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Technical Report

3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Study for single radio voice continuity from 5GS to 3G (Release 16)



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Keywords

3GPP, 5G, Continuity, Single Radio, SRVCC,
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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:

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1 Scope

The scope of the present document is to investigate solutions from architecture point of view to support single radio voice call continuity (SRVCC) from NG-RAN to UTRAN.

Issues to be resolved will be collected and documented in the TR with a possible resolution.

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 23.502: "Procedures for the 5G System".
- [3] 3GPP TS 23.216: "Single Radio Voice Call Continuity (SRVCC)".
- [4] 3GPP TS 23.237: "IP Multimedia Subsystem (IMS) Service Continuity; Stage 2".
- [5] 3GPP TS 23.401: "General Packet Radio Service (GPRS) enhancements for Evolved Universal Terrestrial Radio Access Network (E-UTRAN) access".
- [6] 3GPP TS 23.060: "General Packet Radio Service (GPRS); Service description; Stage 2".
- [7] 3GPP TS 23.501: "System Architecture for the 5G System".

3 Definitions and abbreviations

3.1 Definitions

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

3.2 Abbreviations

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

4 Architectural assumptions and requirements

The following architectural assumptions apply:

- Solutions shall not consider voice continuity from GERAN/UTRAN to NG-RAN.
- Solutions shall not consider voice continuity from NG-RAN to GERAN.

- Solutions shall not consider video service continuity between NG-RAN and GERAN/UTRAN.
- Solutions shall not consider IP address preservation for PS service when UE moves between NG-RAN and GERAN/UTRAN.

NOTE: Solutions that can preserve IP address with no network impacts can be possible.

- Solutions shall not consider service continuity between 5GS and CDMA.

5 Key Issues

5.1 Key Issue #1: Enabling SRVCC from NG-RAN to UTRAN

5.1.1 General description

To enable the SRVCC operation from NG-RAN to UTRAN, following aspects need to be studied:

- How does the UE indicate its capability of supporting SRVCC from NG-RAN to UTRAN;
- How does the 5GC enable the SRVCC from NG-RAN to UTRAN;
- How does the 5GC handle information required for SRVCC (e.g. Session Transfer Number for SRVCC (STN-SR), see TS 23.216 [3]).

5.2 Key Issue #2: SRVCC HO Procedure from NG-RAN to UTRAN

5.2.1 General description

Following aspects need to be studied:

- The procedure for SRVCC HO from NG-RAN to UTRAN;
- How to handle the existing PDU Sessions in 5GS.

5.3 Key Issue #3: Return from UTRAN to E-UTRA or NR

5.3.1 General description

Considering UTRAN PS is not designed for as high data rates as in 5GS, if the UE remains within UTRAN after the release of the CS voice call, the user experience may be degraded vs 5GS. In some scenarios, UTRAN coverage may be overlapping with EUTRA and/or NR coverage, therefore providing an opportunity for resuming to a better user experience upon release of the CS voice call is desired.

The following aspect will be studied:

- How to enable the UE to return from UTRAN after release of the CS voice call towards E-UTRA or NR.

NOTE: PS handover from UTRAN to NG-RAN is not considered. Impact to UTRAN should be minimized.

5.4 Key Issue #4: Analysis of impacts for not supporting PS HO support in conjunction with SRVCC from NG-RAN to UTRAN

5.4.1 General description

SRVCC from NG-RAN to UTRAN procedure should minimise the impacts to the current network functions and the UE.

Following aspects need to be considered:

- Impacts to the UE and network when PDU sessions are not handed over to the UTRAN cell.
- How to consider Service Control Signalling Path.

6 Solutions

6.1 Solution #1: Enable 5G SRVCC with existing mechanism

6.1.1 Description

6.1.1.1 General

This solution resolves the key issue#1 Enabling SRVCC from NG-RAN to UTRAN. This solution reuse the EPS SRVCC as define in the TS 23.216 [3] to report the SRVCC capability, download subscription and transfer context.

6.1.1.2 5GS Registration for SRVCC

5GS Registration procedure for 3GPP 5G SRVCC UE is performed as defined in TS 23.502 [2] with the following additions:

- SRVCC UE includes the SRVCC capability indication as part of the "UE Network Capability" in the Registration Request.
- SRVCC UE includes the MS Classmark 2 and Supported Codecs IE in the Initial Registration message and in the non-periodic Registration messages.
- UDM/HSS includes STN-SR and C-MSISDN as part of the subscription data sent to the AMF. If the STN-SR is present, it indicates the UE is SRVCC subscribed.
- AMF includes a "SRVCC operation possible" indication in the N2 AP Request, meaning that both UE and AMF are SRVCC-capable.

6.1.1.3 Service Request procedure for SRVCC

Service Request procedures for 3GPP 5G SRVCC UE are performed as defined in TS 23.502 [2] with the following additions:

- AMF includes a "SRVCC operation possible" indication in the N2 AP Request, meaning that both UE and AMF are SRVCC-capable.

6.1.1.4 Intra-5GS PS Handover procedure for SRVCC

Intra-5GS handover procedures for 3GPP 5G SRVCC UE are performed as defined in TS 23.502 [2] with the following additions:

- MS Classmark 2, STN-SR, C-MSISDN, and the Supported Codec IE shall be sent from the source AMF to the target AMF if available.
- The target AMF includes a "SRVCC operation possible" indication in the N2 Handover Request, meaning that both UE and the target AMF are SRVCC-capable.

For Xn-based handover, the source 5G RAN node includes a "SRVCC operation possible" indication in the Xn-AP Handover Request message to the target 5G RAN node.

6.1.1.5 eSRVCC from 5G to 3G using ATCF enhancements

Regarding 5G->3G eSRVCC, all the procedures are the same as the ones defined for 4G->2/3G eSRVCC, i.e. originating sessions, terminating sessions and PS to CS access transfer procedure, which are described in clauses 6.2.1.4, 6.2.2.5 and 6.3.2.1.9 of TS 23.237 [4] respectively.

6.1.2 Procedures

Editor's note: Describes the high-level operation, procedures and information flows for the solution.

6.1.3 Impacts on existing nodes and functionality

- NG RAN: NG RAN initiates SRVCC HO from 5G to 3G according to measurement report, and includes SRVCC HO indication in the HO Required message to the AMF.
- UE: The UE sends SRVCC Capability, MS Classmark 2 and Supported Codecs IE in Registration message.
- AMF: Receives the STN-SR and C-MSISDN from UDM/HSS, and sends "SRVCC operation possible" indication to NG-RAN. During intra-AMF handover, the source AMF sends the MS Classmark 2, STN-SR, C MSISDN, and the Supported Codec IE to target AMF
- UDM: When the STN-SR is changed, it inserts the latest STN-SR to AMF.

6.2 Solution #2: Indirect SRVCC procedure

6.2.1 Description

This solution solves Key Issue #2.

6.2.2 Architecture

For this option, there is no direct interface between AMF and MSC. AMF has a N26 interface to MME, MME supports the Sv interface to MSC.

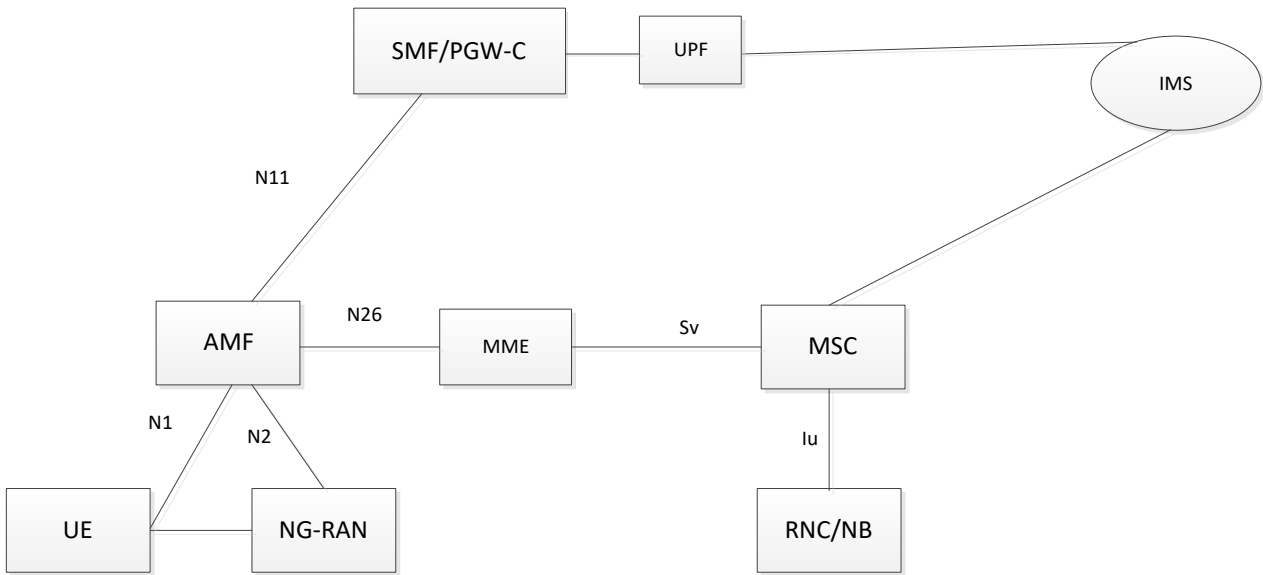


Figure 6.2.2-1: Architecture for indirect SRVCC

For this architecture option, AMF cannot send messages to MSC directly, MME proxies the signalling between AMF and MSC.

6.2.3 Indirect SRVCC call flow

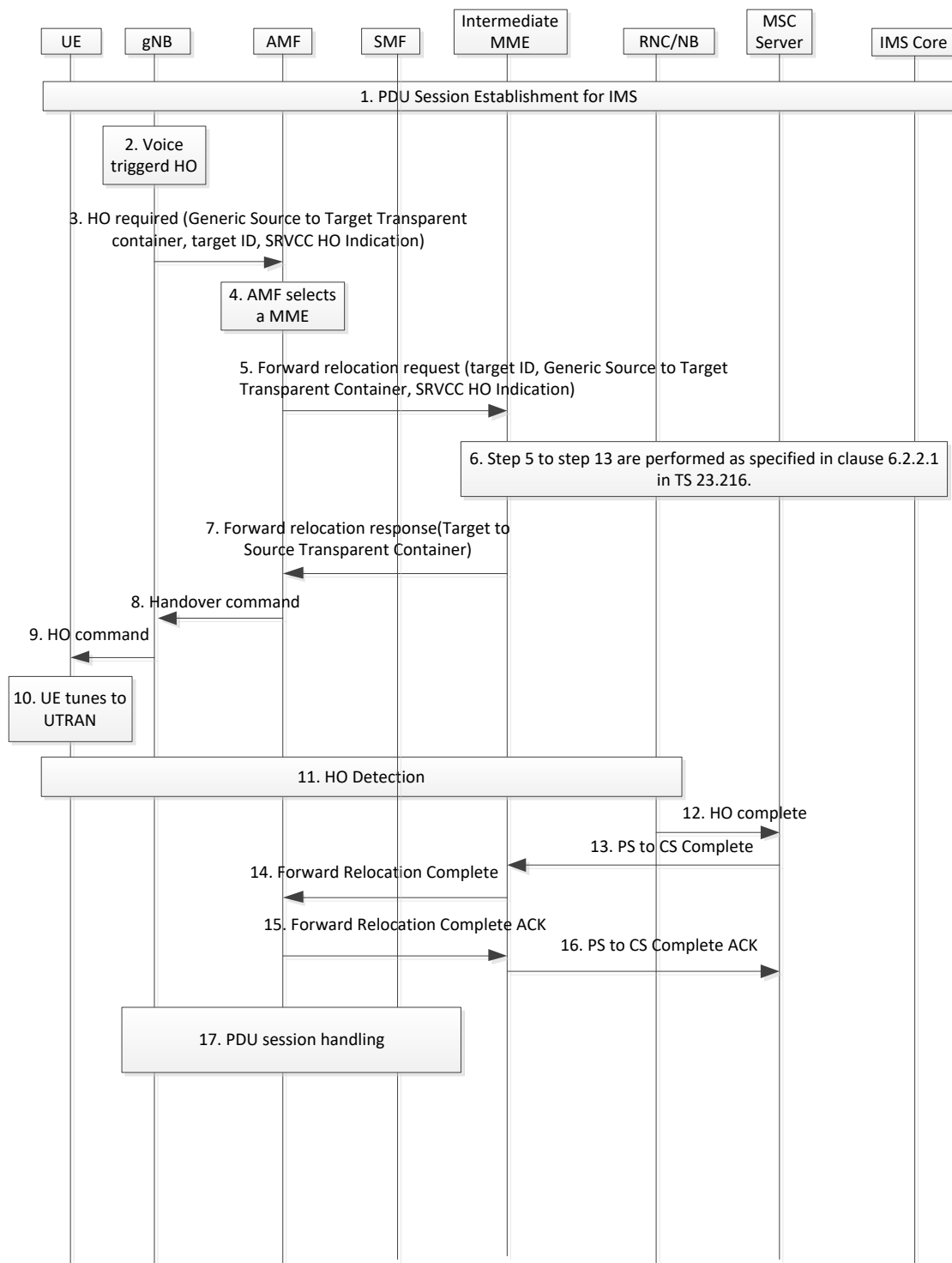


Figure 6.2.3-1: Indirect SRVCC call flow

1. UE establishes the PDU session for IMS.
2. SRVCC HO is triggered by NG-RAN.
3. NG-RAN sends a Handover Required (Target ID, generic Source to Target Transparent Container, SRVCC HO indication) message to the source AMF. The Target ID is the UTRAN cell ID. SRVCC HO indication indicates to AMF that this is for SRVCC. The Generic Source to Target Transparent Container is the Source RNC to Target RNC Transparent container.

4. AMF determines the HO is used for SRVCC by the SRVCC HO indication. AMF selects an Intermediate MME that can have Sv connection to the MSC SERVER/MSC according to the target RNC ID which is included in the Target ID. The Intermediate MME selection can be realised through operator's configuration.
5. AMF sends the forward relocation request (IMSI, Target ID, STN-SR, C-MSISDN, MM Context, Generic Source to Target Transparent Container, SRVCC HO indicator) to Intermediate MME.
6. Intermediate MME initiates the PS-CS handover procedure towards MSC Server. The step 5 to step 13 is performed as specified in clause 6.2.2.1 in TS 23.216 [3].
7. Intermediate MME receives the response message from MSC server after HO preparation is completed. Intermediate MME sends the Forward Relocation Response message (Target to Source Transparent Container) to AMF.
8. AMF sends the HO command to NG-RAN.
9. NG-RAN sends a HO command to the UE. UE detects the SRVCC HO.
10. UE tunes to the target UTRAN cell.
11. Handover Detection at the target RNS occurs, then the target RNS sends Handover Detection message to the target MSC SERVER/MSC.
12. The UE sends a Handover Complete message via the target RNS to the target MSC SERVER. At this stage, the target MSC SERVER/MSC can send/receive voice data.
13. MSC SERVER sends Intermediate MME the SRVCC PS to CS completion.
14. Intermediate MME forwards the Forward Relocation completion message which include the information receive in step 13 to AMF.
15. AMF forwards the Forward Relocation Complete ACK message to Intermediate MME. AMF releases the UE context related to Intermediate MME.
16. Intermediate MME forwards the PS to CS Complete ACK message to MSC server. Intermediate MME removes stored UE context. After receives the message, MSC server removes the UE context related to the Intermediate MME.
17. PDU session handling for the existing established PDU session in 5GS is addressed to the solution to Key Issue #4.

6.2.4 eSRVCC from 5G to 3G using ATCF enhancements

Regarding 5G->3G eSRVCC, all the procedures are the same as the ones defined for 4G->2/3G eSRVCC, i.e. originating sessions, terminating sessions and PS to CS access transfer procedure, which are described in clauses 6.2.1.4, 6.2.2.5 and 6.3.2.1.9 of TS 23.237 [4] respectively.

6.2.5 Impact on existing nodes and functionality

NOTE: Solution #2 is based on Solution #1.

NG-RAN:

- supports the UTRAN cell measurement procedure.
- Indicate SRVCC HO Indication in HO Required message if the SRVCC from 5G to 3G is initiated.

AMF:

- Selects the Intermediate MME according to the Target ID and SRVCC HO Indication.
- Indicate SRVCC HO Indication in Forward Relocation Request message.
- Skips Nsmf_PDUSession_Context procedure for all the PDU session.

- Shall not include any UE EPS PDN Connection IE into Forward Relocation Request message.

Intermediate MME:

- Triggers SRVCC without PS HO procedure according to "SRVCC HO Indication" received from AMF.
- Selects a MSC server according to the Target ID received from AMF.
- Stores the association between Sv interface and N26 interface for the UE, forward signalling between AMF and MSC Server/SGSN.
- Convert N26 based Forward Relocation Request to Sv based SRVCC PS to CS Request, as follows:
 - Allocate Sv based MME Address and MME TEID for Control Plane.
 - Forward the received IMSI, IMEI, Source to Target Transparent Container, Target RNC ID, Target Cell ID, APN, STN-SR and C-MSISDN.
 - Form the last used 5GS PLMN ID as the Anchor PLMN ID.
 - Convert the received mobile station classmark2, supported codecs into MM Context for E-UTRAN (v)SRVCC IE.
 - Derive the CS security keys from the received EPS security keys which are derived from the 5GS security key.
- Convert Sv based SRVCC PS to CS Response to N26 based Forward Relocation Response.
 - Forward the S1AP cause mapped from the received RANAP cause and Target to Source Transparent Container to the AMF.
- Convert N26 based Forward Relocation Complete to Sv based SRVCC PS to CS Complete Notification.
- Release the association between Sv interface and N26 interface for the UE after PS to CS Complete ACK message.

UE:

- Supports UTRAN cell measurement procedure.
- Supports SRVCC from 5GS to UMTS in NAS and AS.
- Derive CS security keys from EPS security keys which are derived from 5GS security keys.

6.3 Solution #3: Returning UE from UTRAN to NR or E-UTRA using MME-lite

6.3.1 Description

This solution addresses key issue #3. In order to return the UE to the NR or E-UTRA in the last used 5GS PLMN after the 5G-SRVCC to UTRAN CS, following enhancements are foreseen.

Editor's note: Returning from UTRAN to NR has dependency on RAN WG6 feedback.

6.3.1.1 Enhancement to SRVCC HO Procedure from NG-RAN to UTRAN CS

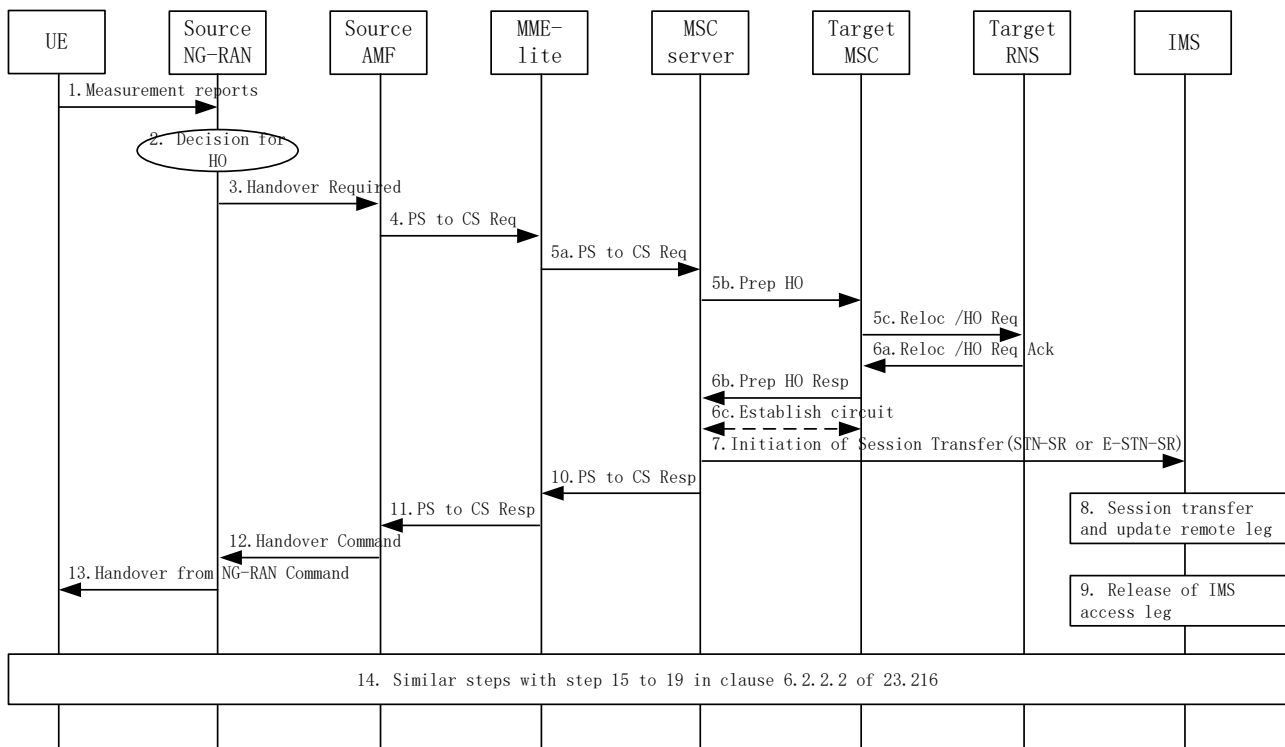


Figure 6.3.1.1-1: 5G-SRVCC HO from NG-RAN to UTRAN-CS

When the condition of triggering 5G-SRVCC HO from NG-RAN to UTRAN CS is matched, the NG-RAN will trigger the 5G-SRVCC HO from NG-RAN to UTRAN CS via the MME-lite. The E-UTRAN to UTRAN SRVCC HO procedure without PS HO (defined in clause 6.2.2.2 of TS 23.216 [3]) is referred.

Messages and parameters defined in TS 23.216 [3] for Sv interface and the interfaces within UTRAN-CS and between MSC and IMS can be reused.

NOTE: Same with assumption in TS 23.216, when MSC receives Sv message from MME-lite, it can determine the last used PLMN ID based on the configuration (e.g. mapping information between the MME-lite IP address and PLMN ID).

6.3.1.2 Returning UE to NR or E-UTRA

When MSC supports the return to NR after 5G-SRVCC, it indicates this to UTRAN during the release of Radio Resource connection that was established for 5G-SRVCC by including the last used 5GS PLMN ID in the existing Iu-CS IE "last used PLMN ID".

In case NR is deployed and NR coverage is available and UTRAN is configured to return the UE to NR, the UTRAN takes the last used PLMN ID into account when selecting the dedicated target frequency list for idle mode mobility to NR in RR Connection Release with redirection procedure.

In case NR coverage is unavailable but E-UTRA coverage is available or both NR and E-UTRA coverage is available but UTRAN is configured to return the UE to E-UTRA, the UTRAN takes the last used PLMN ID into account when selecting the dedicated target frequency list for idle mode mobility to E-UTRA in RR Connection Release with redirection.

In case there is no coverage of NR or E-UTRA for the last used PLMN, the UTRAN selects the dedicated target frequency list for idle mode mobility to NR or E-UTRA in RR Connection Release with redirection per its configuration.

6.3.2 Impacts

MME-lite:

- No.

MSC:

- No.

UTRAN (Returning to NR):

- It needs to take the last used PLMN ID into account when selecting the dedicated target frequency list for idle mode mobility to NR in RR Connection Release with redirection procedure.
- UTRAN RRC needs to include NR target info at redirection with NR target frequency list.
- Additional impact depending whether or not blind redirection to NR is used e.g. ordering and handling of NR measurement reports in connected mode.

UE (Returning to NR):

- UE UTRA RRC needs to support redirection to NR at RRC Connection Release.
- NR measurements and measurement reporting in connected mode if non-blind redirection is supported.

6.3.3 Evaluation

6.4 Solution #4: Return to 5GS when the UE is switched into EPS after voice ends in 3G

6.4.1 Description

This solution is for key issue3.

Scenario1: UTRAN doesn't support fast return the UE to NG RAN. After voice service ends in UTRAN, in case UTRAN moves the UE to EUTRAN and there is NG RAN coverage, EUTRAN may move the UE to NG RAN.

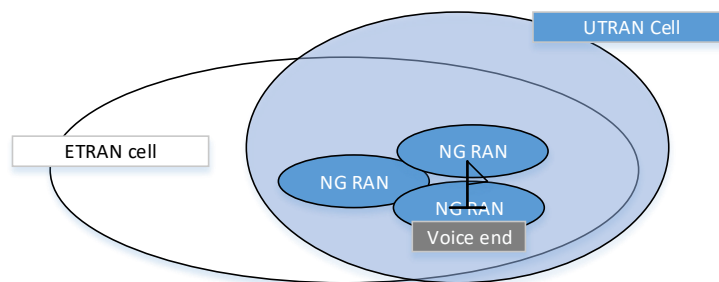


Figure 6.4.1-1: Scenario 1

Scenario2: UTRAN supports fast return the UE to the NG RAN. But there is no NG RAN coverage at the moment that voice service ends in UTRAN, in case UTRAN moves the UE to EUTRAN, subsequently, if the connected UE moves into the NG RAN coverage, EUTRAN may move the UE to NG RAN

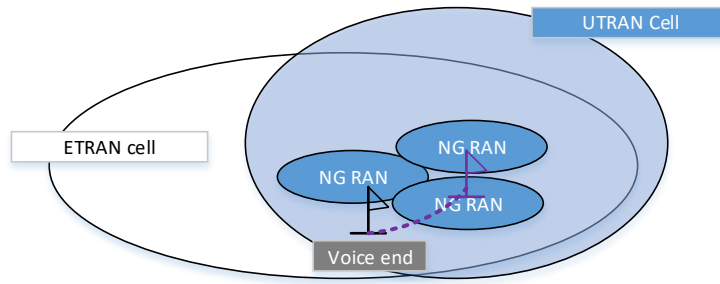


Figure 6.4.1-2: Scenario 2

In order to support moving the UE back the NG RAN, when the UE is handed over or redirected from UTRAN to EUTRAN after voice ends in CS, the UE provides the last serving 5GS PLMN ID in the TAU request. MME uses it to move the UE back to 5GS.

6.4.2 Procedures

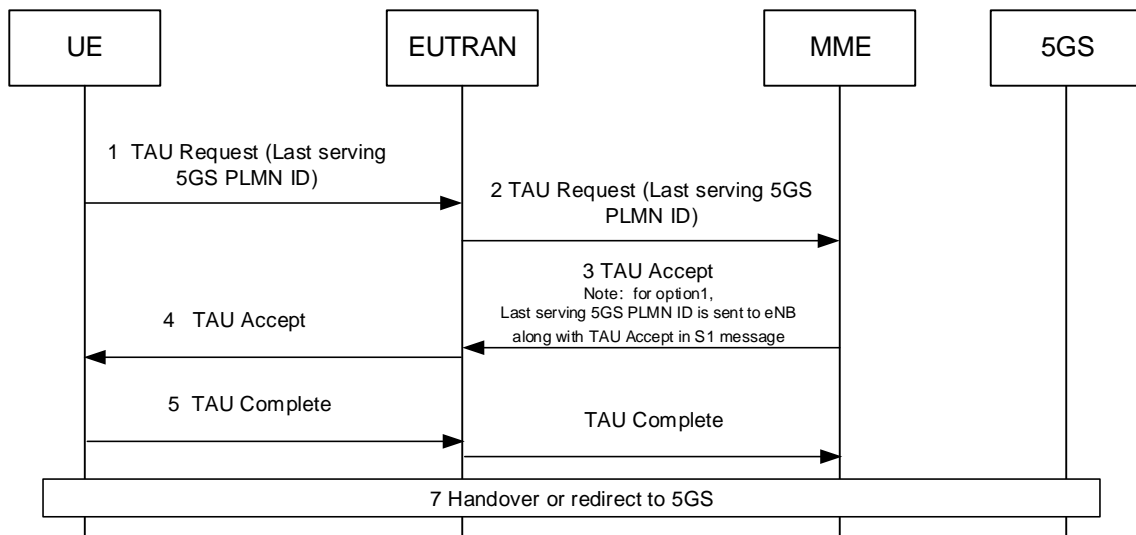


Figure 6.4.2-1: Return to 5GS via EPC

1. UE to (R)AN: RRC message (Uu parameters, TAU Request). The UE is 5G SRVCC handover to 3G CS domain. After voice service ends in 3G CS domain, handover or redirection is triggered to move UE to EPS. The UE indicates the last serving 5GS PLMN ID (new IE) in the TAU Request.

If the UE is handed over from UTRAN to EUTRAN, TAU procedure is initiated at step11 in clause 5.5.2.2.3 Execution phase of clause 5.5.2.2 UTRAN Iu mode to E-UTRAN Inter RAT handover as specified in TS 23.401 [5]. In case the UE is redirected from UTRAN to the EUTRAN, TAU procedure is initiated after the UE access to EUTRAN.

2. S1 message (S1 parameters, TAU Request). If the last serving 5GS PLMN ID is included in the TAU Request, the MME:
 - Option1: forwards the last serving 5GS PLMN ID to the EUTRAN;
 - Option2: uses the last serving 5GS PLMN ID to prioritize the 5GS frequency in RFSP.
3. S1 message (S1 parameters, TAU Accept, Last serving 5GS PLMN). If the Last serving 5GS PLMN ID is received, the EUTRAN takes the Last serving 5GS PLMN ID into account to handover/redirect the UE to NG RAN or prioritizes the 5G frequency for the UE, when there is NG RAN coverage.
4. (R)AN to UE: RRC message (Uu parameters, TAU Accept).
5. UE to (R)AN: RRC message (Uu parameters, TAU Complete).

6. S1 message (S1 parameters, TAU Complete).
7. Handover or redirection is triggered to move the UE back to 5GS based on the last serving 5GS PLMN.

6.4.3 Impact on existing nodes and functionality

UE

- Indicates the last serving 5GS PLMN ID to the MME in the TAU Request message.

MME

- Option1: Forward the received last serving 5GS PLMN ID to EUTRAN.
- Option2: Take the last serving 5GS PLMN ID into account to set RFSP.

EUTRAN

- Option1: Take the last serving 5GS PLMN ID into account to trigger UE handover/redirection to NG RAN or prioritize the NG RAN frequency for the UE, when there is NG RAN coverage.
- Option2: There is no impact on EUTRAN.

6.5 Solution #5: PDU session release after 5G SRVCC procedure

6.5.1 Description

This solution solves Key Issue #4 to analyse the impacts on UE and network for the PDU sessions that are not handed over to the UTRAN cell.

6.5.2 AMF requests SMF release the remained PDU session

Referring to the interworking between 5GS and EPC, SMF releases the PDU session which is not handover from 5GC to EPC. The similar principle can be reused for PDU session handling after SRVCC from NG-RAN to UTRAN.

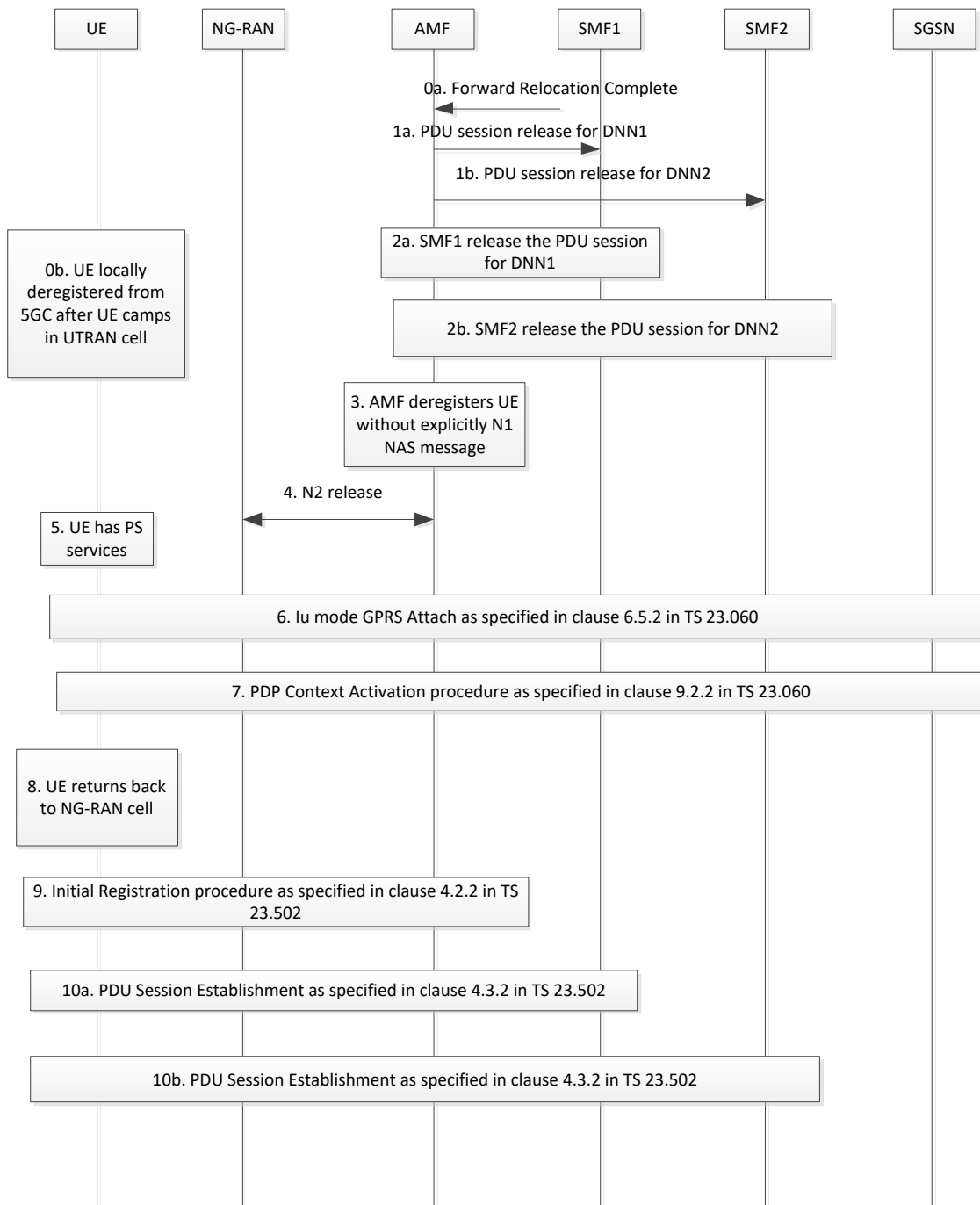


Figure 6.5.2-1: PDU session release after SRVCC from NG-RAN to UTRAN

- 0a. AMF receives the Forward Relocation Complete message to be informed that the SRVCC procedure is completed.
- 0b. UE locally release all the PDU session and deregisters from 5GC after UE camps in the UTRAN cell.
1. AMF requests each SMF to release the PDU session procedure due to 5G SRVCC for all the DNN.
2. SMF release the PDU session(s) in 5GC.
3. AMF deregisters UE without explicit NAS message to UE.
4. AMF initiates the N2 release procedure.
5. UE camps in UTRAN cell, if there are pending UL PS data in UE, the Iu mode GRPS attach procedure is triggered by UE.

6. UE performs the Iu mode GRPS attach procedure as specified in clause 6.5.2 in TS 23.060 [6].
7. UE requests the PDP Context Activation procedure as specified in clause 9.2.2 in TS 23.060 [6].
8. After the voice call in UTRAN cell, UE returns to NG-RAN cell.
9. UE shall perform the "Initial Registration" procedure as specified in TS 23.502 [2].
10. If there are pended UL data/signalling, UE shall re-establish the PDU sessions in NG-RAN for the PS services.

For the 5G capable UE, the non IMS PS service will be interrupted by every 5G SRVCC procedure. UE and 5GS release the PDU session context after the 5G SRVCC procedure and UE need to establish the PDP context in UTRAN cell. UE will go back to NG-RAN cell after several minutes if the voice call is ended, UE need to re-establish the PDU session in NG-RAN cell. UE will repeat the above procedure to release the PDU session connection in 5G and establish the PDP context in UTRAN cell and then re-establish the PDU session connection in 5G if the 5G SRVCC is triggered frequently.

6.5.3 Impacts on existing nodes and functionality

AMF

- After receiving Forward Relocation Complete message, AMF shall trigger PDU session release for all the DNN and deregistered UE without explicit N1 NAS message.
- A new release cause is sent from AMF to SMF during PDU session release procedure.

UE

- UE locally release all the PDU sessions which were established in NG-RAN and locally deregistered after UE camps in UTRAN cell.
- UE performs the GPRS attach in PS domain in UTRAN cell and establishes the PDP context if there are pended UL PS data/signalling.

6.6 Solution #6: PDU session suspend after 5G SRVCC procedure

6.6.1 Description

This solution solves Key Issue #4 to analyses the impacts on UE and network for the PDU sessions that are not handed over to the UTRAN cell.

6.6.2 AMF request SMF suspend the remained PDU session

In order to avoid UE re-establishing PDU sessions in 5GS frequently due to 5G SRVCC, one option is to suspend the PDU session in 5GS after 5G SRVCC.

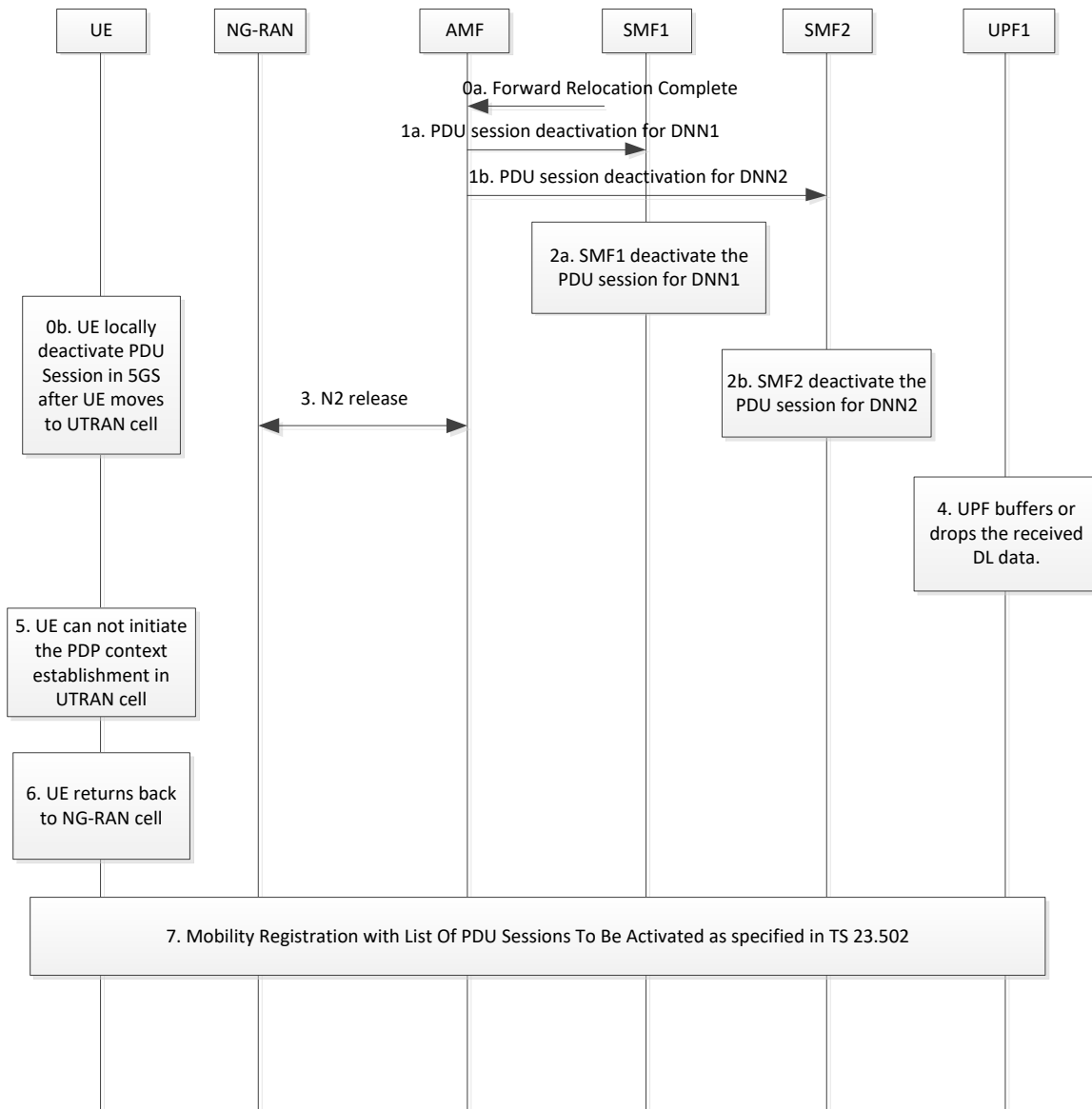


Figure 6.6.2-1: PDU session deactivate after SRVCC from NG-RAN to UTRAN

- 0a. AMF receives the Relocation Forward Complete message to be informed that the SRVCC procedure is completed.
- 0b. UE locally deactivate all the PDU session after UE camps to a UTRAN cell,
 1. AMF requests each SMF to deactivate the PDU session due to 5G SRVCC procedure for all the non IMS DNN.
 2. SMF deactivates the PDU session.
 3. AMF initiates the N2 release procedure. AMF stores the UE context.
 4. SMF informs UPF that PDU session deactivation is due to 5G SRVCC in step 2. UPF stores the cause and if there are DL data receiving, UPF pending the received DL data or locally drop the data without inform SMF.
 5. UE cannot attach in SGSN and establish the PDP context in SGSN in UTRAN cell because UE cannot register in 5G and 3G PS domain simultaneously.
 6. After the voice service in UTRAN cell, UE returns to NG-RAN cell.
 7. UE initiates the mobility registration procedure with the list of PDU Session to Be Activated as specified in TS 23.502 [2] to re-activate the PDU session which were established before 5G SRVCC.

For this solution both UE and 5GC suspend the PDU session after the 5G SRVCC procedure, the advantage is to avoid PDU session re-establishment procedure after UE terminate the voice call and come back to NG-RAN side. The drawback is that the UE cannot initiate the PDP context in UTRAN PS domain and all the DL data associated with the suspended PDU session will be dropped in UPF.

6.6.3 Impacts on existing nodes and functionality

AMF

- After receive PS to CS complete message, AMF shall trigger PDU session deactivation for all the non-IMS DNN.
- A new cause which indicates 5G SRVCC is sent from AMF to SMF during PDU session deactivation procedure.

SMF

- A new cause which indicates 5G SRVCC is sent from SMF to UPF during PDU session deactivation procedure.

UPF

- Locally store or drop the received DL data if the PDU session is deactivated due to 5G SRVCC.

UE

- Locally deactivate the PDU session in 5GS after HO to UTRAN cell.
- UE cannot initiate the GPRS attach in UTRAN cell.
- UE cannot establish the PDP context in UTRAN cell.
- When moves from UTRAN cell to NG-RAN, UE will trigger a mobility registration procedure in NG-RAN cell.

6.7 Solution #7: Returning UE from UTRAN to E-UTRA using MME-lite

6.7.1 Description

This solution addresses key issue #3. In order to return the UE to E-UTRA in the last used 5GS PLMN after the 5G-SRVCC to UTRAN CS, following enhancements are foreseen.

6.7.1.1 Enhancement to SRVCC HO Procedure from NG-RAN to UTRAN CS

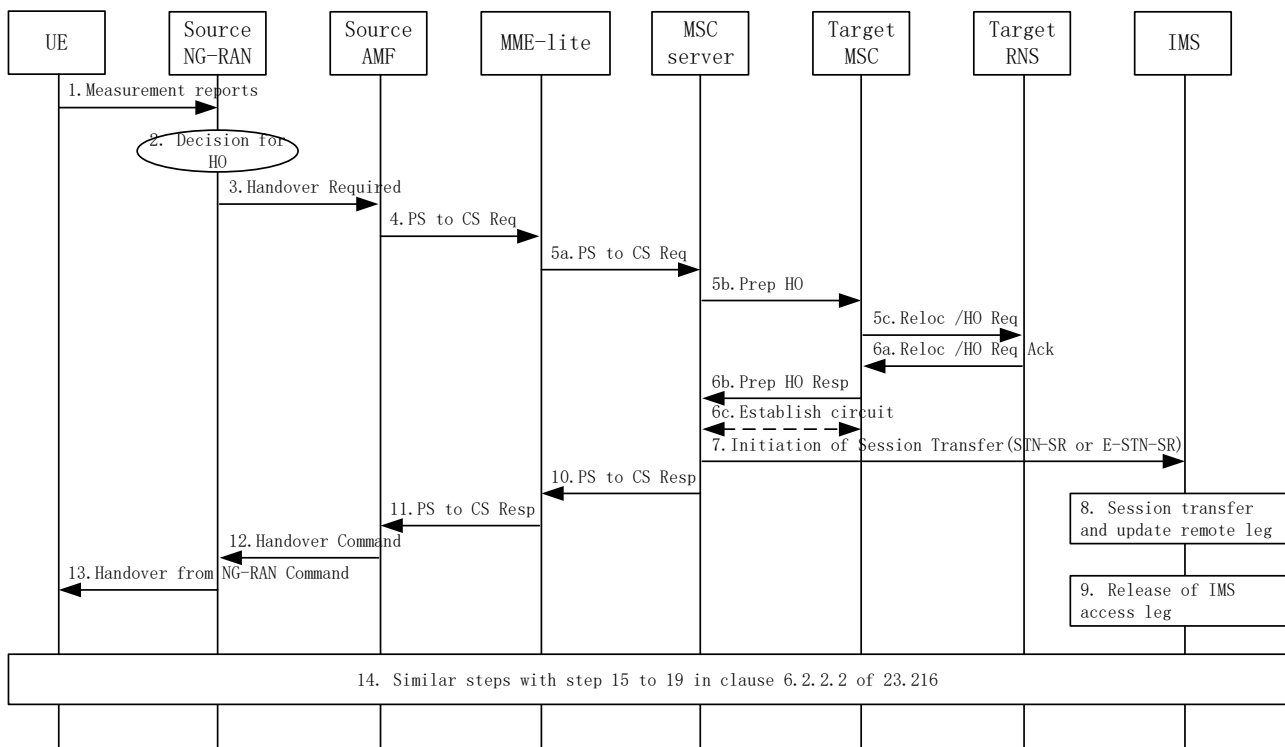


Figure 6.7.1.1-1: 5G-SRVCC HO from NG-RAN to UTRAN-CS

When the condition of triggering 5G-SRVCC HO from NG-RAN to UTRAN CS is matched, the NG-RAN will trigger the 5G-SRVCC HO from NG-RAN to UTRAN CS via the MME-lite. The E-UTRAN to UTRAN SRVCC HO procedure without PS HO (defined in clause 6.2.2.2 of TS 23.216 [3]) can be referred with following difference for the purpose of returning UE to NG-RAN with following additions:

- In step 5a, 5b, a new indication for differentiating the last used 3GPP system (i.e. 5GS) and last used 3GPP RAT (i.e. E-UTRA, NR) are included in the PS to CS Request/Prepare Handover Request/Handover Request message.
- When receiving the last used 3GPP system indication and last used 3GPP RAT (i.e. E-UTRA, NR), the MSC needs to store them in the UE's Context along with the last used PLMN ID (MSC determines by identifying the source MME-lite address, which is same with current design in TS 23.216 [3]).

Other messages and parameters defined in TS 23.216 [3] for Sv interface and the interfaces within UTRAN-CS and between MSC and IMS can be reused.

6.7.1.2 Returning UE to E-UTRA

MSC knows whether the UE was SRVCC handed over from NR or E-UTRA based on the last used 3GPP system indication and last used 3GPP RAT information.

Returning UE to NR is not supported by MSC and UTRAN.

Both MSC and UTRAN are configured to only support returning UE to E-UTRA. To support the return to E-UTRA after 5G-SRVCC, the MSC behaves as following:

- If UE was SRVCCed from EPS, the MSC only includes the last used PLMN ID in Iu-CS signalling. Based on this information the UTRAN determines to return UE to E-UTRA.
- If UE was SRVCCed from E-UTRA connected to 5GC, the MSC includes the last used PLMN ID and the last used 3GPP system indication in Iu-CS signalling. Based on this information the UTRAN determines to return UE to E-UTRA connected to 5GC.
- If UE was SRVCCed from NR connected to 5GC, the MSC does not include either the last used PLMN ID or the last used 3GPP system indication in Iu-CS signalling, UTRAN doesn't return the UE to NR.

UTRAN takes the last used 3GPP system indication and last used PLMN ID into account when selecting the dedicated target frequency list for idle mode mobility to E-UTRA in RR Connection Release with redirection.

In case there is no coverage of E-UTRA for the last used 5GS PLMN and last used 3GPP system, the UTRAN selects the dedicated target frequency list for idle mode mobility to E-UTRA in RR Connection Release with redirection per its configuration.

6.7.2 Additional Impacts

MME-lite:

- It needs to send the last used 3GPP system indication and last used 3GPP RAT to MSC over Sv interface.

MSC:

- It needs to store the last used 3GPP system indication and last used 3GPP RAT in UE's Context.
- It needs to send the last used 3GPP system indication to UTRAN in RRC connection release.

UTRAN:

- It needs to receive the last used 3GPP system indication from MSC and determines the target frequency list for idle mode mobility to E-UTRA in RR Connection Release with redirection.

UE:

- No.

6.8 Solution #8: Solution for key issue 3# - 2 Step method Return 5GS After 5G SRVCC with existing mechanism

6.8.1 Description

This solution includes 2 steps to return 5GS:

- Step 1: Returning EPS with the existing Return back to E-UTRAN in the TS 23.216 [3] clause 6.2.3.
- Step 2: mobility to 5GS with the existing mechanism in the TS 23.502 [2].

6.8.2 Procedures

Editor's note: Describes the high-level operation, procedures and information flows for the solution.

6.8.3 Impact on existing nodes and functionality

There is no impact on the existing UTRAN and EPS system.

6.9 Solution #9: Solution for key issue 3# - Return 5GS After 5G SRVCC depend on UE implementation

6.9.1 Description

For returning 5GS, to avoid impact on the RNC, this solution proposes that it depends on the UE implementation to return 5GS, e.g. the UE is configured that the 5GS is preferred, the RFSP during the UE camping on the 5GS.

6.9.2 Procedures

Editor's note: Describes the high-level operation, procedures and information flows for the solution.

6.9.3 Impact on existing nodes and functionality

There is no standard impact.

UE

- It depends on UE implementation.

7 Evaluation

7.1 Evaluation on solution for key issue #1

For Key Issue#1: Enabling SRVCC from NG-RAN to UTRAN

- Solution#1 brings the necessary preparation for 5GS to 3G SRVCC in 5GC and NG RAN.

7.2 Evaluation on solution for key issue #2

For Key Issue#2: SRVCC HO Procedure from NG-RAN to UTRAN

- Solution#2 reuses the existing SRVCC mechanism as much as possible and can minimize the impact on 5GS and 3G.

7.3 Evaluation about solutions for Key Issue #4

Solution #5 and Solution #6 are addressed to solve the key issue 4 which focuses on how to handle the PDU sessions which were established in 5GC before 5G-SRVCC. Following are some evaluations for Solution#5 and Solution#6.

Solution#5: PDU Session Release after 5G-SRVCC procedure

Pros:

- Reuse PDU session release handling as inter-RAT HO from 5GS to EPC.
- Reuse the current inter-working handling between 5G and GERAN/UTRAN. UE triggers GPRS attach in UTRAN cell after 5G-SRVCC procedure and triggers initial registration in NR after UE move back to NR cell. Less impacts on both UE and network side.

Cons:

- PS services are always interrupted after 5G-SRVCC.
- UE need to re-establish PDP context in UTRAN PS mode triggered by the application that is notified about the release of the IP address.
- PS services are interrupted when UE moves back to NR which is the same as normal inter-RAT mobility from 3G to 5G.
- UE need to re-establish PDU session in NR when UE moves back to NR triggered by the application that is notified about the release of the IP address which is the same as normal inter-RAT mobility from 3G to 5G.

Solution #6: PDU Session Suspend after 5G-SRVCC procedure

Pros:

- When UE moves back to NR, UE activates user plane during the registration procedure, UE can send UL data rapidly.

Cons:

- 5GS need enhancement to support PDU session deactivation due to 5G-SRVCC.
- New mechanism need to be addressed in 5GC to avoid paging UE after 5G-SRVCC.
- All the DL data are buffered or potentially dropped while UE stays in UTRAN cell.
- UE cannot attach in PS mode and cannot establish PDP context in UTRAN cell potentially for protracted periods of time while the UE is in UMTS coverage only.

According to the above analysis, solution 5 has less impacts on both UE and network side than solution #6.

7.4 Evaluation on solutions for key issue #3

For Solution #3:

Regarding the returning from UTRAN to NR, it has RAN6 dependency.

Regarding the returning from UTRAN to E-UTRA, it has no impact to UE, UTRAN and MSC. In this case, the pros and cons are:

Pros:

- No impact to UE, UTRAN and 5G System.
- No impact to MSC.
- Slight impact to AMF and MME-lite implementation.

Cons:

- UE may be redirected to E-UTRAN if the operator uses same PLMN ID for both EPS and 5GS.

For Solution #4:

This solution returns the UE to 5GS in case the UE is switched to EUTRAN by UTRAN after voice ends.

Pros:

- No impact to 3G and 5G system;

Cons:

- Impact to 4G system.

For Solution #7 (with MSC and UTRAN impact):

Returning from UTRAN to NR is not supported.

To support returning from UTRAN to E-UTRA connected to 5GC, the last used last used 3GPP system indication and last used 3GPP RAT need to be transferred from MME-lite to MSC over Sv interface. The last used 5GS PLMN ID and last used 3GPP system indication need to be transferred from MSC to UTRAN over Iu-CS interface.

Pros:

- No impact to UE;

Cons:

- Impact to UTRAN: new information in Iu-cs (last used 3GPP system).
- Returning UE from UTRAN to NR is not supported.

For Solution #8:**Pros:**

- No impact to 5GC and UTRAN.

Cons:

- It takes longer time to return to 5GS.

For Solution #9:**Pros:**

- No impact to 5GC and UTRAN

Cons:

- Impact UE implementation.

8 Conclusions

For Key Issue#1: Enabling SRVCC from NG-RAN to UTRAN

Solution#1 (Enable 5G SRVCC with existing mechanism) is selected to resolve key issue#1: Enabling SRVCC from NG-RAN to UTRAN. Normative work is expected to be reflected in TS 23.501 [7], TS 23.502 [2] and TS 23.216 [3] for this aspect.

For Key Issue#2: SRVCC HO Procedure from NG-RAN to UTRAN

Solution#2 (Indirect SRVCC procedure) is selected to resolve key issue#2: SRVCC HO Procedure from NG-RAN to UTRAN. Normative work is expected to be reflected in TS 23.216 [3] for this aspect.

Conclusion for Key Issue 4:

Solution#5: PDU Session Release after 5G-SRVCC procedure is adopted as conclusion. IMS service control is assumed to be transferred to the CS domain when UE moves to UTRAN cell due to 5G-SRVCC.

For key issue #3, it's concluded solution #9 is selected and no normative work is needed.

Annex A: Change history

Change history							
Date	Meeting	TDoc	CR	Rev	Cat	Subject/Comment	New version
2018-04	SA2#127	S2-183281	-	-	-	TR skeleton (agreed in S2-183281)	0.0.0
2018-09	SP#81	SP-180743	-	-	-	MCC editorial update for presentation to TSG SA#81 for approval	1.0.0
2018-09	SP#81	SP-180743	-	-	-	MCC editorial update for publication after TSG SA#81 approval	16.0.0