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TECHNICAL SPECIFICATION

**5G;**
**Architecture enhancements for 5G System (5GS) to support Vehicle-to-Everything (V2X) services (3GPP TS 23.287 version 19.1.0 Release 19)**

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# Contents

# Foreword

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

# 1 Scope

The present document specifies architecture enhancements to the 5G System to facilitate vehicular communications for Vehicle-to-Everything (V2X) services, over the following reference points, based on service requirements defined in TS 22.185 [2] and TS 22.186 [3]:

- PC5 reference point: NR PC5 RAT, LTE PC5 RAT.
- Uu reference point: NR, E-UTRA.

This specification also covers interworking with 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 TS 22.185: "Service requirements for V2X services; Stage 1".

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

[4] ISO 17419:2018: "Intelligent transport systems - Cooperative systems - Globally unique identification".

[5] IEEE Std 1609.12-2016: "IEEE Standard for Wireless Access in Vehicular Environments (WAVE) - Identifier Allocations".

[6] 3GPP TS 23.501: "System Architecture for the 5G System; Stage 2".

[7] 3GPP TS 23.502: "Procedures for the 5G System; Stage 2".

[8] 3GPP TS 23.285: "Architecture enhancements for V2X services".

[9] 3GPP TS 36.300: "Evolved Universal Terrestrial Radio Access (E-UTRA) and Evolved Universal Terrestrial Radio Access Network (E-UTRAN); Overall description; Stage 2".

[10] 3GPP TS 36.304: "Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) procedures in idle mode".

[11] 3GPP TS 38.300: "NR; NR and NG-RAN Overall Description; Stage 2".

[12] 3GPP TS 38.304: "NR; User Equipment (UE) procedures in Idle mode and RRC Inactive state".

[13] 3GPP TS 23.122: "Non-Access-Stratum (NAS) functions related to Mobile Station (MS) in idle mode".

[14] 3GPP TS 36.331: "Evolved Universal Terrestrial Radio Access (E-UTRA); Radio Resource Control (RRC); Protocol specification".

[15] 3GPP TS 38.331: "NR; Radio Resource Control (RRC); protocol specification".

[16] 3GPP TS 23.503: "Policy and Charging Control Framework for the 5G System; Stage 2".

[17] 3GPP TS 23.303: "Proximity-based Services (ProSe); Stage 2".

[18] IEEE Std 1609.3-2010: "IEEE Standard for Wireless Access in Vehicular Environments (WAVE) - Networking Services".

[19] ISO 29281-1:2013: "Intelligent Transport Systems - Communications access for land mobiles (CALM) - Non-IP networking - Part 1: Fast networking & transport layer protocol (FNTP)".

[20] 3GPP TS 23.288: "Architecture enhancements for 5G System (5GS) to support network data analytics services".

[21] IETF RFC 4862: "IPv6 Stateless Address Autoconfiguration".

[22] 3GPP TS 38.413: "NG-RAN; NG Application Protocol (NGAP)".

[23] 3GPP TS 38.423: "NG-RAN; Xn Application Protocol (XnAP)".

[24] 3GPP TS 24.587: "Vehicle-to-Everything (V2X) services in 5G System (5GS); Stage 3".

[25] 3GPP TS 37.340: "Evolved Universal Terrestrial Radio Access (E-UTRA) and NR; Multi-connectivity; Stage 2".

[26] 3GPP TS 33.536: "Security aspects of 3GPP support for advanced Vehicle-to-Everything (V2X) services".

[27] CCSA YD/T 3707-2020: "Technical requirements of network layer of LTE-based vehicular communication".

[28] 3GPP TS 23.247: "Architectural enhancements for 5G multicast-broadcast services; Stage 2".

[29] 3GPP TS 26.502: "5G multicast-broadcast services; User Service architecture".

[30] 3GPP TS 26.517: "5G Multicast-Broadcast User Services; Protocols and Formats".

[31] ETSI TS 102 637-2 V1.2.1: "Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Part 2: Specification of Cooperative Awareness Basic Service".

[32] ETSI TS 102 637-3 V1.1.1: "Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Part 3: Specifications of Decentralized Environmental Notification Basic Service".



# 3 Definitions and abbreviations

## 3.1 Definitions

For the purposes of the present document, the terms and definitions given in TR 21.905 [1] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in TR 21.905 [1].

**Application Layer connection-less group:** An application layer group without group formation in the V2X application layer, e.g., sensor sharing.

**Application Layer ID:** An identifier identifying an entity, e.g. a vehicle, a pedestrian, an RSU within the context of a specific V2X application. The format of this identifier is outside the scope of 3GPP.

NOTE 1: The Application Layer ID could be e.g. Station ID or Vehicle ID defined by other SDOs e.g. ETSI, Society of Automotive Engineers (SAE), etc.

NOTE 2: The usage of Application Layer ID, e.g. one Application Layer ID is associated with one V2X application, one Application Layer ID is associated with more than one V2X applications, or one Application Layer ID is used for all V2X applications in the UE, is up to application layer implementation.

**Application Layer managed group:** An application layer group with group formation and management in the V2X application layer, e.g., platooning, cooperative adaptive cruise control.

**Groupcast mode communication:** It refers to V2X communication over PC5 reference point within a group of UEs where any UE in the group can act as transmitting UE and the rest act as receiving UEs. See also TS 38.300 [11] for more information. The "group" here refers to Application Layer managed group or Application Layer connection-less group.

**Member ID:** An identifier uniquely identifying a member in the Application Layer managed group and that is managed by the V2X application layer.

**Mode of communication:** Mode of communication to be used by the UE over PC5 reference point i.e. broadcast mode (LTE PC5 and NR PC5), groupcast mode (NR PC5) or unicast mode (NR PC5).

**NR Tx Profile:** The transmission mechanism or format to be used by the UE over NR PC5 RAT (e.g. PC5 DRX support or not), see TS 38.300 [11] and TS 38.331 [15].

**NR eTx Profile:** The enhanced transmission mechanism or format to be used by the UE over NR PC5 RAT (e.g. related to PC5 carrier aggregation), see TS 38.300 [11] and TS 38.331 [15].

NOTE 3: The contents of the NR Tx Profile and the NR eTx Profile are not visible to the V2X layer.

**V2X application:** An application using one or more V2X services e.g. an active safety application in a vehicle, using V2X services such as emergency warning and vehicle to vehicle safety and awareness. A V2X application may operate towards a V2X Application Server.

**V2X communication:** A communication to support Vehicle-to-Everything (V2X) services leveraging Uu and / or PC5 reference points. V2X services are realized by various types of V2X applications, i.e. Vehicle-to-Vehicle (V2V), Vehicle-to-Pedestrian (V2P), Vehicle-to-Infrastructure (V2I) and Vehicle-to-Network (V2N).



**V2X message:** A dedicated messaging type of V2X service, for example ITS messages.

**V2X service:** A data service, offered to V2X applications and optionally V2X Application Servers. A V2X service belongs to one V2X service type. It may include message or other data delivery, as defined in TS 22.185 [2] and TS 22.186 [3]. A V2X service can be associated with one or more V2X applications, and a V2X application can be associated with one or more V2X services.



**V2X service type:** A type of V2X service, which is identified by e.g. ITS-AID (ITS Application Identifier), PSID (Provider Service Identifier) or AID (Application Identifier).

For the purposes of the present document, the following terms and definitions given in ISO 17419:2018 [4] apply:

**Intelligent Transport Systems**

**ITS Application Identifier**

For the purposes of the present document, the following term and definition given in IEEE Std 1609.12-2016 [5] apply:

**Provider Service Identifier**

For the purposes of the present document, the following term and definition given in CCSA YD/T 3707-2020 [27] applies:

**Application Identifier**

For the purposes of the present document, the following term and definition given in TS 23.285 [8] apply:

**Tx Profile**

## 3.2 Abbreviations

For the purposes of the present document, the abbreviations given in TR 21.905 [1] 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].

| | |
|---|---|
| AF | Application Function |
| AID | Application Identifier |
| AS layer | Access Stratum layer |
| ITS | Intelligent Transport Systems |
| ITS-AID | ITS Application Identifier |
| MBS | Multicast/Broadcast Service |
| NID | Network identifier |
| PFI | PC5 QoS Flow Identifier |
| PQI | PC5 5QI |
| PSID | Provider Service Identifier |
| RSU | Road Side Unit |
| SNPN | Stand-alone Non-Public Network |
| V2I | Vehicle-to-Infrastructure |
| V2N | Vehicle-to-Network |
| V2P | Vehicle-to-Pedestrian |
| V2V | Vehicle-to-Vehicle |
| V2X | Vehicle-to-Everything |

# 4 Architecture model and concepts



## 4.1 General concept



There are two modes of operation for V2X communication, namely V2X communication over PC5 reference point and V2X communication over Uu reference point. These two operation modes may be used by a UE independently for transmission and reception.

V2X communications over PC5 reference point are supported by LTE and/or NR.

V2X communications over Uu reference point are supported by E-UTRA connected to 5GC and/or NR connected to 5GC:

- For E-UTRA connected to 5GC, V2X communication over Uu reference point is only unicast.
- For NR connected to 5GC, V2X communication over Uu reference point can be unicast and/or multicast/broadcast as defined in TS 23.247 [28].

An RSU is not an architectural entity, but an implementation option. This is achieved by collocating a V2X application logic/server with some entities of the 3GPP system, as shown in examples in Annex B.

## 4.2 Architectural reference model

### 4.2.1 PC5 and Uu based V2X architecture reference model

#### 4.2.1.1 Non-roaming 5G System architecture for V2X communication over PC5 and Uu reference points

Figure 4.2.1.1-1 shows the high level view of the non-roaming 5G System architecture for V2X communication over PC5 and Uu reference points.

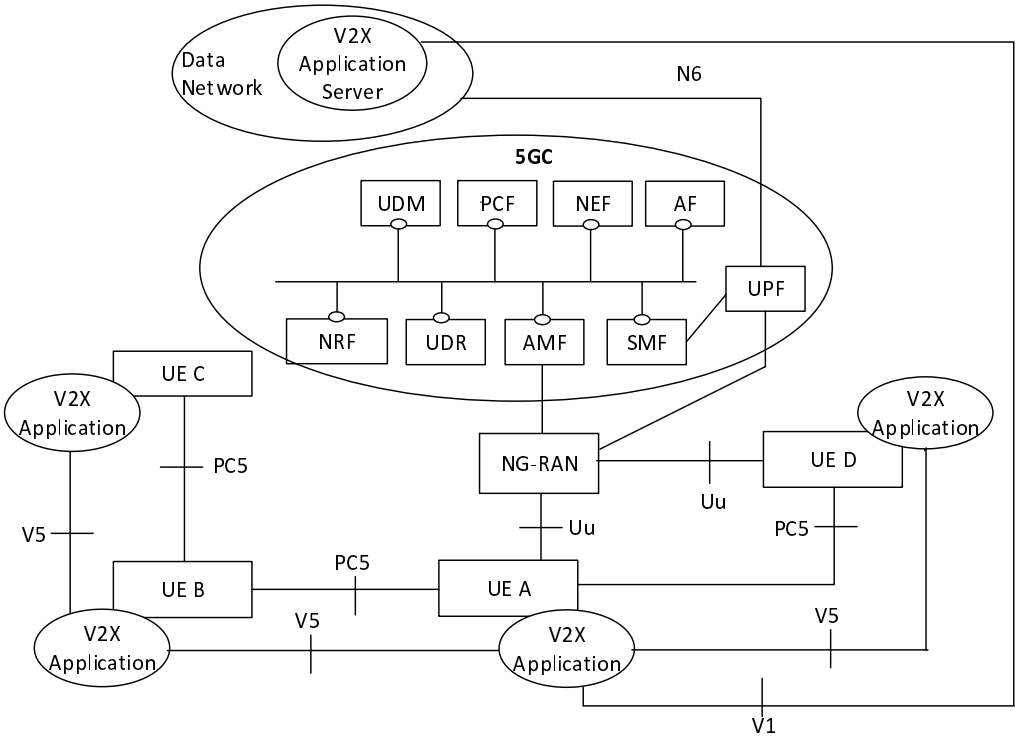


**Figure 4.2.1.1-1: Non-roaming 5G System architecture for V2X communication over PC5 and Uu reference points**



### 4.2.1.2 Roaming 5G System architecture for V2X communication over PC5 and Uu reference points

Figure 4.2.1.2-1 and Figure 4.2.1.2-2 show the high level view of the roaming 5G System architectures for V2X communication over PC5 and Uu reference points. In these figures, UE A uses a subscription of HPLMN.

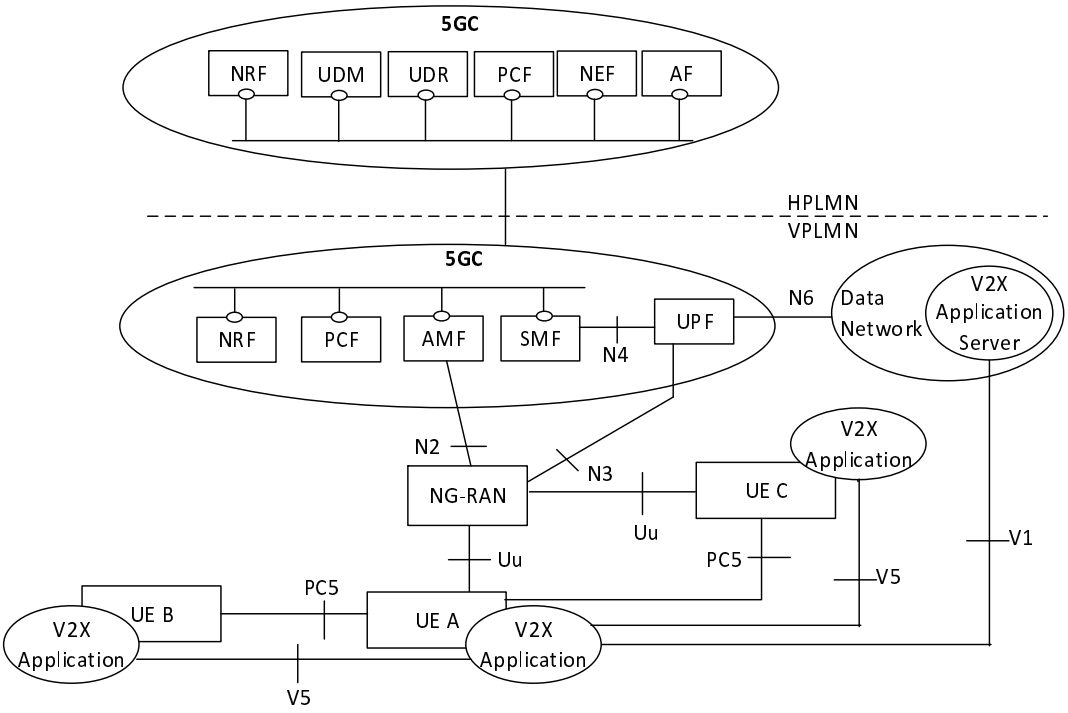


**Figure 4.2.1.2-1: Roaming 5G System architecture for V2X communication over PC5 and Uu reference points - Local breakout scenario**

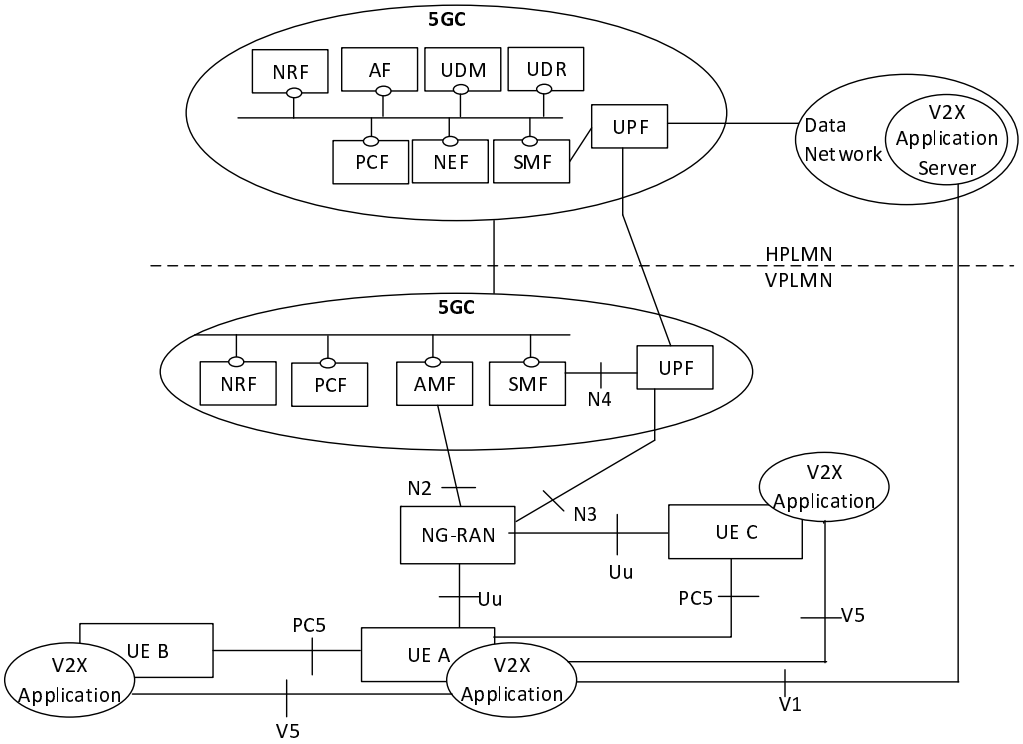


**Figure 4.2.1.2-2: Roaming 5G System architecture for V2X communication over PC5 and Uu reference points - Home routed scenario**



### 4.2.1.3 Inter-PLMN 5G System architecture for V2X communication over PC5 reference point

In the case of inter-PLMN V2X communication over PC5 reference point, the PC5 parameters need to be configured in a consistent way among the UEs within a certain region. The architecture for the Inter-PLMN PC5 case is similar to the one defined in clause 4.2.1.1.

## 4.2.2 AF-based service parameter provisioning for V2X communications

The 5G System provides NEF services to enable communication between NFs in the PLMN and V2X Application Server. Figure 4.2.2-1 shows the high level view of AF-based service parameter provisioning for V2X communications. The V2X Application Server may provide V2X service parameters to the PLMN via NEF. The NEF stores the V2X service parameters in the UDR.

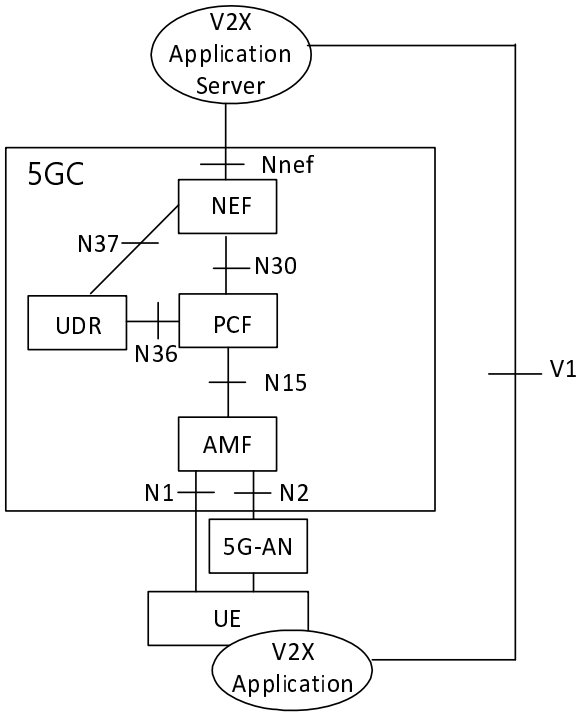


**Figure 4.2.2-1: 5G System architecture for AF-based service parameter provisioning for V2X communications**

## 4.2.2A MBS for Uu based V2X architecture reference model

The reference architectures for MBS for Uu based V2X communication are based on the MBS reference architectures specified in clause 5.1 of TS 23.247 [28].

Configuration options at Service and/or Application for MBS specified in Annex A of TS 23.247 [28] and Interworking at reference points MB2 and xMB specified in Annex C of TS 23.247 [28], can be applied for Uu based V2X communication via MBS.

The V2X Application Server acts as an AF/AS defined in clause 5.1 and Annex A of TS 23.247 [28].

## 4.2.3 Reference points

**V1**: The reference point between the V2X applications in the UE and in the V2X Application Server. This reference point is out of scope of this specification.

**V5**: The reference point between the V2X applications in the UEs. This reference point is not specified in this release of the specification.

**PC5**: The reference point between the UEs, and it includes the LTE based PC5 and/or NR based PC5.

**N1**: In addition to the relevant functions defined in TS 23.501 [6] for N1, in the case of V2X Service it is also used to convey the V2X policy and parameters (including service authorization) from AMF to UE and to convey the UE's V2X-Uu Capability and PC5 Capability for V2X information from UE to AMF.

**N2**: In addition to the relevant functions defined in TS 23.501 [6] for N2, in the case of V2X Service it is also used to convey the V2X policy and parameters (including service authorization) from AMF to NG-RAN.

**Uu**: The reference point between the UE and the NG-RAN.

### 4.2.4 Service-based interfaces

**Nudm**: In addition to the relevant services defined in TS 23.501 [6] for Nudm, in the case of V2X Service, services provided by UDM are used to get V2X Service related subscription information to AMF during Initial registration procedure or UE Configuration Update (UCU) procedure to inform AMF subscription information has changed.

**Npcf**: In addition to the relevant services defined in TS 23.501 [6] for Npcf, in the case of V2X Service, services provided by H-PCF are used to provide V2X Service related parameters to V-PCF for UE and NG-RAN in the roaming case.

**Nudr**: In addition to the relevant services defined in TS 23.501 [6] for Nudr, in the case of V2X Service, services provided by UDR are used to notify the PCF and the UDM of the update of the V2X Service related information.

**Nnef**: In addition to the relevant services defined in TS 23.501 [6] for Nnef, in the case of V2X Service, services provided by NEF are used by the V2X Application Server to update V2X Service related information of 5GC.

**Namf:** In addition to the relevant services defined in TS 23.501 [6] for Namf, in the case of V2X Service, services provided by AMF are consumed by PCF to provide the V2X Service related parameters for the UE and the NG-RAN to AMF, and to enable the AMF create or update UE context related to V2X service.

**Nnrf:** In addition to the relevant services defined in TS 23.501 [6] for Nnrf, in the case of V2X Service, services provided by NRF are used to discover the PCF that supports V2X.

## 4.3 Architecture reference model for interworking with EPS V2X

The interworking between 5GS V2X and EPS V2X does not require any new interface between 5GS V2X and EPS V2X architectures and does not impact existing network function entities in EPC and 5GC. Figure 4.3-1 shows one of the architecture reference models.