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1 Scope

The present document specifies the protocols:

- for V2X authorization between the UE and the V2X control function (over the V3 interface);
- for V2X communication among the UEs (over the PC5 interface); and
- for V2X communication between the UE and the V2X application server (over the LTE-Uu interface).

The present document defines the associated procedures for V2X authorization and V2X communication.

The present document also defines the message format, message contents, error handling and system parameters applied by the protocols for V2X.

The present document is applicable to:

- the UE;
- the V2X control function; and
- the V2X application server.

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 23.285: "Architecture enhancements for V2X services".
- [3] 3GPP TS 24.385: "V2X services Management Object (MO)".
- [4] 3GPP TS 24.334: "Proximity-services (ProSe) User Equipment (UE) to Proximity-services (ProSe) Function Protocol aspects; Stage 3".
- [5] IEEE 1609.3 2016: "IEEE Standard for Wireless Access in Vehicular Environments (WAVE) -- Networking Services".
- [6] ISO 29281-1 2013: "Intelligent transport systems -- Communication access for land mobiles (CALM) -- Non-IP networking -- Part 1: Fast networking & transport layer protocol (FNTP)".
- [7] Void.
- [8] 3GPP TS 36.323: "Packet Data Convergence Protocol (PDCP) specification".
- [9] 3GPP TS 23.122: "Non-Access-Stratum (NAS) functions related to Mobile Station (MS) in idle mode".
- [10] 3GPP TS 36.304: "Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) procedures in idle mode".
- [11] 3GPP TS 24.301: "Non-Access-Stratum (NAS) protocol for Evolved Packet System (EPS); Stage 3".

- [12] 3GPP TS 24.008: "Mobile Radio Interface Layer 3 specification; Core Network Protocols; Stage 3".
- [13] IETF RFC 1035: "DOMAIN NAMES - IMPLEMENTATION AND SPECIFICATION".
- [14] 3GPP TS 23.003: "Numbering, addressing and identification".
- [15] 3GPP TS 29.468: "Group Communication System Enablers for LTE (GCSE_LTE); MB2 Reference Point; Stage 3".
- [16] IETF RFC 4566: "SDP: Session Description Protocol".
- [17] IETF RFC 2234: "Augmented BNF for Syntax Specification: ABNF".
- [18] IETF RFC 768: "User Datagram Protocol".
- [19] Void.
- [20] 3GPP TS 33.185: "Security aspect for LTE support of V2X services".
- [21] 3GPP TS 33.401: "3GPP System Architecture Evolution: Security Architecture".
- [22] 3GPP TS 36.331: "Evolved Universal Terrestrial Radio Access (E-UTRA); Radio Resource Control (RRC); Protocol specification".
- [23] ETSI EN 302 636-3 v1.2.1: "Intelligent Transport Systems (ITS); Vehicular Communications; GeoNetworking; Part 3: Network Architecture".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in 3GPP 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 3GPP TR 21.905 [1].

Not served by E-UTRAN for V2X communication: the UE is either:

- outside of E-UTRAN coverage;
- within E-UTRAN coverage but not camped on any cell;
- within E-UTRAN coverage but camped on a non-E-UTRAN cell;
- camped on an E-UTRAN cell not indicating that V2X communication over PC5 is supported by the network; or
- camped on an E-UTRAN cell indicating that V2X communication over PC5 is supported by the network and providing carrier frequencies and/or radio resources for V2X communication over PC5 which do not belong to the provisioned carrier frequency that the UE intends to use.

V2X service identifier: an identifier of a V2X service, e.g. PSID or ITS-AIDs of the V2X application.

For the purposes of the present document, the following terms and definitions given in 3GPP TS 23.285 [2] apply:

Intelligent Transport Systems (ITS)
ITS Application Identifier (ITS-AID)
ProSe Per-Packet Reliability (PPPR)
Provider Service Identifier (PSID)
V2X service

For the purposes of the present document, the following terms and definitions given in 3GPP TS 23.003 [14] apply:

TMGI

3.2 Abbreviations

For the purposes of the present document, the abbreviations given in 3GPP 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 3GPP TR 21.905 [1].

PDB	Packet Delay Budget
PPPP	ProSe Per-Packet Priority
SAI	Service Area Identifier
SDP	Session Description Protocol
UDP	User datagram protocol
V2X	Vehicle-to-Everything

4 General

4.1 Overview

The present specification specifies means for transport of V2X messages. V2X messages are generated and consumed by upper layers of the UE and the V2X application server. V2X messages can contain IP data or non-IP data.

The V2X messages can be transported using:

- V2X communication over PC5; and
- V2X communication over LTE-Uu.

V2X communication over PC5 enables transfer of V2X messages among UEs. For V2X messages containing IP data, only IPv6 is used. IPv4 is not supported in this release of the specifications.

V2X communication over LTE-Uu enables transfer of V2X messages between a UE and a V2X application server. V2X messages are carried over LTE-Uu in payload of a UDP/IP packet. A UE using V2X communication over LTE-Uu:

- can use unicast transport (in uplink, downlink or both of them);
- can use MBMS transport (in downlink only);
- can use transport for uplink which is the same or different to the transport for downlink; and
- can use also MBMS transport for downlink without using any transport for uplink.

The communication security over the V3 interface and LTE-Uu interface is specified in 3GPP TS 33.185 [20]. The communication security and privacy over the PC5 interface is specified in 3GPP TS 33.185 [20].

NOTE: ProSe charging specified in 3GPP TS 24.334 [4] is expected to be usable for V2X communication over PC5, although no V2X specific procedures for charging are specified in this release.

5 Provisioning of parameters for V2X configuration

5.1 General

V2X communication is configured by the V2X configuration parameters.

5.2 Configuration and precedence of V2X configuration parameters

5.2.1 General

The V2X configuration parameters consist of:

- a) configuration parameters for V2X provisioning as specified in subclause 5.2.3;
- b) configuration parameters for V2X communication over PC5 as specified in subclause 5.2.4; and
- c) configuration parameters for V2X communication over LTE-Uu as specified in subclause 5.2.5.

5.2.2 Precedence of the V2X configuration parameters

The V2X configuration parameters can be:

- a) pre-configured in the ME;
- b) configured in the USIM;
- c) provided by the V2X control function to the ME using procedures specified in subclause 5.3.2, subclause 5.3.3 and subclause 5.3.4; or
- d) any combination of the above.

The UE shall use the V2X configuration parameters in the following order of decreasing precedence:

- a) the V2X configuration parameters provided by the V2X control function to the ME using procedures specified in subclause 5.3.2, subclause 5.3.3 and subclause 5.3.4;
- b) the V2X configuration parameters configured in the USIM; and
- c) the V2X configuration parameters pre-configured in the ME.

5.2.3 Configuration parameters for V2X provisioning

The configuration parameters for V2X provisioning consist of:

- a) optionally a V2X control function address. The V2X control function address can be an FQDN or an IP address; and
- b) optionally parameters of a PDN connection for communication with V2X control function.

5.2.4 Configuration parameters for V2X communication over PC5

The configuration parameters for V2X communication over PC5 consist of:

- a) an expiration time for the validity of the configuration parameters for V2X communication over PC5;
- b) a list of PLMNs in which the UE is authorized to use V2X communication over PC5 when the UE is served by E-UTRAN for V2X communication;
- c) an indication of whether the UE is authorized to use V2X communication over PC5 when the UE is not served by E-UTRAN for V2X communication;
- d) per geographical area:
 - 1) radio parameters for V2X communication over PC5 applicable when the UE is not served by E-UTRAN for V2X communication and is located in the geographical area, with an indication of whether these radio parameters are "operator managed" or "non-operator managed";
- e) a list of the V2X services authorized for V2X communication over PC5. Each entry of the list contains:
 - 1) a V2X service identifier; and
 - 2) a destination Layer-2 ID;
- f) PPPP to PDB mapping rules between the ProSe Per-Packet Priority (PPPP) and the Packet Delay Budget (PDB) for V2X communication over PC5;
- g) optionally, a default destination Layer-2 ID;
- h) optionally, a configuration for the applicability of privacy for V2X communication over PC5, containing:

- 1) a T5000 timer indicating how often the UE shall change the source Layer-2 ID and source IP address (for IP data) self-assigned by the UE for V2X communication over PC5; and
- 2) a list of the V2X services which require privacy for V2X communication over PC5. Each entry in the list contains:
 - A) a V2X service identifier; and
 - B) optionally, one or more associated geographical areas;
- i) optionally, V2X service identifier to V2X frequency mapping rules between the V2X service identifiers and the V2X frequencies with associated geographical areas for V2X communication over PC5; and
- j) optionally, a list of the V2X services authorized for ProSe Per-Packet Reliability (PPPR). Each entry of the list contains a V2X service identifier and a ProSe Per-Packet Reliability (PPPR) value; and
- k) optionally, V2X service identifier to Tx Profile mapping rules between the V2X service identifiers and the Tx Profile for V2X communication over PC5.

5.2.5 Configuration parameters for V2X communication over LTE-Uu

The configuration parameters for V2X communication over LTE-Uu consist of:

- a) an expiration time for the validity of the configuration parameters for V2X communication over LTE-Uu;
- b) optionally parameters of a PDN connection for V2X communication over LTE-Uu using unicast; and
- c) a list of PLMNs in which the UE is authorized to use V2X communication over LTE-Uu. For each PLMN, the list contains:
 - 1) optionally a V2X AS MBMS configuration for receiving V2X application server information using MBMS consisting of:
 - A) a TMGI;
 - B) a list of service area identifiers (SAIs);
 - C) a frequency; and
 - D) an SDP encoded as specified in subclause 7.3;
 - 2) for transfer of a V2X message of a V2X service not identified by a V2X service identifier:
 - A) optionally one or more V2X MBMS configuration(s) for receiving V2X communication over LTE-Uu using MBMS consisting of:
 - i) a TMGI;
 - ii) a list of service area identifiers (SAIs);
 - iii) a frequency; and
 - iv) an SDP body;
 - B) optionally one or more V2X application server address(es) applicable when the UE is registered to the PLMN. A V2X application server address can be an FQDN or an IP address; and
 - C) optionally per geographical area, one or more V2X application server address(es) applicable when the UE is registered to the PLMN and is located in the geographical area. A V2X application server address can be an FQDN or an IP address; and
 - 3) for transfer of a V2X message of a V2X service identified by a V2X service identifier:
 - A) a list of the V2X services authorized for V2X communication over LTE-Uu. Each entry of the list contains:
 - i) a V2X service identifier;

- ii) optionally one or more V2X MBMS configuration(s) for receiving V2X communication over LTE-Uu using MBMS consisting of:
 - a TMGI;
 - a list of service area identifiers (SAIs);
 - a frequency; and
 - an SDP body encoded as specified in subclause 7.2;
 - iii) optionally a V2X application server address for the unicast V2X communication over LTE-Uu applicable when the UE is registered to the PLMN. A V2X application server address consists of:
 - an FQDN, or an IP address; and
 - a UDP port; and
 - iv) optionally per geographical area, one or more V2X application server address(es) for the unicast V2X communication over LTE-Uu applicable when the UE is registered to the PLMN and is located in the geographical area. A V2X application server address consists of:
 - an FQDN, or an IP address; and
 - a UDP port;
- B) optionally one or more default V2X MBMS configuration(s) for receiving V2X communication over LTE-Uu using MBMS consisting of:
- i) a TMGI;
 - ii) a list of service area identifiers (SAIs);
 - iii) a frequency; and
 - iv) an SDP body encoded as specified in subclause 7.2;
- C) optionally per type of data (IP and non-IP) and V2X message family (in case of non-IP), one or more default V2X application server addresses for the unicast V2X communication over LTE-Uu applicable when the UE is registered to the PLMN. Each V2X application server address consists of:
- i) an FQDN, or an IP address; and
 - ii) a UDP port;
- D) optionally per type of data (IP and non-IP), V2X message family (in case of non-IP) and a geographical area, one or more default V2X application server addresses for the unicast V2X communication over LTE-Uu applicable when the UE is registered to the PLMN. A V2X application server address consists of:
- i) an FQDN, or an IP address; and
 - ii) a UDP port; and
- E) a list of V2X service identifiers of the V2X services authorized for V2X communication over LTE-Uu using existing unicast routing.

5.3 Procedures

5.3.1 General

The procedures specified in remaining subclauses of the parent subclause of this subclause enable modification of the configuration parameters of the UE specified in subclause 5.2. The UE and the V2X control function shall support requirements for securing communication over V3 reference point as specified in 3GPP TS 33.185 [20].

5.3.2 V2X control function discovery procedure

In order to discover the V2X control function IP address, the UE shall proceed in following order of decreasing precedence:

- a) if the V2X control function address specified in subclause 5.2.3 is provisioned and is an IP address, the UE shall use this IP address as the discovered V2X control function address;
- b) if the V2X control function address specified in subclause 5.2.3 is provisioned and is an FQDN, the UE shall perform DNS lookup of the V2X control function FQDN as specified in IETF RFC 1035 [13] and shall use the resulting IP address as the discovered V2X control function address;
- c) if the V2X control function address specified in subclause 5.2.3 is not provisioned and the UE is pre-configured with a V2X control function FQDN, the UE shall perform DNS lookup as specified in IETF RFC 1035 [13] of the V2X control function FQDN and shall use the resulting IP address as the discovered V2X control function address; and
- d) if the V2X control function address specified in subclause 5.2.3 is not provisioned and the UE is not pre-configured with a V2X control function FQDN, the UE shall self-construct the V2X control function FQDN as specified in 3GPP TS 23.003 [14], shall perform DNS lookup as specified in IETF RFC 1035 [13] of the V2X control function FQDN and shall use the resulting IP address as the discovered V2X control function address.

5.3.3 V2X authorization procedure

5.3.3.1 General

The V2X authorization procedure enables the UE to retrieve V2X communication parameters from the V2X control function.

The UE shall initiate the V2X authorization procedure:

- a) when the UE receives a request from upper layers to send or to receive using V2X communication over PC5 a V2X message of a V2X service identified by a V2X service identifier and:
 - 1) the expiration time of validity of the configuration parameters for V2X communication over PC5 indicates a timer earlier than the current time; or
 - 2) the V2X service identifier is not listed in an entry of the list of the V2X services authorized for V2X communication over PC5 and the registered PLMN is in the list of PLMNs in which the UE is authorized to use V2X communication over PC5 as specified in subclause 5.2.4;
- b) when the UE is served by E-UTRAN for V2X communication and the UE changes its registered PLMN to a PLMN which is not listed in the list of PLMNs in which the UE is authorized to use V2X communication over PC5 when the UE is served by E-UTRAN for V2X communication;
- c) when the UE is served by E-UTRAN for V2X communication and the UE changes its registered PLMN to a PLMN which is not listed in the list of PLMNs in which the UE is authorized to use V2X communication over LTE-Uu;
- d) when the UE receives a request from upper layers to send or to receive using V2X communication over LTE-Uu a V2X message of a V2X service not identified by a V2X service identifier and the expiration time of validity of the configuration parameters for V2X communication over LTE-Uu indicates a timer earlier than the current time; or
- e) when the UE receives a request from upper layers to send or to receive a V2X message using V2X communication over LTE-Uu of a V2X service identified by a V2X service identifier and:
 - 1) the expiration time of validity of the configuration parameters for V2X communication over LTE-Uu indicates a timer earlier than the current time; or
 - 2) the V2X service identifier is not listed in an entry of the list of the V2X services authorized for V2X communication over LTE-Uu and the registered PLMN is in the list of PLMNs in which the UE is authorized to use V2X communication over LTE-Uu as specified in subclause 5.2.5.

If the parameters of a PDN connection for communication with V2X control function specified in subclause 5.2.3 are configured:

- a) if a PDN connection according to these parameters is not established yet, the UE shall establish a PDN connection according to these parameters; and
- b) if a PDN connection according to these parameters is already established (due to application of the present specification or due to another application), the UE shall send and receive messages of the V2X authorization procedure via the PDN connection established according to these parameters.

The UE shall send messages of the V2X authorization procedure to the V2X control function IP address discovered as specified in subclause 5.3.2.

5.3.3.2 V2X authorization procedure initiation

In order to initiate the V2X authorization procedure, the UE shall request client-initiated provisioning of the management object specified in 3GPP TS 24.385 [3].

Upon receiving a request for client-initiated provisioning of the management object specified in 3GPP TS 24.385 [3], the V2X control function may update the management object specified in 3GPP TS 24.385 [3] in the UE.

5.3.3.3 V2X authorization procedure successful

If client-initiated provisioning of the management object specified in 3GPP TS 24.385 [3] successfully finishes, the UE and the V2X control function shall consider the V2X authorization procedure to be successfully completed.

5.3.3.4 V2X authorization procedure not successful

If the UE receives no response within an implementation dependent time after sending of the request for client-initiated provisioning of the management object specified in 3GPP TS 24.385 [3], the UE shall determine that the V2X authorization procedure is unsuccessfully completed.

5.3.4 V2X authorization update procedure

5.3.4.1 General

The V2X authorization update procedure enables the V2X control function to provide new V2X configuration parameters to the UE.

If the parameters of a PDN connection for communication with V2X control function specified in subclause 5.2.3 are configured:

- a) if a PDN connection according to these parameters is not established yet, the UE shall establish a PDN connection according to these parameters; and
- b) if a PDN connection according to these parameters is already established (due to application of the present specification or due to another application), the UE shall send and receive messages of the V2X authorization update procedure via the PDN connection established according to these parameters.

The UE shall send messages of the V2X authorization update procedure to the V2X control function IP address discovered as specified in subclause 5.3.2.

5.3.4.2 V2X authorization update procedure initiation

In order to initiate the V2X authorization update procedure, the V2X control function shall send a notification requesting the UE to initiate server-initiated provisioning of the management object specified in 3GPP TS 24.385 [3] to the UE.

Upon receiving a notification requesting the UE to initiate server-initiated provisioning of the management object specified in 3GPP TS 24.385 [3], the UE shall request server-initiated provisioning of the management object specified in 3GPP TS 24.385 [3].

Upon receiving a request for server-initiated provisioning of the management object specified in 3GPP TS 24.385 [3], the V2X control function shall update the management object specified in 3GPP TS 24.385 [3] in the UE.

5.3.4.3 V2X authorization update procedure successful

If server-initiated provisioning of the management object specified in 3GPP TS 24.385 [3] successfully finishes, the UE and the V2X control function shall consider the V2X authorization update procedure to be successfully completed.

5.3.4.4 V2X authorization update procedure not successful

If the V2X control function does not receive a request for server-initiated provisioning of the management object specified in 3GPP TS 24.385 [3] within an implementation dependent time after sending of the notification requesting the UE to initiate server-initiated provisioning of the management object specified in 3GPP TS 24.385 [3], the V2X control function shall determine that the V2X authorization update procedure is unsuccessfully completed.

If the UE receives no response within an implementation dependent time after sending of the request for server-initiated provisioning of the management object specified in 3GPP TS 24.385 [3], the UE shall determine that the V2X authorization update procedure is unsuccessfully completed.

6 V2X communication

6.1 V2X communication over PC5

6.1.1 General

This subclause describes the procedures at the UE, and between UEs, for V2X communication over PC5.

The UE shall support requirements for securing V2X communication over PC5 as specified in 3GPP TS 33.185 [20]. The UE shall support a privacy protection for the V2X communication over PC5 subject to regional regulatory requirements and/or operator policy for a V2X application as specified in 3GPP TS 33.185 [20], subclause 6.1.2.4. Both IP based and non-IP based V2X communication over PC5 are supported. For IP based V2X communication, only IPv6 is used. IPv4 is not supported in this release of the present document.

6.1.2 Transmission of V2X communication over PC5

6.1.2.1 Initiation

The upper layers can request the UE to send a V2X message of a V2X service identified by a V2X service identifier using V2X communication over PC5. The request from the upper layers includes:

- a) the V2X message;
- b) the V2X service identifier of the V2X service for the V2X message;
- c) the type of data in the V2X message (IP or non-IP);
- d) if the V2X message contains non-IP data, the V2X message family (see subclause 7.1) of data in the V2X message;
- e) the V2X message priority; and
- f) optionally the ProSe Per-Packet Reliability (PPPR) value.

Upon a request from upper layers to send a V2X message of a V2X service identified by a V2X service identifier using V2X communication over PC5, if the UE is configured with V2X service identifier to V2X frequency mapping rules for V2X communication over PC5 as specified in subclause 5.2.4 and there is one or more V2X frequencies associated with the V2X service identifier of the V2X service for the V2X message in the current the geographical area, pass the one or more V2X frequencies associated with the V2X service identifier of the V2X service for the V2X message to the lower layers. Then, the UE shall proceed as follows:

- a) if the following conditions are met:
 - 1) the UE is served by E-UTRAN for V2X communication;
 - 2) the UE intends to use the radio resources (i.e. carrier frequency) provided by an E-UTRAN cell;

- 3) the registered PLMN is in the list of PLMNs in which the UE is authorized to use V2X communication over PC5 when the UE is served by E-UTRAN for V2X communication as specified in subclause 5.2.4; and
- 4) the V2X service identifier of the V2X service is included in the list of V2X services authorized for V2X communication over PC5 as specified in subclause 5.2.4 or the UE is configured with a default destination Layer-2 ID for V2X communication over PC5 as specified in subclause 5.2.4;

then the UE shall:

- 1) request radio resources for V2X communication over PC5 as specified in 3GPP TS 24.334 [4] subclause 10.2.2. When requesting the radio resources for V2X communication over PC5, if:
 - A) a ProSe Per-Packet Reliability (PPPR) value is received from the upper layers; and
 - B) one of the following conditions is met:
 - i) the list of the V2X services authorized for ProSe Per-Packet Reliability (PPPR) is not configured; or
 - ii) the V2X service identifier of the V2X service for the V2X message and the received ProSe Per-Packet Reliability (PPPR) value are included in an entry of the list of the V2X services authorized for ProSe Per-Packet Reliability (PPPR);

then the UE shall indicate to lower layers the received ProSe Per-Packet Reliability (PPPR) value; and

- 2) perform transmission of V2X communication over PC5 as specified in subclause 6.1.2.2; and

b) if the following conditions are met:

- 1) the UE is:
 - A) not served by E-UTRAN for V2X communication;
 - B) in limited service state as specified in 3GPP TS 23.122 [9], if the reason for the UE being in limited service state is one of the following:
 - i) the UE is unable to find a suitable cell in the selected PLMN as specified in 3GPP TS 36.304 [10];
 - ii) the UE received an ATTACH REJECT message or a TRACKING AREA UPDATE REJECT message or a SERVICE REJECT message with the EMM cause #11 "PLMN not allowed" as specified in 3GPP TS 24.301 [11] or a LOCATION UPDATING REJECT message or a GPRS ATTACH REJECT message or a ROUTING AREA UPDATE REJECT message or SERVICE REJECT message with the EMM cause #11 "PLMN not allowed" as specified in 3GPP TS 24.008 [12]; or
 - iii) the UE received an ATTACH REJECT message or a TRACKING AREA UPDATE REJECT message or a SERVICE REJECT message with the EMM cause #7 "EPS services not allowed" as specified in 3GPP TS 24.301 [11] or a LOCATION UPDATING REJECT message or a GPRS ATTACH REJECT message or a ROUTING AREA UPDATE REJECT message or a SERVICE REJECT message with the EMM cause #7 "GPRS services not allowed" as specified in 3GPP TS 24.008 [12]; or
 - C) in limited service state as specified in 3GPP TS 23.122 [9] for reasons other than i), ii) or iii) above, and located in a geographical area for which the UE is provisioned with "non-operator managed" radio parameters as specified in subclause 5.2.4;
- 2) the UE is authorized to use V2X communication over PC5 when the UE is not served by E-UTRAN for V2X communication as specified in subclause 5.2.4; and
- 3) the V2X service identifier of the V2X service is included in the list of V2X services authorized for V2X communication over PC5 as specified in subclause 5.2.4 or the UE is configured with a default destination Layer-2 ID for V2X communication over PC5 as specified in subclause 5.2.4;

then the UE shall:

- 1) select radio resources for V2X communication over PC5 as specified in subclause 6.1.2.3; and

- 2) perform transmission of V2X communication over PC5 as specified in subclause 6.1.2.2;

else the UE shall not perform transmission of V2X communication over PC5.

If the UE is camped on an E-UTRAN cell indicating that V2X communication over PC5 is supported by the network, but not broadcasting any carrier frequencies and radio resources for V2X communication over PC5 as specified in 3GPP TS 36.331 [23], the UE shall request radio resources for V2X communication over PC5 as specified in 3GPP TS 24.334 [4] subclause 10.2.2.

6.1.2.2 Transmission

The UE shall include the V2X message in a protocol data unit and pass it to the lower layers for transmission along with the following parameters:

- a) a Layer-3 protocol data unit type (see 3GPP TS 36.323 [8]) set to:
 - 1) IP packet, if the V2X message contains IP data; or
 - 2) non-IP packet, if the V2X message contains non-IP data;
- b) the source Layer-2 ID set to the Layer-2 ID self-assigned by the UE for V2X communication over PC5;
- c) the destination Layer-2 ID set to:
 - 1) the destination Layer-2 ID associated with the V2X service identifier of the V2X service in this list of V2X services authorized for V2X communication over PC5 as specified in subclause 5.2.4, if the V2X service identifier of the V2X service is included in the list of V2X services authorized for V2X communication over PC5 as specified in subclause 5.2.4; or
 - 2) the default destination Layer-2 ID configured to the UE for V2X communication over PC5 as specified in subclause 5.2.4, if the V2X service identifier of the V2X service is not included in the list of V2X services authorized for V2X communication over PC5 and the UE is configured with a default destination Layer-2 ID for V2X communication over PC5;
- d) if the V2X message contains non-IP data, an indication to set the non-IP type field of the non-IP type PDU to the value corresponding to the V2X message family (see subclause 7.1) used by the V2X service as indicated by upper layers;
- e) if the V2X message contains IP data, the source IP address set to the source IP address self-assigned by the UE for V2X communication over PC5;
- f) the ProSe Per-Packet Priority set to the value corresponding to the V2X message priority received from upper layers. The mapping of V2X message priority to ProSe Per-Packet Priority is configured on the UE and is out of the scope of this specification;
- g) if the UE is configured with PDB (Packet Delay Budget)-to-ProSe Per-Packet Priority mapping rules for V2X communication over PC5 as specified in subclause 5.2.4, the PDB associated with the ProSe Per-Packet Priority as specified in subclause 5.2.4;
- h) if:
 - 1) a ProSe Per-Packet Reliability (PPPR) value is received from the upper layers; and
 - 2) one of the following conditions is met:
 - A) the list of the V2X services authorized for ProSe Per-Packet Reliability (PPPR) is not configured; or
 - B) the V2X service identifier of the V2X service for the V2X message and the received ProSe Per-Packet Reliability (PPPR) value are included in an entry of the list of the V2X services authorized for ProSe Per-Packet Reliability (PPPR);then the ProSe Per-Packet Reliability (PPPR) value; and
- i) if the UE is configured with V2X service identifier to Tx Profile mapping rules for V2X communication over PC5 as specified in subclause 5.2.4, the Tx Profile associated with the V2X service identifier as specified in subclause 5.2.4.

If the UE has an emergency PDN connection, the UE shall send an indication to the lower layers to prioritize transmission over the emergency PDN connection as compared to transmission of V2X communication over PC5.

6.1.2.3 Procedure for UE to use provisioned radio resources for V2X communication over PC5

When the UE is not served by E-UTRAN for V2X communication, the UE shall select the radio parameters to be used for V2X communication over PC5 as follows:

- if the UE can determine itself located in a geographical area, and the UE is provisioned with radio parameters for the geographical area, the UE shall select the radio parameters associated with that geographical area; or
- in all other cases, the UE shall not initiate V2X communication over PC5.

It is out of scope of the present specification to define how the UE can locate itself in a specific geographical area. When the UE is in coverage of a 3GPP RAT it can for example use information derived from the serving PLMN. When the UE is not in coverage of a 3GPP RAT it can use other techniques, e.g. Global Navigation Satellite System (GNSS). The UE shall not consider user provided location as a valid input to locate itself in a specific geographical area.

If the UE intends to use "non-operator managed" radio parameters as specified in subclause 5.2.4, the UE shall initiate V2X communication over PC5 with the selected radio parameters.

If the UE intends to use "operator managed" radio parameters as specified in subclause 5.2.4, before initiating V2X communication over PC5, the UE shall check with lower layers whether the selected radio parameters can be used in the current location without causing interference to other cells as specified in 3GPP TS 36.331 [22], and:

- if the lower layers indicate that the usage would not cause any interference, the UE shall initiate V2X communication over PC5; or

NOTE: If the lower layers find that there exists a cell operating the provisioned radio resources (i.e., carrier frequency), and the cell belongs to the registered PLMN or a PLMN equivalent to the registered PLMN, and the UE is authorized for V2X communication over PC5 in this PLMN, the UE can use the radio parameters indicated by the cell as specified in 3GPP TS 36.331 [22].

- else if the lower layers report that one or more PLMNs operate in the provisioned radio resources (i.e. carrier frequency) then:

a) if the following conditions are met:

- 1) none of the PLMNs reported by the lower layers is the registered PLMN or equivalent to the registered PLMN;
- 2) at least one of the PLMNs reported by the lower layers is in the list of authorized PLMNs for V2X communication over PC5 and provides radio resources for V2X communication over PC5 as specified in 3GPP TS 36.331 [22]; and
- 3) the UE does not have an emergency PDN connection;

then the UE shall:

- 1) if in EMM-IDLE mode, perform PLMN selection triggered by V2X communication over PC5 as specified in 3GPP TS 23.122 [9]; or
- 2) else if in EMM-CONNECTED mode, either:
 - i) perform a detach procedure as specified in 3GPP TS 24.301 [11] and then perform PLMN selection triggered by V2X communication over PC5 as specified in 3GPP TS 23.122 [9]; or
 - ii) not initiate V2X communication over PC5.

Whether the UE performs i) or ii) above is left up to UE implementation; or

- b) else the UE shall not initiate V2X communication over PC5.

If the registration to the selected PLMN is successful, the UE shall proceed with the procedure to initiate V2X communication over PC5 as specified in subclause 6.1.2.1.

If the UE is performing V2X communication over PC5 using radio parameters associated with a geographical area and moves out of that geographical area, the UE shall stop performing V2X communication over PC5 and then:

- if the UE is not served by E-UTRAN for V2X communication or the UE intends to use radio resources for V2X communication over PC5 other than those operated by the serving E-UTRAN cell, the UE shall select appropriate radio parameters for the new geographical area as specified above; or
- if the UE is served by E-UTRAN for V2X communication and intends to use radio resources for V2X communication over PC5 operated by the serving E-UTRAN cell, the UE shall proceed with the procedure to initiate V2X communication over PC5 when served by E-UTRAN for V2X communication.

6.1.2.4 Privacy of V2X transmission over PC5

Upon initiating transmission of V2X communication over PC5, if:

- the V2X service identifier of a V2X service requesting transmission of V2X communication over PC5 is in the list of V2X services which require privacy for V2X communication over PC5 as specified in subclause 5.2.4; and
- the UE is located in a geographical area in which this V2X service requires privacy for V2X communication over PC5 as specified in subclause 5.2.4, or the UE is not provisioned any geographical areas in which this V2X services requires privacy for V2X communication over PC5,

the UE shall proceed as follows:

- if timer T5000 is not running, start timer T5000;
- upon:
 - a) getting an indication from upper layers that the application layer identifier has been changed; or
 - b) timer T5000 expiration,then:
 - a) change the value of the source Layer-2 ID self-assigned by the UE for V2X communication over PC5;
 - b) if the V2X message contains IP data, change the value of the source IP address self-assigned by the UE for V2X communication over PC5;
 - c) provide an indication to upper layers that the source Layer-2 ID and/or the source IP address are changed; and
 - d) restart timer T5000; and
- upon stopping transmission of V2X communication over PC5, stop timer T5000.

6.1.3 Reception of V2X communication over PC5

The UE can be configured by upper layers with one or more destination Layer-2 ID(s) for reception of V2X messages over PC5. For each received protocol data unit over PC5, the receiving UE shall check if the destination Layer-2 ID of the received protocol data unit matches one of the configured destination Layer-2 IDs. If yes, the UE shall then check whether the protocol data unit type as defined 3GPP TS 36.323 [8] provided by the lower layers for the received packet is set to IP packet or non-IP packet, and pass the protocol data unit to the corresponding upper layer entity.

6.2 V2X communication over LTE-Uu

6.2.1 General

Procedures for V2X communication over LTE-Uu for V2X services not identified by a V2X service identifier are out of scope of the present version of the present specification. Security procedures specified in 3GPP TS 33.401 [21] for LTE-Uu, and application layer security as defined in other SDOs (e.g. IEEE or ETSI ITS) apply, as stated in 3GPP TS 33.185 [20].

6.2.2 Transmission of V2X communication over LTE-Uu from UE to V2X application server

The upper layers can request the UE to send a V2X message of a V2X service identified by a V2X service identifier using V2X communication over LTE-Uu. The request from the upper layers includes:

- a) the V2X message;
- b) the V2X service identifier of the V2X service for the V2X message;
- c) the type of data in the V2X message (IP or non-IP); and
- d) if the V2X message contains non-IP data, the V2X message family (see subclause 7.1) of data in the V2X message.

Upon a request from upper layers to send a V2X message of a V2X service using V2X communication over LTE-Uu:

- a) if the registered PLMN of the UE is not in the list of PLMNs in which the UE is authorized to use V2X communication over LTE-Uu as specified in subclause 5.2.5, the UE shall determine that the transmission of V2X communication over LTE-Uu from UE to V2X application server is not authorized and shall not continue with the rest of the steps; and
- b) if the V2X service is identified by a V2X service identifier:
 - 1) if:
 - A) the type of data in the V2X message is non-IP; or
 - B) the type of data in the V2X message is IP, and the V2X service identifier is not included in the list of V2X service identifiers of the V2X services authorized for V2X communication over LTE-Uu using existing unicast routing as specified in subclause 5.2.5;then:
 - A) the UE shall discover the V2X application server address as described in subclause 6.2.6. If the V2X application server address cannot be discovered, the UE shall determine that the transmission of V2X communication over LTE-Uu from UE to V2X application server is not possible and shall not continue with the rest of the steps; and
 - B) the UE shall generate a UDP message as described in IETF RFC 768 [18]. In the UDP message, the UE shall include the V2X message provided by upper layers in the data octets field. The UE shall send the UDP message to the determined V2X application server address; and
 - 2) if the type of data in the V2X message is IP, and the V2X service identifier is included in the list of V2X service identifiers of the V2X services authorized for V2X communication over LTE-Uu using existing unicast routing as specified in subclause 5.2.5, then the UE shall send the V2X message using existing unicast routing.

6.2.3 Reception of V2X communication over LTE-Uu from UE to V2X application server

The V2X application server shall be configured with one or more UDP ports for reception of the V2X communication over LTE-Uu from the UE.

If the V2X application server supports V2X messages of IP type of data and of non-IP type of data, then the V2X application server shall be configured with different UDP ports for V2X messages of different types of data.

If the V2X application server supports V2X messages of several V2X message families, then the V2X application server shall be configured with different UDP ports for V2X messages of different V2X message families.

The V2X application server shall extract a V2X message of a V2X service from a UDP message received on a local IP address and a UDP port configured for the V2X service.

6.2.4 Transmission of V2X communication over LTE-Uu from V2X application server to UE

The V2X application server shall be configured with a multicast IP address and one or more UDP ports for transport of the V2X communication over LTE-Uu to the UE.

If the V2X application server supports V2X messages of IP type of data and of non-IP type of data, then the V2X application server shall be configured with different UDP ports for V2X messages of different types of data.

If the V2X application server supports V2X messages of several V2X message families, then the V2X application server shall be configured with different UDP ports for V2X messages of different V2X message families.

In order to transport a V2X message of a V2X service identified by a V2X service identifier via an MBMS bearer, the V2X application server shall generate a UDP message. In the UDP message, the V2X application server:

- a) shall set data octets field to the V2X message; and
- b) shall set the destination IP address and the destination UDP port to the configured multicast IP address and the configured UDP port associated the type of data of the V2X message and the V2X message family of the data of the V2X message (in case of non-IP).

The V2X application server sends the UDP message as the user plane data to the BM-SC for transport via the MBMS bearer.

6.2.5 Reception of V2X communication over LTE-Uu from V2X application server to UE

The upper layers can request the UE to receive a V2X message of a V2X service identified by a V2X service identifier using V2X communication over LTE-Uu. The request from the upper layers includes:

- a) the V2X service identifier of the V2X service for the V2X message to be received;
- b) the type of data in the V2X message to be received (IP or non-IP); and
- c) if the V2X message to be received contains non-IP data, the V2X message family (see subclause 7.1) of data in the V2X message to be received.

Upon a request from upper layers to receive a V2X message of a V2X service using V2X communication over LTE-Uu:

- a) if the registered PLMN of the UE is not in the list of PLMNs in which the UE is authorized to use V2X communication over LTE-Uu as specified in subclause 5.2.5, the UE shall determine that the transmission of V2X communication over LTE-Uu from V2X application server to UE is not authorized and shall not continue with the rest of the steps; and
- b) if the V2X service is identified by a V2X service identifier:
 - 1) the UE shall discover one or more V2X MBMS configuration(s) for receiving V2X communication over LTE-Uu using MBMS as described in subclause 6.2.7. If the V2X MBMS configuration for receiving V2X communication over LTE-Uu using MBMS is not discovered, the UE shall determine that the transmission of V2X communication over LTE-Uu from Uu from V2X application server to UE is not possible and shall not continue with the rest of the steps;
 - 2) if the type of data is IP, the UE shall listen for a UDP packet:
 - A) with the destination IP address set to the IP address indicated in the "c=" line applicable for the "m=" line with the application/vnd.3gpp.v2x media type with the type parameter indicating IP in the SDP body of the V2X MBMS configuration for receiving V2X communication over LTE-Uu using MBMS; and
 - B) with the destination UDP port set to the port indicated in the "m=" line with the application/vnd.3gpp.v2x media type with the type parameter indicating IP in the SDP body of the V2X MBMS configuration for receiving V2X communication over LTE-Uu using MBMS;

received via an MBMS bearer corresponding to the TMGI, the list of SAIs and the frequency of the V2X MBMS configuration for receiving V2X communication over LTE-Uu using MBMS. If several V2X MBMS

configurations for receiving V2X communication over LTE-Uu using MBMS were discovered, the UE shall perform this action once per each discovered V2X MBMS configurations for receiving V2X communication over LTE-Uu using MBMS;

- 3) if the type of data is non-IP, the UE shall listen for a UDP packet:
 - A) with the destination IP address set to the IP address indicated in the "c=" line applicable for the "m=" line with the application/vnd.3gpp.v2x media type with:
 - i) the type parameter indicating non-IP; and
 - ii) the v2x-message-family parameter indicating the V2X message family;

in the SDP body of the V2X MBMS configuration for receiving V2X communication over LTE-Uu using MBMS; and
 - B) with the destination UDP port set to the port indicated in the "m=" line with the application/vnd.3gpp.v2x media type with:
 - i) the type parameter indicating non-IP; and
 - ii) the v2x-message-family parameter indicating the V2X message family;

in the SDP body of the V2X MBMS configuration for receiving V2X communication over LTE-Uu using MBMS;

received via an MBMS bearer corresponding to the TMGI, the list of SAIs and the frequency of the V2X MBMS configuration for receiving V2X communication over LTE-Uu using MBMS. If several V2X MBMS configurations for receiving V2X communication over LTE-Uu using MBMS were discovered, the UE shall perform this action once per each discovered V2X MBMS configurations for receiving V2X communication over LTE-Uu using MBMS; and
- 4) the UE shall extract the V2X message from the data octets field of the received UDP message as described in IETF RFC 768 [18] and pass the V2X message to upper layers.

6.2.6 V2X application server discovery

6.2.6.1 General

Before initiating V2X communication over LTE-Uu, the UE needs to discover the V2X application server to which the V2X messages shall be sent. The UE shall proceed as follows, in priority order:

- a) if the serving PLMN is associated with a V2X AS MBMS configuration for receiving V2X application server information using MBMS in the configuration parameters for V2X communication over LTE-Uu provisioned to the UE as specified in subclause 5.2.5, the UE shall perform the procedure in subclause 6.2.6.2 to discover the V2X application server;
- b) else if the V2X service of the V2X message is identified by a V2X service identifier and this V2X service identifier is associated with a V2X application server IP address and UDP port in the list of V2X services authorized for V2X communication over LTE-Uu for the serving PLMN and the geographical area in which the UE is located as specified in subclause 5.2.5, the UE shall use this IP address and UDP port for V2X communication over LTE-Uu;
- c) else if the V2X service of the V2X message is identified by a V2X service identifier and this V2X service identifier is associated with a V2X application server FQDN and UDP port in the list of V2X services authorized for V2X communication over LTE-Uu for the serving PLMN and the geographical area in which the UE is located as specified in subclause 5.2.5, the UE shall perform DNS lookup as specified in IETF RFC 1035 [13], then use the resulting IP address and the configured UDP port for V2X communication over LTE-Uu;
- d) else if the V2X service of the V2X message is identified by a V2X service identifier and this V2X service identifier is associated with a V2X application server IP address and UDP port in the list of V2X services authorized for V2X communication over LTE-Uu for the serving PLMN as specified in subclause 5.2.5, the UE shall use this IP address and UDP port for V2X communication over LTE-Uu;

- e) else if the V2X service of the V2X message is identified by a V2X service identifier and this V2X service identifier is associated with a V2X application server FQDN and UDP port in the list of V2X services authorized for V2X communication over LTE-Uu for the serving PLMN as specified in subclause 5.2.5, the UE shall perform DNS lookup as specified in IETF RFC 1035 [13], then use the resulting IP address and the configured UDP port for V2X communication over LTE-Uu;
- f) else if the V2X service of the V2X message is identified by a V2X service identifier, the V2X message contains IP data, and the default V2X application server address applicable for the serving PLMN, the geographical area in which the UE is located and the IP type of data as specified in subclause 5.2.5 is configured and contains an IP address and a UDP port, then the UE shall use the IP address and the UDP port for V2X communication over LTE-Uu;
- g) else if the V2X service of the V2X message is identified by a V2X service identifier, the V2X message contains IP data, and the default V2X application server address applicable for the serving PLMN, the geographical area in which the UE is located and the IP type of data as specified in subclause 5.2.5 is configured and contains an FQDN and a UDP port, then the UE shall perform DNS lookup of the FQDN as specified in IETF RFC 1035 [13], and shall use the resulting IP address and the UDP port for V2X communication over LTE-Uu;
- h) else if the V2X service of the V2X message is identified by a V2X service identifier, the V2X message contains IP data, and the default V2X application server address applicable for the the serving PLMN and the IP type of data as specified in subclause 5.2.5 is configured and contains an IP address and a UDP port, then the UE shall use the IP address and the UDP port for V2X communication over LTE-Uu;
- i) else if the V2X service of the V2X message is identified by a V2X service identifier, the V2X message contains IP data, and the default V2X application server address applicable for the serving PLMN and the IP type of data as specified in subclause 5.2.5 is configured and contains an FQDN and a UDP port, then the UE shall perform DNS lookup of the FQDN as specified in IETF RFC 1035 [13], and shall use the resulting IP address and the UDP port for V2X communication over LTE-Uu;
- j) else if the V2X service of the V2X message is identified by a V2X service identifier, the V2X message contains non-IP data, and the default V2X application server address applicable for the serving PLMN, the geographical area in which the UE is located and the V2X message family of the non-IP data as specified in subclause 5.2.5 is configured and contains an IP address and a UDP port, then the UE shall use the IP address and the UDP port for V2X communication over LTE-Uu;
- k) else if the V2X service of the V2X message is identified by a V2X service identifier, the V2X message contains non-IP data, and the default V2X application server address applicable for the serving PLMN, the geographical area in which the UE is located and the V2X message family of the non-IP data as specified in subclause 5.2.5 is configured and contains an FQDN and a UDP port, then the UE shall perform DNS lookup of the FQDN as specified in IETF RFC 1035 [13], and shall use the resulting IP address and the UDP port for V2X communication over LTE-Uu;
- l) else if the V2X service of the V2X message is identified by a V2X service identifier, the V2X message contains non-IP data, and the default V2X application server address applicable for the serving PLMN and the V2X message family of the non-IP data as specified in subclause 5.2.5 is configured and contains an IP address and a UDP port, then the UE shall use the IP address and the UDP port for V2X communication over LTE-Uu;
- m) else if the V2X service of the V2X message is identified by a V2X service identifier, the V2X message contains non-IP data, and the default V2X application server address applicable for the serving PLMN and the V2X message family of the non-IP data as specified in subclause 5.2.5 is configured and contains an FQDN and a UDP port, then the UE shall perform DNS lookup of the FQDN as specified in IETF RFC 1035 [13], and shall use the resulting IP address and the UDP port for V2X communication over LTE-Uu;
- n) else if the V2X service of the V2X message is not identified by a V2X service identifier and the UE is configured with a V2X application server IP address for the serving PLMN and the geographical area in which the UE is located as specified in subclause 5.2.5, the UE shall use this IP address for V2X communication over LTE-Uu;
- o) else if the V2X service of the V2X message is not identified by a V2X service identifier and the UE is configured with a V2X application server FQDN for the serving PLMN and the geographical area in which the UE is located as specified in subclause 5.2.5, the UE shall perform DNS lookup as specified in IETF RFC 1035 [13], then use the resulting IP address for V2X communication over LTE-Uu;

- p) else if the V2X service of the V2X message is not identified by a V2X service identifier and the UE is configured with a V2X application server IP address for the serving PLMN as specified in subclause 5.2.5, the UE shall use this IP address for V2X communication over LTE-Uu; and
- q) else if the V2X service of the V2X message is not identified by a V2X service identifier and the UE is configured with a V2X application server FQDN for the serving PLMN as specified in subclause 5.2.5, the UE shall perform DNS lookup as specified in IETF RFC 1035 [13], then use the resulting IP address for V2X communication over LTE-Uu.

NOTE: It is out of scope of the present specification to define how the UE can locate itself in a specific geographical area. When the UE is in coverage of a 3GPP RAT it can for example use information derived from the serving PLMN. When the UE is not in coverage of a 3GPP RAT it can use other techniques.

If multiple V2X application servers are discovered, the V2X application server to be used is selected by the V2X application layer.

The UE shall perform V2X application server discovery again when the UE changes its registered PLMN.

If the V2X application server used by the UE is associated with a particular geographical area, the UE shall perform V2X application server discovery again when the UE moves out of that geographical area.

6.2.6.2 V2X application server discovery using MBMS

6.2.6.2.1 General

The purpose of the V2X application server discovery using MBMS procedure is to allow the UE to receive the V2X application server information over MBMS bearers.

The UE shall only initiate the V2X application server discovery using MBMS procedure if:

- a) the UE is authorized for V2X communication over LTE-Uu in the serving PLMN as specified in subclause 5; and
- b) the serving PLMN is associated with a V2X AS MBMS configuration for receiving V2X application server information using MBMS in the configuration parameters for V2X communication over LTE-Uu provisioned to the UE as specified in subclause 5.2.5.

The UE should use the V2X application server information received over MBMS bearers for transmission of V2X communication over LTE-Uu using unicast only when the UE is registered in the PLMN from which this V2X application server information was received.

6.2.6.2.2 Procedure for V2X application server discovery using MBMS

The UE shall proceed as follows:

- a) the UE shall start listening to the MBMS bearer corresponding to the TMGI, list of SAIs and frequency included in the V2X AS MBMS configuration associated with the serving PLMN in the configuration parameters for V2X communication over LTE-Uu provisioned to the UE as specified in subclause 5.2.5
- b) the UE shall use the IP multicast address and port included in the V2X AS MBMS configuration associated with the serving PLMN in the configuration parameters for V2X communication over LTE-Uu provisioned to the UE as specified in subclause 5.2.5 to receive the V2X local service information. The V2X local service information is encoded as specified in subclause 7.4; and

NOTE: The UE can be in MBMS receive only mode for obtaining the V2X application server information.

- c) If the V2X service identifier of the V2X service requesting V2X communication over LTE-Uu maps to a V2X application server FQDN in the V2X application server information obtained at step 2, the UE shall perform DNS lookup as specified in IETF RFC 1035 [13] to resolve the IP address(es) of the V2X application server.

6.2.7 V2X MBMS parameter discovery

Before receiving a V2X communication over LTE-Uu using MBMS bearer, the UE needs to discover the V2X MBMS parameters via which the V2X communication is to be received.

The UE shall proceed as follows, in priority order:

- a) if the V2X message to be received is of IP type of data, the V2X service of the V2X message to be received is identified by a V2X service identifier, and this V2X service identifier is associated with a V2X MBMS configuration for receiving V2X communication over LTE-Uu using MBMS in the list of V2X services authorized for V2X communication over LTE-Uu for the registered PLMN of the UE and the SDP body of the V2X MBMS configuration for receiving V2X communication over LTE-Uu using MBMS contains a "m=" line of the application/vnd.3gpp.v2x media type with the type parameter indicating IP, the UE shall use the V2X MBMS configuration for receiving V2X communication over LTE-Uu using MBMS. If several such V2X MBMS configurations are configured, the UE shall use all such V2X MBMS configurations for receiving V2X communication over LTE-Uu using MBMS;
- b) else if the V2X message to be received is of non-IP type of data, the V2X message to be received is of V2X message family, the V2X service of the V2X message to be received is identified by a V2X service identifier, and this V2X service identifier is associated with a V2X MBMS configuration for receiving V2X communication over LTE-Uu using MBMS in the list of V2X services authorized for V2X communication over LTE-Uu for the registered PLMN of the UE and the SDP body of the V2X MBMS configuration for receiving V2X communication over LTE-Uu using MBMS contains a "m=" line of the application/vnd.3gpp.v2x media type with:

- 1) the type parameter indicating non-IP; and
- 2) the v2x-message-family parameter indicating the V2X message family;

the UE shall use the V2X MBMS configuration for receiving V2X communication over LTE-Uu using MBMS. If several such V2X MBMS configurations are configured, the UE shall use all such V2X MBMS configurations for receiving V2X communication over LTE-Uu using MBMS;

- c) else if the V2X message to be received is of IP type of data, the V2X service of the V2X message to be received is identified by a V2X service identifier, and the default V2X MBMS configuration for receiving V2X communication over LTE-Uu using MBMS as specified in subclause 5.2.5 is configured and the SDP body of the V2X MBMS configuration for receiving V2X communication over LTE-Uu using MBMS contains a "m=" line of the application/vnd.3gpp.v2x media type with the type parameter indicating IP, the UE shall use the default V2X MBMS configuration for receiving V2X communication over LTE-Uu using MBMS. If several such V2X MBMS configurations are configured, the UE shall use all such V2X MBMS configurations for receiving V2X communication over LTE-Uu using MBMS;
- d) else if the V2X message to be received is of non-IP type of data, the V2X message to be received is of V2X message family, the V2X service of the V2X message to be received is identified by a V2X service identifier, and the default V2X MBMS configuration for receiving V2X communication over LTE-Uu using MBMS as specified in subclause 5.2.5 is configured and the SDP body of the V2X MBMS configuration for receiving V2X communication over LTE-Uu using MBMS contains a "m=" line of the application/vnd.3gpp.v2x media type with:

- 1) the type parameter indicating non-IP; and
- 2) the v2x-message-family parameter indicating the V2X message family;

the UE shall use the default V2X MBMS configuration for receiving V2X communication over LTE-Uu using MBMS. If several such V2X MBMS configurations are configured, the UE shall use all such V2X MBMS configurations for receiving V2X communication over LTE-Uu using MBMS; and

- e) else if the V2X service of the V2X message to be received is not identified by a V2X service identifier, and the V2X MBMS configuration for receiving V2X communication over LTE-Uu using MBMS as specified in subclause 5.2.5 is configured, the UE shall use the V2X MBMS configuration for receiving V2X communication over LTE-Uu using MBMS. If several such V2X MBMS configurations are configured, the UE shall use all such V2X MBMS configurations for receiving V2X communication over LTE-Uu using MBMS.

7 General message format and information elements coding

7.1 V2X message family encoding

The following values are specified to identify the V2X message family:

- 0 Reserved
- 1 IEEE 1609, see IEEE 1609.3 [5]
- 2 ISO, see ISO 29281-1 [6]
- 3 ETSI-ITS, see ETSI EN 302 636-3 23]
- 4-255 Reserved

7.2 V2X MBMS configuration

7.2.1 Minimum components of V2X MBMS configuration

The V2X MBMS configuration is provided to the UE to enable the UE to discover and acquire the V2X communication carried in IP multicast datagrams by the MBMS Bearer Service. It contains at least the following parameters:

- a) a TMGI encoded as specified in 3GPP TS 24.008 [12] excluding the Temporary Mobile Group Identity IEI and Length of Temporary Mobile Group Identity contents;
- b) a list of MBMS Service Area Identifiers (SAIs), with each SAI encoded as specified in 3GPP TS 23.003 [14];
- c) in case of multicarrier support, a frequency encoded as specified in 3GPP TS 29.468 [15]; and
- d) a V2X MBMS configuration SDP encoded as specified in subclause 7.2.2.

7.2.2 Encoding of V2X MBMS configuration SDP

7.2.2.1 Minimum components of V2X MBMS configuration SDP

The V2X MBMS configuration SDP shall contain at least the following parameters:

- a) IP multicast address used for V2X communication over LTE-Uu using MBMS; and
- b) a list of UDP port numbers used for V2X communication over LTE-Uu using MBMS, each associated with a V2X message family or IP type of data as defined in subclause 7.1.

These shall be expressed in SDP syntax (see IETF RFC 4566 [16]) according to the following subclauses.

In a V2X MBMS configuration SDP body, sending entity shall not include any media announcement field ("m=") other than the one specified in subclause 7.2.2.3.

In a V2X MBMS configuration SDP body, receiving entity shall ignore any media announcement field ("m=") other than the one specified in subclause 7.2.2.3.

7.2.2.2 IP multicast address

The IP multicast address shall be defined according to the "connection data" field ("c=") of IETF RFC 4566 [16].

7.2.2.3 List of UDP port numbers and associated V2X message family

The association between a UDP port number and a V2X message family is defined according to the media announcement field ("m=") of IETF RFC 4566 [16], with:

- a) the <port> portion set to the UDP port number;

- b) the <media> portion set to "application";
- c) the <transport> portion set to "udp";
- d) the <fmt> portion set to "vnd.3gpp.v2x"; and
- e) an fmtp attribute:
 - 1) with the <format> portion set to "vnd.3gpp.v2x"; and
 - 2) with the <format specific parameters> portion containing a semicolon separated list of parameters as specified in subclause A.1.2 with:
 - A) a type parameter set to IP or non-IP; and
 - B) if a UDP port is used for exchange of V2X messages of non-IP type of data, a v2x-message-family parameter set to the value of the associated V2X message family as specified in subclause 7.1.

If multiple parameters are indicated in the <format specific parameters> portion of an fmtp attribute with the <format> portion set to "vnd.3gpp.v2x", the order of parameters is not significant.

Sending entity shall not include any parameter not defined in the present version of the present specification in the <format specific parameters> portion of an fmtp attribute with the <format> portion set to "vnd.3gpp.v2x".

Receiving entity shall ignore any parameter included in the <format specific parameters> portion of an fmtp attribute with the <format> portion set to "vnd.3gpp.v2x", such that the parameter is not specified in the present version of the present specification.

Receiving entity shall ignore the media announcement field ("m=") if the type parameter does not contain a value or contains a value not specified in the present version of the present specification.

Editor's note: The vnd.3gpp.v2x application MIME type needs to be registered with IANA.

7.2.2.4 Example of V2X MBMS configuration SDP

Here is an example of a V2X MBMS configuration SDP:

```
v=0
o=user123 2890844526 2890842807 IN IP6 2201:056D::112E:144A:1E24
s=V2X MBMS configuration SDP example
c=IN IP6 FF15::101
m=application 1234 udp vnd.3gpp.v2x
a=fmtp:vnd.3gpp.v2x type=non-IP;v2x-message-family=1
m=application 1235 udp vnd.3gpp.v2x
a=fmtp:vnd.3gpp.v2x v2x-message-family=2;type=non-IP
m=application 1236 udp vnd.3gpp.v2x
a=fmtp:vnd.3gpp.v2x v2x-message-family=3;type=non-IP
m=application 1237 udp vnd.3gpp.v2x
a=fmtp:vnd.3gpp.v2x type=ip
```

7.3 V2X AS MBMS configuration

7.3.1 Introduction

The V2X AS MBMS configuration is provided to the UE to enable the UE to discover and acquire the V2X local service information carried in IP multicast datagrams by the MBMS Bearer Service. It contains at least the following parameters:

- a) a TMGI encoded as specified in 3GPP TS 24.008 [12] excluding the Temporary Mobile Group Identity IEI and Length of Temporary Mobile Group Identity contents;
- b) a list of MBMS Service Area Identifiers (SAIs), with each SAI encoded as specified in 3GPP TS 23.003 [14] ;
- c) in case of multicarrier support, a frequency encoded as specified in 3GPP TS 29.468 [15]; and
- d) a V2X AS MBMS configuration SDP encoded as specified in subclause 7.3.2.

The V2X local service information is carried using the application/vnd.3gpp-v2x-local-service-information MIME type defined in subclause 7.4.

7.3.2 Encoding of V2X AS MBMS configuration SDP

7.3.2.1 Minimum components of V2X AS MBMS configuration SDP

The V2X AS MBMS configuration SDP shall contain at least the following parameters:

- a) IP multicast address used for V2X application server discovery using MBMS; and
- b) UDP port number used for V2X application server discovery using MBMS;

These shall be expressed in SDP syntax (see IETF RFC 4566 [16]) according to the following subclauses.

7.3.2.2 IP multicast address

The IP multicast address shall be defined according to the "connection data" field ("c=") of IETF RFC 4566 [16].

7.3.2.3 Port number

The UDP port number shall be defined according to the <port> sub-field of the media announcement field ("m=") of IETF RFC 4566 [16].

7.3.2.4 Example of V2X AS MBMS configuration SDP

Here is an example of a V2X AS MBMS configuration SDP:

```
v=0
o=user123 2890844526 2890842807 IN IP6 2201:056D::112E:144A:1E24
s=V2X AS MBMS configuration SDP example
c=IN IP6 FF15::101
m=application 1234 UDP vnd.3gpp-v2x-local-service-information
```

7.4 Encoding of V2X local service information

7.4.1 General

This subclause defines the format of the V2X local service information.

This subclause also defines the MIME type used to convey the V2X local service information over MBMS bearers.

7.4.2 application/vnd.3gpp-v2x-local-service-information

The MIME type is used to carry information related to the local V2X application server, and optionally the V2X MBMS configuration. It shall be coded in binary ASN.1 PER as specified below.

```
-- ASN1START
V2X-local-service-information-definitions DEFINITIONS AUTOMATIC TAGS ::= BEGIN

    V2X-local-service-information ::= SEQUENCE {
        V2X-as-info-list           ListOfV2X-as-info,
        V2X-MBMS-configuration-list ListOfV2X-MBMS-configuration OPTIONAL,
        ...
    }

    ListOfV2X-as-info ::= SEQUENCE OF V2X-as-info

    ListOfV2X-MBMS-configuration ::= SEQUENCE OF V2X-MBMS-configuration

    V2X-as-info ::= SEQUENCE {
        V2X-service-identifier    OCTET STRING (SIZE (1..4)),
        V2X-as-address            VisibleString,
        UDP-port                  INTEGER,
        ...
    }
```

```

}
V2X-MBMS-configuration ::= SEQUENCE {
    V2X-service-identifier    OCTET STRING (SIZE (1..4)),
    tmgi                     OCTET STRING (SIZE (8)),
    SAI-list                 ListOfSAIs,
    Frequency                INTEGER (0..262143)           OPTIONAL,
    IP-multicast-address     VisibleString,
    UDP-port                 INTEGER,
    ...
}

ListOfSAIs ::= SEQUENCE OF SAI

SAI ::= INTEGER (0..65535)

-- ASN1STOP

```

7.4.3 Semantics

The V2X-local-service-information contains the following elements:

- a) one or more V2X-AS-info element(s) containing an association between a V2X service identifier and one or more V2X application server address(es). Each V2X-AS-info element consists of:
 - 1) one V2X-service-identifier element containing a 4 octet V2X service identifier;
 - 2) one V2X-as-address element containing a V2X application server IP address or FQDN; and
 - 3) one udp-port element containing a UDP port; and
- b) zero, one or more V2X-MBMS-configuration element(s) containing the information enabling the UE to discover and acquire V2X communication over LTE-Uu using MBMS. Each V2X-MBMS-configuration element consists of the following:
 - 1) one V2X-service-identifier element containing a 4 octet V2X service identifier;
 - 2) one tmgi element containing the TMGI encoded as specified in 3GPP TS 24.008 [12] excluding the Temporary Mobile Group Identity IEI and Length of Temporary Mobile Group Identity contents;
 - 3) one SAI-list element containing:
 - A) one or more SAI element(s) containing an MBMS SAI encoded as specified in 3GPP TS 23.003 [14];
 - 4) zero or one frequency element containing a frequency encoded as specified in 3GPP TS 29.468 [15];
 - 5) one ip-multicast-address element containing an IP multicast address; and
 - 6) one udp-port element containing a UDP port.

8 List of system parameters

8.1 General

The description of timers in table 8.2.1 is considered a brief summary. The complete descriptions of the timers are in the procedures defined in subclause 5 and subclause 6.

8.2 Timers of procedures for V2X communication over PC5

Table 8.2.1: V2X communication over PC5 timers – UE side

TIMER NUM.	TIMER VALUE	CAUSE OF START	NORMAL STOP	ON EXPIRY
T5000	Default 300 seconds NOTE	<p>Upon initiating transmission of V2X communication over PC5, as described in subclause 6.1.2.4.</p> <p>Upon receiving an indication from upper layers that the application layer identifier has been changed while performing transmission of V2X communication over PC5, as described in subclause 6.1.2.4.</p> <p>Upon T5000 expiration while performing transmission of V2X communication over PC5, as described in subclause 6.1.2.4.</p>	<p>Upon stopping transmission of V2X communication over PC5, as described in subclause 6.1.2.4.</p>	<p>Change the value of the source Layer-2 ID self-assigned by the UE for V2X communication over PC5.</p> <p>If the V2X message contains IP data, change the value of the source IP address self-assigned by the UE for V2X communication over PC5.</p> <p>Restart T5000.</p>
<p>NOTE: The default value of this timer is used if the V2X control function does not provision another value to the UE as part of the configuration parameters for V2X communication over PC5.</p>				

Annex A (informative): Documentation of new MIME types and SDP extensions

A.1 vnd.3gpp.v2x MIME type

A.1.1 vnd.3gpp.v2x MIME type registration

Editor's note: The IANA registration for the vnd.3gpp.v2x application MIME type needs to be initiated by MCC once the V2X-CT Work Item is completed.

Your Name:

<MCC name>

Your Email Address:

<MCC email address>

Media Type Name:

Application

Subtype name:

Vendor tree – vnd.3gpp.v2x

Required parameters:

type parameter.

The type parameter can be set to "IP", or "non-IP".

A content of the application/vnd.3gpp.v2x MIME type with the type parameter set to "IP" contains one V2X message such that the V2X message is an IP packet.

A content of the application/vnd.3gpp.v2x MIME type with the type parameter set to "non-IP" and the v2x-message-family parameter indicating a V2X message family contains one V2X message of the V2X message family.

Optional parameters:

v2x-message-family parameter.

The v2x-message-family parameter shall be included when the type parameter is set to "non-IP". Permissible values of the v2x-message-family parameter are specified in TS 24.386 subclause 7.1.

Encoding considerations:

binary.

Security considerations:

This media type does not include provisions for directives that institute actions on a recipient's files or other resources.

The information transported in this media type does not include active or executable content.

This media type does not include provisions for directives that institute actions that, while not directly harmful to the recipient, may result in disclosure of information that either facilitates a subsequent attack or else violates a recipient's privacy in any way.

This media type does not employ compression.

This media type is not targeted for applications that require some sort of security assurance but don't provide the necessary security mechanisms themselves. The security assurance is expected to be provided by the environment this media type operates in. When this media type operates in environment described in 3GPP TS 33.185, security mechanisms are described in 3GPP TS 33.185.

Interoperability considerations:

Receiving entity shall ignore any media type parameter not defined in this media type registration.

If a content of the application/vnd.3gpp.v2x MIME type is transported using UDP transport, the UDP message contains one V2X message.

Published specification:

3GPP TS 24.386 (<http://www.3gpp.org/ftp/Specs/html-info/24386.htm>)

Applications which use this media type:

V2X applications

Fragment identifier considerations:

This media type does not specify how applications interpret fragment identifiers associated with the media type.

Restrictions on usage:

None

Provisional registration? (standards tree only):

n/a

Additional information:

1. Deprecated alias names for this type: n/a
2. Magic number(s): n/a
3. File extension(s): n/a
4. Macintosh File Type Code(s): n/a
5. Object Identifier(s) or OID(s): n/a

Intended usage:

Common.

Other information/general comment:

The media type is intended to be used for V2X communication.

Person to contact for further information:

- Name: <MCC name>
- Email: <MCC email address>
- Author/Change controller:
 - i) Author: 3GPP CT1 Working Group/3GPP_TSG_CT_WG1@LIST.ETSI.ORG
 - ii) Change controller: <MCC name>/<MCC email address>

A.1.2 Mapping vnd.3gpp.v2x MIME parameters into SDP

The information carried in the MIME application type has a specific mapping to fields in SDP.

A vnd.3gpp.v2x connection shall be described by using an SDP m line. According to IETF RFC 4566 [16], the m-line format is the following:

m=<media> <port> <transport> <fmt>

For vnd.3gpp.v2x:

- the media type field shall have a value of "application";
- the port field shall include the transport port for V2X;
- the transport field shall have a value of "udp";
- the format field shall have a value of "vnd.3gpp.v2x".

The following is an example of an m line for a vnd.3gpp.v2x connection:

```
m=application 1234 udp vnd.3gpp.v2x
```

The vnd.3gpp.v2x media type parameters are indicated in the <format specific parameters> portion of the SDP "a=fmtp" attribute by a semicolon separated list of parameters as shown in table A.1.2-1.

Table A.1.2-1: ABNF syntax of the <format specific parameters> portion of the SDP "a=fmtp" attribute

format-specific-parameters	= param *(";" param)
param	= param-name ["=" param-value]
param-name	= ALPHA *(ALPHA / DIGIT / "-")
param-value	= *(param-char)
param-char	= *(%x20-3A / %x3C-FF)

The following is an example of an attribute line for vnd.3gpp.v2x options:

```
a=fmtp:vnd.3gpp.v2x type=non-IP;v2x-message-family=1
```

A.2 application/vnd.3gpp-v2x-local-service-information MIME type

A.2.1 application/vnd.3gpp-v2x-local-service-information MIME type registration

Your Name:

<MCC name>

Your Email Address:

<MCC email address>

Media Type Name:

Application

Subtype name:

Vendor Tree – vnd.3gpp-v2x-local-service-information

Required parameters:

None

Optional parameters:

None.

Encoding considerations:

binary.

Security considerations:

The information transported in this media type does not include active or executable content. Mechanisms for privacy and integrity protection of protocol parameters exist. Those mechanisms as well as authentication and further security mechanisms are described in 3GPP TS 33.185.

This media type does not include provisions for directives that institute actions on a recipient's files or other resources.

This media type does not include provisions for directives that institute actions that, while not directly harmful to the recipient, may result in disclosure of information that either facilitates a subsequent attack or else violates a recipient's privacy in any way.

This media type does not employ compression.

Interoperability considerations:

The media type allows for interoperability of messages transmitted for V2X over MBMS bearers. The messages are sent between user equipment and mobile network.

Published specification:

3GPP TS 24.386 (<http://www.3gpp.org/ftp/Specs/html-info/24386.htm>)

Applications which use this media type:

n/a

Fragment identifier considerations:

The handling in section 5 of IETF RFC 7303 applies.

Restrictions on usage:

None

Provisional registration? (standards tree only):

n/a

Additional information:

1. Deprecated alias names for this type: n/a
2. Magic number(s): n/a
3. File extension(s): n/a
4. Macintosh File Type Code(s): n/a
5. Object Identifier(s) or OID(s): n/a

Intended usage:

Common.

Other information/general comment:

The media type is intended to be used for V2X communication. The content of this media type is formatted according to 3GPP TS 24.386 subclause 7.4.

Person to contact for further information:

- Name: <MCC name>
- Email: <MCC email address>
- Author/Change controller:
 - i) Author: 3GPP CT1 Working Group/3GPP_TSG_CT_WG1@LIST.ETSI.ORG

ii) Change controller: <MCC name>/<MCC email address>

Annex B (informative): Change history

Change history						
Date	TSG #	TSG Doc.	CR	Rev	Subject/Comment	New
2016-10		-	-	-	TS skeleton generated for submission at CT1#100	0.0.0
2016-10	CT1#100	-	-	-	Implementation of C1-164402, C1-164496, C1-164743 and C1-164751	0.1.0
2016-10	CT1#100	-	-	-	Editorial changes	0.1.1
2016-11	CT1#101	-	-	-	Implementation of C1-165099, C1-165314, C1-165315, C1-165324, C1-165328, C1-165389 and C1-165418	0.2.0
2016-11	CT-74	CP-160705			Version 1.0.0 created for presentation for information to CT plenary	1.0.0
2017-01	CT1#101-bis				Implementation of C1-170012, C1-170013, C1-170336, C1-170337, C1-170338, C1-170340, C1-170341, C1-170342, C1-170343, C1-170345, C1-170346 and C1-170521	1.1.0
2017-02	CT1#102				Implementation of C1-170581, C1-170791, C1-170792 and C1-170903	1.2.0
2017-02	CT-75	CP-170156			Version 2.0.0 created for presentation for approval to CT plenary	2.0.0
2017-03	CT-75				Version 14.0.0 created after approval at CT plenary	14.0.0
2017-06	CT-76	CP-171091	0001	1	V2X communication over LTE-Uu - existing unicast routing for V2X messages of a V2X service with a V2X service identifier	14.1.0
2017-06	CT-76	CP-171091	0002		Removal of Editor's note on V2X control function FQDN format	14.1.0
2017-06	CT-76	CP-171091	0003		Addition of PC5 privacy configurability	14.1.0
2017-06	CT-76	CP-171091	0005		Adding UE operation for non-operator-managed	14.1.0
2017-06	CT-76	CP-171091	0006	1	Security support of V2X service	14.1.0
2017-09	CT-77	CP-172110	0007	2	Supporting cross-carrier operation for V2X communication over PC5	14.2.0
2017-09	CT-77	CP-172110	0008		Correction to remove reference to TS 36.101 for "non-operator managed" radio resources	14.2.0
2017-09	CT-77	CP-172110	0009		Correction of ID change for V2X PC5 communication	14.2.0
2017-09	CT-77	CP-172110	0010	2	Mapping between service types and V2X frequencies	14.2.0
2017-09	CT-77	CP-172110	0011	1	Mapping between service types and V2X frequencies	14.2.0
2017-12	CT-78	CP-173056	0013	2	Correction for carrier frequency selection and mapping between V2X service and V2X frequencies	14.3.0
2017-12	CT-78	CP-173056	0015		IANA registration of application/vnd.3gpp-v2x-local-service-information MIME type	14.3.0
2017-12	CT-78	CP-173056	0016	1	Update of IANA registration form for vnd.3gpp.v2x application MIME type	14.3.0

Change history							
Date	Meeting	TDoc	CR	Rev	Cat	Subject/Comment	New version
2018-06	CT-80	CP-181070	0017		B	Support of reliable transmission over PC5	15.0.0
2018-09	CT-81	CP-182152	0018	1	F	Correction for reliable transmission over V2X PC5	15.1.0
2018-09	CT-81	CP-182152	0019	1	B	Support of V2X over PC5 message transmission using Tx Profiles	15.1.0
2018-12	CT-82	CP-183078	0021	2	A	Update of specification reference for V2X message family	15.2.0

History

Document history		
V15.0.0	June 2018	Publication
V15.1.0	September 2018	Publication
V15.2.0	March 2019	Publication