**3GPP SA WG2 Meeting #165 *S2-240xxxx***

**Hyderabad, IN, 14-18 October 2024 *(was S2-2407564)***

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| *CR-Form-v12.3* |
| **CHANGE REQUEST** |
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|  |  | **CR** | **4843** | **rev** | **1** | **Current version:** |  |  |
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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 |  | Radio Access Network | **X** | Core Network | **x** |

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| ***Title:***  | XRM\_Ph2 KI#6 L4S support in non-3GPP access |
|  |  |
| ***Source to WG:*** | Charter Communications, CableLabs, Tencent?, Tencent Cloud?, Nokia?, Samsung? |
| ***Source to TSG:*** | SA2 |
|  |  |
| ***Work item code:*** | XRM\_Ph2 |  | ***Date:*** | 2024-08-09 |
|  |  |  |  |  |
| ***Category:*** | B |  | ***Release:*** | Rel-19 |
|  | *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-17 (Release 17)Rel-18 (Release 18)Rel-19 (Release 19) Rel-20 (Release 20)* |
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| ***Reason for change:*** | The following R19 TR23700-70 conclusions for Key Issue #6 (i.e., clause 8.6) were agreed as principles for normative work:1. Dedicated 5G QoS Flow(s) and non-3GPP access resources (e.g. IPsec Child SAs) are used for carrying L4S enabled IP traffic.
2. For untrusted/trusted access:
	1. ECN marking for L4S is supported in N3IWF/TNGF. It is controlled via N2 signalling (Indication of ECN marking for L4S for a corresponding QoS Flow(s)) and applies to proper mapping between L4S-enabled QoS profile(s) and L4S-enabled IPsec Child SAs.
	2. N3IWF/TNGF in UL shall support and UE in DL can support the IP-in-IP tunnel behaviour of copying ECN bits between outer and inner headers as per IETF RFC 6040 [47].

NOTE: To support this functionality, the UE needs to support UL L4S feedback as described in IETF RFC 9330 [14] which is not in the scope of 3GPP. |
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| ***Summary of change:*** | Introduction of L4S functionality on non-3GPP access resources, according to KI#6 conclusion in TR23.700-70 clause 8.6 |
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| ***Consequences if not approved:*** | New feature not implemented in the specification.  |
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| ***Clauses affected:*** | 4.2.3.2, 4.3.2.2.1, 4.3.3.2, 4.12.5, 4.12.6, 4.12a.5, 4.12a.6 |
|  |  |
|  | **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:*** |  |

\* \* \* \* First change \* \* \* \*

4.2.3.2 UE Triggered Service Request

The UE in CM-IDLE state initiates the Service Request procedure in order to send uplink signalling messages, user data, to request emergency services fallback, or as a response to a network paging request. The UE shall not initiate UE Triggered Service Request from CM-IDLE if there is a Service Gap timer running. After receiving the Service Request message, the AMF may perform authentication. After the establishment of the signalling connection to an AMF, the UE or network may send signalling messages, e.g. PDU Session establishment from UE to the SMF, via the AMF.

The Service Request procedure is used by a UE in CM-CONNECTED to request activation of a User Plane connection for PDU Sessions and to respond to a NAS Notification message from the AMF. When a User Plane connection for a PDU Session is activated, the AS layer in the UE indicates it to the NAS layer.

The Service Request procedure is used by the Multi-USIM UE over 3GPP access, in:

a) CM-CONNECTED state to request release of the UE connection, stop data transmission, discard of any pending data and optionally, store Paging Restriction Information; or

b) CM-IDLE state to request removal of Paging Restriction Information.

The Multi-USIM UE shall not execute UE triggered Service Request procedure with Release Request indication if regulatory prioritized services (e.g. emergency service, emergency callback waiting) are ongoing. After an emergency call, the UE shall not execute a UE triggered Service Request procedure with Release Request indication for a duration which is sufficient for emergency call back.

c) CM-IDLE state to respond to paging with a Reject Paging Indication that indicates that N1 connection shall be released and no user plane connection shall be established. The UE optionally provides the Paging Restriction Information. The UE may be unable to respond to paging with a Reject Paging Indication, e.g. due to UE implementation constraints.

NOTE 1: A Multi-USIM UE in RRC\_INACTIVE/CM-CONNECTED state that decides to reject the RAN paging, requests the release of the UE connection as in bullet a) above. The UE can discard, by implementation, any data or NAS PDUs that it receives before it is released.

For any Service Request, the AMF responds with a Service Accept message to synchronize PDU Session status between UE and network, if necessary. The AMF responds with a Service Reject message to UE, if the Service Request cannot be accepted by network. The AMF may steer the UE from 5GC by rejecting the Service Request. The AMF should take into account the Preferred and Supported Network Behaviour (see clause 5.31.2 of TS 23.501 [2]) and availability of EPC to the UE before steering the UE from 5GC. The Service Reject message may include an indication or cause code requesting the UE to perform Registration procedure.

For this procedure, the impacted SMF and UPF, if any, are all under control of the PLMN serving the UE, e.g. in Home Routed roaming case the SMF and UPF in HPLMN are not involved if V-SMF relocation is not triggered.

For Service Request due to user data, network may take further actions if User Plane connection activation is not successful.

The procedure in this clause 4.2.3.2 is applicable to the scenarios with or without intermediate UPF and with or without intermediate UPF reselection.

If the UE initiates Service Request procedures via non-3GPP Access, functions defined in clause 4.12.4.1 are applied.

The User Plane of all PDU Sessions with redundant I-UPFs or with redundant N3/N9 tunnels for URLLC shall be activated during the Service Request procedure if the UE in CM-IDLE state initiates the Service Request procedure from 3GPP access. If the redundant I-UPFs are to be added/replaced/removed, the N4 Session procedure to manage the I-UPF is done for each I-UPF in steps 6c, 6d,7a, 7b, 8a, 8b, 9, 10, 17a,17b, 20a, 20b, 21a,21b, 22a and 22b of the figure 4.2.3.2-1. If the redundant N3/N9 tunnels are used for URLLC and the I-UPF is to be added/replaced/removed, the N4 Session procedure to update the tunnel is done for each N3/N9 tunnel in steps 6c, 6d, 7a, 7b, 8a, 8b, 9, 10, 17a, 17b. 20a, 20b, 21a and 21b of the figure 4.2.3.2-1.

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**Figure 4.2.3.2-1: UE Triggered Service Request procedure**

1. UE to (R)AN: AN message (AN parameters, Service Request (List Of PDU Sessions To Be Activated, List Of Allowed PDU Sessions, security parameters, PDU Session status, 5G-S-TMSI, [NAS message container], Exempt Indication, [Release Request indication], [Paging Restriction Information], [Reject Paging Indication])).

 The NAS message container shall be included if the UE is sending a Service Request message as an Initial NAS message and the UE needs to send non-cleartext IEs, see clause 4.4.6 of TS 24.501 [25].

 The Multi-USIM UE in CM-CONNECTED state may include the Release Request indication and optionally Paging Restriction Information in the Service Request message over 3GPP access, if the UE intends to leave CM-CONNECTED state.

 The Multi-USIM UE in CM-IDLE state may include the Release Request indication and not include Paging Restriction Information in the Service Request message over 3GPP access, if the UE intends to delete the Paging Restriction Information.

 If the Multi-USIM UE in CM-IDLE state decides not to accept the paging, it may send a Service Request message including a Reject Paging Indication and optionally Paging Restriction Information, unless it is not able to send this message e.g. due to UE implementation constraints.

 The List Of PDU Sessions To Be Activated is provided by UE when the UE wants to re-activate the PDU Session(s). The List Of Allowed PDU Sessions is provided by the UE when the Service Request is a response of a Paging or a NAS Notification for a PDU Session associated with non-3GPP access and identifies the PDU Sessions that can be transferred to 3GPP access.

 In the case of NG-RAN:

- The AN parameters include 5G-S-TMSI, Selected PLMN ID (or PLMN ID and NID, see clause 5.30 of TS 23.501 [2]), Establishment cause and may also include NSSAI information. The Establishment cause provides the reason for requesting the establishment of an RRC connection. Whether and how the UE includes the NSSAI information as part of the AN parameters is dependent on the value of the Access Stratum Connection Establishment NSSAI Inclusion Mode parameter, as specified in clause 5.15.9 of TS 23.501 [2].

- The UE sends Service Request message towards the AMF encapsulated in an RRC message to the NG-RAN. The RRC message(s) that can be used to carry the 5G-S-TMSI and this NAS message are described in TS 38.331 [12] and TS 36.331 [16].

 If the Service Request is triggered by the UE for user data, the UE identifies, using the List Of PDU Sessions To Be Activated, the PDU Session(s) for which the UP connections are to be activated in Service Request message. When the UE includes the List Of PDU Sessions To Be Activated, the UE shall indicate PDU Sessions only associated with the access the Service Request is related to. If the Service Request is triggered by the UE for signalling only, the UE doesn't identify any List Of PDU Sessions To Be Activated. If this procedure is triggered for paging response and the UE has at the same time some user data to be transferred, the UE identifies the PDU Session(s) whose UP connections are to be activated in Service Request message, by the List Of PDU Sessions To Be Activated. Otherwise the UE does not identify any PDU Session(s) in the Service Request message for paging response. As defined in TS 24.501 [25] the UE shall include always-on PDU Sessions which are accepted by the network in the List Of PDU Sessions To Be Activated even if there are no pending uplink data for those PDU Sessions or when the Service Request is triggered for signalling only or when the Service Request is triggered for paging response.

 If the Service Request over 3GPP access is triggered in response to the paging or NAS Notification indicating non-3GPP access, the Service Request message shall identify the list of PDU Sessions associated with the non-3GPP access that can be re-activated over 3GPP access in the List Of Allowed PDU Sessions, as described in clause 4.2.3.3 (step 6) of this specification and in clause 5.6.8 of TS 23.501 [2]. When the UE over 3GPP access is in NB-N1 mode and the resulting number of PDU Sessions with user plane resources activated for the UE does not exceed the maximum number of supported user plane resources (0, 1 or 2), based on whether the UE supports UP data transfer and the UE's 5GMM Core Network Capability as described in clause 5.31.19 of TS 23.501 [2], the AMF shall notify the SMF that reactivation of the user-plane resources for the corresponding PDU session(s) associated with non-3GPP access can be performed as defined in TS 24.501 [25].

 If the Service Request is triggered to report PS Data Off status change and the UE is in Non-Allowed Area, the UE shall send Service Request message with an indication that the message is exempted from restriction (e.g. Non-Allowed Area). In this case, if the UE is in Non-Allowed Area, the UE shall not include the List Of PDU Sessions To Be Activated and as a result the always-on PDU Session is not re-activated during the Service Request procedure.

 The PDU Session status indicates the PDU Sessions available in the UE.

 The UE shall not trigger a Service Request procedure for a PDU Session corresponding to a LADN when the UE is outside the area of availability of the LADN.

NOTE 2: A PDU Session corresponding to a LADN is not included in the List Of PDU Sessions To Be Activated when the UE is outside the area of availability of the LADN.

 For UE in CM-CONNECTED state, only the List Of PDU Sessions To Be Activated and List Of Allowed PDU Sessions need to be included in the Service Request.

 The UE shall not trigger a Service Request procedure for a PDU Session associated to an S-NSSAI if the S-NSSAI is not valid as per the S-NSSAI location availability information.

NOTE 3: A PDU Session associated to an S-NSSAI is not included in the List Of PDU Sessions To Be Activated when the S-NSSAI is not valid as per the S-NSSAI location availability information.

2. (R)AN to AMF: N2 Message (N2 parameters, Service Request).

 Details of this step are described in TS 38.413 [10]. If the AMF can't handle the Service Request it will reject it.

 When NG-RAN is used, the N2 parameters include the 5G-S-TMSI, Selected PLMN ID (or PLMN ID and NID, see clause 5.30 of TS 23.501 [2]), Location information and Establishment cause, UE Context Request.

 If the UE is in CM-IDLE state, the NG-RAN obtains the 5G-S-TMSI in RRC procedure. NG-RAN selects the AMF according to 5G-S-TMSI. The Location Information relates to the cell in which the UE is camping.

 Based on the PDU Session status, the AMF may initiate PDU Session Release procedure in the network for the PDU Sessions whose PDU Session ID(s) were indicated by the UE as not available.

 When the Establishment cause is associated with priority services (e.g. MPS, MCX), or when the AMF determines that the UE has priority subscription (e.g. MPS, MCX) in the UDM, the AMF includes a Message Priority header to indicate priority information. Other NFs relay the priority information by including the Message Priority header in service-based interfaces, as specified in TS 29.500 [17].

 The AMF enforces the Mobility Restrictions as specified in clause 5.3.4.1.1 of TS 23.501 [2].

 If there is a Service Gap timer running in AMF for the UE and the AMF is not waiting for a MT paging response from the UE and the Service Request is not for regulatory prioritized services like Emergency services or not for exception reporting, the AMF rejects the Service Request with an appropriate cause. In addition, AMF may also provide a UE with a Mobility Management Back-off timer set to the remaining value of the Service Gap timer.

 If the AMF supports RACS and the AMF detects that the selected PLMN is different from the currently registered PLMN for the UE, the AMF determines the UE Radio Capability ID of the newly selected PLMN to the gNB as described in clause 5.4.4.1a of TS 23.501 [2].

 For NR satellite access, the AMF may decide to verify the UE location and determine whether the PLMN is allowed to operate at the UE location, as described in clause 5.4.11.4 of TS 23.501 [2]. If the UE receives a Service Reject message with cause value indicating that the PLMN is not allowed to operate in the present UE location, the UE shall attempt to select a PLMN, as specified in TS 23.122 [22].

3a) AMF to (R)AN: N2 Request (security context, Mobility Restriction List, list of recommended cells / TAs / NG-RAN node identifiers).

 If the 5G-AN had requested for UE Context or there is a requirement for AMF to provide this e.g. the AMF needs to initiate fallback procedure as in clause 4.13.4.2 for Emergency services, AMF initiates NGAP procedure as specified in TS 38.413 [10]. The AMF may provide the indication of NCR-MT authorization information in the UE Context. For UE in CM-IDLE state, 5G-AN stores the Security Context in the UE AN context. Mobility Restriction List is described in clause 5.3.4.1 of TS 23.501 [2].

 The 5G-AN uses the Security Context to protect the messages exchanged with the UE as described in TS 33.501 [15].

 If the NG-RAN node had provided the list of recommended cells / TAs / NG-RAN node identifiers during the AN Release procedure (see clause 4.2.6), the AMF shall include it in the N2 Request. The RAN may use this information to allocate the RAN Notification Area when the RAN decides to enable RRC\_INACTIVE state for the UE.

3. If the Service Request was not sent integrity protected or integrity protection verification failed, the AMF shall reject the Service Request as stated in TS 24.501 [25].

 If the UE in CM-IDLE state triggered the Service Request to establish a signalling connection only, after successful establishment of the signalling connection the UE and the network can exchange NAS signalling and steps 4 to 11 and 15 to 22 are skipped.

 If the UE in Non-Allowed Area triggered the Service Request with an indication that the message is exempted from restriction (e.g. Non-Allowed Area), the AMF should accept the Service Request. In this case, if the UE is in Non-Allowed Area, the AMF rejects user plane setup request from the SMF except for emergency services.

 If the procedure was triggered in response to paging or NAS notification indicating non-3GPP access and the AMF received N1 SM Container only from the SMF in step 3a of clause 4.2.3.3, the AMF sends the NAS signalling including the N1 SM Container to the UE in step 7 of clause 4.2.3.3 without updating the access associated to the PDU Session.

 If the Service Request message is received over 3GPP access without a Release Request indication or a Reject Paging Indication, the AMF shall delete any stored Paging Restriction Information for this UE and stop restricting paging accordingly.

 If the Service Request message over 3GPP access includes a Release Request indication or a Reject Paging Indication, then:

- the AMF may accept or reject the received Paging Restriction Information requested by the UE based on operator policy. If the AMF rejects the Paging Restriction Information, the AMF removes any stored Paging Restriction Information from the UE context and discards the UE requested Paging Restriction Information. If the AMF accepts the Paging Restriction Information from the UE, the AMF stores the Paging Restriction Information from the UE in the UE context.

- If no Paging Restriction Information is provided, no paging restrictions apply and the AMF removes any stored Paging Restriction Information from the UE context.

- no User Plane resources are established and instead the AMF triggers the AN Release procedure as described in clause 4.2.6.

NOTE 4: If AMF does not perform steps 5-7 before step 2 then some DL data might not be delivered to the UE.

 If the procedure was triggered in response to paging and the Service Request message includes a Reject Paging Indication, the AMF initiates the UCU procedure as described in step 7 of clause 4.2.3.3 before the triggering of the AN Release procedure.

4. [Conditional] AMF to SMF: Nsmf\_PDUSession\_UpdateSMContext Request (PDU Session ID(s), Operation Type, UE location information, Access Type, RAT Type, UE presence in LADN service area, Indication of Access Type can be changed, [MO Exception Data Counter], [Satellite backhaul category], [GEO Satellite ID]).

 The Nsmf\_PDUSession\_UpdateSMContext Request is invoked:

- If the UE identifies List Of PDU Sessions To Be Activated in the Service Request message;

- This procedure is triggered by the SMF but the PDU Session(s) identified by the UE correlates to other PDU Session ID(s) than the one triggering the procedure; or

- If this procedure is triggered by the SMF in response to paging or NAS notification indicating 3GPP access or if this step onwards is invoked following step 4a of clause 4.2.3.3 and the current UE location is outside the "Area of validity for the N2 SM information" provided by the SMF in step 3a of clause 4.2.3.3 or the "Area of validity for the N2 SM information" was not provided by the SMF in step 3a of clause 4.2.3.3, the AMF shall not send the N2 information provided by the SMF in step 3a of clause 4.2.3.3. Otherwise, if the current UE location is in the "Area of validity for the N2 SM information", steps 4 to 11 are skipped; or

- If this procedure is triggered by the SMF in response to paging or NAS notification indicating non-3GPP access and the AMF received N2 SM Information only, or both N1 SM Container and N2 SM Information in step 3a of clause 4.2.3.3.

 If the DNN corresponds to an LADN then the "UE presence in LADN service area" indicates if the UE is IN or OUT of the LADN service area. If the AMF does not provide the "UE presence in LADN service area" indication and the SMF determines that the DNN corresponds to a LADN, then the SMF considers that the UE is OUT of the LADN service area.

 The AMF determines the PDU Session(s) for which the UP connection(s) shall be activated and sends an Nsmf\_PDUSession\_UpdateSMContext Request to SMF(s) associated with the PDU Session(s) with Operation Type set to "UP activate" to indicate establishment of User Plane resources for the PDU Session(s). The AMF determines Access Type and RAT Type, see clause 4.2.2.2.1. If the RAT type is NB-IoT, the AMF shall ensure that the number of PDU session(s) for which UP connection(s) are active does not exceed this UE's maximum number of supported user plane resources (0, 1 or 2) based on whether the UE supports UP data transfer and the UE 5GMM Core Network Capability as described in clause 5.31.19 of TS 23.501 [2].

 If the procedure was triggered in response to paging or NAS Notification indicating non-3GPP access, the AMF received N2 SM Information in step 3a of clause 4.2.3.3 and the PDU Session for which the UE was paged or notified is not in the List Of Allowed PDU Sessions provided by the UE, the AMF notifies the SMF that the UE is not reachable. For other PDU Sessions in the List Of Allowed PDU Sessions the Service Request Procedure succeeds without re-activating the User Plane of any PDU Sessions, unless they have also been included by the UE in the List Of PDU Sessions To Be Activated.

 If the procedure was triggered in response to paging or NAS notification indicating non-3GPP access and the PDU Session for which the UE was paged or notified is in the List Of Allowed PDU Sessions provided by the UE and the AMF received N2 SM Information only or N1 SM Container and N2 SM Information from the SMF in step 3a of clause 4.2.3.3, the AMF notifies the SMF that the access type of the PDU session can be changed. The AMF discards any already received N1 SM Container and N2 SM Information. In Home Routed roaming case, the V-SMF triggers Nsmf\_PDUSession\_Update service operation towards the H-SMF to notify the access type of the PDU Session can be changed and the procedure continues as specified in clause 4.3.3.3 from step 1a to step 10.

 If the UE is accessing via the NB-IoT RAT, the AMF may inform all (H-)SMFs whether the RRC establishment cause is set to "MO exception data", as described in clause 5.31.14.3 of TS 23.501 [2]. The AMF may immediately send the MO Exception Data Counter to the (H-)SMF.

 If the AMF, based on configuration, as described in clauses 5.43.4 and 5.43.2 of TS 23.501 [2], is aware that satellite backhaul category and/or GEO Satellite ID has changed and needs to be updated to the SMF, the AMF includes the new Satellite backhaul category or new GEO Satellite ID or both as described in clauses 5.43.4 and 5.43.2 of TS 23.501 [2].

 The AMF may receive a Service Request to establish another NAS signalling connection via a new NG-RAN while it has maintained an old NAS signalling connection for UE still via an old NG-RAN. The new NG-RAN and the old NG-RAN can be the same NG-RAN node. In this case, AMF shall trigger the AN release procedure toward the old NG-RAN to release the old NAS signalling connection as defined in clause 4.2.6 and:

- For the PDU Sessions indicated by the UE in the List Of PDU Sessions To Be Activated, the AMF requests the SMF to activate the PDU Session(s) immediately by performing this step 4; and

NOTE 5: This activates the UP of PDU Session(s) using resources of the new NG-RAN.

- For the PDU Sessions indicated by the old NG-RAN in the "List of PDU Session ID(s) with active N3 user plane" but not in the List Of PDU Sessions To Be Activated sent by the UE, the AMF requests the SMF to deactivate the PDU Session(s).

NOTE 6: This deactivates the UP of PDU Session(s) that are no more needed by the UE.

5a. Void.

5b. If the PDU Session ID corresponds to a LADN and the SMF determines that the UE is outside the area of availability of the LADN based on the "UE presence in LADN service area" from the AMF, the SMF decides to (based on local policies) either:

- keep the PDU Session, but reject the activation of User Plane connection for the PDU Session and inform the AMF about it. If the procedure has been triggered by a Network Triggered Service Request as described in clause 4.3.2.3, the SMF may notify the UPF that originated the Data Notification to discard downlink data for the PDU Sessions and/or to not provide further Data Notification messages; or

- to release the PDU Session: the SMF releases the PDU Session and informs the AMF that the PDU Session is released.

 In any case of the two cases above the SMF answers to the AMF (step10) with an appropriate reject cause and the User Plane Activation of PDU Session is stopped.

 Otherwise, based on the location info received from the AMF, the SMF checks the UPF Selection Criteria according to clause 6.3.3 of TS 23.501 [2] and determines to perform one of the following:

- accepts the activation of UP connection and continue using the current UPF(s);

- accepts the activation of UP connection and selects a new intermediate UPF (or add/remove an intermediate UPF), if the UE has moved out of the service area of the UPF that was previously connecting to the AN, while maintaining the UPF(s) acting as PDU Session Anchor. The steps to perform I-UPF addition/change/removal are described as conditional steps in the following of the current procedure; or

NOTE 7: If the old and/or new I-UPF implements an UL CL or BP functionality and a PDU Session Anchor for connectivity to the local access to the Data Network as described in clause 5.6.4.2 of TS 23.501 [2], the signalling described in the current clause is intended as the signalling to add, remove or change the PDU Session Anchor and must be complemented by the signalling to add, release or change the UL CL or BP as described respectively in clauses 4.3.5.4, 4.3.5.5 and 4.3.5.7.

- rejects the activation of UP connection of a PDU Session of SSC mode 2 and trigger re-establishment of the PDU Session after Service Request procedure to perform the allocation of a new UPF to act as PDU Session Anchor, e.g. the UE has moved out of the service area of the anchor UPF which is connecting to NG-RAN.

 In the case that the SMF fails to find suitable I-UPF, the SMF decides to (based on local policies) either:

- trigger re-establishment of PDU Session. After Service Request procedure, SMF sends N1 SM message to the UE via the AMF by invoking Namf\_Communication\_N1N2MessageTransfer containing the cause indicating PDU Session re-establishment is required for the UE; or

- keep the PDU Session, but reject the activation request of User Plane connection for the PDU Session and inform the AMF about it; or

- release the PDU Session after Service Request procedure.

 If the SMF has determined that the UE is performing Inter-RAT mobility to or from the NB-IoT RAT then the SMF uses the "PDU Session continuity at inter RAT mobility" to determine how to handle the PDU Session.

6a. [Conditional] SMF to UPF (PSA): N4 Session Modification Request.

 Depending on the network deployment, the CN Tunnel Info of UPF (PSA) allocated for N3 or N9 interface may be changed during the Service Request procedure, e.g. UPF connected to different IP domains. If different CN Tunnel Info need be used, the SMF sends N4 Session Modification Request message to UPF (PSA) and requests CN Tunnel Info providing the target Network Instance.

6b. [Conditional] UPF (PSA) to SMF: N4 Session Modification Response.

 The UPF (PSA) sends an N4 Session Establishment Response message to the SMF. The UPF provides CN Tunnel Info to the SMF. The UPF (PSA) associate the CN Tunnel Info with UL Packet detection rules provided by the SMF.

 If the redundant I-UPFs are used for URLLC, each I-UPF provides UL CN Tunnel Info for N3 interface to the SMF in the N4 Session Establishment Response message.

 If the redundant N3 tunnels are used for URLLC, the UPF (PSA) provides redundant UL CN Tunnel Info for N3 interface to the SMF in N4 Session Establishment Response message.

6c. [Conditional] SMF to new UPF (intermediate): N4 Session Establishment Request.

 If the SMF selects a new UPF to act as intermediate UPF for the PDU Session, or if the SMF selects to insert an intermediate UPF for a PDU Session which did not have an intermediate UPF, an N4 Session Establishment Request message is sent to the new UPF, providing Packet detection, Data forwarding, enforcement and reporting rules to be installed on the intermediate UPF. The CN Tunnel Info (on N9) of PSA, i.e. which is used to establish the N9 tunnel, for this PDU Session is also provided to the intermediate UPF.

 If a new UPF is selected by the SMF to replace the old (intermediate) UPF, the SMF may also include a request for the new UPF to allocate a second tunnel endpoint for buffered DL data from the old I-UPF and to indicate via usage reporting end marker reception on this second tunnel. In this case, the UPF is instructed by the SMF to buffer the DL data it may receive at the same time from the UPF (PSA).

6d. New UPF (intermediate) to SMF: N4 Session Establishment Response.

 The new intermediate UPF sends an N4 Session Establishment Response message to the SMF. The UPF provides DL CN Tunnel Info as requested by SMF in step 6c. The SMF starts a timer, to be used in step 22a to release the resource in old intermediate UPF if there is one.

7a. [Conditional] SMF to UPF (PSA): N4 Session Modification Request.

 If the SMF selects a new UPF to act as intermediate UPF for the PDU Session, the SMF sends N4 Session Modification Request message to PDU Session Anchor UPF, providing DL Tunnel Info from new intermediate UPF. If the new intermediate UPF was added for the PDU Session, the UPF (PSA) begins to send the DL data to the new I-UPF as indicated in the DL CN Tunnel Info. The UPF (PSA) sends one or more "end marker" packets for each N9 tunnel to the old I-UPF immediately after switching the path to new I-UPF.

 If the Service Request is triggered by the network and the SMF removes the old I-UPF but does not replace it with a new I-UPF, the SMF may also include a request for the UPF to allocate a second tunnel endpoint for buffered DL data from the old I-UPF and to indicate end marker reception on this second tunnel via usage reporting. In this case, the UPF (PSA) begins to buffer the DL data it may receive at the same time from the N6 interface. The UPF (PSA) sends one or more "end marker" packets for each N9 tunnel to the old I-UPF immediately after switching the path to (R)AN.

7b. The UPF (PSA) sends N4 Session Modification Response message to SMF.

 If requested by SMF, the UPF (PSA) sends DL CN tunnel info for the old (intermediate) UPF to the SMF. The SMF starts a timer, to be used in step 22a to release the resource in old intermediate UPF if there is one.

 If the UPF that connects to RAN is the UPF (PSA) and if the SMF finds that the PDU Session is activated when receiving the Nsmf\_PDUSession\_UpdateSMContext Request in step 4 with Operation Type set to "UP activate" to indicate establishment of User Plane resources for the PDU Session(s), it deletes the AN Tunnel Info and initiates an N4 Session Modification procedure to remove Tunnel Info of AN in the UPF.

8a. [Conditional] SMF to old UPF (intermediate): N4 Session Modification Request (New UPF address, New UPF DL Tunnel ID)

 If the service request is triggered by the network and the SMF removes the old (intermediate) UPF, the SMF sends the N4 Session Modification Request message to the old (intermediate) UPF, providing the DL Tunnel Info for the buffered DL data. If the SMF allocated new I-UPF, the DL Tunnel Info is from the new (intermediate) UPF acting as N3 terminating point. If the SMF did not allocate a new I-UPF, the DL Tunnel Info is from the new UPF (PSA) acting as N3 terminating point. The SMF starts a timer to monitor the forwarding tunnel as step 6d or 7b.

 If the old I-UPF receives end marker packets and there is no associated tunnel to forward these packets, the old I-UPF discards the received end marker packets and does not send any Data Notification to SMF.

 If the SMF find the PDU Session is activated when receiving the Nsmf\_PDUSession\_UpdateSMContext Request in step 4 with Operation Type set to "UP activate" to indicate establishment of User Plane resources for the PDU Session(s), it deletes the AN Tunnel Info and initiates an N4 Session Modification procedure to remove Tunnel Info of AN in the UPF.

8b. old UPF (intermediate) to SMF: N4 Session Modification Response

 The old (intermediate) UPF sends N4 Session Modification Response message to SMF.

9. [Conditional] old UPF (intermediate) to new UPF (intermediate): buffered downlink data forwarding

 If the I-UPF is changed and forwarding tunnel was established to the new I-UPF, the old (intermediate) UPF forwards its buffered data to the new (intermediate) UPF acting as N3 terminating point. If indicated by SMF in step 6c, the new I-UPF reports to SMF when end marker packet is received. Then the SMF initiates N4 Session Modification procedure to indicate the new I-UPF to send the buffered downlink packet(s) received from the UPF (PSA).

10. [Conditional] old UPF (intermediate) to UPF (PSA): buffered downlink data forwarding

 If the old I-UPF is removed and no new I-UPF is assigned for the PDU Session and forwarding tunnel was established to the UPF (PSA), the old (intermediate) UPF forwards its buffered data to the UPF (PSA) acting as N3 Terminating Point. If indicated by SMF in step 7a, the UPF (PSA) reports to SMF when the end marker packet has been received. Then the SMF initiates N4 Session Modification procedure to request the UPF (PSA) to send the buffered DL data received from the N6 interface.

11. [Conditional] SMF to AMF: Nsmf\_PDUSession\_UpdateSMContext Response (N2 SM information (PDU Session ID, QFI(s), QoS profile(s), CN N3 Tunnel Info, S-NSSAI, User Plane Security Enforcement, UE Integrity Protection Maximum Data Rate, RSN, PDU Session Pair ID), N1 SM Container, Cause) to the AMF. If the UPF that connects to RAN is the UPF (PSA), the N3 CN Tunnel Info is the UL CN Tunnel Info of the UPF (PSA). If the UPF that connects to RAN is the new intermediate UPF, the CN N3 Tunnel Info is the UL Tunnel Info of the intermediate UPF.

 For the PDU Session with redundant I-UPFs or with redundant N3 tunnels for URLLC, the two UL N3 CN Tunnel Info are included, the SMF also indicates the NG-RAN that one of the CN Tunnel Info is used as the redundancy tunnel of the PDU session as described in clause 5.33.2.2 of TS 23.501 [2].

 The SMF shall send N1 SM Container and/or N2 SM Information to the AMF when applicable. (e.g. when the SMF was notified from the AMF that the access type of the PDU Session can be changed in step 4).

 For a PDU Session that the SMF has determined to accept the activation of UP connection in step 5a or 5b, the SMF generates only N2 SM information and sends Nsmf\_PDUSession\_UpdateSMContext Response to the AMF to establish the User Plane(s). The N2 SM information contains information that the AMF shall provide to the NG-RAN. The SMF may indicate for each QoS Flow whether redundant transmission shall be performed by a corresponding redundant transmission indicator. If the SMF decided to change the PSA UPF for the SSC mode 3 PDU Session, the SMF triggers the change of SSC mode 3 PDU Session anchor as an independent procedure described in clause 4.3.5.2 or clause 4.3.5.3 after accepting the activation of UP of the PDU Session.

 For each QoS Flow, the SMF may at most request one of the following to the NG-RAN:

- ECN marking for L4S at NG-RAN in the case of ECN marking for L4S in RAN as described in clause 5.37.3 of TS 23.501 [2]; or,

- Congestion information monitoring as described in clauses 5.45.3 and 5.37.4 of TS 23.501 [2]; or,

- provide information for ECN marking for L4S at UPF in the case of ECN marking for L4S by PSA UPF as described in clause 5.37.3 of TS 23.501 [2].

 In case of non-3GPP access, where the 5G-AN corresponds to an N3IWF or TNGF:

- For each QoS Flow, the SMF may request the following to the N3IWF or TNGF:

 - ECN marking for L4S at N3IWF or TNGF in the case of ECN marking for L4S in non-3GPP access as described in clause 5.37.3 of TS 23.501 [2].

The SMF can reject the activation of UP of the PDU Session by including a cause in the Nsmf\_PDUSession\_UpdateSMContext Response. Following are some of the cases:

- If the PDU Session corresponds to a LADN and the UE is outside the area of availability of the LADN as described in step 5b;

- If the AMF notified the SMF that the UE is reachable only for regulatory prioritized service and the PDU Session to be activated is not for a regulatory prioritized service; or

- If the SMF decided to change the PSA UPF for the requested PDU Session as described in step 5b. In this case, after sending Nsmf\_PDUSession\_UpdateSMContext Response, the SMF triggers another procedure to instruct UE to re-establish the PDU Session as described in clause 4.3.5.1 for SSC mode 2.

- If the SMF received negative response in Step 6b due to UPF resource unavailability.

 If the PDU Session has been assigned any EPS bearer ID, the SMF also includes the mapping between EPS bearer ID(s) and QFI(s) into the N2 SM information to be sent to the NG-RAN.

 The User Plane Security Enforcement information is determined by the SMF upon PDU session establishment as described in clause 5.10.3 of TS 23.501 [2]. If the User Plane Security Enforcement information indicates that Integrity Protection is "Preferred" or "Required", the SMF also includes the UE Integrity Protection Maximum Data Rate.

 The RSN and PDU Session Pair ID are included when applicable, as determined by the SMF during PDU Session establishment as described in clause 5.33.2.1 of TS 23.501 [2].

12. AMF to (R)AN: N2 Request (N2 SM information received from SMF, security context, Mobility Restriction List, UE-AMBR, List of UE-Slice-MBR(s) (optional and for 3GPP access type only), MM NAS Service Accept, list of recommended cells / TAs / NG-RAN node identifiers, UE Radio Capability, Core Network Assistance Information, Tracing Requirements, UE Radio Capability ID, QMC Configuration information). The Allowed NSSAI for the Access Type for the UE and if available, Partially Allowed NSSAI (as described in clause 5.15.17 of TS 23.501 [2]), are included in the N2 message. If the subscription information includes Tracing Requirements, the AMF includes Tracing Requirements in the N2 Request. If the subscription information includes QMC Configuration information, the AMF includes QMC Configuration information in the N2 Request.

 If the UE triggered the Service Request while in CM-CONNECTED state, only N2 SM information received from SMF and MM NAS Service Accept are included in the N2 Request.

 If the Service Request procedure is triggered by the Network (as described in clause 4.2.3.3) while the UE is in CM-CONNECTED state, only N2 SM information received from SMF is included in the N2 Request.

 If the Service Request procedure is triggered by the Network (as described in clause 4.2.3.3) while the UE is in CM-IDLE state, only N2 SM information received from SMF and MM NAS Service Accept is included in the N2 Request.

 For a UE that was in CM-IDLE state when the Service Request was triggered, the NG-RAN stores the Security Context. If the Service Request is not triggered by UE for a signalling connection only, RAN also stores QoS Information for the QoS Flows of the PDU Sessions that are activated and N3 Tunnel IDs in the UE RAN context and Mobility Restriction List (as described in clause 5.3.4.1 of TS 23.501 [2]).

 MM NAS Service Accept includes PDU Session status in AMF. Any local PDU Session Release during the Session Request procedure is indicated to the UE via the Session Status. PDU Session Reactivation Result is provided in Service Accept for the PDU sessions in the List Of PDU Sessions To Be Activated and the PDU Session in the List of Allowed PDU Sessions which has caused paging or NAS notification. If the PDU Session Reactivation Result of a PDU Session is failure, the cause of the failure is also provided. One of the possible causes of failure for a PDU Session reactivation is when the AMF determines that the UE is not inside the NS-AoS of the network slice of the PDU Session.

 If the AMF accepts the Paging Restriction Information sent from the UE, the AMF informs the UE about the acceptance/rejection of the requested Paging Restriction Information in the MM NAS Service Accept message.

 If AMF receives multiple TAIs from the NG-RAN in step 2 and determines that some, but not all of them are forbidden by subscription or by operator policy, the AMF shall include the forbidden TAI(s) in the MM NAS Service Accept message.

 If there are multiple PDU Sessions that involves multiple SMFs, AMF does not need to wait for responses from all SMFs in step 11 before it sends N2 SM information to the RAN. However, the AMF shall wait for all responses from the SMFs before it sends MM NAS Service Accept message to the UE.

 AMF shall include at least one N2 SM information from SMF if this step is triggered for PDU Session User Plane activation. AMF may send additional N2 SM information from SMFs in separate N2 message(s) (e.g. N2 tunnel setup request), if there is any. Alternatively, if multiple SMFs are involved, the AMF may send one N2 Request message to (R)AN after all the Nsmf\_PDUSession\_UpdateSMContext Response service operations from all the SMFs associated with the UE are received.

 If the NG-RAN node had provided the list of recommended cells / TAs / NG-RAN node identifiers during the AN Release procedure (see clause 4.2.6), the AMF shall include it in the N2 Request. The NG-RAN may use this information to allocate the RAN Notification Area when the NG-RAN decides to enable RRC\_INACTIVE state for the UE.

 The AMF includes the UE's "RRC Inactive Assistance Information" as defined in clause 5.3.3.2.5 of TS 23.501 [2].

 If the NG-RAN node does not support RACS and the AMF have UE Radio Capability ID but not the UE Radio Capability information, then AMF will use Nucmf\_UECapabilityManagement\_Resolve to try to retrieve the corresponding UE Radio Capability information.

 If the NG-RAN node does not support RACS, or the AMF does not have UE Radio Capability ID in UE context, the AMF shall include the UE Radio Capability information, if available, to the NG-RAN node as described in TS 23.501 [2]. If the RAT Type is NB-IoT then NB-IoT specific UE Radio Access Capability Information is included instead, if available.

 If AMF has UE Radio Capability ID in UE context valid for the PLMN the UE is currently in and the NG-RAN supports RACS, the AMF signals the UE Radio Capability ID. If the NG-RAN node does not have mapping between the UE Radio Capability ID and the corresponding UE radio capabilities, it shall use the non-UE associated procedure described in TS 38.413 [10] to retrieve the mapping from the AMF.

 The AMF may include the Core Network Assistance Information which includes Core Network assisted RAN parameters tuning and Core Network assisted RAN paging information as defined in TS 23.501 [2].

 If the UE included support for restriction of use of Enhanced Coverage, the AMF sends Enhanced Coverage Restricted information to the (R)AN in the N2 message.

 If the UE and the AMF have negotiated to enable MICO mode and the AMF uses the Extended connected timer, then the AMF provides the Extended Connected time value to NG-RAN (see clause 5.31.7.3 of TS 23.501 [2]) in this step. The Extended Connected Time value indicates the minimum time the RAN should keep the UE in RRC\_CONNECTED state regardless of inactivity.

 If the AMF accepted MICO mode in the last registration procedure and knows there may be mobile terminated data or signalling pending, the AMF maintains the N2 connection for at least the Extended Connected Time as described in clause 5.31.7.3 of TS 23.501 [2] and provides the Extended Connected Time value to the RAN in N2 message with Service Accept message. The RAN should keep the UE in RRC\_CONNECTED state for an Extended Connected Time period in order to ensure the downlink data and/or signalling is delivered to the UE.

 If the RAN receives two CN Tunnel Info for a PDU session in step 11 for redundant transmission, RAN also allocates two AN Tunnel Info correspondingly and indicate to SMF one of the AN Tunnel Info is used as the redundancy tunnel of the PDU session as described in clause 5.33.2.2 of TS 23.501 [2].

13. (R)AN to UE: The NG-RAN performs RRC Connection Reconfiguration with the UE depending on the QoS Information for all the QoS Flows of the PDU Sessions whose UP connections are activated and Data Radio Bearers. For a UE that was in CM-IDLE state, if the Service Request is not triggered by UE for a signalling connection only, the User Plane security is established at this step, which is described in detail in TS 38.331 [12] and TS 36.331 [16]. For a UE that was in CM-IDLE state, if the Service Request is triggered by UE for a signalling connection only, AS security context may be established in this step, which is described in detail in TS 38.331 [12] and TS 36.331 [16].

 If the N2 Request includes a NAS message, the NG-RAN forwards the NAS message to the UE. The UE locally deletes context of PDU Sessions that are not available in 5GC.

NOTE 8: The reception of the Service Accept message does not imply the successful activation of the User Plane radio resources.

NOTE 9: If not all the requested User Plane AN resources are successfully activated, see TS 38.413 [10].

 After the User Plane radio resources are setup, the uplink data from the UE can now be forwarded to NG-RAN. The NG-RAN sends the uplink data to the UPF address and Tunnel ID provided in the step 11.

 If the NG-RAN can not establish redundant user plane for the PDU Session as indicated by the RSN parameter and PDU Session Pair ID, the NG-RAN takes the decision on how to proceed with the PDU Session as described in TS 23.501 [2].

14. [Conditional] (R)AN to AMF: N2 Request Ack (List of PDU Sessions To Be Established with N2 SM information (AN Tunnel Info, List of accepted QoS Flows for the PDU Sessions whose UP connections are activated, List of rejected QoS Flows for the PDU Sessions whose UP connections are activated, PDU Set Based Handling Support Indication), established QoS Flows status (active/not active) (for one of the following: congestion information monitoring, ECN marking for L4S at PSA UPF, ECN marking for L4S at NG-RAN, ECN marking for L4S at N3IWF or TNGF), List of PDU Sessions that failed to be established with the failure cause given in the N2 SM information element).

 The message may include N2 SM information(s), e.g. AN Tunnel Info. NG-RAN may respond N2 SM information with separate N2 message (e.g. N2 tunnel setup response) if AMF sends separate N2 message in step 11.

 If multiple N2 SM information are included in the N2 Request message in step 12, the N2 Request Ack includes multiple N2 SM information and information to enable the AMF to associate the responses to relevant SMF.

 For List of PDU Sessions To Be Established, if the N2 SM information received from SMF included PDU Set QoS Parameters, NG-RAN includes the PDU Set Based Handling Support Indication in N2 SM information for the PDU Session that enables PDU Set based handling in NG-RAN as described in clause 5.37.5.3 of TS 23.501 [2].

15. [Conditional] AMF to SMF: Nsmf\_PDUSession\_UpdateSMContext Request (N2 SM information, RAT Type, Access Type) per PDU Session to the SMF. The AMF determines Access Type and RAT Type, see clause 4.2.2.2.1.

 If the AMF received N2 SM information (one or multiple) in step 14, then the AMF shall forward the N2 SM information to the relevant SMF per PDU Session ID. If the UE Time Zone has changed compared to the last reported UE Time Zone then the AMF shall include the UE Time Zone IE in this message.

 If the PDU Session is moved from the non-3GPP access to 3GPP access (i.e. N3 tunnel for the PDU Session is established successfully), the SMF and AMF update associated access of the PDU Session. The UE updates associated access of the PDU Session when the user plane resource for the PDU Session is successfully established.

 Procedure for unpausing a charging pause initiated earlier is specified in clause 4.4.4.

 If a PDU Session is rejected by the serving NG-RAN with an indication that the PDU Session was rejected because User Plane Security Enforcement is not supported in the serving NG-RAN and the User Plane Enforcement Policy indicates "Required" as described in clause 5.10.3 of TS 23.501 [2], the SMF shall trigger the release of this PDU Session. In all other cases of PDU Session rejection, the SMF can decide whether to release the PDU Session or to deactivate the UP connection of this PDU Session.

 If some of the QoS Flows of a PDU Session are not accepted by the serving NG-RAN, the SMF shall initiate the PDU Session Modification procedure to remove the non-accepted QoS Flows from the PDU Session after this procedure is completed.

16. [Optional] SMF to PCF: If dynamic PCC is deployed and if Policy Control Request Trigger condition(s) have been met (e.g. change of Access Type, change of UE location), performs SMF initiated SM Policy Modification procedure as defined in clause 4.16.5.1. The PCF may provide updated policies.

17a. [Conditional] SMF to new intermediate UPF: N4 Session Modification Request (AN Tunnel Info and List of accepted QFI(s)).

 If the SMF selected a new UPF to act as intermediate UPF for the PDU Session in step 5b, the SMF initiates a N4 Session Modification procedure to the new I-UPF and provides AN Tunnel Info. The Downlink Data from the new I-UPF can now be forwarded to NG-RAN and UE.

17b. [Conditional] UPF to SMF: N4 Session Modification Response.

18a. [Conditional] SMF to UPF (PSA): N4 Session Modification Request (AN Tunnel Info, List of rejected QoS Flows).

 If a User Plane is to be setup or modified and after the modification there is no I-UPF, the SMF initiates a N4 Session Modification procedure to UPF (PSA) and provides AN Tunnel Info. The Downlink Data from the UPF (PSA) can now be forwarded to NG-RAN and UE.

 For QoS Flows in the List of rejected QoS Flows, the SMF shall instruct the UPF to remove the rules (e.g. Packet Detection Rules etc.) which are associated with the QoS Flows.

 If SMF decides to perform redundant transmission for one or more QoS Flows of the PDU, the SMF also indicates the UPF (PSA) to perform packet duplication for the QoS Flow(s) in downlink direction by forwarding rules.

 If the PCC rule(s) are updated in step 16, the SMF may initiate a N4 Session Modification procedure to UPF (PSA) based on the updated PCC rule(s).

18b. [Conditional] UPF to SMF: N4 Session Modification Response.

19. [Conditional] SMF to AMF: Nsmf\_PDUSession\_UpdateSMContext Response.

20a. [Conditional] SMF to new UPF (intermediate): N4 Session Modification Request.

 If forwarding tunnel has been established to the new I-UPF and if the timer SMF set for forwarding tunnel at step 8a has expired, SMF sends N4 Session modification request to new (intermediate) UPF acting as N3 terminating point to release the forwarding tunnel.

20b. [Conditional] new UPF (intermediate) to SMF: N4 Session modification response.

 New (intermediate) UPF acting as N3 terminating point sends N4 Session Modification response to SMF.

21a. [Conditional] SMF to UPF (PSA): N4 Session Modification Request.

 If forwarding tunnel has been established to the UPF (PSA) and if the timer SMF set for forwarding tunnel at step 7b has expired, SMF sends N4 Session modification request to UPF (PSA) acting as N3 Terminating Point to release the forwarding tunnel.

21b. [Conditional] UPF (PSA) to SMF: N4 Session Modification Response.

 UPF (PSA) acting as N3 Terminating Point sends N4 Session Modification Response to SMF.

22a. [Conditional] SMF to old UPF: N4 Session Modification Request or N4 Session Release Request.

 If the SMF decided to continue using the old UPF in step 5b, the SMF sends an N4 Session Modification Request, providing AN Tunnel Info.

 If the SMF decided to select a new UPF to act as intermediate UPF in step 5b and the old UPF is not PSA UPF, the SMF initiates resource release, after timer in step 6b or 7b expires, by sending an N4 Session Release Request (Release Cause) to the old intermediate UPF.

22b. [Conditional] Old intermediate UPF to SMF: N4 Session Modification Response or N4 Session Release Response.

 The old UPF acknowledges with an N4 Session Modification Response or N4 Session Release Response message to confirm the modification or release of resources.

For the mobility related events described in clause 4.15.4, the AMF invokes the Namf\_EventExposure\_Notify service operation after step 4.

Upon reception of the Namf\_EventExposure\_Notify with an indication that the UE is reachable, if the SMF has pending DL data the SMF invokes the Namf\_Communication\_N1N2MessageTransfer service operation to the AMF to establish the User Plane(s) for the PDU Sessions, otherwise the SMF resumes sending DL data notifications to the AMF in the case of DL data.

Upon reception of the Namf\_EventExposure\_Notify with an indication that UE is reachable only for regulatory prioritized service, the SMF deactivates the PDU Session if the service of the PDU Session is not regulatory prioritized. For home routed roaming case, the V-SMF triggers the deactivation of the PDU Session, in addition, the H-SMF refrains from sending downlink signalling if the signalling is not related to regulatory prioritized service upon receiving the notification.

\* \* \* \* Second change \* \* \* \*

4.3.2.2.1 Non-roaming and Roaming with Local Breakout

Clause 4.3.2.2.1 specifies PDU Session establishment in the non-roaming and roaming with local breakout cases. The procedure is used to:

- Establish a new PDU Session;

- Handover a PDN Connection in EPS to PDU Session in 5GS without N26 interface;

- Switching an existing PDU Session between non-3GPP access and 3GPP access. The specific system behaviour in this case is further defined in clauses 4.9.2 and 4.9.3; or

- Request a PDU Session for Emergency services.

In the case of roaming, the AMF determines if a PDU Session is to be established in LBO or Home Routing. In the case of LBO, the procedure is as in the case of non-roaming with the difference that the AMF, the SMF, the UPF and the PCF are located in the visited network. PDU Sessions for Emergency services are never established in Home Routed mode. If Control Plane CIoT 5GS Optimisation is enabled for the PDU session with LBO, the NEF is not used as the anchor of this PDU Session.

NOTE 1: UE provides both the S-NSSAIs of the Home PLMN and Visited PLMN to the network as described in clause 5.15.5.3 of TS 23.501 [2].

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**Figure 4.3.2.2.1-1: UE-requested PDU Session Establishment for non-roaming and roaming with local breakout**

The procedure assumes that the UE has already registered on the AMF thus unless the UE is Emergency Registered the AMF has already retrieved the user subscription data from the UDM.

1. From UE to AMF: NAS Message (S-NSSAI(s), [Alternative S-NSSAI], UE Requested DNN, PDU Session ID, Request type, Old PDU Session ID, N1 SM container (PDU Session Establishment Request, [Port Management Information Container])).

 In order to establish a new PDU Session, the UE generates a new PDU Session ID.

 The UE initiates the UE Requested PDU Session Establishment procedure by the transmission of a NAS message containing a PDU Session Establishment Request within the N1 SM container. The PDU Session Establishment Request includes a PDU session ID, Requested PDU Session Type, a Requested SSC mode, 5GSM Capability, PCO, SM PDU DN Request Container, [Number Of Packet Filters], [Header Compression Configuration], UE Integrity Protection Maximum Data Rate, [Always-on PDU Session Requested], [RSN], [URSP rule enforcement reports] and [PDU Session Pair ID].

 The Request Type indicates "Initial request" if the PDU Session Establishment is a request to establish a new PDU Session and indicates "Existing PDU Session" if the request refers to an existing PDU Session switching between 3GPP access and non-3GPP access or to a PDU Session handover from an existing PDN connection in EPC. If the request refers to an existing PDN connection in EPC, the S-NSSAI is set as described in clause 5.15.7.2 of TS 23.501 [2]

 When Emergency service is required and an Emergency PDU Session is not already established, a UE shall initiate the UE Requested PDU Session Establishment procedure with a Request Type indicating "Emergency Request".

 The Request Type indicates "Emergency Request" if the PDU Session Establishment is a request to establish a PDU Session for Emergency services. The Request Type indicates "Existing Emergency PDU Session" if the request refers to an existing PDU Session for Emergency services switching between 3GPP access and non-3GPP access or to a PDU Session handover from an existing PDN connection for Emergency services in EPC.

 The 5GSM Core Network Capability is provided by the UE and handled by SMF as defined in clause 5.4.4b of TS 23.501 [2].

 The Number Of Packet Filters indicates the number of supported packet filters for signalled QoS rules for the PDU Session that is being established. The number of packet filters indicated by the UE is valid for the lifetime of the PDU Session. For presence condition, see TS 24.501 [25].

 The UE Integrity Protection Maximum Data Rate indicates the maximum data rate up to which the UE can support UP integrity protection. The UE shall provide the UE Integrity Protection Data Rate capability independently of the Access Type over which the UE sends the PDU Session Establishment Request.

 If the use of header compression for Control Plane CIoT 5GS optimisation was negotiated successfully between the UE and the network in the previous registration procedure, the UE shall include the Header Compression Configuration, unless "Unstructured" PDU Session Type is indicated. The Header Compression Configuration includes the information necessary for the header compression channel setup. Optionally, the Header Compression Configuration may include additional header compression context parameters.

 The NAS message sent by the UE is encapsulated by the AN in a N2 message towards the AMF that should include User location information and Access Type Information.

 The PDU Session Establishment Request message may contain SM PDU DN Request Container containing information for the PDU Session authorization by the external DN.

 The UE includes the S-NSSAI from the Allowed NSSAI of the current access type or Partially Allowed NSSAI. If the UE is provided with the mapping of an S-NSSAI that is replaced by an Alternative S-NSSAI, the UE shall provide both the Alternative S-NSSAI and the S-NSSAI that is replaced by it. If the Mapping of Allowed NSSAI or Mapping Of Partially Allowed NSSAI was provided to the UE, the UE shall provide both the S-NSSAI of the VPLMN from the Allowed NSSAI or Partially Allowed NSSAI and the corresponding S-NSSAI of the HPLMN from the Mapping Of Allowed NSSAI or Mapping Of Partially Allowed NSSAI. If the UE is provided with the mapping of the VPLMN S-NSSAI to a VPLMN Alternative S-NSSAI, the UE provides both the VPLMN Alternative S-NSSAI and the VPLMN S-NSSAI in the PDU Session Establishment message. If the UE is provided with the mapping of the HPLMN S-NSSAI to a HPLMN Alternative S-NSSAI, the UE provides both the HPLMN Alternative S-NSSAI and the HPLMN S-NSSAI in the PDU Session Establishment message. The AMF verifies whether the Alternative S-NSSAI and the S-NSSAI provided in the PDU Session Establishment Request message is valid based on the UE context as described in clause 5.15.19 of TS 23.501 [2].

 If the procedure is triggered for SSC mode 3 operation, the UE shall also include the Old PDU Session ID which indicates the PDU Session ID of the on-going PDU Session to be released, in NAS message. The Old PDU Session ID is included only in this case.

 The AMF receives from the AN the NAS SM message (built in step 1) together with User Location Information (e.g. Cell Id in the case of the NG-RAN).

 The UE shall not trigger a PDU Session establishment for a PDU Session corresponding to a LADN when the UE is outside the area of availability of the LADN.

 The UE shall not trigger a PDU Session establishment for a PDU Session associated to an S-NSSAI if the S-NSSAI is not valid as per the S-NSSAI location availability information.

 If the UE is establishing a PDU session for IMS and the UE is configured to discover the P-CSCF address during connectivity establishment, the UE shall include an indicator that it requests a P‑CSCF IP address(es) within the SM container.

 The PS Data Off status is included in the PCO in the PDU Session Establishment Request message.

 The UE capability to support Reliable Data Service is included in the PCO in the PDU Session Establishment Request message.

 If the UE has indicated that it supports transfer of Port Management Information Containers as per UE 5GSM Core Network Capability and if the PDU session type is Ethernet, then the UE shall include the MAC address of the DS-TT Ethernet port used for this Ethernet PDU session. If the UE is aware of the UE-DS-TT Residence Time, then the UE shall additionally include the UE-DS-TT Residence Time.

 If the UE requests to establish always-on PDU session, the UE includes an Always-on PDU Session Requested indication in the PDU Session Establishment Request message.

 As described in TS 23.548 [74], a UE that hosts EEC(s) may indicate in the PCO that it supports the ability to receive ECS address(es) via NAS and to transfer the ECS Address(es) to the EEC(s).

 A UE that hosts the EDC functionality shall indicate in the PCO its capability to support the EDC functionality (see clause 5.2.1 of TS 23.548 [74]).

 The UE may also include PDU Session Pair ID and/or RSN in PDU Session Establishment Request message as described in clause 5.33.2.1 of TS 23.501 [2].

 A UE that supports EAS re-discovery as described in clause 6.2.3.3 of TS 23.548 [74], may indicate so in the PCO.

 Port Management Information Container may be received from DS-TT and includes port management capabilities, i.e. information indicating which standardized and deployment-specific port management information is supported by DS-TT as defined in clause 5.28.3 of TS 23.501 [2].

 If UE supports to report URSP rule enforcement to network and the URSP rule that triggered this PDU Session Establishment Request included the Indication for reporting URSP rule enforcement, the UE may provide URSP rule enforcement report as described in clause 6.6.2.4 of TS 23.503 [20].

2. For NR satellite access, the AMF may decide to verify the UE location as described in clause 5.4.11.4 of TS 23.501 [2].

 The AMF determines that the message corresponds to a request for a new PDU Session based on that Request Type indicates "initial request" and that the PDU Session ID is not used for any existing PDU Session of the UE. If the NAS message does not contain an S-NSSAI, the AMF determines an S-NSSAI of the Serving PLMN for the requested PDU Session from the current Allowed NSSAI for the UE. If there is only one S-NSSAI in the Allowed NSSAI, this S-NSSAI shall be used. If there is more than one S-NSSAI in the Allowed NSSAI, the S-NSSAI selected is either according to the UE subscription, if the subscription contains only one default S-NSSAI and the corresponding mapped HPLMN S-NSSAI of the Serving PLMN is included in the Allowed NSSAI, or based on operator policy (e.g. also ensures any UE Requested DNN is allowed for the selected S-NSSAI)). When the NAS Message does not contain a DNN, the AMF determines the DNN for the requested PDU Session by selecting the default DNN for the S-NSSAI (irrespective of whether the S-NSSAI is included in the NAS message or determined by the AMF) if the default DNN is present in the UE's Subscription Information (or for the corresponding S-NSSAI of the HPLMN, in the case of LBO); otherwise the serving AMF selects a locally configured DNN for this S-NSSAI of the Serving PLMN. If the AMF cannot select an SMF (e.g. the UE requested DNN is not supported by the network, or the UE requested DNN is not in the Subscribed DNN List for the S-NSSAI (or its mapped value for the HPLMN in the case of LBO) and wildcard DNN is not included in the Subscribed DNN list), the AMF shall, based on operator policies received from PCF, either reject the NAS Message containing PDU Session Establishment Request from the UE with an appropriate cause or request PCF to replace the UE requested DNN by a selected DNN. If the DNN requested by the UE is present in the UE subscription information but indicated for replacement in the operator policies received from PCF, the AMF shall request the PCF to perform a DNN replacement to a selected DNN. AMF requests DNN replacement as specified in clause 4.16.2.1.1. If the DNN requested by the UE is present in the UE subscription information but not supported by the network and not indicated for replacement in the operator policies received from PCF, the AMF shall reject the NAS Message containing PDU Session Establishment Request from the UE with an appropriate cause value.

 The AMF selects an SMF as described in clause 6.3.2 of TS 23.501 [2] and clause 4.3.2.2.3. If the Request Type indicates "Initial request" or the request is due to handover from EPS or from non-3GPP access serving by a different AMF, the AMF stores an association of the S-NSSAI(s), the DNN, the PDU Session ID, the SMF ID as well as the Access Type of the PDU Session. If the AMF determines to replace the S-NSSAI received from the UE with the Alternative S-NSSAI or the AMF receives the Alternative S-NSSAI and the S-NSSAI is by the UE, the AMF selects the SMF based on the Alternative S-NSSAI.

 During registration procedures, the AMF determines the use of the Control Plane CIoT 5GS Optimisation or User Plane CIoT 5GS Optimisation based on UEs indications in the 5G Preferred Network Behaviour, the serving operator policies and the network support of CIoT 5GS optimisations. The AMF selects an SMF that supports Control Plane CIoT 5GS optimisation or User Plane CIoT 5GS Optimisation as described in clause 6.3.2 of TS 23.501 [2].

 If the Request Type is "initial request" and if the Old PDU Session ID indicating the existing PDU Session is also contained in the message, the AMF selects an SMF as described in clause 4.3.5.2 and stores an association of the new PDU Session ID, the S-NSSAI(s), the selected SMF ID as well as Access Type of the PDU Session.

 If the Request Type indicates "Existing PDU Session", the AMF selects the SMF based on SMF-ID received from UDM. The case where the Request Type indicates "Existing PDU Session" and either the AMF does not recognize the PDU Session ID or the subscription context that the AMF received from UDM during the Registration or Subscription Profile Update Notification procedure does not contain an SMF ID corresponding to the PDU Session ID constitutes an error case. The AMF updates the Access Type stored for the PDU Session.

 If the Request Type indicates "Existing PDU Session" referring to an existing PDU Session moved between 3GPP access and non-3GPP access, then if the Serving PLMN S-NSSAI of the PDU Session is present in the Allowed NSSAI of the target access type or Partially Allowed NSSAI, the PDU Session Establishment procedure can be performed in the following cases:

- the SMF ID corresponding to the PDU Session ID and the AMF belong to the same PLMN;

- the SMF ID corresponding to the PDU Session ID belongs to the HPLMN;

 Otherwise the AMF shall reject the PDU Session Establishment Request with an appropriate reject cause.

NOTE 2: The SMF ID includes the PLMN ID that the SMF belongs to.

 The AMF shall reject a request coming from an Emergency Registered UE and the Request Type indicates neither "Emergency Request" nor "Existing Emergency PDU Session". When the Request Type indicates "Emergency Request", the AMF is not expecting any S-NSSAI and DNN value provided by the UE and uses locally configured values instead. The AMF stores the Access Type of the PDU Session.

 If the Request Type indicates "Emergency Request" or "Existing Emergency PDU Session", the AMF selects the SMF as described in clause 5.16.4 of TS 23.501 [2].

 If the AMF is running a slice deregistration inactivity timer for the S-NSSAI of the PDU Session and the timer is associated with the Access Type over which the PDU Session Establishment Request was received, the AMF stops the timer.

3. From AMF to SMF: Either Nsmf\_PDUSession\_CreateSMContext Request (SUPI, selected DNN, UE requested DNN, S-NSSAI(s), [Alternative S-NSSAI], [Slice Area Restriction indication], PDU Session ID, AMF ID, Request Type, [PCF ID, Same PCF Selection Indication], Priority Access, [Small Data Rate Control Status], N1 SM container (PDU Session Establishment Request), User location information, Access Type, RAT Type, PEI, GPSI, UE presence in LADN service area, Subscription For PDU Session Status Notification, DNN Selection Mode, Trace Requirements, Control Plane CIoT 5GS Optimisation indication, Control Plane Only indicator, Satellite backhaul category, GEO Satellite ID, [PVS FQDN(s) and/or PVS IP address(es), Onboarding Indication], Disaster Roaming service indication) or Nsmf\_PDUSession\_UpdateSMContext Request (SUPI, DNN, S-NSSAI(s), SM Context ID, AMF ID, Request Type, N1 SM container (PDU Session Establishment Request), User location information, Access Type, RAT type, PEI, Serving Network (PLMN ID, or PLMN ID and NID, see clause 5.18 of TS 23.501 [2]), Satellite backhaul category, GEO Satellite ID), [PCF binding information, notification of SM Policy Association establishment Indication].

 If the AMF does not have an association with an SMF for the PDU Session ID provided by the UE (e.g. when Request Type indicates "initial request"), the AMF invokes the Nsmf\_PDUSession\_CreateSMContext Request, but if the AMF already has an association with an SMF for the PDU Session ID provided by the UE (e.g. when Request Type indicates "existing PDU Session"), the AMF invokes the Nsmf\_PDUSession\_UpdateSMContext Request.

 The AMF sends the S-NSSAI of the Serving PLMN from the Allowed NSSAI or Partially Allowed NSSAI to the SMF. If the AMF determined to replace the S-NSSAI received from the UE with an Alternative S-NSSAI and the AMF selected the SMF based on the Alternative S-NSSAI in step 2, the AMF sends both the S-NSSAI value of the Alternative S-NSSAI and the S-NSSAI value of the S-NSSAI received from the UE to the SMF. If the Alternative S-NSSAI and the S-NSSAI is provided by the UE and the AMF selected the SMF based on the Alternative S-NSSAI in step 2, the AMF sends both the S-NSSAI value of the Alternative S-NSSAI and the S-NSSAI value of the S-NSSAI received from the UE to the SMF. For roaming scenario in local breakout (LBO), the AMF also sends the corresponding S-NSSAI of the HPLMN from the Mapping Of Allowed NSSAI or Mapping Of Partially Allowed NSSAI to the SMF. If the AMF determines to replace the HPLMN S-NSSAI received from the UE with the HPLMN Alternative S-NSSAI or the AMF receives the HPLMN Alternative S-NSSAI and the HPLMN S-NSSAI provided by the UE, the AMF sends both HPLMN S-NSSAI and HPLMN Alternative S-NSSAI to the SMF.

 When the AMF determines that the S-NSSAI is subject to area restriction, i.e. the S-NSSAI is configured with an NS-AoS, or the S-NSSAI is present in the Partially Allowed NSSAI, the AMF sends Slice Area Restriction indication to SMF indicating that the PDU Session is subject to area restriction for the S-NSSAI. If the S-NSSAI is replaced with the Alternative S-NSSAI, the AMF checks the area restriction only for the Replaced S-NSSAI.

 The AMF ID is the UE's GUAMI which uniquely identifies the AMF serving the UE. The AMF forwards the PDU Session ID together with the N1 SM container containing the PDU Session Establishment Request received from the UE. The GPSI shall be included if available at AMF.

 The AMF determines Access Type and RAT Type, see clause 4.2.2.2.1.

 The AMF provides the PEI instead of the SUPI when the UE in limited service state has registered for Emergency services (i.e. Emergency Registered) without providing a SUPI. The PEI is defined in clause 5.9.3 of TS 23.501 [2]. If the UE in limited service state has registered for Emergency services (i.e. Emergency Registered) with a SUPI but has not been authenticated the AMF indicates that the SUPI has not been authenticated. The SMF determines that the UE has not been authenticated when it does not receive a SUPI for the UE or when the AMF indicates that the SUPI has not been authenticated.

 If the AMF determines that the selected DNN corresponds to an LADN then the AMF provides the "UE presence in LADN service area" that indicates if the UE is IN or OUT of the LADN service area. If the AMF enforces the LADN Service Area per LADN DNN and S-NSSAI, then the AMF also provides an indication that "the PDU Session is subject to LADN per LADN DNN and S-NSSAI".

 If the Old PDU Session ID is included in step 1 and if the SMF is not to be reallocated, the AMF also includes Old PDU Session ID in the Nsmf\_PDUSession\_CreateSMContext Request.

 DNN Selection Mode is determined by the AMF. It indicates whether an explicitly subscribed DNN has been provided by the UE in its PDU Session Establishment Request.

 The SMF may use DNN Selection Mode when deciding whether to accept or reject the UE request.

 When the Establishment cause received as part of AN parameters during the Registration procedure or Service Request procedure is associated with priority services (e.g. MPS, MCX), or when the AMF determines the UE has priority subscription (e.g. MPS, MCX) in the UDM, the AMF includes a Message Priority header to indicate priority information. The SMF uses the Message Priority header to determine if the UE request is subject to exemption from NAS level congestion control. Other NFs relay the priority information by including the Message Priority header in service-based interfaces, as specified in TS 29.500 [17].

 In the local breakout case, if the SMF (in the VPLMN) is not able to process some part of the N1 SM information that Home Routed Roaming is required and the SMF responds to the AMF that it is not the right SMF to handle the N1 SM message by invoking Nsmf\_PDUSession\_CreateSMContext Response service operation. The SMF includes a proper N11 cause code triggering the AMF to proceed with home routed case. The procedure starts again at step 2 of clause 4.3.2.2.2.

 In the non-roaming case, for PDU Session with Request Type "initial request", the AMF checks if the PCF Selection Assistance info from the UDM indicates that the same PCF is required for the requested DNN and S-NSSAI and if required, the AMF includes in Nsmf\_PDUSession\_CreateSMContext Request both the Same PCF Selection Indication and the PCF ID selected by the AMF, this PCF ID identifies the H-PCF,

 If PCF Selection Assistance info is not received from the UDM, the AMF may include a PCF ID in the Nsmf\_PDUSession\_CreateSMContext Request based on operator policies. This PCF ID identifies the H-PCF in the non-roaming case and the V-PCF in the local breakout roaming case.

 The AMF includes Trace Requirements if Trace Requirements have been received in subscription data.

 If the AMF decides to use the Control Plane CIoT 5GS Optimisation or User Plane CIoT 5GS Optimisation as specified in step 2 or to only use Control Plane CIoT 5GS Optimisation for the PDU session as described in clause 5.31.4 of TS 23.501 [2], the AMF sends the Control Plane CIoT 5GS Optimisation indication or Control Plane Only indicator to the SMF.

 If the AMF determines that the RAT type is NB-IoT and the number of PDU Sessions with user plane resources activated for the UE has reached the maximum number of supported user plane resources (0, 1 or 2) based on whether the UE supports UP data transfer and the UE's 5GMM Core Network Capability as described in clause 5.31.19 of TS 23.501 [2], the AMF may either reject the PDU Session Establishment Request or continue with the PDU Session establishment and include the Control Plane CIoT 5GS Optimisation indication or Control Plane Only indicator to the SMF.

 The AMF includes the latest Small Data Rate Control Status if it has stored it for the PDU Session.

 If the RAT type was included in the message, then the SMF stores the RAT type in SM Context.

 If the UE supports CE mode B and use of CE mode B is not restricted according to the Enhanced Coverage Restriction information in the UE context in the AMF, then the AMF shall include the extended NAS-SM timer indication. Based on the extended NAS-SM timer indication, the SMF shall use the extended NAS-SM timer setting for the UE as specified in TS 24.501 [25].

 If the identity of an NWDAF is available to the AMF, the AMF informs the SMF of the NWDAF ID(s) used for UE related Analytics and corresponding Analytics ID(s).

 If the AMF, based on configuration, is aware that the UE is accessing over a gNB using satellite backhaul as defined in clause 5.43.4 of TS 23.501 [2], the AMF determines the type of satellite backhaul category and includes Satellite backhaul category to the SMF.

 If the AMF, based on configuration, is aware that the UE is accessing over a gNB using GEO satellite backhaul, the AMF may, based on configuration, include the GEO satellite ID as described in clause 5.43.2 of TS 23.501 [2].

 The AMF may provide the Disaster Roaming service indication as specified in TS 23.501 [2].

4. If Session Management Subscription data for corresponding SUPI, DNN and S-NSSAI of the HPLMN is not available, then SMF retrieves the Session Management Subscription data using Nudm\_SDM\_Get (SUPI, Session Management Subscription data, selected DNN, S-NSSAI of the HPLMN, Serving PLMN ID, [NID]) and subscribes to be notified when this subscription data is modified using Nudm\_SDM\_Subscribe (SUPI, Session Management Subscription data, selected DNN, S-NSSAI of the HPLMN, Serving PLMN ID, [NID]). The UDM may get this information from UDR by Nudr\_DM\_Query (SUPI, Subscription Data, Session Management Subscription data, selected DNN, S-NSSAI of the HPLMN, Serving PLMN ID, [NID]) and may subscribe to notifications from UDR for the same data by Nudr\_DM\_subscribe. If a S-NSSAI is subject to network slice usage control and the S-NSSAI is dedicated to a single AF, for a PDU Session for non-roaming subscribers, the UDM may provide a Slice Usage Policy information including whether a network slice is on demand and a PDU Session inactivity timer value as described in clause 5.15.15 of TS 23.501 [2]. If the SMF received Alternative S-NSSAI (for the HPLMN in roaming case) in step 3, the SMF retrieves subscription data as specified in clause 5.15.19 of TS 23.501 [2].

 The SMF may use DNN Selection Mode when deciding whether to retrieve the Session Management Subscription data e.g. if the (selected DNN, S-NSSAI of the HPLMN) is not explicitly subscribed, the SMF may use local configuration instead of Session Management Subscription data.

 If the Request Type in step 3 indicates "Existing PDU Session" or "Existing Emergency PDU Session" the SMF determines that the request is due to switching between 3GPP access and non-3GPP access or due to handover from EPS. The SMF identifies the existing PDU Session based on the PDU Session ID. In such a case, the SMF does not create a new SM context but instead updates the existing SM context and provides the representation of the updated SM context to the AMF in the response.

 If the Request Type is "Initial request" and if the Old PDU Session ID is included in Nsmf\_PDUSession\_CreateSMContext Request, the SMF identifies the existing PDU Session to be released based on the Old PDU Session ID.

 The Subscription data includes the Allowed PDU Session Type(s), Allowed SSC mode(s), default 5QI and ARP, subscribed Session-AMBR, SMF-Associated external parameters.

 IP Index or Static IP address/prefix may be included in the subscription data if the UE has subscribed to it.

 The SMF checks the validity of the UE request: it checks:

- Whether the UE request is compliant with the user subscription and with local policies;

- (If the selected DNN corresponds to an LADN), whether the UE is located within the LADN service area based on the "UE presence in LADN service area" indication from the AMF. If the AMF does not provide the "UE presence in LADN service area" indication and the SMF determines that the selected DNN corresponds to a LADN, then the SMF considers that the UE is OUT of the LADN service area.

 The SMF determines whether the PDU Session requires redundancy and the SMF determines the RSN as described in clause 5.33.2.1 of TS 23.501 [2]. If the SMF determines that redundant handling is not allowed or not possible for the given PDU Session, the SMF shall either reject the establishment of the PDU Session or accept the establishment of a PDU session without redundancy handling based on local policy.

 If the UE request is considered as not valid, the SMF decides to not accept to establish the PDU Session.

NOTE 3: The SMF can, instead of the Nudm\_SDM\_Get service operation, use the Nudm\_SDM\_Subscribe service operation with an Immediate Report Indication that triggers the UDM to immediately return the subscribed data if the corresponding feature is supported by both the SMF and the UDM.

 For a Disaster Roaming service, the UDM provides the Session Management Subscription data to the SMF based on the local policy and/or the local configuration as specified in clause 5.40.4 of TS 23.501 [2].

 For an S-NSSAI subject to NSAC and if LBO applies, the SMF in supporting VPLMN stores the applicable NSAC admission mode.

5. From SMF to AMF: Either Nsmf\_PDUSession\_CreateSMContext Response (Cause, SM Context ID or N1 SM container (PDU Session Reject (Cause))) or an Nsmf\_PDUSession\_UpdateSMContext Response depending on the request received in step 3.

 If the SMF received Nsmf\_PDUSession\_CreateSMContext Request in step 3 and the SMF is able to process the PDU Session establishment request, the SMF creates an SM context and responds to the AMF by providing an SM Context ID.

 If the UP Security Policy for the PDU Session is determined to have Integrity Protection set to "Required", the SMF may, based on local configuration, decide whether to accept or reject the PDU Session request based on the UE Integrity Protection Maximum Data Rate.

NOTE 4: The SMF can e.g. be configured to reject a PDU Session if the UE Integrity Protection Maximum Data Rate has a very low value, if the services provided by the DN would require higher bitrates.

 When the SMF decides to not accept to establish a PDU Session, the SMF rejects the UE request via NAS SM signalling including a relevant SM rejection cause by responding to the AMF with Nsmf\_PDUSession\_CreateSMContext Response. The SMF also indicates to the AMF that the PDU Session ID is to be considered as released, the SMF proceeds to step 20 and the PDU Session Establishment procedure is stopped.

6. Optional Secondary authentication/authorization.

 If the Request Type in step 3 indicates "Existing PDU Session", the SMF does not perform secondary authentication/authorization.

 If the Request Type received in step 3 indicates "Emergency Request" or "Existing Emergency PDU Session", the SMF shall not perform secondary authentication\authorization.

 If the SMF needs to perform secondary authentication/authorization during the establishment of the PDU Session by a DN-AAA Server as described in clause 5.6.6 of TS 23.501 [2], the SMF triggers the PDU Session establishment authentication/authorization as described in clause 4.3.2.3.

7a. If dynamic PCC is to be used for the PDU Session, the SMF performs PCF selection as described in clause 6.3.7.1 of TS 23.501 [2]. If the Request Type indicates "Existing PDU Session" or "Existing Emergency PDU Session", the SMF shall use the PCF already selected for the PDU Session.

 Otherwise, the SMF may apply local policy.

7b. The SMF may perform an SM Policy Association Establishment procedure as defined in clause 4.16.4 to establish an SM Policy Association with the PCF and get the default PCC Rules for the PDU Session. The SMF shall include the 3GPP Data Off status if received in step 1. The GPSI, PVS FQDN(s) and/or PVS IP address(es) and the Onboarding Indication shall be included if available at SMF in the case of ON-SNPN. The SMF shall include both the S-NSSAI and the Alternative S-NSSAI, if received in step 3. If the Request Type in step 3 indicates "Existing PDU Session", the SMF provides information on the Policy Control Request Trigger condition(s) that have been met by an SMF initiated SM Policy Association Modification procedure as defined in clause 4.16.5.1. The PCF may provide policy information defined in clause 5.2.5.4 (and in TS 23.503 [20]) to SMF.

 The PCF for the UE subscribes to notifications of event "UE reporting Connection Capabilities from associated URSP rule" as defined in clause 6.1.3.18 in TS 23.503 [20], using Npcf\_PolicyAuthorization\_Subscribe (EventId set to "UE reporting Connection Capabilities from associated URSP rule", EventFilter set to at least "list of Connection Capabilities") to the PCF for the PDU Session. The PCF for session may notify the PCF for UE about the URSP rule enforcement together with the PDU session parameters that this application associated with by Npcf\_PolicyAuthorization\_Notify.

 During the SM Policy Association Establishment procedure, if the PCF detects the request relates to SM Policy Association enabling integration with TSN or TSC or Deterministic Networking (as defined in TS 23.501 [2] clause 5.28) based on local configuration (e.g. for a certain requested DNN/S-NSSAI for which Time Sensitive Networking, Time Sensitive Communications, Time Synchronization and/or Deterministic Networking is applicable), the PCF may provide policy control request trigger for 5GS Bridge/Router Information as defined in clause 6.1.3.5 of TS 23.503 [20].

 The PCF, based on the Emergency DNN, sets the ARP of the PCC rules to a value that is reserved for Emergency services as described in TS 23.503 [20].

NOTE 5: The purpose of step 7 is to receive PCC rules before selecting UPF. If PCC rules are not needed as input for UPF selection, step 7 can be performed after step 8.

- During the SM Policy Association Establishment procedure for PDU Sessions for non-roaming UEs, if a S-NSSAI is subject to network slice usage control, the PCF may provide a Slice Usage Policy information including whether a network slice is on demand and a PDU Session inactivity timer value as described in clause 5.15.15 of TS 23.501 [2].

8. If the Request Type in step 3 indicates "Initial request", the SMF selects an SSC mode for the PDU Session as described in clause 5.6.9.3 of TS 23.501 [2]. The SMF also selects one or more UPFs as needed as described in clause 6.3.3 of TS 23.501 [2]. In the case of PDU Session Type IPv4 or IPv6 or IPv4v6, the SMF allocates an IP address/prefix for the PDU Session (unless configured otherwise) as described in clause 5.8.2 of TS 23.501 [2]. In the case of PDU Session Type IPv6 or IPv4v6, the SMF also allocates an interface identifier to the UE for the UE to build its link-local address. For Unstructured PDU Session Type the SMF may allocate an IPv6 prefix for the PDU Session and N6 point-to-point tunnelling (based on UDP/IPv6) as described in clause 5.6.10.3 of TS 23.501 [2]. For Ethernet PDU Session Type, neither a MAC nor an IP address is allocated by the SMF to the UE for this PDU Session.

 If the AMF indicated Control Plane CIoT 5GS Optimisation in step 3 for this PDU session, then,

1) For Unstructured PDU Session Type, the SMF checks whether UE's subscription include a "NEF Identity for NIDD" for the DNN/S-NSSAI combination. When the "NEF Identity for NIDD" is present in the UE's subscription data, the SMF will select the NEF identified for the S-NSSAI and selected DNN in the "NEF Identity for NIDD" as the anchor of this PDU Session. Otherwise, the SMF will select a UPF as the anchor of this PDU Session.

2) For other PDU Session Types, the SMF will perform UPF selection to select a UPF as the anchor of this PDU Session.

 If the Request Type in Step 3 is "Existing PDU Session", the SMF maintains the same IP address/prefix that has already been allocated to the UE in the source network.

 If the Request Type in step 3 indicates "Existing PDU Session" referring to an existing PDU Session moved between 3GPP access and non-3GPP access the SMF maintains the SSC mode of the PDU Session, the current PDU Session Anchor and IP address.

NOTE 6: The SMF may decide to trigger e.g. new intermediate UPF insertion or allocation of a new UPF as described in step 5 in clause 4.2.3.2.

 If the Request Type indicates "Emergency Request", the SMF selects the UPF as described in clause 5.16.4 of TS 23.501 [2] and selects SSC mode 1.

 SMF may select a UPF (e.g. based on requested DNN/S-NSSAI) that supports NW-TT functionality.

 SMF may select a PSA UPF that supports PDU Set identification and marking for a QoS flow with PDU Set based handling capability.

9. SMF may perform an SMF initiated SM Policy Association Modification procedure as defined in clause 4.16.5.1 to provide information on the Policy Control Request Trigger condition(s) that have been met. If Request Type is "initial request" and dynamic PCC is deployed and PDU Session Type is IPv4 or IPv6 or IPv4v6, SMF notifies the PCF (if the Policy Control Request Trigger condition is met) with the allocated UE IP address/prefix(es).

NOTE 7: If an IP address/prefix has been allocated before step 7 (e.g. subscribed static IP address/prefix in UDM/UDR) or the step 7 is performed after step 8, the IP address/prefix can be provided to PCF in step 7 and the IP address/prefix notification in this step can be skipped.

 If the PCF has subscribed to Policy Control Request Trigger for "UE reporting Connection Capabilities from associated URSP rule" and if SMF received the URSP rule enforcement report (i.e. connection capabilities information) from the UE at step 1, then the SMF may include the URSP rule enforcement report as described in clause 6.1.3.5 of TS 23.503 [20] and clause 6.6.2.4 of TS 23.503 [20].

 The PCF may provide updated policies to the SMF. The PCF may provide policy information defined in clause 5.2.5.4 (and in TS 23.503 [20]) to SMF.

 The PCF may make policy control decisions based on the awareness of URSP rule enforcement, as described in clause 6.1.1.5 in TS 23.503 [20].

10. If Request Type indicates "initial request", the SMF initiates an N4 Session Establishment procedure with the selected UPF(s), otherwise it initiates an N4 Session Modification procedure with the selected UPF(s):

10a. The SMF sends an N4 Session Establishment/Modification Request to the UPF and provides Packet detection, enforcement and reporting rules to be installed on the UPF for this PDU Session. If the SMF is configured to request IP address allocation from UPF as described in clause 5.8.2 of TS 23.501 [2] then the SMF indicates to the UPF to perform the IP address/prefix allocation and includes the information required for the UPF to perform the allocation. If the selective User Plane deactivation is required for this PDU Session, the SMF determines the inactivity timer and provides it to the UPF. For a PDU Session for non-roaming subscribers, if the S-NSSAI of the PDU Session is subject to network slice usage control, the SMF obtains the PDU Session inactivity timer value for the PDU Session as described in step 4 or step 7 or uses preconfigured value and configures the UPF to run the PDU Session inactivity timer. The SMF provides Trace Requirements to the UPF if it has received Trace Requirements. If the Reliable Data Service is enabled for the PDU Session by the SMF as specified in TS 23.501 [2], the RDS Configuration information is provided to the UPF in this step. The SMF provides Small Data Rate Control parameters to the UPF for the PDU Session, if required. The SMF provides the Small Data Rate Control Status to the UPF, if received from the AMF. If the Serving PLMN intends to enforce Serving PLMN Rate Control (see clause 5.31.14.2 of TS 23.501 [2]) for this PDU session then the SMF shall provide Serving PLMN Rate Control parameters to UPF for limiting the rate of downlink control plane data packets.

 For a PDU Session of type Ethernet or IP, if the trigger for 5GS Bridge/Router information is armed in step 7b, the SMF, based on local configuration (e.g. for a certain requested DNN/S-NSSAI for which Time Sensitive Networking, Time Sensitive Communications, Time Synchronization and/or Deterministic Networking is applicable), includes a bridge information indication or a router information indication to request the UPF to provide a port number.

 If SMF decides to perform redundant transmission for one or more QoS Flows of the PDU session as described in clause 5.33.1.2 of TS 23.501 [2], two CN Tunnel Info are requested by the SMF from the UPF. The SMF also indicates the UPF to eliminate the duplicated packet for the QoS Flow in uplink direction. The SMF indicates the UPF that one CN Tunnel Info is used as the redundancy tunnel of the PDU session described in clause 5.33.2.2 of TS 23.501 [2].

 If SMF decides to insert two I-UPFs between the PSA UPF and the NG-RAN for redundant transmission as described in clause 5.33.1.2 of TS 23.501 [2], the SMF requests the corresponding CN Tunnel Info and provides them to the I-UPFs and PSA UPF respectively. The SMF also indicates the PSA UPF to eliminate the duplicated packet for the QoS Flow in uplink direction. The SMF indicates the PSA UPF that one CN Tunnel Info is used as the redundancy tunnel of the PDU session described in clause 5.33.2.2 of TS 23.501 [2].

NOTE 8: The method to perform elimination and reordering on RAN/UPF based on the packets received from the two GTP-U tunnels is up to RAN/UPF implementation. The two GTP-U tunnels are terminated at the same RAN node and UPF.

 If Control Plane CIoT 5GS Optimisation is enabled for this PDU session and the SMF selects the NEF as the anchor of this PDU Session in step 8, the SMF performs SMF-NEF Connection Establishment Procedure as described in clause 4.25.2.

 If interworking with TSN deployed in the transport network is supported (see clause 4.4.8 of TS 23.501 [2]) and the UPF supports CN-TL, the SMF includes a TL-Container with a get-request to the N4 Session Establishment/Modification request that is sent to the UPF, as described in clause 5.28a.2 of TS 23.501 [2].

 If SMF decides to enable ECN marking for L4S by PSA UPF, a QoS Flow level ECN marking for L4S indicator shall be sent by SMF to PSA UPF over N4 as described in clause 5.37.3.3 of TS 23.501 [2].

 If selected PSA UPF supports Nupf\_EventExposure service, the SMF should include DNN and S-NSSAI in the N4 Session Establishment procedure.

NOTE 9: If SMF does not provide DNN and S-NSSAI to UPF it could result in rejections for the Nupf\_EventExposure\_Subscribe service operations, unless UPF is configured with a DNN and S-NSSAI for a specific IP address range.

10b. The UPF acknowledges by sending an N4 Session Establishment/Modification Response.

 If the SMF indicates in step 10a that IP address/prefix allocation is to be performed by the UPF then this response contains the requested IP address/prefix. The requested CN Tunnel Info is provided to SMF in this step. If SMF indicated the UPF to perform packet duplication and elimination for the QoS Flow in step 10a, two CN Tunnel Info are allocated by the UPF and provided to the SMF. If SMF decides to insert two I-UPFs between the PSA UPF and the NG-RAN for redundant transmission as described in clause 5.33.1.2 of TS 23.501 [2], CN Tunnel Info of two I-UPFs and the UPF (PSA) are allocated by the UPFs and provided to the SMF. The UPF indicates the SMF that one CN Tunnel Info is used as the redundancy tunnel of the PDU session as described in clause 5.33.2.2 of TS 23.501 [2].

 If SMF requested UPF to provide a port number then UPF includes the port number and user-plane Node ID in the response according to TS 23.501 [2]. To support integration with IEEE TSN, the user-plane node ID is Bridge ID. To support integration with IETF DetNet, the user-plane node ID can be Router ID. Besides the network instance, the SMF may also provide DNN/S-NSSAI for the UPF to respond with user-plane Node ID based on pre-configuration information.

 If multiple UPFs are selected for the PDU Session, the SMF initiate N4 Session Establishment/Modification procedure with each UPF of the PDU Session in this step.

NOTE 10: If the PCF has subscribed to the UE IP address change Policy Control Trigger (as specified in clause 6.1.3.5 of TS 23.503 [20]) then the SMF notifies the PCF about the IP address/prefix allocated by the UPF. This is not shown in figure 4.3.2.2.1-1.

 If interworking with TSN deployed in the transport network is supported and the UPF supports CN-TL and received a TL-Container with a get-request from the SMF/CUC in step 10a (see clause 4.4.8 of TS 23.501 [2]), the UPF/CN-TL includes a TL-Container with a get-response in the N4 Session Establishment/Modification response, as described in clause 5.28a.2 of TS 23.501 [2]. The SMF/CUC stores the information provided in the get-response.

11. SMF to AMF: Namf\_Communication\_N1N2MessageTransfer (PDU Session ID, N2 SM information (PDU Session ID, QFI(s), QoS Profile(s), CN Tunnel Info, S-NSSAI from the Allowed NSSAI or Partially Allowed NSSAI, Session-AMBR, PDU Session Type, User Plane Security Enforcement information, UE Integrity Protection Maximum Data Rate, RSN, PDU Session Pair ID, TL-Container), N1 SM container (PDU Session Establishment Accept ([QoS Rule(s) and associated UL Protocol Description(s) (if available), QoS Flow level QoS parameters if needed for the QoS Flow(s) associated with the QoS rule(s)], selected SSC mode, S-NSSAI(s), UE Requested DNN, allocated IPv4 address, interface identifier, Session-AMBR, selected PDU Session Type, [Reflective QoS Timer] (if available), [P-CSCF address(es)], [Control Plane Only indicator], [Header Compression Configuration], [Always-on PDU Session Granted], [Small Data Rate Control parameters], [Small Data Rate Control Status], [Serving PLMN Rate Control], [PVS FQDN(s) and/or PVS IP address(es)], [Non-3GPP QoS Assistance Information Container]))). If multiple UPFs are used for the PDU Session, the CN Tunnel Info contains tunnel information related with the UPFs that terminate N3.

 The SMF may provide the SMF derived CN assisted RAN parameters tuning to the AMF by invoking Nsmf\_PDUSession\_SMContextStatusNotify (SMF derived CN assisted RAN parameters tuning) service. The AMF stores the SMF derived CN assisted RAN parameters tuning in the associated PDU Session context for this UE.

 The N2 SM information carries information that the AMF shall forward to the (R)AN which includes:

- The CN Tunnel Info corresponds to the Core Network address(es) of the N3 tunnel corresponding to the PDU Session. If two CN Tunnel Info are included for the PDU session for redundant transmission, the SMF also indicates the NG-RAN that one of the CN Tunnel Info used as the redundancy tunnel of the PDU session as described in clause 5.33.2.2 of TS 23.501 [2].

- One or multiple QoS profiles and the corresponding QFIs can be provided to the (R)AN. This is further described in clause 5.7 of TS 23.501 [2]. The SMF may indicate for each QoS Flow whether redundant transmission shall be performed by a corresponding redundant transmission indicator.

- The PDU Session ID may be used by AN signalling with the UE to indicate to the UE the association between (R)AN resources and a PDU Session for the UE.

- A PDU Session is associated to an S-NSSAI of the HPLMN and if applicable, to an S-NSSAI of the VPLMN and a DNN. The S-NSSAI provided to the (R)AN, is the S-NSSAI with the value for the Serving PLMN (i.e. the HPLMN S-NSSAI or, in LBO roaming case, the VPLMN S-NSSAI). When Alternative S-NSSAI is received from AMF in step 3, the S-NSSAI provided to the (R)AN is the Alternative S-NSSAI.

- User Plane Security Enforcement information is determined by the SMF as described in clause 5.10.3 of TS 23.501 [2].

- If the User Plane Security Enforcement information indicates that Integrity Protection is "Preferred" or "Required", the SMF also includes the UE Integrity Protection Maximum Data Rate as received in the PDU Session Establishment Request.

- The use of the RSN parameter and the PDU Session Pair ID by NG-RAN are described in clause 5.33.2.1 of TS 23.501 [2].

- For each QoS Flow, the SMF may at most request one of the following to the NG-RAN:

- ECN marking for L4S at NG-RAN in the case of ECN marking for L4S in RAN as described in clause 5.37.3 of TS 23.501 [2]; or

- Congestion information monitoring as described in clauses 5.45.3 and 5.37.4 of TS 23.501 [2]; or

- provide information for ECN marking for L4S at UPF in the case of ECN marking for L4S by PSA UPF as described in clause 5.37.3 of TS 23.501 [2].

- In case of non-3GPP access, where the 5G-AN corresponds to an N3IWF or TNGF:

- For each QoS Flow, the SMF may request the following to the N3IWF or TNGF:

 - ECN marking for L4S at N3IWF or TNGF in the case of ECN marking for L4S in non-3GPP access as described in clause 5.37.3 of TS 23.501 [2].

- TL-Container as described in clause 5.28a.2 of TS 23.501 [2]. If interworking with TSN deployed in the transport network is supported and the NG-RAN supports AN-TL (see clause 4.4.8 of TS 23.501 [2]), the SMF includes a TL-Container with a get-request to the N2 SM information, as described in clause 5.28a.2 of TS 23.501 [2].

 The N1 SM container contains the PDU Session Establishment Accept that the AMF shall provide to the UE. If the UE requested P-CSCF discovery then the message shall also include the P-CSCF IP address(es) as determined by the SMF and as described in clause 5.16.3.4 of TS 23.501 [2]. The PDU Session Establishment Accept includes S-NSSAI from the Allowed NSSAI or Partially Allowed NSSAI. The S-NSSAI value of the Alternative S-NSSAI is included in the PDU session Establishment Accept if the SMF has received the Alternative S-NSSAI from the AMF. For LBO roaming scenario, the PDU Session Establishment Accept includes the S-NSSAI from the Allowed NSSAI or Partially Allowed NSSAI for the VPLMN and also it includes the corresponding S-NSSAI of the HPLMN from the Mapping Of Allowed NSSAI or Mapping Of Partially Allowed NSSAI that SMF received in step 3. If the SMF has received the VPLMN Alternative S-NSSAI from the AMF, the PDU Session Establishment Accept includes the VPLMN Alternative S-NSSAI. If the SMF has received the HPLMN Alternative S-NSSAI from the AMF, the PDU Session Establishment Accept includes the HPLMN Alternative S-NSSAI. If the PCF, based on the local configuration, provides the PCC rules with Protocol Descriptions for UL in step 7b or step 9, the SMF may additionally provide the Protocol Description for UL with the associated QoS rule as described in clause 5.37.5.1 of TS 23.501 [2].

 If the PDU Session being established was requested to be an always-on PDU Session, the SMF shall indicate whether the request is accepted by including an Always-on PDU Session Granted indication in the PDU Session Establishment Accept message. If the PDU Session being established was not requested to be an always-on PDU Session but the SMF determines that the PDU Session needs to be established as an always-on PDU Session, the SMF shall include an Always-on PDU Session Granted indication in the PDU Session Establishment Accept message indicating that the PDU session is an always-on PDU Session.

 If Control Plane CIoT 5GS Optimisation is enabled for this PDU session, the N2 SM information is not included in this step. If Control Plane CIoT 5GS optimisation is enabled for this PDU session and the UE has sent the Header Compression Configuration in the PDU Session Establishment Request and the SMF supports the header compression parameters, the SMF shall include the Header Compression Configuration in the PDU Session Establishment Accept message. If the UE has included Header Compression context parameters in Header Compression Configuration in the PDU Session Establishment Request, the SMF shall establish the header compression context and may acknowledge the Header Compression context parameters. If the header compression context is not established during the PDU Session Establishment procedure, before using the compressed format for sending the data, the UE and the SMF need to establish the header compression context based on the Header Compression Configuration. If the SMF has received the Control Plane Only Indicator in step 3, the SMF shall include the Control Plane Only Indicator in the PDU Session Establishment Accept message. The SMF shall indicate the use of Control Plane only on its CDR. If the Small Data Rate Control is configured in the SMF, the SMF shall also include Small Data Rate Control parameters and the Small Data Rate Control Status (if received from the AMF) in the PDU Session Establishment Accept message as described in clause 5.31.14.3 of TS 23.501 [2]. If the Serving PLMN intends to enforce Serving PLMN Rate Control (see clause 5.31.14.2 of TS 23.501 [2]) for this PDU session then the SMF shall include the Serving PLMN Rate Control parameters in the PDU Session Establishment Accept message. The UE shall store and use Serving PLMN Rate Control parameters as the maximum allowed limit of uplink control plane user data.

 If the UE indicates the support of RDS in the PCO in the PDU Session Establishment Request and RDS is enabled for the PDU Session, the SMF shall inform the UE that RDS is enabled in the PCO in the PDU Session Establishment Accept (see clause 5.31.6 of TS 23.501 [2]).

 If the NIDD parameters (e.g. maximum packet size) were received from NEF during the SMF-NEF Connection Establishment procedure in step 10, the SMF shall inform the UE of the NIDD parameters in the PCO in the PDU Session Establishment Accept (see clause 5.31.5 of TS 23.501 [2]).

 If the UE indicated in the PCO that it supports the ability to receive ECS address(es) via NAS, the SMF may provide the ECS Address Configuration Information (as described in clause 6.5.2 of TS 23.548 [74]) to the UE in the PCO. The SMF may derive the ECS Address Configuration Information based on local configuration and/or UE subscription information. In non-roaming scenarios, the SMF may also derive the ECS Address Configuration Information based on the UE's location.

 If the UE indicated in the PCO that it supports the EDC functionality, the SMF may indicate to the UE either that the use of the EDC functionality is allowed for the PDU Session or that the use of the EDC functionality is required for the PDU Session (see clause 5.2.1 of TS 23.548 [74]).

 Multiple QoS Rules, QoS Flow level QoS parameters if needed for the QoS Flow(s) associated with those QoS rule(s) and QoS Profiles may be included in the PDU Session Establishment Accept within the N1 SM and in the N2 SM information.

 The Namf\_Communication\_N1N2MessageTransfer contains the PDU Session ID allowing the AMF to know which access towards the UE to use.

 If the PDU session establishment failed anywhere between step 5 and step 11, then the Namf\_Communication\_N1N2MessageTransfer request shall include the N1 SM container with a PDU Session Establishment Reject message (see clause 8.3.3 of TS 24.501 [25]) and shall not include any N2 SM container. The (R)AN sends the NAS message containing the PDU Session Establishment Reject to the UE. In this case, steps 12-17 are skipped.

 Based on the S-NSSAI and DNN for PIN, the SMF may provide the UE with per QoS-flow Non-3GPP QoS Assistance Information in the N1 SM container as specified in clause 5.44.3.3 of TS 23.501 [2].

12. AMF to (R)AN: N2 PDU Session Request (N2 SM information, NAS message (PDU Session ID, N1 SM container (PDU Session Establishment Accept)), [CN assisted RAN parameters tuning]). If the N2 SM information is not included in the step 11, an N2 Downlink NAS Transport message is used instead.

 The AMF sends the NAS message containing PDU Session ID and PDU Session Establishment Accept targeted to the UE and the N2 SM information received from the SMF within the N2 PDU Session Request to the (R)AN.

 If the SMF derived CN assisted RAN parameters tuning are stored for the activated PDU Session(s), the AMF may derive updated CN assisted RAN parameters tuning and provide them the (R)AN.

13. (R)AN to UE: The (R)AN may issue AN specific signalling exchange with the UE that is related with the information received from SMF. For example, in the case of a NG-RAN, an RRC Connection Reconfiguration may take place with the UE establishing the necessary NG-RAN resources related to the QoS Rules for the PDU Session request received in step 12.

 (R)AN also allocates (R)AN Tunnel Info for the PDU Session. In the case of Dual Connectivity, the Master RAN node may assign some (zero or more) QFIs to be setup to a Master RAN node and others to the Secondary RAN node. The AN Tunnel Info includes a tunnel endpoint for each involved (R)AN node and the QFIs assigned to each tunnel endpoint. A QFI can be assigned to either the Master RAN node or the Secondary RAN node and not to both.

 If the (R)AN receives two CN Tunnel Info for a PDU session in step 12 for redundant transmission, (R)AN also allocates two AN Tunnel Info correspondingly and indicate to SMF one of the AN Tunnel Info is used as the redundancy tunnel of the PDU session as described in clause 5.33.2.2 of TS 23.501 [2].

 (R)AN forwards the NAS message (PDU Session ID, N1 SM container (PDU Session Establishment Accept)) provided in step 12 to the UE. (R)AN shall only provide the NAS message to the UE if the AN specific signalling exchange with the UE includes the (R)AN resource additions associated to the received N2 command.

 If MICO mode is active and the NAS message Request Type in step 1 indicated "Emergency Request", then the UE and the AMF shall locally deactivate MICO mode.

 If the N2 SM information is not included in the step 11, then the following steps 14 to 16b and step 17 are omitted.

 If the UE is running a slice deregistration inactivity timer for the S-NSSAI of the established PDU Session and the timer is associated with the Access Type over which the PDU Session Establishment Request was received, the UE stops the timer as described in clause 5.15.15 of TS 23.501 [2].

14. (R)AN to AMF: N2 PDU Session Response (PDU Session ID, Cause, N2 SM information (PDU Session ID, AN Tunnel Info, List of accepted/rejected QFI(s), User Plane Enforcement Policy Notification, TL-Container, established QoS Flows status (active/not active) (for one of the following: congestion information monitoring, ECN marking for L4S at PSA UPF, ECN marking for L4S at NG-RAN, ECN marking for L4S at N3IWF or TNGF), PDU Set Based Handling Support Indication)).

 The AN Tunnel Info corresponds to the Access Network address of the N3 tunnel corresponding to the PDU Session.

 The (R)AN may reject the addition or modification of a QoS Flow, e.g. due to handling of the UE-Slice-MBR as described in clause 5.7.1.10 of TS 23.501 [2]. If the (R)AN rejects QFI(s) the SMF is responsible of updating the QoS rules and QoS Flow level QoS parameters associated to the rejected QoS Flow(s) in the UE accordingly.

 The NG-RAN rejects the establishment of UP resources for the PDU Session when it cannot fulfil User Plane Security Enforcement information with a value of Required. The NG-RAN notifies the SMF when it cannot fulfil a User Plane Security Enforcement with a value of Preferred.

 If the NG-RAN cannot establish redundant user plane for the PDU Session as indicated by the RSN parameter and PDU Session Pair ID, the NG-RAN takes the decision on whether to reject the establishment of RAN resources for the PDU Session based on local policies as described in TS 23.501 [2].

 If interworking with TSN deployed in the transport network is supported and the NG-RAN supports AN-TL and received a TL-Container with a get-request from the SMF/CUC in step 12 (see clause 4.4.8 of TS 23.501 [2]), the NG-RAN/AN-TL includes a TL-Container with a get-response to the N2 SM information, as described in clause 5.28a.2 of TS 23.501 [2].

 NG-RAN includes the PDU Set Based Handling Support Indication in N2 SM information as defined in clause 5.37.5.3 of TS 23.501 [2].

15. AMF to SMF: Nsmf\_PDUSession\_UpdateSMContext Request (SM Context ID, N2 SM information, Request Type).

 The AMF forwards the N2 SM information received from (R)AN to the SMF.

 If the list of rejected QFI(s) is included in N2 SM information, the SMF shall release the rejected QFI(s) associated QoS profiles.

 If the N2 SM information indicates failure of user plane resource setup, the SMF shall reject the PDU session establishment by including a N1 SM container with a PDU Session Establishment Reject message (see clause 8.3.3 of TS 24.501 [25]) in the Nsmf\_PDUSession\_UpdateSMContext Response in step 17. Step 16 is skipped in this case and instead the SMF releases the N4 Session with UPF.

 If the User Plane Enforcement Policy Notification in the N2 SM information indicates that no user plane resources could be established and the User Plane Enforcement Policy indicated "required" as described in clause 5.10.3 of TS 23.501 [2], the SMF shall reject the PDU session establishment by including a N1 SM container with a PDU Session Establishment Reject message (see clause 8.3.3 of TS 24.501 [25]) in the Nsmf\_PDUSession\_UpdateSMContext Response in step 17. Step 16 is skipped in this case.

 If the N2 SM information includes a TL-Container with a get-response as described in clause 5.28a.2 of TS 23.501 [2], the SMF/CUC stores the information provided in the get-response.

16a. The SMF initiates an N4 Session Modification procedure with the UPF. The SMF provides AN Tunnel Info to the UPF as well as the corresponding forwarding rules.

 If SMF decides to perform redundant transmission for one or more QoS Flows of the PDU, the SMF also indicates the UPF to perform packet duplication for the QoS Flow(s) in downlink direction by forwarding rules.

 In the case of redundant transmission with two I-UPFs for one or more QoS Flows of the PDU, the SMF provides AN Tunnel Info to two I-UPFs and also indicates the UPF (PSA) to perform packet duplication for the QoS Flow(s) in downlink direction by forwarding rules. The SMF also provides the UL Tunnel Info of the UPF (PSA) to the two I-UPFs and the DL Tunnel Info of the two I-UPFs to the UPF (PSA).

 If the N2 SM information includes the PDU Set Based Handling Support Indication, SMF configures PSA UPF to perform PDU Set information marking for the QoS flow as defined in clause 5.37.5.3 of TS 23.501 [2].

NOTE 11: If the PDU Session Establishment Request was due to mobility between 3GPP and non-3GPP access or mobility from EPC, the downlink data path is switched towards the target access in this step.

16b. The UPF provides an N4 Session Modification Response to the SMF.

 If multiple UPFs are used in the PDU Session, the UPF in step 16 refers to the UPF terminating N3.

 After this step, the UPF delivers any down-link packets to the UE that may have been buffered for this PDU Session.

16c. If Request Type in step 3 indicates neither "Emergency Request" nor "Existing Emergency PDU Session" and if the SMF has not yet registered for this PDU Session, then the SMF registers with the UDM using Nudm\_UECM\_Registration (SUPI, DNN, S-NSSAI of HPLMN, PDU Session ID, SMF Identity, Serving Node PLMN ID, [NID], PCF ID) for a given PDU Session. As a result, the UDM stores following information: SUPI, SMF identity and the associated DNN, S-NSSAI of HPLMN, PDU Session ID, PCF ID and Serving Network (PLMN ID, [NID], see clause 5.18 of TS 23.501 [2]). The UDM may further store this information in UDR by Nudr\_DM\_Update (SUPI, Subscription Data, UE context in SMF data). If the UDM has existing applicable event exposure subscriptions for events detected in SMF for this UE or any of the groups this UE belongs to (possibly retrieved from UDR), UDM invokes the Nsmf\_EventExposure\_Subscribe service for creating the event exposure subscriptions. If the SMF received Alternative S-NSSAI in step 3, the S-NSSAI provided to the UDM is the replaced S-NSSAI.

 If the Request Type received in step 3 indicates "Emergency Request":

- For an authenticated non-roaming UE, based on operator configuration (e.g. related with whether the operator uses a fixed SMF for Emergency calls, etc.), the SMF may register in the UDM using Nudm\_UECM\_Registration (SUPI, PDU Session ID, SMF identity, Indication of Emergency Services) for a given PDU Session that is applicable for emergency services. As a result, the UDM shall store the applicable PDU Session for Emergency services.

- For an unauthenticated UE or a roaming UE, the SMF shall not register in the UDM for a given PDU Session.

17. SMF to AMF: Nsmf\_PDUSession\_UpdateSMContext Response (Cause).

 The SMF may subscribe to the UE mobility event notification from the AMF (e.g. location reporting, UE moving into or out of Area Of Interest), after this step by invoking Namf\_EventExposure\_Subscribe service operation as specified in clause 5.2.2.3.2. For LADN, the SMF subscribes to the UE moving into or out of LADN service area event notification by providing the LADN DNN as an indicator for the Area Of Interest (see clause 5.6.5 and 5.6.11 of TS 23.501 [2]).

 If SMF receives the indication in step 3 that "the PDU Session is subject to LADN per LADN DNN and S-NSSAI", the SMF subscribes to the UE moving into or out of LADN service area event notification by providing the LADN DNN and S-NSSAI as an indicator for the Area Of Interest.

 If SMF receives the indication in step 3 that the PDU Session is subject to area restriction for the S-NSSAI, the SMF subscribe to "UE mobility event notification" event for reporting UE presence in Area of Interest by providing the S-NSSAI as an indicator for the Area Of Interest (see clauses 5.6.11 and 5.3.4.4 of TS 23.501 [2]).

 After this step, the AMF forwards relevant events subscribed by the SMF.

 For those scenarios where the PCFs serving the AMF and the SMF are different, the SMF informs the AMF of the NWDAF ID(s) used for UE related Analytics and corresponding Analytics ID(s).

18. [Conditional] SMF to AMF: Nsmf\_PDUSession\_SMContextStatusNotify (Release)

 If during the procedure, any time after step 5, the PDU Session establishment is not successful, the SMF informs the AMF by invoking Nsmf\_PDUSession\_SMContextStatusNotify (Release). The SMF also releases any N4 session(s) created, any PDU Session address if allocated (e.g. IP address) and releases the association with PCF, if any. In this case, step 19 is skipped.

 For a PDU Session for non-roaming subscribers, if the S-NSSAI of the PDU Session is subject to network slice usage control and there is no other PDU Session using the S-NSSAI over the same Access Type, the AMF starts the slice deregistration inactivity timer for the S-NSSAI over this Access Type as described in clause 5.15.15.3 of TS 23.501 [2].

19. SMF to UE: In the case of PDU Session Type IPv6 or IPv4v6, the SMF generates an IPv6 Router Advertisement and sends it to the UE. If Control Plane CIoT 5GS Optimisation is enabled for this PDU Session the SMF sends the IPv6 Router Advertisement via the AMF for transmission to the UE using the Mobile Terminated Data Transport in Control Plane CIoT 5GS Optimisation procedures (see clause 4.24.2), otherwise the SMF sends the IPv6 Router Advertisement via N4 and the UPF.

20. When the trigger for 5GS Bridge/Router information available is armed, then the SMF may initiate the SM Policy Association Modification as described in clause 4.16.5.1.

 SMF provides the 5GS Bridge/Router information (e.g. 5GS user-plane Node ID, port number for the PDU session, MAC address of the DS-TT Ethernet port for Ethernet PDU Session type, UE IP address for IP PDU Session type and UE-DS-TT Residence Time (if available) as provided by the UE) to PCF. In the case of Deterministic Networking, the SMF may also provide the MTU size for IPv4 or the MTU size for IPv6. If the SMF received a Port Management Information Container from either the UE or the UPF, then the SMF provides the Port Management Information Container and port number of the related port to the PCF as described in clause 5.28.3.2 of TS 23.501 [2].

 If the SMF has received User Plane Node Management Information from the UPF, then the SMF provides the User Plane Node Management Information Container to the PCF as part of 5GS Bridge/Router information and as described in clause 5.28.3.2 of TS 23.501 [2].

 To support IEEE TSN, the TSN AF calculates the bridge delay for each port pair, i.e. composed of DS-TT Ethernet port and NW-TT Ethernet port, using the UE-DS-TT Residence Time for all NW-TT Ethernet port(s) serving the 5GS Bridge indicated by the 5GS user-plane Node ID. Additionally, the TSN AF determines the 5GS bridge delay for port pair composed of two DS-TT ports connecting to the same 5GS Bridge as sum of bridge delays related to PDU Sessions of the two DS-TT ports.

21. If the PDU Session establishment failed after step 4, the SMF shall perform the following:

 The SMF unsubscribes to the modifications of Session Management Subscription data for the corresponding (SUPI, DNN, S-NSSAI of the HPLMN), using Nudm\_SDM\_Unsubscribe (SUPI, Session Management Subscription data, DNN, S-NSSAI of the HPLMN), if the SMF is no more handling a PDU Session of the UE for this (DNN, S-NSSAI of the HPLMN). The UDM may unsubscribe to the modification notification from UDR by Nudr\_DM\_Unsubscribe (SUPI, Subscription Data, Session Management Subscription data, S-NSSAI of the HPLMN, DNN).

\* \* \* \* Third change \* \* \* \*

4.3.3.2 UE or network requested PDU Session Modification (non-roaming and roaming with local breakout)

The UE or network requested PDU Session Modification procedure (non-roaming and roaming with local breakout scenario) is depicted in figure 4.3.3.2-1.

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**Figure 4.3.3.2-1: UE or network requested PDU Session Modification (for non-roaming and roaming with local breakout)**

1. The procedure may be triggered by following events:

1a. (UE initiated modification) The UE initiates the PDU Session Modification procedure by the transmission of an NAS message (N1 SM container (PDU Session Modification Request (PDU session ID, Packet Filters, Operation, Requested QoS, Segregation, 5GSM Core Network Capability, Number Of Packet Filters, [URSP rule enforcement reports], [Always-on PDU Session Requested], [Requested Non-3GPP Delay Budget])), PDU Session ID, UE Integrity Protection Maximum Data Rate, [Port Management Information Container]) message. Depending on the Access Type, if the UE was in CM-IDLE state, this SM-NAS message is preceded by the Service Request procedure. The NAS message is forwarded by the (R)AN to the AMF with an indication of User location Information. The AMF invokes Nsmf\_PDUSession\_UpdateSMContext (SM Context ID, N1 SM container (PDU Session Modification Request)).

 When the UE requests specific QoS handling for selected SDF(s), the PDU Session Modification Request includes Packet Filters describing the SDF(s), the requested Packet Filter Operation (add, modify, delete) on the indicated Packet Filters, the Requested QoS and optionally a Segregation indication. The Segregation indication is included when the UE recommends to the network to bind the applicable SDF(s) on a distinct and dedicated QoS Flow e.g. even if an existing QoS Flow can support the requested QoS. The network should abide by the UE request, but is allowed to proceed instead with binding the selected SDF(s) on an existing QoS Flow.

NOTE 1: Only one QoS Flow is used for traffic segregation. If UE makes subsequent requests for segregation of additional SDF(s), the additional SDF(s) are multiplexed on the existing QoS Flow that is used for segregation.

 The UE shall not trigger a PDU Session Modification procedure for a PDU Session corresponding to a LADN when the UE is outside the area of availability of the LADN.

 The PS Data Off status, if changed, shall be included in the PCO in the PDU Session Modification Request message.

 For a PDU Session which was established in the EPS, when the UE moves from EPS to 5GS for the first time, the UE includes an Always-on PDU Session Requested indication in the PDU Session Modification Request message if it wants to change the PDU Session to an always-on PDU Session.

 If UE supports to report URSP rule enforcement to network, when the UE associates a newly detected application to an existing PDU Session based on URSP evaluation result and the matched URSP rule included the Indication for reporting URSP rule enforcement, the UE may initiate PDU Session Modification procedure to provide URSP rule enforcement report as described in clause 6.6.2.4 of TS 23.503 [20].

 When PCF is deployed, the SMF shall further report the PS Data Off status to PCF if the PS Data Off event trigger is provisioned, the additional behaviour of SMF and PCF for 3GPP PS Data Off is defined in TS 23.503 [20].

 The 5GSM Core Network Capability is provided by the UE and handled by SMF as defined in clause 5.4.4b of TS 23.501 [2].

 The UE Integrity Protection Maximum Data Rate indicates the maximum data rate up to which the UE can support UP integrity protection. It is set as defined in TS 23.501 [2].

 The Number Of Packet Filters indicates the number of supported packet filters for signalled QoS rules as described in clause 5.17.2.2.2 of TS 23.501 [2].

 When it moves from EPS to 5GS for the first time, a UE that supports EAS re-discovery as described in clause 6.2.3.3 of TS 23.548 [74], may indicate so in the PCO.

 When it moves from EPS to 5GS for the first time, a UE that hosts the EDC functionality shall indicate in the PCO its capability to support the EDC functionality (see clause 5.2.1 of TS 23.548 [74]).

 Port Management Information Container may be received from DS-TT and includes DS-TT port related management information as defined in clause 5.28.3 of TS 23.501 [2].

1b. (PCF initiated SM Policy Association Modification) The PCF performs a PCF initiated SM Policy Association Modification procedure as defined in clause 4.16.5.2 to notify SMF about the modification of policies. This may e.g. have been triggered by a policy decision or upon AF requests, e.g. Application Function influence on traffic routing as described in step 5 in clause 4.3.6.2 or AF to provide Port management information Container.

 If QoS Monitoring is requested by the AF, the PCF generates the QoS Monitoring policy for the corresponding service data flow and provides the policy in the PCC rules to the SMF in this step.

 If Periodicity is provided by the AF, the PCF provides the Periodicity information in the PCC rules. Based on operator's local policies, the PCF sends to the SMF an indication in the PCC Rule to perform N6 Traffic Parameter Measurements for N6 Jitter and, if not received from the AF, also UL and/ or DL Periodicity measurements.

 The PCF may provision a PDU Set Control Information and Protocol Description as described in clause 6.1.3.27.4 of TS 23.503 [20] within PCC Rules based on the information provided by the AF and/or the local operator policies.

 The PCF may provision a Data Burst Handing Information and DL Protocol Description as described in clause 6.3.1 of TS 23.503 [20] within PCC Rules based on the information provided by the AF and/or the local operator policies.

1c. (SMF requested modification) The UDM updates the subscription data of SMF by Nudm\_SDM\_Notification (SUPI, Session Management Subscription Data). The SMF updates the Session Management Subscription Data and acknowledges the UDM by returning an Ack with (SUPI).

1d. (SMF requested modification) The SMF may decide to modify PDU Session. This procedure also may be triggered based on locally configured policy or triggered from the (R)AN (see clause 4.2.6 and clause 4.9.1). It may also be triggered if the UP connection is activated (as described in Service Request procedure) and the SMF has marked that the status of one or more QoS Flows are deleted in the 5GC but not synchronized with the UE yet. It may also be triggered to update QoS profile in the NG RAN and PDU Set information marking in the PSA UPF upon completion of mobility procedure as defined in clause 5.37.5.3 of TS 23.501 [2].

 If interworking with TSN deployed in the transport network is supported and either the UPF supports CN-TL or NG-RAN supports AN-TL (see clause 4.4.8 of TS 23.501 [2]), the procedure may be triggered due to reception of Status group from TN CNC.

 The SMF may decide to modify PDU Session to send updated ECS Address Configuration Information to the UE as defined in clause 6.5.2 of TS 23.548 [74].

 The SMF may decide to modify PDU Session to send updated DNS server address to the UE as defined in clause 6.2.3.2.3 of TS 23.548 [74].

 The SMF may decide to modify PDU Session to send the EAS rediscovery indication to the UE as defined in clause 6.2.3.3 of TS 23.548 [74].

 If the SMF receives one of the triggers in step 1b ~ 1d, the SMF starts SMF requested PDU Session Modification procedure.

1e. (AN initiated modification) (R)AN shall indicate to the SMF when the AN resources onto which a QoS Flow is mapped are released irrespective of whether notification control is configured. (R)AN sends the N2 message (PDU Session ID, N2 SM information) to the AMF. The N2 SM information includes the QFI, User location Information and an indication that the QoS Flow is released. The AMF invokes Nsmf\_PDUSession\_UpdateSMContext (SM Context ID, N2 SM information).

 (AN initiated notification control) If notification control is configured for a GBR QoS Flow, (R)AN sends a N2 message (PDU Session ID, N2 SM information) to SMF when the (R)AN decides the QoS targets of the QoS Flow cannot be fulfilled or can be fulfilled again, respectively. The N2 SM information includes the QFI and an indication that the QoS targets for that QoS Flow cannot be fulfilled or can be fulfilled again, respectively. When QoS targets cannot be fulfilled, the N2 SM information indicates a reference to the Alternative QoS Profile matching the values of the QoS parameters that the NG-RAN is currently fulfilling as specified in clause 5.7.2.4 of TS 23.501 [2]. If the QoS Flow has a TSCAI including Capability for BAT adaptation and without Burst Arrival Time, the N2 SM information can also include a BAT offset as described in clause 5.27.2.5 of TS 23.501 [2]. The AMF invokes Nsmf\_PDUSession\_UpdateSMContext (SM Context ID, N2 SM information). If the PCF has subscribed to the event, SMF reports this event to the PCF for each PCC Rule for which notification control is set in step 2.

1f. (AMF initiated modification) If the UE supports CE mode B and use of CE mode changes from restricted to unrestricted or vice versa in the Enhanced Coverage Restriction information in the UE context in the AMF and the UE has already established PDU sessions, then the AMF shall trigger a PDU session modification to the SMFs serving the UE's PDU sessions when the AMF determines that NAS-SM timer shall be updated due to the change of Enhanced Coverage Restriction and include the extended NAS-SM indication only if use of CE mode B is now unrestricted in the Enhanced Coverage Restriction information in the UE context in the AMF.

 If the AMF, based on configuration, is aware that the UE is accessing over a gNB using GEO satellite backhaul and GEO Satellite ID needs to be updated to the SMF, the AMF may, based on configuration, include the latest GEO Satellite ID as described in clause 5.43.2 of TS 23.501 [2].

1g. (AMF initiated modification) the AMF informs the SMF of updates of the NWDAF ID(s) used for UE related Analytics and corresponding Analytics ID(s). Also, If the PCF request notification of SM Policy Association and there is any PDU Session established to that DNN, S-NSSAI [PCF binding information, notification of SM Policy Association establishment Indication].

1h. (AMF initiated modification) When the AMF determines that the S-NSSAI is to be replaced with an Alternative S-NSSAI (as described in clause 5.15.19 of TS 23.501 [2]), the AMF invokes Nsmf\_PDUSession\_UpdateSMContext Request (SM Context ID, S-NSSAI, Alternative S-NSSAI) to the SMF of the PDU session associated with the S-NSSAI.

 (AMF initiated modification) When the AMF determines that the S-NSSAI is subject to area restriction, e.g. when the S-NSSAI is configured with an NS-AoS, or when the S-NSSAI is present in the Partially Allowed NSSAI, the AMF invokes Nsmf\_PDUSession\_UpdateSMContext Request (SM Context ID, S-NSSAI, Slice Area Restriction indication) to the SMF indicating that the PDU Session is subject to area restriction for the S-NSSAI. If the S-NSSAI is replaced with the Alternative S-NSSAI, the AMF checks the area restriction only for the Replaced S-NSSAI for this PDU Session.

 Based on the extended NAS-SM timer indication, the SMF shall use the extended NAS-SM timer setting for the UE as specified in TS 24.501 [25].

2. The SMF may need to report some subscribed event to the PCF by performing an SMF initiated SM Policy Association Modification procedure as defined in clause 4.16.5.1. This step may be skipped if PDU Session Modification procedure is triggered by step 1b or 1d. If dynamic PCC is not deployed, the SMF may apply local policy to decide whether to change the QoS profile.

 The PCF may make policy control decisions based on the awareness of URSP rule enforcement, as described in clause 6.1.1.5 in TS 23.503 [20].

 Steps 2a to 7 are not invoked when the PDU Session Modification requires only action at a UPF (e.g. gating).

2a. The SMF may update the UPF with N4 Rules related to new or modified QoS Flow(s).

NOTE 2: This allows the UL packets with the QFI of a new or modified QoS Flow to be transferred.

 If the SMF initiated the PDU Session Modification procedure in step 1b due to PCF initiated SM Policy Association Modification that adds one or more PCC Rule(s) with a TSC Assistance Container and if interworking with TSN deployed in the transport network is supported, the SMF may instruct the UPF to assign or remove a distinct N3 tunnel end point address for the QoS Flow(s) assigned with a TSC Assistance Container.

 If the SMF initiated the PDU Session Modification procedure in step 1d due to reception of Status group from TN CNC, the SMF includes a TL-Container with a set-request to the N4 Session Modification request that is sent to the UPF, as described in clause 5.28a.2 of TS 23.501 [2].

 If the SMF initiated the PDU Session Modification procedure in step 1b due to PCF initiated SM Policy Association Modification that adds one or more PCC Rule(s) with UL and/or DL Periodicity, the SMF composes the TSCAI with the periodicity information.

 If the SMF initiated the PDU Session Modification procedure in step 1b due to PCF initiated SM Policy Association Modification that adds one or more PCC Rule(s) with an indication to perform N6 Traffic Parameter measurements (e.g. the N6 Jitter range associated with the DL Periodicity, and the UL/DL periodicity), the SMF instructs the UPF to perform N6 Traffic Parameter measurement associated with the DL Periodicity for the QoS Flow, as described in clause 5.37.8.2 of TS 23.501 [2].

 If N6 Traffic Parameter measurements are requested and DL Periodicity is received in the PCC Rule, the SMF shall include the DL Periodicity as well as the indication of N6 Traffic Parameter measurement in the request to the UPF, see clause 5.8.5.11 of TS 23.501 [2].

 If the PCC Rule includes a Protocol Description and PDU Set QoS parameters for DL and the SMF decides to enable PDU Set Identification and marking for PDU Set based Handling by PSA UPF, the SMF should provide the Protocol Description information and PDU Set Marking indication to the UPF and request the UPF to mark the PDU Set Information in each PDU belonging to the PDU Sets as described in clause 5.37.5.2 and 5.8.5.4 of TS 23.501 [2].

 If the SMF decides to enable End of Data Burst marking by PSA UPF, the SMF should request the UPF to mark End of Data Burst as described in clause 5.37.8.3 of TS 23.501 [2] . If the PCC Rule includes a Protocol Description, the SMF should provide the Protocol Description information to the UPF.

 If the PDU Set information marking has been activated in the UPF for a QoS flow, the SMF may request the UPF to stop the marking of the PDU Set information based on the indication from the RAN or PCF, e.g. if the Target RAN does not support the PDU Set based handling as described in clause 5.37.5.3 of TS 23.501 [2].

 If the PCF initiated SM Policy Association Modification that adds one or more PCC Rule(s) with PDU Set Control Information, the SMF performs PDU Set based QoS handling, see clause 5.37.5 of TS 23.501 [2].

 If redundant transmission has not been activated to the PDU session and the SMF decides to perform redundant transmission for the QoS Flow, the SMF indicates to the UPF to perform packet duplication and elimination for the QoS Flow.

 If redundant transmission has been activated on the PDU Session and the SMF decides to stop redundant transmission, the SMF indicates the UPF to release the CN Tunnel Info which is used as the redundancy tunnel of the PDU Session and also indicates the UPF to stop packet duplication and elimination for the corresponding QoS Flow(s).

NOTE 3: The method to perform elimination and reordering on RAN/UPF based on the packets received from the two GTP-U tunnels is up to RAN/UPF implementation. The two GTP-U tunnels are terminated at the same RAN node and UPF.

 If redundant transmission has not been activated to the PDU Session and the SMF decides to perform redundant transmission for the QoS Flow with two I-UPFs between the PSA UPF and the NG-RAN, the SMF sends a N4 Session Establishment Request message to the I-UPFs including UL CN Tunnel Info of the PSA UPF and a request to allocate CN Tunnel Info.

 SMF may make use of Redundant Transmission Experience analytics provided by NWDAF, when SMF takes a decision whether to perform redundant transmission, or stop redundant transmission if it had been activated, as described in clause 6.13 of TS 23.288 [50].

 If the AMF initiated the PDU Session Modification procedure in step 1h due to network slice replacement with the Alternative S-NSSAI and if the SMF determines that the PDU Session is retained, the SMF sends N4 Session Modification request message to the UPF to replace the S-NSSAI with the Alternative S-NSSAI, as described in clause 5.15.19 of TS 23.501 [2].

2b. The UPF(s) respond to the SMF. If redundant transmission has not been activated to the PDU session and the SMF indicated the UPF to perform packet duplication and elimination for the QoS Flow in step 2a, the UPF allocates an additional CN Tunnel Info. The additional CN Tunnel Info is provided to the SMF.

 If redundant transmission has not been activated to the PDU Session and the SMF decides to perform redundant transmission for the QoS Flow with two I-UPFs in step 2a, the UPFs allocate CN Tunnel Info. The CN Tunnel Info of each I-UPF is provided to the SMF.

 If interworking with TSN deployed in the transport network is supported and the UPF supports CN-TL and received a TL-Container with a set-request from the SMF/CUC in step 2a (see clause 4.4.8 of TS 23.501 [2]), the UPF/CN-TL includes a TL-Container with a set-response to the N4 Session Modification response, as described in clause 5.28a.2 of TS 23.501 [2].

 If requested by SMF in step 2a, the PSA UPF will initiate N4 Session Level reporting for N6 Traffic Parameter Measurement Report as described in clause 4.4.2.2. If N6 Traffic Parameter(s) are available then the response to the SMF in this step may include the N6 Traffic Parameter(s) (e.g. the N6 Jitter range associated with the DL Periodicity, and the UL/DL periodicity) for the QoS Flow (see clause 5.37.8.2 of TS 23.501 [2]). The SMF composes the TSCAI with the received N6 Traffic Parameters.

3a. For UE or AN initiated modification or AMF initiated modification, the SMF responds to the AMF through Nsmf\_PDUSession\_UpdateSMContext Response ([N2 SM information (PDU Session ID, QFI(s), QoS Profile(s), [Alternative QoS Profile(s)], Session-AMBR], [CN Tunnel Info(s)]), N1 SM container (PDU Session Modification Command (PDU Session ID, QoS rule(s) and associated UL Protocol Description(s) (if available), QoS rule operation, QoS Flow level QoS parameters if needed for the QoS Flow(s) associated with the QoS rule(s), Session-AMBR, [Always-on PDU Session Granted], [Port Management Information Container], [Non-3GPP QoS Assistance Information Container]))). See clause 5.7 of TS 23.501 [2] for the QoS Profile, Alternative QoS Profile and QoS rule and QoS Flow level QoS parameters. Alternative QoS Profile is only valid for AN initiated modification.

 If the PDU Session Modification was requested by the UE to modify a PDU Session to an always-on PDU Session, the SMF shall include an Always-on PDU Session Granted indication in the PDU Session Modification Command to indicate whether the PDU Session is to be changed to an always-on PDU Session or not via the Always-on PDU Session Granted indication in the PDU Session Modification Command.

 The N2 SM information carries information that the AMF shall provide to the (R)AN. It may include the QoS profiles and the corresponding QFIs to notify the (R)AN that one or more QoS flows were added, or modified. It may include only QFI(s) to notify the (R)AN that one or more QoS flows were removed. The SMF may indicate for each QoS Flow whether redundant transmission shall be performed by a corresponding redundant transmission indicator. If the SMF decides to activate redundant transmission in step 2a, the SMF includes the allocated additional CN Tunnel Info in the N2 SM information. If the SMF decides to perform redundant transmission for new QoS Flow with two I-UPFs in step 2a, the SMF includes the allocated CN Tunnel Info of the two I-UPFs in the N2 SM information. If the PDU Session Modification was triggered by the (R)AN Release in step 1e the N2 SM information carries an acknowledgement of the (R)AN Release. If the PDU Session Modification was requested by the UE for a PDU Session that has no established User Plane resources, the N2 SM information provided to the (R)AN includes information for establishment of User Plane resources. For Network Slice Replacement if the SMF determines that the PDU Session is to be retained, the S-NSSAI in N2 SM information is set to Alternative S-NSSAI.

- If the SMF has received a Requested Non-3GPP Delay Budget for a QoS flow from the PEGC, the SMF may adjust the dynamic CN PDB signalled to the NG-RAN as defined in clause 5.44.3.4 of TS 23.501 [2].

 If redundant transmission has been activated on the PDU Session and the SMF decides to stop redundant transmission in step 2a, the SMF indicates the (R)AN to release the AN Tunnel and stop packet duplication and elimination associated with the redundancy tunnel of the PDU Session.

 The N1 SM container carries the PDU Session Modification Command that the AMF shall provide to the UE. It may include the QoS rules and associated UL Protocol Description(s) (if available), QoS Flow level QoS parameters if needed for the QoS Flow(s) associated with the QoS rule(s) and corresponding QoS rule operation and QoS Flow level QoS parameters operation to notify the UE that one or more QoS rules were added, removed or modified. If the PCF provides the PCC rules with Protocol Description for UL in step 2, based on operator policy, the SMF may additionally provide the Protocol Description for UL with the associated QoS rule as described in clause 5.37.5.1 of TS 23.501 [2].

 For the AMF initiated the PDU Session Modification procedure in step 1h due to network slice replacement, and if the SMF determines that the PDU Session is to be retained, the SMF includes the Alternative S-NSSAI in the PDU Session Modification Command to the UE and a cause value indicating that the S-NSSAI of the PDU Session is replaced with the Alternative S-NSSAI.

 If the AMF initiated the PDU Session Modification procedure in step 1h due to network slice replacement and if the PDU Session is SSC mode 3 and if the SMF determines that the PDU Session is to be re-established on the Alternative S-NSSAI, the SMF includes the Alternative S-NSSAI in the PDU Session Modification Command to the UE and a cause value indicating that a PDU Session re-establishment on the Alternative S-NSSAI is required. The UE re-establishes a new PDU Session on the Alternative S-NSSAI, as described in clause 5.15.19 in TS 23.501 [2]. If the PDU Session is SSC mode 1 or SSC mode 2, the SMF may initiate release of the PDU Session as described in clause 4.3.4.2.

 If port number and a Port Management Information Container have been received from PCF in Step 2 and the port number matches the port number assigned for the DS-TT port for this PDU session, then SMF includes the Port Management Information Container in the N1 SM container.

 The SMF may need to send transparently through NG-RAN the PDU Session Modification Command to inform the UE about changes in the QoS parameters (i.e. 5QI, GFBR, MFBR) that the NG-RAN is currently fulfilling after the SMF receives QoS Notification Control as defined in clause 5.7.2.4 of TS 23.501 [2]. When the SMF sends on the PDU Session Modification Command transparently through NG-RAN, the N2 SM information is not included as part of the Namf\_Communication\_N1N2MessageTransfer.

 If the UE indicated in the PCO that it supports the EDC functionality, the SMF may indicate to the UE either that the use of the EDC functionality is allowed for the PDU Session or that the use of the EDC functionality is required for the PDU Session (see clause 5.2.1 of TS 23.548 [74]).

 Based on the S-NSSAI and DNN for PIN, the SMF may provide the UE with per QoS-flow Non-3GPP QoS Assistance Information in the N1 SM container.

 If SMF receives the indication indicating that the PDU Session is subject to area restriction for the S-NSSAI, and if SMF has not subscribed before, the SMF subscribes to "UE mobility event notification" event for reporting UE presence in Area of Interest by providing the S-NSSAI as an indicator for the Area Of Interest (see clauses 5.6.11 and 5.3.4.4 of TS 23.501 [2]).

 If SMF does not receive the indication indicating that the PDU Session is subject to area restriction for the S-NSSAI, and if the SMF has subscribed the "UE mobility event notification" event in the AMF before, the SMF may unsubscribe "UE mobility event notification" event in the AMF.

3b. For SMF requested modification, the SMF invokes Namf\_Communication\_N1N2MessageTransfer ([N2 SM information] (PDU Session ID, QFI(s), QoS Profile(s), [Alternative QoS Profile(s)], Session-AMBR, [CN Tunnel Info(s)], QoS Monitoring indication, QoS Monitoring reporting frequency, QoS monitoring parameter), [TSCAI(s)], TL-Container(s), [ECN marking for L4S indicator(s)]), N1 SM container (PDU Session Modification Command (PDU Session ID, QoS rule(s) and associated UL Protocol Description(s) (if available), QoS Flow level QoS parameters if needed for the QoS Flow(s) associated with the QoS rule(s), QoS rule operation and QoS Flow level QoS parameters operation, Session-AMBR))).

- For each QoS Flow, the SMF may at most request one of the following to the NG-RAN:

- ECN marking for L4S indicator at NG-RAN in the case of ECN marking for L4S in RAN as described in clause 5.37.3 of TS 23.501 [2]; or

- Congestion information monitoring as described in clauses 5.45.3 and 5.37.4 of TS 23.501 [2]; or

- provide information for ECN marking for L4S at UPF in the case of ECN marking for L4S by PSA UPF as described in clause 5.37.3 of TS 23.501 [2].

 - In case of non-3GPP access, where the 5G-AN corresponds to an N3IWF or TNGF:

- For each QoS Flow, the SMF may request the following to the N3IWF or TNGF:

 - ECN marking for L4S at N3IWF or TNGF in the case of ECN marking for L4S in non-3GPP access as described in clause 5.37.3 of TS 23.501 [2].

If the SMF initiated the PDU Session Modification procedure in step 1b due to PCF initiated SM Policy Association Modification that adds one or more PCC Rule(s) with a TSC Assistance Container and if interworking with TSN deployed in the transport network is supported, the SMF may instruct the NG-RAN to assign or remove a distinct N3 tunnel end point address for the QoS Flow(s) assigned with a TSC Assistance Container.

 The SMF may indicate for each QoS Flow whether redundant transmission shall be performed by a corresponding redundant transmission indicator. If the SMF decides to activate redundant transmission in step 2a, the SMF includes the allocated additional CN Tunnel Info in the N2 SM information. If the SMF decides to perform redundant transmission for new QoS Flow with two I-UPFs in step 2a, the SMF includes the allocated CN Tunnel Info of the two I-UPFs in the N2 SM information.

 If redundant transmission has been activated on the PDU Session and the SMF decides to stop redundant transmission in step 2a, the SMF indicates the (R)AN to release the AN Tunnel and stop packet duplication and elimination associated with the redundancy tunnel of the PDU Session.

 The SMF indicates the request for QoS Monitoring for the QoS Flow according to the information received from the PCF in step 1b, or based on SMF local policy, e.g. when the RAN rejected the creation of a specific QoS Flow. In the case of receiving the QoS Monitoring indication, the RAN enables the RAN part of UL/DL packet delay measurement for the QoS Flow and the QoS Monitoring reporting frequency is used by RAN to determine the packet delay measurement frequency of the RAN part. In the case of receiving a congestion information request, RAN initiates reporting of UL and/or DL QoS Flow congestion information to PSA UPF as defined in clause 5.45.3 of TS 23.501 [2]. The TSCAI is defined in clause 5.27.2 of TS 23.501 [2].

 If the SMF initiated the PDU Session Modification procedure in step 1d due to reception of Status group from TN CNC, the SMF includes a TL-Container with a set-request to the N2 SM information, as described in clause 5.28a.2 of TS 23.501 [2].

 The SMF indicates EAS rediscovery indication to the UE, if that initiated the PDU Session Modification procedure in step 1d as defined in clause 6.2.3.3 of TS 23.548 [74].

 If the UE is in CM-IDLE state and an ATC is activated, the AMF updates and stores the UE context based on the Namf\_Communication\_N1N2MessageTransfer and steps 4, 5, 6 and 7 are skipped. When the UE is reachable e.g. when the UE enters CM-CONNECTED state, the AMF forwards the N1 message to synchronize the UE context with the UE.

 If the PCF provides the PCC rules with Protocol Description for UL in step 2, based on operator policy, the SMF may provide the Protocol Description(s) for UL with the associated QoS rule(s) as described in clause 5.37.5.1 of TS 23.501 [2].

3c. For SMF requested modification due to updated SMF-Associated parameters from the UDM, the SMF may provide the SMF derived CN assisted RAN parameters tuning to the AMF. The SMF invokes Nsmf\_PDUSession\_SMContextStatusNotify (SMF derived CN assisted RAN parameters tuning) towards the AMF. The AMF stores the SMF derived CN assisted RAN parameters tuning in the associated PDU Session context for this UE.

3d. For SMF requested modification due to updated NWDAF ID, the SMF informs the AMF of updates of the NWDAF ID(s) used for UE related Analytics and corresponding Analytics ID(s).

4. The AMF may send N2 ([N2 SM information received from SMF], NAS message (PDU Session ID, N1 SM container (PDU Session Modification Command))) Message to the (R)AN.

5. The (R)AN may issue AN specific signalling exchange with the UE that is related with the information received from SMF. For example, in the case of a NG-RAN, an RRC Connection Reconfiguration may take place with the UE modifying the necessary (R)AN resources related to the PDU Session or if only N1 SM container is received in step 4 from AMF, RAN transports only the N1 SM container to the UE.

 The (R)AN may consider the updated CN assisted RAN parameters tuning to reconfigure the AS parameters.

 As part of this, the N1 SM container is provided to the UE. If the N1 SM container includes a Port Management Information Container then the UE provides the container to DS-TT.

 If new DNS server address is provided to the UE in the PCO, the UE can refresh all EAS(s) information (e.g. DNS cache) bound to the PDU Session, based on UE implementation as described in clause 6.2.3.2.3 of TS 23.548 [74].

 If EAS rediscovery indication is provided to the UE, the UE can trigger EAS rediscovery procedure as defined in clause 6.2.3.3 of TS 23.548 [74].

6. The (R)AN may acknowledge N2 PDU Session Request by sending a N2 PDU Session Ack (N2 SM information (List of accepted/rejected QFI(s), AN Tunnel Info, PDU Session ID, Secondary RAT usage data, TL-Container(s), BAT offset, Periodicity, established QoS Flows status (active/not active) (for one of the following: congestion information monitoring, ECN marking for L4S at PSA UPF, ECN marking for L4S at NG-RAN, ECN marking for L4S at N3IWF or TNGF), PDU Set Based Handling Support Indication), User location Information) Message to the AMF. In the case of Dual Connectivity, if one or more QFIs were added to the PDU Session, the Master RAN node may assign one or more of these QFIs to a NG-RAN node which was not involved in the PDU Session earlier. In this case the AN Tunnel Info includes a new N3 tunnel endpoint for QFIs assigned to the new NG-RAN node. Correspondingly, if one or more QFIs were removed from the PDU Session, a (R)AN node may no longer be involved in the PDU Session anymore and the corresponding tunnel endpoint is removed from the AN Tunnel Info. The NG-RAN may reject QFI(s) if it cannot fulfil the User Plane Security Enforcement information for a corresponding QoS Profile, e.g. due to the UE Integrity Protection Maximum Data Rate being exceeded. When receiving the request for QoS Monitoring, the (R)AN may indicate its rejection to perform QoS Monitoring, e.g. due to the (R)AN load condition. The (R)AN may reject the addition or modification of a QoS Flow, e.g. due to handling of the UE-Slice-MBR as described in clause 5.7.1.10 of TS 23.501 [2]. If the (R)AN rejects the addition or modification of a QoS Flow, the SMF is responsible of updating the QoS rules and QoS Flow level QoS parameters associated to that QoS Flow in the UE accordingly. NG-RAN includes the PDU Set Based Handling Support Indication in N2 SM information as defined in clause 5.37.5.3 of TS 23.501 [2]

 If the PLMN has configured secondary RAT usage reporting, the NG-RAN node may provide RAN Usage Data Report. The User Location Information shall include the serving cell's ID and if Dual Connectivity is activated for the UE, the PSCell ID.

 If the redundant transmission has not been activated to the PDU session and the SMF indicates to the RAN that one of the QoS Flow shall perform redundant transmission, the RAN includes an additional AN tunnel info in N2 SM information.

 If interworking with TSN deployed in the transport network is supported and the NG-RAN supports AN-TL and received a TL-Container with a set-request from the SM/CUC in step 3b (see clause 4.4.8 of TS 23.501 [2]), the NG-RAN/AN-TL includes a TL-Container with a set-response to the N2 SM information, as described in clause 5.28a.2 of TS 23.501 [2].

 If the NG-RAN has determined a BAT offset and optionally a periodicity as described in clause 5.27.2.5 of TS 23.501 [2], the NG-RAN provides the BAT offset and optionally the periodicity in the N2 SM information.

7. The AMF forwards the N2 SM information and the User location Information received from the AN to the SMF via Nsmf\_PDUSession\_UpdateSMContext service operation. The SMF replies with a Nsmf\_PDUSession\_UpdateSMContext Response.

 If the N2 SM information indicates failure of whole N2 SM request (i.e. no part of the N2 SM request is successful in (R)AN), the SMF assumes that the NAS PDU, if provided in step 3, was not forwarded by NG-RAN to UE, as described in TS 38.413 [10]. In this case, if the PDU Session modification is UE triggered the SMF shall reject the PDU session modification by including a N1 SM container with a PDU Session Modification Reject message (see clause 8.3.3 of TS 24.501 [25]) in the Nsmf\_PDUSession\_UpdateSMContext Response in step 7b. Step 8 is skipped in this case.

 Otherwise, the SMF assumes that the NAS PDU was sent to UE successfully. If the (R)AN rejects QFI(s), the SMF is responsible of updating the QoS rules and QoS Flow level QoS parameters if needed for the QoS Flow(s) associated with the QoS rule(s) in the UE accordingly, i.e. the SMF shall trigger a separate NAS PDU Session Modification procedure after step 11 to align the SM context of this PDU Session in UE.

8. The SMF may update N4 session of the UPF(s) that are involved by the PDU Session Modification by sending N4 Session Modification Request message to the UPF (see NOTE 3).

 The SMF may update the UPF with N4 Rules related to new, modified or removed QoS Flow(s), unless it was done already in step 2a.

NOTE 4: This allows the DL packets of the new or modified QoS Flow to be transferred.

 If an additional AN Tunnel Info is returned by RAN in step 6, the SMF informs the UPF about this AN Tunnel Info for redundant transmission. In the case of redundant transmission with two I-UPFs, the SMF provides AN Tunnel Info to two I-UPFs. If CN Tunnel Info of two I-UPFs is allocated by the UPFs in step 2b, the SMF also provides the DL CN Tunnel Info of two I-UPFs to the UPF (PSA).

 If the QoS Monitoring is enabled for the QoS Flow, the SMF provides the N4 rules containing the QoS Monitoring policy generated according to the information received in step 1b to the UPF via the N4 Session Modification Request message as defined in clause 5.45 of TS 23.501 [2].

 If port number and a Port Management Information Container have been received from PCF in Step 2 and the port number matches the port number of the NW-TT port for this PDU session, then SMF includes the Port Management Information Container in the N4 Session Modification Request. If the N4 Session Modification Request includes a Port Management Information Container, then UPF also includes a Port Management Information Container in the N4 Session Modification Response.

 If SMF decides to enable ECN marking for L4S by PSA UPF, a QoS Flow level ECN marking for L4S indicator shall be sent by SMF to PSA UPF over N4 as described in clause 5.37.3.3 of TS 23.501 [2].

 If the N2 SM information includes the PDU Set Based Handling Support Indication and there are PCC Rules with PDU Set QoS parameters for DL, SMF configures PSA UPF to activate PDU set identification and marking for the QoS flow as described in clause 5.37.5.3 of TS 23.501 [2].

9. The UE acknowledges the PDU Session Modification Command by sending a NAS message (PDU Session ID, N1 SM container (PDU Session Modification Command Ack, [Port Management Information Container])) message.

10. The (R)AN forwards the NAS message to the AMF.

11. The AMF forwards the N1 SM container (PDU Session Modification Command Ack) and User Location Information received from the AN to the SMF via Nsmf\_PDUSession\_UpdateSMContext service operation. The SMF replies with a Nsmf\_PDUSession\_UpdateSMContext Response.

 If the SMF initiated modification is to delete QoS Flows (e.g. triggered by PCF) which do not include QoS Flow associated with the default QoS rule and the SMF does not receive response from the UE, the SMF marks that the status of those QoS Flows is to be synchronized with the UE.

 If interworking with TSN deployed in the transport network is supported, for any QoS Flow including a TSC Assistance Container, the SMF/CUC derives the merged stream requirements as described in Annex M of TS 23.501 [2]. If AN-TL and CN-TL are supported, the SMF/CUC uses the information provided in the get-responses stored during the PDU Session Establishment procedure to derive the merged stream requirements. The SMF/CUC interacts with the CNC deployed in the transport network and provides the merged stream requirements in the Talker and Listener groups to the TN CNC. The TN CNC uses the merged stream requirements as input to select respective path(s) and calculate schedules in TN.

 Based on the processing results, the TN CNC provides a Status group that contains the merged end station communication-configuration back to the SMF/CUC.

12. The SMF may update N4 session of the UPF(s) that are involved by the PDU Session Modification by sending N4 Session Modification Request (N4 Session ID) message to the UPF. For a PDU Session of Ethernet PDU Session Type, the SMF may notify the UPF to add or remove Ethernet Packet Filter Set(s) and forwarding rule(s).

NOTE 5: The UPFs that are impacted in the PDU Session Modification procedure depends on the modified QoS parameters and on the deployment. For example in the case of the session AMBR of a PDU Session with an UL CL changes, only the UL CL is involved. This note also applies to the step 8.

13. If the SMF interacted with the PCF in step 1b or 2, the SMF notifies the PCF whether the PCC decision could be enforced or not by performing an SMF initiated SM Policy Association Modification procedure as defined in clause 4.16.5.1. If the trigger for 5GS Bridge/Router information available is armed and the SMF received a Port Management Information Container from either UE or UPF, then SMF provides the Port Management Information Container and the port number of the related port to the PCF in this step, as described in clause 5.28.3.2 of TS 23.501 [2]. If the trigger for 5GS Bridge/Router information available is armed and the SMF received the User Plane node Management Information Container from UPF, then the SMF provides the User Plane node Management Information Container to the PCF as described in clause 5.28.3.2 of TS 23.501 [2]. If trigger for Notification on BAT offset is armed and the SMF received BAT offset and/or Periodicity from the RAN, then the SMF provides the BAT offset and/or Periodicity to the PCF as described in clause 5.27.2.5 of TS 23.501 [2].

 SMF notifies any entity that has subscribed to User Location Information related with PDU Session change.

 If step 1b is triggered to perform Application Function influence on traffic routing by step 5 in clause 4.3.6.2, the SMF may reconfigure the User Plane of the PDU Session as described in step 6 in clause 4.3.6.2.

 If interworking with TSN deployed in the transport network is supported and if the Status group from TN CNC to SMF/CUC in step 11 includes InterfaceConfiguration and if the AN-TL/CN-TL are supported, the SMF/CUC initiates a PDU Session Modification procedure as in step 1d.

\* \* \* \* Fourth change \* \* \* \*

4.12.5 UE Requested PDU Session Establishment via Untrusted non-3GPP Access

Clause 4.12.5 specifies how a UE can establish a PDU Session via an untrusted non-3GPP Access Network as well as to hand over an existing PDU Session between 3GPP access and non-3GPP access. The procedure applies in non-roaming, roaming with LBO as well as in home-routed roaming scenarios.

For non-roaming and LBO scenarios, if the UE is simultaneously registered to a 3GPP access in a PLMN different from the PLMN of the N3IWF, the functional entities in the following procedures are located in the PLMN of the N3IWF. For home-routed roaming scenarios, the AMF, V-SMF and associated UPF in VPLMN in the following procedure is located in the PLMN of the N3IWF.

The procedure below is based on the PDU Session Establishment procedure specified in clause 4.3.2.2.1 (for non-roaming and roaming with LBO) and the PDU Session Establishment procedure specified in clause 4.3.2.2.2 (for home-routed roaming).

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**Figure 4.12.5-1: PDU Session establishment via untrusted non-3GPP access**

1. The UE shall send a PDU Session Establishment Request message to AMF as specified in step 1 of clause 4.3.2.2.1. This message shall be sent to N3IWF via the IPsec SA for NAS signalling (established as specified in clause 4.12.2) and the N3IWF shall transparently forward it to AMF in the 5GC.

2a. In the case of non-roaming or roaming with Local Breakout, steps 2-11 specified in clause 4.3.2.2.1are executed according to the PDU Session Establishment procedure over 3GPP access. In the case of home-routed roaming, steps 2-14 specified in clause 4.3.2.2.2 are executed according to the PDU Session Establishment procedure over 3GPP access.

2b. As described in step 12 of clause 4.3.2.2.1, the AMF shall send a N2 PDU Session Request message to N3IWF to establish the access resources for this PDU Session.

If L4S in untrusted non-3GPP access is supported and if applicable as per clause 5.37.3 of TS 23.501 [2], for a QoS flow, the AMF shall forward the L4S indicator to the N3IWF for ECN marking for the corresponding L4S-enabled QoS flow.

NOTE x: The SMF is assumed to have corresponding PCC rule(s) for the specific DNN and NSSAI associated with the L4S QoS flow for which ECN marking is expected.

3. Based on its own policies and configuration and based on the QoS profiles received in the previous step, the N3IWF shall determine the number of IPsec Child SAs to establish and the QoS profiles associated with each IPsec Child SA. For example, the N3IWF may decide to establish one IPsec Child SA and associate all QoS profiles with this IPsec Child SA. In this case, all QoS Flows of the PDU Session would be transferred over one IPsec Child SA.

For each L4S-enabled QoS Flow, the N3IWF shall establish a dedicated IPsec Child SA.

4a. The N3IWF shall send to UE an IKE Create\_Child\_SA request according to the IKEv2 specification in RFC 7296 [3] to establish the first IPsec Child SA for the PDU Session. The IKE Create\_Child\_SA request indicates that the requested IPsec Child SA shall operate in tunnel mode. This request shall include a 3GPP-specific Notify payload which contains (a) the QFI(s) associated with the Child SA, (b) the identity of the PDU Session associated with this Child SA, (c) optionally, a DSCP value associated with the Child SA, (d) optionally a Default Child SA indication and (e) optionally, the Additional QoS Information specified in clause 4.12a.5

 The IKE Create\_Child\_SA request shall also include another 3GPP-specific Notify payload, which contains the UP\_IP\_ADDRESS that is specified in step 8 below.

 If a DSCP value is included, then the UE and the N3IWF shall mark all IP packets sent over this Child SA with this DSCP value. There shall be one and only one Default Child SA per PDU session. The UE shall send all QoS Flows to this Child SA for which there is no mapping information to a specific Child SA. The IKE Create\_Child\_SA request also contains other information (according to RFC 7296 [3]) such as the SA payload, the Traffic Selectors (TS) for the N3IWF and the UE, etc.

 After receiving the IKE Create\_Child\_SA request, if the Additional QoS Information is received, the UE may reserve non-3GPP Access Network resources according to the Additional QoS Information.

4b. If the UE accepts the new IPsec Child SA, the UE shall send an IKE Create\_Child\_SA response according to the IKEv2 specification in RFC 7296 [3]. During the IPsec Child SA establishment the UE shall not be assigned an IP address.

4c-4d. If in step 3 the N3IWF determined to establish multiple IPsec Child SAs for the PDU Session, then additional IPsec Child SAs shall be established, each one associated with one or more QFI(s), optionally with a DSCP value, with a UP\_IP\_ADDRESS and optionally with the Additional QoS Information specified in clause 4.12a.5. For each IPsec Child SA, if the Additional QoS Information is received, the UE may reserve non-3GPP Access Network resources according to the Additional QoS Information for the IPsec Child SA.

5. After all IPsec Child SAs are established, the N3IWF shall forward to UE via the signalling IPsec SA (see clause 4.12.2.2) the PDU Session Establishment Accept message received in step 2b.

6. The N3IWF shall send to AMF an N2 PDU Session Response.

7. In the case of non-roaming or roaming with Local Breakout, all steps specified in clause 4.3.2.2.1 after step 14 are executed according to the PDU Session Establishment procedure over 3GPP access. In the case of home-routed roaming, all steps specified in clause 4.3.2.2.2 after step 18 are executed according to the PDU Session Establishment procedure over 3GPP access.

8. On the user-plane:

- When the UE has to transmit an UL PDU, the UE shall determine the QFI associated with the UL PDU (by using the QoS rules of the PDU Session), it shall encapsulate the UL PDU inside a GRE packet and shall forward the GRE packet to N3IWF via the IPsec Child SA associated with this QFI. The header of the GRE packet carries the QFI associated with the UL PDU. The UE shall encapsulate the GRE packet into an IP packet with source address the "inner" IP address of the UE and destination address the UP\_IP\_ADDRESS associated with the Child SA.

- When the N3IWF receives a DL PDU via N3, the N3IWF uses the QFI and the identity of the PDU Session in order to determine the IPsec Child SA to use for sending the DL PDU over NWu. The N3IWK encapsulates the DL PDU inside a GRE packet and copies the QFI in the header of the GRE packet. The N3IWF may include also in the GRE header a Reflective QoS Indicator (RQI), which shall be used by the UE to enable reflective QoS. The N3IWF shall encapsulate the GRE packet into an IP packet with source address the UP\_IP\_ADDRESS associated with the Child SA and destination address the "inner" IP address of the UE.

- PDUs belonging to L4S-enabled QoS flow(s) shall be transferred over dedicated IPsec Child SA(s). If a DSCP value is included, then the UE and the N3IWF shall mark all IP packets sent over this IPsec Child SA with this DSCP value.

\* \* \* \* Fifth change \* \* \* \*

4.12.6 UE or Network Requested PDU Session Modification via Untrusted non-3GPP access

The UE or network requested PDU Session Modification procedure via untrusted non-3GPP access is depicted in figure 4.12.6-1. The procedure applies in non-roaming, roaming with LBO as well as in home-routed roaming scenarios.

For non-roaming and LBO scenarios, the functional entities in the following procedures are located in the PLMN of the N3IWF.

The procedure below is based on the PDU Session Modification procedure specified in clause 4.3.3.2 (for non-roaming and roaming with LBO) and on the PDU Session Modification procedure specified in clause 4.3.3.3 (for home-routed roaming).

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**Figure 4.12.6-1: UE or Network Requested PDU Session Modification via untrusted non-3GPP access**

1. If the PDU Session Modification procedure is initiated by the UE, the UE shall send a PDU Session Modification Request message to AMF as specified in step 1 of clause 4.3.2.2. The message shall be sent to N3IWF via the established IPsec SA for NAS signalling. The N3IWF shall transparently forward the PDU Session Modification Request to AMF/SMF.

2. In the case of non-roaming or LBO, the steps 1a (from AMF) to 1e and steps 2-3 as per the PDU Session Modification procedure in clause 4.3.3.2 are executed.

 In the case of home-routed, the steps 1a (from AMF) to 1d and steps 2-3 as per the PDU Session Modification procedure in clause 4.3.3.3 are executed.

3. The AMF sends N2 PDU Session Resource Modify Request (N2 SM information received from SMF, NAS message) message to the N3IWF. This step is the same as step 4 in clause 4.3.3.2 (for non-roaming and roaming with Local Breakout) and step 5 in clause 4.3.3.3 (for home-routed roaming).

If L4S in untrusted non-3GPP access is supported and if applicable as per clause 5.37.3 of TS 23.501 [2], for a QoS flow, the AMF shall forward the L4S indicator to the N3IWF for ECN marking for the corresponding L4S-enabled QoS flow.

4. The N3IWF may issue IKEv2 signalling exchange with the UE that is related with the information received from SMF according to the IKEv2 specification in RFC 7296 [3]. Based on the N2 SM information received from the SMF, the N3IWF may perform one of the following:

4a. The N3IWF may decide to create a new Child SA for the new QoS Flow(s). In this case, the N3IWF establishes a new Child SA by sending an IKE\_CREATE\_CHILD\_SA request message, which includes the SA, the PDU Session ID, the QFI(s), optionally a DSCP value and optionally the Additional QoS Information specified in clause 4.12a.5. If the Additional QoS Information is received, the UE may reserve non-3GPP Access Network resources according to the Additional QoS Information.

For each L4S-enabled QoS Flow, the N3IWF shall establish a dedicated IPsec Child SA. If a DSCP value is included, then the UE and the N3IWF shall mark all IP packets sent over this IPsec Child SA with this DSCP value.

4b. The N3IWF may decide to add or remove QoS Flow(s) to/from an existing Child SA. In this case, the N3WIF updates the QoS Flow and Child SA mapping information by sending an INFORMATIONAL request message, which includes the QFI(s) associated with the Child SA and optionally the Additional QoS Information specified in clause 4.12a.6, which contains the new QoS information that should be associated with the existing Child SA. If the Additional QoS Information is received, the UE may update the reserved non-3GPP Access Network resources for the existing Child SA according to the Additional QoS Information.

4c. The N3IWF may decide to delete an existing Child SA, e.g. when there is no QoS Flow mapped to this Child SA. In this case, the N3IWF deletes the existing Child SA by sending INFORMATIONAL request message, which includes a Delete payload.

NOTE: If the N3IWF has included the Default Child SA indication during the establishment of one of the Child SAs of the PDU Session, the N3IWF may not update the mapping between QoS Flows Child SAs.

5. The N3IWF acknowledges N2 PDU Session Request by sending a N2 PDU Session Response Message to the AMF to acknowledge the success or failure of the request.

6. In the case of non-roaming or LBO, step 7 as per the PDU Session Modification procedure in clause 4.3.3.2 is executed. In the case of home-routed, the steps 8-10 as per the PDU Session Modification procedure in clause 4.3.3.3 are executed.

7. The N3IWF sends the PDU Session Modification Command to UE (if received in step 3) and receives the response message from UE.

 Steps 4a/4c and step 7 may happen consecutively. Steps 7b map happen before step 4b/4d.

8. The N3IWF forwards the NAS message to the AMF.

9. For non-roaming and roaming with LBO, all the steps after step 10 in clause 4.3.3.2 are executed according to the general PDU Session Modification procedure. For home-routed roaming, all steps after step 13 in clause 4.3.3.3 are executed according to the general PDU Session Modification procedure.

\* \* \* \* Sixth change \* \* \* \*

4.12a.5 UE Requested PDU Session Establishment via Trusted non-3GPP Access

After the UE registers to 5GC via trusted non-3GPP access, the UE may request a PDU Session establishment by using the same procedure as the one specified in clause 4.12.5 for untrusted non-3GPP access, with the following modifications:

- The N3IWF in Figure 4.12.5-1 should be substituted with a TNGF and the Untrusted non-3GPP access should be substituted with a Trusted non-3GPP Access Point (TNAP).

- The TNGF may send a TNGF Identities parameter to AMF inside an N2 Uplink NAS Transport message. The TNGF Identities parameter contains a list of identifiers (i.e. FQDNs or IP addresses) of N3 terminations supported by the TNGF. If received by the AMF, it shall forward it to the SMF, which may use it as input to UPF selection. The AMF provides ULI information received from TNGF to the SMF which then propagates it to the PCF.

- If the L4S in trusted non-3GPP access is supported and if applicable as per clause 5.37.3 of TS 23.501 [2], for a QoS flow, the AMF shall forward the L4S indicator to the TNGF for ECN marking for the corresponding L4S-enabled QoS flow.

NOTE y: The SMF is assumed to have corresponding PCC rule(s) for the specific DNN and S-NSSAI associated with the L4S QoS flow(s) for which ECN marking is expected.

- The IKEv2 Create Child SA Request message that is sent by the TNGF to UE (in steps 4a and 4c), in order to establish a child SA for one or more QoS flows, shall also include Additional QoS Information. The Additional QoS Information shall contain:

a) If the IPsec child SA carries a GBR flow: QoS Characteristics and GBR QoS Flow Information:

- The QoS Characteristics are associated with the 5QI of the GBR flow and are defined in clause 5.7.3 of TS 23.501 [2]. The TNGF either receives the QoS Characteristics via the N2 interface (in the case of a dynamically assigned 5QI), or is pre-configured with the QoS Characteristics (in the case of a standardized 5QI).

- The GBR QoS Flow Information (defined in TS 38.413 [10]) is part of the QoS Profile received via the N2 interface and contains: MFBR, GFBR and optionally Maximum Packet Loss Rate. The Notification Control is not included in the QoS profile.

b) If the IPsec child SA carries a non-GBR flow: QoS Characteristics:

- The QoS Characteristics are defined in bullet a) above.

 The TNGF may aggregate multiple GBR flows or multiple non-GBR flows into the same IPsec child SA. In this case, the TNGF derives, in an implementation specific way, the QoS Characteristics of the aggregated flow by considering the QoS Characteristics of the individual flows. Similarly, the TNGF derives, in an implementation specific way, the GBR QoS Flow Information of an aggregated GBR flow by considering the GBR QoS Flow Information of the individual GBR flows.

NOTE: The above behaviour of the TNGF does not create any impact on the N2 interface.

- After receiving an IKEv2 Create Child SA Request message, the UE shall use the Additional QoS Information contained in this message to determine what QoS resources to reserve over the non-3GPP access, including e.g. guaranteed bit rates and delay bounds for UL/DL communication. How the UE determines what QoS resources to reserve over the non-3GPP access and how these QoS resources are reserved, is outside the scope of 3GPP specifications.

- For each L4S-enabled QoS Flow, the TNGF shall establish a dedicated IPsec Child SA. If a DSCP value is included, then the UE and the TNGF shall mark all IP packets sent over this Child SA with this DSCP value.

- If the UE fails to reserve QoS resources over non-3GPP access for the QoS flows associated with the child SA (e.g. because the non-3GPP Access Network rejects the allocation of the requested bit rates), the UE shall reject the IKEv2 Child SA Request. Based on operator policy, the network may reattempt to establish the Child SA without the Additional QoS Information.

\* \* \* \* Seventh change \* \* \* \*

4.12a.6 UE or network Requested PDU Session Modification via Trusted non-3GPP access

The UE or network requested PDU Session Modification procedure via trusted non-3GPP access is the same procedure as the one specified in clause 4.12.6 for untrusted non-3GPP access, with the following modifications:

- The N3IWF in Figure 4.12.6-1 should be substituted with a TNGF and the Untrusted non-3GPP access should be substituted with a Trusted non-3GPP Access Point (TNAP).

If the L4S in trusted non-3GPP access is supported and if applicable as per clause 5.37.3 of TS 23.501 [2], for a QoS flow, the AMF shall forward the L4S indicator to TNGF for ECN marking for the corresponding L4S-enabled QoS flow.

- The IKEv2 Create Child SA Request sent by the TNGF in step 4a, in order to create new QoS flow(s) for the PDU Session, shall include the Additional QoS Information defined in clause 4.12a.5. If the UE decides to reserve QoS resources over non-3GPP access for the QoS flows associated with the Child SA but fails to reserve these resources, the UE shall reject the IKEv2 Child SA Request. Based on operator policy, the network may reattempt to establish the Child SA without the Additional QoS Information.

For each L4S-enabled QoS Flow, the TNGF shall establish a dedicated IPsec Child SA. If a DSCP value is included, then the UE and the TNGF shall mark all IP packets sent over this Child SA with this DSCP value.

- The IKEv2 Informational Request sent by the TNGF in step 4b shall include the Additional QoS Information defined in clause 4.12a.5, when the IKEv2 Informational Request is sent to modify one or more existing QoS flows. If the UE decides to reserve QoS resources over non-3GPP access for the QoS flows associated with the Child SA but fails to reserve these resources, the UE shall indicate the failure in the IKEv2 Informational Response. The TNGF includes the list of QoS flows which are failed to setup in step 5. Based on operator policy, the network may reattempt to modify the failed QoS Flows without the Additional QoS Information.

- The IKEv2 Informational Request sent by the TNGF in step 4c to release an existing IKEv2 Child SA shall trigger the UE to release the resources reserved over non-3GPP access for this IKEv2 Child SA.

- If, after the PDU Session establishment, the UE determines that the QoS resources reserved over non-3GPP access for the QoS flows associated with a Child SA are released, then the UE shall initiate an INFORMATIONAL exchange, as specified in RFC 7296 [3], to delete the Child SA. After the Child SA is deleted, the TNGF initiates PDU Session Modification procedure as described in step 1e, in clause 4.3.3.2, including the list of QoS flows, which are released.

\* \* \* End of changes \* \* \* \*