
Subscriber Services

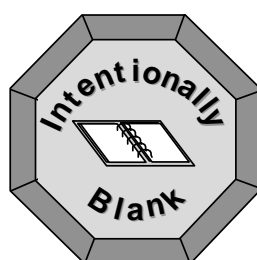
Chapter 14

This chapter is designed to provide the student with an overview of the signaling related to subscriber services.

OBJECTIVES:

Upon completion of this chapter the student will be able to:

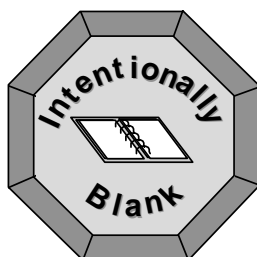
- identify the protocols used for supplementary service signaling.
- give examples of how an active supplementary service may affect call handling.
- describe how non-GSM defined supplementary services can be managed by the mobile subscriber.
- describe the advantages and basic usage of the CAMEL Phase 1 network feature.



14 Subscriber Services

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INTRODUCTION

In GSM it is possible for the subscribers to check and modify the parameters and status of their Supplementary Services (SS). For example, some services like call barring can be activated/deactivated at the subscriber's request. In addition, when call forwarding is used, the subscriber can check the forwarded-to number.

The subscriber controls supplementary services via the MS, by performing a Man Machine Interface (MMI) procedure. According to GSM specification 02.30, this can be done in two ways. First, by entering a sequence of digits 0-9 mixed with * and #, or second, by using dedicated keys or menu procedures if the manufacturer has provided the MS with enhanced MMI capabilities.

It is not only GSM defined supplementary services that can be managed by the subscriber. The Unstructured Supplementary Service Data (USSD) feature enables the mobile subscriber to invoke and control supplementary services defined by the operator. This is described in the USSD section of this chapter.

SS signaling procedures can be initiated not only by an MS in idle mode but also when the MS is in active state.

The part of the SS signaling described above concerns the state of the service (registration, deregistration, activation, deactivation, interrogation, etc.). Another aspect of SS related signaling is the influence an active supplementary service has on call handling. For example, an active supplementary service can cause variations in the call establishment procedure.

In many cases, the only nodes involved in SS management signaling are the MS and the HLR. The MSC/VLR acts as a relay on the signaling path between the MS and the HLR. When SS information in the HLR changes, the HLR is responsible for updating the MSC/VLR to keep it in line with the service state in the HLR.

Active SS handling can be carried out on the local level for the MSC/VLR. One example is "barring of outgoing calls" service. Mobile subscribers have information about whether this service is activated/deactivated in the VLR. A Setup message from the MS to MSC/VLR is followed by a Release Complete message from MSC/VLR to MS. In this case, all the necessary checking

of SS data is performed in the VLR and the HLR is not involved.

SS MANAGEMENT

No matter which MMI procedure is used by the subscriber for SS management, the MS generates signaling messages to be sent over the air. The network may respond with a message containing acknowledgment or error information. These messages exchanged over the radio interface can be divided into two categories:

- Separate Message Category
- Common Information Element Category.

See Figure 14-1.

Separate Message Category	Common Information Element Category
Hold Hold Acknowledge Hold Reject Retrieve Retrieve Acknowledge Retrieve Reject	Register Facility Setup Alerting Connect Disconnect Release Release Complete Call Proceeding

Figure 14-1 Message categories.

The messages in the Separate Message Category are used during the active phase of a call for request, acknowledgment and rejection of specific procedures (putting calls on hold and retrieving them). These messages have a fixed meaning and content, without any variable Information Elements (IEs). The Hold/Retrieve procedures are performed in the MSC/VLR, therefore these messages do not carry any information for the HLR.

All of the messages in the Common Information Message Category have an information element called “facility” (not to be confused with the Facility message). The content of the facility IE depends on the supplementary service. It includes an operation code and parameters indicating the desired SS

procedure.

Operation used for call independent SS
RegisterSS EraseSS ActivateSS DecativateSS InterrogateSS RegisterPassword GetPassword ForwardCheckSS-Indication ProcessUnstructedSS-Request UnstructedSS-Request UnstructedSS-Notify ProcessUnstructedSS-Data
Operation used for call related SS
ProcessUnstructedSS-Data ForwardChargeAdvice NotifySS ForwardCUG-Info BuildMPTY HoldMPTY RetrieveMPTY SplitMPTY

Figure 14-2 SS-operations.

During communication between the MS and the HLR for example, at activation of call forwarding unconditional, a MAP like protocol is used.

It differentiates from the MAP protocol in that one of the peers (the MS) is not directly connected to the SS7 network. Between the MS and MSC/VLR, the MAP content of signaling is transferred in CM messages belonging to the common information element category. From MSC/VLR to HLR the information is sent in MAP messages, supported by TCAP and the other protocols in the SS7 protocol stack.

The MSC/VLR performs necessary mapping between the CM and MAP protocols.

If the MS is idle when the subscriber initiates the SS management procedure, there is no existing signaling connection. In this case such a connection must be established exclusively for the supplementary services management procedure. This process is referred to as call independent, or

non-call related SS management. If the MS is already involved in a call, a signaling connection exists and is used for the message transfer. This is denoted by call related supplementary services management. Figure 14-2 shows the relationship between operations and call related/call independent SS management.

CALL INDEPENDENT SS MANAGEMENT

The MMI procedures performed by the mobile user are supported by the layer 3 signaling between the MS and the MSC/VLR. For call independent supplementary services management, mapping between the MMI procedures and a SS control entity exists in the CM sublayer of layer 3. The SS entity starts by creating a MM connection to its peer, as described in chapter 6 “Um Interface”. Three messages from the common information element category can be sent on this MM connection. They are:

- Register
- Facility
- Release Complete

These messages are standard layer 3 messages with a general format as shown in chapter 6 “Um Interface”. A special SS-Protocol Discriminator is used (PD-value = 1011).

All three have a facility IE. This element carries a request for or acknowledgment of an SS operation according to Figure 14-2 (call independent SS).

First a Register message is sent to assign a new transaction identifier to the signaling procedure.

Then there can be an exchange of Facility messages.

Finally a Release Complete message is sent to release the transaction identifier.

A description of the message content, and examples of call independent SS signaling procedures is located in the GSM specifications 04.10 and 04.80

CALL RELATED SS-MANAGEMENT

At the establishment or clearing of a call, SS related information can be exchanged because many of the messages in the CC protocol carry a facility IE. That is, those messages belong to the common information element category. For example, a subscriber may send a Setup message with a facility IE containing a request for a SS procedure and receive an acknowledgment in the facility IE of the Alerting, Connect or any other appropriate message.

During the active state of a call, the Facility message is used for transfer of facility IEs.

In this state, messages belonging to the Separate Message Category can also be used to perform Call Hold/Retrieve procedures.

This means that in a call related case, the SS information is carried in CC messages sent between CC peer entities and using the CC Protocol Discriminator (PD-value = 0011).

MAPPING IN MSC/VLR

At reception of supplementary services signaling on the A-interface, the MSC/VLR requests, if necessary, access to the HLR over the D-interface and performs mapping between layer 3 messages on the radio path and TCAP messages as shown in Figure 14-3 and Figure 14-4.

Layer 3 radio path message	TCAP
Register Facility Release Complete	Begin Continue End

Figure 14-3 A- to D- interface mapping in MSC/VLR.

TCAP	Layer 3 radio path message
Begin Continue End Abort	Register Facility/Register Release Complete/Register Release Complete

Figure 14-4 D- to A- interface mapping in MSC/VLR.

The SS operation code and parameters are transferred between the facility IE in the CM message and the component portion of the TCAP message. Influence on call handling by active SS.

The following section on Call Forwarding provides an example of how active supplementary services affects call handling.

CALL FORWARDING

If Call Forwarding is activated, it affects the routing of incoming calls to the mobile subscriber.

Call Forwarding unconditional means that the HLR, knowing the status of the supplementary service, can perform the forwarding by returning the C-number when the GMSC asks for routing information.

Call Forwarding on busy means that the call must be sent to the serving MSC/VLR. If a check in the VLR indicates that the mobile subscriber is busy, the MSC/VLR performs Call Forwarding.

Call Forwarding on no reply always means that the forwarding is performed by the serving MSC/VLR because the MS has been successfully paged but there is no answer within a time set by the subscriber at activation. In this case, the call must also be sent to the serving MSC/VLR.

Call forwarding on not reachable affects the routing in different ways depending on how the information that the mobile subscriber is not reachable is obtained. Sometimes the HLR knows this and can perform the forwarding. In other cases, this information can only be obtained after an effective (and unsuccessful) paging attempt over the air. For example at a temporary loss of coverage for an attached and fully registered mobile station. In this case, the call must be sent to the serving MSC/VLR which then performs the forwarding.

DEFAULT CALL FORWARDING

The purpose of Default Call Forwarding (DCF) is to provide the mobile subscribers with a default forward-to number which is registered in HLR by the operator.

This optional feature in Ericsson's GSM system simplifies the call forwarding mechanism to for example, the voice mail system. Without DCF, the GSM call offering supplementary services must be used. This means that the C-number must be changed by the subscriber. This is done explicitly or by dialing a short code any time the subscriber alternates between the voice mail service and his/her ordinary C-number.

Invocation of default call forwarding is executed if no call offering service or single personal number has been invoked for the call (and default call forwarding is active).

The forwarding is done on one or more of the conditions "not reachable", "busy" and "no reply". It can be specified by the operator per basic service group. It is therefore possible to differentiate the conditional forwarding (on subscriber status) between for example voice mail and fax mail. The default forward-to number can be registered by the operator only.

An announcement including the cause for the re-routing is given to the calling subscriber when applicable or suppressed at call forwarding.

USSD

Unstructured Supplementary Service Data (USSD) is an optional feature in Ericsson's GSM system.

GENERAL

USSD enables a mobile user to invoke and control supplementary services, that are:

- not supported by the subscribers mobile equipment, that is, the needed functionality (for example, signaling) is not implemented in the mobile.
- non-GSM supplementary services for which no functional signaling is defined.

Unidentified MMI input from the mobile subscriber is transported to a USSD application on the network side that can analyze and act on the unstructured data. Transparent transport through the network is possible through a container mechanism provided by the protocol.

The USSD application is the function that performs the actual service operation and can reside in the MSC/VLR and/or the HLR.

The Transparent Transfer to/from an External Node (TTEN) application resides in the HLR and allows the MS to operate services in other nodes than the ones specified by GSM. See Figure 14-5. In the external nodes, the subscriber can for example, interrogate service data for specific services or register, erase, activate, or deactivate services.

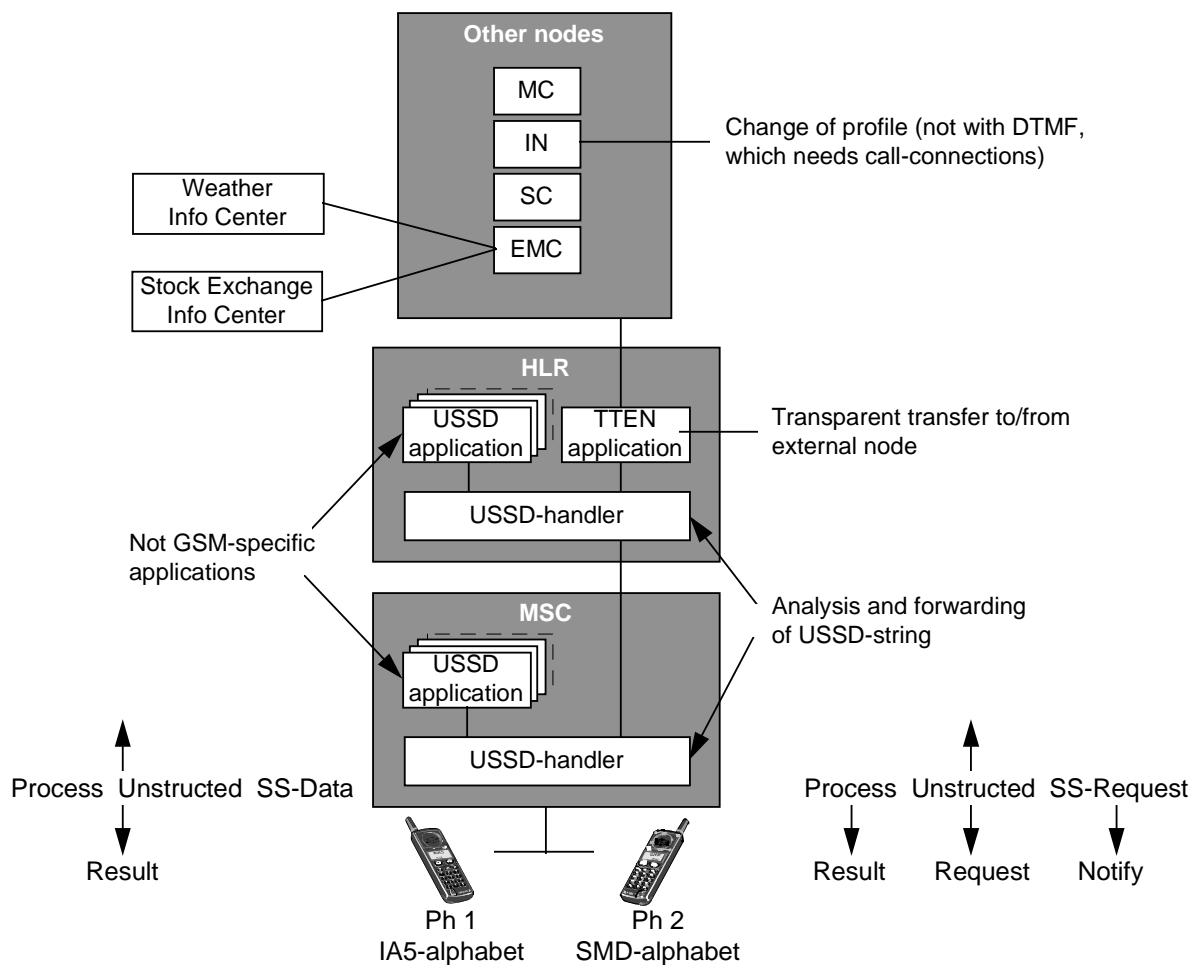


Figure 14-5 USSD overview.

These kinds of supplementary services can be offered to all subscribers independently of mobile equipment (provided USSD is supported). Operators can offer their subscribers services as USSD applications rather than GSM specified services that also need terminal support.

USSD can be used by Ericsson built applications in the MSC/VLR and/or HLR. The operator can by command allocate the service code or procedure code (see USSD string) to an application. That is, the operator decides how for example, the invocation of a feature is to be carried out. (for example, *33#).

USSD may be used from the MS to the network or from the network to the MS. Both GSM phase 1 and GSM phase 2 USSD is supported. Network initiated USSD is however only supported in the GSM phase 2 specifications.

Indication of tariff area to MS, is one application that requires support from USSD.

MS INITIATED USSD OPERATIONS

These operations are initiated by the MS as soon as the MS user enters an unidentified MMI string. They allow the MS user to send the string in a transparent way to an application in the network.

MS initiated USSD operations are defined for:

- MAP 1 (ProcessUnstructuredSS-Data) as well as - MAP2 (ProcessUnstructuredSS-Request), see Figure 14-2.

NETWORK INITIATED USSD OPERATIONS

These operations can be initiated by an application resident for example, in MSC/VLR or HLR, and allow the application to:

- provide a mobile subscriber with information (Unstructured SS-Notify)
- request information from the mobile subscriber (Unstructured SS-Request), see Figure 14-2

Network initiated USSD operations are only defined for MAP2.

USSD STRING

The USSD string formats recognized by the USSD handler are:

a) dXc#, where:

d = 1, 2 or 3 characters of the set (*, #)

X = 2 or 3 decimal characters of the set (0-9) (X is known as the Service Code)

c = * followed by characters from the used alphabet (c is optional)

b) Y, where:

Y = 1 or 2 decimal characters of the set (0-9) (Y is known as the procedure code)

This string together with the IMSI, and for MAP2 the data coding scheme, is what the USSD handler needs to determine the application invoked by the mobile initiated USSD request.

USSD HANDLER

The USSD handler, see Figure 14-5, is in charge of:

- analyzing the syntax of the operations and protocol rules
- identifying the USSD application for incoming mobile initiated USSD operations
- forwarding the USSD string (and data coding scheme in case of MAP2) unmodified to and from an application
- generating an abort, error component or reject component upon an indication received from the USSD application

CAMEL

GSM networks have always included Intelligent Network (IN) functions. This has allowed for creating, controlling, and porting services. Roaming subscribers now have access to their full portfolio of IN services through the new Customized Applications for Mobile Enhanced Logic (CAMEL) mechanism in GSM Phase 2+. For the time being, the ETSI Special Mobile Group has specified CAMEL Phase 1 which is referred to in this Chapter as simply CAMEL.

GENERAL

CAMEL is a network feature and not a supplementary service. It is a tool to help the network operator provide the subscribers with the operator specific services even when roaming outside the Home PLMN (HPLMN). This means that service providers can create and deploy services using standard network building blocks, and that roaming subscribers' home networks can remotely control services in the visited network.

With the implementation of the GSM Phase 2+ feature Optimal Routing a distinction is done between Home and Interrogating PLMN. An Interrogating PLMN (IPLMN) is the PLMN, which interrogates the HPLMN of the called party. The IPLMN is always the HPLMN when Optimal Routing is not used. The relationship between the two and the Visiting PLMN (VPLMN) is shown in Figure 14-6.

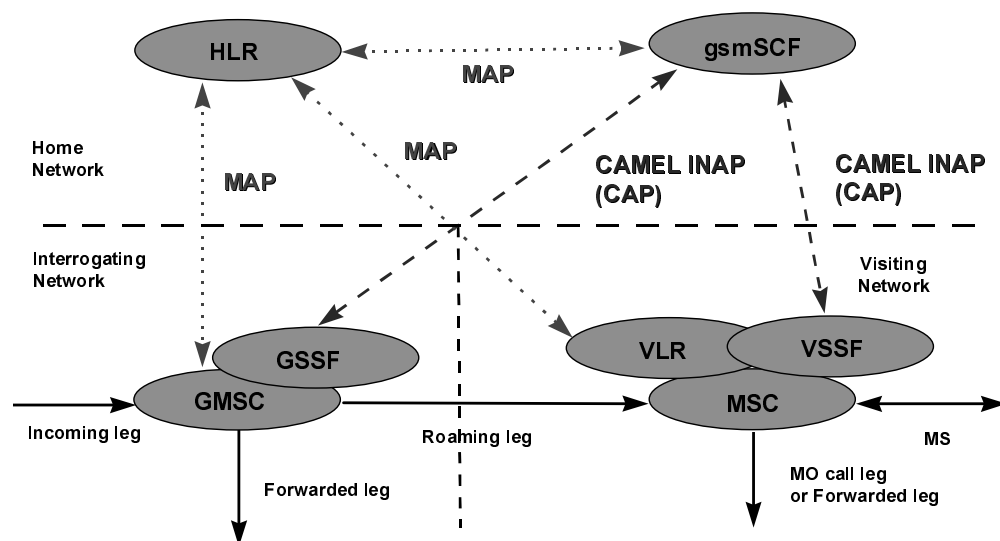


Figure 14-6 CAMEL network architecture.

The operator specific services are implemented using IN principles, whereby CAMEL provides the mechanisms necessary for integrating GSM and IN functional entities, including support for roaming.

This is achieved by routing calls via an integrated Service Switching Function in the GMSC and MSC/VLR to a GSM-specific Service Control Function. See Figure 14-6. GSM Service Switching Function (gsmSSF) is a functional entity that interfaces the MSC/GMSC to the GSM Service Control Function (gsmSCF). The gsmSCF contains the CAMEL service logic to implement operator specific services and is specified as part of the HPLMN. The concept of the gsmSSF is derived from the IN SSF, but uses different triggering mechanisms because of the nature of the mobile network. This functionality is integrated in the MSCs in the VPLMN or IPLMN. Communication between gsmSSF and gsmSCF is provided by the CAP protocol (CAMEL Intelligent Network Application Part).

In its first phase CAMEL supports :

- mobile originated and forwarded calls
- mobile terminating calls
- suppression of announcements
- any time interrogation

FUNCTIONALITY

CAMEL applies to all circuit switched basic services, except emergency calls. When this feature is supported in GMSC, the GMSC may receive an Originating or Terminating CAMEL Subscription Information (O/T-CSI), or both, from the HLR as part of the terminating call handling. In MSC/VLR the Originating CAMEL Subscription Information (O-CSI) is received as part of the subscriber data sent from HLR in the location update.

The presence of an O-CSI or T-CSI indicates that an instance of the gsmSSF, which is integrated with the MSC/GMSC, is to be invoked. An O/T-CSI contains the address of the gsmSCF containing the service logic, a service key which is sent transparently to the gsmSCF and a default call handling parameter indicating the required handling in case an error occurs in the communication between the gsmSSF and the gsmSCF.

The O-CSI is used when an originating CAMEL service is to be invoked on an outgoing call leg, that is for mobile originated calls and forwarded calls. Since calls can be forwarded in both GMSC and MSC/VLR, originating CAMEL services may be invoked from the MSC/VLR as well as the GMSC.

The T-CSI is used when a terminating CAMEL service is to be invoked in the GMSC for an incoming call. The terminating CAMEL service in the GMSC may be followed by a call forwarding and an originating CAMEL service.

Additionally the suppression of announcements is supported in the GMSC and in the MSC/VLR. This function is used when services are invoked for the terminating calls and it enables a CAMEL service logic to indicate that all announcements (and tones) which may be played in the GMSC or the MSC/VLR in case of unsuccessful call set-up shall be suppressed.

The HLR provides an interface towards the gsmSCF for the Any Time Interrogation feature. When this feature is supported the gsmSCF may request the Subscriber State and Location Information for a certain mobile subscriber. The feature offers certain service advantages, some of which have been listed below :

- Decisions based on the called MS location facilitate offering different types of tariffs depending on the location of the called MS. Or, for instance, someone who does not want to be disturbed while at home/work. To be used in the following services:
 - Economy Call Area
 - Location Dependent Screening
- Decisions based on the called MS status for a more effective routing of calls. This also saves transmission since the call is not set-up when the called MS is busy or not reachable. To be used in the following services:
 - Personal Number
 - Virtual Private Network
- Routing of calls to the nearest available mobile and fixed subscriber. To be used in the following service:
 - Universal Access Number
- Retrieving (monitoring) MS status or location. To be used in the following service:

- Call Completion Services

SUBSCRIBER AND OPERATOR BENEFITS

CAMEL enables the subscriber to use a number of non-standardized (operator specific) services provided by the HPLMN, both whilst within the HPLMN and when roaming outside the HPLMN. Some examples of services possible with CAMEL include:

- **Private Numbering Plan** - For example including abbreviated dialing for such services as Friends&Family.
- **Incoming Call Screening** - Calls to a B-subscriber can be screened according to certain conditions (e.g. A-subscriber number, B-subscriber location, etc).
- **Location and Time Dependent Routing** - Calls to or from a subscriber are routed according to location and/or time of the day.
- **Outgoing Call Restrictions**
- **Simple prepaid service**

An example of a potential service based on Location Dependent Routing is shown in Figure 14-7. This feature provides the possibility in the MSC/VLR to associate geographical coordinates with the cell identity or location area (where the subscriber is registered). The geographical coordinates are transferred to the gsmSCF as the location information.

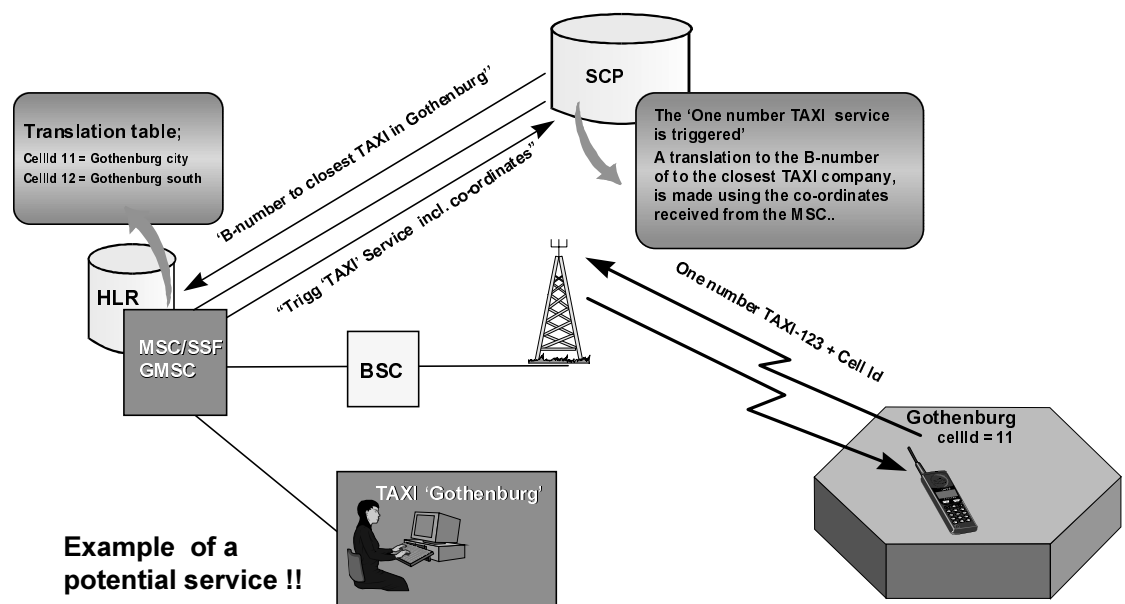


Figure 14-7 Geographical Coordinates in MSC/VLR (example of a potential service).

CAMEL can be used to provide operator specific services not provided by competing operators, thus allowing an excellent service differentiation capability. This enables operators to target certain market segments with tailored service offerings, and attract new customers.

Fraud prevention services can be introduced giving the operator greater supervision (the HPLMN is 'informed' when a subscribers attempts a call) and control capabilities (for example, flexible operator determined barring), importantly also whilst subscribers are roaming in foreign networks.

CAMEL also allows operator specific services to be provided in a multivendor network, as interfaces and protocols have been clearly defined between all functional entities included. For example, the interface between MSC/gsmSSF and gsmSCF.

Operators implementing CAMEL in their networks become more attractive to be selected as roaming partners, thereby attracting high revenue roaming traffic, as the operator specific services provided to subscribers in the HPLMN also function in the visited PLMN.

EXTENDED CAMEL

This feature is an Ericsson innovative extension to the CAMEL standard in a CAMEL network architecture. It thus allows, in a standardized manner, the use of existing high functional IN capabilities available today whilst the subscriber is within the HPLMN.

It is also possible to route calls using this feature (from the (G)MSC) to an external node). This external node can be a Service Switching Point (SSP) or a Service Node.

The subscriber will be able to use more advanced services than those possible in networks supporting only CAMEL while in the HPLMN. It is possible for the subscriber to have seamless services, with a higher level of functionality in the HPLMN than when in the VPLMN. For example, the numbering plan of a high functional Virtual Private Network could be kept whilst roaming whereas the overall functionality available in the VPLMN will be reduced.

The operator can offer advanced operator specific services based on the full IN capabilities.

Since this feature is provided with only minor additions to the CAMEL protocol, the functionality provided by this feature is based on standard open interfaces where so far only manufacturer proprietary solutions have been available. By default, this also leads to a harmonization of subscriber data handling in the HLR.

By means of the external routing (e.g. to MSC/SSF) functionality provided by this feature, it is possible to provide services in a multivendor switching system network environment. An interworking agreement is necessary between Ericsson and the other switching system vendor(s) present in the network.

COMPATIBILITY

The CAMEL feature requires MAP V3 implementation which offers better support for vendor specific services. The use of MAP V3 for vendor specific services is recommended, since the new version of MAP is especially designed to minimize the risk for interference between different vendor specific services.

Whatever the future holds for GSM, services must be evolved and gradually enhanced in a backwards-compatible way so that subscribers do not need to sacrifice existing services and functionality in order to enjoy the new ones. Where possible, subscribers provisioned with services using the CAMEL feature shall not be provisioned with GSM services having an adverse interaction with the CAMEL based services. GSM supplementary services shall not have any knowledge of CAMEL based services.

Call independent supplementary service operations (registration, erasure, activation, deactivation and interrogation) are not modified by CAMEL.

The ETSI Special Mobile Group has already started the specification of CAMEL Phase 2.