|  |  |
| --- | --- |
| 3GPP TR 23.700-41 V0.2.0 (2022-04) | |
| Technical Report | |
| 3rd Generation Partnership Project;  Technical Specification Group Services and System Aspects;  Study on enhancement of network slicing;  Phase 3  (Release 18) | |
|  | |
|  | 3GPP-logo_web |
|  | |
| The present document has been developed within the 3rd Generation Partnership Project (3GPP TM) and may be further elaborated for the purposes of 3GPP. The present document has not been subject to any approval process by the 3GPPOrganizational Partners and shall not be implemented. This Specification is provided for future development work within 3GPPonly. The Organizational Partners accept no liability for any use of this Specification. Specifications and Reports for implementation of the 3GPP TM system should be obtained via the 3GPP Organizational Partners' Publications Offices. | |

|  |
| --- |
|  |
| ***3GPP***  Postal address  3GPP support office address  650 Route des Lucioles - Sophia Antipolis  Valbonne - FRANCE  Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16  Internet  http://www.3gpp.org |
| ***Copyright Notification***  No part may be reproduced except as authorized by written permission. The copyright and the foregoing restriction extend to reproduction in all media.  © 2022, 3GPP Organizational Partners (ARIB, ATIS, CCSA, ETSI, TSDSI, TTA, TTC).  All rights reserved.  UMTS™ is a Trade Mark of ETSI registered for the benefit of its members  3GPP™ is a Trade Mark of ETSI registered for the benefit of its Members and of the 3GPP Organizational Partners LTE™ is a Trade Mark of ETSI registered for the benefit of its Members and of the 3GPP Organizational Partners  GSM® and the GSM logo are registered and owned by the GSM Association |

Contents

Foreword 4

1 Scope 6

2 References 6

3 Definitions of terms and abbreviations 7

3.1 Terms 7

3.2 Abbreviations 7

4 Architectural Assumptions and Requirements 7

5 Key Issues 7

5.1 Key Issue #1: Support of Network Slice Service continuity 7

5.1.1 Description 7

5.2 Key Issue #2: Support of providing VPLMN network slice information to a roaming UE 8

5.2.1 Description 8

5.3 Key Issue #3: Network Slice Area of Service for services not mapping to existing TAs boundaries, and Temporary network slices 8

5.3.1 Description 8

5.4 Key Issue #4: Support of NSAC involving multi service Area 9

5.4.1 Description 9

6 Solutions 9

6.0 Mapping of Solutions to Key Issues 9

6.X Solution #X: <Solution Title> 9

6.X.1 Introduction 9

6.X.2 Functional Description 9

6.X.3 Procedures 9

6.X.4 Impacts on services, entities and interfaces 10

7 Overall Evaluation 10

8 Conclusions 10

8.X Conclusions for Key Issue #X 10

Annex A: Change history 11

# Foreword

This Technical Report has been produced by the 3rd Generation Partnership Project (3GPP).

The contents of the present document are subject to continuing work within the TSG and may change following formal TSG approval. Should the TSG modify the contents of the present document, it will be re-released by the TSG with an identifying change of release date and an increase in version number as follows:

Version x.y.z

where:

x the first digit:

1 presented to TSG for information;

2 presented to TSG for approval;

3 or greater indicates TSG approved document under change control.

y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.

z the third digit is incremented when editorial only changes have been incorporated in the document.

In the present document, modal verbs have the following meanings:

**shall** indicates a mandatory requirement to do something

**shall not** indicates an interdiction (prohibition) to do something

The constructions "shall" and "shall not" are confined to the context of normative provisions, and do not appear in Technical Reports.

The constructions "must" and "must not" are not used as substitutes for "shall" and "shall not". Their use is avoided insofar as possible, and they are not used in a normative context except in a direct citation from an external, referenced, non-3GPP document, or so as to maintain continuity of style when extending or modifying the provisions of such a referenced document.

**should** indicates a recommendation to do something

**should not** indicates a recommendation not to do something

**may** indicates permission to do something

**need not** indicates permission not to do something

The construction "may not" is ambiguous and is not used in normative elements. The unambiguous constructions "might not" or "shall not" are used instead, depending upon the meaning intended.

**can** indicates that something is possible

**cannot** indicates that something is impossible

The constructions "can" and "cannot" are not substitutes for "may" and "need not".

**will** indicates that something is certain or expected to happen as a result of action taken by an agency the behaviour of which is outside the scope of the present document

**will not** indicates that something is certain or expected not to happen as a result of action taken by an agency the behaviour of which is outside the scope of the present document

**might** indicates a likelihood that something will happen as a result of action taken by some agency the behaviour of which is outside the scope of the present document

**might not** indicates a likelihood that something will not happen as a result of action taken by some agency the behaviour of which is outside the scope of the present document

In addition:

**is** (or any other verb in the indicative mood) indicates a statement of fact

**is not** (or any other negative verb in the indicative mood) indicates a statement of fact

The constructions "is" and "is not" do not indicate requirements.

# 

# 1 Scope

The Technical Report studies the gaps and performs evaluations of potential architecture enhancements to support Network Slicing with the following objectives:

1. Study whether and how to address the following scenario in order to provide service continuity: if an existing network slice or network slice instance cannot serve the PDU session, or if the existing network slice instance cannot meet the performance requirements of the applications. The study should investigate whether deployment optimization is sufficient. Minimized system optimisations can be considered if valuable.

2. Study whether and how to initiate a registration for a rejected S-NSSAI that was rejected in a first TA of the RA but may be available in another TA of the RA.

3. Study whether and how to support the following stage one Rel-18 EASNS requirements related to roaming specified in TS 22.261 clause 6.1.2.1, i.e. Requirement on enhancement the information available to the UE in roaming scenarios regarding the availability of network slices in VPLMNs available in the roaming country, in order to allow the UE to select and obtain services from the VPLMN supporting the network slices which UE may wish to use.

4. Study whether and how to enhance the system to ensure network controlled behaviour of network slice usage including UE registration and PDU Session establishment (e.g. so that when performing NSAC the network slice can serve UEs/PDU Sessions with actual activity).

5 Study deployment considerations when a service provided has an area of service that does not overlap with the already deployed Tracking Areas and/or have a limited lifetime, and how existing mechanisms including network slicing can help support such scenarios. If existing mechanisms are concluded to be not sufficient to achieve the scenarios, study whether and how additional mechanisms can resolve the analysed gap.

6. Study whether and how to enhance the support of NSAC when more than one NSACF is involved in enforcing a shared maximum allowed number of the UEs or PDU Sessions for a network slice in one PLMN or in roaming, in order to avoid fragmentation of the shared maximum allowed number. This item depends on the outcome of corresponding R17 CRs.

# 2 References

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

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

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

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

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

[2] 3GPP TS 23.501: "System architecture for the 5G System (5GS)".

[3] 3GPP TR 38.832: "Study on enhancement of Radio Access Network (RAN) slicing".

[4] 3GPP TS 22.261: "Service requirements for next generation new services and markets; Stage 1".

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

# 3 Definitions of terms and abbreviations

## 3.1 Terms

For the purposes of the present document, the terms given in TR 21.905 [1], TS 23.501 [2] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in TR 21.905 [1] and TS 23.501 [2].

## 3.2 Abbreviations

For the purposes of the present document, the abbreviations given in TR 21.905 [1], TS 23.501 [2] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in TR 21.905 [1] and TS 23.501 [2].

# 4 Architectural Assumptions and Requirements

The following architectural requirements apply:

- Solutions may include reuse (in part or totally) of existing mechanisms. When reuse is deemed to be possible, whether new approaches shall also be adopted or added shall be subject of evaluation. (i.e. it shall be considered whether the reuse of existing system capabilities is sufficiently effective and efficient in addressing the problem space).

# 5 Key Issues

## 5.1 Key Issue #1: Support of Network Slice Service continuity

### 5.1.1 Description

This Key issues is aiming to address WT#1. The following scenarios can happen:

**1) No mobility scenario:**

Scenario 1a): network slice is overloaded in NG-RAN.

Scenario 1b): network slice or network slice instance is overloaded or undergoing planned maintenance in CN (e.g., network slice termination).

Scenario 1c): network performance of the network slice cannot meet the SLA.

**2) Inter RA Mobility scenario:**

Scenario 2a): network slice is not supported in the target RAN node.

Scenario 2b): network slice in target RAN node is overloaded.

Scenario 2c): network slice is not supported in the target CN.

Scenario 2d): network slice or network slice instance is overloaded in the target CN.

This key issue is to study whether and how to provide service continuity for PDU sessions in network slices in the above scenarios 1b), 1c) and 2d).

NOTE 1: PDU Session with different SSC modes will be considered during the study.

NOTE 2: For scenario 1a) and 2b), TR 38.832 [3] already has conclusion. However it doesn't preclude that solutions defined for this key issue can also be used in these scenarios.

NOTE 3: For scenario 2a) and 2c), it is a deployment issue and assumed not to be studied in SA WG2.

Editor's note: It is FFS whether there is a need to study 2a) and 2c).

NOTE 4: Coordination with RAN working groups may be needed to conclude the key issue.

## 5.2 Key Issue #2: Support of providing VPLMN network slice information to a roaming UE

### 5.2.1 Description

As an outcome of SA WG1 EASNS (Enhanced Access to and Support of Network Slice) work, clause 6.1.2.1 of TS 22.261 [4] captures the following service requirement for a roaming UE.

*For a roaming UE activating a service/application requiring a network slice not offered by the serving network but available in the area from other network(s), the HPLMN shall be able to provide the UE with prioritization information of the VPLMNs with which the UE may register for the network slice.*

This key issue aims at addressing the following aspects for a roaming UE requiring a network slice not offered by higher priority VPLMN(s) but available from other network(s):

- Study how and when the HPLMN provides the UE with information about slice availability per VPLMN and prioritization information of the VPLMNs with which the UE may register for the network slice. The study includes the content of the information.

- Study how and when to use the information received by the UE from the HPLMN to influence automatic PLMN selection.

NOTE 1: For details on PLMN selection aspects and impacts on PLMN selection of solutions of this key issue, coordination with CT1 is needed.

NOTE 2: Impacts to manual selection is not in scope of the key issue.

This key issue only considers the network selection procedure for the 3GPP access type.

NOTE 3: Coordination with the Study Item FS\_5WWC\_Ph2 is required regarding the VPLMN selection procedure when non-3GPP access type is used.

## 5.3 Key Issue #3: Network Slice Area of Service for services not mapping to existing TAs boundaries, and Temporary network slices

### 5.3.1 Description

Network Slices are deployed for services over an Area of Service which may match the existing TAs or for which the Area of Service can be different. Currently, the network slice availability (i.e. where the network slices are defined to be supported) is designed to match deployed TA boundaries. In addition, the UEs and network configuration can be impacted when network slices are deployed and decommissioned over certain time interval (e.g. the Configured NSSAI can change when a network slice is no longer available or becomes available, this can affect the Allowed NSSAI and other parameters, and in turn the RA may need to change, etc.).

This Key Issue will study how to address the issues described above and whether system level improvements are needed to mitigate e.g. the deployment and control plane issues that arise due to the currently defined system behaviour:

- The support of services over network slices when the services have Area of Service not matching the existing deployed TA boundaries

- The support of network slices which have a limited lifetime (including how to gracefully terminate a network slice which can apply also to network slices which have a longer lifespan in order to avoid abrupt PDU Session release).

NOTE: Coordination with SA5 can be needed for Network Slice Life Cycle Management aspects.

## 5.4 Key Issue #4: Support of NSAC involving multi service Area

### 5.4.1 Description

For one S-NSSAI, there is only one configured global Maximum allowed number value for NSAC. It is possible more than one service area is associated with one S-NSSAI, e.g. to split a PLMN into multi-service areas. This impacts the use cases below as there will be more than one NSACF handling the UE:

- Multi NSACF deployed within one PLMN: For NSACF deployment more than one service area are defined within one PLMN. For each service area one NSACF or NSACF set is selected for slice admission control. This include the control of the maximum allowed number of UE or PDU session.

- Roaming: when one user resides at the visit PLMN, the NSAC (Maximum PDU session) may be controlled by the NSACF in the VPLMN (e.g. for LBO PDU session), or the NSACF in the HPLMN (e.g. for HR PDU session).

- EPS interworking: when the user establishes a HR PDN connection at the EPS network and move to 5GS later, the NSACF(Maximum UE number) selected by the SMF+PGW-C and AMF may be different.

This key issue addresses the above cases, to ensure consistent NSAC handling against the configured global Maximum allowed number. The following aspects will be covered by the key issue:

- UE Registration.

- PDU Session establishment.

- Session continuity when UE move across the service area.

## 5.5 Key Issue #5: Improved support of RAs including TAs supporting Rejected S-NSSAIs

### 5.5.1 General description

When the AMF creates a Registration Area (RA) with one or more Tracking Areas (TAs), all the S-NSSAIs of the S-NSSAIs in the Allowed NSSAI need to be available in all the TAs of the RA. If the UE requests an S-NSSAI that is not available in current TA, with current specifications this S-NSSAI is rejected with an indication that the S-NSSAI is not available in the RA. This cause code indicates to the UE that the UE is not allowed to try to register the S-NSSAI again in any of the TAs of the RA. This restriction is placed on the UE even if some of the TAs in the RA do support the S-NSSAI. This then creates the need to choose between optimal RA (considering the trade-off between paging load vs. the load generated due to Mobility Registration Update (MRU) requests) and the goal to allow the UE to register as soon as possible with the S-NSSAI that was not supported in the TA where the S-NSSAI was not available and therefore not allowed.

This key issue will study whether and how to allow the UE to initiate a registration for an S-NSSAI which was rejected for the RA when the UE enters a TA that is part of the RA and the TA supports this S-NSSAI.

NOTE: When an RA is created considering the trade-off between paging load vs the load generated due to Mobility Registration Update (MRU), without considering the need of the UE to register with an S-NSSAI in these TAs, the AMF can add to the RA TAs that support an S-NSSAI that was not available in the TA where the S-NSSAI was not allowed.

5.6 Key Issue #6: Improved network control of the UE behaviour

5.6.1 Description

In the 5GS specifications up to rel-17, a UE Registers/Deregisters with a Network Slice and establishes/tears down PDU sessions based on own policy taking into account network provided information such as the URSPs. However, this does not allow an operator e.g. to enforce that the UE only registers with a S-NSSAI when it is actually needed to have connectivity in the related network slice. A UE may in fact choose to register with all the Configured NSSAIs and then use the URSP just to decide which DNNs to connect to at run time. Also, it is not clear whether a UE can be requested by the operator to establish connectivity with a DNN based on own logic and URSPs at any time e.g. based on the UE configuration alone.

Operators currently do not have the ability to enforce when the UE can register with network slices based on e.g. only on actual need of connectivity in a network slice, or by configuration independent of detected need of connectivity, etc. depending on e.g. what is best for the domain of application (e.g. to save battery usage one may just register based on configuration despite the URSPs are provisioned, or, when NSAC is applied on the number of UEs, the operators may want the UE to deregister from the slice subject to NSAC and register with it based on actual usage.)Operators also cannot provide to the UE a policy for deregistration of a network slice or tear down of a PDU session (e.g. the operator cannot control the time when a PDU session is released after it is last needed by any application running in the UE, nor can the operator define the earliest time a UE is allowed to deregister from a network slice after there are no more PDU sessions established over it).

There is also no way for the serving PLMN to steer a UE to a preferred slice of the serving PLMN (i.e. the HPLMN or VPLMN) even if the UE may have the related HPLMN slice included in the possible connectivity options (URSP) for one application.

NOTE: for the purpose of this Key Issue, usage of a PDU session means there is at least one application actually uses the connectivity of the PDU session.

This Key Issue will study how to enable network-controlled behaviour and ensure the proper utilization of Slices in the system (e.g. what the network can request to the UE, and how, and what additional policies the network can provide to the UE) taking into account the above aspects (e.g. actual slice usage, UE activity, etc.).

# 6 Solutions

## 6.0 Mapping of Solutions to Key Issues

Table 6.0-1: Mapping of Solutions to Key Issues

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Solutions | Key Issues | | | | | |
| KI#1 | KI#2 | KI#3 | KI#4 | KI#5 | KI#6 |
| Solution #1: Additional S-NSSAI associated with the PDU session | X |  |  |  |  |  |
| Solution #2: Slice Re-mapping Capabilities for Network Slice Service Continuity | X |  |  |  |  |  |
| Solution #3: Support of Network Slice Service continuity using SSC mode 3 | X |  |  |  |  |  |
| Solution #4: PDU Session on compatible network slice | X |  |  |  |  |  |
| Solution #5: PDU session handover to a target CN with an alternative S-NSSAI support | X |  |  |  |  |  |
| Solution #6: Extended SoR VPLMN Slice Information transfer to UEs |  | X |  |  |  |  |
| Solution #7: Enabling awareness of Network Slice availability in VPLMNs |  | X |  |  |  |  |
| Solution #8: Gracefully network slice termination |  |  | X |  |  |  |
| Solution #9: Support of a Network Slice with an AoS not matching existing TA boundaries |  |  | X |  |  |  |
| Solution #10: Associating a validity timer with a temporary slice |  |  | X |  |  |  |
| Solution #11: Enabling UEs to Request S-NSSAIs not uniformly available |  |  | X |  | X |  |
| Solution #12: Solution for Centralized Counting for Multiple Service Areas and 5GS-EPS Interworking |  |  |  | X |  |  |
| Solution #13: Hierarchical NSACF Architecture for Maximum UE/PDU Session number control |  |  |  | X |  |  |
| Solution #14: Maximum Number Distribution in multiple NSACFs |  |  |  | X |  |  |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |

6.1 Solution #1: Additional S-NSSAI associated with the PDU session

6.1.1 Introduction

This solution aims to address the key issues#1: Support of Network Slice Service continuity, particularly it reuses the concept that the PDU session can be associate with two S-NSSAIs (based on values provided in mapping of Allowed NSSAI). The scenario covers the case where NFs (SMF, UPF...) in a network slice instance support multiple S-NSSAIs. How to split the resource depends on implementation. It is possible that the resource of one S-NSSAI is getting congested, while other S-NSSAI is not (e.g. there is a fixed allocation of resources to each S-NSSAI in the NF instances). This solution proposes that when one S-NSSAI is congested, the network can associate the PDU session with additional S-NSSAI in order to provide service continuity during mobility scenario, so the resource allocated in SMF and/or UPF for one S-NSSAI can be shared by other S-NSSAI if other S-NSSAI is getting congested.

Editor's note: The validity of the scenario that this solution covers is to be further assessed.

NOTE: This solution may be extended to cover no mobility scenarios 1b and 1c described in clause 5.1.1

Editor's note: It is FFS whether and how the PDU Session can be associated with more than one S-NSSAI within a PLMN

6.1.2 Functional Description

In this solution it is assumed that a network slice instance may be associated with multiple S-NSSAIs in the PLMN, and each S-NSSAI may use different network resources. The AMF, SMF and UPF is configured with which S-NSSAIs are associated with the network slice instance. When the UE establishes PDU session it determines the requested S-NSSAI based on the URSP rules. The PDU Session is initially associated with this requested S-NSSAI. When this requested S-NSSAI become congest, the network may associate the PDU session with an additional S-NSSAI which can be associated with the network slice instance. After the S-NSSAI congestion is mitigated, the network may remove the additional S-NSSAI of the PDU Session.

When the AMF determines to associate the PDU session with an additional S-NSSAI, it provides the additional S-NSSAI to SMF. The SMF uses this additional S-NSSAI in the N2 information and send it to NG-RAN. The SMF may also send the additional S-NSSAI to the UPF.

This additional S-NSSAI is not provided to the UE, so from UE perspective the PDU session is still associated with the original requested S-NSSAI and therefore no impact on the UE side. Since the PDU session is still associated with the original S-NSSAI, the anchor SMF/UPF and the IP address is not changed so service continuity is ensured.

For PDU Session with home routed scenario, the AMF may determine to associate this PDU session with additional S-NSSAI in the VPLMN. The AMF doesn’t update the slice mapping between VPLMN and HPLMN in the UE.

NOTE: When the AMF detects that the original requested S-NSSAI is not congested, the AMF may remove the additional S-NSSAI associated with the PDU session.

6.1.3 Procedures

The target AMF is configured that both S-NSSAI#1 and S-NSSAI#2 are associated with one network slice instance.



Figure 6.1.3-1: Procedure

1. The UE establishes a PDU session with the requested S-NSSAI#1 via S-RAN.

2. S-RAN performs a UE measurement and determines that a handover to the T-RAN is needed. The S-RAN sends a handover required message(T-RAN node information, a source to target transparent container, an SM N2 information list, PDU session ID(s)) to the AMF via the N2 interface.

3. The source AMF selects a target AMF based on the T-RAN node information and create UE context in the target AMF.

4. If the target AMF is notified that the S-NSSAI#1 is under congestion in the CN and the service continuity of the PDU session is required, the target AMF checks if the S-NSSAI#2 is supported in the T-RAN node. If it is supported the target AMF determines to associate the PDU session with additional S-NSSAI#2.

5. The target AMF sends an Nsmf\_PDUSession\_UpdateSMContext request message (the PDU session ID, the S-NSSAI#2, N2 SM Information) to the SMF. The SMF associates the S-NSSAI#2 with the PDU session.

6. The SMF may modify the N4 session to update the network slice information in the UPF.

7. The SMF sends a Nsmf\_PDUSession\_UpdateSMContext response message (PDU session ID, N2 SM Information) to the target AMF. The N2 SM information includes the S-NSSAI#2 received from the AMF.

8. The rest steps in N2 based handover procedure are performed.

6.X.4 Impacts on existing entities and interfaces

AMF

SMF

UPF

NG-RAN (TBD)

Editor's note: Detailed list of impacts is FFS.

6.2 Solution #2: Slice Re-mapping Capabilities for Network Slice Service Continuity

6.2.1 Introduction

The solution addresses the Key Issue #1: Support of network slice service continuity.

6.2.2 Functional Description

The solution provides a mechanism to determine a re-mapped slice for a network slice that requires slice re-mapping due to an overload, planned maintenance, etc. and to move ongoing PDU sessions to the re-mapped slice.

Editor's note: The specific scenarios that this solution is intending to resolve are FFS.

6.2.3 Procedures

6.2.3.1 General

During a registration procedure, AMF selects PCF that supports slice re-mapping and obtain an information for slice re-mapping. A call flow for slice re-mapping policy at registration procedure is shown in Figure 6.2.3.2-1.

When a network slice that requires slice re-mapping occurs, due to the policy received from PCF during the registration, AMF interacts with PCF to obtain a remapped S-NSSAI for each PDU session that is associated with a network slice that requires slice re-mapping. Once a PCF selects and provides a re-mapped slice for the network slice that requires slice re-mapping, for each old PDU session associated with the network slice that requires slice re-mapping, AMF may interact with SMF to change the S-NSSAI of the PDU session. A call flow for changing S-NSSAI of PDU session is shown in Figure 6.2.3.3-1.

6.2.3.2 Registration



Figure 6.2.3.2-1: Slice re-mapping policy at registration procedure

1. A UE triggers registration with the network.

2. The AMF may interact with AUSF and UDM according to clause 4.2.2.2.2 in TS 23.502 [5].

3. If the AMF decides to perform PCF discovery and selection and if the AMF supports slice re-mapping, the AMF may select PCF that supports slice re-mapping by utilizing NRF or local configuration.

Editor's Note: whether there needs to be information in the NRF regarding support of slice re-mapping is FFS

4. The AMF may request PCF to obtain AM policy.

5. The PCF provides a policy including a PCR trigger that instructs the AMF to interact with PCF when a network slice that requires slice re-mapping occurs to AMF.

6. A rest of the UE registration procedure according to clause 4.2.2.2.2 in TS 23.502 [5].

6.2.3.3 Change of S-NSSAI of a PDU Session



Figure 6.2.3.3-1: Change of S-NSSAI of a PDU Session

1. The AMF determines that a network slice that requires slice re-mapping occurs.

2. From AMF to PCF: AM Policy Association ID, S-NSSAI that requires slice re-mapping, Allowed NSSAI.

If the AMF has received a PCR trigger that instructs the AMF to interact with PCF when a network slice that requires slice re-mapping occurs and the AMF determined in step 1 that a network slice that requires slice re-mapping occurs, the AMF triggers AM Policy Association modification procedure to PCF.

3. From PCF to AMF: AM Policy Association ID, selected S-NSSAI.

The PCF selects re-mapped S-NSSAI and provides it to the AMF based on the S-NSSAI that requires slice re-mapping and the Allowed NSSAI received from AMF in step 2.

The PCF may update URSP rules and triggers UE Configuration Update procedure based on the S-NSSAI that requires slice re-mapping and the selected re-mapped S-NSSAI.

Editor's note: It is FFS whether and how the change of S-NSSAI of a PDU session applies to roaming scenario.

4. For each old PDU session associated with the network slice that requires slice re-mapping, AMF may trigger a change of the slice of the old PDU session to the selected re-mapped S-NSSAI received in step 3.

Editor's note: Details on how PDU Session with the selected re-mapped S-NSSAI can be achieved are FFS.

6.2.4 Impacts on services, entities and interfaces

AMF:

- Support slice re-mapping

- send a message to SMF to trigger a change of S-NSSAI

SMF:

- trigger SSC mode operation with a S-NSSAI received from AMF as a new PDU session

NRF:

- Support discovery of PCF that support slice re-mapping

PCF:

- Support slice re-mapping

6.3 Solution #3: Support of Network Slice Service continuity using SSC mode 3

6.3.1 Introduction

This solution addresses KI#1 scenarios of mobility.

6.3.2 Functional Description

This solution considers a UE which is in CM-CONNECTED mode and arrives at an area where it needs to be handed over to a cell outside the current RA where a PDU session in a certain slice cannot continue as the slice is no longer available for any of the reasons documented in the KI#1. Specifically, the RAN is based on local information detecting the target RAN node cannot serve the current slice and it is configured with a valid replacement. This may be dues to e.g. the AMFs in target RAN node region not supporting the S-NSSAI any more for e.g. maintenance or other causes so they provide an AMF configuration update to tell the RAN a S-NSSAI no longer is supported.

This solution relies on using SSC mode 3 in a network-controlled manner. The next clause provides the necessary details.

6.3.3 Procedures

The call flow below in figure 6.3.3-1 proposes using SSC mode 3 to provide the service continuity solution. A single NG-RAN node may also be involved, two NG-RAN nodes are shown for generality and only the Xn Handover case is shown but this can apply also to NG Handover.

Source NG-RAN node 1

SMF

2. UE has ongoing PDU session 1 of slice 10

UE

Target NG-RAN node 2

**3. HO request (pdu session 1)**

AMF

**Handover command (PDU session 1 temporary accepted)**

**7. NAS PDU Session Modification Command (end slice 10, new slice 11)**

**Handover complete**

**8. Establish resources for PDU session 2 on slice 11**

**9. Release pdu session 1 of slice 10**

SSC mode 3 Timer expiry

**10. UE Configuration Update (new Allowed NSSAI= slice 11 only)**

**4. PSR (end slice 10, new slice 11)**

**5. update (end slice 10, new slice 11)**

**Register Accept (Allowed NSSAI (slices 10, 11)**

**6.Register Request**

**1: UE Allowed NSSAI (slices 10, 11)**

Figure 6.3.3-1: service continuity upon slice change

0. NG-RAN nodes have been configured with slice re-mapping of slice 10 to 11 due to any cause.

1. AMF has sent the UE Allowed NSSAI to the serving NG-RAN node and the UE per existing procedures.

2. UE has ongoing PDU session 1 of slice 10 for which SSC mode 3 has been selected.

3. Source NG-RAN triggers Handover to target NG-RAN. The target NG-RAN node 2 informs during the HO procedure the source NG-RAN node 1 that it accepts the PDU session 1 of slice 10 temporarily due to slice re-mapping action which it has been configured with for slice 10. It also indicates the new slice 11 for the PDU session.

4. At handover completion, the target NG-RAN indicates to AMF in Path Switch Request that PDU session 1 of slice 10 needs to be terminated and a new PDU session is to be setup with slice 11.

Editor's note: it is FFS how the target NG-RAN can detect congestion in CN.

5. AMF sends an Update message to SMF indicating end of PDU session 1 of slice 10 and remapping to slice 11. The SMF triggers step 7 as the UE has indicated SSC mode 3.

6. The UE performs the post-handover registration (as Source and Target NG RAN nodes have different slice support, they don't belong to the same registration area for the UE) requesting Slice 10 and slice 11 as indicated in the handover command. Because the AMF has received (end slice 10) at step 4, the AMF still includes the slice 10 in the *Allowed NSSAI* towards the UE at this step (the slice is indeed still temporarily available until it receives from SMF notification of the final release of PDU session 1 of slice 10 at step 9). This is just a temporary allowed NSSAI that will be soon replaced and may include two S-NSSAIs in the serving PLMN supporting same HPLMN S-NSSAI exceptionally.

Editor's note: The feasibility of indicating two serving network S-NSSAI for one HPLMN S-NSSAI in the Allowed NSSAI is FFS.

7. In reaction to step 5, the SMF triggers towards the UE the NAS PDU Session Modification Command (Cause, PCO (PDU Session Address Lifetime value), end slice 10, new slice 11) to invoke SSC mode 3. The (end slice 10, new 11) may be included towards the UE to prompt the UE to setup the new PDU session 2 with slice 11.

Editor's note: Whether SSC3 PDU Session modification can be used to change the slice is FFS.

8. The UE triggers the establishment of PDU session 2 with slice 11 according to SSC mode 3 procedure as per existing procedures described in clause 4.3.2.2.1 of TS 23.502 [5].

9. At the expiry of SSC mode 3 timer, the SMF triggers the release of the PDU session 1 of slice 10 according to SSC mode 3 procedures (existing procedures described in clause 4.3.2.2.1 of TS 23.502 [5]).

10. Upon notification from the SMF that PDU session of no longer supported slice 10 has been released, the AMF sends a final the UCU (UE Configuration Update) message in order to update the *Allowed NSSAI* towards the NG-RAN and the UE. In this example, the new *Allowed NSSAI* is slice 11.

6.3.4 Impacts on services, entities and interfaces

The solution has the following impacts:

NG-RAN node:

- configuration to perform slice remapping for certain slices and related behaviour as per above procedure

AMF

- temporarily allow slices while SSC3 completes for the PDU session and do UE configuration update to provide the final allowed NSSAI when the SSC mode 3 new PDU session is up and running and old PDU session leg released.

UE

- trigger SSC mode 3 when the PDU session is temporarily accepted in the new slice as specified in the handover command.

- perform registration procedure by taking into account the indicated slice as replacement of the ongoing slice.

- performs SSC mode 3 with the slice indicated to replace the ongoing slice.

6.4 Solution #4: PDU Session on compatible network slice

6.4.1 Introduction

This solution addresses the bellow requirements from Key Issue #1: Support of Network Slice Service continuity.

**1) No mobility scenario:**

Scenario 1b): network slice or network slice instance is overloaded.

6.4.2 Functional description

This solution allows for a PDU Session establishment on a compatible network slice if the network slice on which the PDU Session is initially required is not available or is overloaded. The assumption in this solution is that an Application in the UE may be allowed to get a service from more than one network slice as per the network slice selection criteria (NSSP) within the URSP rules in the UE. In such a case the UE may include a compatible S-NSSAI as an extra parameter in the PDU Session Establishment Request message along with the S-NSSAI on which the PDU Session is required and the PDU Session establishment procedure can continue on the compatible S-NSSAI in case the initially required S-NSSAI is not available or is overloaded.

6.4.3 Procedures



**Figure 6.4.3-1: PDU Session on compatible network slice**

1. When an Application in the UE requires service, the UE triggers PDU Session Establishment Request to the AMF in which the UE includes the S-NSSAI and the DNN on which the service is available based on the S-NSSAI selection and DNN selection criteria within the URSP rules in the UE. Optionally, the UE may include in the PDU Session Establishment Request a compatible S-NSSAI, if available. The compatible S-NSSAI is another S-NSSAI from the network slice selection criteria within the URSP if the network slice selection criteria within the URSP rules in the UE allows the Application requiring service to use more than one S-NSSAI. The UE includes a compatible S-NSSAI in the PDU Session Establishment Request if one is available in the network slice selection criteria within the URSP and it is in the Allowed NSSAI list for the UE.

2. If the S-NSSAI on which a PDU Session is required by the UE is overloaded or not available and the UE has included compatible S-NSSAI in the PDU Session Establishment Request message, the AMF selects an SMF based on the compatible S-NSSAI and the AMF continues the PDU Sessions Establishment procedure on the compatible S-NSSAI instead of the initially requested S-NSSAI.

3. The AMF sends Nsmf\_PDUSession\_CreateSMContext Request message to the SMF in which the AMF includes the compatible S-NSSAI received by the UE.

4. Continue PDU Session Establishment on the compatible S-NSSAI as per clause clause 4.3.2.2.1 of TS 23.502 [5]. The SMF may notify the UE that the PDU Session is established on the compatible S-NSSAI.

Editor's note: It is FFS whether the AMF shall indicate to the UE the reason for the network slice switch.

6.4.4 Impacts on services, entities and interfaces

UE

- new compatible S-NSSAI parameter in the PDU Session Establishment Request.

AMF

- PDU Session switch to a compatible S-NSSAI.

6.5 Solution #5: PDU session handover to a target CN with an alternative S-NSSAI support

6.5.1 Introduction

This solution addresses the bellow requirements from Key Issue #1: Support of Network Slice Service continuity.

**2) Inter RA Mobility scenario:**

Scenario 2d): network slice or network slice instance is overloaded in the target CN.

6.5.2 Functional description

This solution allows for a PDU Session handover to an alternative network slice when the current network slice is not supported by the target CN or it is overloaded in the target CN. At PDU Session establishment the UE may include in the PDU Session Establishment Request an alternative S-NSSAI, if available. The alternative S-NSSAI is another S-NSSAI from the network slice selection criteria within the URSP rules in the UE in case the URSP rules allow the Application requiring the service to use more than one S-NSSAI. Then this alternative S-NSSAI is stored in the UE context within the AMF and used for PDU Session handover to this alternative S-NSSAI if the current S-NSSAI is not supported in the target CN. The solution works only for PDU Sessions established with SSC2.

6.5.3 Procedures



**Figure 6.5.3-1: PDU session handover to a target CN with an alternative S-NSSAI support**

1. An Application in the UE requires service on S-NSSAI. The UE initiates PDU Session Establishment procedure on that S-NSSAI to the S-AMF. Optionally, the UE may include in the PDU Session Establishment Request an alternative S-NSSAI, if available. The alternative S-NSSAI is another S-NSSAI from the network slice selection criteria within the URSP if the URSP rules allow the Application requiring the service to use more than one S-NSSAI. The UE includes an alternative S-NSSAI in the PDU Session Establishment Request if one is available in the network slice selection criteria within the URSP and it is in the Allowed NSSAI list for the UE.

2. The S-AMF may perform some further checks for the eligibility of the alternative S-NSSAI(s) received from the UE (e.g. whether these alternative S-NSSAI(s) are part of the Allowed S-NSSAI for the UE) before the S-AMF stores the alternative S-NSSAI in the UE context

3. Continue and complete the PDU Session establishment procedure on S-NSSAI as per clause 4.3.2.2.1 of TS 23.502 [5].

4. At some stage the S-RAN triggers handover request to the S-AMF.

5. The S-RAN selects a T-RAN supporting the current S-NSSAI and possibly supporting the alternative S-NSSAI. The S-AMF proceeds with the N2 handover procedure to T-RAN and T-AMF supporting the current and the alternative S-NSSAI.

6. UE registration with the T-AMF. The current and the alternative S-NSSAI received from the S-AMF during theN2 handover is supported and allowed in the T-AMF after the UE registration.

7. If at step 5 the UE did handover to a T-RAN supporting the current and the alternative S-NSSAI however, the T-AMF is overloaded for the current S-NSSAI, then the PDU Session switches to the alternative S-NSSAI via PDU Session modification to the alternative S-NSSAI procedure as per clause 4.3.3.2.1 of TS 23.502 [5]. The T-AMF may select another SMF if the PDU Session switches to an alternative S-NSSAI.

8. T-RAN initiates PDU Session Modification Command to the UE with the alternative S-NSSAI in case of PDU Session switch to an alternative S-NSSAI.

6.5.4 Impacts on services, entities and interfaces

UE

- new alternative S-NSSAI parameter in the PDU Session Establishment Request message.

AMF

- alternative S-NSSAI(s) handling.

6.6 Solution #6: Extended SoR VPLMN Slice Information transfer to UEs

6.6.1 Introduction

This solution targets KI#2, namely the issues of:

- "how and when the HPLMN provides the UE with information about slice availability per VPLMN"; and

- "study how and when to use the information received by the UE from the HPLMN to influence automatic PLMN selection".

6.6.2 Functional Description

In this solution the SoR AF verifies if the Subscribed S-NSSAIs are available in the VPLMN where the UE is currently trying to register. If some of the Subscribed S-NSSAIs or all are not available, depending on operator policy, the SoR AF may provide additional information that can be sent to the UE regarding VPLMNs and/or other networks that do support the Subscribed S-NSSAIs or a subset of them (e.g. called slice-based SoR).

The decision by the UDM to request the SoR AF to verify if slice-basedSoR information is required depends on the UE capabilities to handle this additional information, the UE current location (e.g. the current serving network ID) and on the Subscribed S-NSSAIs.

Two options are proposed for the UDM to obtain UE capabilities; a network based approach and a UE based approach.

- In the UE based approach, the UE includes at 5GC Registration a transparent container intended for the UDM. The AMF in the VPLMN transparently sends this container to the UDM. The UDM in turn can forward the received information from the SoR AF to the UE in the Registration Response.

- In the network based approach, the UDM fetches the UE capabilities using an extended UE Parameter Update procedure. The UE includes its capabilities in the UPU acknowledgment sent to UDM via the AMF in an UL NAS TRASNPORT.

The AMF sends the received information from the SoR AF via the UDM in a DL NAS TRANPORT message to the UE.

The following UE behaviour applies:

- Initially when the UE roams to a different country, the UE selects PLMN (automatic or manual selection) according to the existing mechanism, e.g. by using "Operator controlled PLMN selector with Access Technology" list.

- If the UE wants to use an S-NSSAI which is not available in the current serving PLMN or in the current Registration Area (RA) and the UE is configured with slice-based SoR, the UE triggers network selection procedure by considering the slice-based network selection information.

6.6.3 Procedures

#### 6.6.3.1. Extended SoR VPLMN Slice Information transfer to UE

The procedure below is a high level solution to provide the slice-based SoR to the UE.



**Fig: 6.6.3.1-1 UE Initiated for Extended SoR Information**

The steps in the call flow are described briefly below:

1. A trigger is detected in the UDM for a roaming UE to provide slice-based SoR information, e.g. the UDM is preconfigured (e.g. via the OAM or OSS based on Service Level Agreements with the roaming partners) that one or more of the UE's Subscribed S-NSSAIs are not available in specific visited country or networks (VPLMNs). The UDM may retrieve the UE capabilities to handle the slice-based SoR information. The slice-based SoR information may be either generated in the UDM or the UDM may request the SoR AF to create it.

If the UDM can create the slice-based SoR information itself, the UDM proceeds further with step 5.

After the UE's UPU/SoR capabilities are retrieved, they may be stored in the UDM on per IMEI basis.

2. The UDM initiates towards the SoR AF an Nsoraf\_SoR\_Get Request (VPLMN ID), SUPI of the UE, access type (see 3GPP TS 29.571 [05], subscribed S-NSSAIs, UE location, UE capability to receive enhanced information). The UDM passes transparently information included in the container and relevant for the SoR AF to consider.

3. SoR AF creates slice-based SoR information taking into account the information provided by the UDM and availability of the Subscribed S-NSSAIs in the possible VPLMNs. To enable the SoR AF to create the slice-based SoRinformation, the SoR AF scans the possible list of VPLMNs, and for each one determines the extent to which the Subscribed NSAAIs are supported. The SoR AF may then order the information as an example as shown below:

- VPLMNs supporting all the Subscribed NSSAIs in any order preferred by HPLMN.

- VPLMN supporting a subset of the Subscribed NSSAIs in any order preferred by HPLMN.

- List of additional networks supporting the Subscribed NSSAIs or Requested NSSAIs not preferred by HPLMN.

Editor’s note: Additional information to be included is FFS.

4. SoR AF sends the slice-based SoR information to the UDM in a Nsoraf\_SoR\_Get Response.

5. UDM sends the slice-based “steering of roaming information” to the UE via the AMF.

6. UE uses the slice-based SoR info and if the Allowed NSSAI doesn't include all slices desired by the UE then the UE scans for VPLMN supporting the S-NSSAIs not in Allowed NSSAI and selects and registers accordingly.

The two options for UDM detection of UE capabilities are described below. Both options incorporate the common aspects between them for completeness and clarity. Steps 2 to 4, and step 6 are common for both options.

##### 6.6.3.1.1 UE Initiated capability indication

The procedure below implements the UE initiated option to indicate the UPU/SoR capabilities.



**Fig: 6.6.3.1.1-1 UE Initiated for Extended SoR Information**

The steps in the call flow are described briefly below:

1. While roaming, the UE includes a new transparent container in a 5GC Registration Request, when UE performs Initial Registration or when the UE wants HPLMN to be aware of UE changes e.g. UE capability changes or UE requests new network slices. This new container is an indication that the UE wants the UDM to provide the UE with information relevant to Subscribed/Requested NSSAIs in the current VPLMN as well as other VPLMNs where the UE is currently located. The container includes the requested information and includes UE information that is pertinent to the request. The UE may send a protected container (transparent for AMF i.e. container is protected with home network security information) that includes info relevant for UDM e.g. UE capabilities, UE location, Requested NSSAI, etc.

NOTE: Security aspects on how to protect the UE capabilities provided by the UE are to be discussed in SA3.

Editor's note: Additional information to be included in the container is FFS

2. new info: AMF forwards the received container transparently from the UE in the Nudm\_UECM\_Reg Request towards the UDM.

3. UDM uses UE capabilities to check that UE supports ability to handle the additional information, and if the UE does support the additional information, then UDM initiates a request to the SoR AF and indicates in such a request the UE capabilities.

4. This is identical to step 2 in clause 6.6.3.1.

5. This is identical to step 3 in clause 6.6.3.1.

6. This is identical to step 4 in clause 6.6.3.1.

7. HPLMN (or CH) sends SoR information within the Access and Mobility Subscription data i.e. AMF is transparent to the content of such data.

8. AMF forwards the “steering of roaming information” within the Registration Accept as per current specification.

9. This is identical to step 6 in clause 6.6.3.1. .

6.6.3.1.2 Network Triggered capability indication

The procedure below implements the Network triggered option to retrieve the UPU/SoR capabilities.



**Fig: 6.6.3.1.2-1 Network Initiated for Extended SoR Information**

The steps in the call flow are briefly described below:

1. The UE performs a regular Registration. During that procedure, the UDM may interact with the SoR AF to provide SoR info to the UE during initial registration (e.g based on local configuration)

2. UDM decides to fetch the UE capabilities to see if the UE supports slice-based SoR information. The UDM may determine to trigger this step based on e.g. local configuration, UE location in specific PLMN or a new indication provided by the SoR AF to the UDM in step 1.

3. The UDM triggers an extended UPU procedure requesting the UE to send its UPU capabilities in the response. Hence, UDM sends to the AMF, an Nudm SDM Notification including a UPU transparent container to trigger the UE to return its UPU capabilities.

NOTE: Security aspects of the protection of the UPU transparent container are to be discussed in SA3.

4. The AMF sends a DL NAS TRANSPORT message to the UE, where this DL NAS TRANSPORT message including the UPU transparent container where the UDM requests the UE capabilities of the UE to handle enhanced SoR information (e.g., a list of VPLMNs and optional supported network slices and/or applicability/validity info, as described herein).

5. The UE returns its capabilities within an UPU ACK transparent container in an NAS UL TRANSPORT message to the AMF.

6. The AMF sends, to the UDM, an Nudm\_SDM\_Info including the UPU ACK transparent container indicating that the UE has the capabilities to receive enhanced SoR information.

7. This is identical to step 2 in clause 6.6.3.1.

8. This is identical to step 3 in clause 6.6.3.1.

9. This is identical to step 4 in clause 6.6.3.1.

10. The UDM sends, to the AMF, a Nudm\_Notify and includes the enhanced SoR information.

11. The AMF sends a DL NAS TRANSPORT message including the enhanced SoR information to the UE. Optionally, an ID of the enhanced SoR information may be included in the message. The UE stores the enhanced SoR information.

12. The UE returns UPU ACK in an NAS UL TRANSPORT message to the AMF.

13. The AMF sends to the UDM an Nudm\_SDM\_Info UPU to acknowledge UE reception of the enhanced SoR info including the VPLMN List.

14. This is identical to step 6 in clause 6.6.3.1.

6.6.4 Impacts on Existing Nodes and Functionality

Editor's note: This clause captures impacts on existing 3GPP nodes and functional elements.

6.7 Solution #7: Enabling awareness of Network Slice availability in VPLMNs

6.7.1 Introduction

This solution addresses KI#2 from TR 23.700-41, clause 5.2 and explains how the UE may use information about slice availability per VPLMN and prioritization information, received from the HPLMN to influence automatic PLMN selection.

6.7.2 Functional Description

During the Registration procedure, if the AMF does not have subscription data for the UE, the AMF invokes Nudm\_SDM\_Get service operation to HPLMN UDM to get Access and Mobility subscription Data for the UE. Upon receipt of a Nudm\_SDM\_Get message, and as part of the Steering of Roaming procedure, the UDM includes in the list of preferred VPLMN/Access Technology combinations, a list of supported S-NSSAIs.

The AMF relays the Steering of Roaming information, including the S-NSSAI information associated with the VPLMN/Access Technology combination.

When the Steering of Roaming information, including the S-NSAAI information is received, the UE determines, based on the list of VPLMNs available in the area, and the S-NSSAIs supported in these VPLMNs, whether the UE may attempt to obtain service on a higher priority VPLMN as specified in the received Steering of Roaming information.

The solution considers two cases:

- Option 1: The UE’s USIM is not configured to receive a Slice-Aware SoR. If the UE is not configured to receive Slice-Aware SoR information, and the current VPLMN has rejected S-NSSAIs the UE has requested, then the UE, as an implementation option, may determine to execute a Deregistration procedure. The UE may indicate in the Deregistration Request message, within the Deregistration Type, that the Deregistration procedure has been triggered due to lack of S-NSSAI support. When the Deregistration Type indicates, “Required S-NSSAI not supported/available”, the AMF informs the UDM that the UE has Deregistered due to lack of S-NSSAI in this VPLMN.

If during the Deregistration procedure the UDM received an indication that the UE has requested Deregistration due to lack of S-NSSAI support in a VPLMN, the UDM may keep a “Slice-Aware SoR pending” flag in the UE subscription information indicating that the UE may re-register in a different VPLMN to seek S-NSSAI support and that Slice-Aware SoR information shall be sent to the UE upon a subsequent Registration attempt.

During a subsequent Registration, if the AMF does not have subscription data for the UE, the AMF invokes Nudm\_SDM\_Get service operation to HPLMN UDM to get Access and Mobility subscription Data for the UE. If the “Slice-Aware SoR pending” flag is set, upon receipt of a Nudm\_SDM\_Get message, and as part of the Steering of Roaming procedure, the UDM may include in the list of preferred VPLMN/Access Technology combinations, a list of supported S-NSSAIs

- Option 2: The UE is capable and configured to receive Slice-Aware SoR information. The UE indicates in the Registration Request that the UE shall receive Slice-aware SoR information, e.g., including VPLMN, location (e.g., geographical coordinates or specific TA) and S-NSSAI combination.

During a registration procedure, if the AMF does not have subscription data for the UE, the AMF invokes Nudm\_SDM\_Get service operation to HPLMN UDM to get Access and Mobility subscription Data for the UE. Upon receipt of a Nudm\_SDM\_Get message, and as part of the Steering of Roaming procedure, the UDM may include in the list of preferred VPLMN/Access Technology combinations, a list of supported S-NSSAIs.

6.7.3 Procedures

6.7.3.1 Option 1 – UE’s USIM is NOT configured to receive a Slice-Aware SoR

This option is characterized in that the HPLMN relies on the Slice-Aware SoR pending flag to provide the UE with Slice-Aware SoR information.

A UE may request access Registration to a VPLMN in its current VPLMN/access technology list, while roaming in a visited network. The UE constructs the Requested NSSAI based on the NSSP, which the UE uses to associate applications to specific S-NSSAIs.

The visited network accepts the Registration request, via a Registration Accept message, but it may reject the UE’s request for an S-NSSAI, the UE included in the Requested NSSAI. As the UE is not configured to expect to receive Slicer-Aware SoR, the HPLMN may not deliver the Slice-Aware SoR

If no Slice-Aware SoR information is provided, the UE may decide, in an implementation specific manner, that it does not want to remain in a VPLMN that does not provide the entire Requested S-NSSAI, or S-NSSAIs the UE requires for specific applications, and the UE triggers a Deregistration procedure, and it provides a new Deregistration Type: “S-NSSAI not available” and it provides which S-NSSAI(s) was/were not available. The including of the new De-Registration type indicates to the UDM that the UE is capable and configured to receive the “Slide-Aware SoR” information.

The VPLNN AMF accepts the Deregistration Request, and if the UE indicated Deregistration Type as “S-NSSAI not available”, the AMF notifies the UDM the UE has Deregister and it provides the Deregistration Type as: “S-NSSAI not available”.

The UDM interprets the receipt of the new Registration type as an implicit indication that the UE is configured to receive the Slice-Aware SoR information, and it may set a new Flag to indicate that the UE may attempt to re-register and that SoR may be used to provide information about available S-NSSAI in VPLMNs the UE may access, in the area the UE is currently located.

The UDM may request SoR information from the SOR-AF, and it may indicate that the S-NSSAI associated to the VPLMN/access technology are required.

The SOR-AF may use analytics and information from AMF VPLMN and possible NSSF at the VPLMN to derive S-NSSAI information in TA from relevant VPLMNs. The SOR-AF provides a Slice-Aware SoR container to the UDM, and the UDM can include it during the next Registration for UE for which a “Slice-Aware SoR” flag is set, or if local configuration warrants it.

Alternatively, the UDM may decide to include the Slice-Aware SoR container in the Deregistration service operation Output. If the UDM includes the Slice-Aware SoR container in the Deregistration service operation Output, the AMF relays it to the UE in the Deregistration accept message.

If the UE does not get the Slice-Aware SoR container in the Deregistration accept message, the UE may decide to attempt a new Registration to attempt access to a specific S-NSSAI, and it may decide to deprioritize this VPLMN.

If this is an initial registration or if the UE indicates that is capable and configured to received Slice-Aware SoR information, the AMF triggers a SoR operation through a Nudm\_SDM\_Get request message, indicating that the S-NSSAI information is also required. The UDM may request SoR information from the SOR-AF, if not already requested. Note that such request could be executed either because of a Nudm\_SDM\_Get request message or as a result of a Nudm\_UECM\_DeregistrationNotification message.

The UDM may use information from the SOR-AF to provides the list of VPLMN/access technologies and associated S-NSSAIs in the Nudm\_SDM\_Get\_response message.

The AMF may provide to the UE in the Registration Accept message as part of the SOR container, the list of VPLMN/access technologies and associated S-NSSAIs.

The UE may reselect to a higher priority VPLMN that may support S-NSSAI according to the information receive in the SoR container.

6.7.3.2 Option 2 – UE’s USIM is configured to receive a Slice-Aware SoR

This option is characterized in that the HPLMN relies on the indication in the UDM that the UE is expected to receive the Slice-Aware SoR information. This is based on existing SoR principles as described in TS 23.122 and does not rely on URSP rules.

A UE request access Registration to a VPLMN in its current VPLMN/access technology list, while roaming in a visited network. The UE constructs the Requested NSSAI based on the NSSP.

The visited network accepts the Registration request, via a Registration Accept message, but it may reject the UE’s request for an S-NSSAI, the UE included in the Requested NSSAI.

If this is an initial registration or if the UE indicates that is capable and configured to received Slice-Aware SoR information, the AMF triggers a SoR operation through a Nudm\_SDM\_Get request message, indicating that the S-NSSAI information is also required. The UDM may request SoR information from the SOR-AF, if not already requested.

The UDM may use information from the SOR-AF to provides the list of VPLMN/access technologies and associated S-NSSAIs.

In this option, since UE’s USIM is configured to receive a Slice-Aware SoR, the Slice-Aware SoR information is provided to the UE in the Registration Accept message, therefore a list of VPLMN/access technologies and associated S-NSSAIs may be provided to the UE as part of the SOR container. If the UE did not receive Slice-Aware SoR information in the Registration Accept message, the UE may trigger reselection as per regular PLMN selection procedure, the UE may consider this PLMN as low priority.

The UE may reselect to a higher priority VPLMN that may support S-NSSAI according to the information receive in the SoR container.

6.7.4 Impacts on services, entities and interfaces

UE:

- The UE triggers a Deregistration procedure and it provides a new Deregistration Type: "S-NSSAI not available" and it may provide which S-NSSAI(s) was/were not available.

- The UE receives, in the Registration Accept message, Slice-Aware SoR information including a list of VPLMN/access technologies and associated S-NSSAIs provided to the UE as part of the SOR container.

- The UE reselects to a higher priority VPLMN that may support S-NSSAI according to the information receive in the SoR container.

AMF:

- The AMF provides information to the SOR-AF on available S-NSSAIs for certain VPLMN/access technology combination. The AMF gathers this information with the help of the NSSF and the AN, when the 5G-AN nodes establish or update the N2 connection with the AMF.

- During a Deregistration Request procedure, the AMF notifies the UDM that UE has Deregistered and it provides the Deregistration Type as: "S-NSSAI not available".

UDM:

- The UDM is notified in the Nudm\_UECM\_DeregistrationNotifiy, that the UE has Deregistered and the UDM gets the Deregistration Type as: "S-NSSAI not available".

- The UDM interprets the receipt of the new Registration type as an implicit indication that the UE is configured to receive the Slice-Aware SoR information, and it may set a new Flag to indicate that the UE may attempt to re-register and that SoR may be used to provide information about available S-NSSAI in VPLMNs the UE may access in the area the UE is currently located.

- The UDM requests SoR information from the SOR-AF, and it indicates that the S-NSSAI(s) associated to the VPLMN/access technology are required.

- The UDM uses information from the SOR-AF to provide the list of VPLMN/access technologies and associated S-NSSAIs in the Nudm\_SDM\_Get\_response message.

SOR-AF:

- The SOR-AF uses analytics and information from AMF VPLMN and possible NSSF at the VPLMN to derive S-NSSAI information in TA from relevant VPLMNs.

- The SOR-AF gets a request from the UDM, via a Nsoraf\_SoR\_request message, indicating that the S-NSSAI associated to the VPLMN/access technology are required.

- The SOR-AF uses analytics and information from AMF VPLMN and possible NSSF at the VPLMN to derive S-NSSAI information in TA from relevant VPLMNs.

6.8 Solution #8: Gracefully network slice termination

6.8.1 Introduction

The solution addresses the Key Issue#3, and in particular how to avoid service disruption due to an abrupt PDU Session release, when a network slice is terminated due to an undergoing planned maintenance in CN or due to the end of network slice’s lifetime.

The scenario, where the solution is addressing, is the following:

- An operator would like to terminate a network slice for maintenance purpose or due to the end of network slice’s lifetime, while there are still some UEs being registered to the network slice and some PDU Sessions including the PDU Session for Emergency, Critical and Priority services, which are established in the network slice. This leads to a removal of UEs and to release of existing PDU Sessions from the network slice, and hence resulting to an abrupt service disruption and a degradation of service quality experience by a user.

This solution makes the following assumptions:

- OAM is configured with the information about when and which network slice is to be terminated.

6.8.2 Functional Description

The solution is based on the following principles:

- To achieve a graceful network slice termination, prior to the time for terminating the S-NSSAI, it is proposed to check whether the PDU Session is active or inactive, then to first release inactive PDU Session and slowly release other active PDU Session when it becomes inactive. For PDU Session for emergency, critical and priority service, it is recommended to keep such PDU Session at least for an operator-defined period of time.

Editor's note: It is FFS how to support roaming scenario, where a network slice of the serving network is to be terminated.

Editor's note: It is FFS how to adapt the solution, in case OAM may directly interact with SMF or NFs affected from the event that the S-NSSAI is to be terminated.

6.8.3 Procedures

Figure 6.8.3-1 describes an overview of the procedure how the network slice is terminated while minimizing abrupt service disruption as much as possible.



**Figure 6.8.3-1: Updating session management subscriber data in SMF**

1. The UDM is configured by the OAM with the information of which S-NSSAI is subject to be terminated, and when the S-NSSAI will be terminated. This information is part of the session management subscriber data.

NOTE 1: The information about "when the S-NSSAI will be terminated” can be in different forms, e.g., "to be terminated in a due time, like in 1 hour", or "to be terminated at a specific date and time".

2. The UDM notifies the update of the session management subscriber data to the affected SMF(s) by the means of invoking Nudm\_SDM\_Notification service operation.

3. The SMF modifies the session management subscriber data in the UE SM context that is stored in the SMF. The SMF performs the following for a PDU Session associated with the S-NSSAI marked as "subject to be terminated":

NOTE 2: This step 3 is performed for all UEs that are affected by the S-NSSAI marked as "subject to be terminated".

- If a PDU Session is already established but inactive, the SMF releases the PDU Session.

- If a PDU Session is already established and still active, the SMF does not release the PDU Session. When the PDU Session becomes inactive, the SMF releases the PDU Session. Subject to operator’s policy, the SMF may check if the PDU Session is used for Emergency, Critical and Priority services.

- In case the PDU Session is not used for Emergency, Critical and Priority services, the SMF may release the active PDU Session.

Editor's note: It is FFS whether and how the existing and active PDU Session, associated with the S-NSSAI subject to be terminated, for non-emergency non-critical and non-priority services could be continued to avoid abrupt service interruption.

Editor's note: It is FFS what are the criteria/condition for the CN to tear down PDU Sessions.

- In case the PDU Session is used for Emergency, Critical and Priority services, subject to operator’s policy, the SMF may keep the PDU Session for an operator-defined period of time.

- If the SMF receives a new PDU Session Establishment Request for the S-NSSAI, the SMF rejects the request.

Editor's note: It is FFS what and how the AMF/NSSF should perform any additional steps for S-NSSAI subject to be terminated.

4. When SMF has released all PDU Sessions associated with the S-NSSAI subject to be terminated, the SMF informs the UDM of the result accordingly.

5. When UDM receives a response from all affected SMF(s) associated with the S-NSSAI subject to be terminated, the UDM deletes the S-NSSAI from the UE’s subscription data, which triggers an update towards the AMF to remove the S-NSSAI from the Configured NSSAI, and from the Allowed NSSAI. After this, the network operator can safely terminate the corresponding network slice at the point in time according to the schedule known by the OAM.

6.8.4 Impacts on services, entities and interfaces

UDM:

- UDM is enhanced to support which S-NSSAI is subject to be terminated and when the S-NSSAI will be terminated, and to inform SMF by invoking the Nudm\_SDM\_Notification service.

SMF:

- SMF is enhanced to gracefully release PDU Session(s) associated with the S-NSSAI subject to be terminated based on the operator’s policy.

6.9 Solution #9: Support of a Network Slice with an AoS not matching existing TA boundaries.

6.9.1 Introduction

This solution aims to address the key issues#3 by proposing that the RAN is enhanced to support additional TAC broadcast (secondary TACs) that supporting UEs can use. This will require RAN2/3 and CT1 to update their specifications accordingly.

6.9.2 Description

As the use cases for network slicing become more and more advanced and permit addressing private networking and industrial IoT applications, the Area of Service (AoS) of network slice can become limited to small areas of a PLMN which may not map to already existing TA boundaries. In order to accommodate this, with the current set of specification the way to achieve this would be to redesign the TAs topology of the network.

Indeed, if the goal of an operator is to support legacy UEs while using such slices, the only possible solution is to redesign the TA boundaries and potentially add new and smaller TAs.

So, it can be concluded that to support legacy UEs, the only solution possible to address the problem space is to redesign the TAs to enable matching the needs to deploy limited AoS network slices not matching already deployed TAs topology.

While this can be a solution, this implies that even users that do not have interest in the specific limited AoS slices may end up having to be allocated to such smaller tracking area and/or the TAI list can become rather complicated to form or even in some cases exceed the limit of 16 TAs in the TAI-list. It may in some situations cause also additional signalling traffic due to mobility management and needs of UE configuration update even if the UEs are not interested at all by the use of these specific slices. So, for rel-18 and beyond, improvements can be considered.

If there are network slices that the operator knows the customer has full control on the UE population of, and the specification of the supported UEs capabilities is part of the SLA, we can explore alternative option that is presented here.

The solution is based on allowing the broadcast on SIB of additional TACs (we expect only a small number if not just one additional to be only needed to cover most cases, RAN2 to define how many can be configured) that supporting UEs can read. These additional/secondary TAC values are passed to the CN with the associated slices supported in NG-AP messages uses to maintain the supported slices and explicitly indicated as "Secondary TACs" in UE specific signalling when the TAC is included today to signal the UE location in the Initial UE message, The AMF then forms the RA by considering the support of slices as today, but it can only include in the Allowed NSSAI network slices requiring TAs that are broadcasted as secondary TAs in the RA for the supporting UEs (so e.g. Note well that the support of slices that are not fully supported in a TA is not signalled, as per today's specifications (so, e.g., TA4 only uniformly supports S-NSSAI 1 and S-NSSAI 4). See figure 6.9.2-1. These slices whose AoS also requires some secondary TAs, can be allowed in the in the secondary TAs indicated in the RA only for supporting UEs - so, if the RA includes secondary TAs, then only supporting UEs can received these slices S-NSSAIs in the Allowed NSSAI. Primary TAs may be included in the RA for these slices in addition to secondary TAs only if the S-NSSAIs is uniformly supported in the primary TA that are indicated in the RA. Of course these capable UEs are as capable as the legacy UEs to be allowed to use slices that fully match existing deployed TAs (so if the supporting UE requests S-NSSAI 1 only, it can be indicated a RA=(TAI1,TAI5).



**Figure 6.9.2-1: Example TA topology including Primary and Secondary TAs**

Based on the uniform support of network slices per TA in figure 6.9.2-1, if, the UE requests S-NSSAI 3 and S-NSSAI 1 only, then the RA includes TAI 3 but not TAI1. It is not permitted to add TA4 as cells broadcasting TA4 do not always support S-NSSAI 3 (see above in figure 6.9.2-1 that the cells broadcasting TA4 under primary TA5 do not support S-NSSAI 3).

In other words, the uniform support of slices is assumed also at the secondary TAI level.

Since a gNB only provides the supported slices under the TAC it administers, S-NSSAI(s) uniform support by a secondary TA shall be configured in each gNB even though for the cells under its scope support may be considered uniform (e.g. in figure 6.9.2-1 the TA5 and TA1 may be under different gNBs and so TA4 may be considered uniformly supporting S-NSSAI 3 from the gNB supporting TAI1 and not supporting S-NSSAI 3 in gNB supporting TAI5). The alternative is that the AMF or NSSF determine the uniform support based on the received information from the RAN by combining the support indication received by different NG-AP sources (i.e. if gNB 1 declares S-NSSAI3 is supported by TAI4, and gNB5 does not indicate support of S-NSSAI3 by TAI4, then TAI4 does not support S-NSSAI 3 uniformly and the NSSF/AMF can summarize this when they combine the indication by different gNBs).

6.9.3 Procedures

When the UE performs a MRU, it includes support secondary TAs in UE 5GMM capabilities. The Initial UE message or the UL NAS transport message where the Registration Request is carried, convey the User Location Information IE with the primary TAC and the secondary TACs of the Cell Id to determine the S-NSSAIs that are supported in the cell where the UE is.



**Figure 6.9.3-1: enhanced ULI in INITIAL UE/ UL NAS TRANSPORT MESSAGEs**

Indicatively, we propose to modify the "User Location Information IE" in clause 9.3.1.16 of TS 38.413 from

This IE is used to provide location information of the UE.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **IE/Group Name** | **Presence** | **Range** | **IE type and reference** | **Semantics description** | **Criticality** | **Assigned Criticality** |
| CHOICE *User Location Information* | M |  |  |  | - |  |
| >*E-UTRA user location information* |  |  |  |  |  |  |
| >>E-UTRA CGI | M |  | 9.3.1.9 |  | - |  |
| **>>TAI** | **M** |  | **9.3.3.11** |  | **-** |  |
| >>Age of Location | O |  | Time Stamp  9.3.1.75 | Indicates the UTC time when the location information was generated. | - |  |
| >>PSCell Information | O |  | NG-RAN CGI  9.3.1.73 |  | YES | ignore |
| >*NR user location information* |  |  |  |  |  |  |
| >>NR CGI | M |  | 9.3.1.7 |  | - |  |
| **>>TAI** | **M** |  | **9.3.3.11** |  | **-** |  |
| >>Age of Location | O |  | Time Stamp  9.3.1.75 | Indicates the UTC time when the location information was generated. | - |  |
| >>PSCell Information | O |  | NG-RAN CGI  9.3.1.73 |  | YES | ignore |

to

This IE is used to provide location information of the UE.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **IE/Group Name** | **Presence** | **Range** | **IE type and reference** | **Semantics description** | **Criticality** | **Assigned Criticality** |
| CHOICE *User Location Information* | M |  |  |  | - |  |
| >*E-UTRA user location information* |  |  |  |  |  |  |
| >>E-UTRA CGI | M |  | 9.3.1.9 |  | - |  |
| **>>TAI LIST** | **M** |  | **9.3.3.11** |  | **-** |  |
| >>Age of Location | O |  | Time Stamp  9.3.1.75 | Indicates the UTC time when the location information was generated. | - |  |
| >>PSCell Information | O |  | NG-RAN CGI  9.3.1.73 |  | YES | ignore |
| >*NR user location information* |  |  |  |  |  |  |
| >>NR CGI | M |  | 9.3.1.7 |  | - |  |
| **>>TAI LIST** | **M** |  | **9.3.3.11** |  | **-** |  |
| >>Age of Location | O |  | Time Stamp  9.3.1.75 | Indicates the UTC time when the location information was generated. | - |  |
| >>PSCell Information | O |  | NG-RAN CGI  9.3.1.73 |  | YES | ignore |

where the definition of TAI LIST can be like

TAI LIST

This IE indicates the list of TAIs broadcast by the NG RAN node and can be accessed by the UE.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **IE/Group Name** | **Presence** | **Range** | **IE type and reference** | **Semantics description** | **Criticality** | **Assigned Criticality** |
| **TAI Item** |  | *1..<maxnoofsupportedTACs>* |  |  | – |  |
| >TAC | M |  | 9.2.2.5 | Broadcast TAC | – |  |
| **>Broadcast PLMNs** |  | *1..<maxnoofsupportedPLMNs>* |  |  | – |  |
| >>PLMN Identity | M |  | 9.2.2.4 | Broadcast PLMN | – |  |
| >>TAI Type | M |  | ENUMERATED (primary, secondary, …) | slice categorization | - |  |

The *TAI Type* information shall also be conveyed alongside the TAI in the NG-AP NG SETUP REQUEST, RAN CONFIGURATION UPDATE messages. similarly, the same applies on Xn-AP Xn SETUP REQUEST and NG-RAN CONFIGURATION UDPATE message and in the F1-AP F1 SETUP REQUEST and GNB-DU CONFIGURATION UDATE messages.

In the registration Request message itself, the gNB also includes

In the UE Registration Request step 1 of Figure 4.2.2.2.2-1: "Registration procedure" the registration request includes the "last visited TAI" information.

|  |
| --- |
| *[...] UE to (R)AN: AN message (AN parameters, Registration Request (Registration type, SUCI or 5G-GUTI or PEI,* ***[last visited TAI (if available)]****, [****...]*** |

it is proposed that now it is augmented with the "Last visited secondary TAIs" by supporting UEs because these TAIs have to be detected in the AMF as additional to the primary TAI to have complete information.

|  |
| --- |
| *[...] UE to (R)AN: AN message (AN parameters, Registration Request (Registration type, SUCI or 5G-GUTI or PEI,* ***[last visited TAI (if available)]****,****[last visited secondary TAIs(if available and supported by the UE]****] [****...]*** |

6.9.4 Impacts on services, entities and interfaces

The solution has the following impacts:

NG-RAN node:

- Broadcast one or more additional TAIs via a new information element in SIB

- Support new messages in the NG-AP and Xn-AP as well as F1AP procedures to share support of additional secondary TAI, or indicating the cell where the UE is support >1 TAC and what the TAC and which ones the primary/secondary values are.

AMF

- Obtain information on the slice support for primary and secondary TAIs via NGAP procedures

- Assign the registration area considering the primary and secondary TACs and whether the UE is a legacy UE or new UE.

- Page UEs considering the primary and secondary TAC if informed via NGAP procedures as well as the corresponding registration areas of the UEs

- Obtain UE’s primary TAC and secondary TACs via initial UE message

UE

- When multiple TACs are available for the selected PLMN, the UE selects (all things being equal) a primary or secondary TAC inside the RA

- perform registration procedure by taking into account the secondary TAC broadcasted.

6.10 Solution #10: Associating a validity timer with a temporary slice.

6.10.1 Introduction

The solution addresses second part of the key issue #3 " Network Slice Area of Service for services not mapping to existing TAs boundaries, and Temporary network slices " which states that there can be case where a network slice is deployed temporarily for a particular time period

The network (e.g. AMF) associates a validity timer for each S-NSSAI which is deployed temporarily. This validity timer for each temporary S-NSSAI is sent to the UE e.g. in the configured NSSAI list during the registration procedure. When the UE receives the S-NSSAI with a validity timer in the configured NSSAI, the UE runs a validity timer. The UE will register to the S-NSSAI when the validity timer is running. Once the validity timer expires the UE locally removes the S-NSSAI from the allowed NSSAI list and the UE locally release the PDU session associated with the S-NSSAI. The network (e.g. AMF) also runs the validity timer for the S-NSSAI, once the validity timer expires the network removes the S-NSSAI from the allowed NSSAI list and locally release the PDU sessions associated with the S-NSSAI. The UE provides the capability to the AMF which provides to the UDM or other network function that it support configured NSSAI with validity timer. The UE not supporting the timer doesn’t get the validity timer in the configured NSSAI. In addition of UDM other entities can also provide the validity timer. This covers both the case where the timer is set in the serving network (for the serving S-NSSAI) and from the subscription (UDM-based, for the subscribed S-NSSAI).

6.10.2 Procedures

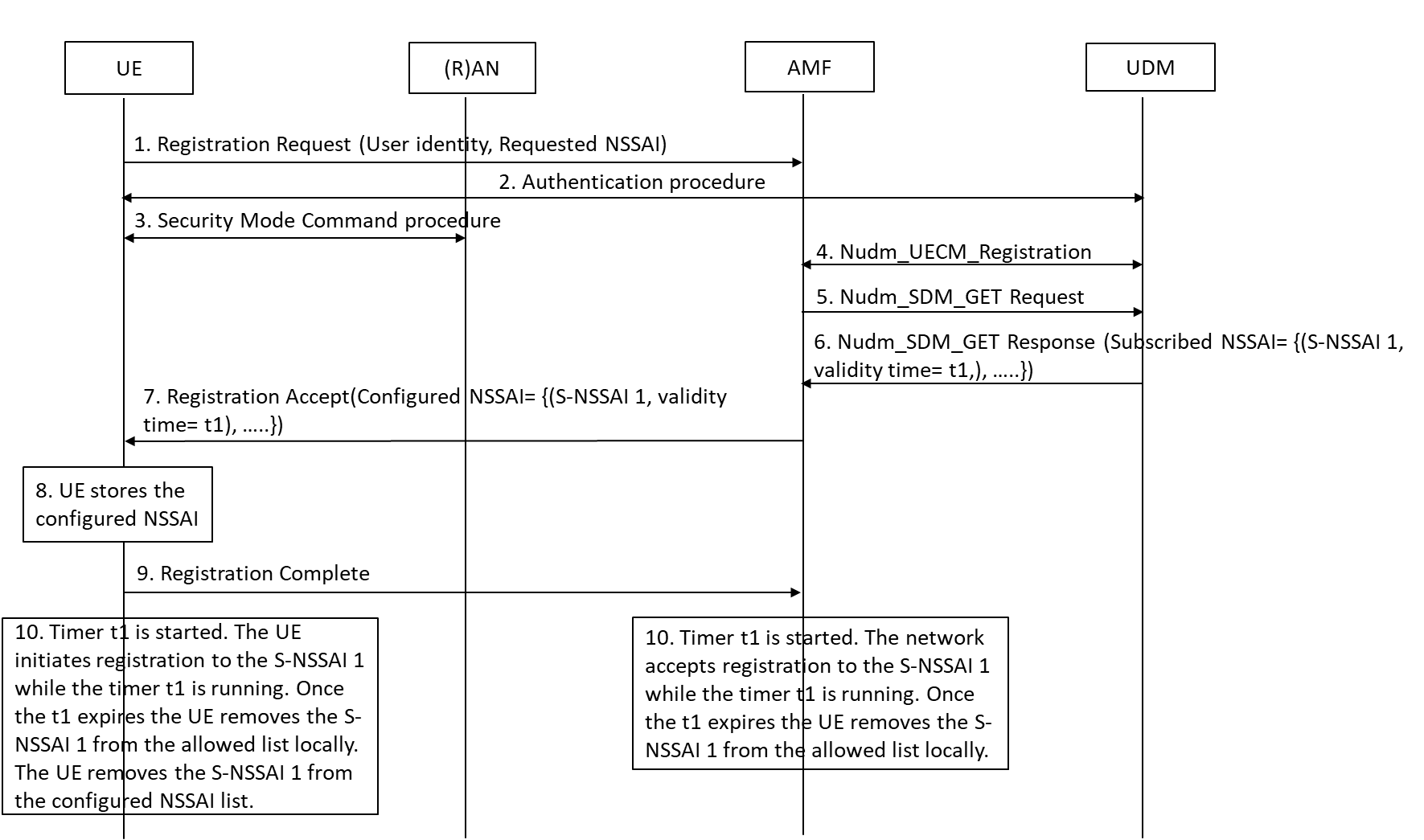


Figure 6.10.2-1: Handling of a temporary network slice.

The detailed procedure are as described below:

0. The UE can be preconfigured with configured NSSAI with validity timer. Configured NSSAI can also come in UE Configuration Update message.

Editor's Notes: it is FFS whether a S-NSSAI can be added or removed dynamically in the UE subscription.

1. The UE initiates registration procedure and sends registration request messgae.

2-3. The network may trigger authentication procedure and security mode command procedure.

4-6. The AMF registers to the UDM for the UE. the UDM provides the subscribed NSSAI to the AMF. In the subscribed NSSAI the UDM associate a validity time for each temporary S-NSSAI.

NOTE: the validity timer for a temporary S-NSSAI can also be provided by other NSSF.

7. The AMF sends configured NSSAI = Subscribed NSSAI to the UE in the registration accept message.

8. The UE stores the configured NSSAI.

9. The sends registration complete message to the AMF.

10a. The UE starts t1. The UE initiates registration to the S-NSSAI 1 while the timer t1 is running. Once the t1 expires the UE removes the S-NSSAI 1 from the allowed list locally. The UE removes the S-NSSAI 1 from the configured NSSAI list.

10b. AMF starts t1 is. The AMF accepts registration to the S-NSSAI 1 while the timer t1 is running. Once the t1 expires the UE removes the S-NSSAI 1 from the allowed list locally.

NOTE: The value of the timer can be hours, days or months and details can be captured in stage 3.

Editor's note: The impact of termination of temporary slice to NFs other than AMF is FFS.

Editor's note: It is FFS whether a slice which does not have associated validity timer can be configured with validity timer using UPU procedure.

Editor's Note: If the UE is in connected state, how the PDU session of the network slice is gracefully released is FFS.

6.10.3 Impacts on services, entities and interfaces

UE

- Handling of validity timer for a S-NSSAI.

AMF

- Handling of validity timer for a S-NSSAI.

UDM

- UDM needs to provide the validity timer for a temporary S-NSSAI for a UE to the AMF.

6.11 Solution #11: Enabling UEs to Request S-NSSAIs not uniformly available

6.11.1 Introduction

This solution applies to KI#XX for WT#2 and KI#3.

6.11.2 Functional Description

The high-level points of the proposed solution are:

- The AMF creates an RA for the UE as per current mechanisms ensuring the optimal size of the RA with respect to the S-NSSAIs that can be allowed

- The Allowed NSSAI contains only S-NSSAIs that are allowed in the whole RA

- The AMF provides a set of conditions to the UE for the S-NSSAIs (here called Conditional S-NSSAI) that are valid only under specific condition and therefore cannot be placed in the Allowed NSSAI (here called Conditional S-NSSAI)

- the conditions may include a list of TAs (not included in the present RA) where the S-NSSAI is allowed

- the conditions may include an Area of Service (as defined in KI#3) for the S-NSSAI

Editor's note: How an RA is defined if an Area of Service does not match exactly a TA is FFS.

Editor's note: It is FFS whether and how the specific details of the Area of Service constraints are provided to the UE.

- the conditions may include "time-related conditions" (e.g. specific times at which an S-NSSAI is available or the time period in which the S-NSSAI is available) to support the use cases associated with KI#3

- multiple conditions may be associated to an S-NSSAI (e.g. list of TAs and "time-related conditions")

NOTE 1: An S-NSSAI that is allowed in the whole RA or part of the RA but only under specific time conditions would be placed in the Conditional S-NSSAI.

- the conditions may be provided by placing the S-NSSAI in an enhanced existing Rejected NSSAI IE (i.e. the S-NSSAI in the Rejected NSSAI may be associated with conditions and the UE is allowed to register for the S-NSSAI when the conditions are valid)

- alternatively, the conditions are provided by placing the S-NSSAI in a new Conditionally Allowed NSSAI IE which contains all the S-NSSAIs the UE requested and that cannot be placed in the Allowed NSSAI, but that may be available under different conditions (other TAs, other times, etc.)

NOTE 2: The decision with respect to which IE is used to convey the additional information should be taken in CT1.

NOTE 3: S-NSSAIs that are placed in the Pending NSSAI may be considered Conditional NSSAIs once the NSSAA procedure is completed successfully

- The AMF provides the conditions to the UE anytime the AMF provides, or updates, the Allowed NSSAI and Rejected NSSAI to the UE (e.g. registration procedure, UCU procedure)

Editor's note: How the AMF is provided such condition information, e.g. via OAM or other mechanisms, is FFS.

- The UE shall not request resources for a Conditional S-NSSAI unless the associated conditions indicate the S-NSSAI is available (e.g. specific TA or time)

- When the UE determines that a Conditional S-NSSAI is available and that the applications in the UE require connectivity with the Conditional S-NSSAI, the UE may re-register with the network including the Conditional S-NSSAI.

- in IDLE mode, when the UE performs a Service Request for an S-NSSAI that is no longer available (e.g. the UE has moved outside the TA where the S-NSSAI is available or the time conditions have changed), the request for the resources associated to the S-NSSAI is rejected and an indication is provided to the UE as to why. If the S-NSSAI was in the Allowed NSSAI, the AMF may provide a new Allowed NSSAI, and either a new Rejected NSSAI or Conditionally Allowed NSSAI to the UE.

- Not all AMFs in a network may support this extension, thus to enable compatibility a UE receiving the additional information shall ignore it, and no capability indication to the AMF is required.

Editor's note: Whether non-supporting AMFs can support S-NSSAIs with area or time constraints is FFS.

6.11.3 Procedures

Editor's note: This clause describes high-level procedures and information flows for the solution.

6.11.4 Impacts on services, entities and interfaces

The following impacts have been identified:

* UE:

- interpreting and processing new information in Rejected NSSAI or new Conditional S-NSSAI IE

* AMF:

- providing new information in Rejected NSSAI or new Conditional S-NSSAI IE

- providing rejection cause at Service Request

6.12 Solution #12: Solution for Centralized Counting for Multiple Service Areas and 5GS-EPS Interworking

6.12.1 Description

In this solution, and in support of 5GS only slices, when multiple Service Areas are deployed, it is proposed that a single central NSACF NF performs the PLMN global counting and admission to ensure a consistent counting, e.g. such that during handover between different Service Areas no additional admission needs to be performed. The admission request includes all necessary information to enable the central NSACF NF to collect all pertinent information per Service Area. Interaction between the NF performing the admission, be it the SMF or the AMF, occurs with the designated central NSCAF for that purpose. The central NSACF NF responsible for PLMN global count is discovered via NRF or can be pre-configured.

Editor's note: It is FFS if the central NSACF is located at the HPLMN how the NRF query which is based on the service area or configuration based mechanism is supported.

Two options are proposed to enable a Service Area to perform some local tasks; e.g. keeping local statistics in conjunction with centralized counting with a single central NSACF NF:

**Option 1: Transparent Proxying to central NSACF NF Via an intermediate NF**

Based on policy, an NF, e.g SMF or AMF performing the admission with the central NSACF NF may additionally and optionally interact with a local NF associated with the Service Area, for any additional capabilities not supported by the central NSACF NF. Such additional capabilities are not specified. but can be e.g. to keep local statistics.

Editor's note: It is FFS whether this local NF can be the enhancement of the Rel-17 NSACF.

Editor’s Note: to support the local statistics it is expected that all message between AMF/SMF and the central NSACF need go through that local NF. Then how to ensure the same service area AMF/SMF go through the same local NF?The interaction with such a local NF is such, that the local NF in the Service Area proxies the original request, as is, to the central NSACF NF, after performing the tasks it desires upon receipt of the admission Request intended for the central NSACF NF. Hence, in this option1, the interaction with the central NSACF server is proxied via an intermediate NF to the central NF, as long as it is transparent to the central NSACF NF. Transparent means that the central NSACF NF cannot distinguish whether the Request is direct from the AMF/SMF or proxied via an intermediate NF.

**Option 2: Dual Interaction with Local NF, and central NSACF NF**

Based on policy, an NF, e.g SMF or AMF performing the admission with the central NSACF NF may additionally and optionally interact with a local NF associated with the Service Area, for any additional capabilities not supported by the central NSACF NF. Such additional capabilities are not specified. but can be e.g. to keep local statistics

Editor's note: It is FFS how the AMF/SMF interact with local NF, e.g. replicate all message with the central NSACF or others? This also depend on which NF is the local NF.

Hence the AMF/SMFs performs dual interactions in parallel; once towards the central NSACF NF, and an additional one towards a local NF in the Service Area.

In support of roaming, and to enable such a central NF to handle roaming UEs, as well as home bound UEs, the admission query to the central NF includes the PLMN-ID where the UE is roaming.

To support EPS counting while interworking with 5GS when activated and where home routing is the only option for attachment to EPS, a central NSCAF NF could be optionally dedicated for 5GS-EPS interworking shared count. In this case, such a dedicated NF is discovered. The PLMN can also reuse a single NSACF NF for all admissions.

Similar to the 5GS case, and based on policy, a NF performing admission with the central NSACF responsible for the shared 5GS-EPS count may additionally and optionally interact with a local NF associated with the Service Area, for any additional capabilities not supported by the central NSACF NF. Such additional capabilities are not specified. Hence, in this case as well, both options 1 and 2 above for 5GS only slices are supported for the 5GS-EPS interworking case.

With central count regardless of any interactions with a local NF based on either option 1 or option 2, admission is solely based on the central NSACF, even if these local NFs are local NSACFs maintaining count.

Editor's note: It is FFS whether it is same central NSACF for above three case, i.e. EPS interworking, roaming, multi 5G service area. If not, how to achieve service continuity if UE encounter the related scneairo.

6.12.2 Procedures

6.12.2.1 UE Registration Admission

6.12.2.1.1 5GS only slices

In this procedure, there is a single central NSACF NF performing the count for the entire PLMN. The AMF discovers the central NSACF NF performing the PLMN global counting. The NF profile for the NSACF is updated to indicate that the NSACF is the central NSACF for the S-NSSAI handling the PLMN global count for 5GS slices, i.e. discovery procedure in TS 23.502 [5] clause 5.2.7.2.2 is updated and clause 6.3.22 of TS 23.501 [2] is updated, and the central NSACF information can be encoded as part of the NSACF service capabilities as a specific capability or as part of the NSACF Serving Area information.

The AMF performs admission as in clause 4.2.11.2 of TS 23.502 [5] with the following changes:

- The AMF includes the Service Area, and the PLMN ID in its request to the central NSACF NF.

- AMF performs either option 1 or option 2 below:

- In support of **option 1**, the AMF, based on policy, communicates directly with central NSACF NF or via an intermediate NF that proxies the original request unaltered to the central NSACF. The actions performed in the intermediate NF are out of scope.

- In support of **option 2**, the AMF, based on policy, sends the admission request to the central NSACF NF, and sends the admission request as well to a local NF in the Service Area. The local NF performs tasks out of scope of standardization.

- The central NSACF NF does not change the number of registered UE for a UE that is moving between multiple Service Areas given that the UE has already been admitted and successfully registered in an old Service Area. In this case, the central NSACF NF performing the PLMN global counting only updates the UE stored information.

The AMF, in case the policy is to communicate additionally with local NSACFs (option 2), updates the applicable local NSACF with the change i.e. UE leaving one Service Area and entering the new Service Area.

With central count regardless of any interactions with a local NSACF based on either option 1 or option 2, admission is solely based on the central NSACF, even if these local NSACFs maintaining count.

6.12.2.1.2 5GS-EPS Interworking with EPS Counting Active

In this solution, there is a shared count for maximum number of Registered UEs for interworking between 5GS and EPS. The count can be performed by a central NSACF NF dedicated for 5GS-EPC interworking, or the central NSACF NF used for 5GS slices can be used. The count can be separate or bundled with the 5GC only slices count.

If a dedicated 5GS-EPS central NSACF NF is used, the AMF/SMF+PGW-C discovers the central NSACF NF handling the shared 5GS-EPS count for the number of Registered UEs. The NF profile for the NSACF is updated to indicate that the NSACF is the central NSACF for the for shared 5GS-EPS count for number of Registered UEs., i.e. TS 23.502 [5] clause 5.2.7.2.2 is updated and clause 6.3.22 of TS 23.501 [2] is updated, and the central NSACF information can be encoded as part of the NSACF service capabilities as a specific capability or as part of the shared 5GS-EPS count.

The AMF/SMF+PGW-C performs admission as in clause 4.2.11.2 of TS 23.502 [5] with the following changes:

- The AMF/ SMF+PGW-C includes the Service Area, the PLMN ID where the UE is currently in its request to the central NSACF responsible for shared 5GS-EPS count for number of Registered UEs

- AMF/SMF+PGW-C performs either option 1 or option 2 below:

- In support of **option 1**, the AMF/SMF+PGW-C, based on policy, communicates directly with central NSACF NF or via an intermediate NF that proxies the original request unaltered to the central NSACF. The actions performed in the intermediate NF are out of scope.

- In support of **option 2**, the AMF/SMF+PGW-C, based on policy, sends the admission request to the central NSACF NF, and sends the admission request as well to a local NF in the Service Area. The local NF performs tasks out of scope of standardization.

The NSACF NF responsible for the shared 5GS-EPS count or number of Registered UEs does not change the number of registered UE for a UE that is moving between multiple Service Areas given that the UE has already been admitted and registered in an old Service Area and counted for. The NSACF NF handling the shared 5GS-EPS count simply updates the UE stored information.

The AMF/SMF+PGW-C, in case the policy is to communicate additionally with local NSACFs (option 2), updates the applicable local NSACF with the change i.e. UE leaving one access to another access.

6.12.2.2 Roaming

Roaming is covered by the above solution as the PLMN ID is included in an admission request, enabling the NSACF NF to identify roaming UEs.

6.12.2.3 UE PDU Session Admission

6.12.2.3.1 5GS only slices

In this procedure, the SMF discovers the central NSACF NF performing the PLMN global counting for number of PDU sessions for network slices subject to NSAC. The NF profile for the NSACF is updated to indicate that the NSACF is the central NSACF for the S-NSSAI handling the PLMN global count for the number of PDU sessions, i.e. TS 23.502 [5] clause 5.2.7.2.2 is updated and clause 6.3.22 of TS 23.501 [2] is updated, and the central NSACF information can be encoded as part of the NSACF service capabilities as a specific capability or as part of the NSACF Serving Area information.

The SMF performs admission as in clause 4.2.11.4 of TS 23.502 [5] with the following changes:

- The SMF includes the Service Area, and the PLMN ID in its request to the central NSACF NF.

- SMF performs either option 1 or option 2 below:

- In support of **option 1**, the SMF, based on policy, communicates directly with central NSACF NF or via an intermediate NF that proxies the original request unaltered to the central NSACF. The actions performed in the intermediate NF are out of scope.

- In support of **option 2**, the SMF, based on policy, sends the admission request to the central NSACF NF, and sends the admission request as well to a local NF in the Service Area. The local NF performs tasks out of scope of standardization.

When a PDU session is handed over between two Service Areas, the central NSACF NF handling the number of PDU session does not change the number of PDU sessions if the session is successfully handed over. In case of a successful handover, the central NSACF NF performing the PLMN global counting simply updates the UE stored information. The SMF, in case the policy is to communicate additionally with local NSACFs (option 2), updates the applicable local NSACFs with the change i.e. UE leaving one Service Area and entering the new Service Area.

With central count regardless of any interactions with a local based on either option 1 or option 2, admission is solely based on the central NSACF, even if these local NFs are local NSACFs maintaining count.

6.12.2.3.2 5GS-EPS Interworking with EPS Counting Active

In this solution, there is a shared count for maximum number of PDU sessions between 5GS and EPS performed by a central NSACF NF dedicated for that purpose, or the central NSACF NF used for 5GS slices can be used.

If a dedicated 5GS-EPS central NSACF NF is used, the SMF/SMF+PGW-C discovers the central NSACF NF handling the shared 5GS-EPS count for the number of PDU sessions for a slice subject to NSACF. The NF profile for the NSACF is updated to indicate that the NSACF is the central NSACF for the for shared 5GS-EPS count for number of PDU sessions i.e. TS 23.502 [5] clause 5.2.7.2.2 is updated and clause 6.3.22 of TS 23.501 [2] is updated, and the central NSACF information can be encoded as part of the NSACF service capabilities as a specific capability or as part of the shared 5GS-EPS count.

The SMF/SMF+PGW-C performs admission as in clause 4.2.11.2 of TS 23.502 [5] with the following changes:

- The SMF/ SMF+PGW-C includes the Service Area, the PLMN ID in its request to the central NSACF NF responsible for shared 5GS-EPS count for maximum number of PDU sessions.

- SMF/SMF+PGW-C performs either option 1 or option 2 below:

- In support of **option 1**, the SMF/SMF+PGW-C, based on policy, communicates directly with central NSACF NF or via an intermediate NF that proxies the original request unaltered to the central NSACF. The actions performed in the intermediate NF are out of scope.

- In support of **option 2**, the SMF/SMF+PGW-C, based on policy, sends the admission request to the central NSACF NF, and sends the admission request as well to a local NF in the Service Area. The local NF performs tasks out of scope of standardization.

When a PDU session is handed over between 5GS and EPS, the central NSACF NF handling the number of PDU session does not change the number of PDU sessions if the session is successfully handed over between 5GS and EPS. In case of a successful handover, the NSACF NF handling the shared 5GS-EPS count simply updates the UE stored information.

The SMF/SMF+PGW-C, in case the policy is to communicate additionally with local NSACFs (option 2), updates the applicable local NSACF with the change i.e. UE leaving one access to another access.

6.12.3 Impacts on services, entities and interfaces

Editor's note: This clause captures impacts on existing 3GPP nodes and functional elements.

6.13 Solution #13: Hierarchical NSACF Architecture for Maximum UE/PDU Session number control

6.13.1 Introduction

This is a solution to Key Issue #4, "Support of NSAC involving multi service Area".

As defined in Rel-17 an NSACF is deployed on a service area basis, which can be one NSACF instance or one NSACF Set. Each NSACF performs maximum number of registered UE or established PDU session number control independently. It is possible that UE registration or PDU session establishment is rejected by the network due to the maximum number of UE/PDU session is reached at the current serving NSACF even the maximum number may still be available at other NSACF. This also impacts the session continuity when the UE moves across the service area.

Thus how to enhance the NSAC mechanism when multi NSACFs are deployed at the network need be considered.

6.13.2 Functional Description

The hierarchical NSACF architecture for UE number control is shown as the Figure 6.X.2-1. For an S-NSSAI, one NSACF acting as Primary NSACF is introduced. Other NSACFs take the same role as the existing NSACF, i.e. serving one service area. The slice SLA attributes, i.e. the global maximum number values, is only configured at the Primary NSACF. The global maximum number value is shared among different service area(s). The Primary NSACF registers its NF profile to the NRF, which can be discovered by other NF.



**Figure 6.13.2-1: Hierarchical NSACF Architecture for UE number control**

**Nxx:** Reference point between Primary NSACF and NSACF.

With the replacement of the AMF with SMF, same architecture is used for maximum PDU session number control.

To improve the signalling efficiency the Primary NSACF may allocate partial of the global maxim number value to the NSACF, i.e. the local maximum number. When the AMF or SMF interact with the NSACF, if the local maximum number at the NSACF is reached, the NSACF interact with the Primary NSACF.

For the subscription of the registered UE number or PDU session number, same handling as the multi NSACF defined in TS 23.502 [5] is executed, i.e. the NRF return the primary NSACF and other NSACF to the NEF and NEF subscribes and get notification from primary NSACF and other NSACF as before.

6.13.3 Procedures

Editor's note: Whether the Primary NSACF is a new NF and its service operation need be separated from the existing NSACF service operation is FFS.

#### 6.13.3.1 Registration management Procedures



**Figure 6.13.3.1-1: NSAC check of the maximum number of UEs**

The enforcement of maximum number of UEs registered for an S-NSSAI is performed as following:

1-2. Same as the steps 1-2 defined in clause 4.2.11.2 of TS 23.502 [5].

3. The NSACF performs NSAC for the indicated S-NSSAI.

If the update flag parameter from the AMF indicates increase,

- If the local maximum number of UEs is available, the NSACF execute same as step 3 defined in clause 4.2.11.2 of TS 23.502 [5]. Steps 4-7 are skipped.

- If the local maximum number of UEs is reached, the NSACF interact with the Primary NSACF. Step 4-7 are executed.

If the update flag parameter from the AMF indicates decrease,

- If the UE entry to be deleted is stored at the NSACF, i.e. the UE entry with the same UE ID, NF ID and Access type is stored at the NSACF, the NSACF execute same as step 3 defined in clause 4.2.11.2 of TS 23.502 [5]. Steps 4-7 are skipped.

- If the UE entry to be deleted is not stored at the NSACF, the NSACF interact with the Primary NSACF. Steps 4-7 are executed.

4. If the Primary NSACF has not been discovered before, the NSACF discovers and selects the Primary NSACF per the NF type.

5. The NSACF invokes Nnsacf\_NSAC\_NumberOfUEsUpdate\_Request to the Primary NSACF.

The NSACF forwards the update request to the Primary NSACF. If the update flag parameter from the AMF indicates increase, the NSACF also include the local maximum number of UEs, which is the previous value received from Primary NSACF, i.e. the configured one before.

6. The Primary NSACF performs NSAC for the indicated S-NSSAI.

If the update flag parameter from the NSACF indicates increase and the local maximum number is received, per operator’s policy, the Primary NSACF may want to delegate the following NSAC update request done at the NSACF. If the following NSAC update request is expected to be updated at the NSACF, the Primary NSACF increases the local maximum number of UEs allocated to the NSACF and ignores the received UE ID information. If the update flag parameter from the NSACF indicates increase and the following NSAC update request is expected to be updated at the Primary NSACF, or the update flag parameter from the NSACF indicates decrease, per the received UE ID information the UE entry stored at the Primary NSACF is updated for the related UE ID, NF ID and Access type.

NOTE: The UE entry managed by the Primary NSACF is used to support the session continuity when the UE moves to the new service area and local maximum number is reached at the target NSACF.

If the update flag parameter from the NSACF indicates decrease, the Primary NSACF updates the UE entry for the related UE ID, NF ID and Access type.

7. The Primary NSACF returns the Nnsacf\_NSAC\_NumberOfUEsUpdate\_Response. If the local maximum number of UEs is increased by the Primary NSACF, the updated local maximum number of UEs is also included, i.e. the updated configured value.

8. The NSACF checks the response from primary NSACF and determines whether it need update the UE entry stored at the NSACF.

If the local maximum number of UEs is received from Primary NSACF, the NSACF replaces the local maximum number of UEs with the received updated value and update the UE entry for the related UE ID, NF ID and Access type. In other case the NSACF forwards the response to the AMF.

9. Same as the step 4 defined in clause 4.2.11.2 of TS 23.502 [5].

6.13.3.2 PDU Session management Procedures



**Figure 6.13.3.2-1: NSAC check of the maximum number of PDU Sessions**

The enforcement of maximum number of PDU Session established for an S-NSSAI is performed as following:

1-2. Same as the steps 1-2 defined in clause 4.2.11.4 of TS 23.502 [5].

3. The NSACF performs NSAC for the indicated S-NSSAI.

If the UE entry update at the NSACF is possible, e.g. Adding the associated PDU session ID for increase case or removing the associated PDU session ID for decrease case, same as step 3 defined in clause 4.2.11.4 of TS 23.502 [5] is executed. Steps 4-8 are skipped. Otherwise the NSACF interact with the Primary NSACF.

4. If the Primary NSACF has not been discovered before, the NSACF discovers and selects the Primary NSACF per the NF type.

5. The NSACF invokes Nnsacf\_NSAC\_NumberUpdate\_Request to the Primary NSACF. The message includes the S-NSSAI, requested local maximum PDU session number, i.e. increasing the local maximum PDU session number.

6. The Primary NSACF checks the global maximum PDU session number and determine whether accept or reject the requested the local maximum PDU session number from NSACF, i.e. whether the update of the local maximum PDU session number of NSACF is accepted or not.

7. The Primary NSACF returns the Nnsacf\_NSAC\_NumberUpdate\_Response. The response include an allocated local maximum PDU session number, i.e. the updated configured value.

8. The NSACF replaces the local maximum PDU session number with the received allocated local maximum PDU session number value. If the allocated local maximum PDU session number is increasing, the NSACF creates or adds the associated PDU session ID into the UE entry. Otherwise the NSACF rejects the permission to establish the PDU session.

9. Same as the step 4 defined in clause 4.2.11.4 of TS 23.502 [5].

6.13.3.3 Redistribution of local maximum number



**Figure 6.13.3.3-1: Redistribution of local maximum number**

At any time the Primary NSACF may update the allocated local Maximum number of UE or PDU session configured at the NSACF as following:

1-2. The Primary NSACF subscribes the slice event exposure service from the NSACF. This is to get the current registered number of UE or established PDU session number. Per the subscription, the NSACF notifies the registered number of UE or established PDU session number to Primary periodically or above the related threshold per the event subscribed.

3. Per the received current registered UE/PDU session number and operator’s policy, the Primary NSACF decides to update the local maximum UE/PDU session number value configured at the NSACF, i.e. the configured value.

4. The Primary NSACF invokes Nnsacf\_NSAC\_NumberUpdate\_Request to the NSACF. The message includes the allocated local maximum number.

5. The NSACF replaces the local maximum number with the received allocated local maximum number value.

6. The NSACF returns the Nnsacf\_NSAC\_NumberUpdate\_Response.

6.13.3.4 Session continuity handling

For maximum number of UE control, the NSACF discovered by the AMF (or SMF+PGW-C) is deployed as the following:

- Different service area within one PLMN: the NSACF is deployed in each service area.

- Roaming: the NSACF is located at the VPLMN.

* EPS interworking: when the UE camps at the EPS network, the SMF+PGW-C select the NSACF at the serving PLMN or the NSACF at the HPLMN depending on whether the PDU session is LBO PDU session or HR PDU session. When the UE camps at the 5GS network, the AMF selects the NSACF at the camping service area of the serving PLMN.

In above all case there is only one Primary NSACF instance or one NSACF Set, which is located at the HPLMN.

When UE moves across different service area, different NSACF may be interacted to perform the maximum UE number control. If local Maximum number is not reached at the NSACF, the NSACF accepts the UE registration at the new service area. If local Maximum number is reached, the NSACF forwards the NSAC request to the Primary NSACF. The Primary NSACF updates the UE ID entry per the received UE ID information until the maximum number at the Primary NSACF is reached. Thus even if the local maximum number at one NSACF is reached, the session continuity is still supported.

6.13.4 Impacts on services, entities and interfaces

The following impacts are foreseen by this solution:

NSACF:

- A new NSACF type, i.e. Primary NSACF, is introduced. Compare to the Rel-17 NSACF function, it manages the global Maximum number value and distribute global Maximum number to NSACF additionally.

- Support the update of the local Maximum number per the instruction from Primary NSACF.

- Determines whether the UE ID entry update is to be performed at the NSACF or Primary NSACF.

6.14 Solution #14: Maximum Number Distribution in multiple NSACFs

6.14.1 Introduction

This solution aims to address the KI#4: Support of NSAC involving multi service Area. This solution can be applicable to both non roaming scenario and roaming scenario.

NOTE: This solution doesn’t resolve the service continuity issue.

6.14.2 Functional Description

In this solution, there is one centralized NSACF controlling the overall maximum number of UEs and maximum number of PDU Sessions of the S-NSSAI. The distributed NSACF requests the local maximum number from the centralized NSACF. The centralized NSACF may also update the local maximum number to the related NSACFs,

In roaming case the NSACF in VPLMN interacts with the centralized NSACF in the HPLMN to retrieve the local maximum number and perform the NSAC locally.

The central NSACF may invoke Nnsacf\_SliceEventExposure service to request the number of UE and number of PDU session in each distributed NSACF.

Editor's note: It is FFS whether the central NSACF is a new node, and resolve it at next meeting.

6.14.3 Procedure



**Figure 6.14.3-1: Procedure for Maximum Number Distribution in multiple NSACFs**

1. When there is no local maximum number in NSACF, or the number of UE or number of PDU session of the S-NSSAI will reach the local maximum number in the NSACF , it sends Local Maximum Number Request to centralized NSACF to request a new local maximum number.

2. If the request is accepted, the central NSACF sends a new maximum number to the NSACF. The NSACF stores the new local maximum number of the S-NSSAI.

3. At any time the centralized NSACF may send Local Maximum Number update message to update the local maximum number in the NSACF which has requested the local maximum number.

4. The NSACF stores the new local maximum value and send response message to the centralized NSACF.

6.14.4 Impacts on services, entities and interfaces

**NSACF:**

- new interaction between NSACFs for maximum number distribution

## 6.X Solution #X: <Solution Title>

### 6.X.1 Introduction

Editor's note: This clause lists the key issue(s) addressed by this solution.

### 6.X.2 Functional Description

Editor's note: This clause outlines solution principles, assumptions and high-level architectures, etc.

### 6.X.3 Procedures

Editor's note: This clause describes high-level procedures and information flows for the solution.

### 6.X.4 Impacts on services, entities and interfaces

Editor's note: This clause describes impacts to existing services, entities and interfaces.

# 7 Overall Evaluation

Editor's note: This clause will provide evaluation of different solutions.

# 8 Conclusions

Editor's note: This clause will list conclusions that have been agreed during the course of the study item activities.

## 8.X Conclusions for Key Issue #X

Annex A:  
Change history

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Change history** | | | | | | | |
| **Date** | **Meeting** | **TDoc** | **CR** | **Rev** | **Cat** | **Subject/Comment** | **New version** |
| 2022-02 | SA2#149E | S2-2200563 | - | - | - | Skeleton | 0.0.0 |
| 2022-02 | SA2#149E | - | - | - | - | Implementation of following documents approved in SA2#149e: S2-2201033, S2-2201348, S2-2201857, S2-2201350, S2-2201352, S2-2201353  Following is made by rapporteur:  - Editorial fixes | 0.1.0 |
| 2022-04 | SA2#150E | - | - | - | - | Implementation of following documents approved in SA2#150e: S2-2203080, S2-2203081, S2-2203082, S2-2203083, S2-2203084, S2-2203085, S2-2203086, S2-2203087, S2-2203088, S2-2203089, S2-2203090, S2-2203091, S2-2203092, S2-2203093, S2-2203094, S2-2203095  Following is made by rapporteur:  - Editorial fixes  - Added figure title in 6.1.3  - Sub-clause renumbering in 6.2  - Removed "(In) Step" in front of each step numbering in 6.6, 6.13  - Removed editor's note on general guidance if some descriptions are captured. | 0.2.0 |