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**Title: Evaluation of the solutions for Key Issue 2**

**Document for: Approval**

**Agenda Item: 6.21**

**Work Item / Release: FS\_eNS / Rel-16**

*Abstract of the contribution: This document proposes evaluation for solutions for Key Issue 2. It also proposes some clarifications to the corresponding solutions.*

# 1. Introduction

This document proposes evaluation for solutions for Key Issue 2. It also proposes some clarifications to the corresponding solutions.

# 2. Proposal

It is proposed to add the solution below in TR 23.740

\*\*\* Start of changes \*\*\*\*

## 6.2 Solutions for KI#2

### 6.2.1 Solution#2.1: Network slice instance selection in initial AMF

#### 6.2.1.1 Introduction

This solution address the key issue#2: Enabling interworking for slicing between EPC and 5GC.

#### 6.2.1.2 Functional description

The PGW-C+SMF knows the S-NSSAI or each PDN connection. In connected mode, Initial AMF uses the Nsmf\_PDUSessionCreateSMContext service operation with the PGW-C+SMF that returns the S-NSSAI and PDU Session ID to the Initial AMF selected by the source MME. Then the Initial AMF determines the set of network slices supported for the UE, and, if required, selects the Target AMF and forward the handover message to the target AMF . The rest are same procedure as normal EPS to 5GS handover procedure using N26 interface.

For IDLE mode mobility from EPS to 5GS using N26 interface, the Target AMF uses the Nsmf\_PDUSessionCreateSMContext service operation with the PGW-C+SMF to retrieve the S-NSSAI of the transferred PDU Connection. The S-NSSAI of the PDU session returned by PGW-C+SMF is used to select a correct V-SMF as described in clause 4.11.1.3.3 of TS 23.502 [3].

NOTE 1: This solution uses existing solution in Release 15 to correlate the EBI and S-NSSAI of the PDU session as described in clause 4.11.1.2.2 and clause 4.11.1.3.3 in TS 23.502 [3]. The AMF sends UE EPS PDN Connection received from MME to SMF and the SMF return the EBI information and the S-NSSAI of the PDU session.

#### 6.2.1.3 EPS to 5GS handover Procedures

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



Figure-6.2.1.3: EPS to 5GS handover using N26 interface

1. Step 1 to step 6 are same as normal EPS to 5GS handover using N26 interface.

Editor's note: Step 4 must be aligned with TS 23.502 to use CreateSMContext.

7. The SMF + PGW-C sends a Nsmf\_PDUSession\_UpdateSMContext Response (PDU Session ID, N2 SM Information (PDU Session ID, QoS Rules, EPS Bearer Setup List, H-CN Tunnel-Info, S-NSSAI), S-NSSAI) to the initial AMF. SMF includes mapping between QoS flows and EPS bearers as part of N2 SM Information container.

8. The Initial AMF performs network slice instance selection and the target AMF based on the S-NSSAI received in step 7.  
  
In home-routed roaming case, if the VPLMN and HPLMN have an SLA to support non-standard S-NSSAI values in the VPLMN, the Initial AMF uses the NSSF of the VPLMN to map the S-NSSAI values to the respective S-NSSAI values to be used in the VPLMN.

9. The initial AMF sends Namf\_Communication\_CreateUEContext service operation (Target 5GAN Node ID, Source to Target Transparent Container, EPS MM Context, EPS Bearer Context(s), N2 SM Information received in step 7, S-NSSAI received in step 7) message to the target AMF. Based on the S-NSSAI the target AMF may reselect a new V-SMF2. In case of no change of V-SMF, step 10-12 are skipped and in step 13 the target AMF uses the N2 SM Information received in step 7.

10. If the target AMF reselects a new V-SMF2, it sends Nsmf\_PDUSession\_UpdateSMContext Request(UE EPS PDN Connection, N2 SM Information) to V-SMF2.

Editor's note: Step 10 must be aligned with TS 23.502 to use Nsmf\_PDUSessionCreateSMContext. The V-SMF must send a Nsmf\_PDUSessionCreate to PGW-C+SMF.

11-12. The V-SMF2 establishes the N4 session with V-UPF2. The V-UPF2 allocates CN tunnel information. The V-SMF2 updates N2 SM Information with the S-NSSAI and the CN tunnel information of V-UPF2. The V-SMF2 then sends Nsmf\_PDUSession\_UpdateSMContext Response (PDU Session ID, N2 SM Information) towards target AMF.

13-31. Step 13 to step 31 are same procedure as normal EPS to 5GS handover procedure using N26 interface in clause 4.11.1.2.2 of TS 23.502 [3]. In additional, in step 19, the initial AMF initiates resource release of V-SMF1 and V-UPF. The Forward Relocation Complete notification message is relayed by an initial AMF in case that the target AMF does not support N26 interface.

#### 6.2.1.4 Impacts on existing entities and interfaces

No impact on EPC.

No impacts on UE.

In connected mode, the Initial AMF selects the target network slice instance and the target AMF based on the S-NSSAI received from the PGW-C+SMF. Then it sends the Namf\_Communication\_CreateUEContext service operation with the EPS MM Context , EPS Bearer Context(s)and the N2 SM Info received from V-SMF1 to target AMF. The initial AMF removes the resources in V-SMF1 and V-UPF1 after the UE context has been transferred to target AMF.

The target AMF sends N2 SM Info received from initial AMF to V-SMF2.

The V-SMF2 updates the N2 SM Info received from target AMF with S-NSSAI and CN tunnel information of V-UPF2 and sends the N2 SM Info to the 5G-AN.

#### 6.2.1.5 Evaluation

Editor's note: This clause provides an evaluation of the solution.

This solution is based on Rel-15 solution and can provide slicing interworking between EPC and 5GC for both Rel-15 UE and Rel-16 UE. The AMF, the PGW-C+SMF and the Nsmf\_PDUSession\_UpdateSMContext need to be modified to return the S-NSSAI from the PGW-C+SMF to the Initial/Target AMF.

Additional step to retrieve the S-NSSAI from the PGW-C+SMF (i.e. network slicing selection) is introduced in handover preparation phase which may add more handover latency.

The solution requires Rel-16 AMF and Rel-16 PGW+SMF.

### 6.2.2 Solution #2.2: Slice-aware mobility from EPC to 5GC

#### 6.2.2.1 Introduction

The solution addresses key issue number 2.

#### 6.2.2.2 Functional description

For mobility from EPC to 5GC, IDLE mode and CONNECTED mode mobility are addressed separately.

##### 6.2.2.2.1 Idle Mode Mobility from EPC to 5GC

The SM context in the EPC that is provided to the 5GC in case of mobility from EPC to 5GC does not contain any slicing information. This applies regardless if the UE initially registers and establishes connectivity in 5GC and then moves to EPC, or the UE initially registers and establishes connectivity in EPC.

As a result, when the UE moves to the 5GC from EPC, the AMF will have no information about the slice (identified by S-NSSAI) associated the UE's PDN connections moved from EPC. Consequently, the AMF will also not be able to verify whether the AMF selected during the mobility from EPC to 5GC is appropriate for the slices that the UE is connected to for its active PDU sessions.

To address this scenario, a solution is proposed based on the following.

6.2.2.2.1.1 Usage of slice mapping information for single-registration mode UEs

The solution uses the mapping of slices to PDN Connections. The UE determines the slice mapping per current release 15 mechanisms:

- For PDU sessions originally established over 5GC (i.e. before the UE has moved to EPC) the UE applied NSSP to determine S-NSSAI and DNN. When moving to EPC, the UE locally keeps the S-NSSAI information for those PDU sessions moved from 5GC.

- For PDN connections established over EPC, during PDN connection establishment in the EPC, the UE is provided by the PGW-C+SMF via PCO the S-NSSAI associated with the PDN connection, together with a PLMN ID that the S-NSSAI relates to. The UE stores this S-NSSAI and the PLMN ID associated with the PDN connection.

When moving from EPC to 5GC, for each PDU session single-registration mode UEs provide the AMF with slice mapping information containing the S-NSSAIs associated to the PDU Sessions active in the UE, together with the EPS bearer identity of the default EPS bearer corresponding to the PDN connection. The UE sends the slice mapping information in the Registration request when mobility from EPC to 5GC mobility happens.

The UE sends the slice mapping information and in the roaming case:

- In the AMF: When the AMF receives the slice mapping information from the UE in the Registration request, the AMF maps S-NSSAIs sent by the UE to S-NSSAIs for the Serving PLMN. AMF selects V-SMFs and V-UPFs based on slice mapping information (instead of default V-SMFs / default V-UPFs as in Rel-15)

- In the UE: When the UE receives the Configured NSSAI for the Serving PLMN (which includes the S-NSSAI values which can be used in the Serving PLMN and a mapping to the corresponding S-NSSAI values in the Configured NSSAI for the HPLMN) in the Registration Accept from the AMF, the UE updates the S-NSSAIs locally stored for sessions created in EPC to reflect the correct S-NSSAI for the current PLMN.

##### 6.2.2.2.2 Connected Mode Mobility from EPC to 5GC

Selecting the target AMF, and by that a set of network slices, based on information available at the source MME introduces a risk that the UE gets served by an AMF that is not appropriate and possibly by network slice(s) that are not in the UE's subscription. Even though this is corrected by a subsequent Registration procedure, if network slice isolation is supported it gets violated, and there may be service interruption for the UE. It is necessary to select an AMF that supports the network slices (S-NSSAI) associated to the UE's PDN connections and allowed by the UE's subscription. This requires information on the UE's subscribed S-NSSAIs, and network slices (S-NSSAI) associated to the UE's PDN connections which the MME does not have.

It is therefore proposed that

- for each active PDN connection the UE associates an S-NSSAI with the EPS Bearer ID for the default bearer of the PDN connection. The UE then sends to the serving MME a transparent handover container comprising, for each PDN connection, the EPS Bearer ID for the default bearer of the PDN connection (which identifies the PDN connection) and the associated S-NSSAI per each created PDN connection. The UE sends the information to the MME during an Attach procedure, if PDN connections were established in the 5GS, Tracking Area Update procedures, and upon establishment of a PDN connection in the EPS.

- At handover from EPS to a 5GS network, the source MME select an AMF based on current mechanisms and ensuring the selected AMF is capable of performing AMF selection (e.g. based on appropriate DNS configuration). The MME provides the transparent handover container to the AMF selected by the MME. The AMF selected by the MME, together with the NSSF, selects a target AMF and forwards the signalling from the source MME to the target AMF. The target AMF is selected considering the S-NSSAIs associated to PDN connections that are in the transparent handover container. The UE does not get registered in the AMF selected by the MME, but only by the target AMF. The target AMF selects V-SMFs and V-UPFs based on slice mapping information provided by the MME (instead of default V-SMFs / default V-UPFs as in Rel-15).

#### 6.2.2.3 Procedures

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

#### 6.2.2.4 Impacts on existing entities and interfaces

Editor's note: This clause describes impacts on existing entities and interfaces.

Impacts on EPC: MME must be enhanced to support the transfer of transparent handover container from UE in EPC Attach and Tracking Area Update procedures. The MME must be enhanced to store the transparent handover container to the UE context and update the container whenever updated by the UE. The MME must be enhanced to support the transfer of transparent handover container in S10 interface to the Target MME or Initial AMF.

Impacts on UE: The UE must be enhanced to include the association of default EPS Bearer ID and S-NSSAI in transparent handover container in EPC Attach and Tracking Area Update request. The UE must send the updated transparent handover container in Tracking Area Update request to MME whenever a new PDN connection has been established, or the old one has been released. The UE must be enhanced to include the association of default EPS Bearer ID and S-NSSAI in Registration Request.

The AMF must be enhanced to support the reception of S-NSSAI and default EPS Bearer ID from MME (connected mode) and from UE (idle-mode). The Initial/Target AMF uses the default EPS Bearer ID to map the S-NSSAI to the PDN Connection(s) received from the MME.

#### 6.2.2.5 Evaluation

Editor's note: This clause provides an evaluation of the solution.

The proposed solution supports deployments with and without Decor/eDecor

There are no extra steps in the handover preparation, therefore no additional delay.

The solution requires Rel-16 UE, Rel-16 MME and Rel-16 AMF

### 6.2.3 Solution #2.3: Inter RAT mobility Slice support

#### 6.2.3.1 Introduction

The solution solves the key issue #2, especially on the below item:

- Selecting an AMF based on the slices associated to the active PDN connections the UE has in the EPC.

- Selecting an appropriate V-SMF based on the slices associated to the active PDN connections the UE has in the EPC.

#### 6.2.3.2 Functional description

**AMF/V-SMF selection during CONNECTED state mobility**

An interim AMF is selected by MME during handover phase as in Rel-15. The interim AMF/SMF can connect to all possible slices that support interworking with EPS. After handover is completed, the UE initiates the registration procedure. The interim AMF selects the final AMF based on S-NSSAI of established PDN connections. And the AMF is relocated during the registration procedure if it is needed.

The interim AMF gets the S-NSSAI of serving PLMN of established PDN connection either from PGW-C during handover procedure (LBO or non Roaming case), or from UE in registration request (HR case). For home routed roaming case, if the AMF is not provided with S-NSSAI of VPLMN by the UE, based on received S-NSSAI of HPLMN from PGW-C+SMF, the AMF determines the S-NSSAI of VPLMN itself via local mapping information exist or NSSF.

The registration procedure needs to be enhanced to support AMF relocation as well as V-SMF change in CM-CONNECTED state.

**AMF selection during IDLE state mobility**

In idle mobility, the UE has S-NSSAI and the associated PLMN of established PDN connections sent by the PGW-C+SMF. In local breakout roaming case or non-roaming case, i.e. the associated PLMN is the serving PLMN, the UE can include the S-NSSAI of established PDN connections in RRC message. 5G AN selects correct AMF based on the S-NSSAI of established PDN connections in RRC message.

In case the PDN connection is home routed, i.e. the associated PLMN is the home PLMN, the S-NSSAI provided by PGW-C to UE is S-NSSAI in HPLMN. In this case, UE sends the S-NSSAI in HPLMN to AMF in NAS. The AMF determine the corresponding S-NSSAI in VPLMN, e.g. via local provision mapping information or query from NSSF, and select a final AMF, which may be different from the one selected by 5G AN, based on the S-NSSAI (in VPLMN) of established PDN connections.

**V-SMF selection during IDLE state mobility**

With N26 case:

The UE includes the S-NSSAI of corresponding PDN connection together with default EBI into registration request. The Context retrieved from MME includes default EBI. Thus, the AMF can correlate the S-NSSAI with corresponding PDN connection.

For home routed roaming case, the UE provides the S-NSSAI of HPLMN to AMF in NAS and the AMF determines the S-NSSAI of VPLMN, e.g. via local provision information or NSSF.

The AMF selects the V-SMF(s) based on the S-NSSAI(s) of the VPLMN associated with the established PDN connection(s).

Without N26 case:

The UE includes HPLMN value of S-NSSAI(s) associated to the PDU Session ID of each established PDN connection(s) in registration request. The AMF determines its corresponding VPLMN value of the S-NSSAI, e.g. via NSSF or local provision information. In Registration Accept message, the AMF includes the VPLMN value of the S-NSSAI(s) associated to PDU Session ID of each established PDU Session(s) in the message. Hence, UE knows VPLMN value of S-NSSAI associated to each established PDU Session, and can include S-NSSAI in PDU Session Establishment Request. The AMF selects V-SMF based on S-NSSAI received in PDU Session Establishment Request.

#### 6.2.3.3 Procedures

##### 6.2.3.3.1 Registration with AMF and V-SMF change during CONNECTED state mobility



Figure 6.2.3.3.1-1: AMF/V-SMF relocation during registration procedure when UE is in CM-CONNECTED state

1. UE sends Registration request to the interim AMF. The UE includes HPLMN value of S-NSSAI(s) associated with established PDN connection(s) and its corresponding default EBI in Registration request. This is for the case that the UE get the S-NSSAI from the HPLMN and not able to map it to the S-NSSAI of VPLMN.

3. A final AMF is selected by interim AMF based on subscribed S-NSSAI(s), S-NSSAI(s) associated with established PDN connection(s) which can be the S-NSSAI of HPLMN, and UE requested NSSAI. The interim AMF may query NSSF or based on the local provision mapping information for Allowed S-NSSAI determination. If the interim AMF is not provided with VPLMN value of S-NSSAI(s) associated with established PDN connection(s) by the UE, the interim AMF provides the HPLMN value of S-NSSAI(s) associated with established PDN connection(s) to NSSF, and NSSF will provide its corresponding VPLMN value to the interim AMF in response.

4. The interim AMF forwards the registration request to final AMF as in step 7a of figure 4.2.2.2.3-1 in clause 4.2.2.2.3 of TS 23.502 [3], with the following enhancement:

An indication is included in the message to indicate that the registration is in CM-CONNECTED state, so that the final AMF will not retrieve UE context based on mapped GUTI in the registration request.

5. TS 23.502 [3] Steps 4 ~ 16 of figure 4.2.2.2.2-1 or step 8~16 of figure 4.2.2.2.2-1, excluding step 10, are performed.

6. The final AMF selects the final V-SMF(s) based on VPLMN value of S-NSSAI(s) associated with the established PDN connection(s).

7. For each established PDU Session, the final AMF determine the related final V-SMF based on the VPLMN value of S-NSSAI. If the selected final V-SMF is different from the interim V-SMF, the final AMF invokes Nsmf\_PDUSession\_CreateSMContext to the selected final V-SMF, including the interim V-SMF ID in the message.

8. The final V-SMF retrieves SM context from interim V-SMF based on V-SMF ID received from AMF.

10~16. Handover the PDU session user plane path to the final V-UPF. After step 12, the uplink path has been switched, and after step 15, the downlink path has been switched. The PGW-U+UPF sends end marker via interim V-SMF after step 15.

Editor’s Note: The exact procedure how to relocate the V-SMF should be aligned with the conclusions in ETSUN study. Solutions in ETSUN do not relocate the AMF in connected mode using Registration procedure.

21. The final AMF notifies the interim AMF by invoking Namf\_Communication\_RegistrationCompleteNotify after the sessions have been switched to final V-SMF/V-UPF. The interim AMF can release session in interim V-SMF and V-UPF.

##### 6.2.3.3.2 Registration with AMF and V-SMF change during IDLE state mobility

See the related description in clause 6.2.3.2.

#### 6.2.3.4 Impacts on existing entities and interfaces

AMF:

- AMF is enhanced to determine the final AMF based on the default EBI and the associated S-NSSAI in the in the Registration Request message and a new indication to the final AMF for not to retrieve UE context based on mapped GUTI.

- For each PDU Session, at the Registration Accept message, the associated S-NSSAI of VPLMN is returned to UE.

- AMF must be enhanced to support V-SMF relocation procedures

UE:

- The UE must include the default EBI and the associated S-NSSAI, which can be either the HPLMN value or serving PLMN value, in the Registration Request message.

SMF:

- SMF must be enhanced to support V-SMF relocation procedures

Editor’s Note: The exact procedure how to relocate the V-SMF should be aligned with the conclusions in ETSUN study. Solutions in ETSUN do not relocate the AMF in connected mode using Registration procedure.

6.2.3.5 Evaluation

Editor's note: This clause provides an evaluation of the solution.

In both connected and idle-mode, the final AMF is selected based on S-NSSAIs associated with the transferred PDN Connections. This has a drawback that when the UE needs to initiate a new PDU session in 5GC which is not using any of the previous S-NSSAI(s), a new AMF may need to be selected.

Editor's note: How the AMF is relocated when the UE initiates a new PDU Session that is not using any of the existing S-NSSAI(s) is FFS.

There are no extra steps in the handover preparation, therefore no additional delay.

The solution requires Rel-16 UE, Rel-16 SMF and Rel-16 AMF

### 6.2.4 Solution #2.4: Connected mode mobility from EPC to 5GC

#### 6.2.4.1 Introduction

Key issue 2 raises questions on AMF selection and V-SMF selection during the mobility procedure from EPC to 5GC. As there is no assumption that the mechanisms of AMF selection and V-SMF selection for Idle state UE and Connected state UE are same, this solution only considers Connected mode mobility from EPC to 5GC.

#### 6.2.4.2 Functional description

In order to select appropriate AMF and V-SMF based on the information of network slices that the UE is using, this solution makes following assumptions:

- The S-NSSAIs that the UE is using need to be known by the NF that executes the selection.

- Legacy EPC nodes are not required to be enhanced to support S-NSSAI-based AMF or V-SMF selection.

- Current EPC and 5GC interworking procedure should be used as the baseline.

Based on such assumptions, this solution proposes an S-NSSAI based AMF and V-SMF selection mechanism.

In this solution, it is assumed that only combo nodes in EPC are allowed to be enhanced, i.e. PGW-C+SMF and HSS+UDM.

During the PDN connectivity establishment procedure, as described in current specification TS 23.501, the PGW-C+SMF will receive from the UE an ePCO containing PDU session ID, and determines the S-NSSAI corresponding to the PDN connection based on the operator policies, e.g. PGW address and APN. Therefore, the PGW-C+SMF can know the information of the slice the UE is accessing. In order to let the 5GC NFs obtain such information, this solution proposes to store the default EPS Bearer ID and S-NSSAI associated with the PDU Session ID into the HSS+UDM.

When the inter-system handover from EPC to 5GC is performed, during the handover preparation phase, the MME selects AMF as defined in the TS 23.502 [3] (Rel 15). The selected AMF firstly fetches UE subscription data containing pairs of default EPS bearer ID and S-NSSAI associated with the PDU Session ID from the HSS+UDM, and then determines whether it can serve all slices identified by S-NSSAIs fetched from the HSS+UDM. If the selected AMF can not serve all S-NSSAIs, it requests NSSF to select a target AMF/AMF set based on the S-NSSAIs.

After the target AMF is determined, the old selected AMF initiates an AMF relocation procedure as specified in the TS 23.502 [3]. The old selected AMF also provide the target AMF the pair of default EBI and S-NSSAI information. The target AMF can select a correct V-SMF based on S-NSSAI for each PDU session which is anchored in another PLMN.

#### 6.2.4.3 Procedures

##### 6.2.4.3.1 Enhancement to PDN connection establishment



Figure 6.2.4.3.1-1: PDN connection establishment enhancement

For each PDN connection, after the PGW-C+SMF determines the associated S-NSSAI based on operator policies, it registers with the UDM and stores the identity of the PDN connection (default EPS Bearer ID) and the S-NSSAI associated with the PDU Session ID into the HSS+UDM.

The S-NSSAI stored in the HSS+UDM will be used for AMF selection and V-SMF selection.

##### 6.2.4.3.1 Enhancement to handover preparation from EPC to 5GC

The enhancement to the handover procedure is quite similar as the AMF relocation procedure defined in the clause 4.2.2.2.3 in TS 23.502 [3].



Figure 6.2.4.3.1-1: Enhancement for Handover preparation from EPC to 5GC

According to the existing handover procedure from EPC to 5GC, the MME selects an AMF and sends Forward Relocation Request to the AMF. This AMF is called initial AMF in this solution.

In order to determine a suitable serving AMF, the initial AMF uses the step 3 of "Registration with AMF re-allocation" procedure in TS 23.502 [3] to fetch slice interworking related subscription data first, i.e. pairs of EBI and S-NSSAI associated with the PDU Session ID, and then the initial AMF knows the S-NSSAIs that the UE is using. The initial AMF selects the target AMF based on these S-NSSAIs.

The target AMF completes the handover preparation in the target side, and responds the MME with a Forward Relocation Response.

#### 6.2.4.4 Impacts on existing entities and interfaces

Editor's note: This clause describes impacts on existing entities and interfaces.

No impact on EPC.

No impacts on UE.

The Initial AMF uses the Nudm\_SDM\_Get service operation to retrieve the S-NSSAI associated with the default Bearer ID and the PDU Session ID.

The PGW-C+SMF must register to UDM for each PDN Connection established in EPC. The PGW-C+SMF updates the default EPS Bearer ID and the S-NSSAI associated with the PDU Session ID to the HSS+UDM.

HSS+UDM must be enhanced to support the storage of default EPS Bearer ID and the assocated S-NSSAI.

#### 6.2.4.5 Evaluation

Editor's note: This clause provides an evaluation of the solution.

Extra step is required in the handover preparation to retrieve the S-NSSAI from the UDM.

The solution requires Rel-16 AMF, Rel-16 PGW-C+SMF, and Rel-16 HSS+UDM.

### 6.2.5 Solution#2.5: Using the NF discovery to find the S-NSSAI.

#### 6.2.5.1 Introduction

This solution addresses the key issue#2: Enabling interworking for slicing between EPC and 5GC, and especially how to select the target AMF and V-SMF based on the S-NSSAI of the ongoing PDN connection in mobility from EPC to 5GC.

#### 6.2.5.2 Functional description

The solution is based on following principles on how to find out the S-NSSAI for the ongoing PDN connections:

As specified in Rel-15, when the UE moves from EPC to 5GC, the AMF uses the Nnrf\_NFDiscovery service operation and PGW-C address (FQDN) as an input parameter to discover the corresponding SMF address (FQDN or IP address).

In this solution, the NRF is used to map the PGW-C address to SMF address and corresponding S-NSSAI. For example, the NF discovery service (Nnrf\_NFDiscovery) is enhanced to include also the S-NSSAI that is served by the SMF. The NRF returns the S-NSSAI of the SMF, along the SMF address, when the AMF discovers the SMF via Nnrf\_NFDiscovery service operation. As the Nnrf\_NFDiscovery service operation is generic, it could return the S-NSSAI also in general SMF discovery not related to EPC interworking. In this case, the S-NSSAI is not used.

As it may be the SMF serves multiple S-NSSAIs, then the PGW-C must be configured with TEID ranges, one TEID range per S-NSSAI served by the SMF. The NRF is configured with the mapping from PGW-C address and TEID range to SMF address and S-NSSAI. The AMF uses the PGW-C address and TEID received from MME as an input to find out the corresponding SMF address and S-NSSAI. Nnrf\_NFDiscovery service operation is enhanced to include also the PGW-C TEID as an input parameter for SMF discovery.

Rest of the procedures follow the principles in Solutions 2.1 and 2.2 on how to select the Target AMF and V-SMF:

- In connected mode, the MME selects the AMF as currently specified in Rel-15. This AMF then acts as an Initial AMF and uses the above procedure to find out the S-NSSAI for each PDN Connection. Based on the list of S-NSSAIs, the Initial AMF can select the Target AMF, using the NSSF service as in Rel-15. The Initial AMF forwards the list of PDN Connections associated with the S-NSSAI and SMF address to the Target AMF. In home-routed roaming case, the Target AMF selects the V-SMF based on the S-NSSAI received from the Initial AMF.

- In idle mode, in home-routed roaming case, once the Target AMF has used the above procedure to find out the S-NSSAI for each PDN connection it received from the MME, the Target AMF selects the V-SMF based on the S-NSSAI.

It should be noted, that although the above description uses the NRF for SMF discovery, depending on the conclusions in FS\_eSBA, also the common Service Framework may be used for service instance discovery.

#### 6.2.5.3 Procedures

##### 6.2.5.3.1 EPS to 5GS handover using N26 interface

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



Figure-6.2.5.3.1-1: EPS to 5GS handover using N26 interface

1. Step 1 to step 3 are the same as in Rel-15 EPS to 5GS handover using N26 interface. The AMF selected by the MME becomes an Initial AMF in this solution.

4. The Initial AMF uses the PGW-C address and TEID in PDN Connections received from the MME as an input parameter to NRF (e.g. Nnrf\_NFDiscovery) service to discover the SMF address. The NRF returns also the S-NSSAI for the SMF for each PDN Connection.

If the Initial AMF cannot serve all the S-NSSAI(s), the Initial AMF invokes the Nnssf\_NSSelection\_Get service operation from the NSSF to select the Target AMF.

In home-routed roaming case, if the VPLMN and HPLMN have an SLA to support non-standard S-NSSAI values in the VPLMN, the Initial AMF uses the NSSF of the VPLMN to map the S-NSSAI values to the respective S-NSSAI values to be used in the VPLMN.

5. In case the Target AMF is different to Initial AMF, the Initial AMF sends Namf\_Communication\_CreateUEContext service operation (Target 5GAN Node ID, Source to Target Transparent Container, EPS MM Context, EPS Bearer Context(s), , list of S-NSSAI(s) and SMF addresses received in step 4) message to the Target AMF. In home-routed roaming case, the Target AMF selects the V-SMF based on the S-NSSAI associated with the PDN Connection.

Steps 6-26 are the same as in Rel-15 EPS to 5GS handover procedure using N26 interface in clause 4.11.1.2.2 of TS 23.502.

#### 6.2.5.4 Impacts on existing entities and interfaces

No impact on EPC.

No impacts on UE.

The Initial AMF uses the NRF, e.g. Nnrf\_NFDiscovery service to map the PGW-C address and TEID to SMF address and the S-NSSAI.

For example, the Nnrf\_NFDiscovery service operation is enhanced to include also the S-NSSAI that is served by the SMF. The NRF returns the S-NSSAI of the SMF, along the SMF address, when the AMF discovers the SMF via Nnrf\_NFDiscovery service operation.

If the SMF serves multiple S-NSSAIs, then the PGW-C must be configured with TEID ranges, one TEID range per S-NSSAI served by the SMF. In this case, the NRF is configured with the association from PGW-C address and TEID range to SMF address and S-NSSAI.

#### 6.2.5.5 Evaluation

Editor's note: This clause provides an evaluation of the solution.

There are no extra steps in the handover preparation, therefore no additional delay.

The solution requires Rel-16 AMF and Rel-16 PGW-C+SMF

\*\*\* Next change \*\*\*\*

# 7 Evaluation

Editor's note: This clause will provide a general evaluation of the solutions, if needed.

## 7.x Evaluations for KI#2: Enabling interworking for slicing between EPC and 5GC

### 7.x.1 Analysis

#### 7.x.1.1 General

There are 5 solutions (Solutions 2.1 – 2.5) for Key Issue #2 (Enabling interworking for slicing between EPC and 5GC).

#### 7.x.1.2 Solutions 2.1, 2.2, 2.3 and 2.5

The solutions 2.1, 2.2, 2.3 and 2.5 have a several commonalities as described below:

Connected mode mobility:

In handover from EPC to 5GC, the MME uses the Rel-15 procedures to select the AMF that acts as an Initial AMF. The target serving node selection in MME is not impacted. The initial AMF selects the Target AMF based on the S-NSSAI of the transferred PDN Connections(s) and passes the S-NSSAI information to the Target AMF. The Target AMF selects the V-SMF based on the S-NSSAI of the transferred PDN Connection.

After the handover has been completed, the UE initiates a Registration Request as per current Rel-15 procedures.

Idle-mode mobility:

In mobility from EPC to 5GC in home-routed roaming case, the Target AMF is selected as per Rel-15 procedures. The Target AMF selects the V-SMF based on the S-NSSAI of the transferred PDN Connection.

The difference in the Solutions 2.1, 2.2, 2.4 and 2.5 is how the Initial/Target AMF finds out the S-NSSAI of the transferred PDN Connection(s).

Solution 2.1

The Initial (in connected mode) or Target AMF (in idle mode) uses the service operation Nsmf\_PDUSession\_UpdateSMContext to retrieve the PDU Session ID and corresponding S-NSSAI from the H-SMF. Nsmf\_PDUSession\_UpdateSMContext needs to be modified to return the S-NSSAI to the AMF.

Extra steps are required in handover preparation phase from the AMF via default V-SMF to H-SMF to query the S-NSSAI for the transferred PDN Connection and then to clear the resources in the default V-SMF and V-UPF.

Solution 2.2

In connected mode mobility, the UE provides the default EPS Bearer ID and the associated S-NSSAI in a transparent handover container to MME in Attach, Tracking Area Update and PDN Connection Establishment procedures. The MME stores the transparent handover container and provides it to the Initial AMF.

In idle-mode mobility, the UE provides the default EPS Bearer ID and the associated S-NSSAI in Registration Request to the Target AMF.

The Initial/Target AMF uses the default EPS Bearer ID received from UE (in connected mode carried transparently via MME) to map the S-NSSAI to the PDN Connection(s) received from the MME.

Solution 2.4

The PGW-C+SMF is enhanced to register to UDM and update it with the EPS Bearer ID and the associated S-NSSAI when the PDN Connection is established in EPC. The Initial (in connected mode) or Target AMF (in idle mode) uses the Nudm\_SDM\_Get service operation to retrieve the default EPS Bearer ID, PDU Session ID and corresponding S-NSSAI from the UDM. Nudm\_SDM\_Get needs to be modified to return the S-NSSAI and default EPS Bearer ID to the AMF.

Extra step is required during the handover preparation phase to retrieve the EPS Bearer ID and S-NSSAI from the UDM.

Solution 2.5

The AMF uses the Nnrf\_NFDiscovery service operation and PGW-C address (FQDN) as an input parameter to discover the corresponding SMF address (FQDN or IP address), as in Rel-15 procedures. The NF discovery service (Nnrf\_NFDiscovery) is enhanced to support the retrieval of the S-NSSAI associated with the transferred PDN Connection(s). The NRF is configured with the mapping from PGW-C address (FQDN) and TEID range to SMF address and S-NSSAI.

#### 7.x.1.3 Solution 2.3

The solution is based on the principle that in home-routed roaming case the V-SMF is relocated (from default V-SMF to the S-NSSAI specific V-SMF) during the Registration Request procedure, this applies to both connected and idle-mode mobility. The exact procedure to relocate the V-SMF would need to be aligned with the conclusions in ETSUN study. Therefore the impacts to AMF and SMF in this solution rely strongly on the conclusions of ETSUN; if the procedures in ETSUN are not suitable for V-SMF relocation this solution, then additional V-SMF relocation procedure is required.

The UE provides the default EPS bearer ID and the associated S-NSSAI to AMF in in Registration Request and the AMF determines the V-SMF based on the S-NSSAI.

The solution aims to improve also the Target AMF selection in the idle-mode mobility, although it is not clear why the Rel-15 procedures would need to be improved in this respect. Also it seems the “enhancement” is in fact a dis-improvement, as the Target AMF is getting selected based on the S-NSSAI of the transferred PDN Connections.

There is no extra delay to the handover preparation, as the sole procedure affects only to Registration procedure.

### 7.x.2 Conclusions

The following table summarizes the key impacts of the solutions.

Table 7.x.2-1: Key impacts of the solutions

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Solution 2.1 | Solution 2.2 | Solution 2.3 | Solution 2.4 | Solution 2.5 |
| UE impact | No | Yes  (S-NSSAI in Registration Request and in EPC Attach, TAU, PDN Connection) | Yes  (S-NSSAI in Registration Request) | No | No |
| EPC impact | No | Yes  (S-NSSAI in EPC Attach, TAU, PDN Connection) | No | No | No |
| PGW-C+SMF impact | No | No | Yes  (V-SMF relocation, depending on ETSUN) | Yes  (S-NSSAI storing to UDM) | No |
| V-SMF impact | No | No | Yes  (V-SMF relocation, depending on ETSUN) | No | No |
| AMF impact | Yes | Yes | Yes | Yes | Yes |
| UDM impact | No | No | No | Yes  (S-NSSAI storing to UDM) | No |
| Extra delay in handover preparation | Yes  (S-NSSAI query from SMF and V-SMF release) | No | No | Yes  (UDM query) | No |

Since the Solution 2.5 has the least impacts to 5GS, no impact to UE or EPC, and no extra delay to handover preparation phase, therefore this study concludes the Solution 2.5 is selected for the basis of the Technical Specification work for Key Issue 2.

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