**3GPP TSG-SA2 Meeting #147-e *S2-2107678***

**Online, ,18-22 October 2021**

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| *CR-Form-v12.1* | | | | | | | | |
| **CHANGE REQUEST** | | | | | | | | |
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|  | **23.501** | **CR** | **3333** | **rev** | **-** | **Current version:** | **17.2.0** |  |
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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:*** | Clarification of NSAC | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Source to WG:*** | Nokia, Nokia Shanghai Bell | | | | | | | | | |
| ***Source to TSG:*** | SA2 | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Work item code:*** | eNS\_Ph2 | | | | |  | ***Date:*** | | | 2021-09-29 |
|  |  | | | |  | |  | | |  |
| ***Category:*** | F |  | | | | | ***Release:*** | | | Rel-17 |
|  | *Use one of the following categories:* ***F*** *(correction)* ***A*** *(mirror corresponding to a change in an earlier release)* ***B*** *(addition of feature),* ***C*** *(functional modification of feature)* ***D*** *(editorial modification)*  Detailed explanations of the above categories can be found in 3GPP [TR 21.900](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)* | |
|  |  | | | | | | | | | |
| ***Reason for change:*** | | This CR resolves some critical issues that have been discussed in SA2#147e | | | | | | | | |
|  | |  | | | | | | | | |
| ***Summary of change:*** | | Clarifies that NSACF services can be proxied and also that the PDU sessionrelated update service operation can be used to count the number of UEs per netwrok slice . it is clarified NSAS Information for a S-NSSAI is in subscrtiption data | | | | | | | | |
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| ***Consequences if not approved:*** | | The NSAC feature is not complete nor deployable | | | | | | | | |
|  | |  | | | | | | | | |
| ***Clauses affected:*** | | 4.2.11, 4.2.2.2.2, 4.11.0a.5, 4.11.5.9, 4.15.3.1, 4.15.3.2.10, 5.2.3.3.1, 5.2.21.1, 5.2.21. | | | | | | | | |
|  | |  | | | | | | | | |
|  | | **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:*** | |  | | | | | | | | |
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| ***This CR's revision history:*** | |  | | | | | | | | |

FIRST CHANGE

### 4.2.11 Network Slice Admission Control Function (NSACF) procedures

#### 4.2.11.1 General

The Network Slice Admission Control Function procedures are performed for an S-NSSAI which is subject to Network Slice Admission Control (NSAC) as described in TS 23.501 [2]. If charging needs to be enabled, the NSACF may act as a NF (CTF) and interact with the CHF to support the Event based charging as defined in TS 32.290 [42].

#### 4.2.11.2 Number of UEs per network slice availability check and update procedure

The number of UEs per network slice availability check and update procedure is to update (i.e. increase or decrease) the number of UEs registered with a S-NSSAI which is subject to NSAC. The AMF determines which S-NSSAI is subject to NSAC based on the subscription information, indicating which network slice is subject to NSAC.



Figure 4.2.11.2-1: Number of UEs per network slice availability check and update procedure

1. If the AMF is not aware of which NSACF to communicate, the AMF performs NSACF discovery as described in clause 6.3.22 of TS 23.501 [2] and in clause 5.2.7.3.2. The AMF triggers the Number of UEs per network slice availability check and update procedure to update the number of UEs registered with a network slice when a network slice subject to NSAC is included in the Allowed NSSAI (i.e. the AMF requests to register the UE with the S-NSSAI) or removed from the Allowed NSSAI (i.e. the AMF requests to de-register the UE from the S-NSSAI) for a UE. The trigger event at the AMF also includes the change of Allowed NSSAI in case of inter-AMF mobility. The procedure is triggered in the following cases:

- At UE Registration procedure, according to clause 4.2.2.2.2 (including Registration types of Initial Registration or Mobility Registration Update in inter-AMF mobility in CM-CONNECTED or CM-IDLE state):

- before the Registration Accept in step 21 if the EAC mode is active; or

- after the Registration Accept message if the EAC mode is not active;

- At UE Deregistration procedure, as per clause 4.2.2.3, after the Deregistration procedure is completed;

- At UE Configuration Update procedure (which may result from NSSAA procedure or subscribed S-NSSAI change):

- before the UE Configuration Update message if the EAC mode is active and the update flag is to increase; or

- after the UE Configuration Update message if the EAC mode is active and the update flag is to decrease; or

- after the UE Configuration Update message if the EAC mode is not active.

NOTE 1: Depending on the deployment, there may be different NSACF for different S-NSSAI subject to NSAC, and hence, during the registration, AMF triggers the Number of UEs per network slice availability check and update procedure to multiple NSACFs.

2. The AMF sends Nnsacf\_NSAC\_NumOfUEsUpdate\_Request message to the NSACF. The AMF includes in the message the UE ID, access type, the S-NSSAI(s), the NF ID and the update flag which indicates whether the number of UEs registered with the S-NSSAI(s) is to be increased when the UE has gained registration to network slice(s) subject to NSAC or the number of UEs registered with the S-NSSAI(s) is to be decreased when the UE has deregistered from S-NSSAI(s) or could not renew its registration to an S-NSSAI subject to NSAC.

If this is the first time to perform NSAC procedure for the S-NSSAI towards the NSACF, the AMF includes notification endpoint for EAC Notification to implicitly subscribe the EAC notification for the S-NSSAI from the NSACF.

3. The NSACF updates the current number of UEs registered for the S-NSSAI, i.e. increases or decrease the number of UEs registered per network slice based on the information provided by the AMF in the update flag parameter.

If the update flag parameter from the AMF indicates increase, the following applies:

- If the UE ID is already in the list of UEs registered with the network slice, the current number of UEs is not increased as the UE has already been counted as registered with the network slice. The NSACF creates a new entry associated with this new update and shall also maintain the old entry associated with previous update. The multiple entries for the same UE ID in the NSACF are differentiated based on the NF ID of the NF sending the update request. The NSACF removes the entry associated with the NF ID upon reception of a request having update flag indicating decrease.

NOTE 2: The use case of having two or more entries in the NSACF for the same UE can happen during (a) inter-AMF mobility when the new AMF request update to the NSACF before the old AMF sends request to deregister the UE;

- If the UE ID is not in the list of UE IDs registered with the network slice and the maximum number of UEs registered with the network slice has not been reached yet, the NSACF adds the UE ID in the list of UEs registered with the network slice as a new entry associated with this new update and increases the current number of the UEs registered with the network slice. If the UE ID is not in the list of UEs registered with that S-NSSAI and the maximum number of UEs for that S-NSSAI has already been reached, then the NSACF may return a result parameter indicating that the maximum number of UEs registered with the network slice has been reached.

If the update flag parameter from the AMF indicates decrease and if there is only one entry associated with the UE ID, the NSACF removes the UE ID from the list of UEs registered with the network slice for each of the S-NSSAI(s) indicated in the request from the AMF and also the NSACF decreases the number of UEs per network slice that is maintained by the NSACF for each of these network slices. If there are multiple entries associated with the UE ID, the NSACF removes the entry associated with the NF ID but the UE ID is kept in the list of UEs registered with the S-NSSAI.

The NSACF takes access type into account for increasing and decreasing the number of UEs per network slice as described in clause 5.15.11.1 of TS 23.501 [2].

The NSACF stores the notification endpoint for EAC Notification associated with the S-NSSAI if it is received from the AMF. The NSACF can use this AMF notification endpoint to update the EAC mode as described in clause 4.2.11.3.

NOTE 3: This enables the NSACF to maintain up-to-date information about the AMFs serving the S-NSSAIs.

4. The NSACF returns the Nnsacf\_NSAC\_NumOfUEsUpdate\_Response in which the NSACF includes the S-NSSAI(s) for which the maximum number of UEs per network slice has already been reached along with a result parameter indicating that the maximum number of UEs registered with the network slice has been reached.

At UE Registration procedure, if only some of the S-NSSAIs reached the maximum number of UEs per S-NSSAI, the AMF sends a Registration Accept message to the UE in which the AMF includes the rejected S-NSSAI(s) in the rejected NSSAI list for which the NSACF has indicated that the maximum number of UEs per network slice has been reached, and for each rejected S-NSSAI the AMF includes a reject cause set to 'maximum number of UEs per network slice reached' and optionally a back-off timer.

When for all the Requested S-NSSAI(s) provided in step 2 the NSACF returned the maximum number of UEs per network slice has been reached and if one or more subscribed S-NSSAIs are marked as default in the subscription data and not subject to Network Slice Admission Control, the AMF can decide to include these Default Subscribed S-NSSAIs in the Allowed NSSAI. Otherwise, the AMF rejects the UE request for registration. In the Registration Reject message the AMF includes the rejected S-NSSAI(s) in the rejected NSSAI parameter, and for each rejected S-NSSAI the AMF includes a reject cause to indicate that the maximum number of UEs per network slice has been reached and optionally a back-off timer.

NOTE 4: If the use case requires the UE to remain reachable at all times with at least one slice, it is recommended that at least one of the Subscribed S-NSSAIs is marked as the default S-NSSAI which is not subject to Network Slice Admission Control. This will ensure the UE is able to access to services even when maximum number of UEs per network slice has been reached.

When a NSACF acts as proxy towards another NSACF, the NSACF relays the Nnsacf\_NSAC\_NumOfUEsUpdate requests and responses between the AMF and this NSACF.

#### 4.2.11.3 Configuration for Early Admission Control (EAC) update procedure

The configuration for Early Admission Control (EAC) update procedure indicates to the AMF the activation or the deactivation of the EAC mode for the S-NSSAI subject to NSAC. EAC mode means that the AMF is required to perform the number of UEs per network slice availability check and update procedure before the S-NSSAI subject to NSAC is included in the Allowed NSSAI and sent to the UE. EAC mode is only applicable in the AMF when the update flag is set to increase.

The AMF implicitly subscribes to the EAC notification for the S-NSSAI when it performs the first network slice availability check and update procedure for the S-NSSAI with the NSACF. The NSACF sends the EAC mode notification towards all notification endpoints associated with the S-NSSAI.



Figure 4.2.11.3-1: Early Admission Control (EAC) update procedure

1) The number of UEs registered with a network slice subject to NSAC crosses a certain operator defined threshold. The NSACF determines whether to activate or deactivate the EAC mode.

2) The NSACF triggers Nnsacf\_NSAC\_EACNotify operation including the S-NSSAI for which the EAC mode is to be activated or deactivated and a EAC flag set to activated if the number of UEs registered with the network slice is above certain threshold or set to deactivated if the number of the UEs registered with the network slice is below certain threshold.

3) The AMF uses the EAC flag to decide when to trigger the number of UEs per network slice availability check and update procedure so that delays to the registration procedure and impact to the already allowed network slices are avoided.

If the EAC flag indicates EAC mode activated, the AMF triggers the number of UEs per network slice availability check and update procedure before the Registration Accept step of the registration procedure or before the UE Configuration Update message.

If the EAC flag indicates EAC mode deactivated, the AMF triggers the number of UEs per network slice availability check and update procedure after Registration Accept step of the registration procedure or after the UE Configuration Update.

When a NSACF acts as proxy towards another NSACF, the NSACF may receive a Nnsacf\_NSAC\_EACNotify (EAC flag=activated/deactivated) from another NSACF. if so, it relays such notification to the AMFs that it handles.

#### 4.2.11.4 Number of PDU Sessions per network slice availability check and update procedure

The number of PDU Sessions per network slice availability check and update procedure is to update (i.e. increase or decrease) the number of PDU Sessions established on S-NSSAI which is subject to NSAC. The SMF is configured with the information indicating which network slice is subject to NSAC.

NOTE 1: EAC mode is not applicable for Number of PDU Sessions per network slice availability check and update procedure.



Figure 4.2.11.4-1: Number of PDU Sessions per network slice availability check and update procedure

1. If the SMF is not aware of which NSACF to communicate, the SMF performs NSACF discovery as described in clause 6.3.22 of TS 23.501 [2] and in clause 5.2.7.3.2. The SMF anchoring the PDU session triggers the Number of PDU Sessions per network slice availability check and update procedure for the network slices that are subject to NSAC at the beginning of a PDU Session Establishment procedure (clause 4.3.2.2.1 and clause 4.3.2.2.2) only for new PDU Sessions to be established, and as a last step of successful PDU Session Release procedure (clause 4.3.4.2 and clause 4.3.4.3).

NOTE 2: SMFs handling PDU sessions associated with UE Request Type "Existing PDU Session" for handover purposes do not interact with the NSACF.

2. The SMF anchoring the PDU session sends Nnsacf\_NSAC\_NumOfPDUsUpdate\_Request message to the NSACF. The SMF includes in the message the UE-ID, the PDU session ID, S-NSSAI for which the number of PDU Sessions per network slice update is required, access type and the update flag which indicates that the number of PDUs established on the S-NSSAI is to be increased if the procedure is triggered at the beginning of PDU Session Establishment procedure or indicates that the number of PDU Sessions on the S-NSSAI is to be decreased if the procedure is triggered at the end of PDU Sessions Release procedure.

NOTE 3: For SSC mode 3 PDU session, the SMF of the new PDU Session invokes the NSACF to increase the number of PDU Session and adds the new PDU session ID in the NSACF. When the old PDU session is released the SMF of the old PDU session invokes the NSACF to decrease the number of PDU Session and remove the old PDU session ID in the NSACF.

NOTE 4: An SMF anchoring an IPv6 Multi-homed PDU session does not invoke NSACF for an S-NSSAI subject to NSAC when the PDU session replaces an existing anchor according to clause 4.3.5.3.

3. The NSACF updates the current number of PDU Sessions established on the S-NSSAI, i.e. increase or decrease the number of PDU Sessions per network slice based on the information provided by the anchor SMF in the update flag parameter. The NSACFmay also update the number of UEs with at least one PDU session established on the S-NSSAI, i.e. increase or decrease the number of UEs with at least one PDU session per network slice based on the information provided by the anchor SMF in the update flag parameter and the number of PDU sessions for the UE recorded in the NSACF.

If the update flag parameter from the SMF anchoring the PDU session indicates increase and the maximum number of PDU Sessions established on the S-NSSAI has already been reached, or the number of UEs with at least one PDU session has already been reached, or both, then the NSACF may return a result parameter indicating that the maximum number of PDU Sessions per network slice has been reached or that the number of UEs with at least one PDU session has already been reached, or both, with an availability status indicating the S-NSSAI is not available. If the maximum number of PDU Sessions established on the S-NSSAI has not been reached, the NSACF checks the UE ID. If the UE ID is located, the NSACF, stores the PDU Session ID, and increases the number of PDU Sessions for that S-NSSAI. If the NSACF did not locate the UE ID, it checks whether the maximum number UEs with at least one PDU session has already been reached. If it has laready been reached, the NSACF may return a result parameter indicating that the maximum number of UEs with at least one PDU session per network slice has been reached with an availability status indicating the S-NSSAI is not available and not create an entry for the UE ID. Otherwise, it creates an entry for the UE ID, stores the PDU Session ID, and increases the number of PDU Sessions for that S-NSSAI and the number of UEs with at least one PDU session per network slice.

If the update flag parameter from the SMF anchoring the PDU session indicates decrease the current number of PDU Sessions per S-NSSAI, the NSACF locates the UE ID, and decreases the number of PDU Sessions for that S-NSSAI and its related PDU Session ID. If the UE ID has no more PDU sessions, after the decrease, the NSACF removes the UE ID entry and decreses the number of UEs with at least one PDU session per network slice.

The NSACF takes access type into account for increasing and decreasing the number of PDU Sessions per S-NSSAI as described in clause 5.15.11.2 of TS 23.501 [2].

4. The NSACF acknowledges the update to the anchor SMF with Nnsacf\_NSAC\_NumOfPDUsUpdate\_Response message. If the NSACF returned maximum number of PDU Sessions per S-NSSAI reached result, or maximum number UEs with at least one PDU session reached resut, the SMF rejects the PDU Session establishment request with reject cause set to 'maximum number of PDU Sessions per S-NSSAI reached' or, respectively, 'maximum number of UEs with at least one PDU session per S-NSSAI reached' and optionally a back-off timer.

When a NSACF acts as proxy towards another NSACF, the NSACF relays the Nnsacf\_NSAC\_NumOfPDUsUpdate requests and responses between the SMF and this NSACF.

#### 4.2.11.5 Network Slice Admission Control Support for Roaming

##### 4.2.11.5.1 NSACF Support for Roaming by VPLMN

For network slice admission control of roaming UEs, the HPLMN is in charge of the counting of PDU sessions, UEs and UEs with at least one PDU session in the network slice. For LBO PDU sessions and to count the number of UEs in a network slice of the HPLMN, the VPLMN NSACF (V-NSACF) proxies the NSACF interactions with the HPLMN NSACF (H-NSACF) by selecting a H-NSACF based on the PLMN ID associated with the UE ID, and the S-NSSAI of the HPLMN.

NOTE: Subject to interoperator bilateral agremeents, it may be possible for the HPLMN to delegatea maximum number of allowed UEs per mapped S-NSSAI in HPLMN and/or a maximum number of allowed PDU Sessions in LBO mode per mapped S-NSSAI in HPLMN to the VPLMN for each S-NSSAI in HPLMN that is subject to NSAC as per the subscription information. IF so, these values ,may be stored in one NSCAF in the VPLMN responsible for network slice admission control for the S-NSSAI of the HPLMN, subject to NSAC. this option is no further specified and assumes it is not possible that a single maximum number of PDU sessions applies acrossr the LBO and non LBO sessions, and that the counting of the number of UEs with at least a single PDU session applies separately for LBO and non LBO sessions.

The maximum number of UEs registered with a network slice monitoring and enforcement is done in the HPLMN by the NSACF in the HPLMN as per the description in Figure 4.2.11.2-1 with the following differences:

- Step 2, in the Nnsacf\_NSAC\_NumOfUEsUpdate\_Request service operation the AMF provides themapped S-NSSAI in HPLMN to the NSACF in the VPLMN.

- Step 3, the NSACF in the VPLMN acts as a proxy towards the NSACF of the HPLMN which then acts as NSACF for the transaction and provides the result to the V-NSACF that then itneracts with the AMF as specified in this figure.

For LBO, enforcement of the maximum number of PDU Sessions established for an S-NSSAI is performed in the HPLMN by the NSACF in the HPLMN as per the description in Figure 4.2.11.4-1 with the following differences:

- Step 2, in the Nnsacf\_NSAC\_NumOfPDUsUpdate\_Request service operation the V-SMF provides the mapped S-NSSAI of HPLMN to the NSACF in the VPLMN.

- Step 3, the NSACF in the VPLMN acts as a proxy towards the NSACF of the HPLMN which then acts as NSACF for the transaction and provides the result to the V-NSACF that then itneracts with the AMF as specified in this figure.

##### 4.2.11.5.2 NSACF Support for Roaming by HPLMN

the H-NSACF performs NSAC based on request by the V-NSACF or the H-SMF for PDU sessions in the home-routed roaming case, for the S-NSSAI(s) subject to NSAC.

SECOND CHANGE

#### 4.11.0a.5 PDN Connection Establishment

During establishment of non-emergency PDN connection in the EPC, the UE and the SMF+PGW-C exchange information via PCO as described in clause 5.15.7 of TS 23.501 [2]. For UE with 5GC NAS capability disabled (i.e. N1 mode is disabled), the UE may also allocate a PDU Session ID and send it to the SMF+PGW-C via PCO. If the SMF+PGW-C supports more than one S-NSSAI and the APN is valid for more than one S-NSSAI, before the SMF+PGW-C provides an S-NSSAI to the UE, the SMF+PGW-C should check such that the selected S-NSSAI is among the UE's subscribed S-NSSAIs, and that the S-NSSAI is not subject to Network Slice-Specific Authentication and Authorization, by retrieving the Subscribed S-NSSAI from UDM using the Nudm\_SDM\_Get service operation (the SMF+PGW-C discovers and selects a UDM as described in clause 6.3.8 of TS 23.501 [2]). If the SMF+PGW-C is in a VPLMN, the SMF+PGW-C uses the Nnssf\_NSSelection\_Get service operation to retrieve a mapping of the Subscribed S-NSSAIs to Serving PLMN S-NSSAI values. If the S-NSSAIs supported by the SMF+PGW-C are all subject to NSSAA, then the SMF+PGW-C should reject the PDN connection establishment. If the selected S-NSSAI is subject to NSAC and EPS counting is required for the S-NSSAI, the SMF+PGW-C uses the Nnsacf\_NSAC\_NumberOfUEsUpdate services operation to check if the selected S-NSSAI is available as described in clause 4.11.5.9. The SMF+PGW-C uses the Nudm\_SDM\_Subscribe service operation to subscribe the change of the Session Management Subscription data. If the SMF+PGW-C is notified from UDM with subscription data change, the SMF+ PGW-C takes actions for the PDN connection as described in clause 5.17.2.1 of TS 23.501 [2].

As described in TS 23.548 [74], during establishment of a PDN connection, a UE that hosts EEC(s) may indicate to the SMF+PGW-C, 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). If the UE indicated in the PCO that it supports the ability to receive ECS address(es) via NAS, the SMF+PGW-C 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+PGW-C may derive the Edge Configuration Server Information based on local configuration, the UE's location, and/or UE subscription information.

The SMF+PGW-C may use the bearer modification procedure without bearer QoS update to send the UE a PCO with updated ECS Address Configuration Information as defined in clause 6.5.2 of TS 23.548 [74] to the UE.

During establishment of non-emergency PDN connection in the EPC, if PGW-C+SMF is selected for a UE that has 5GS subscription, the SMF may be configured to obtain the subscribed IP index from UDM as part of subscription data using the Nudm\_SDM\_Get service operation (the PGW-C+SMF discovers and selects a UDM as described in clause 6.3.8 of TS 23.501 [2]).

During establishment of non-emergency PDN connection in the EPC, if SMF+PGW-C is selected for a UE that has 5GS subscription but does not support 5GC NAS and is accessing via EPC/E-UTRAN and if the SMF+PGW-C supports more than one S-NSSAI and the APN is valid for more than one S-NSSAI, the SMF+PGW-C+PGW-C may proceed as specified in first paragraph of this clause or select any S-NSSAI associated with the APN of the PDN connection. The SMF+PGW-C shall not provide any 5GS related parameters to the UE.

NOTE: The SMF+PGW-C knows that the UE does not support 5GS NAS if the UE does not provide PDU Session ID in PCO (see clause 5.15.7 of TS 23.501 [2]).

During establishment of emergency PDN connection:

- The SMF+PGW-C is to be derived from the emergency APN or to be statically configured in the Emergency Configuration Data in MME.

- 5GC interworking support with N26 or without N26 is determined based on UE's 5G NAS capability and local configuration (in the Emergency Configuration Data in MME).

- The S-NSSAI configured for the emergency APN in SMF+PGW-C is not sent to the UE by the SMF+PGW-C. One S-NSSAI is configured for the emergency APN.

During establishment of non-emergency PDN connection and emergency PDN connection, if SMF+PGW-C is selected for a UE that does not support 5GC NAS, the SMF+PGW-C creates unique PDU Session ID for each PDN connection of the UE.

The unique PDU Session ID can be created based on the EPS Bearer IDs assigned by the MME for the PDN Connections associated with the UE and not be in the range of PDU Session ID values that can be created by a 5GC NAS capable UE.

When the SMF+PGW-C establishes the PDN connection successfully, the SMF+PGW-C provides the ID of the PCF ID selected for the PDN connection in the UDM using the Nudm\_UECM\_Registration service operation.

A SMF+PGW-C may support L2TP as described in clause 4.3.2.4. In this case step 1 and step 7 of Figure 4.3.2.4‑1 correspond to a PDN Connection establishment and a SMF+PGW-C replaces the SMF in that Figure.

To support User Plane Integrity Protection with EPS and policies that Require User Plane integrity protection to be used, at PDN connection establishment, the MME shall indicate to the SMF+PGW-C (via the Serving GW) whether the UE and the MME support User Plane Integrity Protection in EPS. If the MME and the UE support User Plane Integrity Protection, then the SMF+PGW-C informs the MME of the User Plane integrity protection policy (Required, Preferred, Not Needed) applicable to the PDN connection on a per-EPS bearer basis.

THIRD CHANGE

#### 4.11.5.9 Network Slice Admission Control

Support of NSAC in conjunction with interworking with EPC is described in clause 5.15.11.5 of TS 23.501 [2].

If EPS counting is required for a network slice, the SMF+PGW-C performs NSACF discovery that supports controlling the maximum number of PDU sessions per network slice andf the maximum number of UEs with at least one PDU session per network slice as described in clause 6.3.22 of TS 23.501 [2] and in clause 5.2.7.3.2. Also, the AMF disables NSAC on the number of UEs registered in the network slice when PS counting is required for a network slice.

The following impacts are applicable to clause 4.2.11.4 (Number of PDU Sessions per network slice availability check and update procedure):

- The SMF+PGW-C invokes this procedure to perform network slice availability check on the number of PDU Sessions and if the S-NSSAI is subject to EPS counting, on the number of UEs with at least one PDU session per network slice, and update the number of PDU sessions and, if the S-NSSAI is subject to EPS counting, UEs with at least one PDU session per network slice, for the S-NSSAI associated with the PDN connection during PDN connection establishment. In this case the SMF in figure 4.2.11.2-1 is replaced with SMF+PGW-C.

- Step 3, The NSACF determines whether or not to accept the request as described in clause 5.15.11.5 of TS 23.501 [2].

The SMF+PGW-C performs NSACF discovery that supports controlling the maximum number of UEs per network slice as described in clause 6.3.22 of TS 23.501 [2] and in clause 5.2.7.3.2.

FOURTH CHANGE

##### 4.2.2.2.2 General Registration



Figure 4.2.2.2.2-1: Registration procedure

1. UE to (R)AN: AN message (AN parameters, Registration Request (Registration type, SUCI or 5G-GUTI or PEI, [last visited TAI (if available)], Security parameters, [Requested NSSAI], [Mapping Of Requested NSSAI], [Default Configured NSSAI Indication], [UE Radio Capability Update], [UE MM Core Network Capability], [PDU Session status], [List Of PDU Sessions To Be Activated], [Follow-on request], [MICO mode preference], [Requested Active Time], [Requested DRX parameters for E-UTRA and NR], [Requested DRX parameters for NB-IoT], [extended idle mode DRX parameters], [LADN DNN(s) or Indicator Of Requesting LADN Information], [NAS message container], [Support for restriction of use of Enhanced Coverage], [Preferred Network Behaviour], [UE paging probability information], [UE Policy Container (the list of PSIs, indication of UE support for ANDSP and the operating system identifier)] and [UE Radio Capability ID], [Release Request indication], [Paging Restriction Information], PEI, [NSSRG handling support indication], [PLMN with Disaster Condition])).

NOTE 1: The UE Policy Container and its usage is defined in TS 23.503 [20].

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

The AN parameters shall also include an IAB-Indication if the UE is an IAB-node accessing 5GS.

The Registration type indicates if the UE wants to perform an Initial Registration (i.e. the UE is in RM-DEREGISTERED state), a Mobility Registration Update (i.e. the UE is in RM-REGISTERED state and initiates a Registration procedure due to mobility or due to the UE needs to update its capabilities or protocol parameters, or to request a change of the set of network slices it is allowed to use), a Periodic Registration Update (i.e. the UE is in RM-REGISTERED state and initiates a Registration procedure due to the Periodic Registration Update timer expiry, see clause 4.2.2.2.1), an Emergency Registration (i.e. the UE is in limited service state), or a Disaster Roaming Registration.

When the UE is using E-UTRA, the UE indicates its support of CIoT 5GS Optimisations, which is relevant for the AMF selection, in the RRC connection establishment signalling associated with the Registration Request.

When the UE is performing an Initial Registration or a Disaster Roaming Registration the UE shall indicate its UE identity in the Registration Request message as follows, listed in decreasing order of preference in the case of registration with a PLMN:

i) a 5G-GUTI mapped from an EPS GUTI, if the UE has a valid EPS GUTI.

ii) a native 5G-GUTI assigned by the PLMN to which the UE is attempting to register, if available;

iii) a native 5G-GUTI assigned by an equivalent PLMN to the PLMN to which the UE is attempting to register, if available;

iv) a native 5G-GUTI assigned by any other PLMN, if available.

NOTE 2: This can also be a 5G-GUTIs assigned via another access type.

v) Otherwise, the UE shall include its SUCI in the Registration Request as defined in TS 33.501 [15].

If the UE is registering with an SNPN, when the UE is performing an Initial Registration the UE shall indicate its UE identity in the Registration Request message as follows, listed in decreasing order of preference:

i) a native 5G-GUTI assigned by the same SNPN to which the UE is attempting to register, if available;

ii) a native 5G-GUTI assigned by any other SNPN along with the NID of the SNPN that assigned the 5G-GUTI, if available;

iii) Otherwise, the UE shall include its SUCI in the Registration Request as defined in TS 33.501 [15].

When the UE performing an Initial Registration has both a valid EPS GUTI and a native 5G-GUTI, the UE shall also indicate the native 5G-GUTI as Additional GUTI. If more than one native 5G-GUTIs are available, the UE shall select the 5G-GUTI in decreasing order of preference among items (ii)-(iv) in the list above.

The NAS message container shall be included if the UE is sending a Registration Request message as an Initial NAS message and the UE has a valid 5G NAS security context and the UE needs to send non-cleartext IEs, see clause 4.4.6 in TS 24.501 [25]. If the UE does not need to send non-cleartext IEs, the UE shall send a Registration Request message without including the NAS message container.

If the UE does not have a valid 5G NAS security context, the UE shall send the Registration Request message without including the NAS message container. The UE shall include the entire Registration Request message (i.e. containing cleartext IEs and non-cleartext IEs) in the NAS message container that is sent as part of the Security Mode Complete message in step 9b.

When the UE is performing an Initial Registration (i.e., the UE is in RM-DEREGISTERED state) with a native 5G-GUTI then the UE shall indicate the related GUAMI information in the AN parameters. When the UE is performing an Initial Registration with its SUCI, the UE shall not indicate any GUAMI information in the AN parameters.

When the UE is performing an Initial Registration or a Mobility Registration and if CIoT 5GS Optimisations are supported the UE shall indicate its Preferred Network Behaviour (see clause 5.31.2 of TS 23.501 [2]). If S1 mode is supported the UE's EPC Preferred Network Behaviour is included in the S1 UE network capabilities in the Registration Request message, see clause 8.2.6.1 of TS 24.501 [25].

For an Emergency Registration, the SUCI shall be included if the UE does not have a valid 5G-GUTI available; the PEI shall be included when the UE has no SUPI and no valid 5G-GUTI. In other cases, the 5G-GUTI is included and it indicates the last serving AMF.

The UE may provide the UE's usage setting based on its configuration as defined in clause 5.16.3.7 of TS 23.501 [2]. The UE provides Requested NSSAI (as described in clause 5.15.5.2.1 of TS 23.501 [2] and, if the UE supports the subscription-based restrictions to simultaneous registration of network slices, also taking into account the NSSRG Information constraints as described in clause 5.15.12 of TS 23.501 [2] and, in the case of Initial Registration or Mobility Registration Update, the UE includes the Mapping Of Requested NSSAI (if available), which is the mapping of each S-NSSAI of the Requested NSSAI to the HPLMN S-NSSAIs, to ensure that the network is able to verify whether the S-NSSAI(s) in the Requested NSSAI are permitted based on the Subscribed S-NSSAIs. In the case of inter PLMN mobility, if the serving PLMN S-NSSAI(s) corresponding to the established PDU Session(s) are not present in the UE, the associated HPLMN S-NSSAI(s) associated with the established PDU Session(s) shall be provided in the Mapping Of Requested NSSAI as described in clause 5.15.5.2.1 TS 23.501 [2].

The UE includes the Default Configured NSSAI Indication if the UE is using a Default Configured NSSAI, as defined in TS 23.501 [2].

The UE may include UE paging probability information if it supports the assignment of WUS Assistance Information from the AMF (see TS 23.501 [2]).

In the case of Mobility Registration Update, the UE includes in the List Of PDU Sessions To Be Activated the PDU Sessions for which there are pending uplink data. When the UE includes the List Of PDU Sessions To Be Activated, the UE shall indicate PDU Sessions only associated with the access the Registration Request is related to. As defined in TS 24.501 [25] the UE shall include always-on PDU Sessions which are accepted by the network in the List Of PDU Sessions To Be Activated even if there are no pending uplink data for those PDU Sessions.

NOTE 3: A PDU Session corresponding to a LADN is not included in the List Of PDU Sessions To Be Activated when the UE is outside the area of availability of the LADN.

The UE MM Core Network Capability is provided by the UE and handled by AMF as defined in clause 5.4.4a of TS 23.501 [2]. The UE includes in the UE MM Core Network Capability an indication if it supports Request Type flag "handover" for PDN connectivity request during the attach procedure as defined in clause 5.17.2.3.1 of TS 23.501 [2]. If the UE supports 'Strictly Periodic Registration Timer Indication', the UE indicates its capability of 'Strictly Periodic Registration Timer Indication' in the UE MM Core Network Capability. If the UE supports CAG, the UE indicates its capability of "CAG supported" in the UE MM Core Network Capability. If the UE operating two or more USIMs, supports and intends to use one or more Multi-USIM feature(s), the UE indicates one or more Multi-USIM specific features described in clause 5.38 of TS 23.501 [2] in the UE MM Core Network Capability.

The UE may provide either the LADN DNN(s) or an Indication Of Requesting LADN Information as described in clause 5.6.5 of TS 23.501 [2].

If available, the last visited TAI shall be included in order to help the AMF produce Registration Area for the UE.

The Security parameters are used for Authentication and integrity protection, see TS 33.501 [15]. Requested NSSAI indicates the Network Slice Selection Assistance Information (as defined in clause 5.15 of TS 23.501 [2]). The PDU Session status indicates the previously established PDU Sessions in the UE. When the UE is connected to the two AMFs belonging to different PLMN via 3GPP access and non-3GPP access then the PDU Session status indicates the established PDU Session of the current PLMN in the UE.

The Follow-on request is included when the UE has pending uplink signalling and the UE doesn't include List Of PDU Sessions To Be Activated, or the Registration type indicates the UE wants to perform an Emergency Registration. In Initial Registration and Mobility Registration Update, UE provides the UE Requested DRX parameters, as defined in clause 5.4.5 of TS 23.501 [2]. The UE may provide the extended idle mode DRX parameters as defined in clause 5.31.7.2 of TS 23.501 [2] to request extended idle mode DRX.

The UE provides UE Radio Capability Update indication as described in TS 23.501 [2].

The UE includes the MICO mode preference and optionally a Requested Active Time value if the UE wants to use MICO Mode with Active Time.

The UE may indicate its Service Gap Control Capability in the UE MM Core Network Capability, see clause 5.31.16 of TS 23.501 [2].

For a UE with a running Service Gap timer in the UE, the UE shall not set Follow-on Request indication or Uplink data status in the Registration Request message (see clause 5.31.16 of TS 23.501 [2]), except for network access for regulatory prioritized services like Emergency services or exception reporting.

If UE supports RACS and has been assigned UE Radio Capability ID(s), the UE shall indicate a UE Radio Capability ID as defined in clause 5.4.4.1a of TS 23.501 [2] as non-cleartext IE.

The PEI may be retrieved in initial registration from the UE as described in clause 4.2.2.2.1.

If a UE supports the subscription-based restrictions to simultaneous registration of network slices feature, it includes the NSSRG handling support indication according to clause 5.15.12 of TS 23.501 [2]. The AMF stores whether the UE supports this feature in the UE context.

When a UE in MUSIM mode wants to enter CM-IDLE state immediately e.g. after having performed mobility or periodic registration, it includes the Release Request indication and optionally provides Paging Restriction Information.

When the UE is performing a Disaster Roaming Registration, the UE may indicate the PLMN with Disaster Condition if UE does not have valid 5G-GUTI indicating the PLMN with Disaster Condition and the PLMN with Disaster Condition is not the HPLMN of the UE or the PLMN with Disaster Condition is the HPLMN of the UE but the UE does not provide its SUCI.

2. If a 5G-S-TMSI or GUAMI is not included or the 5G-S-TMSI or GUAMI does not indicate a valid AMF the (R)AN, based on (R)AT and Requested NSSAI, if available, selects an AMF

The (R)AN selects an AMF as described in clause 6.3.5 of TS 23.501 [2]. If UE is in CM-CONNECTED state, the (R)AN can forward the Registration Request message to the AMF based on the N2 connection of the UE.

If the (R)AN cannot select an appropriate AMF, it forwards the Registration Request to an AMF which has been configured, in (R)AN, to perform AMF selection.

3. (R)AN to new AMF: N2 message (N2 parameters, Registration Request (as described in step 1) and [LTE-M Indication].

When NG-RAN is used, the N2 parameters include the Selected PLMN ID (or PLMN ID and NID, see clause 5.30 of TS 23.501 [2]), Location Information and Cell Identity related to the cell in which the UE is camping, UE Context Request which indicates that a UE context including security information needs to be setup at the NG-RAN.

When NG-RAN is used, the N2 parameters shall also include the Establishment cause and IAB-Indication if the indication is received in AN parameters in step 1.

Mapping Of Requested NSSAI is provided only if available.

If the Registration type indicated by the UE is Periodic Registration Update, then steps 4 to 19 may be omitted.

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

The RAT Type the UE is using is determined (see clause 4.2.2.2.1) and based on it the AMF determines whether the UE is performing Inter-RAT mobility to or from NB-IoT. If the AMF receives the LTE M indication, then it considers that the RAT Type is LTE-M and stores the LTE-M Indication in UE Context.

If a UE includes a Preferred Network Behaviour, this defines the Network Behaviour the UE supports and is expecting to be available in the network as defined in clause 5.31.2 of TS 23.501 [2].

If the UE has included the Preferred Network Behaviour, and what the UE indicated it supports in Preferred Network Behaviour is incompatible with the network support, the AMF shall reject the Registration Request with an appropriate cause value (e.g. one that avoids retries on this PLMN).

If there is a Service Gap timer running in the UE Context in AMF for the UE, and Follow-on Request indication or Uplink data status is included in the Registration Request message, the AMF shall ignore the Follow-on Request indication and Uplink data status and not perform any of the actions related to the status.

If the UE has included a UE Radio Capability ID in step 1 and the AMF supports RACS, the AMF stores the Radio Capability ID in UE context.

For NR satellite access, if the AMF can determine based on the Selected PLMN ID and ULI (including Cell ID) received from the gNB that the UE is attempting to register to a PLMN that is not allowed to operate at the present UE location, then the AMF should reject the Registration Request indicating a suitable Cause value and, if known in AMF, the country of the UE location. Otherwise, e.g. if the AMF is not aware of the UE location with sufficient accuracy to make a final decision, the AMF proceeds with the Registration procedure and may initiate UE location procedure as specified in clause 6.10.1 of TS 23.273 [51] and be prepared to deregister the UE if the information received from LMF proves that the UE is registered to a PLMN that is not allowed to operate in the UE location.

NOTE 4: The location information cannot be guaranteed to be sufficiently accurate for the AMF to determine in all cases the country where UE is located.

NOTE 5: Some countries use multiple MCCs and some MCCs, such as 901, can be allowed in multiple countries and therefore the UE can register in a PLMN with MCC different from the one returned to the UE.

Upon receiving a Registration Reject with the country in which the UE is located, the UE shall attempt to register to a PLMN that is allowed to operate at the UE location as specified in TS 23.122 [22].

For a Disaster Roaming Registration, based on the ULI (including Cell ID) received from the NG-RAN, the PLMN with Disaster Condition derived from the UE's 5G-GUTI, derived from the UE's SUCI or indicated by the UE and the local configuration, the AMF determines if Disaster Roaming service can be provided. If the current location is not subject to Disaster Roaming service or the Disaster Roaming service is not provided to the PLMN with Disaster Condition derived from the UE's 5G-GUTI, derived from the UE's SUCI or indicated by UE, then the AMF should reject the Registration Request indicating a suitable Cause value.

4. [Conditional] new AMF to old AMF: Namf\_Communication\_UEContextTransfer (complete Registration Request) or new AMF to UDSF: Nudsf\_Unstructured Data Management\_Query().

The new AMF determines the old AMF using the UE's 5G-GUTI. If the new AMF received an NID in the Registration request, it determines that the 5G-GUTI was assigned by an SNPN and determines the old AMF using the 5G-GUTI and NID of the SNPN.

(With UDSF Deployment): If the UE's 5G-GUTI was included in the Registration Request and the serving AMF has changed since last Registration procedure, new AMF and old AMF are in the same AMF Set and UDSF is deployed, the new AMF retrieves the stored UE's SUPI and UE context directly from the UDSF using Nudsf\_UnstructuredDataManagement\_Query service operation or they can share stored UE context via implementation specific means if UDSF is not deployed. This includes also event subscription information by each NF consumer for the given UE. In this case, the new AMF uses integrity protected complete Registration request NAS message to perform and verify integrity protection.

(Without UDSF Deployment): If the UE's 5G-GUTI was included in the Registration Request and the serving AMF has changed since last Registration procedure, the new AMF may invoke the Namf\_Communication\_UEContextTransfer service operation on the old AMF including the complete Registration Request NAS message, which may be integrity protected, as well as the Access Type, to request the UE's SUPI and UE Context. See clause 5.2.2.2.2 for details of this service operation. In this case, the old AMF uses either 5G-GUTI and the integrity protected complete Registration request NAS message, or the SUPI and an indication that the UE is validated from the new AMF, to verify integrity protection if the context transfer service operation invocation corresponds to the UE requested. The old AMF also transfers the event subscriptions information by each NF consumer, for the UE, to the new AMF. If the old AMF has not yet reported a non-zero MO Exception Data Counter to the (H-)SMF, the Context Response also includes the MO Exception Data Counter.

If the old AMF has PDU Sessions for another access type (different from the Access Type indicated in this step) and if the old AMF determines that there is no possibility for relocating the N2 interface to the new AMF, the old AMF returns UE's SUPI and indicates that the Registration Request has been validated for integrity protection, but does not include the rest of the UE context.

For inter PLMN mobility, UE Context information includes HPLMN S-NSSAIs corresponding to the Allowed NSSAI for each Access Type, without Allowed NSSAI of old PLMN.

NOTE 6: The new AMF Sets the indication that the UE is validated according to step 9a, if the new AMF has performed successful UE authentication after previous integrity check failure in the old AMF.

NOTE 7: The NF consumers do not need to subscribe for the events once again with the new AMF after the UE is successfully registered with the new AMF.

If the new AMF has already received UE contexts from the old AMF during handover procedure, then step 4,5 and 10 shall be skipped.

For an Emergency Registration, if the UE identifies itself with a 5G-GUTI that is not known to the AMF, steps 4 and 5 are skipped and the AMF immediately requests the SUPI from the UE. If the UE identifies itself with PEI, the SUPI request shall be skipped. Allowing Emergency Registration without a user identity is dependent on local regulations.

5. [Conditional] old AMF to new AMF: Response to Namf\_Communication\_UEContextTransfer (SUPI, UE Context in AMF (as per Table 5.2.2.2.2-1)) or UDSF to new AMF: Nudsf\_Unstructured Data Management\_Query(). The old AMF may start an implementation specific (guard) timer for the UE context.

If the UDSF was queried in step 4, the UDSF responds to the new AMF for the Nudsf\_Unstructured Data Management\_Query invocation with the related contexts including established PDU Sessions, the old AMF includes SMF information DNN, S-NSSAI(s) and PDU Session ID, active NGAP UE-TNLA bindings to N3IWF/TNGF/W-AGF, the old AMF includes information about the NGAP UE-TNLA bindings. If the Old AMF was queried in step 4, Old AMF responds to the new AMF for the Namf\_Communication\_UEContextTransfer invocation by including the UE's SUPI and UE Context.

If old AMF holds information about established PDU Session(s) and it is not an Initial Registration, the old AMF includes SMF information, DNN(s), S-NSSAI(s) and PDU Session ID(s).

If old AMF holds UE context established via N3IWF, W-AGF or TNGF, the old AMF includes the CM state via N3IWF, W-AGF or TNGF. If the UE is in CM-CONNECTED state via N3IWF, W-AGF or TNGF, the old AMF includes information about the NGAP UE-TNLA bindings.

If old AMF fails the integrity check of the Registration Request NAS message, the old AMF shall indicate the integrity check failure. If the new AMF is configured to allow emergency services for unauthenticated UE, the new AMF behaves as follows:

- If the UE has only an emergency PDU Session, the AMF either skips the authentication and security procedure or accepts that the authentication may fail and continues the Mobility Registration Update procedure; or

- If the UE has both emergency and non emergency PDU Sessions and authentication fails, the AMF continues the Mobility Registration Update procedure and deactivates all the non-emergency PDU Sessions as specified in clause 4.3.4.2.

NOTE 8: The new AMF can determine if a PDU Session is used for emergency service by checking whether the DNN matches the emergency DNN.

If old AMF holds information about AM Policy Association and the information about UE Policy Association (i.e. the Policy Control Request Trigger for updating UE Policy as defined in TS 23.503 [20]), the old AMF includes the information about the AM Policy Association, the UE Policy Association and PCF ID. In the roaming case, V-PCF ID and H-PCF ID are included.

If old AMF was a consumer of UE related NWDAF services, the old AMF includes information about active analytics subscriptions, i.e. the Subscription Correlation ID, NWDAF identifier (i.e. Instance ID or Set ID), Analytics ID(s) and associated Analytics specific data in the Namf\_Communication\_UEContextTransfer response. Usage of the analytics information by the new AMF is specified in TS 23.288 [50].

During inter PLMN mobility, the handling of the UE Radio Capability ID in the new AMF is as defined in TS 23.501 [2].

NOTE 9: When new AMF uses UDSF for context retrieval, interactions between old AMF, new AMF and UDSF due to UE signalling on old AMF at the same time is implementation issue.

6. [Conditional] new AMF to UE: Identity Request ().

If the SUCI is not provided by the UE nor retrieved from the old AMF the Identity Request procedure is initiated by AMF sending an Identity Request message to the UE requesting the SUCI.

7. [Conditional] UE to new AMF: Identity Response ().

The UE responds with an Identity Response message including the SUCI. The UE derives the SUCI by using the provisioned public key of the HPLMN, as specified in TS 33.501 [15].

8. The AMF may decide to initiate UE authentication by invoking an AUSF. In that case, the AMF selects an AUSF based on SUPI or SUCI, as described in clause 6.3.4 of TS 23.501 [2].

If the AMF is configured to support Emergency Registration for unauthenticated SUPIs and the UE indicated Registration type Emergency Registration, the AMF skips the authentication or the AMF accepts that the authentication may fail and continues the Registration procedure.

9a. If authentication is required, the AMF requests it from the AUSF; if Tracing Requirements about the UE are available at the AMF, the AMF provides Tracing Requirements in its request to AUSF. Upon request from the AMF, the AUSF shall execute authentication of the UE. The authentication is performed as described in TS 33.501 [15]. The AUSF selects a UDM as described in clause 6.3.8 of TS 23.501 [2] and gets the authentication data from UDM.

Editor's note: It is FFS how the AUSF executes authentication of the UE, in the case of Disaster Roaming Registration.

Once the UE has been authenticated the AUSF provides relevant security related information to the AMF. If the AMF provided a SUCI to AUSF, the AUSF shall return the SUPI to AMF only after the authentication is successful.

After successful authentication in new AMF, which is triggered by the integrity check failure in old AMF at step 5, the new AMF invokes step 4 above again and indicates that the UE is validated (i.e. through the reason parameter as specified in clause 5.2.2.2.2).

9b If NAS security context does not exist, the NAS security initiation is performed as described in TS 33.501 [15]. If the UE had no NAS security context in step 1, the UE includes the full Registration Request message as defined in TS 24.501 [25].

The AMF decides if the Registration Request needs to be rerouted as described in clause 4.2.2.2.3, where the initial AMF refers to the AMF.

9c. The AMF initiates NGAP procedure to provide the 5G-AN with security context as specified in TS 38.413 [10] if the 5G-AN had requested for UE Context. Also, if the AMF decides that EPS fallback is supported (e.g. based on UE capability to support Request Type flag "handover" for PDN connectivity request during the attach procedure as defined in clause 5.17.2.3.1 of TS 23.501 [2], subscription data and local policy), the AMF shall send an indication "Redirection for EPS fallback for voice is possible" towards 5G-AN as specified in TS 38.413 [10]. Otherwise, the AMF indicates "Redirection for EPS fallback for voice is not possible". In addition, if Tracing Requirements about the UE are available at the AMF, the AMF provides the 5G-AN with Tracing Requirements in the NGAP procedure.

9d. The 5G-AN stores the security context and acknowledges to the AMF. The 5G-AN uses the security context to protect the messages exchanged with the UE as described in TS 33.501 [15].

10. [Conditional] new AMF to old AMF: Namf\_Communication\_RegistrationStatusUpdate (PDU Session ID(s) to be released e.g. due to slice not supported).

If the AMF has changed the new AMF informs the old AMF that the registration of the UE in the new AMF is completed by invoking the Namf\_Communication\_RegistrationStatusUpdate service operation.

If the authentication/security procedure fails, then the Registration shall be rejected, and the new AMF invokes the Namf\_Communication\_RegistrationStatusUpdate service operation with a reject indication towards the old AMF. The old AMF continues as if the UE context transfer service operation was never received.

If one or more of the S-NSSAIs used in the old Registration Area cannot be served in the target Registration Area, the new AMF determines which PDU Session cannot be supported in the new Registration Area. The new AMF invokes the Namf\_Communication\_RegistrationStatusUpdate service operation including the rejected PDU Session ID towards the old AMF. Then the new AMF modifies the PDU Session Status correspondingly. The old AMF informs the corresponding SMF(s) to locally release the UE's SM context by invoking the Nsmf\_PDUSession\_ReleaseSMContext service operation.

If new AMF received in the UE context transfer in step 5 the information about the AM Policy Association and the UE Policy Association and decides, based on local policies, not to use the PCF(s) identified by the PCF ID(s) for the AM Policy Association and the UE Policy Association, then it will inform the old AMF that the AM Policy Association and the UE Policy Association in the UE context is not used any longer and then the PCF selection is performed in step 15.

If the new AMF received in the UE context transfer in step 5 the information about UE related analytics subscription(s), the new AMF may take over the analytics subscription(s) from the old AMF. Otherwise, if the new AMF instead determines to create new analytics subscription(s), it informs the old AMF about the analytics subscriptions (identified by their Subscription Correlation ID) that are not needed any longer and the old AMF may now unsubscribe those NWDAF analytics subscriptions for the UE according to TS 23.288 [50].

11. [Conditional] new AMF to UE: Identity Request/Response (PEI).

If the PEI was not provided by the UE nor retrieved from the old AMF the Identity Request procedure is initiated by AMF sending an Identity Request message to the UE to retrieve the PEI. The PEI shall be transferred encrypted unless the UE performs Emergency Registration and cannot be authenticated.

For an Emergency Registration, the UE may have included the PEI in the Registration Request. If so, the PEI retrieval is skipped.

If the UE supports RACS as indicated in UE MM Core Network Capability, the AMF shall use the PEI of the UE to obtain the IMEI/TAC for the purpose of RACS operation.

12. Optionally the new AMF initiates ME identity check by invoking the N5g-eir\_EquipmentIdentityCheck\_Get service operation (see clause 5.2.4.2.2).

The PEI check is performed as described in clause 4.7.

For an Emergency Registration, if the PEI is blocked, operator policies determine whether the Emergency Registration procedure continues or is stopped.

13. If step 14 is to be performed, the new AMF, based on the SUPI, selects a UDM, then UDM may select a UDR instance. See clause 6.3.9 of TS 23.501 [2].

The AMF selects a UDM as described in clause 6.3.8 of TS 23.501 [2].

14a-c. If the AMF has changed since the last Registration procedure, or if the UE provides a SUPI which doesn't refer to a valid context in the AMF, or if the UE registers to the same AMF it has already registered to a non-3GPP access (i.e. the UE is registered over a non-3GPP access and initiates this Registration procedure to add a 3GPP access), the new AMF registers with the UDM using Nudm\_UECM\_Registration for the access to be registered (and subscribes to be notified when the UDM deregisters this AMF). In this case, if the AMF does not have event exposure subscription information for this UE, the AMF indicates it to UDM. Then, if the UDM has existing applicable event exposure subscriptions for events detected in AMF for this UE or for any of the groups this UE belongs to (possibly retrieved from UDR), UDM invokes the Namf\_EventExposure\_Subscribe service for recreating the event exposure subscriptions.

The AMF provides the "Homogenous Support of IMS Voice over PS Sessions" indication (see clause 5.16.3.3 of TS 23.501 [2]) to the UDM. The "Homogenous Support of IMS Voice over PS Sessions" indication shall not be included unless the AMF has completed its evaluation of the support of "IMS Voice over PS Session" as specified in clause 5.16.3.2 of TS 23.501 [2].

During initial Registration, if the AMF and UE supports SRVCC from NG-RAN to UTRAN the AMF provides UDM with the UE SRVCC capability.

If the AMF determines that only the UE SRVCC capability has changed, the AMF sends UE SRVCC capability to the UDM.

NOTE 10: At this step, it is possible that the AMF does not have all the information needed to determine the setting of the IMS Voice over PS Session Supported indication for this UE (see clause 5.16.3.2 of TS 23.501 [2]). Hence the AMF can send the "Homogenous Support of IMS Voice over PS Sessions" later on in this procedure.

If the AMF does not have subscription data for the UE, the AMF retrieves the Access and Mobility Subscription data, SMF Selection Subscription data, UE context in SMF data and LCS mobile origination using Nudm\_SDM\_Get. If the AMF already has subscription data for the UE but the SoR Update Indicator in the UE context requires the AMF to retrieve SoR information depending on the NAS Registration Type ("Initial Registration" or "Emergency Registration") (see Annex C of TS 23.122 [22]), the AMF retrieves the Steering of Roaming information using Nudm\_SDM\_Get. This requires that UDM may retrieve this information from UDR by Nudr\_DM\_Query. After a successful response is received, the AMF subscribes to be notified using Nudm\_SDM\_Subscribe when the data requested is modified, UDM may subscribe to UDR by Nudr\_DM\_Subscribe. The GPSI is provided to the AMF in the Access and Mobility Subscription data from the UDM if the GPSI is available in the UE subscription data. The UDM may provide indication that the subscription data for network slicing is updated for the UE. If the UE is subscribed to MPS in the serving PLMN, "MPS priority" is included in the Access and Mobility Subscription data provided to the AMF. If the UE is subscribed to MCX in the serving PLMN, "MCX priority" is included in the Access and Mobility Subscription data provided to the AMF. The UDM also provides the IAB-Operation allowed indication to AMF as part of the Access and Mobility Subscription data. The AMF shall trigger the setup of the UE context in NG-RAN, or modification of the UE context in NG-RAN if the initial setup is at step 9c, including an indication that the IAB-node is authorized.

Editor's note: It is FFS how the UDM provides applicable subscription data for Disaster Roaming service to the AMF, in the case of Disaster Roaming Registration.

The new AMF provides the Access Type it serves for the UE to the UDM and the Access Type is set to "3GPP access". The UDM stores the associated Access Type together with the serving AMF and does not remove the AMF identity associated to the other Access Type if any. The UDM may store in UDR information provided at the AMF registration by Nudr\_DM\_Update.

If the UE was registered in the old AMF for an access, and the old and the new AMFs are in the same PLMN, the new AMF sends a separate/independent Nudm\_UECM\_Registration to update UDM with Access Type set to access used in the old AMF, after the old AMF relocation is successfully completed.

The new AMF creates an UE context for the UE after getting the Access and Mobility Subscription data from the UDM. The Access and Mobility Subscription data includes whether the UE is allowed to include NSSAI in the 3GPP access RRC Connection Establishment in clear text. The Access and Mobility Subscription data may include Enhanced Coverage Restricted information. If received from the UDM and the UE included support for restriction of use of Enhanced Coverage in step 1, the AMF determines whether Enhanced Coverage is restricted or not for the UE as specified in clause 5.31.12 of TS 23.501 [2] and stores the updated Enhanced Coverage Restricted information in the UE context.

The Access and Mobility Subscription data may include the NB-IoT UE Priority.

The subscription data may contain Service Gap Time parameter. If received from the UDM, the AMF stores this Service Gap Time in the UE Context in AMF for the UE.

For an Emergency Registration in which the UE was not successfully authenticated, the AMF shall not register with the UDM.

The AMF enforces the Mobility Restrictions as specified in clause 5.3.4.1.1 of TS 23.501 [2]. For an Emergency Registration, the AMF shall not check for Mobility Restrictions, access restrictions, regional restrictions or subscription restrictions. For an Emergency Registration, the AMF shall ignore any unsuccessful registration response from UDM and continue with the Registration procedure.

NOTE 11: The AMF 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 AMF and the UDM.

14d. When the UDM stores the associated Access Type (e.g. 3GPP) together with the serving AMF as indicated in step 14a, it will cause the UDM to initiate a Nudm\_UECM\_DeregistrationNotification (see clause 5.2.3.2.2) to the old AMF corresponding to the same (e.g. 3GPP) access, if one exists. If the timer started in step 5 is not running, the old AMF may remove the UE context for the same Access Type. Otherwise, the AMF may remove UE context for the same Access Type when the timer expires. If the serving NF removal reason indicated by the UDM is Initial Registration, then, as described in clause 4.2.2.3.2, the old AMF invokes the Nsmf\_PDUSession\_ReleaseSMContext (SM Context ID) service operation towards all the associated SMF(s) of the UE to notify that the UE is deregistered from old AMF for the same Access Type. The SMF(s) shall release the PDU Session on getting this notification.

If the old AMF has established an AM Policy Association and a UE Policy Association with the PCF(s), and the old AMF did not transfer the PCF ID(s) to the new AMF (e.g. new AMF is in different PLMN), the old AMF performs an AMF-initiated Policy Association Termination procedure, as defined in clause 4.16.3.2, and performs an AMF-initiated UE Policy Association Termination procedure, as defined in clause 4.16.13.1. In addition, if the old AMF transferred the PCF ID(s) in the UE context but the new AMF informed in step 10 that the AM Policy Association information and UE Policy Association information in the UE context will not be used then the old AMF performs an AMF-initiated Policy Association Termination procedure, as defined in clause 4.16.3.2, and performs an AMF-initiated UE Policy Association Termination procedure, as defined in clause 4.16.13.1.

If the old AMF has an N2 connection for that UE (e.g. because the UE was in RRC Inactive state but has now moved to E-UTRAN or moved to an area not served by the old AMF), the old AMF shall perform AN Release (see clause 4.2.6) with a cause value that indicates that the UE has already locally released the NG-RAN's RRC Connection.

If the UE context in the old AMF contains an Allowed NSSAI including one or more S-NSSAI(s) subject to NSAC, but not subject to EPS counting, the old AMF upon receipt of the Nudm\_UECM\_DeregistrationNotification from the UDM, sends an update request message for each S-NSSAI subject to NSAC to the corresponding NSACF(s) with update flag parameter set to decrease (see clause 4.2.11.2).

At the end of registration procedure, the AMF may initiate synchronization of event exposure subscriptions with the UDM if the AMF does not indicate unavailability of event exposure subscription in step 14a.

NOTE 12: The AMF can initiate synchronization with UDM even if events are available in the UE context (e.g. as received from old AMF) at any given time and based on local policy. This can be done during subscription change related event.

14e. [Conditional] If old AMF does not have UE context for another access type (i.e. non-3GPP access), the Old AMF unsubscribes with the UDM for subscription data using Nudm\_SDM\_unsubscribe.

15. If the AMF decides to initiate PCF communication, the AMF acts as follows.

If the new AMF decides to use the (V-)PCF identified by the (V-)PCF ID included in UE context from the old AMF in step 5, the AMF contacts the (V-)PCF identified by the (V-)PCF ID to obtain policy. If the AMF decides to perform PCF discovery and selection and the AMF selects a (V)-PCF and may select an H-PCF (for roaming scenario) as described in clause 6.3.7.1 of TS 23.501 [2] and according to the V-NRF to H-NRF interaction described in clause 4.3.2.2.3.3.

16. [Optional] new AMF performs an AM Policy Association Establishment/Modification. For an Emergency Registration, this step is skipped.

If the new AMF selects a new (V-)PCF in step 15, the new AMF performs AM Policy Association Establishment with the selected (V-)PCF as defined in clause 4.16.1.2.

If the (V-)PCF identified by the (V-)PCF ID included in UE context from the old AMF is used, the new AMF performs AM Policy Association Modification with the (V-)PCF as defined in clause 4.16.2.1.2.

If the AMF notifies the Mobility Restrictions (e.g. UE location) to the PCF for adjustment, or if the PCF updates the Mobility Restrictions itself due to some conditions (e.g. application in use, time and date), the PCF shall provide the updated Mobility Restrictions to the AMF. If the subscription information includes Tracing Requirements, the AMF provides the PCF with Tracing Requirements.

If the AMF supports DNN replacement, the AMF provides the PCF with the Allowed NSSAI and, if available, the Mapping Of Allowed NSSAI.

If the PCF supports DNN replacement, the PCF provides the AMF with triggers for DNN replacement.

17. [Conditional] AMF to SMF: Nsmf\_PDUSession\_UpdateSMContext ().

For an Emergency Registered UE (see TS 23.501 [2]), this step is applied when the Registration Type is Mobility Registration Update.

The AMF invokes the Nsmf\_PDUSession\_UpdateSMContext (see clause 5.2.8.2.6) in the following scenario(s):

- If the List Of PDU Sessions To Be Activated is included in the Registration Request in step 1, the AMF sends Nsmf\_PDUSession\_UpdateSMContext Request to SMF(s) associated with the PDU Session(s) in order to activate User Plane connections of these PDU Session(s). Steps from step 5 onwards described in clause 4.2.3.2 are executed to complete the User Plane connection activation without sending the RRC Inactive Assistance Information and without sending MM NAS Service Accept from the AMF to (R)AN described in step 12 of clause 4.2.3.2. When a User Plane connection for a PDU Session is activated, the AS layer in the UE indicates it to the NAS layer.

- If the AMF has determined in step 3 that the UE is performing Inter-RAT mobility to or from NB-IoT, the AMF sends Nsmf\_PDUSession\_UpdateSMContext Request to SMF(s) associated with the UEs PDU Session(s), so the SMF(s) can update them according to the "PDU Session continuity at inter RAT mobility" subscription data. Steps from step 5 onwards described in clause 4.2.3.2 are executed without sending MM NAS Service Accept from the AMF to (R)AN described in step 12 of clause 4.2.3.2.

When the serving AMF has changed, the new serving AMF notifies the SMF for each PDU Session that it has taken over the responsibility of the signalling path towards the UE: the new serving AMF invokes the Nsmf\_PDUSession\_UpdateSMContext service operation using SMF information received from the old AMF at step 5. It also indicates whether the PDU Session is to be re-activated.

NOTE 13: If the UE moves into a different PLMN, the AMF in the serving PLMN can insert or change the V-SMF(s) in the serving PLMN for Home Routed PDU session(s). In this case, the same procedures described in clause 4.23.3 are applied for the V-SMF change as for the I-SMF change (i.e. by replacing the I-SMF with V-SMF). During inter-PLMN change, if the same SMF is used, session continuity can be supported depending on operator policies.

Steps from step 5 onwards described in clause 4.2.3.2 are executed. In the case that the intermediate UPF insertion, removal, or change is performed for the PDU Session(s) not included in "PDU Session(s) to be re-activated", the procedure is performed without N11 and N2 interactions to update the N3 user plane between (R)AN and 5GC.

The AMF invokes the Nsmf\_PDUSession\_ReleaseSMContext service operation towards the SMF in the following scenario:

- If any PDU Session status indicates that it is released at the UE, the AMF invokes the Nsmf\_PDUSession\_ReleaseSMContext service operation towards the SMF in order to release any network resources related to the PDU Session.

If the serving AMF is changed, the new AMF shall wait until step 18 is finished with all the SMFs associated with the UE. Otherwise, steps 19 to 22 can continue in parallel to this step.

18. [Conditional] If the new AMF and the old AMF are in the same PLMN, the new AMF sends a UE Context Modification Request to N3IWF/TNGF/W-AGF as specified in TS 29.413 [64].

If the AMF has changed and the old AMF has indicated that the UE is in CM-CONNECTED state via N3IWF, W-AGF or TNGF and if the new AMF and the old AMF are in the same PLMN, the new AMF creates an NGAP UE association towards the N3IWF/TNGF/W-AGF to which the UE is connected. This automatically releases the existing NGAP UE association between the old AMF and the N3IWF/TNGF/W-AGF.

19. N3IWF/TNGF/W-AGF sends a UE Context Modification Response to the new AMF.

19a. [Conditional] After the new AMF receives the response message from the N3IWF, W-AGF or TNGF in step 19, the new AMF registers with the UDM using Nudm\_UECM\_Registration as step 14a, but with the Access Type set to "non-3GPP access". The UDM stores the associated Access Type together with the serving AMF and does not remove the AMF identity associated to the other Access Type if any. The UDM may store in UDR information provided at the AMF registration by Nudr\_DM\_Update.

19b. [Conditional] When the UDM stores the associated Access Type (i.e. non-3GPP) together with the serving AMF as indicated in step 19a, it will cause the UDM to initiate a Nudm\_UECM\_DeregistrationNotification (see clause 5.2.3.2.2) to the old AMF corresponding to the same (i.e. non-3GPP) access. The old AMF removes the UE context for non-3GPP access.

19c. The Old AMF unsubscribes with the UDM for subscription data using Nudm\_SDM\_unsubscribe.

20a. Void.

21. New AMF to UE: Registration Accept (5G-GUTI, Registration Area, [Mobility restrictions], [PDU Session status], [Allowed NSSAI], [Mapping Of Allowed NSSAI], [Configured NSSAI for the Serving PLMN], [Mapping Of Configured NSSAI], [NSSRG Information], [rejected S-NSSAIs], [Pending NSSAI], [Mapping Of Pending NSSAI], [Periodic Registration Update timer], [Active Time], [Strictly Periodic Registration Timer Indication], [LADN Information], [accepted MICO mode], [IMS Voice over PS session supported Indication], [Emergency Service Support indicator], [Accepted DRX parameters for E-UTRA and NR], [Accepted DRX parameters for NB-IoT], [extended idle mode DRX parameters], [Paging Time Window], [Network support of Interworking without N26], [Access Stratum Connection Establishment NSSAI Inclusion Mode], [Network Slicing Subscription Change Indication], [Operator-defined access category definitions], [List of equivalent PLMNs], [Enhanced Coverage Restricted information], [Supported Network Behaviour], [Service Gap Time], [PLMN-assigned UE Radio Capability ID], [PLMN-assigned UE Radio Capability ID deletion], [WUS Assistance Information], [Truncated 5G-S-TMSI Configuration], [Connection Release Supported], [Paging Cause Indication for Voice Service Supported], [Paging Restriction Supported], [Reject Paging Request Supported]).

If the Requested NSSAI does not include S-NSSAIs which map to S-NSSAIs of the HPLMN subject to Network Slice-Specific Authentication and Authorization and the AMF determines that no S-NSSAI can be provided in the Allowed NSSAI for the UE in the current UE's Tracking Area and if no default S-NSSAI(s) not yet involved in the current UE Registration procedure could be further considered, the AMF shall reject the UE Registration and shall include in the rejection message the list of Rejected S-NSSAIs, each of them with the appropriate rejection cause value.

The Allowed NSSAI for the Access Type for the UE is included in the N2 message carrying the Registration Accept message. The Allowed NSSAI contains only S-NSSAIs that do not require, based on subscription information, Network Slice-Specific Authentication and Authorization and, based on the UE Context in the AMF, those S-NSSAIs for which Network Slice-Specific Authentication and Authorization previously succeeded, regardless of the Access Type. The Mapping Of Pending NSSAI is the mapping of each S-NSSAI of the Pending NSSAI for the Serving PLMN to the HPLMN S-NSSAIs.

If the UE has indicated its support of the Network Slice-Specific Authentication and Authorization procedure in the UE MM Core Network Capability in the Registration Request, AMF includes in the Pending NSSAI the S-NSSAIs that map to an S-NSSAI of the HPLMN which in the subscription information has indication that it is subject to Network Slice-Specific Authentication and Authorization, as described in clause 4.6.2.4 of TS 24.501 [25]. In such case, the AMF then shall trigger at step 25 the Network Slice-Specific Authentication and Authorization procedure, specified in clause 4.2.9.2, except, based on Network policies, for those S-NSSAIs for which Network Slice-Specific Authentication and Authorization have already been initiated on another Access Type for the same S-NSSAI(s). The UE shall not attempt re-registration with the S-NSSAIs included in the list of Pending NSSAIs until the Network Slice-Specific Authentication and Authorization procedure has been completed, regardless of the Access Type.

If the UE has not indicated its support of the Network Slice-Specific Authentication and Authorization procedure in the UE 5GMM Core Network Capability in the Registration Request, and the Requested NSSAI includes S-NSSAIs which map to HPLMN S-NSSAIs subject to Network Slice-Specific Authentication and Authorization, the AMF includes those S-NSSAIs in the Requested NSSAI in the Rejected S-NSSAIs.

If no S-NSSAI can be provided in the Allowed NSSAI because:

- all the S-NSSAI(s) in the Requested NSSAI are to be subject to Network Slice-Specific Authentication and Authorization; or

- no Requested NSSAI was provided or none of the S-NSSAIs in the Requested NSSAI matches any of the Subscribed S-NSSAIs, and all the S-NSSAI(s) marked as default in the Subscribed S-NSSAIs are to be subject to Network Slice-Specific Authentication and Authorization.

The AMF shall provide an empty Allowed NSSAI. Upon receiving an empty Allowed NSSAI and a Pending NSSAI, the UE is registered in the PLMN but shall wait for the completion of the Network Slice-Specific Authentication and Authorization procedure without attempting to use any service provided by the PLMN on any access, except e.g. emergency services (see TS 24.501 [25]), until the UE receives an Allowed NSSAI.

The AMF stores the NB-IoT Priority retrieved in Step 14 and associates it to the 5G-S-TMSI allocated to the UE.

If the Registration Request message received over 3GPP access does not include any Paging Restriction Information, the AMF shall delete any stored Paging Restriction Information for this UE and stop restricting paging accordingly.

If the Registration Request message received over 3GPP access includes a Release Request indication, then:

- the AMF updates the UE context with any received Paging Restriction Information, then enforces it in the network triggered Service Request procedure as described in clause 4.2.3.3;

- the AMF does not establish User Plane resources and triggers the AN release procedure as described in clause 4.2.6 after the completion of Registration procedure.

The AMF sends a Registration Accept message to the UE indicating that the Registration Request has been accepted. 5G-GUTI is included if the AMF allocates a new 5G-GUTI. Upon receiving a Registration Request message of type "Initial Registration", "mobility registration update", or "Disaster Roaming Registration" from the UE, the AMF shall include a new 5G-GUTI in the Registration Accept message. Upon receiving a Registration Request message of type "periodic registration update" from the UE, the AMF should include a new 5G-GUTI in the Registration Accept message. If the UE is already in RM-REGISTERED state via another access in the same PLMN, the UE shall use the 5G-GUTI received in the Registration Accept for both registrations. If no 5G-GUTI is included in the Registration Accept, then the UE uses the 5G-GUTI assigned for the existing registration also for the new registration. If the AMF allocates a new Registration area, it shall send the Registration area to the UE via Registration Accept message. For a Disaster Roaming Registration, the AMF allocates the Registration Area limited to the area with Disaster Condition as specified in clause 5.40 of TS 23.501 [2]. If there is no Registration area included in the Registration Accept message, the UE shall consider the old Registration Area as valid. Mobility Restrictions is included if mobility restrictions applies for the UE and Registration Type is not Emergency Registration. The AMF indicates the established PDU Sessions to the UE in the PDU Session status. The UE removes locally any internal resources related to PDU Sessions that are not marked as established in the received PDU Session status. If the AMF invokes the Nsmf\_PDUSession\_UpdateSMContext procedure for UP activation of PDU Session(s) in step 18 and receives rejection from the SMF, then the AMF indicates to the UE the PDU Session ID and the cause why the User Plane resources were not activated. When the UE is connected to the two AMFs belonging to different PLMN via 3GPP access and non-3GPP access then the UE removes locally any internal resources related to the PDU Session of the current PLMN that are not marked as established in received PDU Session status. If the PDU Session status information was in the Registration Request, the AMF shall indicate the PDU Session status to the UE.

If the RAT Type is NB-IoT and the network is configured to use the Control Plane Relocation Indication procedure then the AMF shall include in the Registration Accept message the Truncated 5G-S-TMSI Configuration that the UE using Control Plane CIoT 5GS Optimisation uses to create the Truncated 5G-S-TMSI, see clause 5.31.4.3 of TS 23.501 [2].

The Allowed NSSAI provided in the Registration Accept is valid in the Registration Area and it applies for all the PLMNs which have their Tracking Areas included in the Registration Area. The Mapping Of Allowed NSSAI is the mapping of each S-NSSAI of the Allowed NSSAI to the HPLMN S-NSSAIs. The Mapping Of Configured NSSAI is the mapping of each S-NSSAI of the Configured NSSAI for the Serving PLMN to the HPLMN S-NSSAIs.

If the UE has indicated its support of the subscription-based restrictions to simultaneous registration of network slices feature, the AMF includes, if available, the NSSRG Information, defined in clause 5.15.12 of TS 23.501 [2].

If the UE has not indicated its support of the subscription-based restrictions to simultaneous registration of network slices feature, and the subscription information for the UE includes SRG information, and the AMF is providing the Configured NSSAI to the UE, the Configured NSSAI shall include the S-NSSAIs according to clause 5.15.12 of TS 23.501 [2].

The AMF shall include in the Registration Accept message the LADN Information for the list of LADNs, described in clause 5.6.5 of TS 23.501 [2], that are available within the Registration area determined by the AMF for the UE. The AMF may include Operator-defined access category definitions to let the UE determinine the applicable Operator-specific access category definitions as described in TS 24.501 [25].

If the UE included MICO mode in the Registration Request, then AMF responds in the Registration Accept message whether MICO mode should be used. When MICO mode is allowed for the UE, the AMF may include an Active Time value and/or Strictly Periodic Registration Timer Indication in the Registration Accept message. The AMF determines the Periodic Registration Update timer value, Active Time value and the Strictly Periodic Registration Timer Indication based on local configuration, Expected UE Behaviour if available, UE indicated preferences, UE capability, UE subscription information and network policies, or any combination of them so as to enable UE power saving, as described in clause 5.31.7 of TS 23.501 [2]. The AMF determines to apply the Strictly Periodic Registration Timer Indication to the UE if the UE indicates its capability of the Strictly Periodic Registration Timer Indication in the registration request message, as described in step 1. If the AMF provides the Periodic Registration Update timer value with the Strictly Periodic Registration Timer Indication to the UE, the UE and the AMF start the Periodic Registration Update timer after this step, as described in clause 5.31.7.5 of TS 23.501 [2].

In the case of registration over 3GPP access, the AMF Sets the IMS Voice over PS session supported Indication as described in clause 5.16.3.2 of TS 23.501 [2]. In order to set the IMS Voice over PS session supported Indication the AMF may need to perform the UE Capability Match Request procedure in clause 4.2.8a to check the compatibility of the UE and NG-RAN radio capabilities related to IMS Voice over PS. If the AMF hasn't received Voice Support Match Indicator from the NG-RAN on time then, based on implementation, AMF may set IMS Voice over PS session supported Indication and update it at a later stage.

In the case of registration over 3GPP access and the AMF has retrieved or determined according to local configuration a Target NSSAI and a corresponding RFSP Index for the purpose of allowing the NG-RAN to redirect the UE to a cell supporting network slices not available in the current TA as described in clause 5.3.4.3.3 of TS 23.501 [2], the AMF provides the Target NSSAI and the corresponding RFSP Index to the NG-RAN.

In the case of registration over non-3GPP access, the AMF Sets the IMS Voice over PS session supported Indication as described in clause 5.16.3.2a of TS 23.501 [2].

The Emergency Service Support indicator informs the UE that emergency services are supported, i.e. the UE is allowed to request PDU Session for emergency services. If the AMF received "MPS priority" from the UDM as part of Access and Mobility Subscription data, based on operator policy, "MPS priority" is included in the Registration Accept message to the UE to inform the UE whether configuration of Access Identity 1 is valid within the selected PLMN, as specified in TS 24.501 [25]. If the AMF received "MCX priority" from the UDM as part of Access and Mobility Subscription data, based on operator policy and UE subscription to MCX Services, "MCX priority" is included in the Registration Accept message to the UE to inform the UE whether configuration of Access Identity 2 is valid within the selected PLMN, as specified in TS 24.501 [25]. The Accepted DRX parameters are defined in clause 5.4.5 of TS 23.501 [2]. The AMF includes Accepted DRX parameters for NB-IoT, if the UE included Requested DRX parameters for NB-IoT in the Registration Request message. The AMF Sets the Network support of Interworking without N26 parameter as described in clause 5.17.2.3.1 of TS 23.501 [2]. If the AMF accepts the use of extended idle mode DRX, the AMF includes the extended idle mode DRX parameters and Paging Time Window as described in 5.31.7.2 of TS 23.501 [2].

If the UDM intends to indicate the UE that subscription has changed, the Network Slicing Subscription Change Indication is included. If the AMF includes Network Slicing Subscription Change Indication, then the UE shall locally erase all the network slicing configuration for all PLMNs and, if applicable, update the configuration for the current PLMN based on any received information.

The Access Stratum Connection Establishment NSSAI Inclusion Mode, as specified in clause 5.15.9 of TS 23.501 [2], is included to instruct the UE on what NSSAI, if any, to include in the Access Stratum connection establishment. The AMF can set the value to modes of operation a,b,c defined in clause 5.15.9 of TS 23.501 [2] in the 3GPP Access only if the Inclusion of NSSAI in RRC Connection Establishment Allowed indicates that it is allowed to do so.

For a UE registered in a PLMN, the AMF may provide a List of equivalent PLMNs which is handled as specified in TS 24.501 [25]. For a UE registered in an SNPN, the AMF shall not provide a list of equivalent PLMNs to the UE.

If the UE included support for restriction of use of Enhanced Coverage in step 1, the AMF sends the Enhanced Coverage Restricted information to the NG-RAN in N2 message. The AMF also sends Enhanced Coverage Restricted information to the UE in the Registration Accept message.

If the UE receives Enhanced Coverage Restricted information in the Registration Accept message, the UE shall store this information and shall use the value of Enhanced Coverage Restricted information to determine if Enhanced Coverage feature should be used or not.

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

The AMF indicates the CIoT 5GS Optimisations it supports and accepts in the Supported Network Behaviour information (see clause 5.31.2 of TS 23.501 [2]) if the UE included Preferred Network Behaviour in its Registration Request.

The AMF may steer the UE from 5GC by rejecting the Registration Request. The AMF should take into account the Preferred and Supported Network Behaviour (see clause 5.31.2 of TS 23.501 [2]) and availability of EPC to the UE before steering the UE from 5GC.

If the AMF accepts MICO mode and knows there may be mobile terminated data or signalling pending, the AMF maintains the N2 connection for at least the Extended Connected Time as described in clause 5.31.7.3 of TS 23.501 [2], and provides the Extended Connected Time value to the RAN.

The AMF includes Service Gap Time if Service Gap Time is present in the subscription information (steps 14a-c) or the Service Gap Time has been updated by the Subscriber Data Update Notification to AMF procedure (see clause 4.5.1) and the UE has indicated UE Service Gap Control Capability.

If the UE receives a Service Gap Time in the Registration Accept message, the UE shall store this parameter and apply Service Gap Control (see clause 5.31.16 of TS 23.501 [2]).

If the network supports WUS grouping (see TS 23.501 [2]), the AMF shall send the WUS Assistance Information to the UE. If the UE provided the UE paging probability information in Step 1, the AMF takes it into account to determine the WUS Assistance Information.

When the UE and the AMF supports RACS as defined in clause 5.4.4.1a of TS 23.501 [2], and the AMF needs to configure the UE with a UE Radio Capability ID, and the AMF already has the UE radio capabilities other than NB-IoT radio capabilities for the UE, the AMF may provide the UE with the UE Radio Capability ID for the UE radio capabilities the UCMF returns to the AMF in a Nucmf\_assign service operation for this UE. Alternatively, when the UE and the AMF support RACS, the AMF may provide the UE with an indication to delete any PLMN-assigned UE Radio Capability ID in this PLMN (see clause 5.4.4.1a of TS 23.501 [2]).

If the UE is "CAG supported", and the AMF needs to update the CAG information of the UE, the AMF may include the CAG information as part of the Mobility Restrictions in the Registration Accept message.

If the UE indicates support for the Paging Cause Indication for Voice Service feature in the Registration Request message and if the network supports and intends to apply the Paging Cause Indication for Voice Service feature for the UE, the AMF includes an indication that the UE supports the Paging Cause Indication for Voice Service feature in the N2 message carrying the Registration Accept message.

If the Multi-USIM UE has indicated support for one or more Multi-USIM Specific Capabilities in the UE 5GMM Core Network Capability in step 1, the AMF shall indicate to the Multi-USIM UE whether the corresponding one or more Multi-USIM specific features described in clause 5.38 of TS 23.501 [2] are supported, based on network capability and preference by the network (i.e. based on local network policy), by providing one or more of the Connection Release Supported, Paging Cause Indication for Voice Service Supported, Paging Restriction Supported and Reject Paging Request Supported indications. If the Multi-USIM UE has indicated support for the Paging Cause Indication for Voice Service feature, the AMF supporting the Paging Cause Indication for Voice Service shall include an indication in the N2 message that the UE supports the Paging Cause Indication for Voice Service feature. The AMF shall only indicate Paging Restriction Supported together with either Connection Release Supported or Reject Paging Request Supported. The UE shall only use Multi-USIM specific features that the AMF indicated as being supported.

21b. [Optional] The new AMF performs a UE Policy Association Establishment as defined in clause 4.16.11. For an Emergency Registration, this step is skipped.

The new AMF sends a Npcf\_UEPolicyControl Create Request to PCF. PCF sends a Npcf\_UEPolicyControl Create Response to the new AMF.

PCF triggers UE Configuration Update Procedure as defined in clause 4.2.4.3.

22. [Conditional] UE to new AMF: Registration Complete ().

The UE sends a Registration Complete message to the AMF when it has successfully updated itself after receiving any of the [Configured NSSAI for the Serving PLMN], [Mapping Of Configured NSSAI], [NSSRG Information] and a Network Slicing Subscription Change Indication, or CAG information in step 21.

The UE sends a Registration Complete message to the AMF to acknowledge if a new 5G-GUTI was assigned.

If new 5G-GUTI was assigned, then the UE passes the new 5G-GUTI to its 3GPP access' lower layer when a lower layer (either 3GPP access or non-3GPP access) indicates to the UE's RM layer that the Registration Complete message has been successfully transferred across the radio interface.

NOTE 14: The above is needed because the NG-RAN may use the RRC Inactive state and a part of the 5G-GUTI is used to calculate the Paging Frame (see TS 38.304 [44] and TS 36.304 [43]). It is assumed that the Registration Complete is reliably delivered to the AMF after the 5G-AN has acknowledged its receipt to the UE.

When the List Of PDU Sessions To Be Activated is not included in the Registration Request and the Registration procedure was not initiated in CM-CONNECTED state, the AMF releases the signalling connection with UE, according to clause 4.2.6.

When the Follow-on request is included in the Registration Request, the AMF should not release the signalling connection after the completion of the Registration procedure.

If the AMF is aware that some signalling is pending in the AMF or between the UE and the 5GC, the AMF should not release the signalling connection immediately after the completion of the Registration procedure.

If PLMN-assigned UE Radio Capability ID is included in step 21, the AMF stores the PLMN-assigned UE Radio Capability ID in UE context if receiving Registration Complete message.

If the UE receives PLMN-assigned UE Radio Capability ID deletion indication in step 21, the UE shall delete the PLMN-assigned UE Radio Capability ID(s) for this PLMN.

23. [Conditional] AMF to UDM: If the Access and Mobility Subscription data provided by UDM to AMF in 14b includes Steering of Roaming information with an indication that the UDM requests an acknowledgement of the reception of this information from the UE, the AMF provides the UE acknowledgement to UDM using Nudm\_SDM\_Info. For more details regarding the handling of Steering of Roaming information refer to TS 23.122 [22].

23a. For Registration over 3GPP Access, if the AMF does not release the signalling connection, the AMF sends the RRC Inactive Assistance Information to the NG-RAN.

For Registration over non-3GPP Access, if the UE is also in CM-CONNECTED state on 3GPP access, the AMF sends the RRC Inactive Assistance Information to the NG-RAN.

The AMF also uses the Nudm\_SDM\_Info service operation to provide an acknowledgment to UDM that the UE received CAG information, or the Network Slicing Subscription Change Indication (see step 21 and step 22) and acted upon it.

24. [Conditional] AMF to UDM: After step 14a, and in parallel to any of the preceding steps, the AMF shall send a "Homogeneous Support of IMS Voice over PS Sessions" indication to the UDM using Nudm\_UECM\_Update:

- If the AMF has evaluated the support of IMS Voice over PS Sessions, see clause 5.16.3.2 of TS 23.501 [2], and

- If the AMF determines that it needs to update the Homogeneous Support of IMS Voice over PS Sessions, see clause 5.16.3.3 of TS 23.501 [2].

25. [Conditional] If the UE indicates its support for Network Slice-Specific Authentication and Authorization procedure in the UE MM Core Network Capability in Registration Request, and any S-NSSAI of the HPLMN is subject to Network Slice-Specific Authentication and Authorization, the related procedure is executed at this step (see clause 4.2.9.1). Once the Network Slice-Specific Authentication and Authorization procedure is completed for all S-NSSAIs, the AMF shall trigger a UE Configuration Update procedure to deliver an Allowed NSSAI containing also the S-NSSAIs for which the Network Slice-Specific Authentication and Authorization was successful, and include any rejected NSSAIs with an appropriate rejection cause value.

The AMF shall remove the mobility restriction if the Tracking Areas of the Registration Area were previously assigned as a Non-Allowed Area due to pending Network Slice-Specific Authentication and Authorization.

The AMF stores an indication in the UE context for any S-NSSAI of the HPLMN subject to Network Slice-Specific Authentication and Authorization for which the Network Slice-Specific Authentication and Authorization succeeds.

Once completed the Network Slice-Specific Authentication and Authorization procedure, if the AMF determines that no S-NSSAI can be provided in the Allowed NSSAI for the UE, which is already authenticated and authorized successfully by a PLMN, and if no default S-NSSAI(s) could be further considered, the AMF shall execute the Network-initiated Deregistration procedure described in clause 4.2.2.3.3, and shall include in the explicit De-Registration Request message the list of Rejected S-NSSAIs, each of them with the appropriate rejection cause value.

The mobility related event notifications towards the NF consumers are triggered at the end of this procedure for cases as described in clause 4.15.4.

FIFTH CHANGE

#### 4.15.3.1 Monitoring Events

The Monitoring Events feature is intended for monitoring of specific events in 3GPP system and making such monitoring events information reported via the NEF. It is comprised of means that allow NFs in 5GS for configuring the specific events, the event detection, and the event reporting to the requested party.

To support monitoring features in roaming scenarios, a roaming agreement needs to be made between the HPLMN and the VPLMN. If the AMF/SMF in the VPLMN determine that normalisation of a an event report is required, the AMF/SMF normalises the event report before sending it to the NEF.

The set of capabilities required for monitoring shall be accessible via NEF to NFs in 5GS. Monitoring Events via the UDM, the AMF, the SMF and the GMLC enables NEF to configure a given Monitor Event at UDM, AMF, SMF or GMLC, and reporting of the event via UDM and/or AMF, SMF or GMLC. Depending on the specific monitoring event or information, it is the AMF, GMLC or the UDM that is aware of the monitoring event or information and makes it reported via the NEF.

The following table enumerates the monitoring events and their detection criteria:

Table 4.15.3.1-1: List of events for monitoring capability

|  |  |  |
| --- | --- | --- |
| Event | Detection criteria | Which NF detects the event |
| Loss of Connectivity | Network detects that the UE is no longer reachable for either signalling or user plane communication (see NOTE 4).  The AF may provide a Maximum Detection Time, which indicates the maximum period of time without any communication with the UE after which the AF is to be informed that the UE is considered to be unreachable (see NOTE 7). | AMF |
| UE reachability | Detected when the UE transitions to CM-CONNECTED state or when the UE will become reachable for paging, e.g., Periodic Registration Update timer. It indicates when the UE becomes reachable for sending downlink data to the UE.  The AF may provide the following parameters:  1) Maximum Latency;  2) Maximum Response Time;  3) Suggested number of downlink packets. (see NOTE 5 and NOTE 7).  This event requires the Reachability Filter set to UE reachable for DL traffic" (see clause 5.2.2.3.1-1). For the usage of this event, see clauses 4.2.5.2 and 4.2.5.3.  When requesting UE reachability monitoring, the AF may in addition request Idle Status Indication to be included in the UE reachability event reporting. | AMF, UDM |
| Location Reporting | This event is detected based on the Event Reporting Information Parameters that were received in the Monitoring Request (one-time reporting, maximum number of reports, maximum duration of reporting, periodicity, etc., as specified in clause 4.15.1).  It reports either the Current Location or the Last Known Location of a UE.  When AMF is the detecting NF:  One-time and Continuous Location Reporting are supported. For Continuous Location Reporting the serving node(s) sends a notification every time it becomes aware of a location change, with the granularity depending on the accepted accuracy of location (see NOTE 1).  For One-time Reporting with immediate reporting flag set, AMF reports the Last Known Location immediately.  When AMF is the detecting NF:  If the immediate reporting flag is not set, the AMF reports the UE Current Location (In case the AMF does not have the UE current location in the granularity as requested by the location report, the AMF retrieves the information via NG-RAN Location reporting procedure as defined in clause 4.10).  When GMLC is the detecting NF:  Immediate and Deferred Location Reporting is supported. For Deferred Location Reporting the event types UE availability, Area, Periodic Location and Motion are supported. | AMF, GMLC |
| Change of SUPI-PEI association | This event is detected when the association between PEI and subscription (SUPI) changes (USIM change). | UDM |
| Roaming status | This event is detected based on the UE's current roaming status (the serving PLMN and/or whether the UE is in its HPLMN) and notification is sent when that status changes. (see NOTE 2).  If the UE is registered via both 3GPP and N3GPP Access Type, then both instances of Roaming status are included. | UDM |
| Communication failure | This event is detected when RAN or NAS level failure is detected based on connection release and it identifies RAN/NAS release code. | AMF |
| Availability after Downlink Data Notification failure | This event is detected when the UE becomes reachable again after downlink data delivery failure.  When requesting Availability after Downlink Data Notification failure monitoring, the AF may in addition request Idle Status Indication to be included in the UE reachability event reporting. | AMF |
| PDU Session Status | This event is detected when PDU session is established or released. (see NOTE 6) | SMF |
| Number of UEs present in a geographical area | This event is detected based on the Event Reporting Information Parameters that were received in the Monitoring Request (Level of aggregation, Sampling ratio, see clause 4.15.1).  It indicates the number of UEs that are in the geographical area described by the AF. The AF may ask for the UEs that the system knows by its normal operation to be within the area (Last Known Location) or the AF may request the system to also actively look for the UEs within the area (Current Location). | AMF |
| CN Type change | The event is detected when the UE moves between EPC and 5GC. It indicates the current CN type for a UE or a group of UEs when detecting that the UE switches between being served by a MME and an AMF or when accepting the event subscription. (see NOTE 3) | UDM |
| Downlink data delivery status | It indicates the downlink data delivery status in the core network. Events are reported at the first occurrence of packets being buffered, transmitted or discarded, including:  - Downlink data in extended buffering, including:  - First data packet buffered event  - Estimated buffering time, as per clause 4.2.3.3  - First downlink data transmitted event  - First downlink data discarded event | SMF |
| UE reachability for SMS delivery | This event is detected when an SMSF is registered for a UE and the UE is reachable as determined by the AMF and the UDM. This enables the UE to receive an SMS. See clauses 4.2.5.2 and 4.2.5.3. | UDM |
| Number of registered UEs, of UEs with at least one PDU session or established PDU Sessions | It indicates the current number of registered UEs, of UEs with at least one PDU session or of established PDU Sessions for a network slice that is subject to Network Slice Admission Control. | NSACF |
| Area Of Interest | It indicates change of the UE presence in the Area Of Interest. | AMF, GMLC |
| NOTE 1: Location granularity for event request, or event report, or both could be at cell level (Cell ID) or TA level. The granularity can also be expressed by other formats such as geodetic uncertainty shapes (e.g. polygons, circles, etc.) or civic addresses (e.g. streets, districts, etc.) which can be mapped by NEF to AMF specific granularity levels.  NOTE 2: Roaming status means whether the UE is in HPLMN or VPLMN based on the most recently received registration state in the UDM.  NOTE 3: CN type of CN Type change event is defined in clause 5.17.5.1 of TS 23.501 [2].  NOTE 4: In the case of UDM service operation information flow, the UDM should set the subscribed periodic registration timer to a smaller value than the value of Maximum Detection Time, since the value of the mobile reachable timer is larger than the value of the periodic registration timer.  NOTE 5: Maximum Latency, Maximum Response Time and Suggested number of downlink packets are defined in clause 4.15.6.3a.  NOTE 6: The NEF makes a mapping between the 5GS internal event "PDU Session Status" and the T8 API event "PDN Connectivity Status".  NOTE 7: The preferred method for provisioning Network Configuration Parameters is External Parameter Provisioning specified in clause 4.15.6.3a. Provisioning event specific parameters as part of Monitoring Request is expected to be used only by the AF that does not support Parameter Provisioning procedure specified in clause 4.15.6.3a. | | |

SIXTH CHANGE

##### 4.15.3.2.10 Number of UEs and PDU Sessions per network slice notification procedure



Figure 4.15.3.2.10-1: Number of UEs and PDU Sessions per network slice notification procedure

1. To subscribe or unsubscribe for the number of UEs, the number of UEs with at least one PDU session or the number of PDU Sessions per network slice notification with the NSACF, the AF sends Nnef\_EventExposure\_Subscribe/Unsubscribe Request (Event ID, Event Filter, Event Reporting information) message to the NEF. The Event ID parameter defines the subscribed event ID, i.e. Number of Registered UEs or Number of UEs with at least one PDU sessions or Number of Established PDU Sessions. The Event Filter parameter defines the S-NSSAI for which reporting is required. The Event Reporting information parameter defines the mode of reporting, i.e. threshold based reporting with included a threshold value or periodic reporting with included periodicity time interval.

Notifications related to the threshold based subscriptions behave as follows:

- A single notification is sent only when the number of registered UEs, number of UEs with at least one PDU sessions, or the number of established PDU Sessions reaches the threshold. A single notification is sent every time there is a change from being below the threshold to reach the threshold.

- A single notification is sent only once when the number of registered UEs, number of UEs with at least one PDU sessions,or the number of established PDU Sessions go below the threshold after reaching it. A single notification is sent every time there is a change from reaching the threshold to coming down below the threshold.

2. The NEF checks whether the AF is authorised for the requested subscription. If authorised, the NEF may query the NRF to find the NSACF responsible for the requested S-NSSAI. The NEF forwards the request to the primary NSACF for the S-NSSAI handling the specific Event ID with Nnsacf\_SliceEventExposure\_Subscribe/Unsubscribe Request (Event ID, Event Filter, Event Reporting information).

3. The NSACF confirms with Nnsacf\_SliceEventExposure\_Subscribe/Usubscribe Response message to the NEF.

4. The NEF forwards the response from NSACF via the Nnef\_EventExposure\_Subscribe/Unsibscribe Response message to the AF.

5. When the reporting condition for a subscribed event is fulfilled, the NSACF triggers a notification towards the AF.

6. The NSACF sends the Nnsacf\_SliceEvent Exposure\_Notify (Event ID, Event Filter, Event Reporting information) message to the NEF. If the subscription is for event based notification (e.g. based on the monitored event reaching a threshold value), the Event Reporting information parameter contains confirmation for the event fulfilment. If the subscription is for periodic notification, the Event Reporting information parameter provides information for the current number of UEs registered with a network slice (e.g. represented in percentage of the maximum number of the UEs registered with the network slice), information for the current number of UEs with at least one PDU sessions in a network slice (e.g. represented in percentage of the maximum number of the UEs with at least one PDU sessions in the network slice), information for the current number of PDU Sessions in a network slice (e.g. represented in percentage of the maximum number of the UEs established on the network slice) or both.

7. The NEF forwards the message to the AF in the Nnef\_EventExposure\_Notify (Event ID, Event Filter, Event Reporting information) message.

A notification can relate either to the "Number of Registered UEs" event, "Number of Registered UEs with at least one PDU sessions" event or the "Number of Established PDU Sessions" event.

SEVENTH CHANGE

##### 4.15.3.2.12 Number of UEs and PDU Sessions per network slice status retrieval by AF procedure



Figure 4.15.3.2.12-1: Number of UEs and PDU Sessions per network slice status retrieval by AF procedure

1. To retrieve information about the number of the UEs registered with a network slice, the number of UEs with at least one PDU sessions in a network slice or the number of the PDU Sessions established on a network slice or a combination thereof, the AF sends Nnef\_SliceStatus\_Retrieval Request (Event ID, Event Filter) message to the NEF. The Event ID parameter defines the information to be reported, i.e. the number of registered UEs with a network slice, the number of UEs with at least one PDU sessions in a network slice, or the number of the PDU sessions with a network slice or a combination thereof. The Event Filter parameter defines the S-NSSAI for which reporting is required.

2. The NEF checks whether the AF is authorised. If authorised, the NEF may query the NRF to find the NSACF responsible for the requested S-NSSAI.

3. The NEF invokes the request to the NSACF with Nnsacf\_SliceStatus\_Retrieval Request (Event ID, Event Filter).

4. The NSACF returns the Nnsacf\_SliceStatus\_Retrieval Response (Event ID, Event Filter, Event Reporting information) message to the NEF. In the Event Reporting information parameter the NSACF provides information for the current number of the UEs registered with a network slice (e.g. represented in percentage of the maximum number of the UEs registered with the network slice), information for the current number of UEs with at least one PDU sessions in a network slice (e.g. represented in percentage of the maximum number of the UEs with at least one PDU sessions in the network slice), or information for the current number of the PDU Sessions on a network slice (e.g. represented in percentage of the maximum number of the PDU Sessions established on the network slice) or both depending on the Event ID.

5. The NEF invokes the message to the AF with the Nnef\_SliceStatus\_Retrieval Response (Event ID, Event Filter, Event Reporting information) message.

For one S-NSSAI if multiple of NSACF is deployed in the network, the procedure has following difference:

- Step 2: The NEF finds that there are several different NSACFs served the indicated S-NSSAI.

- Step 3: The NEF invokes the request to all related NSACF. If the NSACF Set is configured in the network, the NEF selects the NSACF per NSACF Set, i.e. only one NSACF instance is selected from the NSACF Set and this NSACF instance retrieves the slice status of this Set.

- Step 5: The NEF aggregates the event reporting information from all selected NSACF before invokes the response message to the AF.

EIGHTH CHANGE

##### 5.2.3.3.1 General

Subscription data types used in the Nudm\_SubscriberDataManagement Service are defined in Table 5.2.3.3.1-1 below.

Table 5.2.3.3.1-1: UE Subscription data types

| Subscription data type | Field | Description |
| --- | --- | --- |
| Access and Mobility Subscription data (data needed for UE | GPSI List | List of the GPSI (Generic Public Subscription Identifier) used both inside and outside of the 3GPP system to address a 3GPP subscription (see NOTE 9). |
| Registration and Mobility Management) | Internal Group ID-list | List of the subscribed internal group(s) that the UE belongs to. |
|  | Subscribed UE-AMBR | The maximum aggregated uplink and downlink MBRs to be shared across all Non-GBR QoS Flows according to the subscription of the user. |
|  | Subscribed UE-Slice-MBR(s) | List of maximum aggregated uplink and downlink MBRs to be shared across all GBR and Non-GBR QoS Flows related to the same S-NSSAI according to the subscription of the user. There is a single uplink and a single downlink value per S-NSSAI. |
|  | Subscribed S-NSSAIs | The Network Slices that the UE subscribes to. In the roaming case, it indicates the subscribed Network Slices applicable to the Serving PLMN (NOTE 11). |
|  | Default S-NSSAIs | The Subscribed S-NSSAIs marked as default S-NSSAI. In the roaming case, only those applicable to the Serving PLMN (NOTE 12). |
|  | S-NSSAI subject to NSAC | The Subscribed S-NSSAIs marked as subject to NSAC. |
|  | S-NSSAI subject to NSAC with EPS counting | The Subscribed S-NSSAIs marked as subject to NSAC with EPS counting. |
|  | S-NSSAIs subject to Network Slice-Specific Authentication and Authorization | The Subscribed S-NSSAIs marked as subject to NSSAA. When present, the GPSI list shall include at least one GPSI. |
|  | Network Slice Simultaneous Registration Group Information | Optionally, for each S-NSSAI in the Subscribed S-NSSAIs, one or more value of Network Slice Simultaneous Registration Group(s) (NOTE 11) associated with the S-NSSAI. |
|  | UE Usage Type | As defined in clause 5.15.7.2 of TS 23.501 [2]. |
|  | RAT restriction | 3GPP Radio Access Technology(ies) not allowed the UE to access. |
|  | Forbidden area | Defines areas in which the UE is not permitted to initiate any communication with the network. |
|  | Service Area Restriction | Indicates Allowed Areas in which the UE is permitted to initiate communication with the network, and Non-allowed areas in which the UE and the network are not allowed to initiate Service Request or SM signalling to obtain user services. |
|  | Core Network type restriction | Defines whether UE is allowed to connect to 5GC and/or EPC for this PLMN. |
|  | CAG information | The CAG information includes Allowed CAG list and, optionally an indication whether the UE is only allowed to access 5GS via CAG cells as defined in clause 5.30.3 of TS 23.501 [2]. |
|  | CAG information Subscription Change Indication | When present, indicates to the serving AMF that the CAG information in the subscription data changed and the UE must be updated. |
|  | RFSP Index | An index to specific RRM configuration in the NG-RAN. |
|  | Subscribed Periodic Registration Timer | Indicates a subscribed Periodic Registration Timer value, which may be influenced by e.g. network configuration parameter as specified in clause 4.15.6.3a. |
|  | Subscribed Active Time | Indicates a subscribed active time value, which may be influenced by e.g. network configuration parameter as specified in clause 4.15.6.3a. |
|  | MPS priority | Indicates the user is subscribed to MPS as indicated in clause 5.16.5 of TS 23.501 [2]. |
|  | MCX priority | Indicates the user is subscribed to MCX as indicated in clause 5.16.6 of TS 23.501 [2]. |
|  | AMF-Associated Expected UE Behaviour parameters | Information on expected UE movement and communication characteristics. See clause 4.15.6.3 |
|  | Steering of Roaming | List of preferred PLMN/access technology combinations and/or Credentials Holder controlled prioritized lists of preferred SNPNs and GINs or HPLMN/Credentials Holder indication that no change of the above list(s) stored in the UE is needed (see NOTE 3).  Optionally includes an indication that the UDM requests an acknowledgement of the reception of this information from the UE. |
|  | SoR Update Indicator for Initial Registration | An indication whether the UDM requests the AMF to retrieve SoR information when the UE performs Registration with NAS Registration Type "Initial Registration". |
|  | SoR Update Indicator for Emergency Registration | An indication whether the UDM requests the AMF to retrieve SoR information when the UE performs Registration with NAS Registration Type "Emergency Registration". |
|  | Network Slicing Subscription Change Indicator | When present, indicates to the serving AMF that the subscription data for network slicing changed and the UE configuration must be updated. |
|  | Tracing Requirements | Trace requirements about a UE (e.g. trace reference, address of the Trace Collection Entity, etc.) is defined in TS 32.421 [39].  This information is only sent to AMF in the HPLMN or one of its equivalent PLMN(s). |
|  | Inclusion of NSSAI in RRC Connection Establishment Allowed | When present, it is used to indicate that the UE is allowed to include NSSAI in the RRC connection Establishment in clear text for 3GPP access. |
|  | Service Gap Time | Used to set the Service Gap timer for Service Gap Control (see clause 5.31.16 of TS 23.501 [2]). |
|  | Subscribed DNN list | List of the subscribed DNNs for the UE (NOTE 1). Used to determine the list of LADN available to the UE as defined in clause 5.6.5 of TS 23.501 [2]. |
|  | UDM Update Data | Includes a set of parameters see clause 4.20.1 for parameters possible to deliver) to be delivered from UDM to the UE via NAS signalling as defined in clause 4.20 (NOTE 3).  Optionally includes an indication that the UDM requests an acknowledgement of the reception of this information from the UE and an indication for the UE to re-register. |
|  | NB-IoT UE priority | Numerical value used by the NG-RAN to prioritise between UEs accessing via NB-IoT. |
|  | Enhanced Coverage Restriction | Specifies whether CE mode B is restricted for the UE, or both CE mode A and CE mode B are restricted for the UE, or both CE mode A and CE mode B are not restricted for the UE. |
|  | NB-IoT Enhanced Coverage Restriction | Indicates whether Enhanced Coverage for NB-IoT UEs is restricted or not. |
|  | IAB-Operation allowed | Indicates that the subscriber is allowed for IAB-operation as specified in clause 5.35.2 of TS 23.501 [2]. |
|  | Charging Characteristics | It contains the Charging Characteristics as defined in Annex A of TS 32.256 [71].  This information, when provided, shall override any corresponding predefined information at the AMF. |
|  | Extended idle mode DRX cycle length | Indicates a subscribed extended idle mode DRX cycle length value. |
|  | PCF Selection Assistance info | list of combination of DNN and S-NSSAI that indicates that the same PCF needs to be selected for AM Policy Control and SM Policy Control (NOTE 10). |
|  | AerialUESubscriptionInfo | Aerial UE Subscription Information. It contains an Indication on whether Aerial service for the UE is allowed or not. |
| Slice Selection Subscription data (data needed for | Subscribed S-NSSAIs | The Network Slices that the UE subscribes to. In roaming case, it indicates the subscribed network slices applicable to the serving PLMN (NOTE 11). |
| Slice Selection as described in clause 4.2.2.2.3 and | Default S-NSSAIs | The Subscribed S-NSSAIs marked as default S-NSSAI. In the roaming case, only those applicable to the Serving PLMN (NOTE 12). |
|  | S-NSSAI subject to NSAC | The Subscribed S-NSSAIs marked as subject to NSAC. |
|  | S-NSSAI subject to NSAC with EPS counting | The Subscribed S-NSSAIs marked as subject to NSAC with EPS counting. |
| in clause 4.11.0a.5) | S-NSSAIs subject to Network Slice-Specific Authentication and Authorization | The Subscribed S-NSSAIs marked as subject to NSSAA. |
|  | Network Slice Simultaneous Registration Group (NSSRG) Information | Optionally, for each S-NSSAI in the Subscribed S-NSSAIs, the one or more value of Network Slice Simultaneous Registration Group(s) (NOTE 11) associated with the S-NSSAI. |
| SMF Selection | SUPI | Key |
| Subscription data (data needed for SMF | **SMF Selection Subscription data contains one or more S-NSSAI level subscription data:** | |
| Selection as described | S-NSSAI | Indicates the value of the S-NSSAI. |
|  | S-NSSAI subject to NSAC | The Subscribed S-NSSAIs marked as subject to NSAC. |
|  | S-NSSAI subject to NSAC with EPS counting | The Subscribed S-NSSAIs marked as subject to NSAC with EPS counting. |
| in clause 6.3.2 of | Subscribed DNN list | List of the subscribed DNNs for the UE (NOTE 1). |
| TS 23.501 [2]) | Default DNN | The default DNN if the UE does not provide a DNN (NOTE 2). |
|  | DNN(s) subject to aerial services | List of DNNs that are used for aerial services (e.g. UAS operations or C2, etc.) as described in TS 23.256 [80]. (see NOTE 13). |
|  | LBO Roaming Information | Indicates whether LBO roaming is allowed per DNN, or per (S-NSSAI, subscribed DNN). |
|  | Interworking with EPS indication list | Indicates whether EPS interworking is supported per (S-NSSAI, subscribed DNN). |
|  | Same SMF for Multiple PDU Sessions to the same DNN and S-NSSAI | Indication whether the same SMF for multiple PDU Sessions to the same DNN and S-NSSAI is required. |
|  | Invoke NEF indication | When present, indicates, per S-NSSAI and per DNN, that NEF based infrequent small data transfer shall be used for the PDU Session (see NOTE 8). |
|  | SMF information for static IP address/prefix | When static IP address/prefix is used, this may be used to indicate the associated SMF information per (S-NSSAI, DNN). |
| UE context in SMF | SUPI | Key. |
| data | PDU Session Id(s) | List of PDU Session Id(s) for the UE. |
|  | **For emergency PDU Session Id:** | |
|  | Emergency Information | The SMF+PGW-C FQDN for emergency session used for interworking with EPC. |
|  | **For each non-emergency PDU Session Id:** | |
|  | DNN | DNN for the PDU Session. |
|  | SMF | Allocated SMF for the PDU Session. Includes SMF IP Address and SMF NF Id. |
|  | SMF+PGW-C FQDN | The S5/S8 SMF+PGW-C FQDN used for interworking with EPS (see NOTE 5). |
|  | PCF ID | The PCF ID serving the PDU Session/PDN Connection. |
| SMS Management Subscription data (data needed by | SMS parameters | Indicates SMS parameters subscribed for SMS service such as SMS teleservice, SMS barring list |
| SMSF for SMSF Registration) | Trace Requirements | Trace requirements about a UE (e.g. trace reference, address of the Trace Collection Entity, etc.) is defined in TS 32.421 [39].  This information is only sent to a SMSF in HPLMN. |
| SMS Subscription data | SMS Subscription | Indicates subscription to any SMS delivery service over NAS irrespective of access type. |
| (data needed in AMF) |  |  |
| UE Context in SMSF data | SMSF Information | Indicates SMSF allocated for the UE, including SMSF address and SMSF NF ID. |
|  | Access Type | 3GPP or non-3GPP access through this SMSF |
| Session Management Subscription data (data needed for PDU | GPSI List | List of the GPSI (Generic Public Subscription Identifier) used both inside and outside of the 3GPP system to address a 3GPP subscription. |
| Session Establishment) | Internal Group ID-list | List of the subscribed internal group(s) that the UE belongs to. |
|  | Trace Requirements | Trace requirements about a UE (e.g. trace reference, address of the Trace Collection Entity, etc…) is defined in TS 32.421 [39].  This information is only sent to a SMF in the HPLMN or one of its equivalent PLMN(s). |
|  | **Session Management Subscription data contains one or more S-NSSAI level subscription data:** | |
|  | S-NSSAI | Indicates the value of the S-NSSAI. |
|  | S-NSSAI subject to NSAC | The Subscribed S-NSSAIs marked as subject to NSAC. |
|  | S-NSSAI subject to NSAC with EPS counting | The Subscribed S-NSSAIs marked as subject to NSAC with EPS counting. |
|  | Subscribed DNN list | List of the subscribed DNNs for the S-NSSAI (NOTE 1). |
|  | **For each DNN in S-NSSAI level subscription data:** | |
|  | DNN | DNN for the PDU Session. |
|  | Aerial service indication | Indicates whether the DNN is used for aerial services (e.g. UAS operations or C2, etc.) as described in TS 23.256 [80]. |
|  | Framed Route information | Set of Framed Routes. A Framed Route refers to a range of IPv4 addresses / IPv6 Prefixes to associate with a PDU Session established on this (DNN, S-NSSAI).  See NOTE 4. |
|  | IP Index information | Information used for selecting how the UE IP address is to be allocated (see clause 5.8.2.2.1 in TS 23.501 [2]). |
|  | Allowed PDU Session Types | Indicates the allowed PDU Session Types (IPv4, IPv6, IPv4v6, Ethernet, and Unstructured) for the DNN, S-NSSAI. See NOTE 6. |
|  | Default PDU Session Type | Indicates the default PDU Session Type for the DNN, S-NSSAI. |
|  | Allowed SSC modes | Indicates the allowed SSC modes for the DNN, S-NSSAI. |
|  | Default SSC mode | Indicate the default SSC mode for the DNN, S-NSSAI. |
|  | Interworking with EPS indication | Indicates whether interworking with EPS is supported for this DNN and S-NSSAI. |
|  | 5GS Subscribed QoS profile | The QoS Flow level QoS parameter values (5QI and ARP) for the DNN, S-NSSAI (see clause 5.7.2.7 of TS 23.501 [2]). |
|  | Charging Characteristics | It contains Charging Characteristics as defined in Annex A clause A.1 of TS 32.255 [45]. This information, when provided, shall override any corresponding predefined information at the SMF. |
|  | Subscribed-Session-AMBR | The maximum aggregated uplink and downlink MBRs to be shared across all Non-GBR QoS Flows in each PDU Session, which are established for the DNN, S-NSSAI. |
|  | Static IP address/prefix | Indicate the static IP address/prefix for the DNN, S-NSSAI. |
|  | User Plane Security Policy | Indicates the security policy for integrity protection and encryption for the user plane. |
|  | PDU Session continuity at inter RAT mobility | Provides for this DDN, S-NSSAI how to handle a PDU Session when UE the moves to or from NB-IoT. Possible values are: maintain the PDU session; disconnect the PDU session with a reactivation request; disconnect PDU session without reactivation request; or to leave it to local VPLMN policy. |
|  | NEF Identity for NIDD | When present, indicates, per S-NSSAI and per DNN, the identity of the NEF to anchor Unstructured PDU Session. When not present for the S-NSSAI and DNN, the PDU session terminates in UPF (see NOTE 8). |
|  | NIDD information | Information such as External Group Identifier, External Identifier, MSISDN, or AF Identifier used for SMF-NEF Connection. |
|  | SMF-Associated Expected UE Behaviour parameters | Parameters on expected characteristics of a PDU Session their corresponding validity times as specified in clause 4.15.6.3. |
|  | Suggested number of downlink packets | Parameters on expected PDU session characteristics as specified in clauses 4.15.3.2.3b and 4.15.6.3a. |
|  | ATSSS information | Indicates whether MA PDU session establishment is allowed. |
|  | Secondary authentication indication | Indicates that whether the Secondary authentication/authorization (as defined in clause 5.6 of TS 23.501 [2]) is required for PDU Session Establishment as specified in clause 4.3.2.3. (see NOTE 14) |
|  | DN-AAA server UE IP address allocation indication | Indicates that whether the SMF is required to request the UE IP address from the DN-AAA server (as defined in clause 5.6 of TS 23.501 [2]) for PDU Session Establishment as specified in clause 4.3.2.3. |
|  | DN-AAA server addressing information | If at least one of secondary DN-AAA authentication, DN-AAA authorization or DN-AAA UE IP address allocation is required by subscription data, the subscription data may also contain DN-AAA server addressing information. |
|  | Edge Configuration Server Address Configuration Information | Consists of one or more FQDN(s) and/or IP Address(es) of Edge Configuration Server(s) as defined in clause 6.5.2 of TS 23.548 [74]. |
|  | API based secondary authentication indication | Indicates that whether the API based Secondary authentication/authorization (as defined in clause 5.2.3 of TS 23.256 [80]) is required for PDU Session Establishment as specified in clause 4.3.2.3. (see NOTE 14). |
| Identifier translation | SUPI | Corresponding SUPI for input GPSI. |
|  | (Optional) MSISDN | Corresponding GPSI (MSISDN) for input GPSI (External Identifier). This is optionally provided for legacy SMS infrastructure not supporting MSISDN-less SMS. The presence of an MSISDN should be interpreted as an indication to the NEF that MSISDN shall be used to identify the UE when sending the SMS to the SMS-SC via T4. |
|  | GPSI | Corresponding GPSI for input SUPI and Application Port ID. |
| Intersystem continuity Context | (DNN, PGW FQDN) list | For each DNN, indicates the SMF+PGW-C which support interworking with EPC. |
| LCS privacy  (data needed by GMLC) | LCS privacy profile data | Provides information for LCS privacy classes and Location Privacy Indication (LPI) as defined in clause 5.4.2 in TS 23.273 [51] |
| LCS mobile origination  (data needed by AMF) | LCS Mobile Originated Data | When present, indicates to the serving AMF which LCS mobile originated services are subscribed as defined in clause 7.1 in TS 23.273 [51]. |
| User consent (see TS 23.288 [50]) | User consent for UE data collection | Indicates whether the user has given consent for collecting, distributing, and analysing UE related data. User consent is provided per purpose (e.g. analytics, model training). |
| UE reachability | UE reachability information | Provides, per PLMN, the list of NF IDs or the list of NF sets or the list of NF types authorized to request notification for UE's reachability (NOTE 7). |
| V2X Subscription data (see TS 23.287 [73]) | NR V2X Services Authorization | Indicates whether the UE is authorized to use the NR sidelink for V2X services as Vehicle UE, Pedestrian UE, or both. |
|  | LTE V2X Services Authorization | Indicates whether the UE is authorized to use the LTE sidelink for V2X services as Vehicle UE, Pedestrian UE, or both. |
|  | NR UE-PC5-AMBR | AMBR of UE's NR sidelink (i.e. PC5) communication for V2X services. |
|  | LTE UE-PC5-AMBR | AMBR of UE's LTE sidelink (i.e. PC5) communication for V2X services. |
| ProSe Subscription data (see TS 23.304 [77]) | ProSe Service Authorization | Indicates whether the UE is authorized to use ProSe Direct Discovery, ProSe Direct Communication, or both and whether the UE is authorized to use or serve as a ProSe UE-to-Network Relay. |
|  | ProSe NR UE-PC5-AMBR | AMBR of UE's NR sidelink (i.e. PC5) communication for ProSe services. |
| MBS Subscription data (see TS 23.247 [78]) | MBS Service Authorization | Indicates whether the UE is authorized to use Multicast MBS service. |
| NOTE 1: The Subscribed DNN list can include a wildcard DNN.  NOTE 2: The default DNN shall not be a wildcard DNN.  NOTE 3: The Steering of Roaming information and UDM Update Data are protected using the mechanisms defined in TS 33.501 [15].  NOTE 4: Framed Route information and Framed Route(s) are defined in TS 23.501 [2].  NOTE 5: Depending on the scenario PGW-C FQDN may be for S5/S8, or for S2b (ePDG case).  NOTE 6: The Allowed PDU Session Types configured for a DNN which supports interworking with EPC should contain only the PDU Session Type corresponding to the PDN Type configured in the APN that corresponds to the DNN.  NOTE 7: Providing a list of NF types or a list of NF sets may be more appropriate for some deployments, e.g. in highly dynamic NF lifecycle management deployments.  NOTE 8: For a S-NSSAI and a DNN, the "Invoke NEF Indication" shall be present in the SMF selection subscription data if and only if the "NEF Identity for NIDD" Session Management Subscription Data includes a NEF Identity. When the "NEF Identity for NIDD" Session Management Subscription Data includes a NEF Identity for a S-NSSAI and DNN, the "Control Plane Only Indicator" will always be set for PDU Sessions to this S-NSSAI and DNN (see clause 5.31.4.1 of TS 23.501 [2]).  NOTE 9: When multiple GPSIs are included in the GPSI list, any GPSI in the list can be used in NSSAA procedures.  NOTE 10: The same PCF can be selected to serve the UE and to serve one or multiple PDU sessions, each of them is indicated in the list of S-NSSAI, DNN combinations in the PCF Selection Assistance Info. Providing one combination of DNN and S-NSSAI in the PCF Selection Assistance Info is assumed if interworking with EPS is needed. In case multiple PDU sessions to one DNN, S-NSSAI are established in EPS, it is appropriate to select same PCF by configuration or by using existing method, e.g. same PCF selection in usage monitoring.  NOTE 11: If Network Slice Simultaneous Registration Group information is present, and the VPLMN does not support the subscription-based restrictions to simultaneous registration of network slices, the subset of the Subscribed S-NSSAIs defined in clause 5.15.12 of TS 23.501 [2], are included, without providing the NSSRG information.  NOTE 12: The Default S-NSSAIs (if more than one is present) are associated with common NSSRG values if NSSRG information is present. At least one Default S-NSSAI shall be present in a subscription including NSSRG information.  NOTE 13: When UUAA is performed in the AMF (as in clause 5.2.2 of TS 23.256 [80]) and UUAA-MM status is FAILED or PENDING, the AMF shall reject PDU session establishment requests from the UE for a DNN that is subject to aerial services.  NOTE 14: For a DNN in S-NSSAI either a DN-AAA based secondary authentication, or an API based secondary authentication can be configured. When API based authentication of the PDU session is required, Secondary authentication indication shall not be present. | | |

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#### 5.2.21.1 General

The following table illustrates the NSACF services.

Table 5.2.21.1-1: List of NSACF services

|  |  |  |  |
| --- | --- | --- | --- |
| Service Name | Service Operations | Operation Semantics | Example Consumer(s) |
| Nnsacf\_NSAC | NumOfUEsUpdate | Request/Response | AMF, SMF, NSACF (NOTE 1) |
|  | NumOfPDUsUpdate |  | SMF, NSACF |
|  | EACNotify |  | AMF, NSACF |
| Nnsacf\_SliceEventExposure | Subscribe | Subscribe/Notify | NEF, AF (NOTE 2) |
|  | Unsubscribe |  | NEF, AF |
|  | Notify |  | NEF, AF |
| Nnsacf\_SliceStatus | Retrieval | Request/Response | NEF, AF |
| NOTE: If a NSACF acts as proxy then it can request services of another NSACFs.  NOTE 2: The AF can access NSACF services either via NEF to NSACF in case of untrusted AF or directly in case of trusted AF. | | | |

#### 5.2.21.2 Nnsacf\_NSAC services

##### 5.2.21.2.1 General

**Service Description:** The Nnsacf\_NSAC services control the number of UEs registered with a Network Slice, the number of UEs with at least one PDU session associated with a Network Slice and the number of PDU Sessions associated with a network slice for the network slices subject to NSAC. The consumer NF (e.g. AMF) can request the NSACF to check whether the number of UEs registered with a network slice has reached the maximum number of UEs per network slice and the consumer NF can also request the NSACF to update the number of UEs registered with a network slice. The SMF can request the NSACF to check whether the number of PDU Sessions established on a network slice has reached the maximum number of PDU Sessions per network slice and the SMF can also request the NSACF to update the number of PDU Sessions established on a network slice. The NSACF can indicate to the consumer fucntion when a threshold has been reached on any of the above and request to reject the UE registration or PDU session establishment.

##### 5.2.21.2.2 Nnsacf\_NSAC\_NumOfUEsUpdate service operation

**Service Operation name:** Nnsacf\_NSAC\_NumOfUEsUpdate

**Description:** Updates the number of UEs registered with a network slice (e.g. increase or decrease) when the UE registration status for a network slice subject to NSAC has changed. Also, if the number of the UEs registered with the network slice is to be increased and the Early Availability Check (EAC) mode in the NSACF is activated for that network slice (see Nnsacf\_NSAC\_EACNotify service operation), the NSACF first checks whether the number of UEs registered with the network slice has reached the maximum number of UEs per network slice threshold. If the maximum number of UEs registered with the network slice has already been reached, the UE registration for that network slice is rejected. If the EAC is not activated, the NSACF increases or decreases the number of UEs per network slice as per the input parameters below.

**Inputs, Required:** S-NSSAI(s), UE ID (SUPI), NF ID, access type, update flag.

**Inputs, Conditional:** Notification endpoint for EAC Notification for the S-NSSAI.

The S-NSSAI(s) parameter is a list of one or more network slices for which the number of UEs registered with a network slice is to be updated and checked if the maximum number of UEs per network slice threshold has already been reached.

The UE ID is used by the NSACF to maintain a list of UE IDs registered with the network slice. The NSACF also takes access type into account for increasing and decreasing the number of UEs per network slice as described in clause 5.15.11.1 of TS 23.501 [2].

The NF ID parameter is the NF instance ID of the NF (e.g. AMF or SMF + PGW-C) sending the request to the NSACF.

The update flag input parameter indicates whether the number of UEs registered with a network slice is to be:

- increased when the UE registers to a new network slice subject to NSAC. If the UE ID is already in the list of UEs registered with the network slice, the number of UEs registered with the network slice is not increased as the UE has already been counted as registered with the network slice. If the UE ID is not in the list of UE IDs registered with the network slice and the maximum number of UEs registered with the network slice has not been reached yet, the NSACF adds the UE ID in the list of UEs registered with the network slice and increases the number of the UEs registered with the network slice. If the UE\_ID is not in the list of UEs registered with that S-NSSAI and the maximum number of UEs per network slice for that S-NSSAI has already been reached, then the NSACF returns maximum number of UEs per network slice reached result;

- decreased when the UE deregisters for a network slice that is subject to NSAC. The NSACF decreases the number of the UEs registered with the network slice and removes the UE ID from the list of UEs registered with the network slice.

If this is the first time to perform NSAC procedure for the S-NSSAI towards the NSACF, the AMF includes notification endpoint for EAC Notification to implicitly subscribe the EAC notification for the S-NSSAI from the NSACF.

The NSACF may optionally return the current status of the network slice availability (e.g. a percentage out of the maximum number of UEs registered with a network slice) in the availability status parameter. This information may be used for NSACF signalling and load balancing in case multiple NSACFs are serving the same network slice.

**Outputs, Required:** availability status.

**Outputs, Conditional:** maximum number of UEs per Network Slice reached (if availability status is "not available")

##### 5.2.21.2.3 Nnsacf\_NSAC\_EACNotify service operation

**Service Operation name:** Nnsacf\_NSAC\_EACNotify

**Description:** The NSACF may trigger notification to the consumer NF (e.g. AMF) to indicate the activation of the Early Availability Check (EAC) mode for a certain network slice which is subject to NSAC when the number of the UEs registered with the network slice is above certain operator defined threshold (e.g. a percentage of the maximum number of UEs allowed to register with the network slice) and the deactivation of the EAC mode when the number of the UEs registered with the network slice is below certain operator defined threshold which may be same or different from the activation threshold.

**Inputs, Required:** S-NSSAI, EAC flag.

The S-NSSAI input parameter is the network slice for which the NSACF activates or deactivates the EAC mode.

The EAC flag input parameter indicates whether the Slice EAC mode is activated or deactivated.

**Inputs, Optional:** None.

**Output, Required:** None.

**Output, Optional:** None.

##### 5.2.21.2.4 Nnsacf\_NSAC\_NumOfPDUsUpdate service operation

**Service Operation name:** Nnsacf\_NSAC\_NumOfPDUsUpdate

**Description:** Updates the number of PDU Sessions established on a network slice (e.g. increase or decrease). Also, if the number of PDU Sessions on the network slice is to be increased, the NSACF first checks whether the number of the PDU Sessions on that Network Slice has reached the maximum number of PDU Sessions per network slice threshold. If the maximum number of PDU Sessions on the Network Slice has already been reached, the PDU Session Establishment procedure is rejected. The NSACF first checks whether the number of UEs with at least one PDU session of the Network Slice has reached the maximum number of per network slice threshold. If the maximum number of UEs with at least one PDU Session on the Network Slice has already been reached, the PDU Session Establishment procedure is rejected.

**Inputs, Required:** S-NSSAI, UE ID, PDU Session ID, Access Type, update flag.

The S-NSSAI parameter is the network slice for which the number of PDU Sessions established on a network slice is to be updated.

The UE ID is used by the NSACF to maintain a list of UE IDs that has established PDU sessions with the network slice.

PDU Session ID is used by the NSACF to maintain for each UE ID, the PDU Session ID(s) for established PDU Sessions.

The Access Type parameter indicates whether the PDU session is established over 3GPP or non 3GPP access type.

The update flag input parameter indicates whether the number of the PDU Sessions established on that network slice is to be increased, for example at PDU Session Establishment procedure, or decreased, for example at PDU Session Release procedure.

**Inputs, Optional:** None.

**Outputs, Required:** availability status

**Outputs, Conditional:** maximum number of PDU Sessions per Network Slice reached and or Maximum number of UEs with at least one PDU session of the Network Slice is reached (if availability status is "not available").

#### 5.2.21.3 Void

#### 5.2.21.4 Nnsacf\_SliceEventExposure services

##### 5.2.21.4.1 General

**Service Description:** The Nnsacf\_SliceEventExposure services provide event based notifications to the consumer NF related to the current number of UEs registered for a network slice or/and the current number of PDU Sessions established on a network slice.

##### 5.2.21.4.2 Nnsacf\_SliceEventExposure\_Subscribe service operation

**Service operation name:** Nnsacf\_SliceEventExposureSubscribe

**Description:** This service operation is used by the consumer NF to subscribe or modify a subscription with the NSACF for event based notifications of the current number of UEs registered for a network slice, the current number of UEs with at least one PDU session in a network slice, or the current number of PDU Sessions established in a network slice or all of them.

**Inputs, Required:** Event ID, Event Filter, Event Reporting information.

The Event ID parameter defines whether to notify the number of UEs registered with a network slice, the current number of UEs with at least one PDU session in a network slice or the number of PDU Sessions established on a network slice or a combination thereof .

The Event Filter parameter is the S-NSSAI for which the events are to be notified to the consumer NF.

The Event Reporting information parameter defines whether the notification is threshold based (e.g. the notification is triggered when the current number of UEs reaches a defined threshold value) or the notification is periodical (e.g. the notification is triggered at expiry of a periodic timer).

**Inputs, Optional:** Notification threshold, Notification periodicity.

The Notification threshold parameter is optional. It is provided when the Notification is threshold base. The notification threshold parameter may be a numeric value or a percentage of the maximum number of the UEs, the maximum number of UEs with at least one PDU session in a network slice or of PDU Sessions per network slice.

The Notification periodicity parameter is optional. It is provided when the Notification is periodical. The Notification periodicity parameter defines the time between the notification periodicity.

**Outputs, Required:** Operation execution result response, Subscription Correlation Id.

##### 5.2.21.4.3 Nnsacf\_SliceEventExposure\_Unsubscribe service operation

**Service operation name:** Nnsacf\_SliceEventExposure\_Unsubscribe

**Description:** This service operation is used by the consumer NF to unsubscribe from the event notification.

**Inputs, Required:** Subscription Correlation Id.

**Outputs, Required:** Operation execution result response.

##### 5.2.21.4.4 Nnsacf\_SliceEventExposure\_Notify service operation

**Service operation name:** Nnsacf\_SliceEventExposure\_Notify

**Description:** This service operation is used by the NSACF to report the current number of UEs registered with a network slice, the current number of UEs with at least one PDU session in a network slice or the current number of PDU Sessions established in a network slice in numbers or in percentage from the maximum allowed numbers, based on threshold or at expiry of periodic timer.

**Inputs, Required:** Event ID, Event Filter, Event Reporting information, Notification Correlation Information.

The Event ID parameter defines the type of the reported information, i.e. the number of UEs registered with a network slice, the number of UEs with at least one PDU session in a network slice or the number of PDUs Sessions established on a network slice or both.

The Event Filter parameter is the S-NSSAI for which the Notification applies.

The Event Reporting information parameter provides the network slice status information in terms of the current number of UEs registered with a network slice, the current number of UEs with at least one PDU session in a network slice or the current number of PDU Sessions established on a network slice or or a combination thereof. If the Notification is threshold based where the threshold is a certain number of UEs registered with a network slice or PDU Sessions established on a network slice or the threshold is a percentage of the maximum number of UEs registered with a network slice, ,the maximum number of UEs with at least one PDU session in a network slice or the maximum number of PDU Sessions established on a network slice, the Event Reporting information parameter contains confirmation for reaching this threshold value. If the Notification is periodical, the Event Reporting information parameter provides information for the current number of UEs registered with a network slice (e.g. represented in percentage of the maximum number of the UEs registered with the network slice), information for the current number of UEs with at least one PDU session in a network slice (e.g. represented in percentage of the maximum number of the UEs with at least one PDU session in the network slice) or information for the current number of PDU Sessions established on a network slice (e.g. represented in percentage of the maximum number of the PDU Sessions established on the network slice) or both with periodicity provided during the subscription.

**Outputs, Required:** None.

#### 5.2.21.5 Nnsacf\_SliceStatus services

##### 5.2.21.5.1 General

**Service Description:** The Nnsacf\_SliceStatus services provide network slice status information on request from the consumer NF (e.g. AF via NEF) related to the current number of UEs registered with a network slice or the current number of PDU Sessions established on a network slice or both.

##### 5.2.21.5.2 Nnsacf\_SliceStatus\_Retrieval service operation

**Service operation name:** Nnsacf\_SliceStatus\_Retrieval

**Description:** This service operation is used by the consumer NF to retrieve the network slice status information related to the number of UEs registered for a network slice, of the number of UEs registered with at least a PDU session in the network slice, or the number of PDU Sessions established on a network slice or both.

**Inputs, Required:** Event ID, Event Filter.

The Event ID parameter defines whether the requested information is about the number of UEs registered with a network slice, the number of UEs registered with at least a PDU session in the network slice, or the number of PDU Sessions established on a network slice or a combination thereof.

The Event Filter parameter is the S-NSSAI for which the requested information is applicable.

**Outputs, Required:** Event ID, Event Filter, Event Reporting information.

The Event ID parameter defines the type of the reported information, i.e. information about the number of UEs registered with a network slice, information about the number of UEs registered with at least a PDU session in the network slice, or the number of PDUs Sessions established on a network slice or a combination thereof.

The Event Filter parameter is the S-NSSAI for which the information retrieval is applicable.

The Event Reporting information parameter provides information for the current number of UEs registered with a network slice (e.g. represented in percentage of the maximum number of the UEs registered with the network slice), information for the current number of UEs with at least one PDU session in a network slice (e.g. represented in percentage of the maximum number of the UEs with at least one PDU session in the network slice), or information for the current number of PDU Sessions established on a network slice (e.g. represented in percentage of the maximum number of the PDU Sessions established on the network slice) or both.

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