g. the PDB for the PC5 can be longer than that for the Uu as it is a direct link. The 5QIs used for PC5 is named VQI for differentiation.

NOTE 2: A mapping between the EPS V2X QoS parameters, e.g. PPPP and PPPR, with the new VQIs, e.g. similar to the non-GBR 5QIs defined in TS 23.501 [7], will be defined in normative phase for broadcast operation.

NOTE 3: The working assumption is that NR PC5 design support the use of V2X 5QIs.

NOTE 4: AS layer may handle unicast, groupcast and broadcast traffic by taking all their priorities, e.g. indicated by VQI, into account.

#### 6.19.1.3 V2X 5QI (VQI) values for PC5 broadcast use

A set of new VQIs for V2X use will be defined in normative phase reflecting the service requirements documented in TS 22.186 [4].

NOTE 1: The working assumption is that non-standardized VQI is not supported in this release.

NOTE 2: Whether per packet or per QoS flow QoS Model is used depends on RAN decision.

### 6.19.2 Procedures

Editor's note: This clause describes procedures to use the new QoS model for PC5 communication. It depends on RAN development as well.

#### 6.19.2.1 QoS support for unicast communication over PC5 interface

##### 6.19.2.1.0 General

To enable QoS support for eV2X one-to-one communication over PC5 interface, the followings procedures need to be supported.

Editor's note: The following procedures may be further updated depending on the progress on PC5 QoS Model.

##### 6.19.2.1.1 QoS parameters provision to UE and NG-RAN

The PC5 QoS parameters and PC5 QoS rule are provisioned to the UE as part of service authorization parameters using the solution defined for Key Issue #5. The PC5 QoS rule is used to map the V2X services (e.g. PSID or ITS-AIDs of the V2X application) to the PC5 QoS flow.

The PC5 QoS parameters retrieved by the PCF from the UDR are provided to the NG-RAN via AMF. The AMF stores such information as part of the UE context. For subsequent procedures (e.g., Service request, Handover), the provision of the PC5 QoS parameters via N2 will follow the description as per clause 6.6.2.

NOTE 1: The UE-PC5-AMBR is provided by the UDM and the details will follow the description as per Solution #6.

The PC5 QoS parameters provisioning to the UE and NG-RAN could be triggered by the UE Policy container included in the NAS message provided by the UE. The PCF sends to the AMF the updated PC5 QoS parameters for NG-RAN when needed.

NOTE 2: The detailed PC5 QoS parameters used by NG-RAN will be identified during the normative work phase.

NOTE 3: NG-RAN is configured with static parameters for network scheduled resources allocation mode to support PC5 QoS.

##### 6.19.2.1.2 QoS parameters negotiation between UEs

The PC5 QoS parameters are negotiated at the establishment of one-to-one communication procedure, so the one-to-one communication establishment procedure defined in TS 23.303 [8] is enhanced to support PC5 QoS parameters negotiation between two UEs. After the PC5 QoS parameters negotiation procedure, the same QoS is used in both directions.



Figure 6.19.2.1.2-1: Establishment of secure layer-2 link over PC5

UEs engaged in one to one communication negotiate PC5 QoS parameters during the link establishment procedure.

1. UE-1 sends a Direct Communication Request message to UE-2 in order to trigger mutual authentication. This message includes the requested PC5 QoS parameters.

2. UE-2 initiates the procedure for mutual authentication. The UE-2 includes the accepted PC5 QoS parameters in the Response message.

NOTE: This procedure is aligned with Solution #11 (clause 6.11).

##### 6.19.2.1.3 QoS handling for eV2X communication

When PC5 unicast is used for the transmission of eV2X messages, the following principles are applied for both network scheduled operation mode and UE autonomous resources selection mode:

- PC5 QoS parameters defined in clause 6.19.1.2 applies to the eV2X communication over PC5.

- The eV2X message is sent on the PC5 QoS flow established using the procedure described in clause 6.19.2.1.2.

- The mapping of application layer eV2X message to PC5 QoS parameters is based on the PC5 QoS rule.

When the network scheduled operation mode is used, following additional principles apply:

- UE provides PC5 QoS parameter information to the gNB for resources request.

- When the gNB receives a request for PC5 resource from a UE, the gNB can authorize the requested PC5 QoS parameter based on the PC5 QoS parameters received from AMF.

- gNB can use the PC5 QoS parameter information for PC5 QoS handling.

When the autonomous resources selection mode is used, following additional principle applies:

- The UE can use the PC5 QoS parameter for PC5 QoS handling based on the provisioned information described in clause 6.19.2.1.1.

#### 6.19.2.2 QoS support for broadcast communication over PC5 interface

When PC5 broadcast is used for the transmission of eV2X messages, the following principles are followed for both network scheduled operation mode and UE autonomous resources selection mode:

- PC5 QoS parameters (e.g. VQI) defined in clause 6.19.1.2 applies to the eV2X communication over PC5.

- The application layer sets the PC5 QoS parameters for each eV2X message when passing it to V2X layer for transmission.

When the network scheduled operation mode is used, following additional principles apply:

- UE provides PC5 QoS information reflecting PC5 QoS parameters to the gNB for resources request.

- gNB can use the PC5 QoS information reflecting PC5 QoS parameters for QoS handling.

When the autonomous resources selection mode is used, following additional principle applies:

- The UE can use the PC5 QoS parameters for PC5 QoS handling.

NOTE: The choice of per packet QoS model or bearer based QoS model for broadcast is based on RAN decisions.

#### 6.19.2.3 QoS support for group communication over PC5 interface

The procedure on QoS support for group communication over PC5 interface is described in clause 6.21.2 (Solution #21).

### 6.19.3 Impact on existing entities and interfaces

Following are the impacts to the UE and other NFs:

- UE needs to support new QoS model for PC5 communication.

- AMF provides NG-RAN with the QoS parameters for PC5 communication fetched from PCF in associating N2 messages for different procedures.

- NG-RAN receives QoS parameters for PC5 communication from AMF and enforces QoS parameter for the network schedule mode.

- UDR stores QoS parameters for PC5 communication.

Editor's note: It is FFS if mapping of PPPP, PPPR to the new VQI would be necessary for broadcast traffic.

### 6.19.4 Topics for further study

Editor's note: This clause describes topics for further study.

### 6.19.5 Conclusions

The solution captured in clauses 6.19.1 to 6.19.3 should move to normative phase.

## 6.20 Solution #20: Authorization Policy for eV2X communication over PC5 interface and NG-Uu interface

### 6.20.1 Functional Description

This solution addresses the aspects of "Policy and parameters provisioned to UE" in Key Issue #5 "Service Authorization and Provisioning to UE for eV2X communications over PC5 reference point", Key Issue #11 "Service Authorization and Provisioning to UE over NG-Uu reference point" and PC5 interworking aspect of Key Issue #12 "System migration and interworking for eV2X" partially.

This solution is based on clause 4.4.1.1.2 of TS 23.285 [5] and applies for the PCF based eV2X architecture in Annex A.1. In the solution, some Authorization Policy parameters are for in coverage and the others are for out of coverage.

Since NR and E-UTRA can both connect to 5GC, a UE can be served by either E-UTRA connected to 5GC or NR, in the perspective of Uu interface. In addition, depending on the operator's deployment and UE's subscription, it is possible that a UE is authorized for only one RAT or both RATs for PC5 in a PLMN.

This solution describes the authorization policy provided to UE, considering the scenario that UE is connected to 5GC.

### 6.20.2 Authorization Policy parameters to UE Connected to 5GC

#### 6.20.2.1 Authorization Policy parameters for PC5 Communication

The following Authorization policy/parameters for eV2X communications over PC5 reference point is provisioned to the UE connected to 5GC:

1) Authorization policy:

- When the UE is "served by E-UTRA" or "served by NR":

- PLMNs in which the UE is authorized to perform eV2X communications over PC5 reference point when "served by E-UTRA" or "served by NR".

For each above PLMN:

- RAT(s) over which the UE is authorized to perform eV2X communications over PC5 reference point.

- When the UE is "not served by E-UTRA" and "not served by NR":

- Indicates whether the UE is authorized to perform eV2X communications over PC5 reference point when "not served by E-UTRA" and "not served by NR".

- RAT(s) over which the UE is authorized to perform eV2X communications over PC5 reference point.

2) Radio parameters when the UE is "not served by E-UTRA" and "not served by NR":

- Includes the radio parameters per PC5 RAT (i.e. LTE PC5, NR PC5) with Geographical Area(s) and an indication of whether they are "operator managed" or "non-operator managed". The UE uses the radio parameters to perform V2X communications over PC5 reference point when "not served by E-UTRA" and "not served by NR" only if the UE can reliably locate itself in the corresponding Geographical Area. Otherwise, the UE is not authorized to transmit.

NOTE 1: The radio parameters are to be defined by RAN WGs. Whether a frequency band is "operator managed" or "non-operator managed" in a given Geographical Area is defined by local regulations.

3) Policy/parameters for PC5 Tx Profile selection:

- The mapping of service types (e.g. PSID or ITS-AIDs) to Tx Profiles.

4) Policy/parameters related to privacy:

- The list of V2X services, e.g. PSID or ITS-AIDs of the V2X applications, with Geographical Area(s) that require privacy support.

5) Policy/parameters when LTE PC5 is selected:

Same as specified in 3) Policy/parameters in clause 4.4.1.1.2 of TS 23.285 [5] except for the mapping of service types to Tx Profiles and the list of V2X services with Geographical Area(s) that require privacy support.

6) Policy/parameters when NR PC5 is selected:

- The mapping of service types (e.g. PSID or ITS-AIDs) to V2X frequencies with Geographical Area(s).

NOTE 2: The V2X frequencies with Geographical Area(s) will be determined by RAN WGs.

Editor's note: Whether Destination Layer-2 ID is part of the Policy/Parameter and how to determine the Destination Layer-2 ID are based on the conclusion of Key Issue #9.

Editor's note: Which QoS parameter(s) is used and how to determine the QoS parameter(s) is based on the conclusion of Key Issue #4.

#### 6.20.2.2 Policy parameters for NG-Uu Communication

The following Authorization policy/parameters for eV2X communications over NG-Uu reference point is provisioned to the UE connected to 5GC:

1) Mapping of the V2X services (e.g. PSID or ITS-AIDs of the V2X application) to:

- PDU Session Type (IP type or Unstructured type);

- SSC Mode;

- S-NSSAI(s);

- DNN(s).

NOTE: Above listed information elements (i.e. PDU Session Type, SSC Mode, S-NSSAI(s) and DNN(s)) are used by UE as UE Local Configuration specified in TS 23.503 [10].

#### 6.20.2.3 Policy parameters for both Uu and NG-Uu Communication

The following parameters for eV2X communications over Uu and NG-Uu reference point is provisioned to the UE connected to 5GC:

1) Mapping of the V2X services (e.g. PSID or ITS-AIDs of the V2X application) to V2X Application Server address information (consisting of IP address/FQDN) for unicast;

2) List of FQDNs or IP addresses of the V2X Application Servers, associated with served geographical area information and list of PLMNs that the configuration applies to;

Editor's note: whether MBMS related information is part of the authorization Policy and parameters has dependency on the conclusion of Key Issue #14.

### 6.20.3 Impact on existing entities and interfaces

UE:

- The UE stores the Authorization Policy and uses this information to decide whether it is authorized to send eV2X message over PC5 via which RAT.

- The UE stores the information to establish PDU sessions over NG-Uu and determine the V2X Application Server address over Uu/NG-Uu.

Editor's note: The impacts on Network Functions are FFS.

### 6.20.4 Topics for further study

Editor's note: This clause describes topics for further study.

### 6.20.5 Conclusions

Editor's note: This clause provides conclusions of the solution.

## 6.21 Solution #21: Group communication enhancement for NR PC5

### 6.21.1 Functional Description

#### 6.21.1.1 General description

This solution addresses Key Issue#1 (clause 5.1) "Support of eV2X Group Communicaiton", Key Issue#4 (clause 5.4) "Support of PC5 QoS framework enhancement for eV2X".

This solution addressed the support of the groupcast operation introduced in NR PC5 at AS layer. The solution follows the general principles established in Solution #1 (clause 6.1) that the group management is peformed by Application Layer; and uses the QoS Model introduced in Solution#19 (clause 6.19).

#### 6.21.1.2 Solution description

This solution follows the below principles when NR PC5 is the selected RAT:

- V2X Layer informs the Access Stratum (AS) Layer of the Destination L2 ID for the group communication transmission, based on group identifier provided by Application Layer;

- V2X Layer informs the Access Stratum (AS) Layer of the Source L2 ID (self-assigned by the UE) for the group communication transmission;

- V2X Layer informs the Access Stratum Layer of the communication type, and QoS parameters (including 5QI) and Range for the group communication traffic;

NOTE 1: Range may also be provided to AS Layer for the dynamic group communication operations, depending on RAN decisions.

- V2X Layer informs the Access Stratum Layer of the Destination L2 ID for the group communication reception;

- When V2X Layer receives no group information from Application Layer, it should then use the default mapping, e.g. derive destination L2 ID and QoS parameters (e.g. VQI) and Range based on PSID/ITS-AID mapping, and use those for the operation;

- V2X Layer coverts the Group Identifier provided by Application Layer into the Destination L2 ID, using a mechanism defined by stage 3.

NOTE 2: Different Destination L2 IDs may be used for different QoS levels.

NOTE 3: Stage 3 needs to standardize the mechanism to be used by both transmitting and receiving UE, e.g. a specific hash function.

### 6.21.2 Procedures

With reference to Figure 6.21.2-1, the operations of the Transmitting UE (Tx UE) and Receiving UE (Rx UE) are presented.



Figure 6.21.2-1: End to end group communication operation

As concluded in Solution #1 (clause 6.1), the group management is carried out in Application Layer, and therefore, the Group Identifier is determined by Application Layer and passed down to the V2X layer.

For the Tx UE side, the V2X Layer converts the Group Identifier into the form of a Destination L2 ID. The Destination L2 ID is passed down from the V2X Layer to the AS layer. The Source L2 ID is self-assigned by the UE and is provided by the V2X Layer to the AS layer.

In addition, from the Application Layer, QoS parameters associated with the group communication, identified by the Group Identifier, is indicated to the V2X Layer via the control interface. The QoS parameters include the characteristics represented by 5QI (as explained in Solution #19), and the Range parameter.

When the Application Layer passes down the data packet that is associated with the Gorup Identifier, the V2X Layer tags the packet with the configured QoS settings (5QI and Range) and passes those down to AS Layer. The V2X Layer also indicates to the AS Layer that it is for group communication, in order to differentiate it from broadcast traffic.

At the Rx UE side, the V2X Layer also passes the Destination L2 ID converted from the Group Identifier to the AS Layer, such that it would be able to manage the receiving operation, e.g. performing HARQ.

NOTE 1: The mechanism to convert the Group Identifier to L2 ID is defined by stage 3.

For the data traffic from the Application Layer without the Group Identifier associated, V2X Layer treats them with legacy operation, i.e. using default PSID/ITS-AID mapping to determine destination L2 ID and QoS parameters (e.g. VQI) and Range.

When PC5 group communication is used for the transmission of eV2X messages, the following principles are followed for both network scheduled operation mode and UE autonomous resources selection mode:

- PC5 QoS parameters (e.g. VQI) and Range defined in clause 6.19.1.2 apply to the eV2X group communication over PC5.

- When the Application Layer passes down the data packet that is associated with the Gorup Identifier, the application layer sets the PC5 QoS parameters and Range for each Group Identifier when passing eV2X messages to V2X layer for transmission.

- For the data traffic from the Application Layer without the Group Identifier associated, the V2X layer sets the PC5 QoS parameters based on the default mapping between PSID/ITS-AID and PC5 QoS parameters and Range, and then passing it to AS layer for transmission.

NOTE 2: The details on default mapping between PSID/ITS-AID and PC5 QoS parameters and Range if needed is to be specified in the normative work.

When the network scheduled operation mode is used, following additional principles apply:

- UE provides PC5 QoS information reflecting PC5 QoS parameters to the gNB for resources request.

- gNB can use the PC5 QoS information reflecting PC5 QoS parameters for QoS handling.

When the autonomous resources selection mode is used, following additional principle applies:

- The UE can use the PC5 QoS parameters for PC5 QoS handling.

NOTE 3: The choice of per packet QoS model or bearer based QoS model for group communication is based on RAN decisions.

### 6.21.3 Impact on existing entities and interfaces

Following are the impacts to the UE:

- Enhanced interactions among different layers in the UE regarding the group communication identification and QoS requirements.

NOTE: The mechanism to convert the Group Identifier provided by upper layer to destination L2 ID is defined by stage 3.

### 6.21.4 Topics for further study

None.

### 6.21.5 Conclusions

Solution documented in clauses 6.21.1 to 6.21.3 addressed the Key Issue #1 (Support of eV2X Group Communication) and should be used as the baseline for normative phase work.

## 6.22 Solution #22: Authorization for NR based PC5 communication when the UE is served by EPS

### 6.22.1 Functional Description

#### 6.22.1.1 General Description

The solution applies to Key Issue#13

This solution allows the network operator to control the transmission of V2X messages over PC5 over NR or LTE in network scheduled mode of operation.

The following are proposed:

- The UE includes its enhanced V2X capability as an additional parameter within the "UE Network Capability" in the Attach Request message

- The MME based on subscription information provides information to the RAN node whether the UE is authorized for V2X communication over NR and/or LTE PC5

- The UE when attached in EPS uses the same V2X configuration information received by the same PLMN (over 5GS) to determine whether a V2X message needs to be sent over NR based PC5 or LTE based PC5.

Editor's Note: This solution has RAN dependency and is based on the assumption that an eNB is able to schedule resources for V2X message transmission over PC5 over both LTE and NR

### 6.22.2 Procedures

#### 6.22.2.1 UE indicates its NR PC5 capability to the EPS network

For Rel. 14 V2X, the UE includes its V2X capability within the "UE Network Capability" information in the Attach Request message.

In order to allow an EPS operator to control authorization of transmission over NR and/or LTE PC5, a Rel.16 UE includes its "enhanced V2X" capability as additional capability within the "UE Network Capability" information.

#### 6.22.2.2 Authorization for sending V2X message over PC5 using NR RAT

The MME currently provides a "V2X services authorized" indication within the S1-AP Initial Context Setup Request indicating that the UE is authorized for V2X communication over PC5 (as Vehicle UE, Pedestrian UE or both).

An additional indication is needed to indicate to the RAN that the UE is authorized to for "eV2X communication over PC5". The RAN node uses this information to perform resource managements for V2X communication over NR/LTE PC5 in network scheduled mode.

The MME also requires to include the allowed AMBR for PC5 transmission (UE-PC5-AMBR) that is used by the RAN node in network scheduled mode. It is proposed to use the same parameter for managing resources to allow the RAN node to determine the maximum allowed AMBR for both NR and LTE transmissions over PC5.

#### 6.22.2.3 Provisioning of V2X configuration for NR based PC5 communication.

There are already solutions specified where the UE receives V2X Configuration assisting the UE to perform PC5 RAT selection based on the requested V2X service (for example see Solution #12).

The Rel 16 UE uses the V2X configuration information received from the V2X Control Function of the 5GS network to decide whether a V2X message over PC5 should be sent via an LTE or NR RAT when camping on an EPS network. Such UE does not contact the V2X Control Function in the EPS network to receive V2X configuration information.

### 6.22.3 Impact on existing entities and interfaces

UE

- Provide an additional indication within the UE Network Capability information element of the Initial Attach/TAU message that enhanced V2X is supported

MME

- Provide an additional indication to the RAN node that the UE is authorized for V2X transmissions over NR PC5.

HSS

- Provide an additional indication to the MME whether a UE is authorized for V2X transmission over NR PC5

eNB

- Receiving an indication from the MME that the UE is authorized for V2X transmission over NR PC5

- Support scheduling resources for V2X messages over NR PC5

### 6.22.4 Topics for further study

Editor's note: This clause describes topics for further study.

### 6.22.5 Conclusions

Editor's note: This clause provides conclusions of the solution.

## 6.23 Solution #23: Early notification for Dynamic Application Adjustment

### 6.23.1 Functional Description

This solution addresses Key Issue #15 (Enhancements to assist Application Adjustment) by enabling the 5GS to send early notifications about potential change in QoS to AF for the expected position(s) of the UE in the future, allowing timely dynamic application adjustments, e.g. changes of Level of Automation.

The solution includes four phases:

1. Request for notification or subscription to notification(s) about potential change in QoS: during this phase, the 5GS receives from the AF the configuration parameters needed to define the QoS KPIs of interests, the geographical location, the timing, and the triggering conditions for the notification about potential change in QoS.

NOTE 1: The request can come from the UE, but in that case it goes via the AF.

2. QoS KPIs, external context and UE expected position(s) information collection: during this phase, the 5GS identifies the 5GS coordinates of the expected UE position(s) and collects the corresponding statistics information on the QoS KPIs of interests, possibly enriched by external context information and to be filtered according to UE current context information.

3. Decision about notification about potential change in QoS: during this phase, according to the configuration as per phase#1 and upon info collected as per phase#2, the 5GS verifies whether the triggering conditions for the notification about potential change in QoS are met and if so, the AF receives one or more notifications about potential change in QoS.

NOTE 2: AF may forward the notification(s) to the UE.

4. V2X application adjustment. Upon being notified about a potential change in QoS, the eV2X application may be adjusted at the AF, e.g. changing the Level of Automation.

### 6.23.2 Procedures



Figure 6.23.2-1: Enhancements for Early QoS Potential Change Notification

0.a: The NWDAF collects from, e.g., OAM system the 5GS QoS KPIs information relevant for the notification about potential change (e.g., Average UL/DL Throughput per UE, DRB Accessibility, etc.).

0.b: The NWDAF may collect from the 3rd party AF (i.e. non related to the 3GPP system) context information (e.g. weather condition statistics) to be correlated with 5GS QoS KPIs. The external context information is mapped to 5GS coordinates (e.g. to cell IDs) and correlated with the QoS KPIs information.

NOTE 0: Whether new Event ID needs to be defined to collect external context information from the 3rd party AF and which NF (NWDAF or NEF) maps the external context information into the 3GPP related information can be discussed at normative phase.

NOTE 1: Steps 0.a and 0.b may be repeated whenever updated QoS KPIs and/or external context information is available.

1: The PCF receives from the AF (via NEF) a request for notification or subscription to notification(s) about potential change in QoS containing information on:

- expected future UE positions (geographic location and time). The PCF receives this information from AF (via NEF) as part of the requestsubscription for notification;

- the QoS KPIs of interest;

- the threshold(s) of interest (per QoS KPI).

NOTE 2: If the PCF receives the request from the AF (via NEF), the PCF is the SM Policy PCF.

NOTE 3: This solution assumes that the user consents to provide such information to the AF or 5GS for services requiring network notification about potential QoS changes.

NOTE 4: Relevant QoS KPIs may depend upon the eV2X Application considered. Definition of the QoS KPIs for the notification about potential change is left to normative phase.

NOTE 5: Solutions to protect the user privacy (e.g. anonymization) can be considered at normative phase.

2: The PCF, assisted by the NEF, maps information on expected future UE positions retrieved by AF onto 5GS coordinates (e.g. cell ID), to allow a mapping between collected QoS KPIs information and the expected future UE positions.

3: The PCF interacts with the NWDAF to retrieve the QoS statistics. For the 5QI of the service, the QoS KPI statistics for the relevant cells and time intervals are selected. More details are provided in clause 6.23.2A.

4: The PCF determines if the eV2X application has to be notified about a potential change in QoS. The decision is determined upon the following input:

- current and expected future UE positions, identified as per step 2;

- statistics of QoS KPIs information, as per step 3;

- QoS KPIs and threshold(s) of interest received from AF as per step 1.

The PCF checks whether the statistics of QoS KPIs information in any cell identified in step 2 is below any of the threshold(s) provided by the AF for the time the UE is expected to be in the cell. For every cell identified in step 2, the lowest threshold that is crossed is relevant for the per-UE notification to the AF.

5: The PCF sends one or more notifications to the AF informing about the outcome of step 4, i.e. the threshold(s) crossed and the time when the potential change(s) in QoS may happen or that no threshold is crossed.

6: eV2X application adjustment may take place at AF upon reception of the notification about potential change in QoS.

### 6.23.2A Details of analytics retrieval from the NWDAF

#### 6.23.2A.1 Input Data

Table 6.23.2A.1-1: Input information

|  |  |  |
| --- | --- | --- |
| Information | Source | Description |
| Cell ID(s) | PCF/NEF | Cell(s) for which the information is needed |
| Time interval(s) | PCF/NEF | Time interval(s) for which the information is needed. |
| 5QI(s) | PCF | 5QI(s) for which the information is needed. |

#### 6.23.2A.2 Output Analytics

Table 6.23.2A.2-1 shows the minimum set of analytic IDs by the NWDAF to retrieve information from the OAM.

Table 6.23.2A.2-1: Output information

| Analytic ID | Analytic Filter | Description |
| --- | --- | --- |
| Per 5QI UE non-GBR average bitrate | Time,  Date,  Cell ID(s) | Average UE bitrate in the cell for the indicated time for the requested 5QI. |
| Per 5QI GBR average failure rate | Time,  Date,  Cell ID(s) | Average failure rate in the cell for the indicated time for the requested 5QI. |

### 6.23.3 Impact on existing entities

NWDAF:

- Provides "per cell" 5GS QoS KPIs analytics per 5QI collected from OAM;

- Collects from 3rd party AF (i.e. non related to the 3GPP system) external context information to be correlated with 5GS QoS KPIs.

- If the QoS KPI statistics have to be exposed as analytics: Define the parameter values of analytics request (an Analytics ID associated to per-5QI per-cell UE non-GBR average bitrate and to per-5QI per-cell GBR average failure rate).

NOTE: According to the eNA defined framework, the NWDAF is already capable of retrieving from the OAM system the QoS KPI statistics for the relevant cells and time intervals.

PCF:

- Decides about potential change in QoS based on inputs such as:

- configuration parameters provided by AF;

- 5QI (and perhaps GBR) authorized for the V2X service;

- location information provided by AF;

- "per cell" 5GS QoS KPIs information for the 5QI provided by NWDAF.

- Notifies potential change in QoS to AF.

AF:

- Requests the PCF to notify about potential changes in QoS.

NEF:

- Assists to the PCF for expected UE position mapping.

### 6.23.4 Evaluation

This solution fulfils the requirements as per Key Issue#15 (Enhancements to assist application adjustments for eV2X services, according to notifications about potential change in the delivered QoS). It defines 5GS enhancements to provide early per-UE notifications about potential change in the delivered QoS, necessary to assist application adjustments for eV2X services.

### 6.23.5 Conclusions

Editor's note: Conclusions are FFS.

## 6.24 Solution #24: Solution for AF-initiated UE provisioning

### 6.24.1 Functional Description

#### 6.24.1.1 General Description

This solution addresses the Key Issue #5 and Key Issue #11. This solution applies to the CP-based architecture alternative#4 in Annex A.

Figure 6.24.1.1-1 shows V2X architecture reference model in the perspective of UE provisioning. This solution proposes NEF service to enable communication between NFs in the PLMN and V2X Application Server (i.e. Application Function). The V2X Application Server can provide V2X service parameters to the PLMN via NEF. The NEF stores the V2X service parameters in the UDR. The UDR is considered as V2X repository.



Figure 6.24.1.1-1: V2X architecture reference model for AF-initiated service parameter provisioning

#### 6.24.1.2 AF-initiated Service Parameter provisioning

An AF may send requests to provision V2X service parameters. The network stores the service parameters in the V2X repository (UDR) and delivers it to the UE when the UE is reachable.

The AF may issue requests on behalf of applications not owned by the PLMN serving the UE.

The AF requests are sent to the NEF, as described in clause 6.24.1.3. PCF delivers the V2X service parameters provided by the AF to the UE as described in clause 6.24.2.

NOTE 1: In the case of architecture without CAPIF support, the AF is locally configured with the API termination points for the service. In case of architecture with CAPIF support, the AF obtains the service API information from the CAPIF core function via the Availability of service APIs event notification or Service Discover Response as specified in TS 23.222 [21].

NOTE 2: The AF can also provision the UE with the V2X service parameters via V1 directly as described in clause 4.1.1.

The AF request contains the information as below:

- Service Description,

- Service Parameters,

- Target UE(s) or a group of UEs.

Service Description identifies a service the Service Parameters are applied to. Service Parameters are the service specific information which needs to be provisioned in the Network and in the UE in order to support the service identified by the Service Description. Target UE(s) or a group of UEs indicate the UE(s) who the Provisioning information shall be delivered to.

In case of V2X service, the Service Description indicates V2X service (e.g. V2X S-NSSAI and/or DNN). The Service Parameters includes policy/provisioning parameters for V2X communication over Uu and PC5 (e.g. the mapping of V2X services to V2X Application Server address information for unicast, the list of V2X services that require privacy support, etc.).

NOTE 3: The set of V2X service policy/provisioning parameters is discussed in other solutions (e.g. Solution  #20). The V2X service parameters provided from the V2X AS depends on the conclusion of those solutions.

#### 6.24.1.3 NEF service for Service Parameter provisioning

##### 6.24.1.3.1 General

The following table shows the NEF service and service operation for service parameter provisioning:

Table 6.24.1.3.1-1: NF Service provided by the NEF

|  |  |  |  |
| --- | --- | --- | --- |
| Service Name | Service Operations | Operation Semantics | Example Consumer(s) |
| Nnef\_ServiceParameter | Create | Request/Response | AF |
| Update | Request/Response | AF |
| Delete | Request/Response | AF |

##### 6.24.1.3.2 Nnef\_ServiceParameter\_Create operation

**Service operation name:** Nnef\_ServiceParameter\_Create

**Description:** Authorize the request and forward the request to create service parameter provisioning.

##### 6.24.1.3.3 Nnef\_ServiceParameter\_Update operation

**Service operation name:** Nnef\_ServiceParameter\_Update

**Description:** Authorize the request and forward the request to update service parameter provisioning.

##### 6.24.1.3.4 Nnef\_ServiceParameter\_Delete operation

**Service operation name:** Nnef\_ServiceParameter\_Delete

**Description:** Authorize the request and forward the request to delete service parameter provisioning.

#### 6.24.1.4 V2X service parameter delivery

The PCF delivers the V2X service parameters to the UE as described in clause 4.2.4.3 of TS 23.502 [9]. If the UE is not reachable the AMF informs the PCF of UE Policy delivery failure. The PCF may subscribe UE reachability event to the AMF in order to be notified when the UE becomes reachable and deliver the V2X service parameters to the UE.

The PCF may subscribe the "Connectivity state changes (IDLE or CONNECTED)" event as defined in TS 23.502 [9] clause 5.2.2.3 when the PCF is notified UE Policy delivery failure.

### 6.24.2 Procedures

Figure 6.24.2-1 shows procedure for AF-initiated service parameter provisioning. The V2X Application Server (i.e. AF) uses Nnef\_ServiceParameter service to provide the V2X service parameters to the PLMN and the UE.



Figure 6.24.2-1: AF-initiated service parameter provisioning

1. To create a new request, the AF invokes an Nnef\_ServiceParameter\_Create service operation. The content of this service operation (AF request) includes the information described in clause 6.24.1.2.

To update or remove an existing request, the AF invokes an Nnef\_ServiceParameter\_Update or Nnef\_ServiceParameter\_Delete service operation.

2. The AF sends its request to the NEF.

3. (in the case of Nnef\_ServiceParameter\_Create or Update): The NEF stores the AF request information in the UDR.

(in the case of Nnef\_ServiceParameter \_delete): The NEF deletes the AF request information in the UDR.

4. The NEF responds to the AF.

If the UE is registered to the network and the PCF performs the subscription to notification to the data modified in the UDR by invoking Nudr\_DM\_Subscribe (AF service parameter provisioning information, SUPI) at step 0, the following steps are performed:

5. The PCF(s) receive(s) a Nudr\_DM\_Notify notification of data change from the UDR.

6. The PCF initiates UE Policy delivery as specified in clause 4.2.4.3 "UE Configuration Update procedure for transparent UE Policy delivery" of TS 23.502 [9] and in clause 6.24.1.4.

### 6.24.3 Impact on existing entities and interfaces

NEF:

- Interacts with AF by using a newly defined NEF service, Nnef\_ServiceParameter.

UDR:

- Stores V2X service parameters.

PCF:

- Handles V2X service parameters.

### 6.24.4 Topics for further study

None.

### 6.24.5 Conclusions

Nnef\_ChargeableParty and Nnef\_AFsessionWithQoS in clause 4.15.6 of TS 23.502 [9] are not needed for the purpose of V2X service parameters provisioning. Nnef\_ParameterProvision procedure in clause 4.15.6 of TS 23.502 [9] looks largely similar to the Nnef\_ServiceParameter procedure proposed in the Solution #24. However, there are some differences in terms of parameters included in the AF request message and the NF operations. Therefore, the existing NEF services cannot be reused and the new Nnef\_ServiceParameter is needed.

For Key Issue #5 and Key Issue #11, it is concluded that Solution #24 is selected for normative work.

## 6.25 Solution #25: Solution for Key Issue #13

### 6.25.1 Functional Description

When the UE connects to EPC, it needs to indicate its V2X capability for PC5 communication with the corresponding PC5 RAT information (i.e. LTE PC5, NR PC5) as part of the "UE Network Capability" in the Attach Request and Tracking Area Update Request messages. When the MME receives the V2X capability indication, it needs to check with the received subscription information from HSS and determine whether the UE is authorized to use V2X service operation for PC5 with the corresponding RAT. The MME stores this information for the V2X operation and sends the "V2X service authorized" along with NR PC5 RAT and UE-AMBR for NR PC5 additionally to eNB structured as following:

- V2X service authorized;

- UE-PC5-AMBR for LTE PC5;

- UE-PC5-AMBR for NR PC5.

NOTE 1: The additional parameter for NR PC5 should not impact the stage 3 structure of the V2X service authorization information.

The corresponding RAT information needs to be part of V2X operation authorization information and transferred from source eNB to target eNB in S1-AP/X2-AP Handover Request message during handover procedure and from MME to eNB in initial S1-AP message during Attach, TAU and Service Request procedures.

When the UE is in EPS and it does not have valid V2X policy/parameters, the UE requests the V2X policy/parameters from V2X CF as defined in TS 23.285 [5]. For the policy/parameters defined in clause 4.4.1.1.2 of TS 23.285 [5], the corresponding V2X Policy/parameters to support NR PC5 communication is needed. As such, once the UE has selected the PC5 RAT based on the solution for Key Issue #2, it will use the policy/parameters for the selected PC5 RAT.

NOTE 2: The detailed V2X policy/parameters for PC5 communication delivered to UE via User Plane approach in EPS can be identified once the detailed policy/parameters is defined for 5GS.

Editor's Note: This solution has RAN dependency and is based on the assumption that an eNB is able to schedule resources for V2X message transmission over PC5 over both LTE and NR.

### 6.25.2 Impacts on existing entities and interfaces

UE:

- It needs to indicate its V2X capability indication with the corresponding PC5 RAT information (i.e. LTE PC5, NR PC5) as part of the "UE Network Capability" in the Attach Request and Tracking Area Update Request message.

- It needs to understand and store the policy/parameters defined in clause 4.4.1.1.2 of TS 23.285 [5] with a corresponding PC5 RAT information (i.e. LTE, NR).

MME:

- It needs to send following additional V2X service authorization information to eNB in initial S1-AP message:

- UE-PC5-AMBR for NR PC5.

eNB:

- It needs to store the V2X service authorization information with the corresponding PC5 RAT information and the according UE-PC5-AMBR for the PC5 RAT(s);

- It needs to send following additional V2X service authorization information to target eNB in S1-AP/X2-AP Handover Request message during handover procedure:

- UE-PC5-AMBR for NR PC5.

V2X CF:

- For the policy/parameters defined in clause 4.4.1.1.2 of TS 23.285 [5], the corresponding V2X Policy/parameters to support NR PC5 communication is needed.

### 6.25.3 Conclusions

For Key Issue #13, it is concluded to take Solution #25 for normative work.

## 6.26 Solution #26: Path-based QoS booking for Application Adjustment

### 6.26.1 Functional Description

This is a proposal to resolve the Key Issue #15: Enhancements to assist Application Adjustment.

This solution assumes there is a need by V2X AS and the Application in the UE to know in advance of the UE moving to a certain area whether in that area it is likely or not, or whether it is assured or not, that a certain QoS level can be sustained. This provides a high degree of confidence a certain QoS level can be met, but not a 100% guarantee as the wireless link can be subject to local issues that are not predictable. If there is no guarantee, or a guarantee of a low level of QoS or a low assurance, the Application layer adapts. Optionally, the PLMN may indicate the degree of confidence also of its assessment.

The solution allows different degrees of inspection of network resources. If there is a high degree of confidence that in certain areas there will be sufficient resources based on centralised information, it is not necessary to retrieve information from the affected RAN nodes. If, however the centralised status information is not providing such confidence, the retrieval of information from affected RAN nodes is also enabled.

Eventually, if the application layer requires firm commitments, the PLMN provides a booked resource token which the application can provide the UE so the UE can request the QoS when it comes to the desired node. The UE context contains the token so it releases the prebooked resources with matching token when the UE moves to the next RAN node. Otherwise the token will stop being valid on its own outside the validity time window.

The basic principles of this solution are the following:

1) The UE, while determining a path for the vehicle, it would invoke the assistance of the V2X application layer to request the network to perform a booking of resources (i.e. logging of future demand on network resources within a specific time window in affected RAN nodes - note: this is not static reservation from the time the response is given for a UE) along the path or sections of the path option selected by the UE. The network then provides the V2X app with a confirmation the required resources are expected to be available. The request may be for multiple levels of QoS in one time if the application could operate at multiple QoS levels. If multiple request levels are tested the availability of each is specified in the confirmation to the UE.

2) The booking is based on estimate of the arrival time in a coverage area. The PLMN may also include assessment of whether coverage is likely to be poor or not available along the path.

3) If the PLMN provides feedback that the required QoS is not available, the application may adapt based on this along the path.

4) Once the application accepts a level or levels of made available QoS by the network along the path, the UE and network commit with one another and the UE and/or the V2X app may get a token to access the committed/booked resources along the path (e.g. the token, like a booking number, is provided at service request by the UE in both NAS and RRC layers or passed in the UE context).

5) The network will manage QoS allocation in the system, so resources committed are made available when the UE arrives at the expected location.

6) The resources booking and time window may be updated based on the UE updating the V2X app and the V2X app updating the system on the UE progress along the path, and varying network conditions.

7) The network, with a sufficiently large lead time, may at any warn the vehicle some committed resources may not be any longer available if this becomes strictly necessary, so the UE may trigger corrective actions if needed (e.g. negotiate a lower QoS and/or change path). If this update happens the Ue may accept committing to the new proposed QoS along the path. Note the update may also include improvements of available QoS, not only worsening conditions.

8) The UE passes the token to the PLMN when a PDU session is supposed to access the resources that have been booked. The PLMN verifies the UE is authorised to use the token for the PDU session by interacting with the V2X AS (Application Server). The V2X AS keeps a mapping between the GPSI and the token at application layer.

9) The UE in the RAN includes the token so the resources matching with the token are released in the pool of available resources once the UE has moved to the next RAN node.

The information exchanged by UE and V2X app may be discussed but can be largely out of the scope of 3GPP. The V2X app though shall pass to the network time windows and path information and QoS levels required and updates thereof. The network provides to the V2X application and the UE (perhaps mediated by the application) a token to enable access to the resources. The token is stored in the UE context in the RAN and in the CN.

Tokens have a validity time and need to be renewed before they expire so the UE and application need to maintain tokens before the expiration time i.e. if the UE does not arrive at a time that was expected the UE has to update the network, so the network can create new state state/assessment of QoS availability.

### 6.26.2 Procedures

#### 6.26.2.1 V2X application Requested Booking



Figure 6.26.2.1-1: Outline of the application driven path resources booking procedure

1. The UE and V2X app have exchanged information on path, path start time, QoS requirements. This may also be due to a continuous update (e.g. after a previous booking path or timeline has changed).

2. The CN receives a Booking request including a path descriptor (i.e. a suitable way to represent the path and the time the Ue is at certain locations), Qos level(s) required

3. The CN proceeds to a tentative booking of resources along the path. See clause 6.26.2.3 for more details.

4. The CN provides the V2X AS with the outcome of booking request as an offer. This may include no offer of QoS.

5. The V2X app provides the outcome to the UE at application layer as an offer. This may include no offer of QoS. If the UE receives no offer, then the UE assumes no suitable QoS level is available along the path and adapts any application that requires the level of QoS that was requested to assume none is available. Otherwise it selects the desired offered QoS level and proceeds to accept one level of QoS.

6. The UE accepts a level of QoS along the path.

7. The V2X application accepts a level of QoS along the path and provides this acceptance to the CN.

8. The CN and RAN nodes commit to the desired QoS level and a token is assigned with a specific lifetime. This is stored in the RAN nodes along the path. See clause 6.26.2.3.

9. The CN commits the QoS along the path and provide the token to the V2X AS.

10. The V2X AS passes the token to the UE.

#### 6.26.2.2 Network Initiated Booking Update



Figure 6.26.2.2-1: Outline of the application driven path resources booking procedure

1. The system determines a change to an existing booking is needed or possible. This may be triggered by NDWAF which then drives a booking step as in clause 6.26.2.3.

2. The CN provides an update to a booking with an existing TOKEN as a reference.

3. The V2X AS provides the update to the UE.

4. The UE chooses the QoS level it requires and accepts it

5. The V2X AS accepts towards the CN.

6. The CN and RAN nodes involved commit the booking and potentially issue a new validity time for the booking, using steps 10-13 as in clause 6.26.2.3.

7. The CN commits the booking.

8. The V2X AS provides the token with validity time to the UE indicating it is committed.

#### 6.26.2.3 Details of system interactions for resources booking

This clause provides details of the system functions interactions of the steps described above.



Figure 6.26.2.3-1: System details of the resources booking procedure

1. The V2X AS requests certain QoS Level(s) over a certain path (e.g. identified by coordinates and the time and a time window over which a certain QoS level or levels are requested to be provided at each coordinate in the path). The granularity of path description and the way to describe the path is a SLA based parameter and outside the scope of this solution. The path length can be chosen to fit the needs of the specific application and it should be sufficient for safe operation within a certain time window (i.e. it needs not be end-to-end path the UE needs to reach the final destination, which may be quite extensive).

2. The NEF relays the request to NWDAF which determines a list of cell IDs and related TAIs that support the path. The NWDAF performs a preliminary assessment of the availability of resources that may be based on a centralized view of the status of the RAN along the path. The NWDAF may also assess whether there is high likelihood QoS cannot be guaranteed (e.g the NWDAF knows there is patchy coverage along the path)

3. The NDWAF provides the NEF with a list of cell IDs and TAIs and the QoS level(s) that it estimates could be available.

If none is available the NEF immediately ends the transaction by reporting at step 8 that non QoS is offered.

If there is at NWDAF high confidence level the QoS is available, the NWDAF reports that to NEF and the steps 4-7 are skipped and the procedures continues from step 8.

Otherwise steps 4-7 are executed.

4-7. The NEF distributes a booking request with a token to identify the request to AMF(s) that are capable to reach the relevant cell IDs that map to the received coordinates. Note this does not assume that these will become serving AMFs, i.e. these AMFs will not keep state for the UE/token. The AMF(s) then relays the booking request to relevant NG-RAN nodes to determine whether the desired QoS level is available. If so, each RAN node provides a response with indication of which QoS level(s) can be offered to the AMF and the AMF responds to the NEF that summarises the outcome for the V2X AS. The RAN nodes, if steps 4-7 are executed, keep the resources booked for the relevant time window for a time bounded by a guard timer that implies a commit is received from the AMF. If no commit is received the booking is released.

8-14. The V2X AS accepts a certain QoS level. The NEF passes on the acceptance to the affected RAN nodes.

The NEF subscribes with NWDAF to obtain information whether a certain QoS level is likely to be available. This may trigger the NEF to attempt a booking executing steps 4-7 or by directly going step 8 to offer a new QoS level. The AMF also reports to NEF any notification control the RAN may provide to update on the booking status (e.g. the notification control is augmented to report about likelihood existing bookings can no longer be fulfilled or some dedicated procedure TBD). This may trigger a new transaction to provide a new offered QoS.

#### 6.26.2.4 Impact on other procedures

The UE shall include the booking token in a service request at both AS and NAS layers. This is checked against the UE context for validation when received from CN in the RAN. This booking token is sufficient to indicate the reserved resources in the system.

The booking token is included in the UE context in the AS and NAS layer contexts to identify the tokens the UE is authorised to use. The Authorisation is given by the PCF as described in bullet 8 in clause 6.26.1. The UE provides the token when a QoS flow is established to access the booked resources and the authorisation of the token is recorded by the AMF when it executes these services:

- Nsmf\_PDUSession\_CreateSMContext

- Nsmf\_PDUSession\_UpdateSMContext

Other subscription services can also be used to get notifications of revocations or update of validity of tokens from NEF (details would be part of normative work)

### 6.26.3 Impact on existing entities and interfaces

This solution impacts the:

NEF: handling of the V2X AS interaction

NWDAF: handling of QoS evaluations on a path and resolution of path to cell IDs

AMF: interaction with SMF, NEF and the NG-RAN for token management

PCF: handling of tokens

NG-RAN: handling of booking and update of status with NWDAF with status of resources allocated to V2X. Handling of tokens

V2X AS: handling of tokens and QoS bookings along the path, mutual updates between V2X AS and UE side of the applications.

UE: support of the feature as documented above (token handling, Application layer interactions).

### 6.26.4 Topics for further study

Editor's note: This clause describes topics for further study.

### 6.26.5 Conclusions

TBD

## 6.27 Solution #27: Solution for QoS Support for eV2X over Uu Interface

### 6.27.1 Functional Description

This solution addresses Key Issue #3 (QoS Support for eV2X over Uu interface) and it **reuses** the 5GS QoS model specified in TS 23.501 [7] and TS 23.503 [10] with necessary enhancement as follows.

1. An eV2X Application Function (AF) influences the QoS of the eV2X service, by providing service info to the PCF (via NEF if 3rd party AF) as specified in TS 23.503 [10] (and TS 23.203 [12]).

In addition, when supported by the AF and PCF/NEF, the AF may indicate multiple ***Alternative Service Requirement(s)*** in addition to the ***Requested Service Requirement*** in the service info.

The ***Alternative Service Requirement(s)*** is of the same format as the ***Requested Service Requirement*** that an AF normally requests, e.g. instead of providing one set of bandwidth requirements, the AF provides additionally set(s) of bandwidth requirements, marked as the ***Alternative Service Requirement(s)*** in the request.

In addition, the AF may indicate that the PCF is responsible for changes in the QoS profile of the QoS Flow from the ***Requested Service Requirement*** to one of the ***Alternative Service Requirement(s)***.

NOTE 1: The AF can indicate that the PCF is responsible for changes in the QoS profile only if the changes do not affect the required bitrate. This ensures that the change in the bitrate requirements is always triggered by the AF and it can therefore always be aligned with rate adaptation of the data flow.

2. PCF authorize the service info from the AF, translates it into PCC rule with QoS parameters such as 5QI, ARP, GBR/MBR, and optionally PL(Priority Level) and notification control and then sends the PCC rule to the SMF.

If notification control is enabled, the PCF may include ***Alternative QoS parameter set(s)*** in the PCC rule sent to the SMF. The PCF derives the ***Alternative QoS parameter set(s)*** based on the ***Alternative Service Requirement(s)*** provided by the AF.

The ***Alternative QoS parameter set(s)*** is of the same format as the QoS parameter set included in the existing PCC rules.

3. The SMF performs QoS Flow binding and creates a new QoS Flow if no existing QoS Flow can fulfil the service requirement. The SMF also derives the QoS rules and QoS Flow level parameters to the UE, as well as QoS profile to the NG-RAN.

If notification control is enabled, the SMF may derive ***Alternative QoS profile(s)*** based on the ***Alternative QoS parameter set(s),*** and send to the NG-RAN.

The ***Alternative QoS profile(s)*** takes the same format as the QoS Profile, i.e. SMF sends multiple sets of QoS Profiles as defined in TS 23.501 [7] to the NG-RAN, which are marked as "Alternative" except one that serves as the target QoS Profile.

4. The NG-RAN receives a N2 PDU Session Request for the purpose of QoS flow establishment which contains the QoS profile in N2 SM Information. Per TS 23.501 [7], in the QoS profile,

- The GFBR is recommended as the lowest acceptable service bitrate where the service will survive, and MFBR>GFBR can be provided to the RAN. The bit rates above the GFBR value and up to the MFBR value may be provided with relative priority determined by the Priority level of the QoS Flows.

- The PDB for GBR QoS Flows with GBR resource type shall be interpreted as a maximum delay with a confidence level of 98 percent if the QoS flow is not exceeding the GFBR. The PDB for delay critical GBR resource type may be exceeded for at most PER packets, that is, a packet delayed more than PDB is counted as lost if the transmitted data burst is less than MDBV within the period of PDB and the QoS Flow is not exceeding the GFBR.

- The Packet Error Rate (PER) defines an upper bound for the rate of PDUs (e.g. IP packets) that have been processed by the sender of a link layer protocol but that are not successfully delivered by the corresponding receiver to the upper layer, i.e. the PER defines an upper bound for a rate of non-congestion related packet losses. For GBR QoS Flows with Delay critical GBR resource type, a packet which is delayed more than PDB is counted as lost, and included in the PER unless the data burst is exceeding the MDBV within the period of PDB or the QoS Flow is exceeding the GFBR.

If the NG-RAN supports the feature, NG-RAN will also store the ***Alternative QoS profile(s)***.

5. If the NG-RAN cannot fulfil the GFBR requirement, and/or the PDB requirement and/or the PER requirement of the QoS profile, it notifies the 5GC using the procedure as specified in clause 5.7.2.4 of TS 23.501 [7] and then to the AF (i.e. V2X application).

NOTE 2: A non-GBR Flow may use the bit rate up to the value of the session AMBR which can be very high, and consequently the non-GBR QoS Flow may take unreasonably large amount of resources and starve resource for other flows, therefore it's considered unrealistic to apply Notification Control for the non-GBR QoS Flow unless a bit rate parameter is also introduced for non-GBR Flow which means a major change to the QoS model.

If the ***Alternative QoS profile(s)*** were received, in addition to the notification to the 5GC and ton the V2X application that the QoS targets cannot be fulfilled, the NG-RAN, when supporting the feature, checks if any of the ***Alternative QoS Profile(s)*** could be supported***.*** If the NG-RAN can support one of the ***Alternative QoS Profile(s),*** the NG-RAN may include its associated index in the notification, so that the 5GC and V2X application can take this information into account.

If none of the ***Alternative QoS profile(s)*** is applicable, the NG-RAN may provide the information about what QoS characteristics cannot be fulfilled, including the current 'QoS requirements that are guaranteed' (GFBR, PDB and/or PER), using the procedure as specified in clause 5.7.2.4 of TS 23.501 [7] and then to the AF if notification is required so that the V2X application can take this information into account and take proper action.

NG-RAN still tries to fulfil the original QoS target after sending the notification.

When radio condition changes, and the requirement of GFBR, PDB and PER of the QoS profile can be fulfilled again, the NG-RAN notifies the 5GC using the procedure as specified in clause 5.7.2.4 of TS 23.501 [7] and then to the AF (i.e. V2X application). The V2X Application then takes proper action based on information provided by the 3GPP system and other sources if available.

NOTE 3: The format for the indication of ***Alternative QoS Profiles/levels*** between NG-RAN and PCF, and of the ***Alternative Service Requirements*** between PCF and AF can be decided in the normative phase.

NOTE 4: How the NG-RAN decides that the PDB and/or PER cannot be fulfilled is implementation specific.

NOTE 5: Whether the notification enhancement applies to V2X application only is up to the operator policy.

6. If, in step 1, the AF indicated that the PCF is responsible for changes in the QoS profile of the QoS Flow from the ***Requested Service Requirement*** to one of the ***Alternative*** ***Service Requirement(s)***, the PCF triggers a PDU Session Modification as per TS 23.502 [9] clause 4.3.3.2 step 1.d when AN notifies the 5GC that QoS characteristics cannot be fulfilled and if an **Alternative QoS Profile** exists which fits to the information included in the AN notification (i.e. a switch from the **target QoS Profile** to an **Alternative QoS Profile** triggered by PCF is possible).

### 6.27.2 Procedures

Existing 5GS QoS model and QoS Notification Control procedures can be reused with the following enhancement:

(1) That the NG-RAN can also notify the unfulfillment/re-fulfilment of the QoS characteristics of PDB and PER to the 5GC, and then to the Application Function. NG-RAN, when supporting the feature, can also notify 5GC about the currently supported ***Alternative*** ***QoS profile (index)***.

### 6.27.3 Impact on existing entities and interfaces

The following entities are impacted to support Notification Control proposed in this solution.

- NG-RAN notifies the 5GC and, when supporting the feature, provides supported ***Alternative QoS Profile (index)*** to 5GC or the current 'QoS requirements that are guaranteed' (GFBR, PDB and/or PER).

- When enabled, PCF supports to derive the Alternative QoS parameter set(s) based on the Alternative Service Requirement(s) provided by the AF and include the Alternative QoS parameter set(s) in the PCC rule sent to the SMF.

- SMF enables notification at NG-RAN, by providing the ***Alternative QoS Profile(s)*** additionally so that the NG-RAN may include the currently supported ***Alternative*** ***QoS Profile (index)*** when sending a notification to 5GC.

- AF shall be able to provide ***Alternative Service Requirement(s)*** and receive the supported ***Alternative Service Requirement*** from the PCF.

### 6.27.4 Topics for further study

### 6.27.5 Solution evaluation

Comparing to Solution #16 Option 1 (clause 6.16), the NG-RAN does not enforce a different QoS Profile when a notification is sent to the 5GC. Rather, it still tries to fulfil the original QoS Profile, i.e. following the same behaviour as defined in Rel-15.

### 6.27.6 Conclusions

This solution satisfies the Key Issue #3 regarding QoS monitoring, control and notification.

## 6.28 Solution #28: Ecosystem-based gathering of network intelligence for in advance performance estimation

### 6.28.1 Functional Description

The potential of the Automotive and Mobile ecosystem harvesting of network data goes beyond the mere ability of the PLMNs to provide that information. One of the powerful tools that the ecosystem can harness is the sheer large volume of information that can be harvested from devices that are in the field. Indeed, this did not go unnoticed when the MDT was discussed in 3GPP.

In addition, resilience to the deployment of the feature required to operate certain application aspects by the operators and to the always possible case the UE ends up in the EPS is a valuable aspect of considering some degree of independence from the operator provided information. In summary it is extremely likely that V2X applications will require to be able to operate independently from the network (but of course they could enhance their operation from leveraging network information).

There is a wealth of information that can be gathered like experienced data rates, coverage detection, signal strength detection, Cell IDs+ location, QoS levels allowed, notifications from the network, in application Quality reports (which of course the network cannot access). In addition, car sensor data e.g on weather conditions (nowcasting from the field + forecasting from third parties), road conditions, etc. can also be elaborated at the same time and sourced from the Car Groups. Indeed, some information can also be reported shared by and reported to information aggregators /OS ecosystems implicitly or explicitly by the UE and these can become available to the application layer.

In summary the amount if information that can and will be available even without the assistance of networks will be considerable. See Figure 6.28.1-1 as an example of the structure of the ecosystem.



Figure 6.28.1-1: Example overview of the Ecosystem for V2X related information sharing

In this ecosystem the 3GPP community has also a role to play, e.g. the Notification control information, if available, can be sent to the V2X AS (either by the UEs that receive such notifications or by the CN that receives them from the RAN) and indirectly serve as a tool to infer the inability to meet certain QoS in a cell/RAN node for as long as this is not reporting that improved QoS levels are achievable.

The PLMN can also provide exposure of data it gathers via its own regular OAM/Network Automation. All of this can helpful to the V2X ecosystem.

### 6.28.2 Procedures

Use NEF to expose QoS information from the NWDAF useful to satisfy the objectives of this KI. UE impact from this KI is not required (e.g. KI#3 solution information can be reused and harvested by the V2X AS to the benefit of this solution).

### 6.28.3 Impact on existing entities and interfaces

None

### 6.28.4 Topics for further study

None

### 6.28.5 Solution evaluation

This solution is resilient to lack of sharing from PLMNs (i.e. is resilient to such information not being available in EPS).

### 6.28.6 Conclusions

This solution satisfies KI#15. No UE-related impact as part of this Key Issue #15 is expected. If additional information not yet defined by other Work Items or Key issues or not already defined in existing TSs was beneficial to be exposed by PLMNs NEF, this can be defined in normative phase in this work item context, and also in future 3GPP releases. One example is information on availability of certain QoS level with a certain confidence level along a path.

## 6.29 Solution #29: Potential QoS change notification to assist Application Adjustment

### 6.29.1 Functional Description

This solution corresponds to the Key Issue #15 "Enhancements to assist Application Adjustment".

The proposed solution reuses the mechanism defined in TS 23.288 [23] as much as possible. The basic principles of this solution are the following:

**(1)** V2X Application Server requests analytics information regarding potential QoS change in a geographic area via NEF. The request includes the following parameters:

- Analytics ID = "Potential QoS change".

- Analytic Filter Information:

- QoS requirements:

- Standardized 5QI, and applicable additional QoS Characteristics and the corresponding value (conditional, i.e. it is needed for GBR 5QIs to know the GFBR).

- For non-standardized QoS Characteristics, the QoS Characteristics attribute and the corresponding values (optional).

NOTE 1: The V2X Application Server can determine the 5QIs and the QoS characteristics it needs to provide as input to the QoS change notification service based on SLA with the operator which authorizes the V2X Application Server to use certain 5QIs and to use the QoS change notification service only for these. The 5QI provided by the V2X Application Server is one of standardized 5QI values or one that the operator defines.

- Location information:

- The location information indicates a path of interest and is a form of Geographical Area(s), e.g. geographical coordinates or a polygon describing an area.

NOTE 2: The location information could reflect a list of waypoints.

- Time window (optional):

- The time window indicates the time period (e.g., between 1PM and 2PM) to which the information in the the potential QoS change notification applies (which is needed for the specific applications the V2X Application Server serves). If not provided, the NWDAF uses a default value set by the operator based e.g on local policy or SLA. During the normative phase the maximum value of the time window will be determined, but it should not be too long.

- Threshold(s):

- The threshold(s) indicate level(s) which, if crossed, trigger the notification that the potential QoS change (improvement or worsening) can happen. The level(s) relate to the, e.g. average UL/DL throughput, DRB accessibility/retainability, etc. for the relevant 5QI(s) defined in TS 28.552 [24].

NOTE 3: Further details of the threshold may be considered during the normative phase.

NOTE 4: The optional number of UEs indicating for how many UEs the request is for, the optional ARP and the optional N-SSAI may be considered during the normative phase.

NOTE 5: A new Analytic ID "Potential QoS change" needs to be defined for this solution.

NOTE 6: It is assumed that the V2X Application Server makes a request and sets the parameters included in the request by considering notification timing, e.g. how early is the notification expected to be returned to the V2X Application Server so the application has time to adapt.

NOTE 7: The V2X Application Server can either request to subscribe to notifications from the 5GC or send/receive single requests/responses to/from the 5GC.

**(2)** Based on the request from the V2X Application Server, the NEF interacts with NWDAF to request analytics information.

NOTE 8: Whether any mapping of parameters included in the request from the V2X Application Server to information used by the 3GPP system can be discussed in the normative phase.

**(3)** The NWDAF collects data from OAM.

**(4)** The NWDAF provides analytic feedback, i.e. notification of potential QoS change, to the V2X Application Server via the NEF. The analytic feedback contains the following information:

- Information on the location in the geographic area and the time when a QoS change may happen (and what threshold is crossed).

The potential QoS change detected by the NWDAF may be based on the data from OAM, e.g. average UL/DL throughput, DRB accessibility/retainability, etc, for the relevant 5QI(s) defined in TS 28.552 [24], and parameters in the request from the V2X Application Server described in (1). Data collected from other NFs can be used as well.

The NWDAF can detect the need for notification about "potential QoS change" based on comparing the expected value for the KPI of the target 5QI against the threshold(s) provided by the V2X Application Server in any cell over the requested time window. The expected KPI values are derived from the statistics for the 5QI obtained from OAM and other information. OAM information may also include planned or unplanned outages detection and other information that is not in scope for 3GPP to discuss in detail.

NOTE 9: Data collected per 5QI not yet defined but will be defined in Rel-16 by other WGs such as SA5, RAN WGs can be used to detect potential QoS change.

### 6.29.2 Procedures

In this clause, the proposed procedure is related to continuous reporting based on operator configuration, however one-time reporting can be also used.

Figure 6.29.2-1 depicts a procedure for potential QoS change notification to assist Application Adjustment. Figure 6.29.2-1 shows the interaction between V2X Application Server and NWDAF performed via the NEF.



Figure 6.29.2-1: Potential QoS change notification to assist Application Adjustment

1. The UE provides information on V2X service, path, path start time and QoS requirements to the V2X Application Server. The path can be a form of geographic coordinates to reflect a list of waypoints.

NOTE 1: The figure shows only one UE for simplicity, anyhow, the V2X Application Server can receive the above information from other UEs.

2. The V2X Application Server subscribes to analytic information provided by NWDAF via NEF. The parameters included in the request are described in clause 6.29.1.

The V2X Application Server may include multiple sets of parameters in order to provide different combinations of "Location information" and "Time window" when requesting analytics information regarding potential QoS change. That is, one request may include multiple sets of parameters to reflect different timescales that may be useful to the V2X Application Server for monitoring for a path of interest.

NOTE 2: The request made by the V2X Application Server does not have to be per-UE.

The V2X Application Server may generate a request for analytics information regarding potential QoS change for multiple UEs based on the information received from the UEs in step 1. The V2X Application Server does not have to provide any information related to UE identifier(s) (e.g. GPSI(s)) in the request. The NWDAF does not have to get noticed or differentiate whether the request from the V2X Application Server is for a single UE or multiple UEs.

NOTE 3: Whether a request is generated for a UE or multiple UEs, and how to set the parameters included in the request are up to the V2X Application Server implementation and out of the scope of 3GPP.

The V2X Application Server may issue a request based on local decision (i.e. without explicit request from a specific UE or UEs) if it needs a map of the QoS available over an entire network of roads within a certain time window for a certain number of potential users.

If the analytic information subscription is authorized by the NEF, the NEF records the association of the analytic trigger and the requester identity.

3. Based on the subscription request from the V2X Application Server, the NEF subscribes to analytic information to NWDAF as described in clause 6.29.1.

4. The NWDAF collects data from OAM as described in clause 6.29.1.

5-6. If the NWDAF detects potential QoS change, the NWDAF provides a notification for potential QoS change to the V2X Application Server via the NEF as described in clause 6.29.1.

7. V2X application adjustment may take place at UE and/or V2X Application Server upon reception of the notification about potential change in QoS.

For the case that the V2X Application Server sends a request for multiple UEs in step 2, the V2X Application Server may perform the V2X application adjustment with every UE corresponding to the request.

NOTE 4: When the request made in step 2 is for multiple UEs, V2X application adjustment may take place at each UE.

### 6.29.3 Impact on existing entities and interfaces

V2X Application Server

- requests indication of potential QoS change in a geographic area via NEF.

- performs mapping between individual UE path requests and subscription to notification per path/road segment.

NEF

- interacts with NWDAF to request analytics information based on the request from the V2X Application Server.

NWDAF

- collects data to detect potential QoS change.

- provides notification on potential QoS change to the V2X Application Server.

### 6.29.4 Topics for further study

### 6.29.5 Solution evaluation

This solution satisfies Key Issue #15.

In this solution, the NWDAF operates UE-independent QoS change monitoring and notification. However, the V2X Application Server manages a request for QoS change notification sent to the NWDAF by considering individual UE request, and performs the V2X application adjustment with a relevant UE when potential QoS change is notified, which means the V2X Application Server interacts with individual UE regarding QoS change notification operation.

### 6.29.6 Conclusions

Editor's note: Conclusions are FFS.

# 7 Conclusions

## 7.0 General

Any solutions or other descriptions as far as not relevant for the conclusions are not further updated. Also any Editor's notes not relevant for the conclusions may remain in the TR.

Any Editor's notes relevant for the conclusions, e.g. related to other WGs dependency, will be resolved in the normative phase.

## 7.1 Conclusions for EPS

In this study, no architecture enhancement of EPS for eV2X is identified. This conclusion is relevant to Key Issue#1.

SA2 may have normative work for V2X enhancement to EPS in Rel-15 if there is any input from RAN WGs and such input causes normative work in SA2. For the normative work of V2X enhancement to EPS in Rel-15, the dedicated work item is not required in SA2.

For Key Issue #2 (3GPP PC5 RAT selection for a V2X application), it is concluded that Solution #12 in clause 6.12 is selected for normative work.

## 7.2 Conclusions for 5G System

For the architectural reference model it is concluded to take Alternative #1 in Annex A.1 as the baseline for normative work.

For Key Issue #1 (Support of eV2X Group Communication), it is concluded that Solution #21 in clause 6.21 is used as the baseline for normative work.

For Key Issue #2 (3GPP PC5 RAT selection for a V2X application), it is concluded that Solution #12 in clause 6.12 is selected for normative work.

For Key Issue #3 (QoS Support for eV2X over Uu interface),

- Regarding QoS characteristics and new standardized 5QI value, it is concluded to take Solution #2 in clause 6.2 as the baseline for normative work. No additional QoS parameters have been identified in addition to the ones already specified in TS 23.501 [7]. Whether the new combinations of QoS parameter values proposed in Solution #2 are supported or not is pending RAN WG2's feedback.

- Regarding QoS Notification Control enhancements, it is concluded that Solution #27 in clause 6.27 is taken as the baseline for normative work.

NOTE 0: As RAN WGs had been requested to evaluate the RAN impacts, solution#27 may be updated and aligned with RAN WG feedbacks in the normative phase.

For Key Issue #4 (Support of PC5 QoS framework enhancement for eV2X), depends on RAN WG decisions, it is concluded that Solution #19 in clause 6.19 is used as the baseline for normative work, with the working assumption that VQI can be supported by NR PC5, and a new set of VQIs would be defined in normative phase.

For Key Issue #5 (Service Authorization and Provisioning to UE for eV2X communications over PC5 reference point) and Key Issue #11 (Service Authorization and Provisioning to UE over NG-Uu reference point), it is concluded that Solution #3 in clause 6.3, Solution #20 in clause 6.20 and Solution #24 in clause 6.24 are selected for normative work.

For Key Issue #6 (Service Authorization to NG-RAN for eV2X communications over PC5 reference point), Solution #6 in clause 6.6 is selected for the normative work.

NOTE 1: For V2X capability indication and V2X related information per PC5 RAT, alignment based on progress/decision in RAN WGs will be performed as part of the normative phase.

For Key Issue #7 (Network Slicing for eV2X Services),

- To facilitate deployment of dedicated network slice for use of, for example, automotive industry and to facilitate roaming support, it is concluded to reuse the Network Slicing functionality for 5GS (see TS 23.501 [7], TS 23.502 [9]) with specifying a new standardized SST value dedicated for V2X services.

- Existing values (both standardized and non-standardized SST) defined in TS 23.501 [7] can also be used for any V2X services e.g. eMBB, URLLC, etc.

For Key Issue #8 (Support of edge computing), it is concluded that the mechanisms to support edge computing defined in TS 23.501 [7] and TS 23.502 [9] can be used. No additional normative work has been identified for this key issue. Potential normative work may be identified by FS\_5G\_URLLC for this key issue.

For Key Issue #9 (Support of unicast/multicast for sensor sharing over PC5), it is concluded that Solution #11 documented in clause 6.11 is adopted as the baseline for normative work, with the following potential updates based on other Working Groups' feedbacks:

- the signalling message definition for unicast link establishment and management, e.g. if and how RRC signalling is used for unicast link;

- the choice of per packet QoS model or bearer based QoS model for broadcast, groupcast, and unicast based on RAN decisions;

- signal to the base station regarding the service used when network scheduled mode is used;

- the potential security related procedure updates for unicast communication over PC5.

NOTE 2: In Key Issue #9 and Solution #11, multicast means groupcast.

For Key Issue #10 (eV2X message transmission and reception) on the support of non-IP based V2X message over NG-Uu reference point, it is concluded to take Solution #18 in clause 6.18 for normative work.

For Key Issue #12 (System migration and interworking for eV2X), it is concluded to take Solution #9 in clause 6.9 and Solution #20 in clause 6.20 for normative work. PC5 interworking can be supported with proper UE configurations by taking into account e.g. regional regulations, deployments, and UE PC5 RAT capability.

For Key Issue #14 (Support of broadcast over NG-Uu), it is concluded to stop further solution work on 5GS MBMS for Release 16. No normative work shall be performed for this key issue in Release 16.

For Key Issue #15 (Enhancements to assist Application Adjustment) it is concluded to select Solution #29 as the basis for normative work.

## 7.3 Interim Conclusions for EPS

For Key Issue #13 (Support NR based PC5 communication when UE connects to EPC), it is concluded that Solution #25 in clause 6.25 is selected for normative work once RAN WGs conclude to support Network Controlled NR PC5 radio resource scheduling in eNB.

Annex A:  
eV2X Architecture variants

# A.0 Description

In the existing V2X system architecture (as defined in TS 23.285 [5]), the V2X Control Function is responsible for provisioning of V2X policy and parameters not only for V2X communication over PC5 but also for V2X communication over LTE-Uu. In the EPC, V2X Control Function uses V3 to provision the parameters to the UE, which relies on OMA-DM. Alternatively, the parameters may be provisioned to the UE through V1 from the V2X Application Server.

In 5GC, it is possible to realize the service authorization and provisioning function with the following options, given the 5GC architecture:

- Provision the V2X policy/parameters via U-plane:

a) Reuse the V2X Control Function as defined in TS 23.285 [5], which provides the V3 via a U-plane connection to the UE;

- Provision the V2X policy/parameters via C-plane:

The parameters are provided to the UE from the AMF through N1. The C-plane based provisioning options are further divided as which entity sends the parameters to the AMF.

b) Define the V2X Control Function as a new CP NF in 5GC, which provides the V2X policy and parameters via C-plane towards the UE, i.e. using the Namf\_Communication\_N1N2MessageTransfer/N1MessageNotify service of the AMF, and the NAS transport to realize V3;

c) V2X Control Function connected to PCF via N5 to provision the V2X policy/parameters using UE Policy delivery mechanism;

d) V2X Control Function connects to NEF and provides the V2X policies/parameters to PCF via NEF, which in turn delivers the policies/parameters to UE via UE Policy delivery mechanism;

e) PCF realizes the V2X policy/parameter provisioning function of the V2X Control Function and delivers the policies/parameters to UE via UE Policy delivery mechanism;

f) AF (i.e. V2X Application Server), connected to 5GC directly or via NEF, realizes the V2X Control Function and provides the parameters to the UE.

# A.1 Alternative#1: eV2X Architecture Reference Model

## A.1.1 Description

### A.1.1.1 Description of existing V2X for EPS

The V2X Control Function in EPC handles the configuration of the UE in two areas:

- Configuration of radio parameters for the use of PC5.

- Configuration of application parameters for the UE to access the application server and to receiving application information over MBMS.

The specific V2X reference points specified by 3GPP are:

**V2**: The reference point between the V2X Application Server and the V2X Control Function in the operator's network. The V2X Application Server may connect to V2X Control Functions belonging to multiple PLMNs.  
In TS 23.285 [5] this is only handling MBMS configuration data and not further specified.

**V3**: The reference point between the UE and the V2X Control Function in UE's home PLMN. It is based on the service authorization and provisioning part of the PC3 reference point defined in clause 5.2 of TS 23.303 [8]. It is applicable to both PC5 and LTE-Uu based V2X communication and optionally MBMS and LTE-Uu based V2X communication.  
This is going over the user plane and used for the UE configuration.

**V4**: The reference point between the HSS and the V2X Control Function in the operator's network.  
The V4 interface allows the V2X Control Function to retrieve V2X related subscription data in order to authorize access from the UE for V2X services.

**V6**: The reference point between the V2X Control Function in the HPLMN and the V2X Control Function in the VPLMN.

### A.1.1.2 5G Description

In 5GC a new reference architecture has been introduced and by that it should be analysed if a simplified V2X architecture can be developed by using some of the available features and thus eliminating the need for components from EPS or if the V2X architecture from EPS shall be reused.

As the V2X Control Function only handles UE configuration it is proposed that the new procedure in 5GC handles UE configuration, see TS 23.502 [9] clause 4.2.4.3 'UE Configuration Update procedure for transparent UE Policy delivery'.

It is proposed to use PCF as the eV2X policy/parameters provisioning functional entity.

The preconfiguration in ME or the UICC as specified in TS 23.285 [5] will still be used where applicable.

If needed by the V2X application, the Application Function (AF) features such as application influence and notification can be applied by V2X application.

In Release 15 5GS, MBMS feature is not supported.

### A.1.1.3 PC5 and Uu based eV2X architecture reference model

Figure A.1.1.3-1 shows the high-level view of the non-roaming 5G System architecture for PC5 and Uu based V2X communication.



Figure A.1.1.3-1: Non-roaming 5G System architecture for PC5 and Uu based V2X communication

Figure A.1.1.3-2 shows the high-level view of the roaming 5G System architecture for PC5 and Uu based V2X communication.



Figure A.1.1.3-2: Roaming 5G System architecture for PC5 and Uu based V2X communication

Figure A.1.1.3-3 shows the high-level view of the inter-PLMN 5G System architecture for PC5 and Uu based V2X communication.



Figure A.1.1.3-3: Inter-PLMN 5G System architecture for PC5 and Uu based V2X communication

The 5G System architectures for PC5 and Uu based V2X communication depicted in Figures A.1.1.3-1, A.1.1.3-2 and A.1.1.3-3 are based on the 5G System architectures defined in TS 23.501 [7] and PC5 and LTE-Uu based V2X architecture reference model defined in TS 23.285 [5].

Editor's note: Service Based architecture will be determined once the final reference architecture selection is completed.

## A.1.2 Procedures

The procedure in TS 23.502 [9] clause 4.2.4.3 'UE Configuration Update procedure for transparent UE Policy delivery' can be used for the UE configuration of V2X related parameters.

It is proposed to use PCF as the eV2X policy/parameters provisioning functional entity.

## A.1.3 Impact on existing entities and interfaces

The reference points V3, V4 and V6 in the EPC V2X architecture is no longer needed as this will be handled in the existing 5GC interfaces.

The configuration of the UE using V3 will instead be handled over existing interfaces as handled by UE Configuration Update procedure.

The reference point between V4 between V2X Control Function and HSS will not be needed as this is handle using the 5GC existing interfaces.

The V6 interface between the VPLMN and the HPLMN V2X Control Functions is not needed as the needed information exchange may be handled by existing roaming interfaces.

Editor's note: The handling of roaming interfaces will be further evolved when a broader picture of the eV2X architectural requirements has been developed

The functionality of V2X Control Function in the 5GC architecture resides in the PCF, see clause A.1.2.

## A.1.4 Topics for further study

It is for further study which existing NFs that will be affected to support the existing V2X functionality and new functionality introduced by other Key Issues in the present document.

# A.2 Alternative#2: Reusing EPS V2X Architecture

## A.2.1 Description

The proposed 5G System architectures for PC5 and Uu based V2X communication are based on the 5G System architectures defined in TS 23.501 [7] and V2X architecture reference model defined in TS 23.285 [5].

Figure A.2.1-1 shows the high level view of the non-roaming 5GS architecture for PC5 and Uu based V2X communication.



Figure A.2.1-1: Non-roaming 5GS architecture for PC5 and Uu based V2X communication

Figure A.2.1-2 shows the high level view of the roaming architecture for PC5 and LTE-Uu based V2X communication. In this figure, UE A uses a subscription of PLMN A and UE B uses a subscription of PLMN B; UE A is roaming in PLMN B while UE B is not roaming.

A V2X Application Server may connect to multiple PLMNs, e.g. one V2X Application Server can connect with the V2X Control Function in PLMN A and the V2X Control Function in PLMN B in the figure.



Figure A.2.1-2: Roaming 5GS architecture for PC5 and Uu based V2X communication

Figure A.2.1-3 shows the high level view of the inter-PLMN architecture for PC5 and Uu based V2X communication. In this figure, UE A uses a subscription of PLMN A and UE B uses a subscription of PLMN B; UE A is roaming in PLMN C while UE B is not roaming.



Figure A.2.1-3: Inter-PLMN architecture for PC5 and Uu based V2X communication

**V1**: The reference point between the V2X application in the UE and in the V2X Application Server. This reference point is out of scope of this specification.

**V2**: The reference point between the V2X Application Server and the V2X Control Function in the operator's network. The V2X Application Server may connect to V2X Control Functions belonging to multiple PLMNs.

**V3**: The reference point between the UE and the V2X Control Function in UE's home PLMN. It is based on the service authorization and provisioning part of the PC3 reference point defined in clause 5.2 of TS 23.303 [8]. It is applicable to both PC5 and Uu based V2X communication.

**V4**: The reference point between the UDM and the V2X Control Function in the operator's network.

**V5**: The reference point between the V2X applications in the UEs. This reference point is not specified in this release of the specification.

**V6**: The reference point between the V2X Control Function in the HPLMN and the V2X Control Function in the VPLMN.

**PC5**: The reference point between the UEs used for user plane for ProSe Direct Communication for V2X Service.

**N2, N3, N6, N8, N10:** same as defined in TS 23.501 [7].

**V2X Control Function, V2X Application Server:** same as defined in TS 23.285 [5].

# A.3 Alternative#3: V2X Control Function as a new CP entity in 5GC

## A.3.1 Description

V2X Control Function is used to provision the UE with necessary parameters in order to use V2X communication. This alternative is equivalent to option b) of clause A.0 and is based on defining a new CN NF specifically for supporting the V2X CF functionalities. Figure A.3.1-1 below depicts the non-roaming architecture for this option.



Figure A.3.1-1: Non-roaming 5GS architecture for PC5 and Uu based V2X communication

Figure A.3.1-2 below depicts the roaming architecture for this option.



Figure A.3.1-2: Roaming 5GS architecture for PC5 and Uu based V2X communication

Figure A.3.1-3 below depicts the roaming architecture for this option.



Figure A.3.1-3: Inter-PLMN 5G System architecture for PC5 and Uu based V2X communication

## A.3.2 Procedures

A UE Configuration Update procedure (similar to TS 23.502 [9] clause 4.2.4.3) needs to be defined.

## A.3.3 Impact on existing entities and interfaces

Considering V3, V4 and V6 introduced in EPS for V2X specific scenario:

- V3 reference point (between UE and V2XCF): a new NAS type (e.g., NAS V2X message) on top of NAS-MM is needed;

- V4 reference point (between V2XCF and UDM): it is possible to reuse the Nudm service interface to access the UDM. This allows the V2XCF to retrieve V2X related data in order to authorize access from the UE for V2X services.

- V6 reference point (between H-V2XCF and V-V2XCF): a new service interface Nv2xcf is used to coordinate among V2XCF in the Home-PLMN and in the Visited-PLMN.

Editor's note: Further details on which data is exchanged over V4 and V6 are needed.

## A.3.4 Topics for further study

Editor's note: It is FFS that whether some new functionalities e.g. the access control for V2X shall be captured for V2XCF as an NF.

# A.4 Alternative#4: eV2X Architecture Reference Model

## A.4.1 Description

The eV2X architecture reference model described in this clause corresponds to the option f) of clause A.0.

Figure A.4.1-1 shows the AF (i.e. V2X Application Server) and the interfaces that the AF is using.



Figure A.4.1-1: AF and the interfaces that the AF is using

When the AF is managed by a PLMN and allowed to access NFs directly (case 1), the AF uses PCF services through the Npcf interface to provide V2X policy and parameters to the UE.

Editor's note: It is FFS whether the PCF services specified in clause 5.2.5 of TS 23.502 [9] can be used or new PCF services need to be defined.

When the AF is managed by a V2X service provider (case 2), the AF uses NEF services through the Nnef interface. The AF uses the Nnef\_ParameterProvision\_Update service described in clause 5.2.6.4 and clause 4.15.6.2 of TS 23.502 [9] to update V2X related information. The V2 reference point between the V2X AS and the PLMN is realized by using Nnef and Naf interfaces.

Editor's note: It is FFS which NF in the PLMN acts as a peer for V2 reference point.

Figure A.4.1-2 depicts the high level view of non-roaming eV2X architecture reference model showing option f). The AF can belong to a PLMN or a V2X Service Provider.



Figure A.4.1-2: Non-roaming eV2X architecture reference model

Annex B:  
Solutions for broadcast/multicast/group delivery over Uu

# B.0 Description

This Annex addresses and documents solutions for FS\_CIoT\_5G as well.

# B.1 Solution #B1: Support of broadcast in 5GS

## B.1.1 Functional Description

### B.1.1.0 General

This solution corresponds Key Issue #14 Support of broadcast over NG-Uu, Key Issue #1 Support of eV2X Group Communication and also Key Issue#8 Support of edge computing for eV2X. This solution proposes 5G-MBMS architecture and corresponding procedures for V2X services. It is considered to utilize E-UTRAN providing multicast/broadcast as specified in TS 36.440 [14], since NG-RAN is composed of ng-eNB (providing E-UTRA user plane and control plane protocol) and gNB (providing NR user plane and control plane protocol). This solution proposes to adopt existing MBMS architecture principle and procedure in EPS, but only necessary functionality for V2X service will be specified for this solution.

### B.1.1.1 5G-MBMS Architecture



Figure B.1.1.1-1: 5G MBMS Architecture

NOTE 1: For this architecture, NG-RAN is ng-eNB providing MBMS as specified in TS 36.440 [14].

MB-AMF performs routing of session management message between MB-SMF and NG-RAN.

MB-SMF is dedicated SMF for MBMS, corresponding to MBMS-GW Control Plane:

- MBMS Bearer Session create/modify/release

- IP multicast address allocation

- Use Nmb (compliant to SGmb) to interact with BMSC-CPF

- Interact with MCE via M3 reference point, which is routed via MB-AMF

MB-UPF is dedicated UPF for MBMS, corresponding to MBMS-GW User Plane:

- Distribution of MBMS user plane data to E-UTRAN (M1 reference point)

- Use SGi-mb to interact with BMSC-UPF

NOTE 2: Edge computing function can be supported by selecting a local MB-UPF when it is available.

BMSC-CPF is Control plane function of BMSC, connecting with Application Server via MB2-C or xMB-C

- TMGI allocation, MBMS Session identifier management, Location dependent content transfer

BMSC-UPF is User plane function of BMSC, connecting with Application Server via MB2-U or xMB-U

- MBMS data transmission, generate charging record

NOTE 3: Edge computing function can be supported by selecting a local BMSC-UPF when it is available.

Editor's note: In this solution, it is encouraged to specify essential functionality for V2X service. Above list of functionality is not exhaustive and also can be modified.

### B.1.1.2 Service-based interfaces and Reference points

The 5G-MBMS architecture contains the following service-based interfaces and reference points:

**Nmb**: Service based interface exhibited by BMSC-CPF equivalent to SGmb as specified in TS 23.246 [16].

**Nmbsmf**: Service based interface exhibited by MB-SMF for MBMS session procedure

**N4mb**: Reference point between MB-SMF and MB-UPF for MBMS session related procedure

Editor's note: It is FFS whether N4mb can be supported as service-based interface.

**M1**: Reference point between E-UTRAN and MB-UPF for MBMS data delivery. IP multicast is used on this interface.

**M3**: Reference point for control plane between E-UTRAN and MB-AMF. It is used to carry session management message between MB-SMF and E-UTRAN.

Editor's note: It is FFS whether functions of M3 reference point can be modified.

**SGimb**: Reference point between BMSC-UPF and MB-UPF for MBMS data delivery.

**MB2** Reference point between BMSC and V2X AS as specified in TS 26.346 [17]

**xMB**: Reference point between BMSC and V2X AS as specified in TS 26.346 [17]

Editor's note: use of MB2 or xMB will depends on service level agreement

## B.1.2 Procedures

### B.1.2.1 Service Announcement

Editor's note: Detail procedure will be specified. For V2X, Application Server provides service announcement information to the UE on behalf of BMSC.

### B.1.2.2 TMGI Management

Editor's note: Detail procedure will be specified.

### B.1.2.3 MBMS Session Management

Editor's note: Detail procedure will be specified for session creation, modification, and release.

## B.1.3 Impact on existing entities and interfaces

Editor's note: This clause describes impacts to existing entities and interfaces.

The solution introduces new network entities:

MB-SMF: Dedicated SMF for MBMS:

- MBMS Bearer Session create/modify/release

- IP multicast address allocation

- Use Nmb (compliant to SGmb) to interact with BMSC-CPF

- Interact with MCE via M3 reference point, which is routed via MB-AMF

- Nmbsmf: Service based interface exhibited by MB-SMF for MBMS session procedure

- N4mb: Reference point between MB-SMF and MB-UPF for MBMS session related procedure

MB-UPF: Dedicated UPF for MBMS:

- Distribution of MBMS user plane data to E-UTRAN (M1 reference point)

- Use SGi-mb to interact with BMSC-UPF

- N4mb: Reference point between MB-SMF and MB-UPF for MBMS session related procedure

BMSC-CPF: Control plane function of BMSC:

- TMGI allocation, MBMS Session identifier management, Location dependent content transfer

- Nmb: Service based interface exhibited by BMSC-CPF

BMSC-UPF: User plane function of BMSC:

- MBMS data transmission, generate charging record

MB-AMF: Support transfer of MBMS session related message via M3 reference points.

## B.1.4 Topics for further study

Editor's note: Topics for FFS will be collected for this particular functionality.

## B.1.5 Conclusions

Editor's note: Conclusions will be collected for this particular functionality.

# B.2 Solution #B2: Support of broadcast/multicast/group delivery over Uu

## B.2.1 Introduction

Editor's note: This clause lists the key issue(s) addressed by this solution.

This solution addresses Key Issue #16: Support of Group communication and messaging in CIoT TR 23.724 [15] and Key Issue #14: Support of broadcast over NG-Uu in this TR. It is based on the 5GS (5GC + E-UTRA) providing a transport only service for groupcast delivery in the air by means of an enhanced SMF (the Group-SMF), an enhanced AMF and Group-UPF. In the CN, the G-SMF establishes an IP Multicast connection between the selected Group-UPF and (R)AN nodes involved in the group communication (GC) session.

## B.2.2 Architecture

Editor's note: This clause outlines solution principles and documents any assumptions made.



Figure B.2.2-1: Architecture for broadcast/multicast/group delivery over Uu in 5G network.

The following applies to the solution:

- 5GC provides the session management and data forwarding for group communication, while AF provides the membership management and security management for group communication.

- It is considered that the RAT is E-UTRA. Consequently, the RAN node is ng-eNB.

- It is considered that the NEF selects the G-SMF at first when the AF requires the 5GC to setup group session.

- The G-SMF selects a specific AMF AMF to support the GC session and message exchanges between the G-SMF and RAN.

- The G-SMF selects UPF(s) and notifies the AF about UPF information and protocol. The control entity for establishing the group session is the G-SMF.

- TMGI is reused for the group session identification in both the RAN and CN side.

## B.2.3 Support of EPC interworking

Editor's note: This clause describes if and how EPC-5GC interworking is supported by this solution.

## B.2.4 Procedures

### B.2.4.1 Service announcement

The service announcement mechanisms allow users to be informed about the necessary information for receiving the group communication service (e.g. TMGI and service start time). The AF performs service announcement by itself via application layer message.

### B.2.4.2 TMGI Management

#### B.2.4.2.1 General

TMGIs are managed between the AF and the G-SMF using procedures for the allocation, update and deallocation procedures upon request from the AF. TMGIs may also be allocated automatically by the G-SMF at Group Session Establishment as described in the clause B.2.4.3.2. Each TMGI is allocated by the G-SMF for a given period of time determined by the G-SMF. If the AF wants to retain access to a TMGI for an extended period of time the AF needs to request extension of the allocation period. The AF may request an extension of the allocation period at any time prior to expiry of the time period.

#### B.2.4.2.2 TMGI Allocation



Figure B.2.4.2.2-1: TMGI allocation procedure.

1. When the AF wishes to have one or more TMGIs for group sessions, the AF sends an Allocate TMGI Request message to the NEF.

2. The NEF checks whether the AF is authorized by NEF to send the requestfor TMGI allocation. If the request is not authorized, then NEF continues in step 6 indicating the reason to failure in the response message.

3. If the AF is authorized by NEF, the NEF selects the G-SMF to manage the session by using the information e.g. the information provided by the AF, load of the G-SMFs and the serving area of G-SMF(s), and sends the request to such G-SMF.

4. G-SMF allocates a set of TMGIs. G-SMF also determines the associating expiration time for the newly-requested TMGIs.

5. The G-SMF sends an Allocate TMGI Response message to the NEF indicating the list of allocated TMGIs, and an expiration time for those TMGIs.

6. NEF sends the allocated TMGIs to AF.

#### B.2.4.2.3 TMGI Refresh



Figure B.2.4.2.3-1: TMGI refresh procedure.

1. The AF includes a list of TMGIs that are already allocated to the AF, and for which the AF wishes to obtain a later expiration time.

2. The NEF checks whether the AF is authorizsed by NEF to send the request to G-SMF. If the request is not authorized, then NEF continues in step 5 indicating the reason to failure in the response message.

3. If the AF is authorized by NEF, NEF sends the request to the related G-SMF.

4. G-SMF determines the associating expiration time for the TMGIs.

5. The G-SMF shall send an Allocate TMGI Response message to the AF indicating the list of allocated TMGIs, and an expiration time for those TMGIs via NEF.

#### B.2.4.2.4 TMGI deallocation



Figure B.2.4.2.4-1: TMGI deallocation procedure.

1. When the AF decides that it no longer needs one or more TMGIs that are allocated to it, the AF shall send a Deallocate TMGI Request message to the NEF with the list of TMGIs to be deallocated. Absence of the list of TMGIs implies that all TMGIs currently allocated to be deallocated.

2. The NEF checks whether the AF is authorized by NEF to send the request. If the request is not authorized, then NEF continues in step 5 indicating the reason to failure in the response message.

3. If the AF is authorized by NEF, NEF sends the request to the related G-SMF.

4. G-SMF shall then deallocate the TMGIs. If the groupcast and group session resources are in use for any of the deallocated TMGIs, those resources are released using the step 4~9 of the procedure defined in clause B.2.4.3.3, and the G-SMF shall release any corresponding resources.

5. The G-SMF shall send a Deallocate TMGI Response message to the NEF indicating the list of allocated TMGIs.

### B.2.4.3 Create, Update and Release a Group Session

#### B.2.4.3.1 General

Creating and releasing group session involves the allocation/deallocation of groupcast resources, based on the configuration provided by the AF, using the following procedures upon request from the AF.

The G-SMF initiates the GC Session Start procedure before the start time of GC Session, which is requested by the AF. This is a request to establish the resources of the network for the transfer of group session data. Through this procedure, the session attributes such as QoS, groupcast area, are provided to the relatedAMF(s) and RAN nodes. In addition the procedure allocates the user plane information to all UPF(s) and E-UTRAN that respond to the GC session start request message.

IP multicast distribution of the user plane data to RAN is supported. The G-SMF allocates an IP Multicast address together with the corresponding IP address of the multicast source are provided to the RAN node via AMF. The group communication payload with the synchronization information shall be distributed by the UPF with IP Multicast to the RAN nodes. The synchronization information is used in the radio interface for the user data transmission synchronization across the RAN nodes similar as described in TS 25.446 [18].

#### B.2.4.3.2 Triggering of the Group Session Establishment



Figure B.2.4.3.2-1: Procedure of triggering group session establishment.

1. In order to activate the group session, AF sends an Group Communication (GC) Session Request message to the NEF, including AF Transaction ID, group session information (groupcast area, scheduled start time, QoS requirements), Application Server information (IP address, port number), and UE information. The UE information may include External Group ID. The groupcast area is the list of Geographic Zone ID(s). The group session information may also include the TMGI.

2. The NEF checks whether the AF is authorized to send the request. If the request is not authorized, then NEF continues in step 11 indicating the reason to failure in the response message.

3. If the AF is authorized by the NEF to send the request, the NEF selects an appropriate G-SMF, and sends the GC Session request to the G-SMF, including the TMGI, service area and/or a list of cell IDs start time, QoS requirements). The NEF may map the groupcast area to RAN service area and a list of cell IDs.

4. If the TMGI is not included, the G-SMF allocates a TMGI and transport network IP multicast address. The G-SMF selects the corresponding G-UPFs and AMFs based on the information of RAN service area and a list of cell IDs. The G-SMF sends a GC Session Start Request message to the AMF nodes to indicate the impending start of the transmission and to provide the session attributes (TMGI, QoS, service area and/or a list of cell IDs, IP address of the multicast source, GC Session Duration, Minimum Time to GC Data Transfer).

5. The AMF sends an N2 message including the session attributes (TMGI, QoS, IP address of the multicast source, GC Session Duration, Minimum Time to GC Data Transfer) to the RAN nodes.

6. If the RAN node accepts IP Multicast distribution, it joins the appropriate transport network IP multicast address allocated by the G-SMF, to enable reception of groupcast data.

The RAN stores the session attributes, and responds the AMF to confirm the reception of the N2 message. The RAN establishes the necessary radio resources for the transfer of groupcast data.

7. The AMF forwards the response from RAN to G-SMF.

8. The G-SMF initiates IP Multicast distribution

9. The UPF acknowledges by sending an N4 Response message.

10. The G-SMF sends a GC Session Response message to the AF including service description, UPF information (IP address and port number).

11. The NEF sends the received response message to AF including the UPF IP address and port number for the user-plane.

#### B.2.4.3.3 Triggering of Session release



Figure B.2.4.3.3-1: Procedure of triggering group session release.

1. When the AF determines that the group session is no longer needed, it shall send a Release GC Session Request message to the NEF, including the TMGI representing the GC Session to be released.

2. The NEF checks whether the AF is authorized by NEF to send the request.

3. If the AF is authorized by NEF to send the request, the NEF sends the Release GC Session Request to the G-SMF.

4. The G-SMF sends a GC Session Stop Request message to the related AMF(s) to indicate the end of GC Session and the resources can be released. The GC Session Context is uniquely identified by the TMGI.

5. The G-AMF forwards N2 message to the RAN nodes.

6. RAN shall disable reception from the IP backbone of the particular groupcast service. Each RAN responds with Session Stop Response message to the AMF. The RAN releases the affected resources and removes the groupcast Context.

7. The AMF responses with Session Stop Response and release its information regarding the session.

8. G-SMF sends N4 request to UPF to delete the groupcast transmission.

9. The UPF acknowledges by sending an N4 Response message.

10. The G-SMF shall send a Release GC Session Response message to the NEF, the result is included.

11. The NEF transfer the message to the AF.

#### B.2.4.3.4 Triggering of Session Modification



Figure B.2.4.3.4-1: Procedure of triggering group session modification.

1. When the AF determines that a created group session need to be modified, it shall send a Modify GC Session Request message to the NEF, including the AF Transaction ID, any new priority and preemption characteristics to be used, and the groupcast area.

2. The NEF checks whether the AF is authorized by NEF to send the request.

3. If the AF is authorized by NEF to send the request, the NEF sends the Modify GC Session request to the G-SMF.

4. If the modification is authorized by G-SMF, The G-SMF sends a Session Update Request (TMGI, QoS, GC Session Duration, Minimum Time to GC Data Transfer) to the G-AMF. The ARP parameter may be different if it is to be updated. The new service area and/or a list of cell IDs maybe included if updated. The G-SMF sends a Session Start Request message to any added AMF, Session Stop Request to any removed AMF, and Session Update to the remaining G-AMF in the new list.

5. The G-AMF sends an N2 message including the GC Session attributes (TMGI, QoS, transport network IP Multicast Address, IP address of the multicast source, GC Session Duration, Minimum Time to GC Data Transfer) to each RAN node that is connected to the AMF.

6. If the RAN has no GC Session context with the TMGI indicated in the N2 message, the RAN creates a GC Session context. Otherwise the RAN compares the new service area and/or a list of cell IDs with the one it has stored in the GC context and make the corresponding update. Then the RAN responds the AMF to confirm the reception of the N2 Message. The RAN establishes/releases the radio resources for the transfer of groupcast data.

7. The AMF updates the GC session attributes in its groupcast Context and responds to the G-SMF.

8. The G-SMF initiates IP Multicast distribution to related UPFs.

9. The UPF acknowledges by sending an N4 Response message.

10. The G-SMF sends a Modify GC Session Response message to the NEF, including the result.

11. The NEF shall send a Modify GC Session Response message to the AF.

## B.2.5 Impacts on existing entities and interfaces/Functional Entities

Editor's note: This clause describes impacts to existing entities and interfaces.

### B.2.5.1 Impacts on existing entities

The solution has impacts on the following network entities:

1. The SMF supports the following additional functions:

- Initiate group Session establishment/modification/release procedure;

- Allocate and refresh the TMGI;

- Notify the AF the information necessary for transmitting the group session data via NEF.

- Support IP multicast transmission between RAN and G-UPF

2. AMF:

- AMF is able to support transfer of messages between the SMF and the RAN related to session for group session.

3. RAN:

- RAN part Group relevant group session activation/modification upon request from core network;

- Deliver the group session data to the designated area;

- Receiving multicast data from UPF.

4. NEF:

- Provides interfaces between both SMF and AF for group session management;

- Mapping the geographical area information to the RAN service area and ECGI.

- Select G-SMF for group session

5. AF:

- Membership management: In transport only mode, the membership management is implemented in the AF side;

- Security: The AF takes charge of encrypting the data of the GC session;

- Service announcement: The AF performs service announcement by itself to announce the necessary parameters to the UE for receiving the data of group communication;

- Triggering of Group relevant group session to SMF directly for through NEF.

6. UPF:

- support multicast transmission to RAN for the group session data

- Distribute the synchronization information with the group session data to the RAN nodes if needed

- Receive the group session data from AF/Content Provider and map into the group session for multicast transmission to RAN

- security association between UPF and AF/Context Provider, e.g. DTLS, IPSec

### B.2.5.2 Impacts on existing interfaces

**N2**: It is the reference point between AMF and RAN for transmitting session attributes (e.g., TMGI, QoS, IP Multicast Address, GC Session Duration, Minimum Time to GC Data Transfer).

**N3**: It is the reference point between UPF and RAN for group session data delivery. IP Multicast is used on this interface to forward data.

**N11**: It is the reference point between G-SMF and AMF for transmitting session attributes (e.g., TMGI, QoS, group session service area, IP Multicast Address, GC Session Duration, Minimum Time to GC Data Transfer).

**Nnef**: It is the service interface provided by NEF, and it shall support the 1) Interact with AF for the group session related actions, and 2) Create/modification/release group session.

## B.2.6 Evaluation

Editor's note: This clause provides an evaluation of the solution.

# B.3 Solution #B3: Support for eMBMS over EPS MBMS with independent unicast from 5GS

## B.3.1 Functional Description

### B.3.1.1 General description

This solution assumes that the Application Server or network function, e.g. V2X Application Server or SCEF, in charge of the broadcast traffic generation has access to the EPS based MBMS system serving the area of the UE. The EPS based eMBMS system is as defined in TS 23.246 [16], with some extensions introduced in TS 23.285 [5]. This solution applies to both eV2X and CIOT.

### B.3.1.2 Solution description

#### B.3.1.2.1 General solution for support of receiving eMBMS traffic for UE connected to 5GS

The MBMS architecture in TS 23.246 [16], clause D.2.3 defines the following UE Scenarios:

*UE Scenario 1: The UE receives both unicast and broadcast service from same PLMN. The UE follows the same functionality as defined in clause 5.2.*

*UE Scenario 2: The UE receives broadcast MBMS service without PLMN subscription over E-UTRAN without the need to access and register with the PLMN offering the MBMS service. The UE acts in Receive Only mode as defined in Annex E.*

*UE Scenario 3: The UE receives unicast service from one serving PLMN's (e.g. the PLMN for which it has unicast subscription), and receive MBMS service through a different PLMN. The UE acts in Receive Only mode with independent unicast as defined in Annex E.*

In TS 23.285 [5], all three secenarios are supported. However, when UE is under the coverage of 5GS, UE Scenario 1 may not be usable due to the lack of broadcast delivery mechanism. In this case, UE Secenario 2 or 3 can be still used for the UE.

The UE in this case is operating in Receive-Only Mode (ROM) as defined in Annex E of TS 23.246 [16]. Specifically, for UE Scenario 3, if the independent unicast for UE is using 5GS, the UE architecture for these scenarios is shown in Figure B.3.1.2.1-1, based on the illustration in TS 23.246 [16].



Figure B.3.1.2.1-1: UE components in Receive Only Mode and Receive Only Mode with independent 5GS unicast

#### B.3.1.2.2 Applying the general solution to eV2X

In TS 23.285 [5], the eMBMS architecture for V2X was specified when EPS is used. It was clarified that the UE can receive the downlink broadcast from the PLMN other than Serving PLMN based on the V2X USD(s) obtained, i.e. use the ROM mode.

Therefore, the same applies even when UE is connected to 5GS over unicast. The only requirement is to provide the UE with the V2X USD(s). Therefore, the three different approaches of providing the V2X USD(s) listed in TS 23.285 [5] can be used as well:

- Existing MBMS service announcement mechanisms specified in TS 23.246 [16] and TS 26.346 [17].

- Provisioning via 5GS from V2X Control Function or PCF depending on conclusion of the architecture.

- Provisioning from the V2X Application Server via V1 reference point.

Following figure shows architecture that supports the MBMS ROM operation with UE connected to 5GS.



Figure B.3.1.2.2-1: Network architecture for receiving MBMS from EPS and independent unicast from 5GS

For UE that is connected via 5GS, it can access the V2X Application Server via the NG-Uu connections using unicast mechanism. Over this link, UE could obtain configurations for V2X operation, including the V2X USD(s) for receiving MBMS traffic over the EPS MBMS system (of the same or different PLMNs). Such configurations can be delivered via either the provisioning mechanism defined for V2X in 5GS (e.g. from V2X Control Function or PCF - not shown in the figure), or from the V2X Application Server via V1.

In case the EPS MBMS system is in another PLMN than that of the 5GS, the V2X Application Server would handle the interaction with the MBMS system of that PLMN. The UE is configured with the V2X Application Server information for the service access, similar to that defined in TS 23.285 [5]. There is no UE impacts in this aspect.

## B.3.2 Procedures

Since the EPS MBMS system is used, the procedure as defined in TS 23.285 [5] clause 5.4.2 can be resused.

## B.3.3 Impact on existing entities and interfaces

There is no impact to the UE, as the UE as specified in TS 23.285 [5] already supports Receive Only Mode operation for MBMS in EPS.

There is no impact to 5GS, as it only provides unicast access to UE as normal.

In case the UE provides NG-RAN Cell IDs to the V2X Application Server, as in clause 5.4.2.1 of TS 23.285 [5], either the V2X Application Server or the BM-SC needs to be able to derive the correct MBMS Service Area and SAI list based on that.

## B.3.4 Topics for further study

Editor's note: This clause describes topics for further study.

## B.3.5 Conclusions

Editor's note: This clause provides conclusions of the solution.

# B.4 Solution #B4: Support of multicast/groupcast/broadcast services in 5GS

## B.4.1 Functional Description

### B.4.1.1 Architecture

This solution proposes a new architecture alternative as a starting point for MBMS services in 5G together for V2X services and CIoT requirements. It is assumed that unilateral development of 5G solution in this context without RAN work and not having full scope of MBMS services is not the best approach to take. The study should also look into efficiency, streamlining and appropriate separation of functions aligned with 5G architecture principles.

Figure B.4.1.1-1 illustrates the functional decomposition and possible interactions among these functions related to MBMS.

NOTE 1: This architecture option proposes RAN WGs to develop NG-RAN MBMS architecture together with SA WG2 in order to determine how the functional split will be determined.



Figure B.4.1.1-1: 5G MBMS functional decomposition

NOTE 2: MCPTT services today do not use xMB interfaces. Though any 3GPP or 3rd Party services can utilise xMB.

NOTE 3: The interfaces among the entities are shown for illustration purposes only and not proposed as an architecture.

Some additional key open questions are (not exhaustive):

- Development of NG-RAN - 5GCN MBMS functional distribution and NG-RAN MBMS functions

- Does the MBMS system offer an IP level service (similar to today's SA WG2 architecture) and / or does the MBMS system also offer delivery services (similar separation as with IMS in SA WG2)?

NOTE 4: SA WG2 work already earlier separated IP Level service and delivery services into Service Type 1 (aka Transport-Only Service) and Service Type 2 (aka full Service) within the TV broadcast services.

- MBMS Services: MCPTT, Live DASH, RTP and file delivery.

NOTE 5: MCPTT has just moved functions from a BM-SC node to the MCPTT AS node. Thus, the MCPTT architecture follows a bit or a different deployment view.

- The BM-SC is supposed to be "transparent" for the MCPTT AS (i.e. MCPTT AS accesses only the MBMS Bearer Services).

- The UPF is an IP level function, similar to MBMS-GW. The function of the MBMS-GW was to separate Core network (GTP tunneling domain) for Service layer (IP routed domain), does MBMS GW user plane have distinct charactiertics that require new entity/NF?

- It may make sense to combine MBMS-GW and BM-SC network functions (control and user plane as 5G system)?

- Separate out the BMSC Application Function component as stand alone enabling appropriate functional separation?

- Can all MBMS Control plane functions be combined including functions currently belonging to MME?

- All EPC MBMS functions are needed. However, functions may be moved / combined to provide better/efficient delivery of the services?

- Keep Unicast and MBMS Functions separated as in EPC? Likely answer is yes.

NOTE 6: It is RAN WGs responsibility to study MBMS architecture for RAN.

NOTE 7: The full architecture needs to be studied together with SA WG4, SA WG6 and RAN WGs.

### B.4.1.2 Service-based interfaces and Reference points

Tbd.

## B.4.2 Procedures

Tbd.

## B.4.3 Impact on existing entities and interfaces

Tbd.

## B.4.4 Topics for further study

Editor's note: This clause describes topics for further study.

## B.4.5 Conclusions

Editor's note: This clause provides conclusions of the solution.

Annex C:  
Change history

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Change history** | | | | | | | |
| **Date** | **Meeting** | **TDoc** | **CR** | **Rev** | **Cat** | **Subject/Comment** | **New version** |
| 2018-12 | SP#82 | - | - | - | - | MCC editorial update for presentation to TSG SA#82 | 1.0.0 |
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