**3GPP TSG-CT WG1 Meeting #127-eC1-20XXXX**

**Electronic meeting, 13-20 November 2020**

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| *CR-Form-v12.0* |
| **CHANGE REQUEST** |
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|  | **24.587** | **CR** | **95** | **rev** | **7** | **Current version:** | **16.2.1** |  |
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| *For* [***HE******LP***](http://www.3gpp.org/3G_Specs/CRs.htm#_blank)*on using this form: comprehensive instructions can be found at* [*http://www.3gpp.org/Change-Requests*](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:***  | Updates to PC5 unicast link establishment procedure |
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| ***Source to WG:*** | Huawei, HiSilicon, InterDigital |
| ***Source to TSG:*** | C1 |
|  |  |
| ***Work item code:*** | eV2XARC |  | ***Date:*** | 2020-10-08 |
|  |  |  |  |  |
| ***Category:*** | **C** |  | ***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 canbe found in 3GPP [TR 21.900](http://www.3gpp.org/ftp/Specs/html-info/21900.htm). | *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)* |
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| ***Reason for change:*** | Following issues are adressed in this CR and they are discussed in detail in the discussion paper C1-206381. The PC5 unicast direct link establishment procedure is used in 2 different scenarios 1. To estalibish a PC5 unicast link between peer UEs ( one to one) which is also known as UE based direct link establishment
2. To establish multiple PC5 unicast link between one initiating UE and multiple target UEs know as the V2X service based direct link establishment.

 In the current specification only case a) is taken care of. Case b) needs to be adressed. The CR (rev 5) was agreed in the meeting CT-126\_e as C1-205484, but had to revise due to the usage ‘may not’ in the phrase ‘UE may not stop the timer T5000’ in 6.1.2.2.4. This is changed to the ‘UE may keep the timer T5000’ running. |
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| ***Summary of change:*** | 1. The initiating UE can establish multiple links with different target UEs in one V2X service oriented type PC5 unicast link establishment procedure (i.e. DIRECT LINK ESTABLISHMENT REQUEST without target user info), including PC5 unicast link authentication procedures and PC5 unicast link security mode control procedures with those different target UEs during this establishment procedure.
2. The timer T5000 started in the V2X service oriented type PC5 unicast link establishment procedure, may not be stopped when receiving DIRECT LINK ESTABLISHMENT ACCEPT.
3. Due to the limit of maximum number of established NR PC5 unicast links, the initiating UE in the V2X service oriented type PC5 unicast link establishment procedure, can use cause value *#5 lack of resources for PC5 unicast link* to reject PC5 unicast link authentication procedures and PC5 unicast link security mode control procedures, leading the failure of the link establishment with a specific target UE (initiating UE of the PC5 unicast link authentication procedure or the PC5 unicast link security mode control procedure).
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| ***Consequences if not approved:*** | Not aligned with SA2 to handle the V2X service oriented type PC5 unicast link establishment procedure (DIRECT LINK ESTABLISHMENT REQUEST without target user info). |
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| ***Clauses affected:*** | 6.1.2.2.1, 6.1.2.2.2, 6.1.2.2.4, 6.1.2.2.6.1, 6.1.2.6.3, 6.1.2.6.5, 6.1.2.7.5, 10.3 |
|  |  |
|  | **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:*** | Rev 4:Removed the description on mandatory source layer-2 ID re-assignment. when receiving direct link authentication request message or direct link security mode control command message, during the V2X service oriented Direct Link Establishment procedure.Rev 6: The CR (rev 5) was agreed in the meeting CT-126\_e as C1-205484, but had to revise due to the usage ‘may not’ in the phrase ‘UE may not stop the timer T5000’ in 6.1.2.2.4. This is changed to the ‘UE may keep the timer T5000’ running. |

\* \* \* First Change \* \* \* \*

#### 6.1.2.2 PC5 unicast link establishment procedure

##### 6.1.2.2.1 General

Depending on the type of the PC5 unicast link establishment procedure (i.e. UE oriented Layer-2 link establishment or V2X Service oriented Layer-2 link establishment in 3GPP TS 23.287[3]), the PC5 unicast link establishment procedure is used to establish a PC5 unicast link between two UEs or to establish multiple PC5 unicast links. The UE sending the request message is called the "initiating UE" and the other UE is called the "target UE". If the request message does not indicate the specific target UE (i.e. target user info is not included in the request message), and multiple target UEs are interested in the V2X service(s) indicated in the request message, then the initiating UE shall handle corresponding response messages received from those target UEs. The maximum number of NR PC5 unicast links established in a UE at a time shall not exceed an implementation-specific maximum number of established NR PC5 unicast links.

NOTE: The recommended maximum number of established NR PC5 unicasts link is 8.

\* \* \* Next Change \* \* \* \*

##### 6.1.2.2.2 PC5 unicast link establishment procedure initiation by initiating UE

The initiating UE shall meet the following pre-conditions before initiating this procedure:

a) a request from upper layers to transmit the packet for V2X service over PC5;

b) the communication mode is unicast mode (e.g. pre-configured as specified in clause 5.2.3 or indicated by upper layers);

c) the link layer identifier for the initiating UE (i.e. layer-2 ID used for unicast communication) is available (e.g. pre-configured or self-assigned) and is not being used by other existing PC5 unicast links within the initiating UE;

d) the link layer identifier for the unicast initial signaling (i.e. destination layer-2 ID used for unicast initial signaling) is available to the initiating UE (e.g. pre-configured, obtained as specified in clause 5.2.3 or known via prior V2X communication);

NOTE 1: In the case where different V2X services are mapped to distinct default destination layer-2 IDs, when the initiating UE intends to establish a single unicast link that can be used for more than one V2X service types, the UE can select any of the default destination layer-2 ID for unicast initial signalling.

e) the initiating UE is either authorised for V2X communication over PC5 in NR-PC5 in the serving PLMN, or has a valid authorization for V2X communication over PC5 in NR-PC5 when not served by E-UTRA and not served by NR. The UE considers that it is not served by E-UTRA and not served by NR if the following conditions are met:

1) not served by NR and not served by E-UTRA for V2X communication over PC5;

2) in limited service state as specified in 3GPP TS 23.122 [2], 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 38.304 [9];

ii) the UE received a REGISTRATION REJECT message or a SERVICE REJECT message with the 5GMM cause #11 "PLMN not allowed" as specified in 3GPP TS 24.501 [6]; or

iii) the UE received a REGISTRATION REJECT message or a SERVICE REJECT message with the 5GMM cause #7 "5GS services not allowed" as specified in 3GPP TS 24.501 [6]; or

3) in limited service state as specified in 3GPP TS 23.122 [2] 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 clause 5.2.3;

f) there is no existing PC5 unicast link for the pair of peer application layer IDs, or there is an existing PC5 unicast link for the pair of peer application layer IDs and:

1) the network layer protocol of the existing PC5 unicast link is not identical to the network layer protocol required by the upper layer in the initiating UE for this V2X service; or

2) the security policy (either signalling security policy or user plane security policy) corresponding to the V2X service identifier is not compatible with the security policy of the existing PC5 unicast link; and

g) the number of established PC5 unicast links is less than the implementation-specific maximum number of established NR PC5 unicast links allowed in the UE at a time.

After receiving the service data or request from the upper layers, the initiating UE shall derive the PC5 QoS parameters and assign the PQFI(s) for the PC5 QoS flows(s) to be established as specified in clause 6.1.2.12.

In order to initiate the PC5 unicast link establishment procedure, the initiating UE shall create a DIRECT LINK ESTABLISHMENT REQUEST message. The initiating UE:

a) shall include the source user info set to the initiating UE’s application layer ID received from upper layers;

b) shall include the V2X service identifier(s) received from upper layer;

c) shall include the target user info set to the target UE’s application layer ID if received from upper layers;

d) shall include the Key establishment information container if the UE PC5 unicast signalling integrity protection policy is set to "signalling integrity protection required" or "signalling integrity protection preferred", and may include the Key establishment information container if the UE PC5 unicast signalling integrity protection policy is set to "signalling integrity protection not needed";

NOTE 2: The Key establishment information container is provided by upper layers.

e) shall include a Nonce\_1 set to the 128-bit nonce value generated by the initiating UE for the purpose of session key establishment over this PC5 unicast link if the UE PC5 unicast signalling integrity protection policy is set to "signalling integrity protection required" or "signalling integrity protection preferred";

f) shall include its UE security capabilities indicating the list of algorithms that the initiating UE supports for the security establishment of this PC5 unicast link;

g) shall include the 8 MSBs of KNRP-sess ID chosen by the initiating UE as specified in 3GPP TS 33.536 [20] if the UE PC5 unicast signalling integrity protection policy is set to "signalling integrity protection required" or "signalling integrity protection preferred";

h) may include a KNRP ID if the initiating UE has an existing KNRP for the target UE; and

i) shall include its UE PC5 unicast signalling security policy. In the case where the different V2X services are mapped to the different PC5 unicast signalling security policies, when the initiating UE intends to establish a single unicast link that can be used for more than one V2X service, each of the signalling security polices of those V2X services shall be compatible, e.g. "signalling integrity protection not needed" and "signalling integrity protection required" are not compatible.

After the DIRECT LINK ESTABLISHMENT REQUEST message is generated, the initiating UE shall pass this message to the lower layers for transmission along with the initiating UE's layer-2 ID for unicast communication and the destination layer-2 ID used for unicast initial signaling, and start timer T5000. The UE shall not send a new DIRECT LINK ESTABLISHMENT REQUEST message to the same target UE identified by the same application layer ID while timer T5000 is running. If the target user info IE is not included in the DIRECT LINK ESTABLISHMENT REQUEST message (i.e. V2X service oriented PC5 unicast link establishment procedure), the initiating UE shall handle multiple DIRECT LINK ESTABLISHMENT ACCEPT messages, if any, received from different target UEs for the establishment of multiple PC5 unicast links before the expiry of timer T5000.

NOTE 2: In order to ensure successful PC5 unicast link establishment, T5000 should be set to a value larger than the sum of T5006 and T5007.



Figure 6.1.2.2.2: UE oriented PC5 unicast link establishment procedure

Initiating UE

Target UEs

Start T5000

DIRECT LINK ESTABLISHMENT REQUEST

DIRECT LINK ESTABLISHMENT ACCEPT

T5000 expires

DIRECT LINK ESTABLISHMENT ACCEPT

Figure 6.1.2.2.3: V2X service oriented PC5 unicast link establishment procedure

\* \* \* Next Change \* \* \* \*

##### 6.1.2.2.4 PC5 unicast link establishment procedure completion by the initiating UE

If the Target user info IE is included in the DIRECT LINK ESTABLISHMENT REQUEST message, upon receipt of the DIRECT LINK ESTABLISHMENT ACCEPT message, the initiating UE shall stop timer T5000. If the Target user info IE is not included in the DIRECT LINK ESTABLISHMENT REQUEST message the initiating UE may keep the timer T5000 running and continue to handle multiple response messages (i.e. the DIRECT LINK ESTABLISHMENT ACCEPT message) from multiple target UEs.

For each of the DIRECT LINK ESTABLISHMENT ACCEPT message received, the initiating UE shall uniquely assign a PC5 link identifier and create a PC5 unicast link context for each of the PC5 unicast link(s). Then the target UE shall store the source layer-2 ID and the destination layer-2 ID used in the transport of this message provided by the lower layers in the PC5 unicast link context(s) to complete the establishment of the PC5 unicast link with the target UE(s).From this time onward the initiating UE shall use the established link(s) for V2X communication over PC5 and additional PC5 signalling messages to the target UE(s).

After receiving the DIRECT LINK ESTABLISHMENT ACCEPT message, the initiating UE shall provide the following information along with the layer-2 IDs to the lower layer, which enables the lower layer to handle the coming PC5 signalling or traffic data:

a) the PC5 link identifier self-assigned for this PC5 unicast link;

b) PQFI(s) and its corresponding PC5 QoS parameters;

c) Indication of activation of the PC5 unicast signalling security protection for the PC5 unicast link, if applicable; and

d) Indication of activation of the PC5 unicast user plane security protection for the PC5 unicast link, if applicable.

The initiating UE shall start timer T5011 if the initiating UE has the privacy configuration as specified in clause 5.2.3.

In addition, the initiating UE may perform the PC5 QoS flow establishment over PC5 unicast link as specified in clause 6.1.2.12.

Upon expiry of the timer T5000, if the DIRECT\_LINK\_ESTABLISHMENT REQUEST message did not include the Target User Info IE, and the initiating UE received at least one DIRECT LINK ESTABLISHMENT ACCEPT message, it is up to the UE implementation to consider the PC5 unicast link establishment procedure as complete or to restart the timer T5000.

\* \* \* Next Change \* \* \* \*

###### 6.1.2.2.6.1 Abnormal cases at the initiating UE

If timer T5000 expires and the Target user info IE is included in the DIRECT LINK ESTABLISHMENT REQUEST message, the initiating UE shall retransmit the DIRECT LINK ESTABLISHMENT REQUEST message and restart timer T5000. After reaching the maximum number of allowed retransmissions, the initiating UE shall abort the PC5 unicast link establishment procedure and may notify the upper layer that the target UE is unreachable.

Upon expiry of the timer T5000, if the DIRECT\_LINK\_ESTABLISHMENT REQUEST message did not include the Target User Info IE and the initiating UE did not receive any DIRECT LINK ESTABLISHMENT ACCEPT message, the initiating UE may retransmit the DIRECT LINK ESTABLISHMENT REQUEST message and restart timer T5000. If the DIRECT\_LINK\_ESTABLISHMENT REQUEST message did not include the Target User Info IE and the initiating UE did not receive any DIRECT LINK ESTABLISHMENT ACCEPT message, then after reaching the maximum number of allowed retransmissions, the initiating UE shall abort the PC5 unicast link establishment procedure and may notify the upper layer that no target UE is available.

NOTE: The maximum number of allowed retransmissions is UE implementation specific.

If the need to establish a link no longer exists before the procedure is completed, the initiating UE shall abort the procedure.

\* \* \* Next Change \* \* \* \*

##### 6.1.2.6.3 PC5 unicast link authentication procedure accepted by the target UE

Upon receipt of a DIRECT LINK AUTHENTICATION REQUEST message, if the target UE determines that the DIRECT LINK AUTHENTICATION REQUEST message can be accepted, the target UE shall create a DIRECT LINK AUTHENTICATION RESPONSE message. The target UE shall check if the number of established PC5 unicast links is less than the implementation-specific maximum number of established NR PC5 unicast links allowed in the UE at a time. In this message, the target UE:

a) shall include the Key establishment information container.

NOTE: The Key establishment information container is provided by upper layers.

After the DIRECT LINK AUTHENTICATION RESPONSE message is generated, the target UE shall pass this message to the lower layers for transmission along with the target UE's layer-2 ID for unicast communication and the initiating UE's layer-2 ID for unicast communication.

\* \* \* Next Change \* \* \* \*

##### 6.1.2.6.5 PC5 unicast link authentication procedure not accepted by the target UE

If the DIRECT LINK AUTHENTICATION REQUEST message cannot be accepted, the target UE shall create a DIRECT LINK AUTHENTICATION REJECT message. In this message, the target UE shall include a PC5 signaling protocol cause IE indicating one of the following cause values:

#a: authentication failure;

#5: lack of resources for PC5 unicast link.

If this PC5 unicast link authentication procedure is triggered during the PC5 unicast link establishment procedure and the implementation-specific maximum number of established NR PC5 unicast links has been reached, then the target UE shall send a DIRECT LINK AUTHENTICATION REJECT message containing PC5 signalling protocol cause value #5 "lack of resources for PC5 unicast link".

After the DIRECT LINK AUTHENTICATION REJECT message is generated, the target UE shall pass this message to the lower layers for transmission along with the initiating UE's layer-2 ID for unicast communication and the target UE's layer-2 ID for unicast communication.

The target UE shall abort the ongoing procedure that triggered the initiation of the PC5 unicast link authentication procedure if the ongoing procedure is the PC5 unicast link establishment procedure and the Target user info is included in the DIRECT LINK ESTABLISHMENT REQUEST message.

Upon receipt of the DIRECT LINK AUTHENTICATION REJECT message, the initiating UE shall stop timer T5006 and abort the ongoing procedure that triggered the initiation of the PC5 unicast link authentication procedure.

\* \* \* Next Change \* \* \* \*

##### 6.1.2.7.5 PC5 unicast link security mode control procedure not accepted by the target UE

If the DIRECT LINK SECURITY MODE COMMAND message cannot be accepted, the target UE shall send a DIRECT LINK SECURITY MODE REJECT message, and the target UE shall abort the ongoing procedure that triggered the initiation of the PC5 unicast link security mode control procedure unless the ongoing procedure is a PC5 unicast link establishment procedure and the Target user info is not included in the DIRECT LINK ESTABLISHMENT REQUEST message. The DIRECT LINK SECURITY MODE REJECT message contains a PC5 signalling protocol cause IE indicating one of the following cause values:

#a: Authentication failure;

#b: Integrity failure;

#c: UE security capabilities mismatch;

#d: LSBs of KNPR-sess ID conflict;

#e: UE PC5 unicast signalling security policy mismatch;

#5 lack of resources for PC5 unicast link; or

#111: Protocol error, unspecified.

If this PC5 unicast link security mode control procedure is triggered during the PC5 unicast link establishment procedure and the implementation-specific maximum number of established NR PC5 unicast links has been reached, then the target UE shall send a DIRECT LINK SECURITY MODE REJECT message containing PC5 signalling protocol cause value #5 "lack of resources for PC5 unicast link".

If the DIRECT LINK SECURITY MODE COMMAND message cannot be accepted because the PC5 unicast link security mode control procedure was triggered during a PC5 unicast link establishment procedure, that the selected security algorithms in the DIRECT LINK SECURITY MODE COMMAND message included the null integrity protection algorithm and the target UE’s PC5 unicast signalling integrity protection policy is set to "signalling integrity protection required", the target UE shall include PC5 signalling protocol cause #e "UE PC5 unicast signalling security policy mismatch" in the SECURITY MODE REJECT message.

If the DIRECT LINK SECURITY MODE COMMAND message cannot be accepted because the PC5 unicast link security mode control procedure was triggered during a PC5 unicast link re-keying procedure, the integrity protection algorithm currently in use for the PC5 unicast link is different from the null integrity protection algorithm and the selected security algorithms in the DIRECT LINK SECURITY MODE COMMAND message include the null integrity protection algorithm, the target UE, the target UE shall include PC5 signalling protocol cause #e "UE PC5 unicast signalling security policy mismatch" in the SECURITY MODE REJECT message.

Upon receipt of the DIRECT LINK SECURITY MODE REJECT message, the initiating UE shall stop timer T5007 and:

a) if the PC5 signalling protocol cause IE in the DIRECT LINK SECURITY MODE REJECT message is set to #d, retransmit the DIRECT LINK SECURITY MODE COMMAND message with a different value for the 8 LSBs of KNPR-sess ID; and

\* \* \* Next Change \* \* \* \*

## 10.3 Timers of PC5 unicast link management procedures

Table 10.3.1: PC5 unicast link management timers

| TIMER NUM. | TIMER VALUE | CAUSE OF START | NORMAL STOP | ON EXPIRY |
| --- | --- | --- | --- | --- |
| T5000 | 8sNOTE 1 | Upon sending a DIRECT LINK ESTABLISHMENT REQUEST message | Upon receiving a DIRECT LINK ESTABLISHMENT ACCEPT or DIRECT LINK ESTABLISHMENT REJECT message from the target UE if the Target user info is included in the DIRECT LINK ESTABLISHMENT REQUEST message | Retransmission of DIRECT LINK ESTABLISHMENT REQUEST message if the Target user info is included in the DIRECT LINK ESTABLISHMENT REQUEST message; ormay abort the ongoing procedure if the Target user info is not included in the DIRECT LINK ESTABLISHMENT REQUEST message |
| T5001 | 5s | Upon sending a DIRECT LINK MODIFICATION REQUEST message | Upon receiving a DIRECT LINK MODIFICATION ACCEPT or DIRECT LINK MODIFICATION REJECT or DIRECT LINK RELEASE REQUEST message from the target UE | Retransmission of DIRECT LINK MODIFICATION REQUEST message |
| T5002 | 5s | Upon sending a DIRECT LINK RELEASE REQUEST message | Upon receiving a DIRECT LINK RELEASE ACCEPT message from the target UE | Retransmission of DIRECT LINK RELEASE REQUEST message |
| T5003 | 5s | Upon receiving a PC5 signalling message or PC5 user plane data | Upon PC5 unicast link release or upon initiating the PC5 unicast link keep-alive procedure | Initiate the PC5 unicast link keep-alive procedure |
| T5004 | 5s | Upon sending a DIRECT LINK KEEPALIVE REQUEST message | Upon receiving a PC5 signalling message or PC5 user plane data | Retransmission of the DIRECT LINK KEEPALIVE REQUEST message |
| T5005 | Default 10mNOTE 2 | Upon receiving a Maximum inactivity period in a DIRECT LINK KEEPALIVE REQUEST message, receiving a PC5 signalling message or receiving PC5 user plane data | Upon receiving a PC5 signalling message or PC5 user plane data | Either initiate the PC5 unicast link keep-alive procedure or the PC5 unicast link release procedure |
| T5006 | 5s | Upon sending a DIRECT LINK AUTHENTICATION REQUEST message | Upon receiving a DIRECT LINK AUTHENTICATION RESPONSE or DIRECT LINK AUTHENTICATION REJECT message from the target UE | Retransmission of DIRECT LINK AUTHENTICATION REQUEST message |
| T5007 | 5s | Upon sending a DIRECT LINK SECURITY MODE COMMAND message | Upon receiving a DIRECT LINK SECURITY MODE COMPLETE or DIRECT LINK SECURITY MODE REJECT message from the target UE | Retransmission of DIRECT LINK SECURITY MODE COMMAND message |
| T5008 | 15s | Upon sending a DIRECT LINK REKEYING REQUEST message | Upon receiving a DIRECT LINK REKEYING RESPONSE message from the target UE | Retransmission of DIRECT LINK REKEYING REQUEST message |
| T5009 |  | Upon sending a DIRECT LINK IDENTIFIER UPDATE REQUEST message | Upon receiving a DIRECT LINK IDENTIFIER UPDATE ACCEPT or DIRECT LINK ESTABLISHMENT REJECT or DIRECT LINK RELEASE REQUEST message from the target UE | Retransmission of the DIRECT LINK IDENTIFIER UPDATE REQUEST message |
| T5010 |  | Upon sending a DIRECT LINK IDENTIFIER UPDATE ACCEPT message | Upon receiving a DIRECT LINK IDENTIFIER UPDATE ACK message or DIRECT LINK RELEASE REQUEST message from the initiating UE | Retransmission of the DIRECT LINK IDENTIFIER UPDATE ACCEPT message  |
| NOTE 1 If the Target user info is not included in the DIRECT LINK ESTABLISHMENT REQUEST message, then the initiating UE may keep the timer T5000 running upon receiving DIRECT LINK ESTABLISHMENT ACCEPT message.NOTE 2 The default value of this timer is used if the DIRECT LINK KEEPALIVE REQUEST message does not provide a timer value in the Maximum inactivity period IE, |