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| Technical Report | |
| 3rd Generation Partnership Project;  Technical Specification Group Services and System Aspects;  Study on System aspects of 5G NR Femto  (Release 19) | |
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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:

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 present document will study and identify potential enhancements for supporting 5G NR Femto deployment. The study will investigate potential enhancements in the following areas:

- How to enable interworking between CAG and CSG cells.

- Study whether and how to support enabling the provisioning of subscribers allowed to access CAG cell and to manage access control by the CAG owner or an authorized administrator.

NOTE 1: Based on RAN WG3 outcome, the overall architecture and enable the required functional and procedural changes can be enhanced for supporting 5G NR Femto deployment during normative work.

# 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; Stage 2".

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

[4] 3GPP TS 23.503: "Policy and charging control framework for the 5G System (5GS); Stage 2".

[5] 3GPP TS 23.401: "General Packet Radio Service (GPRS) enhancements for Evolved Universal Terrestrial Radio Access Network (E-UTRAN) access".

# 3 Definitions of terms and abbreviations

## 3.1 Terms

For the purposes of the present document, the terms given in TR 21.905 [1] 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].

**example:** text used to clarify abstract rules by applying them literally.

## 3.2 Abbreviations

For the purposes of the present document, the abbreviations given in TR 21.905 [1] 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].

<ABBREVIATION> <Expansion>

# 4 Architectural Assumptions and Requirements

## 4.1 Architectural Assumptions

The architecture for support of 5G NR Femto shall be based on the following architectural assumptions:

- the 5GS defined as part of Rel-18 is used as basis for further potential enhancements;

- the need for potential architecture enhancements for supporting 5G NR Femto deployments depends on the outcome of RAN WG3 study;

- It is expected that MME, E-UTRAN and NG-RAN impacts are avoided;

- It is assumed that the existing CAG concept defined for PNI-NPN is re-used for Femto access control without impacts to PNI-NPN.

## 4.2 Architectural Requirements

The solutions should build on 5GS architectural principles as defined in TS 23.501 [2].

# 5 Key Issues

## 5.1 Key Issue #1: Support of UE move between CAG cell of 5G Femto and CSG cell

### 5.1.1 General description

This key issue investigates any needed enhancements to support the UE moving between CAG cell of 5G Femto and CSG cell.

The KI should cover:

- The mobility scenarios to be studied for the UE move (e.g. CSG cell to CAG cell of 5G Femto, vice versa).

- Whether and how control signalling procedures are enhanced to support the mobility scenarios.

NOTE 1: This Key Issue assumes that the existing CAG concept defined for PNI-NPN is re-used for access control when a UE wants to access a 5G Femto cell without impacts to PNI-NPN.

NOTE 2: This Key Issue expects that solutions avoid impacts on EPC (e.g., MME), E-UTRAN and NG-RAN.

Editor's note: It is FFS if idle mode mobility scenario needs to be considered.

## 5.2 Key Issue #2: Enabling provisioning of subscribers allowed to access CAG cell and managing access control by the CAG owner or an authorized administrator

### 5.2.1 Description

The 5G NR Femto aims to re-use the existing CAG mechanism defined for PNI-NPN for access control. In order to add flexibility to the 5G NR Femto, the owner of 5G NR Femto needs to be able to control which UE(s) can access to the 5G NR Femto.

NOTE 1: Ownership of the 5G NR Femto (or CAG or both) concept and a mechanism will be defined in coordination with SA WG3.

This key issue aims to address the following aspects:

- How to enable the CAG owner or an authorized administrator to provision/update CAG information to the network for 5G Femto access control. The provisioning/updating of CAG info to the network that 5G Femto serves and the network that the UE has subscription will be considered.

This key issue will consider the scenario of allowing the access to a CAG cell in the home and visited network.

NOTE 2: It is assumed that the existing CAG concept defined for PNI-NPN is re-used for Femto access control without impacts to PNI-NPN.

NOTE 3: Ownership of the 5G NR Femto (or CAG or both) concept and a mechanism will be defined in coordination with SA WG3.

# 6 Solutions

## 6.0 Mapping of Solutions to Key Issues

Table 6.0-1: Mapping of Solutions to Key Issues

|  |  |  |
| --- | --- | --- |
|  | Key Issues | |
| Solutions | <Key Issue #1> | <Key Issue #2> |
| #1 |  | X |
| #2 |  | X |
| #3 |  | X |
| #4 |  | X |
| #5 | X |  |
| #6 | X |  |
| #7 | X | X |
| #8 | X |  |
| #9 | X |  |

## 6.1 Solution #1: Provisioning of CAG info to the network that 5G Femto serves

### 6.1.1 Description

This solution mainly addresses two aspects that KI#2 states:

i) *"The provisioning/updating of CAG info to the network that 5G Femto serves [..] will be considered".*

ii) *"consider the scenario of allowing the access to a CAG cell in the [..] visited network".*

This solution introduces a new NF called 5G-CAS. 5G-CAS is a UDM-like repository in the Serving PLMN to store CAG info. The CAG info includes Allowed CAG list and associated time validity information for the UE as per TS 23.501 [2] clause 5.30.3. An authorized administrator inputs CAG info via NEF of the Serving PLMN to 5G-CAS. Either AMF retrieves the CAG info from 5G-CAS or 5G-CAS notifies AMF of the CAG info update. AMF then sends it to gNB, when applicable, and to UE.

CAG info in 5G CAS is deployed per UE and provisioned by the authorized administrator per UE. AMF retrieves the CAG info and is notified of the CAG info update per UE.

In this solution, the Serving PLMN refers to the Visited PLMN.

NOTE 1: 5G-CAS is conceptually the same as EPS CSS.

NOTE 2: Control to allow only an authorized administrator to access NEF relies on the CAPIF functionality. That is not part of this solution.

NOTE 3: Provisioning of CAG info into 5G CAS can be performed via OAM instead of via NEF.

This solution works also for the non-roaming case; 5G-CAS stores CAG info for non-roaming UEs as well.

### 6.1.2 Procedures

#### 6.1.2.1 Registration procedure



Figure 6.1.2.1-1: Retrieval of CAG configuration provisioned in the Serving PLMN

1-4. The same as steps 1, 14a and 14b in clause 4.2.2.2.2 of TS 23.502 [3].

5. The subscription data may contain a flag that suggests the Serving PLMN-specific subscription data needs to be retrieved from 5G CAS.

NOTE: According to inter-operator SLA, the AMF can be pre-configured whether to retrieve the Serving PLMN-specific CAG subscription data. This configuration applies to all subscriber of the Home PLMN. In this case, the flag is not needed.

6-7. The same as steps 14c in clause 4.2.2.2.2 of TS 23.502 [3].

8-9. If the subscription data contains the flag, or according to Service Level Agreement with HPLMN, the serving AMF retrieves the Serving PLMN-specific subscription data containing Allowed CAG list for the UE from 5G CAS.

10-11. AMF subscribes to the notification of update of CAG info from 5G CAS.

12. AMF concatenates the Allowed CAG list for the Serving PLMN retrieved from the subscription data in HPLMN and the Allowed CAG list retrieved from 5G CAS in the Serving PLMN and creates an Allowed CAG list. AMF provides this Allowed CAG list to gNB, when applicable, and to UE.

#### 6.1.2.2 Parameter provisioning



Figure 6.1.2.2-1: CAG configuration provisioning to the Serving PLMN

1-4. The same as steps 1,2,5 and 6 in clause 4.15.6.2 of TS 23.502 [3], except for that CAG information is provisioned. The CAG info is provisioned per UE basis.

NOTE 1: Control to allow only an authorized administrator to access NEF relies on the CAPIF functionality. That is not part of this solution.

NOTE 2: Provisioning of CAG info into 5G CAS can be performed via OAM instead of via NEF.

#### 6.1.2.3 Parameter update to UE

This procedure applies when UE has registered and AMF has subscribed to the notification of update of CAG info from 5G CAS during the registration procedure (See steps 10-11 in Figure 6.1.2.1-1).



Figure 6.1.2.3-1: CAG configuration update to UE

1. 5 G CAS sends to AMF a notification of the Serving PLMN-specific subscription data update per UE basis.

2-3. AMF concatenates the locally stored Allowed CAG list and the Allowed CAG list contained in the notification and creates an Allowed CAG list. Then, the same steps as steps 1, 2a, and 2b in clause 4.2.4.2 of TS 23.502 [3] applies. (When needed, the same step as step 2c in clause 4.2.4.2 of TS 23.502 [3] also applies.)

### 6.1.3 Impacts on services, entities and interfaces

The solution has the following impacts:

5G CAS:

- This stands for 5G CAg subscriber Server. 5G CAS is a new NF that is in the Serving PLMN and stores the Serving PLMN-specific subscription data for both non-roaming UEs and roaming UEs. 5G CAS supports a subset of service operations that UDM supports.

UDM:

- Access and mobility subscription data may contain a new flag that suggests AMF that the Serving PLMN-specific subscription data needs to be retrieved from 5G CAS.

NOTE: If there is SLA between serving PLMN and Home PLMN, this flag is not needed.

AMF:

- AMF checks the above-mentioned flag, or local configuration based on Service Level Agreement and accesses 5G CAS when needed. AMF creates an Allowed CAG list for the Serving PLMN per UE by concatenating Allowed CAG lists, one of which is retrieved from HPLMN and the other of which is retrieved in the Serving PLMN.

NEF:

- NEF in the serving network receives CAG info related inputs from an administrator and stores/updates it to 5G CAS.

NOTE: OAM can be used instead of NEF.

gNB and UE are not impacted.

## 6.2 Solution #2: CAG provisioning and access control via V-UDR in the visited network

### 6.2.1 Description

In PNI-NPN, Closed Access Group (CAG) identifies a group of subscribers who are permitted/allowed to access one or more CAG cells of the PLMN identified by CAG ID(s), which is assumed to be reused for 5G Femto access control. A CAG cell is a cell broadcasting one or several CAG IDs. CAG membership of UE is configured in the user subscription data and on the UE. If a UE is roaming, the access control should be performed in the visited network based on CAG IDs configured in visited PLMN (VPLMN), and UE needs be provisioned with the allowed visited CAG cell access information in the visited network.

When introducing the concept of 5G Femto in FS\_5G\_Femto study, the scenario that the UE is roaming to VPLMN (or EHPLMN) and access to CAG cells of 5G Femto in VPLMN must be considered. Currently in 5G, allowed CAG list is provisioned in the HPLMN, of which the allowed CAG list in VPLMN may be also provisioned by HPLMN if SLA is assigned between HPLMN and VPLMN. However, in 5G Femto scenario, the provisioning of CAG access may be rather dynamic e.g. when end users visit friend's home or office in another country. Thus, in roaming cases, it may happen that the UE is not configured with CAG IDs valid in the VPLMN and UE subscription data in HPLMN do not contain list of CAG IDs of the VPLMN. When the UE is registered in the VPLMN (or EHPLMN), the provisioned allowed CAG list must contain VPLMN related CAG IDs to allow the UE to access CAG cells in the VPLMN. This problem applies also to PNI-NPN for which CAG concept was first introduced, i.e., there is no mechanism specified to allow a roaming UE to use a PNI-NPN in the VPLMN if the CAG ID of VPLMN is not provisioned to the UE by HPLMN.

In this solution, the provisioning of a roaming UE and the serving network to enable access control in the VPLMN is provided. As part of this solution, it is assumed that CAG concept as defined for PNI-NPN is re-used for 5G Femto deployments to enable Femto access control in 5G.

### 6.2.2 Procedures

The following figure represents a high-level procedure of the solution.



Figure 6.2.2-1: Call flow for CAG ID(s) provisioning in the visiting network

1: AF creates a request on visited CAG information which may include visited allowed CAG list, GPSI and external location information via AF. Optionally, the request may also include an expiry time in case the given information is only valid temporarily.

NOTE 1: External location represents the location of CAG cell of 5G Femto.

NOTE 2: GPSI can correspond to UE's MSISDN.

NOTE 3: Provisioning of visited CAG information to V-UDR can also be performed via OAM. For this case, the given procedure continues to step 5.

2: The V-NEF receives the AF request and authorizes the request. Then, the V-NEF translates the external location information and maps it to internal Ids such as Cell IDs, TAC.

3: V-NEF stores the translated information to V-UDR in a way that visited CAG information and UE identity are mapped and stored together.

4: V-NEF responses back to AF regarding the request on visited CAG information.

5: UE performs manual selection of CAG cell.

6: UE sends initial registration request or mobility registration update message to the visited network.

7: Option 1: AMF correlates the SUPI and its mapped GPSI/MSISDN received as part of subscription data from H-UDR/UDM, which also delivers the visited CAG allow indication to the serving AMF in visited network. If Visited CAG allow indication is set to true, AMF will get the visited CAG information for this UE by fetching the Visited CAG information from visited UDR using the MSISDN provided from H-UDR/UDM.

For this step, the H-UDR/UDM shall provide MSISDN of the UE. The providing of MSISDN of the UE from H-UDR/UDM can be based on the enabled visited CAG allow indication of the UE and/or based on the indication from AMF that the UE is accessing via a visited CAG cell of 5G Femto. The fetched Visited CAG information is from V-UDR.

Option 2: the AMF establishes AM Policy Association with V-PCF and provides GPSI of the UE. This can be done when a UE is accessing network via CAG cell. The V-PCF subscribes UDR using the GPSI to receive visited CAG information. The received information is provided to the AMF.

8: AMF sends registration accept/reject message.

In case the registration request is rejected due to UE is not allowed to access this particular CAG cell of 5G Femto, then AMF sends the registration reject message to the UE along with a list of allowed CAG IDs. UE may use the received list of allowed CAG IDs e.g., to manually select another CAG cell from the list.

9: If UE receives a registration accept, UE sends registration complete message.

### 6.2.3 Impacts on services, entities and interfaces

UE:

- receive visited CAG Information from AMF and update internal allowed CAG list,

- provide capability indication to AMF whether it supports visited CAG information.

AMF:

- based on visited CAG allowed list indication, fetch visited CAG Information from UDR (either directly or via UDM) per UE and perform CAG access control based on this information,

- provide visited CAG Information to UE if UE has indicated support of this feature.

UDR:

- store visited CAG Information and visited allowed CAG list indication per subscriber.

NEF:

- expose capability to provision visited CAG Information and visited CAG allowed list indication.

## 6.3 Solution #3: Enable provisioning of CAG information from AF via NEF in roaming scenario

### 6.3.1 Description

This solution is aimed at KI#2 about how to enable the CAG owner or an authorized administrator to provision/update CAG information to the network for 5G Femto access control. The provisioning/updating of CAG info to the network that 5G Femto serves and the network that the UE has subscription will be considered.

The network that 5G Femto serves and the network that the UE has subscription may be different networks (i.e. in roaming scenario). Based on the existing CAG mechanism, the CAG information is part of subscription data stored in the UDM. Therefore, in roaming scenario, it is not feasible for the authorized administrator to update the CAG information of a network in the subscription data stored in the UDM in another network.

In order to enable provisioning of CAG information in the above scenario, a CAG Management Function (CMF) is introduced. This CMF is deployed in the network that the 5G Femto serves. The CMF is used to store the CAG information of the UE which is allowed to access the Femto cell. The CAG information contains GPSI and CAG ID. The GPSI is used to identify the specific UE (e.g. visitor UE). The CAG ID is used to identify the CAG cell which the UE is allowed to access to.

Table 6.X.1-1: CAG information stored in CMF

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Attribute name | Data type | P | Cardinality | Description |
| GPSI | GPSI | M | 1 | GPSI (Generic Public Subscription Identifier) used both inside and outside of the 3GPP system to address a 3GPP subscription. |
| CAG-ID | CsgID | M | 1 | CAG ID of the Femto |

The UE of CAG owner can provide CAG information related to the UE of the visitor (i.e. visitor of Femto cell) to the server used by the authorized administrator. The AF corresponding to the authorized administrator provides this information to the CMF. CMF can create and store the CAG information based on the information from the AF (authorized administrator).

When the UE of visitor selects the CAG cell manually and registers via a CAG cell of 5G Femto, AMF can request the CMF to authorize whether the UE is allowed to access the network via the CAG cell.

The home network of visitor UE can be the same network which Femto served or other network which has roaming agreement with the network which Femto served. For both roaming scenario and non-roaming scenario, the AMF will select the CMF in the same network to get the CAG information.

If there are more than one CMFs deployed in the network, the CMF selection shall be considered. In the procedure of provisioning CAG information to the CMF by AF, the NEF shall select a CMF based on the range at which the CAG ID belongs to. In the visitor UE’s Registration procedure, the AMF shall select the CMF based on the CAG ID of the selected femto. For example if the CMF#1 support the information for CAG ID in range from 1 to 1000 and the CMF#2 support the information for CAG ID in range from 1001 to 2000, if the UE supporting CAG ID 500 and 1500 and selects the Femto supporting CAG ID 500, the CMF1 is selected by the AMF. Otherwise the Registration procedure will be rejected since AMF cannot retrieve the corresponding CAG information for access control.

Therefore, in order to ensure the same CMF will be selected by both NEF and AMF, the CAG ID can be the input to discover and select the CMF. The CMF registers the CAG ID RANGE to the NRF. NEF or AMF triggers the NF discovery procedure and sends CAG ID to the NRF. NRF selects the appropriate CMF based on CAG ID and sends the NF profile to the NEF or AMF.

### 6.3.2 Procedures

#### 6.3.2.1 Procedure for provisioning CAG information to the CMF



Figure 6.3.2.1-1: CAG information provisioning

1. The owner of the 5G Femto establishes a connection with the AF responsible to manage the access to the 5G Femto in order to provide the CAG information which includes the list of UE identifier(s) (i.e. the GPSI) and allowed the list of CAG IDs of Femto cell which the UE is allowed to access to. The list may include one or more UEs (i.e. visitor of Femto cell) and one or more CAG IDs. Optionally, validity conditions associated with the allowed CAG list may be provided. This interaction takes place at application layer and it is outside the scope of this study.

2 The AF provides the CAG information in a Nnef\_ParameterProvision\_Create or Nnef\_ParameterProvision\_Update Request to the NEF. The CAG information contains the lists of CAG ID(s) of Femto cell and the list of GPSI(s) of visitor UE(s) which are allowed to connect to the Femto cell identified by the provided CAG ID(s).

3. NEF selects a CMF based on provided CAG ID(s), as described in clause 6.3.2.4.

NOTE: CMF selected by NEF is in the network which Femto served.

4. If the AF is authorised by the NEF to provision the parameters, the NEF requests to create, update and store the provisioned parameters as part of the subscriber data in CMF via Ncmf\_ParameterProvision\_Create or Ncmf\_ParameterProvision\_Update Request message. The CMF stores the provided CAG information.

4. CMF responds to the request with Ncmf\_ParameterProvision\_Create/Update Response. If the procedure failed, a cause value indicating the reason is provided.

5. NEF responds to the request with Nnef\_ParameterProvision\_Create/Update Response. If the procedure failed, a cause value indicating the reason is provided.

#### 6.3.2.2 Procedure for visitor UE registration



Figure 6.3.2.2-1: Visitor UE registration procedure

1. The visitor UE of Femto cell intending to connected to a 5G Femto manually selects the CAG cell and attempts the registration.

NOTE: How the UE is aware of the CAG ID to be selected is considered outside the scope of this study.

2. The UE sends a Registration Request including an indication of connection as visitor UE.

3. RAN performs the AMF selection.

4. RAN sends the Registration Request to the selected AMF.

5. AMF performs AUSF selection. If the visitor UE of Femto cell is in roaming scenario, the AMF shall select the AUSF in the home network of visitor UE.

6. The authentication is performed as described in TS 33.501.

7. AMF retrieves the Access and Mobility Subscription data using Nudm\_SDM\_Get. The GPSI is provided to the AMF in the Access and Mobility Subscription data from the UDM if the GPSI is available in the UE subscription data. The selected UDM is in the home network of visitor UE.

8. AMF selects a CMF based on CAG ID, as described in clause 6.3.2.4. The CMF is in the same network with Femto in both roaming scenario and non-roaming scenario.

9. AMF determines to perform the access control for the CAG cell via CMF based on the indication from the UE in the Registration Request. The AMF provides the GPSI of visitor UE to the CMF. CMF provides the CAG information associated with this GPSI to the AMF (i.e. the list of CAG ID associated to the UE). The AMF determines whether the UE is allowed to access to the CAG cell by checking if the CAG ID is included in retrieved information. If the CAG ID is not included in the list, AMF shall reject the registration request.

10. Steps 15 - 25 in clause 4.2.2.2.2 of TS 23.502 [3] (General Registration).

#### 6.3.2.3 Procedure for CMF Registration



Figure 6.3.2.3-1: CMF Registration and Update

1. CMF sends Nnrf\_NFManagement\_NFRegister Request or Nnrf\_NFManagement\_NFUpdate Request to NRF to inform the NRF of its NF profile. The NF profile of CMF contains NF type, NF instance ID, FQDN or IP address of NF, Names of supported NF services and PLMN ID. The NF profile of CMF contains the Range of CAG IDs which are managed by the CMF.

2. The NRF stores the NF profile of CMF. The NF profile contains the Range of CAG IDs which are managed by the CMF.

3. The NRF acknowledge NF Registration is accepted via Nnrf\_NFManagement\_NFRegister response.

#### 6.3.2.4 Procedure for CMF discovery



Figure 6.3.2.4-1: CMF discovery procedure

1. The NF service consumer (i.e. AMF or NEF) intends to discover services of CMF. The NF service consumer invokes Nnrf\_NFDiscovery\_Request from an appropriate configured NRF in the same PLMN. The request includes the CAG ID(s). If the NF consumer is AMF, the request includes the CAG ID of Femto which UE accessed from. If the NF consumer is NEF, the request includes the CAG ID which is provided by AF in the provisioning procedure.

2. The NRF authorizes the Nnrf\_NFDiscovery\_Request. Based on the profile of the expected NF/NF service and the type of the NF service consumer, the NRF determines whether the NF service consumer is allowed to discover the expected NF instance(s).

3. The NRF determines the serving CMF matching the CAG ID in the request (i.e. CMF for which the CAG ID is in the CAG ID RANGE of CMF) received in Nnrf\_NFDiscovery\_Request and sends the NF profile of the determined CMF.

### 6.3.3 Impacts on services, entities and interfaces

UE:

- For the UE of visitor, the ability to indicate that it is a visitor UE for CAG cell of 5G NR Femto in the Registration Request

NOTE: The interactions between the UE and the AF takes place at application layer therefore is outside the scope of this study and this interaction has no impact on the UE.

AF:

- Capability to perform the External Parameter Provisioning procedure to provide the UE identifier, allowed CAG list and validity conditions to the CMF.

CMF:

- A new NF to store the CAG information based on the provisioned data.

AMF:

- Capability to retrieve the CAG information stored in the CMF.

- Capability to select CMF based on CAG ID.

NEF:

- Capability to select CMF based on CAG ID.

- Capability to support the new parameter in the External Parameter Provisioning procedure.

NRF:

- Ability to store the CMF profile and discover the CMF based on CAG ID.

## 6.4 Solution #4: provisioning of subscribers allowed to access CAG cell using CAG subscription update from AF

### 6.4.1 Description

CAG owner or administrator may provision to 5GC subscribers allowed to access a CAG cell.

In principle provisioning CAG information to UDM is based on the clause 4.2.4.2 of TS 23.502 [3] and provisioning the updated CAG information is based on the clause 4.15.6.2 of TS 23.502 [3]:

- AF (CAG owner or administrator) provides UE ID (e.g. SUPI, MSISDN or GPSI), and allowed Cell information (e.g. cell ID(s), FEMTO device ID) or CAG information per PLMN ID, including Validity Time (for temporary users) per UE via Nnef\_ParameterProvision\_Create/Update/Delete procedures.

- NEF authorizes the request from AF, determines SUPI from GPSI/MSISDN if needed, may derive corresponding CAG information per UE and then provision into UDM.

- And UDM may provide CAG information to the corresponding UEs via UCU procedures via AMF.

- The result of UE provisioning can be reported to AF.

NOTE 1: When an AF in a visited PLMN wants to let the UE use the Femto service in the vPLMN, the AF should provision the CAG information to UDM as above.

NOTE 2: It is assumed that HPLMN of a target UE has a mechanism for authorizing AF that has no pre-configured relation with the HPLMN to change CAG info of the target UE, e.g., by using a token-based scheme. It is assumed that PLMN of 5G Femto, together with the HPLMN, has a mechanism for authorizing only AF that is used by the CAG owner to change CAG info. Specification of the needed scheme is outside the SA2 remit. It is assumed that operator deploys a necessary authorization scheme at NEF.

Editor's note: To be aligned with SA6 FS\_CAPIF\_Ph3 on how to authorize AF that has no pre-configured relation with the HPLMN (the first case in the above). FFS on how to authorize only AF that is used by the CAG owner to change CAG info at the HPLMN (the second case in the above).

### 6.4.2 Procedures

#### 6.4.2.1 General

The Figure 6.4.1-1 shows the procedure for how the AF provision CAG subscriptions allowed to access CAG cell:



Figure 6.4.2.1-1: Procedures for AF to provision CAG subscriptions allowed to access CAG cell

The steps of Figure 6.4.2.1-1 are described as follows:

1. The AF provides UE ID (e.g. SUPI, MSISDN or GPSI), allowed Cell information (e.g. cell ID(s), FEMTO device ID) or CAG information including Validity Time (for temporary users) per UE via Nnef\_ParameterProvision\_Create/Update/Delete procedures.

2. NEF authorizes the request from AF, determines SUPI from GPSI/MSISDN if needed and, may derive corresponding CAG information or allowed Cell information per UE and then provisioned into UDM.

3/5. UDM is provisioned CAG information and can be updated to UDR also.

6. UDM sets the CAG information update indicator to confirm its update.

7-10. CAG information is provisioned.

11-12. CAG information update result is notified to the AF via NEF.

#### 6.4.2.2 AF request redirection

Figure 6.4.2.2-1 shows the procedure for how NEF redirects AF request:



**Figure 6.4.2.2-1: Procedure for AF request redirection**

The steps of Figure 6.4.2.2-1 are described as follows:

1. AF provides information to NEF in the Serving PLMN as in step 1 of Figure 6.4.2.1-1.

2. When the UE ID is for a roaming UE, NEF sends back to AF an HTTP response indicating redirection to an NEF in HPLMN of the UE.

3. AF provides information to NEF in HPLMN of the UE as in step 1 of Figure 6.4.2.1-1.

4. Step 2 and onwards of Figure 6.4.2.1-1 continue.

NOTE: It is assumed that HPLMN of a target UE and PLMN that 5G Femto serves have SLA to allow the redirection described in this clause.

### 6.4.3 Impacts on services, entities and interfaces

UDM:

- CAG information for UE(s) are provisioned from AF via NEF and notify the result of provisioning to NEF (step 11 of Figure 6.4.2.1-1).

NEF:

- To receive and authorize CAG owner or administrator's input (UE ID, allowed Cell information or CAG information) with assistance of CAPIF and, if required, change them into 5GS term (e.g. CAG information) and provide UDM.

- To receive notification of the result of provisioning from UDM and forward it to AF (step 12 of Figure 6.4.2.1-1)

- To redirect AF request to an NEF in HPLMN of a roaming UE.

AF:

- To provide UE ID and allowed Cell information or CAG information to 5GC.

## 6.5 Solution #5: Handover from/to CSG cell to/from CAG cell using mapped CAG/CSG ID

### 6.5.1 Description

In LTE Femto, Closed Subscriber Group (CSG) identifies a group of subscribers who are permitted/allowed to access one or more CSG cells of the PLMN identified by CSG ID(s). A CSG cell is a cell broadcasting one or several CSG IDs. The CSG membership of a UE is configured in the user subscription data and on the UE. If a UE tries to connect to a CSG cell the network (MME) checks whether the UE is allowed to do so considering the subscription data.

In 5G, a Closed Access Group (CAG) identifies a group of subscribers who are permitted/allowed to access one or more CAG cells associated to the CAG ID. A CAG cell is a cell broadcasting one or several CAG IDs. The CAG concept is like the CSG concept in EPS but was originally introduced in the context of PNI-NPNs to prevent UE(s), which are not allowed to access the NPN via the associated cell(s), from automatically selecting and accessing the associated CAG cell(s). The CAG based access control was introduced in 3GPP Release-16.

As a part of KI#1, it is noted that the mobility scenarios for a UE (i. e., moving from/to a CSG cell of HeNB to/from a CAG cell of 5G Femto) are going to be studied. These mobility scenarios would be valid as the deployment of 5G Femto may start on top of an existing LTE Femto deployment such as in an Enterprise deployment.

In this solution, the handover from/to CSG cell to/from CAG cell of 5G Femto is provided with an assumption that the CAG concept as defined for PNI-NPN is re-used for 5G Femto deployments. This solution proposes:

* to reuse the existing access control mechanisms at the source side based on a CSG ID (for the mobility from a CSG cell to a CAG cell of 5G Femto), and based on a CAG ID (for the mobility from a CAG cell of 5G Femto to a CSG cell); and
* to support access control for the moving UE at the source cell in order to mitigate any unnecessary signalling that may happen if the UE is not allowed to access the target CSG or CAG cell.

The benefit of the proposed solution is that it enables to support the mobility from/to LTE Femto CSG cells in a system which already supports CAG access control (due to NPN or access to 5G Femto cells) without any further impacts than provisioning of a dedicated partition of CAG IDs. More specifically, the 5G source system is required to reserve CAG IDs with the leftmost five bits set to zeros, for supporting mobility from/to a CSG cell. This means that the remaining number of CAG IDs to be used for the 5G intra-system (e.g. NPN or CAG cell of 5G Femto) is reduced from 2^32 into (2^32 – 2^27) which means a reduction of only about 3 percent maximum (if all range is used). Such a reduction can be considered as minor and acceptable for the 5G intra-system operation. Accordingly, this requires the operator to reserve the partition of CAG IDs and not use it other than for supporting mobility from/to a CSG cell.

### 6.5.2 Procedures

The following figure represents a high-level procedure of the solution.

Editor’s Note: How source RAN recognize the CSG/CAG Id of the target 5G(4G) cell based on measurement report containing E-UTRA(NR) measurement IE is FFS.



Figure 6.5.2-1: UE mobility from CAG cell of 5G Femto to 4G CSG cell

Step 0a. 5GS is configured in a way that the existing CAG ID values are partitioned to reserve CAG IDs with leftmost five bits set to zeros, for supporting mobility from/to a CSG cell.

Step 0b. It is assumed that UE is configured with the allowed CAG and CSG list for access to CAG and CSG cells when the registered PLMN sends allowed CAG list during the registration procedure or UE configuration update procedure.

Step 1. Target 4G CSG cell broadcasts a CSG ID(s) over SIB1.

Step 2. The UE reads the CSG ID of the target CSG cell and constructs a mapped CAG ID. The UE can construct a mapped CAG ID for a CSG cell where the mapped CAG ID is an encoding of partitioned CAG IDs to CSG IDs and can be obtained with 32-bit bitstring by setting five zeros as leftmost bits followed by the 27 bits of the CSG ID of a CSG cell.

Step 3. The UE sends to the source 5GS a 5G measurement report message including the mapped CAG ID constructed at Step 2. In this step, there is no change on the existing measurement reporting procedure as the reported mapped CAG ID is aligned with the existing CAG ID concept.

Step 4. The source 5GS uses the mapped CAG ID to perform the access control in the same way as dealing with the existing intra-system CAG ID access control (e.g. for NPN).

In the proposed solution, the source 5GS performs the access control without any changes to the existing mechanism. When the source 5GS concludes that the UE is allowed to access to the target cell, the existing procedure in Figure 4.11.1.2.1-1 of TS 23.502 [3] continues from step 3. When the source 5GS concludes that the UE is not allowed to access to the target cell, the handover procedure stops and no further signalling to/access control is needed.

Figure 6.5.2-2: UE mobility from 4G CSG cell to CAG cell of 5G Femto

Step 0a. 5GS is configured in a way that the existing CAG ID values are partitioned to reserve CAG IDs with leftmost five bits set to zeros, for supporting mobility from/to a CSG cell.

Step 0b. It is assumed that UE is configured with the allowed CAG and CSG list for access to CAG and CSG when the registered PLMN sends allowed CAG list during the registration procedure or UE configuration update procedure.

Step 1. Target CAG cell of 5G Femto broadcasts a CAG ID(s) over SIB1.

Step 2. The UE reads the CAG ID of the target CAG cell of 5G Femto and constructs a mapped CSG ID. The UE can construct a mapped CSG ID for a CAG cell where the mapped CSG ID is an encoding of the partitioned CAG IDs to CSG IDs and can be obtained with 27 bits bitstring out of the received CAG ID with 32 bits bitstring by removing five zeros at leftmost bits of the read CAG ID.

Step 3. The UE sends to the source 4GS a 4G measurement report message including the mapped CSG ID constructed at Step 2. In this step, there is no change on the existing measurement reporting procedure as the reported mapped CSG ID is aligned with the existing CSG ID concept.

Step 4. The source 4GS uses the mapped CSG ID to perform the access control in the same way as dealing with the existing intra-system CSG ID access control (e.g. for LTE Femto).

In the proposed solution, the source 4GS performs the access control without any changes to the existing mechanism. When the source 4GS concludes that the UE is allowed to access to the target cell, the existing procedure in Figure 4.11.1.2.2.2-1 of TS 23.502 [3] continues from step 3. In this case, the access control at target 5GS can also take place based on the existing procedures. When the source 4GS concludes that the UE is not allowed to access to the target cell, the handover procedure stops and no further signalling to/access control at the target 5GS is needed.

### 6.5.3 Impacts on services, entities and interfaces

- UE – receiving CSG-CAG ID partitioning constructing and reporting mapped CSG/CAG ID (depending on the considered mobility direction).

Editor’s Note: impacts to NGRAN/EUTRAN are FFS.

## 6.6 Solution #6: Management-based CAG cell and CSG cell mapping to support interworking

### 6.6.1 Introduction

This solution provides methods to support interworking procedure between CAG cell and CSG cell based on management-based CAG cell and CSG cell mapping i.e., locally configured correlation between CAG information and CSG information.

### 6.6.2 Functional Description

The solution is based on the existing mechanism of CAG for PNI-NPN as specified in TS 23.501 [2] with following enhancements:

- The correlation between CAG information and CSG information (including corresponding Home eNB ID) can be configured locally in the AMF that the 5G NR Femto cell is connected to.

- Below tables illustrate the configuration in AMF for correlation between Home eNB, CSG information and CAG information.

Table 6.6.2-1: Home eNB Correlation configuration in AMF

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Attribute name | Data type | P | Cardinality | Description |
| Global Home eNB ID | PLMN ID + BIT String (28) | M | 1 | Home eNB ID |
| CSG-ID | CsgID | O | 1 | CSG Id of the Home eNB |
| Cell Access Mode | ENUMERATED (hybrid, …) | O | 1 | Access mode of the cell as defined in TS 36.413 [x] |
| CorrespondingCAGlist | array(CagID) | O | 0..N | List of CAG IDs corresponding to the CSG-ID |

Table 6.6.2-1 provides the relation between Home eNB ID and CSG-ID which can be used by AMF to derive the needed CSG ID during the 5GS to EPS handover procedure. Table 6.6.2-1 provides also the relation between CSG-ID and CAG ID which can be used by the AMF to derive the needed CSG membership information together with Cell Access Mode information, during the 5GS to EPS handover procedure. After the AMF has derived the CSG ID of the target cell, the AMF set the CSG membership, if any of the allowed CAG-IDs in the UE’s subscription data matches one of the CAG IDs that is correlated with the determined CSG ID.

- AMF actions during the handover procedures.

- During the HO procedure from 5GS to EPS, the AMF provides to the MME in the Forward Relocation Request message with CSG related information, based on CAG information in subscription data and the configured correlation between the Target ID contained in N2 Handover Required signalling (i.e. the Global Home eNB ID) and the corresponding CSG information as described in table 6.6.2-1.

- During the HO procedure from EPS to 5GS, the AMF performs normal HO procedure based on existing access control function.

Editor’s note: The roaming aspect and further needs of the UDM involvement is FFS.

### 6.6.3 Procedures

#### 6.6.3.1 HO procedure from 5GS to EPS

The procedure is based on clause 4.11.1.2.1 of TS 23.502 [3] as illustrated in figure 6.6.3.1-1 below.



Figure 6.6.3.1-1: 5GS to EPS handover procedure

The following steps, referring to steps in clause 4.11.1.2.1 of TS 23.502 [3] as base, are enhanced for the CSG ID correlation handling in AMF.

3. Based on the target ID (Home eNB ID), the AMF checks the correlation information between target Home eNB ID and the corresponding CSG ID as described in table 6.x.2-1 above and includes the derived CSG ID. The AMF further checks the allowed CAG IDs in the UE’s subscription and its correlation to the target Home eNB's CSG ID and Cell Access Mode information and sets proper CSG membership indication as part of the Forward Relocation Request message towards MME. If the CSG ID is not correlated with any allowed CAG IDs of the UE, the AMF rejects the HO.

It’s assumed that NG-RAN without enhancement can trigger the handover required as in step 1 for the UE towards the target CSG cell as normal cell as described in TS 38.300 [x] clause 9.3.2.2.

#### 6.6.3.2 HO procedure from EPS to 5GS

The procedure is based on clause 4.11.1.2.2 and of TS 23.502 [3] as illustrated in figure 6.6.3.2-2 below.



Figure 6.6.3.2-2: EPS to 5GS Handover procedure, preparation phase

Based on the following text in clause 5.30.3.4 of TS 23.501. The CAG access control can be enforced by AMF during Registration after the HO. No enforcement is needed.

- During transition from CM-IDLE to CM-CONNECTED and during Registration after connected mode mobility from E-UTRAN to NG-RAN as described in clause 4.11.1.2.2 of TS 23.502 [3]:

- The AMF shall verify whether UE access is allowed by Mobility Restrictions:

NOTE: The AMF may provide the Mobility Restriction information as part of the HO Request message if AMF has stored UE subscription information.

It’s assumed that E-UTRAN without enhancement can trigger the handover required as in step 1 for the UE towards the target CAG cell as normal cell as described in TS 36.300 [x] clause 10.2.

### 6.6.4 Impacts on services, entities, and interfaces

**AMF:**

- Support correlation information configuration related to Home eNB ID, CSG ID and CAG information.

- Support formulation of CSG related information towards MME during 5GS to EPS handover.

Editor’s note: Whether there is UE impact is FFS.

6.7 Solution #7: Reusing the existing mechanism for UE configuration and idle mobility

6.7.1 Description

In the Architectural Assumptions, the CAG concept is used for the 5G femto as following:

- It is assumed that the existing CAG concept defined for PNI-NPN is re-used for Femto access control without impacts to PNI-NPN.

In this solution, to access the 5G Femto cell, the UE may be pre-configured or (re)configured with the following CAG information:

- an Allowed CAG list i.e. a list of CAG Identifiers the UE is allowed to access; and

The HPLMN may configure or re-configure a UE with the above CAG information using the UE Configuration Update procedure for access and mobility management related parameters described in clause 4.2.4.2 of TS 23.502 [3].

The above CAG information is provided by the HPLMN on a per PLMN basis.

The UE may be locally pre-configured with the allowed 4G CSG list or following the CSG handling defined in the TS 23.401 [5].

Editor's note: If the UE is not configured with the allowed 4G CSG and 5G CAG lists, how it works is FFS.

During the idle mobility from 4G to 5G femto cell:

- The UE uses the Allowed CAG list to perform the network and cell selection as described in clause 5.30.3.4 of TS 23.501 [2].

During the idle mobility from 5G to 4G CSG cell:

- The UE perform the network and cell selection as described in TS 23.401 [5].

6.7.2 Procedures

There is no new procedure defined

6.7.3 Impacts on services, entities and interfaces

There is no change to the existing mechanism on UE configuration, provisioning and idle mobility.

6.8 Solution #8: The connected mode mobility between 4G CSG cell and 5G CAG cell

6.8.1 Description

This solution is to address the connected mode mobility part of KI#1 and propose enhancements to support the UE connected mode mobility between CAG cell of 5G and CSG cell of 4G.

The high level principle/assumption of this solution can be summarized as follows:

- The 4G and 5G interworking architecture with N26 interface defined in the 23.501 [2] clause 4.3.1 is applied.

- There is UE’s allowed 4G CSG list and 5G CAG list subscription in the UDM/HSS.

- The UDM/HSS can provide the UE allowed 4G CSG list and 5G CAG list to AMF. The AMF creates the Mobility restriction list (including allowed CAG and CSG list) accordingly and send it to NG-RAN.

- The NG-RAN is pre-configured with the CSG information (CSG ID and Cell Access Mode) of neighbouring 4G CSG cell which can be done by OAM.

- According to the UE measurement report, the pre-configured CSG information of neighbouring 4G CSG cell and allowed CSG list in the Mobility restriction list, the NG-RAN determines the target 4G CSG cell and initiates the 5GS to EPS HO procedure.

- There is no change to EPS side

NOTE: For the EPS to 5GS HO, the normal 4G to 5G Handover is performed. After the handover, the UE perform the registration, the AMF perform the CAG Access control as per TS 23.501 [2].

6.8.2 Procedures

#### 6.8.3.1 HO from 5GS to EPS

The clause 4.2.2.2.2 of TS 23.502 [3] (General Registration) is re-used with following additional handling.

- In the step 14b, the UDM provides the UE allowed 4G CSG list and 5G CAG list to AMF.

- In step 21, the AMF providers the Mobility restriction list (including allowed CAG and CSG list) to NG-RAN.



Figure 6.8.3.1-1: 5GS to EPS handover

The clause 4.11.1.2.1 of TS 23.502 [3] (5GS to EPS handover using N26 interface) is re-used with following additional handling.

- The NG-RAN is pre-configured with the CSG information of neighbouring 4G CSG cell

- In step 1, the NG-RAN determines the target CSG cell for handover, and send the CSG ID and Access Mode of target cell to AMF in the Handover required message.

- In step 3, the AMF check the UE’s CSG subscription and sets proper CSG membership indication as part of the Forward Relocation Request message towards MME.

#### 6.8.3.2 HO from EPS to 5GS

The procedure is same with clause 4.11.1.2.2 of TS 23.502 [3]. There is no enhancement for this procedure. In the existing mechanism:

- In step 10 in clause 4.11.1.2.2.2 (Preparation phase), the NG-RAN has provided supported CAG List of target cell in the Handover Request ACK to the AMF as per 38.413 [x] clause 9.2.3.5.

- In step 12 in clause 4.11.1.2.2.3 (Execution phase), the UE performs the EPS to 5GS Mobility Registration Procedure. AMF shall verify whether the UE is allowed to access to the CAG cell according to the allowed CAG list from UDM and supported CAG List from NG-RAN.

6.8.3 Impacts on services, entities and interfaces

Editor's note: Because the RAN impact solution is not considered in this SID, the inclusion of this solution in evaluation and conclusion phase is FFS..

**UDM:**

- There is UE allowed 4G CSG list and 5G CAG list subscription in the UDM/HSS.

- The UDM provides the allowed 4G CSG list and 5G CAG list as subscription data to AMF.

**AMF:**

- It creates the Mobility restriction list according to allowed CAG and CSG list received from UDM, and send it to NG-RAN.

- Support formulation of membership indication towards MME during 5GS to EPS handover.

**NG-RAN:**

- To be pre-configured with the CSG information of neighbouring 4G CSG cell which can also be done by OAM.

Editor's note: How the 5G Femto gNB is configured is FFS.

- According to the allowed CSG list in the Mobility restriction list and the pre-configured CSG information of neighbouring 4G CSG cell, the NG-RAN determines the target CSG cell.

- In the HO required message, it indicate the target CSG cell id and Access Mode to the AMF.

## 6.9 Solution #9: Solution for mobility between CAG and CSG cells

### 6.9.1 Description

The solution aims to address the issues described in KI#1 to support mobility between a CAG cell of 5G Femto and a CSG cell of HeNB/EPC.

The solutions assumes the followings:

- The existing CAG concept defined for PNI-NPN is re-used for access control when a UE wants to access a 5G Femto cell without impacts to PNI-NPN.

- Impacts on EPC, E-UTRAN and NG-RAN should be avoided.

- UE subscription information includes allowed CAG and CSG list for the UE

- UE includes the CAG ID broadcast by a target CAG cell of a 5G Femto gNB, in the measurement report to the source HeNB to avoid impact on the UE

A UE is provisioned with the allowed CAG and CSG list for access to CAG cells of a 5G Femto gNB and CSG cells of a 4G HeNB, respectively. If the UE finds a CAG cell of a 5G Femto while communicating through a CSG cell attached to the EPC, it may sends a CAG ID for the corresponding CAG cell of the 5G Femto to the source HeNB. The CAG ID is forwarded to the AMF via MME transparently, to check allowed CAG list by the AMF based on the UE subscription data from the UDM.

### 6.9.2 Procedures

A screenshot of a computer

Description automatically generated

Figure 6.9.2-1 Procedures for UE mobility from CSG cell to CAG cell

0. It is assumed that UE has been provisioned with the allowed CAG and CSG list for access to CAG cells of 4G HeNBs and CSG cells of 5G Femto gNBs. The UE is currently attached to a CSG cell and EPC and set up a PDN connection(s).

1. The UE discovers an available CAG cell of 5G Femto and reports to the source HeNB. Based on the control of the source HeNB, the UE may sends the measurement report to the source HeNB which may include a CAG ID corresponding to a CAG cell of a 5G Femto.
2. The source eNB may send Handover Required message to the MME. The message includes the CAG ID of the CAG cell of the 5G Femto in the Source to Target Transparent Container IE.
3. The MME forwards the handover request to the AMF. The MME MM context includes the CSG subscription data as in Table 5.7.2-1 of TS 23.401. The CSG subscription data also includes the allowed CAG ID(s) information for a UE.
4. The AMF selects the SMF+PGW-C and requests to create Session Management context for UE’s PDU session(s).
5. The AMF forwards the handover request to the target 5G Femto gNB.
6. The gNB sends acknowledges message to the AMF that includes the CAG ID received from the source HeNB. The AMF checks if the CAG ID can be acceptable for the UE based on the UE’s CSG subscription data that is received form the MME, operator policies, etc. Otherwise, the AMF rejects the handover request from the MME and requests the removal of UE context from SMF and gNB.
7. If the CAG can be allowed for the UE, the rest of the interworking handover procedures will proceed.

The same procedure may be applied for the case that the UE moves from 5GS to the EPS, i.e., from CAG cells to CSG cells.

### 6.9.3 Impacts on services, entities and interfaces

Editor's note: Because the RAN impact solution is not considered in this SID, the inclusion of this solution in evaluation and conclusion phase is FFS.

UE:

* No impact

AMF:

* Check CAG list that recieves in the Forward Relocation Request message

UDM:

* CSG subscription data includes both CSG ID(s) and CAG ID(s) that are allowed for the UE

HeNB:

* Forwards the CAG ID of a 5G Femto cell in the source to target transparent container

# 7 Overall Evaluation

Editor's note: This clause provides evaluations of different solutions.

7.1 Key Issue #2: Enabling provisioning of subscribers allowed to access CAG cell and managing access control by the CAG owner or an authorized administrator

Solution #1, #2, #3 and #4 are proposed to address Key Issue #2: Enabling provisioning of subscribers allowed to access CAG cell and managing access control by the CAG owner or an authorized administrator.

A comparison of solutions on above aspect is shown in Table 7.1-1.

Table 7.1-1: Comparison of solutions

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | 1 | 2 | 3 | 4 |
| Which network the CAG information is provisioned | Serving network | Serving network | Serving network | Home network |
| Which network Function the CAG information is stored | CAS, stores the Serving PLMN-specific CAG subscription data | V-UDR, stores visited CAG Information and visited allowed CAG list indication per subscriber. | CMF, store the CAG information based on the provisioned data. | UDM |
| UE impact | N/A | UE provide capability indication to AMF whether it supports visited CAG information | UE indicates it is a visitor UE in the Registration message. | N/A |
| AMF impact  (Note 1) | According to the flag in subscription data, AMF retrieves the CAG list from 5G CAS. | According to the allowed indication in subscription data and UE indication, the AMF retrieves the CAG info from V-UDR. | According to UE indication, the AMF retrieves the CAG info from CMF. |  |
| UDM subscription data | a flag in subscription data, indication Serving PLMN-specific subscription data needs to be retrieved | visited CAG allow indication and MSISDN in UE subscription data |  |  |
| NEF impact | V-NEF, enhance the PP procedure to provision the CAG to CAS | V-NEF receives the AF request, and store CAG information to V-UDR | Same with sol#1. | H-NEF, enhance the PP procedure to provision the CAG to UDM |
|  |  |  |  |  |
| Note 1: After obtaining the CAG list, the AMF perform the access control according to 23.502 [3] | | | | |

# 8 Conclusions

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

8.1 Key Issue #2: Enabling provisioning of subscribers allowed to access CAG cell and managing access control by the CAG owner or an authorized administrator

For interim conclusions, the following aspects are taken as way forward:

- The NEF API, i.e. Parameter Provisioning specified in the 23.502 [3] clause 4.15.6 is enhanced to support the 5G Femto CAG provisioning.

Editor's note: Whether this enhanced procedure is applied to Serving network or Home network is FFS.

Annex A (informative):  
Change history

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Change history** | | | | | | | |
| **Date** | **Meeting** | **TDoc** | **CR** | **Rev** | **Cat** | **Subject/Comment** | **New version** |
| 2024-01 | SA2#160-Ad Hoc-e | S2-2401377 | - | - | - | Proposed skeleton agreed for FS\_5G\_Femto | 0.0.0 |
| 2024-01 | SA2#160-Ad Hoc-e | S2-2401716 | - | - | - | Scope for TR 23.700-45 | 0.1.0 |
| 2024-01 | SA2#160-Ad Hoc-e | S2-2401717 | - | - | - | Architecture assumptions and requirements for TR 23.700-45 | 0.1.0 |
| 2024-01 | SA2#160-Ad Hoc-e | S2-2401718 | - | - | - | New KI: Support of UE move between CAG cell of 5G Femto and CSG cell. | 0.1.0 |
| 2024-01 | SA2#160-Ad Hoc-e | S2-2401719 | - | - | - | New KI: Enabling provisioning of subscribers allowed to access CAG cell and managing access control by the CAG owner or an authorized administrator. | 0.1.0 |
| 2024-03 | SA2#161 | S2-2403237 | - | - | - | TR Scope update. | 0.2.0 |
| 2024-03 | SA2#161 | S2-2403239 | - | - | - | KI#1 update not to support one-way handover for 5G Femto Mobility. | 0.2.0 |
| 2024-03 | SA2#161 | S2-2403665 | - | - | - | KI#2 New solution for Provisioning of CAG info to the network that 5G Femto serves. | 0.2.0 |
| 2024-03 | SA2#161 | S2-2403520 | - | - | - | KI#2 Solution for CAG provisioning and access control via V-UDR in the visited network. | 0.2.0 |
| 2024-03 | SA2#161 | S2-2403246 | - | - | - | KI#2, New Solution for enabling provisioning of CAG information in roaming scenario. | 0.2.0 |
| 2024-03 | SA2#161 | S2-2403247 | - | - | - | New Solution for KI#2: provisioning of subscribers allowed to access CAG cell. | 0.2.0 |
| 2024-03 | SA2#162 | S2-2405814 | - | - | - | KI#1 Solution for handover from/to CSG cell to/from CAG cell using mapped CAG/CSG ID. | 0.3.0 |
| 2024-03 | SA2#162 | S2-2405789 | - | - | - | KI#1, New solution Management based CAG and CSG correlation to support UE move. | 0.3.0 |
| 2024-03 | SA2#162 | S2-2405812 | - | - | - | KI#1, new solution on reusing the existing mechanism for UE configuration and idle mobility. | 0.3.0 |
| 2024-03 | SA2#162 | S2-2405792 | - | - | - | KI#1, new solution on the connected mobility between 4G CSG and 5G CAG. | 0.3.0 |
| 2024-03 | SA2#162 | S2-2405791 | - | - | - | KI#1: New solution for mobility support between CAG and CSG cells. | 0.3.0 |
| 2024-03 | SA2#162 | S2-2405794 | - | - | - | Update to KI#2, Solution #2. | 0.3.0 |
| 2024-03 | SA2#162 | S2-2405521 | - | - | - | KI#1, update the solution 1. | 0.3.0 |
| 2024-03 | SA2#162 | S2-2405795 | - | - | - | KI#2, Update of solution#3 on CMF selection. | 0.3.0 |
| 2024-03 | SA2#162 | S2-2405523 | - | - | - | Update Sol#4: provisioning of subscribers allowed to access CAG cell using CAG subscription update from AF. | 0.3.0 |
| 2024-03 | SA2#162 | S2-2405796 | - | - | - | KI#2, evaluation and conclusion. | 0.3.0 |