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*Technical Report*

## 3rd Generation Partnership Project;
## Technical Specification Group Services and System Aspects;
## Study on roaming architecture for voice over IP Multimedia Subsystem (IMS) with local breakout
## (Release 11)

Keywords

3GPP, IMS, LTE, Roaming, Voice

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# Contents

# 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;

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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.

# 1 Scope

In the context of support of roaming for voice over IMS, the GSM Association has decided that local breakout in the visited network will be needed (see GSMA PRD IR.65 [6]). This is because local breakout can be regarded as one cornerstone to allow the replication of the charging principles on which CS roaming is based on. However there are several other aspects that need to be considered e.g. the split/bundling of user and control plane, capturing of SDP information needed to generate charging records, to make such principles applicable to voice over IMS roaming.

This study item will therefore investigate solutions for the provision of voice over IMS in roaming scenarios that facilitate the realization of a charging model that replicates the principles of CS model.

It will be studied whether changes to the core 3GPP specifications are needed and if so which ones. The study will focus on IMS layer and not EPC aspects.

As some of the aspects of the roaming are outside the scope of 3GPP (e.g. decision to anchor media or control plane, interaction with carrier networks, roaming agreements) this study will be performed in close cooperation with the GSM Association which may provide additional requirements and guidance during its development.

# 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 23.002: "Network Architecture".

[3] 3GPP TS 23.228: "IP Multimedia Subsystem (IMS); Stage 2".

[4] 3GPP TS 23.079: "Support of Optimal Routeing (SOR); Technical Realization".

[5] 3GPP TS 23.066: "Support of Mobile Number Portability (MNP); Technical realization; Stage 2".

[6] GSMA PRD IR.65: "IMS Roaming and Interworking Guidelines", version 4.0, GSM Association.

[7] IETF RFC 4904 (June 2007): "Representing Trunk Groups in tel/sip Uniform Resource Identifiers (URIs)".

[8] 3GPP TS 24.229: "IP multimedia call control protocol based on Session Initiation Protocol (SIP) and Session Description Protocol (SDP); Stage 3".

[9] 3GPP TS 23.216: "Single Radio Voice Call Continuity (SRVCC); Stage 2".

[10] 3GPP TS 23.237: "IP Multimedia Subsystem (IMS) Service Continuity: Stage 2".

[11] 3GPP TS 23.292: "IP Multimedia Subsystem (IMS) centralized services; Stage 2".

[12] 3GPP TR 23.885: "Feasibility Study of Single Radio Voice Call Continuity (SRVCC) from UTRAN/GERAN to E-UTRAN/HSPA; Stage 2".

# 3 Definitions, symbols and abbreviations

## 3.1 Definitions

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

## 3.2 Abbreviations

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

# 4 Requirements

Editor's note: Requirements in this section are subject to be updated according to input provided by the GSMA.

## 4.1 Service control requirements

The solution shall:

- Ensure that the service control is performed by the HPLMN (e.g. to cater for the case where the destination address is modified). The service control is retained by the HPLMN also in the case where the destination network is the same as the VPLMN where the roaming user is.
- Allow to reach a user whose number has been ported to a different PLMN using the same resolution mechanism adopted by the VPLMN for their own users.

NOTE: The implementation of number portability, TS 23.066 [5], may be different depending on the country.

It shall be possible, based on roaming agreements, to provide the signalling breakout of the IMS voice call from the VPLMN.

## 4.2 VPLMN requirements

The solution will be such as to allow the VPLMN to support outgoing voice over IMS calls from inbound roamers:

- towards any kind of destination network, i.e. CS (e.g. GSM, UMTS, ISDN, POTS) or PS (e.g. TISPAN, 3GPP IMS) network;
- using any kind of interconnection it might require, i.e. legacy CS (e.g. ISUP, SIP-I) or PS (e.g. IPX, direct connection) interconnection.

The solution will be such as to allow supporting incoming voice over IMS calls to outbound roamers:

- from any kind of originating network, i.e. CS (e.g. GSM, UMTS, ISDN, POTS) or PS (e.g. TISPAN, 3GPP IMS) network;
- using service aware interconnection.

The solution will be such to allow the VPLMN to provide the anchor functionality close to where the call is originated from, and the VPLMN shall be able to steer the selection of anchor function by providing the HPLMN with a reference to the preferred anchor function. If the VPLMN does not provide the anchor functionality address the HPLMN shall use the default address for the VPLMN.

## 4.3 SRVCC requirements

The solution shall be compatible with the use of SRVCC as specified in TS 23.216 [9] and TS 23.237 [10], including when ATCF enhancements are used.

The application of a Single Radio VCC procedure to the roaming UE shall not result in changes in the user charging.

## 4.4 Media plane considerations

The solution should consider the case where the HPLMN requests the user plane to be anchored in the HPLMN.

In order not to contravene the existing interconnection model, the media plane shall not be routed without the associated signalling through intermediate carrier networks.

The solution should consider the cases where voice over IMS is provided with CS media, using one of the following procedures:

- "Origination using I2 reference point" (see TS 23.292 [11]);
- "Termination using I2 reference point" (see TS 23.292 [11]);
- "Termination to non ICS UE not registered in IMS" (see TS 23.292 [11]);
- any procedure for "PS - CS Access Transfer" specified in TS 23.237 [10] clause 6.3.2.1;
- any procedure for "PS - PS in conjunction with PS - CS Access Transfer" specified in TS 23.237 [10] clause 6.3.2.3.

### 4.4.1 Optimal Routing

The solution shall be such as to permit the application of Optimal Media Routing as specified in TS 23.002 [2] and TS 23.228 [3]. This is in line with GSM where the support of optimal routing (TS 23.079 [4]) is optional.

## 4.5 Charging Records considerations

For those solutions which rely on routing the session set up signalling back to the originating VPLMN once the session has been processed by the HPLMN, the VPLMN needs to be able to produce easily a complete Call record. Correlation is needed between the two signalling flows, namely VPLMN to HPLMN and HPLMN to VPLMN.

The VPLMN-provided charging record may indicate whether a signalling loopback has been executed (indicating that such CDR was produced as a result of returning the session set up signalling only back to the originated VPLMN) or not.

# 4A Reference Architecture

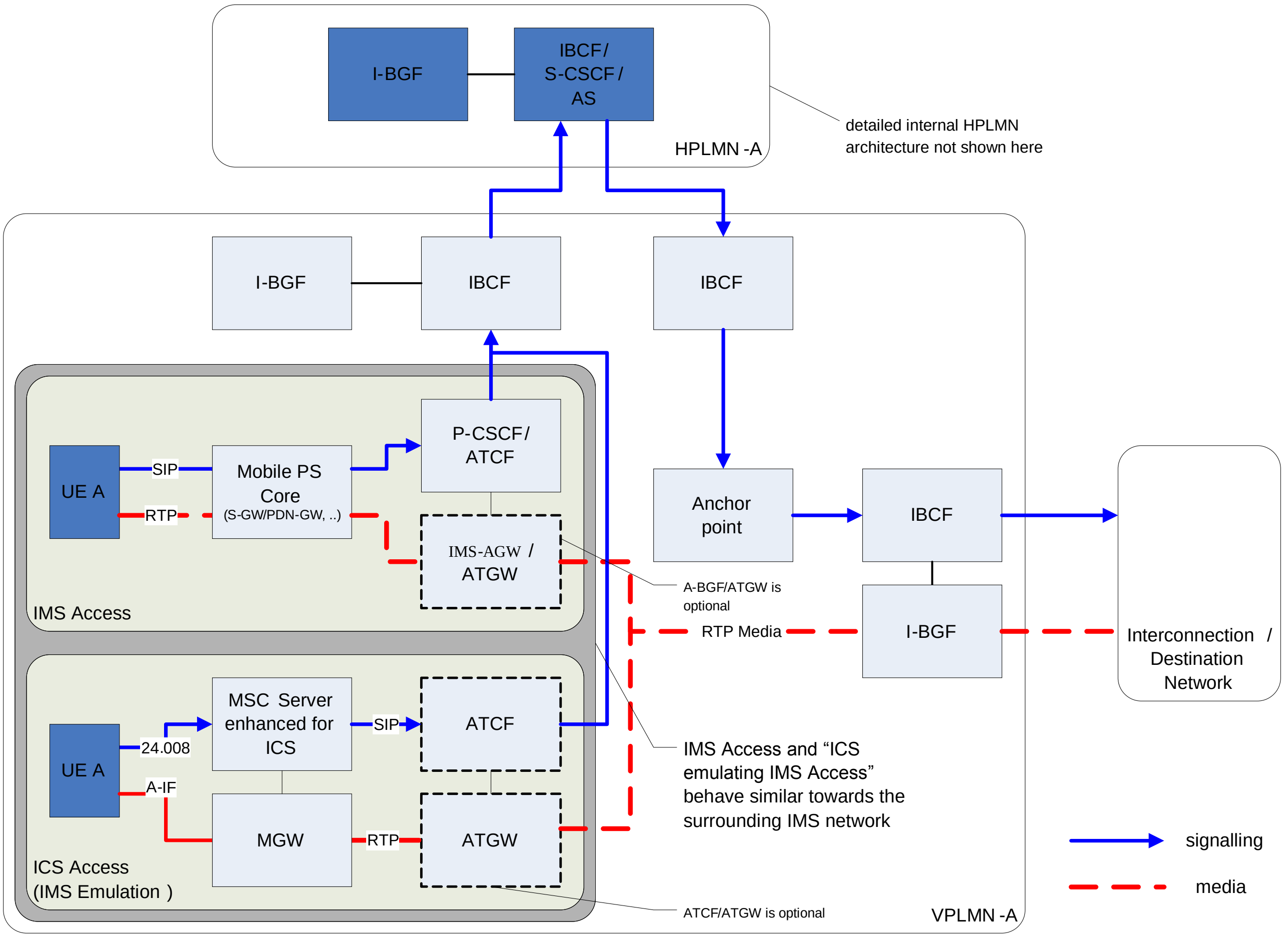



**Figure 4A-1: Reference Architecture**

# 5 Solutions Alternatives for Originating Sessions

## 5.1 CS Copy Cat model based on V-CSCF

### 5.1.1 Reference Architecture

Figure 5.1-1 provides an alternative IMS Voice roaming architecture using a V-CSCF functionality that provides the VPLMN call routing. This functionality required to route the call back through the VPLMN, correlated the call legs, and provide dynamic routing in the VPLMN to any breakout point (IP or PSTN interconnects).

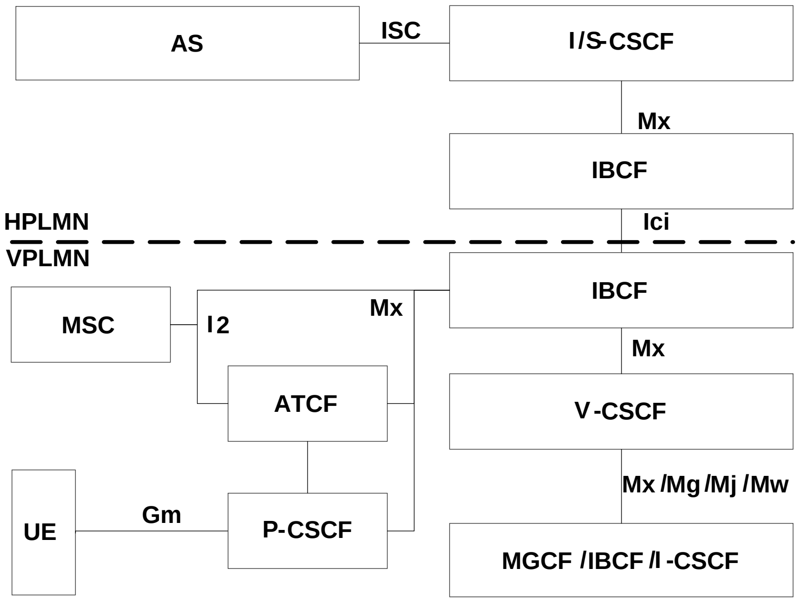



**Figure 5.1-1: IMS Voice Roaming architecture alternative**

NOTE: The V-CSCF can be functionality within existing functional entities (e.g. P-CSCF, BGCF, or IBCF), or potentially combined with Transit functionality.

## 5.1.2 Functional Entities

### 5.1.2.1 V-CSCF

The V-CSCF includes functionality to:

- Perform CDR generation.
- Provide calling party termination routing functionality.
- Provide breakout points to any type of interconnect network (CS/PSTN or IMS).
- Provide breakout for both E.164 numbers and SIP URIs.

NOTE: The V-CSCF can be considered as functionality within existing functional entities (e.g. P-CSCF, BGCF, or IBCF) or potentially combined with Transit functionality.

The solution will be such to allow the VPLMN to provide the V-CSCF close to where the call is originated from, and the VPLMN shall be able to steer the selection of V-CSCF by providing the HPLMN with a reference to the preferred V-CSCF.

### 5.1.2.2 IBCF

An IBCF supporting Optimal Media Routing (see TS 23.228 [3] Annex Q) is used at each of the roaming interconnects.

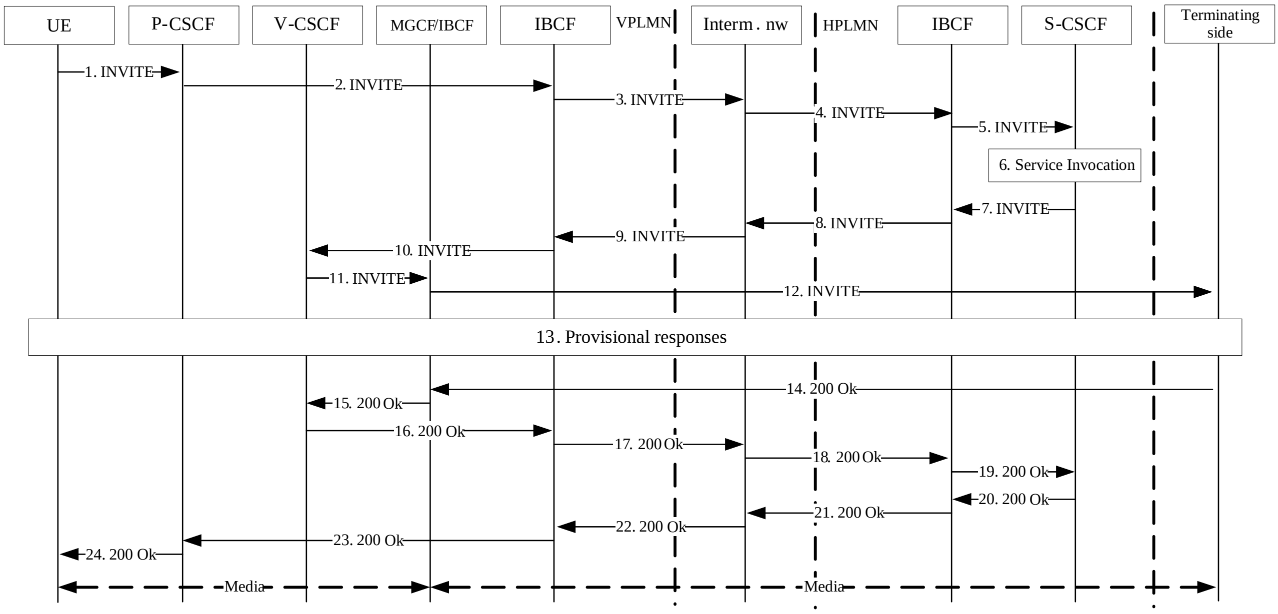
## 5.1.3 Procedures and Flows

### 5.1.3.1 Registration procedures

The procedures of TS 23.228 [3] apply.

### 5.1.3.2 Session origination procedures with VPLMN routing

The clause describes the procedures when an originated flow is routed back from the originating HPLMN to the originating VPLMN for onward routing decision. For simplicity of the drawings, only one intermediate network is shown, and only the originating side routing. The termination routing is expected to follow the procedures of TS 23.228 [3].




NOTE: The charging aspects for the different call legs need to be addressed, but is left for SA WG5.

**Figure 5.1.3.2-1: Session Origination flow with VPLMN routing**

The following steps are performed:

1. The UE initiates a session towards the remote end, and forwards it to the P-CSCF.

2. The P-CSCF performs normal handling of the INVITE, with the additional procedure of adding the address of the V-CSCF to the INVITE (this could be a FQDN pointing to one or more physical functions). The INVITE is forwarded toward the home network (IBCF next hop).

3. The IBCF adds additional OMR information to allow short cut of media for the HPLMN tromboning prior forwarding the message to the intermediate network.

4. The intermediate network applies OMR procedures as required, prior forwarding to the originating HPLMN.

5. The IBCF in the HPLMN applies the OMR procedures as required, and forwards the INVITE to the S-CSCF.

6. The S-CSCF performs service invocation.

7. The S-CSCF performs routing decision and based on that the UE is roaming, and a roaming agreement for VPLNM call routing is in place and home routing is not required, the S-CSCF decides to route back to the VPLMN for onward call routing. It routes the session back to the VPLMN based on the V-CSCF address received in the INVITE (added by the VPLMN in step 2). If the VPLMN does not provide the anchor functionality address the HPLMN shall use a default derived address for the VPLMN V-CSCF.

8. The IBCF applies the OMR procedures as required, and forwards the INVITE to the intermediate network.

9. The intermediate network applies OMR procedures as required, prior forwarding to the VPLMN.

10. When receiving the INVITE, the IBCF will apply OMR procedures (and will detect that a media loop is now available within the VPLMN). The IBCF forwards the INVITE towards the V-CSCF.

11. The V-CSCF will perform calling party number routing using the same mechanisms as used for the S-CSCF. If required, the call may be routed through a BGCF for further number analysis if not available in ENUM. The V-CSCF forwards the INVITE towards the remote end (i.e., towards IBCF or MGCF). When forwarding to an IBCF, the V-CSCF ensures by means of signalling that media is anchored in the VPLMN.

NOTE: In case the called user is an IMS user of the VPLMN- the call will be routed directly to the terminating side, (i.e., I-CSCF of the VPLMN) without traversing an MGCF/IBCF.

12. The MGCF/IBCF performs normal call routing procedures to route towards the remote network/end.

13. Provisional responses may be received. At this time, the OMR shortcut within the VPLMN will be found and established.

14-15. A final response is received from the terminating side, and forwarded towards the V-CSCF.

15. The V-CSCF generates needed CDRs, and will route back the 200 OK towards the HPLMN. The V-CSCF will also include an indication "call is routed via VPLMN" in the 200 OK.

16-19. The 200 OK is routed back towards the S-CSCF. OMR procedures are applied, and CDR generation performed.

20. The S-CSCF forwards the 200 OK with the indication "call is routed via VPLMN".

21-24. The 200 OK is forwarded back to the UE.

At this point, the signalling path will be established via the HPLMN, and back to the VPLMN. The media path will remain in the VPLMN and send out directly together with signalling towards the terminating network.

The above procedures will also work:

- for an originating session for (v)SRVCC that use ATCF enhancements. In such case, an ATCF is included in the signalling path at step 2.
- for an originating sessions that uses CS media with MSC Server enhanced for ICS. In such case, the INVITE in step 1 is replaced by a CS call setup, and the P-CSCF is replaced by the MSC Server enhanced for ICS. The MSC Server enhanced for ICS will need to provide the V-CSCF. As an alternative, the V-CSCF address can be provided by an IBCF.
- for an originating session that uses CS media with MSC Server enhanced for ICS and ATCF, for SRVCC to E-UTRAN/HSPA (see TR 23.885 [12]). In such case, the INVITE in step 1 is replaced by a CS call setup, and the P-CSCF is replaced by the MSC Server enhanced for ICS and the ATCF. The MSC Server enhanced for ICS or the ATCF will need to provide the V-CSCF address. As an alternative, the V-CSCF address can be provided by an IBCF.

The same applies to the procedures described in clauses 5.1.3.3, 5.1.3.4 and 5.1.3.5.

#### 5.1.3.3 VPLMN originating call routing with CS breakout in VPLMN

The signalling flow in the figure below illustrates a scenario in which an originated flow is routed back from the originating HPLMN to the originating VPLMN for onward routing decision. For simplicity of the drawings, only one intermediate network is shown. The V-CSCF is shown as separate logical entity, but can be collocated with, e.g. CSCF, BGCF, IBCF. Originating call routing in the V-CSCF results in a breakout to the CS domain in VPLMN-A.

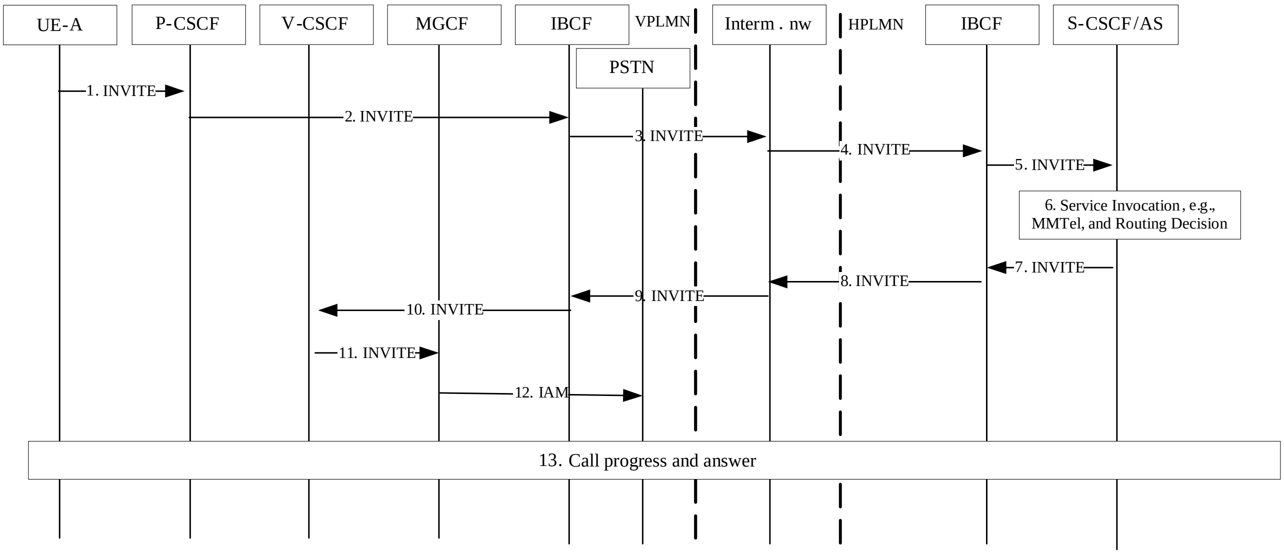



**Figure 5.1.3.3-1: VPLMN originating call routing with CS breakout in VPLMN**

The following steps are performed:

1-10. These steps are done in accordance to clause 5.1.3.2.

11. The V-CSCF will perform calling party number routing using the same mechanisms as used for the S-CSCF. Address resolution determines that the call is to be broken out to the CS domain in the local PLMN. The V-CSCF forwards the INVITE towards an MGCF.

NOTE: The V-CSCF may instead forward the INVITE to a BGCF, which will determine the need for CS breakout and then route towards an MGCF.

12. The MGCF interworks SIP to CS domain signalling and performs normal call routing procedures to route towards the remote end.

13. Call progress and answer indications are interworked by the MGCF.

### 5.1.3.4 VPLMN originating call routing with CS breakout in Destination PLMN

The signalling flow in the figure below illustrates a scenario in which an originated flow is routed back from the originating HPLMN to the originating VPLMN for onward routing decision. For simplicity of the drawings, only one intermediate network is shown. The V-CSCF is shown as separate logical entity, but can be collocated with, e.g. CSCF, BGCF, IBCF. Originating call routing in the V-CSCF results in a breakout to the CS domain in the HPLMN/VPLMN of the called CS UE.

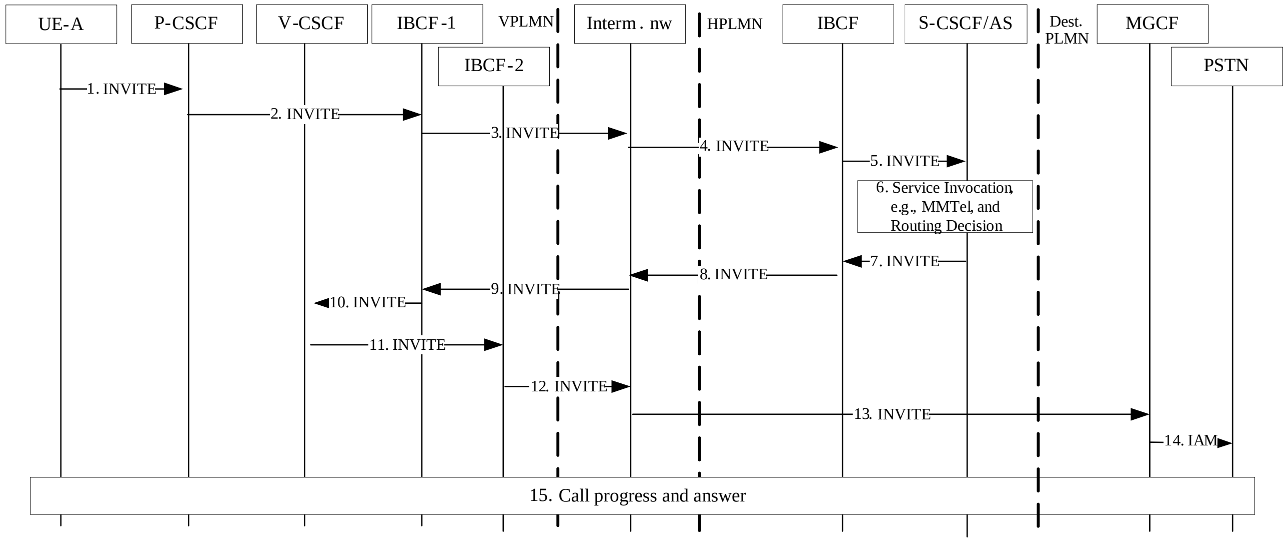



**Figure 5.1.3.4-1: VPLMN originating call routing with CS breakout in Destination PLMN**

The following steps are performed:

1-11. These steps are done in accordance to clause 5.1.3.2.

12-13. These steps are handled as a terminating interconnection case in accordance to existing procedures. Breakout to the PSTN occurs in the IPX network as close to the destination as possible. The intermediate network forwards the INVITE towards an MGCF in the Destination PLMN.

14. The MGCF interworks SIP to CS domain signalling and performs normal call routing procedures to route towards the remote end.

15. Call progress and answer indications are interworked by the MGCF.

### 5.1.3.5 Home routing procedures

#### 5.1.3.5.1 CS copy cat model for home routing

The clause describes the procedures when an originated flow is routed back from the originating HPLMN to the originating VPLMN for onward routing decision. In this scenario, the terminating party will be in the HPLMN (i.e. this will be an originating request to another HPLMN subscriber).

For simplicity of the drawings, only one intermediate network is shown. The V-CSCF is shown as separate logical entity, but can be collocated with e.g. either CSCF, BGCF, or IBCF.

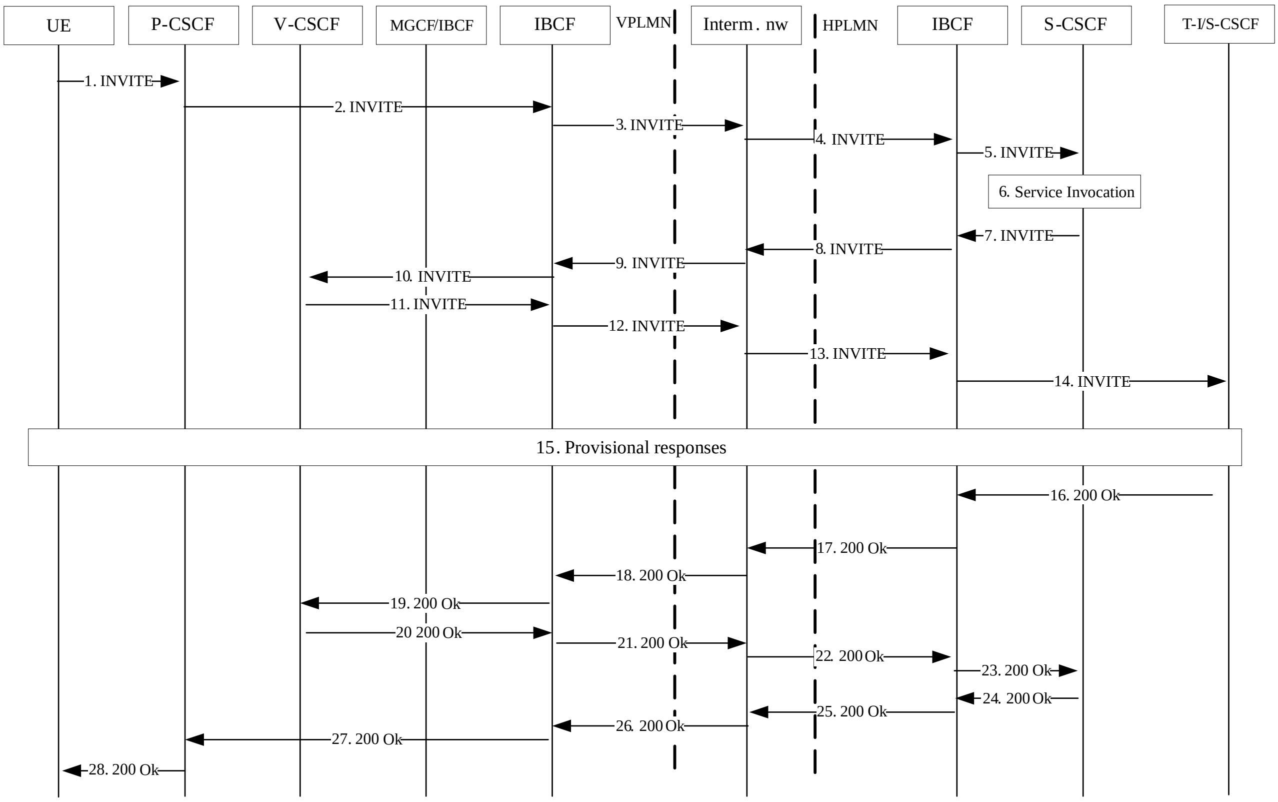



**Figure 5.1.3.5-1: Session Origination flow for Copy cat model with HPLMN routing**

The following steps are performed:

1-11. These steps are done in accordance to clause 5.1.3.2.

12-14. These steps are handled as a terminating interconnection case in accordance to existing procedures. The terminating S-CSCF receives the incoming INVITE and processes it according to standard procedures.

15. This step is done in accordance to clause 5.1.3.2.

16-28. During the final responses, the media path will be confirmed. Due to the use of the OMR procedures for the initial signalling tromboning to the home network, the media will be routed to the home network following the terminating call leg path (step 11-14), and the charged accordingly.

### 5.1.3.5.2 Home routing without involving V-CSCF

The clause describes the procedures of an optimized copy cat model, when the home network decides to handle the call termination routing by itself (e.g. when the calling party is in the same network) and not to involve the V-CSCF in the VPLMN.

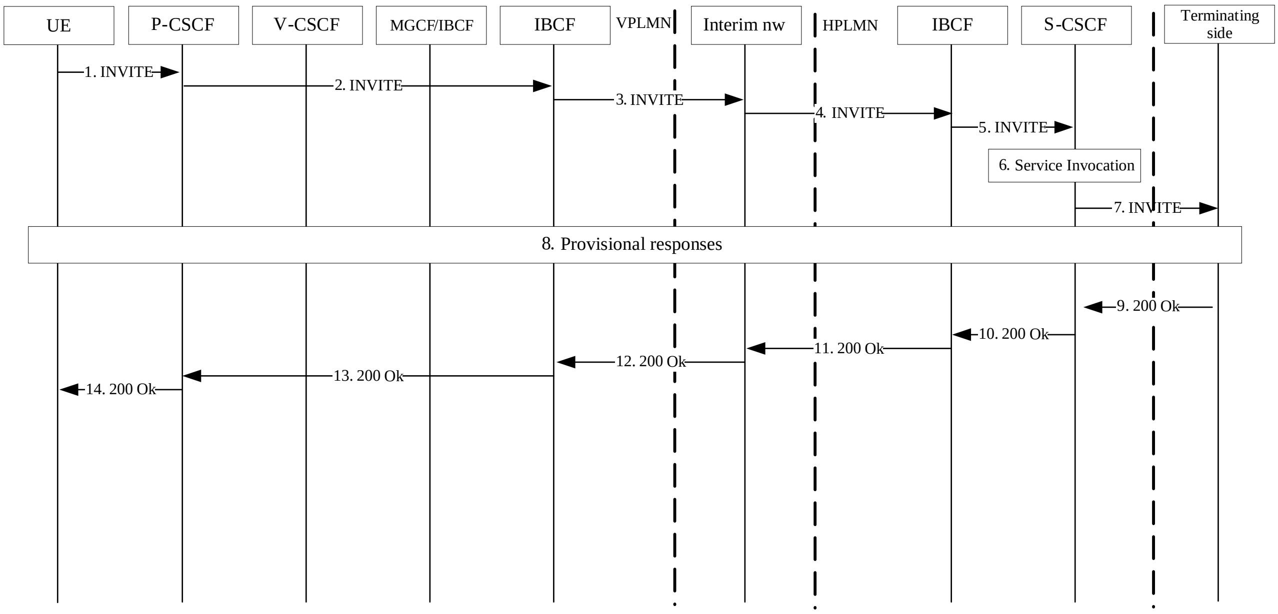



**Figure 5.1.3.5-2: Session Origination flow with HPLMN routing without involving V-CSCF**

The following steps are performed:

1-6. These steps are done in accordance to clause 5.1.3.2.

7. The S-CSCF will check if VPLMN routing should be performed. In this example, the calling party number is within its own domain, and the policy is such that it decides to have home routing of the call and not return the call to the VPLMN for onward routing.

8. Provisional responses may be provided.

9-14. The final response is provided back.

14. When the P-CSCF receives the 200 OK, the P-CSCF, having detected that no indication "call is routed via VPLMN" is present, will apply the CDR generation to allow TAP records to be generated (as in this case, the V-CSCF is not in the path to be able to produce such for the settlement).

NOTE: The absence of the indication "call is routed via VPLMN" is not a guarantee for the VPLMN that "Home routing without involving V-CSCF" is used, because this indication is conveyed through the HPLMN and the HPLMN is therefore able to remove it. For example, a HPLMN could fraudulently remove this indication in order to pay to the VPLMN the price of a home-routed call while the HPLMN has actually routed the signalling back to the VPLMN as described in clause 5.1.3.2. In order to detect avoid this, additional means could be required, e.g., the VPLMN correlates the CDRs generated by the P-CSCF and by the V-CSCF, the VPLMN ensuring that when home routing is applied, the IBCFs are anchoring traffic on the first call leg, etc.

#### 5.1.3.5.3 CS copy cat model for home routing using Home Routing AS

The clause describes the procedures when during originating service execution in the Home network an originated flow is routed back from the originating HPLMN to the originating VPLMN for home routing of both s. In this scenario, the terminating party will be in the HPLMN (i.e., this will be an originating request to another HPLMN subscriber).

For simplicity of the drawings, only one intermediate network is shown. The V-CSCF is shown as separate logical entity, but can be collocated with, e.g. either CSCF, BGCF, or IBCF.

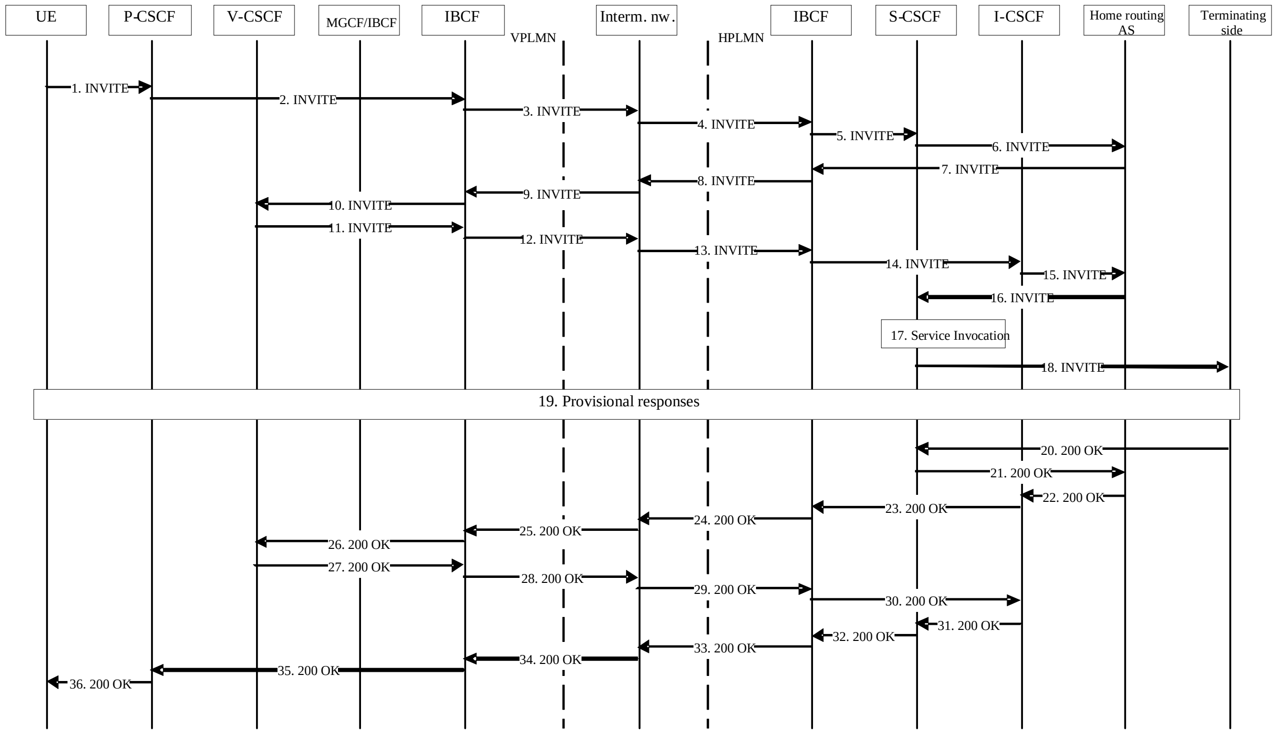



**Figure 5.1.3.5-3: Session Origination flow for Copy cat model with HPLMN routing**

The following steps are performed:

1-5. These steps are done in accordance to clause 5.1.3.2.

6. As part of the service invocation and based on installed Filter Criteria the S-CSCF send the INVITE to the Home Routing AS.

7. The Home routing AS checks that the UE is roaming and that a roaming agreement for VPLMN call routing is in place and decides that that the call shall be home routed. It saves the content of the request URI in the Invite message, replaces it with a Routing Number, adds in charging information, the HPLMN id as the ORIG-IOI, and routes the session back to the VPLMN based on the V-CSCF address received in the INVITE (added by the VPLMN in step 2).

8-11. This step is done in accordance to clause 5.1.3.2.

12-15. These steps are handled as a terminating interconnection case in accordance with existing procedures.

The I-CSCF in the Home network recognizes that the Request URI contains a routing number and follows standards procedures for a call towards a PSI, and sends the INVITE to the Home routing AS.

NOTE: As part of step 11 and 12, the V-CSCF will instruct the IBCF to anchor the media and "disable" OMR, ensuring that the media will follow the signalling to the home network. The HPLMN will also ensure that OMR is not applied on the roaming leg if OMR has been disabled by the VPLMN.

16 The Home Routing AS replaces the content of the Request URI and the charging info with what was received from the S-CSCF in step 7, and follows standard procedures to return the INVITE to the S-CSCF in accordance with standard procedures. The Home Routing AS omits the address of the VPLMN V-CSCF in the INVITE.

17. The S-CSCF continues the originating service invocation.

18. The S-CSCF checks if VPLMN routing should be performed, but as no V-CSCF address is included in the INVITE message, it decides that routing shall be done directly to the destination.

19 Provisional responses may be provided.

20-36. During the final responses, the media path will be confirmed. Due to the use of the OMR procedures for the initial signalling tromboning to the home network and the Home routing AS, the media will be routed to the home network following the second call leg path (steps 11-18), and the charged accordingly.

## 5.2 Transit routing via VPLMN

### 5.2.1 General

After handling an originating request and before making a final routing decision, the S-CSCF can invoke a Transit Routing Function (TRF) based on local policy. This local policy uses configuration data for each roaming partner. The Transit Routing Function is defined in clause 5.19 of TS 23.228 [3], where it is also described as simply a "transit function". The acronym "TRF" is defined here for convenience. Based on the Request URI, VPLMN identity, and local policy, the TRF can forward the request to the IMS peering access point of the VPLMN. The TRF in the HPLMN can use ENUM/DNS and/or BGCF routing information to help determine whether routing of the signalling back to the VPLMN is required by local policy for a particular Request URI. The IMS peering access point in the VPLMN invokes the TRF in the VPLMN. The TRF in the VPLMN applies VPLMN routing procedures to determine subsequent handling of the call.

The S-CSCF determines the VPLMN identity from the P-Visited-Network-ID header received during the registration procedure.

The HPLMN includes a loopback indicator when forwarding the request back to the VPLMN so that the VPLMN can identify that the transit request originated in the VPLMN.

The TRF in the HPLMN can be co-located with the BGCF when local policy requires access to BGCF routing data to determine if the request is to be routed back to the VPLMN. Otherwise the TRF in the HPLMN can be co-located with the S-CSCF.

The TRF in the VPLMN can be co-located with the I-CSCF.

NOTE 1: It is assumed that Optimal Media Routing (OMR) is applied to the signalling between the VPLMN and the HPLMN to avoid anchoring media in the HPLMN. IBCFs on the signalling paths between the VPLMN and HPLMN must support OMR.

NOTE 2: It is assumed with this and any other option requiring routing of signalling back to the VPLMN that any required media resources are allocated within the VPLMN to avoid tromboning media through the HPLMN.

NOTE 3: Charging aspects remain to be addressed by SA WG5.

### 5.2.2 Architecture impacts

This alternative has no architecture impacts. TRF, S-CSCF, I-CSCF, BGCF and/or IBCF procedures are augmented to support related use cases.

### 5.2.3 Example use cases

#### 5.2.3.1 Transit routing via VPLMN after successful ENUM/DNS resolution

Figure 5.2.3.1-1 shows an example use case of the transit routing of an originating request via VPLMN after successful ENUM/DNS resolution. In this use case, the HPLMN forwards the request to the VPLMN upon identifying the use case and subsequent routing is performed within the VPLMN. Other scenarios are possible where the HPLMN selects to not forward the request to the VPLMN, where the VPLMN chooses to forward the request to its own I-CSCF for routing to a VPLMN subscriber, or where the VPLMN fails to resolve the Request URI using ENUM/DNS and applies CS breakout procedures. These other use cases are not shown.

NOTE 1: The TRFs in the figure are shown as standalone entities for clarity but are expected to be co-located with existing functional entities.

NOTE 2: Intermediate networks can be inserted in the paths between the PLMNs but are not shown in the figure and do not change the flow.

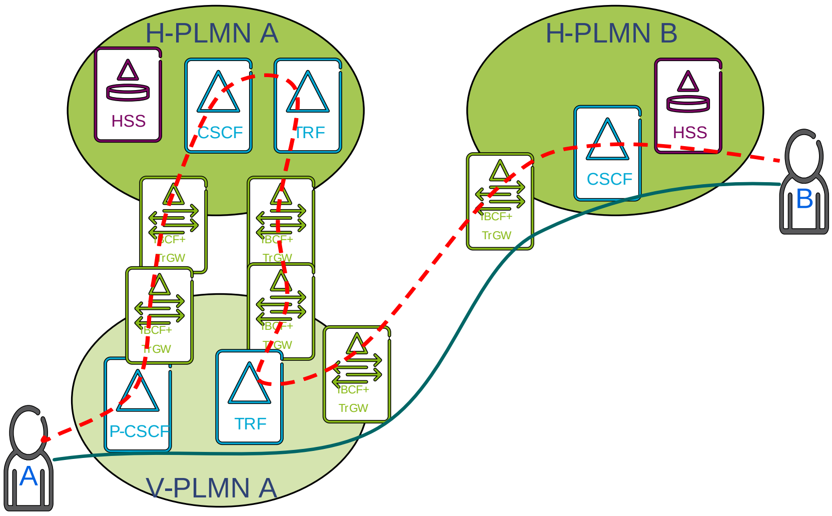



**Figure 5.2.3.1-1: Transit routing via VPLMN after successful ENUM/DNS resolution - example use case**

### 5.2.3.2 Transit routing via VPLMN for CS breakout

Figure 5.2.3.2-1 shows an example use case of the transit routing of an originating request via VPLMN for CS breakout. In this use case, the HPLMN forwards the request to the VPLMN upon identifying the CS breakout case and the CS breakout is performed within the VPLMN. Other scenarios are possible where the HPLMN selects to not forward the request to the VPLMN, where the VPLMN chooses to forward the request to another network for CS breakout, or where the VPLMN successfully applies local ENUM/DNS procedures to route the request. These other use cases are not shown.

NOTE 1: The TRFs in the figure are shown as standalone entities for clarity but are expected to be co-located with existing functional entities.

NOTE 2: Intermediate networks can be inserted in the paths between the VPLMN and HPLMN but are not shown in the figure and do not change the flow.

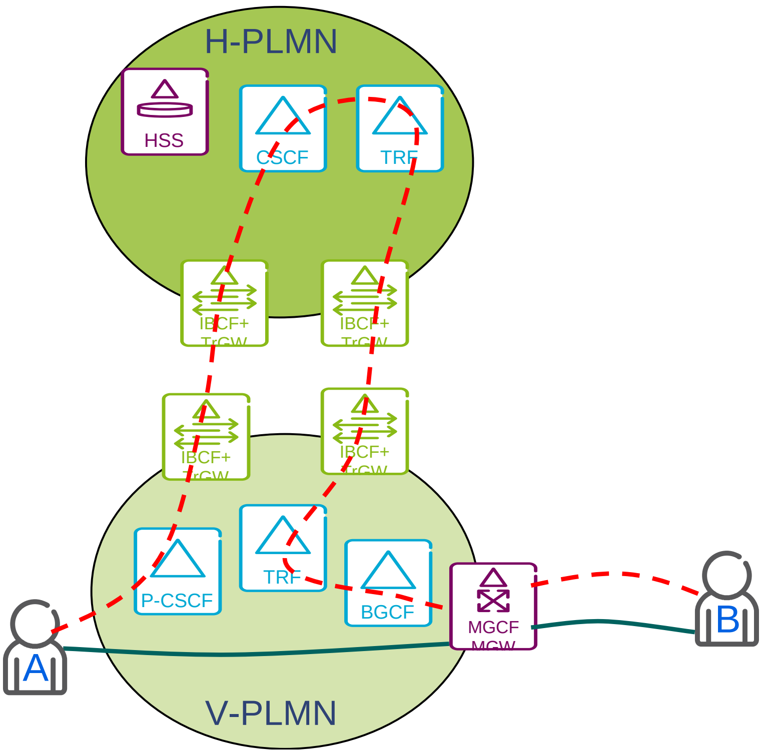



**Figure 5.2.3.2-1: Transit routing via VPLMN for CS breakout - example use case**

## 5.2.4 Session origination procedures

### 5.2.4.1 Session origination procedure for transit routing via VPLMN

This clause describes the session origination procedure for transit routing via the VPLMN. The HPLMN determines when to invoke this procedure. The procedure describes the case where the destination network is reached via IMS routing from the VPLMN, but is also applicable to all types and locations of destination networks, e.g. CS breakout and VPLMN as destination network.

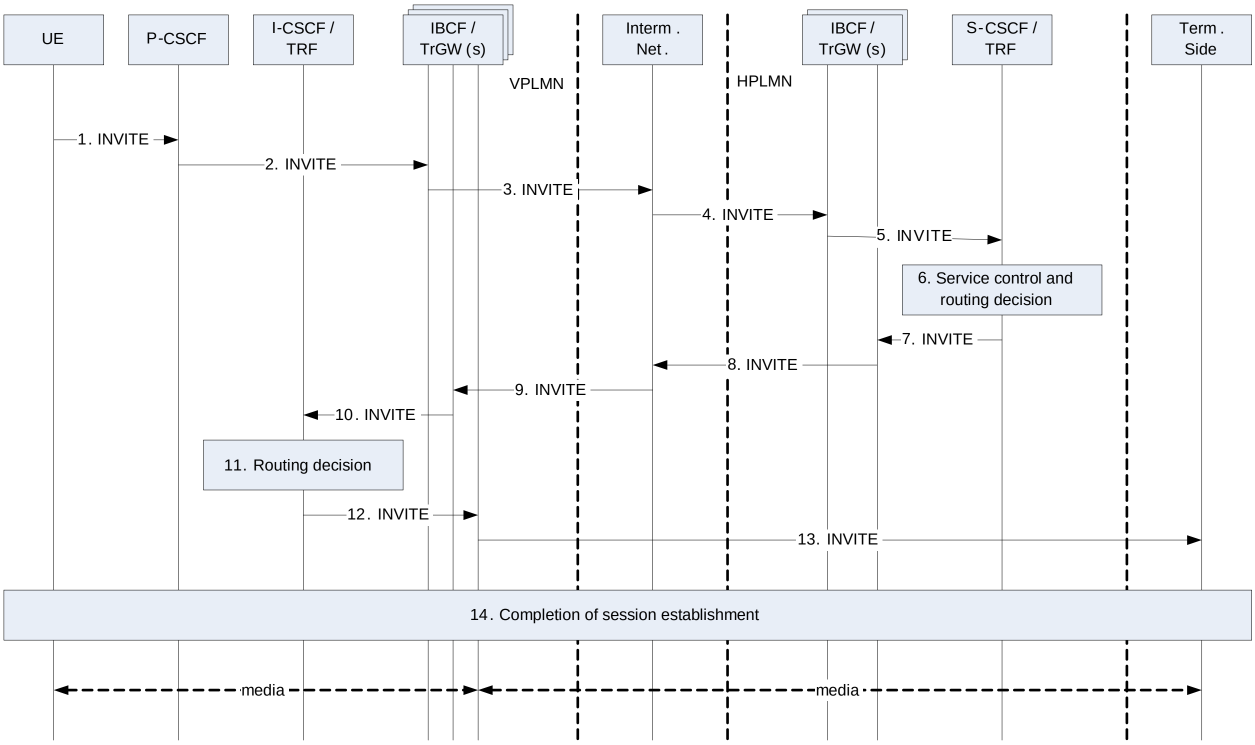



**Figure 5.2.4-1: Session origination procedure for transit routing via VPLMN**

1-2. Following normal procedures, the roaming UE sends an INVITE request to the P-CSCF, which is then forwarded to the first IBCF in the VPLMN before exiting the network. The P-CSCF forwards the request to an IBCF that allows TrGW bypass using OMR. The INVITE request (or a subsequent message) can include UE location information.

3. This first IBCF in the VPLMN allocates a TrGW for the media and follows standard OMR procedures when forwarding the INVITE request to allow this TrGW to be bypassed if the INVITE request later returns to the VPLMN and no other intermediate nodes anchor the media before the request returns.

4-5. The intermediate network and the first IBCF in the HPLMN forward the INVITE request to the S-CSCF. Nodes in the intermediate network and the first IBCF in the HPLMN support OMR and allow their TrGWs to be bypassed.

6. The S-CSCF invokes application servers as necessary to perform service control and then invokes a TRF that performs a modified routing procedure. The TRF decides to route the INVITE request back to the VPLMN based on a combination of local policy, the identity of the visited network, whether any needed MRF resources are available in the VPLMN, whether needed MRF resources are to be allocated only within the VPLMN, and whether routing information associated with the Request URI is received either from ENUM or the BGCF.

NOTE: If this TRF is not co-located with the S-CSCF then the request forwarded from the S-CSCF to the TRF includes the visited network identity.

7. The TRF derives the I-CSCF address in the VPLMN from the visited network identity, and forwards the request towards the I-CSCF in the VPLMN. The TRF includes in the INVITE request a loopback indicator to inform the VPLMN that this request is being routed back to the VPLMN for transit routing. The TRF retains the UE

location information in the INVITE request if it is available. The TRF forwards the request to an IBCF that allows TrGW bypass using OMR.

8-9. The second IBCF in the HPLMN and the intermediate network forward the INVITE request towards the I-CSCF in the VPLMN. Nodes in the intermediate network support OMR and allow their TrGWs (if any) to be bypassed.

10. The second IBCF in the VPLMN receives the INVITE request, notes that the SDP includes an alternative media address within the VPLMN that allows bypass of allocated TrGWs, applies OMR to signal removal of any TrGWs allocated between the VPLMN and HPLMN, and forwards the request to the I-CSCF.

11. Based on local policy and the presence of the loopback indicator in the request, the I-CSCF invokes the TRF to route the INVITE request toward the destination network according to the Request URI based on ENUM or BGCF information. The called party information is included in the Request URI.

12. In this flow, ENUM returns the domain of an external network and the request is routed towards the destination network via the third IBCF in the VPLMN. The TRF forwards the request to an IBCF that anchors media. If UE location information is available in the INVITE request, the TRF can select an IBCF close to the point of call origination.

13. The third IBCF in the VPLMN allocates a TrGW for the media when forwarding the INVITE request towards the destination network. Intermediate nodes on the path to the destination network are not shown. The destination network also anchors media before forwarding outside of its network to prevent any further application of OMR on the path from the VPLMN.

14. During subsequent session establishment signalling, OMR information passed back through the IBCFs and intermediate networks between the VPLMN and HPLMN cause them to release any allocated TrGWs. The end-to-end media flow is established from the UE through the third IBCF/TrGW in the VPLMN toward the destination network. If necessary for charging purposes, the P-CSCF can derive the called party information from the history-info header received in a response to the INVITE request.

The above procedure will also work:

- for an originating session for (v)SRVCC that use ATCF enhancements; in such case, an ATCF is included in the signalling path at step 2;
- for an originating sessions that uses CS media with MSC Server enhanced for ICS; in such case, the INVITE in step 1 is replaced by a CS call setup, and the P-CSCF is replaced by the MSC Server enhanced for ICS;
- for an originating session that uses CS media with MSC Server enhanced for ICS and ATCF, for SRVCC to E-UTRAN/HSPA (see TR 23.885 [12]). In such case, the INVITE in step 1 is replaced by a CS call setup, and the P-CSCF is replaced by the MSC Server enhanced for ICS and the ATCF.

### 5.2.4.2 Session origination procedure for home routing

This clause describes the session origination procedure for home routing. The HPLMN determines when to invoke this procedure. The procedure describes the standard IMS routing case where the destination network is reached via IMS routing from the HPLMN, but is also applicable to all types and locations of destination networks, e.g., CS breakout and HPLMN as destination network.

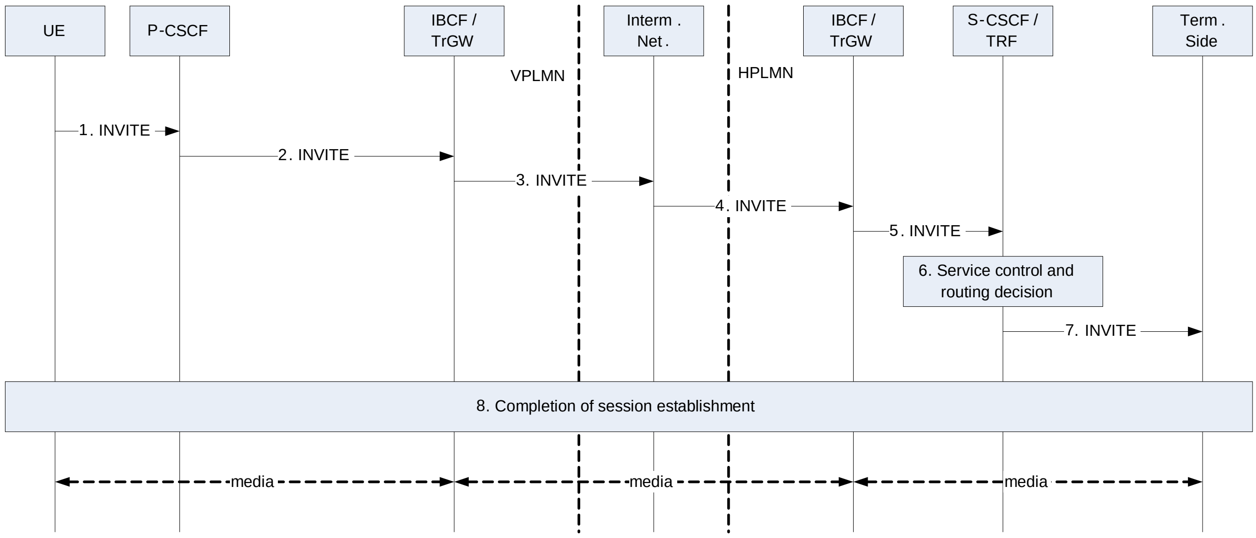



**Figure 5.2.4.2-1: Session origination procedure for home routing**

1-2. Following normal procedures, the roaming UE sends an INVITE request to the P-CSCF, which is then forwarded to the IBCF in the VPLMN before exiting the network. The P-CSCF forwards the request to an IBCF.

3. The IBCF in the VPLMN allocates a TrGW for the media and follows OMR procedures or not when forwarding the INVITE request.

4-5. The intermediate network and the first IBCF in the HPLMN forward the INVITE request to the S-CSCF. Nodes in the intermediate network and the IBCF in the HPLMN may support OMR and may allow their TrGWs to be bypassed.

6. The S-CSCF invokes application servers as necessary to perform service control and then invokes a TRF. The TRF decides to perform standard IMS routing procedures after deciding not to route the INVITE request back to the VPLMN.

7. The TRF performs standard IMS routing procedures to forward the request towards the destination network.

8. During subsequent session establishment signalling, all allocated TrGWs on the media path are retained. The end-to-end media flow is established from the UE through the IBCF/TrGWs toward the destination network, and may include additional media resources not shown. If necessary for charging purposes, the P-CSCF can derive the called party information from the history-info header received in a response to the INVITE request.

## 5.3 Transit function in the visited network

### 5.3.1 General

Procedures described in this clause use only existing mechanisms, the transit function, to route the SIP session requests back to the visited network. These solutions do not require architecture change, new functionality or new reference point is not introduced.

If it is required to differentiate scenario when the transit function is used for route-back from other transit function scenarios the originating visited network may assign an additional URL for the (network entity hosting the) transit function, so the call case can be identified.

### 5.3.2 Alternative A - configuration based route-back

#### 5.3.2.1 Description

The procedure described in this clause assumes that originating home network support additional routing capabilities (i.e. transit functions) and based on roaming agreements with originating visited network the originating home network routes originating requests to a transit function of the originating visited network.

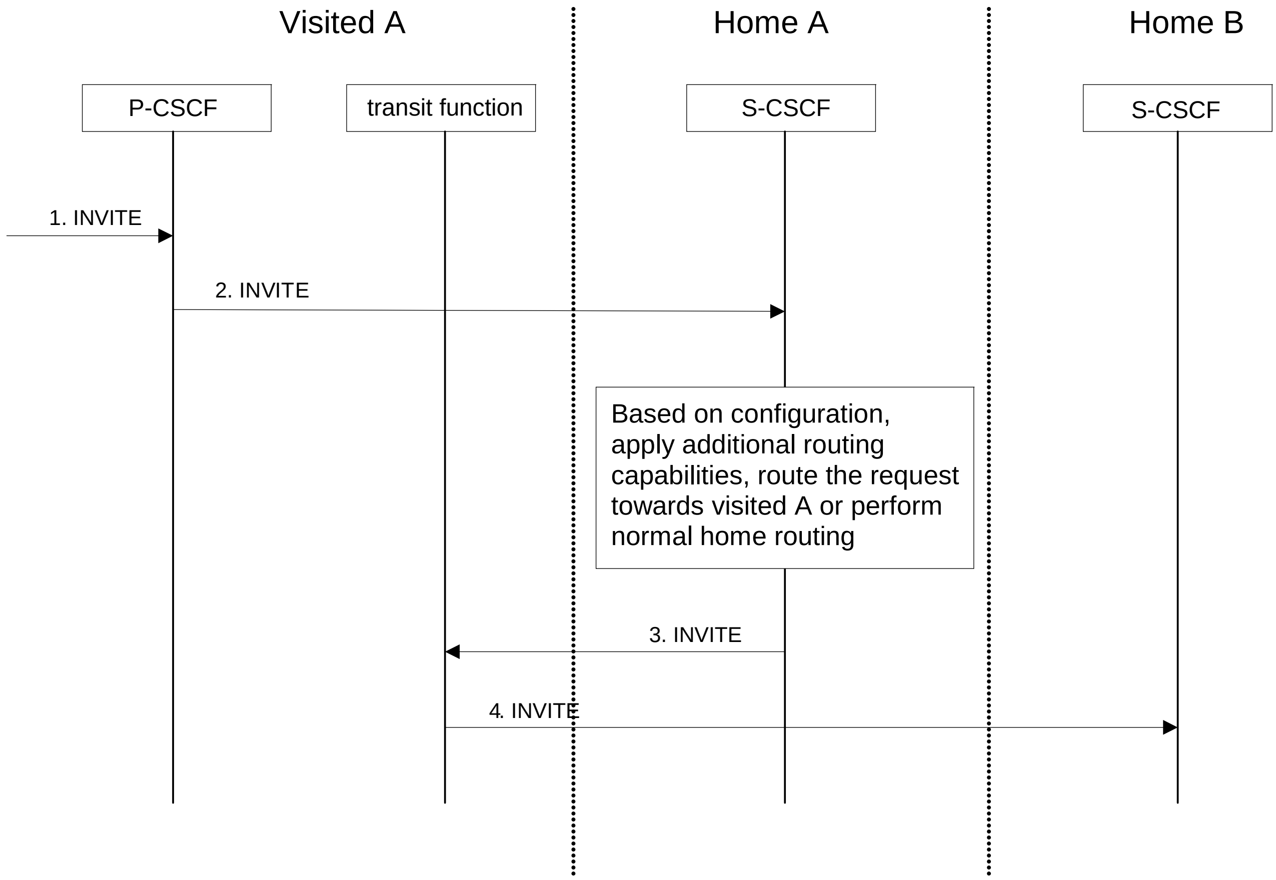



**Figure 5.3.2.1-1: Configuration based route-back**

1) P-CSCF receives an originating request from the roaming UE.

2) P-CSCF forwards the request to S-CSCF applying standard routing procedures.

3) After triggering originating services for the served user (not shown in the figure), the S-CSCF detects that the request is received from a user roaming in visited A network, and according to internal logic and interconnect agreements (see clause 5.3.2.2) the S-CSCF applies additional routing capabilities to forward the request to a transit function in the originating visited network or perform normal home routing.

NOTE 1: Alternatively, the last originating service can be a "route-back service" that will act as UAS towards the S-CSCF, and simply forwards the request back to the originating visited network.

4) Transit function in the originating visited network forward the request towards the terminating home network (either directly, or using transit functions of other networks).

NOTE 2: The rest of the request routing and responses are not shown.

The above procedure will also work:

- for an originating session for (v)SRVCC that use ATCF enhancements; in such case, an ATCF is included in the signalling path between P-CSCF and IBCF;

- for an originating sessions that uses CS media with MSC Server enhanced for ICS; in such case, the P-CSCF is replaced by the MSC Server enhanced for ICS;

- for an originating session that uses CS media with MSC Server enhanced for ICS and ATCF, for SRVCC to E-UTRAN/HSPA (see TR 23.885 [12]). In such case, the P-CSCF is replaced by the MSC Server enhanced for ICS and the ATCF.

#### 5.3.2.2 Routing back to visited network

There are multiple choices how to route back to the visited network, this clause just provides some ideas for better understanding:

Each visited operator may provide a re-routing address (e.g. trf.csp.com) as part of a Service Level Agreement (SLA). The re-routing addresses may be either stored in local configuration data in HPLMN or in a DNS data base (either configured by the VPLMN or the HPLMN). Once the home network receives a request it uses that address for routing back (i.e. S-CSCF adds the address to the top-most route header).

The home network may use the PANI header or uses the P-Visited-Network id information from IMS registration to select the proper re-routing address (either via a DNS query or taken from local configuration data).

In general this works quite similar as the local number call re-routing where the home network needs to route the call back to the visited network where the local service is provided.

#### 5.3.2.3 Evaluation

**Pro**

- Simple, no additional requirement for existing functions.
- if ongoing transit charging work in CT WG1 / SA WG5 fulfils all RAVEL requirements, then there is no need to standardize anything.
- With recent IPXS changes (service triggering in transit network) transit function will not limit the functionalities the originating visited network may need to perform.

**Con**

- None.

### 5.3.3 Alternative B - Route-back triggered by the visited network

#### 5.3.3.1 Description

The procedure described in this clause assumes that originating visited network changes the originating request to trigger routing the originating request back to the visited network. Assuming that no service in the originating home network performs 3pcc and changes the originating request completely, as a consequence of change in the originating visited network normal SIP routing procedures will cause the request to return to the originating visited network.

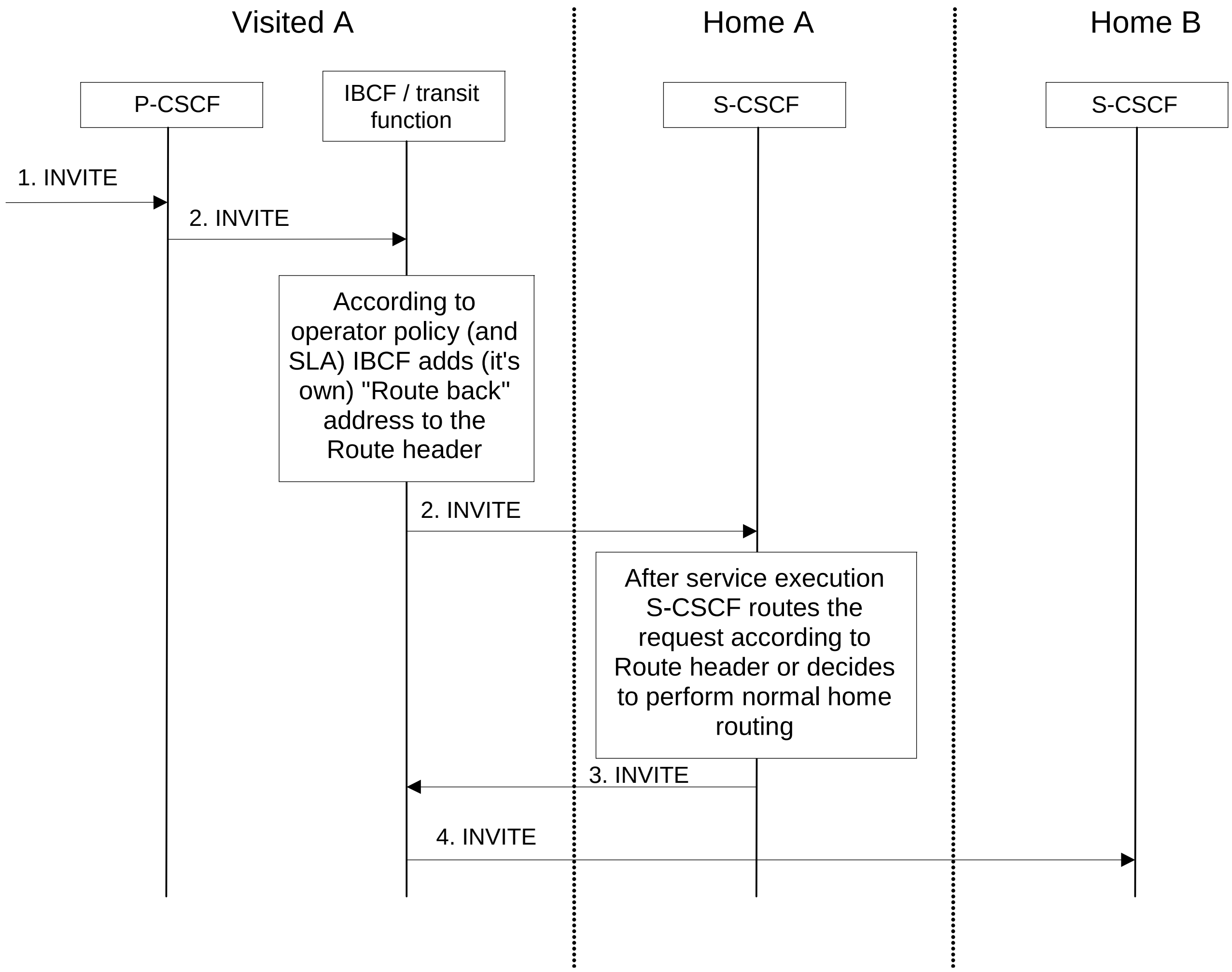



**Figure 5.3.3.1-1: Route-back triggered by visited network**

1) P-CSCF receives an originating request from the roaming UE.

2) According to local policy the P-CSCF forwards the request towards the originating home network via an IBCF.

NOTE 1: It can be assumed that IBCF is used during registration as well, so P-CSCF only applies standard routing procedures.

3) Based on local policy the IBCF adds its own address as the last entry to the route of the request. It also includes a token to the route entry to enable the correlation of the current request and the request returning from the originating home network.

NOTE 2: Alternatively, the IBCF adds SIP Trunk Group Parameters (see RFC 4904 [7] and clause 5.3.3.2) to indicate desired "re-entry" function.

4) After executing the services (not shown in the figure) the IBCF URI with the token is left in the route, so the S-CSCF will route the request according to that (see step 11 in 5.4.3.2 of TS 24.229 [8]) back to the originating visited network or decides to perform normal home routing.

NOTE 3: Whether or not the routing procedures above are in line with existing procedures described in TS 24.229 [8] is under the responsibility of Stage 3.

NOTE 4: The usage of trunk group parameter would guarantee that request termination procedure in S-CSCF routes the request back to the originating visited network.

5) Transit function in the visited network forward the request towards the terminating home network (either directly, or using transit functions of other networks).

NOTE 5: The rest of the request routing and responses are not shown.

The above procedure will also work:

- for an originating session for (v)SRVCC that use ATCF enhancements; in such case, an ATCF is included in the signalling path between P-CSCF and IBCF;
- for an originating sessions that uses CS media with MSC Server enhanced for ICS; in such case, the P-CSCF is replaced by the MSC Server enhanced for ICS;
- for an originating session that uses CS media with MSC Server enhanced for ICS and ATCF, for SRVCC to E-UTRAN/HSPA (see TR 23.885 [12]). In such case, the P-CSCF is replaced by the MSC Server enhanced for ICS and the ATCF.
- The solution allows the VPLMN to provide the anchor functionality close to where the call is originated from, and the VPLMN is able to steer the selection of anchor function by providing the HPLMN with a reference to the preferred anchor function. If the VPLMN does not provide the anchor functionality address the HPLMN uses the default address for the VPLMN.

## 5.3.3.2 Routing back by using SIP Trunk Group Parameters

One option of dynamic re-routing back to the visited network is the use of SIP trunk group parameters as described by RFC 4904 [7].

Hereby adds the visited network (P-CSCF or IBCF) Trunk Group Parameters to the R-URI which indicates the desired "re-entry" function.

For example as follows:

INVITE sip:B-Party;tgrp=CGR2;trunk-context=Realm6@operator.net SIP/2.0

**Table 5.3.3.2-1**

| Home network | Trunk group | Trunk-Context |
|---|---|---|
| Home1.net | CGR1 | Realm5 |
| Home2.net | CGR2 | Realm6 |

### 5.3.3.2.1 Session origination procedure for routing via VPLMN

This clause describes the session origination procedure for routing via the VPLMN. The VPLMN adds trunk parameters which support routing back to VPLMN. But still it is up to the HPLMN to determine whether the call is routed back to VPLMN or normal home routing is performed.

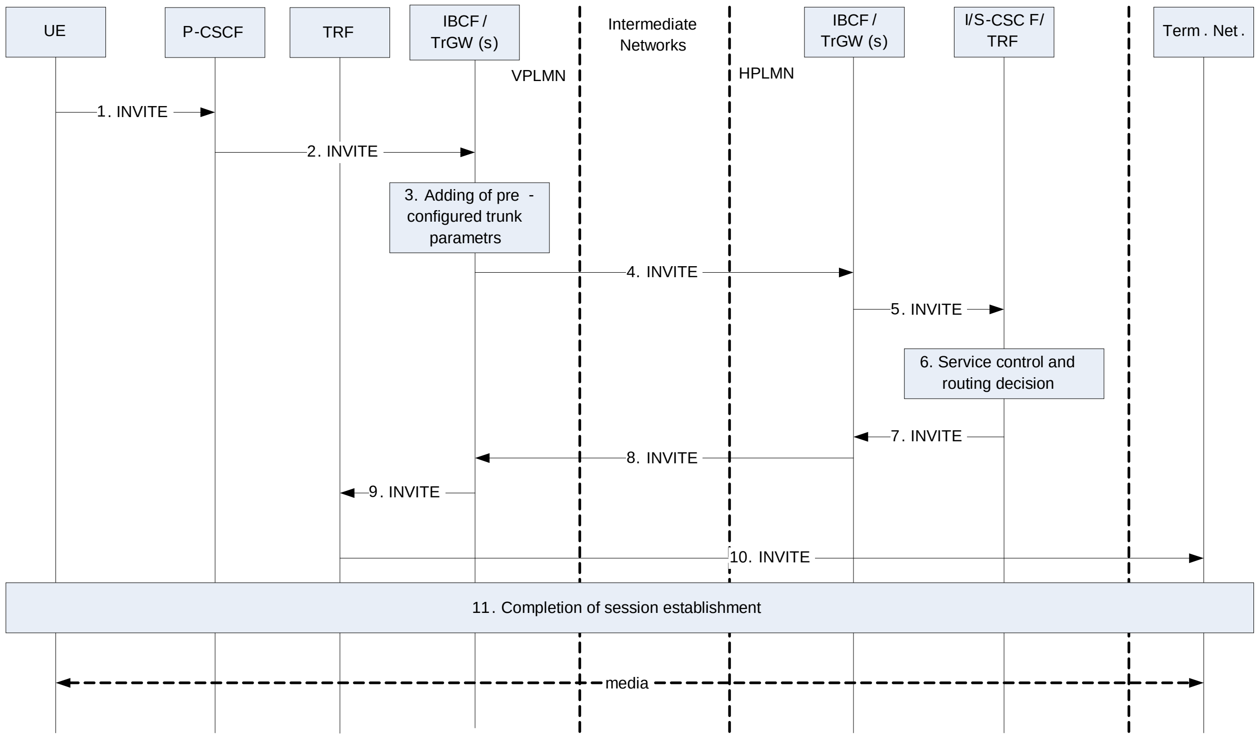



**Figure 5.3.3.2.1-1: Session origination procedure for routing via VPLMN**

1. The roaming UE sends an INVITE request to the P-CSCF.
2. P-CSCF forwards the INVITE to the visited IBCF.
3. The Visited IBCF checks the route header and finds HPLMN domain name within the last entry. The visited IBCF adds preconfigured trunk parameters indicating its own realm and context to the R-URI. The visited IBCF applies OMR procedures to indicate that it can remove TrGWs. It may allocate a TrGW and insert its address into the SDP.
4. Visited IBCF sends INVITE to IBCF in HPLMN, potentially via intermediate networks. The IBCF in HPLMN applies OMR procedures to indicate that it can remove its TrGWs. It may allocate a TrGW and insert its address into SDP.
5. The IBCF in HPLMN forwards the INVITE via I-CSCF to S-CSCF in HPLMN.
6. The S-CSCF performs normal service control and invokes application servers as necessary. The S-CSCF learns from the presence of the trunk parameters in the INVITE that a routeing back to the visited network is possible. Based on local policy the S-CSCF decides to route the call back via the VPLMN and starts a routine to handle the received trunk info. It inserts two additional Route headers for the home IBCF and the visited IBCF into the message based on the provided trunk groups from the visited IBCF. Otherwise, if local policy indicates that normal home routing is applied the S-CSCF removes the trunk info and routes the call towards the terminating network as described in section 5.3.3.2.2.
7. The S-CSCF sends the INVITE to the topmost route header target, i.e. to the home IBCF. Using OMR procedures, the home IBCF determines that its TrGW is not required, and de-allocates a possibly previously allocated TrGW.
8. The home IBCF checks the topmost Route header which is the visited IBCF inserted by the S-CSCF before and identifies the visited PLMN as target peer network. The home IBCF routes the INVITE to the visited IBCF, potentially via intermediate networks.
9. The visited IBCF finds a trunk parameters present which means that routeing via VPLMN is selected. Using OMR procedures, the visited IBCF determines that its TrGW is not required, and de-allocates a possibly previously allocated TrGW. The visited IBCF forwards INVITE towards a TRF (unless TRF functionality is included in the IBCF).
10. Based on the request URI, the TRF routes the request towards the terminating network (via visited IBCF).

11. Completion of session establishment.

#### 5.3.3.2.2 Session origination procedure for home routing

This clause describes the session origination procedure for home routing. The HPLMN determines when to invoke this procedure. The VPLMN just adds trunk parameters for potential routing back but does not make a decision whether the call is routed via VPLMN or if normal home routing is applied.

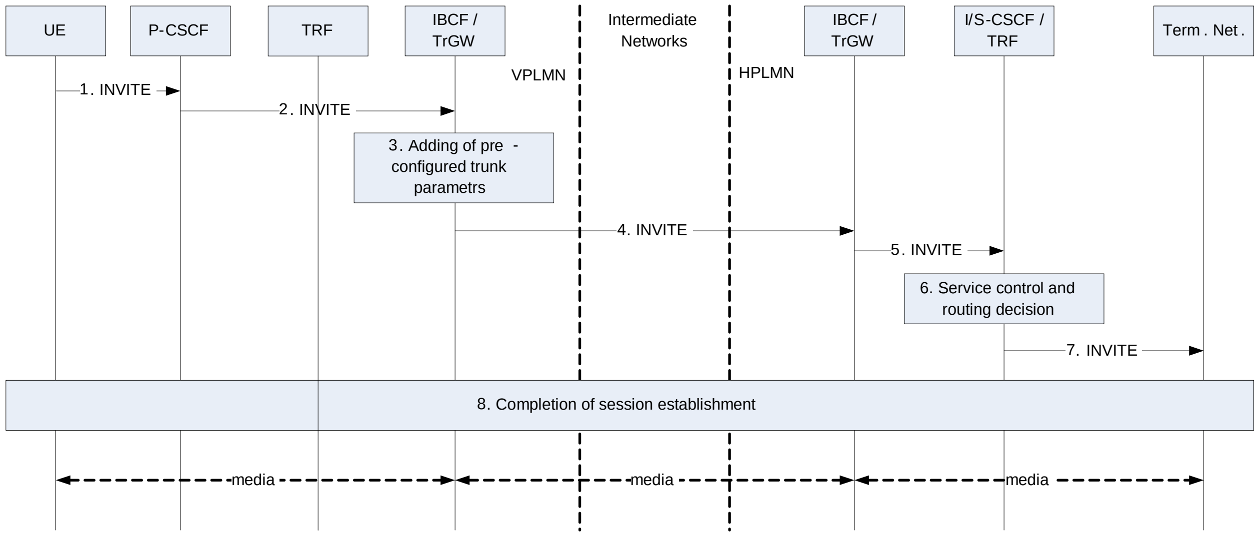



**Figure 5.3.3.2.2-1: Session origination procedure for home routing**

1.-6. Same as for routing via VPLMN as described in section 5.3.3.2.1.

7. The S-CSCF sends the INVITE towards the terminating network.

8. Completion of session establishment.

### 5.3.3.3 Evaluation

**Pro**

- Visited A network is in control.
- Originating visited network can correlate the "start" leg with the loopback leg.
- Loopback is possible even if a routing B2BUA AS splits the dialog and the P-CSCF used for call setup is not visible in signalling.

**Con**

- change in routing procedures if done in P-CSCF (doing it in visited IBCF instead of P-CSCF could be better, manipulating Route in IBCF can be considered as an NNI policy).
- Visited A network is in control: does not allow originating home network to apply IMS home routing.

## 5.4 IMS home routing

### 5.4.1 General

There are two primary use cases for home routing of originating requests in the CS domain:

1. Forced routing to HPLMN application via CAMEL origination trigger.
2. Originating request to another HPLMN subscriber.

Other use cases are possible based on HPLMN policy, such as digit translation via CAMEL, but these appear to be covered by other scenarios described in this technical report.

In this alternative, IMS routing remains unchanged for these use cases.

The only information required for the forced routing use case 1 is that the call is routed to the HPLMN for handling. No further information is available in the CS case compared to standard IMS home routing.

Use case 2 could be treated as a case of transit routing via VPLMN back to the HPLMN but this is unnecessarily wasteful. The information required in the VPLMN for proper charging reconciliation is the Request URI translated by the HPLMN, as made available in the history-info header. It is unnecessary for the VPLMN to make a second routing decision regarding how to reach the HPLMN since it already did that the first time it routed the originating request to the HPLMN.

## 5.4.2 Architecture impacts

This alternative has no architecture impacts. IMS routing procedures remain unchanged. The history-info header provides to the VPLMN the Request URI translated by the HPLMN as required for charging in some use cases.

## 5.4.3 Example home routing use cases

### 5.4.3.1 Forced routing to HPLMN

Figure 5.4.3.1-1 shows an example home routing use case where the HPLMN forces routing from the VPLMN to the HPLMN for service delivery and subsequent routing. No new information is needed in the VPLMN that is not already available in standard IMS signalling during standard IMS routing.

NOTE: Intermediate networks can be inserted in the paths between the PLMNs but are not shown in the figure and do not change the flow.

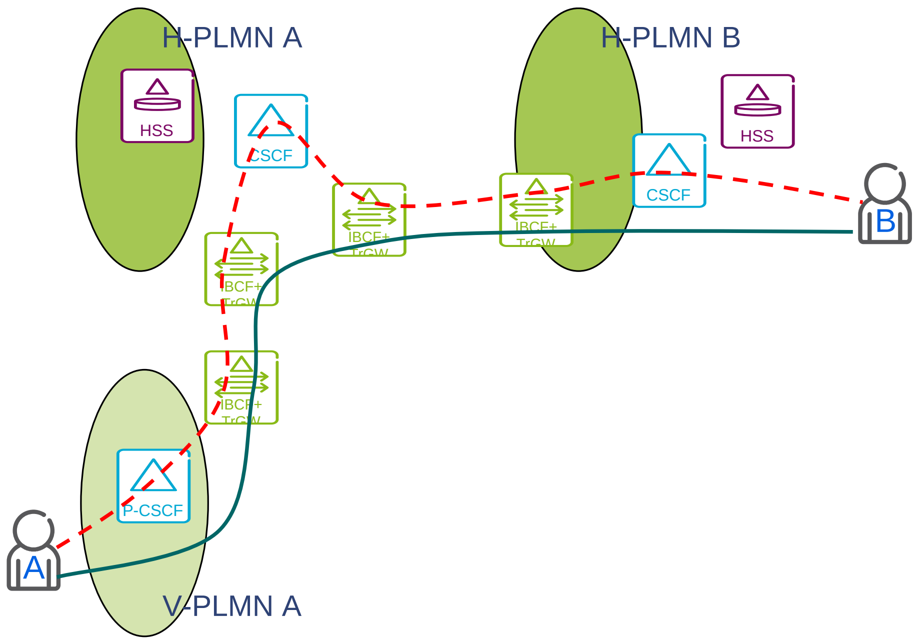



**Figure 5.4.3.1-1: Forced home routing - example use case**

### 5.4.3.2 Routing to another HPLMN subscriber

Figure 5.4.3.2-1 shows an example home routing use case where the originating request is destined for another HPLMN subscriber. The VPLMN derives the Request URI translated by the HPLMN via the SIP history-info header for charging purposes.

NOTE: Intermediate networks can be inserted in the paths between the PLMNs but are not shown in the figure and do not change the flow.

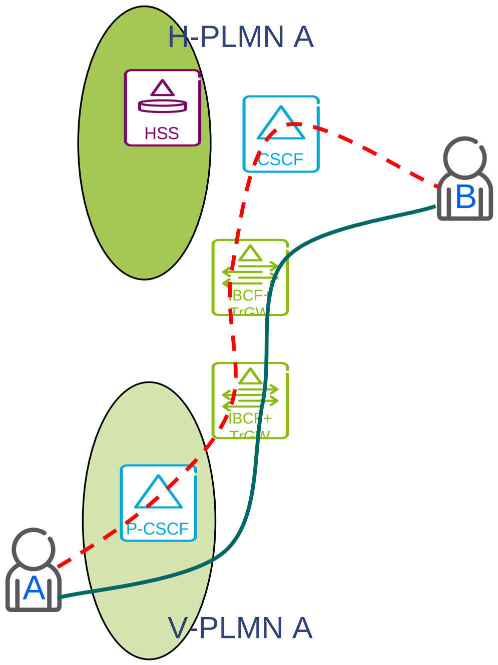



**Figure 5.4.3.2-1: Home routing to another HPLMN subscriber - example use case**

# 5A Solutions Alternatives for Terminating Sessions

## 5A.1 Use of IBCF and removal of OMR attributes

In order to ensure that, for terminating sessions to roaming users, the media plane is not routed to the VPLMN serving the terminating user without associated signalling (e.g. directly from the originating VPLMN to the terminating VPLMN), the terminating HPLMN uses IBCFs and TrGWs at the boundary of its network to anchor the media plane. When S-CSCF of the terminating user routes a terminating session request to another network, it ensures by means of signalling that OMR procedures are not used towards the next network and forwards the request to an IBCF, that then anchors the media plane in a TrGW.

NOTE: This prevents OMR (Optimal Media Routing) to be applied on the terminating side of the session, but does not prevent OMR to be applied on the originating side.

# 6 Alternatives Assessment and Conclusions

## 6.1 Assessment

### 6.1.1 General

### 6.1.2 Specific Criteria

**Table 6.1.2-1**

| | **Solution 5.1** | **Solution 5.2** | **Solution 5.3A** | **Solution 5.3B** |
|---|---|---|---|---|
| **Name** | **V-CSCF** | **TRF (Transit and Routing Function).** | **Transit Function** | **Transit Function** |
| Placement of functionality | Proposed to be part of existing function (e.g., CSCF or BGCF) or to be combined with the Transit functionality. Placement not concluded. | TRF as an extension of current transit function in VPLMN. Recommended to be located with I-CSCF. TRF in HPLMN invoked for routing after S-CSCF (/BGCF). Placement of TRF in HPLMN recommended to be with S-CSCF or BGCF. | Extends existing Transit Function in VPLMN. Placement of Transit function in VPLMN is left open. | Extends existing Transit Function in VPLMN. Placement of Transit function in VPLMN is left open. |
| Differentiation of traffic cases | Explicit procedures to separate the roaming loopback from other traffic cases. | Explicit indicator from HPLMN to VPLMN (TRF) to separate the roaming loopback from other traffic cases. | No specific procedures defined in basic procedures. Dedicated URI proposed as an option to provide explicit differentiation. | No specific procedures defined in basic procedures. Dedicated URI proposed as an option to provide explicit differentiation. |
| Home network impact | S-CSCF | TRF & S-CSCF / BGCF | S-CSCF | S-CSCF |
| VPLMN routing based on configuration or explicit indication | VPLMN provide address to anchor | Anchor address derived or configured | Anchor address derived or configured | VPLMN provide address to anchor |

### 6.1.3 Home Routing

**Table 6.1.3-1**

| | **Solution 5.4.2 & Solution 5.1.3.5.2 (Direct home routing)** | **Solution 5.1.3.5.1 (CS Copy cat)** | **…** |
|---|---|---|---|
| Charging considerations | Charging will be treated differently between VPLMN routing and Home routing. Signaling and media will be traversing on the first call leg between VPLMN and HPLMN. This is different from the VPLMN routing where only signaling will be sent on the first call leg. | Same type of charging principles can apply both for VPLMN routing and home routing. Media is only charged together with the second call leg from VPLMN to the HPLMN. | |
| Signaling delay | - | Introduces a signaling delay in call setup compared to Solution 5.4.2 & Solution 5.1.3.5.2 due to tromboning to VPLMN. | |
| Other Impacts | - | As a result of the additional signaling, the procedure can increase the risk of call failure. | |

## 6.2 Conclusions

The following high-level principles are proposed to be followed:

- The P/S-CSCF/Anchor and other nodes performing routing procedures in different networks can control the application of OMR procedures by indicating in the signalling whether an IBCF/TrGW should apply OMR or not.
- In order to allow scenarios where the media is not routed through the originating HPLMN, IBCFs handling incoming requests to the network should support OMR and allow bypass of TrGWs. Anchoring of media can be controlled via outgoing IBCFs.
- The HPLMN decides whether to perform the loopback procedure based on local policy and on knowledge of the support of the procedure in the VPLMN.
- When home routing is used, the VPLMN will be provided with enough information to determine that home routing has been applied (or not been applied). Example of such stage 3 solutions could be to derive the called party information from the history-info header, if available, or by use of explicit indication (or lack of it).
- If local policy requires access to BGCF routing data to make the loopback decision for a particular INVITE request, then the loopback decision should be performed in the BGCF. Else it should be performed in the S-CSCF.
- The VPLMN Signalling Anchor performs onward routing towards the terminating network by selecting appropriate breakout point (CS/PSTN or IMS).
- The VPLMN Signalling Anchor can use originating UE location information to select a nearby breakout point for media anchoring.
- The VPLMN can provide the HPLMN with a reference to the preferred signalling anchor function to steer the selection of the anchor function. If the VPLMN does not provide the Signalling Anchor functionality address then the HPLMN uses the default derived address for the VPLMN.
- The Signalling Anchor function is proposed to be specified as an addition to the Transit function. The name of the Transit function may need to be extended to reflect that it also includes roaming Signalling Anchor as part of it, but is left for the normative phase to find appropriate terminology.
- When the HPLMN operator wishes to route the call rather than delegating to the VPLMN, the principles of forced home routing by the HPLMN will be applied. The signalling and media will be traversing on the first call leg between the VPLMN and the HPLMN.

# Annex A: CS voice Charging and interconnection principle - high level description

## A.1 General Business Logic

Figure A.1-1 depicts a generalized CS voice roaming scenario where the calling party (UE_A) is roaming in a visited network (VPLMN_A) and where also the destination (UE_B) is roaming. It should be noted however that the same charging and interconnection principles remain valid also when the destination is not roaming or is a fixed network (PSTN). Considering that for voice over IMS the application server executing the service is in the home network, the closest CS call case is that where a camel interaction between the Visited network where the calling party is and the home network of the calling party exists.

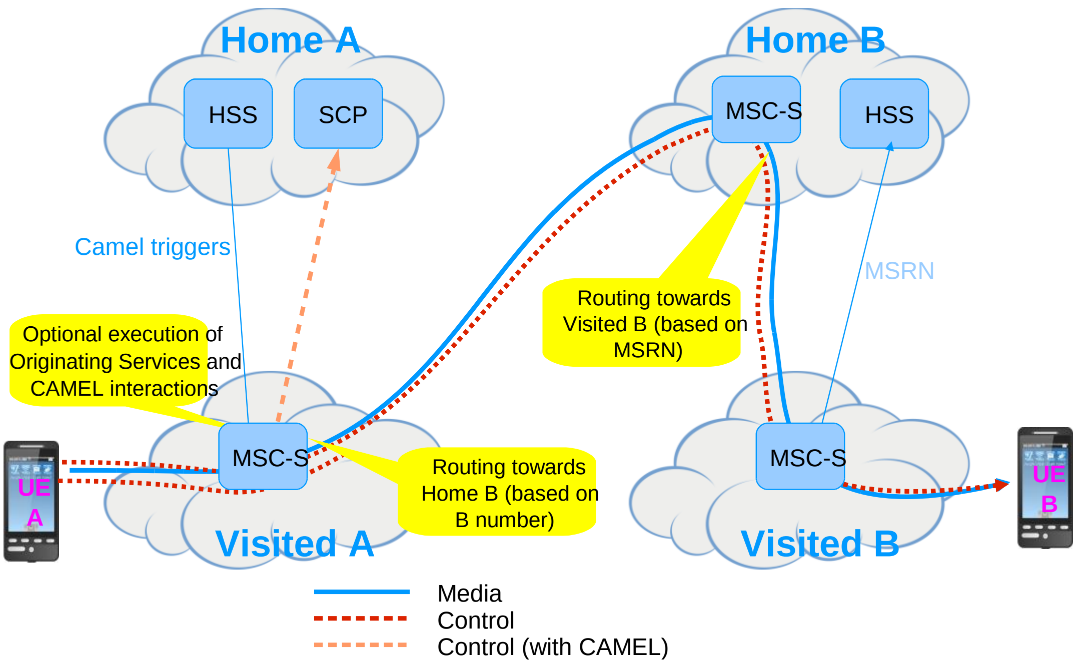



**Figure A.1-1: Generic routing of media plane and control plane for a CS voice call**

From charging and interconnection principles point of view the scenario depicted in Figure A.1-1 contains of 4 fully independent business transactions:

a) Roaming relation between Home A and Visited A (regulated by the respective roaming contract).

b) Interconnect relation between Visited A and Home B (regulated by interconnect agreements, typically cascaded through one or more carriers).

c) Interconnect relation between Home B and Visited B (regulated by interconnect agreements, typically cascaded through one or more carriers).

d) Roaming relation between Home B and Visited B (regulated by the respective roaming contract).

NOTE: Home B and Visited B also have a roaming relation (Roaming Contract). However, in this scenario the roaming relation is irrelevant and remains in the background in regard to the applied business transactions.

It is important to respect the commercial independence of all business entities involved in the above scenario. In CS those 3 transactions are independent also from a technical point of view. From a commercial point of view it is virtually impossible to agree obligations in one contractual relation that are predetermined by technical decisions linked to another contractual relationship.

The billing of User A is subject to operator policies and therefore it is not further discussed in this paper.

# A.2 Payment flows

Figure A.2-1 shows relevant money flows relevant for interconnection call originated by a user (UE A), whilst roaming in a visited network (VPLM A) calling a subscriber (UA B) of HPLM B who is roaming in VPLMN B. The Figure A.2-1 illustrates the four business relations described in the previous section.

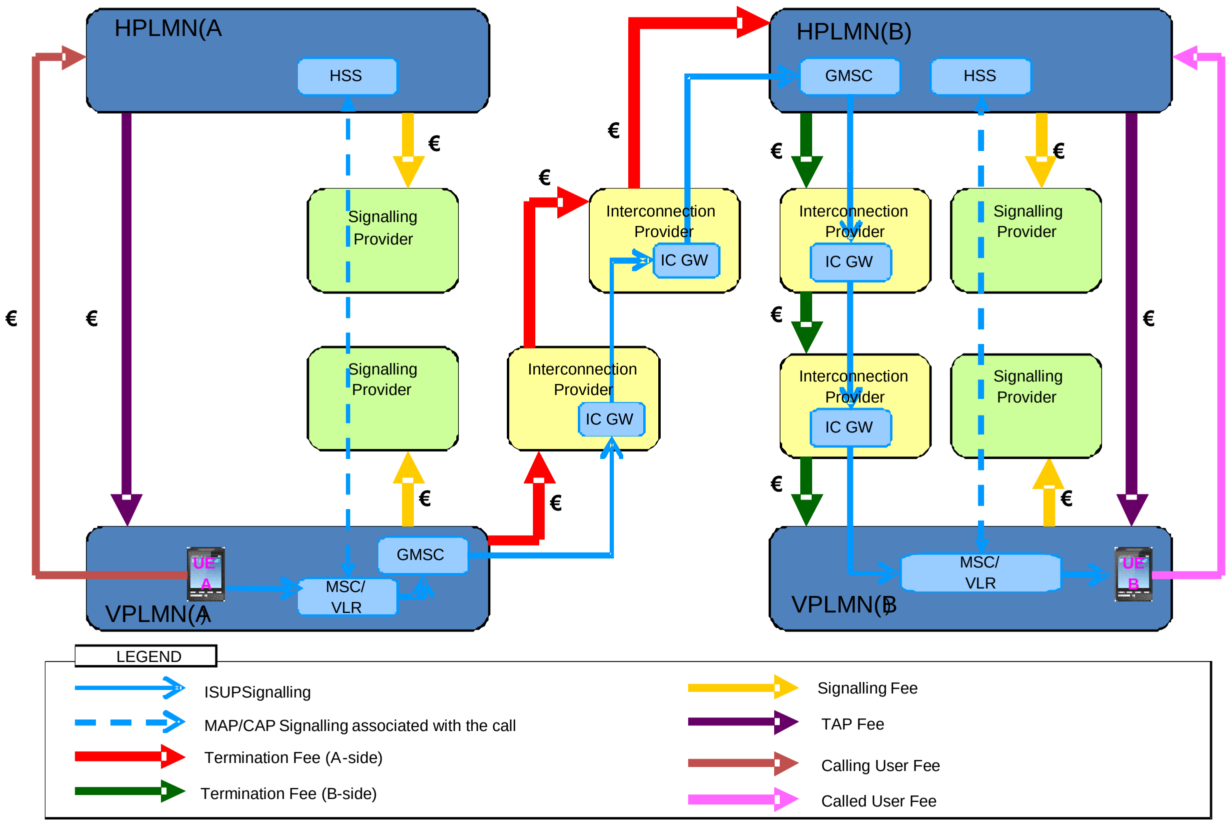



**Figure A.2-1: Cascade billing for interconnect and roaming charging for a CS voice call with both calling party and called party roaming outside their home PLMN**

The three important aspects to keep in mind are:

1. The charging levied by VPLMN A is towards the HPLMN of UE_A is a function of the destination number dialled by UE_A. However, if the HPLMN of UE_A, via CAMEL interaction, modifies to the destination number, the inter-operator charging is based on the actual destination conveyed by the "CAMEL Destination number".

2. The parties involved in carrying the call, be them IPX carrier, mobile operator or transit network apply the so called "cascade billing" so that each node charges the node from where it receives the traffic and is charged by the node to which the traffic is sent ("termination fee" principle). This "termination fee" principle is based on actual termination of the media, not based in signalling traffic. There are two distinct sets of termination fees, one set covers the transport of media from VPLMN A to HPLM B, the other for the transport of media from HPLMN B to VPLMN B.

3. Charging must be deterministic.

### A.2.1 Deterministic charging

From aspect 1. in clause A.2, it can be deduced that the VPLMN_A, for the purpose of charging, does not need to be aware of any further redirection of the call performed by the destination network. Anyway it is not granted whether VPLMN_A will be informed about redirections invoked due to call forwarding or any other service in the course of the further call set-up. In this context it is important to ensure that charging remains deterministic (aspect 3.). VPLMN_A (and UE_A) should only be charged according to the Interconnect relation between VPLMN_A and HPLMN_B. If the HPLMN_B decides to redirect the call (e.g. due to roaming, call redirection, answer phone), this should be the sole responsibility of HPLMN_B.

### A.2.2 IPX Voice Hubbing

Mobile operators generally only have direct connection to a handful of destination networks, so they rely on the carrier services. For the purpose of packet voice interconnect the GSMA has specified the IPX and IPX Voice Hubbing. IPX Voice Hubbing will be provided by carriers and is necessary to support interconnection with the several hundreds of possible destinations.

The IPX cloud is created by a number of international IPX networks. The IPX specification has defined 3 levels of involvement of the IPX provider in the connection of a voice call:

- Pure Transport (simple IP connectivity, non-service aware).
- Service Hub (here IPX Voice Hubbing).
- Service Transit (special case for direct Interconnection with service awareness, which is less relevant in this context).

In both the Service Transit and Service Hub cases the IPX provider is aware of the type of service being handled, thus enabling the application of cascading responsibilities (e.g. for billing, SLAs, fault clearing, etc.). When both signalling and media planes transverse the same IPX network, such network is commonly referred to as IPX Proxy.

## A.3 Accounting principles

### A.3.1 GSMA roaming business model

The GSMA roaming business model for CS calls between home and visited PLMN, relies on the sum of two separate type of transactions: interconnection accounting and roaming accounting.

The interconnection accounting is applied between direct interconnection partners. When multiple interconnection partners are involved in the communication between the originating network and the destination, then chained accounting applies, however each element of the chain only calculates the accounting fees levied to the subsequent node of the chain and incurred from the previous node.

Interconnection accounting is based on sum counters which record the following information:

- interconnection partner (as derived from the physical address of the connection);
- direction of the traffic;
- tariff time;
- service;
- whether signalling or media is carried;
- destination (normally grouped in logical sets of zones).

Unlike interconnection accounting, the roaming accounting is a fee levied by the VPLMN to the HPLMN for serving a roaming user. The roaming accounting is based on Transfer Account Procedure (TAP) records defined by the GSM Association and are specific to the identity of the roaming user. Mobile originated calls TAP records requires the charging destination, the address which is used to route the call to the remote network (which may or may not be the dialled number).

## A.3.2 Application of GSMA roaming business model to IMS: no home routing

The call flow in Figure A.3.2-1 summarizes how the current GSMA roaming business model applies to IMS under the assumption that a signalling loopback without media (from VPLMN A to HPLMN A then back to VPLMN A) is executed (see alternatives in clause 6).

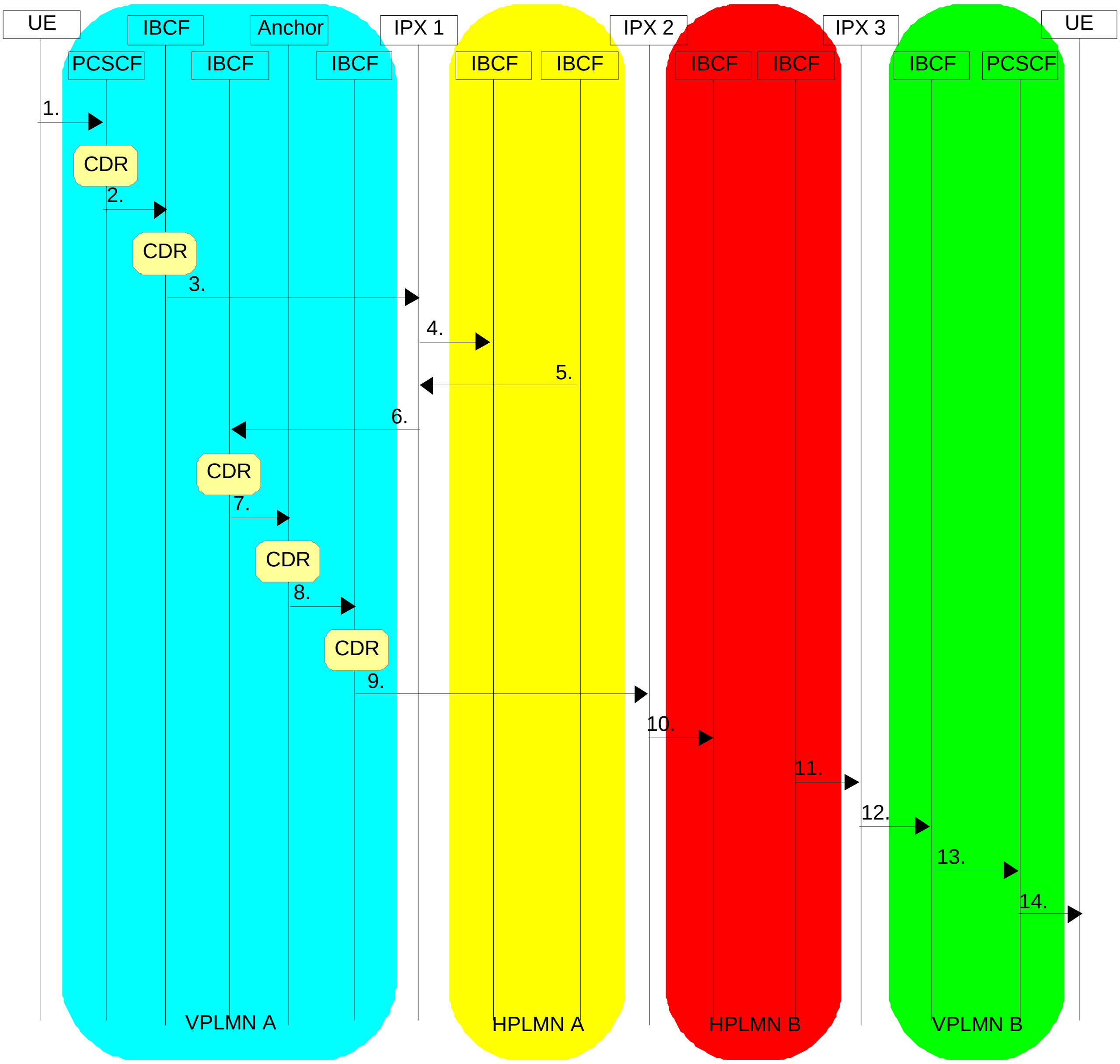



**Figure A.3.2-1: Interconnection and Roaming Accounting for IMS call**

1. The UE generates a mobile originated call with a dialled string which forms the Request URI and sends it to the P-CSCF in the visited network (Local breakout).

2. The P-CSCF creates a CDR where the served party is UE A and destination address is HPLMN A (last address from ROUTE header.

3. The IBCF uses the IPX provider 1 to reach HPLMN A. It updates the sum counter with the parameters: accounting peer = IPX1; direction = OUT; media= Null; destination = HPLMN A. It also includes in the counter

the tariff time and service as appropriate. Upon receiving the MOC signalling, IPX1 updates its sum counter for interconnection with values accounting peer = VPLMN A; direction = IN; media= Null; destination = HPLMN A.

4. IPX1 forwards the signalling to the IBCF in HPLMN A updating the sum counter for outbound traffic towards HPLMN A. On turn HPLMN A updates the sum counter for inbound traffic from IPX1. The Application Server in HPLMN A executes the service logic (e.g. modifies the destination address) and returns the modified signalling to the VPLMN A.

NOTE 1: For the sake of simplicity only one IPX provider is assumed between VPLMN A and HPLMN A. In the more general case the interconnection may require several hops.

5. The HPLMN A routes the signalling back to the VPLMN A via IPX1. Both HPLMN A and IPX 1 update their respective sum counters appropriately.

NOTE 2: For the sake of simplicity the same IPX provider is used in the forward and reverse direction between PLMNs, however in the more general case different IPX providers may be used. See also note 1.

6. IPX 1 forwards the traffic to VPLMN A and both these entities update their sum counters as appropriate. The IPX1 sum counter will for example be updated as follows: accounting peer = VPLMN A; direction = OUT; media = null; destination HPLMN A (last address from ROUTE header). On turn the VPLMN A will update the sum counter with the following values: accounting peer = IPX 1; direction = IN; media = Null; destination HPLMN A.

7. In VPLMN A the signalling is routed to the anchor point . This entity now has all the information needed to route the call to the destination and creates a CDR where served party = P-Asserted Identity of A; media = yes; destination = request URI.

Editor's note: Depending on the physical location of the anchor point, the media may not be anchored at step 7. If this has an impact on information needed in CDRs to levy roaming charges is FFS.

8. The signalling is routed to the destination network, the first step being the IBCF of VPLMN A (see note 2).

9. The IBCF sends the signalling to the destination network (assumed here to be HPLMN B) via a different IPX (IPX2). Both VPLMN A and IPX2 update their sum counters. The sum counter in VPLMN A will now read: Accounting peer = IPX2; direction = OUT; Media = yes; Destination = HPLMN B (as per the Request URI). IPX2 sum counter is updated as follows: accounting peer = VPLMN A; direction = IN; media = yes; Destination = HPLMN B (as per the Request URI).

10. IPX2 now relays the signalling and media to HPLMN B. Both these entities update their sum counters for interconnection accordingly.

11. In the most generic case it can be assumed that the destination is also roaming in VPLMN B. Therefore, once the HPLMN B has calculated the routing of the call and determined that the signalling and media need to be routed to VPLMN B, it contacts IPX3 (see NOTE 2). Both HPLMN B and IPX3 update their sum counters. HPLMN B counter will read: accounting peer = IPX3; direction OUT; media = yes; destination = last address from ROUTE, that is VPLMN B. IPX3 sum counter on turn will be updated so that: accounting peer = HPLMN B; direction IN; media = yes; destination = last address from ROUTE (VPLMN B).

12. IPX3 routes media and signalling to the IBCF of VPLMN B set up to receive incoming traffic. The sum counters of IPX3 and VPLMN B are updated.

13. In VPLMN B the IBCF passes the signalling P-CSCF (the media has reached the IBGW and will be delivered to the UE) which generates a CDR for the mobile terminated call containing the served UE identity.

14. P-CSCF completes the signalling path to UE B.

As described above interconnection charges are settled using the sum counters that have been updated in steps 3, 4, 5, 6, 9, 10, 11 and 12. It should be noted however that depending on operators agreements there may be no charging when only signalling is carried, or simply decide not to use an IPX at all (steps 3, 4, 5 and 6 in the above flow).

Roaming charges are instead based on the CDR generated by the anchor point at step 7 (HPLMN A will compensate VPLMN A based on this record) and by the P-CSCF of VPLMN B at step 13 (HPLMN B will compensate VPLMN B based on this record).

### A.3.3 Application of GSMA roaming business model to IMS: home routing

This technical report documents two mechanisms to allow the HPLMN of the subscriber to force the media to be routed to the destination by the HPLMN.

The first mechanism still relies on the signalling to loopback to the VPLMN anchor point, but modifying in the HPLMN call processing the destination address so that the media is sent to the HPLMN rather than to the intended destination. In this case there is no change to the interconnection and roaming accounting described in clause A.3.2. This option also does not require further standardization compared to what is needed to set up a normal (non home routed) call.

The second mechanism to perform home routing is simply to establish the media path immediately from the I-BGF in VPLMN to the HPLMN so that there is no need for the HPLMN to return the signalling to the VPLMN neither to invoke OMR procedures. As for the interconnection accounting, this will be easily managed, however whereas in the non home routed calls case and first mechanism the TAP record exchanged between VPLMN and HPLMN can be based on the CDR produced by the anchor point, in this case such network function is not invoked therefore the TAP record needs to rely on the CDR generated by the P-CSCF.

NOTE: A possible method for the billing system to determine whether the P-CSCF or the anchor point CDR should be used is to indicate in the P-CSCF CDR whether OMR has been applied or not.

# Annex B: Recommendations for the Convergent Interconnection

## B.1 Convergent Interconnection

As mobile operators are in many circumstances using the same interconnection providers that are used for fixed broadband access, the 3GPP system should allow, for interconnection between PLMNs, to use the same inter-connection infrastructure which is used between Fixed Broadband Access networks.

The 3GPP system ensures that interconnection hubs can serve transit traffic between any type of IMS network in parallel (as for today's legacy CS Interconnection).

The 3GPP system provides sufficient information by means of signalling parameters to the interconnection hub to allow the interconnection provider to determine, on a per session basis the correct traffic handling, i.e. there will be no stateful context within an interconnection hub regardless of whether it is deployed as interconnection hub for mobile or fixed broadband access.

The routing mechanisms and associated signalling parameters ensures that interconnection partners can apply distance based accounting unambiguously.

# Annex C: Change history

| Change history | | | | | | | |
|---|---|---|---|---|---|---|---|
| Date | TSG # | TSG Doc. | CR | Rev | Subject/Comment | Old | New |
| 09-2011 | SP-53 | SP-110480 | - | - | MCC editorial update to version 1.0.0 for presentation to TSG SA for information | 0.4.0 | 1.0.0 |
| 12-2011 | SP-54 | SP-110761 | - | - | MCC editorial update to version 2.0.0 for presentation to TSG SA for approval | 1.2.0 | 2.0.0 |
| 12-2011 | SP-54 | - | - | - | MCC editorial update to version 11.0.0 after TSG SA approval | 2.0.0 | 11.0.0 |
| | | | | | | | |