**SA WG2 Meeting #S2-137E S2-2002019**

**24 - 27 February, 2020, Electronic meeting (revision of S2-2000953)**

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| *CR-Form-v12.0* | | | | | | | | |
| **CHANGE REQUEST** | | | | | | | | |
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|  | **23.287** | **CR** | **0086** | **rev** | **2** | **Current version:** | **16.1.0** |  |
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| *For* ***HE******LP*** *on using this form: comprehensive instructions can be found at  http://www.3gpp.org/Change-Requests.* | | | | | | | | |
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| ***Proposed change affects:*** | UICC apps |  | ME | **x** | Radio Access Network |  | Core Network |  |

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| ***Title:*** | Update of Link identifier update for unicast link procedure | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Source to WG:*** | InterDigital, [LG Electronics],[ Qualcomm Incorporated], Ericsson, Samsung | | | | | | | | | |
| ***Source to TSG:*** | SA WG2 | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Work item code:*** | eV2XARC | | | | |  | ***Date:*** | | | 2020-02-18 |
|  |  | | | |  | |  | | |  |
| ***Category:*** | **F** |  | | | | | ***Release:*** | | | Rel-16 |
|  | *Use one of the following categories:* ***F*** *(correction)* ***A*** *(mirror corresponding to a change in an earlier release)* ***B*** *(addition of feature),* ***C*** *(functional modification of feature)* ***D*** *(editorial modification)*  Detailed explanations of the above categories can be found in 3GPP TR 21.900. | | | | | | | | *Use one of the following releases: Rel-8 (Release 8) Rel-9 (Release 9) Rel-10 (Release 10) Rel-11 (Release 11) Rel-12 (Release 12)* *Rel-13 (Release 13) Rel-14 (Release 14) Rel-15 (Release 15) Rel-16 (Release 16)* | |
|  |  | | | | | | | | | |
| ***Reason for change:*** | | SA3 has identified security issues with the existing link identifier update for a unicast link procedure in TS 23.287 clause 6.3.3.2.  In the existing procedure, an eavesdropper may be able to link the old L2 ID and the new L2 ID of a source UE by making an association with the Kd session ID and/or the destination L2 ID. These identities (Kd session ID and destination L2 ID) are left unchanged and sent in cleartext before/during and after the Link identifier update procedure. For this reasons, SA3 has concluded that changing the Layer 2 identities and the Kd session ID for both UEs at the same time is required to protect the privacy of the PC5 unicast link.  SA3 has sent an LS to SA2 (S2-2000057/S3-194658) indicating the solution in TR 33.836 selected for normative work (i.e. solution #1) and asking SA2 to update the procedure to satify the security requirement.  SA2#137E updates:  To fullfill the privacy requirement, it is required that both UEs changes the Layer2 ID at the same time.Therefore, it needs to be clarified that how does the initiating UE will do if the peer UE does not change it link identifier together with the iniitating UE. | | | | | | | | |
|  | |  | | | | | | | | |
| ***Summary of change:*** | | The Link identifier update for unicast link procedure is updated to allow the change of L2 IDs for both UEs at the same time. | | | | | | | | |
|  | |  | | | | | | | | |
| ***Consequences if not approved:*** | | The privacy requirement is not fulfilled, i.e. a UE (e.g., a vehicle) may be tracked, even after the execution of the Link identifier update procedure. | | | | | | | | |
|  | |  | | | | | | | | |
| ***Clauses affected:*** | | 2, 6.3.3.2, 5.6.1.1, 5.6.1.4, 5.2.1.4 and 5.1.2.1 | | | | | | | | |
|  | |  | | | | | | | | |
|  | | **Y** | **N** |  | | | |  | | |
| ***Other specs*** | |  | **x** | Other core specifications | | | | TS/TR ... CR ... | | |
| ***affected:*** | |  | **x** | Test specifications | | | | TS/TR ... CR ... | | |
| ***(show related CRs)*** | |  | **x** | O&M Specifications | | | | TS/TR ... CR ... | | |
|  | |  | | | | | | | | |
| ***Other comments:*** | |  | | | | | | | | |
|  | |  | | | | | | | | |
| ***This CR's revision history:*** | |  | | | | | | | | |

\* \* \* Start of Changes \* \* \*

# 2 References

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

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

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

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

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

[2] 3GPP TS 22.185: "Service requirements for V2X services; Stage 1".

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

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

[5] IEEE Std 1609.12-2016: "[IEEE Standard for Wireless Access in Vehicular Environments (WAVE) - Identifier Allocations](http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=7428792&queryText=1609.12-2016&newsearch=true)".

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

\* \* \* Next Changes \* \* \*

#### 6.3.3.2 Link identifier update for a unicast link

Figure 6.3.3.2-1 shows the link identifier update procedure for a unicast link. Due to the privacy requirements, identifiers used for unicast mode of V2X communication over PC5 reference point (e.g. Application Layer ID, Source Layer-2 ID and IP address/prefix) shall be changed over time as specified in clauses 5.6.1.1 and 5.6.1.4. This procedure is used to update and exchange new identifiers between the source and the peer UEs for a unicast link before using the new identifiers, to prevent service interruptions.

If a UE has multiple unicast links using the same Application Layer IDs or Layer-2 IDs, the UE needs to perform the link identifier update procedure over each of the unicast link.



Figure 6.3.3.2-1: Link identifier update procedure

0. UE-1 and UE-2 have a unicast link established as described in clause 6.3.3.1.

1. UE-1 decides to change its identifier(s), e.g. due to the Application Layer ID change or upon expiry of a timer. UE-1 generates its new Layer-2 ID and send a Link Identifier Update Request message to UE-2 using the old identifiers.

The Link Identifier Update Request message includes the new identifier(s) to use (including the new Layer-2 ID, Security Information, optionally the new Application Layer ID, and optionally new IP address/prefix if IP communication is used). The new identifier(s) should be cyphered to protect privacy. After sending the Link Identifier Update request, if the UE-1 has data to send, UE-1 keeps sending data traffic to UE-2 with the old identifiers until UE-1 sends the Link Identifier Update Ack to UE-2.

NOTE 1: The timer is running on per Source Layer-2 ID.

NOTE 2: When one of the two UEs acts as IPv6 router as described in clause 5.2.1.5 and IP address/prefix also need to be changed, corresponding address configuration procedure would be carried out after the Link Identifier update procedure.

2. Upon reception of the Link Identifier Update Request message, based on privacy configuration as specified in clause 5.1.2.1, UE-2 changes its identifier(s). UE-2 responds with a Link Identifier Update Response message which includes the new identifier(s) to use (including the new Layer-2 ID, Security Information, optionally the new Application Layer ID, and optionally a new IP address/prefix if IP communication is used). The new identifier(s) should be cyphered to protect privacy. The Link Identifier Update Response message is sent using the old identifiers. UE-2 continues to receive traffic with the old Layer-2 ID from UE-1 until UE-2 receives traffic with the new Layer-2 ID from UE-1.After sending the Link Identifier Update response, UE-2 keeps sending data traffic to UE-1 with the old identifier until UE-2 receives the Link Identifier Update Ack message from UE-1.

3. Upon reception of the Link Identifier Update Response message, UE-1 responds with a Link Identifier Update Ack message which includes the new identifier(s) from UE-2, as received on the Link Identifier Update Response message. The Link Identifier Update Ack message is sent using the old identifiers. UE-1 continues to receive traffic with the old Layer-2 ID from UE-2 until UE-1 receives traffic with the new Layer-2 ID from UE-2.

NOTE 3: If UE-2 does not change its identifier(s), according to the privacy policy, UE-1 should stop the current procedure and release the unicast link as described in clause 6.3.3.3.

4. The V2X layer of UE-1 passes the PC5 Link Identifier for the unicast link and the updated Layer-2 IDs (i.e. new Layer-2 ID for UE-1 for the source and new Layer-2 ID of UE-2 for the destination) down to the AS layer. This enables the AS layer to update the provided Layer-2 IDs for the unicast link.

UE-1 starts using its new identifiers and UE-2's new identifiers for this unicast link.

5. The V2X layer of UE-2 passes the PC5 Link Identifier for the unicast link and the updated Layer-2 IDs (i.e. new Layer-2 ID of UE-2 for the source and new Layer-2 ID for UE-1 for the destination) down to the AS layer. This enables the AS layer to update the provided Layer-2 IDs for the unicast link.

UE-2 starts using its new identifiers and UE-1's new identifiers for this unicast link.

NOTE 4: The Security Information in the above messages also needs to be updated at the same time as the Layer-2 IDs. This is defined in TS 33.536 [xx].

\* \* \* Next Changes \* \* \*

#### 5.6.1.1 General

Each UE has one or more Layer-2 IDs for V2X communication over PC5 reference point, consisting of:

- Source Layer-2 ID(s); and

- Destination Layer-2 ID(s).

Source and destination Layer-2 IDs are included in layer-2 frames sent on the layer-2 link of the PC5 reference point identifying the layer-2 source and destination of these frames. Source Layer-2 IDs are always self-assigned by the UE originating the corresponding layer-2 frames.

The selection of the source and destination Layer-2 ID(s) by a UE depends on the communication mode of V2X communication over PC5 reference point for this layer-2 link, as described in clauses 5.6.1.2, 5.6.1.3, and 5.6.1.4. The source Layer-2 IDs may differ between different communication modes.

When IP-based V2X communication is supported, the UE configures a link local IPv6 address to be used as the source IP address, as defined in clause 4.5.3 of TS 23.303 [17]. The UE may use this IP address for V2X communication over PC5 reference point without sending Neighbour Solicitation and Neighbour Advertisement message for Duplicate Address Detection.

If the UE has an active V2X application that requires privacy support in the current Geographical Area, as identified by configuration described in clause 5.1.2.1, in order to ensure that a source UE (e.g. vehicle) cannot be tracked or identified by any other UEs (e.g. vehicles) beyond a certain short time-period required by the application, the source Layer-2 ID shall be changed over time and shall be randomized. For IP-based V2X communication over PC5 reference point, the source IP address shall also be changed over time and shall be randomized. The change of the identifiers of a source UE must be synchronized across layers used for PC5, (e.g. when the Application Layer ID changes, the source Layer-2 ID and the source IP address need to be changed).

\* \* \* Next Changes \* \* \*

#### 5.6.1.4 Identifiers for unicast mode V2X communication over PC5 reference point

For unicast mode of V2X communication over PC5 reference point, the destination Layer-2 ID used depends on the communication peer. The Layer-2 ID of the communication peer, identified by the Application Layer ID, may be discovered during the establishment of the PC5 unicast link, or known to the UE via prior V2X communications, e.g. existing or prior unicast link to the same Application Layer ID, or obtained from application layer service announcements. The initial signalling for the establishment of the PC5 unicast link may use the known Layer-2 ID of the communication peer, or a default destination Layer-2 ID associated with the V2X service type (e.g. PSID/ITS-AID) configured for PC5 unicast link establishment, as specified in clause 5.1.2.1. During the PC5 unicast link establishment procedure, Layer-2 IDs are exchanged, and should be used for future communication between the two UEs, as specified in clause 6.3.3.1.

The Application Layer ID is associated with one or more V2X applications within the UE. If UE has more than one Application Layer IDs, each Application Layer ID of the same UE may be seen as different UE's Application Layer ID from the peer UE's perspective.

The UE maintains a mapping between the Application Layer IDs and the source Layer-2 IDs used for the PC5 unicast links, as the V2X application layer does not use the Layer-2 IDs. This allows the change of source Layer-2 ID without interrupting the V2X applications.

When Application Layer IDs change, the source Layer-2 ID(s) of the PC5 unicast link(s) shall be changed if the link(s) was used for V2X communication with the changed Application Layer IDs.

Based on privacy configuration as specified in clasue 5.1.2.1, the update of the new identifiers of a source UE to the peer UE for the established unicast link may cause the peer UE to change its Layer-2 ID and optionally IP address/prefix if IP communication is used as defined in clause 6.3.3.2.

A UE may establish multiple PC5 unicast links with a peer UE and use the same or different source Layer-2 IDs for these PC5 unicast links.

\* \* \* Next Changes \* \* \*

#### 5.2.1.4 Unicast mode communication over PC5 reference point

Unicast mode of communication is only supported over NR based PC5 reference point. Figure 5.2.1.4-1 illustrates an example of PC5 unicast links.



Figure 5.2.1.4-1: Example of PC5 Unicast Links

The following principles apply when the V2X communication is carried over PC5 unicast link:

- A PC5 unicast link between two UEs allows V2X communication between one or more pairs of peer V2X services in these UEs. All V2X services in the UE using the same PC5 unicast link use the same Application Layer ID.

NOTE 1: An Application Layer ID may change in time as described in clauses 5.6.1.1 and 6.3.3.2, due to privacy. This does not cause a re-establishment of a PC5 unicast link.

- One PC5 unicast link supports one or more V2X services (e.g. PSIDs or ITS-AIDs) if these V2X services are at least associated with the pair of peer Application Layer IDs for this PC5 unicast link. For example, as illustrated in Figure 5.2.1.4-1, UE A and UE B have two PC5 unicast links, one between peer Application Layer ID 1/UE A and Application Layer ID 2/UE B and one between peer Application Layer ID 3/UE A and Application Layer ID 4/UE B.

NOTE 2: A source UE is not required to know whether different target Application Layer IDs over different PC5 unicast links belong to the same target UE.

- A PC5 unicast link supports V2X communication using a single network layer protocol e.g. IP or non-IP.

- A PC5 unicast link supports per-flow QoS model as specified in clause 5.4.1.

When the Application layer in the UE initiates data transfer for a V2X service which requires unicast mode of communication over PC5 reference point:

- the UE shall reuse an existing PC5 unicast link if the pair of peer Application Layer IDs and the network layer protocol of this PC5 unicast link are identical to those required by the application layer in the UE for this V2X service, and modify the existing PC5 unicast link to add this V2X service as specified in clause 6.3.3.4; otherwise

- the UE shall trigger the establishment of a new PC5 unicast link as specified in clause 6.3.3.1.

After successful PC5 unicast link establishment, UE A and UE B use the same pair of Layer-2 IDs for subsequent PC5-S signalling message exchange and V2X service data transmission as specified in clause 5.6.1.4. The V2X layer of the transmitting UE indicates to the AS layer whether a transmission is for a PC5-S signalling message (i.e. Direct Communication Request/Accept, Link Identifier Update Request/Response/Ack, Disconnect Request/Response, Link Modification Request/Accept) or V2X service data.

For every PC5 unicast link, a UE self-assigns a distinct PC5 Link Identifier that uniquely identifies the PC5 unicast link in the UE for the lifetime of the PC5 unicast link. Each PC5 unicast link is associated with a Unicast Link Profile which includes:

- service type(s) (e.g. PSID or ITS-AID), Application Layer ID and Layer-2 ID of UE A; and

- Application Layer ID and Layer-2 ID of UE B; and

- network layer protocol used on the PC5 unicast link; and

- for each V2X service, a set of PC5 QoS Flow Identifier(s) (PFI(s)). Each PFI is associated with QoS parameters (i.e. PQI and optionally Range).

For privacy reason, the Application Layer IDs and Layer-2 IDs may change as described in clauses 5.6.1.1 and 6.3.3.2 during the lifetime of the PC5 unicast link and, if so, shall be updated in the Unicast Link Profile accordingly. The UE uses PC5 Link Identifier to indicate the PC5 unicast link to V2X Application layer, therefore V2X Application layer identifies the corresponding PC5 unicast link even if there are more than one unicast link associated with one service type (e.g. the UE establishes multiple unicast links with multiple UEs for a same service type).

The Unicast Link Profile shall be updated accordingly after a Layer-2 link modification for an established PC5 unicast link as specified in clause 6.3.3.4.

\* \* \* Next Changes \* \* \*

#### 5.1.2.1 Policy/Parameter provisioning

The following information for V2X communications over PC5 reference point is provisioned to the UE:

1) Authorization policy:

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

- PLMNs in which the UE is authorized to perform V2X communications over PC5 reference point when "served by E-UTRA" or "served by NR".

For each above PLMN:

- RAT(s) over which the UE is authorized to perform V2X communications over PC5 reference point.

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

- Indicates whether the UE is authorized to perform V2X communications over PC5 reference point when "not served by E-UTRA" and "not served by NR".

- RAT(s) over which the UE is authorized to perform V2X communications over PC5 reference point.

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

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

Editor's note: The radio parameters (e.g. frequency bands) are to be defined by RAN WGs. The reference to RAN specification will be added when defined in RAN WGs.

NOTE 1: Whether a frequency band is "operator managed" or "non-operator managed" in a given Geographical Area is defined by local regulations.

3) Policy/parameters per RAT for PC5 Tx Profile selection:

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

Editor's note: The Tx Profiles are to be defined by RAN WGs. The reference to RAN specification will be added when defined in RAN WGs.

4) Policy/parameters related to privacy:

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

- A privacy timer value indicating the duration after which the UE shall change each source Layer-2 ID self-assigned by the UE when privacy is required.

5) Policy/parameters when LTE PC5 is selected:

Same as specified in TS 23.285 [8] clause 4.4.1.1.2 item 3) Policy/parameters except for the mapping of service types to Tx Profiles and the list of V2X services with Geographical Area(s) that require privacy support.

6) Policy/parameters when NR PC5 is selected:

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

- The mapping of Destination Layer-2 ID(s) and the V2X services, e.g. PSIDs or ITS-AIDs of the V2X application for broadcast.

- The mapping of Destination Layer-2 ID(s) and the V2X services, e.g. PSIDs or ITS-AIDs of the V2X application for groupcast.

- The mapping of default Destination Layer-2 ID(s) for initial signalling to establish unicast connection and the V2X services, e.g. PSIDs or ITS-AIDs of the V2X application.

NOTE 2: The same default Destination Layer-2 ID for unicast initial signalling can be mapped to more than one V2X services. In the case where different V2X services are mapped to distinct default Destination Layer-2 IDs, when the UE intends to establish a single unicast link that can be used for more than one V2X services, the UE can select any of the default Destination Layer-2 IDs to use for the initial signalling.

- PC5 QoS mapping configuration:

- Input from V2X application layer:

- V2X service (e.g. PSID or ITS-AID).

- (Optional) V2X Application Requirements for the V2X service, e.g. priority requirement, reliability requirement, delay requirement, range requirement.

NOTE 3: Details of V2X Application Requirements for the V2X service is up to implementation and out of scope of this specification.

- Output:

- PC5 QoS parameters defined in clause 5.4.2 (i.e. PQI and conditionally other parameters such as MFBR/GFBR, etc).

- SLRB configurations, i.e. the mapping of PC5 QoS profile(s) to SLRB(s), when the UE is "not served by E-UTRA" and "not served by NR".

- The PC5 QoS profile contains PC5 QoS parameters described in clause 5.4.2, and value for the QoS characteristics regarding Priority Level, Averaging Window, Maximum Data Burst Volume if default value is not used as defined in Table 5.4.4-1.

Editor's note: The SLRB configurations will be determined by RAN WGs. The reference to RAN specification will be added when defined in RAN WGs.

Editor's note: For the PC5 QoS profile, coordination with RAN WGs is needed.

Editor's note: The V2X frequencies with Geographical Area(s) will be determined by RAN WGs. The reference to RAN specification will be added when defined in RAN WGs.

\* \* \* Next Changes \* \* \*

#### 6.3.3.1 Layer-2 link establishment over PC5 reference point

To perform unicast mode of V2X communication over PC5 reference point, the UE is configured with the related information as described in clause 5.1.2.1.

Figure 6.3.3.1-1 shows the layer-2 link establishment procedure for unicast mode of V2X communication over PC5 reference point.



Figure 6.3.3.1-1: Layer-2 link establishment procedure

1. The UE(s) determine the destination Layer-2 ID for signalling reception for PC5 unicast link establishment as specified in clause 5.6.1.4. The destination Layer-2 ID is configured with the UE(s) as specified in clause 5.1.2.1.

2. The V2X application layer in UE-1 provides application information for PC5 unicast communication. The application information includes the V2X service type(s) (e.g. PSID(s) or ITS-AID(s)) of the V2X application and the initiating UE's Application Layer ID. The target UE's Application Layer ID may be included in the application information.

The V2X application layer in UE-1 may provide V2X Application Requirements for this unicast communication. UE-1 determines the PC5 QoS parameters and PFI as specified in clause 5.4.1.4.

If UE-1 decides to reuse the existing PC5 unicast link as specified in clause 5.2.1.4, the UE triggers Layer-2 link modification procedure as specified in clause 6.3.3.4.

3. UE-1 sends a Direct Communication Request message to initiate the unicast layer-2 link establishment procedure. The Direct Communication Request message includes:

- Source User Info: the initiating UE's Application Layer ID (i.e. UE-1's Application Layer ID).

- If the V2X application layer provided the target UE's Application Layer ID in step 2, the following information is included:

- Target User Info: the target UE's Application Layer ID (i.e. UE-2's Application Layer ID).

- V2X Service Info: the information about V2X Service(s) requesting Layer-2 link establishment (e.g. PSID(s) or ITS-AID(s)).

- Security Information: the information for the establishment of security.

NOTE 1: The Security Information and the necessary protection of the Source User Info and Target User Info are defined by SA WG3.

The source Layer-2 ID and destination Layer-2 ID used to send the Direct Communication Request message are determined as specified in clauses 5.6.1.1 and 5.6.1.4. The destination Layer-2 ID may be broadcast or unicast Layer-2 ID. When unicast Layer-2 ID is used, the Target User Info shall be included in the Direct Communication Request message.

UE-1 sends the Direct Communication Request message via PC5 broadcast or unicast using the source Layer-2 ID and the destination Layer-2 ID.

4. Security with UE-1 is established as below:

4a. If the Target User Info is included in the Direct Communication Request message, the target UE, i.e. UE-2, responds by establishing the security with UE-1.

4b. If the Target User Info is not included in the Direct Communication Request message, the UEs that are interested in using the announced V2X Service(s) over a PC5 unicast link with UE-1 responds by establishing the security with UE-1.

NOTE 2: The signalling for the Security Procedure is defined by SA WG3.

When the security protection is enabled, UE-1 sends the following information to the target UE:

- If IP communication is used:

- IP Address Configuration: For IP communication, IP address configuration is required for this link and indicates one of the following values:

- "IPv6 Router" if IPv6 address allocation mechanism is supported by the initiating UE, i.e., acting as an IPv6 Router; or

- "IPv6 address allocation not supported" if IPv6 address allocation mechanism is not supported by the initiating UE.

- Link Local IPv6 Address: a link-local IPv6 address formed locally based on RFC 4862 [21] if UE-1 does not support the IPv6 IP address allocation mechanism, i.e. the IP Address Configuration indicates "IPv6 address allocation not supported".

- QoS Info: the information about PC5 QoS Flow(s). For each PC5 QoS Flow, the PFI and the corresponding PC5 QoS parameters (i.e. PQI and conditionally other parameters such as MFBR/GFBR, etc.).

5. A Direct Communication Accept message is sent to UE-1 by the target UE(s) that has successfully established security with UE-1:

5a. (UE oriented Layer-2 link establishment) If the Target User Info is included in the Direct Communication Request message, the target UE, i.e. UE-2 responds with a Direct Communication Accept message if the Application Layer ID for UE-2 matches.

5b. (V2X Service oriented Layer-2 link establishment) If the Target User Info is not included in the Direct Communication Request message, the UEs that are interested in using the announced V2X Service(s) respond to the request by sending a Direct Communication Accept message (UE-2 and UE-4 in Figure 6.3.3.1-1).

The Direct Communication Accept message includes:

- Source User Info: Application Layer ID of the UE sending the Direct Communication Accept message.

- QoS Info: the information about PC5 QoS Flow(s). For each PC5 QoS Flow, the PFI and the corresponding PC5 QoS parameters requested by UE-1 (i.e. PQI and conditionally other parameters such as MFBR/GFBR, etc).

- If IP communication is used:

- IP Address Configuration: For IP communication, IP address configuration is required for this link and indicates one of the following values:

- "IPv6 Router" if IPv6 address allocation mechanism is supported by the target UE, i.e., acting as an IPv6 Router; or

- "IPv6 address allocation not supported" if IPv6 address allocation mechanism is not supported by the target UE.

- Link Local IPv6 Address: a link-local IPv6 address formed locally based on RFC 4862 [21] if the target UE does not support the IPv6 IP address allocation mechanism, i.e. the IP Address Configuration indicates "IPv6 address allocation not supported", and UE-1 included a link-local IPv6 address in the Direct Communication Request message. The target UE shall include a non-conflicting link-local IPv6 address.

If both UEs (i.e. the initiating UE and the target UE) selected to use link-local IPv6 address, they shall disable the duplicate address detection defined in RFC 4862 [21].

NOTE 3: When either the initiating UE or the target UE indicates the support of IPv6 router, corresponding address configuration procedure would be carried out after the establishment of the layer 2 link, and the link-local IPv6 addresses are ignored.

The source Layer-2 ID used to send the Direct Communication Accept message is determined as specified in clauses 5.6.1.1 and 5.6.1.4. The destination Layer-2 ID is set to the source Layer-2 ID of the received Direct Communication Request message.

Upon receiving the Direct Communication Accept message from peer UE, UE-1 obtains the peer UE's Layer-2 ID for future communication, for signalling and data traffic for this unicast link.

The V2X layer of the UE that established PC5 unicast link passes the PC5 Link Identifier assigned for the unicast link and PC5 unicast link related information down to the AS layer. The PC5 unicast link related information includes Layer-2 ID information (i.e. source Layer-2 ID and destination Layer-2 ID). This enables the AS layer to maintain the PC5 Link Identifier together with the PC5 unicast link related information.

6. V2X service data is transmitted over the established unicast link as below:

The PC5 Link Identifier and PFI are provided to the AS layer, together with the V2X service data.

UE-1 sends the V2X service data using the source Layer-2 ID (i.e. UE-1's Layer-2 ID for this unicast link) and the destination Layer-2 ID (i.e. the peer UE's Layer-2 ID for this unicast link).

NOTE 4: PC5 unicast link is bi-directional, therefore the peer UE of UE-1 can send the V2X service data to UE-1 over the unicast link with UE-1.

\* \* \* End of Changes \* \* \*