GSM MSC/VLR OPERATION

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ERICSSON

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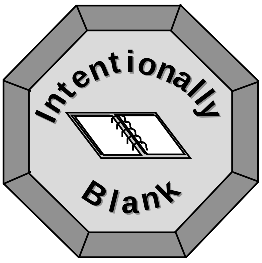
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GSM MSC/VLR Operation

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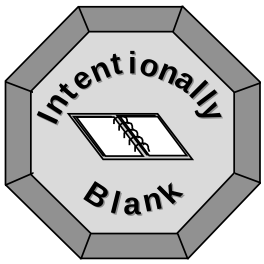
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Introduction

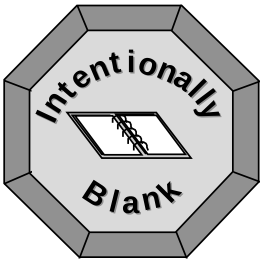
Chapter 1

This chapter is designed to provide the student with an overview of Ericsson's GSM System.

OBJECTIVES:

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

- Describe the main parts of Ericsson's GSM network
- Explain and list the GSM identities and briefly describe the function of each
- List the main AMs of Ericsson's MSC/VLR and identify their functions
- Explain why several MAP versions exist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1 Introduction

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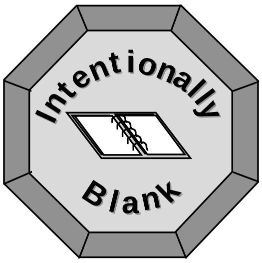
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ERICSSON'S GSM SYSTEM NETWORK

The CME 20 system is Ericsson's implementation of the Global System for Mobile Communication (GSM), encompassing GSM 900 and GSM 1800. GSM is also defined as a GSM 1900 standard for the North American market and Ericsson implements this system with CMS 40.

Due to similarities between the CME 20 system and the CMS 40 system, this manual combines the information regarding both. Throughout this manual, both Ericsson GSM Systems are referred to as the system. Where CME 20 and CMS 40 differ, it is specifically stated. In this manual, CCITT Signaling System No. 7 and ANSI Signaling System 7 are referred to as S7, if common functions of both signaling systems are described.

Figure 1-1 shows an overview of all network nodes within the system network for a mobile terminating call. Also included is an overview of the GPRS (General Packet Radio Service) nodes that, at R8.0, can now interface towards the GSM networks. GPRS is a standardized packet-switched data service for GSM based systems. The introduction of GPRS and its impact on MSC/VLR and HLR will be explained in *Appendix B.*

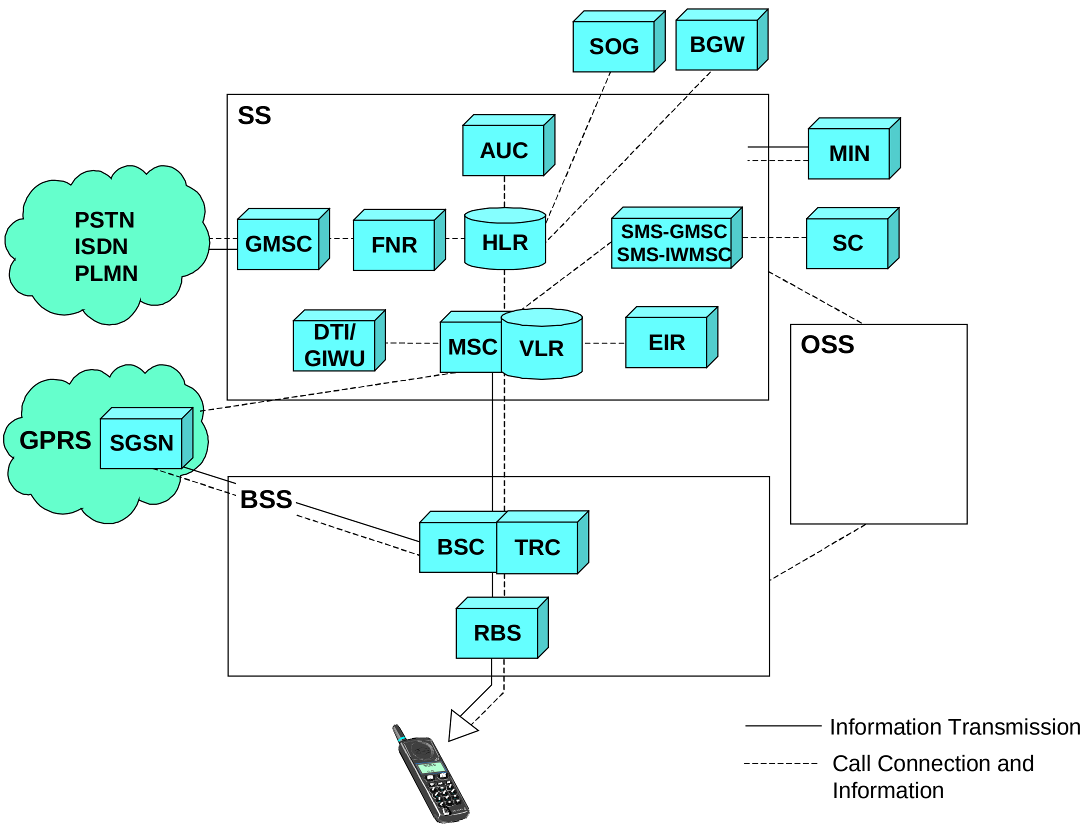


Figure 1-1 Ericsson's GSM System Model

The system contains the following components:

- Base Station System (BSS)
  - Radio Base Station (RBS)
  - Base Station Controller (BSC)
  - TRanscoder Controller (TRC)
- Switching System (SS)
  - Mobile services Switching Center (MSC)
  - Gateway MSC (GMSC)
  - Visitor Location Register (VLR)
  - Home Location Register (HLR)
  - Flexible Number Register (FNR)
  - Authentication Center (AUC)
  - Equipment Identity Register (EIR)
  - Data Transmission Interworking unit (DTI) / GSM InterWorking Unit (GIWU)
  - Short Message Service - Gateway MSC (SMS-GMSC)
  - Short Message Service - InterWorking MSC (SMS-IWMSC)
- Operation and Support System (OSS)
- General Packet Radio Service (GPRS)
  - Serving GPRS Support Node (SGSN)
  - Gateway GPRS Support Node (GGSN)
- Additional items possibly connected:
  - Mobile Intelligent Network (MIN)
  - Service Center (SC)
  - Billing Gateway (BGW)
  - Service Order Gateway (SOG)

NETWORK NODES

Base Station System (BSS)

The Base Station System (BSS) consists of the functional units described in the following sections.

Radio Base Station (RBS)

A Base Transceiver Station (BTS) is the radio equipment required to serve one cell. It contains the antenna system, radio frequency power amplifiers, and digital signaling equipment. The Ericsson product for the BTS is the Radio Base Station (RBS). (Note: An RBS may include 1-3 GSM BTSs.)

The system versions are:

- RBS 200 for GSM 900 and GSM 1800
- RBS 2000 for GSM 900, GSM 1800, and GSM 1900

Base Station Controller (BSC)

The BSC controls and supervises a number of RBSs and radio connections in the system. It handles the administration of cell data, the locating algorithm, and orders handovers.

The BSC is implemented using an Ericsson Digital Switching System AXE 10 switch.

Transcoder Controller (TRC)

The TRC controls and supervises the transcoder resources used by the BSC. The TRC is implemented in an AXE 10 switch.

Combined BSC/TRC

The BSC/TRC is a combined TRC and BSC node. The BSC/TRC is implemented in an AXE 10 switch.

Switching System (SS)

The Switching System (SS) contains the functional units described in the following sections.

Mobile Services Switching Center (MSC)

The MSC is responsible for setting up, routing, and supervising calls to and from the mobile subscriber. Short messages, routed from the SMS-GMSC or sent from the Mobile Station (MS), are relayed in the MSC.

The MSC is implemented using an AXE 10 switch.

Gateway MSC (GMSC)

The GMSC is an MSC serving as an interface between the mobile network and other networks, such as the Public Switched Telephony Network (PSTN) and Integrated Services Digital Network (ISDN) for mobile terminating calls. It contains an interrogation function for retrieving location information from the subscriber’s HLR. The GMSC contains functions for rerouting a call to the MS according to the location information provided by the HLR.

The GMSC is implemented using an AXE 10 switch.

Visitor Location Register (VLR)

The VLR temporarily stores information about the MS currently visiting its service area.

In an Ericsson’s GSM system the VLR is integrated with the MSC in the same AXE 10 switch.

Home Location Register (HLR)

The HLR database stores and manages all mobile subscriptions belonging to a specific operator. The HLR stores permanent data about subscribers, including subscriber's supplementary services, location information, and authentication parameters. When a person buys a subscription, it is registered in the operator’s HLR. The HLR can be implemented with the MSC/VLR or as a standalone database.

The HLR uses Mobile Application Part (MAP) signaling towards the other nodes (Except for PC-based AUC).

Flexible Number Register (FNR)

FNR was first introduced with Ericsson’s release, R6.1, to provide a flexible number function which enables mobile operators to allocate subscriber MSISDN freely without restricting it to the MSISDN series, held in the HLR where the corresponding IMSI series are held.

FNR is modified to provide the function of number portability with R7 in addition to flexible numbering.

Number portability is a network feature that allows the subscribers to retain their MSISDN when they change their service provider within one country, based on the agreement between different network operators.

FNR is a database which stores all the information needed to perform SCCP message translation before rerouting an incoming call to the correct HLR.

The FNR has the same platform as HLR, it can be implemented as a standalone node or can be co-located with the other AMs.

Authentication Center (AUC)

The AUC database is connected to the HLR. The AUC provides the HLR with authentication parameters and ciphering keys by generating triplets. Using these triplets, ciphering of speech, data, and signaling over the air-interface is performed. Both provide system security.

The AUC is available as a PC or VAX-based system or as an integrated AUC. The PC-based version is connected to the Input/Output Group 11 (IOG11) similar to an operator terminal. The VAX-based version uses MAP signaling and is connected via S7 signaling links. The integrated AUC is implemented on an RPD within the AXE 10 and can be co-located with a MSC/VLR. There is also support for RPG/RPG2 (apart from RPD): A new and more powerful RP built for the new building practice BYB 501. The RPG/RPG2 is also more than ten times more powerful than RPD, it is smaller and contains less number of boards.

Equipment Identity Register (EIR)

The EIR database validates mobile equipment. The MSC/VLR can request the EIR to check if an MS has been stolen (black listed), not type-approved (gray listed), normal registered (white listed), or unknown.

The EIR is connected to the VLR via the S7 network and uses MAP signaling.

The EIR is implemented as a UNIX operating system or as a VAX computer platform.

Data Transmission Interworking Unit (DTI)/GSM InterWorking Unit (GIWU)

The DTI/GIWU provides the interface necessary for fax and data communication.

Short Message Service - Gateway MSC (SMS-GMSC)

The SMS-GMSC routes MS-terminated short messages.

For signaling to GSM entities, MAP signaling is used.

For signaling to an Ericsson SC, an Ericsson variant of MAP is used.

Any MSC/GMSC can be implemented as an SMS-GMSC.

Short Message Service - InterWorking MSC (SMS-IWMSC)

The SMS-IWMSC routes MS-originated short messages to the SC for delivery.

For signaling to GSM entities, MAP signaling is used.

For signaling to an Ericsson SC, an Ericsson variant of MAP is used.

Any MSC/GMSC can be implemented as an SMS-IWMSC.

Operation and Support System (OSS)

OSS is an Ericsson product that provides centralized control of the GSM network. OSS provides functions, such as mobile subscriber and cellular network administration and alarm handling.

OSS is based on the Telecommunications Management and Operations Support (TMOS) system.

General Packet Radio Service (GPRS)

Serving GPRS Support Node - SGSN

The Serving GPRS Support Node is a primary component in the GSM network using GPRS. It forwards incoming and outgoing IP packets addressed to/from an MS that is attached within the SGSN service area.

The SGSN handles packet routing and serves all GPRS subscribers that are physically located within the geographical SGSN service area. The (packet-switched) traffic is routed from the SGSN to the BSC, via the BTS to the mobile station.

Gateway GPRS Support Node – GGSN

The Gateway GPRS Support Node is the second new node type, introduced to handle GPRS connections. The GGSN handles the interface to the external IP packet networks and acts like a router for the IP addresses of all GPRS subscribers in the network.

Additional Nodes

Mobile Intelligent Network (Mobile IN)

Mobile IN is used in conjunction with the Public Land Mobile Network (PLMN). It consists of service nodes that provide advanced services to subscribers. Mobile IN functions include the Service Switching Point (SSP) and the Service Control Point (SCP), or a combined Service Switching and Control Point (SSCP).

The SSP function determines whether the SCP function is required. The SCP function provides the service. The SSP is typically located in an MSC. The SCP function may be located in the SSP node or it may be a standalone node.

SSP-SCP communication occurs via the Ericsson Intelligent Network Application Part (INAP) protocol CS 1+. INAP CS 1+ is compatible with the standard protocol INAP CS 1, but offers further functions. When the SSP and SCP are co-located, INAP messages are carried on internal AXE software signals. When the nodes are remote, INAP messages are carried on S7 links and use the Transaction Capabilities Application Part (TCAP) function.

An example of an advanced service provided by Mobile IN is Virtual Private Network (VPN). The VPN service gives the corporate customer a private numbering plan within the PLMN network.

The Mobile IN functions are implemented on AXE 10 platforms.

Note: Mobile IN is not discussed further in this course.

Service Center (SC)

The SC receives, stores, and forwards a short message between the message sender and the MS.

Ericsson offers the SC as a combined messaging system, for example, voice and fax on an MXE platform.

Billing GateWay (BGW)

The BGW collects billing information, Call Data Records (CDRs) in files from the network elements and immediately forwards the information to post-processing systems that use CDR files as input.

The BGW acts as a billing interface to all network elements in an Ericsson network. The flexible interface of the BGW easily adapts to new types of network elements, as well.

Service Order Gateway (SOG)

The SOG connects a Customer Administrative System (CAS) and a set of Ericsson Network Elements (NEs) to allow the CAS to exchange service data with the NEs. It provides a safe and reliable connection for updating the GSM network database and eliminates the operator’s need to create his own interface to each of the NEs.

The SOG provides a remote interface to the HLR, the AUC, and the EIR. This combines the subscription management functionality of the HLR/AUC and the equipment management functionality of the EIR.

Mobile Station (MS)

The MS allows the subscriber to access the network through the radio interface. It is not specified as a network node in Ericsson's GSM system.

The MS consists of:

- Mobile Equipment (ME)

  The ME consists of radio processing functions and an interface to the user and other terminal equipment.

- Subscriber Identity Module (SIM)

  The SIM contains information regarding user subscription and can be used with any mobile equipment.

GSM IDENTITIES

To switch a call to a mobile subscriber, the right identifying codes must be used. A mobile subscriber can make, receive, or forward calls from any location within the GSM Public Land Mobile Network (PLMN) with a high degree of security. GSM uses more than one addressing and numbering plan to identify different networks.

The identities used in a GSM PLMN network are as follows.

MOBILE STATION ISDN NUMBER (MSISDN)

The MSISDN is a number which uniquely identifies a mobile telephone subscription within the Public Switched Telephony Network (PSTN) numbering plan.

In GSM 900 the MSISDN is composed of:

MSISDN = CC + NDC + SN

- CC = Country Code
- NDC = National Destination Code
- SN = Subscriber Number

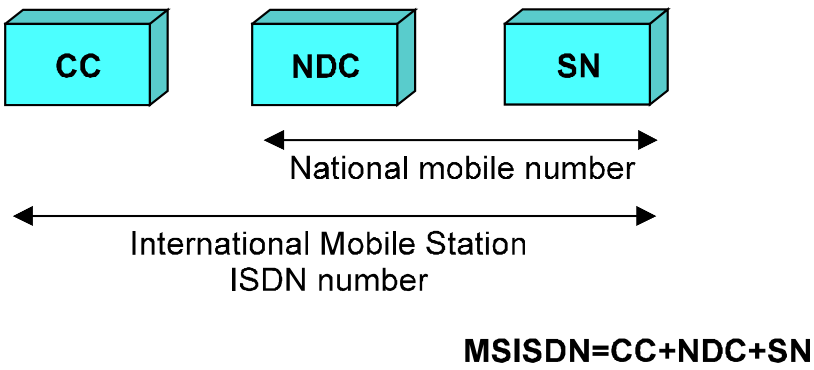


Figure 1-2 MSISDN in GSM 900

In GSM 1900 the MSISDN is composed of:

MSISDN = CC + NPA + SN

- CC = Country Code
- NPA = Number Planning Area
- SN = Subscriber Number

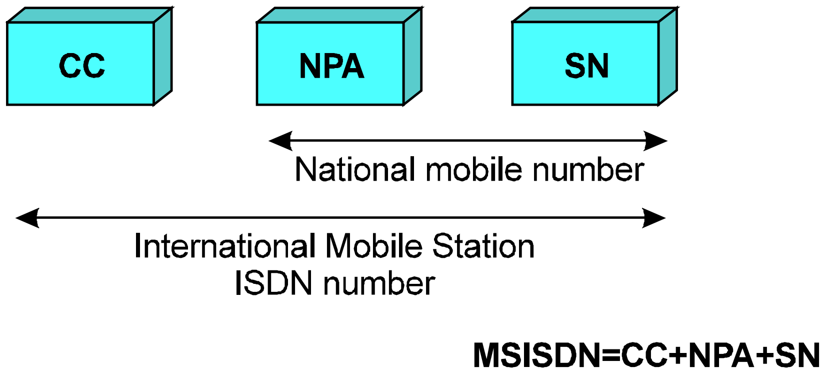


Figure 1-3 MSISDN in GSM 1900

A National Destination Code (NDC)/ Numbering Plan Area (NPA) is allocated to each GSM 900/GSM 1900 PLMN. In some countries more than one NDC/NPA may be required for each GSM 900/GSM 1900 PLMN.

The length of the MSISDN depends on the structure and operating plan of each operator. The maximum length is 15 digits, prefixes not included.

Each subscription is connected to one HLR.

Examples:

A Swedish PSTN subscriber calls a German GSM subscriber.

International prefix in Sweden	Country Code	National Destination Code	Subscriber Number
001	49	172	2011111

INTERNATIONAL MOBILE SUBSCRIBER IDENTITY (IMSI)

The IMSI is a unique identifying code allocated to each subscriber allowing correct identification over the radio path and through the GSM PLMN network.

It is used for all identification signaling in the PLMN and all network related subscriber information is connected to it.

The IMSI is stored in the Subscriber Identity Module (SIM), as well as in the HLR and the VLR.

It consists of three different parts:

IMSI = MCC + MNC + MSIN

- MCC = Mobile Country Code
- MNC = Mobile Network Code
- MSIN = Mobile Subscriber Identification Number

According to the GSM 900/GSM 1900 specifications, IMSI can have a maximum length of 15 digits.

Examples:

A subscriber in the German Telecom GSM 900 network has the following IMSI.

IMSI = 262 02 XXXXXXXXXX

A subscriber in the American GSM 1900 network has the following IMSI:

IMSI = 310 011 XXXXXXXXX

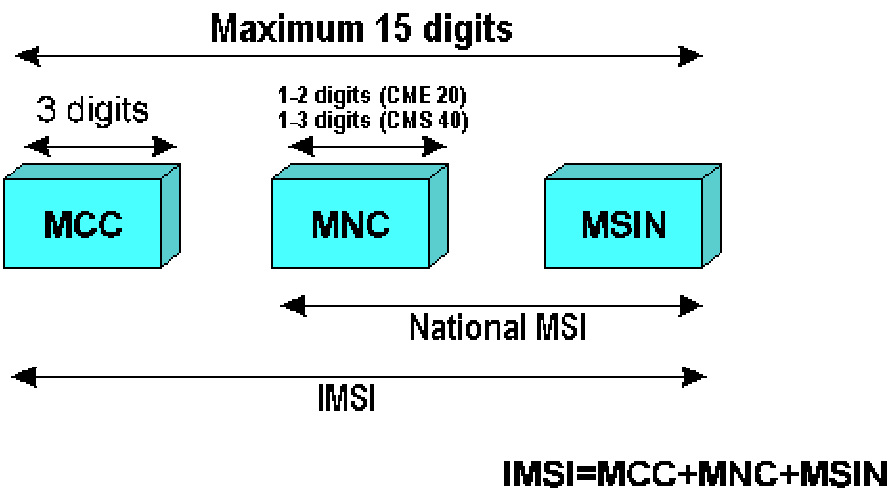


Figure 1-4 IMSI

TEMPORARY MOBILE SUBSCRIBER IDENTITY (TMSI)

The TMSI can be used to keep subscriber information confidential on the air interface. It also increases paging capacity as the length of the TMSI is shorter than the length of the IMSI.

The TMSI is relevant on the local MSC/VLR level only and is changed at certain events or time intervals. Each local operator can define his own TMSI structure.

The TMSI should not consist of more than four octets when used within a Location Area (LA), for example, for paging. When a cell within a new Location Area (LA) is entered, the Location Area Identitiy (LAI) must be added to the four octets to perform a location update.

MOBILE STATION ROAMING NUMBER (MSRN)

When a mobile terminating call is to be set up, the HLR of the called subscriber requests the current MSC/VLR to allocate a MSRN to the called subscriber. This MSRN is returned via the HLR to the GMSC. The GMSC routes the call to the MSC/VLR exchange where the called subscriber is currently registered. The routing is done using the MSRN. When the routing is completed, the MSRN is released.

The interrogation call routing function (request for MSRN) is part of the MAP.

All data exchanged between GMSC-HLR-MSC/VLR for the purpose of interrogation is sent over S7 signaling.

The MSRN is built up like an MSISDN.

In GSM 900, the MSRN is composed of the following:

MSRN = CC + NDC + SN

- CC = Country Code
- NDC = National Destination Code
- SN = Subscriber Number

In GSM 1900 the MSRN is composed of the following:

MSRN = CC + NPA + SN

- CC = Country Code
- NPA = Number Planning Area
- SN = Subscriber Number

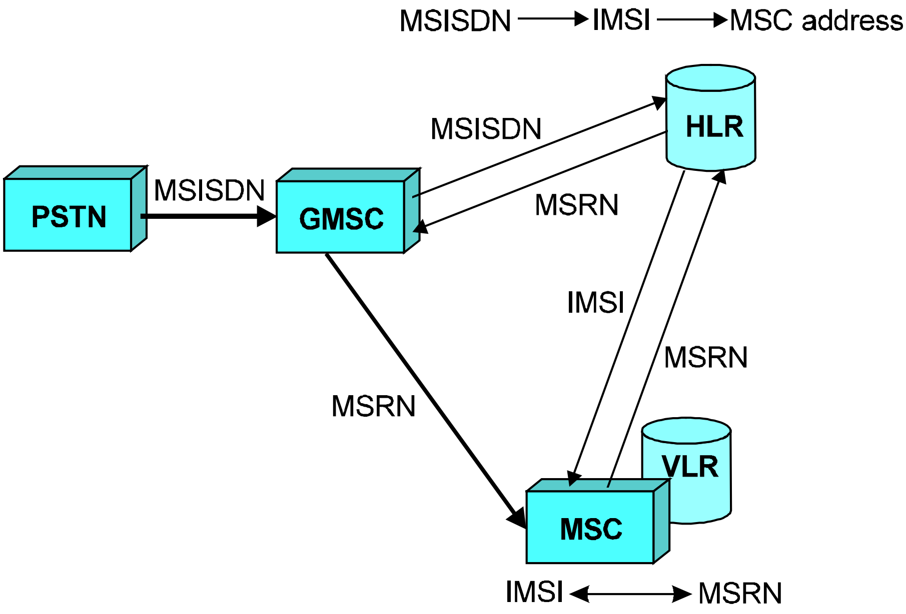


Figure 1-5 MSRN

INTERNATIONAL MOBILE EQUIPMENT IDENTITY (IMEI) AND SOFTWARE VERSION NUMBER (IMEISV)

The IMEI uniquely identifies a Mobile Station (MS) as a piece or assembly of equipment. Using the IMEI stolen or not type-approved, mobiles causing severe malfunctions can be barred. The IMEI consists of 15 digits.

The IMEI consists of the following:

IMEI = TAC + FAC + SNR + sp

- TAC = Type Approval Code

  Determined by a central GSM body and identifies the type of equipment.

- FAC = Final Assembly Code

  The FAC identifies the manufacturer of the equipment

- SNR = Serial NumbeR,

  The SNR is an individual serial number of six digits which uniquely identifies all equipment within each TAC and FAC.

- sp = spare part for future use; this digit should always be zero when it is transmitted by the MS

The IMEI has a total length of 15 digits.

The IMEISV consists of the following:

IMEISV = TAC + FAC + SNR + SVN

- SVN = Software Version Number

  The SVN allows the mobile equipment manufacturer to identify different software versions of a given type-approved mobile equipment.

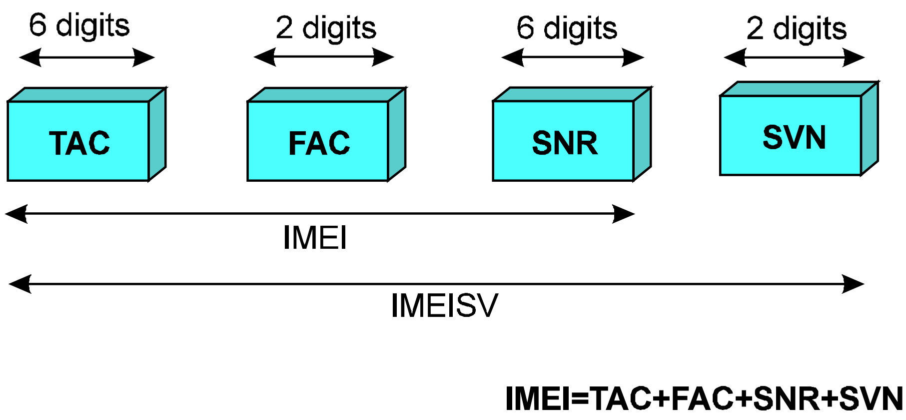


Figure 1-6 IMEISV

LOCATION AREA IDENTITY (LAI)

The LAI, used for paging, indicates to the MSC in which location area the MS is operating. It is also used for location updating of mobile subscribers.

The LAI contains the following:

LAI = MCC + MNC + LAC

- MCC = Mobile Country Code

  Identical to IMSI MCC

- MNC = Mobile Network Code

  Identical to IMSI MNC

- LAC = Location Area Code

  The maximum length of LAC is 16 bits, enabling 65,536 different location areas to be defined in one PLMN.

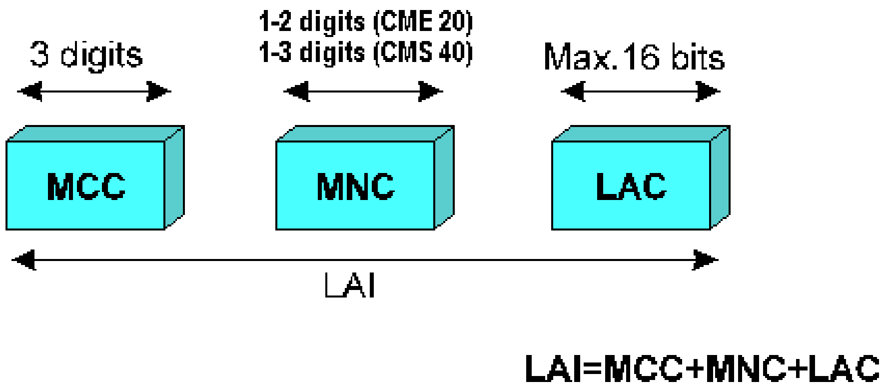


Figure 1-7 LAI

CELL GLOBAL IDENTITY (CGI)

The CGI is used for cell identification within a location area.

The CGI contains the same information as the LAI and also includes a Cell Identity (CI). The CI has a maximum length of 16 bits.

CGI consists of:

CGI = MCC + MNC + LAC + CI

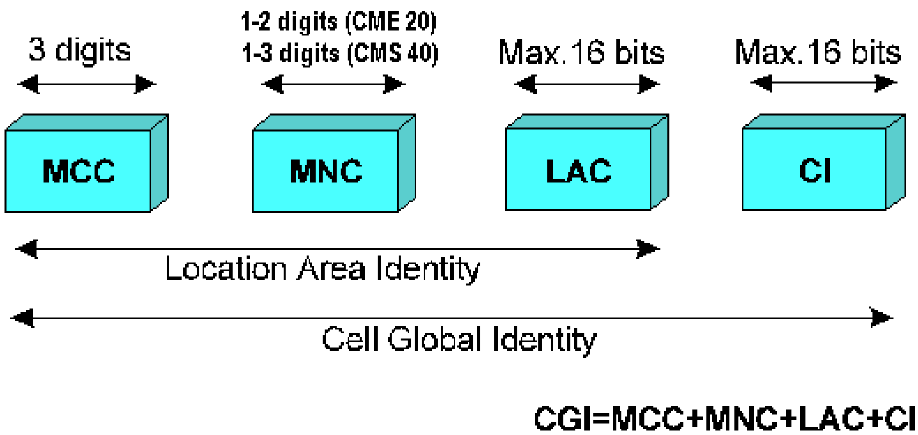


Figure 1-8 CGI

ADDRESSING THE SWITCHING SYSTEM ENTITIES

GLOBAL TITLE (GT)

A Global Title (GT) is an identifying code, such as dialed digits, which does not explicitly contain information that allows routing in the signaling network. This requires the Signaling Connection Control Part (SCCP) translation function, which is described in the SCCP chapter.

The GT is used for addressing signaling information.

Different numbering plans are used to distinguish different networks.

- E.164 is the numbering plan for PSTN/ISDN
- E.212 is the numbering plan for GSM PLMN

Each network entity is identified by its international PSTN/ISDN number. That is, its own command defined address which has the following structure:

Example: E.164: CC + NDC(or NPA) + SN

The CC, NDC, and SN identify the node within the whole GSM, as well as the entity. Entities include the HLR, MSC, VLR, EIR, and AUC.

Refer to the SCCP chapter for more information.

During an incoming call to a mobile subscriber, the GMSC analyzes the MSISDN to locate the appropriate HLR. The digits in the Subscriber Number (MSISDN) are used for the signal routing to the HLR.

MOBILE GLOBAL TITLE (MGT)

When an MS is powered on in a PLMN, the VLR must communicate with the MS’s HLR to perform location updating. The only data available in the MSC/VLR for the SCCP addressing of the HLR is the IMSI number. However, for signaling in the international PSTN/ISDN network, IMSI can not be used. Thus, it is necessary to convert the IMSI number in the MSC/VLR into a Global Title (GT), which enables routing of the S7 signaling to the proper HLR. This converted number is called the Mobile Global Title (MGT).

Structure of the MGT

The MGT is of variable length and is composed of decimal digits arranged in two specific parts. These specific parts are E.164 and E.212. Together they form E.214.

The E.164 part is used to identify the home country and the home PLMN of the mobile subscriber.

The E.212 part is used to identify the HLR the mobile subscriber is registered in and is composed of the Mobile Station Identification Number (MSIN).

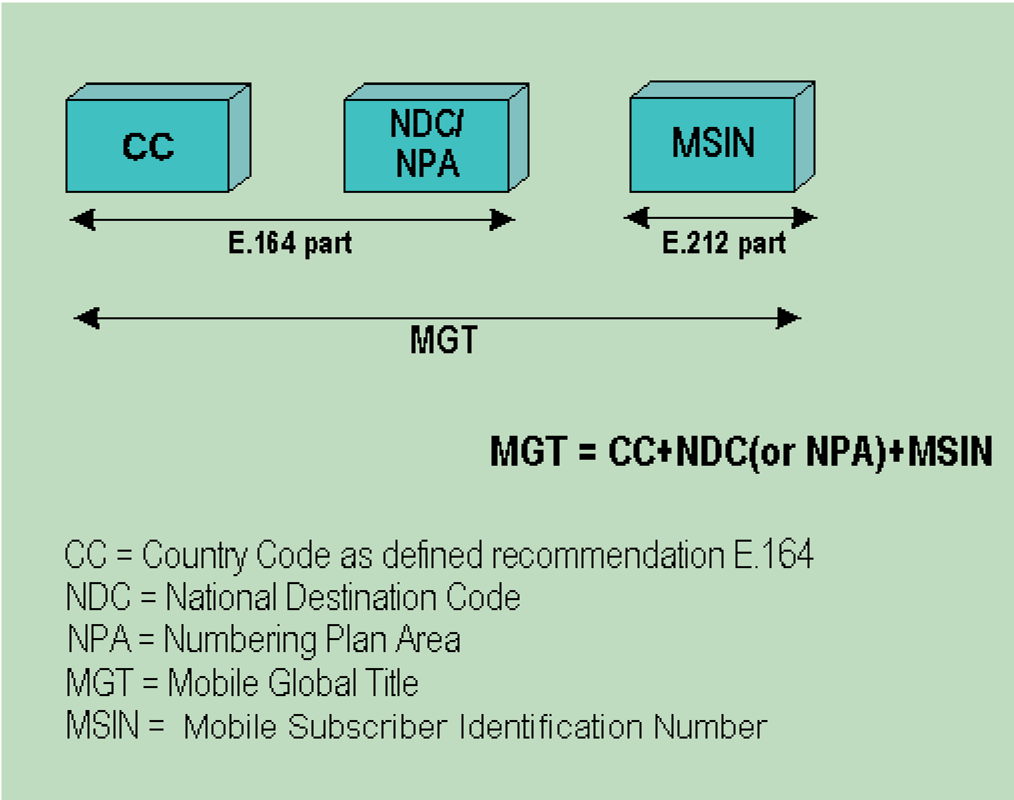


Figure 1-9 Structure of MGT

Derivation of the MGT

The MGT is derived from the IMSI as follows:

1. The CC is derived directly from the MCC.
2. The NDC is derived either from the MNC or from the MNC and some initial digits of the MSIN.
3. The MSIN is mapped directly into the MGT up to its maximum length.

This translation is performed during the IMSI analysis in the MSC/VLR. It is initiated via commands.

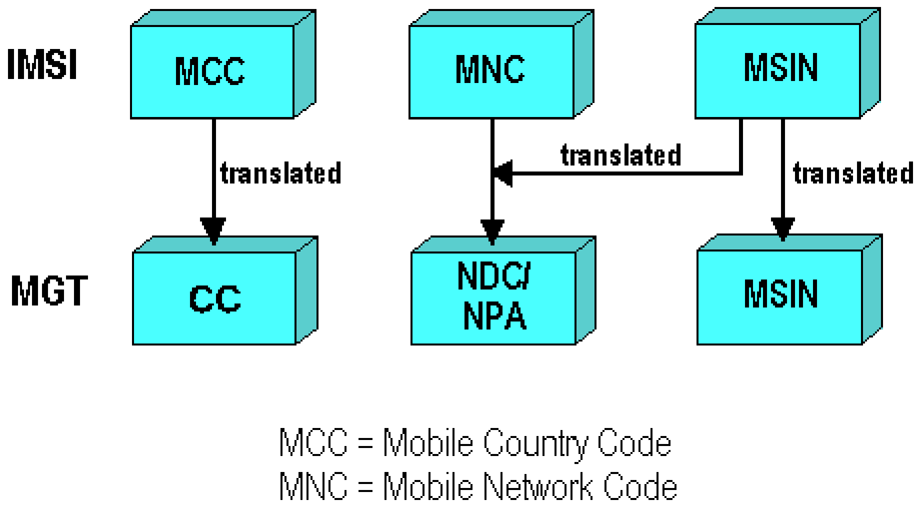


Figure 1-10 Derivation of the MGT from the IMSI

AXE SYSTEM STRUCTURE

The Application Modularity concept describes the structure of AXE 10. This concept is an architectural improvement which changes the structure from functional modularity to application modularity at the APT System Level.

Application Modularity makes it easier to combine several different telecommunication applications in the same AXE-node. The aim is to achieve a state where it is as simple to add, remove, or change different applications within a specific AXE switch, as it is to add, remove, or change, individual nodes within a network.

The system architecture is built up as shown in the following diagram:

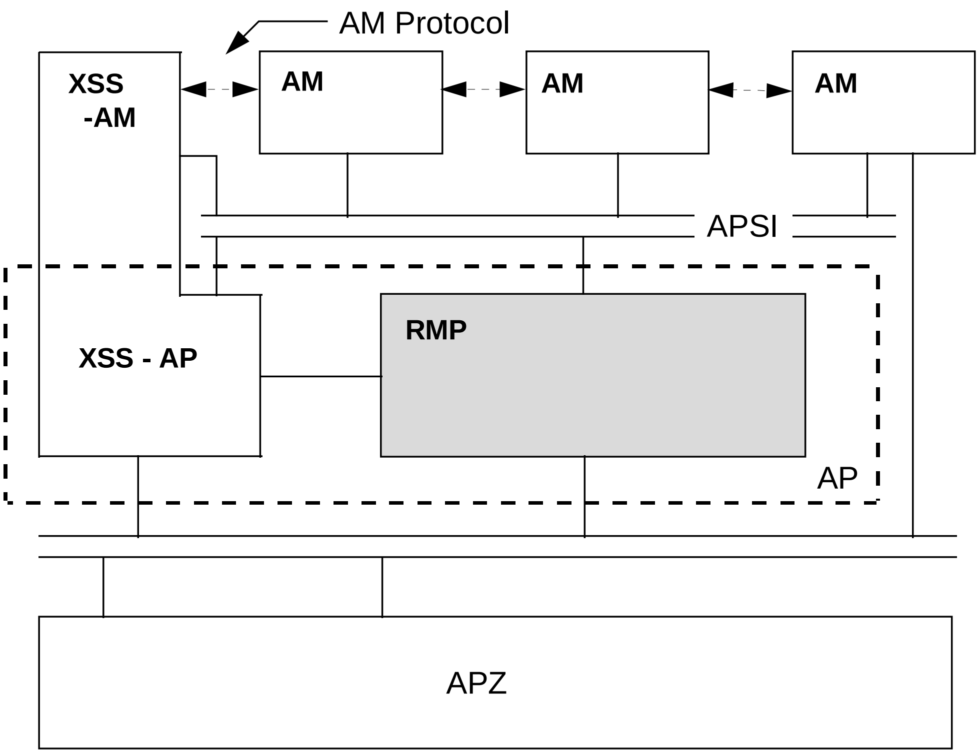


Figure 1-11 AXE System Architecture

Application Modules (AMs) are independent components which make it possible to easily implement new telecommunication applications in AXE 10. An AM is independent of the internal structure of other AMs, the XSS, RMP, and APZ.

The Application Platform (AP) contains the RMP and XSS-AP. The Resource Module Platform (RMP) is the location for common resources, required by new and existing applications.

The RMP coordinates the use of the common resources which are available to users in the AMs and the XSS via the Application Platform Service Interface APSI. All hardware should be located in the RMP.

The Existing Source System (XSS) contains application functionality (APT) developed according to traditional AXE 10 architecture, but which is adapted according to AM architecture. The Application Part of XSS contains its software and can act like an AM; it communicates with AMs via protocols and can request services via APSI. The Platform Part of XSS contains the existing common resources which, at present, still include hardware.

AMs in the MSC/VLR

Some AMs the MSC/VLR can contain or be combined with are:

Formatting and Output AM (FOAM):

FOAM is responsible for the formatting and output of charging information. FOAM gets charging data from the RMP and formats it in accordance with the subscriber’s or administrator’s requests.

SYStem Operation and Maintenance AM (SYSOMAM):

SYSOMAM is responsible for the system-wide operation and maintenance functions. Note that operation and maintenance commands intended only for a particular AM or XSS are handled directly by the AM or XSS.

Flexible Numbering Register AM (FNRAM):

FNRAM implements the flexible number routing function, that is, the disconnection of the fixed relation between the IMSI and the HLR that the IMSI belongs to. FNRAM can be implemented as a standalone gateway or can be co-located with other AMs.

Home Location Register AM (HLRAM):

By using the HLRAM it is possible to combine the HLR function with other mobile applications in the same physical node in a flexible way. The HLRAM contains the Home location Register Subsystem (HRS) with changes that are necessary to be able to use the communication services offered by APSI.

AUthentication Center AM (AUCAM):

AUCAM is responsible for providing the triplets needed for authentication and ciphering. Using AUCAM the authentication functionality is integrated in the AXE 10.

Digital Access Services AM (DASAM):

DASAM acts as a digital access node by routing a call from the subscriber to the node that handles the services for the subscriber. DASAM offers Primary Rate (30B+D) and Basic Rate (2B+D) digital access. The hardware and some of the software for this digital access is situated in the Platform Part of XSS and is managed by DASAM. DASAM is used only in GSM 900.

ISDN User Services AM (IUSAM):

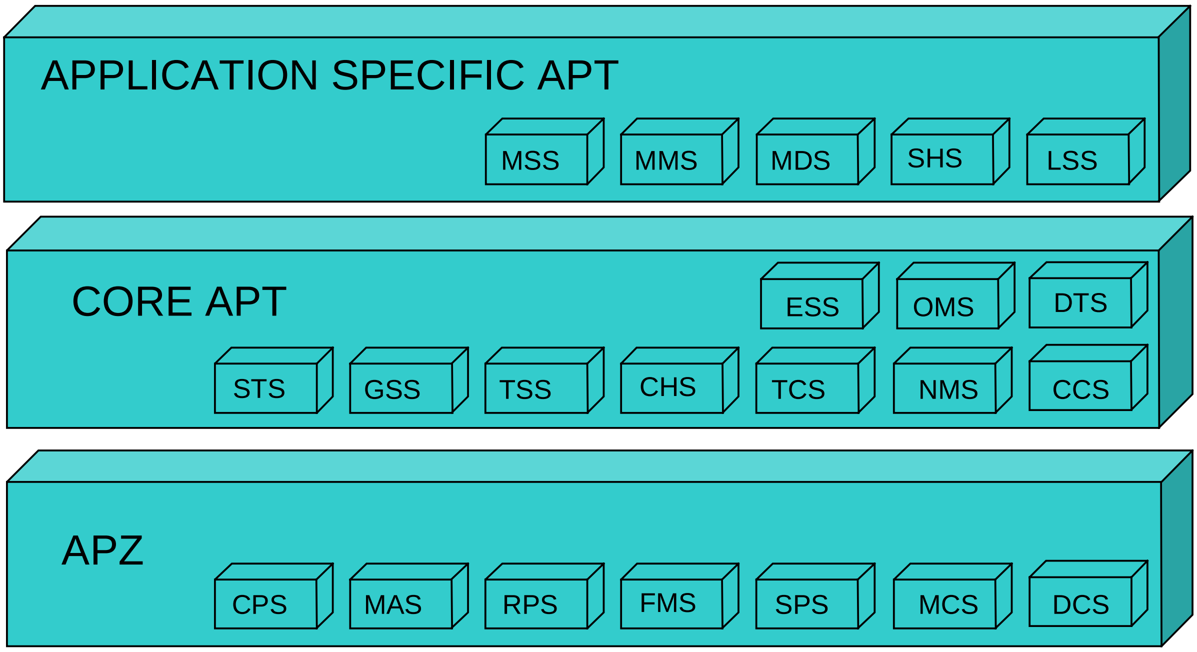
IUSAM implements ISDN-E Services for subscribers. These Services include Basic and Supplementary Services. IUSAM is used only in GSM 900.

ISDN-E Operation and Maintenance AM (ISOMAM):

In the Application Modularity concept application dependent O&M AMs are provided. ISOMAM offers the O&M functionality for the ISDN-E application. ISOMAM is used only in GSM 900.

AXE SUBSYSTEMS IN THE MSC/VLR

The MSC/VLR is composed of the main AXE Control System (APZ) subsystems and a number of Application Part (APT) subsystems which belong to XSS and RMP.



CCS = Common Channel signaling Subsystem
CHS = CHarging Subsystem
CPS = Central Processor Subsystem
DCS = Data Communication Subsystem
DTS = Data Transmission Subsystem
ESS = Extended Switching Subsystem
FMS = File Management Subsystem
GSS = Group Switching Subsystem
LSS = Location Service Subsystem
MAS = MAintenance Subsystem
MCS = Man-machine Communication Subsystem
MDS = Mobile Data Subsystem
MMS = Mobile Mobility and radio Subsystem
MSS = Mobile Switching Subsystem
NMS = Network Management Subsystem
OMS = Operation and Maintenance Subsystem
RPS = Regional Processor Subsystem
SHS = SHort message service Subsystem
SPS = Support Processor Subsystem
STS = Statistical and Traffic measurement Subsystem
TCS = Traffic Control Subsystem
TSS = Trunk and Signaling Subsystem

Figure 1-12 Subsystems in the MSC/VLR

The following is a list of mobile specific APT subsystems in the MSC/VLR.

Mobile Switching Subsystem (MSS)

- Handles call set-up, supervision, and release
- Supports charging
- Implements gateway and roaming rerouting functions in the GMSC

Mobile Mobility and Radio Subsystem (MMS)

- Handles location updating, authentication, and ciphering for each radio access
- Handles handover and paging requests
- Stores information about cells and BSCs

Mobile Data Subsystem (MDS)

- Stores visitor data received from the HLR

Short Message Service Subsystem (SHS)

- Contains the Short Message Service (SMS) functionality

Location Service Subsystem (LSS)

- Provides location information and services in MSC/VLR

MOBILE APPLICATION PART (MAP) PHASES

General

MAP is a protocol especially designed to support GSM requirements. The MAP protocol provides the necessary signaling procedures required for information exchange between GSM network entities (for example, HLR, MSC/VLR, and AUC).

MAP is a TCAP user and also uses the (connectionless) services of SCCP and MTP for transmission of information.

Due to the amount of standardization work and the time schedule, the GSM standard is divided into different phases. The GSM phase 1 and phase 2 standards are considered as completed. GSM phase 2+ is a gradual development of the characteristics and the functionality of the GSM system. Thus, GSM phase 2+ will continue to evolve with time. To cater for the evolution of GSM phases, new versions of the MAP protocol have been developed.

In AXE, a specific MAP operation is typically handled by one function block. In "GSM language", the MAP function blocks are referred to as Application System Elements (ASE). An ASE can only communicate with a compatible peer ASE. Compatible in this sense means that they use the same version of the MAP protocol.

A set of Application Service Elements (operations) is called an Application Context. Today, Application Context versions 1, 2, and 3 exist.

Ericsson Variant MAP Protocols

Ericsson has developed their own variants of the different MAP protocol versions. The reason is that Ericsson Proprietary Services are not supported by the standard MAP protocols. An Ericsson Proprietary Service is a service, exclusively offered by Ericsson, and, thus, is not standardized.

MAP VERSION 3

General

To cater for the GSM phase 2+ technical specifications for 09.02 release 1996, a corresponding new MAP protocol has been specified. This protocol is referred to as MAP96. The term "MAP Version 3" is related to the set of MAP96 operations that use Application Context versions equal to 3.

Concept

With MAP V3, the following GSM phase 2+ features are supported (for more information, refer to the individual feature descriptions):

- Operator Determined Barring of outgoing inter-zonal calls
- Operator Determined Barring of outgoing inter-zonal calls, except those directed to the HPLMN country
- Operator Determined Barring of outgoing international calls, except those directed to the HPLMN country, AND barring of outgoing inter-zonal calls

For the above mentioned types of barring the impacted MAP operation is ISD (ISD InsertSubscriberData).

- CAMEL

Impacted MAP operations: ISD, DSD (DeleteSubscriber Data), PRN (ProvideRoamingNumber) and SRI (Send RoutingInformation).

Note that the result message to the SRI operation may, in some circumstances, have to be segmented, due to the introduction of CAMEL.

- High Speed Circuit Switched Data

Impacted MAP operations: ISD, DSD, and PRN.

The following Ericsson specific features require MAP V3:

- Account Codes
- High Penetration Notification

- Mobility Related Triggers

Affected MAP V3 operations for the three features above: ISD and DSD.

- Extended CAMEL

Affected MAP V3 operations: ISD, DSD, and SRI.

In addition, Ericsson offers MAP V3 support for a number of Ericsson proprietary services, which already exist. The use of MAP V3 for vendor specific services is recommended, since the new version of MAP is especially designed to minimize the risk of interference between different vendor specific services.

The following Ericsson proprietary services are supported by the standard MAP V3 protocol, using the protocol extension container (compare the "extension area" in MAP V2):

- Immediate Call Itemization
- Mobile Subscriber Subscription Type
- Single Personal Number
- Dual Numbering
- Originating IN Category Key (OICK)

Impacted MAP V3 operations: ISD, DSD and SRI.

- Terminating IN Category Key (TICK)
- Sending of Calling Party Number and Category

Impacted MAP V3 operation: SRI.

- Announcement Suppression

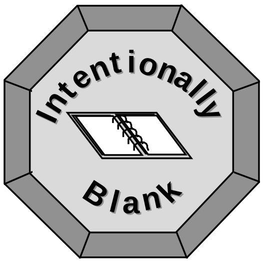
Impacted MAP V3 operations: PRN and SRI.

- MS Priority Level for Channel Allocation

Impacted MAP V3 operations: ISD and DSD.

New MAP operations only available with MAP V3 are:

- ResumeCallHandling
- ProvideSubscriberInfo
- AnyTimeInterrogation.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Message Transfer Part (MTP)

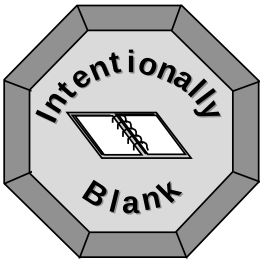
Chapter 2

This chapter is designed to provide the student with a basic knowledge of MTP.

OBJECTIVES:

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

- Explain which items are necessary in an MTP network and briefly describe their functions
- Use MML printout commands to obtain a view of the MTP configuration and use the B-module to interpret the results
- Define an MTP network using the B-module and a work order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2 Message Transfer Part (MTP)

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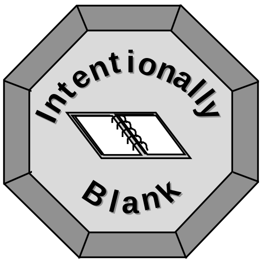
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MESSAGE TRANSFER PART (MTP)

INTRODUCTION

The signaling between the nodes in a GSM network, described in the last chapter, requires a powerful signaling system to exchange information. Powerful signaling is needed to perform call control signaling and other types of information transfer between different exchanges.

The International Telegraph and Telephone Consultative Committee (CCITT) Signaling System No.7 (SS No.7) provides an internationally standardized, general-purpose Common Channel Signaling (CCS) system that can support different applications; including Public Switched Telephony Network (PSTN), Integrated Services Digital Network (ISDN), and Global System for Mobile Communication (GSM).

This is possible, due to its various functional elements, such as Message Transfer Part (MTP), Signaling Connection Control Part (SCCP), Telephony User Part (TUP), and ISDN User Part (ISUP).

Note: International Telecommunications Union (ITU) recommendations for SS No.7 are the Q.7xx-series.

Henceforth, the CCITT Signaling System number 7 and ANSI Signaling System 7 are referred to as S7, if common functions of both signaling systems are described.

MTP is the S7 function that provides the common platform between the different user parts and functional elements. *Figure 2-1* illustrates this relationship.

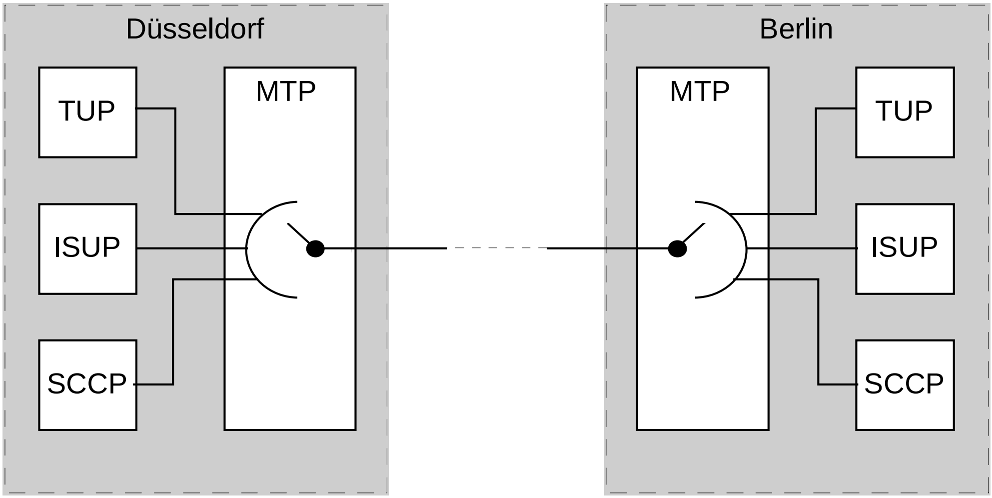


Figure 2-1 Signaling System No. 7

EXAMPLE

A telecommunications network, for example, a PLMN served by a CCS system is composed of a number of switching and processing nodes, interconnected by transmission links. To communicate using S7, each of these nodes has the necessary "within node" features, for example, exchange data. This section provides an overview of MTP from an Operation standpoint. To explain MTP, an example and relevant exchange data printouts are used. See *Figure 2-2*.

Note: The major focus of this chapter is on basic S7 exchange data, therefore, the example does not show S7 supervision data.

The printouts, illustrated in this example, are exclusively made in the switching node.

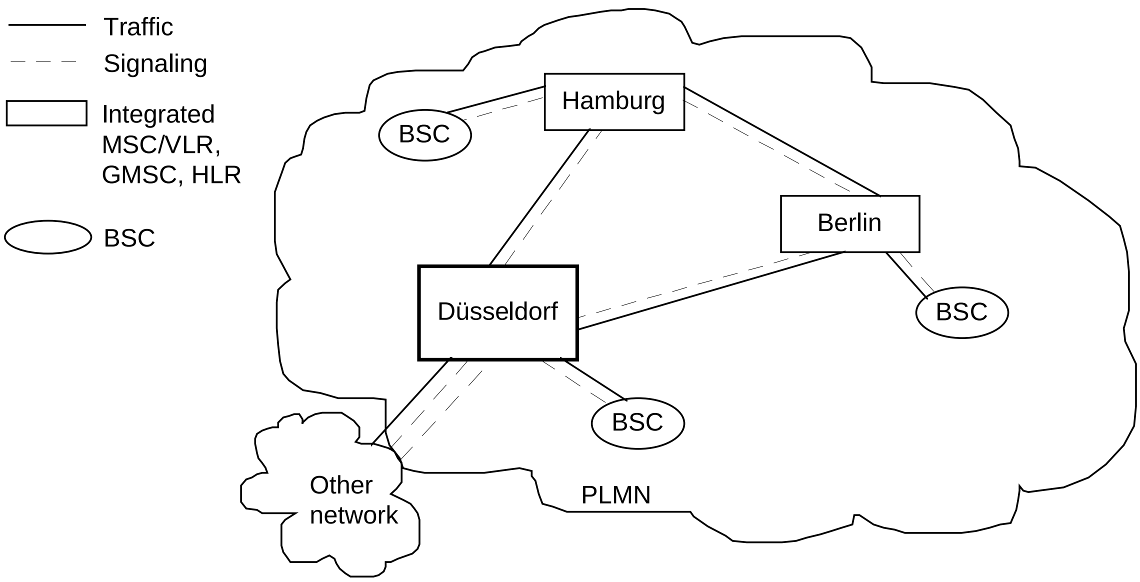


Figure 2-2 Example

PREREQUISITES

The PLMN in this example consists of three switching nodes, Düsseldorf, Hamburg, and Berlin, interconnected by transmission, or traffic and signaling links. Each node is integrated using the Gateway Mobile services Switching Center (GMSC), Home Location Register (HLR), Mobile services Switching Center (MSC), and Visitor Location Register (VLR) on the AXE platform. Each switching node has one BSC connected. Düsseldorf is the gateway to other national and international networks.

The direct path between two cities, for example, Düsseldorf - Berlin, is preferred. An indirect route, for example, Düsseldorf - Hamburg - Berlin, is the second alternative.

ANALOGY BETWEEN CALLS AND S7 MESSAGES

The “sequence” of handling a call is similar to that of an S7 message.

Figure 2-3 provides an overview of the similarities in the early stages of the sequence.

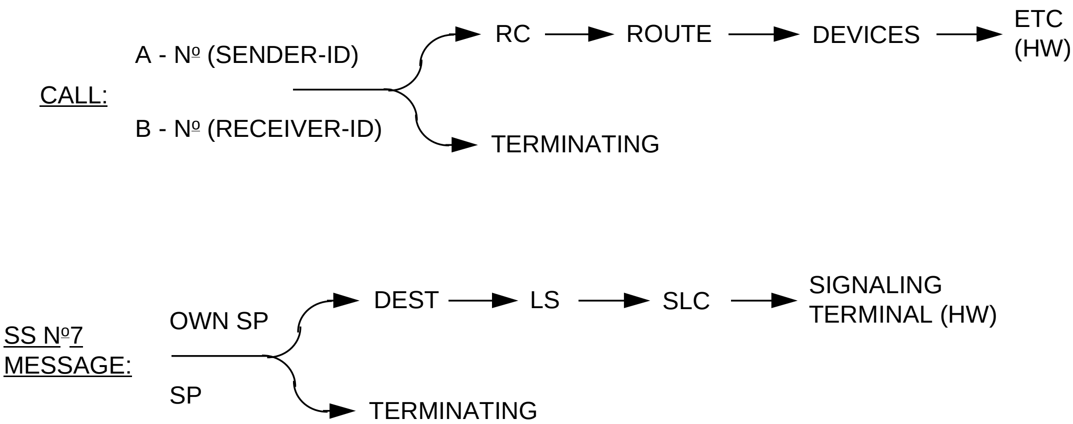


Figure 2-3 Analogy between Calls and an S7 Message

SIGNALING POINT

In a node, a signaling message is either originated, terminated, or transferred. Instead of using an A and a B number, the signaling method uses an address called a Signaling Point (SP). See *Figure 2-3*.

Each node has its own address, called OWNSP, for example, OWNSP for Düsseldorf = 2-6017. See *Figure 2-4* and *Figure 2-5*.

Each node in a network must know all its potential receivers (cooperating SPs). In this example, Düsseldorf knows the SPs (receiver addresses) for Hamburg and Berlin, and for at least one address in the other network(s).

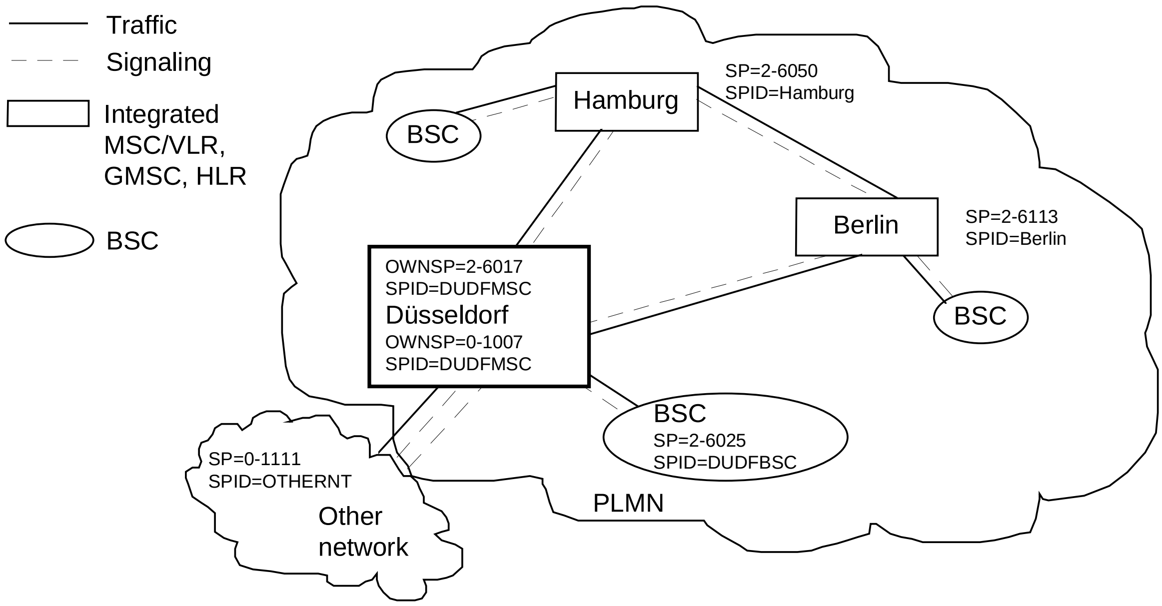


Figure 2-4 The Network and the Signaling Points (SPs).

On the Mobile Switching Center (MSC) - Base Station Controller (BSC) link, the network also uses S7. Therefore, the DUDFMSC switching node knows the SP for DUDFBSC. It does not know the SP for BSC (Hamburg) and BSC (Berlin) because Düsseldorf will never send an S7 message to one of these BSCs, according to the GSM specification.

Normally, a Signaling Point IDentifier (SPID) is tied to an SP.

```
<C7SPP:SP=ALL;

CCITT7 SIGNALING POINT DATA

SP                SPID
0-1007   OWNSP    DUDFMSC
0-1111            OTHERNT
2-6017   OWNSP    DUDFMSC
2-6025            DUDFBSC
2-6050            HAMBURG
2-6113            BERLIN

END
```

Figure 2-5 Signaling Points (SPs) in Düsseldorf

The SP is identified by the Network Indicator (NI) and the Signaling Point Code (SPC), [SP=NI-SPC].

In *Figure 2-5*, the network indicator distinguishes between the different networks, national and international. The Düsseldorf node has two OWNSPs, one for “internal” PLMN (2-6017) usage, and another for other networks (0-1007).

Note: SP addresses in GSM 1900 are structured in a different way than the GSM 900 addresses used throughout this example. Whereas GSM 900 SP addresses consist of a Network Indicator (NI) plus a Signaling Point Code (SPC), GSM 1900 SP addresses are structured as network-cluster-member numbers, for example, 251-10-230 or 251-10-20.

MTP ROUTING AND LINK SET

To generate an originating labeled message, the node uses the SPC of the OWNSP as the Originating Point Code (OPC), and the SPC of the cooperating SP as the Destination Point Code (DPC).

Whether terminating or transferring a message, a node always compares the DPC of the incoming message to its OWNSP. If they are not equal, the node must transfer the message. This requires a routing function called MTP routing.

Figure 2-6 and *Figure 2-7* show the MTP routing for DUDFMSC.

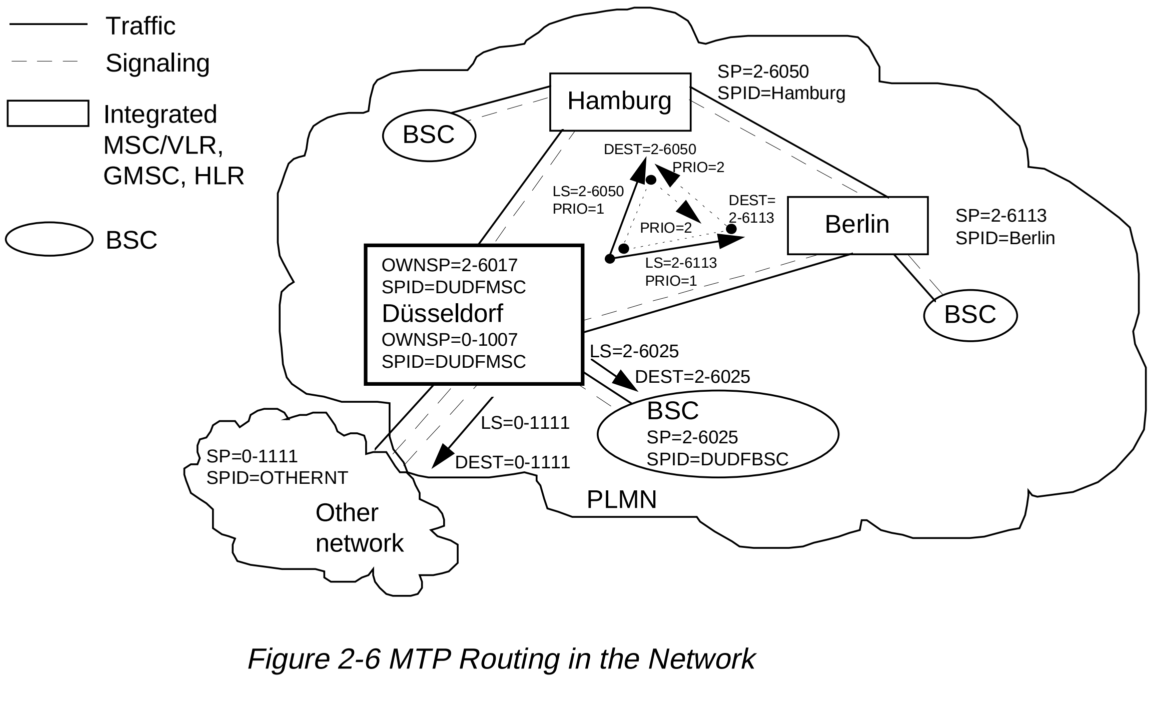


Figure 2-6 MTP Routing in the Network

```
C7RSP:DEST=ALL;
CCITT7 MTP ROUTING DATA
DEST     SPID      DST    PRIO  LSHB  LS       SPID      RST
0-1111   OTHERNT   ACC       1        0-1111   OTHERNT   WO
2-6025   DUDFBSC   ACC       1        2-6025   DUDFBSC   WO
2-6050   HAMBURG   ACC       1        2-6050   HAMBURG   WO
                             2        2-6113   BERLIN    SB
2-6113   BERLIN    ACC       1        2-6113   BERLIN    WO
                             2        2-6050   HAMBURG   SB
END
```

Figure 2-7 MTP Routing in Düsseldorf (DUDFMSC)

A Signaling Point (SP) to which a message is destined is the DESTination point (DEST). The MTP routing ties a DEST to a Link Set (LS). See *Figure 2-7.*

LS is a concept used for routing purposes and is similar to a route. See *Figure 2-3.*

Its format is the same as for an SP: LS=NI-SPC.

Note: Similarly, an LS in GSM 1900 is identified with a format like the GSM 1900 SP: LS=N-C-M.

Figure 2-7 shows that the MTP routing enables the originating point to see whether or not the destination is accessible. For flexible routing, a priority is tied to an LS, for example, the destination HAMBURG (DEST = 2-6050) is accessible via LS 2-6050 as first choice (PRIO = 1). If this link becomes “faulty”, LS 2-6113 (PRIO = 2) changes from StandBy (SB) to working.

Note: This is optional. BERLIN must support this alternative.

SIGNALING LINK AND SIGNALING TERMINAL

A Link Set (LS) is a group of Signaling Links (SLs) that directly interconnect two SPs. The Signaling Link (SL) is similar to a device in a route. See *Figure 2-3.*

Each Signaling Link (SL) in an LS receives an individual number called a Signaling Link Code (SLC). See *Figure 2-8* and *Figure 2-9*. One Signaling Link (SL) operates on 64 kbit/s.

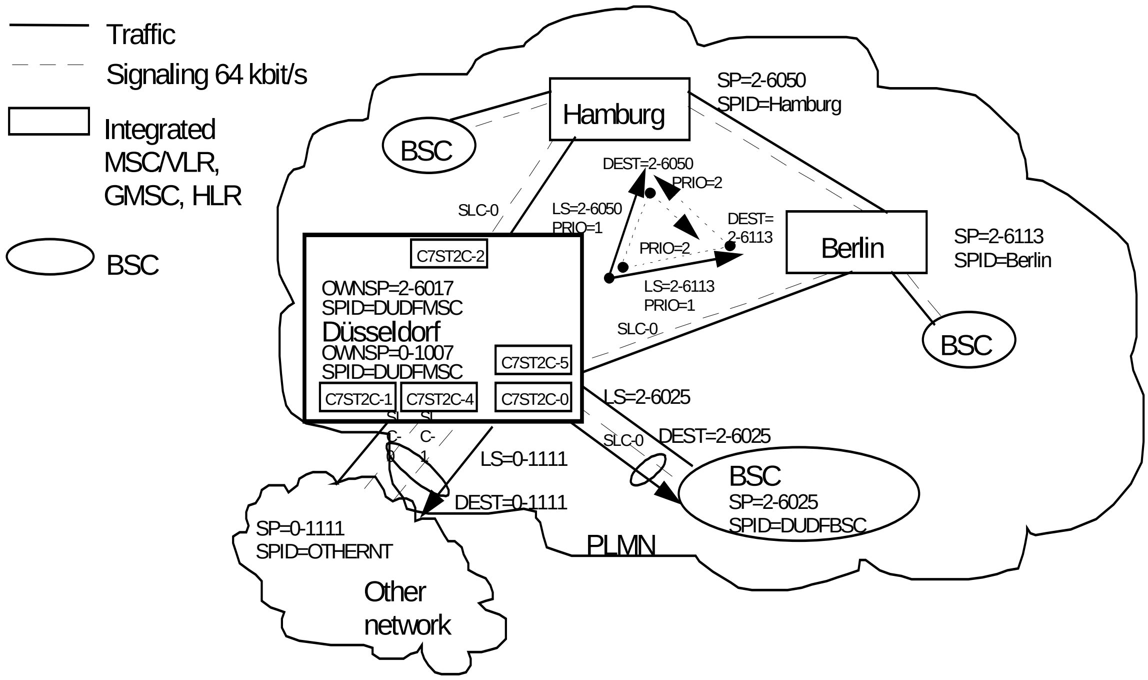


Figure 2-8 Signaling Links (SLs) and Signaling Terminals (STs) in the Network.

The Signaling Terminal (ST) is connected to the Link Set (LS) via the Signaling Link Code (SLC). As a backup, it is recommended to assign more than one Signaling Link (SL) in each set, even if one would be sufficient for the volume of signaling traffic between two SPs.

For our example, let us assume only two Signaling Links (SLs) exist to the international node (SP=0-1111). See *Figure 2-8* and *Figure 2-9*.

```
C7LDP:LS=AL
CCITT7 LINK SET
LS          SPID              ASP
0-1111
         SLC   ACL   PARMG   ST
          0    A1    0       C7ST2C-1
          1    A1    0       C7ST2C-4

LS          SPID              ASP
2-6025
         SLC   ACL   PARMG   ST
          0    A1    0       C7ST2C-0

LS          SPID              ASP
2-6050
         SLC   ACL   PARMG   ST
          0    A1    0       C7ST2C-2

LS          SPID              ASP
2-6113
         SLC   ACL   PARMG   ST
          0    A1    0       C7ST2C-5
END
```

Figure 2-9 Link Set Data in Düsseldorf (DUDFMSC)

From this point on, only the link between the MSC and the BSC in Düsseldorf will be discussed.

HARDWARE AND ROUTE CONNECTION (GSM 900)

Connection of the Signaling Terminal to the Group Switch (GSM 900)

There are different HW types and configurations for C7 signaling terminals.

One variant is an EM controlled signaling terminal (C7ST2) that is connected to the Group Switch (GS) via a multiplexer (PCD-D), which changes the rate from 64kbit/s to 2Mbit/s (Group Switch).

In *Figure 2-10*, another variant is shown. This signaling terminal variant (C7ST2C) is RPD controlled and has a Group Switch Interface. The RPD consists of one RP and up to two virtual EMs, one EM controls one signaling terminal. In contrast to C7ST2, where each signaling terminal is implemented in a separate magazine, a signaling terminal is implemented in the software only in C7ST2C.

There are two versions of RPG. The RPG1 has parallel bus and RPG2 serial bus. One RPG can have up to four signaling terminals implemented.

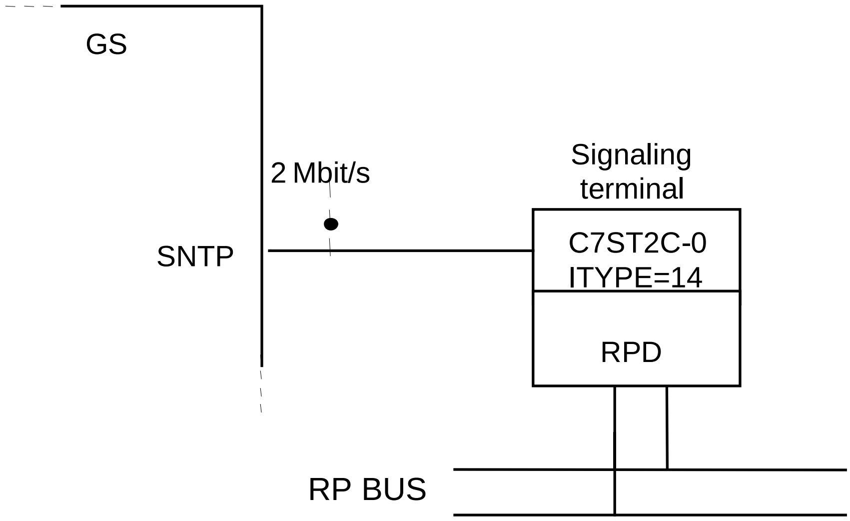


Figure 2-10 Part of Group Switch (GS) in Düsseldorf (DUDFMSC)

In the example (*Figure 2-9*), DUDFMSC uses C7ST2C-0 to DUDFBSC. *Figure 2-11* shows that the terminal is directly connected to the GS and the SNT C7SNT-0. The regional Processor 36 and the Extension Module 0 control this terminal.

```
<C7STP:ST=C7ST2C-0;
CCITT7 SIGNALING TERMINAL DATA
ST         ITYPE   RP    EM   LS        SPID     SLC
C7ST2C-0    14     36     0   2-6025    DUDFBSC  0
END

<NTCOP:SNT=C7SNT-0;
SWITCHING NETWORK TERMINAL CONNECTION DATA
SNT          SNTV   SNTP        DIP   DEV             DEVP
C7SNT-0        1    TSM-0-10          C7ST2C-0&&-3

END
```

Figure 2-11 Signaling Terminal (C7ST2C) Connected to GS

GS Path (GSM 900)

Figure 2-12 and *Figure 2-13* illustrate how a semi-permanent connection builds the path through the GS from an ST (C7ST2C-0), to a two-way trunk device (MALT-16).

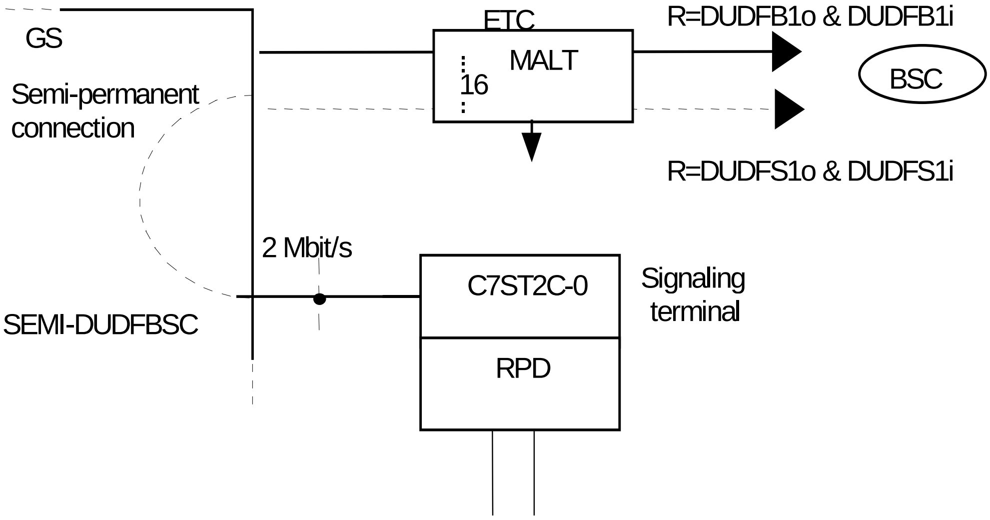


Figure 2-12 Path through the Group Switch (GS)

```
<EXSCP:NAME=SEMI-DUDFBSC;

SEMIPERMANENT CONNECTION DATA

NAME                      CSTATE   DISTC   MISC
SEMI-DUDFBSC              ACT      35

 SIDE1                    SSTATE   ATT  ES
 DEV=MALT-16              ACT

 SIDE2                    SSTATE   ATT  ES
 DEV=C7ST2C-0             ACT

END
```

Figure 2-13 Semi-permanent Connection Data

Route Data (GSM 900)

Figure 2-14 illustrates how the two-way trunk devices (MALT) are connected to traffic routes (FNC=3) and signaling routes (FNC=5).

Note: Regional Processor (RP), Extension Module (EM), Switching Network Terminal (SNT), and Digital Path (DIP) data are not explained.

```
<EXROP:DETY=MALT;
ROUTE DATA

R          ROUTE PARAMETERS
DUDFB1O    DETY=MALT      TTRANS=3    FNC=3
           R=DUDFB1I      SI=SCCP     SP=6025

DUDFB1I    DETY=MALT      PRI=10      FNC=3
           R=DUDFB1O      SI=SCCP     SP=6025

DUDFS1O    DETY=MALT      TTRANS=3    FNC=5
           R=DUDFS1I      SI=SCCP     SP=6025

DUDFS1I    DETY=MALT      PRI=10      FNC=5
           R=DUDFS1O      SI=SCCP     SP=6025
END

<EXDRP:R=DUDFB1O;
DEVICE RP/EM DATA

DEV         R          RP    EMG    EM    ADMSTATE
                                          EM  R   SNT S
MALT-1      DUDFB1O    46           0     C   C   C   C
            DUDFB1I

MALT-15     DUDFB1O    46           0     C   C   C   C
            DUDFB1I

MALT-17     DUDFB1O    46           0     C   C   C   C
            DUDFB1I

MALT-31     DUDFB1O    46           0     C   C   C   C
            DUDFB1I
END

<EXDRP:R=DUDFS1O;
DEVICE RP/EM DATA

DEV         R          RP    EMG    EM    ADMSTATE
                                          EM  R   SNT S
MALT-16     DUDFS1O    46           0     C   C   C   C
            DUDFS1I
END
```

Figure 2-14 Route Data (GSM 900)

HARDWARE AND ROUTE CONNECTION (GSM 1900)

The GSM 1900 system uses two types of signaling terminals:

- C7STD
- S7DS0A

The S7DS0A is the primary terminal type used for signaling between nodes in the GSM 1900 network. The C7STD is used only when connecting to the GSM InterWorking Unit (GIWU).

C7STD Connection and Route Data (GSM 1900)

The C7STD connects the GIWU platform to the MSC/VLR in which it is located. Hardware connections and route definitions are performed exactly as described in the GSM 900 configuration.

The C7STD in GSM 1900 requires connection to the GS via a PCD-D and an SNT. A semi-permanent connection through the GS is needed to form the path from the PCD-D to a bothway trunk, owned by the device type MALT. Both traffic routes (FNC=3) and signaling routes (FNC=5) must be defined using the device type MALT.

S7DS0A Connection and Route Data (GSM 1900)

In GSM 1900 implementations, the DS0A is the primary Signaling Terminal (ST). It provides the signaling connections to other network nodes. DS0A is controlled by the function block S7ST.

Each DS0A ST contains a DS0A link interface that provides a direct connection to a DS0 Dataport channel unit in a D4 channel bank. The DS0A does not require connection to a PCD-D or to the GS, nor is a semi-permanent connection required.

The DS0A is controlled by regional and central software, requiring RP and EM definition. Command S7STP prints the data for ST type DS0A (Figure 2-15):

```
<S7STP:ST=S7ST-4;

SS7 SIGNALING TERMINAL DATA

ST       TYPE    BITRATE   DRS  LS             SLC   RP
         EM
S7ST-4   DS0A                   251-10-230     0     74
         0
END
```

Figure 2-15 DS0A Signaling Terminal Data

Bothway MALT traffic routes (FNC=3) are connected in the usual manner. Since the DS0A signaling path is not connected through a GS, no signaling routes (FNC=5) need to be defined. All MALT devices are assigned for traffic; none are reserved as control channels (*Figure 2-16*).

```
<EXROP:DETY=MALT;

ROUTE DATA

R          ROUTE PARAMETERS
BSC02O     DETY=MALT           TTRANS=3       FNC=3
           R=BSC02I
           RNO=1     SPA=2-251-10-230         SI=SCCP
BSC02I     DETY=MALT           TTRANS=3       FNC=3
           R=BSC02O
           RNO=1     SPA=2-251-10-230         SI=SCCP
END


<EXDRP:R=BSC02O;

DEVICE RP/EM DATA

DEV        R          RP    EMG   EM   ADMSTATE
                                       EM   R   SNT  S
MALT-0     BSC02O     74          0    C     C    C   C
           BSC02I

......
MALT-23    BSC02O     74          0    C     C    C   C
           BSC02I
MALT-24    BSC02O     75          0    C     C    C   C
           BSC02I

......
MALT-47    BSC02O     75          0    C     C    C   C
           BSC02I
END
```

Figure 2-16 Route Data (GSM 1900)

HIGH SPEED SIGNALING LINKS (HSL)

GENERAL

In R8, High Speed signaling Links (HSL) are introduced in Ericsson's GSM system. HSL uses a complete 2 Mbit/s E1 link for signaling. HSL needs special hardware (RPP). The O&M of HSL follows the same principles as for conventional low-speed links.

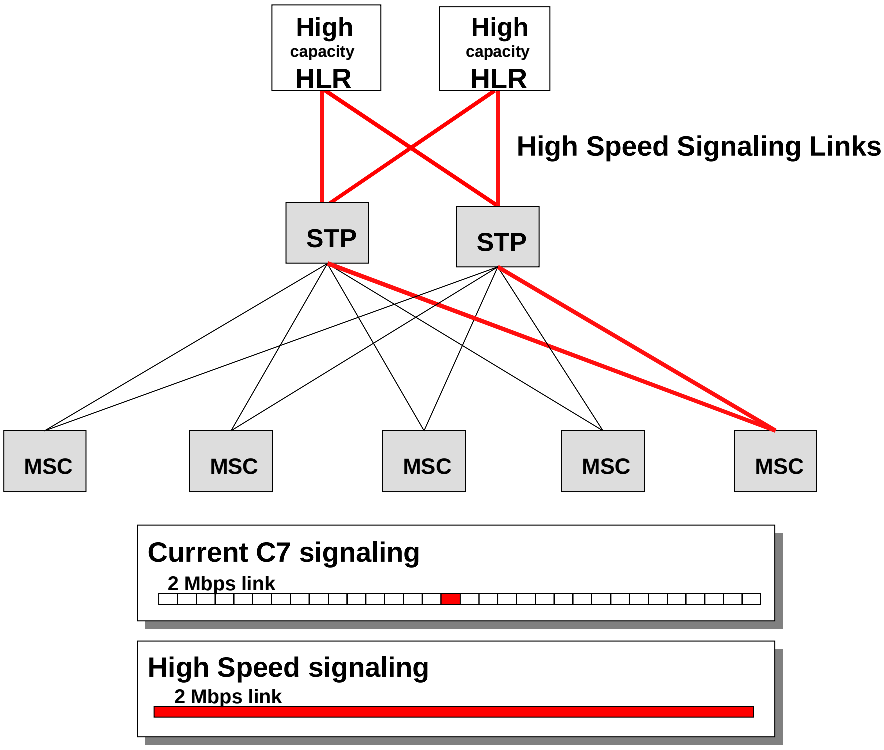


Figure 2-17 High Speed signaling Links HSL

There is, in particular, a need for high capacity link sets between STP nodes and Home Location Registers (HLRs). In conventional No.7 Signaling networks link sets have a maximum of 16 signaling links. This places an upper limit of 1 Mbit/s on the link set. This can now be replaced with 32 Mbit/s in 16 HSLs.

CONCEPT

The High Speed signaling Link (HSL) is part of Signaling System No.7 Message Transfer Part (MTP) for 2.0 Mbit/s signaling links. The HSL uses the Signaling ATM Adaptation Layer (SAAL) and the ATM Layer protocol (B-ISDN). (See *Figure 2-18*)

The HSLs are used especially for selected link sets, for example, links to high capacity HLR and for HLR redundancy. They can co-exist with the 64 kbit/s signaling links in the same node.

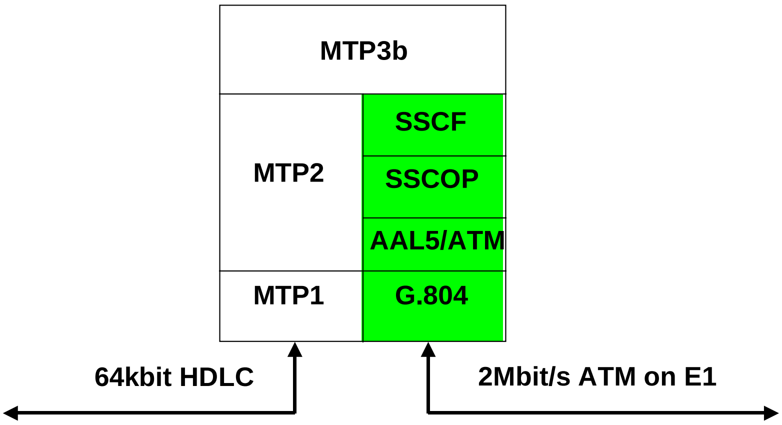


Figure 2-18 Protocol Stack of Conventional and High Speed Signaling Link

SSCF: Service Specific Co-ordination Function Q.2140
SSCOP: Service Specific Connection Oriented Protocol Q.2110
AAL5 ATM Adaptation Layer, type 5 I.363

STANDALONE HLR

The S7 (MTP) configuration is the same in a standalone HLR for Signaling Points (SPs), Link Sets (LSs), Signaling Links (SLs), and Signaling Terminals (STs). However, due to the fact that it does not have a Group Switch (GS), the terminals are connected to a “simple” multiplexer, for example, drop-insert, and not to the GS. Therefore, no SNT, DIP, Routes (traffic or signaling) exist in such a node.

MAJOR S7 PRINTOUTS

Table 2-1 presents the major S7 MTP print commands.

Note: This overview does NOT replace any official system documentation, for example, the B-module.

	Command (GSM 900)	Command (GSM 1900)	Description
Signaling point	C7SPP:SP=sp;	S7DEP:DEST=dest;	OWNSP, SP DATA
MTP Routing	C7RSP:DEST=dest;	S7RSP:DEST=dest;	Data, STATE
	C7RAI/C7RAE:DEST =dest;		Activation/Deactivation
	C7RUP:DEST=dest;	S7DSP:DSET=dest;	Supervision DATA
Link Set	C7LDP:LS=ls;	S7SLP:LS=ls;	DATA (LS, SLC, ST, SPID)
	C7LTP:LS=ls;	S7LTP:LS=ls;	STATE
	C7SUP:LS=ls;		Supervision DATA
Signaling Link	C7LDP:LS=ls;	S7LDP:LS=ls;	DATA (LS, SLC, ST, SPID)
	C7IHI/C7IHE:LS=ls, SLC=slc;	S7IHI/S7IHE:LS=ls, SLC=slc;	Inhibiting/Uninhibiting
	C7LAI/C7LAE:LS=ls, SLC=slc;	S7LAI/S7LAE:LS=ls, SLC=slc;	Activation/Deactivation
Signaling Terminal	C7STP:ST=C7ST2-x;	S7STP:ST=S7ST-x;	DATA (ST, RP/EM, LS, SPID, SLC)
	C7TSP:ST=C7ST2-x		STATE
	C7LDP:LS=ls;	S7LDP:LS=ls;	DATA (LS, SLC, ST, SPID)
	BLEMI/BLEME:EM= em,RP=rp;	BLEMI/BLEME:EM= em,RP=rp;	Blocking/Deblocking of ST (SLC must be deactivated)
	C7TDI:ST=C7ST2-x;	S7TDI:ST=S7ST-x;	ST Diagnostic (SLC must be deactivated)
PCD-D	C7SDP:DEV =C7PCDD-x;	n/a	PCDD <--> ST DATA
	STDEP:DEV =C7PCDD-x;	n/a	STATE
	BLODI/BLODE:DEV =C7PCDD-x;	n/a	Blocking/Deblocking

Table 2-1: Major MML Commands - MTP

Signaling Connection Control Part

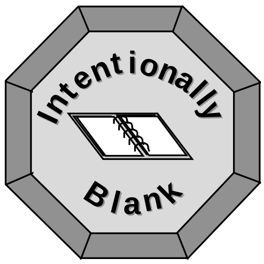
Chapter 3

This chapter is designed to provide the student with a basic knowledge of the SCCP.

OBJECTIVES:

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

- Explain the sequence for a signaling message in the SCCP
- Use MML printout commands to obtain a view of the SCCP configuration and use the B-module to interpret the results
- Define a SCCP network using the B-module and a work order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3 Signaling Connection Control Part

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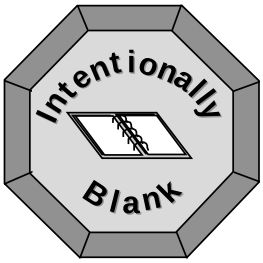
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INTRODUCTION

The S7 consists of various functional elements where the Message Transfer Part (MTP) is the common platform. MTP serves different user parts, such as Telephony User Part (TUP), Integrated Services Digital Network User Part (ISUP), and other functional elements like Signaling Connection Control Part (SCCP).

The SCCP provides additional functionality to fulfill the need for extended services in certain applications.

An example of an extended service is communication with the databases, Home Location Register (HLR) and Visitor Location Register (VLR), without any speech connection, for example, communication during Location Updating.

The combination of the MTP and the SCCP is called the Network Service Part (NSP).

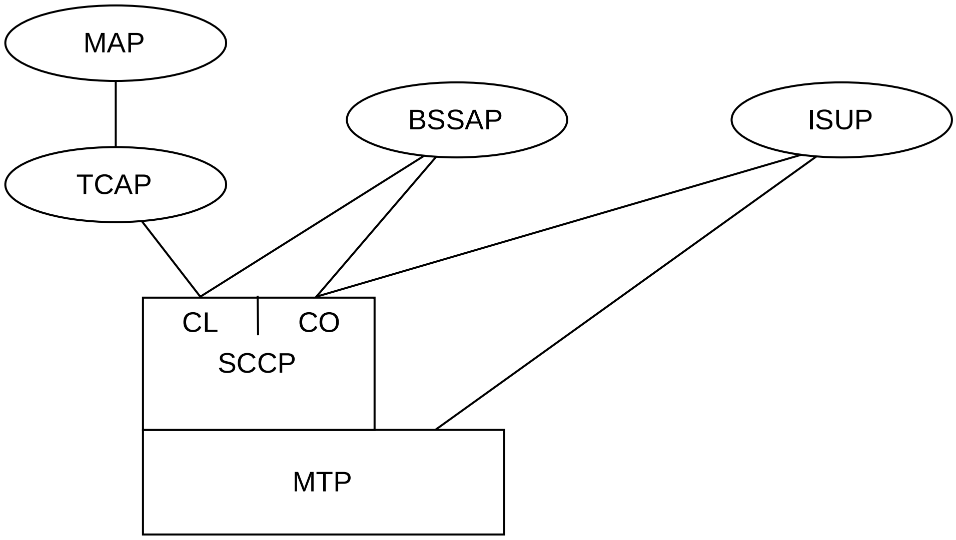
The SCCP supports two network services:

- Connection Oriented (CO)
- ConnectionLess (CL)

See *Figure 3-1*.

The CO transfers many or long signaling messages between two nodes. In this case, it makes sense to “establish a logical connection” between the sender and receiver.

The CL transfers short messages, including routing information, to their destination.



CO = Connection Oriented
CL = ConnectionLess

Figure 3-1 The SCCP and Other Protocols

The protocol between the Mobile services Switching Center/Visitor Location Register (MSC/VLR) and the Base Station Controller (BSC) is called the Base Station System Application Part (BSSAP).

The BSSAP requires both the Connection Oriented (CO) and the ConnectionLess (CL) service. The MSC/VLR, HLR, and GMSC communicate via the Mobile Application Part (MAP), using only the ConnectionLess (CL) mode. The Transaction Capabilities Application Part (TCAP) supports the MAP. However, there is no need to describe the TCAP functionality to understand how GSM works.

Note: BSSAP and TCAP are not explained here.

Whereas the SCCP performs tasks similar to the MTP; for example, routing, the SCCP allows only routing of MAP/BSSAP messages. The MTP and SCCP should be considered as two different networks that are linked together.

SCCP ADDRESSING

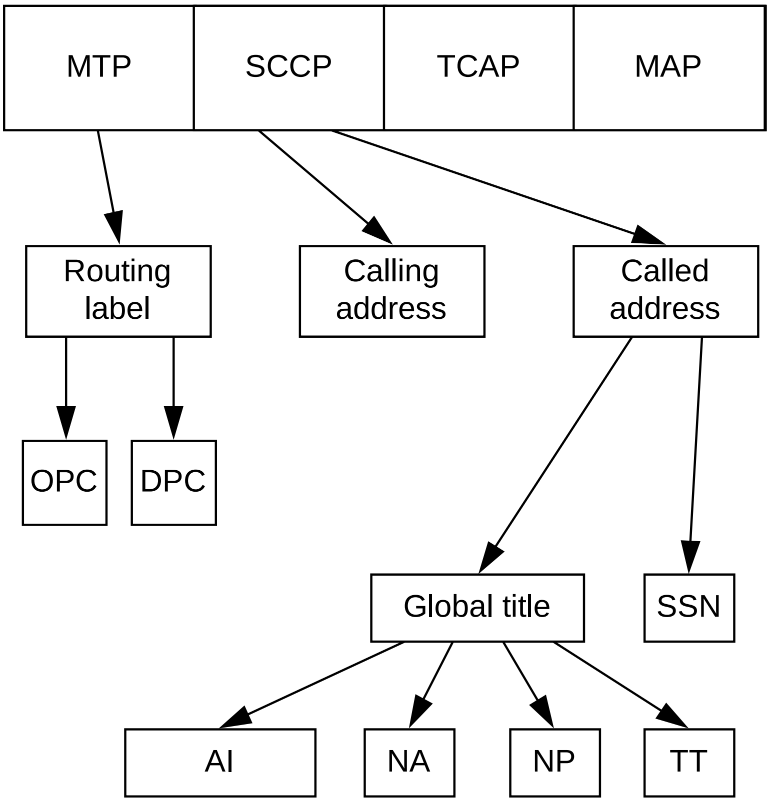
The SCCP enables an S7 to route MAP messages. Routing is always based on addresses. The SCCP uses the following addresses:

- Calling address — identifies call origination
- Called address — identifies call destination

SCCP addressing is very flexible and makes use of three separate elements:

- Destination Point Code (DPC)
- Global Title (GT)
- SubSystem Numbers (SSN)

See *Figure 3-2.*



NA = Nature of Address
AI = Address Information
SSN = SCCP Subsystem Number
TT = Translation Table
NP = Numbering Plan

Figure 3-2 SCCP Addressing

One, two, or three elements may be present in the address information for the called and the calling party. The form of the address depends on the service, application, and underlying network. The Address Indicator shows which information elements are present.

GLOBAL TITLE (GT)

The GT is of variable length, and can contain specified combinations of:

- Address Information (AI)
- Nature of Address (NA)
- Numbering Plan (NP)
- Translation Type (TT)

(See ITU, Q. 71x series)

It does not contain information that allows routing in the signaling network. The translation function is required.

The following sections contain details and typical values for some of the elements previously listed:

SubSystem Number (SSN)

The terminating node examines the SSN to identify the concerned user (node).

6	HLR
7	VLR
8	GMSC, MSC
9	EIR
10	AUC
12	SC
149	SGSN
224	HLR-R (HLR Redundancy)
254	BSC (BSSAP) in case of CCITT signaling (GSM 900)
252	SCP
3	ISUP (if ISUP uses SCCP)

Address Information (AI)

This is an address according to the numbering plan indicated. (See the example in Numbering Plan).

Nature of Address (NA)

NA indicates if the address is

3	National
4	International

Format according to the numbering plan used.

Numbering Plan (NP)

NP indicates the numbering scheme from which the address originates:

1	ISDN/Telephony Numbering Plan (E.163/E.164),
	for example, MSISDN, GT address
7	ISDN/Mobile Numbering Plan (E.214),
	for example, IMSI, MGT (Location Updating)

Translation Type (TT)

A GT requires a translation function. The TT directs the message to the appropriate Global Title (GT) translation.

It is possible for the Address Information (AI) to be translated into different values for different combinations of DPCs, SSNs and GTs.

0	CCITT signaling
9	ANSI signaling
1-8,	Used for the Service Center (SC) interface
10-254	MTS exchange property SMSFMOSMTRTYPE

EXAMPLE**:** NA=4, NP=1, AI=49 172, TT=0

NP indicates a normal ISDN/Telephony number. NA indicates international format for AI. Therefore, 49 is the Country Code (CC) for Germany and 172 is the NDC for the D2 operator, and the Translation Type (TT) is CCITT signaling.

EXAMPLE

This example describes the SCCP from an Operation point of view. It is based on the network, illustrated in *Figure 3-3*, and exchange data printouts are shown on the following pages. It is the same network as in Chapter 2 MTP.

The example focuses on basic S7 exchange data. S7 supervision data is not presented here.

Note: The printouts are exclusively made in the switching node Düsseldorf.

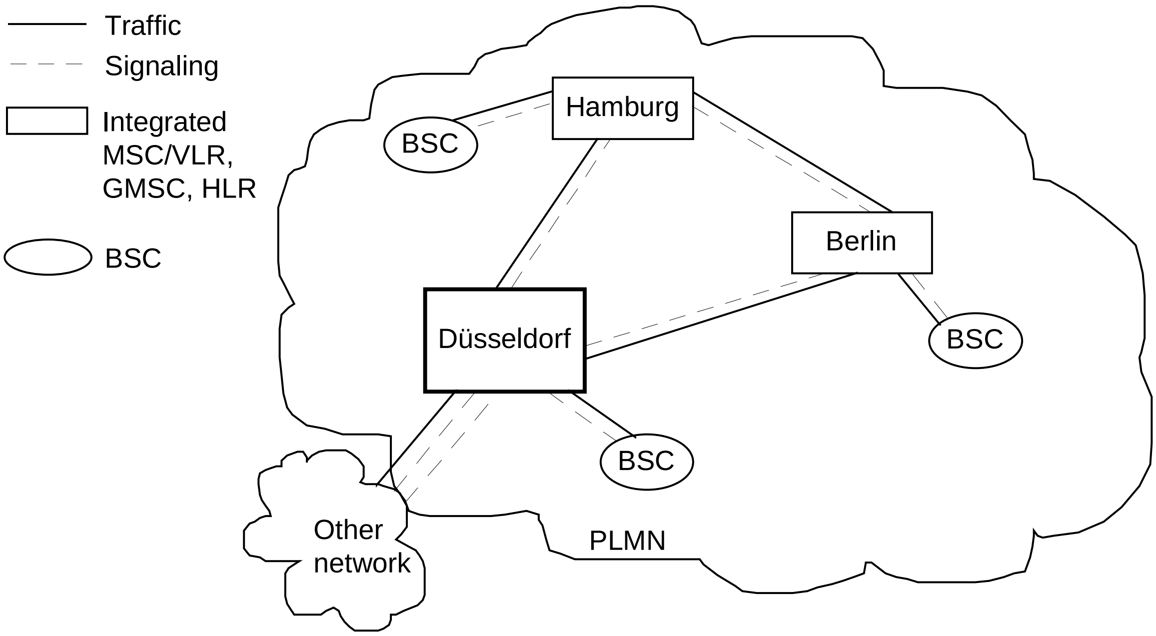


Figure 3-3 Example

PREREQUISITES

The SCCP runs on top of the MTP. The MTP network must be operational before the SCCP can be inititated.

ANALOGY BETWEEN CALLS AND S7 MESSAGES

Figure 3-4 illustrates a similarity between the "sequence" of handling a call and an S7 message (MTP, SCCP).

Note: It is assumed that the reader knows the sequence for handling a call and for handling an MTP message.

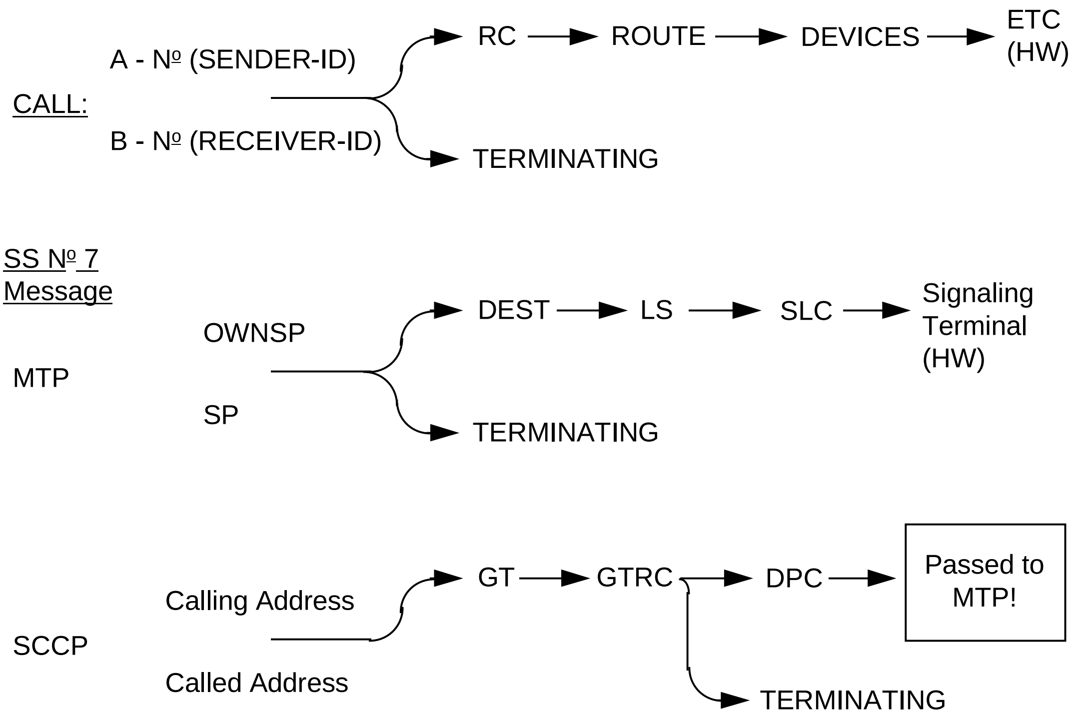


Figure 3-4 Analogies in Sequences

This figure is shown at an early stage in the example to provide the reader with an overview of the SCCP.

The SCCP runs on top of the MTP and only the MTP network has access to the physical link, for example, cable.

To send an MAP message between two different locations, the MTP sequence must be passed after the SCCP sequence.

CALLING AND CALLED ADDRESS

Different elements, for example, DPC, SSN, may be present in the calling and called addresses.

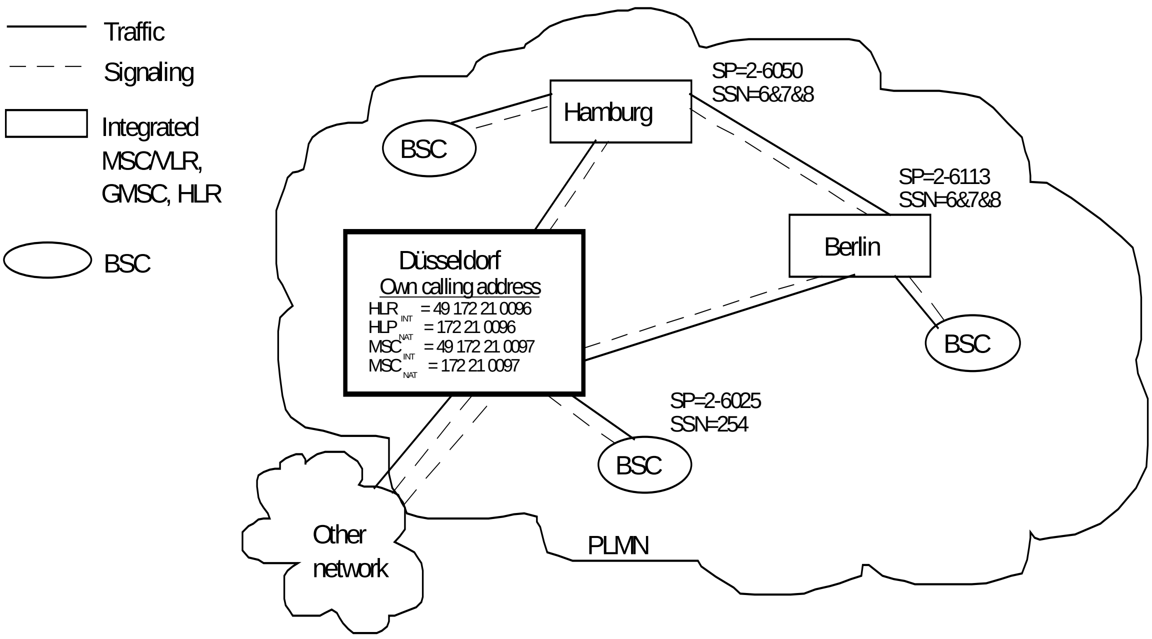


Figure 3-5 Calling and Called Addresses

Each node must have its individual calling address, used in national and international transmission. It has the same structure (defined by E.164) as an MSISDN. The structure is CC+NDC+SN.

See *Figure 3-5* and *Figure 3-6.*

In the individual node address, CC and NDC (NPA in GSM 1900) are pre-determined; the SN is for the network operator to choose. The individual node address for the HLR and the MSC/VLR/GMSC may be different, for example, the HLR (Düsseldorf) address is 49 172 210096, whereas the MSC/VLR/GMSC address is 49 172 210097.

```
<HGCAP;
HLR OWN CALLING ADDRESS DATA

INT                       NAT
49172210096              172210096
END

<MGCAP;
MT OWN CALLING ADDRESS DATA

INT                       NAT
49172210097              172210097
END

<C7NCP:SP=ALL,SSN=ALL;
CCITT7 SCCP NETWORK CONFIGURATION DATA

SP        SPID      SP STATE     BROADCAST STATUS
2-6025    DUDFBSC   ALLOWED      NCON

                    SSN          SUBSYSTEM STATE
                    254          ALLOWED

SP        SPID      SP STATE     BROADCAST STATUS
2-6050    HAMBURG   ALLOWED      CON

                    SSN          SUBSYSTEM STATE
                    6            ALLOWED
                    7            ALLOWED
                    8            ALLOWED

SP        SPID      SP STATE     BROADCAST STATUS
2-6113    BERLIN    ALLOWED      CON

                    SSN          SUBSYSTEM STATE
                    6            ALLOWED
                    7            ALLOWED
                    8            ALLOWED

END
```

Figure 3-6 Printout of own Calling Address and Co-operating SPs

Each node has a list of all potential called addresses, co-operating Signal Points (SPs), in a network. A destination is identified by its Signaling Point Code (SPC), refer to *Figure 3-6*.

Each node knows the SSNs for its subsystems. However, the SSNs available in the co-operating SPs must be defined.

When signaling traffic is permitted in a subsystem, via SCCP, its state is set to ALLOWED.

In the example, node Düsseldorf has SSN=254 (BSC) available at SP=2-6025 (DUDFBSC). The co-operating SPs HAMBURG (2-6050) and BERLIN (2-6113) have integrated the HLRs

(SSN=6), VLRs (SSN=7), and the MSC/GSMCs (SSN=8). OTHERNT (0-1111) and its SSN are unknown to Düsseldorf; therefore, routing can only be performed in the MTP.

GLOBAL TITLE TRANSLATION

A node either originates, terminates, or transfers a message.

To generate an originating labeled message, the node uses the calling and called addresses. The form of the address depends on the service, application, and underlying network.

The Routing Indicator (RI) determines the method of terminating or transferring a message at a node. The form of the indicator depends on the service and application.

Due to these complex interrelations, it can be assumed that:

- HLR(Düsseldorf) serves subscribers having MSISDNs= 49 172 21xxxxx.
- HLR(Hamburg) serves subscribers having MSISDNs= 49 172 40xxxxx.
- HLR(Berlin) serves subscribers having MSISDNs= 49 172 30xxxxx.

Figure 3-7 and *Figure 3-8* illustrate the corresponding Global Title (GT) translation for Düsseldorf.

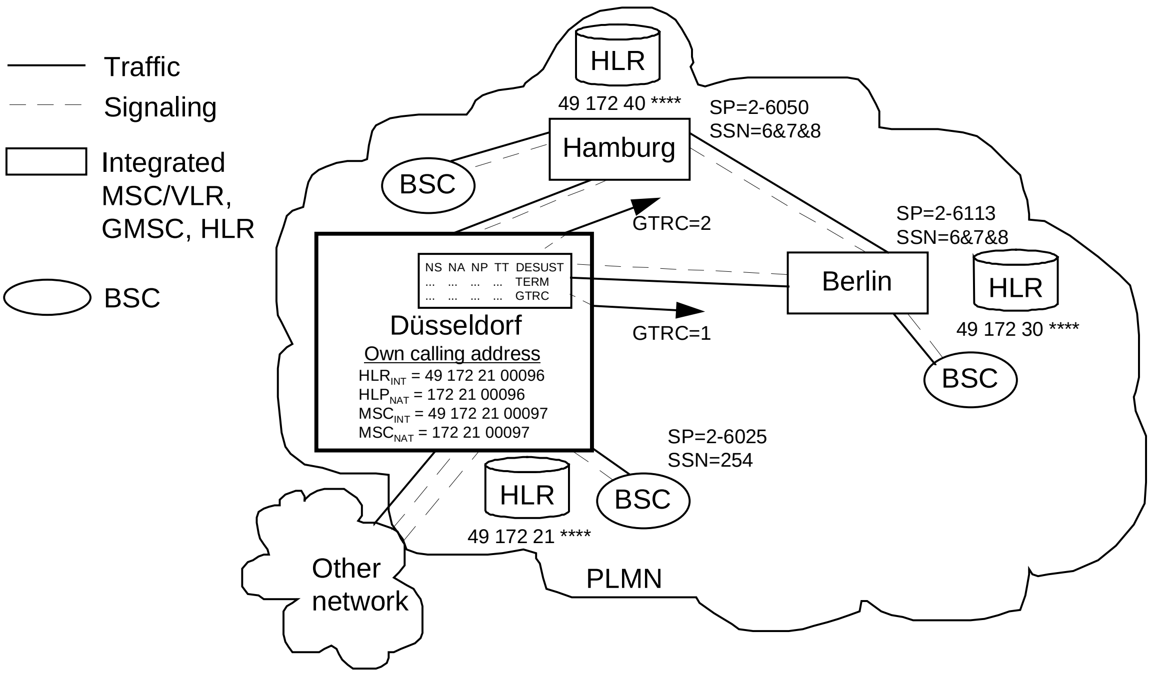


Figure 3-7 Global Title (GT) Translation in Düsseldorf

In this part of the example:

1. GMSC (Düsseldorf) receives a call for MSISDN=49 172 3011111.
2. GMSC (Düsseldorf) requests routing information from the HLR (Berlin), sending an MAP message via the SCCP and MTP network.
3. The first digits (NS=49 172 30) of the MSISDN (NA=4,NP=1) are used as the called address.
4. GMSC must transfer the message. Therefore, the result of the translation is a Global Title Routing Case (GTRC=1).

```
<C7GSP:GTRC=ALL;
CCITT7 GLOBAL TITLE SERIES TRANSLATION DATA

OPERATING

TT   NP  NA   NS                     GTRC
0    1   3    17230                  1
0    1   3    17240                  2
0    1   3    17221                  3
0    1   4    4917230                1
0    1   4    4917240                2
0    1   4    4917221                3
0    7   4    4917230                1
0    7   4    4917240                2
0    7   4    4917221                3
END
```

Figure 3-8 Printout of Global Title (GT) Translation in Düsseldorf

Figure 3-4 illustrates the similarities between Global Title Routing Case (GTRC) and Routing Case (RC). It is the input for the Global Title (GT) routing.

However, in case the call is for MSISDN=49 172 21 22222, GMSC must send an MAP message to the internal HLR.

No Global Title (GT) translation to the BSC (SSN=254) is performed.

Note: In GSM 1900, when no translation is required — when messages are sent to an internal element such as the HLR — these messages are defined as forwarded to a Local SubSystem (LSS), refer to SCCP Routing in GSM 1900.

GLOBAL TITLE ROUTING

The Global Title (GT) routing ties a destination, SP, to a GTRC (See *Figure 3-4*).

Example:

PSP=2-6113 is linked to GTRC=1 and is the Primary Signaling Point (PSP). If the first choice becomes faulty, the specified Secondary Signaling Point (SSP=2-6050) is used as the alternative point.

Note: This is optional. Hamburg must support this alternative.

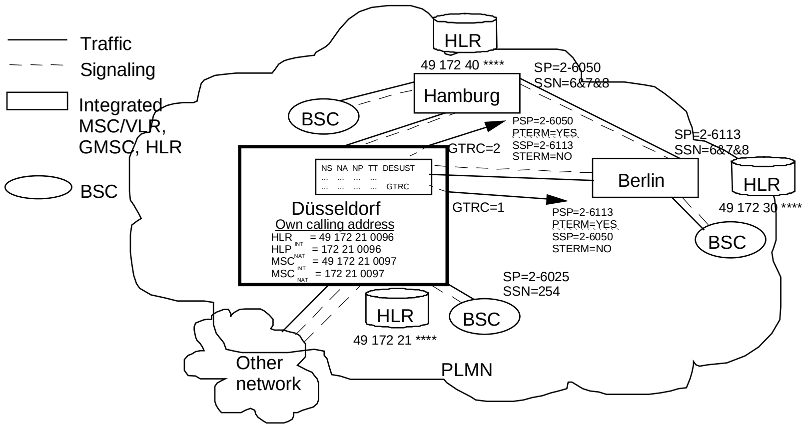


Figure 3-9 Global Title (GT) Routing with Alternatives

The Global Title (GT) routing enables one node to decide how the message must be handled in the next node.

Example:

A message sent with GTRC=1 to PSP=2-6113 must be terminated in the next node (Berlin). Therefore, PSP is marked as PTERM=YES in Düsseldorf.

Note: In GSM 1900, to indicate the message is terminated in the next node, the PSP is given a Routing Indicator (RI) of the SubSystem (SS) and the PSP subsystem is named (PSSN), refer to SCCP Routing in GSM 1900.

```
<C7GCP:GTRC=ALL;

CCITT7 GLOBAL TITLE ROUTING CASE DATA

GTRC PSP    PTERM PINTER PSSN SSP    STERM SINTER SSSN LSH

1    2-6113 YES   NO          2-6050 NO    YES          NO
2    2-6050 YES   NO          2-6113 NO    YES          NO
3    OWNSP  NO    NO                                    NO

 END
```

Figure 3-10 Printout of the Global Title Routing

A message sent with GTRC=1 to Berlin via the alternative Hamburg (SSP=2-6050) must be transferred in Hamburg. Therefore, the SSP is marked STERM=NO in Düsseldorf. Düsseldorf sets the Routing Indicator (RI) so that Hamburg must perform a GT translation and GT routing.

The Routing State indicates which routing; Primary, Secondary, or Prohibited, is possible.

After a node has determined the destination (PSP, SSP) on the SCCP, the MTP uses the Signaling Point (SP) as input to find the appropriate physical link, for example, cable. See *Figure 3-4*.

STANDALONE HOME LOCATION REGISTER (HLR)

There are only minor differences between a standalone and an integrated HLR.

Note: It is assumed here that the network has a single standalone HLR.

- None of the HLR co-operating Signaling Points (SPs) can have SSN=6 (HLR)
- A co-operating SP of the type “standalone HLR” has only SSN=6 (HLR)

SCCP ROUTING IN GSM 1900

SCCP routing in GSM 1900 networks is accomplished primarily as described in the previous example. The major differences are that, in GSM 1900:

- Signaling Points (SPs) are specified as network-cluster-member numbers, for example, 251-10-10, rather than as network indicator-signaling point code numbers. See the chapter MTP.
- The Element National Destination Code (NDC) in the MSISDN is called Numbering Plan Area (NPA). See GSM identity numbers in the chapter "Introduction".
- S7xxx commands are used. No C7xxx commands are applicable. See the paragraph Major Printouts in S7.
- Own-node termination of Global Title (GT) translation (S7TSI) is specified with the parameter LSS (local subsystem). See *Figure 3-11* through *Figure 3-13.*
- Global Title Routing Cases (GTRCs) (S7GCP) are specified with a Routing Indicator (RI) of the Global Title (GT) or the SubSystem (SS). When SS is indicated, the SubSystem Number (SSN) is given. See *Figure 3-11* through *Figure 3-13*.

Figure 3-11, *Figure 3-12*, and *Figure 3-13* contain examples of GSM 1900 S7xxx printouts, comparable to the GSM 900 C7xxx printouts, shown in *Figure 3-6*, *Figure 3-8*, and *Figure 3-10*, respectively.

```
<HGCAP;

HLR OWN CALLING ADDRESS DATA

INT              NAT
nnnnnnn          nnnnnnnnn
END



<MGCAP;

MT OWN CALLING ADDRESS DATA

INT              NAT
nnnnn            nnnnnnnnnn
END



<S7NCP:SP=ALL;

SS7 SCCP NETWORK CONFIGURATION DATA

SP               SP STATE
251-10-0         ALLOWED

SP               SP STATE
251-10-10        ALLOWED

SP               SP STATE
251-10-20        ALLOWED

SP               SP STATE
251-10-230       ALLOWED
END
```

Figure 3-11 Printout of own Calling Address and Co-operating SPs (GSM 1900)

```
<S7TSP:GTS=ALL;

SS7  GLOBAL  TITLE  SERIES  TRANSLATION
DATA

OPERATING

GTS                     TRANSLATION
RESULT
9    1500               GTRC=1
9    1713               GTRC=1
9    234305             GTRC=1
9    310010             GTRC=1
9    310014             GTRC=1
9    311034             GTRC=1
10   1500555            GTRC=1
10   15009991000        GTRC=3
10   15009992000        GTRC=2
10   1512477            GTRC=1
10   17134779           GTRC=1
212  234205             GTRC=1
212  310010             GTRC=1
212  311034             GTRC=1
END
```

```
<S7TSP:GTS=ALL,LSS=ALL;

SS7  GLOBAL  TITLE  SERIES  TRANSLATION
DATA

OPERATING

GTS                     TRANSLATION
RESULT
10   1500222            LSS=8
10   171347702          LSS=8
END
```

Figure 3-12 Printout of Global Title (GT) Translation (GSM 1900)

```
<S7GCP:GTRC=ALL;

SS7 GLOBAL TITLE ROUTING CASE DATA

GTRC   ROUTING STATE   RI   PSP      PSSN SSP
       SSSN

1      PRIMARY         GT   251-10-0
2      PROHIBITED      GT   251-10-20
3      PROHIBITED      GT   251-10-10
END


<S7GCP:GTRC=ALL,RI=GT,SP=251-10-0;

SS7 GLOBAL TITLE ROUTING CASE DATA

GTRC   ROUTING STATE   RI   PSP      PSSN SSP
       SSSN

1      PRIMARY         GT   251-10-0
END


<S7GCP:GTRC=ALL,RI=SS,SP=21-10-
1,SSN=6;

SS7 GLOBAL TITLE ROUTING CASE DATA

GTRC   ROUTING STATE   RI   PSP      PSSN SSP
       SSSN
NONE
END
```

Figure 3-13 Printouts of Global Title (GT) Routing (GSM 1900)

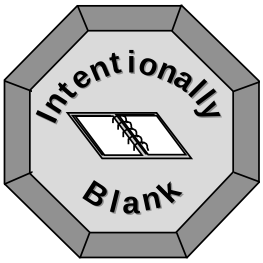
MAJOR PRINTOUTS IN S7

Table 3-1 shows an overview of the major S7 SCCP printout commands.

Note: This overview does NOT replace any official system documentation, for example, the B-module.

	Command (GSM 900)	**Command (GSM 1900)**	**Description**
Own Calling Address	MGCAP	MGCAP	MSC/VLR/GMSC own Calling address
	HGCAP	HGCAP	HLR own Calling address
SCCP Network Configu-ration	C7NCP:SP=sp, SSN=all	S7NCP:SP=all	Co-operating SP + subsystems DATA, STATE
Global Title Trans-lation	C7GSP:GTRC= gtrc	S7TSP:GTS=all, GTRC=all	Translation into GTRC
Global Title Routing	C7GCP:GTRC= gtrc ***or*** C7GCP: GTRC=all,...	S7GCP:GTRC= all ***or*** S7GCP:GTRC= all,RI=GT,SP=sp ***or*** S7GCP:GTRC= all,RI=SS,SP=sp, SSN=ssn	Routing GTRC --> SP

Table 3-1: Major Printout Commands - SCCP.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Mobile Services Switching Center - Base Station Controller

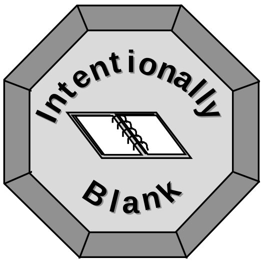
Chapter 4

This chapter provides the student with a knowledge of how the Mobile services Switching Center - Base Station Controller (MSC-BSC) Connection is defined in Ericsson's GMS System.

OBJECTIVES:

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

- Describe the connection between the MSC and a BSC
- Connect a new BSC to an existing MSC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4 Mobile Services Switching Center - Base Station Controller

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INTRODUCTION

The interface between the Mobile services Switching Center (MSC) and the Base Station Controller (BSC) is known as the A- interface. *Figure 4-1* illustrates the A-interface for GSM 900. *Figure 4-2* illustrates the A-interface for GSM 1900.

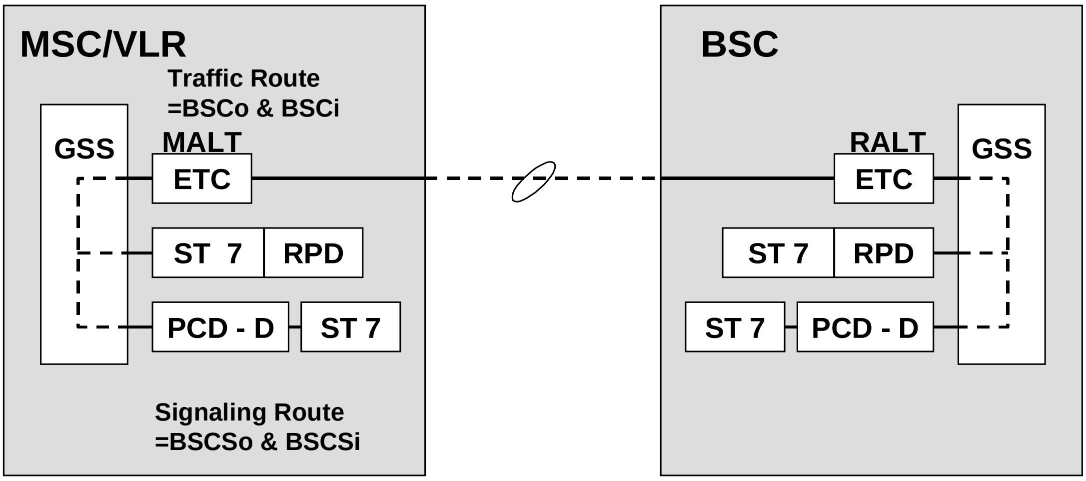


Figure 4-1 A-interface (GSM 900)

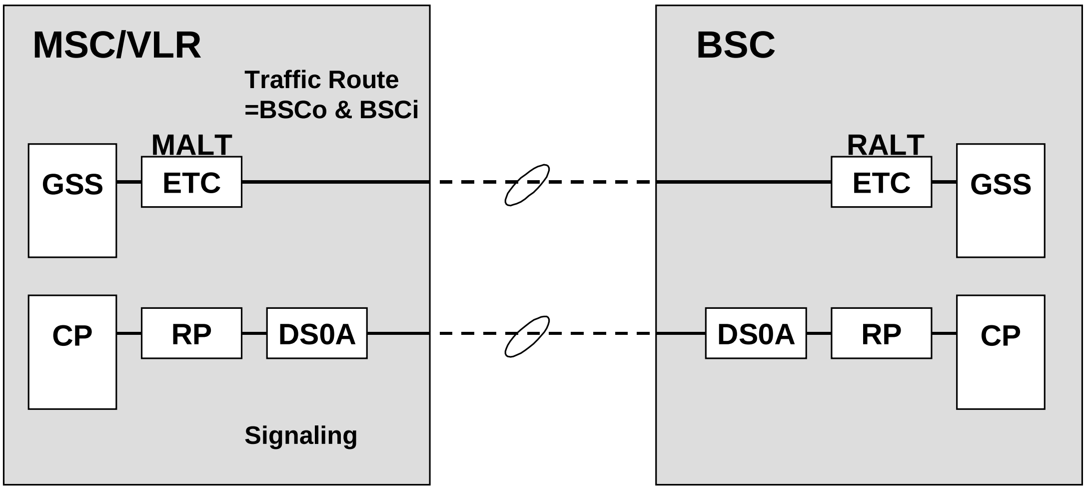


Figure 4-2 A-interface (GSM 1900)

TRANSCODER CONTROLLER (TRC)

Transcoders are required to change the coding of speech to be transmitted over the air interface. Three types of coding exist, Full Rate (FR), Half Rate (HR,) and Enhanced Full Rate (EFR).

Traditionally, the transcoders were placed at the BSC and were controlled by the BSC. The Transcoders can now be configured as a standalone node, placed on the A-Interface, but not under the control of the BSC. Up to 15 BSCs can be connected to one TRC.

Figure 4.1 and *Figure 4.2* show a standalone BSC without the TRC combined with this BSC. In *Figure 4.3*, a combined TRC/BSC and a standalone BSC are shown with the interfaces connected. Note that the MSC is always connected to the A-Interface; only the interface between the TRC and the BSC changes to the Ater-interface, compared to the direct MSC-BSC connection.

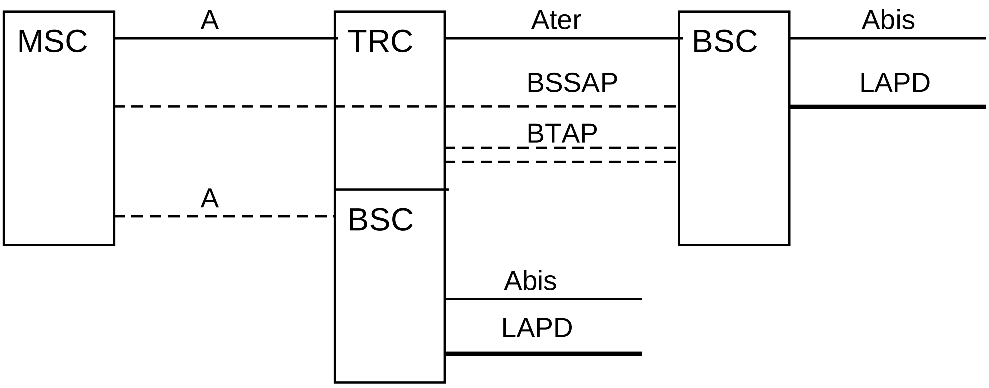


Figure 4-3 Combined TRC/BSC and Standalone BSC

DEFINITION OF MOBILE TELEPHONY A-INTERFACE LINE TERMINAL (MALT) DEVICES

The time slots on the MSC/BSC interface are defined as Mobile telephony A-interface Line Terminal (MALT) devices in the MSC. The MALT function block controls the software for the Exchange Terminal Circuits (ETCs). In addition, MALT handles the administration of routes and devices.

The time slots on the MSC/BSC interface are defined as Radio Control Subsystem (RCS) A-interface Line Terminal (RALT) devices in the BSC.

For all traffic connections between the MSC and the BSC, time slots are seized on the PCM link. For GSM 900, time slots on the PCM are also seized for MSC-BSC signaling. For GSM 1900, signaling is not performed on the PCM link.

SIGNALING LINK ON THE A-INTERFACE

For GSM 900, one channel (64 kbit/s) on a PCM system provides the signaling link between the MSC and the BSC. It links both exchanges and terminates on a Signaling Terminal (ST).

This ST (ST-7) is connected to a Pulse Code Device-Digital (PCD-D) which interfaces with the Group Switch (GS). PCD-D accepts four inputs of 64 kbit/s, that is, four STs connected to it, and has one output of 2 Mbit/s towards the Group Switch (GS). See *Figure 4-1*. For further variants to implement a Signaling Terminal, refer to Chapter 2 (MTP).

For GSM 1900, the signaling link between the MSC and the BSC is provided by a Signaling Terminal (ST) of the type DS0A, which provides a 64 kbit/s direct link — a link with no connection through the Group Switch (GS). See *Figure 4-2*.

For Ericsson's GMS System, the protocol Base Station System Application Part (BSSAP) signals over the A-interface. The BSSAP uses the MTP and SCCP.

The BSSAP supports messages sent over the A-interface, between the MSC and the BSC/BTS. In addition, it supports messages sent transparently between the MSC and the MS. See *Figure 4-4.*

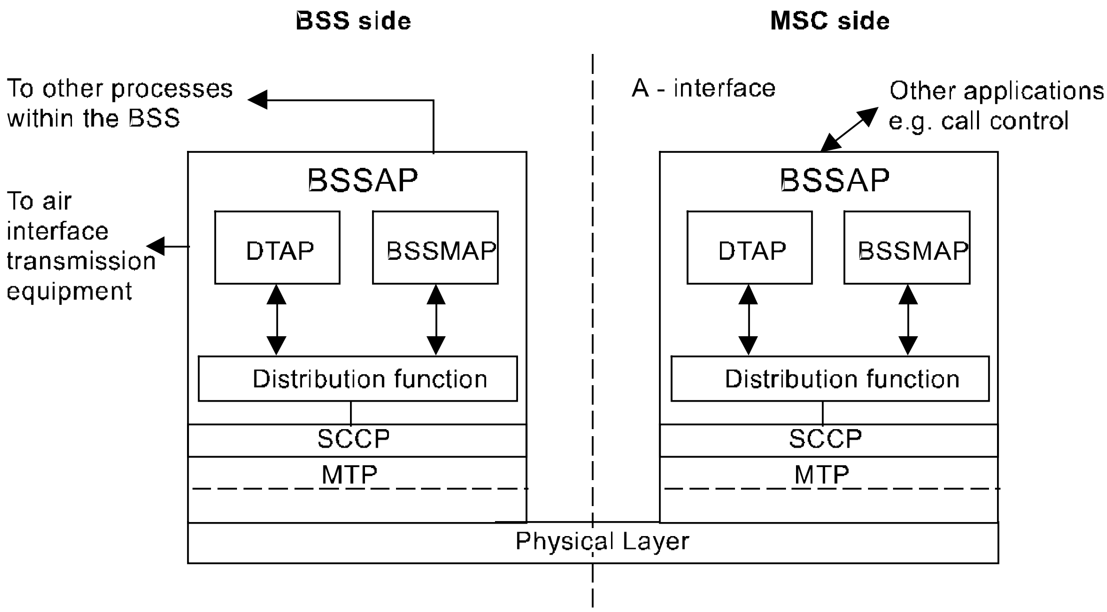


Figure 4-4 The BSSAP

CONNECTING A BSC TO THE MSC

Besides traffic and signaling routes towards the BSC, the MSC requires information about the cell structure of the BSC for charging and administration functions.

In the following example, all the commands necessary for connection of a BSC to an MSC in GSM 900, will be examined. Only the actions necessary in the MSC are described.

Note: The example described is valid for connecting an Ericsson BSC to an Ericsson MSC. If a BSC of another vendor is connected to an Ericsson MSC, it might be necessary to introduce circuit pools for the different speech codecs.

OPI:

Mobile Telephony, BSC, Connect

AI:

MALT

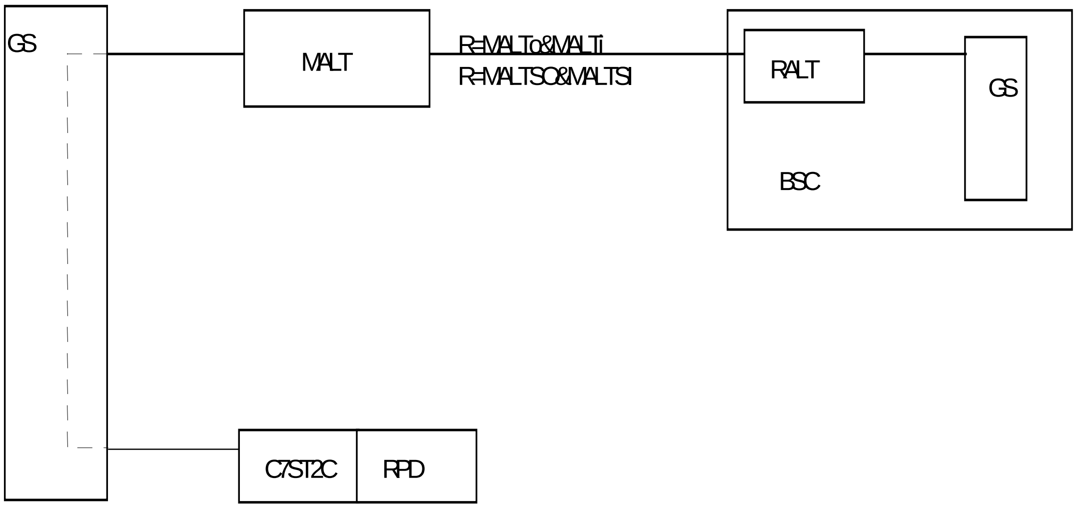


Figure 4-5 BSC Connection.

First, a route must be defined for normal bothway traffic from the MSC to the BSC. The FuNction Code (FNC) 3 indicates that it is a traffic route.

EXROI:R=MALTO&MALTI, DETY=MALT, FNC=3,

SP=2-1000,SI=SCCP;

The DEvice TYpe (DETY) used is MALT, the Service Indicator (SI) is the Signaling Connection Control Part (SCCP).

Then, the signaling routes are defined. The FNC 5 indicates the signaling route.

EXROI:R=MALTSO&MALTSI, DETY=MALT, FNC=5;

Provided that the MTP part of the signaling between the MSC/VLR and the BSC is already defined, the SCCP configuration must be defined. The Signaling Point (SP) of the BSC must be known. The commands used are as follows:

C7NPI: SP=2-l000;

C7NSI:SP=2-1000, SSN=254;

For GSM, the SubSystem Number (SSN) for the BSC is defined as 254. This SubSystem Number (SSN) is defined for BSSAP signaling.

MGBSI:BSC=BSCA, R1 =MALTO, R2=MALTI;

The BSC, identified by its name (BSCA), is associated to the previously defined incoming and outgoing traffic routes.

The devices are then connected to the routes; the device MALT-16 is used for signaling. The parameter MISC1 is used to indicate the Circuit Identification Code (CIC) for the first device in the route. The CIC in the MSC must be the same as the CIC defined in the BSC.

EXDRI:R=MALTO&MALTI, DEV=MALT-l&&-15, MISC1 = 1;

EXDRI:R=MALTO&MALTI, DEV=MALT-17&&-31 ,MISC1 = 17;

EXDRI:R=MALTSO&MALTSI, DEV=MALT-16;

Next, the devices are taken from pre-post service into service state.

EXDAI:DEV=MALT-l&&-31;

For the signaling, a semi-permanent connection through the Group Switch (GS) must be set up. In this example, the semi-permanent connection is made between MALT-16 and C7ST2C-0.

The semi-permanent connection is defined using:

EXSPI:NAME=SEMIP01;

EXSSI:DEV1=MALT-16;

EXSSI:DEV2=C7ST2C-0;

EXSPE;

The semi-permanent connection is activated using:

EXSCI:NAME=SEMIP0l, DEV=MALT-l6;

The final step is to define all the cells allocated to a BSC. The MSC requires this information to change charging and routing origins for originating calls.

An example of the command, used to define a cell in the MSC, is as follows:

MGCEI:CELL=BSCA22, CGI=262-02-l0-l0, BSC=BSCA;

In this example, a new cell (BSCA22) is defined and is connected to the BSC (BSCA). The Cell Global Identity (CGI) is stated. In this example, the mobile country code is 262, the mobile network code is 02, the location area code is 10, and the cell identity is 10.

MGCEC:CELL=BSCA22, RO=4, CO=1, EA= 1;

The charging and routing origins and the emergency area for mobile originated calls are defined.

OPERATIONAL INSTRUCTION (OPI)

When defining the exchange data for a BSC, the following OPIs should be used:

- Mobile Telephony, BSC, Connect
- Mobile Telephony, BSC, Disconnect
- Mobile Telephony, BSC, Change
- Mobile Telephony, BSC, Route, Add
- Mobile Telephony, BSC, Route, Delete
- Mobile Telephony, Cell, Define
- Mobile Telephony, Cell, Delete
- Mobile Telephony, Cell Data, Change

ADAPTATION DIRECTION

Mobile Telephony Data: Base Station Controller

Mobile Telephony Data: A-Interface Circuit Pool Compatibility

Mobile Telephony Data: Base Station Controller Route

APPLICATION INFORMATION

Mobile Telephony A-Interface Terminal Changeable Exchange Adaptation

Mobile Mobility and Radio Data Changeable Exchange Adaptation

ABBREVIATIONS

The following are abbreviations used when defining a BSC in the MSC:

- SSN : the SubSystem Number for the BSC in GSM
- R: Route
- SP: Signaling Point
- FNC: FuNction Code
- CGI: Cell Global Identity

Location Updating

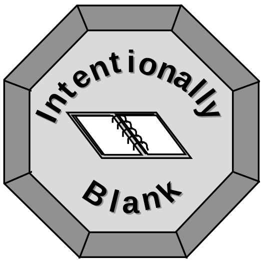
Chapter 5

This chapter provides the student with a knowledge of the exchange data, necessary to enable Location Updating from the data transcript perspective.

OBJECTIVES:

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

- Explain how a Location Updating is handled in the MSC/VLR
- Define the exchange data in the MSC that is necessary to allow a Location Updating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5 Location Updating

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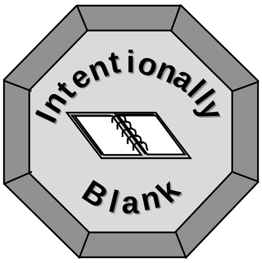
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INTRODUCTION

When the MS is powered on in an MSC/VLR service area, the MS must carry out a Location Update. If the IMSI is not recognized in the VLR, the VLR requests subscriber information from the HLR where the MS's subscription is held. Remember, when a new subscription is taken out, the subscription belongs to one HLR, and the MS becomes a visitor whenever it is powered on in an MSC/VLR service area.

The VLR uses MAP signaling to communicate with the HLR to carry out a location update. All MAP signaling uses the SCCP and the SCCP nodes are addressed using a Global Title (GT). A GT is similar to a dialed number and is based on the E.164 series.

The MS has only sent the IMSI up to the MSC/VLR, which is based on the E.212 series, this is not a dialed number in the telephony network. For the VLR to communicate with the HLR, the IMSI must be modified to a format allowing it to be used in the SCCP network. This new number series is referred to as a Mobile Global Title (MGT) and is based on the E.214 series, made up of the CC + NDC + MSIN. The CC identifies the country code and the NDC the network. The MGT is only used for Location Updating.

This MGT is then used to route the MAP signal through the SCCP network from a VLR to the subscribers HLR.

IMSI NUMBER SERIES ANALYSIS

Whenever a new roaming agreement is taken out, the information on how to convert the IMSI to a MGT must be specified in each MSC/VLR; this needs to be specified even for the PLMN's own subscribers.

The IMSI Number Series Analysis also gives information about what the MS is allowed to do within the current PLMN. This may differ from one roaming agreement to another.

```
      !********************************!
      !***** IMSI NUMBER ANALYSIS *****!
      !********************************!

MGISI:IMSIS= 262 02 21,
                       M= 7-4917221,! MODIFICATION+MSIN => NS (C7GSI) !
                       NA=4,        ! INTERNATIONAL NUMBER PLAN       !
                        ANRES=
                       OBA-30&      ! BO FOR ORIGINATING CALLS        !
                       CBA-49&      ! CALL BARRING FOR GERMAN SUBS.  !
                        BO=30&
                       PLMN-2&      ! ANNOUNCEMENT LANG. INDICATION   !
                       ERIS-12&     ! ERICSSON SPECIFIED SERVICES     !
                                    ! B0=1 => SPN, B1=1 => ICI,       !
                                    ! B2=1 => OIN, B3=1 => DMSISDN    !
                       MAPVER-1&    ! MAP VERSION                     !
                       NRRG-0&      ! ROAM. RESTR. GROUP              !
                       OWNMS&       ! OWN PLMN                        !
                       NATMS;       ! NATIONAL PLMN                   !
```

Figure 5-1 IMSI Number Series Analysis Data Transcript

Figure 5-1 shows the command and some of the parameters to specify a new agreement. The **M** parameter is the modification from the IMSI to the MGT. The **ANRES** parameter specifies what an MS with an IMSI starting with 262 02 21 is allowed to do in the network. The available options within ANRES can be found in the AI for Mobile Telephony Data.

With regard to Location Updating, two of the ANRES parameters are of interest, these are:

- ERIS
- MAPVER

Both relate to the MAP signaling requirements between the VLR and the HLR. The value ranges and the meaning of these values are given in the AI for the owning block of the parameter, for example, MAPVER is owned by MAPVC.

In *Figure 5-1*, the IMSIS of 262 02 21 is converted into a MGT of 49 172 21 by the parameter M, M=7-49 172 21. The MGT is in the international format.

To support the communication between the VLR and the HLR the ANRES parameters of ERIS and MAPVER are important.

- ERIS is used to identify that the HLR will support Single Personal Number, Immediate Call Itemization, Originating Intelligent Network, and Dual MSISDN.
- MAPVER indicates the MAP that should be used to the HLR. MAPVER-1 means that MAP version 2 should be used.

Some of the other parameters are mandatory parameters, but are not relevant for Location Updating, however, they will be explained in a later module.

The IMSI Number Series Analysis Table is made up of an operating and a non-operating side; changes are made to the non-operating side and then switched. The main commands to use are MGIZI, MGICI, MGISI, MGIAI, MGIAR, and MGISP.

GLOBAL TITLE ANALYSIS

When the Update Location MAP signal is sent, the NP parameter in the SCCP is set to a default value, NP=7. NP=7 means the number used is a Mobile Global Title (MGT).

The Global Title (GT) Analysis must reflect this, shown in *Figure 5.2*. Note that the Command C7GSI is used in GSM 900 only; GSM 1900 uses the command S7TSI.

```
C7GSI:TT=0,  NP=7 ,NA=4,NS=49,GTRC=4; !MGT GERMAN SUBSCRIBERS!

C7GSI:TT=0,NP=1,NA=4,NS=49,GTRC=4;     ! HLR/VLR GERMANY   !
```

Figure 5-2 SCCP Data for Location Update

The GT Analysis as defined in *Figure 5-2* will use GTRC=1 for a number series, NS=49, to realize a location updating (NP=7). The command line with NP=1 and GTRC=4, is used for the VLR to communicate with the HLR, once Location Updating has taken place. (For more information, refer to the chapter on the SCCP.)

In GSM 900 (command C7GSI), termination (PTERM=YES, PSP=OWNSP) should be defined, if the VLR and the HLR are in the same node.

Note: It is very important to remember that if a GT Analysis for NP=7 does not exist, a Location Update will not be made.

In practice, these two lines, one with NP=7 (Location Updating) and NP=1 (for all other VLR to HLR communication), are required for every Roaming Agreement that exists. Furthermore, data must be added when a new HLR is installed in your own PLMN.

If the PLMN has more than one HLR, the number series must be expanded to uniquely identify the individual HLR concerned.

In GSM 1900, the GT Analysis must be defined as follows:

S7TSI: GTS=gts, GTRC=gtrc, RI=GT;	S7TSI: GTS=gts, GTRC=gtrc, RI=SS, LSS=lss;

For GSM 1900, the NP and TT are system-derived, depending on the provision of the parameters NA and M, at an IMSI analysis.

If the VLR and HLR are in the same node, a Routing Indicator (RI) of SubSystem (RI=SS) and a Local SubSystem (LSS) should be defined in GSM 1900 (command S7TSI).

Figure 5-3 gives an overview of which data is checked and required during a Location Updating, if the subscriber enters a new MSC/VLR area.

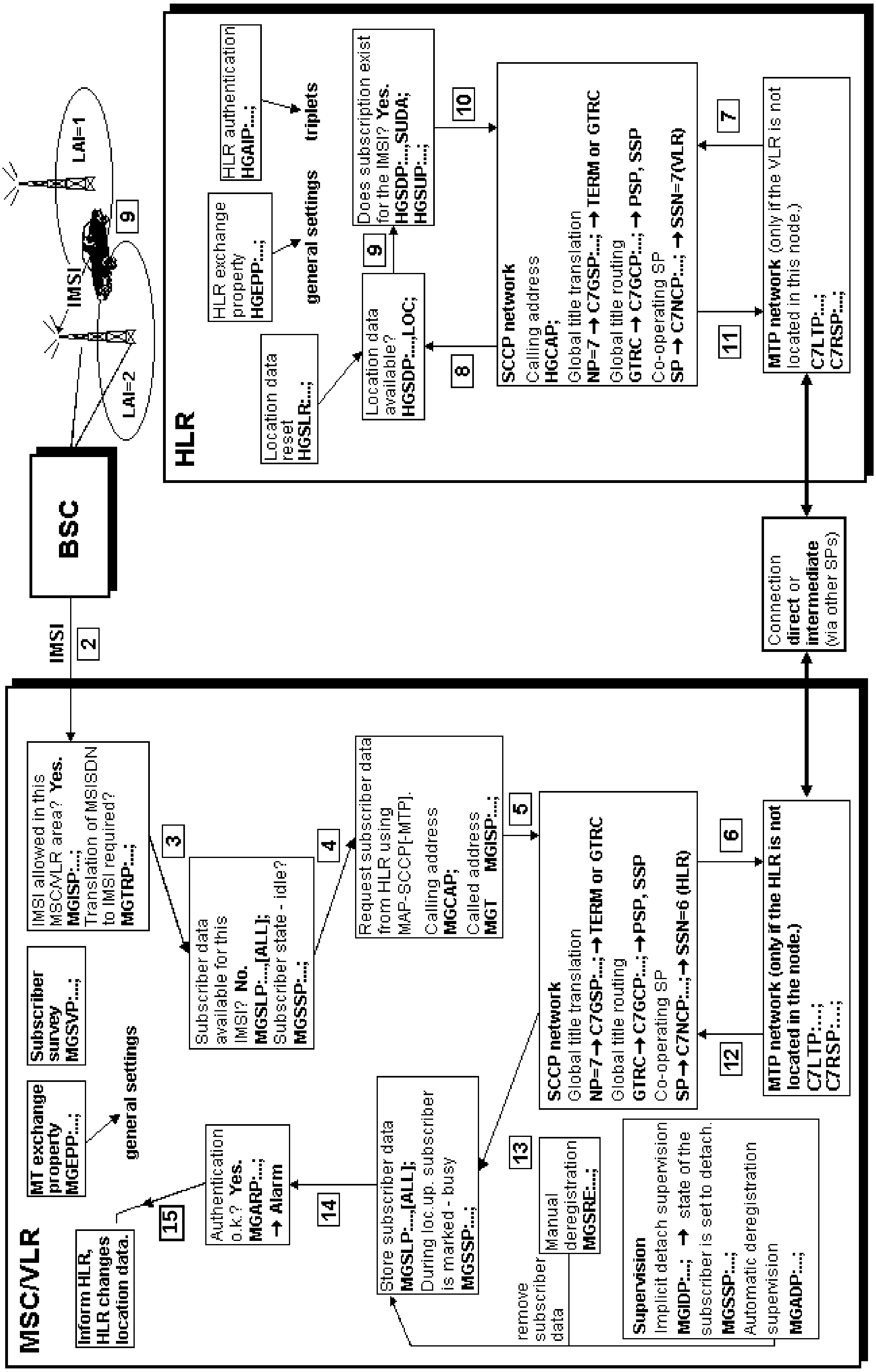

MSC/VLR
HLR
BSC
IMSI
2
LAI=1
LAI=2
9
IMSI allowed in this MSC/VLR area? Yes. MGISP:...; Translation of MSISDN to IMSI required? MGTRP:...;
Subscriber survey MGSVP:...;
MT exchange property MGEPP:...;
general settings
3
Subscriber data available for this IMSI? No. MGSLP:...,[ALL]; Subscriber state - idle? MGSSP:...;
4
Request subscriber data from HLR using MAP-SCCP[-MTP]. Calling address MGCAP; Called address MGT MGISP:...;
5
SCCP network Global title translation NP=7→C7GSP:...;→TERM or GTRC Global title routing GTRC→C7GCP:...;→PSP, SSP Co-operating SP SP→C7NCP:...;→SSN=6 (HLR)
6
12
MTP network (only if the HLR is not located in the node.) C7LTP:...; C7RSP:...;
Connection direct or intermediate (via other SPs)
Store subscriber data MGSLP:...,[ALL]; During loc.up. subscriber is marked - busy MGSSP:...;
13
Manual deregistration MGSRE:...;
remove subscriber data
Supervision Implicit detach supervision MGIDP:...; → state of the subscriber is set to detach. MGSSP:...; Automatic deregistration supervision MGADP:...;
14
Authentication o.k.? Yes. MGARP:...; → Alarm
15
Inform HLR, HLR changes location data.
Location data reset HGSLR:...;
HLR exchange property HGEPP:...;
general settings
HLR authentication HGAIP:...;
triplets
Location data available? HGSDP:...,LOC;
8
9
Does subscription exist for the IMSI? Yes. HGSDP:...,SUDA; HGSUP:...;
10
SCCP network Calling address HGCAP; Global title translation NP=7 → C7GSP:...; → TERM or GTRC Global title routing GTRC → C7GCP:...; → PSP, SSP Co-operating SP SP → C7NCP:...; → SSN=7(VLR)
7
11
MTP network (only if the VLR is not located in this node.) C7LTP:...; C7RSP:...;

Figure 5-3

Call to Mobile Station from Integrated Services Digital Network

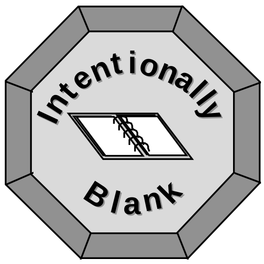
Chapter 6

This chapter provides the student with a knowledge of how Ericsson's GSM System network elements work together on a call from an Integrated Services Digital Network (ISDN) subscriber to a mobile subscriber.

OBJECTIVES:

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

- Describe how an ISDN-to-MS call is handled in each of the functional applications: GMSC, HLR, and MSC/VLR
- Define exchange data for the GMSC, HLR, and MSC/VLR to allow a mobile terminating call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6 Call to Mobile Station from Integrated Services Digital Network

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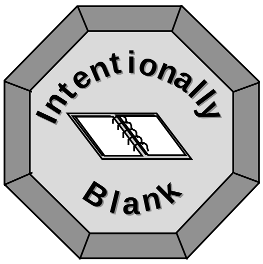
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GENERAL

The major difference between making a call to a mobile subscriber and making a call to an PSTN or ISDN subscriber is that the location of the mobile subscriber is unknown. Therefore, the Mobile Station (MS) must be located and paged before a connection can be established.

A call to a GSM subscriber enters the network through a Gateway-MSC (GMSC). A GMSC is the interface between a GSM Public Land Mobile Network (PLMN) and all other networks for a mobile terminating call. This chapter first examines the functions of a GMSC, and then describes how a call is handled in a GSM network implemented by Ericsson's GSM System.

GMSC

INTRODUCTION

A GMSC connects GSM networks with other networks for a mobile terminating call. It is the point in the PLMN where calls to mobile subscribers first enter. Furthermore, the GMSC is necessary for all mobile terminating calls.

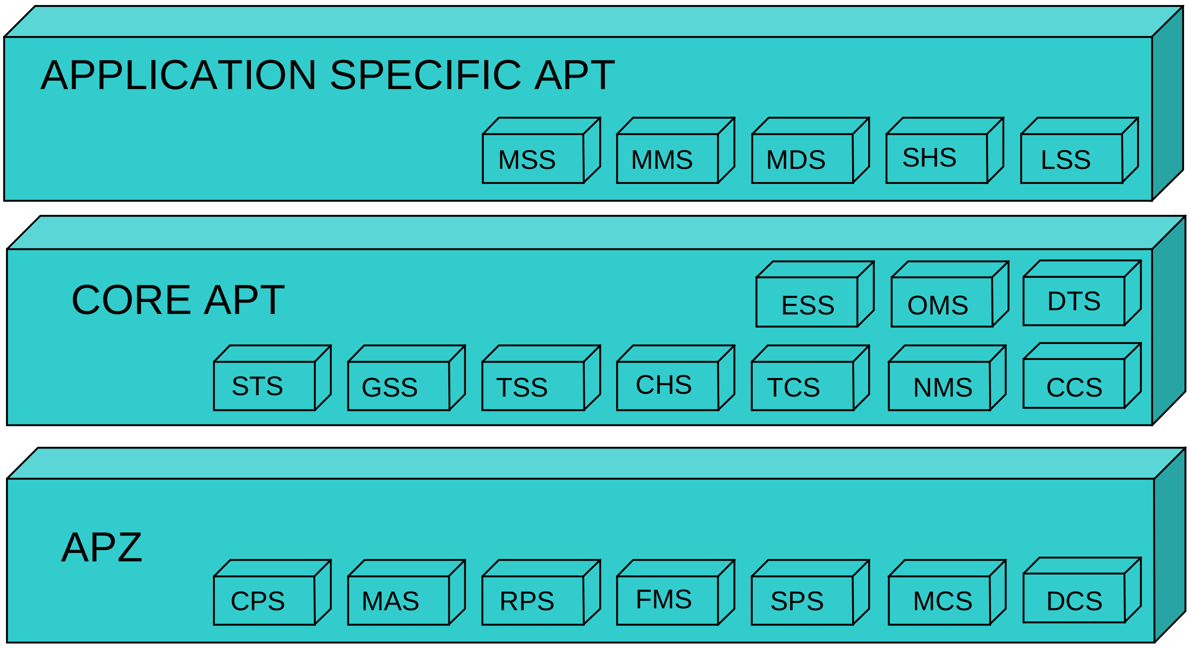
A GMSC has the following features:

- It contains an interrogation function used for retrieving information on the location of the mobile subscriber from the Home Location Register (HLR). The location given is the address of the Mobile Switching Center/Visitor Location Register (MSC/VLR) where the subscriber is currently located.
- It is used only for calls to a mobile subscriber, regardless of whether the call is mobile-originated or PSTN/ISDN-originated.
- It is implemented by an Ericsson Digital Switching System (AXE) exchange with the Mobile Switching Subsystem (MSS) and can be integrated with the MSC/VLR. MSS is a software subsystem.

AXE STRUCTURE

Subsystems

A GMSC consists of all of the main AXE Control System (APZ) subsystems and a number of AXE Switching System (APT) subsystems which belong to the eXisting Source System (XSS) and the Resource Module Platform (RMP). See *Figure 6-1*. The main APT subsystem which implements the gateway telephony functions is the MSS.



CCS = Common Channel signaling Subsystem
CHS = CHarging Subsystem
CPS = Central Processor Subsystem
DCS = Data Communication Subsystem
DTS = Data Transmission Subsystem
ESS = Extended Switching Subsystem
FMS = File Management Subsystem
GSS = Group Switching Subsystem
LSS = Location Service Subsystem
MAS = MAintenance Subsystem
MCS = Man-machine Communication Subsystem
MDS = Mobile Data Subsystem
MMS = Mobile Mobility and radio Subsystem
MSS = Mobile Switching Subsystem
NMS = Network Management Subsystem
OMS = Operation and Maintenance Subsystem
RPS = Regional Processor Subsystem
SHS = SHort message service Subsystem
SPS = Support Processor Subsystem
STS = Statistical and Traffic measurement Subsystem
TCS = Traffic Control Subsystem
TSS = Trunk and Signaling Subsystem

Figure 6-1 AXE Subsystems in the GMSC

In a GMSC, the MSS implements gateway and roaming rerouting functions, including Mobile Application Part (MAP) signaling:

- Roaming Rerouting — This function is responsible for rerouting an incoming call according to the information obtained from the HLR.

The GMSC can reroute the call to the MSC/VLR where the called subscriber is located, or to a C-number in case call forwarding is activated.

It also contains functions for charging and co-ordinates announcement sending to the A-subscriber in the case of call forwarding.

- MAP function — This function is responsible for the signaling procedures with the HLR.

  MAP functions interrogate the HLR for routing information (roaming number- Mobile Station Roaming Number [MSRN], or a C-number for call forwarding).

HARDWARE STRUCTURE

The hardware structure of a GMSC or an MSC/VLR (See *Figure 6-2* and *Figure 6-3*) needs the following special equipment:

- Echo cancelers are equipped for speech calls from the PSTN or ISDN (echo cancelers towards the ISDN are only necessary if an ISDN routes a call that originates in an analog PSTN).
- Multiplexers are used to interface the S7 Signaling Terminal (ST) with the HLR.

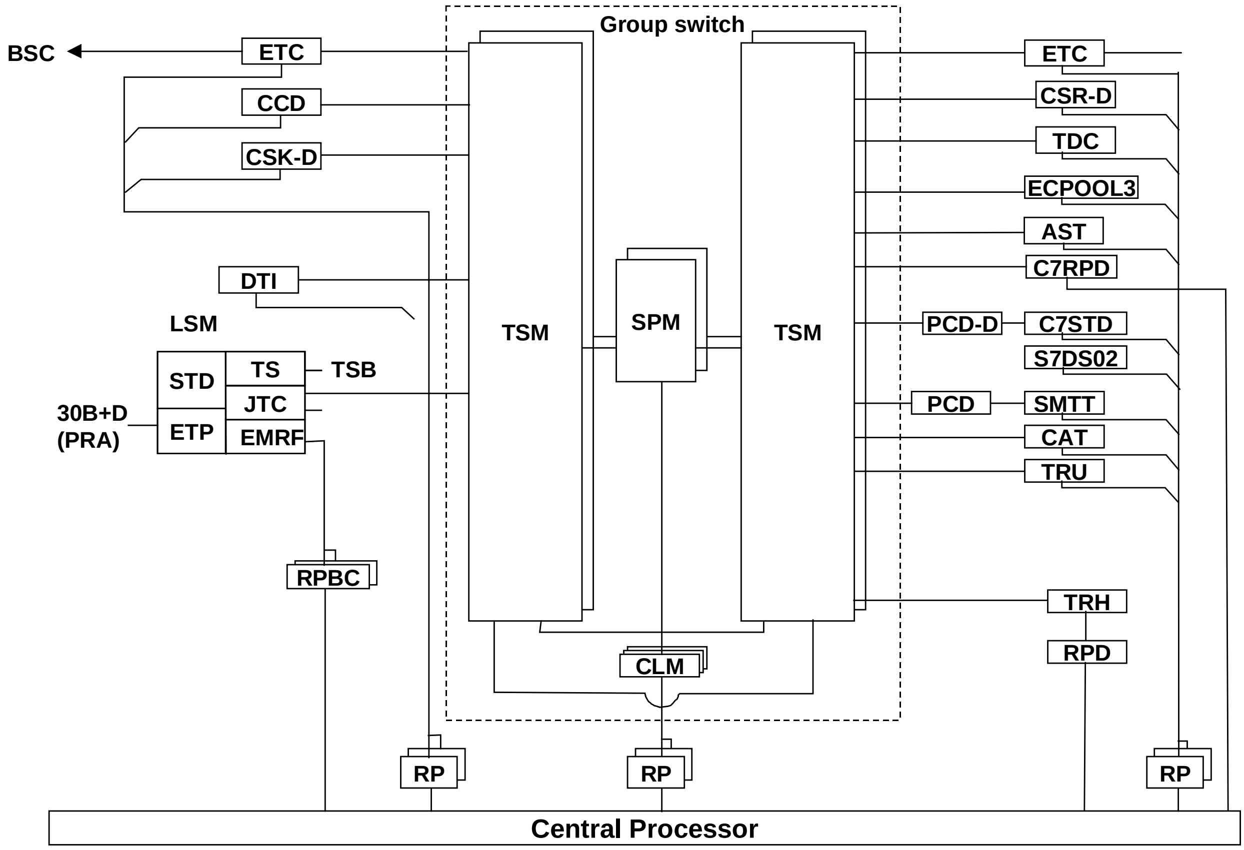


Figure 6-2 Hardware Structure of GMSC or MSC (BYB 202)

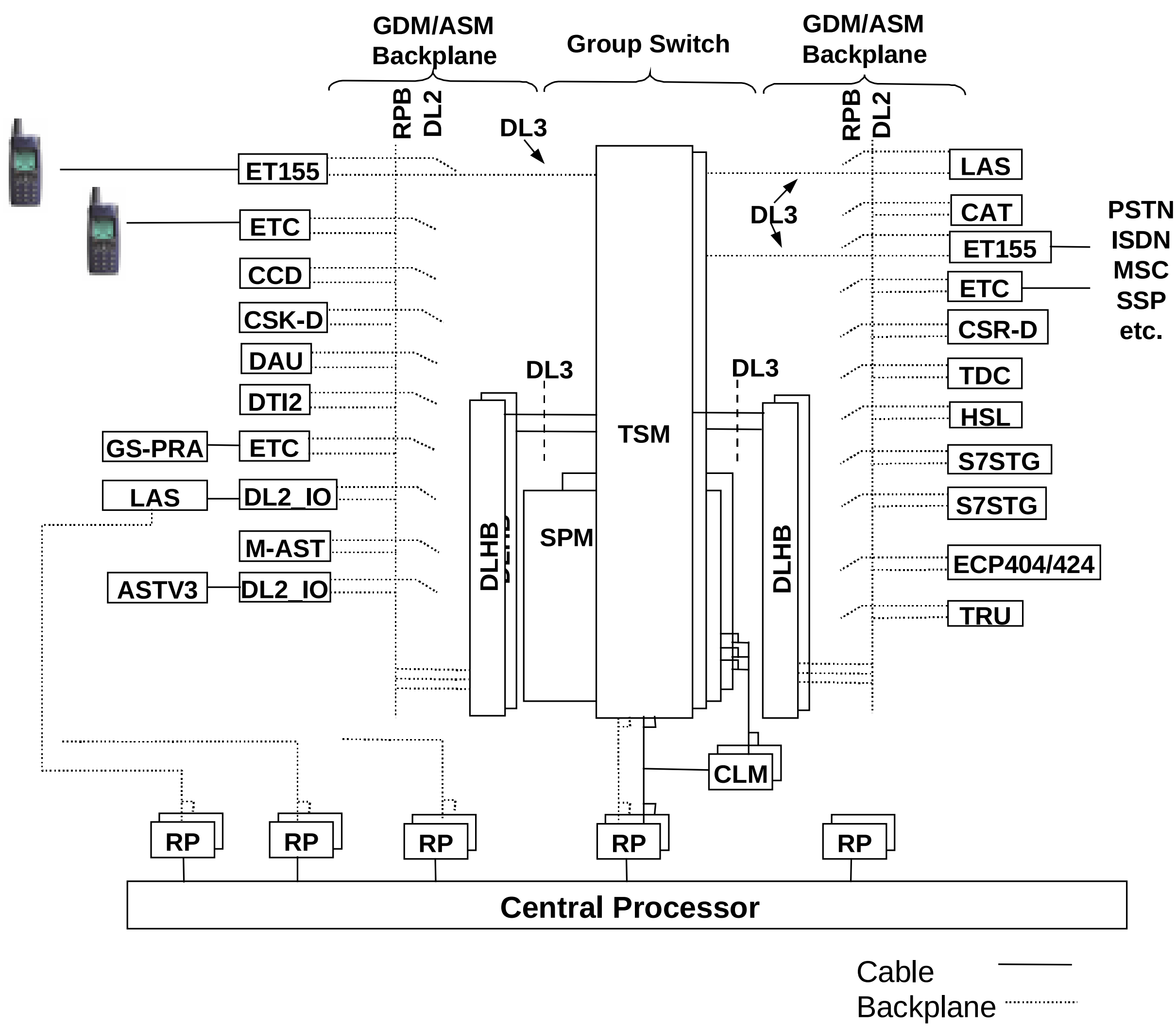


Figure 6-3 Hardware Structure of GMSC or MSC (BYB 501)

CALL FROM AN ISDN TO AN MS

INTRODUCTION

In this chapter, a call from an ISDN subscriber to a mobile subscriber is described. Using this example, the roles of the nodes involved are explained. In addition, common explanations of exchange data are added.

The mobile subscriber called from an ISDN has the Mobile Station Integrated Services Digital Network (MSISDN) number 49 172 2011111. Both subscribers are in the same country.

A-SUBSCRIBER (ISDN) DIALS B-NUMBER (MSISDN)

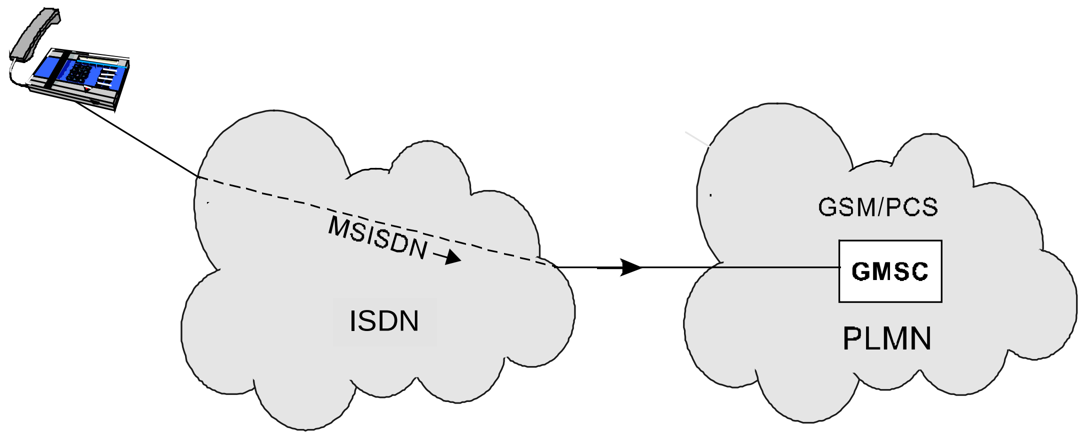


Figure 6-4 A-subscriber Dials MSISDN Number

The A-subscriber dials the B-subscriber's MSISDN number-49172 20 11111:

- The dialed digits are transferred from the A-subscriber's ISDN network to the Gateway Mobile service Switching Center (GMSC) of the GSM PLMN, indicated in the number. See *Figure 6-4*.

EXCHANGE DATA FOR THE GMSC

Before examining the call set-up in the example, the necessary GMSC exchange data must be analyzed.

Own Calling Address Data

Recall from Chapter 3 that each network element in the GSM network must have an internationally significant address, or an "Own Calling Address" for S7 signaling communication. See *Figure 6-5*.

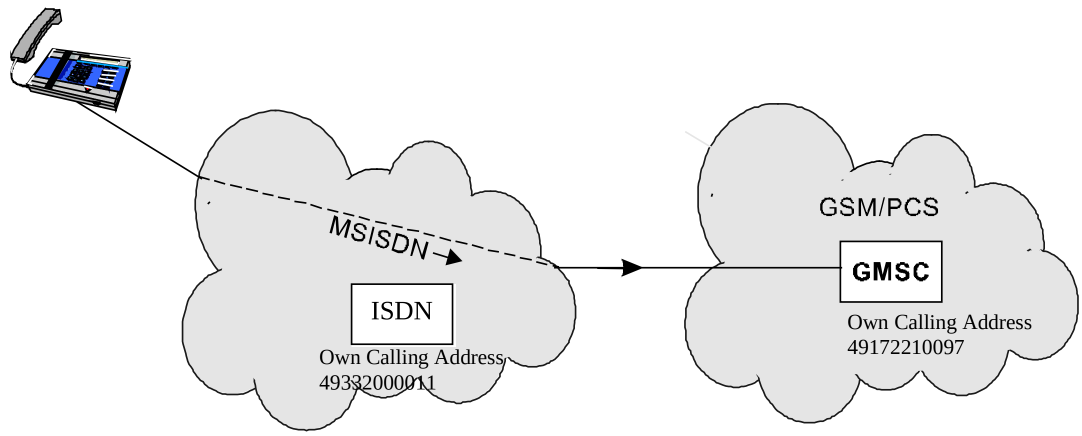


Figure 6-5 Own Calling Address Data

The OPI "Mobile Telephony, Own Calling Address, Define" is used to define your own calling address for the GMSC.

Pre-analysis Data

GSM networks must be able to work with networks that use different kinds of numbering plans. In order to work together, some additional parameters are transmitted with the subscriber number in the call set-up signaling. These parameters, along with the B-Origin (BO) (See *Figure 6-6*) and A-Origin (AO) indicating the incoming route data, are used as inputs to Pre-analysis.

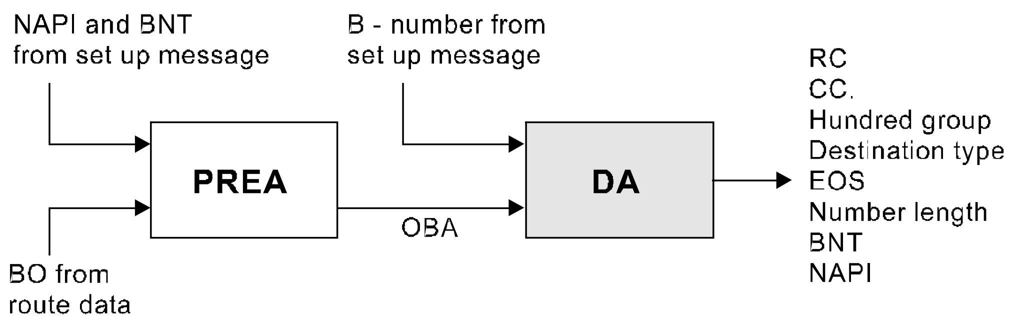


Figure 6-6 Pre-analysis (PREA) and Digit Analysis (DA) of B-number Data

The following are possible alternatives for the incoming parameters in the Initial Address Message (IAM):

- Numbering Plan Indicator (NAPI):
  - 0 - Spare
  - 1 - PSTN/ISDN (E163/E164)
  - 2 - Data
  - 3 to 15 - Spare
- B-Number Type (BNT):
  - 0 - Reserved
  - 1 - International number
  - 2 - Unknown B-number type
  - 3 - Subscriber number
  - 4 - National significant number
  - 5 to 10 - spare, standard use
  - 11 to 15 - spare, international use

To define B-number Pre-analysis, the following OPIs are used:

- A-Number Pre-Analysis, Data, Change
- B-Number Pre-Analysis, Data, Change

Route Data

Route Data assigns certain characteristics to a particular route. *Figure 6-7* shows the route data required for a route to the HLR using MAP version 1 and supporting Ericsson specific supplementary services.

```
EXROP:R= GRI1;

ROUTE DATA

R           ROUTE PARAMETERS

GRI1        DETY=GRI BO=8 CO=1

            RSV=31 MIS1=17 MIS2=0

            MIS3=15 MIS6=0

DETY        Device Type
RSV=31      Specifies MAP version and what Ericsson services
            are valid (see AI for GRI)
CO=1        Charging Origin for Roaming Number
MIS1=17     Origin for Forwarded-to number
MIS2=0      Charging origin for Forwarded-to number
MIS3-15     Indicates which origins are used (See AI for GRI)
MIS6=0      Plmn Indicator, own subscriber
```

Figure 6-7 Route Data

To activate the interrogation function, the software interrogation routes to the HLR must be defined. Data must be provided to handle the rerouting of the MSRN or of the C-number, in case the subscriber has activated call forwarding. Details of these parameters are given in Application Information (AI) for the function block GMSC Roaming Interrogation (GRI).

To define the software interrogation routes to the HLR, use the OPI " Data Record Route, Connect".

To activate the roaming rerouting function, a software route GMSC Roaming Rerouting (GRR) with device type GRR also needs to be defined. No parameters need to be specified.

Routes to the ISDN and the MSC/VLR where the mobile subscriber is currently located must also be defined. Two different device types are needed:

- One for routes to the ISDN/PSTN, which include echo cancelers (device type UPD3E). Note that echo cancelers towards ISDN are only necessary to handle calls originating from an analog PSTN.
- One to the MSC without echo cancelers (device type UPD33).

Refer to AI: User Part physical Device (UPD).

Routing Analysis

Once devices are connected to routes, the next step is to define Route Analysis for the new routes using the OPI "Routing Analysis Data, Change". See *Figure 6-8*.

```
ANRSP : RC=20;

ROUTING CASE DATA

OPERATING AREA
RC   CCH   BR   ROUTING              SP    DATA
20   YES        P01=1  R=GRI1        MMI   COT  EST  SI   ESS  ESR
                                           0    0    0    0    0
30   YES        P01=1  R=MSCVLR1     441   COT  EST  SI   ESS  ESR
                                           0    0    0    0    0
END
```

Figure 6-8 Route Analysis Data

B-number Analysis

The data described to this point is used to define the B-number analysis tables. An example of an extract of a B-number Analysis table is shown in *Figure 6-9*.

```
B-NUMBER ANALYSIS DATA
OPERATING AREA
B-NUMBER        MISCELL  F/N  ROUTE     CHARGE L    A
8-4
8-49
8-491
8-4917
8-49172
8-491722188                   RC=30           11-15
41-4
41-49
41-491
41-4917
41-49172
41-49172201                   RC=20           11-15
```

Figure 6-9 B-number Analysis Data

The OPI, used to modify the B-number Analysis table, is “B-number Analysis Data, Change”.

GMSC CALL HANDLING

Back to the example: The incoming call set-up message from the ISDN is received in the GMSC. See *Figure 6-10*.

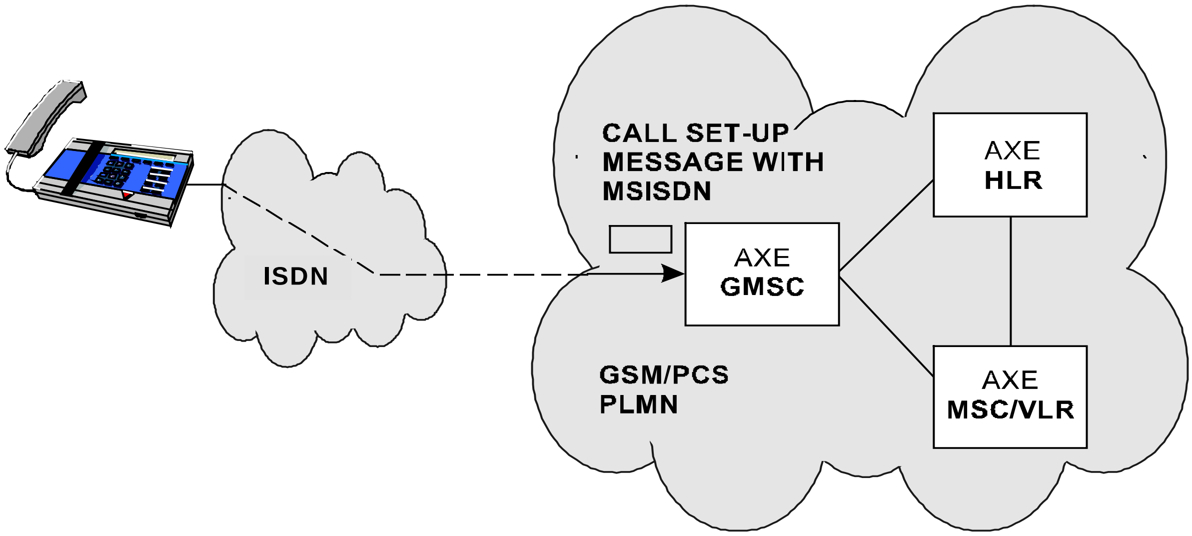


Figure 6-10 Call Set-up Message Received in GMSC

Pre-Analysis of B-Number

In this example, the call set-up message contains the following components:

- B-number (491722011111)
- NAPI=1
- BNT=1

These are transferred to the Register function block RE along with the incoming route data, such as BO=0. The Register Function (RE) initiates the Pre-number analysis. See *Figure 6-11*.

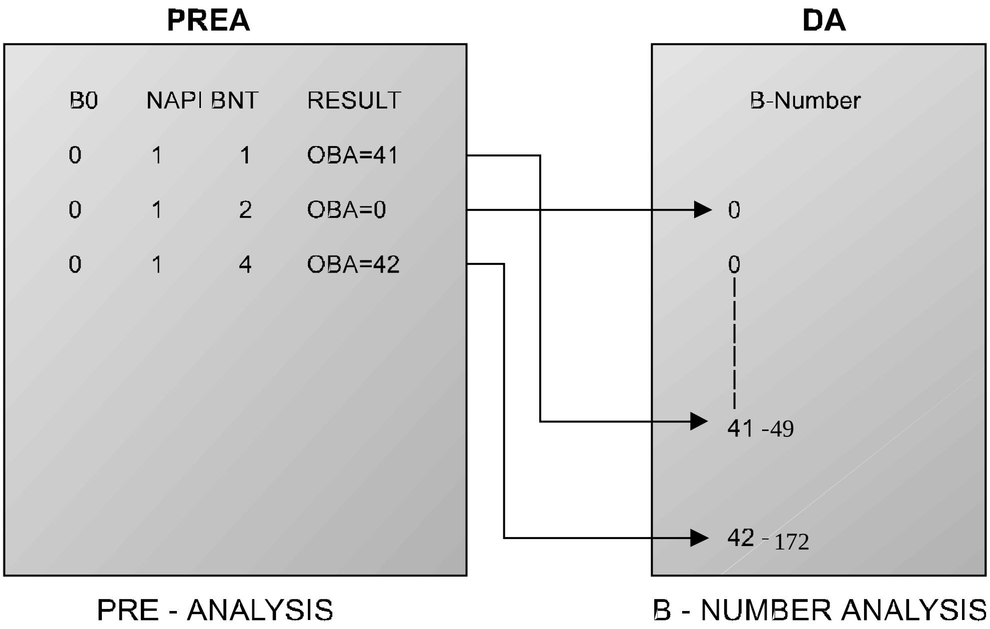


Figure 6-11 Pre-number Analysis

B-Number Analysis

The results from the Pre-analysis are applied to the B-number table and used in the B-number analysis: OBA-41. See *Figure 6-12*.

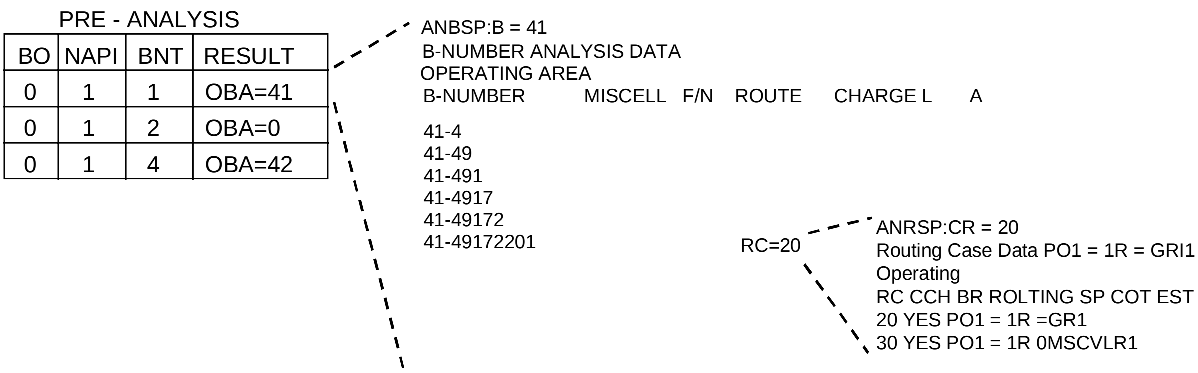


Figure 6-12 Analysis Results

Routing Analysis

The B-number analysis for 491722011111 results in the selection of a Routing Case (RC=20). RC 20 points to a software route with device type GMSC Roaming Interrogation (GRI). See *Figure 6-12*.

Interrogation of the HLR

The interrogation request to the HLR is formulated and the message (using MAP version 1 in this example) “Send Routing Information” is sent to the HLR.

EXCHANGE DATA FOR THE HLR

Before examining the example call set-up, the necessary HLR exchange data must be analyzed.

Own Calling Address Data

The OPI “Home Location Register, Own Calling Address, Define” is used to define your own calling address for the HLR.

HLR Exchange Properties

Exchange properties for the HLR allow the operator to set internal variables, to adapt the exchange to market needs. There are 28 variables covering functions, such as authentication, call barring, and logging conditions:

- The full list of HLR exchange properties are listed in the AI “Home Location Register Changeable Exchange Adaptation”.
- To set the exchange properties, the OPI “Home Location Register, Exchange Property, Change” is used.
- An example of an exchange property that can be changed by command is BARMAXREATPWD. This specifies the maximum number of times that a password (PIN) can be entered for a Subscriber Identity Module (SIM). (Refer to AI “Home Location Register Changeable Exchange Adaptation”.)

Profiles and Subscriber Data

The Subscriber and Profile data is likely to be introduced into the system via an external Subscriber Administration center, for example, the Service Order Gateway (SOG).

There are two ways of assigning services to a subscriber: one single service after the other can be connected to a single subscriber, or a predefined profile can be used. A profile contains a group of services, ready packed to be connected to a subscriber.

The advantage of using profiles is that there is no need to connect services one by one to every single subscriber. The profiles are defined by a combination of frequently used services, which are assigned to the customer as a complete package. See *Figure 6-13* for some example profiles.

```
<HGSPP: PROFILE = ALL;

HLR SUBSCRIBER  PROFILE DATA
PROFILE
0

SUD
CAT - 10    DBSG - 1    TS11 - 1    CFNRY - 1
CFB - 1     CFU - 1     OFA - 1     CFNRC - 1
BAIC - 1

PROFILE
1

SUD
CAT - 10    DBSG - 1    TS11 - 1    OFA  - 0
BICRO - 1   BAIC - 1    CFNRY - 1   CFU - 1
END
```

Figure 6-13 HLR Subscriber Profile Data

This concept makes it easier to introduce subscriptions since services are usually sold in packages. Up to 256 different profiles can be defined. A profile can be changed using the command HGSPC.

A profile is assigned to the subscriber when the subscription is connected using the command HGSUI. A new profile can be assigned to an already connected subscriber via the command HGSDC.

- The OPI used for setting up subscriber profiles is: “Home Location Register, Subscriber Profile Data, Change”
  - the value range for Subscriber Data (SUD) is defined in AI “Home Translation Functions Changeable Exchange Adaptation” (HTRAN)

Subscriber Data in the HLR can be modified using the following OPIs:

- “Home Location Register, Mobile Subscriber, Connect”, to connect a subscriber.
- “Home Location Register, Mobile Subscriber, Disconnect”, to disconnect a subscriber.
- “Home Location Register, Mobile Subscriber Data, Change”, for the modification of subscriber data.
- “Home Location Register, IMSI Changeover, Initiate”, is used for situations where a subscriber may have a lost or stolen SIM card and requires a replacement (retaining the same MSISDN number).

  There are some other OPIs related to this OPI which together complete the whole process of releasing the old and connecting the new IMSI.
- “Home Location Register, Mobile Subscriber Location, Reset”, is used to erase the location information. This can be used by O&M staff in the case of subscriber complaints

Note 1: Basic Services are either Bearer or Teleservices. Basic Services are divided into six groups:

Basic Service Groups (BSGs) include:

- BS20 - BSG “All Date Circuit Asynchronous Services”
- BS30 - BSG “All Data Circuit Synchronous Services”
- TS10 - BSG “All Speech Services”
- TS20 - BSG “All Short Message Services”
- TS60 - BSG “All FAX Services”
- TSD0 - BSG “All Auxiliary Speech Services”

Note 2: Supplementary Services are offered on a per BSG basis.

HLR file output containing permanent subscriber data allows the operator to compare data, stored in an HLR, with data stored in an external subscriber administration center. The OPI “Home Location Register, Permanent Subscriber Data for Mobile Subscribers, File Output, Initiate” is used for this purpose. The data is output to the file HPSDFOAFILE. This file must be pre-defined.

A printout of subscriber data stored in the HLR is shown in *Figure 6-14*.

```
<HGSDP: MSISDN = 491722011111, ALL;
HLR SUBSCRIBER DATA

SUBSCRIBER IDENTITY
MSISDN          IMSI                      STATE          AUTHD
491722011111    262022010001111           CONNECTED      AVAILABLE

PERMANENT SUBSCRIBER DATA

CAT - 10     DBSG - 1     TS11 - 1     CFNRY - 1
CFB - 1      CFU - 1      OFA - 1      CFNRC - 1
BAIC - 1

AMSISDN                   BS           BC
NONE

SUPPLEMENTARY SERVICE DATA
BSG
TS10
SS          STATUS        FNUM         TIME
CFB         NOT ACTIVE
CFU         NOT ACTIVE
CFNRC       NOT ACTIVE
BAIC        NOT ACTIVE

LOCATION DATA
VLR ADDRESS MSRN      MSC NUMBER LMSID

UNKNOWN

END
```

Figure 6-14 HLR Subscriber Data

HLR CALL HANDLING

The HLR receives a signal from the GMSC, which contains the MSISDN number. The Roaming Rerouting function in the HLR requests the MSC/VLR to provide the GMSC with a roaming number. This enables the GMSC to route an incoming call to the MSC/VLR where the subscriber is currently located, or to provide the GMSC with a C-number, if unconditional call forwarding is active.

Send Routing Information

The MAP message “Send Routing Information” is received by the HLR. See *Figure 6-15*.

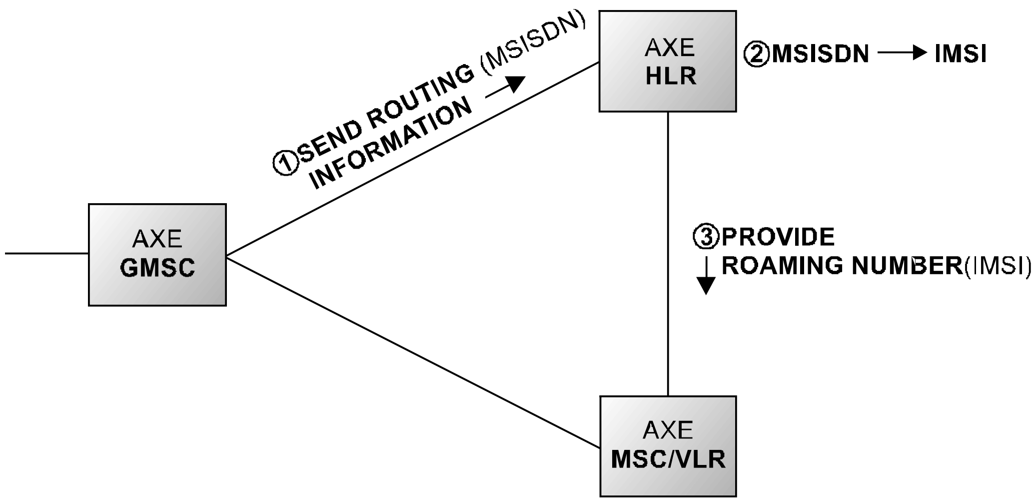


Figure 6-15 "Send Routing Information" Received by the HLR

The message received by the HLR contains an MSISDN (491722011111 in the example), which indicates a normal speech call.

491722011111 is sent to the Home Subscriber Number ANalysis (HSNAN) for analysis and the result is a Home Subscriber Data pointer and a default BSG for that subscriber.

A subscription check is performed for the Basic Service. Home Subscriber Data performs a check of call barring and supplementary services. The data also includes a VLR pointer and an IMSI (262022010001111).

The VLR pointer is translated into a VLR address (491722100097). The “Provide Roaming Number” message is sent to the VLR.

EXCHANGE DATA FOR THE MSC/VLR

Before examining call handling in the MSC/VLR, the exchange data for the MSC/VLR must be defined.

Own Calling Address Data

The OPI “Mobile Telephony, Own Calling Address, Define” is used to define your own calling address for the MSC/VLR.

MMS Exchange Properties

Exchange properties allow the MSC/VLR operator to set internal variables in order to adapt the exchange to market needs. These variables cover functions, such as authentication, call barring, and logging conditions:

- The AI “Mobile Telephony Data, Changeable Exchange Adaptation” contains the full list of exchange properties of the MSC/VLR.
- Use the OPI “Mobile Telephony, Exchange Property, Change” to change the exchange properties.
- An example of an exchange property that can be changed by command is AUTHENTICATE=1. This specifies that authentication is performed.

Roaming Number Route

Select a roaming number by specifying a software route. Within a roaming number software route there are 100 devices and each device is referred to by an individual Mobile Station Roaming Number (MSRN). See *Figure 6-16*.

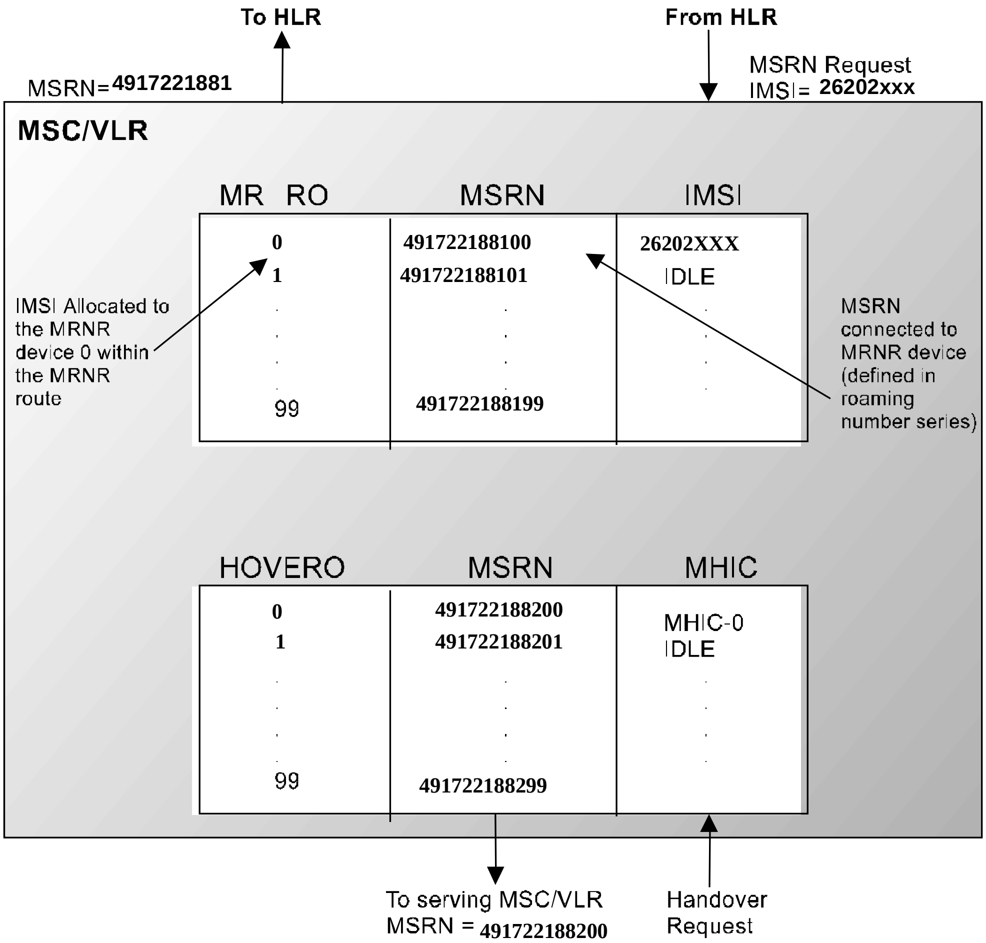


Figure 6-16 Roaming Number Route

- Use the OPI “Mobile Telephony, Roaming and Handover Numbers, Connect” for connecting new MSRNs or handover numbers. A number series can also be defined for a combined roaming/handover use. Related OPIs exist, for example, for disconnection of MSRNs or handover numbers.
- Information is found in the AI for the block MRNR. When defining a route using the command EXROI, the following parameters may look like:
  - R=MRNR0, DETY=MRNR

  After that the MSRNs must be connected to the route. This is done using the command MGRSI. An MSRN series consists of 100 MSRNs. It is important that no MSISDN exists in the MSRN series.

  Later on, the usage of the route must be defined (roaming, handover, or combined use). This is done using the command MGRSC.

MSC/VLR CALL HANDLING

Allocation of a Roaming Number

The MAP message “Provide Roaming Number”, which contains the IMSI number, is received from the HLR and is analyzed. A check is initiated to determine whether or not the subscriber is attached.

When a roaming number is requested, the software blocks select an idle MSRN and temporarily assign it to the IMSI. In *Figure 6-17*, the roaming number 491722188100 is idle and is assigned to the IMSI 262022010001111.

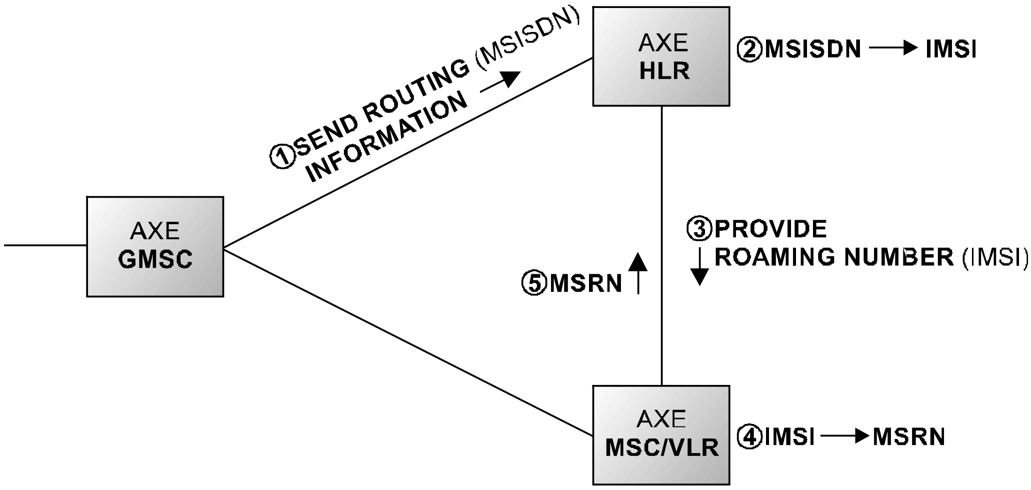


Figure 6-17 Assignment of an MSRN

The MSRN is returned to the HLR.

Note: The number series used for roaming numbers cannot be used for subscribers and should be barred.

HLR CALL HANDLING (2)

The HLR receives the MSRN from the MSC/VLR via the Translation Capabilities Application Part (TCAP) in the message “Provide Roaming Number Response”. The HLR sends it on to the GMSC. See *Figure 6-18*.

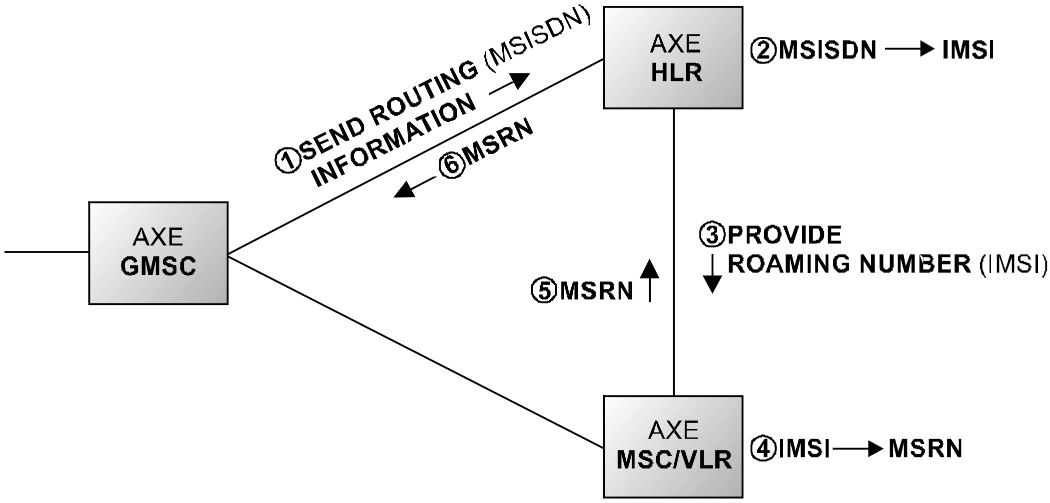


Figure 6-18 Call Handling (2) in the HLR

GMSC CALL HANDLING (2)

The GMSC receives an MSRN from the HLR. See *Figure 6-19*.

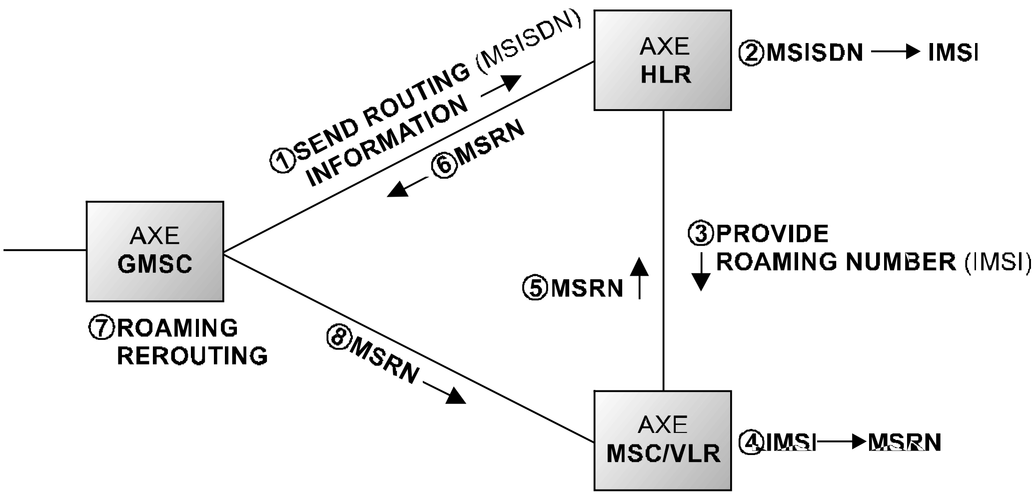


Figure 6-19 Call Handling (2) in the GMSC

Roaming Rerouting is started:

1. A new B-number analysis is initiated using the BO from the GRI route, from the HLR (BO=8). See *Figure 6-7*.
2. The analysis points out an outgoing route.
3. The GMSC sends an IAM message to the MSC/VLR on that route.
4. The message contains the MSRN (491722188100).

MSC/VLR CALL HANDLING (2)

The MSC/VLR receives the IAM message, which contains the MSRN, from the GMSC. See *Figure 6-20*.

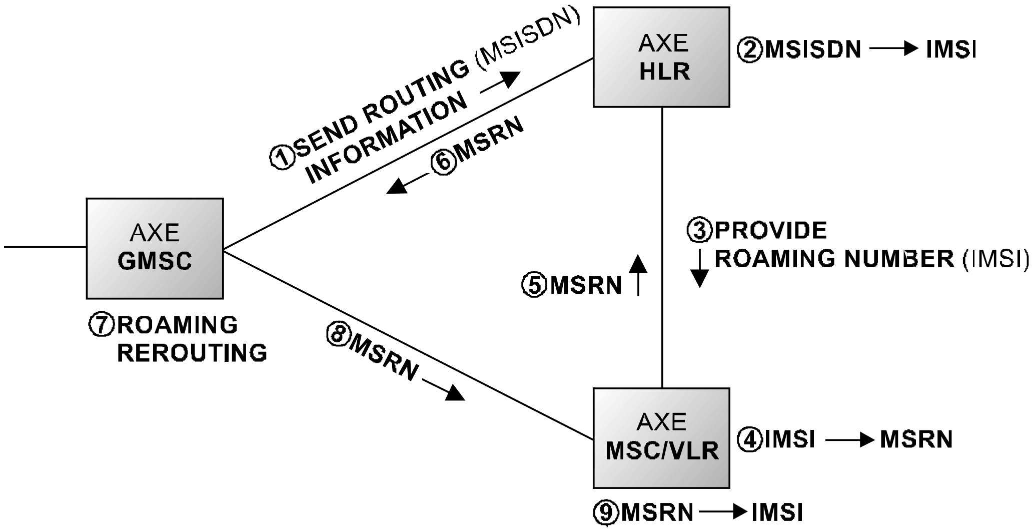


Figure 6-20 Call Handling (2) in the MSC/VLR

The MSC/VLR analyzes the number in the B-number analysis, which results in the Mobile TErminating call (MTE).

The IMSI 262022010001111) is recovered with the help of the MSRN from the roaming number route and is translated to a pointer for the subscriber’s data record.

The record contains the subscriber categories, and the location area for the subscriber is indicated.

A terminating route is seized. See *Figure 6-21*.

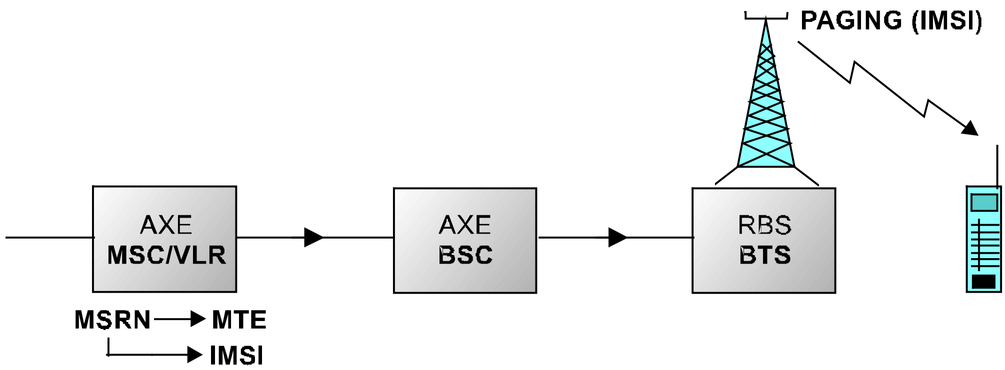


Figure 6-21 Terminating Route

Subscription Check

A subscription check is performed on the subscriber’s data.

- Check detached flag
- Supplementary service active (for conditional call forwarding)
- IMSI analysis: Get any ANRES relevant for IMSI number series

Initiation of Paging

If the MS is attached, paging can now take place.

- Paging is ordered and a paging timer (not reachable timer) is activated
- Paging Response from the MS

Set-up and Call Confirmed

- Authentication can take place.
- IMEI check functions and cipher-mode set-up are implemented
- Set-up message sent to the MS
- Call Confirmed from the MS

Assignment of Traffic Channel

- Assignment Request from the MSC to the BSS
- Assignment Response from the BSS

Through Connection

The MS sends an “Alert” when a ringing signal has been generated at the MS.

- The call is connected through, and a ringing control signal is sent to the A-subscriber.
- When the MS answers, a signal is sent back to the A-subscriber’s exchange for charging.
- Conversation may now begin. See *Figure 6-22*.

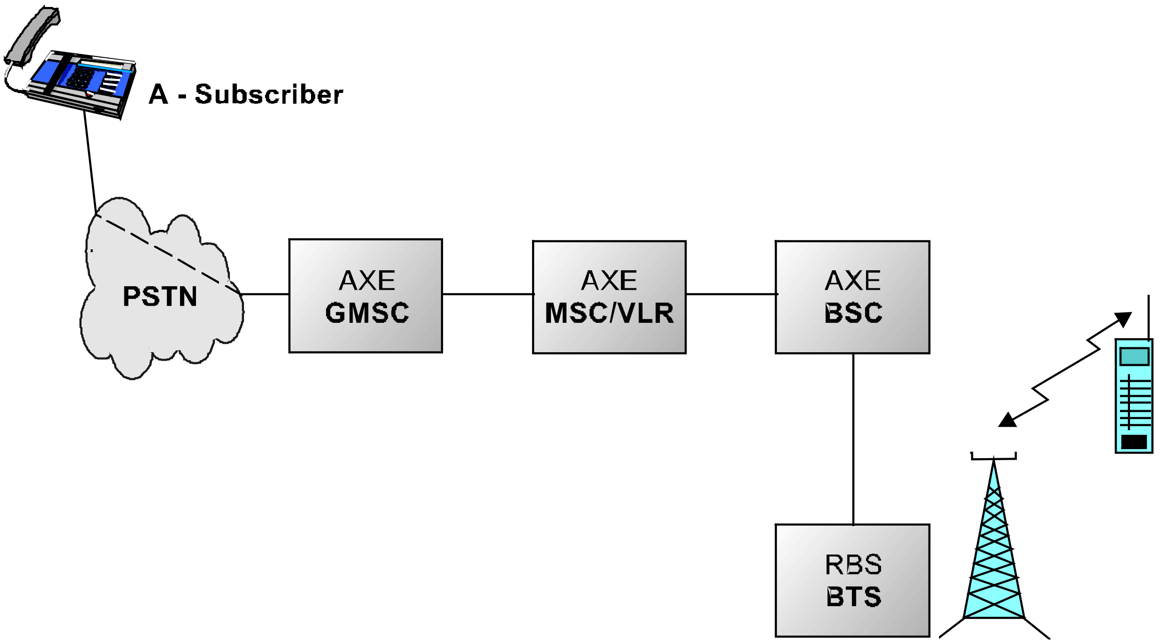


Figure 6-22 Through Connection

ISDN TO MS CALL SURVEY

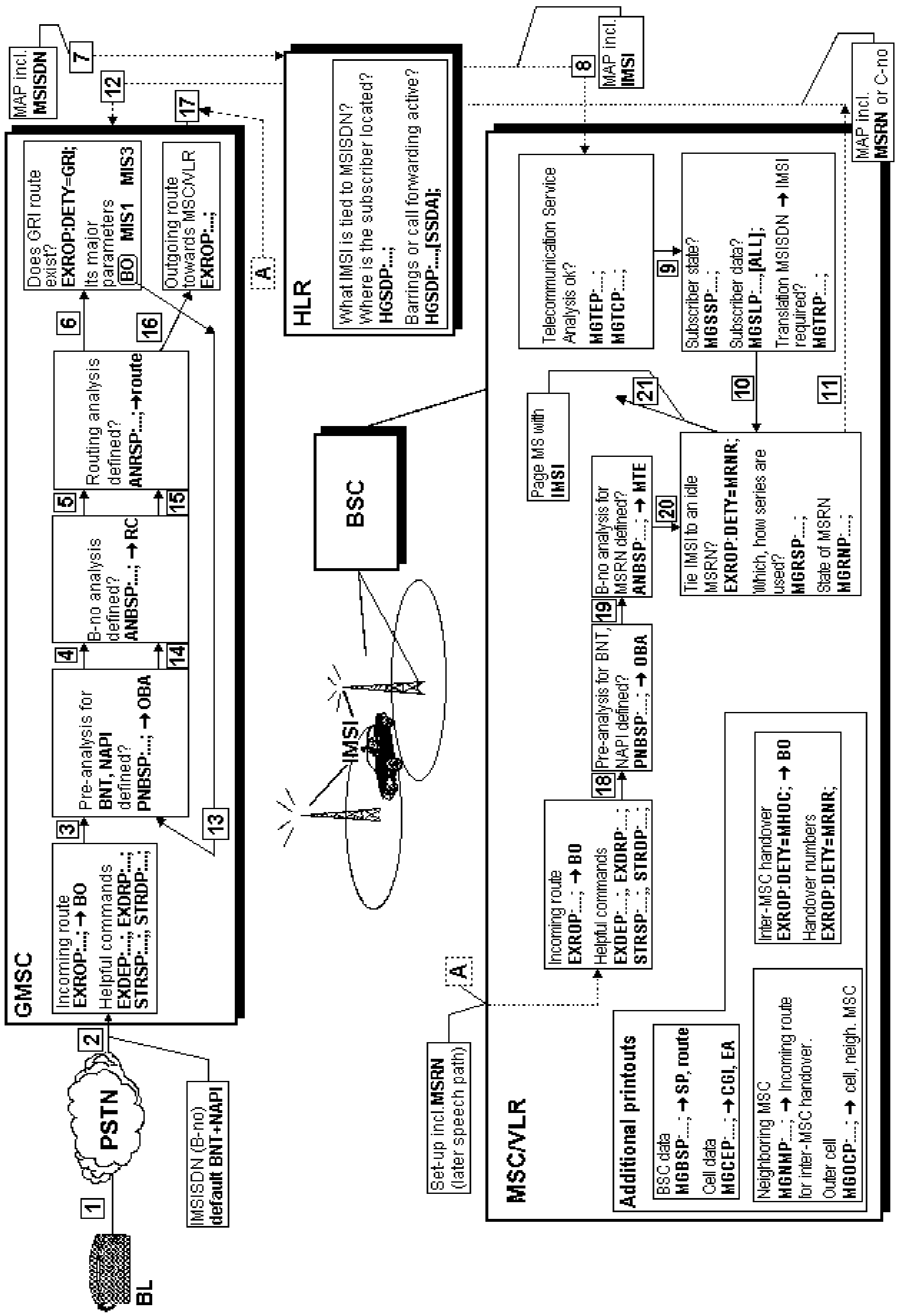


Figure 6-23 PSTN to MS Call Survey

Telecommunication Service Analysis

Chapter 7

This chapter is designed to provide the student with a knowledge of how the Telecommunication Service Analysis, Transmission Medium Requirement Analysis, and Compatibility Check are performed in the MSC.

OBJECTIVES:

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

- Explain the function of the BASC in translating the GSM BC to/from the ISDN BC
- Describe how the Telecommunication Service Analysis is performed in the MSC
- Define the Telecommunication Service Analysis for a TeleService and a Bearer Service (BS)
- List the Transmission Medium Requirement Analysis input and output parameters

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7 Telecommunication Service Analysis

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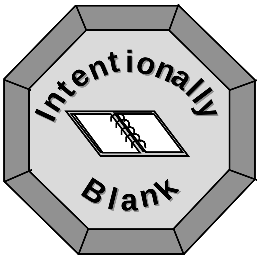
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BEARER CAPABILITIES (BC)

Within an Integrated Services Digital Network (ISDN), a Public Switched Telephony Network (PSTN) and a Global System for Mobile Communication (GSM), a number of different services are available. These services include speech, facsimile, and data transmission with different user rates (URATEs).

The receiving node, as well as intermediate nodes, need information on what service is requested and how the service is to be performed,for example, what URATE is used.

Bearer Capabilities (BCs) contain this information. BCs are part of the User Service Information Element in the Initial Address Message (IAM), and the Bearer Capability Information Element (BCIE) in the SETUP message.

Note: This only applies to the ISDN and GSM, since the PSTN *cannot* provide this type of information.

Different coding schemes are used in the ISDN and GSM because different transmission requirements must be met. These are referred to as ISDN BC and GSM BC.

For every call set-up from the ISDN or GSM, the BC information describes the type of service requested. This is not possible for a call from the PSTN and, therefore, additional MSISDN numbers are used instead.

ISDN BC and GSM BC are described in *Appendix A*.

An exchange in GSM must be able to provide:

- Translation of GSM BC to ISDN BC and vice-versa
- Translation of the requested service into requirements on signaling and transmission capabilities
- Compatibility check to determine if the required signaling and transmission capabilities are fulfilled by the route or equipment to be used

BASIC SERVICE GROUPS

The basic services in GSM are divided into six Basic Service Groups (BSGs):

- TS10 - BSG "All Speech services"
- TS20 - BSG "All Short Message services"
- TS60 - BSG "All Facsimile services"
- TSD0 - BSG "All Auxiliary Speech services"
- BS20 - BSG "All Data Circuit Asynchronous services"
- BS30 - BSG "All Data Circuit Synchronous services"

Supplementary services are offered on a per BSG basis.

Example: A subscriber can have "call forwarding unconditional" active for all fax services (TS60) to his office fax, while still receiving all speech services (TS10) to his mobile phone.

See AI: HTRAN for the type of supplementary services that are available for the respective BSGs.

BASIC SERVICE CODE (BASC)

As previously mentioned, the purpose of Bearer Capability (BC) information is to describe the type of service requested. The BC information is difficult to manage because it consists of numerous octets.

The BASC interprets the GSM BC into commands that are easy to use, for example, MML-commands.

The BASC is only used internally within the Home Location Register (HLR) and the Mobile services Switching Center (MSC).

It can either be a Teleservice Code (TEC) or a Bearer service Code (BEC).

The value of the TEC can be:

- THY - Telephony
- SMSMT - Short message services mobile terminating
- SMSMO - Short message service mobile originating
- ALTSPFAX - Alternate speech/Facsimile group 3

- AFX3 - Automatic facsimile group 3
- AUXTHY - Auxiliary telephony
- EMERG - Emergency call

BEC is a combination of the BEarer service Group (BEG) and the User RATE (URATE).

The BEG can be

- DCDA - Data circuit duplex asynchronous
- DCDS - Data circuit duplex synchronous

The User Rate of DCDA and DCDS originally comprised up to 9600b/s. With the feature High Speed Circuit Switched Data, 14.4kbit/s Channel Coding, and Data Compression, the user data rate can be increased to 56kbit/s under certain circumstances. Refer to Chapter 8, for more information.

Each TEC or BEC in the MSC provides one type of service which is present as BS in the HLR. The HLR command HGBDP can be used to indicate how the Bearer Capabilities (BCs) are related to Basic Services (BSs). There is more information on this relation in the Application Information (AI) concerning the function block HBCAN.

TRANSMISSION RATES

Figure 7-1 shows the possible transmission rates that can be used on the different interfaces between the MSC and the Mobile Station (MS).

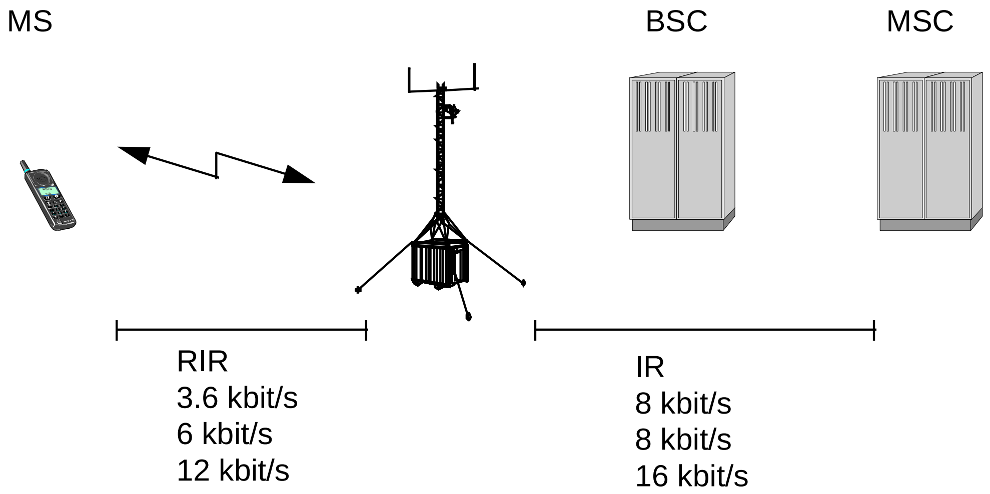

Figure 7-1

Table 7-1 shows the possible combinations of User RATEs (URATEs) and transmission rates:

User Rates URATE	Radio Interface Rate (RIR)	Intermediate Rate (IR)
≤2,4 kbit/s	3,6 kbit/s	8 kbit/s
4,8 kbit/s	6 kbit/s	8 kbit/s
9,6 kbit/s	12 kbit/s	16 kbit/s

Table 7-1.

HALF RATE AND FULL RATE TRAFFIC CHANNELS

The subscriber can select between half rate and full rate traffic channels for speech calls and data calls (not fax).

When half rate is selected, only half of the capacity of a full rate traffic channel is used. This makes it possible to increase the capacity of the network. The operator can offer subscribers "half rate calls" at a reduced cost.

Normally, a full rate traffic channel has a 12 kbit/s Radio Interface Rate (RIR) while a half rate traffic channel has a 6 kbit/s RIR.

Radio Channel Requirement (RCR)	Radio Interface Rate (RIR)	Intermediate Rate (IR)
Full rate	12 kbit/s	16 kbit/s
Full rate/Half rate	6 kbit/s	8 kbit/s

Table 7-2.

6 KBIT/S RADIO INTERFACE RATE ON A FULL RATE TRAFFIC CHANNEL

This function enables 6 kbit/s RIR to be used on a full rate traffic channel. This is only applicable for *non-transparent data calls* with a URATE less than, or equal to, 4.8 kbit/s.

Using 6 kbit/s RIR on a full rate traffic channel, provides extra capacity. This extra capacity is used for additional error correction and for the protection of transmitted data.

MULTIPLE SPEECH CODERS

This function enables the use of multiple speech coder versions for speech calls. The Mobile Station (MS) must be equipped with this feature.

A Speech Coder Version List (SCVL) is a list of preferred speech coders. This list is sent from the MS in the BC message at call set-up.

TELECOMMUNICATION SERVICE ANALYSIS

Telecommunication service analysis must be performed at every call set-up.

The input to this analysis is the BASC information along with additional parameters.

The incoming parameters are analyzed and the result adapts to and configures the system for the selected service, for example, establishing a DTI/GIWU connection for a fax or data call.

The analysis, which is performed in the function block MTECA, is composed of two parts:

1. Telecommunication service analysis
2. Telecommunication service code analysis

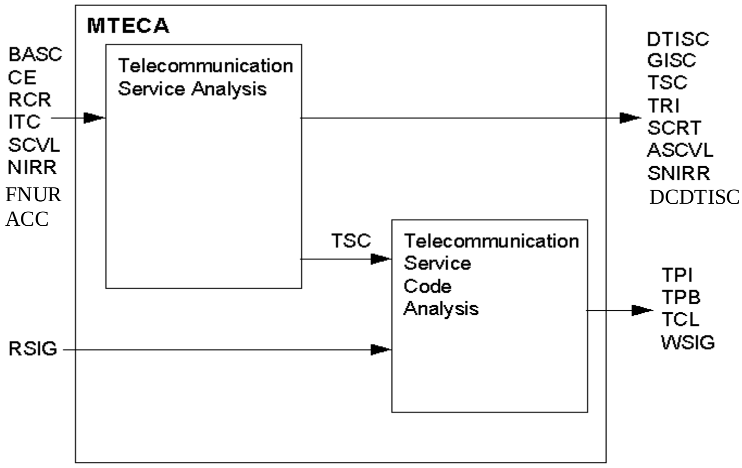

Figure 7-2

The input to this analysis is:

- The Basic Service Code (BASC). It is either a Teleservice Code (TEC) concerning speech, Short Message Service (SMS) or fax, or a Bearer service Code (BEC =BEG + URATE) + CE, if a data call is requested.
- The Connection Element (CE) indicates if a transparent or a non- transparent service is requested.
- The Information Transfer Capability (ITC) in the case of data or fax call. This parameter is a part of ISDN BC and GSM BC:
  - Unrestricted Digital Information (UDI)
  - 3,1 kHz audio
- The Radio Channel Requirement (RCR) is a part of GSM BC and can have any of the following values:
  - Full rate
  - Half rate
  - Dual rate (Full rate preferred)
  - Dual rate (Half rate preferred)

- Negotiation of Intermediate Rate Requested (NIRR)

  This parameter indicates whether extra error protection and correction is selected for certain types of data calls by using 6 kbit/s Radio Interface Data Rate (RIDR) on a full rate traffic channel.

- Required type of SIGnaling (RSIG) is taken from the set-up message and is used to indicate whether ISDN signaling is required.

- Speech Coder Version List (SCVL) is used in GSM 1900 only.

  SCVL is also taken from the set-up message from the Mobile Station (MS). It contains a list of preferred types of speech coders.

- Acceptable Channel Coding (ACC) is added for 14.4kbit/s channel coding

- Fixed Network User Rate (FNUR) allows a user rate from 9.6kbit/s to 56kbit/s depending on the commercial agreement

- Required type of SIGnaling (RSIG) is taken from the set-up message and is used to indicate whether ISDN signaling is required.

The output of this analysis is:

- DTISC (DTI Selection Case)

  DTISC is a pointer to a DTI and is obtained, if the service requires a DTI (for fax or data calls).

- Result code

  This output indicates if the selected service is supported by the MSC, otherwise the call is rejected.

- TeleService communication Code (TSC)

  This parameter is a numeric output from the Telecommunication service analysis. It serves as an:

  – Input to Telecommunication service code analysis.

    The requested service is supported by the MSC, only if the Telecommunication service analysis points out a TSC.

  – Input to charging.

    It provides the ability to apply different charging methods for different call types, for example, a fax call may be more expensive than a speech call. TSC is used as a reference in the TT-files.

- Transparency Indicator (TRI)

  TRI indicates if transparent or non-transparent mode should be used for Bearer Services (BSs).

- Wanted type of SIGnaling (WSIG)

  This parameter indicates if ISDN signaling is required, not required or preferred, and may also be used as a branching parameter in route analysis.

- Tone Protection Information (TPI)

  TPI is used to prevent tone sending for certain types of calls.

- Transmission Break Protection (TBP)

  TBP is used, for example, to prevent breaks in fax calls.

- TCL (Traffic CLass)

  This parameter is used only for a mobile-originating (speech and data) call to a PSTN. It indicates the type A-subscriber.

- Selected Channel Rate and Type (SCRT)

  This output is sent to the BSC to determine the radio resource that is required for the call:

  – Full rate

  – Half rate

  – Dual rate, full rate preferred

  – Dual rate, half rate preferred

- Assigned Speech Coder Version List (ASCVL)

  In GSM 1900, this parameter indicates the type of speech coder that should be used for the call.

- Selected Negotiation of Intermediate Rate Requested (SNIRR)

  This signal confirms that the service requested by the NIRR parameter is supported by the MSC.

- Data Transmission Interworking Selection Case (DTISC) for Data Compression (DCDTISC).

  .

OPI Transmission Service Analysis Administration

```
MGTCI: TSC=1, WSIG=NOIS, TBP=NO, TPI=YES,
NOTE="THY"
```

A TSC for speech is defined with no requirement on signaling capabilities (NOIS) Transmission breaks are not protected (=allowed) and tone sending is allowed.

```
MGTEI: TEC=THY, CRT=DFR-DFRC,
PSCVL=FRV1&FRV3,TSC=1
```

The parameter Channel Rate and Type (CRT) consists of two components which are the Radio Channel Requirement (RCR) and the Selected Channel Rate and Type (SCRT). The RCR is part of the GSM BC, which means it is the Channel Rate and Type (CRT) the mobile asks for. In the example, the RCR defined for TSC=1 is a Dual rate channel, full rate preferred.

The Selected Channel Rate and Type (SCRT) is the information about the radio resource. This information is sent from the MSC to the BSC. In the example, SCRT is Dual rate, full rate preferred with change allowed after first channel allocation.

The Provided Speech Coder Version List (PSCVL) contains the Speech coder full rate version 1 and 3.

```
MGTCI: TSC=7,WSIG=ISPR,TBP=YES,TPI=NO,TCL=12,
NOTE="DA_ANT"
```

A TSC for asynchronous data transmission is defined with the required ISDN. Transmission breaks and tone sending are not allowed, that is, Tone Break Protection is on (TBP = YES) and the Tone Protection Information indicates that tone sending is forbidden (TPI = NO).

```
MGTEI:BEG=DCDA,FNUR="28.8",ITC=AUD,TRI=NT,ACC
="9.6"&"14.4",DTISC=AUDIO,TSC=7
```

For TSC 7, the Fixed Network User Rate (FNUR) up to 28.8 kbit/s will be allowed, the Acceptable Channel Codings (ACC) will be Full rate channel with data rates of 9.6 kbit/s and 14.4kbit/s.

```
MGTCI: TSC=13,WSIG=ISPR,TBP=YES,TPI=NO,TCL=12,
NOTE="DA_ANT"
```

```
DSSCI:DTISC=AUDIO, R1=DTI1O, R2=DTI2O
DSSCI:DTISC=DATCOMP, R1=DTI1O, R2=DTI2O
```

TSC 13 must be predefined with MGTCI, and the parameter DCDTISC with DSSCI, before they can be used in this command.

```
MGTEI:BEG=DCDA,FNUR="19.2",ITC=AUD,TRI=NT,
ACC="4.8"&"9.6",DTISC=AUDIO,DCDTISC=DATCOMP,
TSC=13
```

For TSC 13, the case is similar as for TSC 7, except for the fact that the selected DTISC has either the value AUDIO, or DATCOMP (for data compression).

TRANSMISSION MEDIUM REQUIREMENT ANALYSIS

The Transmission Medium Requirement (TMR) analysis is started when no BASC is available to determine a TSC value and signaling and transmission capabilities. Therefore, an estimated value (TMR), defined for the incoming route, or a system defined default value is taken as input. The command, EXROP, can be used to check which TMR value is tied to an incoming route. TSC, TPI, and TBP are obtained as output of the TMR Analysis. *Figure 7-3* illustrates this analysis.

Input to the analysis is:

- Transmission Medium Requirement (TMR)

Output of the analysis is:

- TSC used for charging, and as pointer in TECA to:
  - Tone Protection Information (TPI)
  - Transmission Break Protection (TBP)

If TSC has no associated values for TBP and TPI, they receive default values.

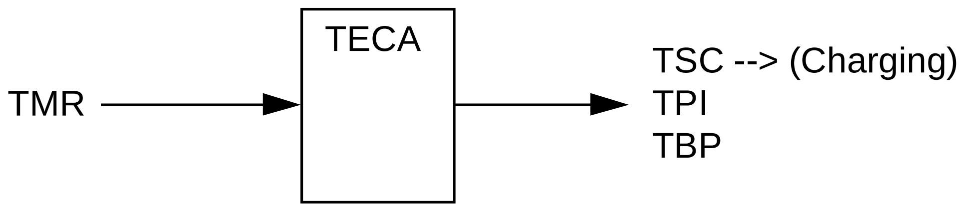

Figure 7-3 Transmission Medium Requirement (TMR) Analysis

COMPATIBILITY CHECK

The Compatibility CHeck (CCH) is initiated by the route analysis (command ANRSI, parameter CCH indicates whether the Compatibility Check is made). It determines whether or not the route is compatible for the service. Three cases exist:

- Outgoing Call
- Terminating BL Call
- Terminating MS Call

Figure 7-4 illustrates the Compatibility CHeck (CCH) for an outgoing call.

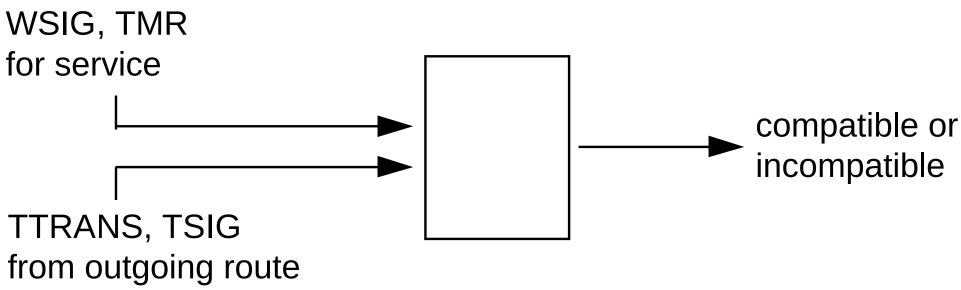

Figure 7-4 Compatibility CHeck (CCH) of Outgoing Calls

Input parameters are:

- WSIG — This parameter is the result of the BASC analysis for mobile originated calls.

  TMR - from the originating side.
- Trunk TRANSmission characteristic (TTRANS) — TTRANS is the transmission characteristic for the route, obtained from route data (command EXROP).
- Trunk SIGnaling capabilities (TSIG) — TSIG are the signaling capabilities of the route. TSIG is hard coded.

Output of the analysis is:

- Call is compatible or not compatible.

In cases where the call is not compatible for this route, an attempt is made at an alternate route.

Data and Fax Calls

Chapter 8

This chapter is designed to provide the student with an explanation of how data and fax calls are handled.

OBJECTIVES:

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

- Explain how data and fax calls are set up
- Describe different traffic cases of data and fax calls
- Define an Additional MSISDN
- Explain the function of the DTI and the GIWU
- Define a DTI Selection Case
- Explain High Speed Data Service
- Explain 14.4kbit/s channel coding and Data Compression

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8 Data and Fax Calls

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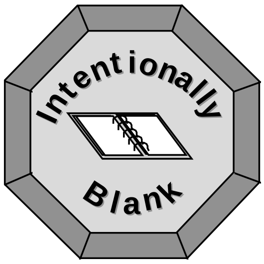
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FAX AND DATA CALL FROM THE ISDN

This chapter describes how mobile terminating data and fax calls are set up from the Integrated Services Digital Network (ISDN).

INITIAL ADDRESS MESSAGE

The incoming set-up message from the ISDN to the Gateway Mobile service Switching Center (GMSC) contains this information:

- A-number
- B-number (MSISDN)
- A-Number Type (ANT) and B-Number Type (BNT)

  This parameter indicates if the number is in a national or international format (with or without country code).
- Numbering Plan Indicator (NAPI)
- ISDN Bearer Capabilities (ISDN BCs)

The Information Transfer Capability (ITC) value indicates Unrestricted Digital Information (UDI), for a data call, and 3,1 kHz audio for a fax call.

The B-number (MSISDN) and the ISDN BC are sent to the Home Location Register (HLR) in the MAP message SEND ROUTING INFORMATION.

ANALYSIS IN THE HLR

The ISDN BC is translated into a GSM BC, which is translated into a BAsic Service Code (BASC).

The MSISDN number is translated into an International Mobile Subscriber Identity (IMSI) number which is sent to the MSC/VLR together with the ISDN BC.

The BASC determines the different types of supplementary services that can be combined with the requested service. This is necessary, if the B-subscriber has the service Call Forwarding Unconditional (CFU) activated. In this case, the HLR returns a C-number to the GMSC instead of a roaming number.

ANALYSIS AND PROVISION OF ROAMING NUMBER IN THE MSC/VLR

The GSM BC is translated into a BASC to determine if the requested service is supported by the MSC.

If the service is not supported, the call set-up process is stopped. This happens if a fax or data call is requested and no GSM Interworking Unit (GIWU) or Data Transmission Interworking unit (DTI) is connected to the serving MSC.

In the Visitor Location Register (VLR), a Mobile Station Roaming Number (MSRN) is tied to the International Mobile Subscriber Identity (IMSI) number. The GSM BC is also stored here until the roaming numbers are returned from the GMSC.

The MSRN is sent to the GMSC via the HLR.

ROUTING OF CALL FROM THE GMSC TO THE MSC/VLR

The call is routed from the GMSC to the MSC/VLR by means of the Roaming number.

FINAL ANALYSIS IN THE MSC/VLR

When the MSRN returns from the GMSC, the IMSI number and the GSM BC are retrieved again.

The GSM BC is translated into a BASC, which is used as an input to the telecommunication service analysis. One of the main outputs from this analysis is a Digital Transmission Interface Selection Case (DTISC).

(For more information on telecommunication service analysis, see Chapter 7.)

A subscription check is performed in the VLR.

A check is also performed to determine if the BSC can support the type of service requested, for example, if half rate or Negotiated Intermediate Rate Requested (NIRR) is requested.

ALTERNATE SPEECH/FAX CALL - MOBILE ORIGINATING

This function offers the subscriber the ability to switch between speech and transparent fax service. This is applicable for both mobile-terminating and mobile-originating calls.

Traffic handling can be divided into two phases:

1. The call establishment phase
2. The in-call modification phase

Call Establishment Phase

When the MS requests the "alternate speech/fax starting with speech", the following procedure takes place:

1. Two GSM BCs, preceded by a repeat indicator, are sent in the set-up message. The two ITC-values are *speech* and *facsimile group 3*.
2. The MSC analyzes the two GSM BCs to determine if they are compatible.
3. The BCs are translated into BASCs corresponding to TS11 and TS62. The BCs and BASCs are then converted to one "internal" BC with an ITC-value equal to *alternate speech/fax* and a BASC corresponding to TS61.
4. A *Mode indicator* is established according to the ITC, specified by the *first* GSM BC in the set-up message. In this case the mode indicator is "speech".
5. A telecommunication service analysis and a check of the subscription are performed in the VLR.
6. Block Mobile telephony InterWorking Unit Coordinator (MIWUC) seizes a device towards the DTI/GIWU. This is the case even if the call begins with speech. The device is seized for the duration of the call.

In-call Modification Phase

When a change from *speech* to *fax* is selected, this procedure takes place:

1. A modify message, containing a GSM BC corresponding to TS 62, is sent from the cell phone.
2. The MSC compares the BC, received in the modify message, with the two old BCs, received in the set-up message.
3. The MSC requests the DTI/GIWU to change to fax-mode.
4. The protocol used on the traffic channel is also adapted for fax-service.

ALTERNATE SPEECH/FAX CALL - MOBILE TERMINATING

A mobile-terminating "alternate speech/fax call" from the ISDN is basically handled in the same way as a mobile-originating call.

The important difference is the ISDN BC and High Layer Capability (HLC):

- ITC is equal to "3.1 KHz Audio"
- HLC indicates "Facsimile group 3"

FAX AND DATA CALLS FROM PSTN

It is not possible to indicate the type of call when calling from the Public Switched Telephony Network (PSTN) because BC cannot be provided in the Initial Address Message (IAM). The only information available is the B-number, Mobile Station Integrated Services Digital Network number (MSISDN) of the called subscriber.

When no BC is provided in the IAM message, the GMSC can not determine if the incoming call is a telephony, fax, or data call.

To ensure that the VLR receives a BC from the HLR for subscribers with one or several Bearer Services (BSs), two solutions are provided:

1. Multiple Numbering Scheme
2. Single Numbering Scheme

MULTIPLE NUMBERING SCHEME

The Multiple Numbering Scheme allows the Home Public Land Mobile Network (HPLMN) to allocate several MSISDNs to one subscriber. Each MSISDN is associated with one BC.

When a call comes from the PSTN, the HLR determines the BC required by using an additional MSISDN assigned to the subscriber.

A subscriber must have an additional MSISDN for each type of service, and the correct MSISDN must be dialed for each type of call. One subscriber can have a maximum of 16 different additional numbers.

Example: A subscriber will need one number for telephony service, a second for asynchronous data service 2400 kbit/s, and a third for automatic fax group 3. A subscriber calling from PSTN must dial the correct MSISDN to use the desired service towards this subscriber.

The additional numbers are tied to a specific service in the HLR. This service is described by means of a GSM BC.

Figure 8-1 presents an overview of how the service is retrieved from an incoming MSISDN in the HLR. The missing BC is generated in the HLR.

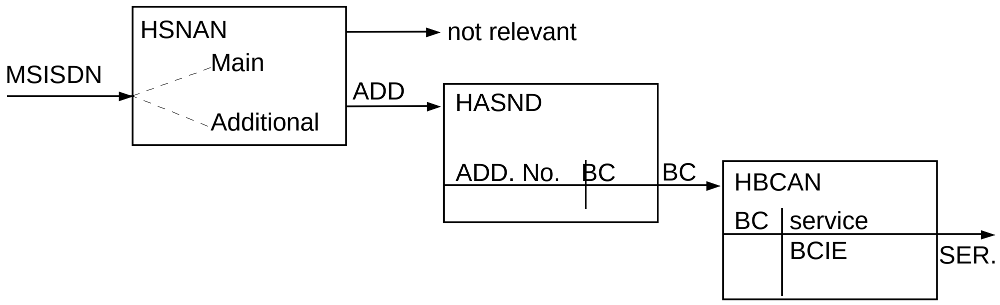


Figure 8-1

Calls Using Additional MSISDN

Terminating calls using additional MSISDNs without an ISDN-BC code are handled according to the BS code obtained from the GSM-BC linked to that number. This linked BC code is sent to the VLR.

Command HGAMI

The Command HGAMI initiates the subscription of a separate MSISDN as an Additional MSISDN linked to a specific GSM-BC for a subscriber. The MSISDN and AMSISDN may not contain the same number in this case.

EXAMPLE:

HGAMI: MSISDN = 49 172 20 11111,

AMSISDN = 49 172 20 22222, BC = 34;

A second MSISDN is tied to an existing subscription. This number must be dialed by the PSTN subscriber to request the service, represented by BC=34.

SINGLE NUMBERING SCHEME

The single numbering scheme is introduced with Ericsson's GSM System.

This scheme allows the HPLMN to allocate just one MSISDN to a subscriber, which is applicable to all services.

In this scheme, the subscriber's main MSISDN is also defined as an additional MSISDN. This provides the ability to link a BC to the main MSISDN and allows terminating calls to act as calls using an additional MSISDN.

Command HGAMI

The command HGAMI initiates the subscription of MSISDN as an additional MSISDN linked to a specific GSM-BC for a subscriber (Single Number Scheme).

The main MSISDN cannot be assigned as a dual number. (See Dual Numbering in Chapter 11 “Additional Traffic Services”.)

EXAMPLE:

HGAMI: MSISDN = 49 172 30 33333, AMSISDN =49 172 30 33333, BC = 56;

Using the main MSISDN as an additional MSISDN is only applicable in the case where the subscriber requires only data or fax calls, that is, no speech calls. Spending an additional MSISDN on one of these services would waste the main MSISDN as the subscriber does not answer any speech calls.

Calls Using Main MSISDN and No ISDN-BC Available

When the main MSISDN is used, but no ISDN-BC is available, the “Default Basic Service Group” can be tied to a subscriber as subscriber data.

EXAMPLE:

HGSDC:MSISDN=49 172 30 44444, SUD=DBSG-1;

- the value of DBSG is defined in AI “Home Translation Functions Changeable Exchange Adaptation”(HTRAN)

The DBSG is used to handle the call, if no BC is sent in the Incoming Address Message (IAM)

INTERWORKING UNITS

GENERAL

InterWorking Units (IWUs) are necessary to support data services within mobile networks with digital transmission. Standard protocols for the fixed network (PSTN and ISDN) cannot be carried by digital interface to MSs.

An IWU extracts analog information received from a modem, and sends it to the MS by a digital protocol. In the reverse direction, information received by the MS via the digital protocol is extracted by the IWU and is sent to the modem by an analog protocol.

In the past, these functions have been implemented using an external GSM InterWorking Unit (GIWU) platform. The communication between this platform and the MSC/VLR occurred over a CCITT-No.7 signaling link.

The DTI is a new IWU that provides the needed data service support. DTI 2 is the second generation of DTI, which enhances the performance of the DTI.

DATA TRANSMISSION INTERFACE (DTI)

For the DTI, the actual data protocol interface on a traffic channel for a call in progress is performed by functions within the Data Transmission Subsystem (DTS).

Figure 8-2 shows the traffic block structure within the MSS, MMS, GSS, and DTS.

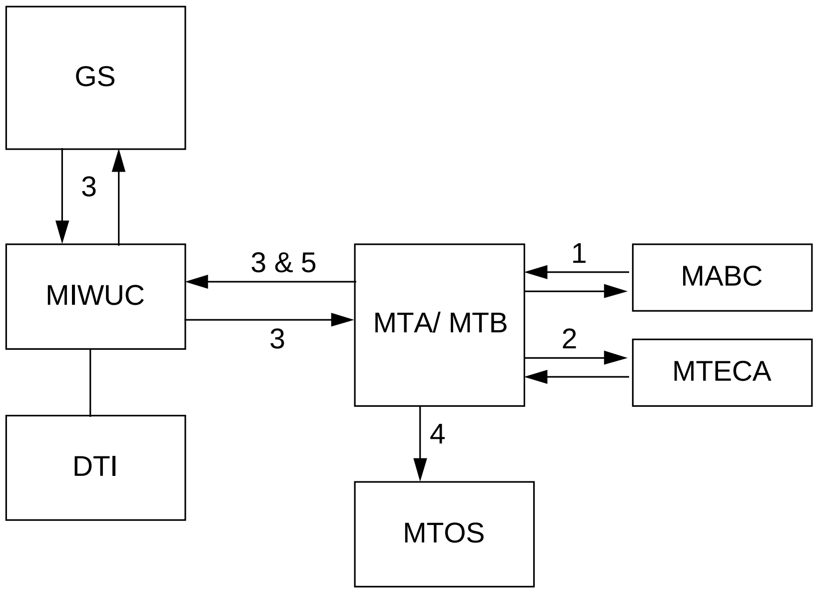


Figure 8-2 Traffic Block Structure

MIWUC belongs to the DTS and consists of separate modules for each type of Interworking-platform. It contains a separate module for handling seizure, control, and distribution signals.

NEC is used for handling the NEC-IWU which is the CMS 30 (PDC) IWU variant.

The different function blocks used during a data or fax call set-up are:

- Mobile TEleCommunication Analysis (MTECA)

  Handling of Teleservice analysis
- Mobile telephony Analysis of Bearer Capabilities (MABC)

  Analysis and conversion of Bearer Capabilities (BCs).
- Mobile A-Line interface Terminal (MALT)

  Handling the A-interface line between the MSC and the BSC, and for generating a ring control tone in the terminating MSC.
- Mobile telephony Call Control Coordinator (MCCC)

  Generating a ring control tone in case of call waiting and coordination handling of call control for call hold, call waiting, and multiparty.
- Mobile TOne Sending (MTOS)

  Handling of tone sending.

Generation of a Ring Control Tone

If a GIWU is in use, it must generate the ring control tone itself.

As opposed to the GIWU, the DTI does not have a ring control tone generation capability. IMALT/MCCC/MTOS generates the ring control tone.

Call Set-up

1. Mobile telephony Analysis of Bearer Capabilities (MABC) analyzes the incoming Bearer Capability (BC), that is, GSM BC/ISDN BC to retrieve the BAsic Service Code (BASC).
2. The BAsic Service Code (BASC) is sent to the MTECA for telecommunication service analysis.

   One of the results of this analysis is a DTI Selection Case (DTISC).
3. Mobile Telephony Traffic Coordinator (MTA/MTB) sends the DTISC to the Mobile telephony InterWorking Unit Coordinator (MIWUC), which will seize an InterWorking Unit (IWU) device and connect it through the Group Switch (GS). A result is sent back to the MTA /MTB.
4. The MTA/MTB orders MTOS to generate the ring control tone.
5. At B-answer the MTA/MTB orders MIWUC to enter call supervision mode.

GIWU/DTI/DTI2 INTERFACE

For fax and data calls, one of DTI , DTI2,GIWU, or a combination of these must be connected in the MSC at call set-up to adapt the system.

Different protocols (Layer 2) and frame structures (Layer 1) used in the fixed network (PSTN, ISDN, and PSPDN) and in GSM must be adapted. The GIWU terminates both protocols.

The three general tasks are:

- Protocol conversion
- Modem pool
- User rate adaptation

Figure 8-3 illustrates an example.

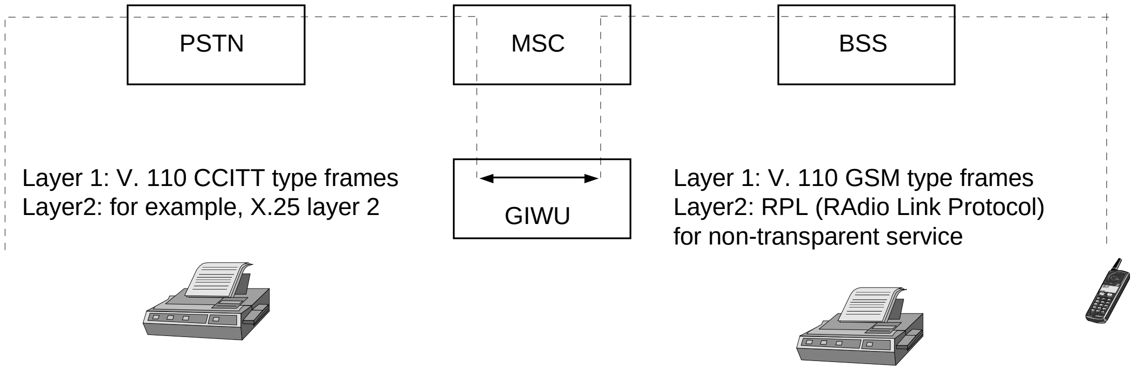


Figure 8-3 Non-Transparent Data Service

The GIWU is not designed for, or integrated on, the AXE platform. However, the unit can be fully operated and maintained by AXE (MSC/VLR).

Figure 8-4 illustrates the general structure with the O&M concept.

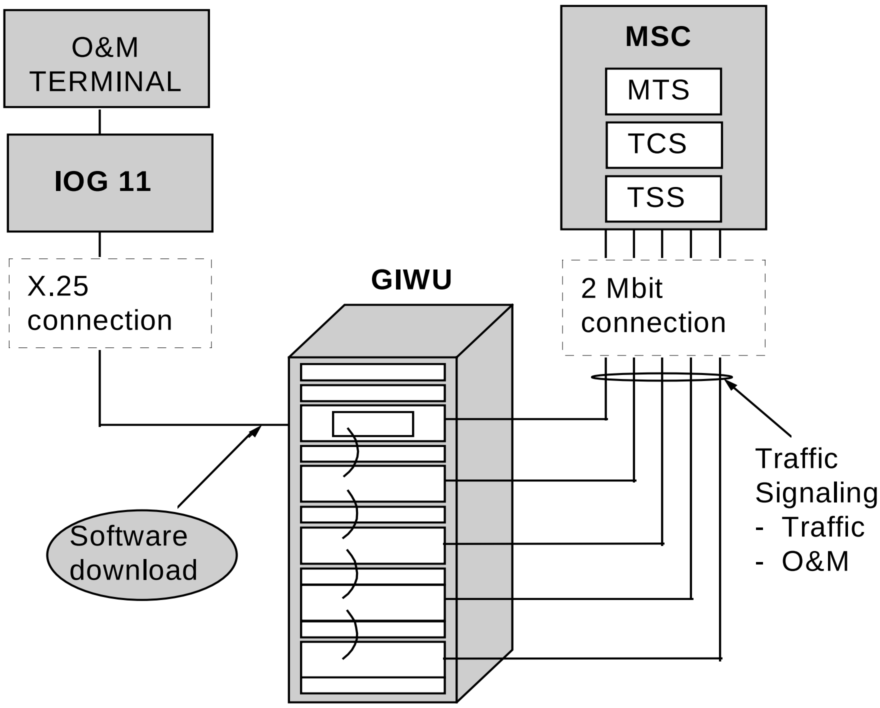


Figure 8-4 GIWU Structure, O & M Concept

The X.25-connection between the GIWU and the IOG is only used to download GIWU software, such as protocol and modem data. The 2 Mbit-connection carries traffic, as well as traffic-related InterWorking unit User Part (IWUP) and O&M-related InterWorking Operation and Maintenance Application Part (IWOMAP) signaling. IWUP is derived from ISUP.

MTP Network and Route

The GIWU is physically connected via Exchange Terminal Circuit (ETC) boards, as shown in *Figure 8-5*. The device handling block is called Mobile telephony InterWorking Unit Line Terminal (MIWULT). The IWUP uses C7 to perform traffic-related signaling. Operation & Maintenance uses IWOMAP. Both protocols use the same signaling link.

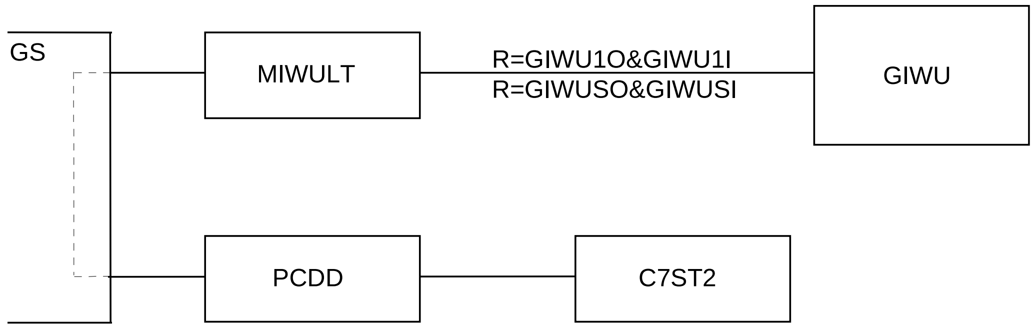


Figure 8-5 GIWU Connection

The signal and timing relationship between time slots of the channel carrying GSM side traffic and the channel carrying network access side traffic is fixed. There are 32 time slots. Time slot 0 is used to synchronize the timing signals. Time slot 31 is reserved for signaling information.

The traffic to/from the BSC on the odd time slots is converted and received/sent on the even time slots from/to the PSTN.

Using the divided time slots one 2 Mbit link can serve 15 data/fax connections. See *Figure 8-6*.

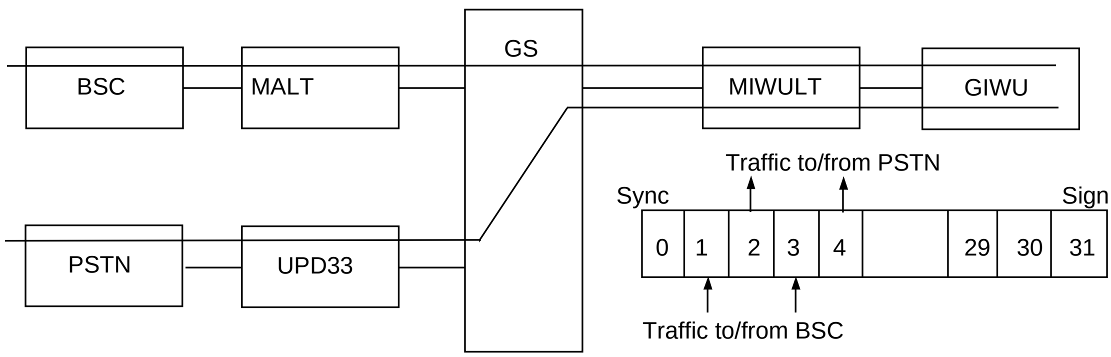


Figure 8-6 Time Slot Allocation between GIWU and MSC

DEFINITION OF DTISC

A DTI Selection Case (DTISC) is one of the results of the Telecommunication Service Analysis. It is connected to one or several GIWU or DTI traffic routes. Thus, the selection case takes on the task of a Routing Case in the B-number analysis.

DSSCI:DTISC=dtisc, R1=r1...[,R2=r2...[,R3=r3...[,R4=r4...]]];

EXAMPLES:

DSSCI:DTISC=FAX,R1= DTIR1, R2=DTIR2;

DSSCI:DTISC=UDI,R1= DTIR2, R2= DTIR3,

DSSCI:DTISC=DATCOMP,R1= DTIR3, R2= DTIR1;

The routes assigned to a DTISC are chosen according to their priority: with increasing route number the priority decreases.

DTISC and BASC Connection

Figure 8-7 shows how a GIWU-route is selected.

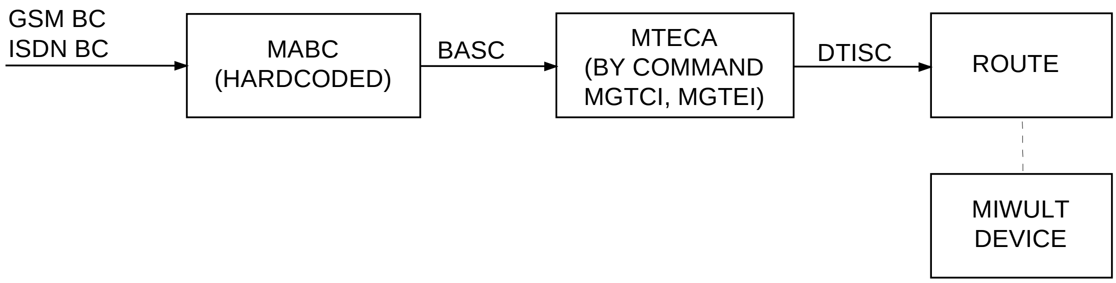


Figure 8-7

HIGH SPEED DATA SERVICE

The High Speed Circuit Switched Data (HSCSD) service (also called multi-slot service) allows the connection of 2 ,3, or 4 time slots on one radio channel. Each time slot carries either 4.8 kbit/s or 9.6 kbit/s of data. The rate coding must be the same for all time slots on one radio channel. PSTN connections support V.34 modems up to 28.8 kbit/s (transparent) or 33.6 kbit/s (non transparent). ISDN connections using V.110 rate adaptation support up to 38.4 kbit/s both for transparent and non-transparent calls.

Asymmetric and symmetric mobiles will be supported. Asymmetric MSs transmit on, for example, one time slot, but receive on four time slots. Symmetric mobiles transmit and receive on the same amount of time slots.

Multi-slot service must be specified in the Telecommunication Service Analysis using the command MGMTI.

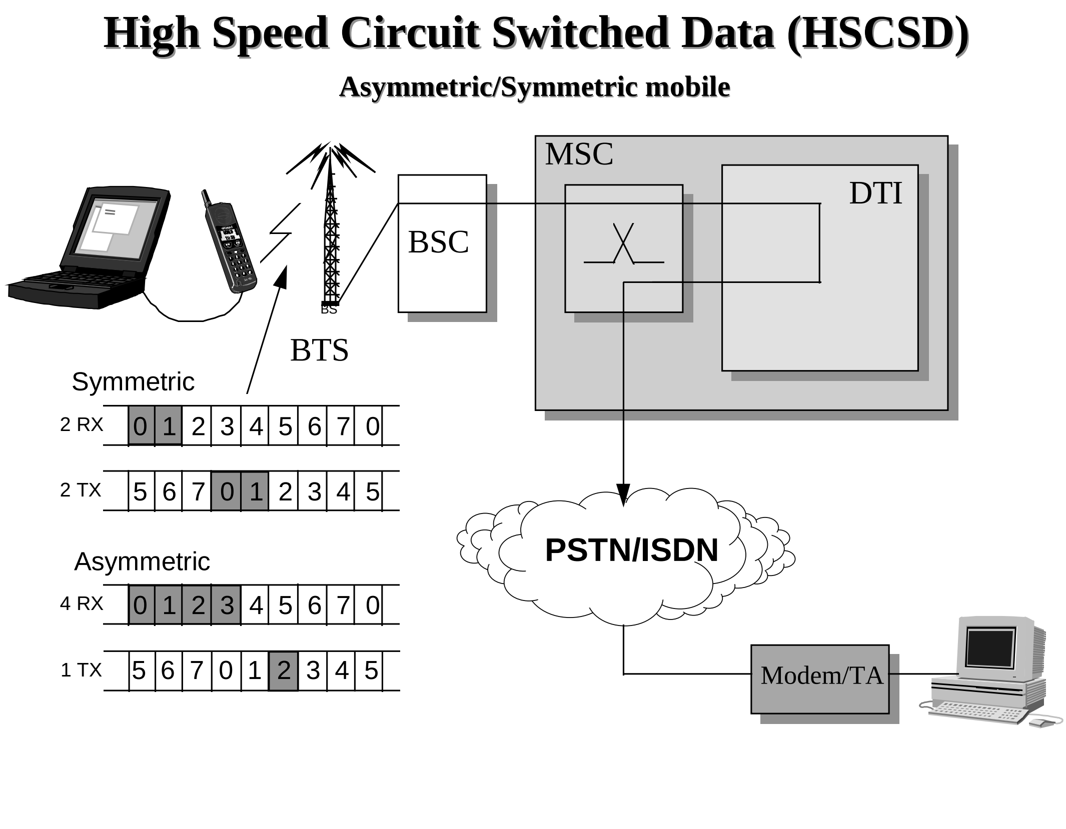


Figure 8-8 HSCSD Service

14.4 KBIT/S CHANNEL CODING

The 14.4 kbit/s Channel Coding function provides the capability to achieve higher user rates using fewer traffic channels. The 14.4 kbit/s channel coding is available for both the single-slot and the multi-slot configuration for data calls. In the case of fax and alternate speech/fax calls only a single-slot configuration is supported.

Using the 14.4 kbit/s channel coding in a multi-slot scenario, the mobile subscriber is able to select higher air interface user rates (for example, 43.2 kbit/s and 57.6 kbit/s). The new possible FNUR values are 48 kbit/s and 56 kbit/s.

The 14.4 kbit/s channel coding provides the End-User with a data rate that is about 50 % higher, and the Operator with an increased interest in data services.

At call set up, the mobile station indicates which channel coding(s) it supports and should be accepted for the call. The possible values are TCH/F4.8, TCH/F9.6, and TCH/F14.4, or a combination of these three.

To implement the 14.4 kbit/s feature in the MSC/VLR, DTI is required, support in the HLR, BSS, and MS is also required. The new AXE parameter, C14400INDICATOR, of the parameter set GSMDTSF in the MSC is introduced.

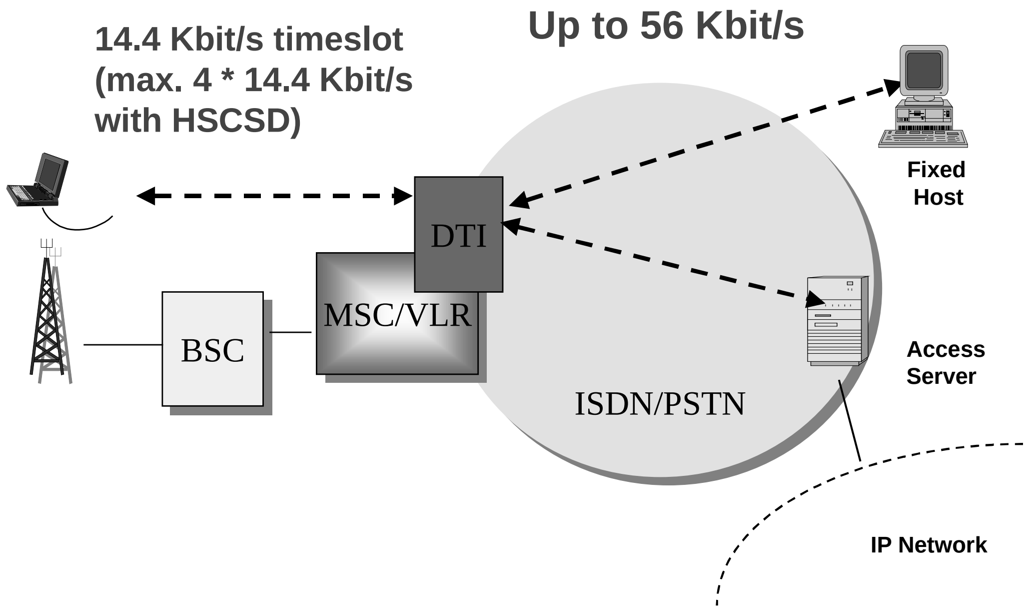


Figure 8-9 14.4kbit/s Data Communication

DATA COMPRESSION

Data compression increases the user data rates for all asynchronous non-transparent Bearer Services. It provides data compression, according to the V42bis protocol for mobile terminating calls by means of storing a compression attribute per bearer capability and mapping the signaling information from the PSTN/ISDN to the GSM signaling information.

An increase of throughput by a factor of 1.5-4 is realistic using that compression method, although the nature of the transmitted data determines the actual throughput gain.

The data compression function can be used in conjunction with High Speed Circuit Switched Data and 14.4 kbps Channel Coding.

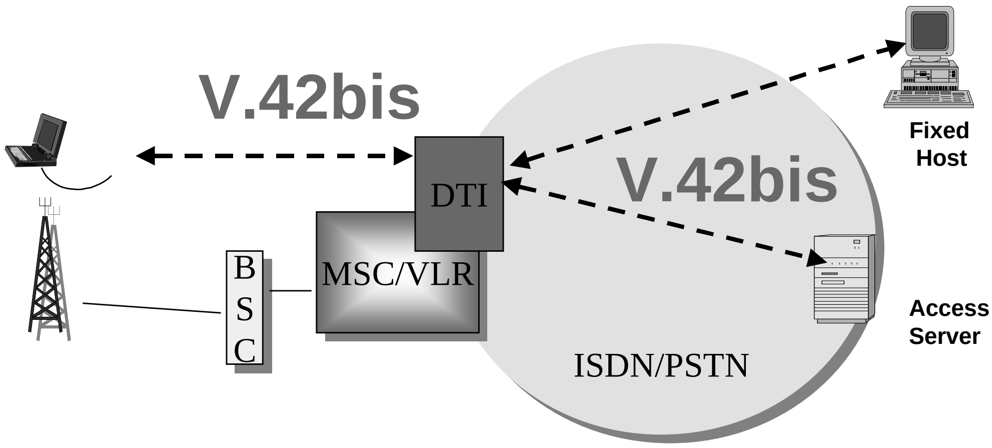


Figure 8-10 V42.bis Data Compression

Data Compression provides the End-User with increased bit rate and the Operator with optimized radio resources.

Data Compression requires special hardware (DTI, DTI2, but not GIWU). To be able to select normal or Data Compression (DC)-specific hardware for a BEG service, a new parameter, DCDTISC, is introduced.

To implement Data Compression support in the HLR and the modem as part of the mobile terminal, specific equipment is needed.

Call from Mobile Subscriber

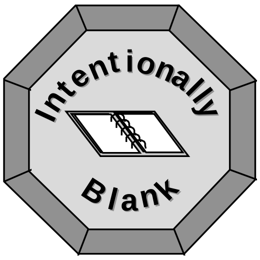
Chapter 9

This chapter is designed to provide the student with the knowledge of how a mobile originating call is handled in the MSC/VLR.

OBJECTIVES:

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

- Explain how a mobile originated call is analyzed
- Describe how a mobile originated emergency call is analyzed in the MSC/VLR
- Define exchange data in the MSC/VLR for a mobile originated call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9 Call from Mobile Subscriber

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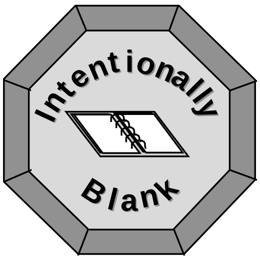
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GENERAL

In this chapter, the exchange data necessary to allow a mobile originated call is described. Many of the areas of analysis, for example, B-number analysis, access barring analysis, and routing case analysis ought to be familiar from previous chapters and courses, therefore, only new or different aspects will be considered in further detail.

Figure 9-1 shows the nodes and information involved in a mobile originated call.

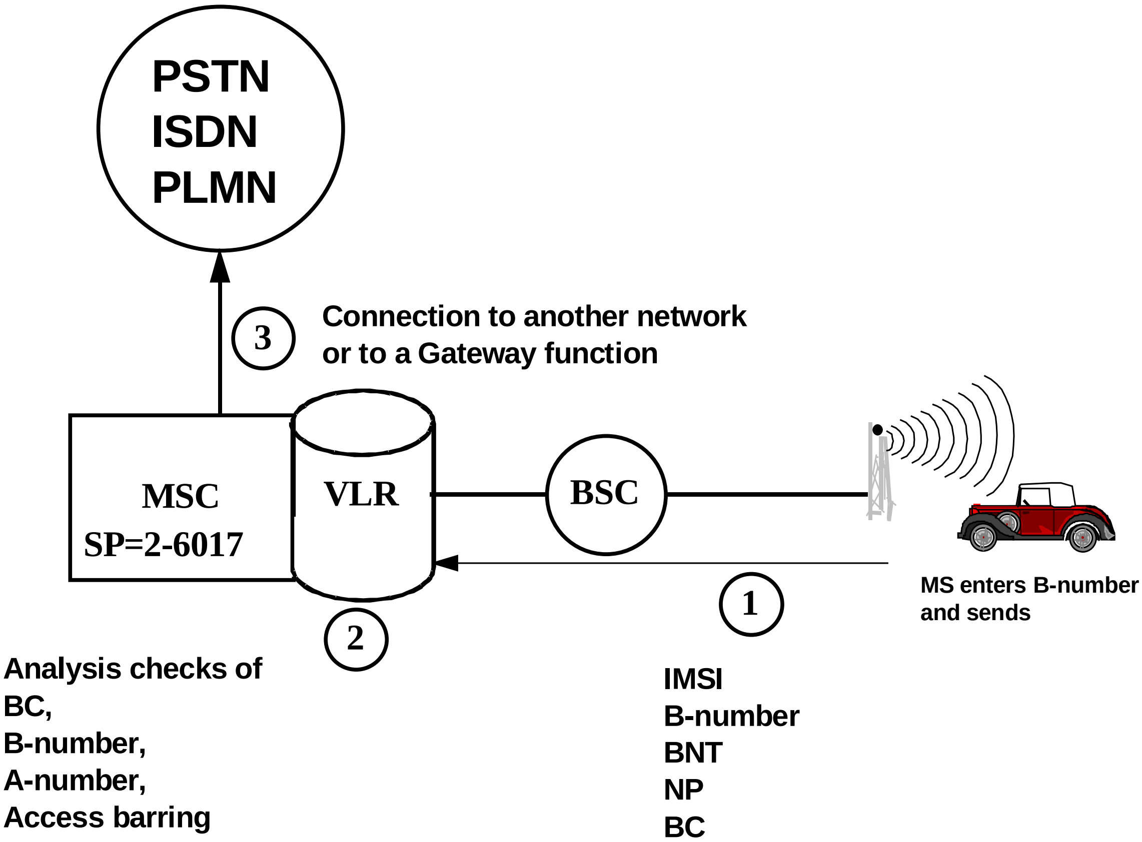


Figure 9-1 Mobile Originated Call

The following sequence of events occurs:

1. The MS sends a DTAP message to the MSC which contains Bearer Capability (BC), the B-number, and other information describing the B-number. The other information includes the B-Number Type (BNT) and the Numbering Plan (NP). The Bearer Capability (BC) describes the type of service required for the call, for example, it may be a telephony call, a fax call, a data call, or even a short message call. The Number

Plan (NP) always indicates that the B-number is based on the E.164 series, NP=1 and the B-Number Type (BNT) usually indicates that the B-number is of type unknown, BNT=2. However, if the “+” key (the “+” key is used instead of the international access code, in Germany 00, Sweden 009) is used BNT indicates that the B-number is in the international format BNT=1.

2. The whole range of analysis takes place in the MSC/VLR, as illustrated in *Figure 9-2*, before an outgoing route is selected.

3. The call is routed to other networks according to the B-number and Routing Case analysis.

ANALYSIS FUNCTIONS

For a mobile originated call to be routed, a number of analysis functions is required, refer to *Figure 9-2* .

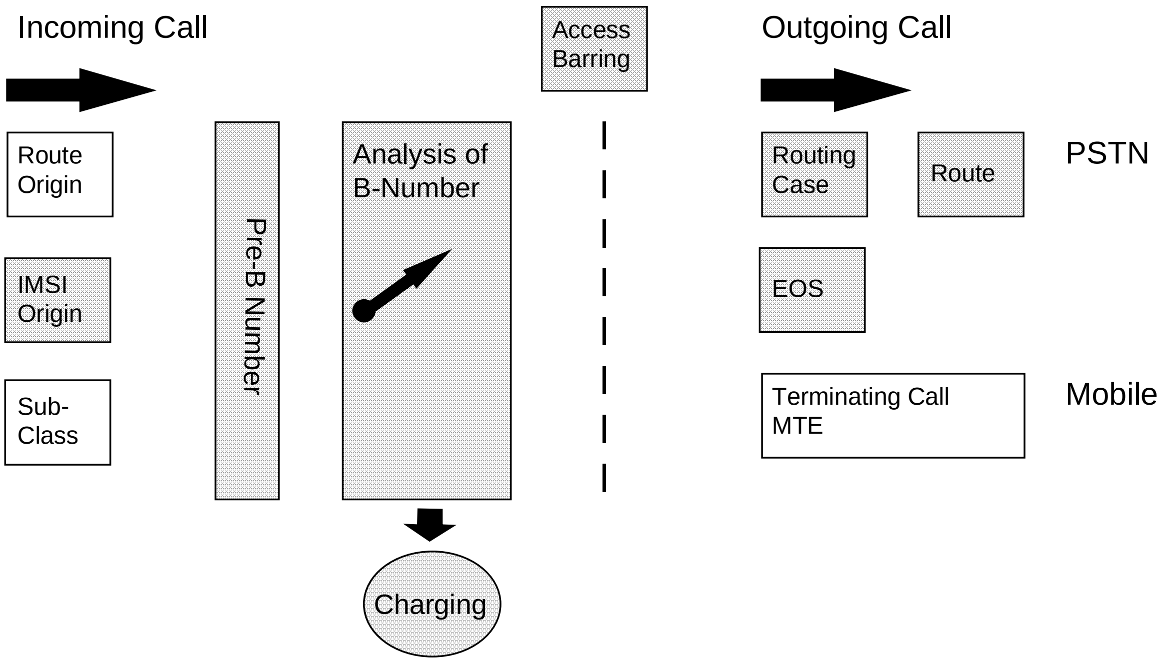


Figure 9-2 Analysis Functions

In addition to the analysis functions, shown in *Figure 9-2*, the aforementioned telecommunication service analysis must take place. The purpose of the telecommunication service analysis is to determine whether the MSC/VLR supports this call type. If the MSC/VLR does not have a GIWU or a DTI, any data or fax calls will fail due to the fact that the GIWU or DTI is required to support the call. For more information about telecommunication service analysis, refer to Chapter 7 “Telecommunication Service Analysis”.

IMSI NUMBER SERIES ANALYSIS

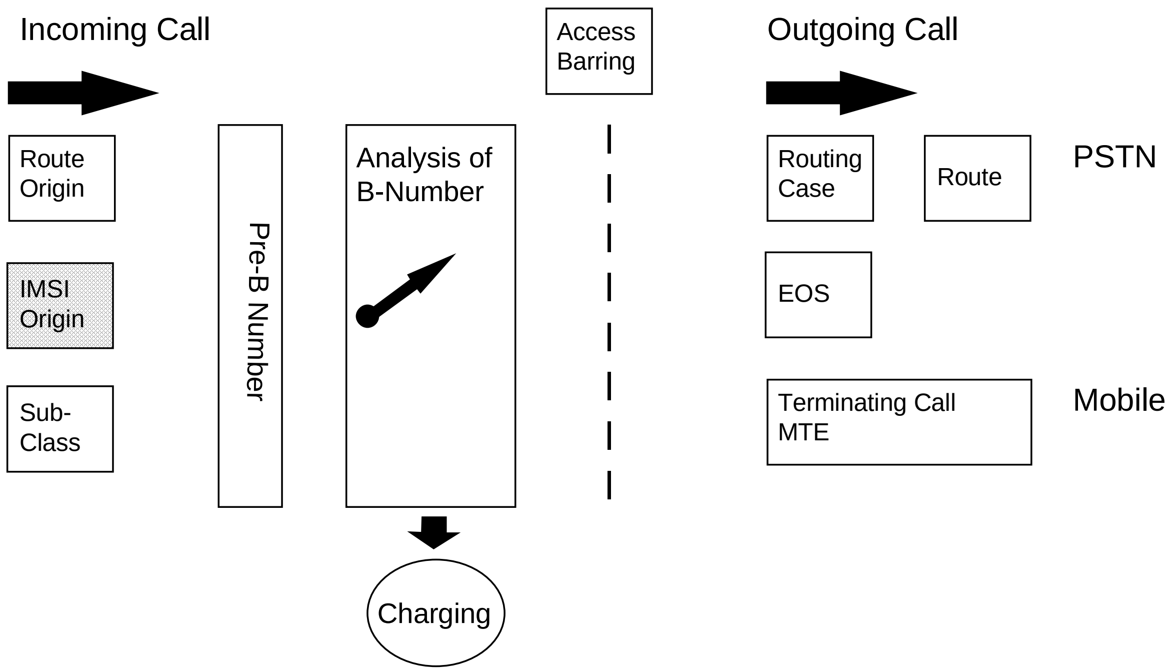


Figure 9-3 IMSI Number Series Analysis

Information about the MS is fetched from the IMSI number series analysis table. This information includes these parameters:

OBA

Origin of B-number Analysis, specifies which B-origin the MS should use for the mobile originated call in the Pre-analysis, or in the B-number Analysis.

CBA

Call Barring Access, this parameter is used in connection with the supplementary service, BOIEXH (Barring of all Outgoing International calls EXcept those directed towards the Home PLMN).

NATMS

NATional Mobile Subscriber is used to determine how the A-number is presented, the default is in the International format, but this parameter places the A-number in the National format.

OWNMS

OWN Mobile Subscriber is used to determine whether the COLP/COLR supplementary service can be used.

All these parameters are defined using the ANRES parameter, a copy is found in the Application Information (AI) for Mobile Telephony Data. To find the parameter values, or to get an explanation of the parameter, refer to the Application Information (AI) for the parameter owning block, for example, the owning block for NATMS, is MTACC (for mobile originated calls), or MTBSS (for mobile terminated calls).

Figure 9-4 shows an example of the result of an IMSI-number analysis.

```
<MGISP:IMSIS=262 02 21;

MT IMSI NUMBER SERIES ANALYSIS DATA

OPERATING TABLE

IMSIS        M             NA    ANRES

262 02 21    7-49 172 21   4     OBA-30

                                 BO-30

                                 MAPVER-1

                                 CBA-49
                                 ....
```

Figure 9-4

BO is the origin used for call forwarding.

The command MGISI defines the IMSI-number analysis. For more information concerning the IMSI-number analysis, refer to Chapter 5 “Location Updating”.

EMERGENCY CALLS

In the Global System for Mobile Communication (GSM) or Personal Communications Service (PCS), the emergency call number is 112. When this number is dialed, the Connection Management (CM) Service request message from the MS indicates that this is an emergency call establishment.

An End of Selection (ES) code is generated:

- 2290 if the call is to be set-up *with* a SIM-card
- 2577 if *no* SIM-card is installed in the MS

This ES code is converted into a B-number which is then analyzed in the ordinary B-number table. The output of this analysis is a Routing Case (RC).

Emergency call routing is determined by the RC, Routing Origin (RO) parameter, and the Emergency Area (EA) parameter.

Figure 9-5 shows the printout from a Routing Case (RC) analysis table for Routing Case (RC) 96.

```
<ANRSP:RC=96;
ROUTING CASE DATA
OPERATING AREA
RC        CCH      BR                ROUTING
96        YES      RO-0
                   EA-1
                   PLMN -0&&-63
                   MST-0&&-15        P01=1 R=KISTA1O
                   RO-0
                   EA-2
                   PLMN-0&&-63
                   MST-0&&-15        P02=1 R=KISTA2O
```

Figure 9-5

The cell where the MS is located at call set-up determines RO and EA. In *Figure 9-6*, CO determines the Charging Origin.

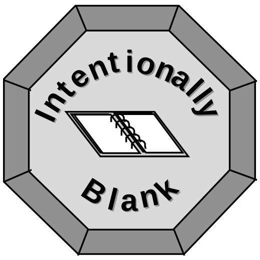
```
<MGCEP:CELL=ALL;

MT CELL DATA

CELL    CGI           BSC      CO   RO   NCS   EA

C6A31   262-02-60-4   BSC6A4   1    0          1

C6A32   262-02-61-5   BSC6A4   2    0          1

C6B31   262-02-62-6   BSC6B4   3    0          2

C6B31   262-02-63-9   BSC6B4   3    0          2
```

Figure 9-6

Exchange properties determine how an emergency call is set up:

- EMCNOIMSI — determines whether an emergency call is allowed *without* a SIM-card.
- EMCNOLU — determines if an emergency call can be carried out when location updating has *not* been made, when a SIM-card is installed in the MS.
- IMEICONTROLEMR — determines if the IMEI check should be performed for a mobile originated emergency call.
- IMEIROUTGRYEMR — determines if an emergency call should be rerouted to announcement or operator, in case the MS is not type-approved (gray listed).

For more information concerning exchange properties, refer to Application Information (AI) 1/APT.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Performance Measurement

Chapter 10

This chapter is designed to provide the student with information about OSS applications for Performance Management

OBJECTIVES:

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

- Describe Performance Management in OSS using Performance Measurement (PM) Data Collection, Performance Measurement (PM) Data Processing, and Statistical Report Package (SRP)
- Describe the most important reports available

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10 Performance Measurement

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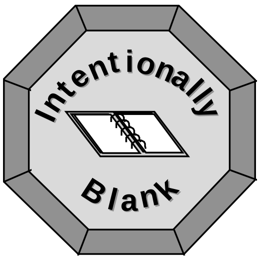
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PERFORMANCE MANAGEMENT

The network operator needs detailed information about the network performance to run the network. Otherwise, it is not possible to plan and dimension the network. The information can also be used to find areas with insufficient service and performance to enable the operator to correct a problem before a fault occurs. The information, delivered by performance management systems, can be used to:

- Identify traffic patterns and traffic distributions
- Determine the amount of traffic in the exchange and the network
- Monitor the Grade of Service (GoS)
- Find areas with insufficient service
- Fault finding

The AXE 10 includes a comprehensive set of measurement functions for all kinds of objects, which are of interest to the operator. The distinction must be made between long-term statistics and short-term recordings.

- Long-term statistics are used for dimensioning, planning, and managing the network
- Short-term recordings are used for fault finding and trouble shooting fault finding

The scope of this chapter only contains the long-term statistics. For more information concerning short-term recordings, refer to the OSS Overview Course.

LONG-TERM STATISTICS

As previously mentioned, long-term statistics are used to dimension, plan and manage the network. Long-term statistics mean, that measurements are performed over a duration of several months or longer. The measurement functions are constantly active and continuously supervise the AXE 10. The AXE 10 includes two subsystems which provide measurement functions for long-term statistics:

- Operation and Maintenance Subsystem (OMS)
- Statistics and Traffic measurement Subsystem (STS)

The OMS provides recording functions for:

- Traffic measurement on routes
- Traffic type measurements
- Traffic dispersion measurements
- Data recording per call
- Processor and input load measurements

STS provides measurement functions for several different objects,for example, STS includes the same measurement functions as OMS, but the recordings are more detailed. In addition to this, STS includes measurement functions for:

- Supervision of the Link Access Protocol for the D-Channel (LAPD)
- Supervision of C7 signaling
- Supervision of the paging in a Base Station Controller (BSC)
- Other objects, for example, number of handovers

INITIATION OF LONG-TERM STATISTICS

OSS provides an application for the initiation, supervision, and collection of long-term statistics, called Performance Measurement (PM) Data Collection. The user can perform OMS and STS measurements using PM Data Collection. PM Data Collection supports these OMS measurements:

- Traffic measurement on routes
- Traffic measurement on traffic types
- Traffic measurement on traffic dispersion

All kinds of STS measurements are supported by the PM Data Collection.

The user can easily handle OMS and STS measurements by means of a graphical user interface. No further knowledge of

OMS or STS is required. All pre-defined measurement functions of the different Network Elements (NEs) are presented in a list. The list is a snapshot of the actual definitions of an NE. If new STS measurement functions are defined by another user, the list must be updated. The system administrator can do this using the Audit function of the PM Data Collection. The results of the recording are transferred from the NE to TMOS and are stored in the PM Application-Data Base (PMA-DB) The user or other applications can access the PMA-DB over an open Standard Query Language (SQL) interface.

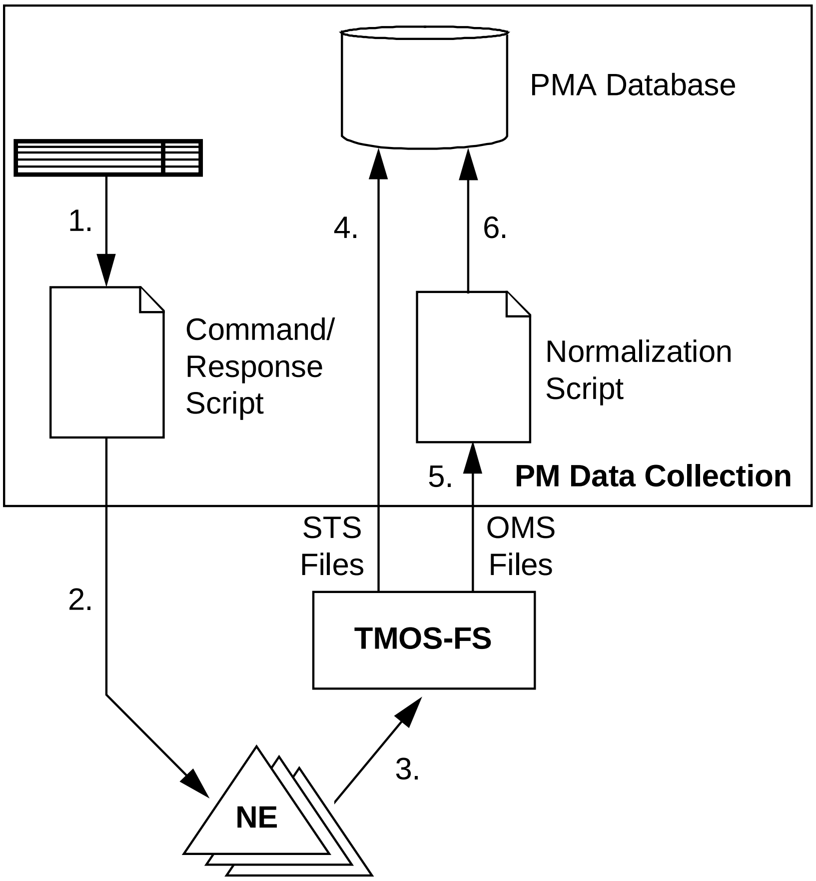


Figure 10-1 The Process of Data Collection

To initiate a recording the user must specify the type of recording, that is, OMS or STS measurement. After that, the NE must be selected. The user gets a list of all available measurement functions of this NE and can easily select the desired function. It is possible to select one or several measurement functions for one measurement job. The user must specify the recording period and the daily recording interval. Then, the recording can be initiated. After that, a new measurement job is created and the job status is displayed in the main window.

All other settings are automatically handled by the PM Data Collection.

1. The parameters, given by the user, are translated by the PM Data Collection. Command and Response scripts are used for the communication with the NE.
2. The recording is defined and started at the NE. The recording results are stored in files on the Input Output Group (IOG).
3. The files are periodically transferred from the IOG to TMOS. The PM Data Collection supervises the file transfer and after a successful file transfer, the files are deleted on the IOG.
4. The files from the STS recordings are stored directly in the PMA-DB.
5. The files from the OMS recordings are first normalized and then stored in the PMA-DB. The normalization function carries out a type of post processing, which formats the OMS files into the STS standard file format. The data stored in the PMA-DB is available over an open SQL interface.

In addition, the PM Data Collection provides functions for including existing STS and OMS PM files in the PMA-DB.

PROCESSING OF LONG-TERM STATISTICS

The recording results are stored as raw data in the PMA-DB. This data can be processed by other applications. An SQL interface is available for accessing the data. OSS includes an application for the processing of the raw data, called Performance Measurement (PM) Data Processing. This application provides several functions which allow the user to post process raw data that is stored in the PMA-DB. These functions are controlled by graphical user interfaces, which allow for easy and comfortable handling. PM Data Processing provides these data processing functions:

- Summarization over a day, week, or month
- Maximum or minimum value per day
- Predefined functions

The user can create his own data processing functions and run these functions through a graphical user interface, provided by the PM Data Processing. This is called a predefined function.

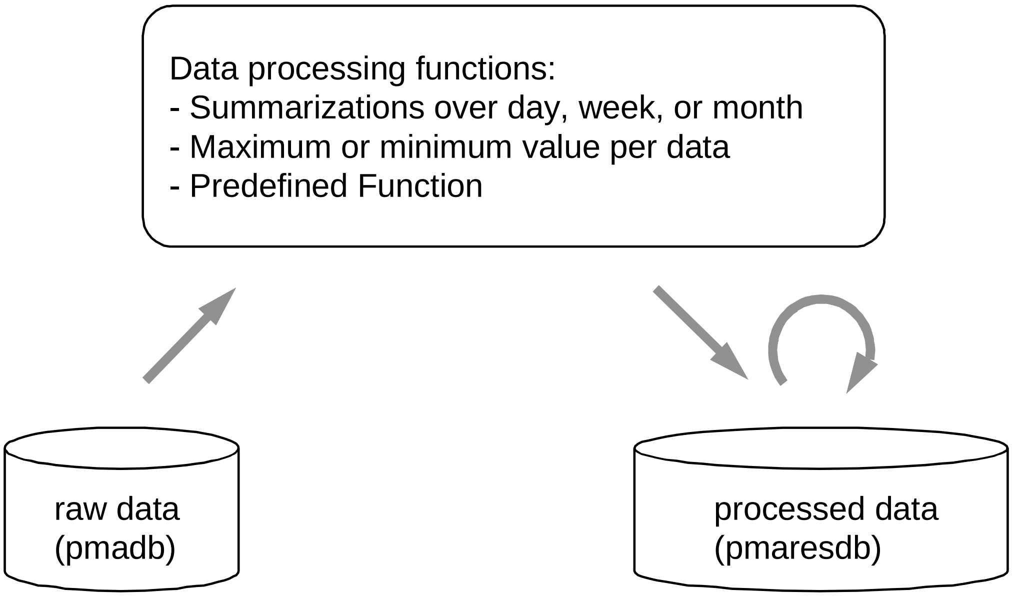


Figure 10-2 The Data Processing Process

PM Data Processing accesses the PMA-DB and collects the raw data according to the specifications given by the user. The raw data is processed and is stored in the Performance Measurement Application RESult-Data Base (PMARES-DB). The processed data is available over an open SQL interface for other applications.

Below is an example of the use of the data processing function:

When the function of summarization over day is selected, a Create Time Sum Day Job is created. The raw data of the specified table is processed and stored on a per day basis. Gauge counters are summarized so that the mean value within the day interval is saved. Cumulative counters are summarized so that the accumulated sum within the day interval is calculated and saved. The processed data is stored in the PMARES-DB.

PRESENTATION OF LONG-TERM STATISTICS

The recording results, stored in the PMA-DB, are available over an open SQL interface. This makes it possible for the network operator to use third party products to collect and process the data from the database, instead of using an Ericsson product. Ericsson provides a tool, which allows the presentation of the data stored in the PMA-DB. The name of the application is Statistical Reports Package (SRP) and it is part of the OSS. The SRP presents STS and OMS measurement data in several reports. Additionally, data of the Cellular Network Administration-Data Base (CNA-DB) is used. The CNA-DB contains the current radio network configuration, which is used for creating reports. In addition to the data stored in the CNA-DB and the PMA-DB, printouts from the Network Elements (NEs) are collected and processed for the reports. Printouts of the subscriber distribution are fetched from the responsible NE. Restart messages are also collected from the NE by the SRP. The data which is presented in the different reports is stored in the Statistical Report Package-Data Base (SRP-DB). For the graphical presentation of the reports in spreadsheets and diagrams, a third party product called Applix Ware is used.

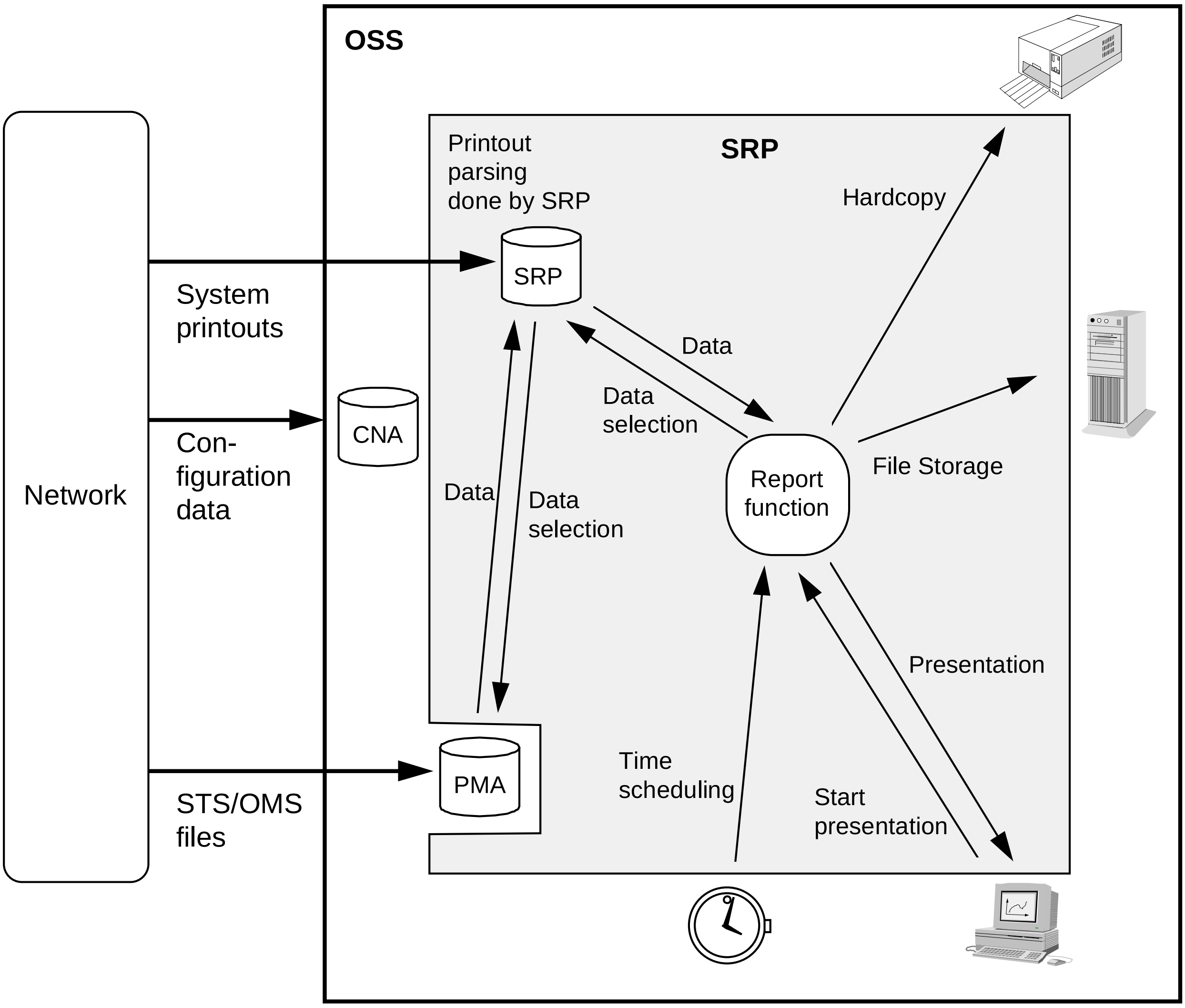


Figure 10-3 The SRP Data Flow

The SRP provides a number of reports that support the user in analyzing the behavior of the radio network and the switching system. Three report types for different user groups are available. Each report package consists of several subreports. The reports can be scheduled, or generated immediately, and presented on screen or saved in a file. To schedule reports the Cellular

Network Activity Manager (CNAM) is used. The reports can be generated once hourly, daily, weekly, or monthly. CNAM supervises the generation process and allows the user to view, delete, and abort SRP jobs.

For some reports, thresholds are used. The thresholds help the user to find cells and routes with exceptional characteristics in the network. The threshold definition is made in the report set-up. Targets are also used to make it easier to compare a current value to a defined value. The user can define groups of Managed Objects, which are used in the report. Managed Objects, in this content, are routes and cells.

The reports in SRP are grouped and structured into three types: Management, Planning, and Engineering, and Operation.

The **Management Summary Report** is customized to provide comprehensive information about the cellular network in both tabular and graphical form. The Management Summary Report contains information from both Mobile services Switching Centers (MSCs) and Base Station Controllers (BSCs), that is, the whole network. This gives the management the ability to increase the control of network size and behavior.

The **Planning and Engineering Reports** are specially intended for planning and engineering personnel and are designed to identify in which areas future expansion of the network is needed. The reports give overviews and detailed statistics for the network planning and engineering. The Planning Summary Report contains information about the whole network, but is more detailed than the Management Summary Report. The information in all reports, except the Planning Summary Report, is sorted according to names and identities. The reports selected to be shown on screen are displayed in a spreadsheet format. This makes it possible to sort the information in the reports according to any performance criteria.

The **Operation Reports** are used as “Management by Exception Reports” and include thresholds to be defined for the performance indicators in the reports. The reports present detailed statistics on the radio network, switching and routing performance. The reports are used to rapidly detect cells and routes with unacceptable performance, enabling the operator to take immediate action to preserve the quality of the network. As in the Planning and Engineering Reports, the information in the Operation Reports is sorted according to names or identities. The reports selected to be displayed on screen, are shown in a spreadsheet format. This makes it possible to sort the information in the reports according to any performance criteria.

Additional Traffic Services

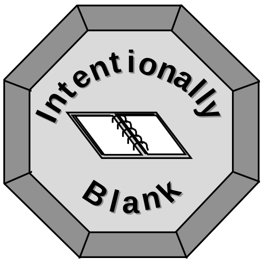
Chapter 11

This chapter is designed to provide the student with additional information on some features, mentioned in earlier chapters, as well as an introduction to some optional features that are available in Ericsson's GSM System.

OBJECTIVES:

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

- Define Dual Numbering service in the HLR
- List the signaling information elements for MAP version cross phase compatibility
- Describe the MAP 2 signaling sequence for a basic handover procedure
- List four methods of call tear down
- Describe Subscription Type handling in the MSC/VLR and the GMSC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11 Additional Traffic Services

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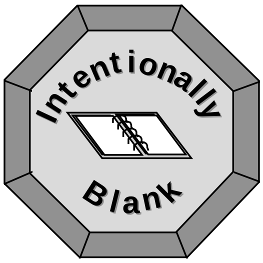
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DUAL NUMBERING

Dual numbering allows a mobile subscriber to charge incoming and outgoing calls to different accounts. A subscriber can, for example, charge all business calls to one account and all private calls to another account using this function.

OPI HLR DUAL NUMBERING ADMINISTRATION

HGAMI:MSISDN=491722112345, AMSISDN=491722112346, BC=1;

A dual number is defined with Bearer Capability (BC) 1.

BC 1 is reserved for "Auxiliary telephony TSD1".

Note: See the chapter on Traffic Cases Data and Fax Calls when using additional Mobile Station ISDN Numbers (MSISDN) in mobile terminated data and fax calls.

CROSS PHASE COMPATIBILITY

Mobile Stations (MSs) are affected by the separation of GSM into different phases. Upward compatibility and infrastructure equipment are required for MSs of different phases to successfully co-exist.

Compatibility is essential, due to the fact that mobile subscribers in the GSM network demand equal access and quality of service, regardless of which mobile equipment version they have. Owners of old equipment are not always willing to upgrade their equipment, but still want access to services that are available in the most recent upgrades.

Therefore, a solution must be found to ensure a smooth upgrade without inconveniencing the customer.

The MSC/VLR of Ericsson's GSM System must be able to handle mobile calls between MSs of different phases, while adhering to the relevant technical specifications of each GSM phase.

In an attempt to facilitate the transition, two GSM specified Supplementary Service (SS) protocol indicators have been introduced into the SS Cross Phase Compatibility feature:

- Screening Indicator (SI)
- Version Indicator (VI)

The Screening Indicator (SI), used for network-initiated SS communications, allows the MSC/VLR to verify that the MS is capable of handling the communication, prior to completing the connection.

The Version Indicator (VI), used for mobile-initiated SS communications, enables the MSC/VLR to select the compatible protocol version, required to complete a transaction.

SCREENING INDICATOR

A Screening Indicator (SI) is sent by the MS prior to connection to indicate that the services are compatible. It is accepted by the GSM phase 2 or phase 2+ MS for the duration of a radio connection.

If the MS did not send a Screening Indicator (SI), the MSC/VLR verifies the service is supported prior to completing the connection. If the MS cannot handle the communication, the MSC/VLR automatically aborts.

VERSION INDICATOR

The SS Version Indicator (VI) can be included in the Supplementary Service Request from the MS. The MSC/VLR uses the SS Version Indicator (VI) to select the compatible protocol version, required to handle a specific SS.

When a new transaction is set up for call independent SS procedures, the MSC/VLR verifies that the indicated version is compatible, prior to completing the transaction. If the indicator is not present, the operation is handled by the HLR. In this case, the MSC/VLR automatically selects GSM phase 1 Mobile Application Part (MAP) to complete the operation.

If the Version Indicator (VI) is received in the MSC/VLR indicating GSM phase 2 or phase 2+, the MSC/VLR processes a local SS request according to the GSM phase, or establishes an MAP dialogue with the appropriate GSM phase.

If the phase 2 MAP dialogue must reference phase 1 MAP, the MSC/VLR processes the operation with phase 1 MAP, if possible.

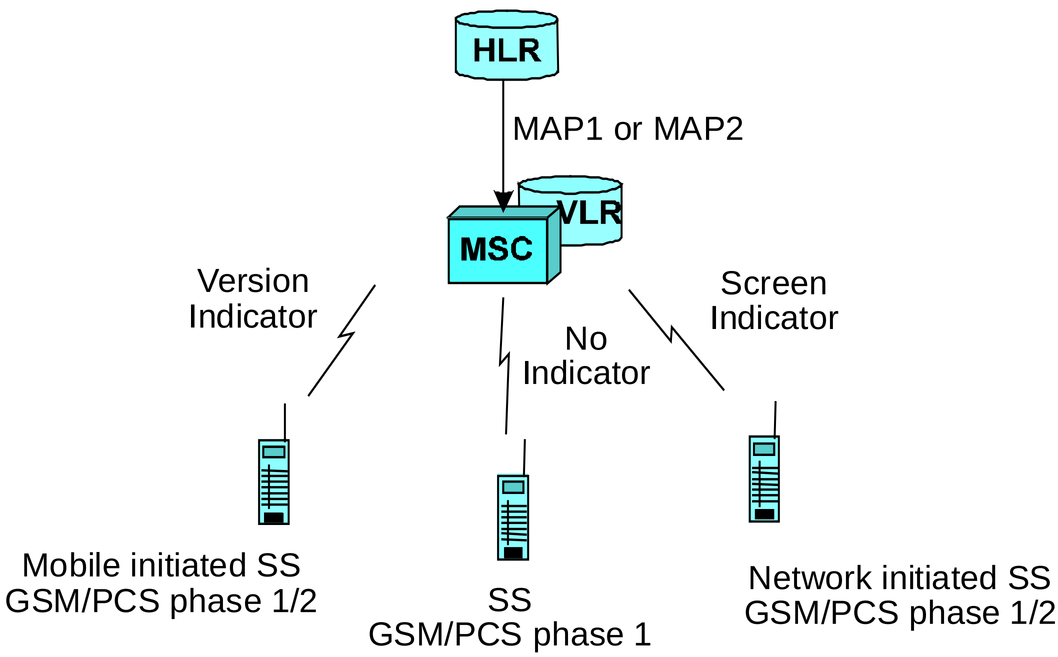


Figure 11-1 Supplementary Service (SS) Version Indicator

HANDOVER

INTER-MSC HANDOVER

Basic Handover-MAP V2

GSM phase 2+ uses different MAP versions: (MAP 1, MAP 2, and MAP 3). This section describes the Basic Handover procedures for MAP 2 only. The other sequences, for example, basic handover, MAP 1, and subsequent handover, MAP 1 and MAP 2, are not covered in this course.

Figure 11-2 illustrates the MAP 2 signaling sequence for a successful basic handover procedure:

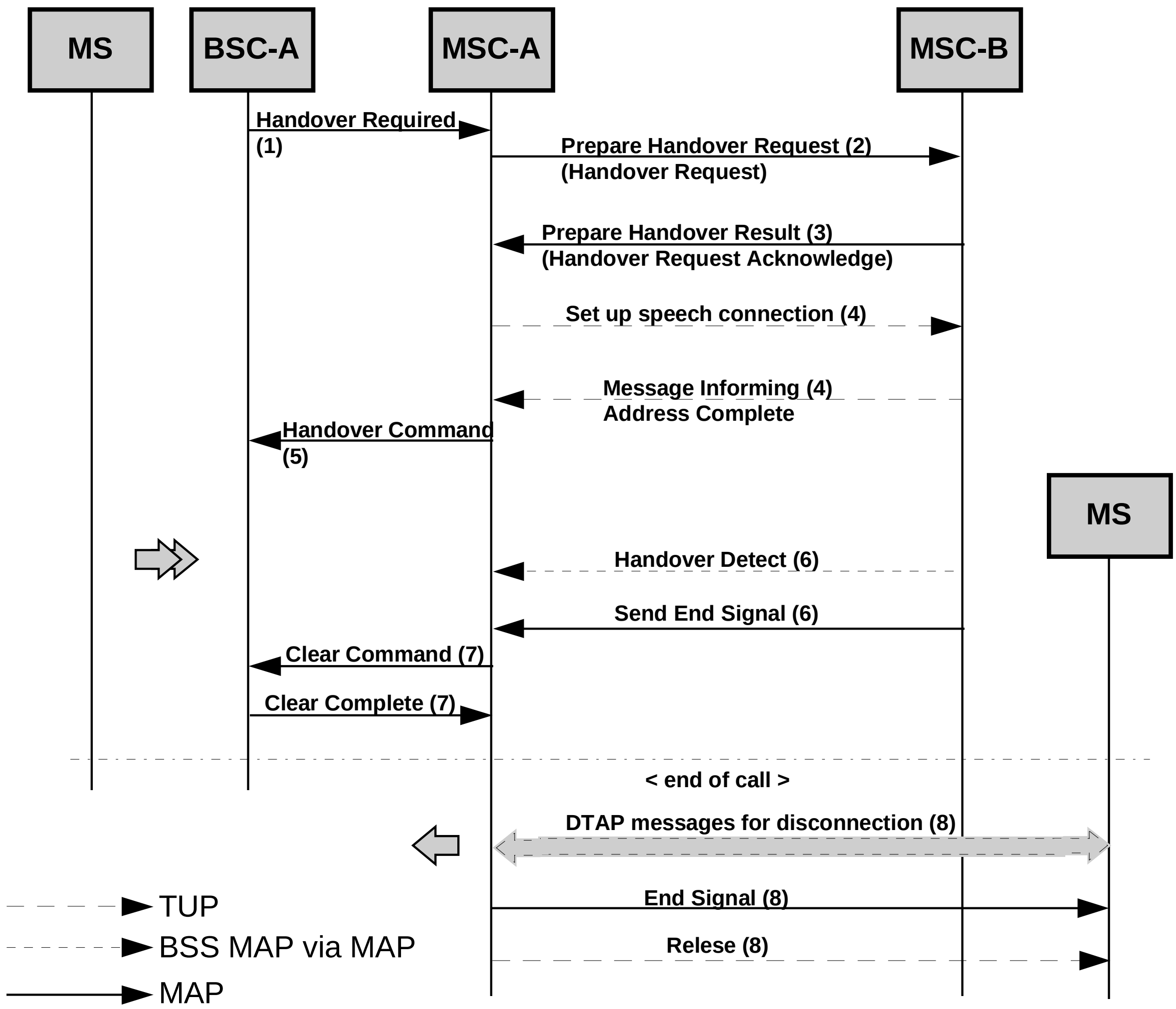


Figure 11-2

1. When the MS moves between cells, the serving BSC detects that a handover to a new cell is necessary. The BSC sends a HANDOVER REQUIRED message to the serving MSC (MSC-A), identifying the cell to which the MS should be handed over.
2. Once the HANDOVER REQUIRED message is received from the serving MSC, MSC-A selects and analyzes the cell in the Cell Identifier List.

   Note: The Cell Identifier List (preferred) is a mandatory information element of the HANDOVER REQUIRED message, which uniquely identifies cells within one or several BSSs.

   MSC-A then sends the PREPARE HANDOVER message and a HANDOVER REQUEST to the target MSC (MSC-B).
3. MSC-B now allocates a free radio resource in the target cell by contacting the target BSC (BSC-B).

   If the allocation is successful, the MSC-B sends a PREPARE HANDOVER reply containing a HANDOVER REQUEST ACKNOWLEDGE message and the handover number, if requested, to MSC-A.

   If the resource allocation is unsuccessful, the reply contains a HANDOVER FAILURE message. A QUEUING INDICATION message is also included, when the requested handover number is not received. In other words, failure to allocate a resource causes the MAP dialogue to abort and the call is continued on the same channel as before.
4. After MSC-B has allocated a radio resource, MSC-A sets up a speech connection with the received handover number to MSC-B through the PLMN or PSTN/ISDN network.
5. MSC-A orders the MS to tune to the new radio channel by sending the HANDOVER COMMAND message to the serving BSC.
6. MSC-A then waits for a response, such as a HANDOVER DETECT message, the answer signal, or the SEND END SIGNAL containing a HANDOVER COMPLETE message. The Group Switch (GS) only operates if a circuit connection has been established and verified via a response before the GS trigger timer expires.
7. If the MSC-A receives a HANDOVER COMPLETE message, the handover is considered complete and the A-interface resources toward BSC-A are released. Now MSC-B has the main radio resource control of the call and is regarded as the serving MSC, but not the anchor MSC.

8. MSC-A has the overall call control until the call is cleared. When the called or calling party initiates clearing of the call, DTAP messages are used to inform the other party of the call clearing.

Now MSC-A releases the speech connection and ends the TCAP dialogue with the END SIGNAL message. This signal is used by the MSC-B to clear its radio side. The RELEASE signal is used to clear the speech path between the MSCs.

MULTIBAND HANDOVER

General

This function enables operators using more than one frequency band to support handovers between different systems. In a multiband-capable network, the operator is able to define neighboring cells belonging to different frequency bands. Multiband-capable MSs are able to update the network with measurement reports on both frequency bands.

The MSC/VLR supports both intra and inter-MSC handovers between GSM frequency bands for BSCs with multiband support. The MSC/VLR is capable of supporting single band GSM 900 or GSM 1800 MSs, as well as dual band MSs in a mixed configuration.

Function benefits include:

- Capacity increase of the existing GSM 900 network by adding GSM 1800 frequencies in hot-spot areas
- Increased coverage of the existing GSM 1800 network by adding GSM 900 frequencies

The subscriber is able to use other MSs that do not support multiband frequency, but are connected to the same SIM card, because this capability is not linked to the subscription.

Definitions

Multiband MS: An MS that can be used in both a GSM 900 and GSM 1800 network. A multiband MS can perform handovers between cells with different frequency bands.

Classmark information: An information element that provides the network with MS equipment priority levels and, therefore, affects the manner in which the network handles MS operation. Three MS Classmarks exist:

- MS Classmark 1
  This type of classmark information is sent to the MSC/VLR in the “Location update request” and the “IMSI detach indication”.
- MS Classmark 2 and 3
  Classmark 2 and classmark 3 information is sent:
  - spontaneously, for example, when a change in the MS’s output power capability has occurred
  - in “CM service request” messages
  - in “Paging response” messages
  - in a “Classmark change” message as a response to a “Classmark inquiry” request from the MSC/VLR
  - in a “Classmark update” message
  - in “Prepare handover” messages
  - in “Handover request (BSSMAP) messages

Classmark 3 information is necessary because it indicates if the MS is capable of supporting the frequency band for GSM 1800.

Function Activation

The function is activated by an application parameter in the block MTB. It is divided into three parts:

- Classmark update
- Multiband handover
- Multiband routing and charging

Classmark Update

The MS Classmark 2 and/or 3 information is sent to the MSC/VLR in the BSSMAP message “Classmark update”.

Multiband Handover

BSC capabilities are changeable using the command MGBSI, and they are used in the MSC/VLR to indicate:

- What type of BSC is connected to the MSC/VLR
- What type of protocol/features the BSC is able to handle

These capabilities are stored in the block Mobile telephony BSS Data (MBSSD).

Figure 11-3 illustrates the use of both MS Classmark 3 information and BSC capability data in an inter-MSC multiband handover.

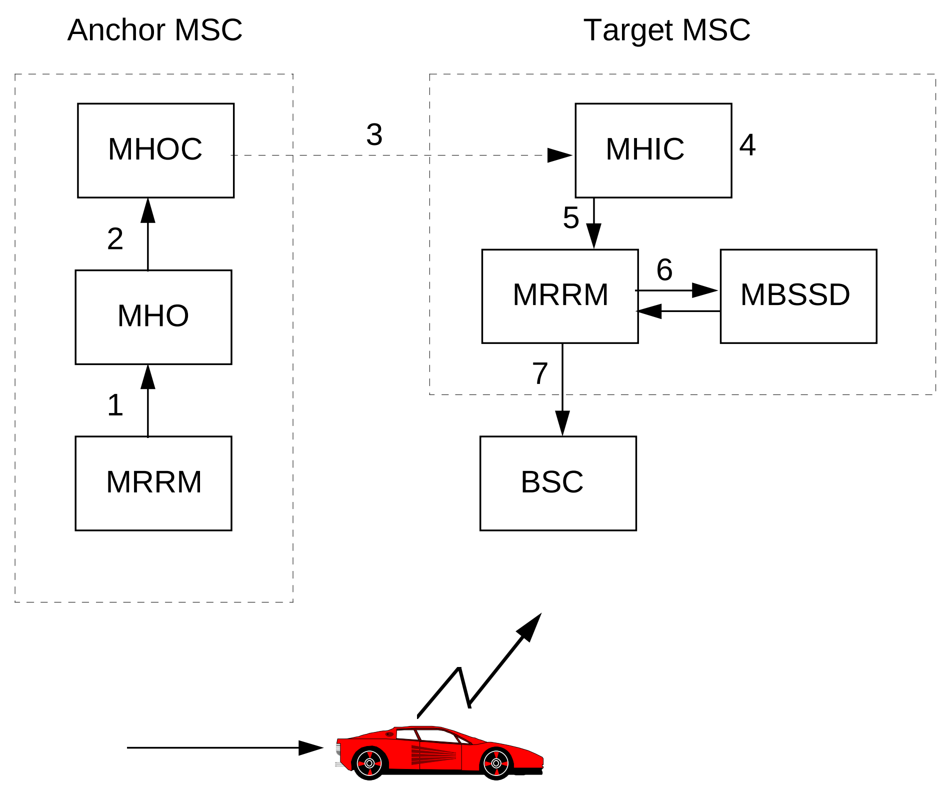


Figure 11-3

1. During Handover Request Allocation, the block Mobile Telephony Handover (MHO) requests handover data, including Classmark 3 information, from the block Mobile Telephony Radio Resource Management (MRRM).
2. The MHO stores the classmark information and forwards it to the MHOC. Classmark 3 information is extracted and stored.
3. The MHOC packs the Classmark 3 information into the MAP message “Prepare handover,” which is sent to the target MSC.
4. The MAP message is received and stored in the block MHIC in the target MSC.
5. Classmark 3 information is then sent to the block MRRM.
6. MRRM checks the BSC capability in the MBSSD to confirm that the target BSC can support multiband operations.

7. If multiband is supported, a Classmark 3 IE is included in the BSSMAP message “Handover request” to the BSC.

Multiband Routing and Charging

The relationship between the Radio Frequency Power (RFP) class and Mobile Subscriber Type (MST) is shown in *Figure 11-4*. The information is only valid if the function “Use of RF Power capability Class for charging and routing” is in use.

	RFP	MST
GSM/DCS 1900	1 2 3 4 5	0 1 2 3 4
DCS 1800	1 2 3	8 9 10

Figure 11-4

Note: The functions “Use of RF Power capability Class for charging and Routing” and “Multiband charging and routing” cannot be activated at the same time.

When “Multiband charging and routing” is used, only 2 MST values are supported:

- Single mode MS = 0 (default)
- Dual mode MS = 1

Sending of Charging Data

For charging purposes, information about the frequency bands supported by the MS is forwarded to the call data record. The information is extracted from the Classmark 3 IE.

1. During the call set-up phase, the (MTA/MTB) and (MCISS) send frequency band information to the block Mobile telephony Call and Event Data Handler for Charging (MCEDHC).
2. MCEDHC checks if multiband charging and routing are supported and sends the data to the charging subsystem.

CALL TEAR DOWN

The Call Tear Down function provides the command interface capabilities to terminate a known fraudulent call. The feature can terminate a call as follows:

- Via a command in the MSC/VLR
- Via a command terminating the subscription in the HLR
- Via a Mobile Location Reset command in the HLR
- Via system-initiation when parallel calls are made using the same SIM card and location updating occurs

The Call Tear Down function can be activated and deactivated in the MSC/VLR with an application parameter.

This feature applies to mobile originated, as well as mobile terminated calls. However, Call Tear Down cannot be performed, if the subscriber is involved in any of the following:

- Emergency call
- Supplementary service transaction
- Mobile originating SMS call

CALL TEAR DOWN VIA A COMMAND IN THE MSC/VLR

This section describes how Call Tear Down is accomplished. Refer to *Figure 11-5*.

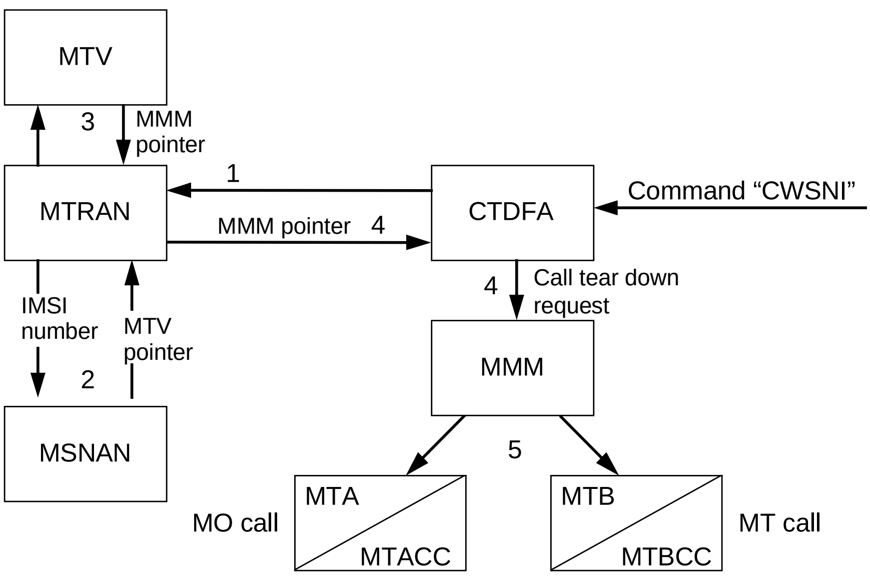


Figure 11-5 Call Tear down Procedures via a Command in the MSC/VLR

Using the command CWSNI with the IMSI number specified, the call will be torn down immediately.

1. The command CWSNI is received in the block CTDFA, which sends it to MTRAN.
2. MTRAN sends the IMSI number to MSNAN to retrieve the MTV pointer.
3. Once the MTV pointer is received, MTRAN verifies that the call is ongoing or is being set up. If this is verified, an MMM pointer is returned from MTV.
4. MTRAN returns the MMM pointer to CTDFA, which sends a Call Tear Down request to the MMM.
5. MMM determines if the state of the call is an emergency call, SMS MO call, or SS transaction. If the Call Tear Down request is not restricted, the request is sent to MTACC and MTA for a mobile originating call, or to MTBCC and MTB for a mobile terminating call.
6. The Call Tear Down request is finally received in the function blocks RE/CLCOF in the TCS.

CALL TEAR DOWN ON SUBSCRIPTION TERMINATION IN THE HLR

When a subscription is removed from the HLR using the command HGSUE, the MAP operation “Cancel Location” is received in the MSC/VLR. This event leads to a de-registration and an immediate disconnection of an ongoing call for that particular subscriber.

CALL TEAR DOWN ON MOBILE LOCATION RESET IN THE HLR

When the command HGSLR, is entered in the HLR with the MSISDN or IMSI specified, the MAP message “Cancel Location” is sent to the MSC/VLR. The result of this operation is identical to the one in the previous example.

CALL TEAR DOWN DUE TO PARALLEL CALLS

Currently, it is possible to make parallel calls, calls with the same IMSI number for one SIM, due to the fact that a SIM card can be removed without disconnecting the call.

However, when location updating is performed in the HLR, a “Cancel Location” message is sent to the previous VLR. This causes an ongoing call in that MSC/VLR to be disconnected in the same manner as described in the previous examples.

Thus, parallel calls can be avoided. See *Figure 11-6.*

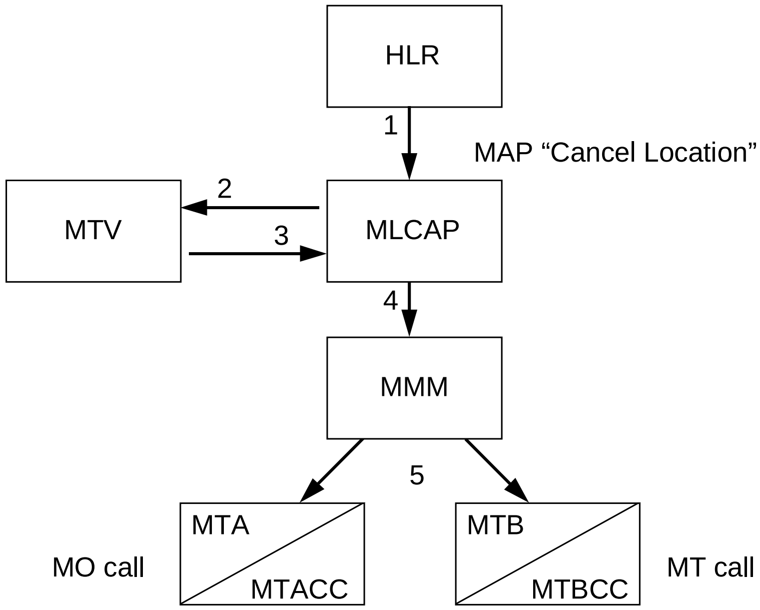


Figure 11-6 Call Tear Down Procedures for Parallel Calls

1. An MAP operation “Cancel Location” with a corresponding IMSI number is received by the MSC/VLR. A policing check is performed to determine whether this MAP operation is restricted or not.
2. MLCAP converts the IMSI number to an MTV pointer and sends it to MTV.
3. If the subscriber is involved in a call, MTV returns an MMM pointer.
4. MLCAP sends a Call Tear Down request to MMM.
5. MMM determines if the call is an emergency call, SMS MO call, or SS transaction. If the Call Tear Down request is not restricted, the request is sent to MTACC and MTA for a mobile originating call, or to MTBCC and MTB for a mobile terminating call.
6. The Call Tear Down request is finally received in the function blocks RE and CLCOF in the TCS.

SUBSCRIPTION TYPE DEPENDENT ANALYSIS

Grouping of subscribers in AXE analysis functions has been accomplished in the past with IMSI and MSISDN number series.

With Ericsson's GSM System, however, the function Subscription Type (ST) is introduced into the MSC/VLR and the HLR as an optional feature. ST makes it possible to group subscribers according to characteristics, independent of the IMSI and MSISDN number series.

ANALYSIS PARAMETERS

The Subscription Type (ST) category value is allocated to a group of subscribers. It can be stored in the VLR per subscriber and is used in the call set-up process.

It is also available in the HLR where one subscription is stored per subscriber.

The ST has a value ranging from 0 to 127 in MAP2 protocol. MDS and MSS internally support a range of 0 to 255, where 128 to 255 are spares.

The operator must define a relationship between the IMSI number series and the subscriber type.

A new analysis result, called Subscription Type ALLowed (STALL), is introduced to make this definition possible. STALL specifies for which IMSI number series the ST is permitted.

ST HANDLING IN THE GMSC

The block GRI verifies that the GMSC supports the ST function. If it is supported, a new PLMN-specific SS-code for the Subscription Type (ST) is set in the feature code list of the "SendRoutingInfo" message. The code is stored in the block MTRAN.

Both a confirmation that the ST function is active in the HLR, and the ST itself, must be received in the SendRoutingInfo message in order to process the ST. If the ST function is not active or the GMSC does not support it, then ST is set to 0.

When a call enters the GMSC, it obtains ST information from the HLR through roaming interrogation. If a subscriber does not have an ST, then no ST is delivered to the GMSC.

ST HANDLING IN THE MSC/VLR

Location Updating

The ST is included in the extension area of the MAP2 “InsertSubscriberData” message.

When the block MSDH2 receives the “InsertSubscriberData” operation from the HLR, it verifies that the ST function is supported by the MSC/VLR.

If the function is supported, MSDH2 performs syntax checks on the ST parameter and sends the ST value to the MTV.

Mobile Originating Call in the MSC/VLR

Figure 11-7 describes the procedures of a call from an MS in the MSC/VLR.

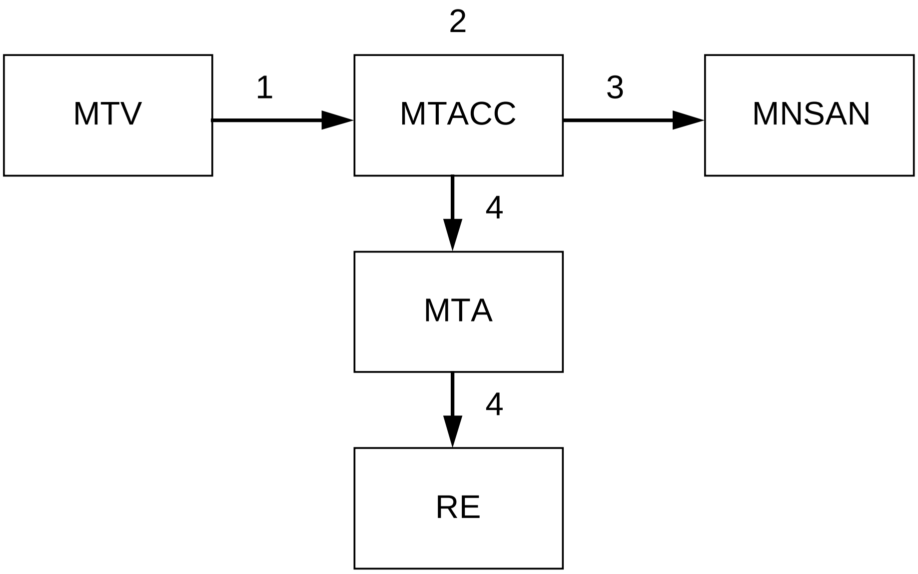


Figure 11-7 Procedures of a Call from an MS in the MSC/VLR

1. MTACC retrieves the ST from MTV.
2. MTACC checks the commercial market parameter to confirm that the ST function is supported by the MSC/VLR. If it is not supported, ST is set to 0.
3. If the function is supported, MTACC checks in MNSAN whether the ST should be applied to the current IMSI using the IMSI number series analysis. If the ST is not applied to the IMSI, or no ST is received from MTV, the default value of the application parameter is used.

4. MTA receives the ST from the MTACC so that it can load the ST into the RE.

Note: For emergency calls, ST is set to 0 and no further checks are performed.

Mobile Terminating Call in the MSC/VLR

Figure 11-8 describes the procedures of a call to an MS in the MSC/VLR.

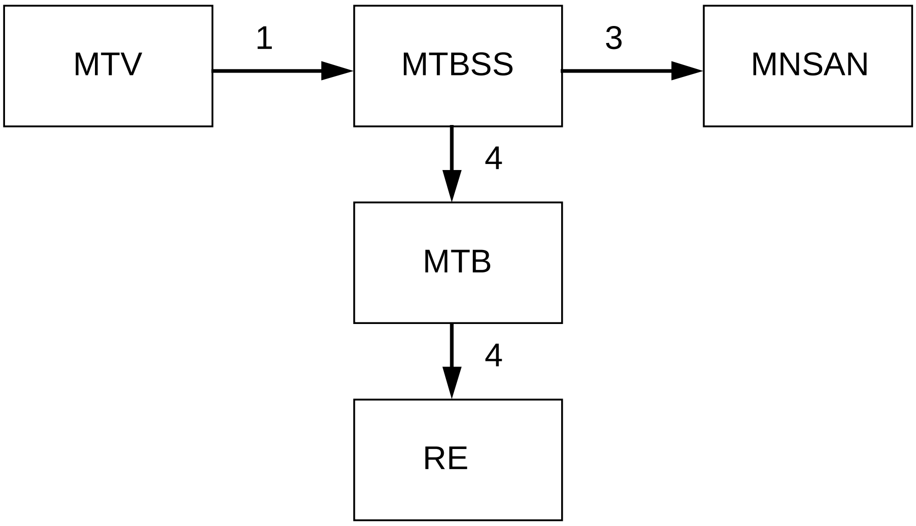


Figure 11-8 Procedures of a Call to an MS in the MSC/VLR

1. When MTBSS is seized during a mobile terminating call, the ST is retrieved from MTV.
2. MTBSS checks whether the ST function is supported by the MSC/VLR. If it is not supported, ST is set to 0.
3. If the function is supported, MTBSS checks in MNSAN whether ST should be applied to the current IMSI using the IMSI number series analysis. If the ST is not applied to the IMSI, the default value of the application parameter is used.
4. Once the checks are performed successfully, MTBSS sends the ST to MTB. MTB can then modify data in RE.

ST HANDLING IN THE HLR

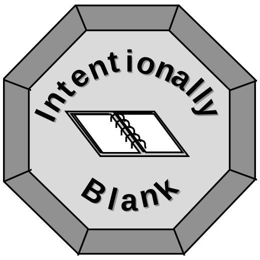
The HLR stores and updates the ST in the MSC/VLR with the operations “InsertSubscriberData” and “DeleteSubscriberData”.

The HLR transfers the ST to the GMSC at routing interrogation by the operation “SendRoutingInformation_response”.

The HLR provides a mechanism to control the delivery of ST, while updating the subscriber data in the subscriber’s VLR. This ST capability only exists, if it is supported by the VLR in the HLR.

Format of the ISDN and GSM Bearer Capabilities

Appendix A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Appendix A
Format of the ISDN and GSM Bearer Capabilities

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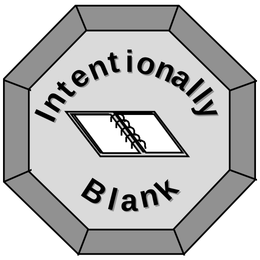
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FORMATS OF THE ISDN AND GSM BEARER CAPABILITIES

ISDN BEARER CAPABILITIES

The ISDN BC consists of several octets, which are sent as a Bearer Capability Information Element (BCIE) in certain S7 signals. All octets are not always included. The structure of the BCIE and the possible values are shown below.

The ISDN BC may be enhanced by additional Elements:

- Low Layer Capabilities (LLCs) - These may be used as additional information by network entities, as well as by the terminal equipment.
- High Layer Capabilities (HLCs) - These are transparently transported by the network and may be used as additional information by the terminal equipment.

Format of ISDN Bearer Capabilities (BC)

Table A-1. Parameters in ISDN Bearer Capability (BC).

	B7	B6	B5	B4	B3	B2	B1	B0
Octet 1	0	0	0	0	0	1	0	0
Octet 2	Length of contents(2|10)							
Octet 3	ext	cs		itc				
Octet 4	ext	tm		itr				
Octet 4.1	ext	rm						
Octet 5	ext	0	1	la1				
Octet 5a	ext	sa	n	ur				
Octet 5b	ext	ir		nct	ncr	flt	flr	0
Octet 5c	ext	nsb		ndb		pi		
Octet 5d	ext	d	mt					
Octet 6	ext	1	0	la2				
Octet 7	ext	1	1	la3				

ISDN Bearer Capability octet 3

Bits 43210 information transfer capability (itc)

00000	speech
01000	Unrestricted Digital Information (UDI)
10000	3.1 kHz audio
10001	Unrestricted Digital Information with tones/announcement (UDI-TA)

Bits 65 coding standard (cs)

00	CCITT standardized coding

Bit 7 extension bit (ext)

1	extension octets not present

ISDN Bearer Capability octet 4

Bits 43210 information transfer rate (itr)

00000	code used for packet mode calls
10000	64 kbit/s
11000	Multirate (64kbit/s base rate)

Bits 65 transfer mode (tm)

00	circuit mode
10	packet mode

Bit 7 extension bit (ext)

1	extension octets not present

ISDN Bearer Capability octet 4.1

Bits 6543210	rate multiplier (rm) Coded as a binary representation of the multiplier base rate. It can take any value from 2 up to 127.
Bit 7	extension bit (ext)
1	extension octets not present

ISDN Bearer Capability octet 5

Bits 43210 user information layer 1 protocol (la1)

00001	CCITT standardized rate adapt.
	V.110/X.30
00011	rec. G.711 A–law
00100	recommendation G.721 32kbit/s ADPCM and recommendation I.460
00101	recommendation H.221 and H.242
00111	Non-CCITT standardized rate adaption
01001	CCITT standardized rate adapt. X.31 HDLC flag stuffing

Bits 65 layer identity (li)

01	user information LAyer 1 protocol (LA1)

Bit 7 extension bit (ext)

0	extension octets present
1	extension octets not present

ISDN Bearer Capability octet 5a

Bits 43210 user rate (ur)

00000	rate is indicated by E–bits specified in rec. I.460 or may be negotiated in band
00001	0.6 kbit/s rec.s V.6 and X.1
00010	1.2 kbit/s rec. V.6
00011	2.4 kbit/s rec.s V.6 and X.1
00100	3.6 kbit/s rec. V.6
00101	4.8 kbit/s rec.s V.6 and X.1
00110	7.2 kbit/s rec. V.6
00111	8 kbit/s rec. I.460
01000	9.6 kbit/s rec.s V.6 and X.1
01001	14.4 kbit/s rec. V.6
01010	16 kbit/s rec. I.460
01011	19.2 kbit/s rec. V.6
10011	28.8 kbit/s
01100	32 kbit/s rec. I.460
01110	48 kbit/s rec.s V.6 and X.1
01111	56 kbit/s rec. V.6
10000	64 kbit/s rec. X.1
10101	0.1345 kbit/s rec. X.1
10110	0.100 kbit/s rec. X.1
10111	0.075/1.2 kbit/s rec.s V.6 and X.1
11000	1.2/0.075 kbit/s rec.s V.6 and X.1
11001	0.050 kbit/s rec.s V.6 and X.1
11010	0.075 kbit/s rec.s V.6 and X.1

11011	0.110 kbit/s rec.s V.6 and X.1
11100	0.150 kbit/s rec.s V.6 and X.1
11101	0.200 kbit/s rec.s V.6 and X.1
11110	0.300 kbit/s rec.s V.6 and X.1
11111	12 kbit/s rec. V.6

Bit 5 negotiation (n)

0	in band negotiation not possible
1	in band negotiation possible

Bit 6 synchronous/asynchronous (sa)

0	synchronous
1	asynchronous

Bit 7 extension bit (ext)

0	extension octets present
1	extension octets not present

ISDN Bearer Capability octet 5b

Bit 1 flow control on reception (flr)

0	cannot accept data with flow control mechanism
1	can accept data with flow control mechanism

Bit 2 flow control on transmission (flt)

0	not required to send data with flow control mechanism
1	required to send data with flow control mechanism

Bit 3 network independent clock on reception (ncr)

0	cannot accept data with network independent clock
1	can accept data with network independent clock

Bit 4 network independent clock on transmission (nct)

0	not required to send data with network independent clock
1	required to send data with network independent clock

Bits 65 intermediate rate (ir)

01	8 kbit/s
10	16 kbit/s
11	32 kbit/s

Bit 7 extension bit (ext)

0	extension octets present
1	extension octets not present

ISDN Bearer Capability octet 5c

Bits 210 parity (pi)

000	odd
010	even
011	none
100	forced to 0
101	forced to 1

Bits 43 number of data bits (ndb)

00	not used
01	5 bits
10	7 bits
11	8 bits

Bits 65 number of stop bits (nsb)

00	not used
01	1 bit
10	1.5 bits
11	2 bits

Bit 7 extension bit (ext)

0	extension octets present
1	extension octets not present

ISDN Bearer Capability octet 5d

Bits 543210 modem type (mt)

000001 V.21

000010 V.22

000011 V.22 bis

000100 V.23

000101 V.26

000110 V.26 bis

000111 V.26 ter

001000 V.27

001001 V.27 bis

001010 V.27 ter

001011 V.29

001100 V.32

001101 V.35

010001 V.21

010010 V.22

010011 V.22 bis

010100 V.23

010101 V.26

010110 V.26 bis

010111 V.26 ter

011000 V.27

011001 V.27 bis

011010 V.27 ter

011011 V.29

011100 V.32

011101 V.32

011110 V.34

Bit 6 duplex mode (d)

0	half duplex
1	full duplex

Bit 7 extension bit (ext)

1	extension octets not present

ISDN Bearer Capability octet 6

Bits 43210 user information layer 2 protocol (la2)

00010	rec. Q.921 (I.441)
00110	rec. X.25, link level

Bit 65 layer identity (li)

10	user information layer 2 protocol (LA2)

Bit 7 extension bit (ext)

1	extension octets not present

ISDN Bearer Capability octet 7

Bits 43210 user information layer 3 protocol (la3)

00010	rec. Q.931 (I.451)
00110	rec. X.25, packet layer

Bit 65 layer identity (li)

11	user information LAyer 3 protocol (LA3)

Bit 7 extension bit (ext)

1	extension octets not present

Format of Low Layer Capabilities

Table A-2. Parameters in Low Layer Compatibility.

	B7	B6	B5	B4	B3	B2	B1	B0
Octet1	0	1	1	1	1	1	0	0
Octet2	Length of contents (3|16)							
Octet 3	ext	cs		itc				
Octet 3a		ni	0	0	0	0		0
Octet 4	ext	tm		ltr				
Octet 4.1	ext	Rm						
Octet 5	ext	0	1	la1				
Octet 5a	ext	sa	n	Ur				
Octet 5b	ext	ir		nct	ncr	Flt	flr	0
Octet 5c	ext	nsb		ndb		pi		
Octet 5d	ext	d	Mt					
Octet 6	ext	1	0	la2				
Octet 6a1	ext	Mola2		0	0	0	Q933	
Octet 6a2	ext	User specified la2						
6b	ext	Ws						
Octet 7	ext	1	1	la3				
Octet 7a1	ext	Mola3		0	0	0	0	0
Octet 7a2	ext	User specified la3						
Octet 7b	ext	0	0	0	Dps			
Octet 7c	ext	Pws						

Low Layer Compatibility octet 3

Bits 43210 information transfer capability (itc)

00000	speech
01000	Unrestricted Digital Information (UDI)
01001	Restricted Digital Information (RDI)
10000	3.1KHZ audio
10001	Unrestricted digital information with tones/announcements(UDI-TA)
11000	video

Bits 65 coding standard (cs)

00	CCITT standardized coding

Bit 7 extension bit (ext)

0	extension octets present
1	extension octets not present

Low Layer Compatibility octet 3a

Bits 543210 spare

000000	spare

Bit 6 negotiation indication (ni)

0	out–band negotiation not possible
1	out–band negotiation possible

Bit 7 extension bit (ext)

1	extension octets not present

Low Layer Compatibility octet 4

Bits 43210 information transfer rate (itr)

00000	code used for packet mode calls
10000	64 kbit/s
10001	2 x 64 kbit/s
10011	384 kbit/s
10101	1536 kbit/s
10111	1920 kbit/s
11000	multirate (64kbi/s base rate)

Bits 65 transfer mode (tm)

00	circuit mode
10	packet mode

Bit 7 extension bit (ext)

0	extension octets present
1	extension octets not present

Low Layer Compatibility octet 4.1

Bits 6543210 rate multiplier (rm)

coded as a binary representation of the multiplier to the base rate. It can take any value from 2 up to 127.

Bit 7 extension bit (ext)

1	extension octets not present

Low Layer Compatibility octet 5

Bits 43210 user information layer 1 protocol (la1)

00001	CCITT standardized rate adaptation V.110/X.30
00011	rec. G.711 A-law
01001	CCITT standardized rate adaptation X.31 HDLC flag stuffing

Bits 65 layer identity (li)

01	user info layer 1 protocol

Bit 7 extension bit (ext)

0	extension octets present
1	extension octets not present

Low Layer Compatibility octet 5a

Bits 43210 user rate (ur)

00	rate is indicated by E bits specified in recommendation I.460 or may be negotiated in band
00010	1.2 kbit/s rec. V.6
00011	2.4 kbit/s rec. V.6 and X.1
00101	4.8 kbit/s rec. V.6 and X.1
01000	9.6 kbit/s rec. V.6 and X.1
11110	0.300 kbit/s rec. V.6 and X.1
01001	14.4 kbit/s recommendation V.6
01011	19.2 kbit/s recommendation V.6
10011	28.8 kbit/s
01101	38.4 kbit/s

01110 48 kbit/s recommendations V.6 and X.1

01111 56 kbit/s recommendation V.6

Bit 5 negotiation (n)

0 in–band negotiation not possible

1 in–band negotiation possible

Bit 6 synchronous/asynchronous (sa)

0 synchronous

1 asynchronous

Bit 7 extension bit (ext)

0 extension octets present

1 extension octets not present

Low Layer Compatibility octet 5b

Bit 1 flow control on reception (flr)

0 cannot accept data with flow control mechanism

1 can accept data with flow control mechanism

Bit 2 flow control on transmission (flt)

0 not required to send data with flow control mechanism

1 required to send data with flow control mechanism

Bit 3 network independent clock on reception (ncr)

0 cannot accept data with network independent clock

1 can accept data with network independent clock

Bit 4 network independent clock on transmission (nct)

0 not required to send data with network independent clock

1	required to send data with network independent clock
Bits 65	intermediate rate (ir)
00	not used
01	8 kbit/s
10	16 kbit/s
11	32kbi/s
Bit 7	extension bit (ext)
0	extension octets present
1	extension octets not present

Low Layer Compatibility octet 5c

Bits 210	parity (pi)
000	odd
010	even
011	none
100	forced to 0
101	forced to 1
Bits 43	number of data bits (ndb)
00	not used
10	7 bits
11	8 bits
Bits 65	number of stop bits (nsb)
00	not used
01	1 bit
10	1.5bits

11	2 bits

Bit 7 extension bit (ext)

0	extension octets present
1	extension octets not present

Low Layer Compatibility octet 5d

Bits 543210 modem type (mt)

000001	V.21
000010	V.22
000011	V.22 bis
000100	V.23
000101	V.26
000110	V.26 bis
000111	V.26 ter
001000	V.27
001001	V.27 bis
001010	V.27 ter
001011	V.29
001100	V.32
001101	V.35
010001	V.21
010010	V.22
010011	V.22 bis
010100	V.23
010101	V.26
010110	V.26 bis

010111 V.26 ter

011000 V.27

011001 V.27 bis

011010 V.27 ter

011011 V.29

011100 V.32

011101 V.32

011110 V.34

Bit 6 duplex mode (d)

1 full duplex

Bit 7 extension bit (ext)

1 extension octets not present

Low Layer Compatibility octet 6

Bits 43210 user information layer 2 protocol (la2)

00001 basic mode ISO 1745

00010 CCITT rec. Q.921 (I.441)

00110 CCITT rec. X.25, link level

00111 CCITT rec. X.25, multi-link

01000 extended LAPB; for half duplex operation (T.71)

01001 HDLC ARM (ISO 4335)

01010 HDLC NRM (ISO 4335)

01011 HDLC ABM (ISO 4335)

01100 LAN logical link control (ISO 8802/2)

01101 CCITT rec. X.75, single link procedure (SLP)

01110 CCITT recommendation Q.922

01111 Core aspects of CCITT recommendation Q.922

10000 user specified

10001 ISO 7776 DTE-DTE operation

Bits 65 layer identity (li)

10 user info layer 2 protocol

Bit 7 extension bit (ext)

0 extension octets present

1 extension octets not present

Low Layer Compatibility octet 6a1

Bits 10 Q.933

00 For use when the coding in recommendation Q.933 is not used

Bits 432 spare

000 spare (this value is not checked)

Bits 65 mode of operation (mola2)

01 normal mode of operation

10 extended mode of operation

Bit 7 extension bit (ext)

1 extension octets not present

0 extension octets present

Low Layer Compatibility octet 6a2

Bits 6543210 user specified layer 2 protocol information

Bit 7 extension bit (ext)

1 extension octets not present

Low Layer Compatibility octet 6b

Bits 6543210 window size (K) (ws)

binary coding of K parameter value in the range 1 to 127

Bit 7 extension bit (ext)

1 extension octets not present ISDN Bearer Capability octet 7

Low Layer Compatibility octet 7

Bits 43210 user information layer 3 protocol (la3)

00010	CCITT rec. Q.931 (I.451)
00110	CCITT rec. X.25, packet layer
00111	ISO 8208/IEC (X.25 packet level protocol for data terminal equipment)
01000	X.223/ISO 8878 use of ISO/IEC 8208 and CCITT X.25 to provide the OSI-CONS)
01001	ISO/IEC 8473 (OSI connectionless mode protocol)
01010	CCITT rec. T.70 minimum network layer
01011	ISO TR/IEC 9577 (protocol identification in the network layer for non-ISO protocols)
10000	user specified

Bits 65 layer identity (li)

11	user info layer 3 protocol (LA3)

Bit 7 extension bit (ext)

0	extension octets present
1	extension octets not present

Low Layer Compatibility octet 7a1

Bits 43210 spare

00000 spare (this value is not checked)

Bits 65 mode of operation (mola3)

01 normal packet sequence numbering

10 extended packet sequence numbering

Bit 7 extension bit (ext)

1 extension octets not present

0 extension octets present

Low Layer Compatibility octet 7a2

Bits 6543210 user specified layer 3 protocol information user specified

Bit 7 extension bit (ext)

1 extension octets not present

Low Layer Compatibility octet 7b

Bits 3210 default packet size (dps)

0100 default packet size 16 octets

0101 default packet size 32 octets

0110 default packet size 64 octets

0111 default packet size 128 octets

1000 default packet size 256 octets

1001 default packet size 512 octets

1010 default packet size 1024 octets

1011 default packet size 2048 octets

1100 default packet size 4096 octets

Bits 654 spare

000 spare (this value is not checked

Bit 7 extension bit (ext)

1 extension octets not present

0 extension octets present

Low Layer Compatibility octet 7c

Bits 6543210 packet window size (pws)

binary coding of packet window size value in the range 1 to 127

Bit 7 extension bit (ext)

1 extension octets not present

Format of High Layer Capabilities

Table A-3. Parameters in High Layer Compatibility.

	B7	B6	B5	B4	B3	B2	B1	B0
Octet 1	0	1	1	1	1	1	0	1
Octet 2	Length of contents(2)							
Octet 3	ext	cs		in			Pm	
Octet 4	ext	Hlci						

High Layer Compatibility octet 3

Bits 10 presentation method of protocol profile (pm)

01 high layer protocol profile (without specification of attributes)

Bits 432 interpretation (in)

100 first (primary or only) high layer characteristics identification to be used in the call

Bits 65 Coding standard (cs)

00 CCITT standardized coding

Bit 7 extension bit (ext)

1 extension octets not present

High Layer Compatibility element octet 4

Bits 6543210 high layer characteristics identification (hlci)

0000100 facsimile group 2/3 (rec. F.182)

Bit 7 extension bit (ext)

1 extension octets not present

GSM BEARER CAPABILITIES

Table A-4. GSM Bearer Capabilities.

<table>
<tr><th></th><th>B7</th><th>B6</th><th>B5</th><th>B4</th><th>B3</th><th>B2</th><th>B1</th><th>B0</th></tr>
<tr><td>1</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td></tr>
<tr><td>2</td><td colspan="8">Length of contents(1|10)</td></tr>
<tr><td>3</td><td>ext</td><td colspan="2">0 1</td><td>Cs</td><td>tm</td><td colspan="3">itc</td></tr>
<tr><td>4</td><td>ext</td><td>dc</td><td colspan="2">S</td><td>d</td><td>c</td><td>nir</td><td>e</td></tr>
<tr><td>5</td><td>ext</td><td>0</td><td>0</td><td colspan="2">ra</td><td colspan="3">sap</td></tr>
<tr><td>5a</td><td>ext</td><td colspan="2">oitc</td><td colspan="2">ora</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>6</td><td>ext</td><td>0</td><td>1</td><td colspan="4">la1</td><td>sa</td></tr>
<tr><td>6a</td><td>ext</td><td>nsb</td><td>n</td><td>ndb</td><td colspan="4">ur</td></tr>
<tr><td>6b</td><td>ext</td><td colspan="2">ir</td><td>nct</td><td>ncr</td><td colspan="3">pi</td></tr>
<tr><td>6c</td><td>ext</td><td colspan="2">ce</td><td colspan="5">mt</td></tr>
<tr><td>6d</td><td>ext</td><td colspan="2">omt</td><td colspan="5">Fnur</td></tr>
<tr><td>7</td><td>ext</td><td>1</td><td>0</td><td colspan="5">la2</td></tr>
</table>

GSM Bearer Capability octet 3

Bits 210 information transfer capability (itc)

000	speech
001	unrestricted digital information
010	3.1 kHz audio, ex PLMN
011	facsimile group 3
101	other itc
111	alternate speech/facsimile group 3
	- starting with speech

Bit 3 transfer mode (tm)

0	circuit mode

Bit 4 coding standard (cs)

0	GSM standardized coding

Bits 65 radio channel requirement (rcr)

01	spare

Bit 7 extension bit (ext)

1	extension octets not present

GSM Bearer Capability octet 4

Bit 0	establishment (e)
0	demand
Bit 1	negotiation of intermediate rate requested (nir)
0	no meaning associated
Bit 2	configuration (c)
0	point–to–point
Bit 3	duplex mode (d)

1 full duplex

Bits 54 structure (s)

00 service data unit integrity

11 unstructured

Bit 6 compression (dc)

0 data compression not possible

1 data compression possible

Bit 7 extension bit (ext)

1 extension octets not present

GSM Bearer Capability octet 5

Bits 210 signaling access protocol (sap)

001 I.440/450

010 X.21

110 X.32

Bits 43 rate adaptation (ra)

00 no rate adaptation

01 V.110/X.30 rate adaptation

10 CCITT X.31 flag stuffing

Bits 65 access identity (ai)

00 octet identifier

Bit 7 extension bit (ext)

1 extension octets not present

GSM Bearer Capability octet 5a

Bits 210	spare
000	spare
Bits 43	other rate adaption (ora)
00	spare
Bits 65	other information transfer capability (oitc)
00	restricted digital information
Bit 7	extension bit (ext)
2	extension octets not present

GSM Bearer Capability octet 6

Bit 0 synchronous/asynchronous (sa)

0	synchronous
1	asynchronous

Bits 4321 user information layer 1 protocol (la1)

0000	default layer 1 protocol

Bits 65 layer identity (li)

01	user info layer 1 protocol (LA1)

Bit 7 extension bit (ext)

0	extension octets present

GSM Bearer Capability octet 6a

Bits 3210 user rate (ur)

0001	0.3 kbit/s rec. X.1 and V.110
0010	1.2 kbit/s rec. X.1 and V.110
0011	2.4 kbit/s rec. X.1 and V.110
0100	4.8 kbit/s rec. X.1 and V.110
0101	9.6 kbit/s rec. X.1 and V.110

Bit 4 number of data bits (ndb)

0	7 bits
1	8 bits

Bit 5 negotiation (n)

0	in–band negotiation not possible

Bit 6 number of stop bits (nsb)

0	1 bit
1	2 bits

Bit 7 extension bit (ext)

0	extension octets present

GSM Bearer Capability octet 6b

Bits 210 parity information (pi)

000	odd
010	even
011	none
100	forced to 0
101	forced to 1

Bit 3 network independent clock on reception (nrc)

0	can not accept data with network independent clock
1	can accept data with network independent clock

Bit 4 network independent clock on transmission (nct)

0	does not require to send data with network independent clock
1	require to send data with network independent clock

Bits 65 intermediate rate (ir)

10	8 kbit/s
11	16 kbit/s

Bit 7 extension bit (ext)

0	extension octets present

GSM Bearer Capability octet 6c

Bits 43210 modem type (mt)

00000	none
00001	V.21
00010	V.22
00011	V.22 bis
00100	V.23
00101	V.26 ter
00110	V.32
01000	autobauding type 1

Bits 65 connection element (ce)

00	transparent
01	non-transparent (RLP)
10	both, transparent preferred
11	both, non-transparent preferred

Bit 7 extension bit (ext)

0	extension octets present
1	extension octets not present

GSM Bearer Capability octet 7

Bits 43210 user information layer 2 protocol (la2)

00110	rec. X.25, link level
01000	ISO 6429, code set 0 (DC1/DC3)
01100	COPnoFLCt (character oriented protocol with no flow mechanism)

Bits 65 layer identity (li)

10	user info layer 2 protocol

Bit 7 extension bit (ext)

1	extension octets not present

ETSI-ISUP

ETSI-ISUP is enhanced with a modified handling of the ACM message and compliance to ITU-T recommendation Q.764 regarding point of through connection. This modification, introduced in R8, improves the handling of the following functions:

- Call in Progress Tone
- High Penetration Alerting
- Notification of Call Forwarding

If required, the old through connection mechanism may still be used.

The feature 'Call In Progress Tone' (CIP tone) indicates to the calling party that a call to a mobile subscriber is being processed, thus reducing the chances of premature disconnection and subsequent revenue losses. The call-in-progress tone is provided to the calling subscriber while the called mobile subscriber is being paged. (See Figure A-2 Call in Progress Tone). A timer allows for delaying the start of the CIP tone sending.

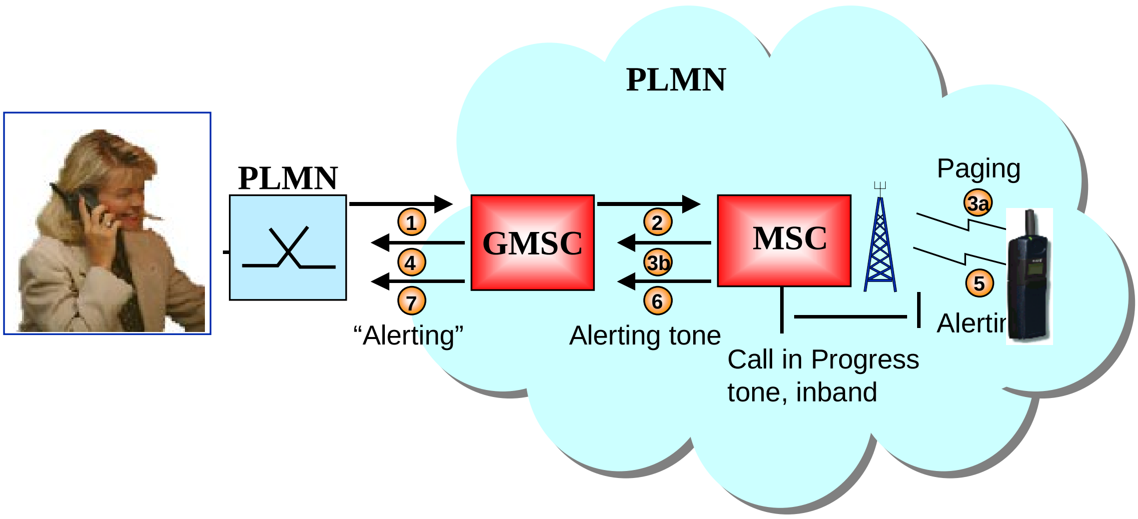


Figure A-1 Call in Progress Tone

The CIP tone is generated only for these terminating calls:

- Speech calls
- Auxiliary speech calls
- Alternating speech/fax calls starting with speech

The CIP tone-sending is terminated when an indication is received from the called party that ringing has been started, that the call has been accepted or abandoned, or if a supplementary service is invoked.

An optional part of this feature allows CIP Tone Triggering in the handset. This function requires corresponding support in the handset and it applies only to calls which originate and terminate in the same MSC.

This optional feature affects the MSC/VLR (NF 493.2). The AXE parameter CIPACTIVM of the parameter set GSMMSSC indicates if the CIP tone sending is enabled, and the parameter TIMECIPM (in GSMMSSC) defines the CIP tone delay timer value.

CONCEPTS AND ABBREVIATIONS

A. General use

BC	Bearer Capability
BS	Bearer Service
BSG	Basic Service Group
GSM–BC	GSM Bearer Capability
HLC	High Layer Compatibility
ISDN–BC	ISDN Bearer Capability
LLC	Low Layer Compatibility
RDI	Restricted Digital Information
SDU	Service Data Unit integrity
TS	TeleService
UDI	Unrestricted Digital Information

B. Parameters in information elements

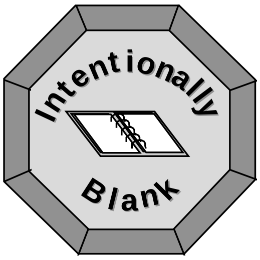
ai	Access Identity
c	Configuration
ce	Connection Element
cs	Coding Standard
d	Duplex mode
e	Establishment
ext	EXTension bit
flr	FLow control on Reception
flt	FLow control on Transmission
hlci	High Layer Characteristics Identification
in	INterpretation

ir	Intermediate Rate
itc	Information Transfer Capability
itr	Information Transfer Rate
itr_do	Information Transfer Rate (Destination –> Origination)
la1	user information LAyer 1 protocol
la2	user information LAyer 2 protocol
la3	user information LAyer 3 protocol
li	user information Layer Identity
mt	Modem Type
n	Negotiation
ni	Negotiation Indicator
ncr	Network independent Clock on Reception
nct	Network independent Clock on Transmission
ndb	Number of Data Bits
nsb	Number of Stop Bits
optla2	OPTional user info LAyer 2 protocol info
optla3	OPTional user info LAyer 3 protocol info
pi	Parity Information
pm	Presentation Method of protocol profile
ra	Rate Adaptation
rcr	Radio Channel Requirement
s	Structure
sa	Synchronous/Asynchronous
sap	Signaling Access Protocol
sy	SYmmetry

ur	User Rate
tm	Transfer Mode

Traffic Cases

Appendix B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Appendix B
Traffic Cases

Table of Contents

Topic	Page

TRAFFIC CASES

This appendix describes several of the traffic cases that the GSM network must be able to handle. To understand the chapters in the book that describe the exchange data that is required to allow certain traffic cases, the student must have a prior knowledge of what takes place in these traffic cases, in fact it is considered a prerequisite.

LOCATION UPDATING

A roaming mobile subscriber, moves freely within the GSM network. Due to the network knowing the location of the MS, it is possible for the mobile subscriber to receive a call wherever he is.

To keep the system updated with the current subscriber location information, the MS must inform the system whenever it changes location area. A location area consists of one or several cells in which an MS can move around without having to update the system on its location. A location area is controlled by one or several Base Station Controllers (BSCs), but by only one Mobile services Switching Center (MSC). An MSC can control more than one location area.

The BSC sends paging messages to the Radio Base Station (RBS), defined within a certain location area. If the MS moves between cells belonging to different location areas, the network must be informed via a procedure called location updating.

There are four different types of location updating:

- Normal
- IMSI detach
- IMSI attach
- Periodic registration

NORMAL LOCATION UPDATING

The Base Transceiver Station (BTS) of every cell continuously transmits the location area identity on the control channel (BCCH). When the MS detects that the broadcast location area identity is different from the one stored in the SIM-card, it performs a location update.

If the mobile subscriber is unknown to the Mobile services Switching Center/Visitor Location Register (MSC/VLR),that is, the broadcast location area belongs to a new MSC/VLR serving area, then the new MSC/VLR must be updated with subscriber information. This subscriber information comes from the Home Location Register (HLR).

This location updating procedure is described in the following steps and is illustrated in *Figure B-1*.

1. The MS requests a location update to be carried out in the new MSC/VLR. The IMSI is used to identify the MS. An International Mobile Equipment Identity (IMEI) check is also performed, if carried out in the network.
2. In the new MSC/VLR, an analysis of the IMSI number is carried out. The result of this analysis is a modification of the IMSI to a Mobile Global Title (MGT) which is used to address the HLR.
3. The new MSC/VLR requests the subscriber information for the MS from the HLR.
4. The HLR stores the address of the new MSC/VLR.
5. The HLR sends the subscriber data to the new MSC/VLR.
6. The HLR also orders the old serving MSC/VLR to cancel all information for the subscriber owing to the fact that the mobile subscriber is now served by another MSC/VLR.
7. When the new MSC/VLR receives the information from the HLR, it sends a location updating confirmation message to the MS.

Note: The HLR is not informed if the mobile subscriber moves from one location area to another within the same MSC/VLR serving area.

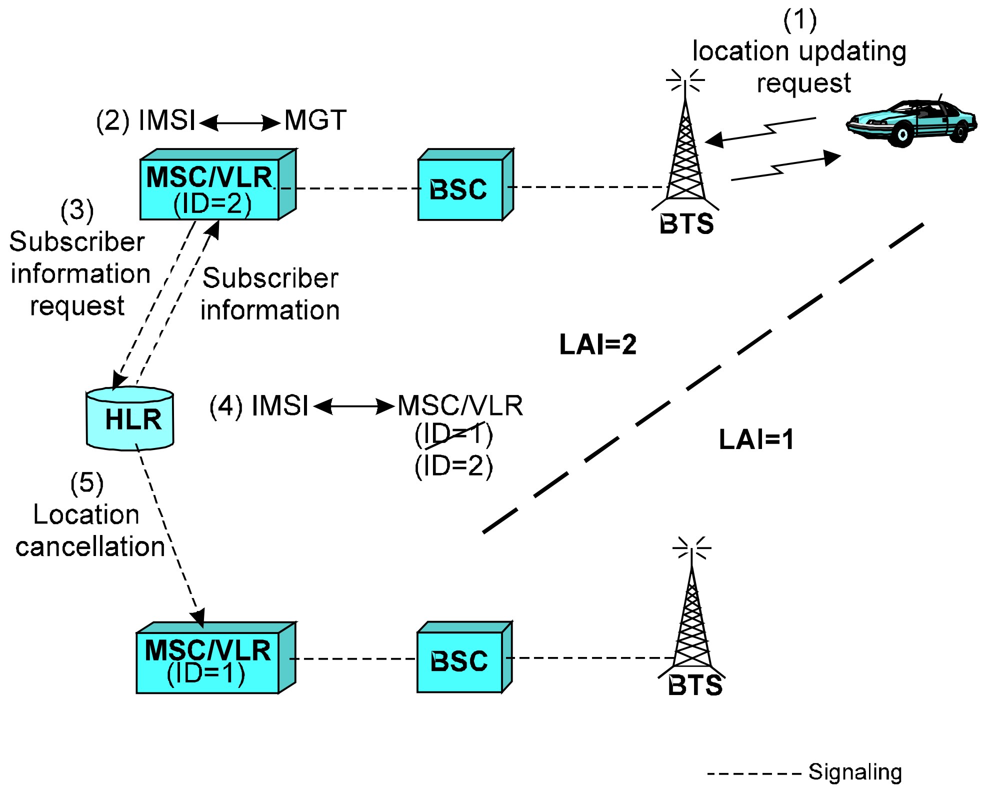


Figure B-1 Normal Location Updating (to a new MSC/VLR)

IMSI DETACH

In the system information broadcast on the control channel (BCCH), the MS receives information on whether the IMSI attach/detach function is used or not. If it is used, the MS must inform the network when it enters an inactive state (detach).

The procedure is as follows (See *Figure B-2*):

1. At power off, or when the SIM card is taken out, the MS asks for a signaling channel.
2. The MS uses this signaling channel to send the IMSI detach message to the MSC/VLR.
3. In the VLR, an IMSI detach flag is set for the subscriber. This is used to reject incoming calls to the MS.

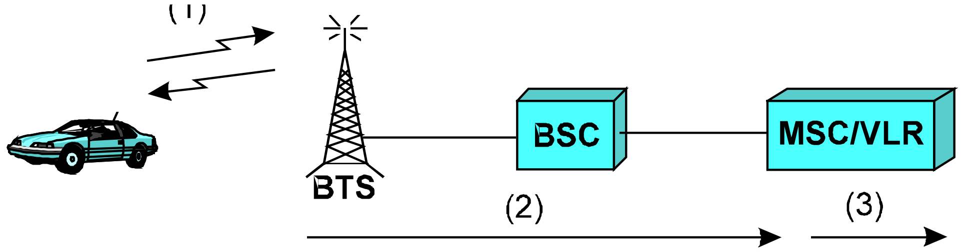


Figure B-2 IMSI Detach

IMSI ATTACH

IMSI attach is a complement to the IMSI detach procedure. It is used by the mobile subscriber to inform the network that it has re-entered an active state and is still in the same location area. If the MS changes location area while being switched off, a normal location update takes place.

The IMSI attach procedure is as follows (See *Figure B-3*):

1. The MS requests a signaling channel.
2. The MSC/VLR receives the IMSI attach message from the MS.
3. The MSC/VLR sets the IMSI attach in the VLR. The mobile is now ready for normal call handling.
4. The VLR returns an acknowledgment to the MS.

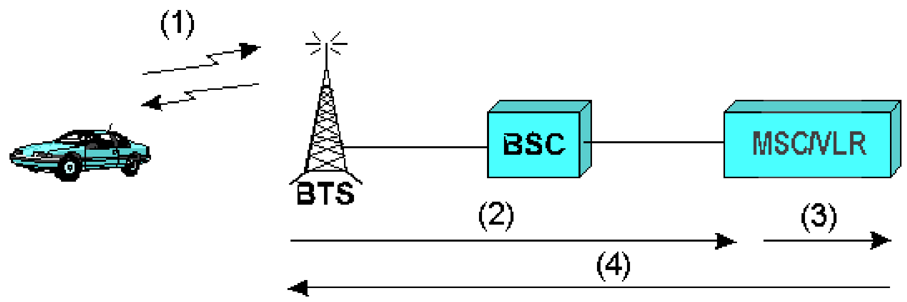


Figure B-3 IMSI Attach

PERIODIC LOCATION UPDATING

Periodic location updating is used to avoid unnecessary paging of the MS in cases where the MSC does not receive the IMSI detach message.

The periodic location updating procedure is as follows (See *Figure B-4*):

1. The MS receives information on whether periodic registration is used. If periodic registration is used, the MS is told how often to inform the system that it is reachable. A special parameter is set by the operator and can take a value from 0 to 255 deci-hours. In cases where the parameter is set to 0, periodic registration is not used in the cell. If the parameter is set to 1, the MS must register every six minutes (when the timer expires).

2. The procedure is controlled by timers both in the MS (See 2a in *Figure B-4*) and in the MSC (See 2b in *Figure B-4*). In the MSC there is a time-scanning function for the MSs.
3. When the timer in the MS expires, the phone is compelled to perform periodic location updating (See 3a in *Figure B-4*). The timers in the MS and the MSC restart. If the cellular phone does not register within the determined time interval plus a safety interval, the MSC scanning function detects this and the MS is marked detached (See 3b in *Figure B-4*).

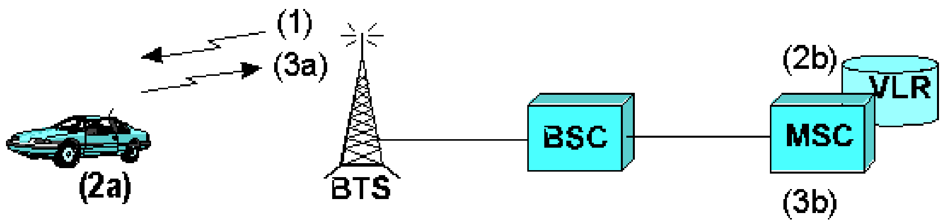


Figure B-4 Periodic Location Updating

CALL TO MOBILE SUBSCRIBER

The following procedures for a call to a mobile subscriber are illustrated in *Figure B-5*.

1. Any call entering the GSM network from the Public Switched Telephony Network/Integrated Services Digital Network (PSTN/ISDN) is routed to the nearest Gateway Mobile services Switching Center (GMSC).
2. The GMSC analyzes the Mobile Station ISDN (MSISDN) to find out which HLR the mobile subscriber is registered in and then sends the MSISDN along with a request for routing information to this HLR. The serving MSC/VLR address is stored in the HLR from location updating. The HLR contains the IMSI that is connected to this MSISDN number.
3. The HLR sends a request for a Mobile Station Roaming Number (MSRN) to the MSC/VLR. Included in the message is the MS’s IMSI. The MSC/VLR allocates an idle MSRN and links it to the IMSI.
4. The MSRN is returned via the HLR to the GMSC.
5. The GMSC, by means of the MSRN, routes the call to the MSC/VLR.
6. When the MSC/VLR receives the call, it uses the MSRN to retrieve the MS’s IMSI. The MSRN is then released.
7. Using the MS’s IMSI, the MSC/VLR identifies the location area in which the phone is currently situated.
8. The MS is paged in all cells within this location area.
9. When the MS responds to the paging message, authentication, cipher mode setting, and an IMEI check are carried out, if defined in the network.
10. If the authentication is confirmed and the ciphering is successful, the call is connected from the MSC to the BSC and the BTS, where a traffic channel is selected on the air path.

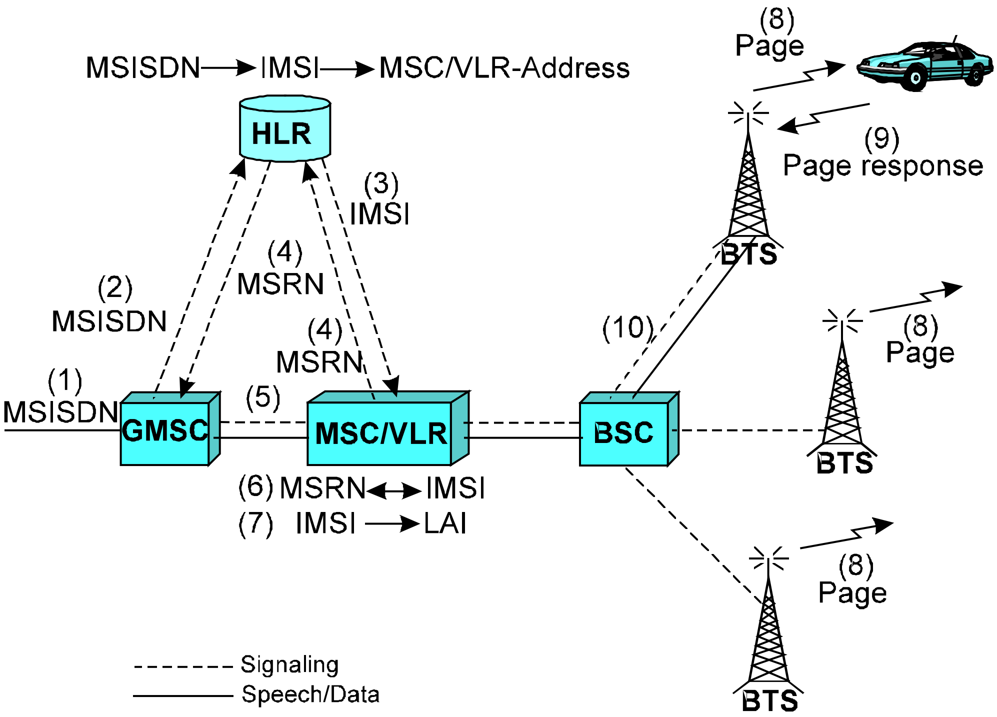


Figure B-5 Call to an MS

CALL FROM MOBILE SUBSCRIBER

This procedure for a call from a mobile subscriber is illustrated in *Figure B-6*.

1. The originating mobile subscriber call starts with a request for a signaling channel using the Random Access Channel (RACH).
2. The MS indicates that it wants to set up a call. The identity of its IMSI is analyzed in the MSC/VLR, and the MS is marked as busy in the VLR.
3. Authentication is performed by the MSC, if defined in the network.
4. Ciphering is initiated and the IMEI is validated by the EIR.

   Note: Ciphering and authentication are optional and are defined by the network operator.
5. The MSC receives a set-up message from the MS. Included in this information is the type of service the MS wants and the number (called the B-number) dialed by the mobile subscriber. The MSC checks that the mobile subscriber does not have services, such as barring of outgoing calls activated. (Barring can be activated either by the subscriber or by the operator.) If the mobile subscriber is not barred, the set-up of the call proceeds.
6. A link is established between the MSC, and the BSC, and a Traffic CHannel (TCH) is seized. Within the link, the following occurs:

   The MSC sends a request to the BSC to assign a Traffic Channel (TCH).

   The BSC checks if there is an idle Traffic Channel (TCH), assigns it to this call, and tells the BTS to activate the channel.

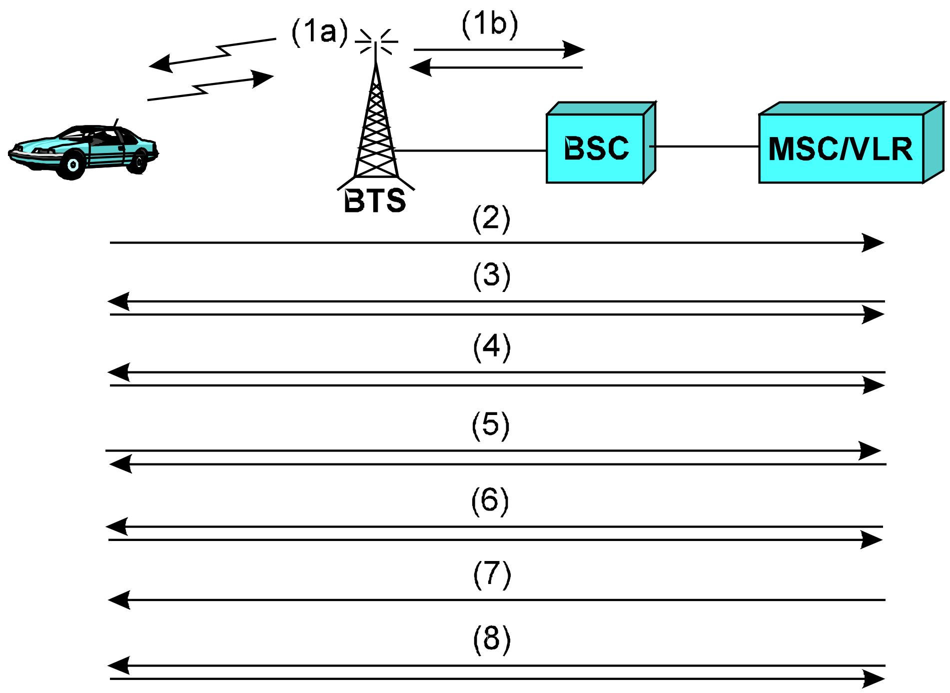
   The BTS sends an acknowledgment back to the BSC when the activation is complete.

   The BSC informs the MSC when the assignment is complete.

   The traffic control subsystem in the MSC/VLR analyzes the digits and sets up the connection to the called subscriber.

8. An alert message is sent to the MS, indicating that a ringing tone has been generated on the B-subscriber side. The tone generated in the exchange on the B-subscriber side is sent to the MS via the Group Switch (GS) in the MSC. This means that it is sent over the air, not generated in the MS.

9. When the B-subscriber answers, the network sends a connect message to the MS to indicate that the call is accepted. The MS returns a connect acknowledgment, which completes the call set-up.



(1a), (1b)	RR connection establishment
(2)	Service indication
(3)	Authentication
(4)	Ciphering mode setting
(5)	Call initiation
(6)	TCH assignment
(7)	Call confirmation
(8)	Call accepted

Figure B-6 Call from an MS

CALL DROP BACK FUNCTION

What happens if a Swedish subscriber wants to call a German mobile subscriber who is currently at the Water Festival in Stockholm?

The Swedish exchange will recognize that it is an international call and routes it to the Swedish international exchange.

The Swedish international exchange routes it via the German international exchange to the German GMSC.

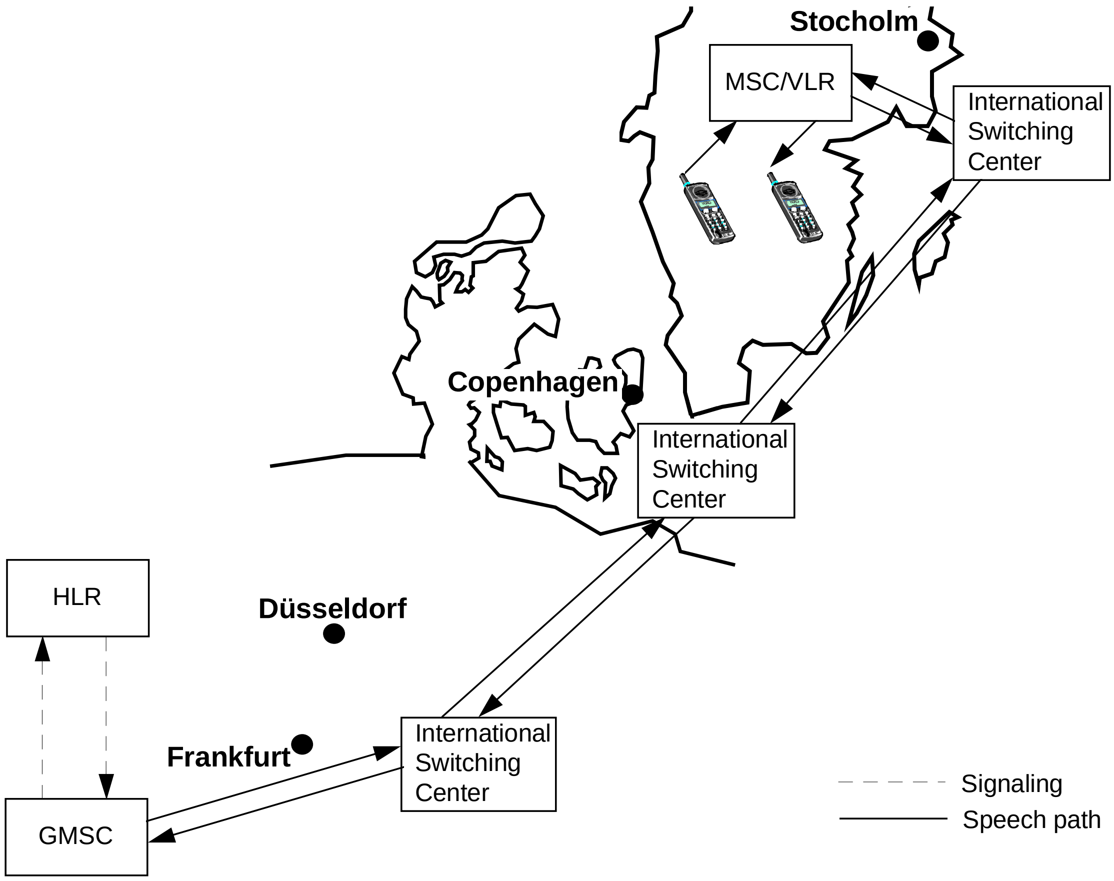


Figure B-7 International Call without Drop Back Function.

The German GMSC will do an interrogation in the HLR and receives an MSRN belonging to a Swedish VLR. The roaming number interrogation between the HLR and the MSC/VLR is not shown in the Figure.

Now, instead of doing a normal routing of the call via the international exchanges to the Swedish VLR, thus occupying two or three thousand *km* of trunk lines, as shown in *Figure B-7* there exists the possibility of dropping the call back to Sweden and to set up the call in Sweden only.

To do so the German GMSC must be able to recognize that the call should be dropped back. This is possible, since your own B-origin is defined for roaming numbers. The Swedish roaming number must lead to a software route that handles the signaling towards the originating exchange.

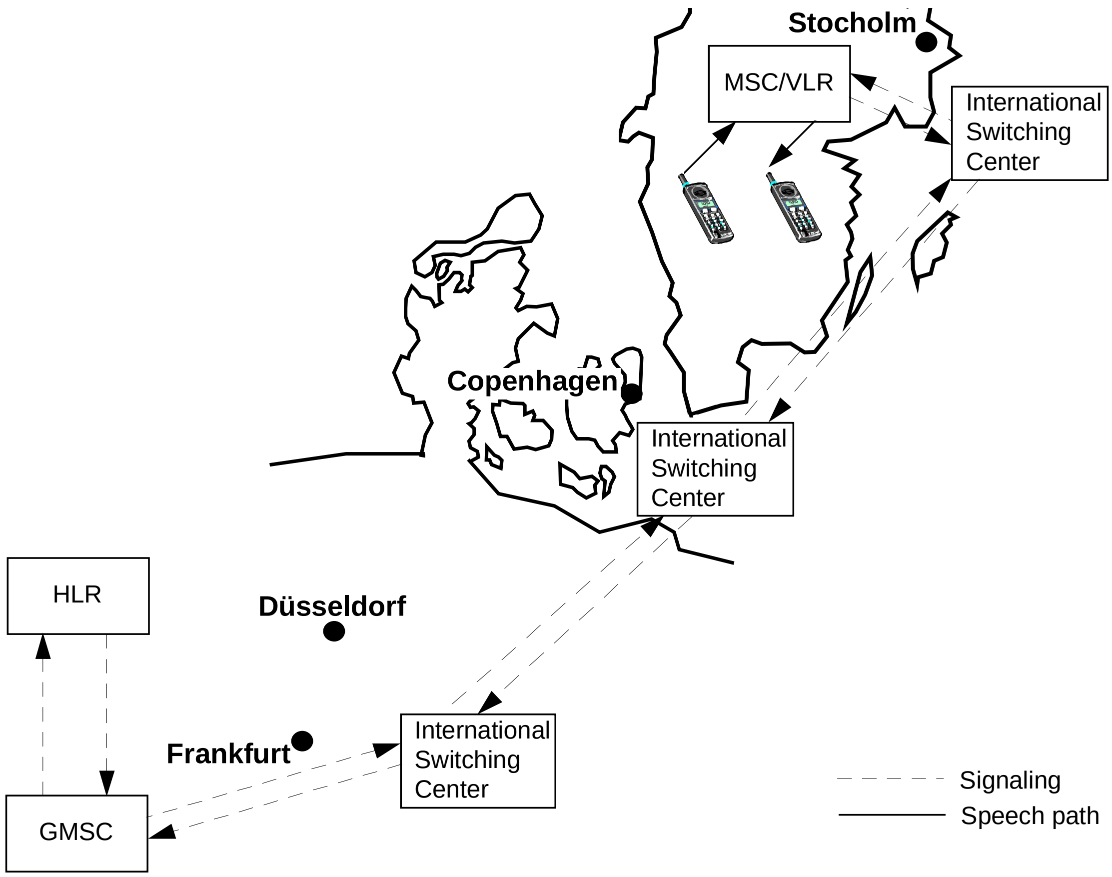


Figure B-8 International Call with Drop Back Function.

In addition, the originating exchange must be able to handle the call drop back function. In our example, the German GMSC checks the data for the Incoming Trunk (IT) to see if it is able to handle the function.

In the Swedish exchange there must also be a software route to handle the signaling from the German GMSC. A check is performed whether the call can be further dropped and if not, the call is finally routed to the German subscriber. In addition to the German GMSC and the Swedish MSC/VLR, every other exchange involved in the call set-up, shown in *Figure B-7* (every “International Switching Center”), must support the drop back.

Figure B-8 shows that concerning drop back, no PSTN lines are required when the calling Swedish subscriber is served by the same MSC/VLR as the German subscriber.

EMERGENCY CALL FROM MOBILE SUBSCRIBER

Regarding emergency calls, calls from unregistered subscribers are permitted (depending on an exchange parameter). For registered mobile subscribers, security related functions are invoked. Failure of these functions is ignored and the call proceeds without ciphering.

Emergency call routing is determined by the routing origin parameter and the emergency area parameter. These parameters are defined in cell data and by the end-of-selection codes for emergency calls with a SIM card (ES = 2290) and emergency calls without a SIM card (ES = 2577).

In GSM the emergency number is 112. In an emergency call set-up with the emergency code, all barring services are ignored.

HANDOVER

During a call and during call set-up, the MS continuously measures the frequencies of neighboring cells, compiles a measurement report, and sends this via the BTS. The BTS adds its own measurements to the BSC. *Figure B-9* shows what information the MS and the BTS add to the measurement report.

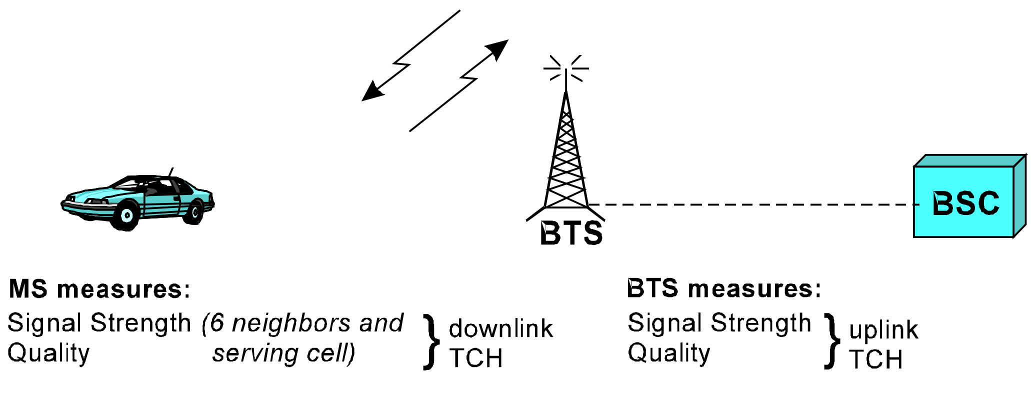


Figure B-9 Measurement Report

In the BSC, the measurements are evaluated in the Locating Procedure. The BSC initiates the handover procedure, if it detects that one of the neighboring cells has a noticeably better signal strength than the serving cell, or for the serving cell, the bit error rate or the timing advance reaches a certain threshold.

How a handover is handled depends on which functional entities the involved cells belong to. Two different cases must be examined:

- Intra-MSC handover — both cells belong to the same MSC. There are two types of intra-MSC handovers defined:
  - Intra-BSC handover — both cells belong to the same BSC. In this case, the BSC manages the greater part of the handover.
  - Inter-BSC handover — the two cells belong to different BSCs, but to the same MSC. In this case, the MSC is involved in the signaling.
- Inter-MSC handover — the two cells belong to different MSCs. In this case, at least two MSCs are involved. This case has some sub-cases which will be covered later. Inter-MSC handovers are defined as national handovers only. According to GSM, this works within one network only. That is, MSCs belonging to one operator.

INTRA-BSC HANDOVER

The sequence involved in an intra-BSC handover, illustrated in *Figure B-10*, is as follows:

1. During a call, the MS measures the signal strength and quality on its own TCH and the signal strength of the neighboring cells. The MS evaluates an average value for each of the cells. Twice per second the MS sends a measurement report to the BTS with measurements from the best neighboring cells.
2. The BTS adds its own measurements made on the TCH and sends the report to the BSC. In the BSC, the locating function is activated to decide if it is necessary to handover the call to another cell.
3. In the case where a handover is required, the BSC checks if a channel is available in the desired cell and, if so, tells the BTS in the new cell to activate a TCH.
4. The BSC then orders the old BTS to send a message to the MS with information about the frequency, time slot, and output power to change to.
5. The MS tunes to the new frequency and sends handover access bursts on the appropriate time slot.
6. When the BTS detects the HO access burst it sends physical information containing timing advance to the MS. The BTS also informs the BSC by sending an HO detection message. The new path through the Group Switch (GS) is through connected.
7. The MS sends a Handover Complete message.
8. Finally, the old BTS is told to deactivate the old TCH.

The intra-BSC handover procedure is completely managed by the BSC without any involvement from the MSC. However, the BSC informs the MSC that a handover has been performed.

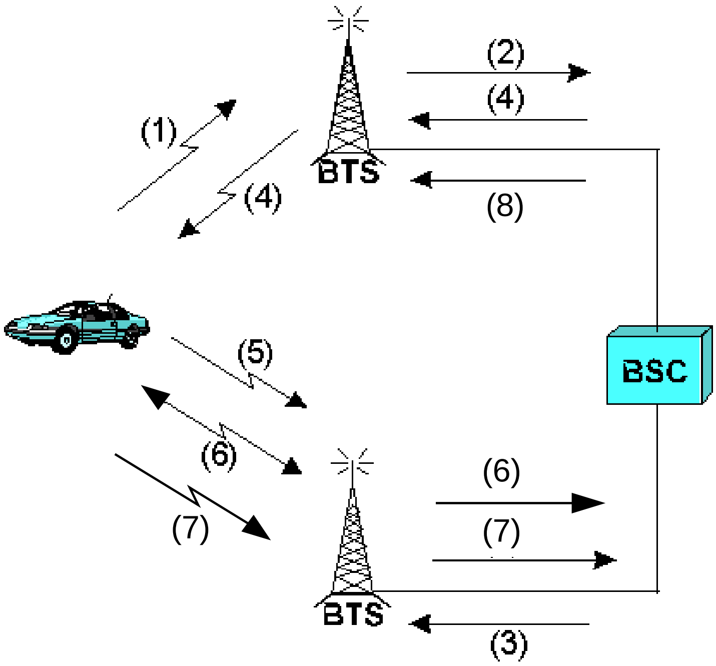


Figure B-10 Intra-BSC Handover

INTER-BSC HANDOVER

If the MS moves to an area covered by a cell belonging to another BSC and a handover is required, an inter-BSC handover takes place. The procedure, illustrated in *Figure B-11*, is as follows:

1. The old BSC has taken the decision, based on the measurement reports, that a call should be handed over to the cell belonging to the new BSC. The serving (old) BSC sends a handover-required message to the MSC, with the identity of the new cell.
2. The MSC knows which BSC controls the BTS and sends a handover request to this BSC.
3. The new BSC now orders the BTS to activate a Traffic CHannel (TCH), if there is one that is idle.
4. When the BTS has activated the TCH, the new BSC sends information about the time slot, frequency, and output power to the MSC.
5. The MSC passes this information on to the old BSC.
6. The MS is told to change to the new TCH.
7. The MS sends a handover burst on the new TCH.

8. As soon as the BTS detects the handover bursts, it sends physical information which contains timing advance and output power to the MS.
9. The new BSC confirms that the BTS has received the handover bursts.
10. This information is passed on to the MSC by the BSC, which changes the path in the Group Switch (GS).
11. The MSC informs the old BSC that the old Traffic CHannel (TCH) is no longer required.
12. The old TCH is deactivated in the BTS.

If the cell belongs to a new LAI, the MS must perform a normal location update after the call is released.

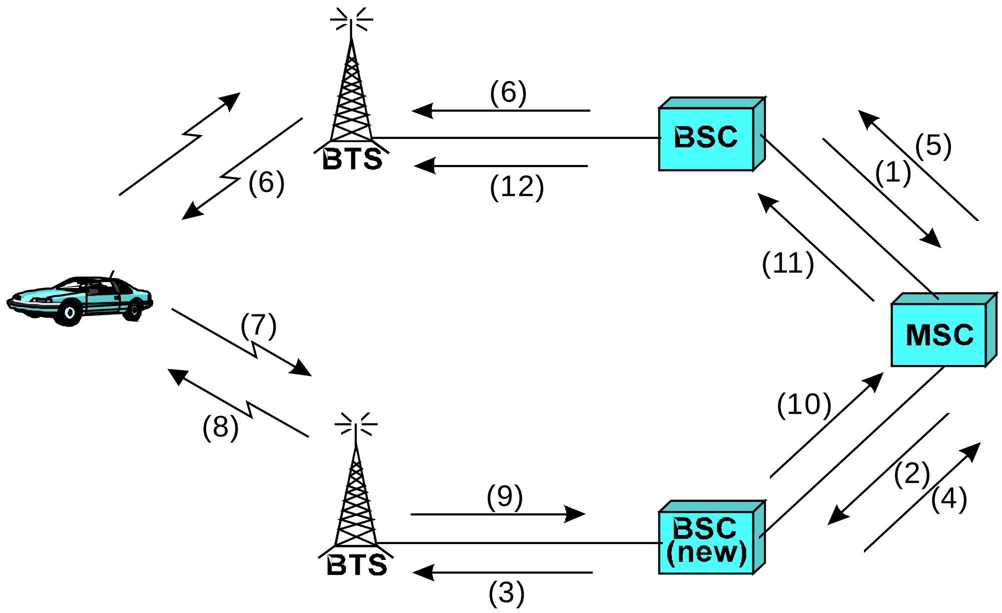


Figure B-11 Inter-BSC Handover

INTER-MSC HANDOVER

During a call, an MS might move between several different MSCs. This is illustrated in *Figure B-12*. The following cases, where the anchor MSC is the first-serving MSC, should be noted:

- Basic handover
- Subsequent handover back to the anchor MSC
- Subsequent handover to a third MSC

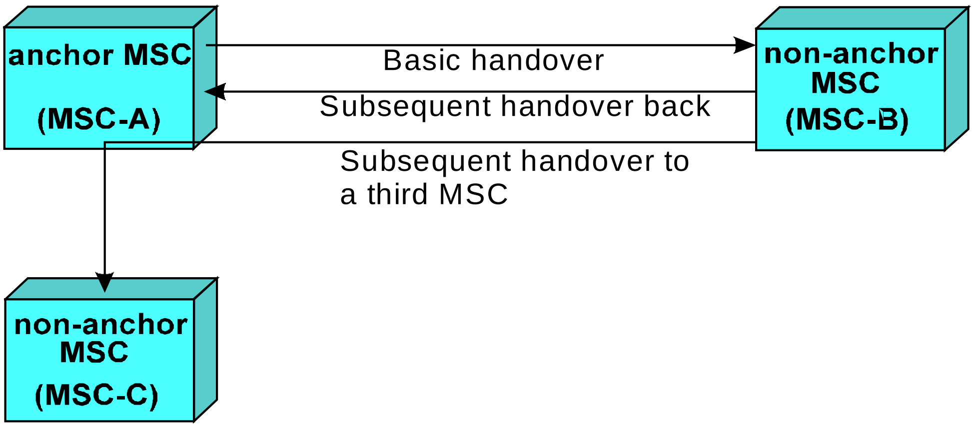


Figure B-12 Different Types of Inter-MSC Handover

The three sub-cases have one point in common. The originating MSC (anchor MSC) has the main control of, for example, charging for the duration of the call. The serving MSC may change, so it only has the radio control.

Note: A large number of MMS Exchange Properties control a handover in the MSC.

Basic Handover

The following is an overview of the basic inter-MSC handover on GSM node level (See *Figure B-13*). The subsequent handover procedures are not discussed, but can be derived from the basic handover procedure.

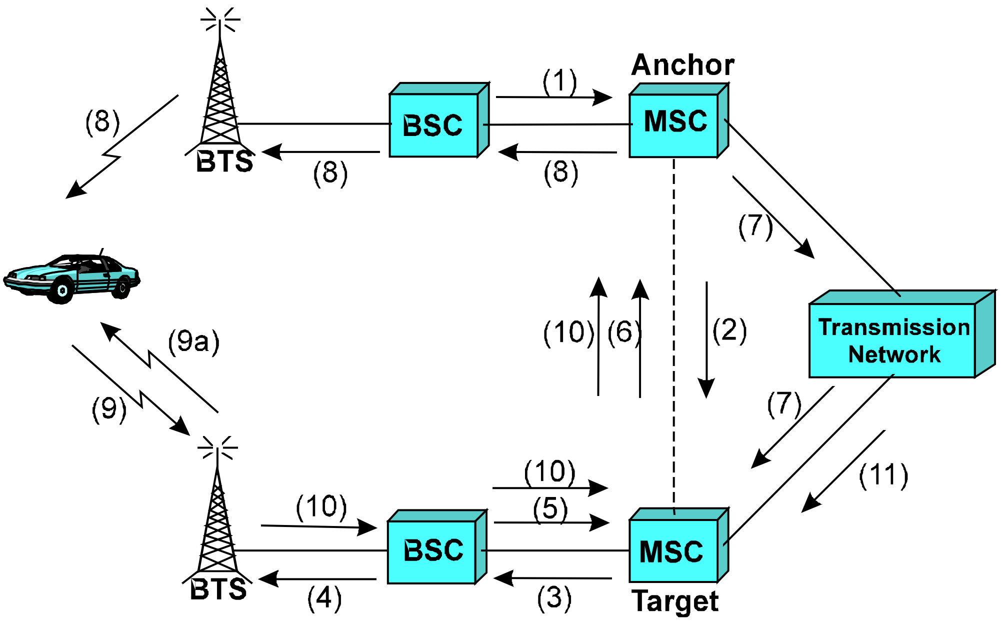


Figure B-13 Inter-MSC Handover of a Call

1. The serving BSC sends a handover-required message to the MSC, as in the former cases.
2. The MSC must ask the target MSC to assist. The target MSC allocates a handover number that reroutes the call.
3. A handover request is sent down to the new BSC.
4. The BSC tells the new BTS to activate a TCH, if an idle TCH is available.
5. The MSC receives the information about the new Traffic CHannel (TCH) from the new BSC.
6. The MSC passes this information back to the anchor MSC with the handover number.
7. A speech path to the new MSC is set up.
8. A handover command message is sent to the MS with information about which frequency and time slot should be used in the new cell.
9. The MS sends handover bursts on the new TCH. When the BTS detects the handover burst it sends physical information containing the timing advance to the MS.
10. The target MSC is informed that the handover was successful and passes this information back to the anchor MSC.
11. A new path in the Group Switch (GS) is set up in the anchor MSC, and the call is switched through. (Also, refer to Inter-MSC Handover in Chapter 11, "Additional Traffic Services.") Now, the old TCH must be deactivated (not shown in the Figure).

The originating MSC retains control of the call until the call is cleared. This MSC is called the anchor MSC. The MAP protocol is used between the MSCs.

The MS must perform a location update when the call is released. The HLR is updated and sends a message to the old MSC/VLR telling the old MSC/VLR to remove all stored information about the subscriber.

MULTI-BAND HANDOVER (GSM 900/GSM 1800 ONLY)

The GSM 900 phase 3 function Multi-band Operation enables operators to use more than one frequency band within their network and to support handovers between these different systems. The MSC/VLR supports both intra-MSC and inter-MSC handovers between GSM and DCS frequency bands for BSCs with multi-band support.

Activation of the function requires MSs that can support two frequency bands. The MSC/VLR, however, allows a mixed configuration that supports both single band GSM 900, or GSM 1800 MSs, as well as the dual band.

Definition of Multi-band Function

In a network that supports the multi-band function, the operator may define cells belonging to different frequency bands as neighbors. MSs with multi-band capability are then able to update the network with measurement reports on both these bands.

The BSC capabilities, defined with the command MGBSI, are used in the MSC/VLR to indicate which type of BSC is connected to the MSC/VLR and whether it is multi-band capable.

The MS's capabilities are indicated by MS classmarks. Classmarks are signaling information elements, used to provide the network with information about the MS equipment.

There are three MS classmarks. Among the data carried in MS Classmark 3 is an indication of whether the MS is capable of supporting the GSM 1800 frequency band.

Multi-band Handover Process

The network is provided with Classmark 3 information in a number of signaling messages, including the MAP message "Prepare Handover" and the Base Station System Mobile Application Part (BSSMAP) message "Handover Request." Classmark information is held in the function block Mobile telephony Radio Resource Management (MRRM). The BSC capabilities, defined by the command MGBSI, are stored in the block MBSSD.

During handover, the function block MRRM checks the block MBSSD to see if the target BSC supports multi-band. If it does, Classmark 3 data is sent in the "Handover request."

(Refer to Multi-band Operation in the chapter "Additional Traffic Services" for an illustration of multi-band handover, and for more information on this feature.)

SHORT MESSAGE SERVICE (SMS)

SMS is a means of transferring a text message consisting of up to 160 alphanumeric characters from one point to another. SMS should not be confused with the SMS-Cell Broadcast Service, which transfers text messages point to multi-point from the BSC.

Short messages can either be transferred from a short message Service Center (SC) to an MS, referred to as mobile-terminated; or from an MS to an SC, referred to as mobile-originated. Only the signaling network transfers a short message. No traffic devices are allocated.

In the case of a mobile-terminated SMS, the MSC interfacing the service center is called an SMS Gateway MSC (SMS-GMSC). In the case of a mobile-originated SMS, it is called an SMS InterWorking MSC (SMS-IWMSC). SMS-GMSC and SMS-IWMSC are functions that can be implemented in any MSC.

MOBILE-TERMINATED SMS

The mobile-terminated SMS has the capability to transfer a short message from the SC to an MS. In addition, it provides information about the delivery of the message through a delivery report, which confirms the delivery of the short message, or through a failure report, which informs the originator that the short message has not been delivered and the reason why. If the short message is not delivered, a specific procedure for later delivery is used.

The mobile-terminated short message can be input to the SC from a variety of sources,for example, speech, telex, facsimile, or other MSs.

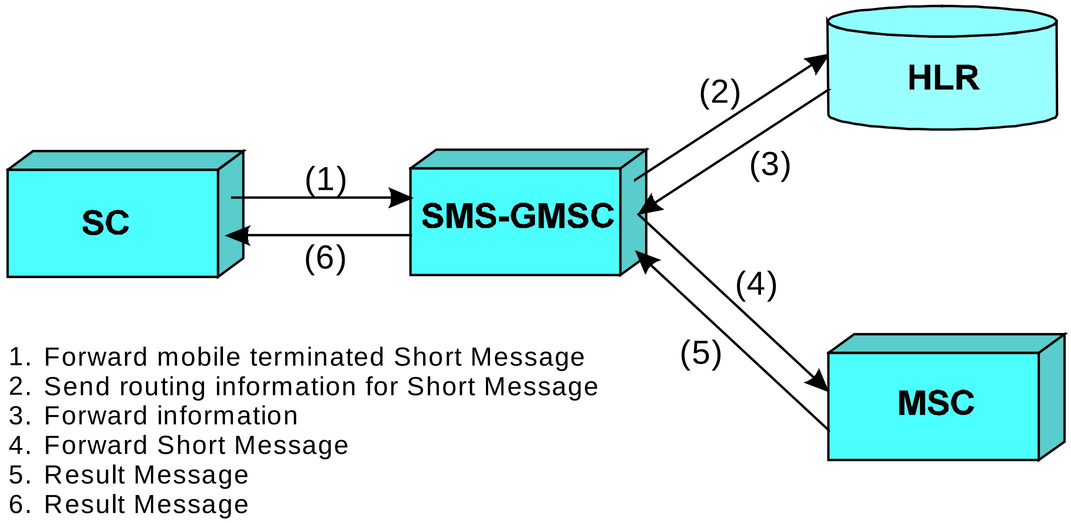


Figure B-14 Successful Mobile-Terminated Short Message Transfer

1. A terminating short message to a mobile subscriber is always routed from the SC to the SMS-GMSC. This is carried out using the Forward Mobile Terminating Short Message.
2. The SMS-GMSC requests routing information from the HLR through the Send Routing Information For Short Message. The MSISDN, received from the SC, is used to address the HLR. The message contains the called subscriber’s MSISDN, the priority, and the SC address.
3. The HLR checks subscriber data related to the received MSISDN number. In the case of an error, the error code is sent back to the SMS-GMSC. The error checks are performed in the following order:
   – Unknown subscriber (if the MSISDN is not allocated)
   – Teleservices not provisioned (if SMS transfer is not provisioned for the mobile subscriber)
   – Call barred (if status of the service ‘barring of incoming calls is active)
   – Absent subscriber (if location is unknown for the mobile subscriber)

If none of the above errors occur, the following routing information is sent back:

- MSC-identity (a signaling address, not a roaming number)
- IMSI
- MWD-set (optional)

MWD-set is a parameter that indicates whether or not the SC address has previously been stored in the Message Waiting Data (MWD) list. The SC is included in the MWD list in the following cases:

- Location is unknown or restricted.
- Location information is available, but the MWD list already contains another SC address, and the priority of this message is low.

Up to eight SC addresses may be stored per MS.

4. The MS address, received from the HLR, is used for addressing the Forward Short Message to the MSC where the MS is currently located. In the MSC/VLR, the identity of the mobile subscriber is derived from the IMSI received in this message.

Provided that the mobile subscriber is registered in the MSC/VLR and not in a detached state, the BSS is ordered to page the mobile subscriber. See *Figure B-15*.

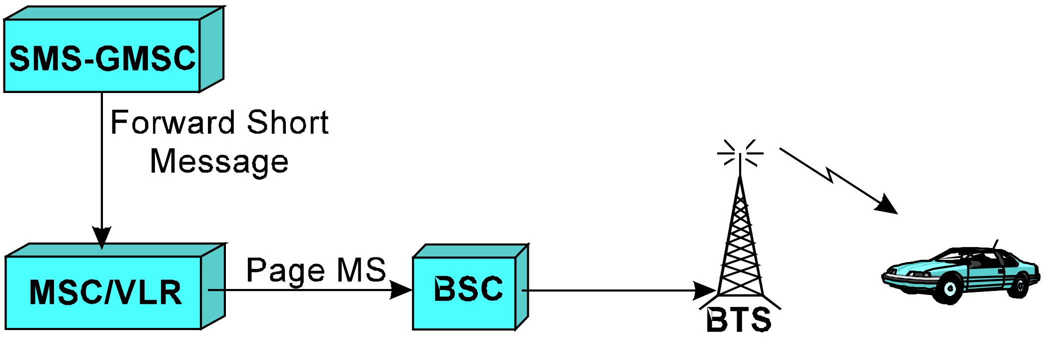


Figure B-15 Short Message Transfer

The mobile subscriber is paged using the Temporary Mobile Subscriber Identity (TMSI) or the IMSI, if the TMSI is unavailable.

After the mobile subscriber has responded to the paging, the procedure for security-related functions, such as authentication, cipher mode setting, and IMEI check, is invoked, if carried out in the network.

The short message is transferred to the MS on a Standalone Dedicated Control CHannel (SDCCH) if the MS is idle, and on the Slow Associated Control CHannel SACCH if the mobile is active during a call.

5. If a short message is successfully delivered, a result message is sent to the SMS-GMSC. In the case of failure, an error message is returned.
6. The delivery report is sent to the SC.

Unsuccessful Mobile-Terminated SMS Delivery

When a mobile subscriber is unreachable, the message waiting flag is set in the MSC/VLR. An error message is then sent to the SMS-GMSC. See *Figure B-16*.

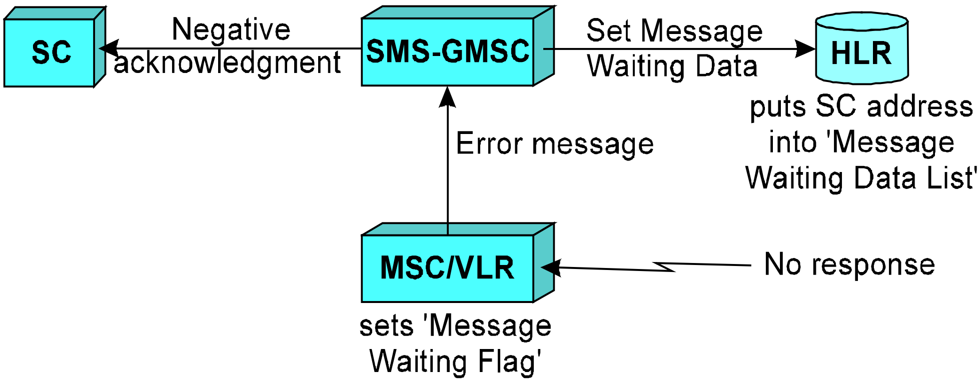


Figure B-16 Unsuccessful Message Transfer

When the SMS-GMSC receives the error message from the MSC/VLR, the Set Message Waiting Data message is sent to the HLR. This message requests the HLR to transfer the SC address to the message-waiting data list. The message contains the MSISDN of the called subscriber and the SC address. If the MSISDN is known and the message waiting data list is not full, the HLR includes the SC-address in the list.

After receiving the answer to the Set Message Waiting Data message, the SMS-GMSC sends a negative acknowledgment to the SC.

Note Mobile Station Present

When the MSC/VLR receives a location updating request and the message waiting flag in the MSC/VLR is set, the Note Mobile Station Present message is sent from the MSC/VLR to the HLR. The message carries the IMSI of the mobile subscriber. See *Figure B-17*.

The HLR now looks for the subscriber data related to the IMSI number, and alerts the SC by sending the Alert Service Center message to the SMS-IWMSC. One message per SC is sent.

The SMS-IWMSC now sends the Alert Service Center message to the SC. The SC address is received in the Alert Service Center message. The reception of this information triggers a new attempt for the SMS delivery in the SC.

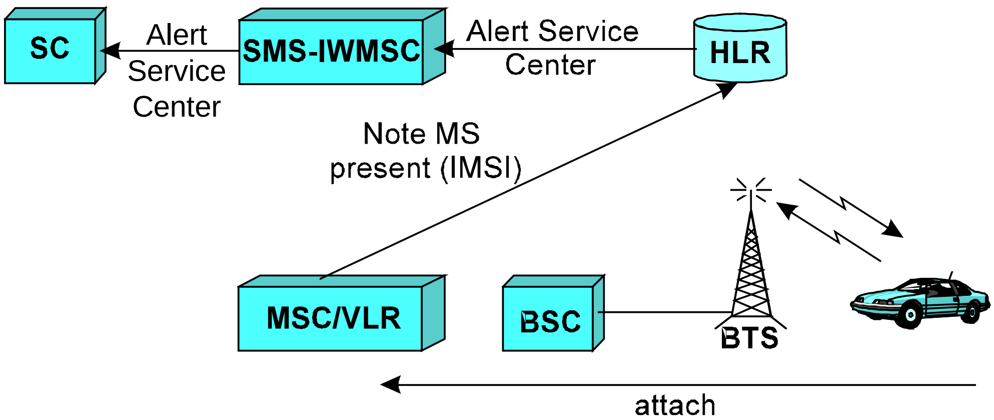


Figure B-17 Note Mobile Station Present

MOBILE-ORIGINATED SMS

The mobile-originated SMS provides the means to transfer a short message from a mobile to an SC. This can be carried out either when the mobile is idle, or when a connection (such as speech or fax) already exists. For both successful and unsuccessful deliveries, the mobile receives a delivery report. This is illustrated in *Figure B-18*.

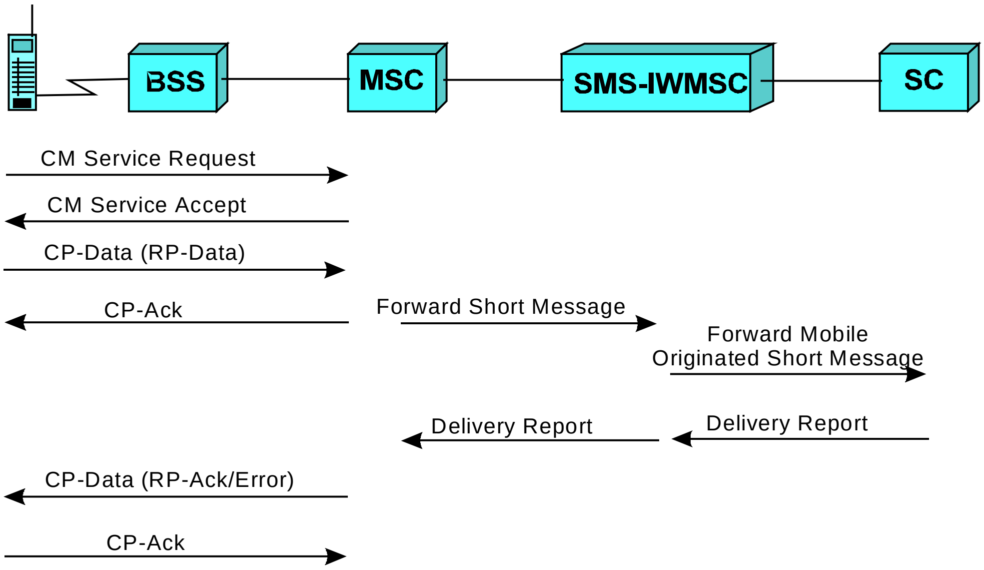


Figure B-18 Mobile-Originated Short Message Transfer

First the MS sends a Connection Management request to the MSC/VLR to set up a signaling connection.

In the case where the MS is idle, the MSC assigns a signaling channel and may start authentication and ciphering. Otherwise, parallel transaction is performed.

An equipment identity check may be performed.

For short message sending, two protocols are used:

- Connection Management Protocol for the air interface
- Relay Protocol for the relaying of short messages

The principle structure of Relay Protocol messages is:

- Destination address
- Originating address
- User information or reason code

The short message is transferred from the MSC/VLR to the SMS-IWMSC. From there, the message Forward Mobile Originated Short Message is forwarded to the SC. A delivery report is sent back the same way.

SUPPLEMENTARY SERVICE PROCEDURE

When a mobile subscriber wants to change a supplementary service, the subscriber must request a signaling channel and invoke a change of the subscriber information in the HLR. This change is necessary because the subscriber might roam into a new MSC/VLR area, which is updated from the HLR and not from the previous MSC/VLR.

The procedure is illustrated in *Figure B-19*.

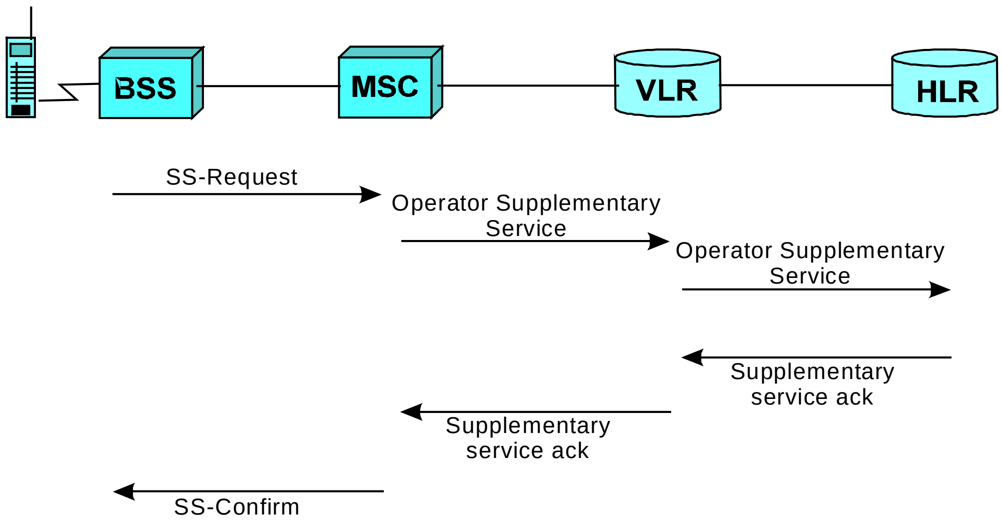


Figure B-19 Invocation of a Supplementary Service Procedure

The MS sends a Supplementary Service request to the MSC, which passes the request on to the VLR. The VLR updates itself and then updates the HLR. From the HLR, an acknowledgment is sent to the VLR, and the VLR sends an acknowledgment to the MS.

CAMEL PHASE 2

The Customized Applications for Mobile network Enhanced Logic (CAMEL) Phase 2 feature is a GSM Phase 2+ network feature. It provides the mechanisms to support operator-specific services that are not covered by standardized GSM services, even while roaming outside the Home PLMN (HPLMN).

The operator-specific services are implemented using Intelligent Network (IN) principles, whereby the CAMEL network feature provides the mechanisms necessary for integrating GSM and IN functional entities, including support for roaming.

CAMEL is based on ETSI CSx standards, and is the first true multi-vendor IN standard. It is an evolving standard in three phases. There is a high commitment to CAMEL from vendors and operators (MoU). The different phases of CAMEL (Phase 1, 2 ,and 3) will be implemented in Ericsson's releases R7, R8, and R9.

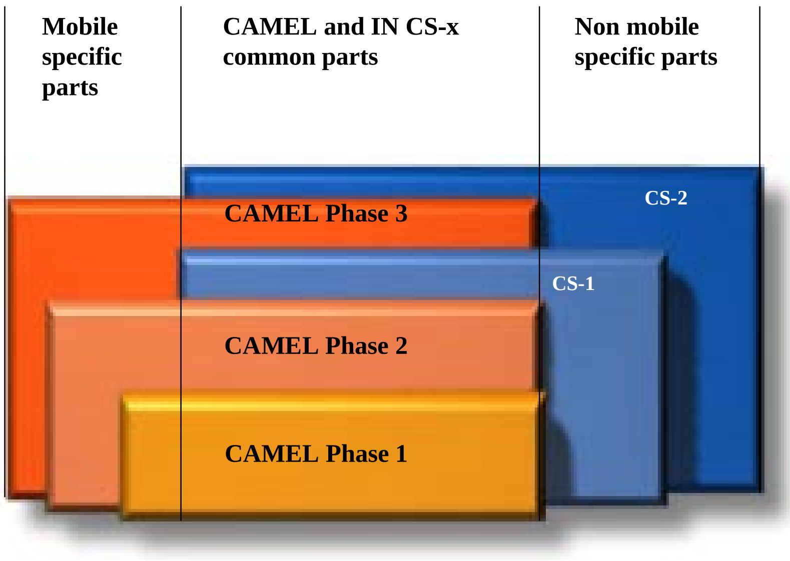


Figure B-20 Evolution of CAMEL Phase 1, 2, and 3 in Comparison with CS-x IN service

CAMEL SERVICES

As CAMEL is a network feature providing a generic capability based upon IN principles, it is possible to support a large number of different services. These services are possible with CAMEL include:

- Prepaid services
- Private Numbering Plan, for example, including abbreviated dialing for services, such as Friends & Family
- Operator controlled Number Translation (OCNT): usage of the HPLMNs short numbers (for example, to the Voice Mail) in international roaming
- Incoming Call Screening Calls to a B-subscriber can be screened according to certain conditions (such as A-subscriber number, B-subscriber location).
- Location and Time Dependent Routing Calls from or to an end-user are routed according to location and/or time of the day
- Personal Number (PN)
- Outgoing Call Restrictions
- Fraud monitoring
- Integration of AoC into CAMEL services

CAMEL NETWORK

Customized Applications for Mobile network Enhanced Logic (CAMEL) is a network feature including support in traditional GSM functional entities (HLR, GMSC, and MSC/VLR), as well as functional entities, originally defined in IN specifications (SSF and SCF).

The feature addresses, in particular, the need for information exchange between the Home PLMN (HPLMN) and the Visited PLMN when an HPLMN-specific service is to be provided to a subscriber roaming outside the HPLMN.

R8 supports the use of specialized resources functions (SRF) located in the visited PLMN, or the home PLMN. The specialized resource functions can either be integrated with the MSC/SSF or standalone (Intelligent Peripherals). The standard will assume that the resources are under the control of the home PLMN.

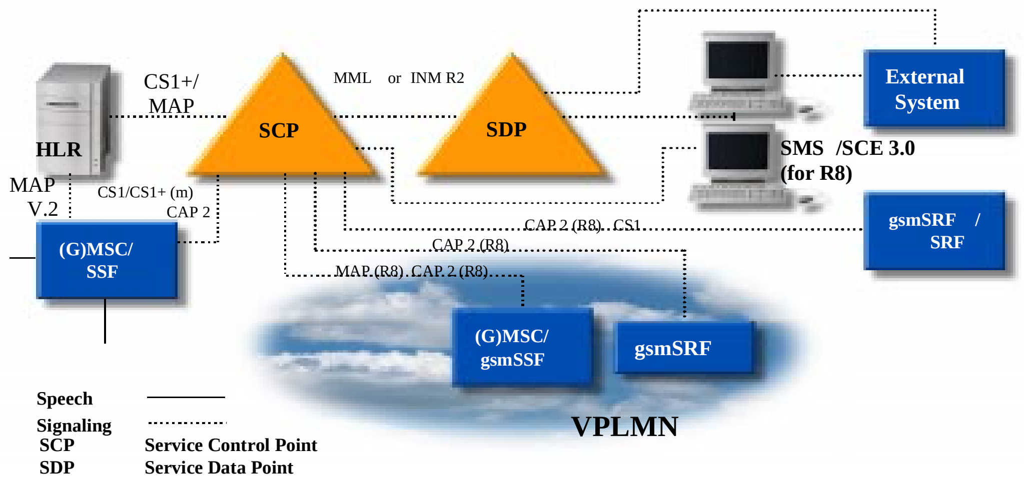


Figure B-21 Camel Network nodes

Subscription Information

When this feature is supported in GMSC, the GMSC may receive an Originating and/or Terminating CAMEL Subscription Information (O/T-CSI) from the HLR as part of the terminating call handling.

In MSC/VLR, the Originating CAMEL Subscription Information (O-CSI) and/or Supplementary Service CAMEL Subscription Information (SS-CSI) may be received as part of the subscriber data from the HLR in the Insert Subscriber Data message (for example, at Location Update).

The presence of an O-CSI or T-CSI indicates that an instance of the gsmSSF (which is integrated with the MSC) should 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.

TRAFFIC HANDLING

The O-CSI is used when an originating CAMEL service is to be invoked for an outgoing call, that is, for mobile-originated calls and forwarded calls. Originating CAMEL services may be invoked in the MSC/VLR, as well as in 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 invoke a CAMEL-triggered call forwarding or another originating CAMEL service.

The SS-CSI is used to indicate to the gsmSCF that a supplementary service has been invoked in the MSC/VLR.

Additionally, suppression of announcements is supported in the GMSC and in the MSC/VLR. This function is used when services are invoked for 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 should be suppressed.

The MSC/VLR supports the handling of requests from the HLR for subscriber information. The information which may be provided is subscriber state and location information.

The MSC/VLR indicates to the HLR which phases (CAMEL phase 1 or 2) are supported.

Example of Traffic Case for OCNT

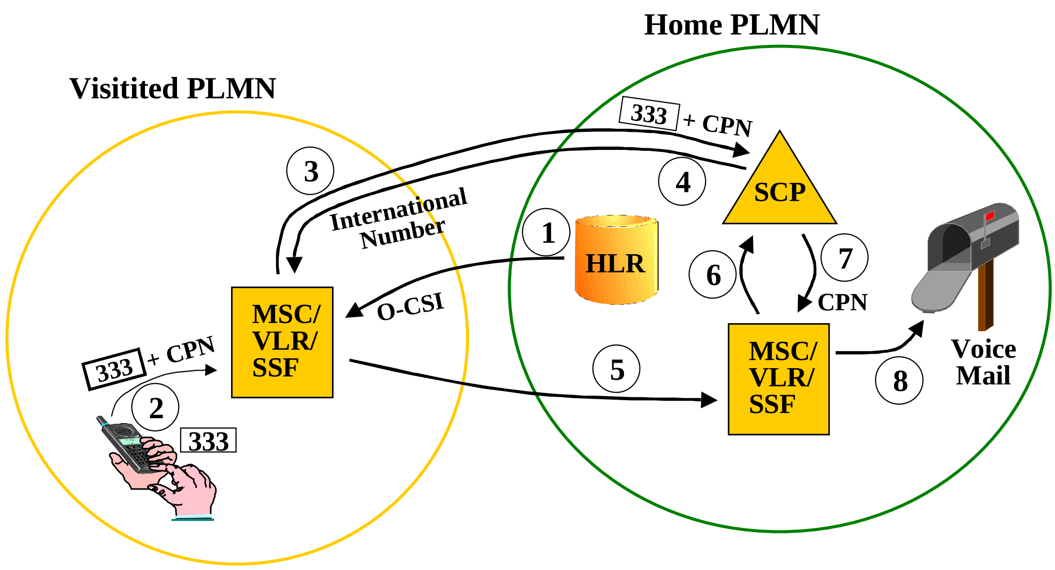


Figure B-22 Traffic Case OCNT

1. When Location Update is performed the HLR sends down all Subscriber specific information, including the Originating Camel Subscription Information, O-CSI.

2. The Mobile Subscriber makes a call to retrieve messages in his voice mail. He dials the usual access number: 333 is used in this example.
3. The OCNT service is invoked. It is verified that the VPLMN belongs to an approved VPLMN.
4. The SCP translates the short number into an international number.
5. This number is used to route the call to the Voice Mail Box, VMB, in the HPLMN.
6. The VMB can request the Calling Party Number, CPN.
7. The CPN provides authentication so the mobile subscriber can listen to his voice mail.
8. The call is routed to the subscriber's voice mail.

Procedures for Mobile Originating Calls

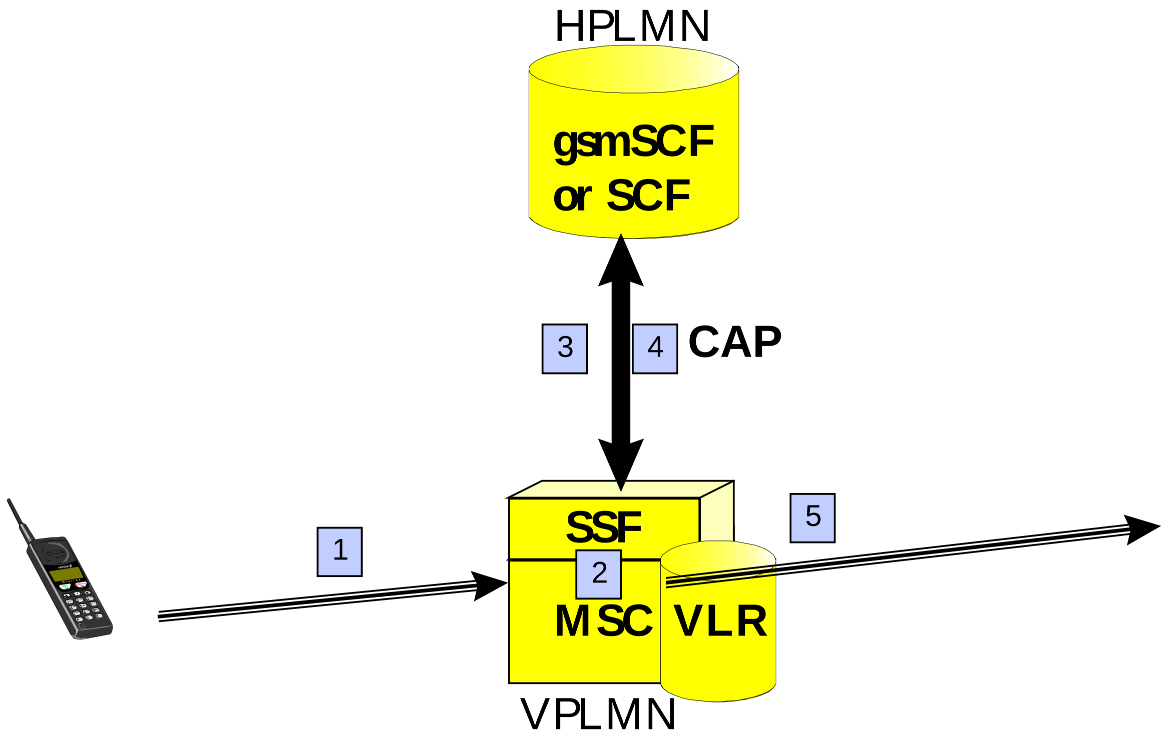


Figure B-23 Mobile Originating CAMEL Call

The purpose of this procedure is to detect a call set-up request and allow the gsmSCF to modify the handling of the call set-up request.

1. There is a mobile originating call.

2. If the subscriber is provisioned with a CAMEL based originating service and the call set-up request event occurs, the VPLMN suspends the call processing, makes contact with the gsmSCF and awaits further instructions.

3. For mobile originated calls, the following information is provided to the gsmSCF, if available:

- Event met;
- IMSI;
- Calling Party’s Number;
- Calling Party’s Category;
- Service Key;
- Location information of the calling subscriber;
- ISDN Bearer Capability;
- High Layer Compatibility;
- Basic Service Code;
- Called Party Number;

4. The answer message from the gsmSCF to the GSSF or VSSF may contain this information:

- Bar the call, that is, release the call prior to connection;
- Allow the call processing to continue unchanged;
- Allow the call processing with modified information. The gsmSCF has the possibility to send the this modified information:
  - Called Party Number;
  - Calling Party’s Number;
  - Calling Party’s Category;
  - Original Called Party Number;
  - Redirection Party Number;
  - Redirection Information.

In addition, the gsmSCF may instruct the VPLMN to:

- Activate other control service events for the call. The gsmSCF has the possibility to send this information:
  - The service event, which will be detected and reported (Called party connection or Call termination);
  - The type of monitoring (control or notification).

Procedures for Mobile Terminated Calls

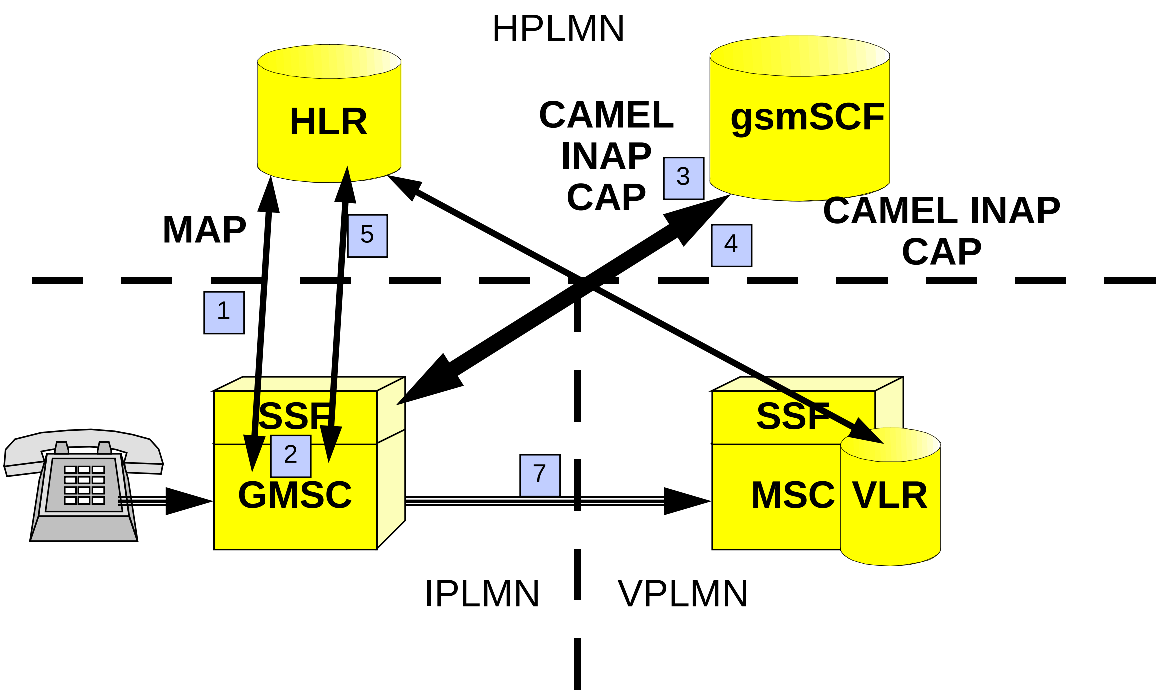


Figure B-24 Mobile Terminating CAMEL Call

1. In the GMSC, the Send Routing Info message is sent to the HLR. In this message there is an indication that this MSC supports CAMEL services. If the subscriber is a CAMEL subscriber it will be indicated in the response (T-CSI information). Otherwise, the call is treated as a normal call.

2. If the subscriber is provisioned with a CAMEL based terminating service and the incoming call request event occurs, the IPLMN suspends call processing, makes contact with the gsmSCF and awaits further instructions.

3. For mobile terminated calls the following information is provided to the gsmSCF, if available:

- Event met;
- Service Key;
- ISDN Bearer Capability;

- High Layer Compatibility;
- Basic Service Code
- Called Party Number;
- Redirecting Number;
- Redirecting Information;
- IMSI;
- Location Number of the calling subscriber (Note: The location information of the calling subscriber is not available, due to signaling constraints.)
- Location information of the called subscriber;
- Calling Party Number;
- Calling Party's Category;
- Original Called Party Number;
- Additional Calling Party Number;
- Subscriber State of the called subscriber.

4. When contact with the gsmSCF has been established, the gsmSCF gives one of these instructions:

- Bar the call, that is, release the call prior to connection;
- Allow the call processing to continue unchanged;
- Allow the call processing with modified information. The gsmSCF has the possibility to send this information:
  - Called Party Number;
  - Calling Party's Number;
  - Calling Party's Category;
  - Original Called Party Number;
  - Redirection Party Number;
  - Redirection Information.

In addition, the gsmSCF may instruct the VPLMN to:

- Activate other control service events for the call. The gsmSCF has the possibility to send this information:
  - The service event which will be detected and reported (Called party connection or Call termination);
  - The type of monitoring (control or notification).

- Suppress tones and announcements which may be played to the calling party, if an unsuccessful call establishment occurs. This is only applicable when the called party number is unchanged by the CSE.

5. For example, the number that the gsmSCF sends back is the same MSISDN as the resulting CAMEL service number. Then, a second Send Routing Message with an indication to suppress T-CSI is sent to the HLR.

6. This results in the VLR provisioning a roaming number as in a normal mobile terminating traffic case.

7. The call performs the normal roaming forwarding step. There is no special CAMEL related activity in the visited MSC/VLR.

GPRS SYSTEM OVERVIEW

General Packet Radio Services system, hereafter, referred to as the GPRS system provides a basic solution for Internet Protocol (IP) communication between Mobile Stations and Internet Service Hosts (IH).

An overview of the system components in the GSM system, integrated with the circuit-switched part of the Ericsson GSM System is illustrated in *Figure B-25*.

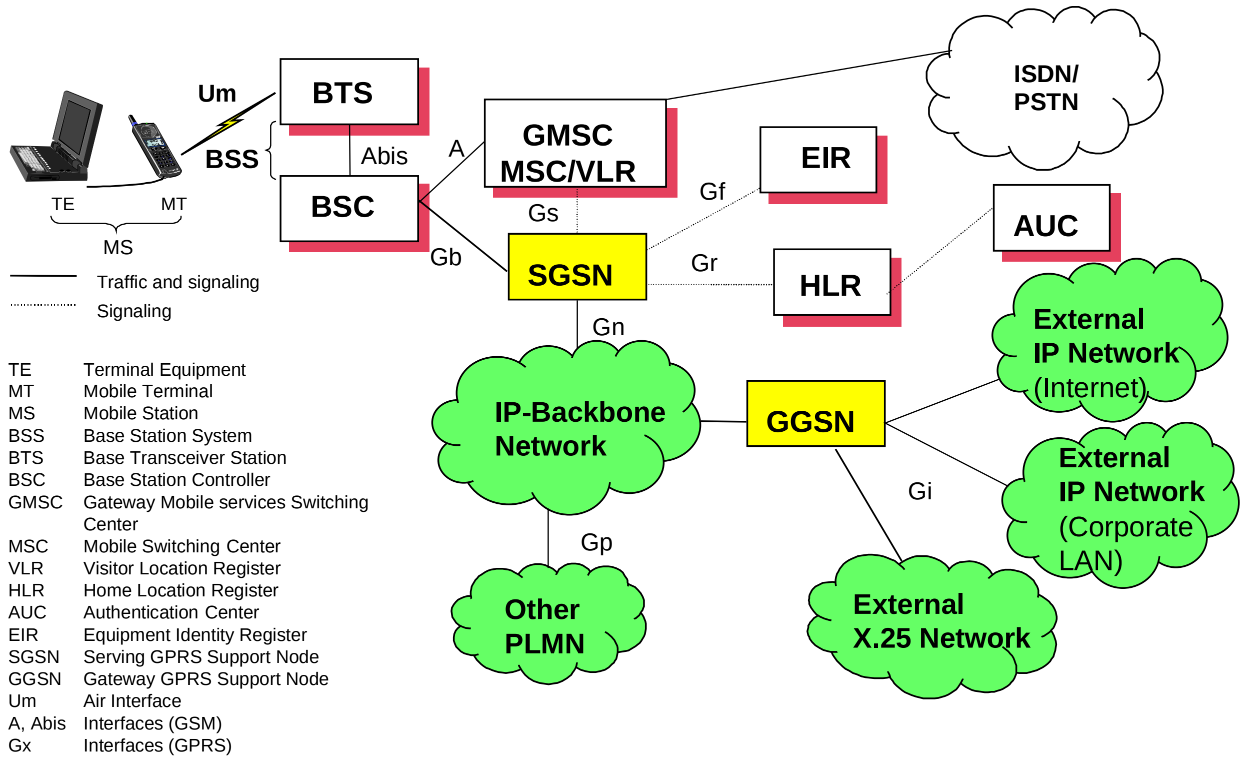


Figure B-25 GPRS Logical Architecture

NETWORK NODES

Terminal Equipment (TE)

The Terminal Equipment (TE) is the computer terminal the end-user works on. This is the component used for the GPRS system to transmit and receive end-user packet data. The TE may be, for example, a laptop computer. The GPRS system provides IP connectivity between the TE and an Internet Service Provider or Corporate LAN, connected to the GPRS system.

From the TE point of view, the MT can be compared to a modem that connects the TE to the GPRS system.

Mobile Terminal (MT)

The Mobile Terminal (MT) communicates with a TE, and over the air with a BTS. The MT must be equipped with software for the GPRS functionality when used in conjunction with the GPRS system. The MT is associated with a subscriber in the GSM system. The MT establishes a link to an SGSN. Channel reselection is provided at the radio link between the MT and the SGSN. The IP connection is static from the TE point of view, that is, the TE is not aware of being mobile and retains its assigned IP address until the MT detaches.

Mobile Station (MS)

The combination of a TE and an MT is an MS (Mobile Station). Often in this document as in the ETSI GSM standard for GPRS, the term MS is used when discussing GPRS features. It can be concluded from the context which parts relate to the MT or the TE. Note that the MT and TE parts may actually be present in the same piece of equipment.

GPRS MSs can, depending on the MS and the network capabilities, operate in three different modes:

- Class A mode of operation allows an MS to have a circuit-switched connection at the same time as it is involved in a package transfer.

- Class B mode of operation allows an MS to be attached to both CS and PS, but it cannot use both services at the same time. However, an MS that is involved in a package transfer can receive a page for circuit switched traffic. The MS is able to suspend the packet transfer for the duration of the circuit switched connection and afterwards it can resume the package transfer.

- Class C mode of operation allows an MS only to be attached to one service at a time. An MS that only supports GPRS and not circuit-switched traffic always works in class C mode of operation.

Base Station System (BSS)

The Base Station System (BSS) consists of a Base Station Controller (BSC) and a Base Transceiver Station (BTS). The BTS is the radio equipment, which transmits and receives information over the air to let the BSC communicate with MSs in the BSCs service area. A group of BTSs is controlled by a BSC. The BTS must contain GPRS-specific software. The BSC provides all the radio-related functions. The BSC has the functionality to set up, supervise, and disconnect circuit-switched and packet-switched calls. It is a high capacity switch that provides functions including handover, cell configuration data, and channel assignment. The BSC must be equipped with GPRS hardware and software when used for GPRS. One or several BSCs are served by an MSC, and a number of BSCs are served by an SGSN.

The BTS separates the MS-originated circuit-switched calls from packet data communication, before the BSC forwards CS calls to the MSC/VLR, and PS data to the SGSN.

The protocols towards the BSC are standard GSM protocols for the desired compatibility.

Mobile Services Switching Center (MSC)

The Mobile services Switching Center (MSC) performs the telephony switching functions of the GSM circuit-switched system, like the SGSN switches the GSM packet-switched traffic. It controls calls to and from other telephony and data systems, such as the Public Switched Telephone Network (PSTN), Integrated Services Digital Network (ISDN), Public Land Mobile Network (PLMN), Public Data Networks, and, possibly, some private networks.

The SGSN Routing Area (RA) is a subset of the MSC (CS) Location Area (LA). An MSC Location Area is a group of BSS cells. The system uses the LAs to search for subscribers in the active state. An LA is the part of the network in which an MS may move around without reporting its location to the network.

One MSC/VLR Service Area (SA) is made up of a number of LAs. The SA is the part of the network that is covered by one MSC.

There may be several MSCs corresponding to one SGSN. One MSC can also be connected to several SGSNs. The configuration is a matter of dimensioning for the actual traffic.

Gateway Mobile Services Switching Center (GMSC)

The GMSC is not changed for use by the GPRS system.

Home Location Register (HLR)

The Home Location Register (HLR) is the database that holds subscription information for every person who has bought a subscription from the GSM/GPRS operator. The HLR stores information for CS and for PS communication. The HLR contains information about, for example, supplementary services, authentication parameters, and whether or not packet communication is allowed. In addition, the HLR includes information about the location of the MS. For GPRS, subscriber information is exchanged between the HLR and the SGSN. Note that the authentication triplets for GPRS are fetched directly from the HLR to the SGSN, that is, the MSC/VLR is not used, as is the case for CS GSM. For more information, see section Visitor Location Register (VLR) Functionality in the SGSN and the MSC, above. The information passing from the HLR to the SGSN is what the operator sets up for the subscriber. This information transfer is performed when the operator changes the subscriber information, or when a new SGSN needs to have data for a subscriber after attach or roaming. The old SGSN also receives information about the roaming. The information going from the SGSN to the HLR is the routing information that is transferred upon MS action, for example, attach or roaming. For a roaming mobile, the HLR may be in a different PLMN than the SGSN that is serving the mobile.

Visitor Location Register (VLR)

The Visitor Location Register (VLR) database holds information about all MSs that are currently located in the MSC location area, or SGSN routing area respectively. The SGSN actually contains the VLR functionality for packet-switched communication. Similarly, the circuit-switched VLR is an integrated component of the Ericsson MSC.

The VLR contains temporary subscriber information needed by the MSC or SGSN to provide services for visiting subscribers.

When an MS roams into a new MSC location area or SGSN routing area, the VLR of that MSC or SGSN requests and stores data about the MS from the HLR. If the MS makes a call at another time, the necessary information for that call set-up will be available immediately.

For mobiles supporting GPRS (PS) and GSM (CS), both the SGSN and the MSC obtain location information from the HLR when the MS is combined-attached, that is, both GPRS- and

IMSI/CS-attached. The SGSN can receive and execute circuit-switched system paging requests from the MSC/VLR.

The GPRS VLR consists of software in a Serving GPRS Support Node (SGSN, see below). The VLR contains information about the SGSN that is used. For the GPRS system, the HLR is used directly for the authentication procedure of the MSs, instead of the (CS) MSC/VLR. The SGSN, thus, obtains the authentication triplets from the HLR.

The MSC/VLR is directly connected to the SGSN using the Gs interface, and indirectly via the BSS using the A and the Gb interfaces.

The Gs interface is used for dealing efficiently with terminals that are attached to both GPRS (PS) and GSM (CS) traffic. The Gs interface, thus, connects the databases in the MSC/VLR and the SGSN. The Gs interface is used to coordinate the location information of MSs that are attached to both GPRS and the CS network. The Gs interface is also used to convey some CS procedures via the SGSN. One example is that the class-A and class-B MSs connect to the MSC/VLR over the SGSN via the combined CS and PS Mobility Management procedures, if there is a Gs interface.

Serving GPRS Support Node (SGSN)

The SGSN is a primary component in the GSM network using GPRS, and it is a new component in GSM. The SGSN forwards incoming and outgoing IP packets addressed to/from an MS that is attached within the SGSN service area. The SGSN provides packet routing and transfer to and from the SGSN service area. The SGSN serves all GPRS subscribers that are physically located within the geographical SGSN service area. A GPRS subscriber may be served by any SGSN in the network, all depending on the location. The traffic is routed from the SGSN to the BSC, via the BTS to the MS. In addition, the SGSN provides:

- Ciphering and authentication
- Session management
- Mobility management
- Logical link management toward the MS
- Connection to HLR, MSC, BSC, GGSN and other nodes
- Output of billing data

The SGSN collects billing information for each MS related to the radio network usage. Both the SGSN and the GGSN collect billing information on usage of the GPRS network resources.

Gateway GPRS Support Node (GGSN)

Like the SGSN, the Gateway GPRS Support Node (GGSN) is a primary component in the GSM network using GPRS and it is a new component. The GGSN provides

- The interface towards the external IP packet networks. The GGSN, therefore, contains access functionality that interfaces external ISP functions like routers and RADIUS servers (Remote Access Dial-In User Service) which are used for security purposes. From the external IP network's point of view, the GGSN acts as a router of the IP addresses of all subscribers served by the GPRS network. The GGSN, thus, exchanges routing information with the external network

- GPRS session management; communication set-up towards the external network

- Functionality for associating subscribers to the right SGSNs of traffic.

- Output of charging data. The GGSN collects charging information for each MS, related to the external data network usage. Both the GGSN and the SGSN collect charging information on usage of the GPRS network resources.

Non-GPRS-Specific System Components

Authentication on GPRS and GSM subscribers is identical.

The change of security for GPRS is related only to ciphering. This change does not require an update of the AUC.

Example of GPRS Traffic Cases

Figure B-26 and *Figure B-27* illustrate how uplink packets and downlink packets are handled between the MS and the SGSN.

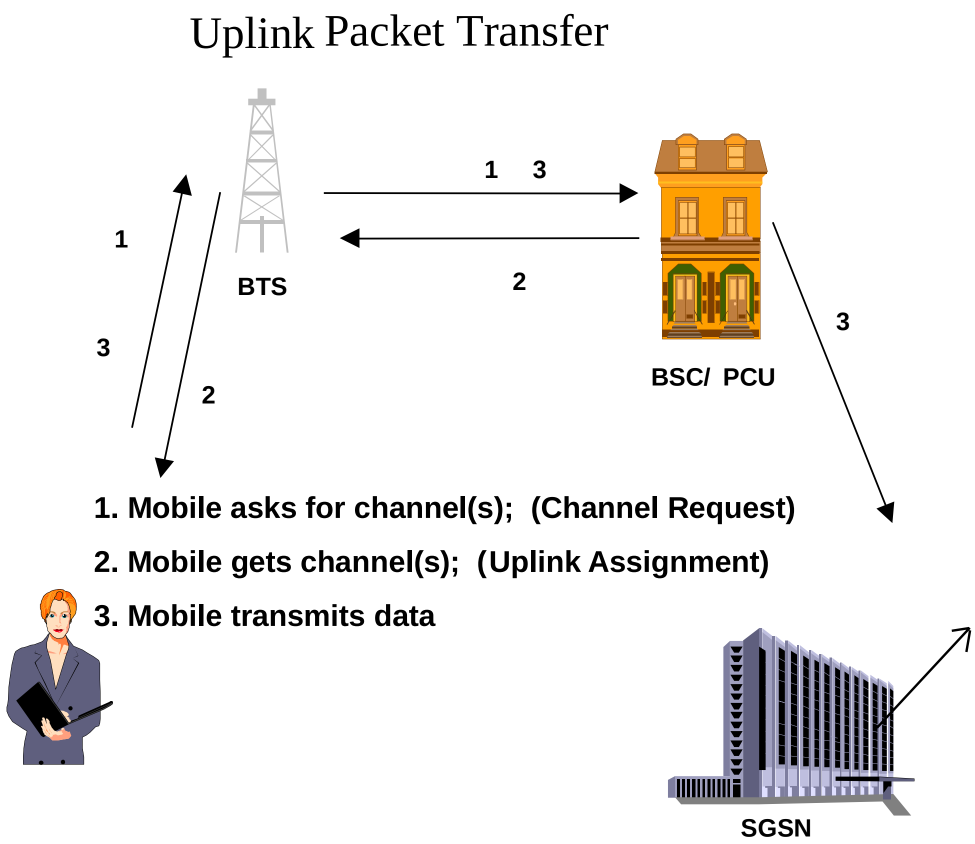


Figure B-26 Uplink Packet Transfer

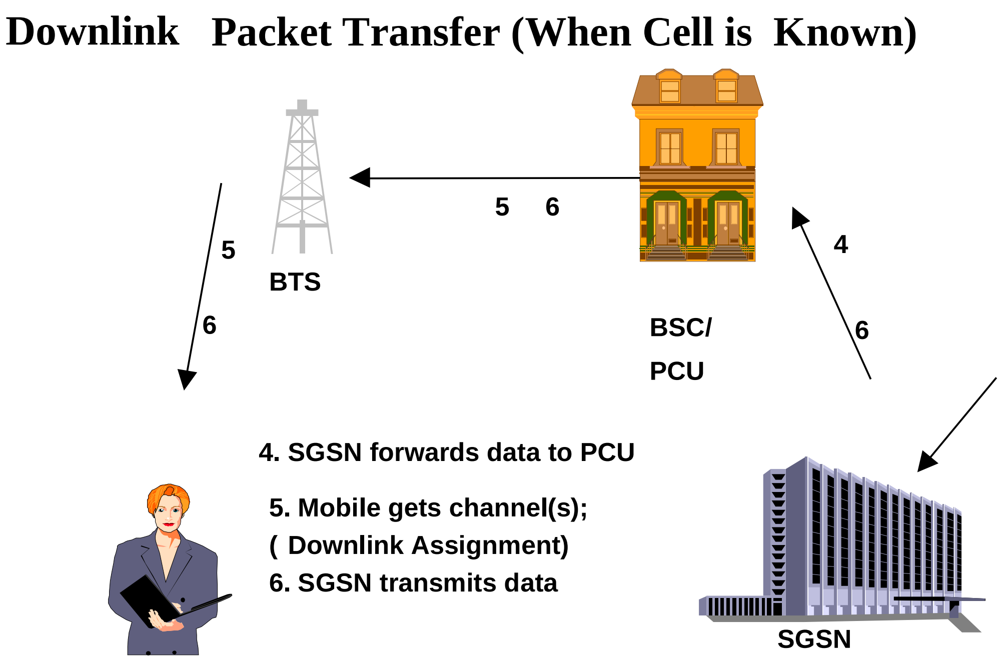


Figure B-27 Downlink Packet Transfer

In Service Performance

Appendix C

ERICSSON

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Appendix C In Service Performance

Table of Contents

Topic	Page

INTRODUCTION TO ISP

The objective of this chapter is to provide a basic understanding of In Service Performance (ISP).

The information has been adapted for an AXE-based mobile telephony system.

To evaluate and improve the performance and service of each network, it is necessary to track, report, and analyze all issues and problems. ISP is a vital part in this chain since it measures the availability or Dependability Performance of a cellular network.

Efficient trouble handling is a very important factor to improve the ISP. It includes not only the time spent on trouble handling, but also accuracy concerning the handling of error data. Therefore, a lot of effort has been put into the trouble handling function.

You will be provided with a survey which outlines the type of problems that may occur and the preventive actions that should be taken to reduce them.

This appendix includes an ISP definition section.

FAULTS DUE TO FAULTY HANDLING

Problems may arise for many different reasons. However, if one is aware of the source of the problem, steps can be taken to prevent them from reoccurring.

Major user errors can be divided into groups which facilitates troubleshooting.

This section describes the types of problems that may occur, their origins and influence on the system.

FAULT CLASSIFICATION

Problem investigation usually proves that one or several factors are the underlying causes of each fault.

There is a rough classification system for classifying user errors and program errors. Errors leading to either System Downtime or Exchange Downtime can be sorted according to the system below:

Fault Source Types

- Hardware
- Software
- Docware
- Handling errors
- External causes
- Unknown

Fault Consequences

Measured in:

- Exchange downtime duration in minutes, per year
- The customer’s financial loss

TYPICAL CAUSES OF USER RELATED ERRORS

Causes of user related errors can be divided into a number of groups. These include:

- Lack of proper user training
- Poor documentation (Ericsson's or the customer's), or failure on the user's part to study and understand the documentation
- Internal communication problems between users
- Lack of concentration on the part of the user
- Lack of organization and unsatisfactory or non-existent routines may also be important factors.

Other user related problem areas include:

- Revision implementation, when a large amount of data must be entered or changed in a short period of time. About two weeks after a revision all faults are usually remedied.
- New software implementation, when there is an insufficient amount of time set aside for testing.
- New function implementation, when there is an insufficient amount of time set aside for this work.
- Due to flexibility of the AXE switch system, there is little control of parameters entered in the system. Therefore, the system may accept incorrect data.

OTHER FAULTS

Although rare, there may also be various hardware problems that cause, for example, power failures.

HOW FAULTS AFFECT THE SYSTEM

Faults can cause anything from a small delay, which may not even be noticeable; to a several minute down period.

In addition, faults can cause various subscriber related problems, affecting both individuals or groups, for example, a common error known as a "hanging subscriber" locks the subscription. This can be caused by software problems resulting from, for example, an unpredictable action carried out by the subscriber.

PREVENTIVE MEASURES

Learning from previous mistakes helps reducing the number of future errors. To answer these questions each time an error occurs may be useful:

- What happened and why?
- Where did it happen and when?
- What kind of disturbance occurred?
- What needed to be done to restore normal traffic?
- What were the consequences?
- How many subscribers were affected?
- What were the reactions from the subscribers?

It is important to evaluate this information to reduce future system downtime and increase system dependability.

The preventive measures and activities, described below, may seem quite obvious. Nevertheless, they should be adhered to at all times to prevent problems.

AVAILABILITY OF CORRECT, UP-TO-DATE SYSTEM INFORMATION

Personnel must have access to correct and up-to-date system information. In addition, it is essential that users can easily access and retrieve the information required, since this may affect the ISP. The latest additions of User Documentation, Manuals, OPIs, etc., must be available and should be followed.

PRECISION DURING SWITCH MAINTENANCE

- Always follow the installation and maintenance procedures described in the manuals.
- Use the correct methods, spares, and tools and do it right the first time.
- Check for signs which may, in your opinion; influence the ISP, now or in the future.
- Use the correct MML-commands.

REGULAR OPERATIONAL REVIEWS

Formalize and carry out a continuous review of the operation. Errors should be compiled in a Trouble Report and the Trouble Report should be discussed regularly. The purpose of the discussion is to identify methods or ideas to reduce faults and improve the ISP, and to determine whether to forward specific Trouble Reports to Ericsson.

ISP AWARENESS

ISP awareness and understanding are vital.

This can be achieved by disseminating performance statistics information on a regular basis.

Look for items in the user interface that may be improved.

MARKET ANSWERING PERFORMANCE

Market Answering is continuously measured and involves not only the length of time needed to supply a solution to the customer, but also the accuracy and quality of the solution. Maintenance and troubleshooting are automatically improved when the customer service is improved.

EFFICIENT ERROR REPORTING

Ensure that the feedback system (Trouble Reports, Customer Service Request, etc.) is accurate and functions well. Establish reporting paths between the site and Ericsson to ensure accurate and timely reporting - via electronic media or Troubleshooting reports.

Collect and register all faults systematically. Compile and order collected data so that conclusions about errors can easily be drawn.

ISP MEETING FORUM

Conduct meetings where the users search for error sources and thoroughly discuss troubleshooting and faults.

USER TRAINING

An important factor in avoiding problems is adequate user training. Therefore, emphasize the importance of proper training.

CERTIFICATION AND QUALITY ASSURANCE

Routines for documentation handling and other administrative processes must be established.

ROOT CAUSE ANALYSIS (RCA)

It is very important to define the reason why an error occurred. Therefore, an RCA is mandatory for each fault

OTHER SUGGESTIONS

- When installing a new revision, allow time for testing all new software.
- Analyze any written corrections and Trouble Reports to avoid re-occurrence of the problem.
- Look for any activity that may have contributed to the problem at the time when the fault occurred.
- Examine whether the exchange was monitored in any other way than by the on-site staff, and determine if any conclusions can be drawn from this.
- Have a supply of spare PC boards at hand.

TROUBLE HANDLING

The trouble handling process is triggered by a fault in software, hardware, docware, etc. The fault may be caused by the switch staff, Ericsson personnel, when they, for example, enter new parameters, or it may be due to a failure in an electronic module. The customer reports problems using the Trouble Report Guidelines, if no other method has been agreed upon. To localize and correct a problem as quickly as possible, the report must be clear and concise, and it must include necessary data from the start.

This section describes the support organization, reporting procedure, and service agreements.

ERICSSON SUPPORT ORGANIZATION

The support organization can vary from market to market.

However, regardless of the structure and size of the organization, the primary task is to improve the ISP for the customer.

Normally, there is one Field Support Center (FSC) per customer. Some FSCs, however, handle more than one customer.

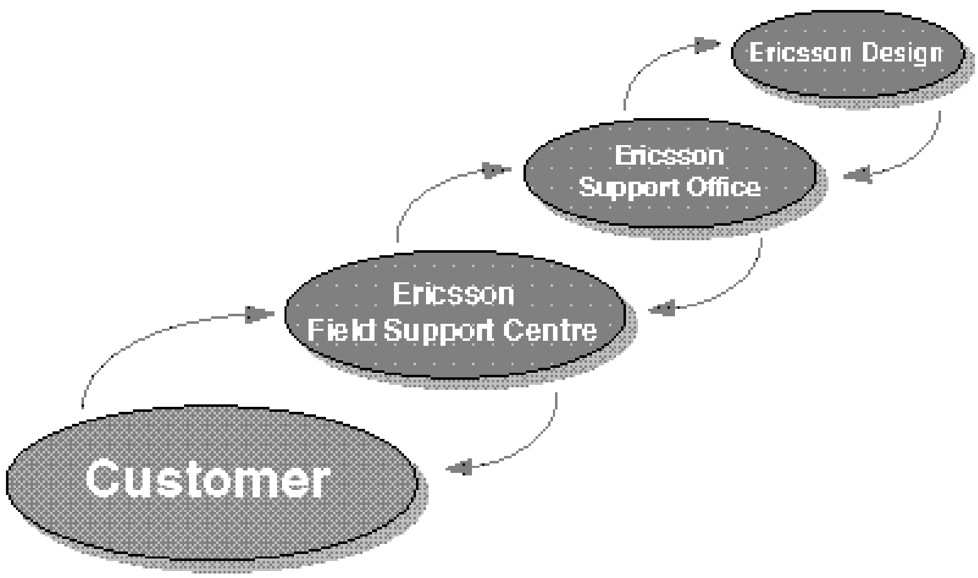

Figure C-1 Ericsson Support Organization.

RESPONDING TO THE CUSTOMER

The amount of turnaround time required to supply an answer to a reported problem is known as “Answering Time”.

This time duration is the sum of the lead times for FSC, Ericsson Support Office (ESO), and Ericsson’s PLM Design (the design office).

THE TROUBLE REPORT

The Trouble Report is used to channel fault information from the customer to Ericsson. It requires a written reply, and, therefore, an official tracking method is created.

It is a tool to report suspected or established faults in:

- Software
- Documentation
- Data transcript
- Parameters and hardware

Following are some general guidelines for completing the report:

- Follow the recommendations in the Trouble Report Guidelines. These are minimum requirements to produce a meaningful Trouble Report.
- Complete the Trouble Report directly after an error occurs as data/information may be lost as time goes by.
- Complete one Trouble Report per error or problem.
- Make sure that all information included is relevant to the reported problem. If there are any doubts, contact your internal support department.
- List names and telephone numbers of people involved.
- Create logs that contain the most common errors so that you can retrieve relevant commands.
- If it is not clear how to complete the Trouble Report, contact the FSC.

- It is essential to be as clear and concise as possible when filling out the report. If required data, descriptions, or enclosures are missing, it may be rejected. Experience shows that each report rejection causes the turnaround to be delayed by 20%.

The following three sections outline the information to be included in the report.

Administrative and Problem Data

Administrative data enables automatic routing of the Trouble Report through the Support/Design organizations.

As a minimum, the following information should be provided on the administrative form:

- Market reference, that is, the customer designation, name of person who created the Trouble Report, and the name of the customer's technician.
- Product/function suspected to be faulty.
- Error/problem consequences.
- Temporary emergency correction, if necessary.
- Enclosures, if any.

Priority Level

A Trouble Report can be assigned one of three (in some cases, two) priority levels. These are designated by the letters A, B, and C, where A-priority is the highest level and C-priority the lowest level. A-priority is, normally, an error that seriously affects a large number of subscribers, or a few subscribers for a long time. The lowest priority is used for minor errors, for example, in documentation.

The priority level can be changed by the customer. This is done mostly for commercial reasons, but can also be motivated for other reasons.

For a description of the priority levels, please refer to the Trouble Report Guidelines and the agreements with Ericsson.

Standard Headings

Standard Headings make it easier for the support staff to locate and recognize an error and use key word searching to detect similar errors.

The Exchange Designation is mandatory information to be entered under the heading TROUBLE LOCALIZATION.

In addition, a clear description of any events and actions already taken to remedy the problem must be given.

A description of the affect on traffic handling must be provided.

TROUBLE REPORT STRUCTURE

This is an example of how the Trouble Report should be completed:

HEADING:	Enter a summarized description of the problem here.
TROUBLE LOCALIZATION:	Here, specify administrative data including site designation, site status, designation of the faulty unit, priority code, and name of the user who entered the information.
INSERTED EMERGENCY CORRECTIONS:	Describe any emergency measures here.
TROUBLE EFFECT:	Specify problem consequences by entering information in the fields after these sub-headings.
TROUBLE DESCRIPTION:	If there are no enclosures, use these lines to describe the problem. If documents are enclosed for describing the trouble, only a summarized trouble description is given here.
TEMPORARY CORRECTIONS:	If the problem has been remedied by any temporary measures, describe these measures here. If the Trouble Report has already been supplied with a solution, enter the coding for this in the program PLEX.
ENCLOSURE INFORMATION ON FILE:	If there are any additional enclosures on file, enter the information here. Include where to find the information in the MHS-system. (This is Ericsson's internal system where all Trouble Reports are stored.) Enclosed information on paper should be avoided.

A history record page follows the headings. The following pages are used for specification of the Trouble Report answers. From the history record, it is possible to see when every event has taken place and the user ID of the person who performed the action.

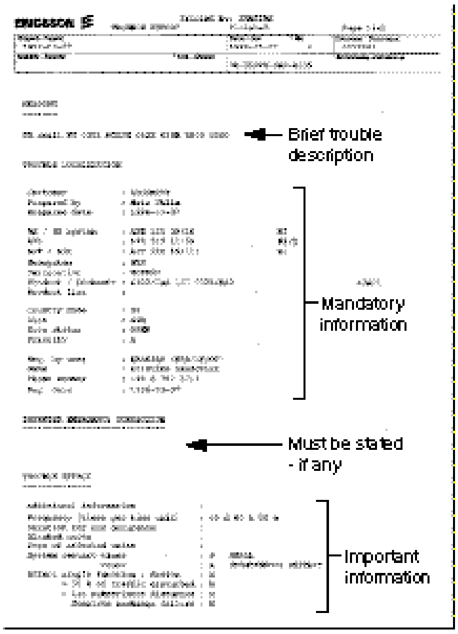

Figure C-2 Trouble Report, Page 1.

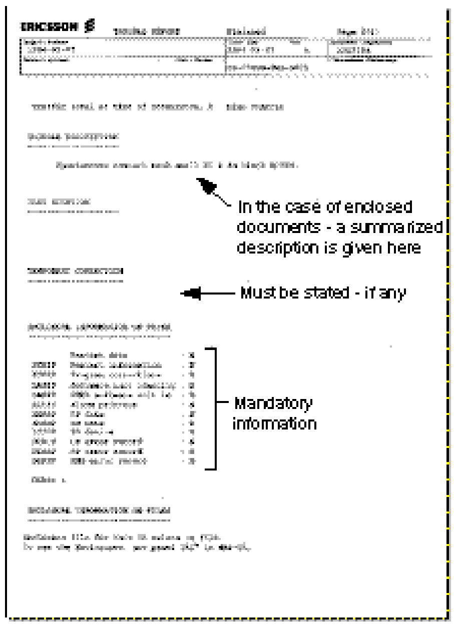

Figure C-3 Trouble Report, Page 2.

LEAD TIME FOR MARKET ANSWERING PERFORMANCE

Lead time for Market Answering is an important factor of the ISP. However, when the necessary information concerning the problem is available, it is also important to provide high quality in the answers and solutions.

Lead time is normally specified in the support contract. Response to customer inquiries is usually supplied by the FSC.

There are four different situations where different information is required. These are stated as follows:

First Situation

In case a problem has not been previously addressed by Ericsson, this information is required:

- Problem Description
- Problem Reason
- Any temporary measures used to solve the problem
- Correction Date
- Identity and date of the delivery package (supplied by the FSC)

Second Situation

If the problem has already been addressed, this information is required:

- A written Trouble Report regarding the problem, from the customer

Third Situation

If the problem does not require any further actions from Ericsson, this information is required:

- If a problem is not identified - explain why
- If no measures are taken - explain why

Fourth Situation

If the problem concerns possible new functions which are not included in the specifications:

- Refer to the appropriate marketing unit

SERVICE AGREEMENTS

Existing service agreements with basic service support can be combined with additional services to create tailor made customer support per customer.

The Procedure Manuals contain customer specific information, established in cooperation with the customer. This information specifies the handling routines for System Support Services, which have been contracted by the customer.

Customer specific information is, for example:

- Working procedures for various tasks
- Definitions
- Service descriptions
- Measurement specifications
- Description of various processes
- Performance statistics for system performance, if there is a System Performance agreement.
- Agenda for technical meetings
- Contact lists
- Organizational obligations

DEFINITIONS

One important measure for the ISP is system downtime. In this section, definitions and factors related to System Downtime are discussed.

NETWORK PERFORMANCE AND QUALITY OF SERVICE

ISP can be treated as a collective term used to describe Network Performance (NP) and Quality of Service (QoS) in more general situations.

Network Performance (NP) is the stated technical performance of the network that enables a telecommunications service user to receive the quality of service level, specified by the service provider.

The CCITT recommendation E800 defines Network Performances as:

"The ability of a network or a network portion to provide the functions related to communications between users".

Quality of Service (QoS) is a term used to state the level of a telecommunications service in user relevant and understandable terms.

The CCITT recommendation E800 defines it as:

" The collective effect of service performance which determines the degree of satisfaction of a user of the service".

The interconnection between NP and QoS is illustrated in the following graph.

ISP defined in broad terms as previously described is influenced by each individual square in the graph.

As shown, the graph consists of two parts, separated by a dashed line, the upper part represents the QoS and the lower represents the NP.

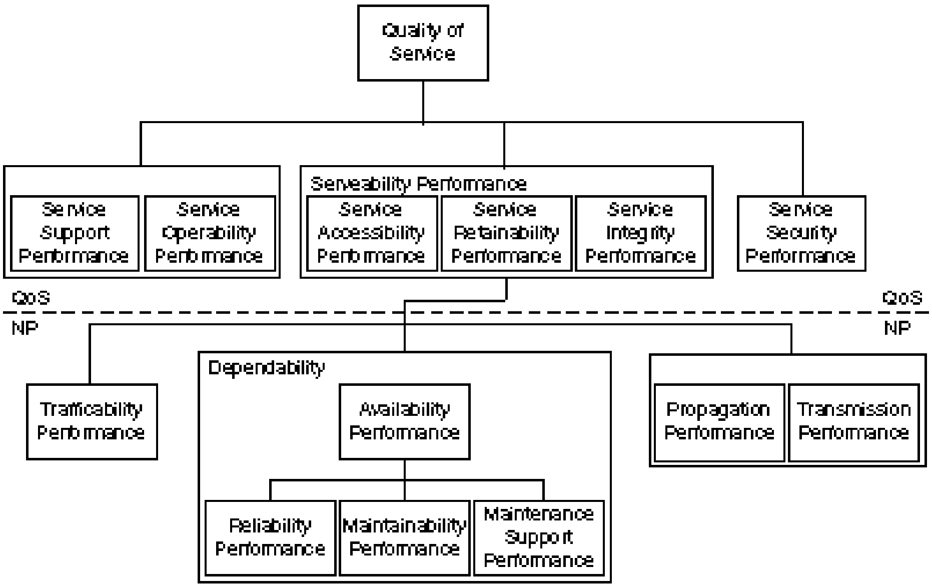

Figure C-4. Network Performance (NP) and Quality of Service (QoS).

The *Service Support Performance* is the contribution from, for example, the operator to the Quality of Service (QoS).

The *Service Operability Performance* is the ease by which the service can be used including characteristics of the terminal used, etc.

The *Serviceability Performance* is the ability of a service to be obtained under specified conditions. This concept is further divided into:

- *Service Accessibility Performance*

  that is, availability
- *Service Retainability Performance*

  that is, ability to avoid interruptions
- *Service Integrity Performance*

  that is, general performance

The Serviceability Performance can be further divided into:

- *Trafficability Performance*

  This is described in purely telecommunications engineering terms, for example, Grade Of Service

- *Dependability Performance*

  This relates to the ability of an item to be in a state to perform a required function.

- *Propagation Performance*

  This refers to the ability of the transmitting medium to transmit the signal within specifications.

- *Transmission Performance*

  This is the level of reproduction of a signal, offered to a telecommunication system under given conditions.

PRESENTATION OF STATISTICS

This figure is an example of how the operator should present average downtimes in minutes.

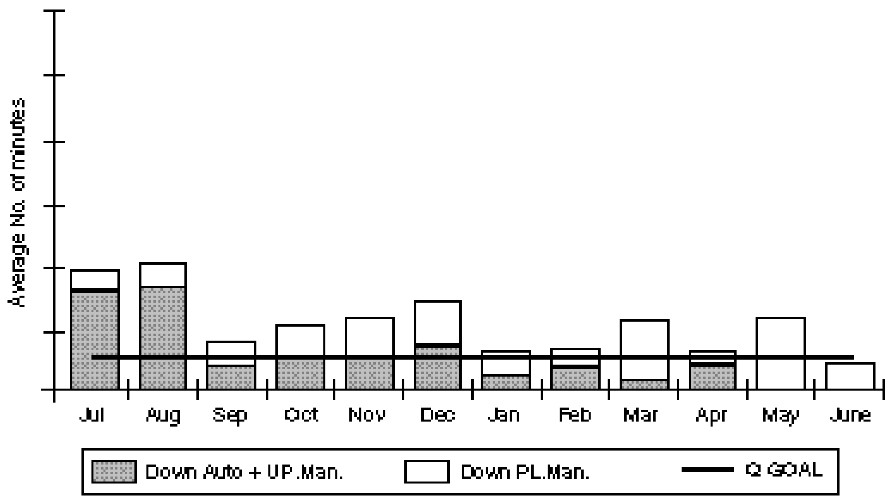

Figure C-5 MSC Downtime/Exchange 1995/96.

Statistics in this graph are compiled and shown in the form displayed on the next page.

This form illustrates a summary of NP and QoS. Predicting or measuring downtime per month for each different type of failure yields a performance survey that is important to both customer and operator.

	QUALITY OF

	NETWORK PERFORMANCES (Ericsson+Operator responsible)					SERVICE (Effects for the subscribers)		
	MSC and BSC network		**RBS Network**			**Total network**		**Loss of profit Operator**
Outage Area	Compl. Syst. F DT>20 min. $\mathbf{CSF_{NET}}$ *-MADT* *-NoE*	Major Syst. F DT<20 min. $\mathbf{MSF_{NET}}$ *-MADT* *-NoE*	Compl. Syst. F MTTR=4 hours $\mathbf{CSF_{RBS}}$ *-MADT* *-NoE*	Compl. Syst. F MTTR=4 hours $\mathbf{CSF_{SEC}}$ *-MADT* *-NoE*	Partial Syst. F MTTR= 4 hours $\mathbf{PSF_{TRU}}$ *-MADT* *-NoE*	Lost Call At- tempt **LCA** *-NoE* *-%*	Cut- offs **CSC** *-NoE* *-%*	Acc. Traffic Vol. **LTV** *-Erl-h* *-%*
MSC			-	-	-			
BSC			-	-	-			
RBS network	-	-						
TOTAL								

MADT Mean Accumulated Down Time in minutes/month

NoE Number of Events/month

DTDown Time per event

MTTR Mean Time To Restoration

In the table, the Mean Accumulated Downtimes (MADTs) caused by Complete System Failure (CSF), Major System Failure (MSF), and Partial System Failure (PSF) are given in minutes per month. In addition, the numbers of events for the period are shown.

Lost Call Attempts and Cut Offs are related to the total network. This gives a measure of the effects for the subscriber. The loss of Traffic Volume is related to the operator.

CAUSE OF FAILURES

The following 3-dimensional Figure illustrates downtimes with respect to Event Cause, Event Type, and Category. Any type of downtime can be described using a combination of these factors.

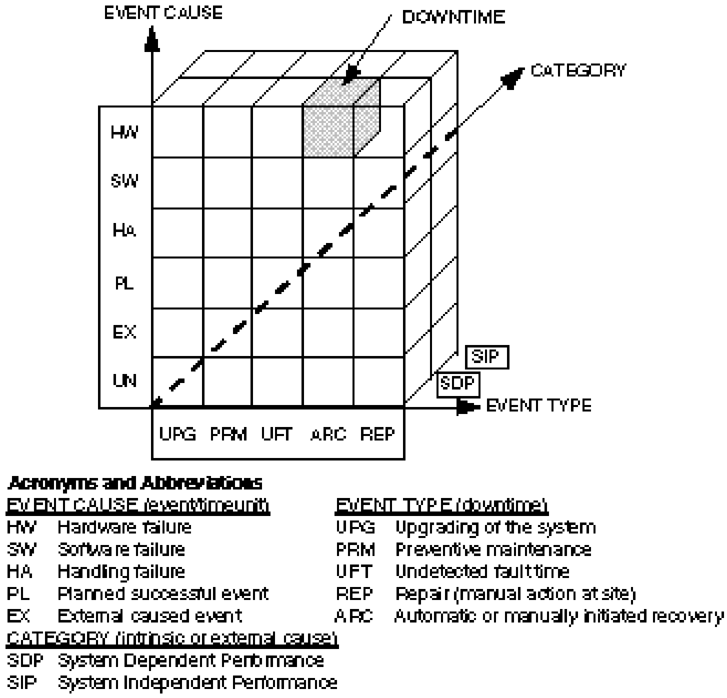

Figure C-6 Downtime with Respect to Event Cause, Event Type, and Category.

In popular terms, the goal of all ISP work is to implement various types of cost-effective measures which contribute to the reduction of the cube volume.

To be able to use operational statistics related to, for example, a Performance Agreement, it is necessary to classify events with respect to System DePendent (SDP) and System IndePendent (SIP) causes. These parameters are displayed on the axis, denominated “Category”.

FACTORS AFFECTING ISP

For an operator of a cellular network, the definition of ISP may be as follows:

ISP minus the operation costs equals the margin.

Thus, a high margin is obtained through a large difference between the ISP and operation costs.

In addition, it is possible to define the ISP as operation dependability or system availability, which, in turn, depends on three principal factors:

- Hardware
- Software
- Human factor

The hardware factor cannot be affected by the everyday user and is, therefore, not dealt with here.

The method or software, that is, how the user interface functions, is important and is a factor that is continuously improved.

The human factor, may be dependent on the user interface design (software), the documentation, as well as the skill/training level and the concentration level of the user. It may also depend on how thoroughly maintenance is carried out and how the administrative routines on the site function.

DOWNTIME

Exchange downtime occurs when the exchange does not handle any traffic.

This is a result of any of these events:

- Small restarts

  Calls in the set-up phase are cleared. Correctly verified calls in the speech position and semi-permanent (nailed-up) connections remain.

- Large restarts

  A large restart is the next higher restart rank. All calls are cleared. Semi-permanent connections remain, if they are correctly verified.

- Large restarts with reloads

  The highest restart rank is the large restart with reload. Memories are automatically reloaded. All calls and connections are cleared. Semi-permanent connections are automatically set up at the end of the large restart.

- Complete Exchange Fault (CEF). This is an event that requires manual action.

Total System Downtime also includes RBS faults and radio transmission problems.

DEPENDABILITY PERFORMANCE

“Dependability” is the term used to describe the availability performance and its influencing factors:

The requirements of the Availability comprise three factors:

- Reliability Performance
- Maintainability Performance
- Maintenance Support Performance

Different combinations of the three factors may result in the same Availability Performance.

An example is this cube that can have the same volume, that is, Availability Performance, but different combinations of side lengths.

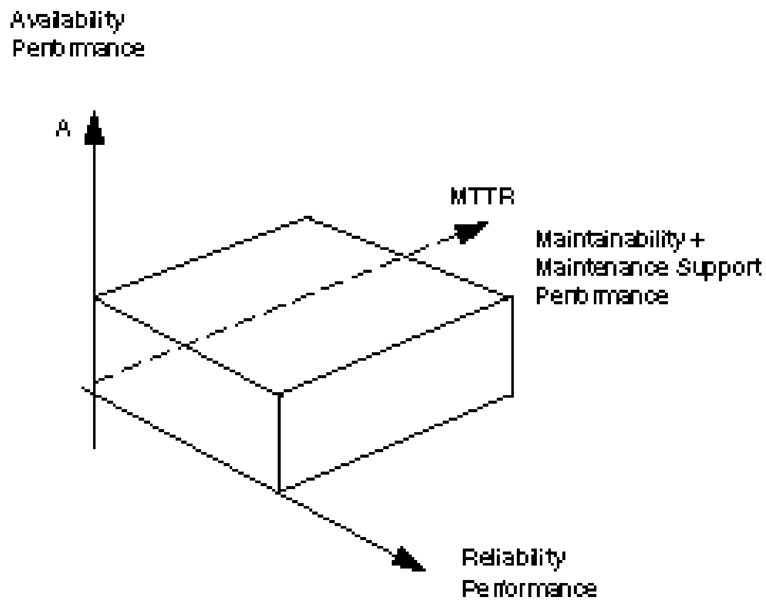

Figure C-7 Dependability Performance.

The availability describes the ability to be in a state to perform a required function under given conditions at a given instant of time, or over a given time interval, assuming that the required external resources are provided.

This ability depends on the combined aspects of reliability performance, maintainability performance, and maintenance support performance.

Availability can be expressed as

$$A = \frac{MTBF}{MTBF + MTTR}$$

where:

MTBF = Mean operating Time Between Failures

MTTR = Mean Time To Restoration

MTTR = MRT + MWT

MRT = Mean Repair Time

MWT = Mean Waiting Time

The statistical long term value for the unavailability time per year should normally be less than six minutes for total system faults.

ISP statistics are collected and reported each month for all systems.

Complete Exchange Failures (CEF) are also reported and are included in the total downtime figures.

Reliability Performance

This factor can be improved by adapting a design so that, for example, failure intensity, performance degradations, and environmental endurance are optimized.

Maintainability Performance

This factor can be improved by adapting a design so that the required support time is reduced, for example, by optimizing the physical accessibility and the built-in test and error indications.

Maintenance Support Performance

This factor can be improved by changing the support organization so that resources are available when needed and by optimizing the training of personnel, documentation, and answering times.

CUSTOMER SERVICE REQUEST (CSR)

The CSR is a customer inquiry intended for system support service. For trouble handling, the CSR is the overall concept which provides the interface between Ericsson and the customer.

In certain cases, a CSR may result in a Trouble Report. See the Figure below.

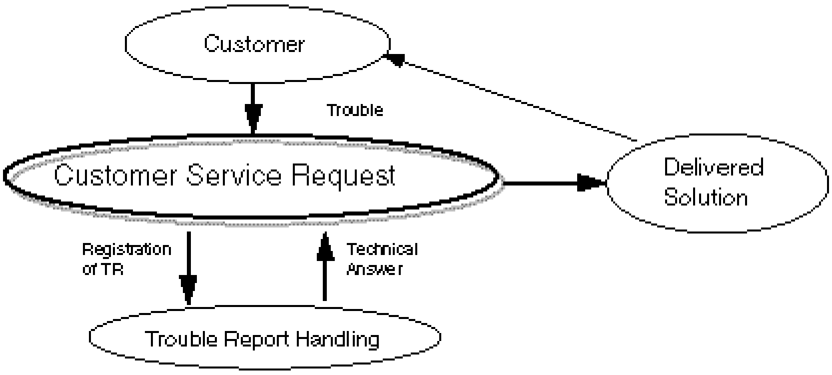

Figure C-8 Customer Service Request (CSR).