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IP Multimedia (IM) Subsystem - Stage 2
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Contents

Foreword

This Technical Specification 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.

1 Scope

This document defines the stage-2 service description for the IP Multimedia (IM) Core Network Subsystem, which includes the elements necessary to support IP Multimedia (IM) services in UMTS. CCITT I.130 [4] describes a three-stage method for characterisation of telecommunication services, and CCITT Q.65 [3] defines stage 2 of the method.

This document does not cover the Access Network functionality or GPRS aspects except as they relate to provision of IM services. The 3GPP TS 23.060 contains GPRS Access Network description and the GSM 03.64 [5] contains an overall description of the GSM GPRS radio interface. 3GPP TS 25.301 [11] contains an overall description of the UMTS Terrestrial Radio Access Network.

This document identifies the mechanisms to enable support for IP multimedia applications. In order to align IP multimedia applications wherever possible with non-3GPP IP applications, the general approach is to adopt non-3GPP specific IP based solutions.

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.

[1] 3GPP TS 23.002: "Network Architecture".

[2] CCITT Recommendation E.164: "Numbering plan for the ISDN era".

[3] CCITT Recommendation Q.65: "Methodology – Stage 2 of the method for the characterisation of services supported by an ISDN".

[4] ITU Recommendation I.130: "Method for the characterization of telecommunication services supported by an ISDN and network capabilities of an ISDN"

[5] GSM 03.64: "Digital cellular telecommunication system (Phase 2+); Overall Description of the General Packet Radio Service (GPRS) Radio Interface; Stage 2".

[6] GSM 01.04: "Digital cellular telecommunications system (Phase 2+); Abbreviations and acronyms".

[7] 3GPP TS 23.221: "Architectural Requirements".

[8] 3GPP TS 22.228: "Service requirements for the IP multimedia core network subsystem"

[9] 3GPP TS 23.207: "End-to-end QoS concept and architecture"

[10] 3GPP TS 24.228: "Signalling flows for the IP multimedia call control based on SIP and SDP"

[11] 3GPP TS 25.301: "Radio interface protocol architecture"

[12] RFC 2543: "SIP: Session Initiation Protocol"

[13] RFC 2396: "Uniform Resource Identifiers (URI): Generic Syntax"

[14] RFC 2486: "The Network Access Identifier"

[15] RFC 2806: "URLs for Telephone Calls"

[16] RFC 2916: "E.164 number and DNS"

[17] ITU Recommendation G.711: "Pulse code modulation (PCM) of voice frequencies"

[18] ITU Recommendation H.248: "Gateway control protocol"

[19] 3GPP TS 33.2xx: "Access Security for IP-based services"

[20] 3GPP TS 33.200: "Network Domain Security"

3 Definitions, symbols and abbreviations

3.1 Definitions

Refer to TS 23.002 [1] for the definitions of some terms used in this document.

For the purposes of the present document the following additional definitions apply.

IP-Connectivity Network: refers to any reference points in the architecture that provide IP connectivity between any two or more IP capable nodes; e.g. Gm, Gi, Mw. An example of an "IP-Connectivity Network" is GPRS.

3.2 Symbols

For the purposes of the present document the following symbols apply:

Cx	Interface between a CSCF and an HSS.
Dx	Interface between an I-CSCF and an SLF.
Gi	Reference point between GPRS and an external packet data network and between an access network and the IM CN Subsystem.
Gm	Interface between a UE and a P-CSCF.
Iu	Interface between the RNS and the core network. It is also considered as a reference point.
kbit/s	Kilobits per second.
Mbit/s	Megabits per second. 1 Mbit/s = 1 million bits per second.
Mg	Interface between a MGCF and a CSCF.
Mm	Interface between a CSCF and an IP multimedia network.
Mw	Interface between a CSCF and another CSCF.
Sc	Interface between a CSCF and an Application Server.

3.3 Abbreviations

For the purposes of the present document the following abbreviations apply. Additional applicable abbreviations can be found in GSM 01.04 [1].

AMR	Adaptive Multi-rate
API	Application Program Interface
AS	Application Server
BCSM	Basic Call State Model
BG	Border Gateway
BGCF	Breakout Gateway Control Function
BS	Bearer Service
CAMEL	Customised Application Mobile Enhanced Logic
CAP	Camel Application Part
CDR	Call Detail Record
CN	Core Network
CS	Circuit Switched
CSCF	Call Session Control Function (??)
CSE	CAMEL Service Environment
DHCP	Dynamic Host Configuration Protocol
DNS	Domain Name System
ENUM	E.164 Number
GGSN	Gateway GPRS Support Node
HSS	Home Subscriber Server
I-CSCF	Interrogating-CSCF

IETF	Internet Engineering Task Force
IM	IP Multimedia
IM CN SS	IP Multimedia Core Network Subsystem
IMS	IP Multimedia Core Network Subsystem
IMSI	International Mobile Subscriber Identifier
IP	Internet Protocol
IPv4	Internet Protocol version 4
IPv6	Internet Protocol version 6
ISDN	Integrated Services Digital Network
ISP	Internet Service Provider
ISUP	ISDN User Part
MAP	Mobile Application Part
MGCF	Media Gateway Control Function
MGF	Media Gateway Function
NAI	Network Access Identifier
OSA	Open Services Architecture
P-CSCF	Proxy-CSCF
PCF	Policy Control Function
PDN	Packet Data Network
PDP	Packet Data Protocol e.g., IP
PEF	Policy Enforcement Function
PLMN	Public Land Mobile Network
PSTN	Public Switched Telephone Network
QoS	Quality of Service
RAB	Radio Access Bearer
RFC	Request for Comments
SCS	Service Capability Server
S-CSCF	Serving-CSCF
SGSN	Serving GPRS Support Node
SLF	Subscription Locator Function
SSF	Service Switching Function
SS7	Signalling System 7
SIM	Subscriber Identity Module
SIP	Session Initiation Protocol
TSGW	Transport Signalling Gateway
UE	User Equipment
UMTS	Universal Mobile Telecommunications System
URL	Universal Resource Locator
USIM	UMTS SIM

4 IP multimedia subsystem concepts

The IP Multimedia CN subsystem comprises all CN elements for provision of multimedia services. This includes the collection of signalling and bearer related network elements as defined in TS 23.002 [1]. IP multimedia services are based on an IETF defined session control capability which, along with multimedia bearers, utilises the PS domain (this may include an equivalent set of services to the relevant subset of CS Services).

In order to achieve access independence and to maintain a smooth interoperation with wireline terminals across the Internet, the IP multimedia subsystem attempts to be conformant to IETF “Internet standards”. Therefore, the interfaces specified conform as far as possible to IETF “Internet standards” for the cases where an IETF protocol has been selected, e.g. SIP.

The IP multimedia core network (IM CN) subsystem enables PLMN operators to offer their subscribers multimedia services based on and built upon Internet applications, services and protocols. There is no intention here to standardise such services within the IM CN subsystem, the intention is that such services will be developed by PLMN operators and other third party suppliers including those in the Internet space using the mechanisms provided by the Internet and the IM CN subsystem. The IM CN subsystem should enable the convergence of, and access to, voice, video, messaging, data and web-based technologies for the wireless user, and combine the growth of the Internet with the growth in mobile communications.

The complete solution for the support of IP multimedia applications consists of terminals, GERAN or UTRAN radio access networks, GPRS evolved core network, and the specific functional elements of the IM CN subsystem described in this technical specification.

4.1 Relationship to CS and PS domains

The IP multimedia subsystem utilizes the PS domain to transport multimedia signalling and bearer traffic. The PS domain maintains the service while the terminal moves and hides these moves from the IP multimedia subsystem.

The IP multimedia subsystem is independent of the CS domain although some network elements may be common with the CS domain. This means that it is not necessary to deploy a CS domain in order to support an IP multimedia subsystem based network.

4.2 IM services concepts

4.2.1 Virtual Home Environment (VHE)

4.2.1.1 Support of CAMEL

It shall be possible for an operator to offer access to services based on the CSE for its IM CN subsystem subscribers. This shall be supported by a CAP interface to the Serving-CSCF. It should be noted that there is no requirement for any operator to support CAMEL services for their IM CN subsystem subscribers or for inbound roamers.

It shall be possible for a home network to provide support for CAMEL based services to a subscriber roaming in a network that does not support CAMEL on the IM CN subsystem or does not support the required CAMEL Version. To achieve this, the home operator may support the CAP capable Serving-CSCF in the home network.

4.2.1.2 Support of OSA

It shall be possible for an operator to offer access to services based on OSA for its IM CN subsystem subscribers. This shall be supported by an OSA API between the Application Server (AS) and the network.

4.2.2 Support of Local Services in the IMS

Visited network provided services offer an opportunity for revenue generation by allowing access to services of a local nature to visiting users (inbound roamers). There shall be a standardised means for providing inbound roamers with access to local services.

4.2.3 Support of roaming subscribers

The architecture shall be based on the principle that the service control for Home subscribed services for a roaming subscriber is in the Home network, e.g., the Serving-CSCF is located in the Home network.

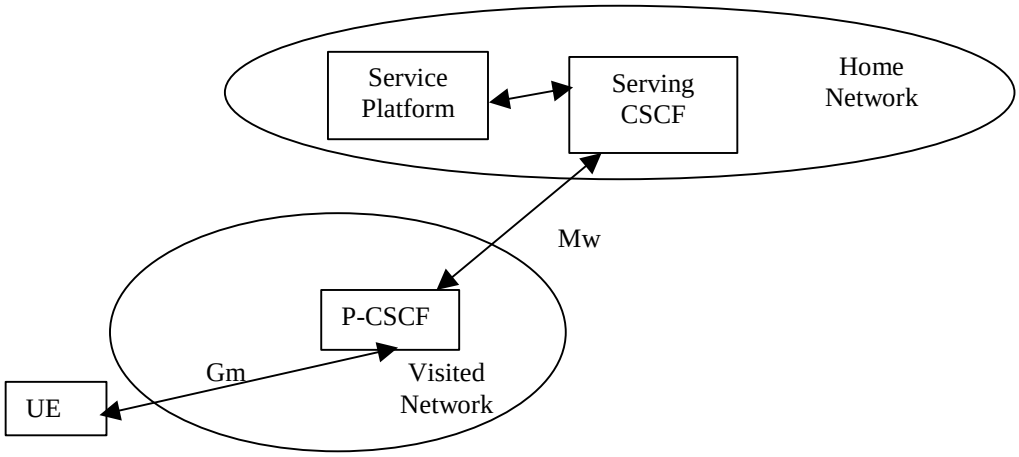


Figure 4-1: Service Platform in Home Network

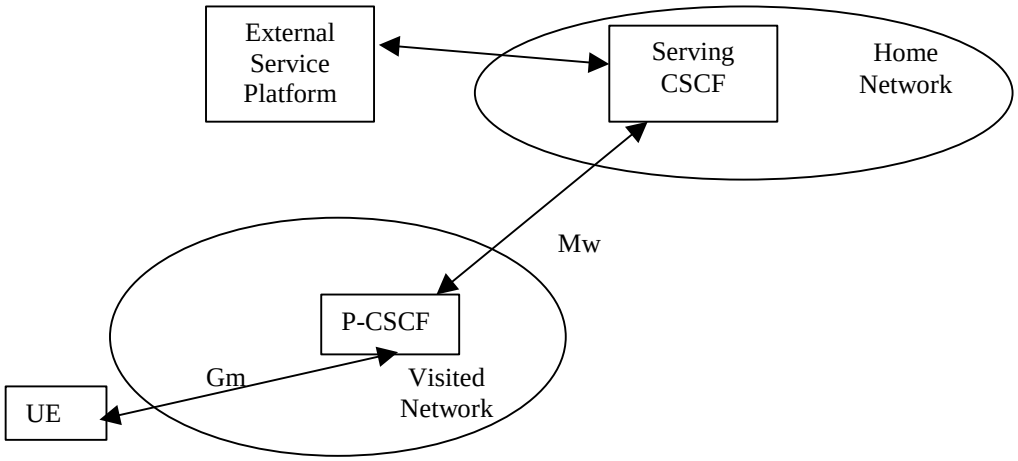


Figure 4-2: External Service Platform

There are two possible scenarios to provide services:

- via the service platform in the Home Network
- via an external service platform (e.g. third party or visited network)

The box representing the external service platform could be located in either the visited network or in the 3rd party platform.

Editor's Note: the types of protocols to be used on the interfaces between the Serving-CSCF and the different service platforms in these different scenarios are FFS.

The roles that the CSCF plays are described below.

- When subscribers roam to visited networks, the Serving-CSCF is located in the home network , the roamed to (visited) network shall support a Proxy-CSCF. The Proxy-CSCF shall enable the session control to be passed to the home network based Serving-CSCF that shall provide service control.

A Proxy-CSCF shall be supported in both roaming and non-roaming case, even when the Serving-CSCF is located in the same IM CN SS.

Reassigning the Proxy-CSCF assigned during CSCF discovery is not a requirement in this release. Procedures to allow registration time Proxy-CSCF reassignment may be considered in future releases.

Network initiated Proxy-CSCF reassignment is not a requirement.

The use of additional CSCFs, that is Interrogating-CSCFs, to be included in the SIP signalling path is optional. Such additional CSCFs may be used to shield the internal structure of a network from other networks.

4.2.4 CSCF to service platform Interface

An Application Server (AS) offering value added IM services resides either in the user's home network or in a third party location. The third party could be a network or simply a stand-alone AS.

The CSCF to AS interface is used to provide services residing in an AS. Two cases were identified:

- Serving-CSCF to an AS in Home Network.
- Serving-CSCF to an AS in External Network (e.g., Third Party or Visited)

Regarding the general provision of services in the IMS, the following statements shall guide the further development.

1. Besides the Cx interface the S-CSCF supports only one standardised protocol for service control purposes, SIP+.
2. Guidelines for SIP+ are needed; SIP+ is based on the SIP protocol information with necessary enhancements to allow for service control; controversial enhancements should be avoided.
3. The depicted functional architecture does not propose a specific physical implementation.
4. Scope of the SIP Application Server: the SIP Application Server may host and execute services. It is intended to allow the SIP Application Server to influence and impact the SIP session on behalf of the services and it uses SIP+ to communicate with the S-CSCF. Further details are needed.
5. The S-CSCF shall decide if a SIP session request is subject to inform a service. The decision at the S-CSCF is based on (filter) information received from the HSS (or other sources, e.g. application servers). To identify the service to be informed is based on information received from the HSS.
6. The purpose of the IM SSF is to translate SIP+ to CAP and to hold the needed functions to do that.
7. The IM SSF and the CAP interface support legacy services only.

The figure below depicts an overall view of how services can be provided.

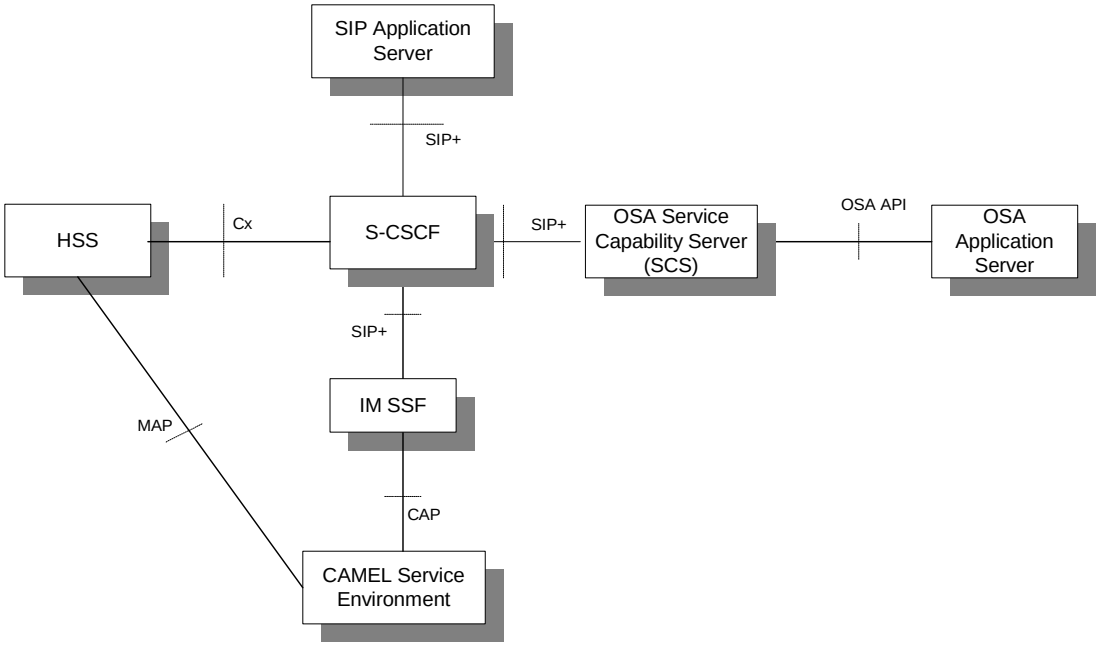


Figure 4.3: Functional architecture for the provision of service in the IMS

4.2.5 The QoS requirements for an IM CN subsystem session

The selection, deployment, initiation and termination of QoS signalling and resource allocation shall consider the following requirements so as to guarantee the QoS requirement associated with an IM CN subsystem session.

1. Independence between QoS signalling and Session Control

   The selection of QoS signalling and resource allocation schemes should be independent of the selected session control protocols. This allows for independent evolution of QoS control and the session control in the IM CN subsystem.

2. Necessity for End-to-End QoS Signalling and Resource -Allocation

   End-to-end QoS indication, negotiation and resource allocation during the session set-up in the IM CN subsystem should be enforced for those services and applications that require QoS better than best-effort services or the Background QoS Class.

3. QoS Signalling at Different Bearer Service Control Levels

   During the session set-up in a IM CN subsystem, at least two levels of QoS signalling/negotiation and resource allocation should be included in selecting and setting up an appropriate bearer for the session:

   a. The QoS signalling/negotiation and resource allocation at the IP Bearer Service (BS) Level:

      The QoS signalling and control at IP BS level is to pass and map the QoS requirements at the IP Multimedia application level to the UMTS BS level and performs any required end-to-end QoS signalling by inter-working with the external network. The IP BS Manager at the UE and the GGSN is the functional entity to process the QoS signalling at the IP BS level.

   b. The QoS signalling/negotiation and resource allocation at the UMTS Bearer Service Level:

      The QoS signalling at the UMTS BS Level is to deliver the QoS requirements from the UE to the RAN, the CN, and the IP BS manager, where appropriate QoS negotiation and resource allocation are activated accordingly. When UMTS QoS negotiation mechanisms are used to negotiate end-to-end QoS, the translation function in the GGSN shall co-ordinate resource allocation between UMTS BS Manager and the IP BS Manager.

   Interactions (QoS class selection, mapping, translation as well as reporting of resource allocation) between the QoS signalling/control at the IP BS Level and the UMTS BS Level take place at the UE and the GGSN which also serve as the interaction points between the IM CN subsystem session control and the UMTS Bearer QoS control.

   UMTS specific QoS signalling, negotiation and resource allocation mechanisms (e.g. RAB QoS negotiation and PDP Context set-up) shall be used at the UMTS BS Level. Other QoS signalling mechanisms such as RSVP at the IP BS Level shall only be used at the IP BS Level.

   It shall be possible to negotiate a single resource allocation at the UMTS Bearer Service Level and utilise it for multiple sessions at the IP Bearer Service Level.

4. Restricted Resource Access at the IP BS Level

   Access to the resources and provisioning of QoS at IP BS Level should be authenticated and authorised by applying appropriate QoS policies via the IP Policy Control element

5. Restricted Resource Access at the UMTS BS Level

   Access to the resources and provisioning of QoS at the UMTS BS Level should be authenticated and authorised by using existing UMTS registration/security/QoS policy control mechanisms.

6. Co-ordination between Session Control and QoS Signalling/Resource Allocation

   a. In establishing an IMS session, it shall be possible for an application to request that the resources needed for bearer establishment be successfully allocated before the destination user is alerted.

   b. In establishing an IMS session, it shall be possible, dependent on the application being offered, to prevent the use of the bearer until the session establishment is completed.

c. In establishing an IMS session, it shall be possible for a terminating application to allow the destination user to participate in determining which bearers shall be established.

d. Successful bearer establishment shall include the completion of any required end-to-end QoS signalling, negotiation and resource allocation

The initiation of any required end-to-end QoS signalling, negotiation and resource allocation processes at different network segments shall take place after the initiation and delivery of a session set-up request.

7. The Efficiency of QoS Signalling and Resource Allocation

   The sequence of end-to-end QoS signalling, negotiation and resource allocation processes at different network segments should primarily consider the delay in negotiating end-to-end QoS and reserving resources that contributes to the session set-up delay. Parallel or overlapping QoS negotiation and resource reservation shall be allowed where possible.

8. Dynamic QoS Negotiation and Resource Allocation

   Changes (upgrading or downgrading) of QoS provided to an active IMS session shall be supported based on either the request from the IM application or the current network loads or radio link quality.

   It shall be possible to maintain a resource allocation in excess of the resources needed for current media flows (but within the restrictions imposed by points #4 and #5 above), in order to e.g. switch to different media flow characteristics without risk of admission control failure.

9. Prevention of Theft of Service

   The possibility for theft of service in the IM CN subsystem shall be no higher than that for the corresponding GPRS and circuit switched services.

10. Prevention of Denial of Service

    The system unavailability due to denial of service attacks in the IM CN subsystem shall be no greater than that for the corresponding GPRS and circuit switched services.

4.2.6 QoS Requirements for IM CN subsystem signalling

The UE shall be able to establish a separate PDP-Context for IM Subsystem related signalling. The UE shall also be able to utilize a general-purpose PDP context for IM subsystem signalling traffic. If the network-operator does not support a dedicated PDP context, the UE shall use a general-purpose PDP context for IM subsystem signalling.

The PDP Context for IM Subsystem related signalling may provide enhanced QoS for signalling traffic.

At PDP context setup it shall be possible for the GGSN to determine if the PDP context is to be used for IM Subsystem related signalling. If the PDP context is to be used for IM Subsystem related signalling, rules and restrictions may apply to the bearer according to operator implementation. A minimum set of capabilities shall be standardised to provide user experience consistency and satisfy user expectation. The rules and restrictions on other capabilities beyond the minimum standardised set are configured by the operator in the GGSN.

To enable the described mechanism to work without requiring end-user interaction and under roaming circumstances, it is a requirement for the UE to be made aware of the rules and restrictions applied by the visited network operator. As there is as yet no mechanism available in Release 5 for providing the information about the restrictions back to the UE, the available set of rules and restrictions in Release 5 is the minimum set of capabilities as defined below.

For the PDP Signalling Context subject to restrictions,

The minimum set of capabilities to be applied is defined as: All messages from the UE on the Signalling PDP Context shall have their destination restricted to the P-CSCF assigned for this UE, or to any one of the set of possible P-CSCFs that may be assigned to this UE.

The UE is not trusted to implement these restrictions, therefore the restrictions as valid in the visited network are enforced by the operator in the GGSN.

4.3 Naming and addressing concepts

4.3.1 Address management

The issues of general IP address management are discussed in 23.221 [7].

The ability of the User plane and the Control Plane for a single session being able to pass through different GGSNs is not defined in this release.

4.3.2 Addressing and routing for access to IM CN subsystem services

This section deals with a UE accessing IM CN subsystem services via UMTS.

A UE accessing IM CN Subsystem services requires an IP address that is logically part of the Visited Network IM CN subsystem IP Addressing Domain. This is established using an appropriate PDP-context. For routing efficiency this context should be connected though a GGSN in the visited network. The connection between the UE and the Visited Network IM CN subsystem is shown below:

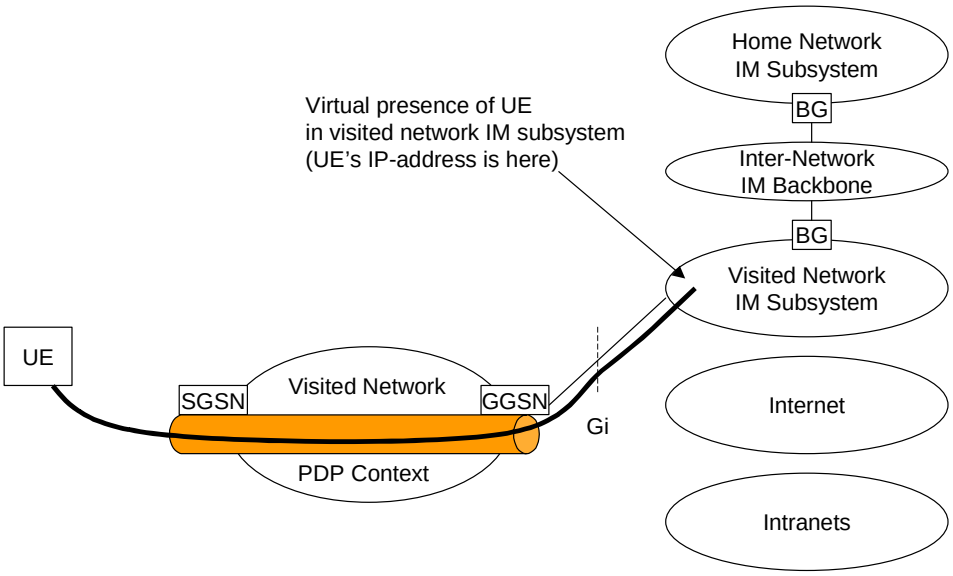


Figure 4.4: UE Accessing IM CN subsystem Services in the visited network

4.3.3 Identification of users

There are various identities that may be associated with a user of IP multimedia services. This section describes these identities and their use.

4.3.3.1 Private user identities

Every IM CN subsystem subscriber shall have a private user identity. The private identity is assigned by the home network operator, and used, for example, for Registration, Authorisation, Administration, and Accounting purposes. This identity shall take the form of a Network Access Identifier (NAI) as defined in RFC 2486 [14]. It is possible for a representation of the IMSI to be contained within the NAI for the private identity.

- The Private User Identity is not used for routing of SIP messages.
- The Private User Identity shall be contained in all Registration requests, (including Re-registration and De-registration requests) passed from the UE to the home network.
- The Private User Identity shall be securely stored on the USIM (it shall not be possible for the UE to modify the Private User Identity)

- The Private User Identity is a unique global identity defined by the Home Network Operator, which may be used within the home network to uniquely identify the user from a network perspective.
- The Private User Identity shall be permanently allocated to a user (it is not a dynamic identity), and is valid for the duration of the user's subscription with the home network.
- The Private User Identity is used to identify the user's information (for example authentication information) stored within the HSS (for use for example during Registration).
- The Private User Identity may be present in charging records based on operator policies.
- The Private User Identity identifies the subscription (e.g. IM service capability) not the user.
- The Private User Identity is authenticated only during registration of the subscriber, (including re-registration and de-registration).
- The HSS and S-CSCF need to obtain and store the Private User Identity.

4.3.3.2 Public user identities

Every IM CN subsystem subscriber shall have one or more public user identities [8]. The public user identity/identities are used by any user for requesting communications to other users. For example, this might be included on a business card.

- Both telecom numbering and Internet naming schemes can be used to address users depending on the Public User identities that the users have.
- The public user identity/identities shall take the form of SIP URL (as defined in RFC2543 [12] and RFC2396 [13]) or E.164 numbers.
- At least one Public User Identity shall be securely stored on the USIM (it shall not be possible for the UE to modify the Public User Identity), but it is not required that all additional Public User Identities be stored on the USIM.
- Public User Identitys are not authenticated by the network during registration.
- Public User Identities may be used to identify the user's information within the HSS (for example during mobile terminated session set-up).

4.3.3.3 Routing of SIP signalling within the IP multimedia subsystem

Routing of SIP signalling within the IMS shall use SIP URLs. E.164 [2] format public user identities shall not be used for routing within the IMS, and session requests based upon E.164 format public user identities will require conversion into SIP URL format for internal IMS usage.

4.3.3.4 Relationship of private and public user identities

The home network operator is responsible for the assignment of the private user identifier, and public user identifiers; other identities that are not defined by the operator may also exist.

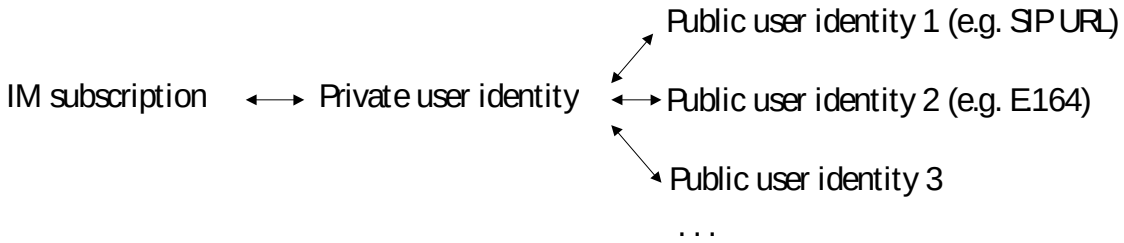


Figure 4.5: Relationship of the private user identity and public user identities

The home domain name of the subscriber shall be stored securely on the USIM, (it shall not be possible for the UE to modify the home domain name).

The storage location of the Private User Identity, Public User Identity and home domain name for a standalone SIP Client could be stored on the USIM.

Editors Note: Mechanisms used to extract the Private User Identity, Public User Identity and home domain name from the USIM (e.g. when an external SIP TE is used) are for further study of the groups T2, T3 and SA3.

It is not a requirement for a user to be able to register on behalf of another user or for a device to be able to register on behalf of another device or for combinations of the above for the IM CN subsystem for this release.

Editor's Note: Public User Identity Portability issues are FFS.

4.3.4 Identification of network nodes

The CSCF, BGCF and MGCF nodes shall be identifiable using a valid SIP URL (Host Domain Name or Network Address) on those interfaces supporting the SIP protocol, (e.g. Gm, Mw, Mm, and Mg). These SIP URLs would be used when identifying these nodes in header fields of SIP messages. However this does not require that these URLs will be globally published in DNS.

4.3.5 Name to address resolution in an IM CN subsystem

The S-CSCF shall support the ability to translate the E.164 address contained in a Request-URI in the non-SIP URL "tel:" format [15] to a SIP routable SIP URL using an ENUM DNS translation mechanism with the format as specified in RFC 2916 [16], (E.164 number and DNS). If this translation fails, then the session may be routed to the PSTN or appropriate notification shall be sent to the mobile.

NOTE: The type of database infrastructure is a matter for the IM operator and this does not require that Universal ENUM service be used.

4.4 Signalling concepts

A Single session control between the UE and CSCF. For Multi-Media type services delivered via the PS Domain within this architecture, a single **session** control protocol shall be used between the user equipment UE and the CSCF (over the Gm reference point).

Protocols over the Gm reference point. The single protocol applied between the UE and CSCF (over the Gm reference point) within this architecture will be based on SIP (as defined by RFC 2543 [12], other relevant RFC's, and additional enhancements required to support 3GPP's needs).

A Single session control on the Mw, Mm, Mg. A single session control protocol shall be used on the session control interfaces between:

- MGCF and CSCF (Mg),
- between CSCFs (Mw), and
- between a CSCF and external IP networks (Mm).

Protocols for the Mw, Mm, Mg. The single session control protocol applied to these interfaces will be based on SIP (as defined by RFC 2543, other relevant RFC's, and additional enhancements required to support 3GPP´s needs).

UNI vs. NNI session control. The SIP based signalling interactions between CN elements may be different then SIP based signalling between the UE and the CSCF.

Network configuration independence. It is a requirement that it shall be possible to hide the network topology from other operators. It shall be possible to restrict the following information from being passed outside of an operator's network: exact number of S-CSCFs, capabilities of S-CSCFs, or capacity of the network. A more detailed explanation of this requirement is given in Annex C.

Editor's Note: Requirements for configuration independence related to P-CSCFs are for further study (Note that UE needs to have the address of P-CSCF).

Restrict access from external networks. The signalling solution shall allow the operator to restrict access from external networks (application level).

Access to HSS. A network operator can control access to the HSS.

4.5 Mobility related concepts

When a IM CN subsystem UE moves from one PLMN to another (or between one subnetwork and another), it should acquire a new IP address from the new (sub)network.

Editor's Note: UE movement between subnetworks is for further study.

Note: An operator may decide to keep the user attached to a GGSN.

Using the current GPRS procedures,

- The UE shall release its current IP address in the previous network i.e., deactivate the PDP context supporting the SIP signalling.
- The UE shall acquire a new IP address, i.e. activate a PDP context.
- The UE shall then execute the discovery and application level registration process to obtain SIP service from the new network.

If the IM CN subsystem UE currently supports an active session, the UE shall delay the acquisition of a new IP address until that session has been terminated.

4.6 Roles of Session Control Functions

The CSCF may take on various roles as used in the IP multimedia subsystem. The following sections describe these various roles.

4.6.1 Proxy-CSCF

The Proxy-CSCF (P-CSCF) is the first contact point within the IM CN subsystem. Its address is discovered by UEs following PDP context activation, using the mechanism described in section “Procedures related to Local CSCF Discovery ”. The P-CSCF behaves like a Proxy (as defined in RFC2543 or subsequent versions), i.e. it accepts requests and services them internally or forwards them on, possibly after translation. The P-CSCF may also behave as a User Agent (as defined in the RFC2543 or subsequent versions), i.e. in abnormal conditions it may terminate and independently generate SIP transactions.

The Policy Control Function (PCF) is a logical entity of the P-CSCF. If the PCF is implemented in a separate physical node, the interface between the PCF and the P-CSCF is not standardised.

The functions performed by the P-CSCF are:

- Forward the SIP register request received from the UE to an I-CSCF determined using the home domain name, as provided by the UE.
- Forward SIP messages received from the UE to the SIP server (e.g. S-CSCF) whose name the P-CSCF has received as a result of the registration procedure.
- As part of processing of the request and before forwarding, the P-CSCF may modify the Request URI of outgoing requests according to a set of provisioned rules defined by the network operator (e.g. Number analysis and potential modification such as translation from local to international format.)
- Forward the SIP request or response to the UE.
- Detect an emergency session and select a S-CSCF in the visited network to handle emergency sessions.
- The generation of CDRs.
- Maintain a Security Association between itself and each UE, as defined in Access Security for IP-based services Specification TS 33.2xx [19].

- Provide security towards Serving-CSCF by security methods defined in Network Domain Security specification TS 33.200 [20].

Editor's Note: The following functions require further study:

- Authorisation of bearer resources and QoS management. Details of the P-CSCF role in QoS management and authorisation of bearer resources for the session are being investigated by the QoS ad-hoc group.

4.6.2 Interrogating-CSCF

Interrogating-CSCF (**I-CSCF**) is the contact point within an operator's network for all connections destined to a subscriber of that network operator, or a roaming subscriber currently located within that network operator's service area. There may be multiple I-CSCFs within an operator's network. The functions performed by the I-CSCF are:

Registration

- Assigning a S-CSCF to a user performing SIP registration (see section on Procedures related to Serving-CSCF assignment)

Session Flows

- Route a SIP request received from another network towards the S-CSCF.
- Obtain from HSS the Address of the S-CSCF.
- Forward the SIP request or response to the S-CSCF determined by the step above

Charging and resource utilisation:

- Generation of CDRs.

In performing the above functions the operator may use the I-CSCF or other techniques to hide the configuration, capacity, and topology of the network from the outside. When the I-CSCF is chosen to meet the hiding requirement then for sessions traversing across different operators domains, the I-CSCF may forward the SIP request or response to another I-CSCF allowing the operators to maintain configuration independence.

4.6.3 Serving-CSCF

The Serving-CSCF (S-CSCF) performs the session control services for the UE. It maintains a session state as needed by the network operator for support of the services. Within an operator's network, different S-CSCFs may have different functionalities. The functions performed by the S-CSCF during a session are:

Registration

- May behave as a Registrar as defined in RFC2543 or subsequent versions, i.e. it accepts registration requests and makes its information available through the location server (eg. HSS).

Session flows

- Session control for the registered endpoint's sessions.
- May behave as a Proxy Server as defined in RFC2543 or subsequent versions, i.e. it accepts requests and services them internally or forwards them on, possibly after translation.
- May behave as a User Agent as defined in RFC2543 or subsequent versions, i.e. it may terminate and independently generate SIP transactions.
- Interaction with Services Platforms for the support of Services
- Provide endpoints with service event related information (e.g. notification of tones/announcement together with location of additional media resources, billing notification)
- Security towards Proxy-CSCF, as defined by the Network Domain Security specification TS 33.200.
- On behalf of an originating endpoint (i.e. the originating subscriber/UE)

- Obtain from a database the Address of the I-CSCF for the network operator serving the destination subscriber from the destination name of the terminating subscriber (e.g. dialled phone number or SIP URL), when the destination subscriber is a customer of a different network operator, and forward the SIP request or response to that I-CSCF.

- When the destination name of the terminating subscriber (e.g. dialled phone number or SIP URL), and the destination subscriber is a customer of the same network operator, forward the SIP request or response to an I-CSCF within the operator's network.

- Depending on operator policy, forward the SIP request or response to another SIP server located within an ISP domain outside of the IM CN subsystem.

- On behalf of a destination endpoint (i.e. the terminating subscriber/UE)

  - Forward the SIP request or response to a P-CSCF for a MT session to a home subscriber within the home network, or for a subscriber roaming within a visited network where the home network operator has chosen not to have an I-CSCF in the path

  - Forward the SIP request or response to an I-CSCF for a MT session for a roaming subscriber within a visited network where the home network operator has chosen to have an I-CSCF in the path.

Charging and resource utilisation:

- Generation of CDRs.

4.6.4 Breakout Gateway Control Function

The Breakout Gateway control function (BGCF) selects the network in which PSTN breakout is to occur. If the BGCF determines that the breakout is to occur in the same network in which the BGCF is located within, then the BGCF shall select a MGCF which will be responsible for the interworking with the PSTN. If the break out is in another network, the BGCF will forward this session signalling to another BGCF, or an MGCF, depending on the configuration, in the selected network.

The functions performed by the BGCF are:

- Receives request from S-CSCF to select appropriate PSTN break out point for the session

- Select the network in which the interworking with the PSTN is to occur. If the interworking is in another network, then the BGCF will forward the SIP signalling to the BGCF of that network.

- Select the MGCF in the network in which the interworking with PSTN is to occur and forward the SIP signalling to that MGCF. This may not apply if the interworking is a different network.

Charging and resource utilisation:

- Generation of CDRs.

The BGCF may make use of information received from other protocols, or may make use of administrative information, when making the choice of which network the interworking shall occur.

5 IP multimedia subsystem procedures

This section documents the main procedures that are used for the provision of services in the IP multimedia subsystem. These procedures are described using text description as well as information flow diagrams. The procedures described in this document are meant to provide a high level description and are not intended to be exhaustive. Additional procedures and details are provided in TS 24.228 [10].

5.1 CSCF related procedures

5.1.1 Procedures related to local CSCF discovery

The Proxy-CSCF discovery shall be performed after GPRS attach using one of the following mechanisms:

1. Use of DHCP to provide the UE with the domain name of a Proxy-CSCF and the address of a Domain Name Server (DNS) that is capable of resolving the Proxy-CSCF name.

2. Transfer a Proxy-CSCF address within the PDP Context Activation signalling to the UE.

The second alternative shall be used for terminals not supporting DHCP.

5.1.2 Procedures related to Serving-CSCF assignment

5.1.2.1 Assigning a Serving-CSCF for a subscriber

When a mobile subscriber becomes active (e.g. when terminal is powered on) and possibly when the subscriber moves, a CSCF shall be assigned to serve the subscriber.

The assignment of an S-CSCF is performed in the I-CSCF. The following information is needed in the selection of the S-CSCF:

1. Required capabilities for subscriber services
   This information is provided by the HSS.

2. Operator preference on a per-user basis
   This information is provided by the HSS.

4. Capabilities of individual S-CSCFs in the home network
   This is internal information within the operator's network. This information may be used in the S-CSCF selection. This information is obtained by the I-CSCF by methods not standardised in this release.

5. Topological (i.e. P-CSCF) information of where the subscriber is located
   This is internal information within the operator's network. This information may be used in the S-CSCF selection. The P-CSCF name is received in the registration request. The topological information of the P-CSCF is obtained by the I-CSCF by methods not standardised in Release 5.

6. Topological information of where the S-CSCF is located
   This is internal information within the operator's network. This information may be used in the S-CSCF selection. This information is obtained by the I-CSCF by methods not standardised in this release.

7. Availability of S-CSCFs
   This is internal information within the operator's network. This information may be used in the S-CSCF selection. This information is obtained by the I-CSCF by methods not standardised in this release.

In order to support the S-CSCF selection described above, it is required that the following types of information be transferred between the CSCF and the HSS:

1. The Cx reference point shall support the transfer of CSCF-UE security parameters from HSS to CSCF.

   Editor's Note: unless SA3 defines a different method to support a secure association between UE and CSCF.

   - This allows the CSCF and the subscriber to communicate in a trusted and secure way (there is no à priori trust relationship between a subscriber and a CSCF)

   - The security parameters can be for example pre-calculated challenge-response pairs, or keys for an authentication algorithm, etc.

2. The Cx reference point shall support the transfer of *service parameters of the subscriber* from HSS to CSCF.

   - This may include e.g. supplementary service parameters, application server address, triggers etc.

Editor's Note: It has also to be made clear what are the functionality of the application level and service level.

3. The Cx reference point shall support the transfer of CSCF capability information from CSCF to HSS.

   - This may include e.g. supported service set, protocol version numbers etc.

4. The Cx reference point shall support the transfer of session signalling transport parameters from CSCF to HSS. The HSS stores the signalling transport parameters and they are used for routing mobile terminated sessions to the Serving-CSCF.

   - The parameters may include e.g. IP-address and port number of CSCF, transport protocol etc.

The information mentioned in items 1 – 4 above shall be transferred before the CSCF is able to serve the mobile subscriber. It shall also be possible to update this information while the CSCF is serving the subscriber, for example if new supplementary services are activated for the subscriber.

5.1.2.2 Cancelling the Serving-CSCF assignment

When the subscriber deactivates the terminal or possibly when he moves, the Serving-CSCF assignment shall be cancelled.

The Cx reference point shall support the indication of cancelling the CSCF assignment.

- It shall be possible to initiate cancelling by both the CSCF and the HSS

5.1.3 Procedures related to Interrogating-CSCF

The architecture shall support multiple I-CSCFs for each operator. A DNS-based mechanism for selecting the I-CSCF shall be used to allow requests to be forwarded to an I-CSCF based, for example, on the location or identity of the forwarding node.

5.1.4 Procedures related to Proxy-CSCF

The routing of the SIP registration information flows shall not take into account previous registrations (i.e., registration state). The routing of the session information flows (e.g., INVITE) shall take into account the information received during the registration process.

5.1.5 Subscription Updating Procedures

HSS will have the capability of informing the S-CSCF whenever the subscription data stored in HSS is changed for an IM subscriber, and the changes affect the subscription data stored in the S-CSCF.

5.2 Application level registration procedures

The following sub-sections address requirements and information flows related to registration in the IP multimedia subsystem. Assumptions that apply to the various information flows are listed as appropriate.

5.2.1 Requirements considered for registration

The following points are considered as requirements for the purpose of the registration procedures.

1. The architecture shall allow for the Serving-CSCFs to have different capabilities or access to different capabilities. E.g. a VPN CSCF or CSCFs in different stages of network upgrade.

2. The network operator shall not be required to reveal the internal network structure to another network. Association of the node names of the same type of entity and their capabilities and the number of nodes will be kept within an operator's network. However disclosure of the internal architecture shall not be prevented on a per agreement basis.

3. A network shall not be required to expose the explicit IP addresses of the nodes within the network (excluding firewalls and border gateways).

4. It is desirable that the UE will use the same registration procedure(s) within its home and visited networks.

5. It is desirable that the procedures within the network(s) are transparent to the UE, when it register with the IM CN subsystem.

6. The Serving-CSCF understands a service profile and the address of the functionality of the Proxy-CSCF.

Editor's Note: The specific procedures for subscription updating in the S-CSCF are FFS.

5.2.2 Registration flows

5.2.2.1 Requirements to consider for registration

The additional requirement for the registration information flow for this section is:

1. A Serving-CSCF is assigned at registration, this does not preclude additional Serving-CSCFs or change of CSCF at a later date. Procedures for use of additional CSCFs are not standardised in this release.

5.2.2.2 Assumptions

The following are considered as assumptions for the registration procedures as described in subclause 5.3.2.3:

1. Radio bearers are already established for signalling and a mechanism exists for the first REGISTER message to be forwarded to the proxy.

2. The I-CSCF shall use a mechanism for determining the Serving-CSCF address based on the required capabilities. The I-CSCF obtains the name of the S-CSCF from its role as an S-CSCF selector (Figure 5-1) for the determination and allocation of the Serving-CSCF during registration.

4. The decision for selecting the S-CSCF for the subscriber in the network is made in the I-CSCF.

5. A role of the I-CSCF is the S-CSCF selection.

Editor's Note: In the following information flows, further work is required to identify the information elements related to credentials and possible additional processes required for authentication of the user and the messages.

In the information flows described in subclauses 5.2.2.3 and 5.2.2.4, there is a mechanism to resolve a name and address. The text in the information flows indicates when the name-address resolution mechanism is utilised.

5.2.2.3 Registration information flow – User not registered

The application level registration can be initiated after the registration to the access is performed, and after IP connectivity for the signalling has been gained from the access network. For the purpose of the registration information flows, the subscriber is considered to be always roaming. For subscribers roaming in their home network, the home network shall perform the role of the visited network elements and the home network elements.

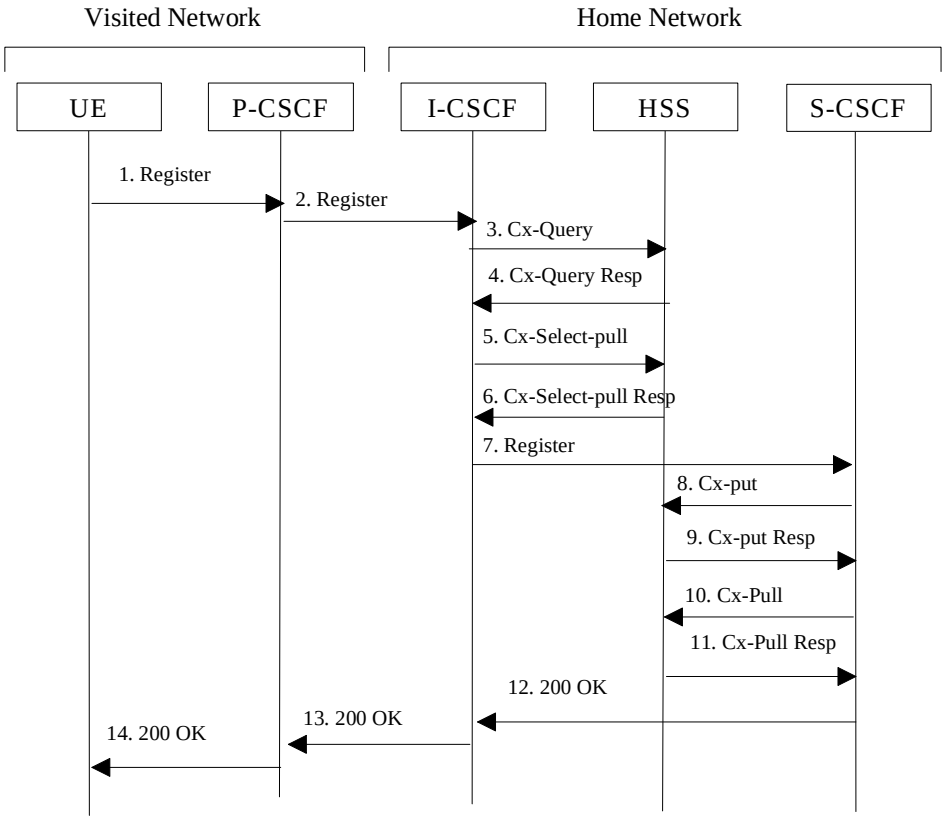


Figure 5.1: Registration – User not registered

1. After the UE has obtained a signalling channel through the access network, it can perform the IM registration. To do so, the UE sends the Register information flow to the proxy (subscriber identity, home networks domain name).

2. Upon receipt of the register information flow, it shall examine the “home domain name” to discover the entry point to the home network (i.e. the I-CSCF). The proxy shall send the Register information flow to the I-CSCF (P-CSCFs “name” in the contact header, subscriber identity, visited network contact name). A name-address resolution mechanism is utilised in order to determine the address of the home network from the home domain name. When the I-CSCF receives the registration information flow from the proxy, it shall examine the subscriber identity and the home domain name, and employ the services of a name-address resolution mechanism, to determine the HSS address to contact.

3. The I-CSCF shall send the Cx-Query information flow to the HSS (P-CSCF name, subscriber identity, home domain name, visited network contact name). The P-CSCF name is the contact name that the operator wishes to use for future contact to that P- CSCF.

Editors Note: It is FFS whether the terminal name, or proxy name, or both is included within this and subsequent register messages.

The Cx-query (P-CSCF name, subscriber identity, home domain name, visited network contact name) information flow is sent to the HSS. The HSS shall check whether the user is registered already. The HSS shall indicate whether the user is allowed to register in that visited network according to the User subscription and operator limitations/restrictions if any.

4. Cx-Query Resp is sent from the HSS to the I-CSCF. If the checking in HSS was not successful the Cx-Query Resp shall reject the registration attempt.

5. At this stage, it is assumed that the authentication of the user has been completed (although it may have been determined at an earlier point in the information flows). The I-CSCF shall send Cx-Select-Pull (serving network indication, subscriber identity) to the HSS to request the information related to the required S-CSCF capabilities which shall be input into the S-CSCF selection function.

6. The HSS shall send Cx-Select-Pull Resp (required S-CSCF capabilities) to the I-CSCF.

7. The I-CSCF, using the name of the S-CSCF, shall determine the address of the S-CSCF through a name-address resolution mechanism and then shall send the register information flow (P-CSCFs "name" in the contact header, subscriber identity, visited network contact name) to the selected S-CSCF.

8. The S-CSCF shall send Cx-Put (subscriber identity, S-CSCF name) to the HSS. The HSS stores the S-CSCF name for that subscriber.

9. The HSS shall send Cx-Put Resp to the I-CSCF to acknowledge the sending of Cx-Put.

10. On receipt of the Cx-Put Resp information flow, the S-CSCF shall send the Cx-Pull information flow (subscriber identity) to the HSS in order to be able to download the relevant information from the subscriber profile to the S-CSCF. The S-CSCF shall store the P-CSCFs name, as supplied by the visited network. This represents the name that the home network forwards the subsequent terminating session signalling to for the UE.

11. The HSS shall return the information flow Cx-Pull Resp (user information) to the S-CSCF. The user information passed from the HSS to the S-CSCF shall include one or more names/addresses information which can be used to access the platform(s) used for service control while the user is registered at this S-CSCF. The S-CSCF shall store the information for the indicated user. In addition to the names/addresses information, security information may also be sent for use within the S-CSCF.

12. The S-CSCF shall determine whether the home contact name is the S-CSCF name or an I-CSCF name. If an I-CSCF is chosen as the home contact name, it may be distinct from the I-CSCF that appears in this registration flow. The home contact name will be used by the P-CSCF to forward signalling to the home network. The S-CSCF shall return the 200 OK information flow (serving network contact name, S-CSCF name) to the I-CSCF.

13. The I-CSCF shall send information flow 200 OK (serving network contact name) to the P-CSCF. The I-CSCF shall release all registration information after sending information flow 200 OK.

14. The P-CSCF shall store the serving network contact name, and shall send information flow 200 OK to the UE.

5.2.2.4 Re-Registration information flow – User currently registered

Editor's Note: the definition of re-registration timers requires further study, however it is noted that the timers in the UE are shorter than the registration related timers in the network.

Periodic application level re-registration is initiated by the UE either to refresh an existing registration or in response to a change in the registration status of the UE. Re-registration follows the same process as defined in subclause 5.2.2.3 "Registration Information Flow – User not registered".

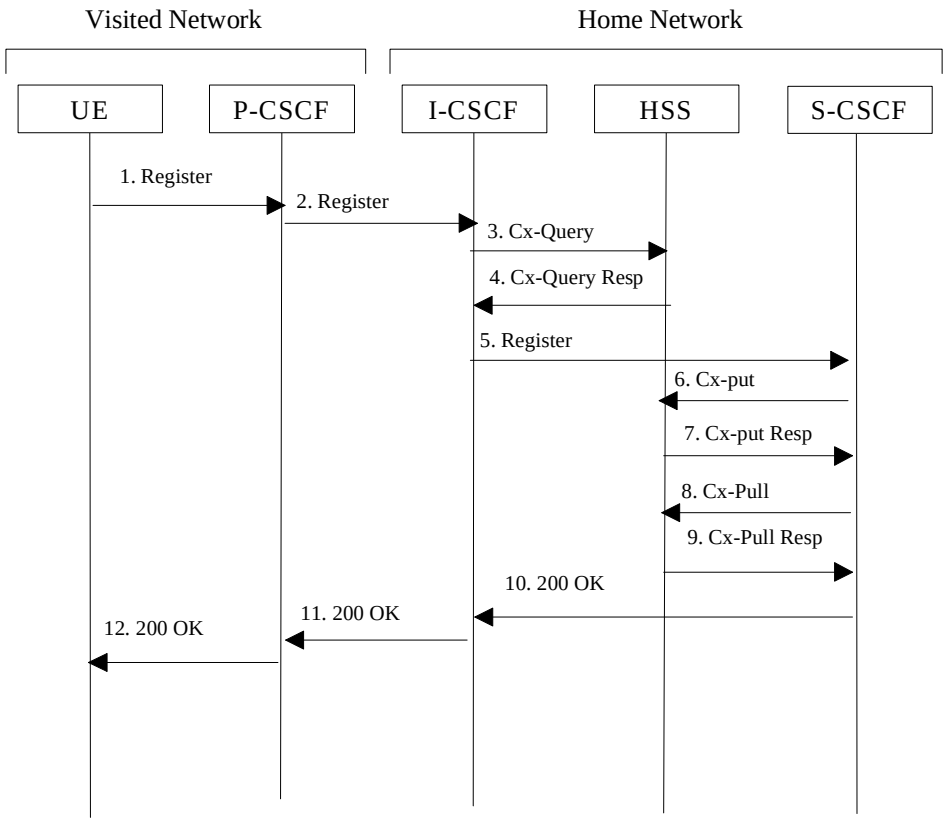


Figure 5.2: Re-registration - user currently registered

1. Prior to expiry of the agreed registration timer, the UE initiates a re-registration. To re-register, the UE sends a new REGISTER request. The UE sends the REGISTER information flow to the proxy (subscriber identity, home networks domain name).

2. Upon receipt of the register information flow, the P-CSCF shall examine the “home domain name” to discover the entry point to the home network (i.e. the I-CSCF). The proxy does not use the entry point cached from prior registrations. The proxy shall send the Register information flow to the I-CSCF (P-CSCFs “name” in the contact header, subscriber identity, visited network contact name). A name-address resolution mechanism is utilised in order to determine the address of the home network from the home domain name. When the I-CSCF receives the registration information flow from the proxy, it shall examine the subscriber identity and the home domain name, and employ the services of a name-address resolution mechanism, to determine the HSS address to contact.

3. The I-CSCF shall send the Cx-Query information flow to the HSS (P-CSCF name, subscriber identity, home domain name, and visited network contact name). The P-CSCF name is the contact name that the operator wishes to use for future contact to that P- CSCF.

Editors Note: It is FFS whether the terminal name, or proxy name, or both is included within this and subsequent register messages.

The Cx-query (P-CSCF name, subscriber identity, home domain name, and visited network contact name) information flow is sent to the HSS.

4. The HSS shall check whether the user is registered already and return an indication indicating that an S-CSCF is assigned. The Cx-Query Resp (indication of entry contact point, e.g. S-CSCF) is sent from the HSS to the I-CSCF.

5. At this stage, it is assumed that the authentication of the user has been completed (although it may have been determined at an earlier point in the information flows). The I-CSCF, using the name of the S-CSCF, shall determine the address of the S-CSCF through a name-address resolution mechanism and then shall send the re-register information flow (P-CSCFs “name” in the contact header, subscriber identity, visited network contact name) to the identified S-CSCF.

6. The S-CSCF shall send Cx-Put (subscriber identity, S-CSCF name) to the HSS. The HSS stores the S-CSCF name for that subscriber. Note: Optionally as an optimisation, the S-CSCF can detect that this is a re-registration and omit the Cx-Put request.

7. The HSS shall send Cx-Put Resp to the S-CSCF to acknowledge the sending of Cx-Put.

8. On receipt of the Cx-Put Resp information flow, the S-CSCF shall send the Cx-Pull information flow (subscriber identity) to the HSS in order to be able to download the relevant information from the subscriber profile to the S-CSCF. The S-CSCF shall store the P-CSCFs name, as supplied by the visited network. This represents the name that the home network forwards the subsequent terminating session signalling to for the UE. Note: Optionally as an optimisation, the S-CSCF can detect that this a re-registration and omit the Cx-Pull request.

9. The HSS shall return the information flow Cx-Pull-Resp (user information) to the S-CSCF. The S-CSCF shall store the user information for that indicated user.

10. The S-CSCF shall determine whether the home contact name is the S-CSCF name or the I-CSCF name. If an I-CSCF is chosen as the home contact name, it may be distinct from the I-CSCF that appears in this registration flow. The home contact name will be used by the P-CSCF to forward signalling to the home network. The S-CSCF shall return the 200 OK information flow (serving network contact name, S-CSCF name) to the I-CSCF.

11. The I-CSCF shall send information flow 200 OK (serving network contact name) to the P-CSCF. The I-CSCF shall release all registration information after sending information flow 200 OK.

12. The P-CSCF shall store the serving network contact name, and shall send information flow 200 OK to the UE.

5.2.2.5 Stored information.

Table 5.1 provides an indication of the information stored in the indicated nodes during and after the registration process.

Table 5.1 Information Storage before, during and after the registration process

Node	Before Registration	During Registration	After Registration
UE - in local network	Credentials Home Domain		Credentials Home Domain Proxy Name/Address
Proxy-CSCF - in local network	Routing Function	Network Entry point UE Address	Network Entry point UE Address
Interrogating-CSCF - in Home network	HSS Address	Serving-CSCF address/name (Editors Note: Access to Potential list of Serving-CSCFs is FFS)	No State Information
HSS	User Service Profile		Serving-CSCF address/name Proxy address/name?
Serving-CSCF (Home)	No state information	HSS Address/name Subscriber profile (limited – as per network scenario) Proxy address/name	May have session state Information HSS Address/name Subscriber information Proxy address/name

5.3 Application level de-registration procedures

5.3.1 Mobile initiated de-registration

Application level de-registration should be initiated by the UE upon roaming to a new network and power off of the terminal (if possible). De-registration is accomplished by a registration with an expiration time of zero seconds. De-registration follows the same path as defined in subclause 5.2.2.3 “Registration Information Flow – User not registered”.

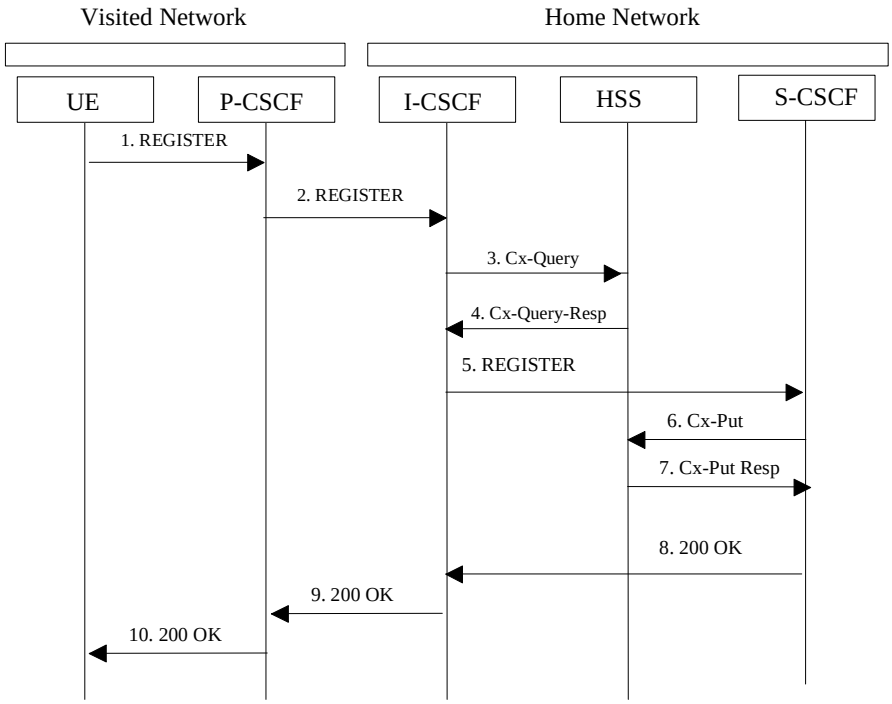


Figure 5.3: De-registration - user currently registered

1. The UE decides to initiate de-registration. To de-register, the UE sends a new REGISTER request with an expiration value of zero seconds. The UE sends the REGISTER information flow to the proxy (subscriber identity, home networks domain name).

2. Upon receipt of the register information flow, it shall examine the “home domain name” to discover the entry point to the home network (i.e. the I-CSCF). The proxy does not use the entry point cached from prior registrations. The proxy shall send the Register information flow to the I-CSCF (P-CSCFs “name” in the contact header, subscriber identity, and visited network contact name). A name-address resolution mechanism is utilised in order to determine the address of the home network from the home domain name. When the I-CSCF receives the registration information flow from the proxy, it shall examine the subscriber identity and the home domain name, and employ the services of a name-address resolution mechanism, to determine the HSS address to contact.

3. The I-CSCF shall send the Cx-Query information flow to the HSS (P-CSCF name, subscriber identity, home domain name, visited network contact name). The P-CSCF name is the contact name that the operator wishes to use for future contact to that P- CSCF. The Cx-query (P-CSCF name, subscriber identity, home domain name, and visited network contact name) information flow is sent to the HSS.

(Editors Note: It is FFS whether the terminal name, or proxy name, or both is included within this and subsequent register messages).

4. The HSS shall determine that the user is currently registered. The Cx-Query Resp (indication of entry point, e.g. S-CSCF) is sent from the HSS to the I-CSCF.

5. The I-CSCF, using the name of the S-CSCF, shall determine the address of the S-CSCF through a name-address resolution mechanism and then shall send the de-register information flow (P-CSCFs “name” in the contact header, subscriber identity, visited network contact name) to the selected S-CSCF.

6. The S-CSCF shall send Cx-Put (subscriber identity, clear S-CSCF name) to the HSS. The HSS clears the S-CSCF name for that subscriber.

7. The HSS shall send Cx-Put Resp to the S-CSCF to acknowledge the sending of Cx-Put.

8. The S-CSCF shall return the 200 OK information flow to the I-CSCF.

9. The I-CSCF shall send information flow 200 OK to the P-CSCF. The I-CSCF shall release all registration information after sending information flow 200 OK.

10. The P-CSCF shall send information flow 200 OK to the UE. The P-CSCF shall release all registration information after sending information flow 200 OK.

5.3.2 Network initiated de-registration

If an ungraceful session termination occurs (e.g. flat battery or mobile leaves coverage), when a stateful proxy server (such as the S-CSCF) is involved in a session, memory leaks and eventually server failure can occur due to hanging state machines. To ensure stable S-CSCF operation and carrier grade service, a mechanism to handle the ungraceful session termination issue is required. This mechanism should be at the SIP protocol level in order to guarantee access independence for the IM CN subsystem.

The IM CN subsystem can initiate a Network Initiated De-Registration procedures for the following reasons:

- **Network Maintenance.**
  Forced re-registrations from subscribers, e.g. in case of data inconsistency at node failure, in case of SIM lost, etc. Cancelling the current contexts of the user spread among the IM CN Subsystem network nodes at registration, and imposing a new IM registration solves this condition.

- **Network/traffic determined**.
  The IM CN subsystem must support a mechanism to avoid duplicate registrations or inconsistent information storage. This case will occur when a subscriber roams to a different network without de-registering the previous one. This case may occur at the change of the roaming agreement parameters between two operators, imposing new service conditions to roamers.

- **Application Layer determined**.
  Thie service capability offered by the IM CN Subsystem to the Application Layers may have parameters specifying whether all IM CN subsystem registrations are to be removed, or only those from one or a group of terminals from the user, etc.

- **Subscription Management**
  The operator must be able to restrict user access to the IM CN subsystem upon detection of contract expiration, removal of IM subscription, fraud detection, etc.

The following sections provide scenarios showing SIP application de-registration. Note that these flows have avoided the strict use of specific SIP protocol message names. This is in an attempt to focus on the architectural aspects rather than the protocol.

Two types of network-initiated de-registration procedures are required:

- To deal with registrations expirations.

- To allow the network to force de-registrations following any of the approved possible causes for this to occur.

5.3.2.1 Network Initiated Application (SIP) De-registration, Registration Timeout

The following flow shows a network initiated IM CN subsystem terminal application (SIP) de-registration based on a registration timeout. A timer value is provided at initial registration and is refreshed by subsequent re-registrations. The flow assumes that the timer has expired. The locations (home or visited network) of the P-CSCF and S-CSCF are not indicated as the scenario remains the same for all cases.

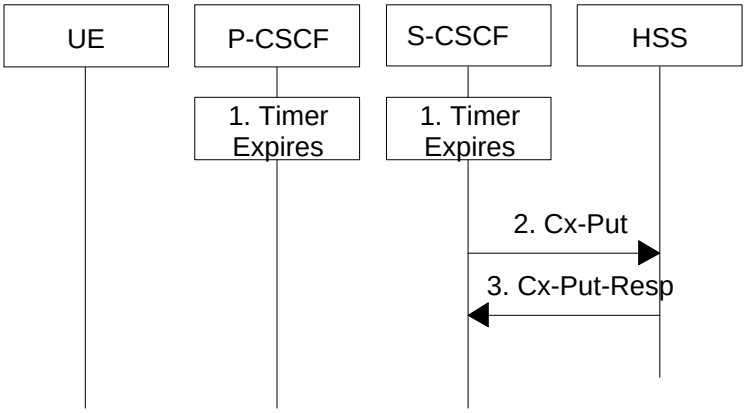


Figure 5.4: Network initiated application de-registration, registration timeout

1. The registration timers in the P-CSCF and in the S-CSCF expire. The timers are assumed to be close enough that no external synchronisation is required. The CSCFs update their internal databases to remove the UE from being registered. It is assumed that any GPRS PDP context cleanup will be handled by independent means.
2. The S-CSCF sends an update to the HSS to remove itself as the registered S-CSCF for this UE.
3. The HSS confirms the update.

5.3.2.2 Network Initiated Application (SIP) De-registration, Administrative

For different reasons (e.g., subscription termination, lost terminal, etc.) a home network administrative function may determine a need to clear a user's SIP registration. This function initiates the de-registration procedure and may reside in various elements depending on the exact reason for initiating the de-registration.

One such home network element is the HSS, which already knows the S-CSCF serving the user and that for this purpose makes use of the Cx-Deregister.

The following flow shows a network initiated IM CN subsystem terminal application (SIP) de-registration based on an administrative action for example. The IP transport infrastructure (e.g., GGSN, SGSN)is not notified. If complete packet access is to be denied, a transport layer administrative mechanism would be used. This scenario does not address the administrative mechanisms used for updating any subscriber records, EIR records, access authorisation, etc. This scenario only addresses the specific action of clearing the SIP application registration that is currently in effect.

Editor’s note: Release of ongoing multimedia sessions during this procedure is FFS.

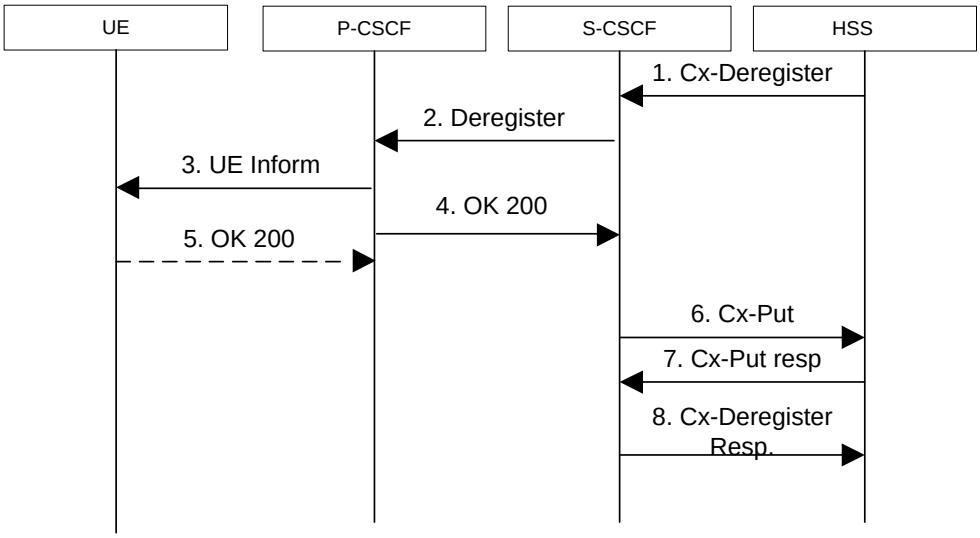


Figure 5.5: Network initiated application de-registration, administrative

1. HSS initiates the de-registration, sending a Cx-Deregister (subscriber identity)

   Note: A third trusted/secured party may also initiate the de-registration, most probably issuing a third party SIP registration with timer set to 0.

2. The S-CSCF issues a de-registration towards the P-CSCF for this UE and updates its internal database to remove the UE from being registered.

3. The P-CSCF informs the UE of the de-registration

Editors note: Due to loss of contact with the mobile, it might be possible that the UE does not receive the information of the deregistration. Implications of this is for FFS.

4. The P-CSCF sends a response to the S-CSCF and updates its internal database to remove the UE from being registered.

5. When possible, the UE sends a response to the P-CSCF to acknowledge the de-registration. A misbehaving UE or a UE that is out of P-CSCF coverage could not answer properly to the de-registration request. The P-CSCF should perform the de-registration in any case, e.g., after the timer for this request expires.

   Note: Steps 4 and 5 may be done in parallel: the P-CSCF does not wait for an answer from the UE before answering to the S-CSCF

6. The S-CSCF sends an update to the HSS to remove itself as the registered S-CSCF for this UE.

7. The HSS confirms the update.

8. The S-CSCF returns a response to the entity that initiated the process.

5.4 Procedures for IP multi-media sessions

Basic sessions between mobile subscribers will always involve two S-CSCFs (one S-CSCF for each). A basic session between a subscriber and a PSTN endpoint involves an S-CSCF for the UE, a BGCF to select the PSTN gateway, and an MGCF for the PSTN.

The session flow is decomposed into three parts – an origination part, an inter-Serving-CSCF/ MGCF part, and a termination part. The origination part covers all network elements between the UE (or PSTN) and the S-CSCF for that UE (or MGCF serving the MGW). The termination part covers all network elements between the S-CSCF for the UE (or MGCF serving the MGW) and the UE (or PSTN).

5.4.1 Bearer interworking concepts

Voice bearers from the IM CN subsystem need to be connected with the voice bearers of other networks. Elements such as Media Gateway Functions (MGW) are provided to support such bearer interworking. One of the functions of the MGW may be to support transcoding between a codec used by the UE in the IM CN subsystem and the codec being used in the network of the other party.

For this release the IM CN subsystem supports the AMR codec as the native codec for voice over IP. Thus the IM CN subsystem is able to interwork with other networks which support this codec (either as native or through transcoding in the other party's network).

The IM CN subsystem is also able to interwork with the CS networks (e.g. PSTN, ISDN, CS domain of some PLMN) by supporting AMR to G.711 [17] transcoding in the IMS MGW element. Furthermore to allow interworking between users of the IM CN subsystem and IP multimedia fixed terminals and other codecs may (this is implementation dependent) be supported by the MGW.

Support for transcoding to other codec formats is for further study.

5.4.2 Interworking with Internet

Depending on operator policy, the S-CSCF may forward the SIP request or response to another SIP server located within an ISP domain outside of the IM CN subsystem.

5.4.3 Interworking with PSTN

The S-CSCF, possibly in conjunction with an application server, shall determine that the session should be forwarded to the PSTN. The S-CSCF will forward the Invite information flow to the BGCF in the same network.

The BGCF selects the network in which the interworking should occur, and the selection of the interworking network is based on local policy.

If the BGCF determines that the interworking should occur in the same network, then the BGCF selects the MGCF which will perform the interworking, otherwise the BGCF forward the invite information flow to the BGCF in the selected network.

The MGCF will perform the interworking to the PSTN and control the MG for the media conversions.

The high level overview of the network initiated PSTN interworking process is shown in figure 5.6.

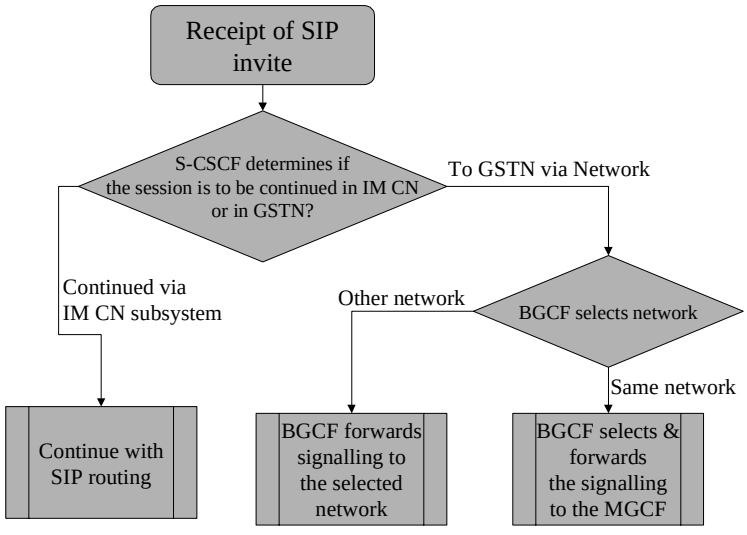


Figure 5.6: Network based PSTN interworking breakout process

5.4.4 Requirements for IP multi-media session control

In order for operators to be able to offer a “carrier-grade” IP multimedia service, and considering that the network cannot trust the UE to give correct references to be put in the CDR or to require bearers whose features (e.g. Bandwidth) are coherent with the media components negotiated through CSCFs, the following features shall be offered:

1. Both end points of the session shall be able to negotiate (according to service /UE settings,) which resources (i.e. which media components) need to be established before the destination party is alerted. The session signalling shall ensure that these resources (including (UMTS) IP-Connectivity Network resources and IP multimedia backbone resources) are made available or reserved before the destination UE rings.

   This should nevertheless not prevent the UE from offering to the end-user the choice of accepting or rejecting the components of the session before establishing the bearers.

2. Depending on regulatory requirements, the IP multimedia service shall be able to charge the originating party for the Access IP-connectivity service of both originating and destination side or when reverse charging applies to charge the terminating party for the Access IP-connectivity service of both originating and terminating side. This implies that it should be easy to correlate CDR held by Access IP-connectivity service (e.g. GPRS) with a session.

3. The session control function of IP multimedia network of an operator (CSCF) shall be able (according to operator choice) to have a strict control (e.g. on source /destination IP address, QoS) on the flows associated with session established through SIP entering the IP multimedia bearer network from Access IP-connectivity service. This does not mean that CSCF is the enforcement point (which actually is the Gateway between the Access IP-connectivity service and the IP multimedia network, i.e. the GGSN in UMTS case) but that the CSCF may be the final decision point for this control.

4. The session control and bearer control mechanisms shall allow the session control to decide when user plane traffic between end-points of a SIP session may start/shall stop. This allows this traffic to start/stop in synchronisation with the start/stop of charging for a session.

5. The Access IP-connectivity service shall be able to notify the IP multimedia session control when Access IP-connectivity service has either modified or suspended or released the bearer(s) of an user associated with a session (because e.g. the user is no longer reachable).

6. The solution shall comply with the architectural rules relating to separation of bearer level, session control level, and service level expressed in 23.221[7].

5.4.5 Storing of session path information

There is a need to store the session path that is determined during the session initiation request in order to route the subsequent session requests through this determined path. This is needed in order to route these session requests through certain nodes, e.g. the ones performing Service Control. CSCFs are assumed to perform certain actions:

1. CSCFs (Proxy and Serving) store a certain part of the session path determined during session initiation. This allows CSCFs to generate requests that traverse all elements on a Route path.

2. P-CSCF will remove the network generated contents of the Via and Record-Route headers of the SIP requests to be sent to the UE. This increases security and reduces SIP message sizes and thus transmission delay over the air interface.

5.4.6 End-user preferences and terminal capabilities

Due to different capabilities of the originating and terminating terminals, it might not be possible to establish all the media suggested by the originator for a particular session. In addition, the destination user may have different preferences of type of media depending on who is originating and on the situation e.g. being in a meeting or driving the car etc.

5.4.6.1 Objectives

The general objectives concerning terminal capabilities and end-user behaviour are listed below.

- **The capabilities of the terminal** have impact on the SDP description in the SIP session flows, since different terminals may support different media types (such as video, audio, application or data) and may have implemented different set of codecs for audio and video. Note that the capabilities of the terminal may change when an external device, such as a video camera is attached to the terminal.

- **The configuration of the terminal** changes the capabilities of the terminal. This can be done by attaching external devices or possibly by a user setting of certain parameters or profiles in the terminal.

- **The preferences of the destination user** may depend on who is originating the session and on the situation. Cost, associated with the session, may also be another factor, i.e. depending on time of the day or day of the week etc. Due to this reason the user may want to accept or reject certain media components.

- **The available resources in the network** play an important role, as certain media streams, consuming high bandwidth, may be denied. Therefore, before the user is alerted that the session set up is successful, it is assumed that the network has guaranteed and has reserved the needed resources for one or several media streams of the session. This does not preclude the possibility for the user to indicate his/her preferences regarding the session also after the alerting, in which case the initial resource reservations may have to be modified.

- **End-to-end quality of service** may be provided by using a variety of mechanisms, including guaranteed end-to-end QoS and best effort. The network may not be able to guarantee the requested end-to-end QoS. This may be the case when the user is establishing sessions through the public Internet. On the other hand, certain sessions, with the agreement of the initiating and terminating endpoints, should have the right to go through even without having the requested QoS guarantee.

5.4.6.2 End-user expectations

From the end-user point of view the following user interactions can be listed:

- For outgoing sessions, it is assumed that the user would like to select certain parameters that define the proposed session. This can be pre-configured as preferences or defined on a per session basis.

- For incoming sessions, it is assumed that the terminal will establish a dialogue with the user. Such dialogue allows the user to manually accept some of the proposed parameters by the originator. This is typically media type (audio, video, whiteboard) and different quality parameters per media type. As an alternative, the user preferences may be pre-configured.

- Before establishing or accepting a new session, the user may define or agree on the following parameters. Some of these parameters may be pre-configured and others are defined on a per session basis.

    1. Type of media, i.e. audio, video, whiteboard, etc. This represents the user preferences of media types.

    2. Combination of QoS attributes and selection of codec. This represents the quality of the media component, the cost and the probability of availability of resources both in the access network and in the core network.

    3. Subset of capabilities used in the terminal. Terminals can have different set of capabilities. However, the user may or may not want to use the maximum set of capabilities. For instance, a user might want to establish a low cost video session with a small window on the screen.

    4. End-to-end quality of service. For certain media streams, the user may want assured end-to-end QoS while for other streams the QoS may be optional or even not desired at all (best effort).

5.4.6.3 Mechanism for bearer establishment

In order to fulfil the above requirements, it is needed that the destination user can be pre-alerted before the bearer establishment and negotiation and PDP context activation has taken place. This gives room for the destination user to choose the media streams and codecs required before an expensive resource (as the air interface is) is established.

Figure 5.7 shows the mechanism for the bearer establishment in which the pre-alerting occurs before the initial bearer creation procedures are performed. Furthermore, a user interaction may also occur after the initial bearers are created as shown in figure 5.7.

The "Other x-CSCFs" entity in figure 5.7 comprises several CSCFs: I-CSCF and S-CSCFs. For the sake of simplicity only the GGSNs are presented from the UMTS access network and the Policy Control Functions have been omitted from the diagram.

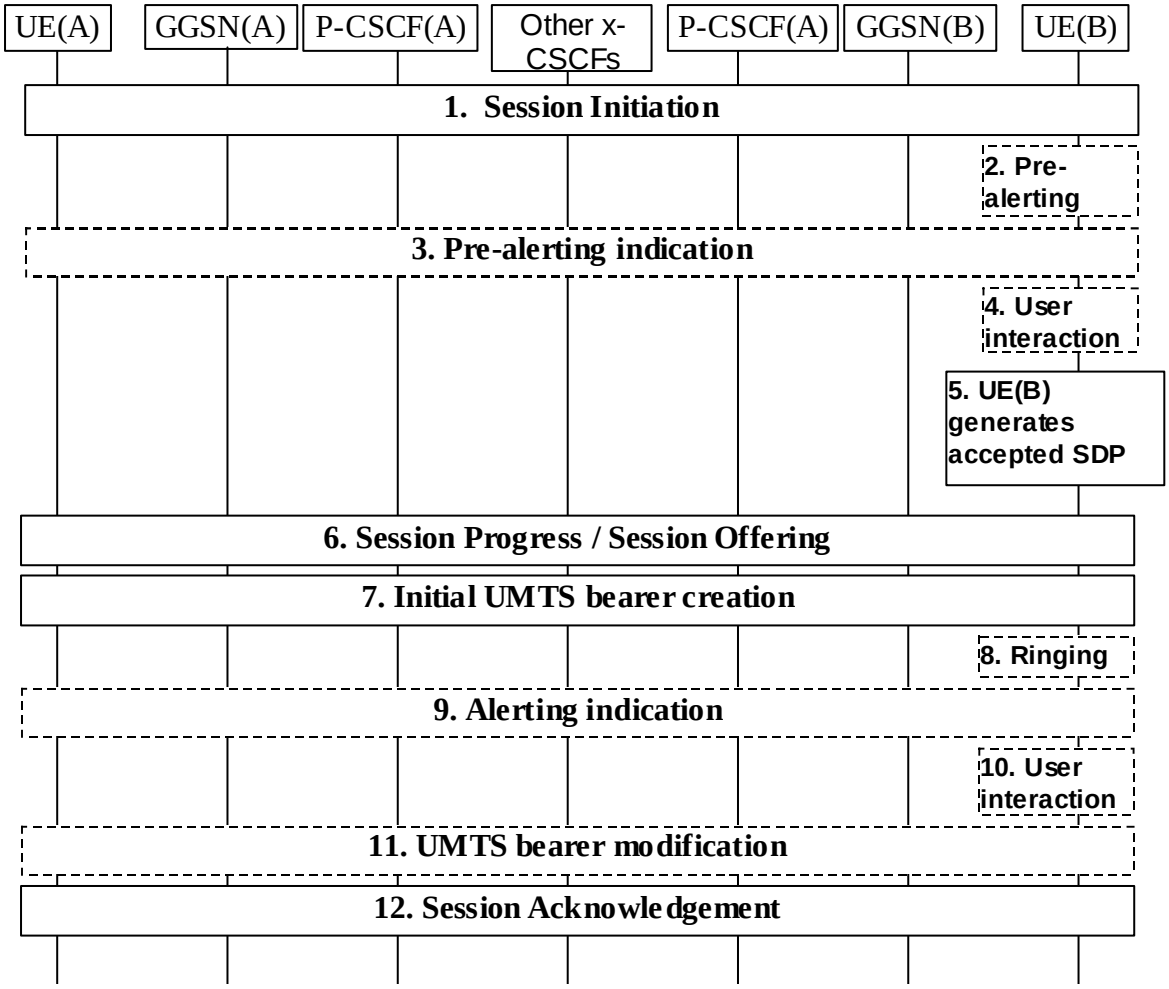


Figure 5.7: Bearer establishment showing optional pre-alerting

1. UE(A) starts a Session Initiation procedure to UE(B) that includes an SDP proposal.

   The steps 2-4 are optional and may depend on terminal implementation and/or terminal pre-configured settings.

2. The user at UE(B) is pre-alerted.

3. An indication of the pre-alerting may be sent towards UE(A).

4. User at UE(B) will then interact and express his/her wishes regarding the actual session.

5. UE(B) generates accepted SDP based on terminal settings, terminal pre-configured profiles and optionally the user's wishes.

6. The accepted SDP is forwarded to UE(A) in the payload of a reliable SIP response.

7. Initial bearer creation procedure is performed. During this bearer creation step the resources in the UE(A)'s and UE(B)'s access network are reserved with PDP context procedures. Bearer resources in external networks may also be reserved at this point.

   The steps 8-10 are also optional and may be skipped.

8. Terminal at UE(B) starts ringing.

9. The alerting indication is sent towards UE(A).

10. User at UE(B) may interact and express his/her wishes regarding the actual session.

11. UE(A) and UE(B) may perform bearer modification procedure at this point, if the initial bearers reserved in step 7 and the wishes of user at UE(B) are different. During this bearer modification step the resources in the UE(A)'s and UE(B)'s access network may be modified by modifying the PDP context, and the resource reservation in the external network may also be modified.

12. Session initiation procedure is acknowledged.

5.4.7 Interaction between QoS and session signalling

At PDP context setup the user shall have access to either GPRS without service-based local policy, or GPRS with service-based local policy. It is operator choice whether to offer both or only one of these alternatives for accessing the IM Subsystem.

For the GPRS without service-based local policy case, the bearer is established according to the user's subscription, local operator's IP bearer resource based policy, local operator's admission control function and GPRS roaming agreements. The establishment of the PDP context bearer shall use the PDP context activation procedure specified in TS 23.060.

For the GPRS with service-based local policy case, Service-Based Local Policy decisions (e.g., authorisation and gating of the bearer by a proxy CSCF) are also applied to the bearer.

The description in this subsection is applicable for the case when service-based local policy is employed.

The GGSN contains a Policy Enforcement Function (PEF) that has the capability of policing packet flow into the IP network, and restricting the set of IP destinations that may be reached from/through a PDP context according to a packet classifier. This 'gate' function has an external control interface that allows it to be selectively 'opened' or 'closed' on the basis of IP destination address and port. When open, the gate allows packets to pass through (to the destination specified in the classifier) and when closed, no packets are allowed to pass through. The control is performed by a PCF, which is a logical entity of the P-CSCF. (Note: If the PCF is implemented in a separate physical node, the interface between the PCF and the P-CSCF is not standardised).

There are five interactions between the PCF and the Policy Enforcement Function (PEF), located within the GGSN:

1. Authorise UMTS and IP resources. This establishes the 'gate' described above

2. Enable media stream authorised in (1), e.g. 'open' the 'gate'

3. Disable media stream authorised in (1), e.g. 'close' the 'gate'

4. Revoke authorisation for UMTS and IP resources

5. Indicate from the GGSN to the P-CSCF (PCF) of PDP Context release.

There are two interactions between the UE and the GGSN:

1. Allocate the UMTS resources and IP resources (i.e. beyond the GGSN), within the previous authorisation from the P-CSCF (PCF)

2. Release UMTS and IP resources

These requirements and functional description of these interactions are explained further in the following sections. The complete specification of the interface between the Policy Control Function and the Policy Enforcement Function, and between the UE and the GGSN, are contained in TS 23.207.

5.4.7.1 Authorise UMTS and IP QoS Resources

The GGSN serves as the Policy Enforcement Point that implements the policy decisions for performing admission control and authorising the UMTS and IP BS QoS Resource request, and policing IP flows entering the external IP network.

Authorisation of UMTS and IP QoS Resources shall be required for access to the IP Multimedia Subsystem. The GGSN shall determine the need for authorisation, possibly based on provisioning and/or based on the APN of the PDP context.

The authorisation shall be made prior to the allocation request from the UE. This authorisation may be given to the GGSN from the P-CSCF(PCF) via a 'Push'-type of interface, or may be 'Pulled' from the P-CSCF(PCF) by the GGSN when the allocation request is received from the UE. The authorisation shall include binding information, which shall also be provided by the UE to the GGSN in the allocation request, which enables accurate matching of requests and authorisations. This binding information may be an authorisation token assigned by the P-CSCF(PCF), possibly in consultation with the GGSN, and may contain information that identifies the P-CSCF(PCF) that generated the token. The authorisation shall include limits on IP packet flows, and may include restrictions on IP destination address and port. These restrictions may take the form of a flowspec and filterspec, as defined in RFC2205. The P-CSCF(PCF) shall use the SDP contained in the SIP signaling to calculate the proper authorisation, as defined in TS 23.207. The authorisation shall be expressed in terms of the IP resources to be authorised.

Authorisation may contain information used by the network operator to correlate usage records generated by the GPRS system with those generated by the IP Multi-Media Subsystem. Such a correlation identifier, if included in the authorisation, shall be provided to the GPRS elements that generate such usage records.

Authorisation information, combined with the QoS allocation request from the UE, shall be sufficient for the GGSN to initiate an RSVP exchange with the remote endpoint of the IP packet flow.

5.4.7.2 Enable Media Stream

The P-CSCF (PCF) provides a final decision about enabling the allocated QoS resources for per-session authorisations.

The GGSN enforces the policy decisions. The GGSN may restrict any use of the UMTS resources prior to this decision from the PCF. The GGSN shall restrict any use of the IP resources prior to this decision from the PCF.

5.4.7.3 Disable Media Stream

The P-CSCF (PCF) provides a final decision about enabling the allocated QoS resources for per-session authorisations.

The GGSN enforces the policy decisions. The GGSN may restrict any use of the UMTS resources after this decision from the PCF. The GGSN shall restrict any use of the IP resources after this decision from the PCF.

5.4.7.4 Revoke authorisation for UMTS and IP Resources

At IP multimedia session release, the UE should deactivate the PDP context(s) used for the IP multimedia session. In various cases, such as loss of signal from the mobile, the UE will be unable to perform this release itself. The P-CSCF, serving as the Policy Control Function, provides indication to the GGSN when the resources previous authorised, and possibly allocated by the UE, are to be released. The GGSN may differentiate charging before and after the IP multimedia session release, or may deactivate the PDP context used for the IP multimedia session. The latter ensures that the PDP context can not be used for other traffic than the IP multimedia session. The functions in the PS domain due to the IP multimedia session release are operator specific and are configured in the GGSN.

5.4.7.5 Indication of PDP Context release

Any release of a PDP Context that was established based on authorisation from the PCF shall be reported to the PCF by the GGSN.

In the particular case of PDP Context termination due to signal fade or loss of power at the UE, this indication is used by the P-CSCF(PCF) to initiate a session release towards the remote endpoint.

5.4.7.6 Allocate UMTS and IP Resources

Allocation of QoS resources shall be initiated by the UE, and shall take place only after successful authorisation by subscription or by the PCF. The UE calculates its QoS resource needs from the SDP contained in the SIP signaling.

Allocation requests from the UE shall contain the binding information provided to the UE in the SIP signaling. The use of this binding information enables the GGSN to correctly match the allocation request to the corresponding authorisation. When a UE combines multiple media flows onto a single PDP context, all of the binding information related to those media flows shall be provided in the context activation/modification request.

The request for UMTS QoS resources may be signaled independently from the request for IP QoS resources by the UE. At the UMTS BS Level, the PDP Context activation shall be used for QoS signaling. At the IP BS Level, RSVP may be used for QoS signaling.

With a request for UMTS QoS resources, the GGSN shall verify the request is less than the sum of the authorised IP resources (within the error tolerance of the conversion mechanism) for all of the combined media flows. With a request for IP QoS resources, the GGSN shall verify the request is less than the authorised IP resources.

5.4.7.7 Release UMTS and IP Resources

Release of QoS resources shall be initiated by the UE, or by the SGSN/GGSN if it determines the UE is unable to communicate (e.g. signal fade or loss of power).

5.4.8 Event and information distribution within IMS during a Session

The S-CSCF shall be able to send service information messages to endpoints. This shall be done based on a SIP Request/Response information exchange containing the service information and/or a list of URI(s) pointing to the location of information represented in other media formats. The stimulus for initiating the service event related information message may come from e.g. an application server or some other network entity.

Editor's note: The exact list of these entities is for further study.

Other entities than an S-CSCF may also have the service capability of sending service information messages to endpoints.

Editor's note: The exact list of these entities is for further study.

This mechanism considers the following issues:

- The IMS has the capability to handle different kinds of media. That is, it is possible to provide information contained within several different media formats e.g. text, pictures or video.
- The UE's level of supporting service event related information and its exchange may depend on the UE's capabilities and configuration.
- A UE not participating in the service related information exchange shall not be effected by a service related information exchange possibly being performed with another UE of the session.

Note: Although this example only shows service information sent from S-CSCF#1, other entities may also invoke service event related information exchange.

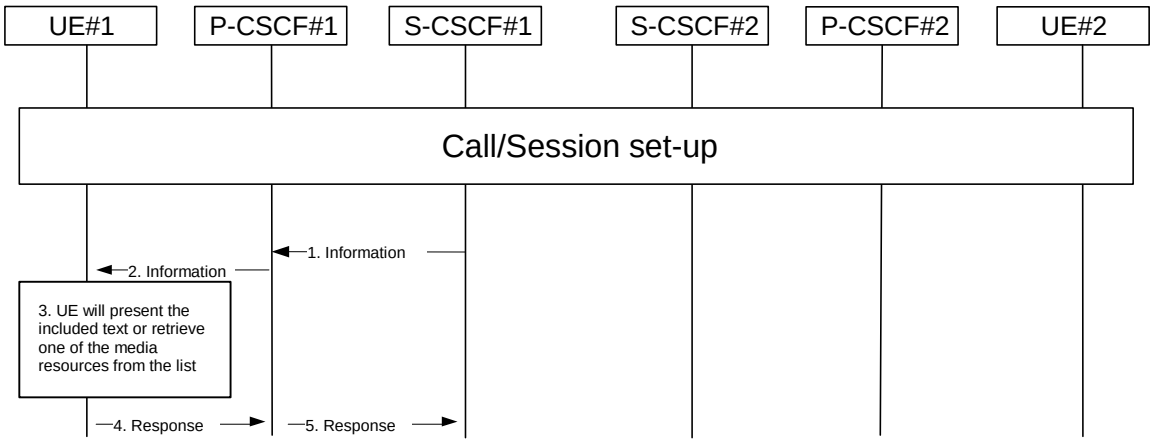


Figure 5.8: S-CSCF provides service event related information to related endpoint

1. When a service event occurs that the S-CSCF wishes to inform an endpoint about, the S-CSCF generates a message request containing information to be presented to the user. The contents may include text describing the service event, a list of URI(s) or other service modification information.

2. P-CSCF forwards the message request.
3. UE presents the service-related information, to the extent that it conforms to its capabilities and configuration, to the user.
4. Possibly after interaction with the user, the UE will be able to include information in the response to the S-CSCF.
5. P-CSCF forwards the response.

Editor's note: How the UE retrieves the service event related information is FFS.

5.4.9 Overview of session flow procedures

This section contains the overview description and list of individual procedures for the end-to-end session flows.

For an IP Multi-Media Subsystem session, the session flow procedures are shown in the following diagram.

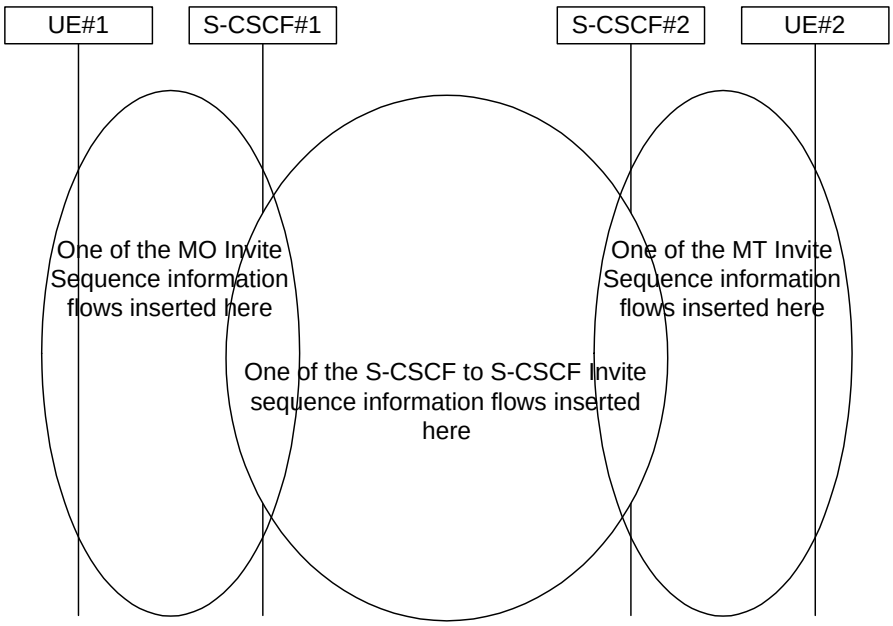


Figure 5.9: Overview of Session Flow Sections

The following procedures are defined:

For the origination sequence:

- (MO#1) Mobile origination, roaming
- (MO#2) Mobile origination, home
- (PSTN-O) PSTN origination

For the termination sequence:

- (MT#1) Mobile termination, roaming
- (MT#2) Mobile termination, home
- (PSTN-T) PSTN termination

For Serving-CSCF/MGCF-to-Serving-CSCF/MGCF sequences:

- (S-S#1) Session origination and termination are served by different network operators,

- (S-S#2) Session origination and termination are served by the same operator.
- (S-S#3) Session origination with PSTN termination in the same network as the S-CSCF.
- (S-S#4) Session origination with PSTN termination in a different network to the S-CSCF

For example, for a non-roaming subscriber initiating a session to another non-roaming subscriber, each a subscriber of the same network operator, it is possible to construct a complete end-to-end session flow from the following procedures:

- (MO#2) Mobile origination, home
- (S-S#2) Single network operator,
- (MT#2) Mobile termination, home

An informative example of this session flow is given in Annex B.1

There are a large number of end-to-end session flows defined by these procedures. They are built from combinations of origination, serving to serving, and termination procedures, as determined from the following table. For each row of the table, any one of the listed origination procedures can be combined with any one of the serving-serving procedures, which can be combined with any one of the termination procedures. In addition, several of the procedures give alternatives for network configuration hiding (the number of such alternatives is shown in parentheses).

Table 5.2: Combinations of session procedures

Origination Procedure (pick one)	Serving-CSCF-to-Serving-CSCF Procedure (pick one)	Termination Procedure (pick one)
MO#1 Mobile origination, roaming, home control of services (2). MO#2 Mobile origination, located in home service area. PSTN-O PSTN origination.	S-S#1 Different network operators performing origination and termination, with home control of termination (2). S-S#2 Single network operator performing origination and termination, with home control of termination.	MT#1 Mobile termination, roaming, home control of services(2). MT#2 Mobile termination, located in home service area. PSTN-T PSTN termination.
MO#1 Mobile origination, roaming, home control of services (2). MO#2 Mobile origination, located in home service area. PSTN-O PSTN origination.	S-S#3 PSTN termination in the same network as the S-CSCF. S-S#4 PSTN termination in different network than the S-CSCF	PSTN-T PSTN termination.

5.5 Serving-CSCF/MGCF to serving-CSCF/MGCF procedures

This section presents the detailed application level flows to define the procedures for Serving-CSCF to Serving-CSCF.

This section contains four session flow procedures, showing variations on the signalling path between the Serving-CSCF that handles session origination, and the Serving-CSCF that handles session termination. This signalling path depends on:

- whether the originator and destination are served by the same network operator,
- whether the network operators have chosen to hide their internal configuration.

The Serving-CSCF handling session origination performs an analysis of the destination address, and determines whether it is a subscriber of the same network operator or a different operator.

If the analysis of the destination address determined that it belongs to a subscriber of a different operator, the request is forwarded (optionally through an I-CSCF within the originating operator's network) to a well-known entry point in the

destination operator's network, the I-CSCF. The I-CSCF queries the HSS for current location information. The I-CSCF then forwards the request to the S-CSCF.If the analysis of the destination address determines that it belongs to a subscriber of the same operator, the S-CSCF passes the request to a local I-CSCF, who queries the HSS for current location information. The I-CSCF then forwards the request to the S-CSCF.

5.5.1 (S-S#1) Different network operators performing origination and termination

The Serving-CSCF handling session origination performs an analysis of the destination address, and determines that it belongs to a subscriber of a different operator. The request is therefore forwarded (optionally through an I-CSCF within the originating operator's network) to a well-known entry point in the destination operator's network, the I-CSCF. The I-CSCF queries the HSS for current location information, and finds the subscriber either located in the home service area, or roaming. The I-CSCF therefore forwards the request to the S-CSCF serving the destination subscriber.

Origination sequences that share this common S-S procedure are:

MO#1 Mobile origination, roaming. The "Originating Network" of S-S#1 is therefore a visited network.

MO#2 Mobile origination, home. The "Originating Network" of S-S#1 is therefore the home network.

PSTN-O PSTN origination. The "Originating Network" of S-S#1 is the home network. The element labeled S-CSCF#1 is the MGCF of the PSTN-O procedure.

Termination sequences that share this common S-S procedure are:

MT#1 Mobile termination, roaming. The "Terminating Network" of S-S#1 is a visited network.

MT#2 Mobile termination, located in home service area. The "Terminating Network" of S-S#1 is the home network.

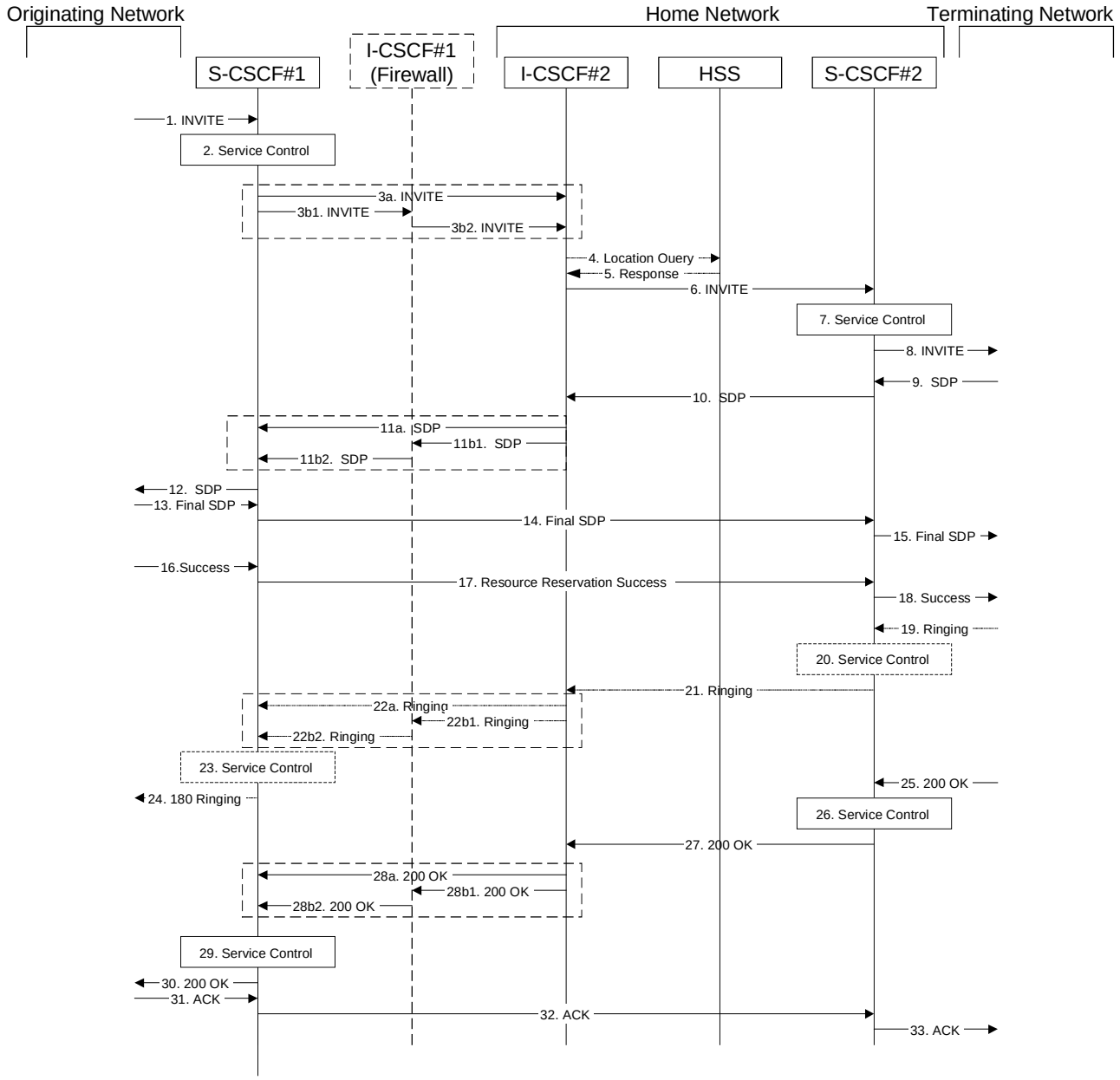


Figure 5.10: Serving to serving procedure - different operators

Procedure S-S#1 is as follows:

1. The SIP INVITE request is sent from the UE to S-CSCF#1 by the procedures of the originating flow.

2. S-CSCF#1 performs whatever service control logic is appropriate for this session attempt.

3. S-CSCF#1 performs an analysis of the destination address, and determines the network operator to whom the subscriber belongs. For S-S#1, flow (2) is an inter-operator message to the I-CSCF entry point for the terminating subscriber. If the originating operator desires to keep their internal configuration hidden, then S-CSCF#1 forwards the INVITE request through an I-CSCF (choice (b)); otherwise S-CSCF#1 forwards the INVITE request directly to I-CSCF#2, the well-known entry point into the terminating subscriber's network (choice (a)).

   (3a) If the originating network operator does not desire to keep their network configuration hidden, the INVITE request is sent directly to I-CSCF#2.

   (3b) If the originating network operator desires to keep their network configuration hidden, the INVITE request is forwarded through an I-CSCF in the originating operator's network, I-CSCF#1.

      (3b1) The INVITE request is sent from S-CSCF#1 to I-CSCF#1

(3b2) I-CSCF#1 performs the configuration-hiding modifications to the request and forwards it to I-CSCF#2

4. I-CSCF#2 (at the border of the terminating subscriber's network) may query the HSS for current location information. If I-CSCF#2 cannot determine, based on analysis of the destination number, that the HSS query will fail, then it will send "Cx-location-query" to the HSS to obtain the location information for the destination. If I-CSCF#2 can determine, based on analysis of the destination number, that the HSS query will fail, it will not send the "Cx-location-query" message, allocate a MGCF for a PSTN termination, and continue with step #6.

5. HSS responds with the address of the current Serving-CSCF for the terminating subscriber.

6. I-CSCF#2 forwards the INVITE request to the S-CSCF (S-CSCF#2) that will handle the session termination.

7. S-CSCF#2 performs whatever service control logic is appropriate for this session setup attempt

8. The sequence continues with the message flows determined by the termination procedure.

9. The media stream capabilities of the destination are returned along the signalling path, as per the termination procedure.

10. S-CSCF#2 forwards the SDP to I-CSCF#2

11. I-CSCF#2 forwards the SDP to S-CSCF#1. Based on the choice made in step #3 above, this may be sent directly to S-CSCF#1 (11a) or may be sent through I-CSCF#1(firewall) (11b1 and 11b2)

12. S-CSCF#1 forwards the SDP to the originator, as per the originating procedure.

13. The originator decides the final set of media streams, and forwards this information to S-CSCF#1 by the origination procedures

14. S-CSCF#1 forwards the final SDP to S-CSCF#2. This may possibly be routed through I-CSCF#1(firewall) or I-CSCF#2(firewall) depending on operator configuration of the I-CSCFs

15. S-CSCF#2 forwards the final SDP to the terminating endpoint, as per the termination procedure

16. When the originating endpoint has completed the resource reservation procedures, it sends the "Resource reservation success" message to S-CSCF#1 by the origination procedures.

17. S-CSCF#1 forwards this message to S-CSCF#2. This may possibly be routed through I-CSCF#1(firewall) or I-CSCF#2(firewall) depending on operator configuration of the I-CSCFs.

18. S-CSCF#2 forwards this message to the terminating endpoint, as per the termination procedure

19. The terminating endpoint may optionally send a provisional response indicating alerting is in progress. This message is sent by the termination procedure to S-CSCF#2.

20. S-CSCF#2 performs whatever service control is appropriate for alerting

21. S-CSCF#2 forwards the ringing message to I-CSCF#2

22. I-CSCF#2 forwards the ringing message to S-CSCF#1. Based on the choice made in step #3 above, this may be sent directly to S-CSCF#1 (22a) or may be sent through I-CSCF#1(firewall) (22b1 and 22b2)

23. S-CSCF#1 performs whatever service control is appropriate for this alerting flow

24. S-CSCF#1 forwards the ringing message to the originator, per the origination procedure

25. The SIP final response, 200-OK, is sent by the terminating endpoint over the signalling path. This is typically generated when the subscriber has accepted the incoming session setup attempt. The message is sent to S-CSCF#2 per the termination procedure

26. S-CSCF#2 performs whatever service control logic is appropriate for this session setup completion

27. The 200-OK is passed to the I-CSCF#2.

28. The 200-OK is passed to the S-CSCF#1. Based on the choice made in step #3 above, this may be sent directly to S-CSCF#1 (28a) or may be sent through I-CSCF#1(firewall) (28b1 and 28b2).

29. S-CSCF#1 performs whatever service control logic is appropriate for this session setup completion

30. The 200-OK is returned to the originating endpoint, by the origination procedure.

31. The originating endpoint sends the final acknowledgement to S-CSCF#1 by the origination procedures.

32. S-CSCF#1 forwards this message to S-CSCF#2. This may possibly be routed through I-CSCF#1(firewall) or I-CSCF#2(firewall) depending on operator configuration of the I-CSCFs.

33. S-CSCF#2 forwards this message to the terminating endpoint, as per the termination procedure

5.5.2 (S-S#2) Single network operator performing origination and termination

The Serving-CSCF handling session origination performs an analysis of the destination address, and determines that it belongs to a subscriber of the same operator. The request is therefore forwarded to a local I-CSCF. The I-CSCF queries the HSS for current location information, and finds the subscriber either located in the home service area, or roaming. The I-CSCF therefore forwards the request to the S-CSCF serving the destination subscriber.

Origination sequences that share this common S-S procedure are:

MO#1 Mobile origination, roaming,. The “Originating Network” of S-S#2 is therefore a visited network.

MO#2 Mobile origination, home. The “Originating Network” of S-S#2 is therefore the home network.

PSTN-O PSTN origination. The “Originating Network” of S-S#2 is the home network. The element labelled S-CSCF#1 is the MGCF of the PSTN-O procedure.

Termination sequences that share this common S-S procedure are:

MT#1 Mobile termination, roaming, . The “Terminating Network” of S-S#2 is a visited network.

MT#2 Mobile termination, home. The “Terminating Network” of S-S#2 is the home network.

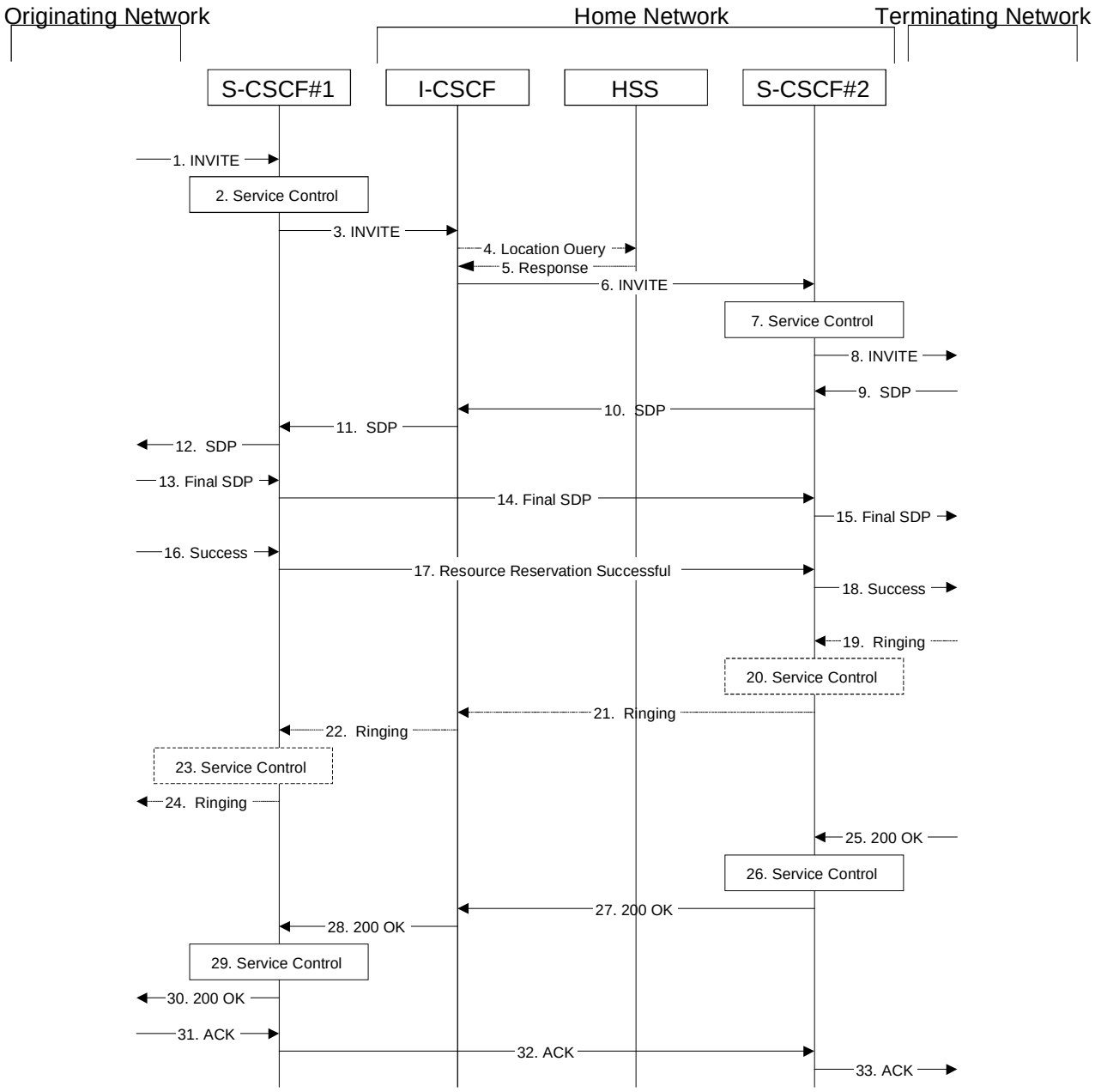


Figure 5.11: Serving to serving procedure - same operator

Procedure S-S#2 is as follows:

1. The SIP INVITE request is sent from the UE to S-CSCF#1 by the procedures of the originating flow.

2. S-CSCF#1 performs whatever service control logic is appropriate for this session setup attempt

3. S-CSCF#1 performs an analysis of the destination address, and determines the network operator to whom the subscriber belongs. Since it is local, the request is passed to a local I-CSCF.

4. I-CSCF may query the HSS for current location information. If I-CSCF cannot determine, based on analysis of the destination number, that the HSS query will fail, then it will send “Cx-location-query” to the HSS to obtain the location information for the destination. If I-CSCF can determine, based on analysis of the destination number, that the HSS query will fail, it will not send the “Cx-location-query” message, allocate a MGCF for a PSTN termination, and continue with step #6.

5. HSS responds with the address of the current Serving-CSCF for the terminating subscriber.

6. I-CSCF forwards the INVITE request to the S-CSCF (S-CSCF#2) that will handle the session termination.

7. S-CSCF#2 performs whatever service control logic is appropriate for this session setup attempt
8. The sequence continues with the message flows determined by the termination procedure.
9. The media stream capabilities of the destination are returned along the signalling path, as per the termination procedure.
10. S-CSCF#2 forwards the SDP to I-CSCF
11. I-CSCF forwards the SDP to S-CSCF#1.
12. S-CSCF#1 forwards the SDP to the originator, as per the originating procedure.
13. The originator decides the final set of media streams, and forwards this information to S-CSCF#1 by the origination procedures
14. S-CSCF#1 forwards the final SDP to S-CSCF#2.
15. S-CSCF#2 forwards the final SDP to the terminating endpoint, as per the termination procedure
16. When the originating endpoint has completed the resource reservation procedures, it sends the “Resource reservation success” message to S-CSCF#1 by the origination procedures.
17. S-CSCF#1 forwards this message to S-CSCF#2.
18. S-CSCF#2 forwards this message to the terminating endpoint, as per the termination procedure
19. The terminating endpoint may optionally send a provisional response indicating alerting is in progress. This message is sent by the termination procedure to S-CSCF#2.
20. S-CSCF#2 performs whatever service control is appropriate for this alerting flow
21. S-CSCF#2 forwards the ringing message to I-CSCF
22. I-CSCF forwards the ringing message to S-CSCF#1.
23. S-CSCF#1 performs whatever service control is appropriate for this alerting flow
24. S-CSCF#1 forwards the ringing message to the originator, per the origination procedure
25. The SIP final response, 200-OK, is sent by the terminating endpoint over the signalling path. This is typically generated when the subscriber has accepted the incoming session setup attempt. The message is sent to S-CSCF#2 per the termination procedure.
26. S-CSCF#2 performs whatever service control logic is appropriate for this session setup completion
27. The 200-OK is passed to the I-CSCF
28. The 200-OK is passed to the S-CSCF#1
29. S-CSCF#1 performs whatever service control logic is appropriate for this session setup completion
30. The 200-OK is passed to the Originating Network
31. The originating endpoint sends the final acknowledgement to S-CSCF#1 by the origination procedures.
32. S-CSCF#1 forwards this message to S-CSCF#2.
33. S-CSCF#2 forwards this message to the terminating endpoint, as per the termination procedure

5.5.3 (S-S#3) Session origination with PSTN termination in the same network as the S-CSCF.

The Serving-CSCF handling session origination performs an analysis of the destination address, and determines, with support of applications or other databases, that the session is destined to the PSTN. The request is therefore forwarded

to a local BGCF. The BGCF determines that the MGCF should be in the same network, and selects a MGCF in that network. The request is then forwarded to the MGCF.

Origination sequences that share this common S-S procedure are:

MO#1 Mobile origination, roaming. The “Originating Network” of S-S#3 is therefore a visited network.

MO#2 Mobile origination, located in home service area. The “Originating Network” of S-S#3 is therefore the home network.

PSTN-O PSTN origination. The “Originating Network” of S-S#3 is the home network. The element labelled S-CSCF#1 is the MGCF of the PSTN-O procedure.

Termination sequences that share this common S-S procedure are:

PSTN-T PSTN termination. This occurs when the MGCF is selected to be in the same network as the S-CSCF.

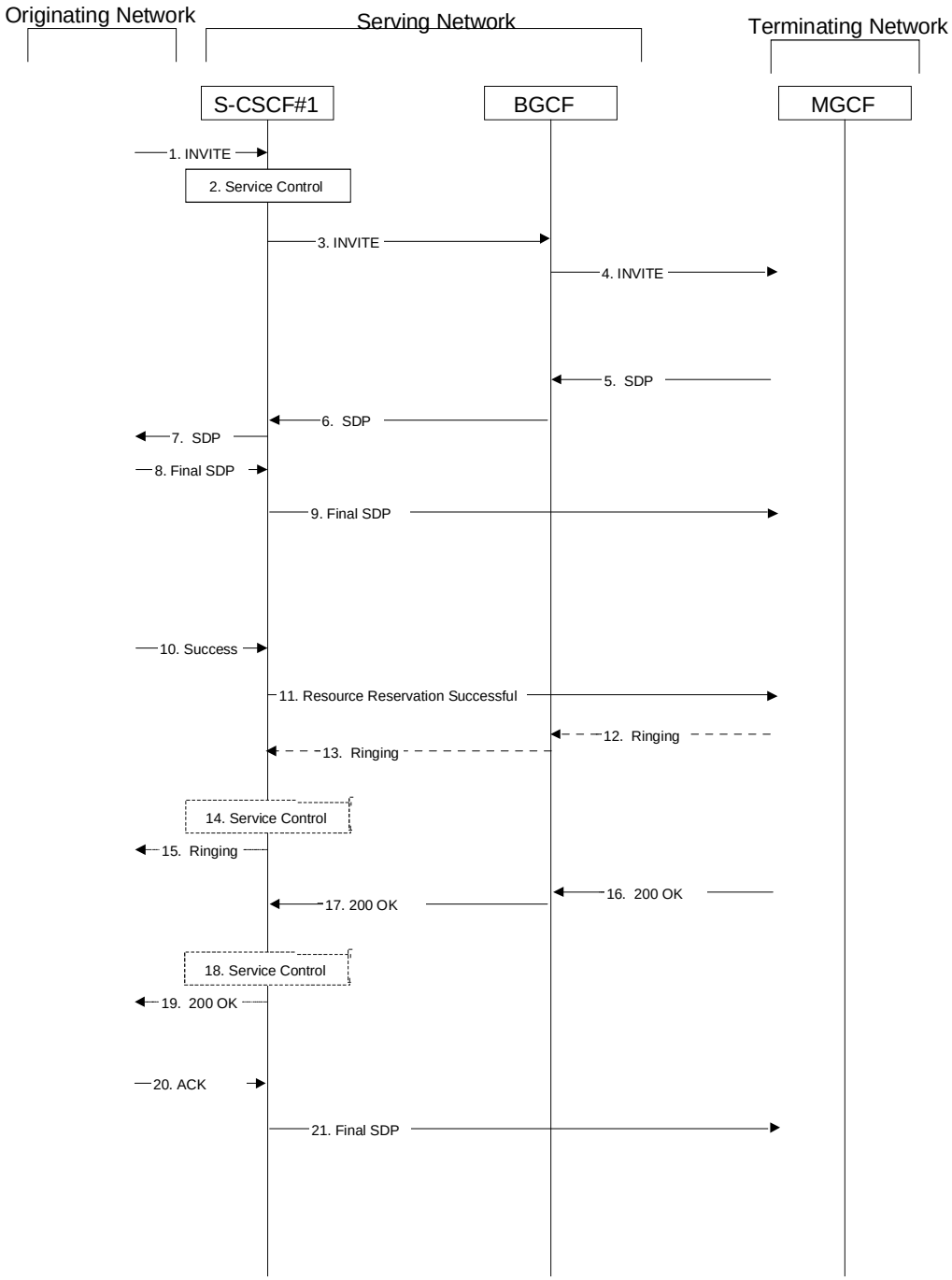


Figure 5.12: Serving to PSTN procedure - same operator

Procedure S-S#3 is as follows:

1. The SIP INVITE request is sent from the UE to S-CSCF#1 by the procedures of the originating flow.
2. S-CSCF#1 performs whatever service control logic is appropriate for this session setup attempt
3. S-CSCF#1 performs an analysis of the destination address. From the analysis of the destination address, S-CSCF#1 determines that this is for the PSTN, and passes the request to the BGCF.
4. The BGCF determines that the MGCF shall be in the same network, and hence proceeds to select an appropriate MGCF. The SIP INVITE request is forwarded to the MGCF. The PSTN terminating information flows are then followed.
5. The media stream capabilities of the destination are returned along the signalling path, as per the PSTN termination procedure.
6. The BGCF forwards the SDP to S-CSCF#1.
7. S-CSCF#1 forwards the SDP to the originator, as per the originating procedure.
8. The originator decides the final set of media streams, and forwards this information to S-CSCF#1 by the origination procedures
9. S-CSCF#1 forwards the final SDP to the terminating endpoint as per the PSTN terminating procedures.
10. When the originating endpoint has completed the resource reservation procedures, it sends the “Resource reservation success” message to S-CSCF#1 by the origination procedures.
11. S-CSCF#1 forwards the “Resource reservation success” to the terminating endpoint as per the PSTN terminating procedures.
12. The terminating endpoint may optionally send a provisional response indicating alerting is in progress to the BGCF
13. The message is forwarded to the S-CSCF#1.
14. S-CSCF#1 performs whatever service control is appropriate for this alerting flow
15. S-CSCF#1 forwards the ringing message to the originator, per the origination procedure
16. When the destination party answers, the termination procedure results in a SIP 200-OK final response to the BGCF
17. The BGCF forwards this information to the S-CSCF#1.
18. S-CSCF#1 performs whatever service control is appropriate for this session setup completion
19. The 200-OK is returned to the originating endpoint, by the origination procedure.
20. The originating endpoint sends the final acknowledgement to S-CSCF#1 by the origination procedures.
21. S-CSCF#1 forwards this message to the terminating endpoint as per the PSTN terminating procedures.

5.5.4 (S-S#4) Session origination with PSTN termination in a different network from the S-CSCF.

The Serving-CSCF handling session origination performs an analysis of the destination address, and determines, with support of applications or other databases, that the session is destined to the PSTN. The request is therefore forwarded to a BGCF. The BGCF determines that the PSTN interworking should occur in another network, and forwards this to a BGCF in the interworking network. The BGCF then selects a MGCF in that network. The request is then forwarded to the MGCF.

Origination sequences that share this common S-S procedure are:

MO#1 Mobile origination, roaming. The “Originating Network” of S-S#4 is therefore a visited network.

MO#2 Mobile origination, located in home service area. The "Originating Network" of S-S#4 is therefore the home network.

PSTN-O PSTN origination. The "Originating Network" of S-S#4 is the home network. The element labelled S-CSCF#1 is the MGCF of the PSTN-O procedure.

Termination sequences that share this common S-S procedure are:

PSTN-T PSTN termination. This occurs when the MGCF is selected to be in the same network as the S-CSCF.

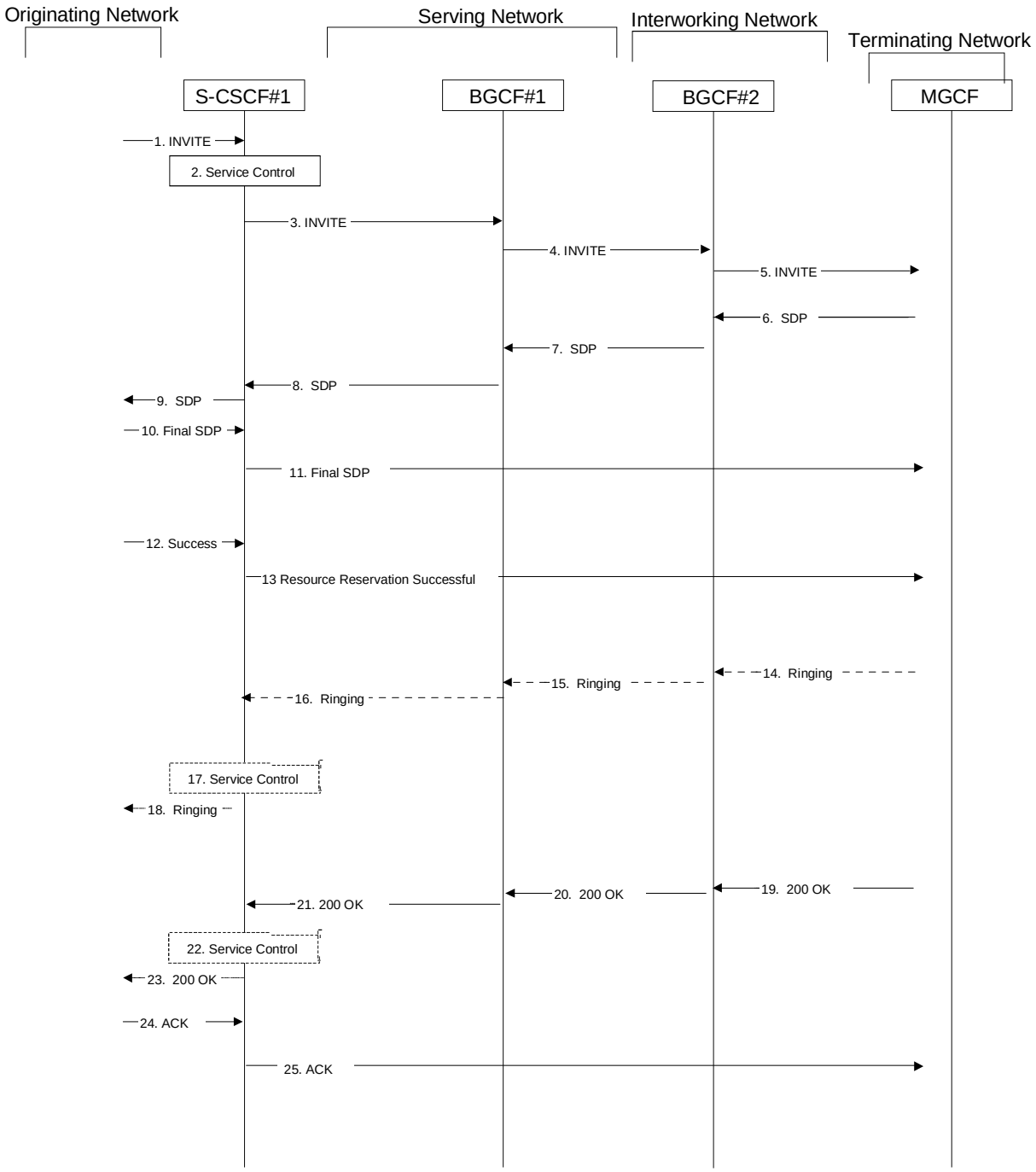


Figure 5.13: Serving to PSTN procedure - different operator

Procedure S-S#4 is as follows:

1. The SIP INVITE request is sent from the UE to S-CSCF#1 by the procedures of the originating flow.

2. S-CSCF#1 performs whatever service control logic is appropriate for this session setup attempt

3. S-CSCF#1 performs an analysis of the destination address. From the analysis of the destination address, S-CSCF#1 determines that this is for the PSTN, and passes the request to the BGCF#1.

4. The BGCF#1 determines that the PSTN interworking should occur in interworking network, and forwards the request on to BGCF#2.

5. BGCF#2 determines that the MGCF shall be in the same network, and hence proceeds to select an appropriate MGCF. The SIP INVITE request is forwarded to the MGCF. The PSTN terminating information flows are then followed.

6. The media stream capabilities of the destination are returned along the signalling path, as per the PSTN termination procedure.

7. BGCF#2 forwards the SDP to BGCF#1

8. BGCF#1 forwards the SDP to S-CSCF#1.

9. S-CSCF#1 forwards the SDP to the originator, as per the originating procedure.

10. The originator decides the final set of media streams, and forwards this information to S-CSCF#1 by the origination procedures

11. S-CSCF#1 forwards the final SDP to the terminating endpoint, as per the PSTN terminating procedure

12. When the originating endpoint has completed the resource reservation procedures, it sends the “Resource reservation success” message to S-CSCF#1 by the origination procedures.

13. S-CSCF#1 forwards the “Resource reservation success” to the terminating endpoint, as per the PSTN terminating procedures.

14. The terminating endpoint may optionally send a provisional response indicating alerting is in progress.

15. This information flow is forwarded to BGCF#1.

16. This information flow is forward to S-CSCF#1

17. S-CSCF#1 performs whatever service control is appropriate for this alerting flow

18. S-CSCF#1 forwards the ringing message to the originator, per the origination procedure

19. When the destination party answers, the termination procedure results in a SIP 200-OK final response.

20. This information flow is forwarded to the BGCF#1

21. This information flow is forwarded to the S-CSCF

22. S-CSCF#1 performs whatever service control is appropriate for this session setup completion

23. The 200-OK is returned to the originating endpoint, by the origination procedure.

24. The originating endpoint sends the final acknowledgement to S-CSCF#1 by the origination procedures.

25. The S-CSCF#1 forwards the acknowledgement to the terminating endpoint, as per the PSTN terminating procedure.

5.6 Origination procedures

This section presents the detailed application level flows to define the Procedures for session originations.

The session origination procedures specify the signalling path between the UE initiating a session setup attempt and the Serving-CSCF that is assigned to perform the session origination service. This signalling path is determined at the time of UE registration, and remains fixed for the life of the registration.

A UE always has a proxy (P-CSCF) associated with it. This P-CSCF is located in the same network as the UE, performs resource authorisation, and may have additional functions in handling of emergency sessions. The P-CSCF is determined by the CSCF discovery process, described in Section 5.1.1 (Local CSCF Discovery).

As a result of the registration procedure, the P-CSCF determines the next hop toward the Serving-CSCF. This next hop may be directly to the S-CSCF in the same network (MO#2 for the roaming case, MO#3 for the home case), or to the S-CSCF in the home network (possibly through an I-CSCF to hide the network configuration) (MO#1). These next-hop addresses could be IPv4/IPv6 addresses, or could be names that are translated via DNS to an IPv4/IPv6 address.

Sessions originated in the PSTN to a mobile destination are a special case of the Origination procedures. The MGCF uses H.248 [19] to control a Media Gateway, and communicates with the SS7 network via the TSGW. The MGCF initiates the SIP request, and subsequent nodes consider the signalling as if it came from a S-CSCF.

5.6.1 (MO#1) Mobile origination, roaming

This origination procedure applies to roaming subscribers. .

The UE is located in a visited network, and determines the P-CSCF via the CSCF discovery procedure described in section 5.1.1. The home network advertises either the S-CSCF or an I-CSCF as the entry point from the visited network.

When registration is complete, P-CSCF knows the name/address of the next hop in the signalling path toward the serving-CSCF, either I-CSCF (if the home network wanted to hide their internal configuration) or S-CSCF (if there was no desire to hide the network configuration). I-CSCF, if it exists in the signalling path, knows the name/address of S-CSCF.

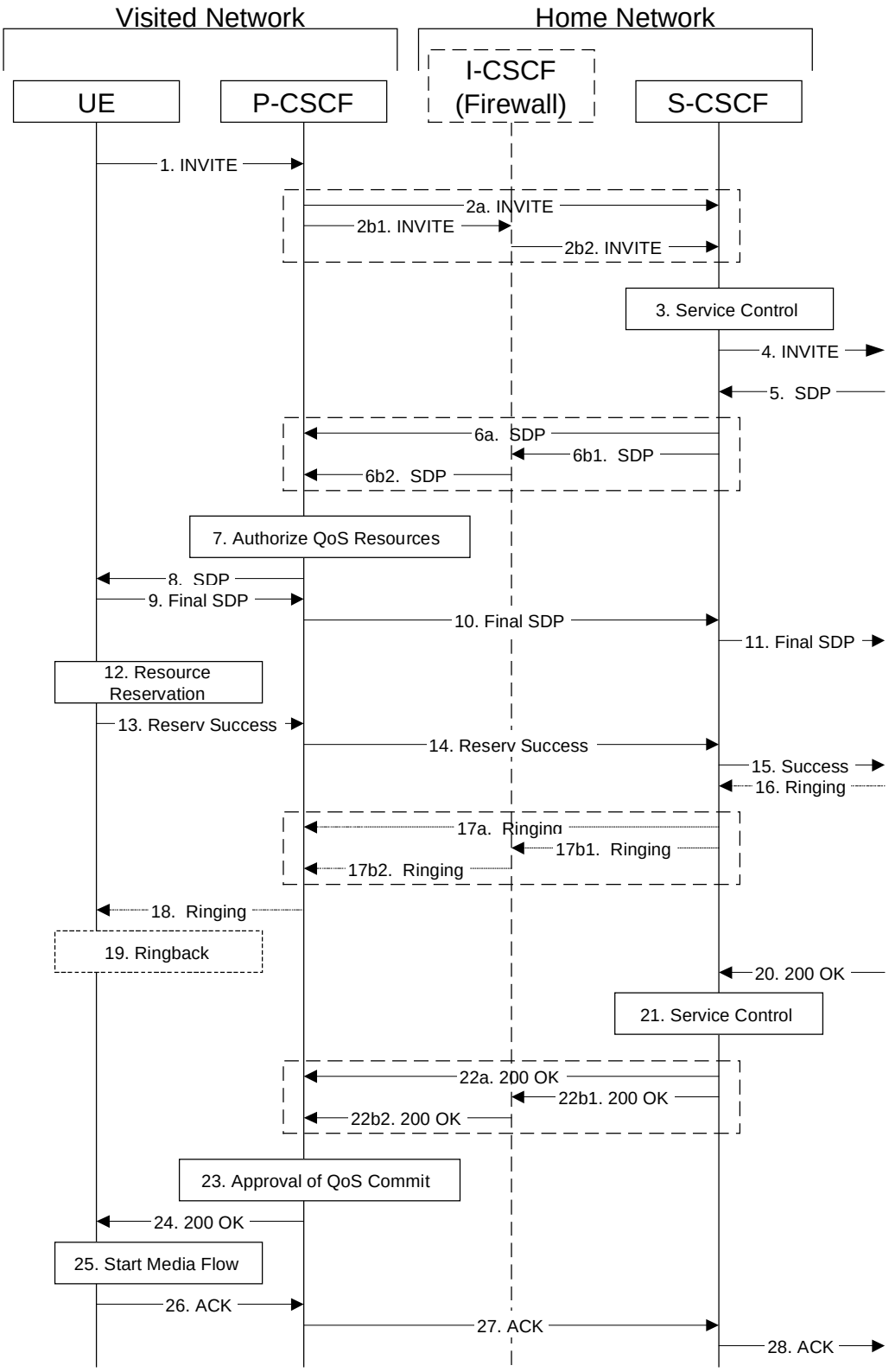


Figure 5.14: Mobile origination procedure - roaming

Procedure MO#1 is as follows:

1. UE sends the SIP INVITE request, containing an initial SDP, to the P-CSCF determined via the CSCF discovery mechanism. The initial SDP may represent one or more media for a multi-media session.

2. P-CSCF remembers (from the registration procedure) the next hop CSCF for this UE.

This next hop is either the S-CSCF that is serving the visiting UE (choice (a)), or an I-CSCF within the home network that is performing the configuration hiding function for the home network operator (choice (b)).

(2a) If the home network operator does not desire to keep their network configuration hidden, the name/address of the S-CSCF was provided during registration, and the INVITE request is forwarded directly to the S-CSCF.

(2b) If the home network operator desires to keep their network configuration hidden, the name/address of an I-CSCF in the home network was provided during registration, and the INVITE request is forwarded through this I-CSCF to the S-CSCF.

(2b1) P-CSCF forwards the INVITE request to I-CSCF

(2b2) I-CSCF forwards the INVITE request to S-CSCF

3. S-CSCF validates the service profile, and performs any origination service control required for this subscriber. This includes authorisation of the requested SDP based on the user's subscription for multi-media services.

4. S-CSCF forwards the request, as specified by the S-S procedures.

5. The media stream capabilities of the destination are returned along the signalling path, per the S-S procedures.

6. S-CSCF forwards the SDP message to P-CSCF. Based on the choice made in step #2 above, this may be sent directly to P-CSCF (6a) or may be sent through I-CSCF(firewall) (6b1 and 6b2).

7. P-CSCF authorises the resources necessary for this session

8. P-CSCF forwards the SDP message to the originating endpoint

9. UE decides the final set of media streams for this session, and sends the Final SDP to P-CSCF

10. P-CSCF forwards the final SDP to S-CSCF. This may possibly be routed through the I-CSCF(firewall) depending on operator configuration of the I-CSCF.

11. S-CSCF forwards this message to the terminating endpoint, as per the S-S procedure.

12. After determining the final media streams in step #9, UE initiates the reservation procedures for the resources needed for this session.

13. When the resource reservation is completed, UE sends the “Resource Reservation Successful” message to the terminating endpoint, via the signalling path established by the INVITE message. The message is sent first to P-CSCF.

14. P-CSCF forwards this message to S-CSCF. This may possibly be routed through the I-CSCF(firewall) depending on operator configuration of the I-CSCF.

15. S-CSCF forwards this message to the terminating endpoint, as per the S-S procedure.

16. The destination UE may optionally perform alerting. If so, it signals this to the originating party by a provisional response indicating Ringing. This message is sent to S-CSCF per the S-S procedure.

17. S-CSCF forwards this message to P-CSCF. Based on the choice made in step #2 above, this may be sent directly to P-CSCF (17a) or may be sent through I-CSCF(firewall) (17b1 and 17b2).

18. P-CSCF forwards the ringing message to UE

Editor’s Note: Additional QoS interactions to handle one-way media at this point (e.g. for PSTN ringback and announcements) is for further study.

19. UE indicates to the originating subscriber that the destination is ringing

20. When the destination party answers, the terminating endpoint sends a SIP 200-OK final response, as specified by the termination procedures and the S-S procedures, to S-CSCF.

21. S-CSCF performs whatever service control is appropriate for the completed session setup.

22. S-CSCF sends a SIP 200-OK final response along the signalling path back to P-CSCF. Based on the choice made in (2) above, this response may either be sent directly from S-CSCF to P-CSCF (choice (a)), or be sent indirectly through I-CSCF firewall (choice (b)).

23. P-CSCF indicates the resources reserved for this session should now be committed.

24. P-CSCF sends a SIP 200-OK final response to the session originator

25. UE starts the media flow(s) for this session

26. UE responds to the 200 OK with a SIP ACK message, which is sent to P-CSCF.

27. P-CSCF forwards the final ACK message to S-CSCF. This may possible be routed through the I-CSCF(firewall) depending on operator configuration of the I-CSCF.

28. S-CSCF forwards the final ACK message to the terminating endpoint, per the S-S procedure.

5.6.2 (MO#2) Mobile origination, home

This origination procedure applies to subscribers located in their home service area.

The UE is located in the home network, and determines the P-CSCF via the CSCF discovery procedure described in section 5.1.1. During registration, the home network allocates an S-CSCF in the home network.

When registration is complete, P-CSCF knows the name/address of S-CSCF.

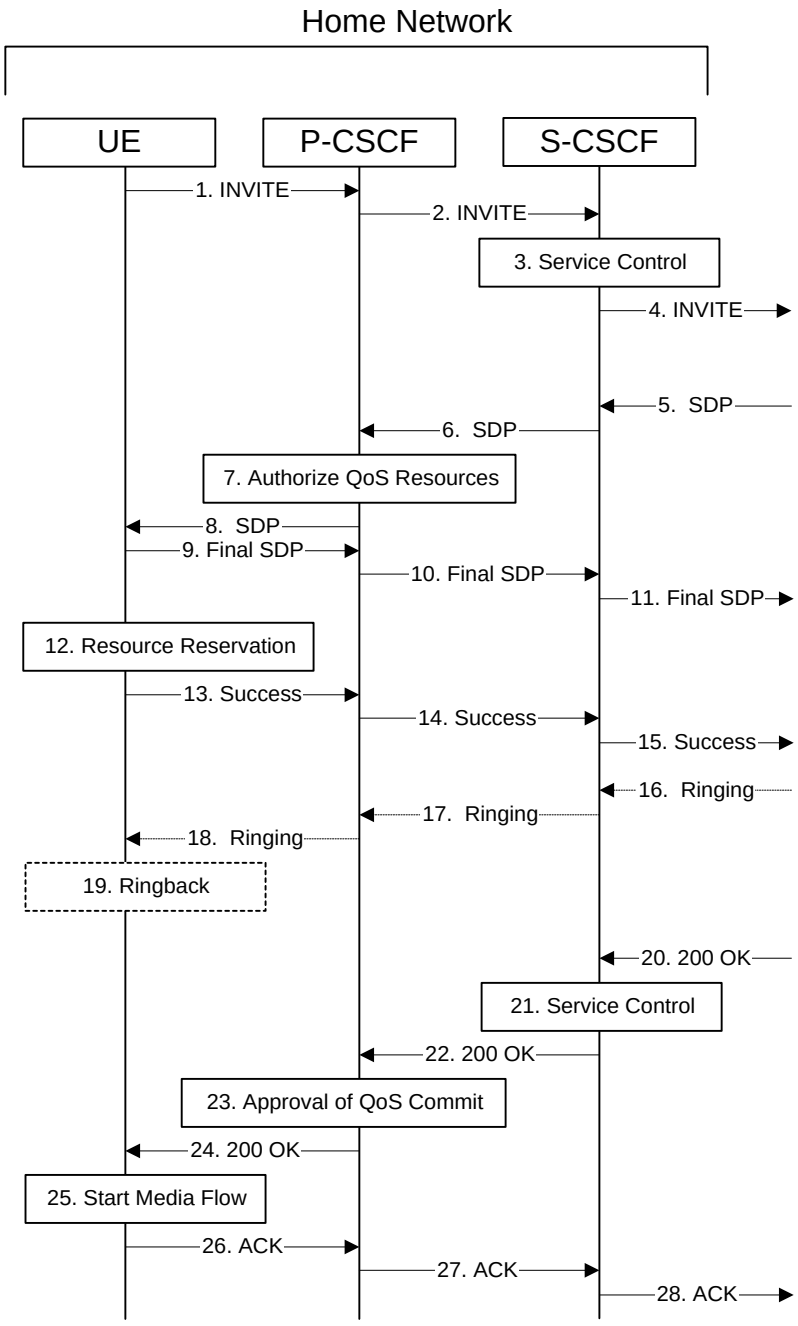


Figure 5.15: Mobile origination procedure - home

Procedure MO#2 is as follows:

1. UE#1 sends the SIP INVITE request, containing an initial SDP, to the P-CSCF determined via the CSCF discovery mechanism. The initial SDP may represent one or more media for a multi-media session.

2. P-CSCF remembers (from the registration procedure) the next hop CSCF for this UE. In this case it forwards the INVITE to the S-CSCF in the home network.

3. S-CSCF validates the service profile, and performs any origination service control required for this subscriber. This includes authorisation of the requested SDP based on the user's subscription for multi-media services.

4. S-CSCF forwards the request, as specified by the S-S procedures.

5. The media stream capabilities of the destination are returned along the signalling path, per the S-S procedures.

6. S-CSCF forwards the SDP message to P-CSCF

7. P-CSCF authorises the resources necessary for this session

8. P-CSCF forwards the SDP message to the originating endpoint.

9. UE decides the final set of media streams for this session, and sends the Final SDP to P-CSCF.

10. P-CSCF forwards this message to S-CSCF

11. S-CSCF forwards this message to the terminating endpoint, as per the S-S procedure.

12. After determining the final media streams in step #9, UE initiates the reservation procedures for the resources needed for this session.

13. When the resource reservation is completed, UE sends the “Resource Reservation Successful” message to the terminating endpoint, via the signalling path established by the INVITE message. The message is sent first to P-CSCF.

14. P-CSCF forwards this message to S-CSCF.

15. S-CSCF forwards this message to the terminating endpoint, as per the S-S procedure.

16. The destination UE may optionally perform alerting. If so, it signals this to the originating party by a provisional response indicating Ringing. This message is sent to S-CSCF per the S-S procedure.

17. S-CSCF forwards this message to P-CSCF.

18. P-CSCF forwards the ringing message to UE.

Editor’s Note: Additional QoS interactions to handle one-way media at this point (e.g. for PSTN ringback and announcements) is for further study.

19. UE indicates to the originating subscriber that the destination is ringing.

20. When the destination party answers, the terminating endpoint sends a SIP 200-OK final response, as specified by the termination procedures and the S-S procedures, to S-CSCF.

21. S-CSCF performs any origination service control required by session setup completion.

22. S-CSCF passes the 200-OK response back to P-CSCF, following the path of the INVITE request of step (2) above.

23. P-CSCF indicates the resources reserved for this session should now be committed.

24. P-CSCF passes the 200-OK response back to UE

25. UE starts the media flow(s) for this session.

26. UE responds to the 200 OK with an ACK message which is sent to P-CSCF.

27. P-CSCF forwards the final ACK message to S-CSCF.

28. S-CSCF forwards the final ACK message to the terminating endpoint, per the S-S procedure.

5.6.3 (PSTN-O) PSTN origination

The MGCF in the IM CN subsystem is a SIP endpoint that initiates requests on behalf of the PSTN and Media Gateway. The subsequent nodes consider the signalling as if it came from a S-CSCF. The MGCF incorporates the network security functionality of the S-CSCF. This MGCF does not invoke Service Control, as this may be carried out in the GSTN or at the terminating S-CSCF. This origination procedure can be used for any of the S-S procedures.

Due to routing of sessions within the PSTN, this origination procedure will only occur in the home network of the destination subscriber. However due to cases of session forwarding and electronic surveillance, the destination of the session through the IM CN subsystem may actually be another PSTN termination.

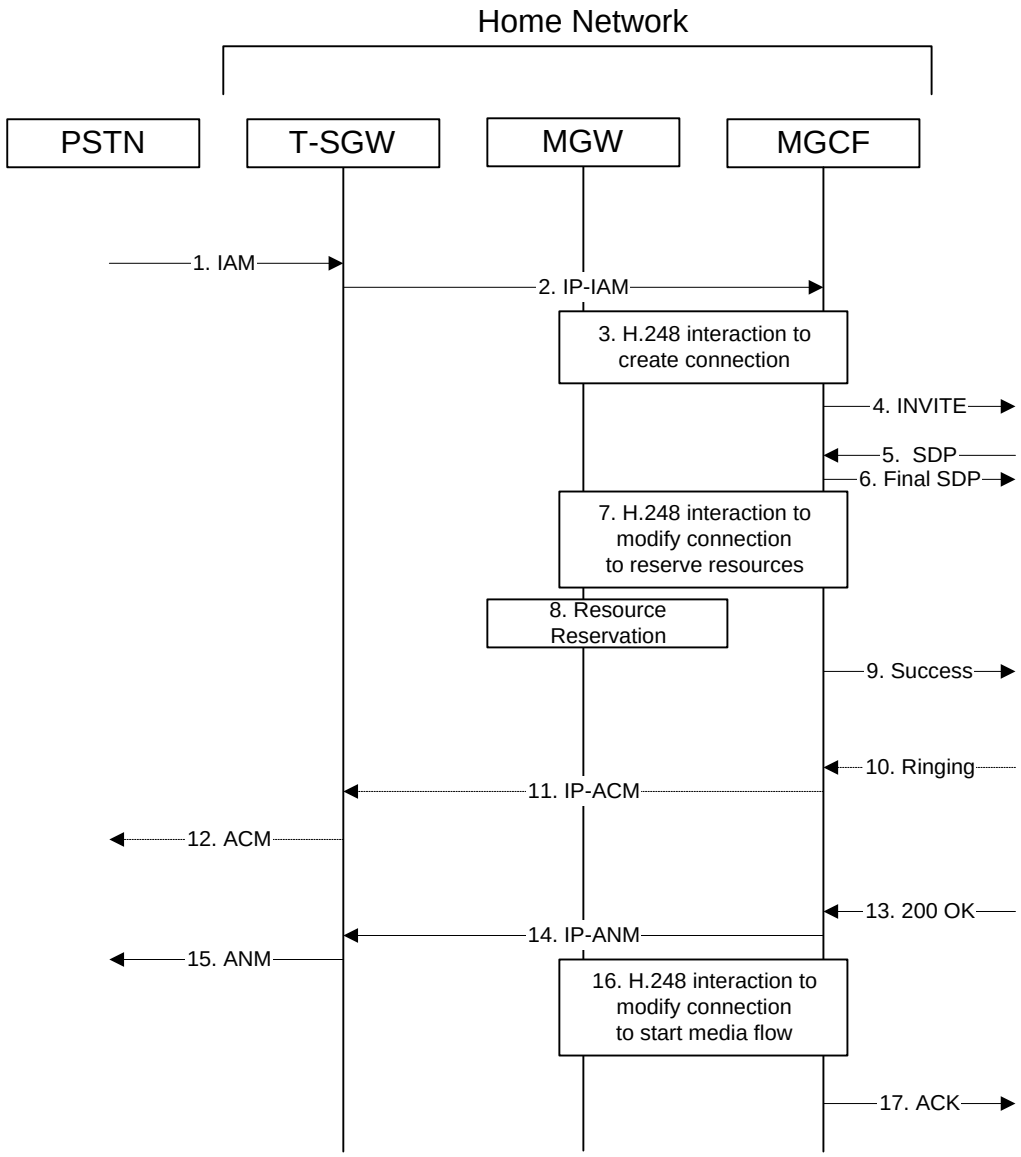


Figure 5.16: PSTN origination procedure

The PSTN Origination procedure is as follows:

1. The PSTN establishes a bearer path to the MGW, and signals to the T-SGW with a SS7 IAM message, giving the trunk identity and destination information

2. The T-SGW forwards the SS7 message, encapsulated in IP, to the MGCF.

3. The MGCF initiates a H.248 command, to seize the trunk and an IP port.

4. The MGCF initiates a SIP INVITE request, containing an initial SDP, as per the proper S-S procedure.

5. The media stream capabilities of the destination are returned along the signalling path, per the S-S procedures.

6. MGCF decides the final set of media streams for this session, and sends the final SDP per the S-S procedures.

7. MGCF initiates a H.248 command to modify the connection parameters and instruct the MGW to reserve the resources needed for the session.

8. MGW reserves the resources needed for the session

9. When the resource reservation is completed, MGCF sends the “Resource Reservation Successful” message to the terminating endpoint, per the S-S procedures.

10. The destination endpoint may optionally perform alerting. If so, it signals this to the originating party by a provisional response indicating Ringing. This message is sent to MGCF per the S-S procedure.

11. If alerting is being performed, the MGCF forwards an IP-ACM message to T-SGW

12. If alerting is being performed, the T-SGW forwards a SS7 ACM message

13. When the destination party answers, the terminating and S-S procedures result in a SIP 200-OK final response being sent to MGCF

14. MGCF forwards an IP-ANM message to T-SGW

15. T-SGW forwards an ANM message to the PSTN

16. MGCF initiates a H.248 command to alter the connection at MGW to make it bidirectional

17. MGCF acknowledges the SIP final response with a SIP ACK message

5.7 Termination procedures

This section presents the detailed application level flows to define the Procedures for session terminations.

The session termination procedures specify the signalling path between the Serving-CSCF assigned to perform the session termination service and the UE. This signalling path is determined at the time of UE registration, and remains fixed for the life of the registration. This signalling path is the reverse of the session initiation signalling path of Section 5.7. Therefore there is a one-to-one correspondence between the origination procedures of section 5.7 and the termination procedures of this section.

A UE always has a proxy (P-CSCF) associated with it. This P-CSCF is located in the same network as the UE, and performs resource authorisation for the sessions to the UE. The P-CSCF is determined by the CSCF discovery process, described in Section 5.1.1 (Local CSCF Discovery).

As a result of the registration procedure, the P-CSCF knows the address of the UE. The assigned S-CSCF, knows the name/address of the P-CSCF (procedure MT#3, and MT#4, depending on the location of S-CSCF and P-CSCF). If the network operator owning the S-CSCF wants to keep their configuration private, the S-CSCF will have chosen an Interrogating-CSCF, I-CSCF, who will perform the firewall functions and pass messages to the P-CSCF (procedure MT#1).

Sessions destined to the PSTN are a special case of the Termination procedures. The MGCF uses H.248 to control a Media Gateway, and communicates with the SS7 network via the T-SGW. The MGCF receives and processes SIP requests, and subsequent nodes consider the signalling as if it came from a S-CSCF.

5.7.1 (MT#1) Mobile termination, roaming

This termination procedure applies to roaming subscribers.

The UE is located in a visited network, and determines the P-CSCF via the CSCF discovery procedure described in section 5.1.1. The home network advertises either the S-CSCF, or an I-CSCF firewall, as the entry point from the visited network.

When registration is complete, S-CSCF knows the name/address of its next hop in the signalling path, either I-CSCF or P-CSCF, I-CSCF (if it exists) knows the name/address of P-CSCF, and P-CSCF knows the name/address of the UE.

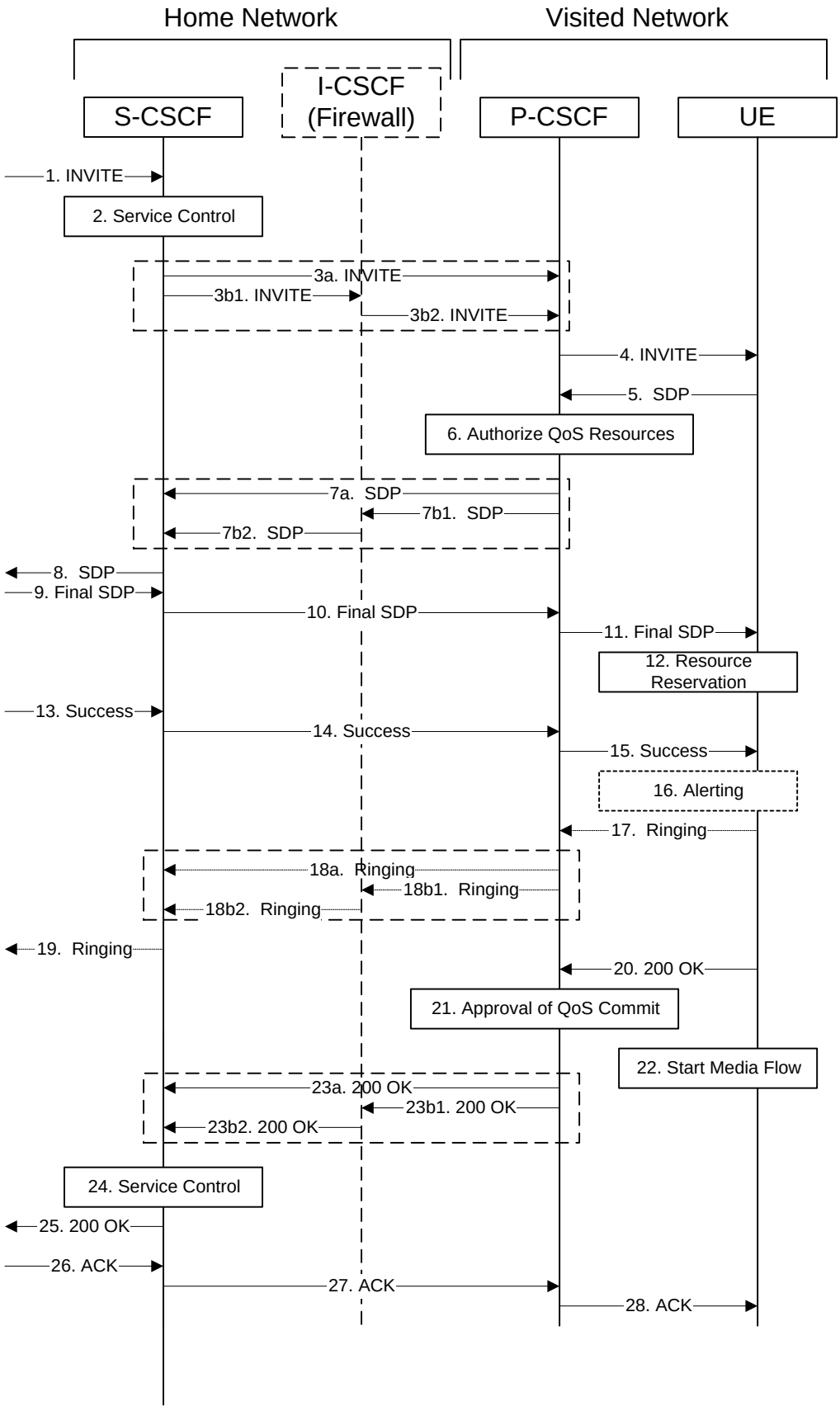


Figure 5.17: Mobile termination procedure - roaming

Procedure MT#1 is as follows:

1. The originating party sends the SIP INVITE request, via one of the origination procedures, and via one of the Inter-Serving procedures, to the Serving-CSCF for the terminating subscriber.

2. S-CSCF validates the service profile, and performs any termination service control required for this subscriber. This includes authorisation of the requested SDP based on the user's subscription for multi-media services.

3. S-CSCF remembers (from the registration procedure) the next hop CSCF for this UE. It forwards the INVITE to the P-CSCF in the visited network, possibly through an I-CSCF.

   This next hop is either the P-CSCF that is serving the visiting UE (choice (a)), or an I-CSCF within the home network that is performing the configuration hiding function for the home network operator (choice (b)).

   (3a) If the home network operator does not desire to keep their network configuration hidden, the INVITE request is forwarded directly to the P-CSCF.

   (3b) If the home network operator desires to keep their network configuration hidden, the INVITE request is forwarded through an I-CSCF to the P-CSCF.

      (3b1) S-CSCF forwards the INVITE request to I-CSCF

      (3b2) I-CSCF forwards the INVITE request to P-CSCF

4. P-CSCF remembers (from the registration procedure) the UE address, and forwards the INVITE to the UE.

5. UE determines the subset of the media flows proposed by the originating endpoint that it supports, and responds with an SDP message back to the originator. This SDP may represent one or more media for a multi-media session. This response is sent to P-CSCF.

6. P-CSCF authorises the resources necessary for this session.

7. P-CSCF forwards the SDP message to S-CSCF. Based on the choice made in step #3 above, this may be sent directly to S-CSCF (7a) or may be sent through I-CSCF (firewall) (7b1 and 7b2).

8. S-CSCF forwards the SDP message to the originator, per the S-S procedure.

9. The originating endpoint sends the final SDP to be used in this session, via the S-S procedure, to S-CSCF.

10. S-CSCF forwards the final SDP to P-CSCF. This may possibly be routed through the I-CSCF (firewall) depending on operator configuration of the I-CSCF.

11. P-CSCF forwards the final SDP to UE.

12. UE initiates the reservation procedures for the resources needed for this session.

13. When the originating endpoint has completed its resource reservation, it sends the “Resource Reservation Successful” message to S-CSCF, via the S-S procedures.

14. S-CSCF forwards the message to P-CSCF. This may possibly be routed through the I-CSCF (firewall) depending on operator configuration of the I-CSCF.

15. P-CSCF forwards the message to UE.

16. Before proceeding with session establishment, the UE waits for two events. First, the resource reservation initiated in step #12 must complete successfully. Second, the resource reservation initiated by the originating endpoint must complete successfully (which is indicated by message #15 received by UE). The UE may now immediately accept the session (and proceed with step #20), or alert the destination subscriber of an incoming session setup attempt (and proceed with step #17).

17. UE may alert the user and wait for an indication from the user before completing the session setup. If so, it indicates this to the originating party by a provisional response indicating Ringing. This message is sent to P-CSCF.

18. P-CSCF forwards the Ringing message to S-CSCF. Based on the choice made in step #3 above, this may be sent directly to S-CSCF (18a) or may be sent through I-CSCF (firewall) (18b1 and 18b2).

19. S-CSCF forwards this message to the originating endpoint, per the S-S procedure.

20. When the destination party answers, the UE sends a SIP 200-OK final response to P-CSCF.

21. P-CSCF indicates the resources reserved for this session should now be committed.

22. UE starts the media flow(s) for this session

23. P-CSCF sends a SIP 200-OK final response along the signalling path back to the S-CSCF
Based on the choice made in (3) above, this response may either be sent directly from P-CSCF to S-CSCF (choice (a)), or be sent indirectly through the I-CSCF firewall (choice (b)).

24. S-CSCF performs whatever service control is required for the session setup completion

25. S-CSCF forwards the SIP 200-OK final response along the signalling path back to the session originator, as per the S-S procedure.

26. The originating party responds to the 200-OK final response with a SIP ACK message that is sent to S-CSCF via the S-S procedure.

27. S-CSCF forwards the SIP ACK message to P-CSCF. This may possibly be routed through the I-CSCF (firewall) depending on operator configuration of the I-CSCF.

28. P-CSCF forwards the ACK message to UE.

5.7.2 (MT#2) Mobile termination, home

This termination procedure applies to subscribers located in their home service area.

The UE is located in the home network, and determines the P-CSCF via the CSCF discovery procedures described in section 5.1.1.

When registration is complete, S-CSCF knows the name/address of P-CSCF, and P-CSCF knows the name/address of the UE.

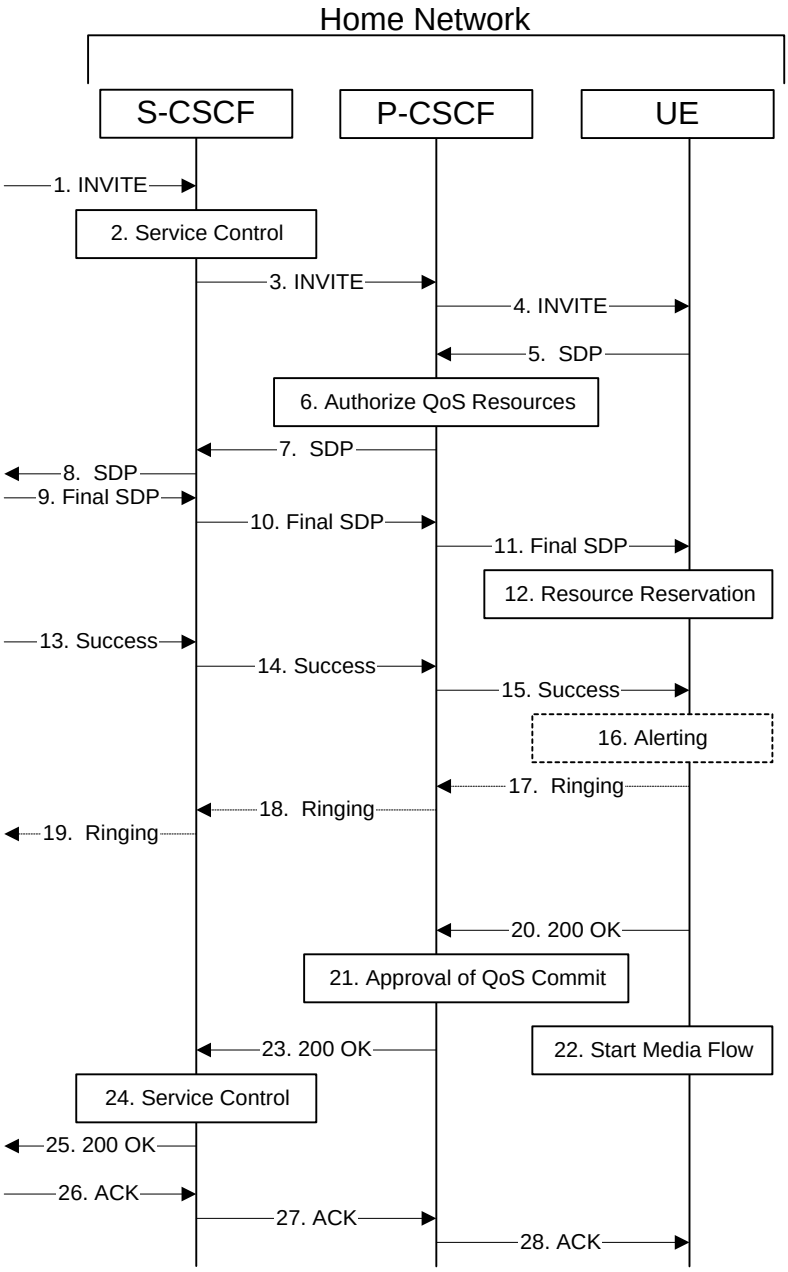


Figure 5.18: Mobile termination procedure - home

Procedure MT#2 is as follows:

1. UE#1 sends the SIP INVITE request, via one of the origination procedures, and via one of the Serving to Serving-CSCF procedures, to the Serving-CSCF for the terminating subscriber.

2. S-CSCF validates the service profile, and performs any termination service control required for this subscriber. This includes authorisation of the requested SDP based on the user's subscription for multi-media services.

3. S-CSCF remembers (from the registration procedure) the next hop CSCF for this UE. It forwards the INVITE to the P-CSCF in the home network.

4. P-CSCF remembers (from the registration procedure) the UE address, and forwards the INVITE to the UE.

5. UE determines the subset of the media flows proposed by the originating endpoint that it supports, and responds with an SDP message back to the originator. This SDP may represent one or more media for a multi-media session. This response is sent to P-CSCF.

6. P-CSCF authorises the resources necessary for this session.

7. P-CSCF forwards the SDP message to S-CSCF.

8. S-CSCF forwards the SDP message to the originator, per the S-S procedure.

9. The originating endpoint sends the final SDP to be used in this session, via the S-S procedure, to S-CSCF.

10. S-CSCF forwards the final SDP to P-CSCF.

11. P-CSCF forwards the final SDP to UE.

12. UE initiates the reservation procedures for the resources needed for this session.

13. When the originating endpoint has completed its resource reservation, it sends the "Resource Reservation Successful" message to S-CSCF, via the S-S procedures.

14. S-CSCF forwards the message to P-CSCF.

15. P-CSCF forwards the message to UE.

16. Before proceeding with session establishment, the UE waits for two events. First, the resource reservation initiated in step #12 must complete successfully. Second, the resource reservation initiated by the originating endpoint must complete successfully (which is indicated by message #15 received by UE). The UE may now immediately accept the session (and proceed with step #20), or alert the destination subscriber of an incoming session setup attempt (and proceed with step #17).

17. UE may alert the user and wait for an indication from the user before completing the session. If so, it indicates this to the originating party by a provisional response indicating Ringing. This message is sent to P-CSCF.

18. P-CSCF forwards the Ringing message to S-CSCF.

19. S-CSCF forwards this message to the originating endpoint, per the S-S procedure.

20. When the destination party answers, UE sends a SIP 200-OK final response to P-CSCF.

21. P-CSCF indicates the resources reserved for this session should now be committed.

22. UE starts the media flow(s) for this session.

23. P-CSCF forwards the 200-OK to S-CSCF, following the path of the INVITE request in step (3) above

24. S-CSCF performs any service control required on session setup completion.

25. S-CSCF forwards the 200-OK final response, as per the appropriate S-S procedure.

26. The session originator responds to the 200-OK by sending the ACK message to S-CSCF via the S-S procedure.

27. S-CSCF forwards the SIP ACK message to P-CSCF.

28. P-CSCF forwards the ACK message to UE.

5.7.3 (PSTN-T) PSTN termination

The MGCF in the IM CN subsystem is a SIP endpoint that initiates and receives requests on behalf of the PSTN and Media Gateway (MGW).Other nodes consider the signalling as if it came from a S-CSCF. The MGCF incorporates the network security functionality of the S-CSCF.

PSTN termination may be done in the same operator's network as the S-CSCF of the session originator. Therefore, the location of the MGCF/MGW/T-SGW are given only as "Terminating Network" rather than "Home Network" or "Visited Network."

Further, agreements between network operators may allow PSTN termination in a network other than the originator's visited network or home network. This may be done, for example, to avoid long distance or international tariffs.

This termination procedure can be used for any of the inter-serving procedures, in place of the S-CSCF.

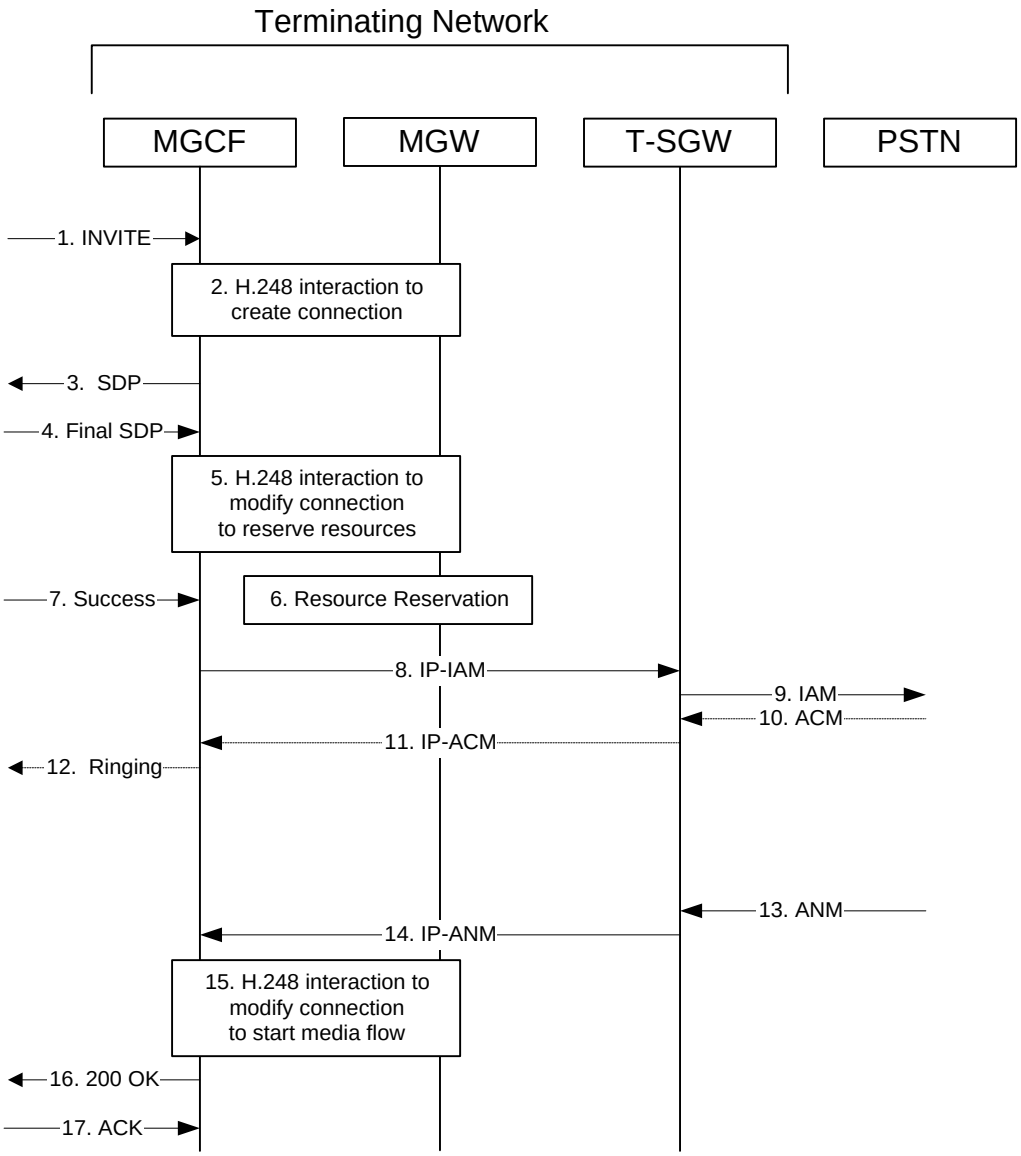


Figure 5.19: PSTN termination procedure

The PSTN termination procedure is as follows:

1. MGCF receives an INVITE request, through one of the origination procedures and via one of the inter-serving procedures.

2. MGCF initiates a H.248 interaction to pick an outgoing channel and determine media capabilities of the MGW.

3. MGCF determines the subset of the media flows proposed by the originating endpoint that it supports, and responds with an SDP message back to the originator. This response is sent via the S-S procedure.

4. The originating endpoint sends the final SDP to be used in this session, via the S-S procedure, to MGCF.

5. MGCF initiates a H.248 interaction to modify the connection established in step #2 and instruct MGW to reserve the resources necessary for the media streams.

6. MGW reserved the resources necessary for the media streams.

7. When the originating endpoint has completed its resource reservation, it sends the “Resource Reservation Successful” message to MGCF, via the S-S procedures.

8. MGCF sends an IP-IAM message to the T-SGW

9. T-SGW receives the IP-IAM and sends the SS7 IAM message into the PSTN.

10. The PSTN establishes the path to the destination. It may optionally alert the destination user before completing the session. If so, it responds with an SS7 ACM message

11. If the PSTN is alerting the destination user, T-SGW sends an IP-ACM message to MGCF

12. If the PSTN is alerting the destination user, MGCF indicates this to the originating party by a provisional response indicating Ringing. This message is sent via the S-S procedures.

13. When the destination party answers, the PSTN sends an SS7 ANM message to T-SGW

14. T-SGW sends an IP-ANM message to MGCF

15. MGCF initiates a H.248 interaction to make the connection in the MGW bi-directional.

16. MGCF sends a SIP 200-OK final response along the signalling path back to the session originator

17. The Originating party acknowledges the final response with a SIP ACK message

5.8 Procedures related to routing information interrogation

The mobile terminated sessions for a subscriber shall be routed either to a Serving-CSCF or to a MGCF (if the subscriber is roaming in a legacy network). When a mobile terminated session set-up arrives at a CSCF that is authorised to route sessions, the CSCF interrogates the HSS for routing information.

The Cx reference point shall support retrieval of routing information from HSS to CSCF. The resulting routing information can be either Serving-CSCF signalling transport parameters (e.g. IP-address).

5.8.1 User identity to HSS resolution

This section describes the resolution mechanism, which enables the I-CSCF to find the address of the HSS, that holds the subscriber data for a given user identity when multiple and separately addressable HSSs have been deployed by the network operator. This resolution mechanism is not required in networks that utilise a single HSS e.g. optionally, it could be switched off on the I-CSCF using O&M mechanisms. An example for a single HSS solution is a server farm architecture. By default, the resolution mechanism shall be supported.

On REGISTER and on MT INVITEs, the I-CSCF queries the HSS for subscriber specific data, e. g. the actual location or authentication parameters. In the case when more than one independently addressable HSS is utilized by a network operator, the HSS where user information for a given subscriber is available has to be found. To get the HSS address the I-CSCF queries the Subscription Locator Functional (SLF) entity. The relationship with number portability is for further study.

The subscription locator is accessed via the Dx interface. The Dx interface is the standard interface between the I-CSCF and the SLF.

A way to use the subscription locator is described in the following.

The Dx interface provides:

- an operation to query the subscription locator from the I-CSCF
- a response to provide the HSS address towards the I-CSCF.

By sending the Dx-operation DX_SLF_QUERY the I-CSCF indicates a subscriber identity of which it is looking for an HSS. By the Dx-operation DX_SLF_RESP the SLF responds with the HSS name. I-CSCF continues by querying the selected HSS. As an option at the registration flow, the I-CSCF may forward the HSS address towards the serving CSCF to simplify the procedure by which the serving CSCF finds the subscriber's HSS.

The following two sections present the session flows on REGISTER and on INVITE messages.

5.8.2 SLF on register

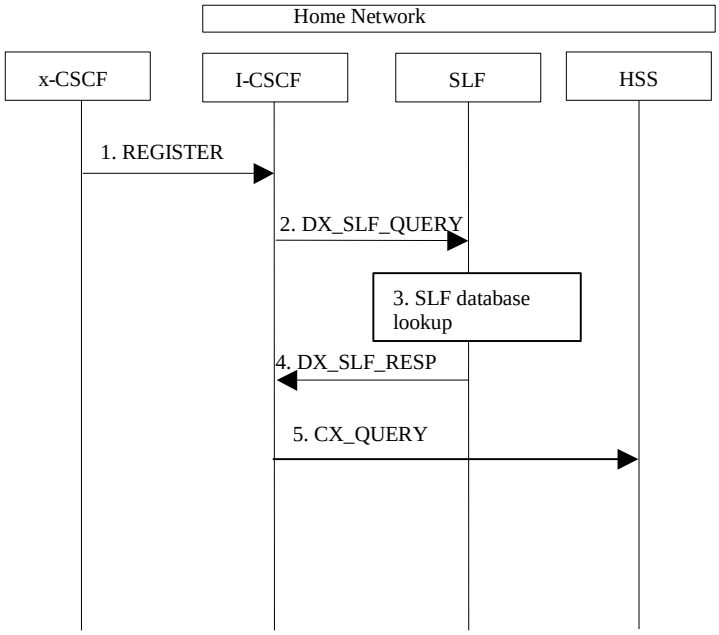


Figure 5.20: SLF on register

1. I-CSCF receives a REGISTER request and now has to query for the location of the subscriber's data.
2. The I-CSCF sends a DX_SLF_QUERY to the SLF and includes as parameter the subscriber identity which is stated in the REGISTER request.
3. The SLF looks up its database for the queried subscriber identity.
4. The SLF answers with the HSS name in which the subscriber's data can be found.
5. The I-CSCF can proceed by querying the appropriate HSS.

5.8.3 SLF on UE invite

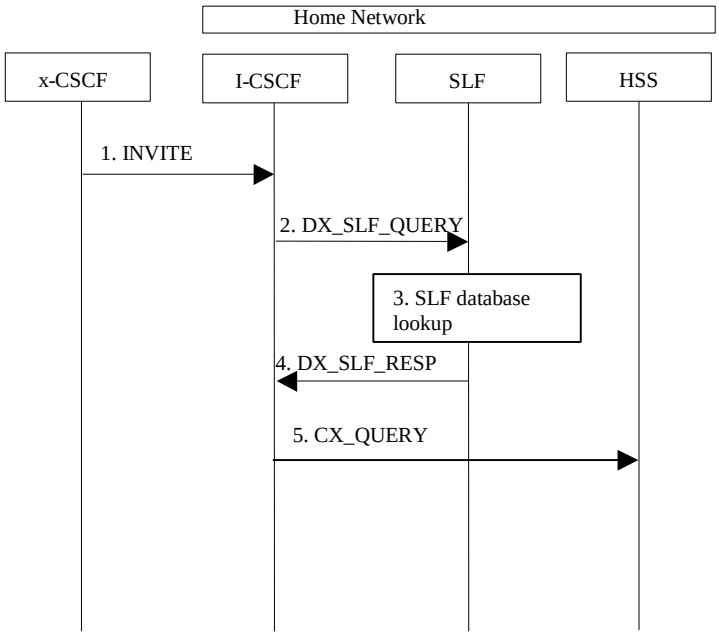


Figure 5.21: SLF on UE invite

1. I-CSCF receives an INVITE request and now has to query for the location of the subscriber's data.
2. The I-CSCF sends a DX_SLF_QUERY to the HSS and includes as parameter the subscriber identity which is stated in the INVITE request.
3. The SLF looks up its database for the queried subscriber identity.
4. The SLF answers with the HSS name in which the subscriber's data can be found.
5. The I-CSCF can proceed by querying the appropriate HSS.

The synchronisation between the SLF and the different HSSs is an O&M issue.

To prevent an SLF service failure e.g. in the event of a server outage, the SLF could be distributed over multiple servers. Several approaches could be employed to discover these servers. An example is the use of the DNS mechanism in combination with a new DNS SRV record. The specific algorithm for this however does not affect the basic SLF concept and is thus for further study.

5.9 Routing of mid-session signalling

During the signalling exchanges that occur to establish an IM Session, the following elements must ensure future signalling messages related to this session are routed through them:

- P-CSCF serving the originating UE, in order to generate the CDR record in the roaming case, and to force release of the resources used for the session
- S-CSCF serving the originating UE, in order to perform any service control required at session setup completion, and to generate the CDR record at session termination
- S-CSCF serving the terminating UE, in order to perform any service control required at session setup completion, and to generate the CDR record at session termination
- P-CSCF serving the terminating UE, in order to generate the CDR record in the roaming case, and to force release of the resources used for the session

Other CSCFs (e.g. I-CSCFs) may optionally request this as well, for example if they perform some function needed in handling mid-session changes or session clearing operations.

All signalling message from the UE related to IMS sessions shall be sent to the P-CSCF.

5.10 Session release procedures

This section provides scenarios showing SIP application session release. Note that these flows have avoided the strict use of specific SIP protocol message names. This is in an attempt to focus on the architectural aspects rather than the protocol. SIP is assumed to be the protocol used in these flows.

The session release procedures are necessary to ensure that the appropriate billing information is captured and to reduce the opportunity for theft of service by confirming that the bearers associated with a particular SIP session are deleted at the same time as the SIP control signalling and vice versa. Session release is specified for the following situations;

- Normal session termination resulting from an end user requesting termination of the session using session control signalling or deletion of the IP bearers associated with a session,
- Session termination resulting from network operator intervention,
- Loss of the session control bearer or IP bearer for the transport of the IMS signalling, and
- Loss of one or more radio connections which are used to transport the IMS signalling

As a design principle the session release procedures shall have a high degree of commonality in all situations to avoid complicating the implementation.

5.10.1 Mobile terminal initiated session release

The following flow shows a mobile terminal initiated IM CN subsystem application (SIP) session release. It is assumed that the session is active and that the bearer was established directly between the two visited networks (the visited networks could be the Home network in either or both cases).

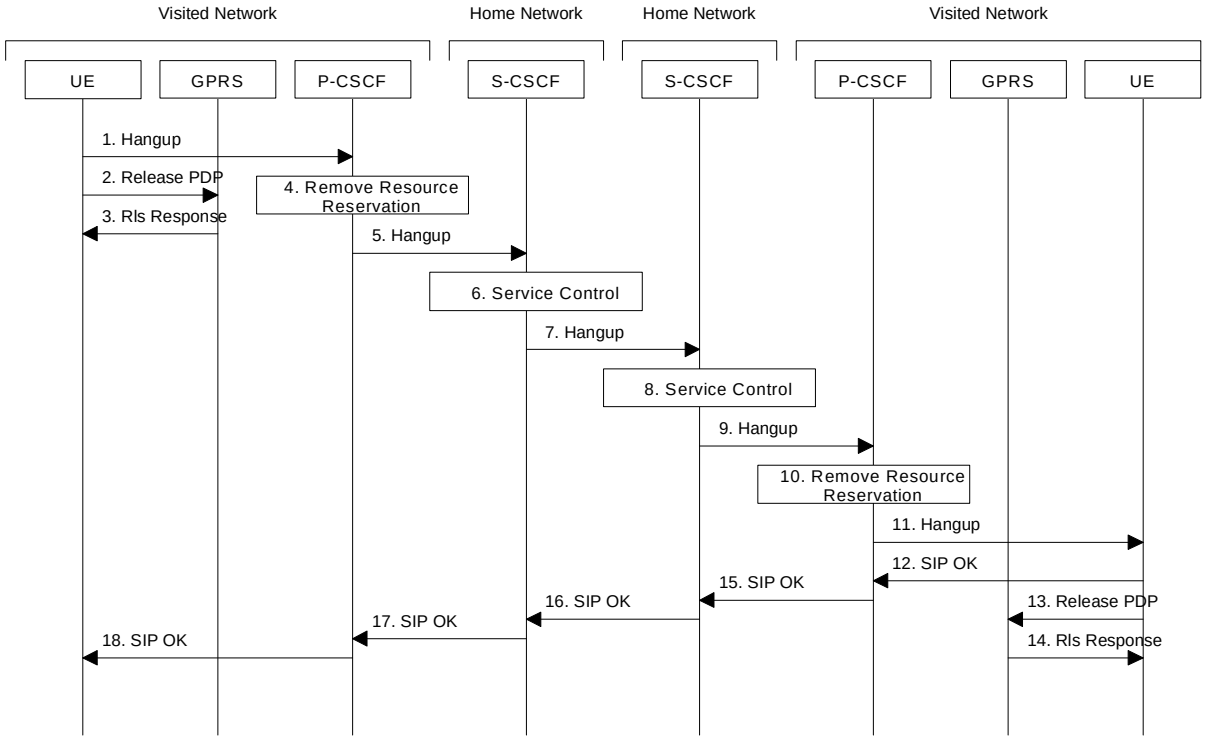


Figure 5.22: Mobile initiated session release

1. One mobile party hangs up, which generates a message (Bye message in SIP) from the UE to the P-CSCF.
2. Steps 2 and 3 may take place before or after Step 1 and in parallel with Step 4. The UE initiates the release of the bearer PDP context. The GPRS subsystem releases the PDP context. The IP network resources that had been reserved for the message receive path to the mobile for this session are now released. This is initiated from the GGSN. If RSVP was used to allocated resources, then the appropriate release messages for that protocol would invoked here.
3. The GPRS subsystem responds to the UE.
4. The P-CSCF removes the authorisation for resources that had previously been issued for this endpoint for this session. This step will also result in a release indication to the GPRS subsystem to confirm that the IP bearers associated with the session have been deleted
5. The P-CSCF sends a hangup to the S-CSCF of the releasing party.
6. The S-CSCF performs whatever service control procedures are appropriate for this ending session.
7. The S-CSCF of the releasing party forwards the Hangup to the S-CSCF of the other party.
8. The S-CSCF performs whatever service control procedures are appropriate for this ending session.
9. The S-CSCF of the other party forwards the Hangup on to the P-CSCF.
10. The P-CSCF removes the authorisation for resources that had previously been issued for this endpoint for this session. This step also results in a release indication to the GPRS subsystem to confirm that the IP bearers associated with the UE#2 session have been deleted.
11. The P-CSCF forwards the Hangup on to the UE.

12. The mobile responds with an acknowledgement, the SIP OK message (number 200), that is sent back to the P-CSCF.

13. Steps 13 and 14 may be done in parallel with step 12. The Mobile initiates the release of the bearer PDP context.

14. The GPRS subsystem releases the PDP context. The IP network resources that were reserved for the message receive path to the mobile for this session are now released. This is initiated from the GGSN. If RSVP was used to allocated resources, then the appropriate release messages for that protocol would invoked here.

15. The SIP OK message is sent to the S-CSCF.

16. The S-CSCF of the other party forwards the OK to the S-CSCF of the releasing.

17. The S-CSCF of the releasing party forwards the OK to the P-CSCF of the releasing.

18. The P-CSCF of the releasing party forwards the OK to the UE.

5.10.2 PSTN initiated session release

The following flow shows a PSTN terminal initiated IM CN subsystem application (SIP) session release. It is assumed that the session is active and that the bearer was established to the PSTN from the Home Network (the visited network could be the Home network in this case).

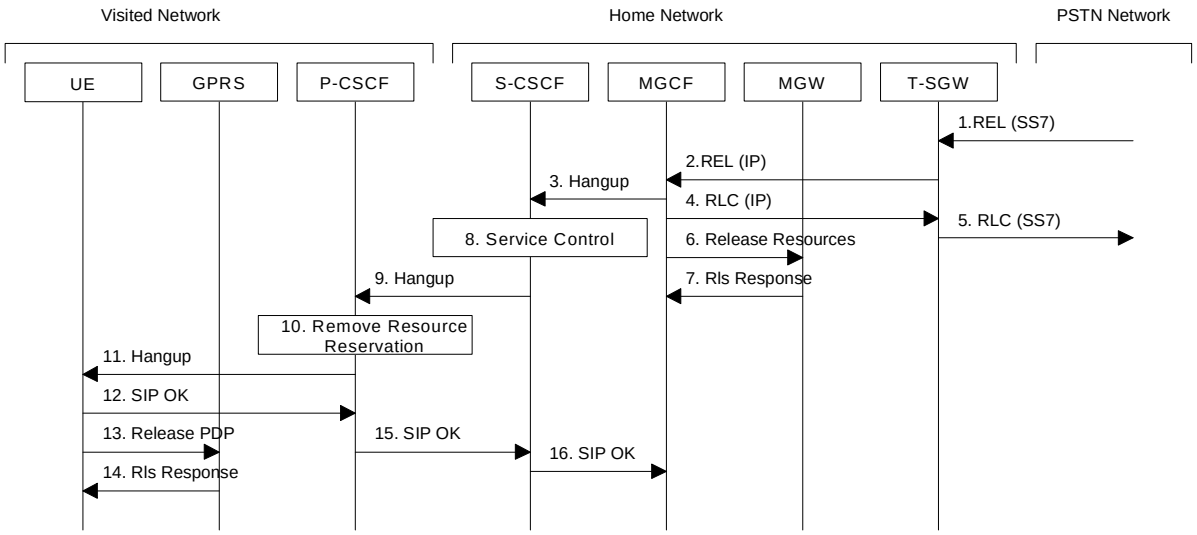


Figure 5.23: PSTN initiated session release

1. PSTN party hangs up, which generates an ISUP REL message over the SS7 link to the T-SGW.

2. The T-SGW changes the transport layer to IP and forwards the message to the associated MGCF.

3. The MGCF sends a Hangup (Bye message in SIP) to the S-CSCF to notify the mobile that the far end party has disconnected.

4. Steps 4 and 5 may be done in parallel with Step 3. Depending on the GSTN network type Steps 4 and 5 may need to wait until after step 16. The MGCF notes the reception of the REL and acknowledges it with an RLC (IP transport). This is consistent with the ISUP protocol.

5. The T-SGW changes the transport layer to SS7 and sends the RLC response back to the PSTN to finish the tear down of the circuit trunk.

6. The MGCF requests the MGW to release the vocoder and ISUP trunk using the H.248/MEGACO Transaction Request (subtract). This also results in disconnecting the two parties in the H.248 context. The IP network resources that were reserved for the message receive path to the PSTN for this session are now released. This is

initiated from the MGW. If RSVP was used to allocated resources, then the appropriate release messages for that protocol would be invoked here.

7. The MGW sends an acknowledgement to the MGCF upon completion of step 6.
8. The S-CSCF performs whatever service control procedures are appropriate for this ending session.
9. The S-CSCF forwards the Hangup to the P-CSCF.
10. The P-CSCF removes the authorisation for resources that had previously been issued for this endpoint for this session. This step also results in a release indication to the GPRS subsystem to confirm that the IP bearers associated with the UE#2 session have been deleted.
11. The P-CSCF forwards the Hangup to the UE.
12. The mobile responds with an acknowledgement, the SIP OK message (number 200), which is sent back to the P-CSCF.
13. Steps 13 and 14 may be done in parallel with step 12. The Mobile initiates the release of the bearer PDP context.
14. The GPRS subsystem releases the PDP context. The IP network resources that had been reserved for the message receive path to the mobile for this session are now released. This is initiated from the GGSN. If RSVP was used to allocated resources, then the appropriate release messages for that protocol would invoked here.
15. The SIP OK message is sent to the S-CSCF.
16. The S-CSCF forwards the message to the MGCF.

5.10.3 Network initiated session release

In case of a break in the radio connection or accidental/malicious removal of a PDP Context that is related to an IMS session, the corresponding session should be terminated in order to avoid billing for session inactivity time. In the event of a break in the radio connection, the RNC initiates the RAB release procedure, which in turn shall result in session termination and a corresponding PDP context deactivation.

The following figure presents GPRS subsystem events that occur following a break in the radio connection. Only the parameters that are required for the communication between the GGSN and the P-CSCF/PCF are shown in the description below.

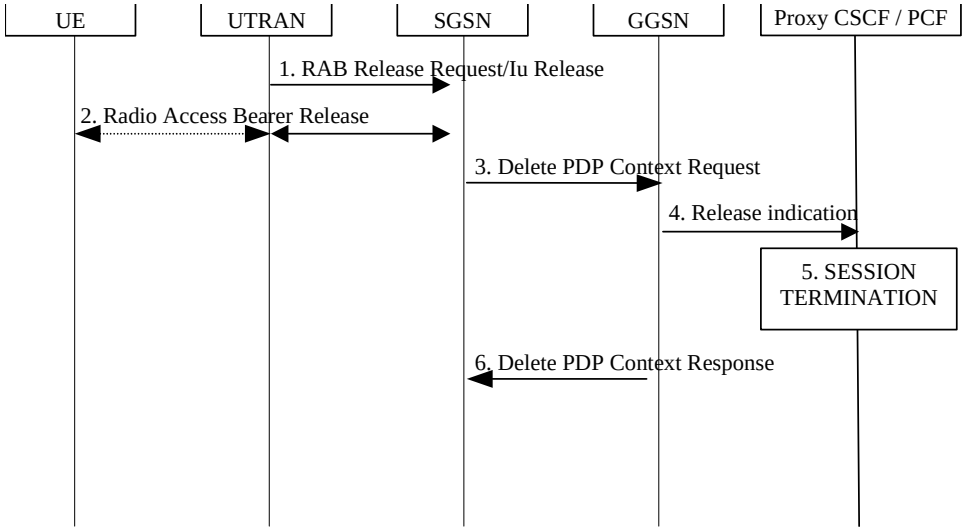


Figure 5.24: Network initiated session release - loss of radio

1. The RNC sends the RAB Release Request or Iu Release Request message to the SGSN to release the RAB.

2. The radio access bearer release procedure is performed. The radio bearers are released if they still exist.

3. The SGSN deactivates the PDP context by sending the Delete PDP Context Request message to the GGSN.

4. If a request state was created in the PCF at PDP context activation, the GGSN sends the Release indication message to the PCF. The message indicates that the corresponding PDP context has been deactivated.

5. The Proxy-CSCF performs session termination.

6. The GGSN sends the Delete PDP Context Response message to the SGSN to acknowledge the PDP context deletion.

After coverage is regained, the UE shall delete the PDP context in conversational or streaming class.

In the event that the UMTS bearer used for the transport of SIP signalling is released prior normal termination of the session using SIP signalling then the IM Subsystem shall be informed.

The following figure presents GPRS subsystem events that occur as a result of accidental removal of a PDP Context used for the transport of SIP signalling. Only the parameters which are required for the communication between the GGSN and the P-CSCF/PCF are shown in the description below.

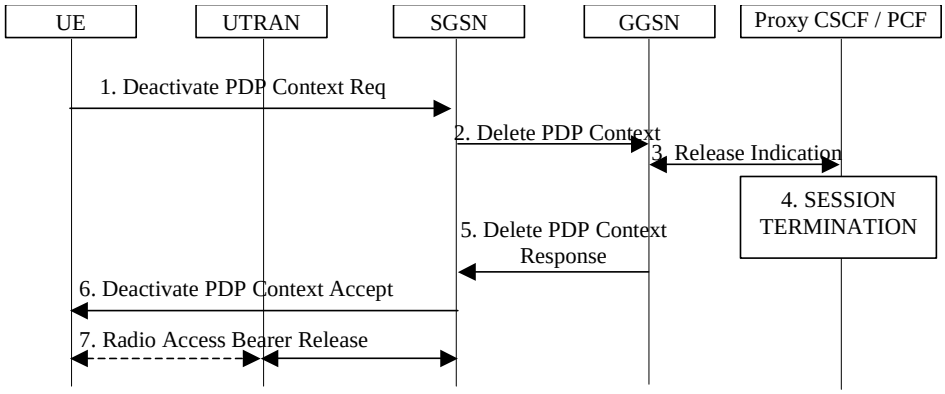


Figure 5.25: Network initiated session release - loss of SIP signalling context

1. The UE deactivates a PDP context by sending a Deactivate PDP Context Request message to the network.

2. The SGSN deactivates the PDP context by sending the Delete PDP Context Request message to the GGSN.

3. If a request state was created in the PCF at PDP context activation, the GGSN sends the Release indication message to the PCF. The message indicates that the corresponding PDP context has been deactivated.

4. The proxy CSCF performs session termination, which is FFS.

5. The GGSN sends the Delete PDP Context Response message to the SGSN to acknowledge the PDP context deactivation.

6. The SGSN responds to the UE with a Deactivate PDP Context Accept message

7. The UE performs the radio access bearer release procedure.

5.10.3.1 Network initiated session release - P-CSCF initiated

The following flow shows a Network initiated IM CN subsystem application (SIP) session release. It is assumed that the session is active and that the bearer was established directly between the two visited networks (the visited networks could be the Home network in either or both cases). One mobile drops its connection due to power down or signal fade, etc. Other network initiated session release scenarios are of course possible. In particular such scenarios initiated in the home network for administrative reasons might begin with an S-CSCF.

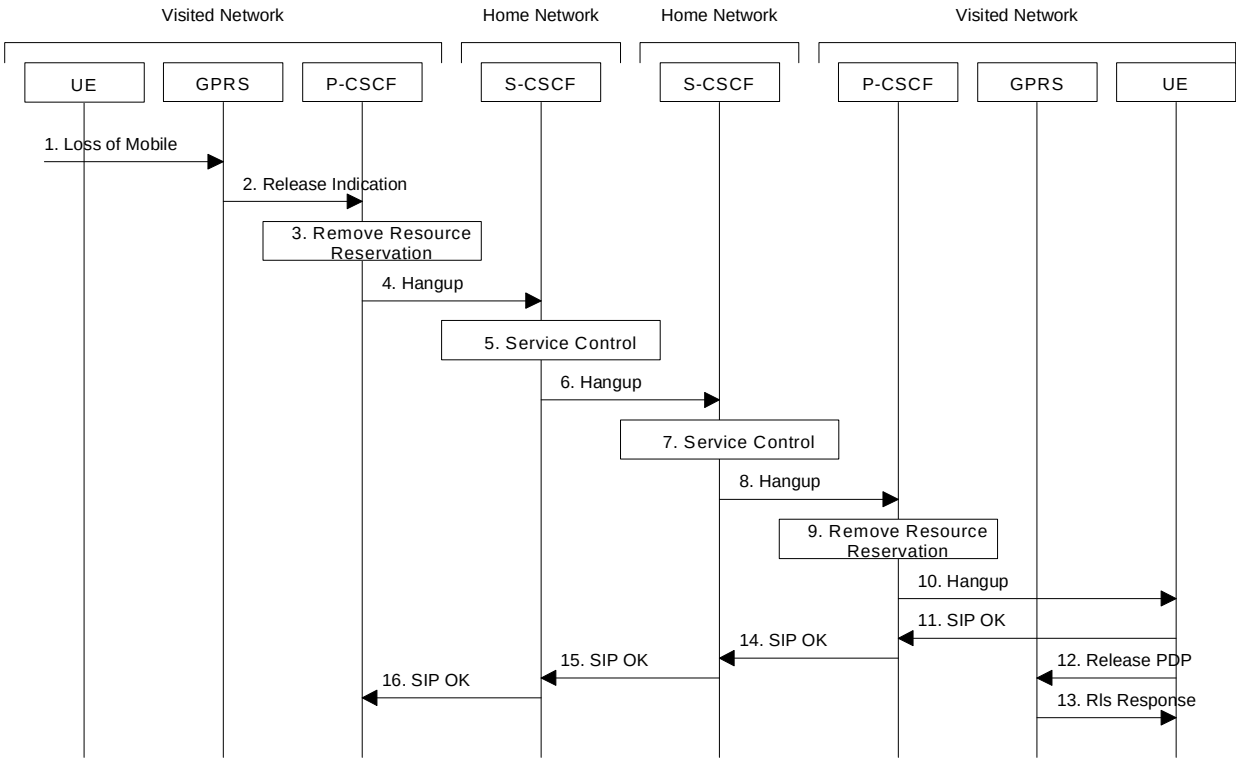


Figure 5.26: Network initiated session release - P-CSCF initiated

1. The bearer for the session is terminated, for example, by a mobile power down or loss of signal, etc. This is noted by the GPRS subsystem.

2. The GPRS subsystem may send a release indication to the P-CSCF for the disconnected mobile. The P-CSCF might also note the release due to a SIP Session Timeout.

Editor's Note: Which mechanism is used to report or detect release in this case is FFS.

3. The P-CSCF removes the authorisation for resources that had previously been issued for this endpoint for this session.

4. The P-CSCF generates a Hangup (Bye message in SIP) to the S-CSCF of the releasing party. It is noted that this message should be able to carry a cause value to indicate the reason for the generation of the hangup.

5. The S-CSCF performs whatever service control procedures are appropriate for this ending session.

6. The S-CSCF of the releasing party forwards the Hangup to the S-CSCF of the other party.

7. The S-CSCF performs whatever service control procedures are appropriate for this ending session.

8. The S-CSCF of the other party forwards the Hangup on to the P-CSCF.

9. The P-CSCF removes the authorisation for resources that had previously been issued for this endpoint for this session. This step also results in a release indication to the GPRS subsystem to confirm that the IP bearers associated with the session have been deleted for UE#2.

10. The P-CSCF forwards the Hangup on to the UE.

11. The mobile responds with an acknowledgement, the SIP OK message (number 200), which is sent back to the P-CSCF.

12. Steps 12 and 13 may be done in parallel with step 11. The Mobile initiates the release of the bearer PDP context.

13. The GPRS subsystem releases the PDP context. The IP network resources that had were reserved for the message receive path to the mobile for this session are now released. This is initiated from the GGSN. If RSVP was used to allocated resources, then the appropriate release messages for that protocol would invoked here.

14. The SIP OK message is sent to the S-CSCF and the P-.

15. The S-CSCF of the other party forwards the OK to the S-CSCF of the releasing party.

16. The S-CSCF of the releasing party forwards the OK to the P-CSCF of the releasing party.

5.10.3.2 Network initiated session release - S-CSCF Initiated

The following flow shows a network-initiated IM CN subsystem application session release, where the release is initiated by the S-CSCF. This can occur in various service scenarios, e.g. administrative, or prepaid.

The procedures for clearing a session, when initiated by an S-CSCF, are as shown in the following information flow.

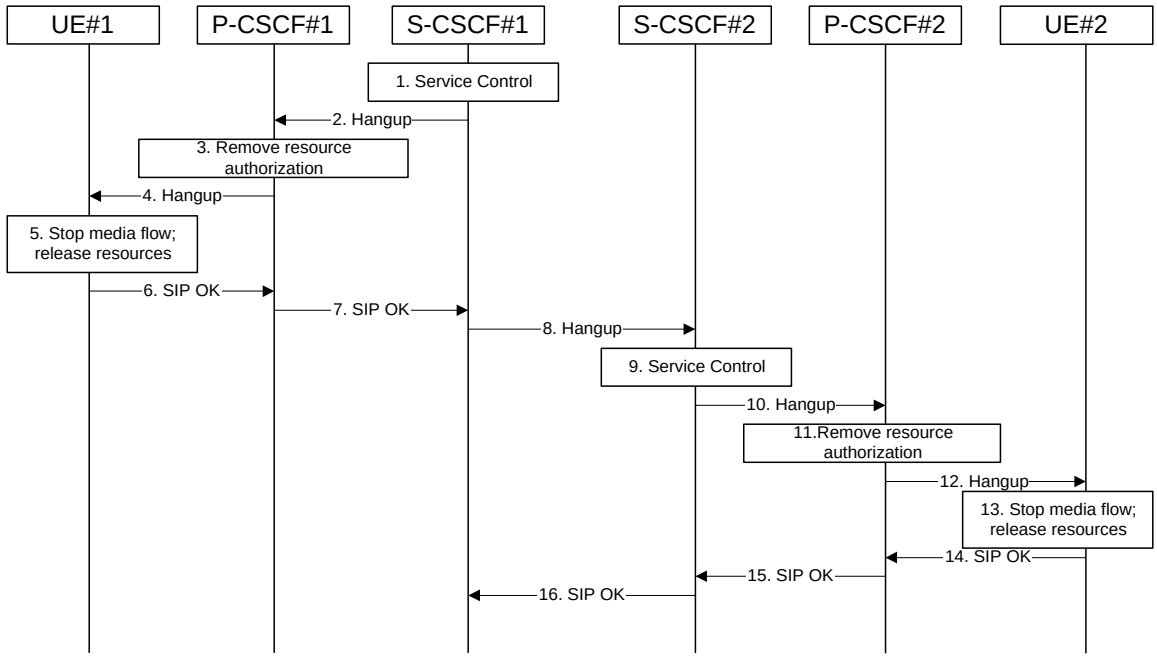


Figure 5.27: Network initiated session release - S-CSCF initiated

Information flow procedures are as follows:

1. S-CSCF#1 decides the session should be terminated, due to administrative reasons or due to service expiration.

2. S-CSCF#1 sends a Hangup message to P-CSCF#1

3. P-CSCF#1 removes the authorisation for resources that had previously been issued for this endpoint for this session. This step also results in a release indication to the GPRS subsystem to confirm that the IP bearers associated with the session have been deleted for UE#1.

4. P-CSCF#1 forwards the Hangup message to UE#1.

5. UE#1 stops sending the media stream to the remote endpoint, and releases the resources used for the session.

6. UE#1 responds with a SIP-OK message to its proxy, P-CSCF#1.

7. P-CSCF#1 forwards the SIP-OK message to S-CSCF#1.

8. S-CSCF#1 sends a Hangup message to S-CSCF#2. This is done at the same time as flow#2

9. S-CSCF#2 performs whatever service control procedures are appropriate for this ending session.

10. S-CSCF#2 forwards the Hangup message to P-CSCF#2.

11. P-CSCF#2 removes the authorisation for resources that had previously been issued for this endpoint for this session. This step also results in a release indication to the GPRS subsystem to confirm that the IP bearers associated with the session have been deleted for UE#2.

12. P-CSCF#2 forwards the Hangup message to UE#2.

13. UE#2 stops sending the media stream to the remote endpoint, and releases the resources used for the session.

14. UE#2 acknowledges receipt of the Hangup message with a SIP-OK final response, send to P-CSCF#2.

15. P-CSCF#2 forwards the SIP-OK final response to S-CSCF#2.

16. S-CSCF#2 forwards the SIP-OK final response to S-CSCF#1.

5.11 Procedures to enable enhanced multimedia services

5.11.1 Session Hold and Resume Procedures

This section gives information flows for the procedures for placing sessions on hold that were previously established by the mechanisms of sections 5.4, 5.5, 5.6, and 5.7, and resuming the session afterwards. Two cases are presented: mobile-to-mobile (UE-UE), and a UE-initiated hold of a UE-PSTN session.

For a multi-media session, it shall be possible to place a subset of the media streams on hold while maintaining the others.

These procedures do not show the use of optional I-CSCFs. If an I-CSCF was included in the signalling path during the session establishment procedure, it would continue to be used in any subsequent flows such as the ones described in this section.

5.11.1.1 Mobile-to-Mobile Session Hold and Resume Procedures

An IMS session was previously established between an initiating UE and a terminating UE. Each of these UEs has an associated P-CSCF in the same network where they are currently located (either home or roaming), and a S-CSCF assigned in their home network . These functional elements co-operate to clear the session, and the procedures are independent of whether they are located in the home or visited networks.

The hold and resume procedures are identical whether the UE that initiated the session also initiates the session-hold, or whether the UE that terminated the session initiates the session-hold.

When a media stream has been placed on hold, it shall not be resumed by any endpoint other than the one that placed it on hold.

The procedures for placing a media stream on hold, and later resuming the media stream, are as shown in the following information flow:

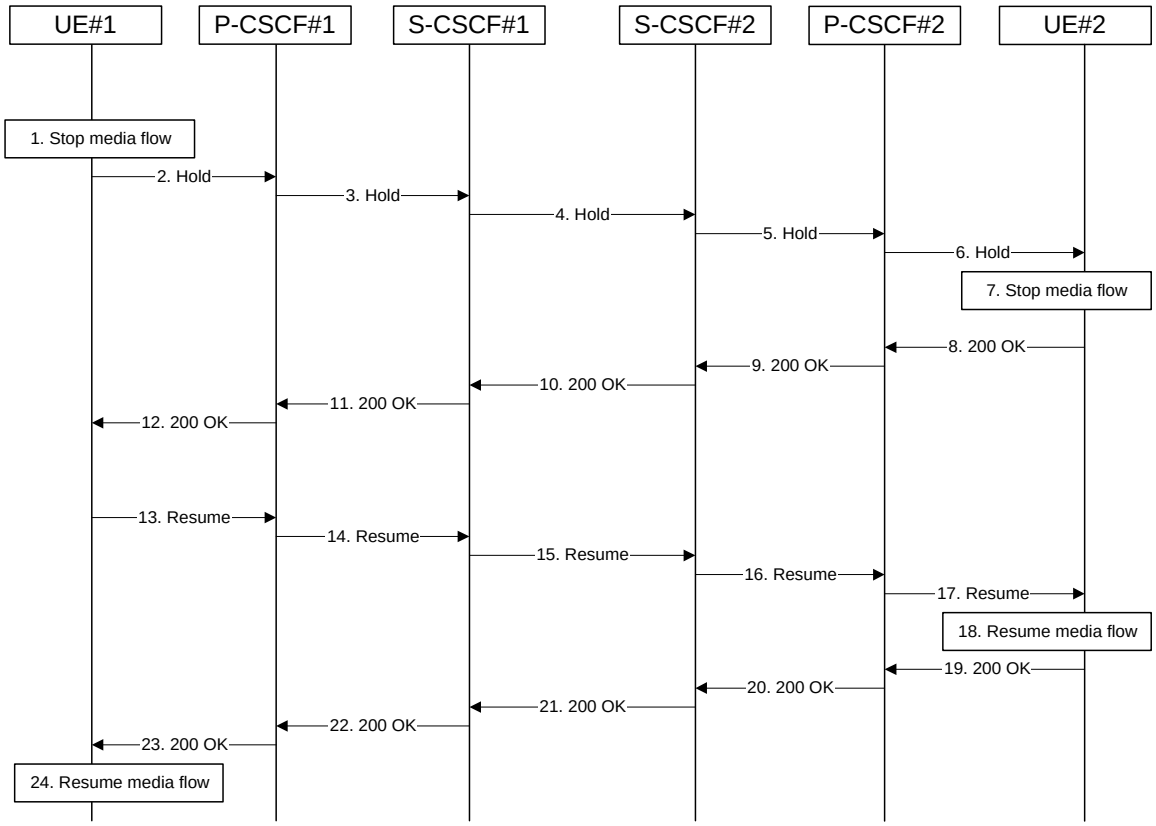


Figure 5.28: Mobile to Mobile session hold and resume

Information flow procedures are as follows:

1. UE#1 detects a request from the subscriber to place a media stream on hold. UE#1 stops sending the media stream to the remote endpoint, but keeps the resources for the session reserved.
2. UE#1 sends a Hold message to its proxy, P-CSCF#1.
3. P-CSCF#1 forwards the Hold message to S-CSCF#1.
4. S-CSCF#1 forwards the Hold message to S-CSCF#2.
5. S-CSCF#2 forwards the Hold message to P-CSCF#2.
6. P-CSCF#2 forwards the Hold message to UE#2.
7. UE#2 stops sending the media stream to the remote endpoint, but keeps the resources for the session reserved.
8. UE#2 acknowledges receipt of the Hold message with a 200-OK final response, send to P-CSCF#2.
9. P-CSCF#2 forwards the 200 OK final response to S-CSCF#2.
10. S-CSCF#2 forwards the 200 OK final response to S-CSCF#1.
11. S-CSCF#1 forwards the 200 OK final response to P-CSCF#1.
12. P-CSCF#1 forwards the 200 OK final response to UE#1.
13. UE#1 detects a request from the subscriber to resume the media stream previously placed on hold. UE#1 sends a Resume message to its proxy, P-CSCF#1.
14. P-CSCF#1 forwards the Resume message to S-CSCF#1.
15. S-CSCF#1 forwards the Resume message to S-CSCF#2.
16. S-CSCF#2 forwards the Resume message to P-CSCF#2.

17. P-CSCF#2 forwards the Resume message to UE#2.

18. UE#2 resumes sending the media stream to the remote endpoint.

19. UE#2 acknowledges receipt of the Resume message with a 200-OK final response, sent to P-CSCF#2.

20. P-CSCF#2 forwards the 200 OK final response to S-CSCF#2.

21. S-CSCF#2 forwards the 200 OK final response to S-CSCF#1.

22. S-CSCF#1 forwards the 200 OK final response to P-CSCF#1.

23. P-CSCF#1 forwards the 200 OK final response to UE#1.

24. UE#1 resumes sending the media stream to the remote endpoint.

5.11.1.2 Mobile-initiated Hold and Resume of a Mobile-PSTN Session

An IMS session was previously established between an initiating UE and a MGCF acting as a gateway for a session terminating on the PSTN, or between an initiating MGCF acting as a gateway for a session originating on the PSTN to a terminating UE. The UE has an associated P-CSCF in the same network where it is currently located (either home or roaming), an S-CSCF assigned in its home network, and a BGCF that chooses the MGCF. These functional elements co-operate to clear the session, and the procedures are independent of whether they are located in the subscriber's home or visited networks. Therefore there is no distinction in this section of home network vs. visited network.

The session hold and resume procedure is similar whether the UE initiated the session to the PSTN, or if the PSTN initiated the session to the UE. The only difference is the optional presence of the BGCF in the case of a session initiated by the UE. Note that the BGCF might or might not be present in the signalling path after the first INVITE is routed.

The procedures for placing a media stream on hold, and later resuming the media stream, are as shown in the following information flow:

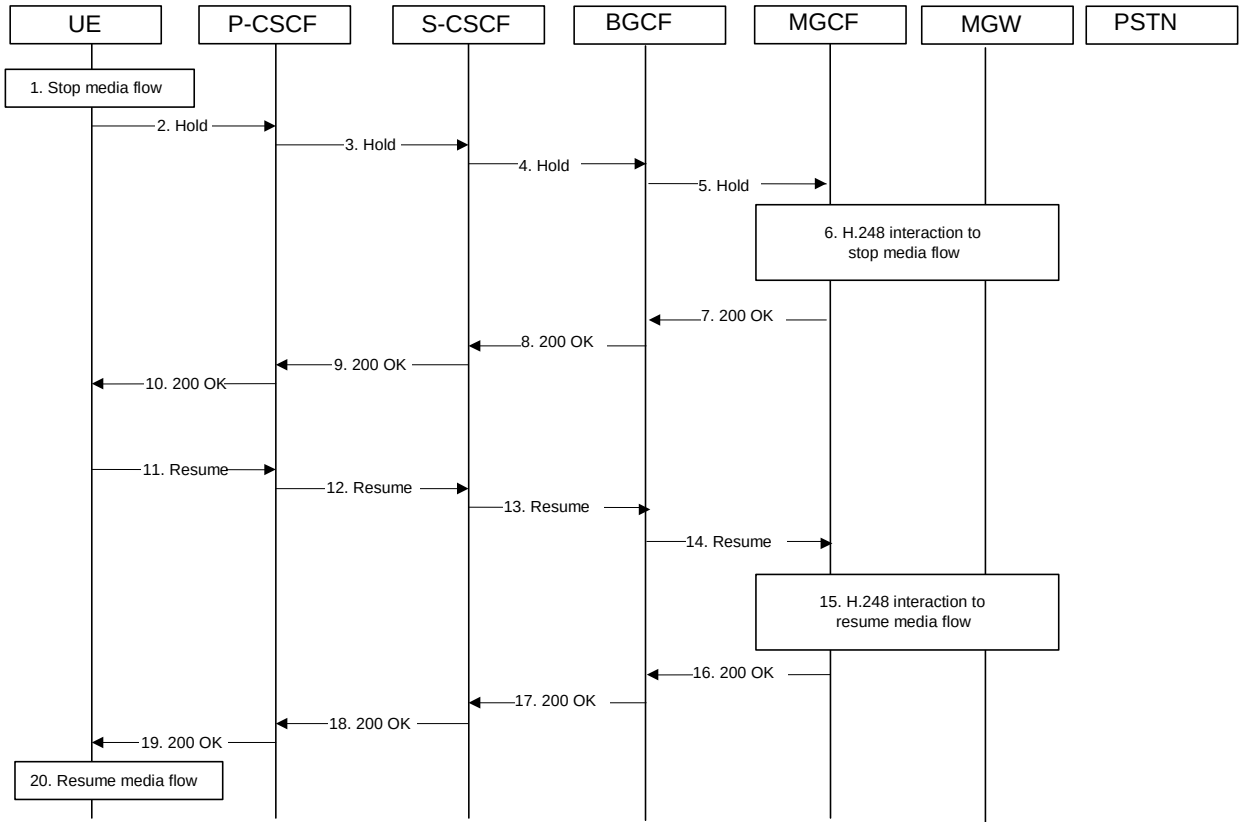


Figure 5.29: Mobile to PSTN session hold and resume

Information flow procedures are as follows:

1. UE detects a request from the subscriber to place a media stream on hold. UE#1 stops sending the media stream to the remote endpoint, but keeps the resources for the session reserved.
2. UE sends a Hold message to its proxy, P-CSCF.
3. P-CSCF forwards the Hold message to S-CSCF.
4. S-CSCF forwards the Hold message to BGCF.
5. BGCF forwards the Hold message to MGCF.
6. MGCF initiates a H.248 interaction with MGW instructing it to stop sending the media stream, but to keep the resources for the session reserved.
7. MGCF acknowledges receipt of the Hold message with a 200-OK final response, send to BGCF.
8. BGCF forwards the 200-OK to the S-CSCF.
9. S-CSCF forwards the 200 OK final response to P-CSCF.
10. P-CSCF forwards the 200 OK final response to UE.
11. UE detects a request from the subscriber to resume the media stream previously placed on hold. UE sends a Resume message to its proxy, P-CSCF.
12. P-CSCF forwards the Resume message to S-CSCF.
13. S-CSCF forwards the Resume message to BGCF.
14. BGCF forwards the Resume message to MGCF.
15. MGCF initiates a H.248 interaction with MGW instructing it to resume sending the media stream.
16. MGCF acknowledges receipt of the Resume message with a 200-OK final response, sent to BGCF.
17. BGCF forwards the 200 OK final response to the S-CSCF.
18. S-CSCF forwards the 200 OK final response to P-CSCF.
19. P-CSCF forwards the 200 OK final response to UE.
20. UE resumes sending the media stream to the remote endpoint.

5.11.2 Procedures for anonymous session establishment

This section gives information flows for the procedures for an anonymous session. However, sessions are not intended to be anonymous to the originating or terminating network operators.

5.11.2.1 Signalling requirements for anonymous session establishment

If the subscriber requests the session to be anonymous, the UE must not reveal any identity information other than that required in the Remote-Party-ID header.

If the originating subscriber requests the session to be anonymous, the terminating side must not reveal any identity or signalling routing information to the destination endpoint. The terminating network should distinguish at least two cases, first where the originator intended the session to be anonymous, and second where the originator's identity was deleted by a transit network.

5.11.2.2 Bearer path requirements for anonymous session establishment

Procedures for establishment of an anonymous bearer path are not standardised in this release.

5.11.3 Procedures for codec and media flow negotiations

This section gives information flows for the procedures for determining the set of mutually-supported codecs between the endpoints of a multi-media session, determining the initial codecs to be used for the multi-media session, and the procedures for changing between codecs when multiple ones are supported.

Editor's note: If transcoding is to be supported, these procedures need to be adjusted.

5.11.3.1 Codec negotiation during initial session establishment

Initial session establishment in the IM CN subsystem must determine a common codec (or set of common codecs for multi-media sessions) that will be used for the session. This is done through an end-to-end message exchange to determine the complete set of common codecs, then the decision is made by the session initiator as to the initial set of media flows.

The session initiator includes an SDP in the SIP INVITE message that lists every codec that the originator is willing to support for this session. When the message arrives at the destination endpoint, it responds with the subset that it is also willing to support for the session. Media authorisation is performed for this common subset. The session initiator, upon receiving the common subset, determines the codec (or set of codecs) to be used initially.

Once the session is established, the procedures of section 5.11.3.2 may be used by either endpoint to change to a different codec that was included in the initial common list, and for which no additional resources are required for media transport. The procedures of section 5.11.3.3 may be used by either endpoint to propose additional codecs, to receive additional authorisation for QoS resources, or to change to a different codec that requires resources beyond those allocated to the session.

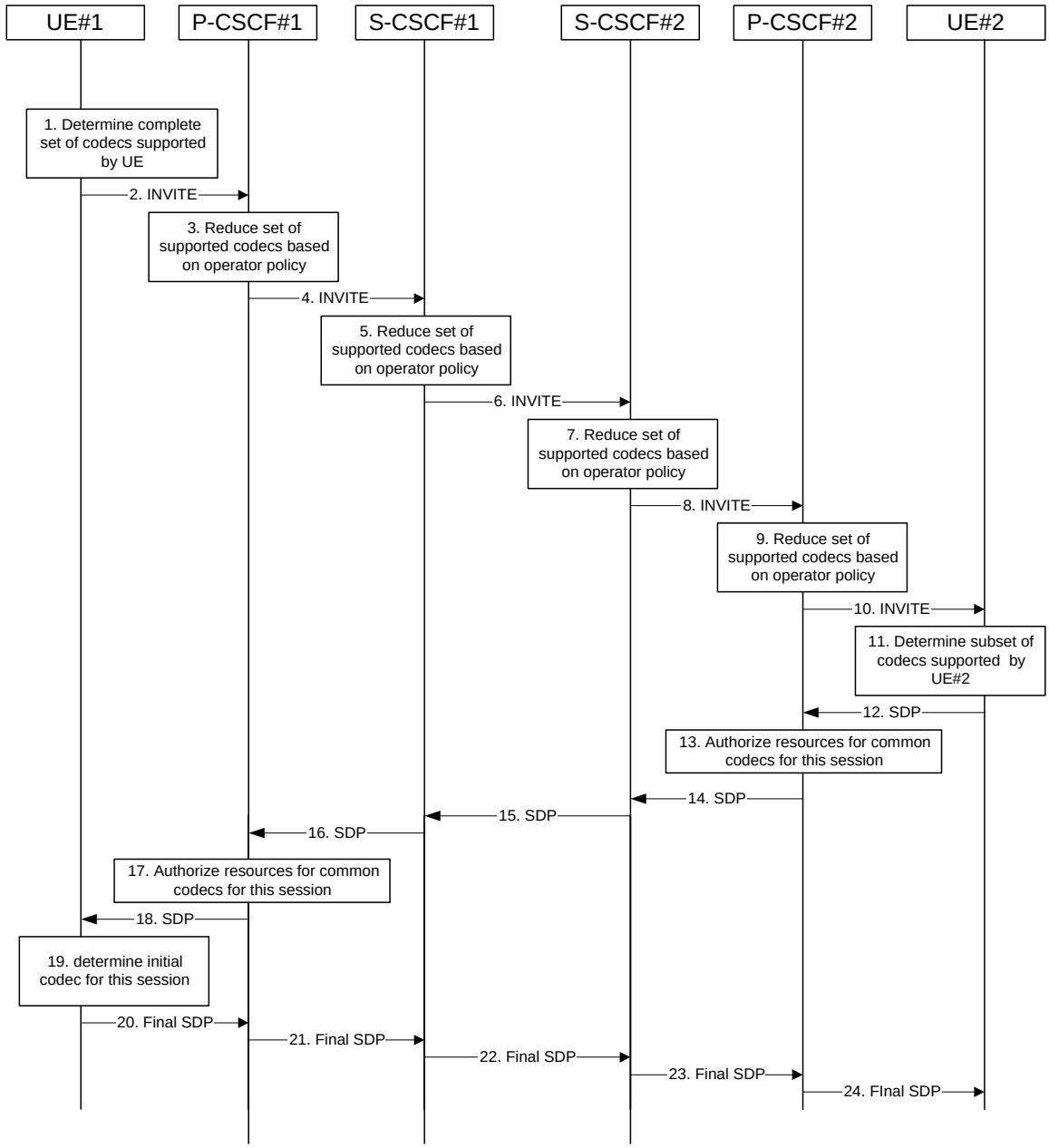


Figure 5.30: Codec negotiation during initial session establishment

The detailed procedure is as follows:

1. UE#1 determines the complete set of codecs that it is capable of supporting for this session. It builds a SDP containing bandwidth requirements and characteristics of each, and assigns local port numbers for each possible media flow. Multiple media flows may be offered, and for each media flow (m= line in SDP), there may be multiple codec choices offered.

2. UE#1 sends the initial INVITE message to P-CSCF#1 containing this SDP

3. P-CSCF#1 examines the media parameters, and removes any choices that the nework operator decides based on local policy, not to allow on the network.

4. P-CSCF#1 forwards the INVITE message to S-CSCF#1

5. S-CSCF#1 examines the media parameters, and removes any choices that the subscriber does not have authority to request.

6. S-CSCF#1 forwards the INVITE, through the S-S Session Flow Procedures, to S-CSCF#2

7. S-CSCF#2 examines the media parameters, and removes any choices that the destination subscriber does not have authority to request.

8. S-CSCF#3 forwards the INVITE message to P-CSCF#2.

9. P-CSCF#2 examines the media parameters, and removes any that the network operator decides, based on local policy, not to allow on the network.

10. P-CSCF#2 forwards the INVITE message to UE#2

11. UE#2 determines the complete set of codecs that it is capable of supporting for this session. It determines the intersection with those appearing in the SDP in the INVITE message. For each media flow that is not supported, UE#2 inserts a SDP entry for media (m= line) with port=0. For each media flow that is supported, UE#2 inserts a SDP entry with an assigned port and with the codecs in common with those in the SDP from UE#1.

12. UE#2 returns the SDP listing common media flows and codecs to P-CSCF#2

13. P-CSCF#2 authorises the QoS resources for the remaining media flows and codec choices.

14. P-CSCF#2 forwards the SDP response to S-CSCF#2.

15. S-CSCF#2 forwards the SDP response to S-CSCF#1

16. S-CSCF#1 forwards the SDP response to P-CSCF#1

17. P-CSCF#1 authorises the QoS resources for the remaining media flows and codec choices.

18. P-CSCF#1 forwards the SDP response to UE#1

19. UE#1 determines which media flows should be used for this session, and which codecs should be used for each of those media flows. If there was more than one media flow, or if there was more than one choice of codec for a media flow, then UE#1 must include an SDP in the “Final SDP” message sent to UE#2.

20-24. UE#2 sends the “Final SDP” message to UE#1, along the signalling path established by the INVITE request

The remainder of the multi-media session completes identically to a single media/single codec session.

5.11.3.2 Codec or media flow change within the existing reservation

After the multi-media session is established, it is possible for either endpoint to change the set of media flows or codec for a media flow. If the change is within the resources already reserved, then it is only necessary to synchronise the change with the other endpoint. Note that an admission control decision will not fail if the new resource request is within the existing reservation.

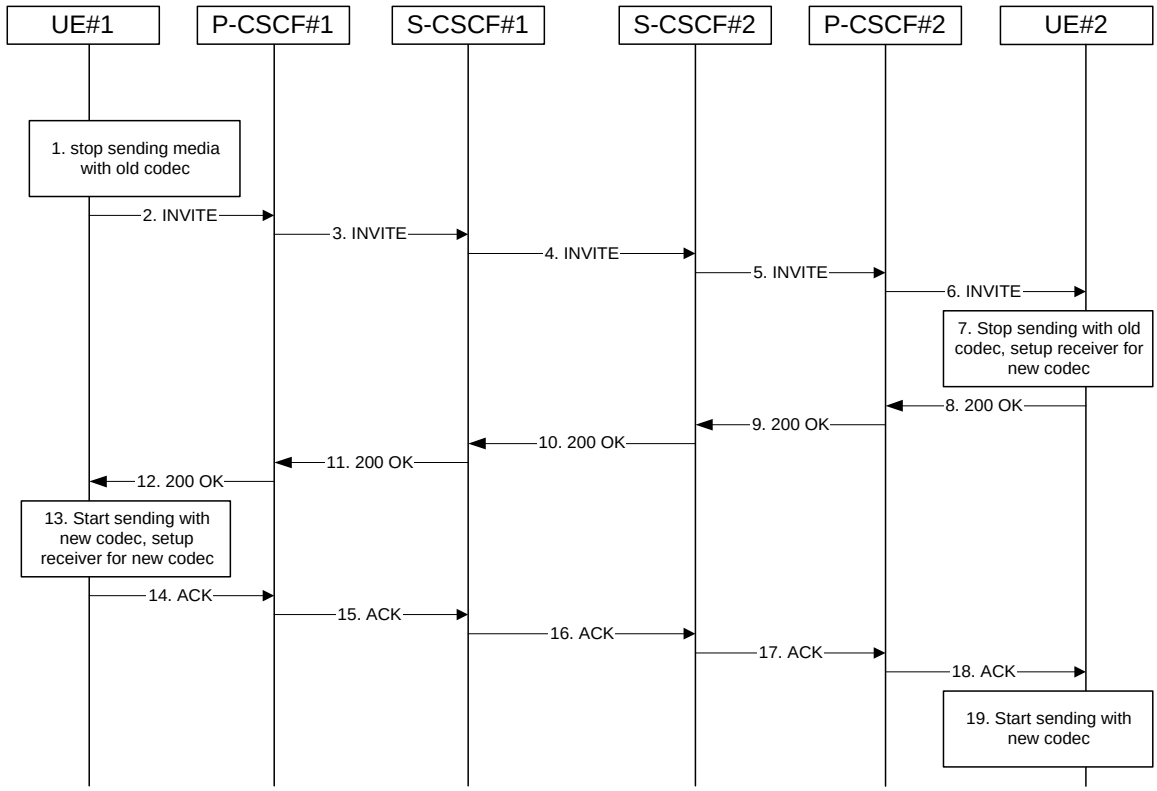


Figure 5.31: Codec or media flow change - same reservation

The detailed procedure is as follows:

1. UE#1 determines that a new media stream is desired, or that a change is needed in the codec in use for an existing media stream. UE#1 evaluates the impact of this change, and determines the existing resources reserved for the session are adequate. UE#1 builds a revised SDP that includes all the common media flows determined by the initial negotiation, but assigns a codec and port number only to those to be used onward. UE#1 stops transmitting media streams on those to be dropped from the session.

2-6. UE#1 sends an INVITE message through the signalling path to UE#2. At each step along the way, the CSCFs recognise the SDP is a proper subset of that previously authorised, and take no further action.

7. UE#2 receives the INVITE message, and agrees that it is a change within the previous resource reservation. (If not, it would respond with a SDP message, following the procedures of 5.11.3.1). UE#2 stops sending the media streams to be deleted, and initialises its media receivers for the new codec.

8-12. UE#2 forwards a 200-OK final response to the INVITE message along the signalling path back to UE#1.

13. UE#1 starts sending media using the new codecs. UE#1 also releases any excess resources no longer needed.

14-18. UE#1 sends the SIP final acknowledgement, ACK, to UE#2.

19. UE#2 starts sending media using the new codecs. UE#2 also releases any excess resources no longer needed

5.11.3.3 Codec or media flow change requiring new resources and/or authorisation

After the multi-media session is established, it is possible for either endpoint to change the set of media flows or codec for a media flow. If the change requires additional resources beyond those previously reserved, then it is necessary to perform the resource reservation and bearer establishment procedures. If the reservation request fails for whatever reason, the original multi-media session remains in progress.

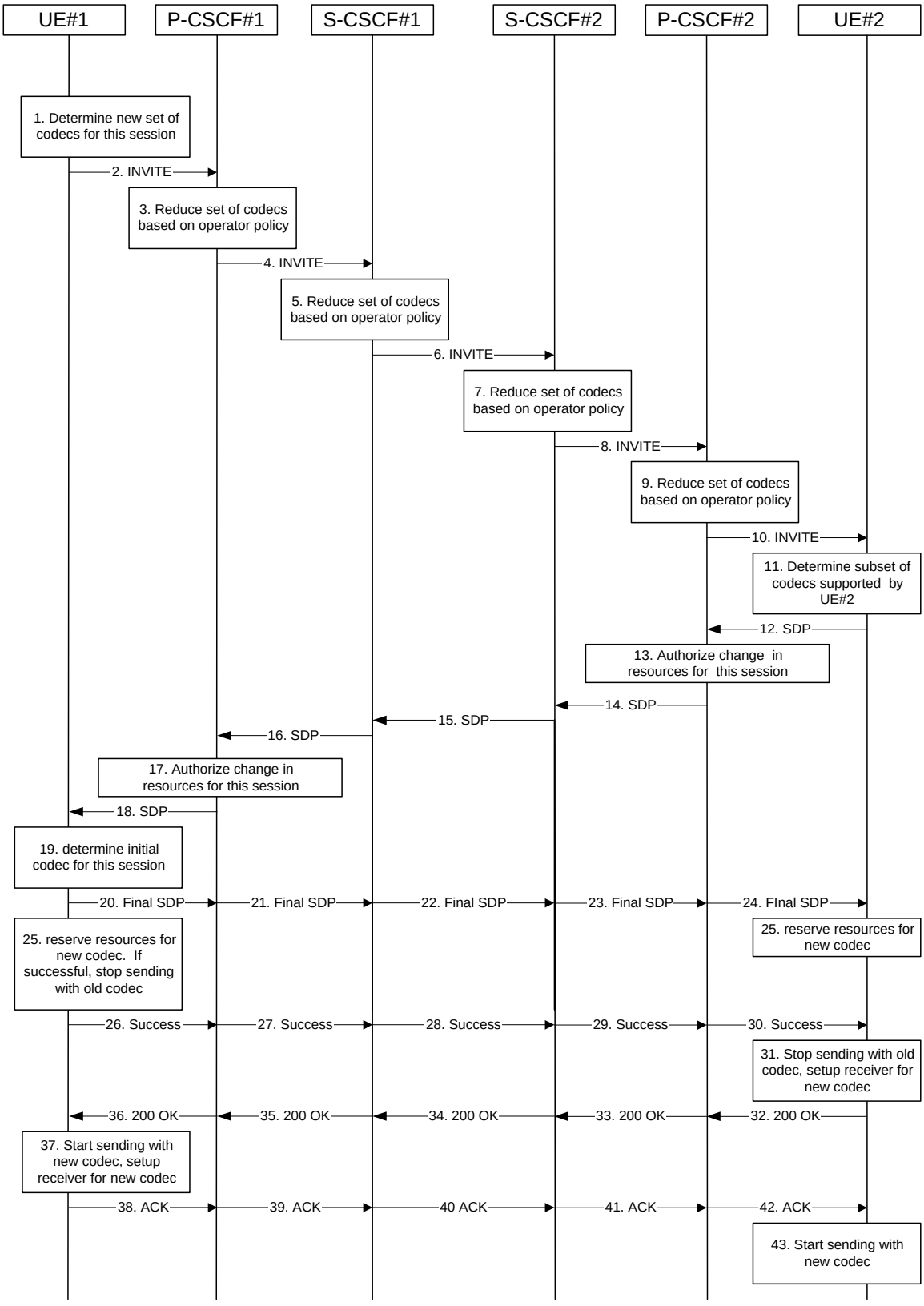


Figure 5.32: Codec or media flow change - new reservation

The detailed procedure is as follows:

1. UE#1 determines the revised set of codecs that it is wishes to support for this session. It builds a SDP containing bandwidth requirements and characteristics of each, and assigns local port numbers for each possible media flow. Multiple media flows may be offered, and for each media flow (m= line in SDP), there may be multiple codec choices offered.

2. UE#1 sends an INVITE message to P-CSCF#1 containing this SDP

3. P-CSCF#1 examines the media parameters, and removes any choices that the network operator decides, based on local policy, not to allow on the network.

4. P-CSCF#1 forwards the INVITE message to S-CSCF#1

5. S-CSCF#1 examines the media parameters, and removes any choices that the subscriber does not have authority to request.

6. S-CSCF#1 forwards the INVITE, through the S-S Session Flow Procedures, to S-CSCF#2

7. S-CSCF#2 examines the media parameters, and removes any choices that the destination subscriber does not have authority to request.

8. S-CSCF#3 forwards the INVITE message to P-CSCF#2.

9. P-CSCF#2 examines the media flows and the codec choices, and removes any that the destination network operator decides, based on local policy, not to allow on the network.

10. P-CSCF#2 forwards the INVITE message to UE#2

11. UE#2 determines the complete set of codecs that it is capable of supporting for this session. It determines the intersection with those appearing in the SDP in the INVITE message. For each media flow that is not supported, UE#2 inserts a SDP entry for media (m= line) with port=0. For each media flow that is supported, UE#2 inserts a SDP entry with an assigned port and with the codecs in common with those in the SDP from UE#1.

12. UE#2 returns the SDP listing common media flows and codecs to P-CSCF#2

13. P-CSCF#2 increases the authorisation for the QoS resources, if needed, for the remaining media flows and codec choices.

14. P-CSCF#2 forwards the SDP response to S-CSCF#2.

15. S-CSCF#2 forwards the SDP response to S-CSCF#1

16. S-CSCF#1 forwards the SDP response to P-CSCF#1

17. P-CSCF#1 increases the authorisation for the QoS resources, if needed, for the remaining media flows and codec choices.

18. P-CSCF#1 forwards the SDP response to UE#1

19. UE#1 determines which media flows should be used for this session, and which codecs should be used for each of those media flows. If there was more than one media flow, or if there was more than one choice of codec for a media flow, then UE#1 must include an SDP in the “Final SDP” message sent to UE#2.

20-24. UE#1 sends the “Final SDP” message to UE#2, including the SDP from step #19 if needed.

25. UE#1 and UE#2 reserve the resources needed for the added or changed media flows. If the reservation is successfully completed by UE#1, it stops transmitting any deleted media streams.

26-30. UE#1 sends the “Resource Reservation Successful” message to UE#2, via the signalling path through the CSCFs.

31. UE#2 stops sending the media streams to be deleted, and initialises its media receivers for the new codec.

32-36. UE#2 sends the 200-OK final response to UE#1, along the signalling path

37. UE#1 starts sending media using the new codecs. UE#1 also releases any excess resources no longer needed.

38-42 UE#1 sends the SIP final acknowledgement, ACK, to UE#2 along the signalling path

43. UE#2 starts sending media using the new codecs. UE#2 also releases any excess resources no longer needed

5.11.3.4 Sample MM session flow - addition of another media

For this end-to-end session flow, we assume the originator is a UE located within the service area of the network operator to whom the UE is subscribed. The UE has already established an IM CN session and is generating an invite to add another media (e.g., video to a voice call) to the already established session. Note that the invite to add media to an existing session could be originated by either end. The invite, and subsequent flows, are assumed to follow the path determined when the initial session was established. Any I-CSCFs that were included in the initial session would be included in this session.

The originating party addresses a destination that is a subscriber of the same network operator.

The destination party is a UE located within the service area of the network operator to which it is subscribed.

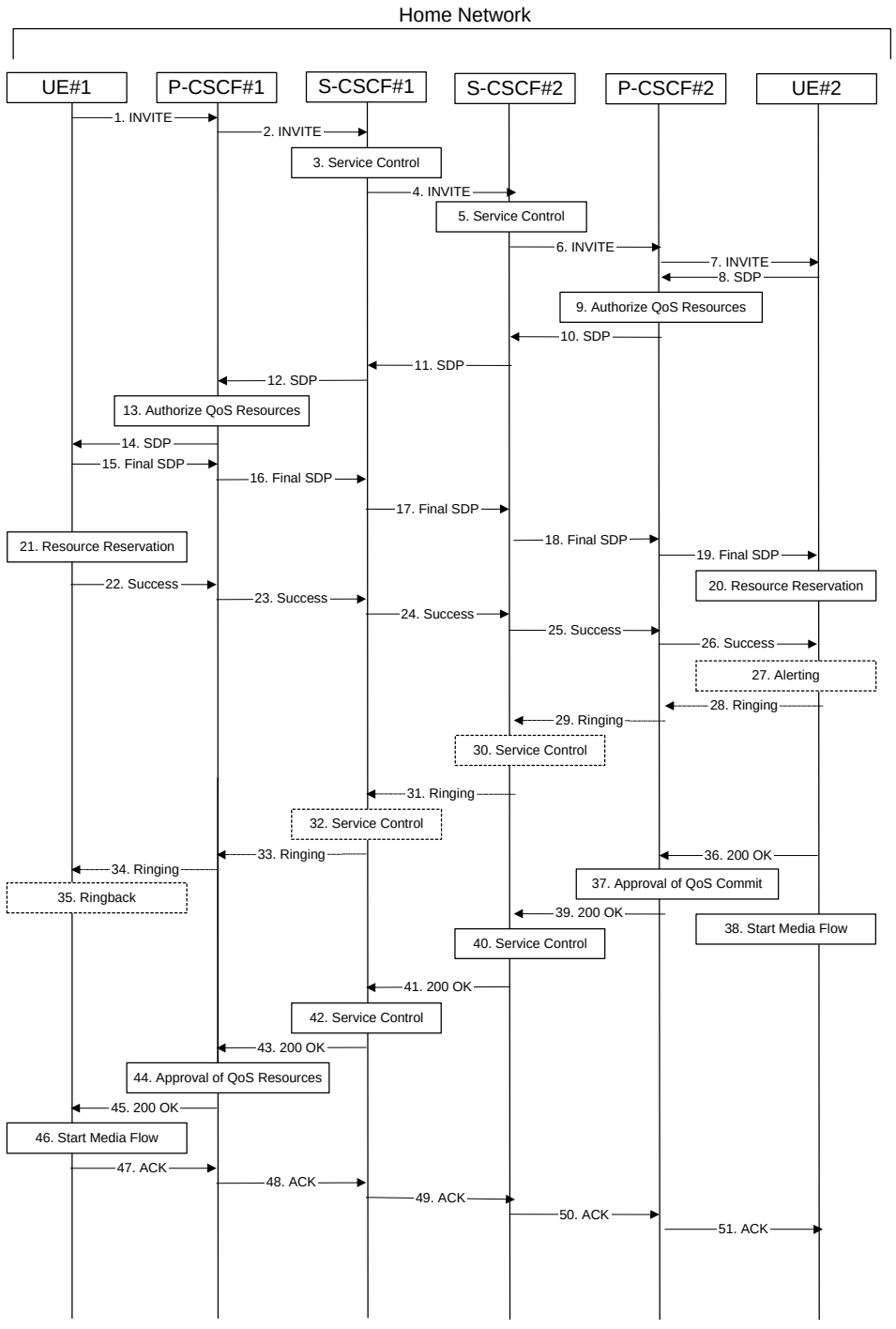


Figure 5.33: Multimedia session flow - addition of another media

Step-by-step processing of this end-to-end session flow is as follows:

1. UE#1 sends a SIP INVITE request, containing new SDP for the new media and including the original SDP, to P-CSCF#1, which was obtained from the CSCF discovery procedures.
2. P-CSCF#1 forwards the INVITE to the next hop name/address, as determined from the registration procedures. In this case the next hop is S-CSCF#1 within the same operator's network.
3. S-CSCF#1 validates the service profile, and performs whatever service control logic is appropriate for this session attempt.
4. S-CSCF#1 recognises that this invite applies to an existing session. It therefore forwards the INVITE along the existing path to S-CSCF#2.
5. S-CSCF#2 validates the service profile, and performs whatever service control logic is appropriate for this session attempt.
6. S-CSCF#2 remembers (from the registration procedure) the next hop CSCF for this UE. It forwards the INVITE to P-CSCF#2 in the home network.
7. P-CSCF#2 remembers (from the registration procedure) the address of UE#2 and forwards the INVITE to UE#2.
8. UE#2 returns the media stream capabilities of the destination to the session originator, along the signalling path established by the INVITE message.
9. P-CSCF#2 authorises the QoS resources required for this additional media.
10. P-CSCF#2 forwards the SDP to S-CSCF#2.
11. S-CSCF#2 forwards the SDP to S-CSCF#1.
12. S-CSCF#1 forwards the SDP message to P-CSCF#1.
13. P-CSCF#1 authorises the additional resources necessary for this new media.
14. P-CSCF#1 forwards the SDP message to the originating endpoint, UE#1.
15. The originator decides the final set of media streams for this media addition, and sends the final SDP to P-CSCF#1.
16. P-CSCF#1 forwards the final SDP to S-CSCF#1.
17. S-CSCF#1 forwards the final SDP to S-CSCF#2.
18. S-CSCF#2 forwards the final SDP to P-CSCF#2.
19. P-CSCF#2 forwards the final SDP to UE#2.
20. UE#2 initiates the resource reservation procedures for the resources necessary for this additional media.
21. After determining the final set of media streams for this additional media, step #15 above, UE#1 initiates the reservation procedures for the additional resources needed for this new media.
22. When UE#1 has successfully reserved the needed resources, it sends the "reservation successful" message to UE#2 along the signaling path established by the INVITE message. The message is sent first to P-CSCF#1.
23. P-CSCF#1 forwards the message to S-CSCF#1.
24. S-CSCF#1 forwards the message to S-CSCF#2.
25. S-CSCF#2 forwards the message to P-CSCF#2.
26. P-CSCF#2 forwards the message to UE#2.
27. UE#2 may optionally delay the session establishment in order to alert the subscriber to the incoming additional media.

28. If UE#2 performs alerting, it sends a ringing indication to the originator via the signalling path. The message is sent first to P-CSCF#2.
29. P-CSCF#2 forwards the ringing message to S-CSCF#2.
30. S-CSCF#2 performs whatever service control is appropriate for this ringing flow.
31. S-CSCF#2 forwards the message to S-CSCF#1.
32. S-CSCF#1 performs whatever service control is appropriate for this ringing flow.
33. S-CSCF#1 forwards the message to P-CSCF#1.
34. P-CSCF#1 forwards the message to UE#1.
35. UE#1 indicates to the originator that the media addition is being delayed due to alerting. Typically this involves playing a ringback sequence.
36. When the destination party accepts the additional media, UE#2 sends a SIP 200-OK final response along the signalling path back to the originator. The message is sent first to P-CSCF#2.
37. P-CSCF#2 approves the commitment of the QoS resources for this additional media.
38. After sending the 200-OK, UE#2 may initiate the new media flow(s).
39. P-CSCF#2 forwards the final response to S-CSCF#2.
40. S-CSCF#2 performs whatever service control is appropriate for this additional media.
41. S-CSCF#2 forwards the final response to S-CSCF#1.
42. S-CSCF#1 performs whatever service control is appropriate for this additional media.
43. S-CSCF#1 forwards the final response to P-CSCF#1.
44. P-CSCF#1 approves the commitment of the QoS resources for this additional media.
45. P-CSCF#1 forwards the final response to UE#1.
46. UE#1 starts the media flow(s) for this additional media.
47. UE#1 responds to the final response with a SIP ACK message, which is passed to the destination via the signalling path. The message is sent first to P-CSCF#1.
48. P-CSCF#1 forwards the ACK to S-CSCF#1
49. S-CSCF#1 forwards the ACK to S-CSCF#2.
50. S-CSCF#2 forwards the ACK to P-CSCF#2.
51. P-CSCF#2 forwards the ACK to UE#2.

5.11.4 Caller-ID procedures

This section gives information flows for the procedures for providing authenticated Caller-ID and Calling-Name information to the destination subscriber. It also describes the mechanisms for blocking the display of Caller-ID if requested by the originator.

5.11.4.1 Procedures for providing authenticated caller-ID

Authentication of the subscriber is performed during the registration procedures, as described in section 5.2.2.3. As a result of the registration procedures, the URL of UE#1 is stored in P-CSCF#1, and the list of possible user names associated with UE#1 is stored in S-CSCF#1. This is shown in the sub-procedure represented in the following information flow in step 1.

When UE#1 attempts to initiate a new session, it includes this URL in the INVITE request. P-CSCF#1 verifies that it is present and correct before passing the request to S-CSCF#1. The S-CSCF#1 then verifies the user-name supplied by UE#1 against the list of possible user-names configured for the subscriber. Thus the INVITE request sent between S-CSCFs will always have authenticated caller-identification information.

If the URL supplied by UE#1 in the INVITE request is incorrect, the P-CSCF may reject the request, or may overwrite with the correct URL.

If the user-name supplied by UE#1 in the INVITE request is incorrect, the S-CSCF may reject the request, or may overwrite with a default user-name for the subscriber.

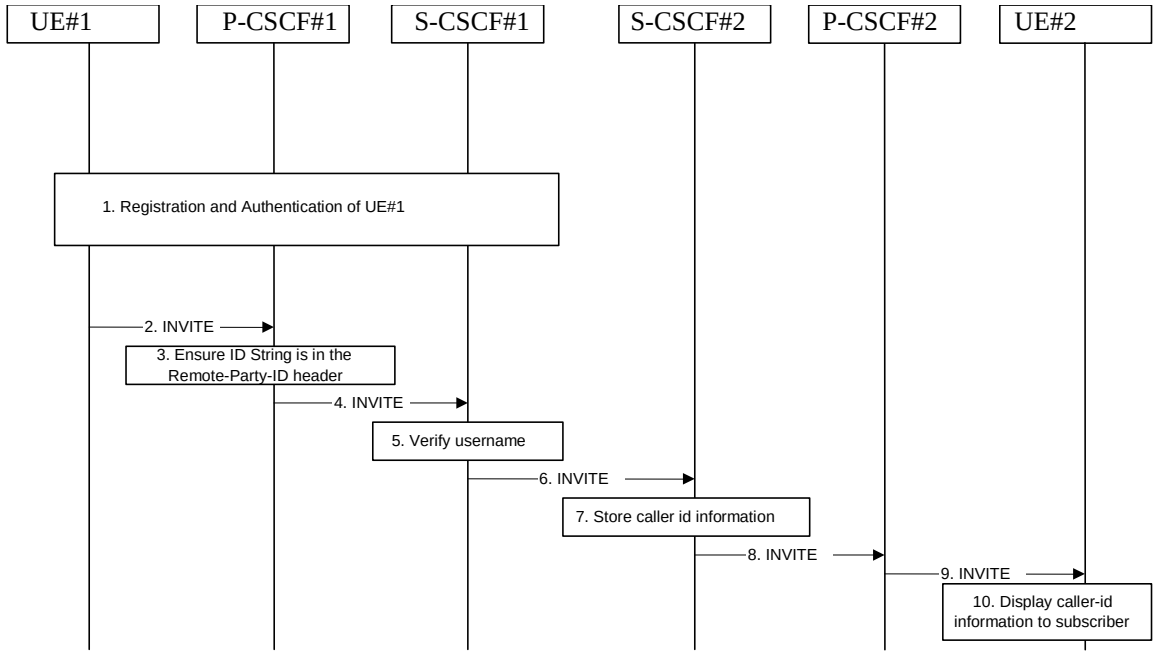


Figure 5.34: Providing authenticated caller-ID

The detailed procedure is as follows:

1. Registration and authentication of UE#1 is performed.

2. UE#1 initiates a new multi-media session, by sending an INVITE request to P-CSCF#1. This INVITE request includes the subscriber-identity URL used in the registration, and a caller-name string that may identify the specific person using the UE.

3. P-CSCF#1 checks the subscriber's identifying URL, and replaces it (or rejects the request) if it is incorrect.

4. P-CSCF#1 forwards the INVITE request, with the verified subscriber identity URL, to S-CSCF#1.

5. S-CSCF#1 verifies the caller-name string provided by UE#1 is included in the set of valid caller-names for this subscriber. It replaces it (or rejects the request) if it is incorrect.

6. S-CSCF#1 forwards the INVITE request, with verified subscriber identity URL and caller-name, to S-CSCF#2.

7. S-CSCF#2 stores the originating subscriber identity, for possible use later in session-trace or return-session services.

8. S-CSCF#2 forwards the INVITE request to P-CSCF#2.

9. P-CSCF#2 forwards the INVITE request to UE#2.

10. UE#2 displays the caller-id and calling-name information to the destination party.

5.11.4.2 Procedures for caller-ID blocking

Regulatory agencies, as well as subscribers, may require the ability of an originator to block the display of their caller identification. This is a function performed by the destination S-CSCF. In this way, the destination subscriber is still able to do a session-return, session-trace, transfer, or any other supplementary service.

The identity of the originator is stored at S-CSCF#2, and S-CSCF#2 generates a private URL that can be passed to UE#2 without compromising the identity of the session originator.

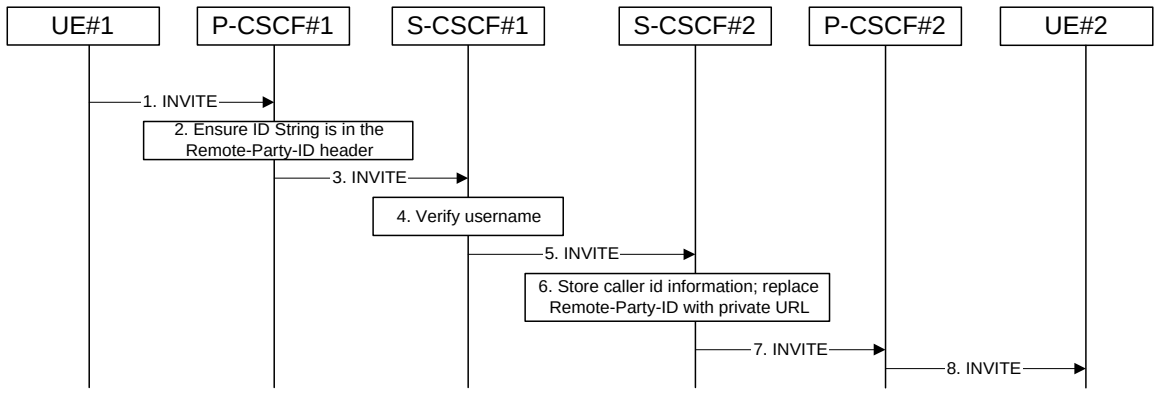


Figure 5.35: Caller-ID blocking

The detailed procedure is as follows:

1. UE#1 initiates a new multi-media session, by sending an INVITE request to P-CSCF#1. This INVITE request includes the subscriber-identity URL used in the registration, and a caller-name string that may identify the specific person using the UE. Also included in this INVITE message is a request that the caller-identity not be revealed to the destination.

2. P-CSCF#1 checks the subscriber's identifying URL, and replaces it (or rejects the request) if it is incorrect.

3. P-CSCF#1 forwards the INVITE request, with the verified subscriber identity URL, to S-CSCF#1.

4. S-CSCF#1 verifies the caller-name string provided by UE#1 is included in the set of valid caller-names for this subscriber. It replaces it (or rejects the request) if it is incorrect. Based on the subscriber's profile, S-CSCF#1 may insert a request in the INVITE message that the caller-identity not be revealed to the destination.

5. S-CSCF#1 forwards the INVITE request, with verified subscriber identity URL and caller-name, to S-CSCF#2.

6. S-CSCF#2 stores the originating subscriber identity, for possible use later in session-trace or return-session services. If caller-id blocking is requested, it replaces the caller-id with a private URL pointing to the stored information. If caller-name blocking is requested, it deletes the calling-name from the INVITE message.

7. S-CSCF#2 forwards the INVITE request to P-CSCF#2.

8. P-CSCF#2 forwards the INVITE request to UE#2.

5.11.5 Session Redirection Procedures

This section gives information flows for the procedures for performing session redirection. The decision to redirect a session to a different destination may be made for different reasons by a number of different functional elements, and at different points in the establishment of the session.

Three cases of session redirection prior to bearer establishment are presented, and one case of session redirection after bearer establishment.

These cases enable the typical services of "Session Forward Unconditional", "Session Forward Busy", "Session Forward Variable", "Selective Session Forwarding", and "Session Forward No Answer", though it is important to recognise that the implementation is significantly different from the counterparts in the CS domain.

5.11.5.1 Session Redirection initiated by S-CSCF to IMS

One of the functional elements in a basic session flow that may initiate a redirection is the S-CSCF of the destination subscriber. The subscriber profile information obtained from the HSS by the 'Cx-pull' during registration may contain complex logic and triggers causing session redirection. S-CSCF#2 sends the SIP INVITE request to the I-CSCF for the new destination (I-CSCF#F in the diagram), who forwards it to S-CSCF#F, who forwards it to the new destination.

In cases when the destination subscriber is not currently registered in the IM CN subsystem, the I-CSCF may assign a temporary S-CSCF to perform the service control on behalf of the intended destination. This temporary S-CSCF takes the role of S-CSCF#2 in the following information flow.

The service implemented by this information flow is typically "Session Forward Unconditional", "Session Forward Variable" or "Selective Session Forwarding". S-CSCF#2 may also make use of knowledge of current sessions in progress at the UE, and implement "Session Forwarding Busy" in this way.

This is shown in the following information flow:

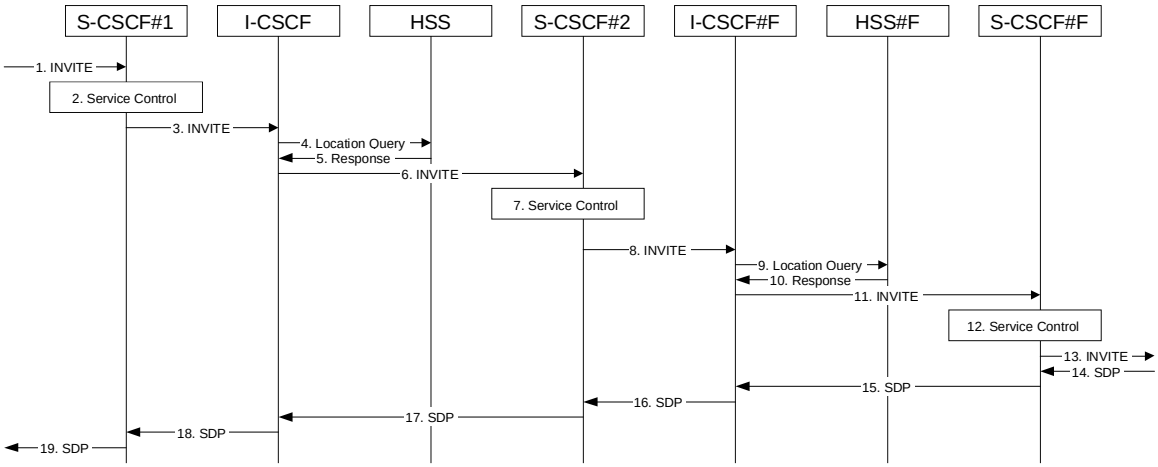


Figure 5.36: Session redirection initiated by S-CSCF to IMS

Step-by-step processing is as follows:

1. The SIP INVITE request is sent from the UE to S-CSCF#1 by the procedures of the originating flow.

2. S-CSCF#1 performs whatever service control logic is appropriate for this session setup attempt.

3. S-CSCF#1 performs an analysis of the destination address, and determines the network operator to whom the destination subscriber belongs. The INVITE message is sent to an I-CSCF for that operator, and may optionally go through an I-CSCF(firewall) if S-CSCF#1 is in a different operator's network than I-CSCF.

4. I-CSCF queries the HSS for current location information of the destination subscriber.

5. HSS responds with the address of the current Serving CSCF (S-CSCF#2) for the terminating subscriber.

6. I-CSCF forwards the INVITE request to S-CSCF#2, who will handle the session termination.

7. S-CSCF#2 performs whatever service control logic is appropriate for this session setup attempt. As a result of this service control logic, S-CSCF#2 determines that the session should be redirected to a new destination URL within the IP Multimedia Subsystem. Based on operator policy and the subscriber profile, S-CSCF#2 may restrict the media streams allowed in the redirected session.

8. S-CSCF#2 sends a SIP INVITE request to an I-CSCF (I-CSCF#F) for the network operator to whom the forwarded destination subscribes. This INVITE request may optionally go through an I-CSCF(firewall) if S-CSCF#2 is in a different operator's network than I-CSCF#F.

9. I-CSCF#F queries the HSS (HSS#F) for current location information of the destination subscriber.

10. HSS#F responds with the address of the current Serving CSCF (S-CSCF#F) for the terminating subscriber.

11. I-CSCF forwards the INVITE request to S-CSCF#F, who will handle the session termination.

12. S-CSCF#F performs whatever service control logic is appropriate for this session setup attempt

13. S-CSCF#F forwards the INVITE toward the destination UE, according to the procedures of the terminating flow.

14. The destination UE responds with the SDP message, and the session establishment proceeds normally.

5.11.5.2 Session Redirection initiated by S-CSCF to CS-domain

The S-CSCF in the scenario above may determine that the session is to be redirected to a CS-domain endpoint, or to the PSTN. It recognizes this situation by the redirected URL being a tel: URL.

Handling of redirection to a tel: URL is shown in the following information flow:

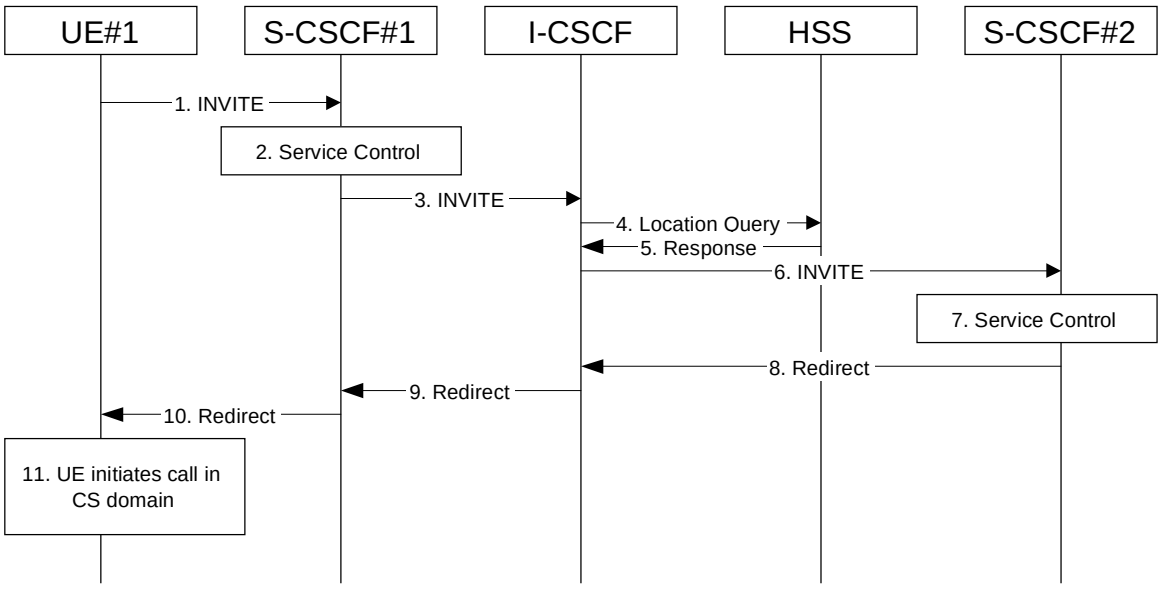


Figure 5.37: Session redirection initiated by S-CSCF to CS-Domain

Step-by-step processing is as follows:

1. The SIP INVITE request is sent from the UE to S-CSCF#1 by the procedures of the originating flow.

2. S-CSCF#1 performs whatever service control logic is appropriate for this session setup attempt.

3. S-CSCF#1 performs an analysis of the destination address, and determines the network operator to whom the subscriber belongs. The INVITE message is sent to an I-CSCF for that operator, and may optionally go through an I-CSCF(firewall) if S-CSCF#1 is in a different operator's network than I-CSCF.

4. I-CSCF queries the HSS for current location information of the destination subscriber.

5. HSS responds with the address of the current Serving CSCF (S-CSCF#2) for the terminating subscriber.

6. I-CSCF forwards the INVITE request to S-CSCF#2, who will handle the session termination.

7. S-CSCF#2 performs whatever service control logic is appropriate for this session setup attempt. As a result of this service control logic, S-CSCF#2 determines that the session should be redirected to a new destination URL in the CS domain, i.e. a tel: URL.

8. S-CSCF#2 sends a SIP Redirect response back to I-CSCF, with redirection destination being the CS-domain address of UE#2. Note that this is not the destination determined in step #7.

9. I-CSCF sends a Redirect response back to S-CSCF#1, containing the redirection destination.

10. S-CSCF#1 forwards the Redirect response back to UE#1.

11. UE#1 initiates the session in the CS domain.

5.11.5.3 Session Redirection initiated by S-CSCF to general endpoint

The S-CSCF in the scenario above may determine that the session is to be redirected to an endpoint outside the IP MultiMedia System and outside the CS-domain. Examples of these destinations include web pages, email addresses, etc. It recognizes this situation by the redirected URL being other than a sip: or tel: URL.

Handling of redirection to a general URL is shown in the following information flow:

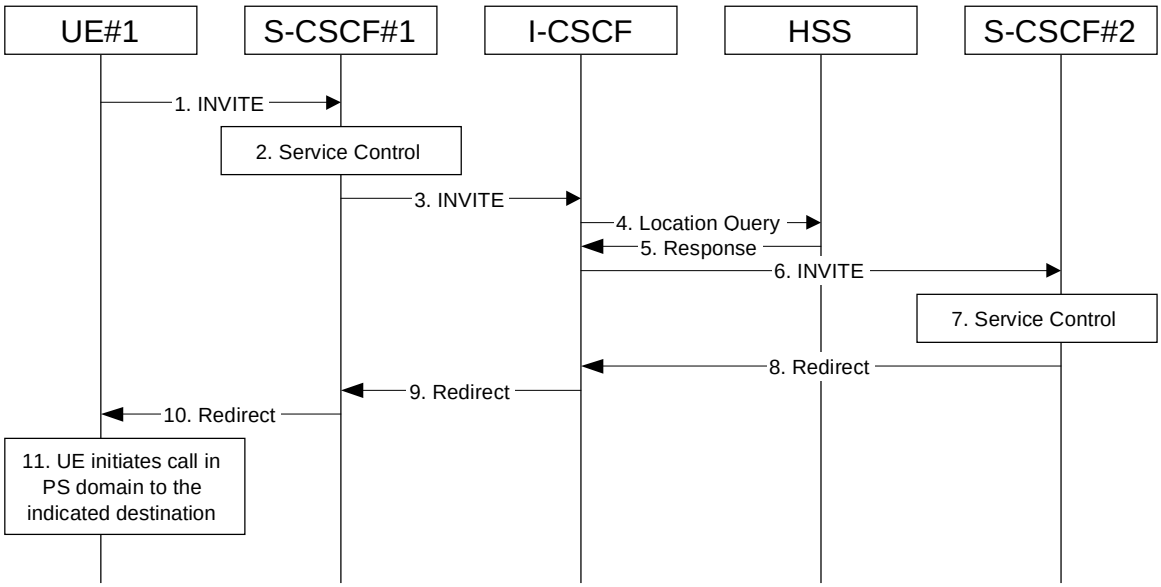


Figure 5.38: Session redirection initiated by S-CSCF to general endpoint

Step-by-step processing is as follows:

1. The SIP INVITE request is sent from the UE to S-CSCF#1 by the procedures of the originating flow.

2. S-CSCF#1 performs whatever service control logic is appropriate for this session setup attempt.

3. S-CSCF#1 performs an analysis of the destination address, and determines the network operator to whom the subscriber belongs. The INVITE message is sent to an I-CSCF for that operator, and may optionally go through an I-CSCF(firewall) if S-CSCF#1 is in a different operator's network than I-CSCF.

4. I-CSCF queries the HSS for current location information of the destination subscriber.

5. HSS responds with the address of the current Serving CSCF (S-CSCF#2) for the terminating subscriber.

6. I-CSCF forwards the INVITE request to S-CSCF#2, who will handle the session termination.

7. S-CSCF#2 performs whatever service control logic is appropriate for this session setup attempt. As a result of this service control logic, S-CSCF#2 determines that the session should be redirected to a new destination URL outside the IMS and outside the CS domain, i.e. other than a sip: or tel: URL.

8. S-CSCF#2 sends a SIP Redirect response back to I-CSCF, with redirection destination being the general URL.

9. I-CSCF sends a Redirect response back to S-CSCF#1, containing the redirection destination.

10. S-CSCF#1 forwards the Redirect response back to UE#1.

11. UE#1 initiates the session to the indicated destination.

5.11.5.4 Session Redirection initiated by P-CSCF

One of the functional elements in a basic session flow that may initiate a redirection is the P-CSCF of the destination subscriber. In handling of an incoming session setup attempt, the P-CSCF normally sends the INVITE request to the destination UE, and retransmits it as necessary until obtaining an acknowledgement indicating reception by the UE.

In cases when the destination subscriber is not currently reachable in the IM CN subsystem (due to such factors as roaming outside the service area or loss of battery, but the registration has not yet expired), the P-CSCF may initiate a redirection of the session. The P-CSCF informs the S-CSCF of this redirection, without specifying the new location; S-CSCF determines the new destination and performs according to sections 1, 2, or 3 above, based on the type of destination.

This is shown in the following information flow:

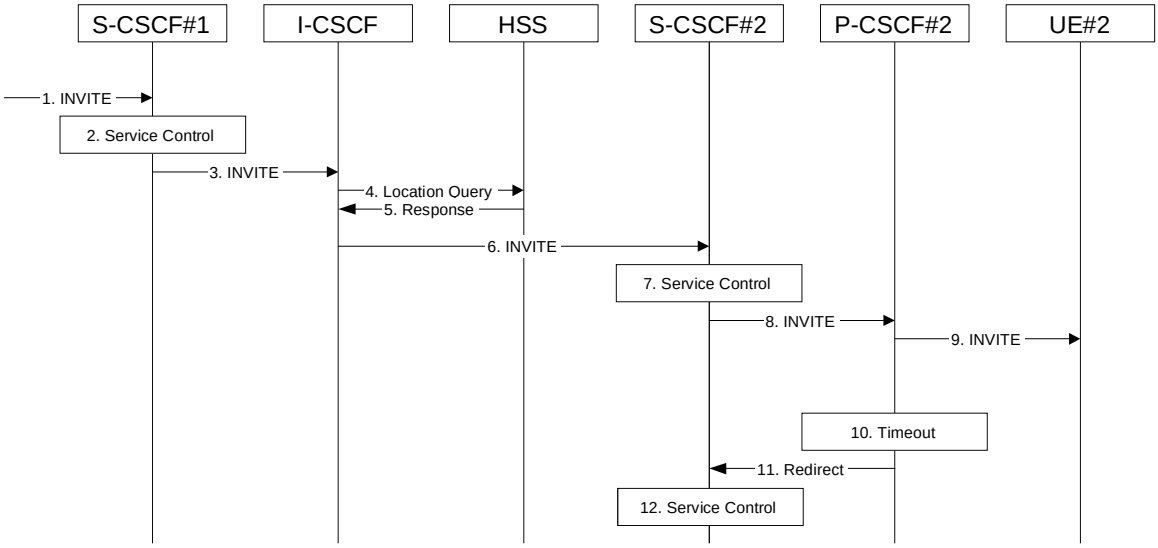


Figure 5.39: Session redirection initiated by P-CSCF

Step-by-step processing is as follows:

1. The SIP INVITE request is sent from the UE to S-CSCF#1 by the procedures of the originating flow.

2. S-CSCF#1 performs whatever service control logic is appropriate for this session setup attempt.

3. S-CSCF#1 performs an analysis of the destination address, and determines the network operator to whom the subscriber belongs. The INVITE message is sent to an I-CSCF for that operator, and may optionally go through an I-CSCF(firewall) if S-CSCF#1 is in a different operator's network than I-CSCF.

4. I-CSCF queries the HSS for current location information of the destination subscriber.

5. HSS responds with the address of the current Serving CSCF (S-CSCF#2) for the terminating subscriber.

6. I-CSCF forwards the INVITE request to S-CSCF#2, who will handle the session termination.

7. S-CSCF#2 performs whatever service control logic is appropriate for this session setup attempt.

8. S-CSCF#2 forwards the INVITE request to P-CSCF#2

9. P-CSCF#2 forwards the INVITE request to UE#2

10. Timeout expires in P-CSCF waiting for a response from UE#2. P-CSCF therefore assumes UE#2 is unreachable.

11. P-CSCF#2 generates a Redirect response, without including a new destination, and sends the message to S-CSCF#2.

12. S-CSCF#2 performs whatever service control is appropriate for this session redirection. If the user does not subscribe to session redirection service, or did not supply a forwarding destination, S-CSCF#2 may terminate the session setup attempt with a failure response. Otherwise, S-CSCF#2 supplies a new destination URL, which may be a phone number, an email address, a web page, or anything else that can be expressed as a URL. Processing continues according to subsections 1, 2, or 3 above, based on the type of destination URL.

5.11.5.5 Session Redirection initiated by UE

The next functional element in a basic session flow that may initiate a redirection is the UE of the destination subscriber. The UE may implement customer-specific feature processing, and base its decision to redirect this session on such things as identity of caller, current sessions in progress, other applications currently being accessed, etc. UE sends the SIP Redirect response to its P-CSCF, who forwards back along the signalling path to S-CSCF#1, who initiates a session to the new destination.

The service implemented by this information flow is typically “Session Forward Busy”, “Session Forward Variable” or “Selective Session Forwarding”.

This is shown in the following information flow:

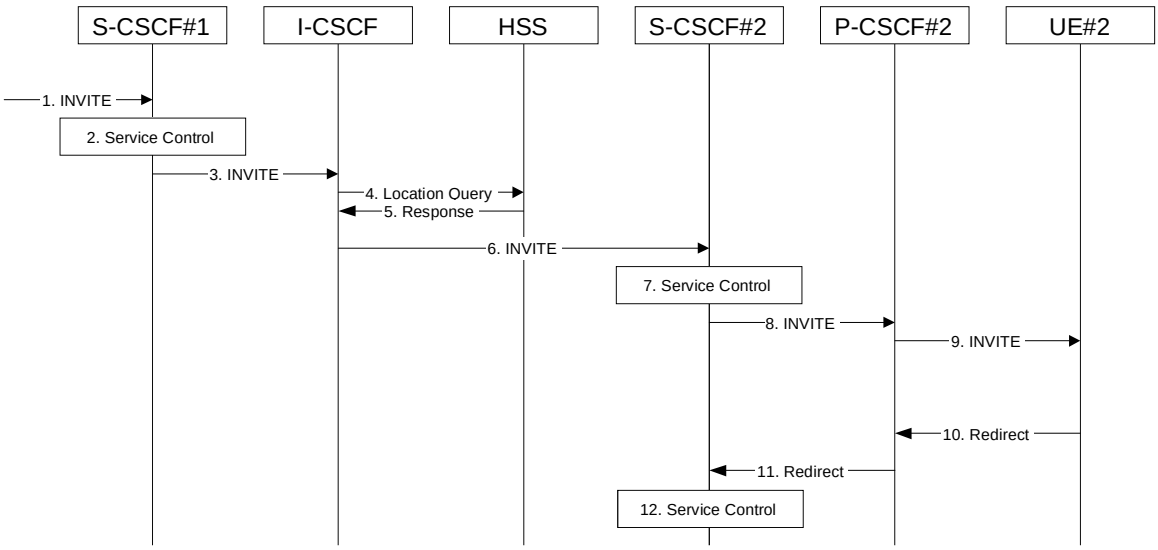


Figure 5.40: Session redirection initiated by UE

Step-by-step processing is as follows:

1. The SIP INVITE request is sent from the UE to S-CSCF#1 by the procedures of the originating flow.

2. S-CSCF#1 performs whatever service control logic is appropriate for this session setup attempt.

3. S-CSCF#1 performs an analysis of the destination address, and determines the network operator to whom the subscriber belongs. The INVITE message is sent to an I-CSCF for that operator, and may optionally go through an I-CSCF(firewall) if S-CSCF#1 is in a different operator’s network than I-CSCF.

4. I-CSCF queries the HSS for current location information of the destination subscriber.

5. HSS responds with the address of the current Serving CSCF (S-CSCF#2) for the terminating subscriber.

6. I-CSCF forwards the INVITE request to S-CSCF#2, who will handle the session termination.

7. S-CSCF#2 performs whatever service control logic is appropriate for this session setup attempt.

8. S-CSCF#2 forwards the INVITE request to P-CSCF#2

9. P-CSCF#2 forwards the INVITE request to UE#2

10. UE#2 determines that this session should be redirected, and optionally supplies the new destination URL. This new destination URL may be a phone number, an email address, a web page, or anything else that can be expressed as a URL. The Redirect response is sent to P-CSCF#2

11. P-CSCF#2 forwards the Redirect response to S-CSCF#2.

12. S-CSCF#2 performs whatever service control is appropriate for this session redirection. If UE#2 does not subscribe to session redirection service, or did not supply a new destination URL, S-CSCF#2 may supply one or may terminate the session setup attempt with a failure response. The new destination URL may be a phone

number, an email address, a web page, or anything else that can be expressed as a URL. The procedures of subsection 1, 2, or 3 given above are followed, based on the type of URL.

5.11.5.6 Session Redirection initiated after Bearer Establishment

The UE of the destination subscriber may request the session be redirected after a customer-specified ringing interval. The UE may also implement customer-specific feature processing, and base its decision to redirect this session on such things as identity of caller, current sessions in progress, other applications currently being accessed, etc. UE sends the SIP Redirect response to its P-CSCF, who forwards back along the signaling path to the originating endpoint, who initiates a session to the new destination.

The service implemented by this information flow is typically “Session Forward No Answer”.

Redirect to another IMS endpoint (e.g. a sip: URL) is shown in the following information flow:

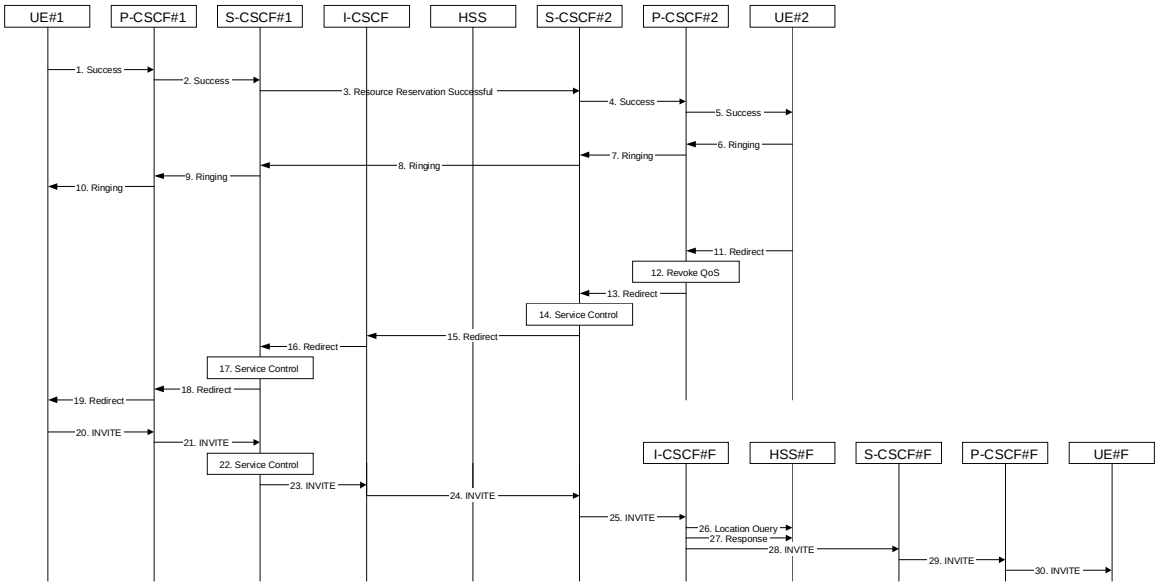


Figure 5.41: Session redirection after bearer establishment

Step-by-step processing is as follows:

1.-10. Normal handling of a basic session establishment, up through establishment of the bearer channel and alerting of the destination subscriber

11. Based on a timeout or other indications, UE#2 decides the current session should be redirected to a new destination URL. This new destination URL may be a phone number, an email address, a web page, or anything else that can be expressed as a URL. The Redirect response is sent to P-CSCF#2.

12. P-CSCF#2 revokes any authorisation for QoS for the current session.

13. P-CSCF#2 forwards the Redirect response to S-CSCF#2.

14. S-CSCF#2 performs whatever service control is appropriate for this session redirection. If UE#2 does not subscribe to session redirection service, or did not supply a new destination URL, S-CSCF#2 may supply one or may terminate the session setup attempt with a failure response. The new destination URL may be a phone number, an email address, a web page, or anything else that can be expressed as a URL. S-CSCF#2 generates a private URL, addressed to itself, containing the new destination.

15. S-CSCF#2 sends a SIP Redirect response back to I-CSCF, containing the private URL addressed to S-CSCF#2.

16. I-CSCF sends a Redirect response back to S-CSCF#1, containing the redirection destination.

17. S-CSCF#1 checks the number of redirections that have occurred for this session setup attempt, and if excessive, aborts the session. S-CSCF#1 stores the new destination information, generates a private URL

addressed to itself pointing to the stored information, and generates a modified Redirect response with the private URL.

18. S-CSCF#1 sends the modified Redirect response to P-CSCF#1

19. P-CSCF#1 sends the Redirect response to UE#1

20. UE#1 resets and releases all resources for the previous session, and initiates a new INVITE request to the address provided in the Redirect response. The new INVITE request is sent to P-CSCF#1

21. P-CSCF#1 forwards the INVITE request to S-CSCF#1

22. S-CSCF#1 retrieves the destination information saved in step #17, and performs whatever other service control is appropriate for this new session setup attempt.

23. S-CSCF#1 determines the network operator of the new destination address. The INVITE message is sent to I-CSCF#2, the I-CSCF for S-CSCF#2.

24. I-CSCF forwards the INVITE to S-CSCF#2

25. S-CSCF#2 decodes the private URL, determines the network operator of the new destination, and sends the INVITE request to the I-CSCF for that network operator.

26. The remainder of this session completes as normal.

5.11.6 Session Transfer Procedures

This section gives information flows for the procedures for performing session transfers. This is presented in two steps: first a basic primitive that can be used by endpoints to cause a multi-media session to be transferred, and second the procedures by which this primitive can be used to implement some well-known session-transfer services.

5.11.6.1 Refer operation

The refer primitive is an information flow indicating a “Refer” operation, which includes a component element “Refer-To” and a component element “Referred-By”. An information flow illustrating this is as follows:

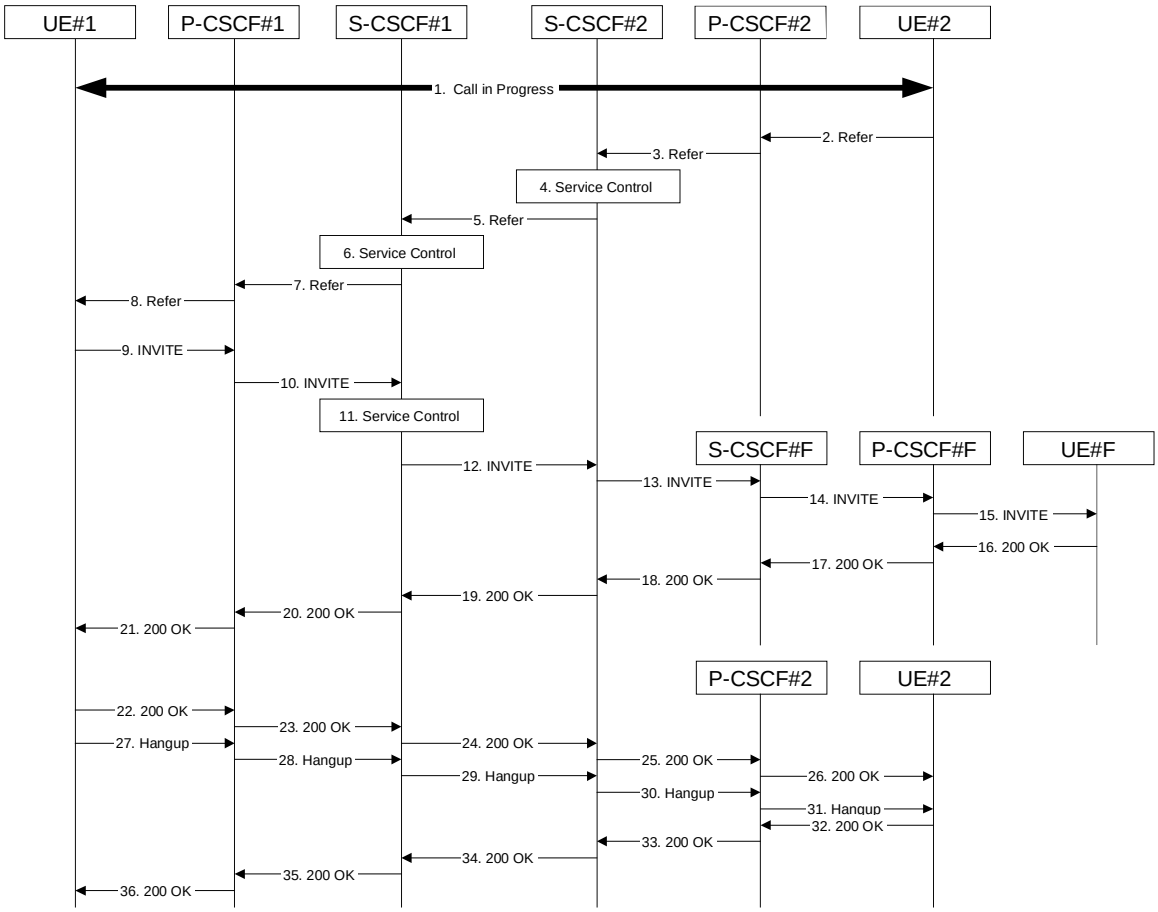


Figure 5.42: Refer operation

Step-by-step description of the information flow:

1. A multi-media session is assumed to already exist between UE#1 and UE#2, established either as a basic session or by one of the supplemental services described in this section.

2. UE#2 sends the Refer command to P-CSCF#2, containing “Refer-To” UE#F and “Referred-By” UE#2.

3. P-CSCF#2 forwards the message to S-CSCF#2

4. S-CSCF#2 performs whatever service control is appropriate for this request. If UE#2 does not subscribe to a transfer service, the request is rejected. S-CSCF#2 generates a private URL, addressed to itself, with the new destination informationand the billing information that will be needed for the new session. It replaces the “Refer-To” value in the request with the private URL.

5. S-CSCF#2 forwards the updated message to S-CSCF#1

6. S-CSCF#1 performs whatever service control is appropriate for this request. It stores the “Refer-To” and “Referred-By” information and replaces it with private URLs, so that UE#1 will not know the identity of UE#2 or UE#F.

7. S-CSCF#1 forwards the updated message to P-CSCF#1

8. P-CSCF#1 forwards the message to UE#1

9. UE#1 initiates a new multi-media session to the destination given by the “Refer-To”, which is a private URL pointing to S-CSCF#1.

10. P-CSCF#1 forwards the INVITE request to S-CSCF#1

11. S-CSCF#1 retrieves the destination information for the new session, and performs whatever service control is appropriate for this new session.

12. S-CSCF#1 determines the network operator addressed by the destination URL, and forwards the INVITE to S-CSCF#2 (or I-CSCF#2, the public entry point for S-CSCF#2).

13. S-CSCF#2 decodes the private URL destination, and determines the final destination of the new session. It determines the network operator addressed by the destination URL. The request is then forwarded onward to S-CSCF#F as in a normal session establishment

14. S-CSCF#F performs whatever service control is appropriate for this new session, and forwards the request to P-CSCF#F

15. P-CSCF#F forwards the request to UE#F

16.-21. The normal session establishment continues through bearer establishment, optional alerting, and reaches the point when the new session is accepted by UE#F. UE#F then sends the 200-OK final response to P-CSCF#F, which is forwarded through S-CSCF#F, S-CSCF#2, S-CSCF#1, P-CSCF#1, to UE#1. At this point a new session is successfully established between UE#1 and UE#F.

22.-26. The Refer request was successful, and UE#1 sends a 200-OK final response to UE#2. This response is sent through P-CSCF#1, S-CSCF#1, S-CSCF#2, P-CSCF#2, and to UE#2.

27.-31. UE#1 clears the original session with UE#2 by sending the BYE message. This message is routed through P-CSCF#1, S-CSCF#1, S-CSCF#2, P-CSCF#2, to UE#2.

32.-36. UE#2 acknowledges the BYE and terminates the original session. It responds with the 200-OK response, routed through P-CSCF#2, S-CSCF#2, S-CSCF#1, P-CSCF#1, to UE#1.

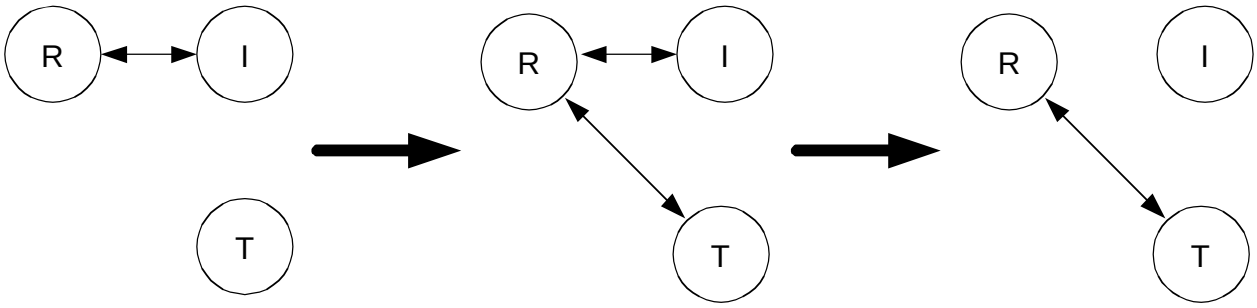
5.11.6.2 Application to Session Transfer Services

This section shows how the Refer primitive given above can be used to provide common session-transfer services.

5.11.6.2.1 Blind Transfer and Assured Transfer

A Blind Transfer starts with an existing session, established between the Initiator (I) and the Recipient (R). In a typical case, this session was actually initiated by R. In the end it is desired that the Recipient has a session with the Target (T).

From the starting configuration, shown in the leftmost diagram, I sends a Refer message to R, who then initiates a session with the Target (T), as shown in the middle diagram. Immediately after sending the Refer message to R, I issues the BYE message to terminate its connection with R. The end configuration is shown in the rightmost diagram.

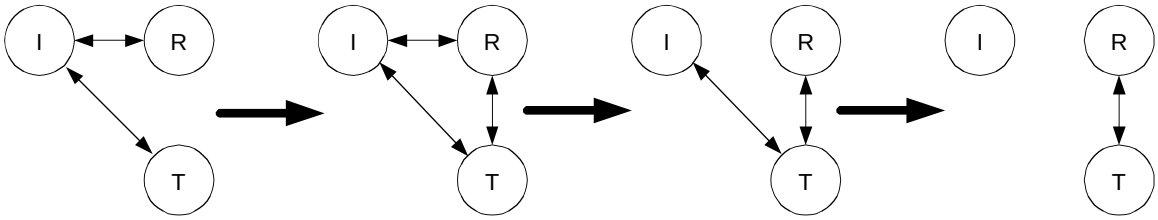


An Assured Transfer is identical to the above, except that I waits until the Refer successfully completes before issuing the BYE message to terminate its connection with R. If the new session from R to T were to fail, R would still have a session with I.

5.11.6.2.2 Consultative Transfer

A Consultative Transfer again starts with an existing session, established from the Initiator (I) to the Recipient (R). The Initiator first consults with the Target (T), then decides to transfer the original session to T.

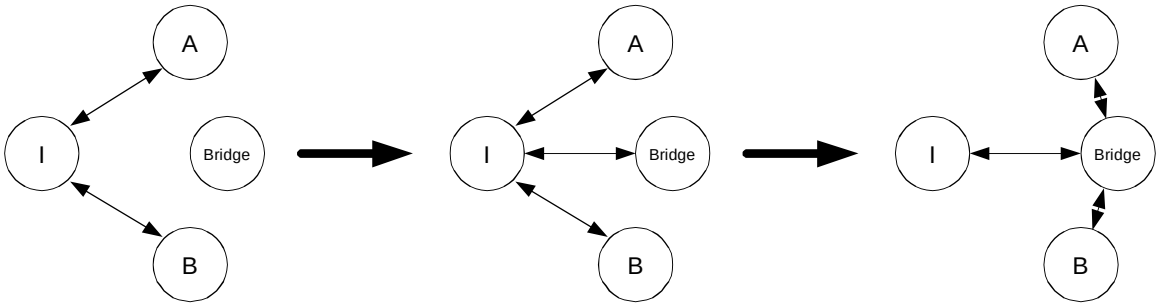
From the starting configuration, as shown in the leftmost diagram in the previous section, I places the session with R on hold and establishes a new session with T. This is shown in the leftmost diagram below. I then sends a Refer message to T, causing T to establish a session with R. This is shown in the second diagram. When the Refer operation completes, I clears its two active sessions, first with R (leaving the configuration as shown in the third diagram) then with T. The end configuration is shown in the rightmost diagram.



5.11.6.2.3 Three-way Session

A three-way session starts with an existing session, between the Initiator (I) and party (A). The initiator places this session on hold, and establishes a second session with party (B). The initiator then decides to create an ad-hoc conference of all three parties.

From the point where the initiator decides to create the ad-hoc conference, shown in the leftmost diagram below, the initiator establishes another session with a third-party conference bridge service. This is shown in the center diagram. The initiator then transfers both of the existing sessions, I->A and I->B, to the bridge, ending in the configuration shown in the rightmost diagram.



The conference bridge service is in control of the termination sequence. On termination of one of the three sessions, it may either terminate the other two sessions by use of the session clearing procedures of section 5.11, or may utilize the procedures of subsection 1 above to transfer one of the remaining endpoints to the other, resulting in a simple two-party session.

Annex A (Informative): Information flow template

This section describes the template used in developing information flow (IF) procedures.

X.Y.Z "Name of procedure (e.g., Terminal location registration)"

In this section, provide a brief prose description of the service or network capability. The "X.Y.Z." refers to the section heading number.

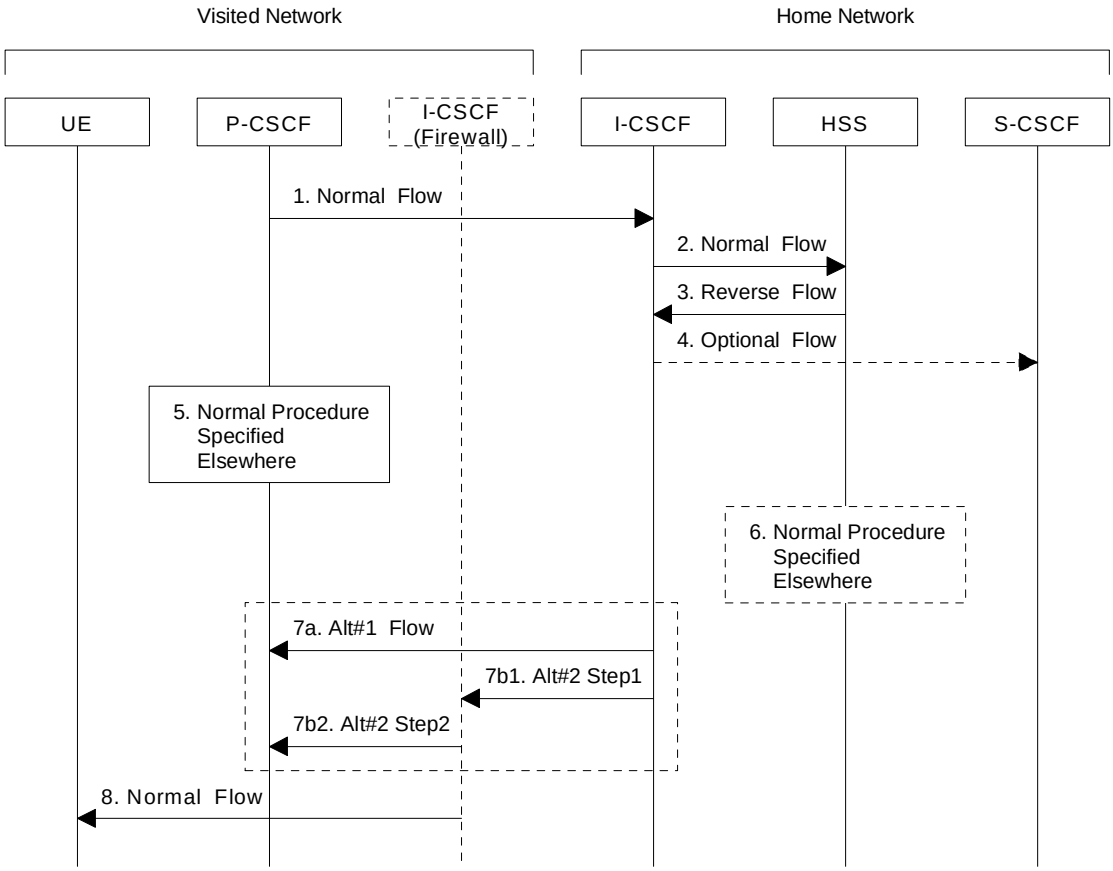


Figure A.1: Information Flow Template

This sub-section consists of subparagraphs each dedicated to one information flow of the IF diagram. For each information flow, a detailed description is provided on the information flow name, certain information elements (IEs) within the information flow, whether the IE is mandatory or optional (M/O), in the sequence as shown in the IF diagram. FE actions (FEA) are also provided in this section. This sub-section format is proposed as follows:

1. Initial information flow: One should normally describe the initiating FE Action (FEA) leading to the first flow. Any information that is specifically required to support the operation should be mentioned (e.g. this flow conveys the subscriber identity to the HSS).

2. Each paragraph should contain a brief description of the flow and any specific start and end FEAs. When information to be conveyed is optional, the conditions for its inclusion should be specified and the response to its presence when received should also be specified (e.g., Include IP Address when condition xyz occurs). For an information flow that is required, the description should indicate whether a response is required based on successful outcome to the received IF, failed outcome, both or neither. e.g., "Response is required indicating Success or Failure".

3. Flows may occur in either direction but not both at the same time. To indicate a shorthand for multiple flows, use a procedure box as in flow 5 or 6.

4. Flows that are an optional part of the procedure should be shown as dotted arrows as in flow 4. These may appear in either direction.

5. A set of flows, representing a common procedure, is shown by a box. The procedure should be numbered and named with a name that corresponds to the procedure as described elsewhere. The location of the box on an entity represents the start of the common procedure regardless of the number of the entities involved in the procedure.

6. An optional set of flows is represented as a dashed box. Otherwise the use is the same as in flow 5.

7. A small number of alternative flows may be shown within a dashed box. The alternatives are shown by a letter immediately following the flow number, e.g. 7a, 7b, 7c, etc. Where a single alternative results in multiple flows, they must be shown with an indication of the proper sequence, e.g. 7b1, 7b2. The subparagraph describing the information flow must describe the decision process taken in choice of alternatives.

   7a. Alternative (a) is described. If alternative (a) is a single information flow, the contents and purpose of that information flow is included here.

   7b. Alternative (b) is described.

      7b1. The first information flow of alternative (b) is described

      7b2. The second information flow of alternative (b) is described. Etc.

8. The final flow in a procedure may provide additional information regarding other procedures that might follow it but such information is not required.

The general characteristics of the information flow template are as follows:

- All relevant functional entities are contained in the flow diagram. Only relevant entities need be shown.

- When an element occurs only in an information flows for which several alternatives exist, the description box for the functional entity and the vertical line shall be dashed lines.

- The specific network affiliation of functional entities may be shown using a labelled bracket over the specific entities as shown in the figure (e.g., Home Network). Such labelling is not required unless the flow would not be clear without it.

- The number associated with each flow provides a “handle” to the functional entity action (FEA) executed by the FE receiving the flow. This number is known only within the scope of the specific information flow diagram. The description of this functional entity action (FEA) immediately follows the information flow description.

- Common Procedures described elsewhere can be used in the information flows in order to simplify the diagram. These may be either required or optional.

- Each common procedure is treated as a single action and therefore is given a unique number.

- An optional flows (flows 4 and 6) are indicated by a dashed arrow or box.

- Co-ordinated flows or flows that illustrate parallel actions are indicated by the flow text description. For example one might see a description such as: "flows 5 and 6 may be initiated any time after flow 3".

- Sequential operation is assumed unless indicated otherwise.

Annex B (Informative): Sample end-end session flows

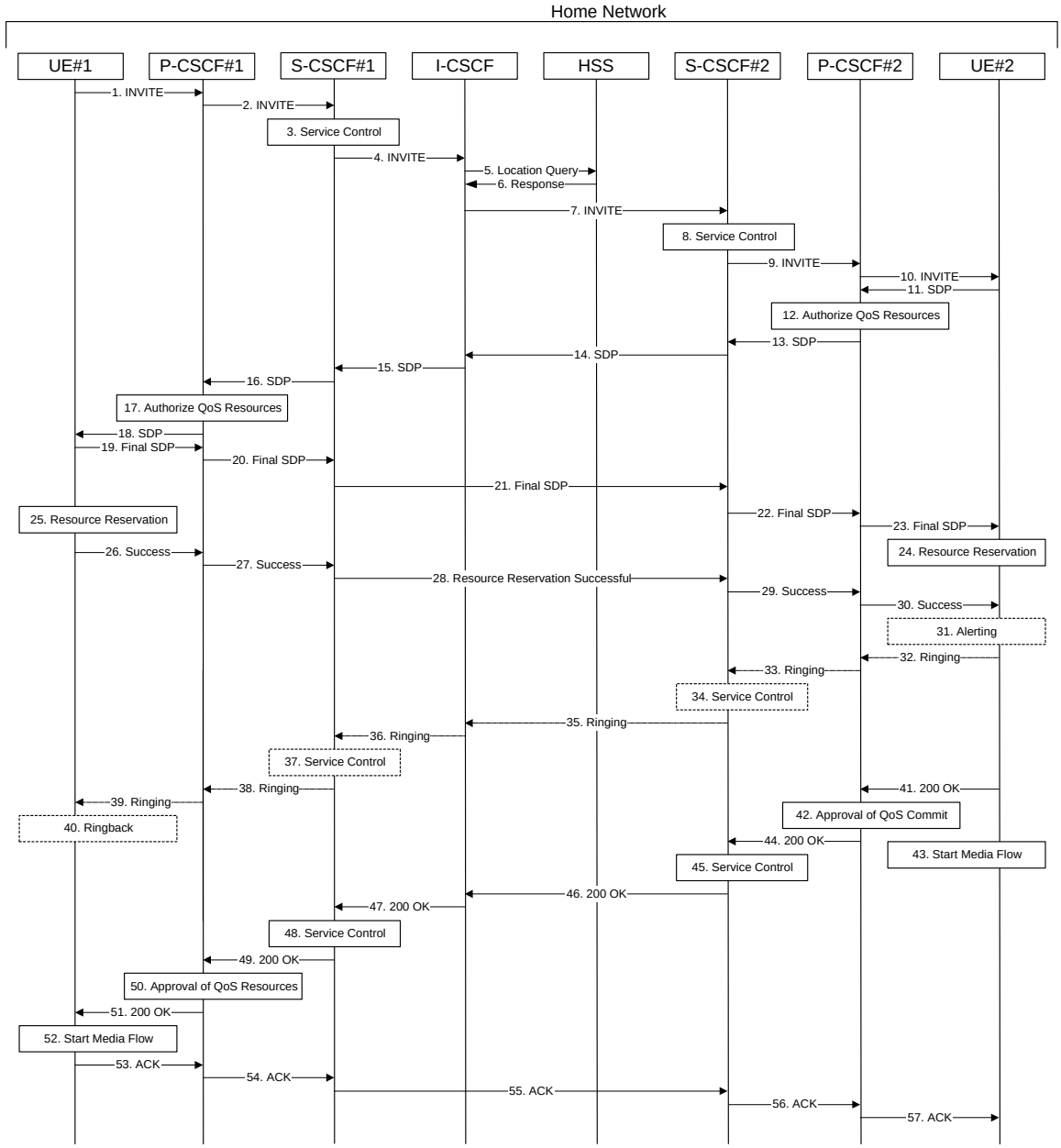
B.1 Sample end-end Session Flow - Mobile Origination/Termination

For this end-to-end session flow, we assume the originator is a UE located within the service area of the network operator to whom the UE is subscribed. The UE has already established the proper PDP contexts for exchanging SIP signalling messages, has performed the proxy discovery procedures described in section 5.1.1, and has registered in the IM CN subsystem. As a result of registration, an S-CSCF has been chosen in the home network.

The originating party addresses a destination that is a subscriber of the same network operator.

The destination party is a UE located within the service area of the network operator to which it is subscribed. This UE has already established the proper PDP contexts for exchanging SIP signalling messages, has performed the proxy discovery procedures described in section 5.1.1, and has registered in the IM CN subsystem. As a result of registration, an S-CSCF was chosen in the home network.

B.1.1 Session flow diagram



Step-by-step processing of this end-to-end session flow is as follows:

1. UE#1 sends a SIP INVITE request, containing an initial SDP, to P-CSCF#1, which was obtained from the CSCF discovery procedures.

2. P-CSCF#1 forwards the INVITE to the next hop name/address, as determined from the registration procedures. In this case the next hop is S-CSCF#1 within the same operator's network.

3. S-CSCF#1 validates the service profile, and performs whatever service control logic is appropriate for this session setup attempt.

4. S-CSCF#1 translates the destination address and determines the session setup will be completed within the home operator's network. It therefore forwards the INVITE to I-CSCF#1.

5. I-CSCF#1 sends 'Cx-location-query' to the HSS to obtain the location information for the destination

6. The HSS responds with 'Cx-location-query-response' and indicates the destination is located in the home service area.

7. I-CSCF#1 forwards the INVITE to S-CSCF#2, which was identified by the HSS as serving this subscriber.
8. S-CSCF#2 validates the service profile, and performs whatever service control logic is appropriate for this session setup attempt.
9. S-CSCF#2 remembers (from the registration procedure) the next hop CSCF for this UE. It forwards the INVITE to P-CSCF#2 in the home network.
10. P-CSCF#2 remembers (from the registration procedure) the address of UE#2 and forwards the INVITE to UE#2.
11. UE#2 returns the media stream capabilities of the destination to the session originator, along the signalling path established by the INVITE message
12. P-CSCF#2 authorises the QoS resources required for this session
13. P-CSCF#2 forwards the SDP to S-CSCF#2
14. S-CSCF#2 forwards the SDP to I-CSCF
15. I-CSCF forwards the SDP to S-CSCF#1
16. S-CSCF#1 forwards the SDP message to P-CSCF#1
17. P-CSCF#1 authorises the resources necessary for this session
18. P-CSCF#1 forwards the SDP message to the originating endpoint, UE#1
19. The originator decides the final set of media streams for this session, and sends the Final SDP to P-CSCF#1
20. P-CSCF#1 forwards the final SDP to S-CSCF#1
21. S-CSCF#1 forwards the final SDP to S-CSCF#2. This message may be routed through I-CSCF, depending on operator configuration of I-CSCF.
22. S-CSCF#2 forwards the final SDP to P-CSCF#2
23. P-CSCF#2 forwards the final SDP to UE#2.
24. UE#2 initiates the resource reservation procedures for the resources necessary for this session.
25. After determining the final set of media streams for this session, step #19 above, UE#1 initiates the reservation procedures for the resources needed for this session
26. When UE#1 has successfully reserved the needed resources, it sends the “reservation successful” message to UE#2 along the signalling path established by the INVITE message. The message is sent first to P-CSCF#1.
27. P-CSCF#1 forwards the message to S-CSCF#1
28. S-CSCF#1 forwards the message to S-CSCF#2. This message may be routed through I-CSCF, depending on operator configuration of I-CSCF.
29. S-CSCF#2 forwards the message to P-CSCF#2
30. P-CSCF#2 forwards the message to UE#2.
31. UE#2 may optionally delay the session establishment in order to alert the subscriber to the incoming session.
32. If UE#2 performs alerting, it sends a ringing indication to the originator via the signalling path. The message is sent first to P-CSCF#2.
33. P-CSCF#2 forwards the ringing message to S-CSCF#2
34. S-CSCF#2 performs whatever service control is appropriate for this ringing session
35. S-CSCF#2 forwards the message to I-CSCF
36. I-CSCF forwards the message to S-CSCF#1

37. S-CSCF#1 performs whatever service control is appropriate for this ringing session.
38. S-CSCF#1 forwards the message to P-CSCF#1
39. P-CSCF#1 forwards the message to UE#1
40. UE#1 indicates to the originator that the session is being delayed due to alerting. Typically this involves playing a ringback sequence.
41. When the destination party answers, UE#2 sends a SIP 200-OK final response along the signalling path back to the originator. The message is sent first to P-CSCF#2.
42. P-CSCF#2 approves the commitment of the QoS resources for this session
43. After sending the 200-OK, UE#2 initiates the media flow.
44. P-CSCF#2 forwards the final response to S-CSCF#2
45. S-CSCF#2 performs whatever service control is appropriate for this completed session.
46. S-CSCF#2 forwards the final response to I-CSCF
47. I-CSCF forwards the final response to S-CSCF#1
48. S-CSCF#1 performs whatever service control is appropriate for this completed session
49. S-CSCF#1 forwards the final response to P-CSCF#1
50. P-CSCF#1 approves the commitment of the QoS resources for this session
51. P-CSCF#1 forwards the final response to UE#1
52. UE#1 starts the media flow for this session
53. UE#1 responds to the final response with a SIP ACK message, which is passed to the destination via the signalling path. The message is sent first to P-CSCF#1.
54. P-CSCF#1 forwards the ACK to S-CSCF#1
55. S-CSCF#1 forwards the ACK to S-CSCF#2. This message may be routed through I-CSCF, depending on operator configuration of I-CSCF.
56. S-CSCF#2 forwards the ACK to P-CSCF#2
57. P-CSCF#2 forwards the ACK to UE#2

B.1.2 Session flow decomposition into procedure blocks

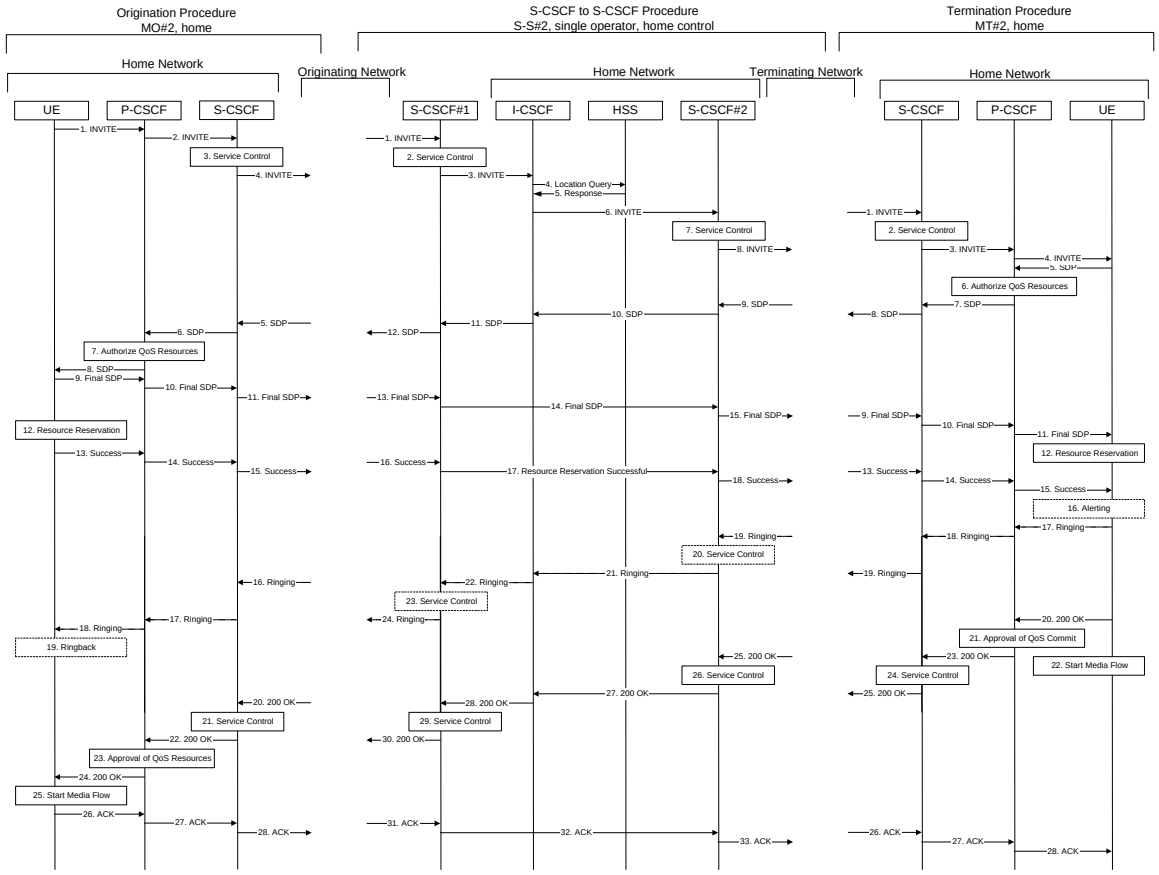
The end-to-end session flow given in the previous section can be decomposed into an originating part, an inter-serving part, and a terminating part.

The originating part is for a mobile origination, with subscriber located in the home operator service area. This procedure is given in Section 5.6.2, *(MO#2) Mobile origination, located in home network.*

The inter-serving part is for a single operator, where the destination party is located within the operator's service area. This procedure is given in Section 5.5.2, *(S-S#2) Single network operator performing origination and termination, with home control of termination*.

The terminating part is for a mobile termination, with subscriber located in the home operator service area. This procedure is given in Section 5.7.2, *(MT#2) Mobile termination, located in home network.*

The following diagram illustrates this decomposition, showing how the three separate procedures fit together to produce an end-to-end session flow.



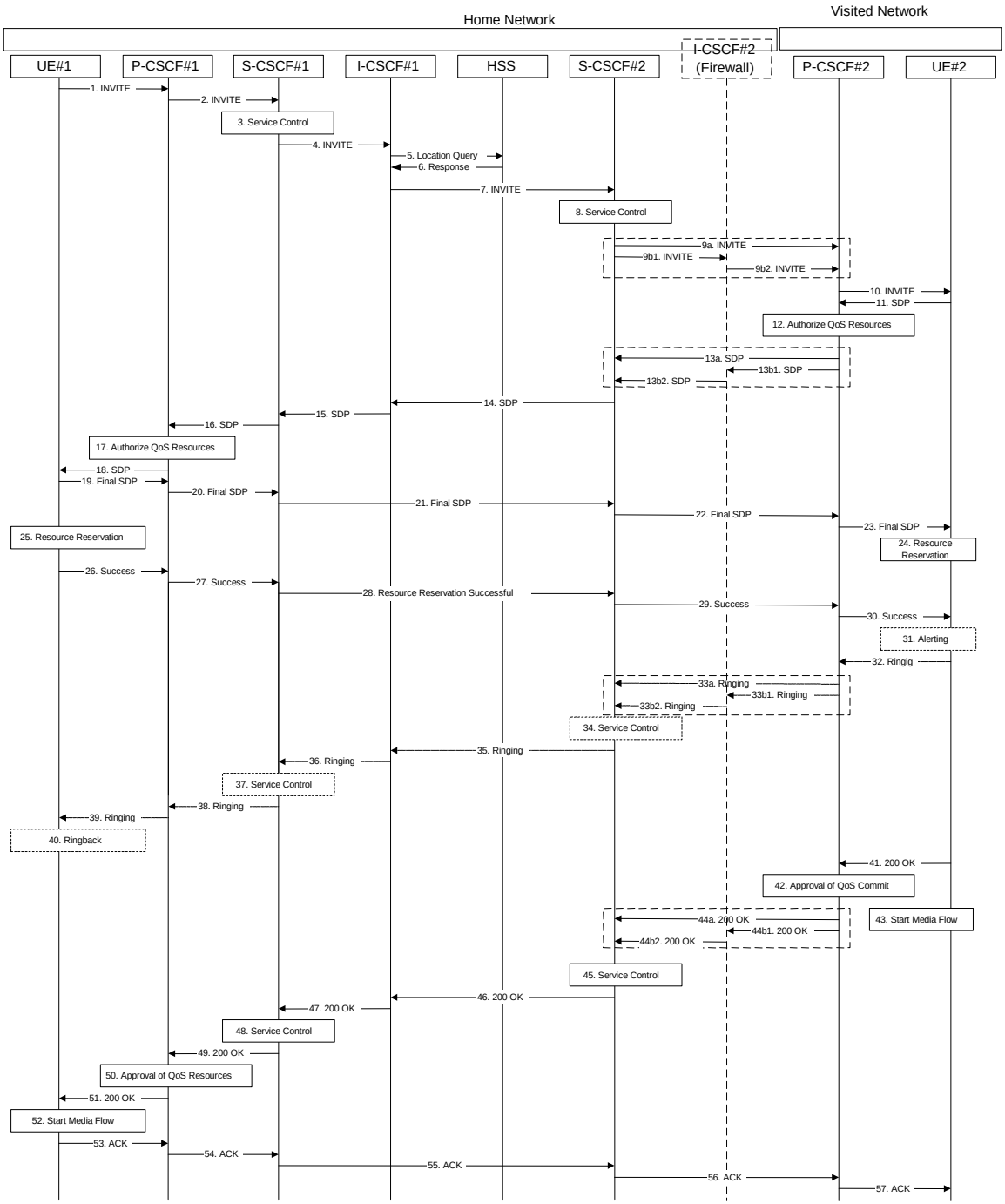
B.2 Sample end-end Session Flow - Mobile Origination, home, to Mobile Termination, roaming

For this end-to-end session flow, we assume the originator is a UE located within the service area of the network operator to whom the UE is subscribed. The UE has already established the proper PDP contexts for exchanging SIP signalling messages, has performed the proxy discovery procedures described in section 5.1.1, and has registered in the IM CN subsystem

The originating party addresses a destination that is a subscriber of the same network operator.

The destination party is a UE located in a service area of a network operator different from that of its service subscription. This UE has already established the proper PDP contexts for exchanging SIP signalling messages, has performed the proxy discovery procedures described in section 5.1.1, and has registered in the IM CN subsystem.

B.2.1 Session flow diagram



Step-by-step processing of this end-to-end session flow is as follows:

1. UE#1 sends a SIP INVITE request, containing an initial SDP, to P-CSCF#1, which was obtained from the CSCF discovery procedures.

2. P-CSCF#1 forwards the INVITE to the next hop name/address, as determined from the registration procedures. In this case the next hop is S-CSCF#1 within the same operator's network.

3. S-CSCF#1 validates the service profile, and performs whatever service control logic is appropriate for this session setup attempt.

4. S-CSCF#1 translates the destination address and determines the session will be completed within the home operator's network. It therefore forwards the INVITE to I-CSCF#1.

5. I-CSCF#1 sends 'Cx-location-query' to the HSS to obtain the location information for the destination

6. The HSS responds with 'Cx-location-query-response' and indicates the destination is a roaming UE, under home network control.

7. I-CSCF#1 forwards the INVITE to S-CSCF#2, which was identified by the HSS as serving this subscriber.

8. S-CSCF#2 validates the service profile, and performs whatever service control logic is appropriate for this session setup attempt.

9. S-CSCF#2 remembers (from the registration procedure) the next hop CSCF for this UE. It forwards the INVITE to P-CSCF#2 in the visited network, possibly through an I-CSCF. This next hop is either the P-CSCF that is serving the visiting UE (choice (a)), or an I-CSCF within the home network that is performing the configuration hiding function for the home network operator (choice (b)).

   (9a) If the home network operator does not desire to keep their network configuration hidden, the INVITE request is forwarded directly to P-CSCF#2.

   (9b) If the home network operator desires to keep their network configuration hidden, the INVITE request is forwarded through I-CSCF#2 to P-CSCF#2.

   (9b1) S-CSCF#2 forwards the INVITE request to I-CSCF#2 within the home network

   (9b2) I-CSCF#2 forwards the INVITE request to P-CSCF#2

10. P-CSCF#2 remembers (from the registration procedure) the address of UE#2, and forwards the INVITE to UE#2

11. UE#2 returns the media stream capabilities of the destination to the session originator, along the signalling path established by the INVITE message

12. P-CSCF#2 authorises the QoS resources required for this session

13. P-CSCF#2 forwards the SDP to S-CSCF#2. Based on the choice made in (9) above, this response may either be sent directly from P-CSCF#2 to S-CSCF#2 (choice (a)), or be sent indirectly through I-CSCF#2 (firewall) (choice (b)).

14. S-CSCF#2 forwards the SDP to I-CSCF#1

15. I-CSCF#1 forwards the SDP to S-CSCF#1

16. S-CSCF#1 forwards the SDP message to P-CSCF#1

17. P-CSCF#1 authorises the resources necessary for this session

18. P-CSCF#1 forwards the SDP message to the originating endpoint, UE#1

19. The originator decides the final set of media streams for this session, and sends the Final SDP to P-CSCF#1

20. P-CSCF#1 forwards the final SDP to S-CSCF#1

21. S-CSCF#1 forwards the final SDP to S-CSCF#2. This message may be routed through I-CSCF#1, depending on operator configuration of I-CSCF#1.

22. S-CSCF#2 forwards the final SDP to P-CSCF#2. This message may be routed through I-CSCF#2, depending on operator configuration of I-CSCF#2.

23. P-CSCF#2 forwards the final SDP to UE#2.

24. UE#2 initiates the resource reservation procedures for the resources necessary for this session.

25. After determining the final set of media streams for this session, step #19 above, UE#1 initiates the reservation procedures for the resources needed for this session

26. When UE#1 has successfully reserved the needed resources, it sends the "reservation successful" message to UE#2 along the signalling path established by the INVITE message. The message is sent first to P-CSCF#1.

27. P-CSCF#1 forwards the message to S-CSCF#1

28. S-CSCF#1 forwards the message to S-CSCF#2. This message may be routed through I-CSCF, depending on operator configuration of I-CSCF.

29. S-CSCF#2 forwards the message to P-CSCF#2. This message may be routed through I-CSCF#2, depending on operator configuration of I-CSCF#2.

30. P-CSCF#2 forwards the message to UE#2.

31. UE#2 may optionally delay the session establishment in order to alert the subscriber to the incoming session.

32. If UE#2 performs alerting, it sends a ringing indication to the originator via the signalling path. The message is sent first to P-CSCF#2.

33. P-CSCF#2 forwards the ringing message to S-CSCF#2. Based on the choice made in (9) above, this response may either be sent directly from P-CSCF#2 to S-CSCF#2 (choice (a)), or be sent indirectly through I-CSCF#2 (firewall) (choice (b)).

34. S-CSCF#2 performs whatever service control is appropriate for this ringing session

35. S-CSCF#2 forwards the message to I-CSCF

36. I-CSCF forwards the message to S-CSCF#1

37. S-CSCF#1 performs whatever service control is appropriate for this ringing session.

38. S-CSCF#1 forwards the message to P-CSCF#1

39. P-CSCF#1 forwards the message to UE#1

40. UE#1 indicates to the originator that the session is being delayed due to alerting. Typically this involves playing a ringback sequence.

41. When the destination party answers, UE#2 sends a SIP 200-OK final response to P-CSCF#2

42. P-CSCF#2 approves the commitment of the QoS resources for this session

43. After sending the 200-OK, UE#2 initiates the media flow.

44. P-CSCF#2 sends a SIP 200-OK final response along the signalling path back toward the session originator. Based on the choice made in (9) above, this response may either be sent directly from P-CSCF#2 to S-CSCF#2 (choice (a)), or be sent indirectly through I-CSCF#2 (firewall) (choice (b)).

45. S-CSCF#2 performs whatever service control is appropriate for the completed session.

46. S-CSCF#2 sends a SIP 200-OK final response along the signalling path back to I-CSCF#1.

47. I-CSCF#1 sends a SIP 200-OK final response along the signalling path back to S-CSCF#1

48. S-CSCF#1 performs whatever service control logic is appropriate for this session setup completion

49. S-CSCF#1 sends a SIP 200-OK final response along the signalling path back to P-CSCF#1

50. P-CSCF#1 approves the commitment of the QoS resources for this session.

51. P-CSCF#1 sends a SIP 200-OK final response along the signalling path back to UE#1

52. UE#1 starts the media flow for this session

53. UE#1 responds to the final response with a SIP ACK message which is passed to UE#2 via the signalling path. The message is sent first to P-CSCF#1

54. P-CSCF#1 forwards the ACK to S-CSCF#1

55. S-CSCF#1 forwards the ACK to S-CSCF#2. This message may be routed through I-CSCF#1, depending on operator configuration of I-CSCF#1

56. S-CSCF#2 forwards the ACK to P-CSCF#2. This message may be routed through I-CSCF#2, depending on operator configuration of I-CSCF#2

57. P-CSCF#2 forwards the ACK to UE#2

B.2.2 Session flow decomposition into procedure blocks

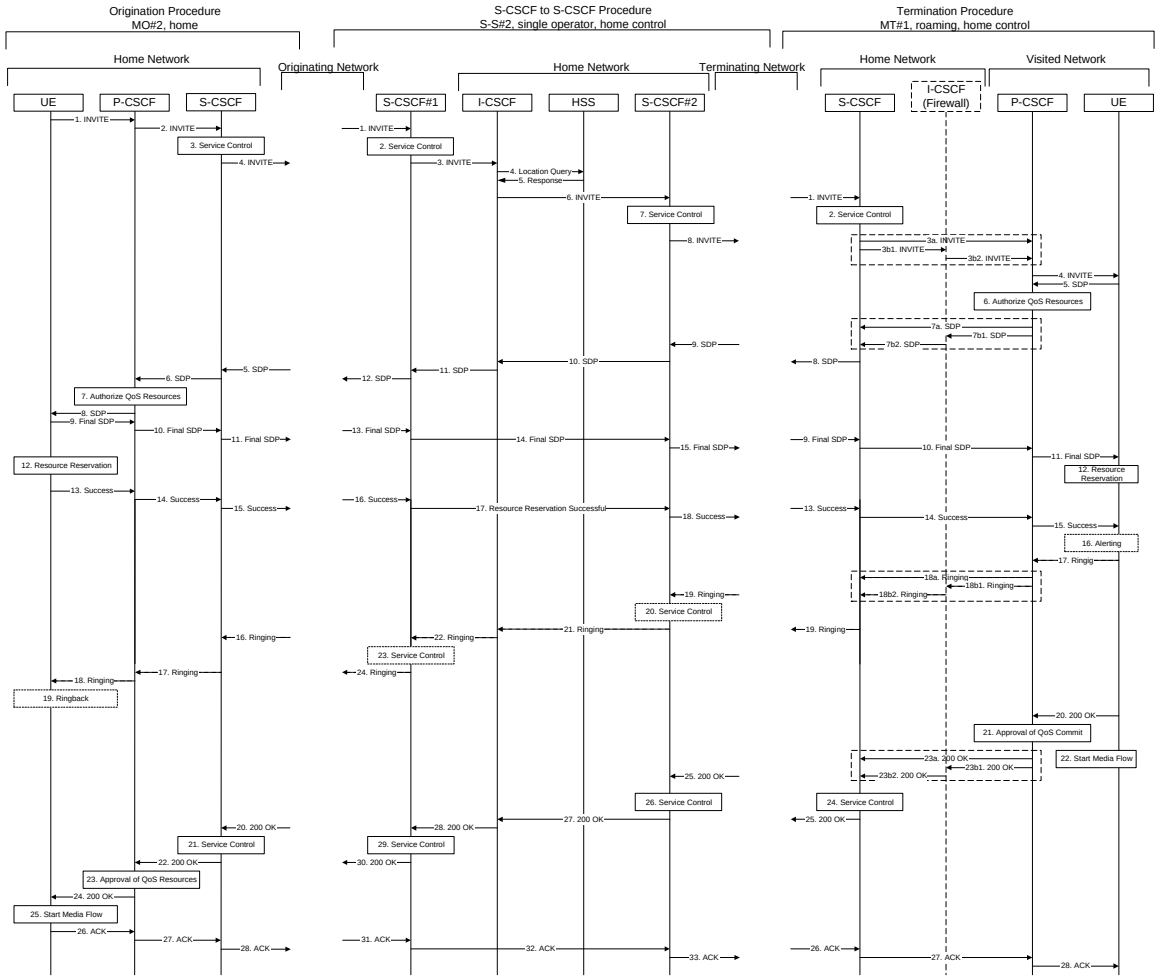
The end-to-end session flow given in the previous section can be decomposed into an originating part, an inter-serving part, and a terminating part.

The originating part is for a mobile origination, with subscriber located in the home operator service area. This procedure is given in Section 5.6.3, *(MO#2) Mobile origination, home*.

The inter-serving part is for a single operator, where the destination party is located within the operator's service area. This procedure is given in Section 5.5.3, *(S-S#2) Single network operator performing origination and termination.*

The terminating part is for a mobile termination, roaming, with home control. This procedure is given in Section 5.7.1, *(MT#1) Mobile termination, roaming*.

The following diagram illustrates this decomposition, showing how the three separate procedures fit together to produce an end-to-end session flow.



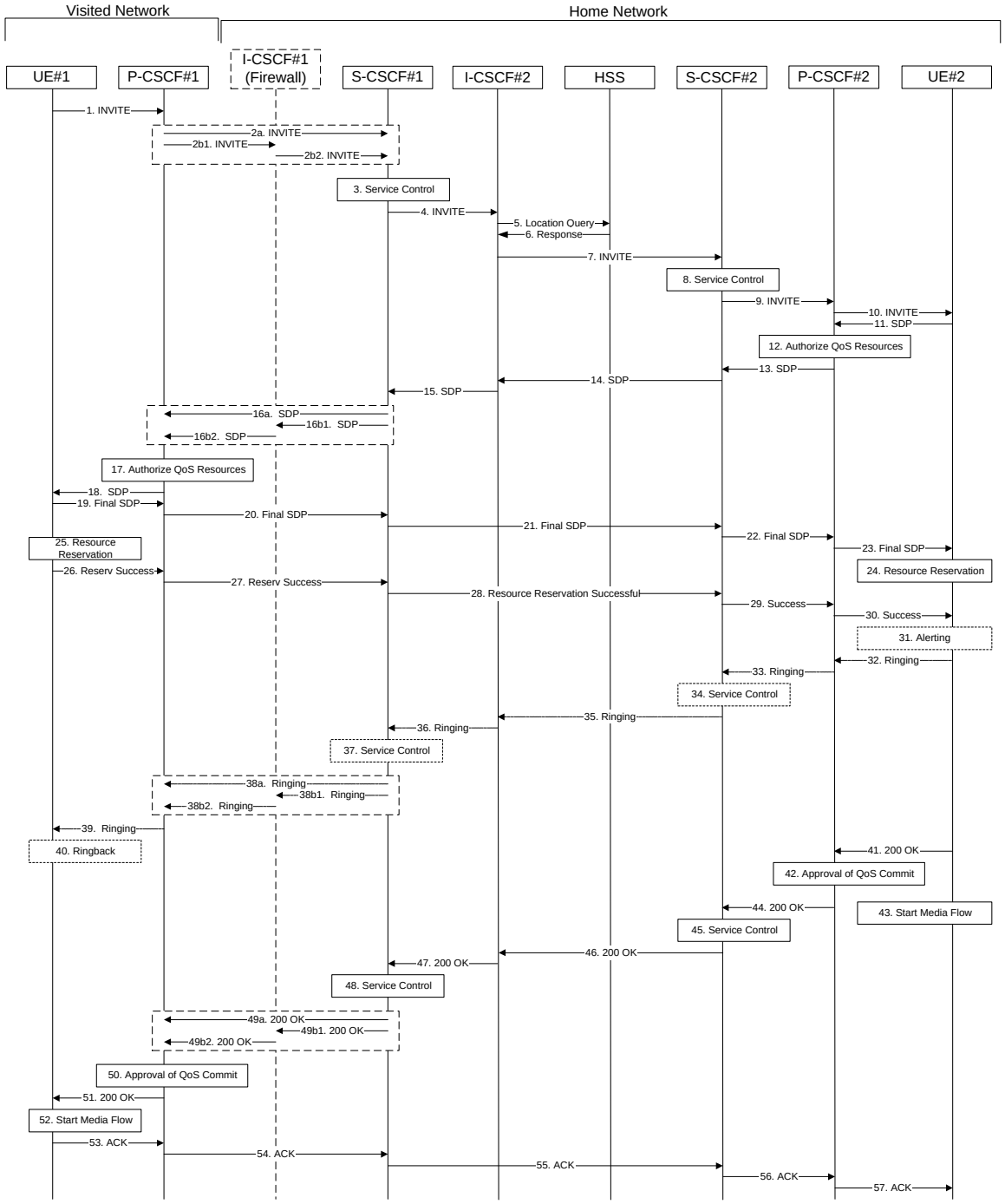
B.3 Sample end-end Session Flow - Mobile Origination, roaming, to Mobile Termination, home

For this end-to-end session flow, we assume the originator is a UE located outside the service area of the network operator to whom the UE is subscribed. The UE has already established the proper PDP contexts for exchanging SIP signalling messages, has performed the proxy discovery procedures described in section 5.1.1, and has registered in the IM CN subsystem.

The originating party addresses a destination that is a subscriber of the same network operator.

The destination party is a UE located within the service area of the network operator to which it is subscribed. This UE has already established the proper PDP contexts for exchanging SIP signalling messages, has performed the proxy discovery procedures described in section 5.1.1, and has registered in the IM CN subsystem.

B.3.1 Session flow diagram



Step-by-step processing of this end-to-end session flow is as follows:

1. UE#1 sends a SIP INVITE request, containing an initial SDP, to P-CSCF#1, which was obtained from the CSCF discovery procedures.

2. P-CSCF#1 remembers (from the registration procedure) the next hop CSCF for this UE. It forwards the INVITE to the S-CSCF within the home operator's network, possibly through an I-CSCF. The next hop is either S-CSCF#1 serving UE#1 (choice (a)), or I-CSCF#1 in the home network that is performing the configuration hiding function for the home network operator (choice (b)).

(2a) If the home network operator does not desire to keep their network configuration hidden, the INVITE request is forwarded directly to S-CSCF#1

(2b) If the home network operator desires to keep their network configuration hidden, the INVITE request is forwarded through an I-CSCF to the S-CSCF

(2b1) P-CSCF#1 forwards the INVITE request to I-CSCF#1 in the home network

(2b2) I-CSCF#1 forwards the INVITE request to S-CSCF#1.

3. S-CSCF#1 validates the service profile, and performs whatever service control logic is appropriate for this session setup attempt.
4. S-CSCF#1 translates the destination address and determines the session will be completed within the home operator's network. It therefore forwards the INVITE to I-CSCF#2.
5. I-CSCF#2 sends 'Cx-location-query' to the HSS to obtain the location information for the destination
6. The HSS responds with 'Cx-location-query-response' and indicates the destination is in the home service area.
7. I-CSCF#2 forwards the INVITE to S-CSCF#2, identified by the HSS as serving this subscriber.
8. S-CSCF#2 validates the service profile, and performs whatever service control logic is appropriate for this session setup attempt.
9. S-CSCF#2 remembers (from the registration procedure) the next hop CSCF for this UE. It forwards the INVITE to P-CSCF#2 in the home network.
10. P-CSCF#2 remembers (from the registration procedure) the UE address, and forwards the INVITE to the UE
11. UE#2 returns the media stream capabilities of the destination to the session originator, along the signalling path established by the INVITE message
12. P-CSCF#2 authorises the QoS resources required for this session
13. P-CSCF#2 forwards the SDP to S-CSCF#2.
14. S-CSCF#2 forwards the SDP to I-CSCF#2.
15. I-CSCF#2 forwards the SDP to S-CSCF#1
16. S-CSCF#1 forwards the SDP message to P-CSCF#1. Based on the choice made in (2) above, this response may either be sent directly from S-CSCF#1 to P-CSCF#1 (choice (a)), of be sent indirectly through I-CSCF#1 Firewall (choice (b)).
17. P-CSCF#1 authorises the resources necessary for this session
18. P-CSCF#1 forwards the SDP message to the originating endpoint, UE#1
19. The originator decides the final set of media streams for this session, and sends the Final SDP to P-CSCF#1
20. P-CSCF#1 forwards the final SDP to S-CSCF#1. This message may be routed through I-CSCF#1, depending on operator configuration of I-CSCF#1.
21. S-CSCF#1 forwards the final SDP to S-CSCF#2. This message may be routed through I-CSCF#2, depending on operator configuration of I-CSCF#2.
22. S-CSCF#2 forwards the final SDP to P-CSCF#2.
23. P-CSCF#2 forwards the final SDP to UE#2.
24. UE#2 initiates the resource reservation procedures for the resources necessary for this session.
25. After determining the final set of media streams for this session, step #19 above, UE#1 initiates the reservation procedures for the resources needed for this session
26. When UE#1 has successfully reserved the needed resources, it sends the "reservation successful" message to UE#2 along the signalling path established by the INVITE message. The message is sent first to P-CSCF#1.

27. P-CSCF#1 forwards the message to S-CSCF#1. This message may be routed through I-CSCF#1, depending on operator configuration of I-CSCF#1.

28. S-CSCF#1 forwards the message to S-CSCF#2. This message may be routed through I-CSCF#2, depending on operator configuration of I-CSCF#2.

29. S-CSCF#2 forwards the message to P-CSCF#2.

30. P-CSCF#2 forwards the message to UE#2.

31. UE#2 may optionally delay the session establishment in order to alert the subscriber to the incoming session.

32. If UE#2 performs alerting, it sends a ringing indication to the originator via the signalling path. The message is sent first to P-CSCF#2.

33. P-CSCF#2 forwards the ringing message to S-CSCF#2.

34. S-CSCF#2 performs whatever service control is appropriate for this ringing session

35. S-CSCF#2 forwards the message to I-CSCF#2

36. I-CSCF#2 forwards the message to S-CSCF#1

37. S-CSCF#1 performs whatever service control is appropriate for this ringing session.

38. S-CSCF#1 forwards the message to P-CSCF#1. Based on the choice made in (2) above, this response may either be sent directly from S-CSCF#1 to P-CSCF#1 (choice (a)), of be sent indirectly through I-CSCF#1 Firewall (choice (b)).

39. P-CSCF#1 forwards the message to UE#1

40. UE#1 indicates to the originator that the session is being delayed due to alerting. Typically this involves playing a ringback sequence.

41. When the destination party answers, the UE sends a SIP 200-OK final response to P-CSCF#2

42. P-CSCF#2 approves the commitment of the QoS resources for this session

43. After sending the 200-OK, US#2 initiates the media flow.

44. P-CSCF#2 sends a SIP 200-OK final response along the signalling path back to S-CSCF#2.

45. S-CSCF#2 performs whatever service control is appropriate for the completed session.

46. S-CSCF#2 sends a SIP 200-OK final response along the signalling path back to I-CSCF#2.

47. I-CSCF#2 sends a SIP 200-OK final response along the signalling path back to S-CSCF#1. Based on the choice made in (2) above, this response may either be sent directly from I-CSCF#2 to S-CSCF#1 (choice (a)), of be sent indirectly through I-CSCF#1 Firewall (choice (b)).

48. S-CSCF#1 performs whatever service control logic is appropriate for this session setup completion

49. S-CSCF#1 sends a SIP 200-OK final response along the signalling path back to P-CSCF#1

50. P-CSCF#1 approves the commitment of the QoS resources for this session.

51. P-CSCF#1 sends a SIP 200-OK final response along the signalling path back to UE#1

52. UE#1 starts the media flow for this session

53. UE#1 responds to the final response with a SIP ACK message, which is passed to UE#2 via the signalling path. This message is sent first to P-CSCF#1.

54. P-CSCF#1 forwards the ACK to S-CSCF#1. This message may be routed through I-CSCF#1, depending on operator configuration of I-CSCF#1.

55. S-CSCF#1 forwards the ACK to S-CSCF#2. This message may be routed through I-CSCF#2, depending on operator configuration of I-CSCF#2.

56. S-CSCF#2 forwards the ACK to P-CSCF#2.

57. P-CSCF#2 forwards the ACK to UE#2.

B.3.2 Session flow decomposition into procedure blocks

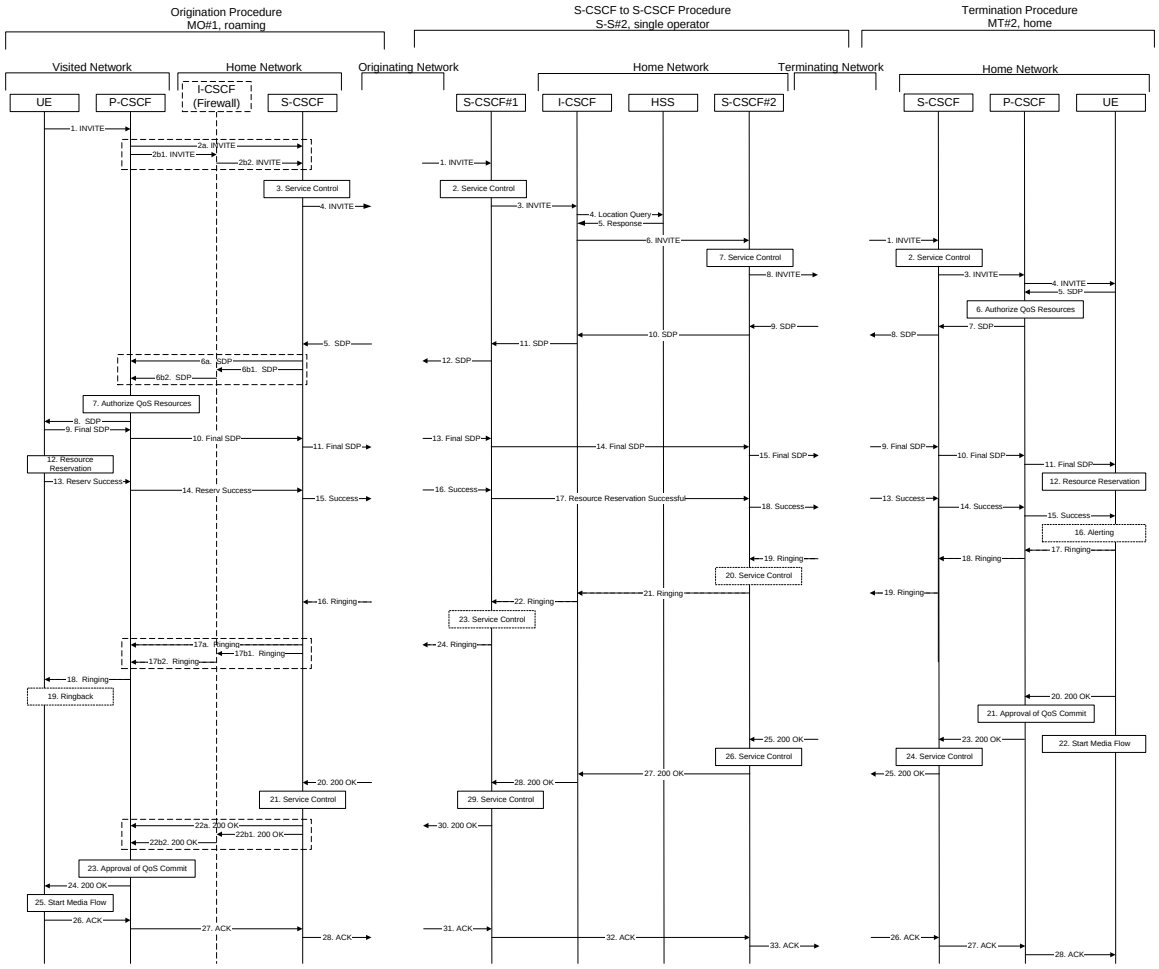
The end-to-end session flow given in the previous section can be decomposed into an originating part, an inter-serving part, and a terminating part.

The originating part is for a mobile origination, with subscriber located in the home operator service area. This procedure is given in Section 5.6.1, *(MO#1) Mobile origination, roaming*.

The inter-serving part is for a single operator, where the destination party is located within the operator's service area. This procedure is given in Section 5.5.2, *(S-S#2) Single network operator performing origination and termination.*

The terminating part is for a mobile termination, with the subscriber located in the home operator service area. This procedure is given in Section 5.7.2, *(MT#2) Mobile termination, home*.

The following diagram illustrates this decomposition, showing how the three separate procedures fit together to produce an end-to-end session flow.



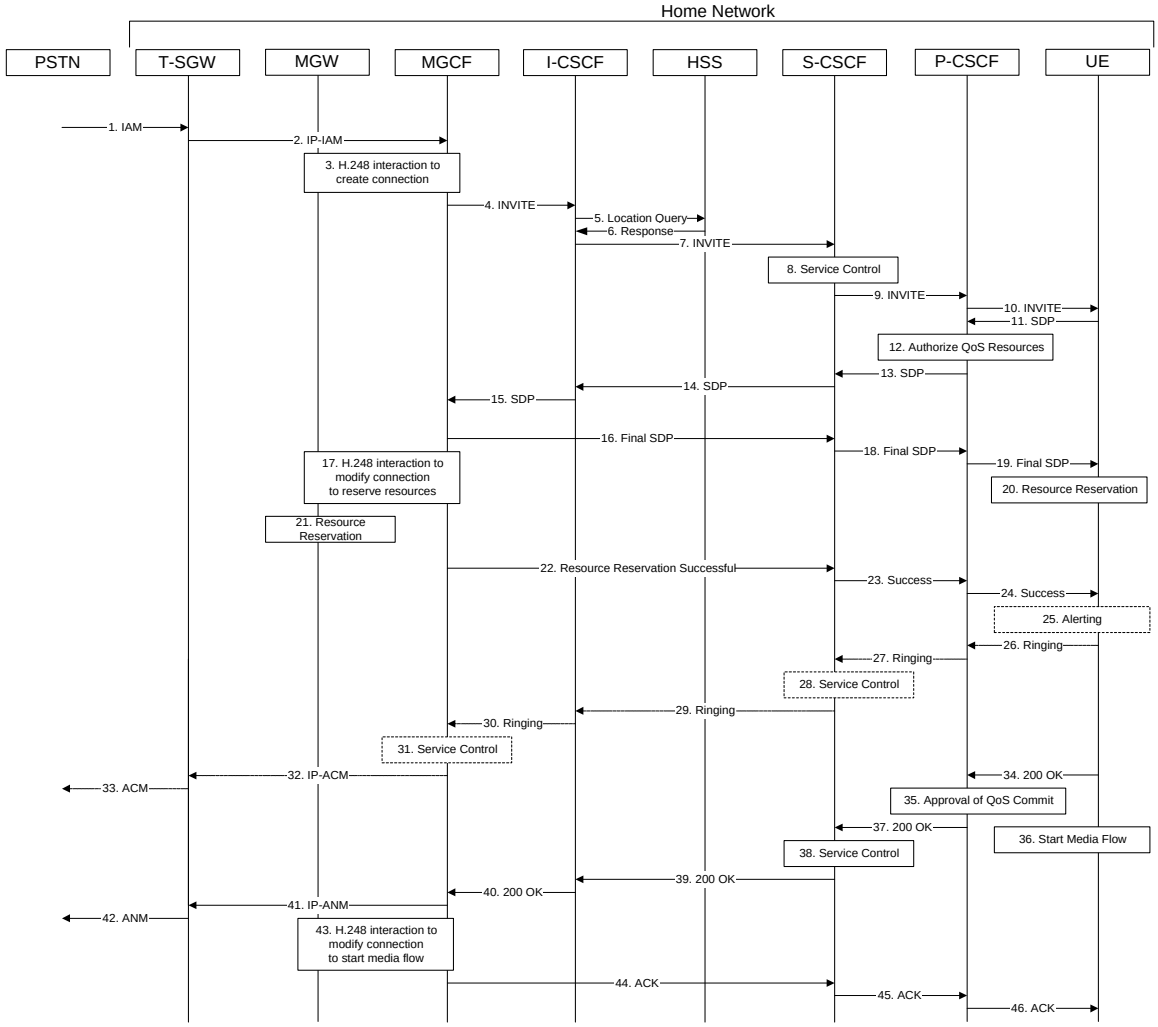
B.4 Sample end-end Session Flow - PSTN Origination Mobile Termination

The originating party on the PSTN addresses a destination that is a subscriber of the 3G network operator.

The destination party is a UE located within the service area of the network operator to which it is subscribed. This UE has already established the proper PDP contexts for exchanging SIP signalling messages, has performed the proxy

discovery procedures described in section 5.1.1, and has registered in the IM CN subsystem. As a result of registration, an S-CSCF was chosen in the home network.

B.4.1 Session flow diagram



Step-by-step processing of this end-to-end session flow is as follows:

1. The PSTN establishes a bearer path to the MGW, and signals to the T-SGW with a SS7 IAM message, giving the trunk identity and destination information

2. The T-SGW forwards the SS7 message, encapsulated in IP, to the MGCF.

3. The MGCF initiates a H.248 command to seize the trunk and an IP port.

4. The MGCF translates the destination address and determines the session will be completed within the home network. MGCF initiates a SIP INVITE request, containing an initial SDP, to I-CSCF.

5. I-CSCF sends ‘Cx-location-query’ to the HSS to obtain the location information for the destination

6. The HSS responds with ‘Cx-location-query-response’ and indicates the destination is in the home service area.

7. I-CSCF forwards the INVITE to S-CSCF, identified by the HSS as serving this subscriber.

8. S-CSCF validates the service profile, and performs whatever service control logic is appropriate for this session setup attempt.

9. S-CSCF remembers (from the registration procedure) the address of P-CSCF, and forwards the INVITE to P-CSCF.

10. P-CSCF remembers (from the registration procedure) the address of UE, and forwards the INVITE to UE.
11. UE#2 returns the media stream capabilities of the destination to the session originator, along the signalling path established by the INVITE message
12. P-CSCF authorises the QoS resources required for this session
13. P-CSCF forwards the SDP to S-CSCF.
14. S-CSCF forwards the SDP to I-CSCF
15. I-CSCF forwards the SDP to MGCF
16. MGCF decides the final set of media streams for this session, and sends the Final SDP to S-CSCF. This message may be routed through I-CSCF, depending on operator configuration of I-CSCF.
17. MGCF initiates a H.248 command to modify the connection parameters and instruct the MGW to reserve the resources needed for the session
18. S-CSCF forwards the final SDP to P-CSCF.
19. P-CSCF forwards the final SDP to UE.
20. UE initiates the resource reservation procedures for the resources necessary for this session.
21. MGW reserves the resources needed for the session
22. When MGW has successfully reserved the needed resources, MGCF sends the “reservation successful” message to UE along the signalling path established by the INVITE message. The message is sent to S-CSCF, and may be routed through I-CSCF, depending on operator configuration of I-CSCF.
23. S-CSCF forwards the message to P-CSCF.
24. P-CSCF forwards the message to UE.
25. UE may optionally delay the session establishment in order to alert the subscriber to the incoming session.
26. If UE performs alerting, it sends a ringing indication to the originator via the signalling path. The message is sent first to P-CSCF.
27. P-CSCF forwards the ringing message to S-CSCF.
28. S-CSCF performs whatever service control is appropriate for this ringing session
29. S-CSCF forwards the message to I-CSCF
30. I-CSCF forwards the message to MGCF
31. MGCF performs whatever service control is appropriate for this ringing session.
32. If alerting is being performed, the MGCF forwards an IP-ACM message to T-SGW
33. If alerting is being performed, the T-SGW forwards a SS7 ACM message
34. When the destination party answers, the UE sends a SIP 200-OK final response to P-CSCF
35. P-CSCF approves the commitment of the QoS resources for this session.
36. After sending the 200-OK, UE initiates the media flow.
37. P-CSCF sends the SIP 200-OK final response to S-CSCF
38. S-CSCF performs whatever service control logic is appropriate for this session setup completion
39. S-CSCF sends the SIP 200-OK final response to I-CSCF
40. I-CSCF sends the SIP 200-OK final response to MGCF

41. MGCF forwards an IP-ANM message to T-SGW

42. T-SGW forwards an ANM message to the PSTN

43. MGCF alters the connection at MGW, via a H.248 command, to make it bi-directional

44. MGCF acknowledges the SIP final response with a SIP ACK message, which is passed to UE#2 via the signalling path. This message is sent to S-CSCF, and may be routed through I-CSCF, depending on operator configuration of I-CSCF.

45. S-CSCF forwards the ACK to P-CSCF

46. P-CSCF forwards the ACK to UE

B.4.2 Session flow decomposition into procedure blocks

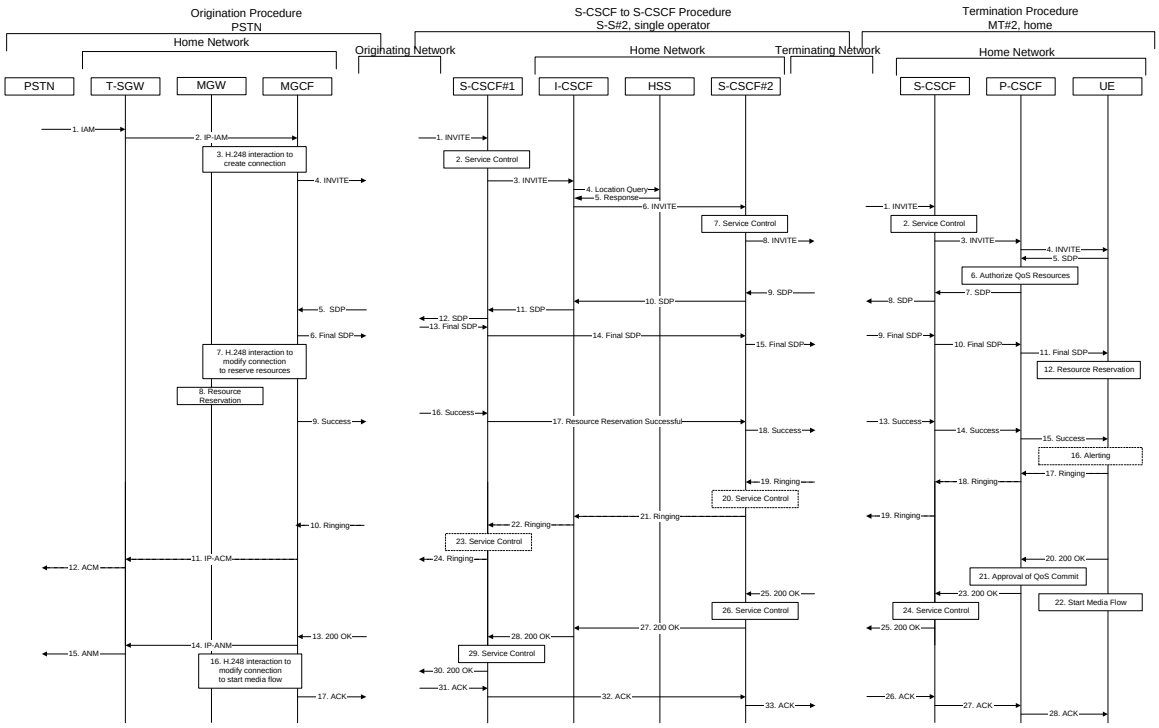
The end-to-end session flow given in the previous section can be decomposed into an originating part, an inter-serving part, and a terminating part.

The originating part is for a mobile origination, with subscriber located in the home operator service area. This procedure is given in Section 5.6.3, *(PSTN-O) PSTN origination*.

The inter-serving part is for a single operator, where the destination party is located within the operator's service area. This procedure is given in Section 5.5.2, *(S-S#2) Single network operator performing origination and termination.*

The terminating part is for a mobile termination, with the subscriber located in the home operator service area. This procedure is given in Section 5.7.2, *(MT#2) Mobile termination, home*.

The following diagram illustrates this decomposition, showing how the three separate procedures fit together to produce an end-to-end session flow.



Note: the S-CSCF#1 in the S-S#3 procedure is the MGCF of the PSTN-O procedure.

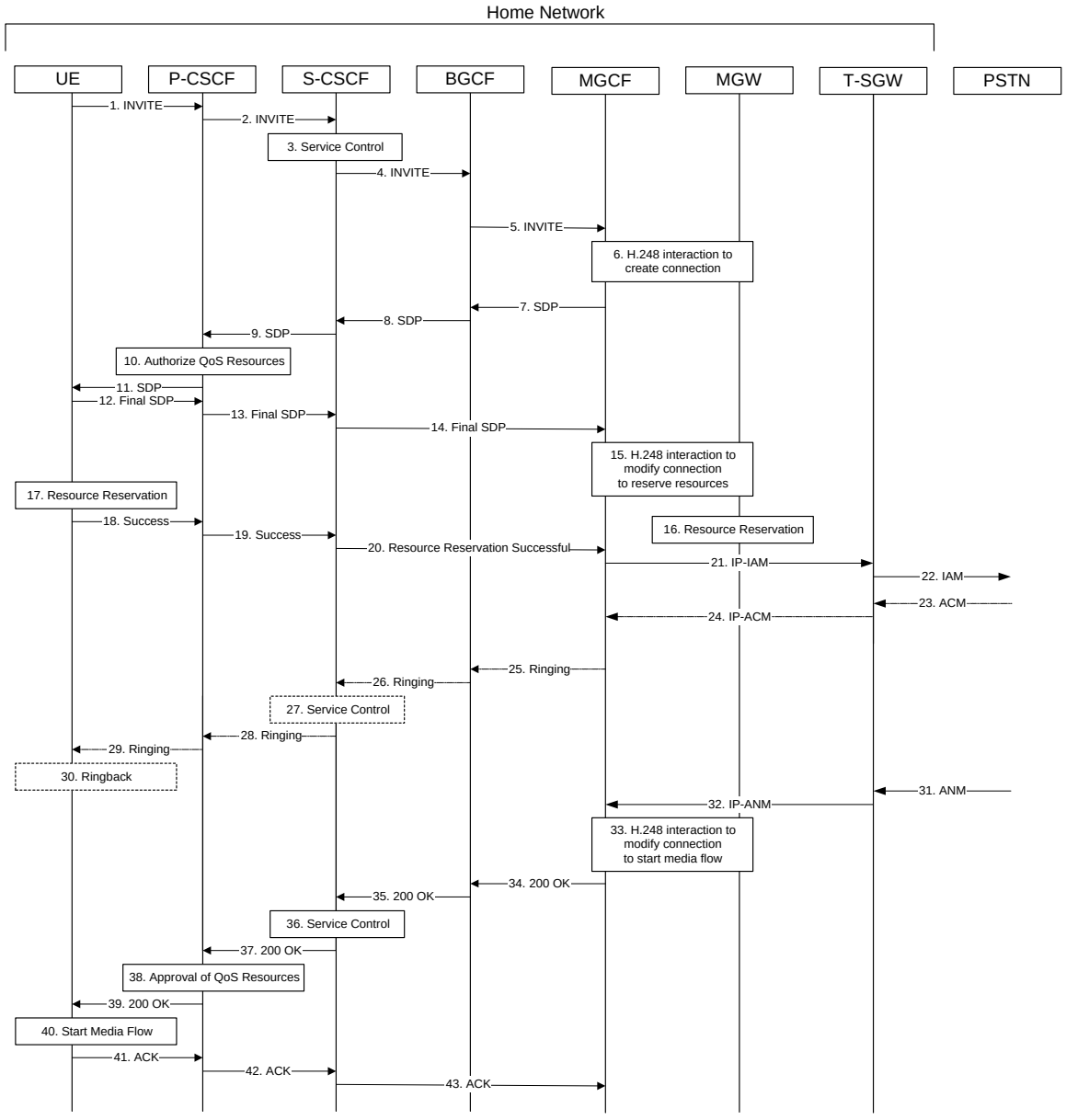
B.5 Sample end-end session flow - Mobile origination, PSTN termination in same network

For this end-to-end session flow, we assume the originator is a UE located within the service area of the network operator to whom the UE is subscribed. The originating party has already established the proper PDP contexts for exchange of SIP signalling messages, has performed the proxy discovery procedures described in section 5.1.1, and has registered in the IM CN subsystem. As a result of registering, an S-CSCF has been chosen in the home network.

The UE originating the session addresses a destination that is a non-3GPP endpoint. Therefore, the session must be completed through a Media Gateway.

The network operator serving this subscriber either decides to use a local PSTN gateway, or does not have agreements with other network operators for optimal gateway selection.

B.5.1 Session flow diagram



Step-by-step processing of this end-to-end session flow is as follows:

1. The UE sends a SIP INVITE request, containing an initial SDP, to the P-CSCF, which was obtained from the CSCF discovery procedures.

2. The P-CSCF forwards the INVITE to the next hop name/address, as determined from the registration procedures. In this case the next hop is the S-CSCF within the same operator's network.

3. The S-CSCF validates the service profile, and performs whatever service control logic is appropriate for this session setup attempt.

4. The S-CSCF translates the destination address and determines the session will break out to the PSTN. It therefore forwards the INVITE to a BGCF.

5. The BGCF decides to use an MGW in the home network, allocates a MGCF, and sends the INVITE request to the MGCF. Procedures for choice of the optimal Media Gateway are not standardised in this release.

6. MGCF initiates a H.248 interaction to pick an outgoing channel and determine media capabilities of the MGW.

7. MGCF determines the subset of the media flows proposed by the originating endpoint that it supports, and responds with an SDP message back to the originator via the signalling path. This response is sent to the BGCF.

8. BGCF forwards the SDP to S-CSCF

9. S-CSCF forwards the SDP message to P-CSCF

10. P-CSCF authorises the resources necessary for this session

11. P-CSCF forwards the SDP message to the originating endpoint, UE.

12. The originator decides the final set of media streams for this session, and sends the Final SDP to P-CSCF.

13. P-CSCF forwards the final SDP to S-CSCF

14. S-CSCF forwards the final SDP to MGCF. This message may be routed directly to the MGCF.

15. MGCF initiates a H.248 interaction to modify the connection established in step #8 and instruct MGW to reserve the resources necessary for the media stream.

16. MGW reserves the resources necessary for the media stream.

17. After determining the final set of media streams for this session, step #14 above, UE initiates the reservation procedures for the resources needed for this session.

18. When UE has successfully reserved the needed resources, it sends the "reservation successful" message to MGCF along the signalling path established by the INVITE message. This message is send first to P-CSCF.

19. P-CSCF forwards the message to S-CSCF.

20. S-CSCF forwards the message to MGCF. This message may be routed through I-CSCF, depending on operator configuration of I-CSCF.

21. MGCF sends an IP-IAM message to the T-SGW

22. T-SGW receives the IP-IAM and sends the SS7 IAM message into the PSTN.

23. When the PSTN has established the path to the destination, it may optionally alert the destination user before completing the session. If so, it responds with an SS7 ACM message

24. T-SGW sends an IP-ACM message to MGCF

25. If the PSTN is alerting the destination user, MGCF indicates this to the originating party by a provisional response indicating Ringing. This message is sent to the BGCF.

26. The BGCF forwards the message to S-CSCF

27. S-CSCF performs whatever service control is appropriate for this ringing session.

28. S-CSCF forwards the message to P-CSCF

Editor's Note: Additional QoS interactions to handle one-way media at this point (e.g. for PSTN ringback and announcements) is for further study.

29. P-CSCF forwards the message to UE

30. UE indicates to the originator that the session is being delayed due to alerting. Typically this involves playing a ringback sequence.

31. When the destination party answers, the PSTN sends an SS7 ANM message to T-SGW

32. T-SGW sends an IP-ANM message to MGCF

33. MGCF initiates a H.248 interaction to make the connection in the MGW bi-directional

34. MGCF sends a SIP 200-OK final response along the signalling path back to the session originator

35. BGCFsends a SIP 200-OK final response along the signalling path back to the session originator

36. S-CSCF performs whatever service control logic is appropriate for this session setup completion

37. S-CSCF sends a SIP 200-OK final response to P-CSCF

38. P-CSCF approves the commitment of the QoS resources for this session

39. P-CSCF sends a SIP 200-OK final response along the signalling path back to the session originator

40. UE starts the media flow for this session

41. UE responds to the final response with a SIP ACK message, which is passed to the MGCF via the signalling path. The message is sent first to P-CSCF

42. P-CSCF forwards the ACK to S-CSCF.

43. S-CSCF forwards the ACK to MGCF.

B.5.2 Session flow decomposition into procedure blocks

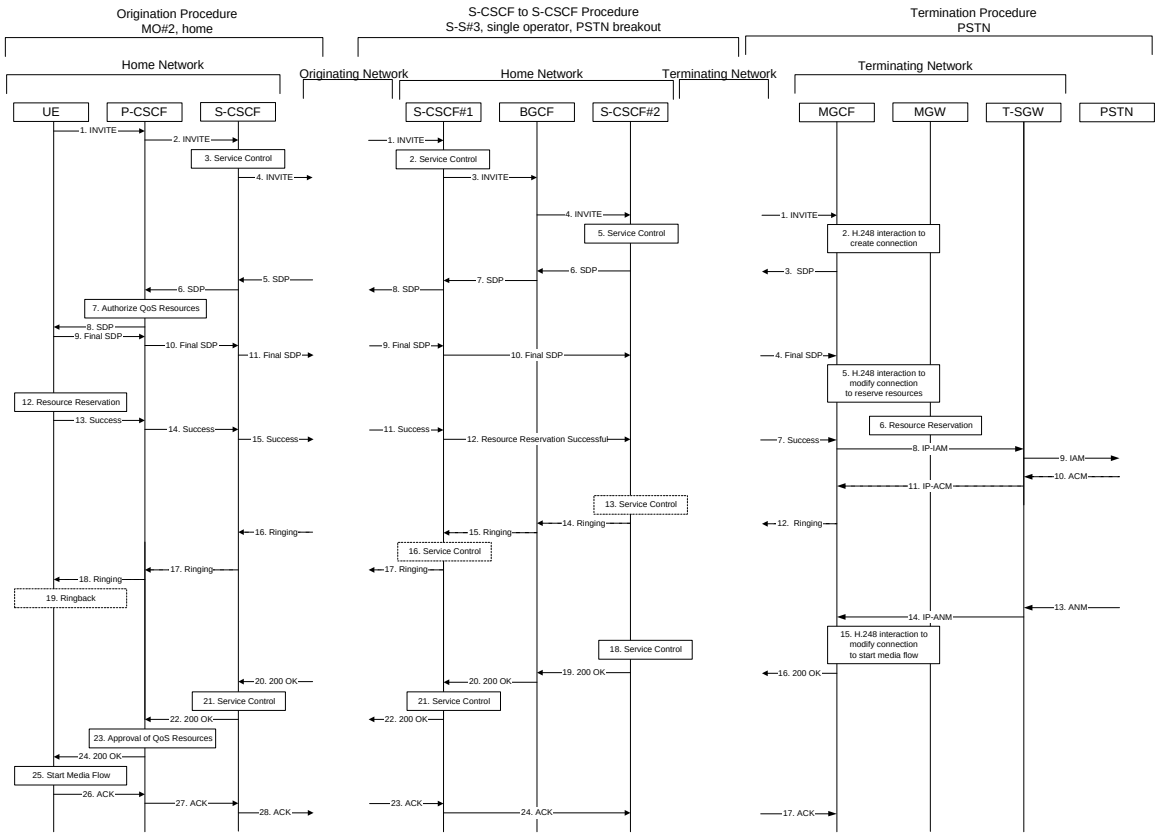
The end-to-end session flow given in the previous section can be decomposed into an originating part, an inter-serving part, and a terminating part.

The originating part is for a mobile origination, with subscriber located in the home operator service area. This procedure is given in Section 5.6.2, *(MO#2) Mobile origination, home*.

The inter-serving part is for a single operator, where the destination party is located within the operator's service area. This procedure is given in Section 5.5.3, *(S-S#3) Session origination with PSTN termination in the same network as the S-CSCF*.

The terminating part is for PSTN termination. This procedure is given in Section 5.7.3, *(PSTN-T) PSTN Termination*.

The following diagram illustrates this decomposition, showing how the three separate procedures fit together to produce an end-to-end session flow.



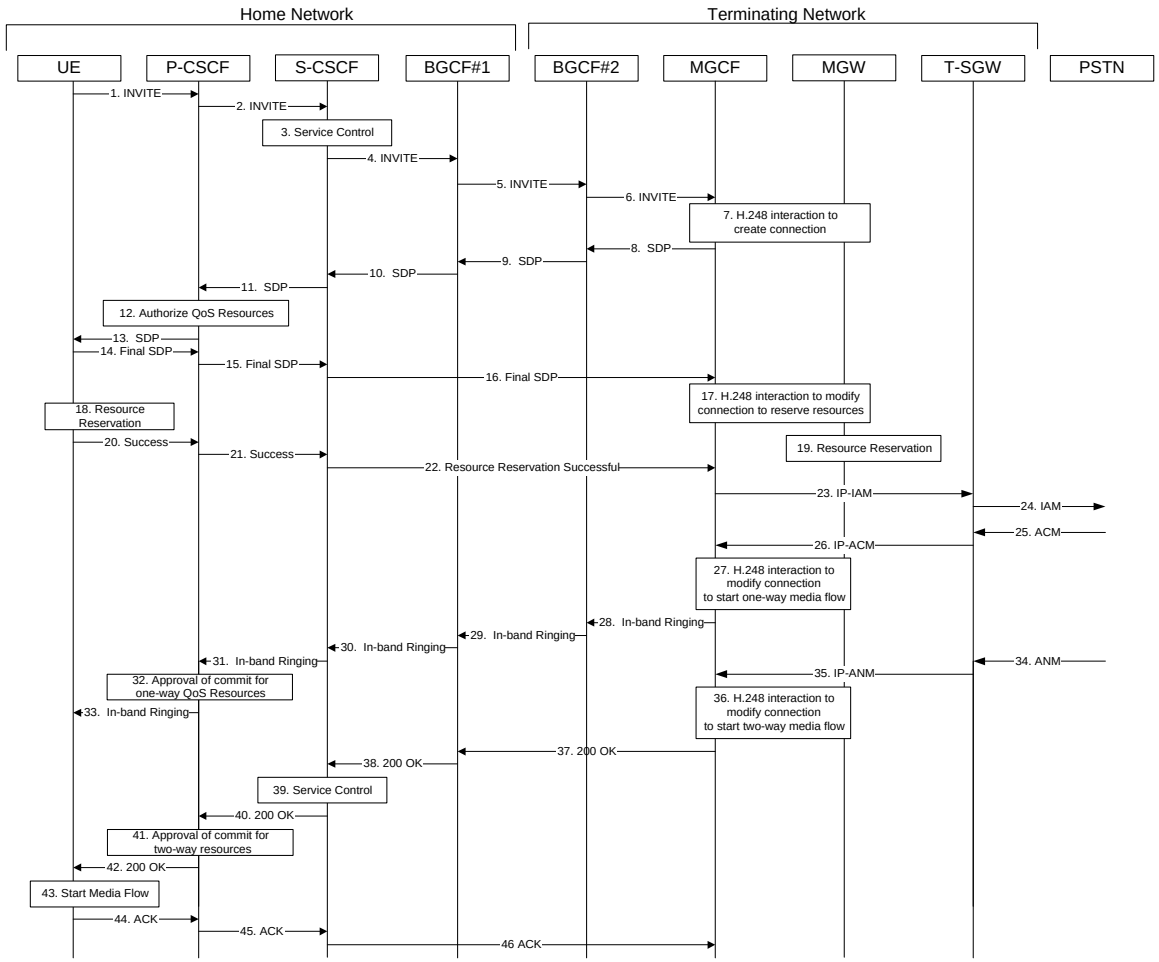
Note: the S-CSCF#2 in the S-S#3 procedure is the MGCF of the PSTN-T procedure.

B.6 Sample end-end Session Flow - Mobile Origination, PSTN Termination by separate network operator

For this end-to-end session flow, we assume the originator is a UE located outside the service area of the network operator to whom the UE is subscribed. The UE has already established the proper PDP contexts for exchanging SIP signalling messages, has performed the proxy discovery procedures described in section 5.1.1, and has registered in the IM CN subsystem.

The UE originating the session addresses a destination that is not a 3GPP endpoint, i.e. an E.164 number that must be completed by the PSTN.

The visited network operator decides not to perform the PSTN gateway function for this session setup attempt, rather to a PSTN gateway of another network operator, the third party with whom prior agreement has been made.



Step-by-step processing of this end-to-end session flow is as follows:

1. The UE sends a SIP INVITE request, containing an initial SDP, to the P-CSCF, which was obtained from the CSCF discovery procedures.

2. The P-CSCF forwards the INVITE to the next hop name/address, as determined from the registration procedures. In this case the next hop is the S-CSCF within the same operator's network.

3. The S-CSCF validates the service profile, and performs whatever service control logic is appropriate for this session setup attempt.

4. The S-CSCF translates the destination address and determines the session will break out to the PSTN. It therefore forwards the INVITE to BGCF#1.

5. BGCF#1 determines that another operator is better able to terminate this PSTN connection, and forwards the INVITE to BGCF#2 in that operator's network.

6. BGCF#2 decides to use an MGW in its network, allocates a MGCF, and sends the INVITE request to the MGCF. Procedures for choice of the optimal Media Gateway are not standardized in Release 5.

7. MGCF initiates a H.248 interaction to pick an outgoing channel and determine media capabilities of the MGW.

8. MGCF determines the subset of the media flows proposed by the originating endpoint that it supports, and responds with an SDP message back to the originator via the signaling path. This response is sent to BGCF#2.

9. BGCF#2 forwards the SDP to BGCF#1.

10. BGCF#1 forwards the SDP to S-CSCF

11. S-CSCF forwards the SDP message to P-CSCF

12. P-CSCF authorizes the resources necessary for this session

13. P-CSCF forwards the SDP message to the originating endpoint, UE.
14. The originator decides the final set of media streams for this session, and sends the Final SDP to P-CSCF.
15. P-CSCF forwards the final SDP to S-CSCF
16. S-CSCF forwards the final SDP to MGCF. This message may be routed directly to the MGCF.
17. MGCF initiates a H.248 interaction to modify the connection established in step #8 and instruct MGW to reserve the resources necessary for the media stream.
18. MGW reserves the resources necessary for the media stream.
19. After determining the final set of media streams for this session, step #13 above, UE initiates the reservation procedures for the resources needed for this session.
20. When UE has successfully reserved the needed resources, it sends the “reservation successful” message to MGCF along the signaling path established by the INVITE message. This message is sent first to P-CSCF.
21. P-CSCF forwards the message to S-CSCF.
22. S-CSCF forwards the message to MGCF. This message may be routed through the BGCFs, depending on operator configuration of the BGCFs.
23. MGCF sends an IP-IAM message to the T-SGW
24. T-SGW receives the IP-IAM and sends the SS7 IAM message into the PSTN.
25. When the PSTN has established the path to the destination, it may optionally alert the destination user before completing the session. If so, it responds with an SS7 ACM message
26. T-SGW sends an IP-ACM message to MGCF
27. MGCF performs the H.248 interaction with MGF to enable a one-way media flow.
28. If the PSTN is alerting the destination user, MGCF indicates this to the originating party by a provisional response indicating Ringing. This message is sent to BGCF#2.
29. BGCF#2 forwards the message to BGCF#1
30. BGCF#1 forwards the message to S-CSCF
31. S-CSCF forwards the message to P-CSCF
32. P-CSCF approves the resources needed for the one-way media flow.

Editor’s Note: Additional QoS interactions to handle one-way media at this point (e.g. for PSTN ringback and announcements) is for further study.

33. P-CSCF forwards the message to UE
34. When the destination party answers, the PSTN sends an SS7 ANM message to T-SGW
35. T-SGW sends an IP-ANM message to MGCF
36. MGCF initiates a H.248 interaction to make the connection in the MGW bi-directional
37. MGCF sends a SIP 200-OK final response along the signaling path back to the session originator
38. BGCF#2 sends a SIP 200-OK final response along the signaling path back to the session originator
39. S-CSCF performs whatever service control is appropriate for this completing session
40. S-CSCF sends the SIP 200-OK final response to the P-CSCF
41. P-CSCF approves the commitment of the QoS resources for this session
42. P-CSCF sends a SIP 200-OK final response along the signaling path back to the session originator

43. UE starts the media flow for this session

44. UE responds to the final response with a SIP ACK message, which is passed to the MGCF via the signaling path. The message is sent first to P-CSCF

45. P-CSCF forwards the ACK to S-CSCF.

46. S-CSCF forwards the ACK to MGCF.

Annex C (informative): Optional configuration independence between operator networks

It is a requirement that it shall be possible to hide the network topology from other operators. It shall be possible to restrict the following information from being passed outside of an operator's network: exact number of S-CSCFs, capabilities of S-CSCFs, or capacity of the network. Hiding requirements of P-CSCFs are for further study (Note that UE needs to have the address of P-CSCF).

The details of the mechanism to fulfil this requirement are yet to be determined. The specific mechanism chosen needs to take into account the following separate aspects of this requirement:

Network management. In the case that network details (i.e. S-CSCF addresses) are visible by other external network elements, any (temporary or permanent) changes to the network topology need to be propagated to network elements outside of the operator's network. This is highly undesirable from a network management perspective.

Network scalability. Establishing security associations on a pair-wise

basis among all CSCFs is likely to be unscalable. The security associations shall be independent of the number of network elements.

Competitivity aspects. The operational details of an operator's network are sensitive business information that operators are reluctant to share with their competitors. While there may be situations (partnerships or other business relations) where the sharing of such information is appropriate, the possibility should exist for an operator to determine whether or not the internals of its network need to be hidden.

Security aspects. Network element hiding may help to reduce the vulnerability of the overall system to external attacks (e.g. denial of service attacks). Further work is needed in this area.

Annex D (informative): Change history

Change history				
Date	**TSG #**	**TSG Doc.**	**Rev**	**Subject/Comment**
2000-07	SA-2	23.228	0.0.1	Initial version of the specification
2000-08			0.0.2	Editorial revisions based on email review
2000-09			0.1.0	Incorporated changes from the following contributions approved by the August 16-18, 2000 meeting in Vancouver (and subsequent email approval): S2-001310, S2-001311, S2-001313, S2-001314, S2-001315, S2-001316, and S2-001322.

2000-09			1.0.0	Incorporated changes from the following contributions approved by the September 4-8, 2000 meeting in Bristol: S2-001316, S2-001484, S2-001540, S2-001548, S2-001602, S2-001605, S2-001618, S2-001619, S2-001633, and S2-001635. Also incorporated the following contributions approved by email: S2-001399 and S2-001636R2.
2000-10			1.1.0	This version incorporates changes from the following contribution approved via email subsequent to the Bristol meeting but following the production of Version 1.0.0: S2-001483. This version also incorporates changes from the following contributions approved by the October 9-12 meeting in Sophia Antipolis: S2-001719, S2-001723, S2-001727, S2-001741, S2-001757, S2-001761, S2-001762, S2-001764, S2-001765, S2-001766, S2-001767, S2-001768, S2-001773, S2-001775, S2-001780, and S2-001782.
2000-10			1.2.0	This version incorporates changes to Figures 4.1 and 4.2 contained in S2-001548 approved in Bristol but inadvertently missed in the editing of Version 1.0.0. This also incorporates changes from contribution S2-001755 approved by the October 9-12 meeting in Sophia Antipolis, which was missed in the previous version.
2000-11			1.3.0	This version incorporates changes contained in S2-001776 approved by email subsequent to the October 9-12 meeting in Sophia Anitpolis meeting.
2000-11			1.4.0	This version incorporates changes from the following contributions approved by the November 13-17, 2000 meeting in Makuhari Japan: S2-001872, S2-001875, S2-001876, S2-001881, S2-001897, S2-001910, S2-002016, S2-002039, and S2-002040. This version also incorporates changes from S2-001777 approved by email subsequent to Sophia Antipolis but inadvertently missed in the editing of Version 1.3.0.
2000-12			1.5.0	This version incorporates changes from the following contributions approved by email subsequent to the November 13-17, 2000 meeting in Makuhari Japan: S2-002007, S2-002011, S2-002012, S2-002017, S2-002045, S2-002046, S2-002055, and S2-002059R1. This version also incorporates changes from the following contributions approved at the East Brunswick, NJ drafting session: S2-002208, S2-002212, S2-002213, and S2-002222.
2001-01			1.5.1	This version incorporates editorial changes. The headings were all changed to the appropriate heading style. The TH style was applied to various figures and various bullet lists were changed to the appropriate style. In addition, this version contains changes from S2-002006 which was approved in the November Makuhari meeting but was incorrectly identified as subject to email approval. This error was identified recently and thus included in this version in Section 5.4.2.
2001-01			1.6.0	Updated after the decision of Home Control of services is the only option to be considered, ie. S-CSCF is always in the Home network (tdoc S2-010148, SA2#16).
2001-02			1.7.0	This version incorporates changes from the following contributions approved by the January 22-26, 2001 meeting in Los Angeles CA: S2-010127, S2-010129, S2-010131, S2-010142, S2-010235, S2-010236, S2-010240, S2-010257, S2-010311, S2-010317, S2-010319, S2-010328, S2-010329, S2-010353, S2-010356, S2-010357, S2-010360, S2-010361, S2-010362, S2-010363, and S2-010366.
2001-02			1.8.0	This version incorporates changes from the following contributions approved by email subsequent to the January 22-26, 2001 meeting in Los Angeles, CA.: S2-010035, S2-010325, S2-010336, S2-010342, S2-010344, S2-010348, S2-010358, and S2-010384.
2001-03			1.8.1	This version incorporates editorial changes agreed during the February 26 - March 2 meeting in Goteborg. Some of these changes were based on contributions S2-010514, S2-010566, and S2-010570.
2001-03			1.8.2	This version was revised based on comments at the meeting to use the term PS domain, to change 23.121 to 23.221, to remove the incorrectly approved S2-010325, and to remove Annex C, D, E, and F.

2001-03			2.0.0	This version incorporates changes from approved contributions at the February 26 - March 2 meeting in Goteborg and based on subsequent email approval following the meeting. The changes are based on the following list of contributions: S2-010508, S2-010509, S2-010685, S2-010712, S2-010724, S2-010726, S2-010728, S2-010755, S2-010756, S2-010759, S2-010791, S2-010792, S2-010793, S2-010797, S2-010802, S2-010803, S2-010804, S2-010805, S2-010806, S2-010823, S2-010824, S2-010825, and S2-010826.