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General Technical Requirements of LTE-Based Vehicular Communication

基于 LTE 的车联网无线通信技术总体技术要求

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General Technical Requirements of LTE-Based Vehicular Communication

1 Scope

This Standard specifies the overall service requirements, system architecture and basic functional requirements of LTE-based vehicular communication.

This Standard is applicable to LTE-based vehicular communication systems.

2 Normative References

The following documents are essential to the application of this document. For the dated documents, only the versions with the dates indicated are applicable to this document; for the undated documents, only the latest version (including all the amendments) is applicable to this document.

3GPP TS 23.246 Multimedia Broadcast/Multicast Service (MBMS) Architecture and Functional Description

3GPP TS 23.303 Proximity-Based Service (ProSe); Stage 2

3GPP TS 23.401 General Packet Radio Service (GPRS) Enhancements for Evolved Universal Terrestrial Radio Access Network (E-UTRAN) Access

3GPP TS 23.468 Group Communication System Enablers for LTE (GCSE_LTE); Stage 2

3GPP TS 33.185 Security Aspect for LTE Support of V2X Services

3GPP TS 36.331 Evolved Universal Terrestrial Radio Access (E-UTRA) Radio Resource Control (RRC); Protocol Specification

3 Terms, Definitions and Abbreviations

3.1 Terms and Definitions

For the purpose of this document, the following terms and definitions apply.

4 Overview

Vehicle-to-Everything (V2X) applications include Vehicle-to-Vehicle (V2V) applications, Vehicle-to-Infrastructure (V2I) applications, Vehicle-to-Network (V2N) applications and Vehicle-to-Pedestrian (V2P) applications.

V2V application refers to the exchange of V2V application information between adjacent on-board UEs. The information exchange is based on the broadcast mode, and the direct mode between UEs may be used, or information may be exchanged between UEs through infrastructure [such as road side unit (RSU), application server].

V2I application refers to the on-board UE sends V2I application information to the RSU or local application server; and the RSU or local application server sends the V2I application information to the on-board UE.

V2N application refers to communication between UE and application server through EPS network.

V2P application refers to the exchange of V2P application information between an on-board UE and a human-held UE. Information exchange may adopt the direct mode between UEs, or exchange information between UEs via infrastructure [such as road side unit (RSU), application server].

The LTE-based vehicular communication system supports Vehicle-to-Vehicle (V2V) applications, Vehicle-to-Infrastructure (V2I) applications, Vehicle-to-Network (V2N) applications, and Vehicle-to-Pedestrian (V2P) applications. These applications may provide users with various services such as road safety, traffic efficiency improvement and infotainment, etc. Appendix A provides application scenarios and demand analysis LTE-based Vehicle-to-Everything.

5 General Service Requirements of LTE-Based Vehicle-to-Everything

5.1 Basic requirements

Requirement 1: When the sending terminal is served by E-UTRAN that supports V2X, the message transmission shall be controlled by the 3GPP network.

Requirement 2: When the Vehicle-to-Everything terminal fails to be served by the E-UTRAN network that supports V2X, it shall be able to support and use the 3GPP network to pre-configure the system parameters for sending and receiving messages.

Requirement 3: Whether or not it is served by the E-UTRAN network that supports

5.2 Effective communication distance

Requirement 16: E-UTRA shall be able to provide sufficient effective communication distance to ensure that the driver has sufficient response time (for instance, 4s).

5.3 Movement speed

Requirement 17: Regardless of whether the Vehicle-to-Everything terminal uses the Vehicle-to-Everything communication service that is provided by E-UTRAN that supports V2X communication, the 3GPP system shall be able to support messages sending between vehicles at a maximum relative speed of 500km/h.

Requirement 18: Regardless of whether the Vehicle-to-Everything terminal or road side unit or pedestrians use the Vehicle-to-Everything communication service that is provided by E-UTRAN that supports V2X communication, the 3GPP system shall be able to support the message sending between vehicles and vehicles at a maximum absolute speed of 250km/h, between vehicles and road side units, as well as between vehicles and pedestrians send messages.

5.4 Communication delay

Requirement 19: For terminals that support vehicle-to-vehicle and vehicle-to-pedestrian communication, whether it is sent directly or forwarded by a road side unit, E-UTRA (N) shall ensure that the maximum communication delay not exceed 100ms.

Requirement 20: Only for special use cases (such as collision detection), the maximum delay of sending V2V messages between E-UTRA (N) Vehicle-to-Everything terminals should not exceed 20ms.

Requirement 21: For vehicle-to-road side unit communication, the maximum communication delay between the vehicle and the road side unit does not exceed 100ms.

Requirement 22: For the communication BETWEEN the Vehicle-to-Everything terminal that supports the V2N service and goes through the 3GPP network entity AND the application server, the maximum end-to-end delay shall not exceed 1000ms.

5.5 Transmission reliability

Requirement 23: The E-UTRAN network shall not rely on application layer retransmission to provide highly reliable transmission.

5.6 Requirements for information security

Requirement 24: When the Vehicle-to-Everything terminal uses the service that is provided by E-UTRAN that supports V2X communication, the 3GPP network shall provide a method for the operator to authorize the Vehicle-to-Everything terminal to

characteristics (such as delay, message size), and does not pay attention to specific message types.

6 Radio Communication System Architecture of LTE-Based Vehicle-to-Everything

6.1 Architecture model

6.1.1 Overview

V2X communication has two mutually independent and complementary working modes; namely, V2X communication based on PC5 direct mode and V2X communication based on LTE-Uu. The working mode based on LTE-Uu may be unicast or MBMS. The UE may use these two working modes to receive and transmit, respectively. For example: A UE may use MBMS to receive V2X messages, but send V2X messages without using LTE-Uu. A UE may also receive V2X messages through LTE-Uu downlink unicast.

The following principles are applicable to these two working modes:

--- Between V2X application servers: may communicate with each other to exchange V2X information;

--- ProSe discovery mechanism is not applicable to V2X services;

--- According to regional control regulations, legal interception is applicable to V2X services.

6.1.2 V2X communication architecture based on PC5 and LTE-Uu

6.1.2.1 V2X communication architecture based on PC5 and LTE-Uu in non-roaming scenarios

Figure 1 shows the V2X communication architecture based on PC5 and LTE-Uu in a non-roaming scenario.

changes.

--- S1-MME: In the V2X scenario, this interface can transmit V2X service authorization from MME to eNodeB.

--- MB2: The interface between V2X application server and BM-SC.

--- SGmb/SGi-mb/M1/M3: SGmb/SGi-mb/M1/M3 interface in MBMS system.

--- LTE-Uu: The interface between UE and E-UTRAN.

6.3 Functional entities

6.3.1 UE

The UE may support the following functions.

--- Exchange V2X control information between UE and V2X control functions through the V3 interface.

--- Perform V2X communication through PC5 interface or LTE-Uu interface.

--- Configure the parameters of V2X communication (such as the destination Layer-2 ID, radio resource parameters, V2X application server address information, etc., for the specific meaning of these parameters, see sub-clause 7.1.1). These parameters may be pre-configured in the UE; or may be configured by the V2X control function belonging to the PLMN through V3 interface signaling.

--- Obtain V2X USD to receive V2X service information through the MBMS broadcast mechanism; to obtain V2X USD may use the existing MBMS service announcement mechanism, or be provided by the V2X control function, or be provided by the V2X application server through the V1 interface.

--- Obtain V2X server USD to receive V2X application server information through MBMS broadcast mechanism.

6.3.2 eNode B

The eNode B may send and receive V2X messages in unicast mode through the LTE-Uu interface; and may also send V2X messages by the MBMS mechanism.

For V2X communication based on the PC5 interface, when the UE is in the “using E-UTRAN service” scenario, the eNode B may support the following functions:

--- Provide UE with relevant radio parameter configuration such as resource pool configuration for PC5 interface communication through broadcast messages;

--- Schedule or configure PC5 interface resources (including dynamic scheduling,

--- Select the appropriate destination MBMS SAI (Service Area ID) based on the geographic location information for broadcasting data.

--- Select the appropriate 3GPP ECGI (E-UTRAN Cell Global Identifier) according to the geographic location information for broadcasting data.

--- Select the appropriate MBMS SAI according to the ECGI provided by the UE for broadcast data.

--- Provide appropriate ECGI or MBMS SAI to BM-SC.

--- Pre-configure local MBMS-related information (for example: IP multicast address, source specific multicast (SSM), C-TEID).

--- Pre-configure the IP address and port number of the local MBMS user plane.

--- Send local MBMS information to BM-SC.

--- Request BM-SC to allocate/de-allocate a group of TMGI.

--- Request BM-SC to activate/de-activate/modify MBMS bearer.

--- For UEs that use the MBMS mechanism to receive V2X service information, provide V2X USD to the V2X control function entity.

6.3.6 BM-SC

In addition to the functions defined in 3GPP TS 23.246 and 3GPP TS 23.468, in the V2X scenario, BM-SC also supports the following functions.

--- Receive L.MBMS information from V2X application server.

--- Send L.MBMS information to MBMS-GW.

6.3.7 MBMS-GW

In addition to the functions defined in 3GPP TS 23.246, in the case of V2X, MBMS-GW also supports the following functions: If L.MBMS information is received from BM-SC, the distribution process of IP multicast distribution is skipped, such as distribution an IP multicast address.

7 Basic Functional Requirements of LTE-Based

scenario of "not using E-UTRAN service". These radio parameters (such as frequency) are described in 3GPP TS 36.331, which contains instructions to indicate whether these resources are "operator managed" or "non-operator managed." 3GPP TS 36.101 defines "non-operator managed" radio resources for V2X communication. These radio resource parameters may only be used when the UE can locate itself in the corresponding geographic zone, otherwise the UE is not authorized to transmit.

c) Parameters used for V2X communication on the PC5 interface.

--- The mapping relationship between the Destination Layer-2 ID and the V2X services (such as the PSID or ITS-AID, and the like services of the V2X application).

NOTE 1: PLMN operators need to coordinate to configure the destination Layer-2 ID of the V2X services in a consistent manner.

NOTE 2: In the case of pre-configuring UE, at least the corresponding parameters of "not using E-UTRAN service" in a) and b) and the parameters of c) need to be configured.

--- When the independent resources choose the V2X communication, the mapping relationship between the ProSe Per-Packet Priority (PPPP) and the packet delay budget (PDB).

7.1.1.1.3 Configuration principles for the parameters of the V2X communication on the PC5 interface

For V2X communication based on the PC5 interface, the operator may pre-configure the parameters required for V2X communication to the UE without the need for the UE to connect to the V2X control function to obtain the initial configuration, and follow the following principles.

--- The parameters required for V2X communication may be configured in UICC or ME, or both UICC and ME.

--- USIM removal or replacement shall not delete the V2X communication configuration parameters in the ME.

--- If a certain group of configuration parameters are saved in both UICC and ME, the group of configuration parameters saved in UICC shall be used first.

--- The UE needs to follow the following principles when using the radio resources used for PC5 interface V2X communication.

- When the UE accesses a cell and is ready to use the radio resources

- The parameters provided to the UE shall support geographic zone settings.

7.1.1.2 Authorization and provision of the V2X communication on the LTE-Uu interface

For V2X communication on the Uu interface, it may be necessary to provide unicast or MBMS transmission related information to the UE. It may contain the following parameter information.

a) Authorize the use of PLMN information for V2X communication based on MBMS. Including V2X USD that is used to receive MBMS-based V2X services in PLMN. V2X USD may be obtained from the V2X application server through the V2 interface.

b) V2X application server address information. Including the FQDN or IP address of the V2X application server related to geographic location information, and the PLMN to which the configuration information is applied.

c) Discovery information of V2X application server using MBMS. Including the PLMN list and the corresponding V2X server USD that receives V2X application server information through MBMS.

d) V2X services, such as the mapping between service identifiers such as PSID or ITS-AID and the following information.

--- A V2X application server address for unicast (including IP address/FQDN and UDP port).

--- V2X USD for MBMS.

7.1.2 Sending and receiving messages on PC5 interface

The PC5 interface (as defined in 3GPP TS 23.303) is used to send and receive V2X messages. V2X communication based on the PC5 interface supports roaming and cross-PLMN operations. The UE may support V2X communication based on the PC5 interface in the scenarios of "using E-UTRAN services" and "not using E-UTRAN services".

The V2X control function of HPLMN authorizes the UE to send and receive V2X messages.

V2X communication is a ProSe direct communication with the following characteristics.

--- The V2X communication on the PC5 interface is connectionless, and there is no signaling interaction process for connection establishment on the PC5 control plane.

--- The existing MBMS service announcement mechanism.

--- Configure in accordance with the method specified in subclause 7.1.1.2.

--- Information provided by the V2X application server through the V1 interface.

In order to reduce the delay of MBMS, it may be achieved by localizing MBMS.

7.1.4 Discovery of V2X application server

7.1.4.1 Overview

When using LTE-Uu mode for V2X communication, the UE needs to discover the V2X application server. The address information of the V2X application server may be configured in the UE or provided by the V3 interface.

When the FQDN is included in the configuration, the UE executes DNS to obtain the address of the V2X application server. The UE shall only use the configured V2X application server information when in the specified geographic zone. The serving PLMN that is changed by the UE or has passed through the configured geographic zone, the UE needs to perform the address acquisition process again.

When MBMS is deployed on the network, other information used for V2X application server discovery may be sent to UE through the MBMS broadcast channel. When the UE is configured to receive V2X application server information through MBMS, the UE can obtain other local V2X application server information through interaction with the network. The priority of the local V2X application server information obtained through MBMS is higher than the V2X application server information in the UE.

7.1.4.2 Discovery and routing of multiple V2X application servers and local V2X application server

There may be multiple V2X application servers in V2X communication, and each V2X application server provides different V2X services or different V2X application servers serve different geographic locations. Therefore, the V2X application server address information may include the information of multiple servers. When multiple V2X application servers are configured, the application layer shall select the appropriate V2X application server.

When a local V2X application server is deployed, the Anycast mechanism may be used to hide server changes from the UE. In this case, a larger area FQDN shall be configured, such as the entire PLMN, and the UE only needs to complete the process of discovering the Anycast address once. The PGW or LGW is responsible for routing data to the correct local V2X application server through the Anycast address.

7.1.5 QoS processing

The subscription information related to the user's V2X service is saved in the HSS.

The operator may delete the V2X service-related subscription from the HSS at any time; and revoke the authority to allow the UE to use the V2X service.

The V2X service-related subscription information is defined as follows.

a) Is the UE authorized to be a vehicle UE, a pedestrian UE, or both a vehicle UE and a pedestrian UE to perform V2X communication based on the PC5 interface.

b) UE-PC5-AMBR for V2X communication on the PC5 interface.

c) A list of PLMNs is authorized to allow the UE to perform V2X communication on the PC5 interface.

HSS provides a) and b) as subscription information to MME, and MME provides a) and b) as UE context information to eNB.

HSS provides c) to the V2X control function.

7.1.8 Support V2X communication under restricted service state

When the UE is in a restricted service state, only V2X communication on the PC5 interface is allowed.

The terminal that is authorized to use V2X communication on the PC5 interface shall be able to use the PC5 interface for V2X communication in a restricted state. When it enters the restricted service state due to the following reasons, it shall conduct V2X communication according to the principles specified in 7.1.1.1.3:

--- Because the terminal cannot find an available PLMN, or

--- Because the terminal received the following rejection reasons:

- Receive "PLMN not allowed" after registration request;
- Receive "GPRS not allowed" after registration request.

A terminal in a restricted service state can only use the radio resources and processes that may be used for V2X communication based on the PC5 interface in the ECM-IDLE mode.

If the terminal enters the restricted service state due to other reasons (for example, there is no SIM card, the registration request response is an illegal MS or illegal ME response, or the registration request response is "an IMSI not recognized by HLR"), and the terminal cannot access the PLMN to obtain ordinary services, then the terminal shall not use the operator-managed radio resources on the PC5 interface for V2X

resource pool is configured, the UE selects the V2X direct link sending resource pool based on the geographic zone.

--- The UE performs sensing to select (or reselect) resources. Based on the sensing result, the UE selects (or reselects) some direct link resources and reserves multiple direct link resources. The UE may support up to 2 parallel and independent resource reservation processes. The UE may also perform a single resource selection.

The UE may select sending resources based on the geographic zone. For the UE in the coverage area, the eNB may provide the mapping relationship between the V2X direct link transmission resource pool and the geographical zone through the SIB21, so that the UE may make independent resource selection. For the UE outside the coverage area, the mapping relationship between the V2X direct link transmission resource pool and the geographic zone is determined by pre-configuration. When the mapping relationship between the geographic zone and the transmission resource pool is configured (or pre-configured), the UE selects the sending resource from the resource pool corresponding to the geographic zone where it is located.

The geographic zone may be configured or pre-configured by the eNB. When a geographic zone is configured, the world is divided into geographic zones with a unique fixed reference point (i.e.: geographic coordinates (0,0)), length, and width. The UE uses a modular operation to determine the identity of the geographic zone according to the length and width of each geographic zone, the number of geographic zones in the length, the number of geographic zones in the width, as well as a fixed reference point. When the UE is not in the coverage area, the number of geographic zones in length and width is determined by pre-configured parameters. When the UE is in coverage area, the length and width of each geographic zone, the number of geographic zones in the length, and the number of geographic zones in the width are provided by the base station; when the UE is outside the coverage area, these parameters are determined by pre-configuration.

The concept of geographic zone does not apply to the abnormal V2X direct sending resource pool and receiving resource pool. Resource pools are not configured based on priority.

For V2X direct communication, during the handover process, the configuration of the sending resource pool, including the abnormal sending resource pool configuration for the target cell, may be sent to the UE in the handover signaling to reduce transmission interruption. In this case, before the handover is completed, as long as it is synchronized with the synchronization source (if the eNB is configured as the synchronization source, it shall be synchronized with the target cell; if the GNSS is configured as the synchronization source, it shall be synchronized with the GNSS), the UE may use the target cell's sending resource pool. When receiving a handover instruction, the UE randomly selects resources from the abnormal resource pool. If the

The UE assistance information may be provided to the eNB for V2X direct link communication. The report of UE assistance information is configured by the eNB. The UE assistance information includes service characteristic parameters related to SPS (for example: SPS interval expected according to the observed service mode, time offset relative to subframe 0 of SFN0, PPPP and maximum TB size). UE assistance information may be reported when SPS is configured or not. The mechanism for triggering UE assistance information depends on the implementation of the UE.

The UE that conducts the V2X direct link communication may adopt the three synchronization references: eNB, UE and GNSS. The serving cell may provide the synchronization configuration of the carrier used for V2X direct link communication; in this case, the UE follows the synchronization configuration provided by the serving cell. If the UE cannot detect a cell on the carrier used for V2X direct link communication, and the UE does not receive a synchronization configuration from the serving cell, the UE follows the pre-configured synchronization configuration. When GNSS is configured as the synchronization source, the UE uses UTC time and the configured (or pre-configured) DFN offset to calculate the frame number and subframe number of the direct link communication. If the eNB timing is configured as the UE's time reference, the UE performs synchronization and downlink measurement according to PCell (RRC_CONNECTED)/serving cell (RRC_IDLE). The UE may inform the PCell of the currently-used synchronization reference type.

The network may configure the UE to adaptively adjust transmission parameters for each transmission resource pool based on the channel busy rate (CBR) measurement.

It may provide direct sending and/or reception resources (including abnormal resource pools) for scheduling resource allocation and UE autonomous resource allocation on different frequencies; and it may be performed in a dedicated signaling SIB21 and/or pre-configuration manner. The serving cell may indicate only one frequency point for the UE; and the UE may obtain the direct link communication resource configuration on this frequency point. If providing multiple frequency points and related resource information, the selected frequency point is determined by the implementation of the UE. If the UE detects that the cell provides resource configuration or cross-carrier resource configuration, the UE shall not use pre-configured sending resources. The frequency points that provide V2X direct link communication resource configuration or cross-carrier configuration may be pre-configured. During cell reselection, the UE in RRC_IDLE may preferentially select the frequency point that provides V2X direct link communication resource configuration for other carriers.

If the UE supports multiple sending channels, the UE can simultaneously send on multiple carriers through the PC5 interface. In the case of supporting multiple V2X frequencies, the mapping between service types and V2X frequencies is configured by the upper layer. The UE shall ensure that the service is transmitted on the corresponding frequency.

synchronously on each layer on the PC5 interface. For example, when the application layer identity changes, both the source Layer-2 ID and the source IP address need to be changed. The UE is configured to use the destination Layer-2 ID of the V2X service. According to the configuration described in subclause 7.1.1.1, select the Layer-2 ID for V2X messages.

7.4 Function description and message flow

7.4.1 Control plane and user plane protocol stack

The PC5-U protocol stack defined in the proximity communication (see 3GPP TS 23.303) is used for V2X communication transmission based on the PC5 interface. The V2X communication transmission based on the PC5 interface supports IP and non-IP PDCP SDU.

For IP PDCP SDU type, only IPv6 is supported.

The Non-IP PDCP SDU contains the Non-IP type header, and the Non-IP type header indicates the V2X message protocol family used by the application layer.

7.4.2 Authorization and update of the V2X communication service

The authorization process of V2X communication reuses the content of 3GPP TS 23.303 subclause 5.2.1, but the V2X control function entity needs to replace the original ProSe function entity; the authorization update process of V2X communication reuses the content of 3GPP TS 23.303 subclause 5.2.2.

7.4.3 V2X communication process based on the PC5 interface

The V2X communication on the PC5 interface reuses the one-to-many ProSe direct communication transmission process (see TS 23.303 subclause 5.4.2 for sending, and TS 23.303 subclause 5.4.3 for receiving). For sending, the ProSe direct communication process has the following modifications:

--- UE self-configures the source Layer-2 ID, as defined in 7.1.7;

--- The UE is configured with a set of Layer-2 IDs related to the service type.

7.4.4 V2X communication process based on the LTE-Uu interface

7.4.4.1 Overview

This process is suitable for local V2X application server discovery (if supported by the network), and may be used by the UE only when the UE is configured to receive V2X application server information from MBMS.

7.4.4.2 Receive V2X application server information via MBMS

The MBMS service area of the V2X service may be configured in the V2X application server. The service area does not change frequently. The V2X application server completes the mapping to the MBMS session through the following process.

--- Manage MBMS session through MBMS bearer activation/deactivation process. The V2X application server utilizes the configured MBMS service area identities (SAIs) and/or the cell ID list of the target broadcast area to perform functions similar to GCS AS.

--- If the UE provides geographic location or cell ID information on the V1 interface, the V2X application server may use this information to determine the target broadcast area for the downlink broadcast of V2X messages.

--- For these processes, the V2X application server knows which TMGI/Flow-ID serves which geographical zone. Therefore, the V2X application server transmits the V2X message to the appropriate MBMS session.

NOTE: The V2X message broadcasting area may exceed the need. The V2X application on the UE may discard messages that have nothing to do with it based on the internal process of the UE.

7.4.4.3.2 Function description

The V2X application server maps the information provided by the UE into a format that the 3GPP MBMS system can understand, such as MBMS SAI and or ECGL.

The UE may provide geographic location information. The V2X application server uses this information to determine the MBMS SAI or cell ID of the target MBMS broadcast area. The V2X application server provides MBMS SAI or cell ID to BM-SC. BM-SC maps the cell ID to MBMS SAI.

7.4.4.3.3 Data transmission based on local MBMS

In order to reduce the delay of MBMS, V2X application server provides L.MBMS (local MBMS) information to BM-SC; namely, M1 interface information (including transmission network IP multicast address, multicast source IP address, C-TEID) and MB2-U interface information (including IP address, UDP port number). These L.MBMS information is pre-configured in the V2X application server.

The L.MBMS information (including M1 interface information and MB2-U interface information) in Figure 7 is provided by the V2X application server to the BM-SC. When the MBMS bearer is activated, the M1 interface information is provided by the BM-SC to the MBMS-GW.

through the MB2-U interface.

If BM-SC does not use the L.MBMS received from the V2X application server, BM-SC allocates MB2-U related addresses according to the normal MBMS process. The V2X application server, through the difference between the MB2-U address received by step 3 and the assigned address, knows that the BM-SC does not use the MB2-U address assigned by the V2X application server. At this time, the V2X application server normally executes the subsequent MBMS process.

7.4.5 The impact of V2X communication on the EPC process

7.4.5.1 E-UTRAN attach process

Compare the V2X-enabled UE attach process with the normal attach process, it has the following differences.

--- In the Attach request message, include the V2X capability indication in the "UE Network Capability". The MME saves this information for V2X operation. V2X capability indicates whether the UE supports V2X communication on the PC5 interface.

--- If the UE indicates the V2X capability, and the UE is subscribed and authorized to use the V2X communication on the PC5 interface, the MME includes a "V2X service authorized" indication in the S1-AP Initial Context Setup Request message to indicate that the UE is authorized to be a vehicle UE or a pedestrian UE or both may use the V2X communication on the PC5 interface.

--- As part of the subscription data, MME obtains UE-PC5-AMBR from HSS and includes it in the S1-AP Initial Context Setup Request message and sends it to eNB. The role of UE-PC5-AMBR is to manage the resources transmitted on the PC5 interface for V2X services when the network scheduling mode is used.

7.4.5.2 Service request process

Compare the service request process of V2X-enabled UE and the normal service request process, it has the following differences.

--- If the UE is V2X capable, and the UE is subscribed and authorized to use the V2X communication on the PC5 interface, the MME includes the "V2X service authorized" indication in the S1-AP Initial Context Setup Request message to indicate that the UE is authorized to authorize a vehicle UE or a pedestrian UE or both may use the V2X communication on the PC5 interface.

--- MME includes UE-PC5-AMBR in the S1-AP Initial Context Setup Request message and sends it to eNB. The role of UE-PC5-AMBR is to manage the resources transmitted on the PC5 interface for V2X services when the network

Where:

v_{rel} – relative speed of the two vehicles (=v_1-v_2);

t_1 - the time from when the vehicle receives the information to when the driver makes a braking action, including the time when the system converts the information into an alarm prompt after the vehicle receives the information, plus the reaction time for the driver to make braking actions based on the alarm prompt;

t_2 – response time of the braking system of this vehicle;

α – the braking deceleration of this vehicle.

Value t_1 and value t_2 are 3.7s and 0.3s, respectively; value α_1 is 3.6m/s^2 (refer to GB/T 33577-2017).

In the highway driving environment, consider v_1 is the maximum speed of 120km/h, and the slow vehicle speed v_2 is 20km/h, then the value v_{rel} is 27.8m/s (corresponding to 120-20=100km/h), and the minimum sensing distance is calculated to be about 218.5m. To ensure reliability, consider two transmissions, each with a transmission delay of 100ms, during which the vehicle movement distance is 0.2×27.8=5.6m, so the communication distance shall be 224m.

In the urban road driving environment, consider v_1 is the maximum speed of 60km/h, and the slow vehicle speed v_2 is 20km/h, then the value v_{rel} is 11.1m/s (corresponding to 60-20=40km/h), and the minimum sensing distance is calculated to be about 61.5m. To ensure reliability, consider two transmissions, each with a transmission delay of 100ms, during which the vehicle movement distance is 0.2×11.1=2.2m, so the communication distance shall be 64m.

A.1.3 Warning of the emergency electronic brake light

A.1.3.1 Description of the scenario

The scenario is shown in Figure A.5. When the vehicle (A) performs emergency braking, the vehicle broadcasts information such as the position, speed, direction, acceleration, and emergency braking of this vehicle; the rear vehicle (B) recognizes the content of the message, if it is on the driving route in front of this vehicle, and when it may cause a rear-end collision, the vehicle behind (B) generates an alarm for this vehicle.

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