**3GPP TSG-SA2 Meeting #154-AH-e *S2-230xxxx***

**Electronic, 16 January - 20 January 2023 (revision of)**

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| *CR-Form-v12.2* |
| **CHANGE REQUEST** |
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|  | **23.502** | **CR** | **0xxx** | **rev** | **-** | **Current version:** | **18.0.0** |  |
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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 |  | Core Network | **X** |

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|  |
| ***Title:***  | Support of integration with IETF Deterministic Networking |
|  |  |
| ***Source to WG:*** | Ericsson, Nokia? |
| ***Source to TSG:*** | SA2 |
|  |  |
| ***Work item code:*** | DetNet |  | ***Date:*** | 2023-01-05 |
|  |  |  |  |  |
| ***Category:*** | B |  | ***Release:*** | Rel-18 |
|  | *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-15 (Release 15)Rel-16 (Release 16)Rel-17 (Release 17)Rel-18 (Release 18)Rel-19 (Release 19)* |
|  |  |
| ***Reason for change:*** | Document DetNet interworking in the specifications per TR 23.700-46 conclusions. |
|  |  |
| ***Summary of change:*** | Include DetNet interworking functionality in the specification. |
|  |  |
| ***Consequences if not approved:*** | Conclusions of the DetNet study are not documented. |
|  |  |
| ***Clauses affected:*** | 4.3.2.2, 4.3.3.2, 4.15, 4.16, 5.2, Annex F. |
|  |  |
|  | **Y** | **N** |  |  |
| ***Other specs*** |  | **X** |  Other core specifications  | TS/TR ... CR ... |
| ***affected:*** |  | **X** |  Test specifications | TS/TR ... CR ... |
| ***(show related CRs)*** |  | **x** |  O&M Specifications | TS/TR ... CR ... |
|  |  |
| ***Other comments:*** |  |
|  |  |
| ***This CR's revision history:*** |  |

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

#### 4.3.2.2 UE Requested PDU Session Establishment

##### 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].



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), 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] 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. If the Mapping of Allowed NSSAI was provided to the UE, the UE shall provide both the S-NSSAI of the VPLMN from the Allowed NSSAI and the corresponding S-NSSAI of the HPLMN from the Mapping Of Allowed NSSAI.

 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.

 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].

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 contains an S-NSSAI of the Serving PLMN but it does not contain a DNN, the AMF determines the DNN for the requested PDU Session by selecting the default DNN for this S-NSSAI 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.

 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, 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].

3. From AMF to SMF: Either Nsmf\_PDUSession\_CreateSMContext Request (SUPI, selected DNN, UE requested DNN, S-NSSAI(s), 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 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 to the SMF.

 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 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 TS 23.501 [2], the AMF includes Satellite backhaul category indication.

 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]). 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.

 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.

 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].

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. 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.

 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, 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.

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.

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.

 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.

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. 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, the SMF (e.g. for a certain requested DNN/S-NSSAI) may include an indication to request 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]), the SMF includes a TL-Container with a get-request to the N4 Session Establishment or Modification request that is sent to the UPF, as described in clause 5.28a.2 of TS 23.501 [2].

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. 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 9: 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 or Modification response, as described in clause 5.28a.2 of TS 23.501 [2]. The SMF/CUC stores 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, 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 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)]))). 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 a 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).

- 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].

- 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 (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. For LBO roaming scenario, the PDU Session Establishment Accept includes the S-NSSAI from the Allowed NSSAI for the VPLMN and also it includes the corresponding S-NSSAI of the HPLMN from the Mapping Of Allowed NSSAI that SMF received in step 3.

 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.

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.

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)).

 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].

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 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).

NOTE 10: 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]) 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 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 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]).

 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.

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.

 If the UE has indicated support of transferring Port Management Information Containers, or SMF local configuration for the given DNN, S-NSSAI indicates support for Deterministic Networking, then SMF informs PCF that 5GS Bridge/Router information is available. 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 case of Deterministic Networking, the SMF also provides the prefix length, MTU size and interface type used by the PDU Session. 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).

\* \* \* Next 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.



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, [Always-on PDU Session Requested])), 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.

 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 the QoS Monitoring for URLLC 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.

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.

 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].

 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.

 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 and the UPF does not support CN-TL, the SMF instructs the UPF to assign 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 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].

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].

3a. For UE or AN 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), 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]))). 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.

 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, 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 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]).

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, [TSCAI(s)], TL-Container), N1 SM container (PDU Session Modification Command (PDU Session ID, QoS rule(s), 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))).

 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 and the NG-RAN does not support AN-TL, the SMF instructs the NG-RAN to assign 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 for URLLC. 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. 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].

 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.

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].

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), 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.

 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].

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 for URLLC 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.

 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.

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 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 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].

 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.

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

#### 4.15.6.x Deterministic Networking specific parameter provisioning

The DetNet controller triggers the procedure to provide Deterministic Networking specific parameters to 5GS.



Figure 4.15.6.x-1: Deterministic Networking specific parameter provisioning

1. The DetNet controller provides YANG data model configuration to the TSCTSF. The TSCTSF uses the identifier of the incoming and outgoing interfaces to determine the affected PDU Session(s) and flow direction, whether it is uplink or downlink. The TSCTSF also determines if the flow is UE to UE in which case two PDU Sessions will be affected for the flow and the TSCTSF breaks up the requirements to individual requirements for the PDU Sessions. If the TSCTSF does not have a corresponding AF session, the TSCTSF shall create an AF session with the PCF

2. The TSCTSF may use the E2E traffic requirements in the YANG configuration, and based on pre-configured mapping, derive 5GS requirements as described in clause 6.1.3.23b in 23.503 [20]. The TSCTSF also decides the TSCAC for each flow description.

3. The TSCTSF provides the mapped parameters and the flow description to the PCF(s) on a per PDU Session basis.

4. The PCF authorizes the request from TSCTSF. If the PCF determines that the requirements can't be authorized, it rejects the request. Once the PCF authorizes the request, the PCF updates the SMF with corresponding new PCC rule(s) with PCF initiated SM Policy Association Modification procedure as described in clause 4.16.5.2.

The PCF(s) determines, based on the parameters received from the TSCTSF, whether the existing QoS flows need to be modified or a new QoS flow needs to be created.

5. The TSCTSF provides response to the DetNet controller.

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

#### 4.16.5.1 SMF initiated SM Policy Association Modification

The SMF may initiate the SM Policy Association Modification procedure if a Policy Control Request Trigger is met.

NOTE 1: When SMF instance is changed within the same SMF set the callback URI can be updated via this procedure.



Figure 4.16.5.1-1: SMF initiated SM Policy Association Modification

For local breakout roaming, the interaction with HPLMN (e.g. step 2) is not used. In local breakout roaming, the V-PCF interacts with the UDR of the VPLMN.

1. When a Policy Control Request Trigger condition is met the SMF requests to update (Npcf\_SMPolicyControl\_Update) the SM Policy Association and provides information on the conditions that have been met as specified in clause 5.2.5.4.5.

 If the SMF is notified by NRF that the stored PCF instance is not reachable, it should query the NRF for PCF instances within the PCF set and select another instance (see clause 6.3.1.0 of TS 23.501 [2]).

 The QoS constraints from the VPLMN are provided by the H-SMF to the H-PCF in the home routed roaming scenario as defined in clause 4.3.2.2.2.

2. When an AF has subscribed to an event that is met due to the report from the SMF, the PCF reports the event to the AF by invoking the Npcf\_PolicyAuthorization\_Notify service operation.

 If the SMF has reported that new 5GS Bridge/Router information has been detected and no AF session exists for this PDU session yet:

- If integration with TSN applies (see clause 5.28 of TS 23.501 [2]), then the PCF informs a pre-configured TSN AF using the Npcf\_PolicyAuthorization\_Notify (5GS Node ID, the port number of the DS-TT port, MAC address of the DS-TT Ethernet port for the PDU Session and UE-DS-TT Residence Time (if available)) service operation for the event of "5GS bridge/Router information Notification" as described in clause 6.1.3.18 of TS 23.503 [20].

- Otherwise, i.e. if the integration with TSN does not apply, the PCF may inform discovered and selected TSCTSF (as described in clause 6.3.24 of TS 23.501 [2]) using the Npcf\_PolicyAuthorization\_Notify (User Plane Node ID, UE-DS-TT Residence Time (if available), the port number for the PDU session and MAC address of the DS-TT Ethernet port for Ethernet type PDU Session or IP address for IP type PDU Session) service operation for the event of "5GS bridge/Router information Notification" as described in clause 6.1.3.18 of TS 23.503 [20]. In the case of private IPv4 address being used for IP type PDU Session, the Npcf\_PolicyAuthorization\_Notify also contains DNN and S-NSSAI of the PDU Session.

NOTE 2: For a given DNN and S-NSSAI, it is assumed that the network only needs to deploy one or TSCTSF Set in this Release of the specification.

 When the TSN AF or TSCTSF receives the Npcf\_PolicyAuthorization\_Notify message and no AF session exists for this PDU Session, the TSN AF shall use the Npcf\_PolicyAuthorization service described in clause 5.2.5.3 to request creation of a new AF session specific to the received MAC address of the DS-TT Ethernet port of the PDU Session, while the TSCTSF shall use the Npcf\_PolicyAuthorization service to request creation of a new AF session specific to the received MAC address of the DS-TT Ethernet port (if available, for Ethernet type PDU Session) or IP address (for IP type PDU Session) of the PDU Session. In the case of private IPv4 address being used for IP type PDU Session, the TSCTSF shall use the Npcf\_PolicyAuthorization service to request creation of a new AF session specific to the received IP address, DNN and S-NSSAI of the IP type PDU Session. The TSN AF or TSCTSF shall then use the Npcf\_PolicyAuthorization service to subscribe for notifications for 5GS Bridge/Router information Notification event over the newly established AF session. The TSN AF or TSCTSF may provide a Port or User-Plane Management Information Container for the PDU Session and related port number in the Npcf\_PolicyAuthorization creation request.

 If the SMF has reported PMIC with port number or UMIC, then the PCF also provides these information elements to the TSN AF or TSCTSF.

If the SMF has reported to the PCF the Framed Route information or IPv6 prefix delegated to the UE corresponding to the PDU Session, the PCF also provides this information to the TSCTSF.

When integration with TSN applies (see clause 5.28 of TS 23.501 [2]), the TSN AF calculates the bridge delay for each port pair, using the UE-DS-TT Residence Time of the DS-TT Ethernet port(s) for the 5GS bridge indicated by the 5GS user-plane Node ID.

3. If the PCF determines a change to policy counter status reporting is required, it may alter the subscribed list of policy counters using the Initial, Intermediate or Final Spending Limit Report Retrieval procedures as defined in clause 4.16.8.

4. The PCF makes a policy decision as described in TS 23.503 [20]. The PCF may determine that updated or new policy information needs to be sent to the SMF.

 If the SMF reported accumulated usage for the PDU session in step 1 the PCF deducts the value from the remaining allowed usage for the subscriber, DNN and S-NSSAI in the UDR by invoking Nudr\_DM\_Update (SUPI, DNN, S-NSSAI, Policy Data, Remaining allowed Usage data, updated data) service operation.

 If the SMF reported accumulated usage for a MK(s) in step 1 the PCF deducts the value from the remaining allowed usage for the MK in the UDR by invoking Nudr\_DM\_Update (SUPI, DNN, S-NSSAI, Policy Data, Remaining allowed Usage data, updated data (including MK(s))) service operation.

 When new PCF instance is selected in step 1, the new PCF should invoke Nbsf\_Management\_Update service operation to update the binding information in BSF.

 In the non-roaming case, the PCF may subscribe to Analytics from NWDAF as defined in clause 6.1.1.3 of TS 23.503 [20].

 In the home-routed roaming scenario, the H-PCF ensures that the QoS constraints provided by the VPLMN are taken into account as described in TS 23.503 [20].

NOTE 3: For local breakout roaming, PDU Session policy control subscription information and Remaining allowed usage subscription information for monitoring control as defined in clause 6.2.1.3 of TS 23.503 [20] are not available in V-UDR and V-PCF uses locally configured information according to the roaming agreement with the HPLMN operator.

5. The PCF answers with a Npcf\_SMPolicyControl\_Update response with updated policy information about the PDU Session determined in step 4.

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

#### 4.16.5.2 PCF initiated SM Policy Association Modification

The PCF may initiate SM Policy Association Modification procedure based on internal PCF event or triggered by other peers of the PCF (AF, NWDAF, CHF, UDR and TSCTSF).



Figure 4.16.5.2-1: PCF initiated SM Policy Association Modification

This procedure may be triggered by a local decision of the PCF or based on triggers from other peers of the PCF (AF, NWDAF, CHF, UDR, and TSCTSF):

An SM Policy Association is established, with the PCF as described in clause 4.16.4 before this procedure is triggered.

For local breakout roaming, the interaction with HPLMN (e.g. step 1b and step 2) is not used. In local breakout roaming, the V-PCF interacts with the UDR of the VPLMN.

1a. Alternatively, optionally, the AF, NEF or TSCTSF provides/revokes service information to the PCF e.g. due to AF session signalling, by invoking Npcf\_PolicyAuthorization\_Create Request or Npcf\_PolicyAuthorization\_Update Request or Npcf\_PolicyAuthorization\_Subscribe Request service operation. The PCF responds to the AF, NEF or TSCTSF.

1b. Alternatively, optionally, the CHF provides a Spending Limit Report to the PCF as described in clause 4.16.8. and responds to the CHF.

1c. Alternatively, optionally, the UDR notifies the PCF about a policy subscription change by invoking Nudr\_DM\_Notify (Notification correlation Id, Policy Data, SUPI, updated data, "PDU Session Policy Control Data" | "Remaining allowed Usage data"); The PCF responds to the UDR.

1d. Alternatively, optionally, some internal event (e.g. timer, or local decision based on analytics information requested and received from NWDAF) occurs at the PCF. The analytics (i.e. Analytics ID) which can be requested from NWDAF are described in clause 6.1.1.3 of TS 23.503 [20].

2. If the PCF determines a change to policy counter status reporting is required, it may alter the subscribed list of policy counters using the Initial, Intermediate or Final Spending Limit Report Retrieval procedures as defined in clause 4.16.8.

NOTE 1: The PCF ensures that information received in step 1 and 2 can be used by later policy decisions.

NOTE 2: For local breakout roaming, PDU Session policy control subscription information and Remaining allowed usage subscription information for monitoring control as defined in clause 6.2.1.3 of TS 23.503 [20] are not available in V-UDR and V-PCF uses locally configured information according to the roaming agreement with the HPLMN operator.

3. The PCF makes a policy decision. The PCF may determine that updated or new policy information need to be sent to the SMF. In the non-roaming case, the PCF may also decide to subscribe to a new Analytics ID from NWDAF as described in clause 6.1.1.3 of TS 23.503 [20].

 If the AF provided a Background Data Transfer Reference ID in step 1a, the PCF may retrieve it from the UDR by invoking the Nudr\_DM\_Query (BDT Reference Id, Policy Data, Background Data Transfer) service.

4. If the PCF has determined that SMF needs updated policy information in step 3 or if the PCF has received a Port Management Information Container for the PDU Session and related port number from the AF or TSCTSF in step 1a, the PCF issues a Npcf\_SMPolicyControl\_UpdateNotify request with possibly updated policy information about the PDU Session.

 If the PCF has received a subscription for 5GS Bridge/Router information Notification in Step 1a, the PCF can include a subscription for SMF event for "5GS Bridge/Router information" associated with the PDU Session into the Npcf\_SMPolicyControl\_UpdateNotify request. In this case, if the SMF has stored the 5GS bridge/Router information and has not reported the event to the PCF, the SMF notifies the PCF for the event of "5GS bridge/Router Information ".

 If the PCF has received a Npcf\_PolicyAuthorization\_Unsubscribe request to unsubscribe for 5GS Bridge/Router information Notification, the PCF can remove the subscription for SMF event for "5GS Bridge/Router information" associated with the PDU Session and issue a Npcf\_SMPolicyControl\_UpdateNotify request with the updated policy information about the PDU Session.

NOTE 3: If the TSCTSF receives a Requested 5GS delay and the TSCTSF does not have the 5GS Bridge/Router information for the AF-session, the TSCTSF can subscribe for the 5GS Bridge/Router information from the PCF by triggering a Npcf\_PolicyAuthorization\_Subscribe request.

5. The SMF acknowledges the PCF request with a Npcf\_SMPolicyControl\_UpdateNotify response.

 If the Npcf\_SMPolicyControl\_UpdateNotify request is received from new PCF instance in the PCF Set, the SMF store the SM policy association towards the new PCF instance.

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

##### 5.2.5.3.2 Npcf\_PolicyAuthorization\_Create service operation

**Service operation name:** Npcf\_PolicyAuthorization\_Create

**Description:** Authorize the request and optionally determines and installs SM Policy Control Data according to the information provided by the NF Consumer or provides Port Management Information Container for ports on DS-TT or NW-TT, or User plane node Management Information Container.

**Inputs, Required:** UE (IP or MAC) address, identification of the application session context.

**Inputs, Optional:** GPSI(s) or SUPI(s) if available, Internal Group Identifier, DNN if available, S-NSSAI if available, Media type, Media format, bandwidth requirements, sponsored data connectivity information if applicable, flow description information as described in clause 6.1.3.6 of TS 23.503 [20], AF Application Identifier, AF Communication Service Identifier, AF Record Identifier, Flow status, Priority indicator, emergency indicator, ASP Identifier, resource allocation outcome, AF Application Event Identifier, a list of DNAI(s) and corresponding routing profile ID(s) or N6 traffic routing information, AF Transaction Id, Early and/or late notifications about UP path management events, temporal validity condition, spatial validity condition, Information for EAS IP Replacement in 5GC, Indication for EAS Relocation, AF indication for simultaneous connectivity over source and target PSA at edge relocation, EAS Correlation indication as described in clause 5.6.7 in 23.501 [2], Background Data Transfer Reference ID, priority sharing indicator as described in clause 6.1.3.15 in TS 23.503 [20], pre-emption control information as described in clause 6.1.3.15 in TS 23.503 [20], Port Management Information Container and related port number, User plane node Management Information Container, TSN AF parameters provided by the TSN AF to the PCF as described in clause 6.1.3.23 of TS 23.503 [20], DetNet parameters provided by the TSCTSF to the PCF as described in clause 6.1.3.23b of TS 23.503 [20], QoS parameter(s) to be measured, Reporting frequency, Target of reporting and optional an indication of local event notification as described in clause 6.1.3.21 of TS 23.503 [20], QoS Reference or individual QoS parameters as described in clause 6.1.3.22 of TS 23.503 [20], Alternative Service Requirements (containing one or more QoS Reference parameters or Requested Alternative QoS Parameter Sets in a prioritized order), TSC Assistance Container, MPS for Data Transport Service indicator as described in clause 6.1.3.11 of TS 23.503 [20].

NOTE: When only one DNAI and corresponding routing profile ID(s) and the Indication for EAS Relocation are available, the presented DNAI is the target DNAI as defined in clause 6.3.7 of TS 23.548 [74].

**Outputs, Required:** Success or Failure (reason for failure, e.g. as defined in clauses 6.1.3.16 and clause 6.1.3.10 of TS 23.503 [20]).

**Outputs, Optional:** The service information that can be accepted by the PCF.

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

# Annex F (informative):Information flows for 5GS integration with TSN or with Deterministic Networking

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

# F.x 5GS DetNet node information reporting

The TSCTSF collects the information for Deterministic Networking from the UPF/NW-TT and the SMF as shown in Figure F.x-1, with the addition of new parameters as shown in Figure F.x-1.



Figure F.x-1: 5GS DetNet node information reporting

1. PDU Session Establishment as defined clause 4.3.2.2.1-1 is used to establish a PDU Session.

2. When Framed Routes or IPv6 prefix delegation applies, the SMF reports to the PCF Framed Route information or prefixes delegated to the UE by IPv6 prefix delegation. If the SMF has reported to the PCF the Framed Route information or prefixes delegated to UE via IPv6 prefix delegation corresponding to the PDU Session, the PCF also provides this information to the TSCTSF.

3-4. The TSCTSF may subscribe to receive exposure information per UE side interface and exposure information per network side interface via port management information notifications.

5. The TSCTSF provides collected exposure information to the DetNet controller. The information being reported to the DetNet controller is defined in TS 23.501 [2] clause 5.28.X.2.

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

# F.y 5GS DetNet node configuration

For 5GS integrating with Deterministic Networing, the DetNet controller provides configuration information to the TSCTSF.



Figure F.y-1: 5GS DetNet node configuration

1. The DetNet controller triggers the procecure to provide Deterministic Networking specific parameters to 5GS, as shown in Figure 4.15.6.x-1.

2. The SMF applies the received PCC rules. This may induce creating a new QoS flow to the PDU session and triggers the resource allocation in RAN.

3. The PCF responds to the TSCTSF, which includes information about the success of the configuration.

4. The TSCTSF provides a response to the DetNet controller regarding the success of the configuration setup.

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