

CSFB and SMSoSGs

Date: 17.10.2009
Revision: 003/CAS/002
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Introduction

The CS FallBack (CSFB) in EPS enables the provisioning of voice and other CS-domain services (e.g. CS UDI video, LCS, USSD) by reuse of CS infrastructure when the UE is served by E-UTRAN. A CSFB enabled terminal, connected to E-UTRAN may use GERAN or UTRAN to connect to the CS-domain. This function is only available in case E-UTRAN coverage is overlapped by either GERAN coverage or UTRAN coverage.

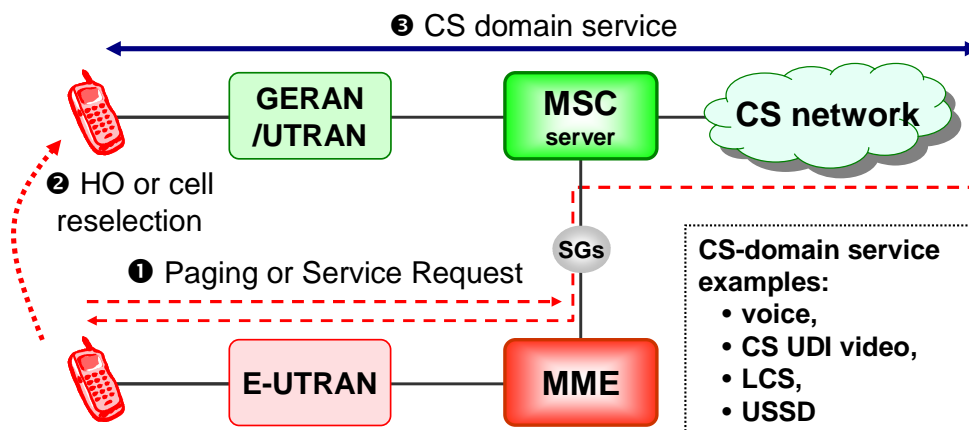


Figure 1 CS FallBack (CSFB)

This chapter also describes the architecture required for SMS over SGs (MME-MSC interface). The MO SMS and MT SMS are signalled over SGs and do not cause any CS FallBack to GERAN/UTRAN RATs, and consequently does not require any overlapped GERAN/UTRAN coverage.

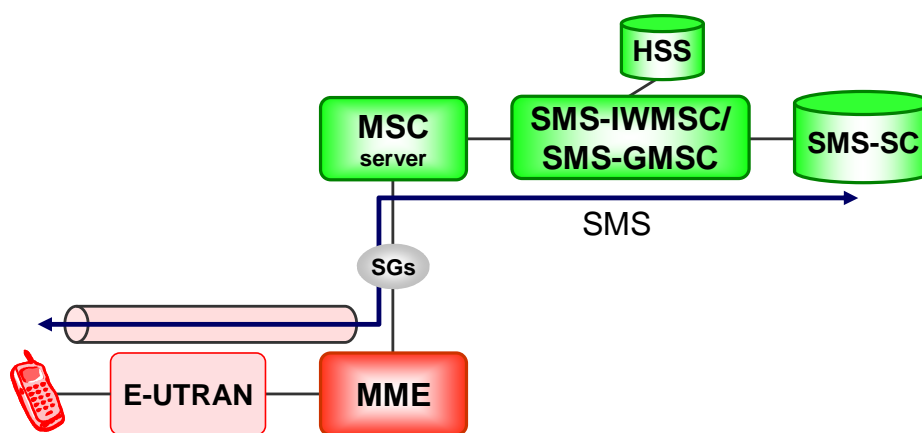


Figure 2 SMS over SGs

Architecture

The CSFB and SMS over SGs in EPS function is realized by using the SGs interface mechanism between the MSC Server and the MME.

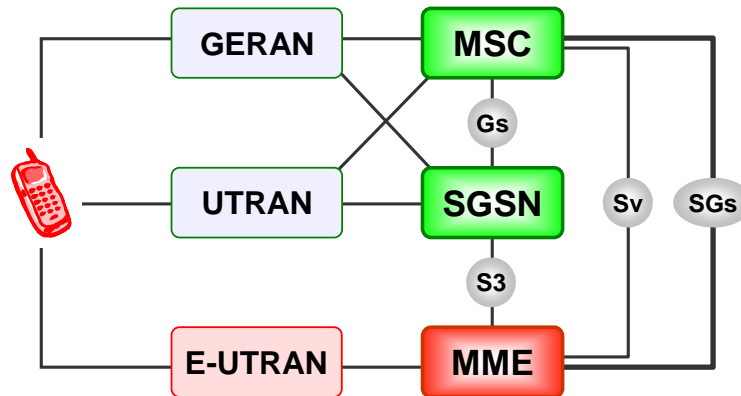


Figure 3 CS Fallback and SMS over SGs architecture

SGs is an interface between the MME and MSC server. It is used for the Mobility Management (MM) and paging procedures between EPS and CS domain, and is based on the Gs (VLR-SGSN) interface procedures. The SGs reference point is also used for the delivery of both Mobile Originating and Mobile Terminating SMS (MO-SMS and MT-SMS).

S3 is an interface between MME and SGSN. It has additional functionality to support CSFB with ISR.

Protocol stack

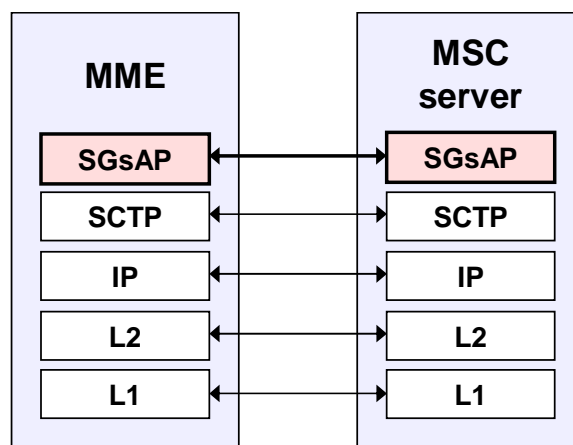


Figure 4 SGs protocol stack

SGs Application Part (SGsAP) protocol is used to connect an MME to an MSC Server. SGsAP is based on the BSSAP+ protocol, used earlier on Gs (SGSN-VLR) interface.

Stream Control Transmission Protocol (SCTP) transfers signalling messages.

Co-existence with IMS

For UE originating calls, the UE performs access domain selection. The service domain selection functionality decides whether the call is serviced in the CS domain or the IMS. Service domain selection functionality may take into account for originating calls whether the user is roaming or not, user preferences, service subscription and operator policy. If the UE is configured for Voice over IMS, the service domain selection functionality takes the 'IMS voice over PS session supported indication' into account and should only initiate IMS voice calls (with the voice bearer in the PS domain) using the RAT where the 'IMS voice over PS session supported indication' applies and indicates support. The "IMS voice over PS session supported indication" applies to E-UTRAN when received in E-UTRAN, and applies to UTRAN when either received in GERAN or UTRAN.

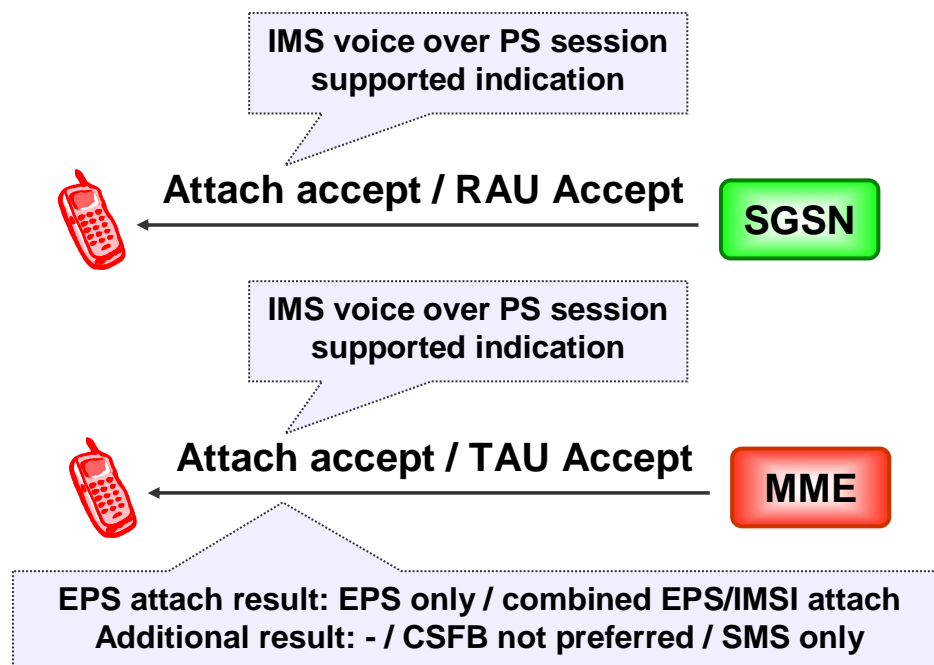


Figure 5 IMS voice over PS session supported indication

To allow for appropriate domain selection, the CSFB and IMS capable UE in E-UTRAN can be provision with the HPLMN operator preferences on how a CSFB/IMS enabled UE is supposed to handle voice services:

- **CS Voice only:** the UE does not attempt to initiate voice sessions over IMS using a PS bearer. The UE attempts combined EPS/IMSI attach.
- **CS Voice preferred, IMS PS Voice as secondary:** the UE tries preferably to use the CS domain to originate and terminate voice calls. The UE attempts combined EPS/IMSI attach and if combined EPS/IMSI attach fails for the CS domain or succeeds with an SMS only indication or succeeds with a CSFB Not Preferred indication, the UE attempts voice over IMS.
- **IMS PS Voice preferred, CS Voice as secondary:** the UE tries preferably to use IMS to originate and terminate voice sessions. If the UE fails to use IMS for voice e.g. due to 'IMS voice over PS session supported indication' indicates voice is not supported, then the services are provided using CS domain. The UE can either perform combined EPS/IMSI attach or EPS attach when attaching to E-UTRAN.
- **IMS PS Voice only:** the UE does not attempt combined EPS/IMSI attach (to support voice services) and perform IMS registration indicating support for voice.

A CSFB/IMS enabled UE may behave in either a 'Voice centric' or 'Data centric' way:

- UE acting in a '**Voice centric**' way always tries to ensure that Voice service is possible. A CSFB/IMS enabled UE acting in a 'Voice centric' way that cannot obtain IMS voice over PS session service, selects a cell of any RAT that provides access to the CS domain. In this case, when CSFB is not supported in the network, the UE camps only on RATs that provides access to the CS domain (e.g. GERAN and UTRAN) and disable E-UTRAN capability.

Upon receiving combined EPS/IMSI attach accept with 'SMS only' indication or with 'CSFB Not Preferred' indication, a voice centric UE that fails to use IMS reselects to another RAT.

- UE acting in a '**Data centric**' way always tries to ensure it gets PS data connectivity, e.g. the UE stays in the current RAT for PS data connectivity even when voice service is not obtained. A CSFB/IMS enabled UE acting in a 'Data centric' way that cannot obtain IMS voice over PS session service in EPS, continues to stay in EPS even when the EPS does not support CSFB.

Upon receiving combined EPS/IMSI attach accept with 'SMS only' indication, a data centric UE stays in the current RAT.

Upon receiving combined EPS/IMSI attach accept with 'CSFB Not Preferred' indication, a data centric stays in the current RAT and is allowed to use CSFB.

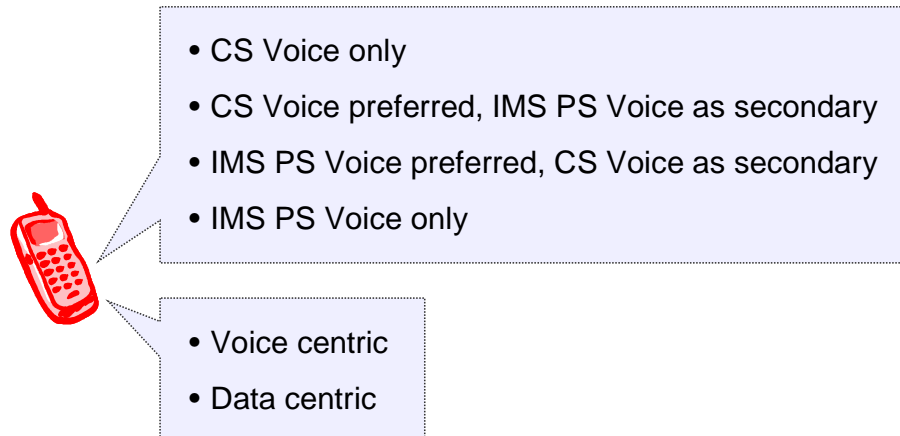


Figure 6 UE configuration (domain selection)

SMS over IP

If a UE is configured to use SMS over IP services it shall, if registered to IMS, send SMS over IMS, even if it is EPS/IMSI attached.

The home operator is able to activate/deactivate the UE configuration to use SMS over IP by means of device management in order to allow alignment with HPLMN support of SMS over IP.

Attach procedure

The attach procedure for the CS fallback and SMS over SGs in EPS is realized based on the combined GPRS/IMSI Attach procedure specified earlier for the Gs interface.

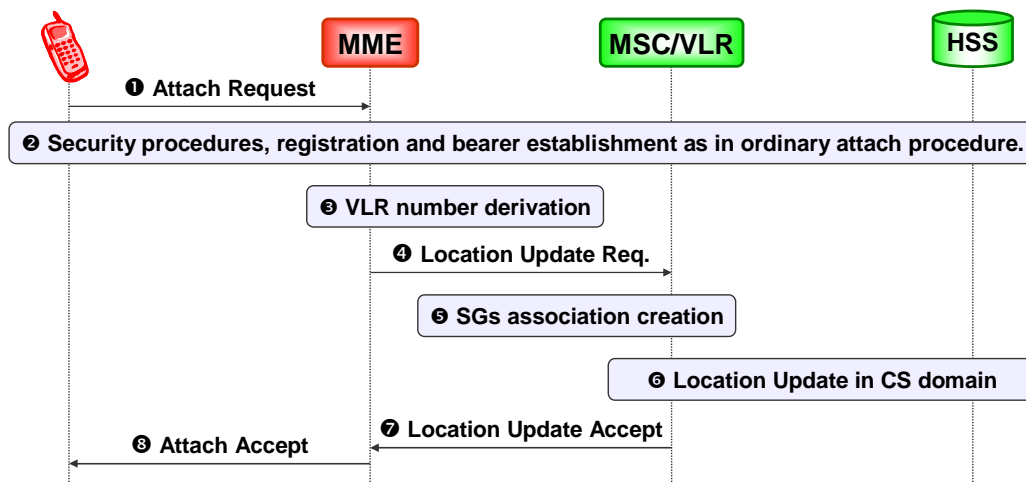


Figure 7 Attach procedure

- 1 The UE initiates the attach procedure by the transmission of an Attach Request. message to the MME. The Attach Type parameter indicates that the UE requests a combined EPS/IMSI attach and informs the network that the UE is capable and configured to use CS fallback. If the UE needs SMS service but not CSFB, the UE includes an 'SMS-only' indication.
- 2 Security procedures, registration and default bearer establishment as in ordinary EPS Attach procedure.
- 3 The MME allocates a default LAI, which is configured on the MME and may take into account the current TAI and/or E-CGI and whether the IMSI attach is for both CSFB and SMS, or for SMS only. The MME derives a VLR number based on the allocated LAI and IMSI. The MME starts the location update procedure towards the new MSC/VLR upon receipt of the subscriber data from the HSS in step 2.
- 4 The MME sends a Location Update Request (new LAI, IMSI, MME IP address, Location Update Type) message to the VLR.
- 5 The VLR creates an association with the MME by storing MME address.
- 6 The VLR performs Location Updating procedure in CS domain.
- 7 The VLR responds with Location Update Accept (TMSI) to the MME.
- 8 The EPS Attach procedure is completed. Attach Accept message includes LAI and TMSI. The existence of LAI and TMSI indicates successful attach to CS domain.

If the UE requests combined EPS/IMSI Attach Request without the 'SMS-only' indication, and if the network supports only SMS over SGs, the network performs the IMSI attach and the MME indicates in the Attach Accept message that the IMSI attach is for SMS only.

When the network accepts a combined EPS/IMSI attach without limiting to 'SMS-only', the network may provide a 'CSFB Not Preferred' indication to the UE.

TA/LA update procedure

The combined TA/LA Update procedure for the CSFB and SMS over SGs in EPS is realized based on the combined RA/LA Update procedure specified in earlier for the Gs interface.

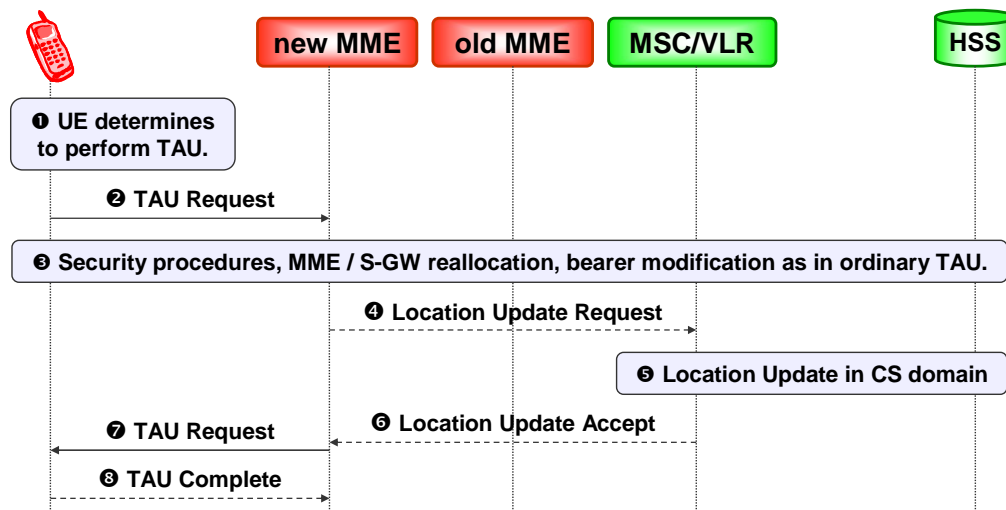


Figure 8 Combined TA/LA update

1 The UE detects a change to a new TA by discovering that its current TAI is not in the list of TAIs that the UE registered with the network.

2 The UE initiates the TAU procedure by sending a TAU Request. The Update Type indicates that this is a combined Tracking Area/Location Area Update Request or a combined Tracking Area/Location Area Update with IMSI attach Request. If the UE needs SMS service but not CSFB, the UE include an 'SMS-only' indication in the combined TA/LA Update procedure.

3 Security procedures, possible MME and S-GW reallocation and bearer modification as in ordinary EPS TAU procedure.

4 If there is an associated VLR in the MM context, the VLR also needs to be updated. If the association has to be established or if the LA changed, the new MME sends a Location Update Request (new LAI, IMSI, MME IP address, Location Update Type) message to the VLR. New LAI is determined in the MME based on the received GUTI from the UE. If this GUTI is mapped from a P-TMSI/RAI, the LAI is retrieved from the GUTI without any modification by the MME. Otherwise, the MME allocates a default LAI, which is configured on the MME and may take into account the current TAI or E-CGI and whether the IMSI attach is for both CSFB and SMS, or for SMS only. The MME retrieves the corresponding VLR number from the determined LAI. If multiple MSC/VLRs serve this LAI an IMSI is used to retrieve the VLR number for the LAI.. The Location Update Type indicates normal location update.

- ⑤ The VLR performs Location Update procedure in CS domain.
- ⑥ The VLR responds with Location Update Accept (TMSI) to the MME.
- ⑦ The MME sends a TAU Accept (LAI, TMSI) message to the UE. The TMSI is optional if the VLR has not changed. The presence of the LAI indicate to the UE that it is IMSI attached. If the UE requests combined TA/LA Update Request without the 'SMS-only' indication, and if the network supports SGs for SMS only, the network performs the IMSI attach and the MME indicates in the TAU Accept message that the IMSI attach is for SMS only.
- ⑧ The UE may send a TAU complete message for the TAU procedure if the LAI/TMSI has been changed.

Periodic TA/LA update procedure

When the UE is camped on E-UTRAN, periodic LA updates are not performed, but periodic TA updates are performed. In this case, an SGs association is established and the MSC/VLR disables implicit detach for EPS-attached UEs and instead rely on the MME to receive periodic TA updates.

Mobile originating call

The procedure for MT call is illustrated in Fig. 9.

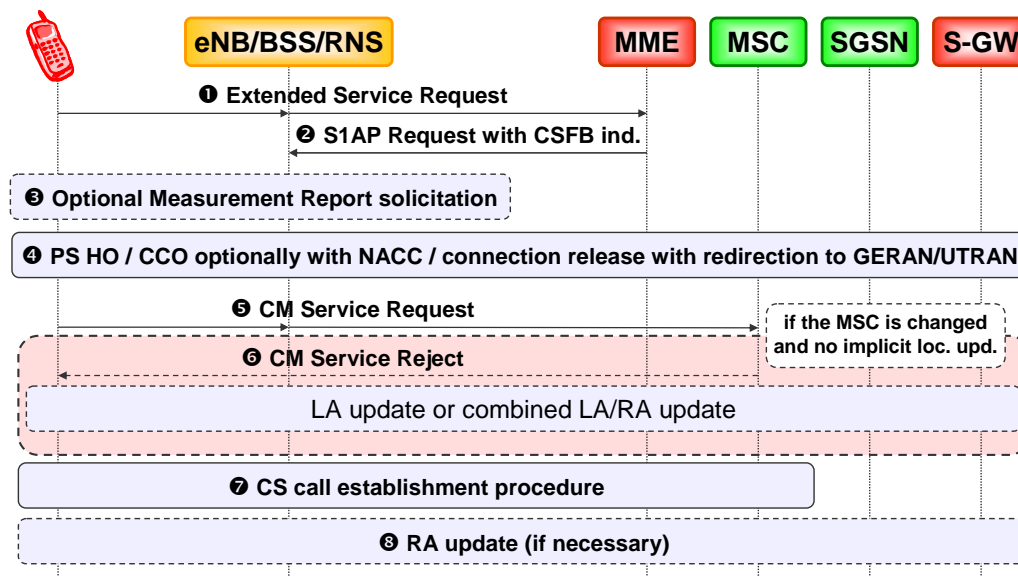


Figure 9 MO call

1 The UE sends an Extended Service Request (CS Fallback Indicator) to MME. CS Fallback Indicator indicates MME to perform CS Fallback. The UE only transmits this request if it is attached to CS domain (with a combined EPS/IMSI Attach) and can not initiate an IMS voice session (because e.g. the UE is not IMS registered or IMS voice services are not supported by the serving IP-CAN, home PLMN or UE).

2 The MME sends an S1-AP Request message to eNB that includes a CS Fallback indicator. This message indicates to the eNB that the UE should be moved to UTRAN/GERAN.

3 The eNB may optionally solicit a measurement report from the UE to determine the target GERAN/UTRAN cell to which PS handover will be performed.

4 If the UE and the network support inter-RAT handover from E-UTRAN to GERAN/UTRAN, the eNB triggers PS handover to a GERAN/UTRAN neighbour cell by sending a Handover Required message to the MME.

If the UE and the network support inter-RAT Cell Change Order (CCO) to GERAN and the target cell is GERAN, the eNB triggers an inter-RAT CCO (optionally with NACC).

If the UE or the network does not support inter-RAT handover from E-UTRAN to GERAN/UTRAN nor inter-RAT CCO, the eNB triggers connection release with redirection to GERAN/UTRAN instead of PS HO or COO.

⑤ The UE establishes CS signalling connection in the target RAT and sends CM Service Request message. The simultaneous support of packet data bearers depends on selected RAT and additional features like e.g. DTM.

⑥ In case the MSC serving the 2G/3G target cell is different from the MSC that served the UE while camped on E-UTRAN, the MSC rejects the service request, if implicit location update is not performed. The CM Service Reject triggers the UE to perform a Location Area Update as follows:

- If the target system operates in Network Mode of Operation (NMO) I the UE performs a combined RA/LA update. In this case, the SGSN establishes a Gs association with the MSC/VLR, which replaces the SGs association with the MME.
- If the target system operates in NMO II or III the UE performs a LA update towards the MSC. In this case, the MSC releases the SGs association with the MME.

⑦ The UE initiates the CS call establishment procedure.

⑧ The UE may trigger the RA update procedure when the sending of uplink packet data is possible.

Mobile Terminating Call

The procedure for MT call is illustrated in Fig. 10.

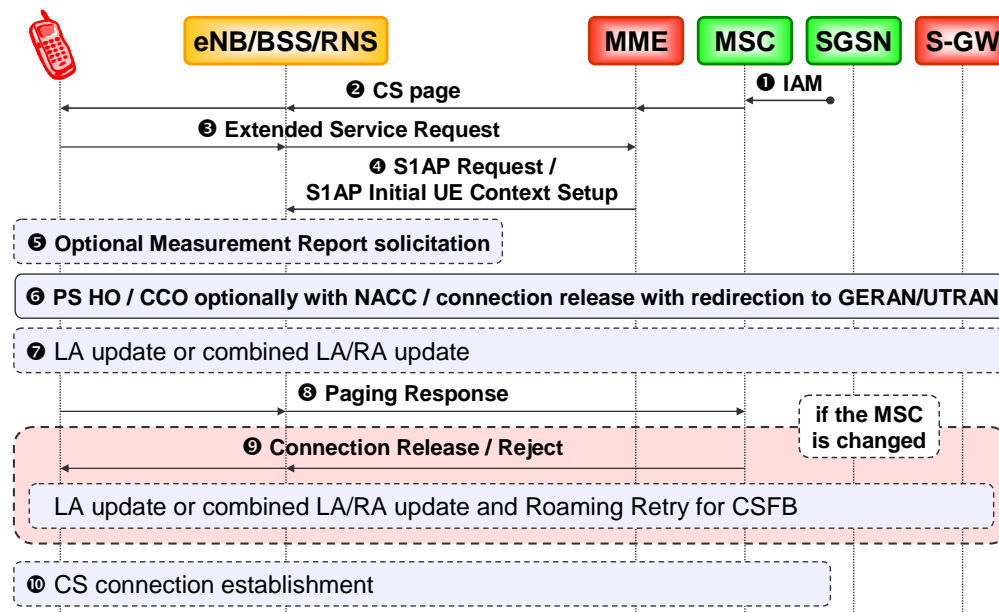


Figure 10 MT call

❶ The MSC receives an incoming voice call.

❷ The MME receives a CS Paging (IMSI, VLR TMSI, Location Information, optional Caller Line Identification) message from the MSC over a SGs interface. The TMSI (or IMSI) received from the MSC is used by the MME to find the S-TMSI which is used as the paging address on the radio interface.

If the UE is in Idle mode the MME pages the UE in all the TAs, the UE is registered to.¹

In active mode the MME reuses the existing connection to relay the CS Page to the UE.

The eNB forwards the paging message to the UE. The message contains a suitable UE Identity (i.e. S-TMSI or IMSI) and a CN Domain indicator and Caller Line Identification if available and needed.

❸ The UE establishes an RRC connection or reuses the existing connection to send an Extended Service Request (CS Fallback Indicator, Reject or Accept) to MME.

¹ This procedure takes place before step ❶, immediately after MSC receives MAP_PRN from HSS, if pre-paging is deployed.

④ MME sends S1AP Initial UE Context Setup or S1AP Request message to eNB that includes CSFB indicator. This message indicates to the eNB that the UE should be moved to UTRAN/GERAN.

⑤ The eNB may optionally solicit a measurement report from the UE to determine the target GERAN/UTRAN cell to which PS handover will be performed.

⑥ If the UE and the network support inter-RAT handover from E-UTRAN to GERAN/UTRAN, the eNB triggers PS handover to a GERAN/UTRAN neighbour cell by sending a Handover Required message to the MME.

If the UE and network support inter-RAT Cell Change Order (CCO) to GERAN and the target cell is GERAN, the eNB triggers an inter-RAT CCO (optionally with NACC).

If the UE or the network does not support inter-RAT handover from E-UTRAN to GERAN/UTRAN nor inter-RAT CCO, the eNB triggers connection release with redirection to GERAN/UTRAN instead of PS HO or COO.

⑦ If the UE obtains LA/RA information of the new UTRAN/GERAN cell (e.g. based on the system information or redirection info) and the LA/RA of the new cell is different from the one stored in the UE, it performs a Location Area Update or a Combined RA/LA procedure if the target system operates in NMO I

⑧ The UE establishes CS signalling connection in the target RAT and sends Paging Response message². The simultaneous support of packet data bearers depends on selected RAT and additional features like e.g. DTM.

⑨ If the MSC that receives the Paging Response is different from the MSC that sent the paging request and if the Location Area Update / Combined RA/LA Update was not performed in step ⑦, the MSC rejects the page response by releasing the A/Iu-cs connection. The BSC/RNC in turn releases the signalling connection for CS domain. The signalling connection release triggers the UE to perform a LA update or Combined RA/LA update.

The LA update triggers the Roaming Retry for CS Fallback procedure, described in the next section.

⑩ In case the MSC serving the 2G/3G cell is the same as the MSC that served the UE while camped on LTE, it shall stop the paging response timer and establish the CS connection.

² MSC should be prepared to receive a paging response after a relatively long time from when the CS Paging was sent. The BSS should be prepared to receive a Paging Response even when the corresponding Paging Request has not been sent by this BSS.

MT Roaming Retry Call

MT Roaming Retry Call applies to a MT call while the called mobile is simultaneously moving from an old to a new MSC, if the GMSC, the HLR and the old terminating VMSC support the MT Roaming Retry procedure.

In that case, upon receipt of an ISUP IAM message which was preceded by a MAP Cancel Location procedure, the old VMSC instructs the GMSC to resume terminating call procedure by sending a MAP Resume Call Handling (RCH) message. The GMSC then releases the ISUP connection to the old VMSC, terminate any open CAP dialogue, and retry the terminating call setup towards the new MSC by sending an additional SRI to the HLR. This second SRI request leads to obtaining a roaming number from the new MSC towards which the call can then be delivered (possibly after new CAMEL interactions).

The similar procedure is used for Roaming Retry for CS fallback. There are only two differences in this procedure compared to the Mobile Terminating Roaming Retry Call procedure described earlier. The first difference is that the paging message triggers the CS fallback including a location update in the new RAT. This functionality is already supported in the CS fallback flows for terminating calls and no additional functionality is needed. The second difference is that the UE may send a page response message after receiving Location Update Accept message. The new MSC ignores or rejects the page response message.

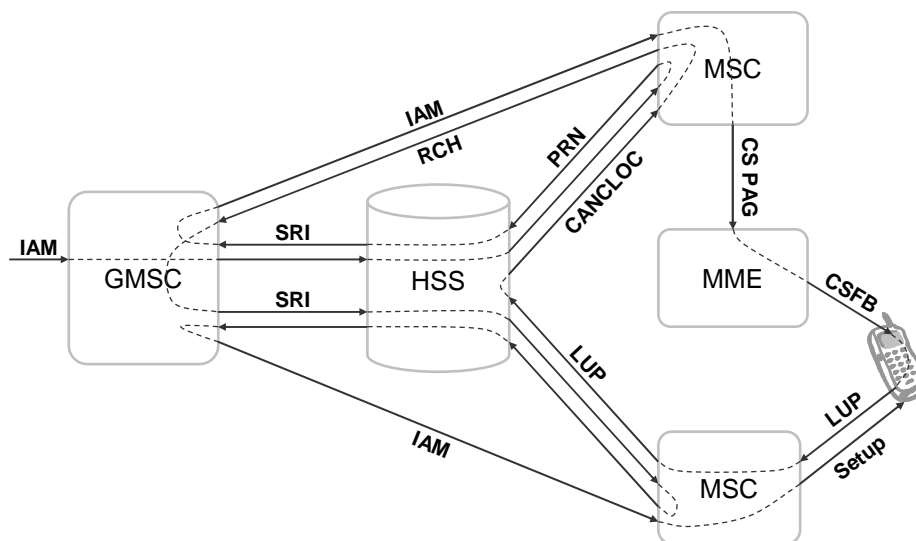


Figure 11 Roaming Retry for CS fallback

SMS

The procedures for SMS over SGs apply only if the UE is EPS/IMSI attached and the CS access domain is chosen by the UE and/or the home PLMN for delivering short messages.

SMS support is based on SGs interface between the MME and the MSC Server and use of NAS signalling between the UE and the MME, i.e. no CS Fallback is performed for SMS.

The SMS protocol entities are reused from the existing MS/UE and MSC 2G/3G implementations.

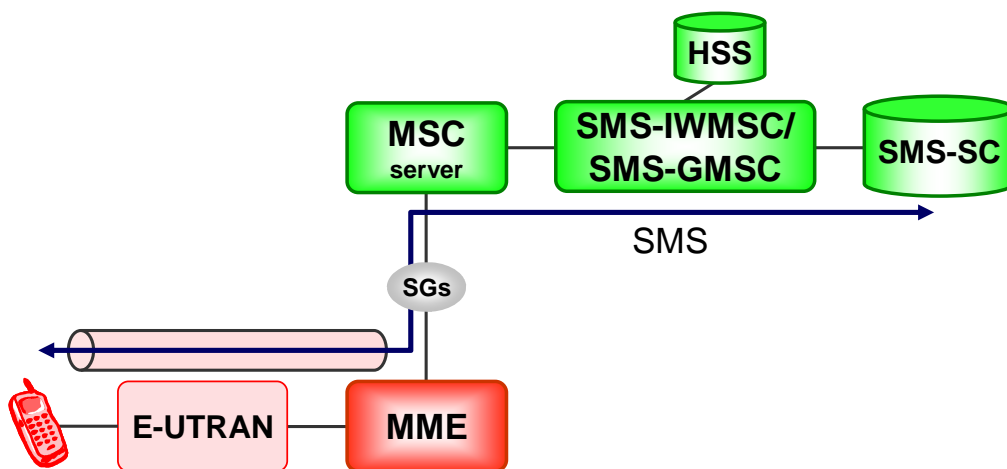


Figure 12 SMS over SGs

Acronyms and Abbreviations

3G	3-rd Generation
3GPP	3rd Generation Partnership Project
AES	Advanced Encryption Standard
CBC	Cipher Block Chaining
CEK	Content Encryption Key
CTR	Counter
DCF	DRM Content Format
DMP	Discrete Media Profile
DRM	Digital Rights Management
EMS	Element Management System
GPRS	General Packet Radio Service
HTTP	Hypertext Transfer Protocol
IP	Internet Protocol
IRDA	Infrared Data Association
ISO	International Organization for Standardization
MIME	Multipurpose Internet Mail Extensions
MMS	Multimedia Messaging Service
OBEX	Object Exchange
ODRL	Open Digital Rights Language
OMA	Open Mobile Alliance
PDA	Personal Digital Assistant
PDCF	Packetized DRM Content Format
PKI	Public Key Infrastructur
PSS	Packet Streaming Service
REL	Rights Expression Language
ROAP	Rights Object Acquisition Protocol
RTSP	Real Time Streaming Protocol
SDP	Session Description Protocol
SMS	Short Message Service
URI	Uniform Resource Identifier
USB	Universal Serial Bus
WAP	Wireless Application Protocol

References

This section contains the locations of various specifications, document references and useful information where you can learn more about this subject.

- [1] 23.272 Circuit Switched (CS) fallback in Evolved Packet System (EPS); Stage 2
- [2] 23.221 Architectural requirements
- [3] 24.301 Non-Access-Stratum (NAS) protocol for Evolved Packet System (EPS); Stage 3

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