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GLOBAL SYSTEM FOR
MOBILE COMMUNICATIONS

**Digital cellular telecommunications system (Phase 2);
Network architecture
(GSM 03.02)**

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Foreword

This third edition draft European Telecommunication Standard (ETS) has been produced by the Special Mobile Group (SMG) Technical Committee of the European Telecommunications Standards Institute (ETSI), and is now submitted for the Unified Approval Phase (UAP) of the ETSI standards approval procedure.

This ETS defines the possible network architecture of a Public Land Mobile Network (PLMN) within the Digital cellular telecommunications system (Phase 2).

This ETS corresponds to GSM Technical Specification (GSM-TS) GSM 03.02 version 4.2.0.

Reference is made within this ETS to GSM-TSs (note).

Reference is also made within this ETS to GSM xx.xx. series. The specifications in the series can be identified, with their full title, within the normative reference Clause of this ETS by the first two digits of their GSM reference number e.g. GSM 09.xx-series, refers to GSM 09.01, GSM 09.02 etc.

NOTE: TC-SMG has produced documents which give the technical specifications for the implementation of the Digital cellular telecommunications system. Historically, these documents have been identified as GSM Technical Specifications (GSM-TSs). These TSs may have subsequently become I-ETSs (Phase 1), or ETSs (Phase 2), whilst others may become ETSI Technical Reports (ETRs). GSM-TSs are, for editorial reasons, still referred to in current GSM ETSs.

Proposed transposition dates	
Date of latest announcement of this ETS (doa):	3 months after ETSI publication
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1 Scope

The purpose of this third edition draft European Telecommunication Standard (ETS) is to present the possible architectures of the mobile system. Clause 3 of this ETS contains a definition of the different functional entities needed to support the mobile service. In clause 4, the configuration of a PLMN is described as well as the organisation of the functional entities; the configuration presented is the most general in order to cope with all the possible implementations which can be imagined in the different countries. To illustrate that purpose, some examples of possible configurations are presented. Clause 5 of this ETS contains a brief description of the interfaces involved which shows the principle of the organisation considered.

1.1 Normative references

This ETS incorporates by dated and undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this ETS only when incorporated in it by amendment or revision. For undated references, the latest edition of the publication referred to applies.

- [1] GSM 01.04 (ETR 100): "Digital cellular telecommunications system (Phase 2); Abbreviations and acronyms".
- [2] GSM 02.16 (ETS 300 508): "Digital cellular telecommunications system (Phase 2); International Mobile station Equipment Identities (IMEI)".
- [3] GSM 03.03 (ETS 300 523): "Digital cellular telecommunications system (Phase 2); Numbering, addressing and identification".
- [4] GSM 03.04 (ETS 300 524): "Digital cellular telecommunications system (Phase 2); Signalling requirements relating to routing of calls to mobile subscribers".
- [5] GSM 03.08 (ETS 300 526): "Digital cellular telecommunications system (Phase 2); Organisation of subscriber data".
- [6] GSM 03.09 (ETS 300 527): "Digital cellular telecommunications system (Phase 2); Handover procedures".
- [7] GSM 03.12 (ETS 300 530): "Digital cellular telecommunications system (Phase 2); Location registration procedures".
- [8] GSM 03.20 (ETS 300 534): "Digital cellular telecommunications system (Phase 2); Security related network functions".
- [9] GSM 04.02 (ETS 300 551): "Digital cellular telecommunications system (Phase 2); GSM Public Land Mobile Network (PLMN) access reference configuration".
- [10] GSM 08.01 (ETS 300 587-1): "Digital cellular telecommunications system (Phase 2); Base Station System - Mobile-services Switching Centre (BSS - MSC) interface General aspects".

- [11] GSM 08.02 (ETS 300 587-2): "Digital cellular telecommunications system (Phase 2); Base Station System - Mobile-services Switching Centre (BSS - MSC) interface Interface principles".
- [12] GSM 08.04 (ETS 300 588): "Digital cellular telecommunications system (Phase 1); Base Station System - Mobile-services Switching Centre (BSS - MSC) interface Layer 1 specification".
- [13] GSM 08.06 (ETS 300 589): "Digital cellular telecommunications system (Phase 2); Signalling transport mechanism specification for the Base Station System - Mobile-services Switching Centre (BSS - MSC) interface".
- [14] GSM 08.08 (ETS 300 590): "Digital cellular telecommunications system (Phase 2); Mobile Switching Centre - Base Station System (MSC - BSS) interface Layer 3 specification".
- [15] GSM 08.20 (ETS 300 591): "Digital cellular telecommunications system (Phase 2); Rate adaption on the Base Station System - Mobile-services Switching Centre (BSS - MSC) interface".
- [16] GSM 08.51 (ETS 300 592): "Digital cellular telecommunications system (Phase 2); Base Station Controller - Base Transceiver Station (BSC - BTS) interface General aspects".
- [17] GSM 08.52 (ETS 300 593): "Digital cellular telecommunications system (Phase 2); Base Station Controller - Base Transceiver Station (BSC - BTS) interface Interface principles".
- [18] GSM 08.54 (ETS 300 594): "Digital cellular telecommunications system (Phase 2); Base Station Controller (BSC) to Base Transceiver Station (BTS) interface Layer 1 structure of physical circuits".
- [19] GSM 08.56 (ETS 300 595): "Digital cellular telecommunications system (Phase 2); Base Station Controller (BSC) to Base Transceiver Station (BTS) Layer 2 specification".
- [20] GSM 08.58 (ETS 300 596): "Digital cellular telecommunications system (Phase 2); Base Station Controller (BSC) to Base Transceiver Station (BTS) interface Layer 3 specification".
- [21] GSM 08.60 (ETS 300 597): "Digital cellular telecommunications system (Phase 2); Inband control of remote transcoders and rate adaptors".
- [22] GSM 08.61 (ETS 300 598): "Digital cellular telecommunications system (Phase 2); Inband control of remote transcoders and rate adaptors (half rate)"
- [23] GSM 09.02 (ETS 300 599): "Digital cellular telecommunications system (Phase 2); Mobile Application Part (MAP) specification".
- [24] GSM 09.03 (ETS 300 600): "Digital cellular telecommunications system (Phase 2); Signalling requirements on interworking between the Integrated Services Digital Network (ISDN) or Public Switched Telephone Network (PSTN) and the Public Land Mobile Network (PLMN)".
- [25] GSM 09.04 (ETS 300 601): "Digital cellular telecommunications system (Phase 2); Interworking between the Public Land Mobile Network (PLMN) and the Circuit Switched Public Data Network (CSPDN)".

- [26] GSM 09.05 (ETS 300 602): "Digital cellular telecommunications system (Phase 2); Interworking between the Public Land Mobile Network (PLMN) and the Packet Switched Public Data Network (PSPDN) for Packet Assembly/Disassembly facility (PAD) access".
- [27] GSM 09.06 (ETS 300 603): "Digital cellular telecommunications system (Phase 2); Interworking between a Public Land Mobile Network (PLMN) and a Packet Switched Public Data Network/Integrated Services Digital Network (PSPDN/ISDN) for the support of packet switched data transmission services".
- [28] GSM 09.07 (ETS 300 604): "Digital cellular telecommunications system (Phase 2); General requirements on interworking between the Public Land Mobile Network (PLMN) and the Integrated Services Digital Network (ISDN) or Public Switched Telephone Network (PSTN)".
- [29] GSM 09.10 (ETS 300 605): "Digital cellular telecommunications system (Phase 2); Information element mapping between Mobile Station - Base Station System and BSS - Mobile-services Switching Centre (MS - BSS - MSC) Signalling procedures and the Mobile Application Part (MAP)".
- [30] GSM 09.11 (ETS 300 606): "Digital cellular telecommunications system (Phase 2); Signalling interworking for supplementary services".

2 Definitions and abbreviations

In addition to the abbreviations given in the remainder of this clause others are listed in GSM 01.04.

2.1 Location register

To establish a call to a mobile station the network must know where this mobile station is located. This information is stored in a function named location register.

2.1.1 Home Location Register (HLR)

The Home Location Register (HLR) is the location register to which a mobile subscriber is assigned for record purposes such as subscriber information.

2.1.2 Visitor Location Register (VLR)

The Visitor Location Register (VLR) is the location register, other than the HLR, used by an MSC to retrieve information for, e.g. handling of calls to or from a roaming mobile station currently located in its area.

2.2 Authentication Centre (AuC)

The Authentication Centre (AuC) is an entity which stores data for each mobile subscriber to allow the International Mobile Subscriber Identity (IMSI) to be authenticated and to allow communication over the radio path between the mobile station and the network to be ciphered. The AuC transmits the data needed for authentication and ciphering via the HLR to the VLR and MSC which need to authenticate a mobile station.

The procedures used for authentication and ciphering are described more fully in TS GSM 03.20.

2.3 Equipment Identity Register (EIR)

The Equipment Identity Register (EIR) in the GSM system is the logical entity which is responsible for storing in the network the International Mobile Equipment Identities (IMEIs), used in the GSM system.

The equipment is classified as "white listed", "grey listed", "black listed" or it may be unknown as specified in GSM 02.16 and GSM 09.02.

2.4 Mobile-services Switching Centre (MSC)

The Mobile-services Switching Centre (MSC) constitutes the interface between the radio system and the fixed networks. The MSC performs all necessary functions in order to handle the calls to and from the mobile stations.

In order to obtain radio coverage of a given geographical area a number of base stations are normally required; i.e. each MSC would thus have to interface several base stations. In addition several MSCs may be required to cover a country.

2.5 Public Land Mobile Network (PLMN)

A Public Land Mobile Network (PLMN) is established and operated by an administration or Recognized Private Operating Agency (RPOA) for the specific purpose of providing land mobile telecommunications service services to the public. A PLMN may be regarded as an extension of a network (e.g. ISDN); it is a collection of MSCs areas within a common numbering plan (e.g. same National Destination Code) and a common routing plan. The MSCs are the functional interfaces between the fixed networks and a PLMN for call set-up.

Functionally the PLMNs may be regarded as independent telecommunications entities even though different PLMNs may be interconnected through the ISDN/PSTN and PDNs for forwarding of calls or network information. A similar type of interconnection may exist for the interaction between the MSCs of one PLMN.

2.6 Cell

The cell is an area of radio coverage identified by a Base station identification as defined in TS GSM 03.03.

2.7 Base Station Controller (BSC) area

The Base Station Controller (BSC) area is an area of radio coverage consisting of one or more cells controlled by one BSC. The boundaries of a BSC area and a location area are independent; a location area may span the boundary between BSC area and a BSC area may span the boundary between location areas.

2.8 Location Area (LA)

The Location Area (LA) is defined as an area in which a mobile station may move freely without updating the location register. A location area may include one or several cells.

2.9 MSC area

The MSC area is the part of the network covered by an MSC. An MSC area may consist of one or several location areas. An MSC area may also consist of one or several BSC areas.

2.10 VLR area

The VLR area is the part of the network controlled by a VLR. A VLR area may consist of one or several MSC areas.

2.11 Zones for Regional Subscription

A PLMN operator may define a number of regional subscription areas, each of which is a subset of the service area for an unrestricted mobile subscriber. A regional subscription area may be contained within the service area of a single PLMN, or may lie within the service areas of two or more PLMNs. Each regional subscription area consists of one or more zones; each zone is contained within the service area of a PLMN.

The definition of a mobile subscriber's regional subscription area is stored within the HLR per National Destination Code(s) (NDC) of a PLMN and is transferred to the VLRs of that PLMN. The VLR evaluates this information to extract the restricted or accessible MSC areas and location areas to which the mobile subscriber is allowed to roam. The VLR informs the HLR if an entire MSC area is restricted.

Zones for Regional Subscription and their handling are defined in GSM 03.03, GSM 03.08 and GSM 09.02.

2.12 Service area

The service area is defined as an area in which a mobile subscriber can be reached by another (mobile or fixed) subscriber without the subscriber's knowledge of the actual location of the mobile station within the area. A service area may consist of several PLMNs. One service area may consist of one country, be a part of a country or include several countries. The location registration system associated with each service area must thus contain a list of all mobile stations located within that service area.

3 The entities of the mobile system

To provide the mobile service as it is defined, it is necessary to introduce some specific functions. These functional entities can be implemented in different equipments or gathered. In any case, exchanges of data occur between these entities.

3.1 The Home Location Register (HLR)

This functional entity is a data base in charge of the management of mobile subscribers. A PLMN may contain one or several HLRs: it depends on the number of mobile subscribers, on the capacity of the equipment and on the organisation of the network. Two kinds of information are stored there:

- the subscription information;
- some location information enabling the charging and routing of calls towards the MSC where the MS is located (e.g. the MS Roaming Number, the VLR address, the MSC address, the Local MS Identity).

Two types of number are attached to each mobile subscription and are stored in the HLR:

- the International Mobile Station Identity (IMSI);
- one or more Mobile Station International ISDN number(s) (MSISDN).

The IMSI or the MSISDN may be used as a key to access the information in the database for a mobile subscription.

The data base contains other information such as:

- teleservices and bearer services subscription information;
- service restrictions (e.g. roaming limitation);
- supplementary services; the HLR contains the parameters attached to these services.

NOTE: Supplementary services parameters need not all be stored in the HLR. However, it seems safer to store all subscription parameters in the HLR even when some are stored in a subscriber card.

The organisation of the subscriber data is outlined in TS GSM 03.08.

3.2 The Visitor Location Register (VLR)

A mobile station roaming in an MSC area is controlled by the Visitor Location Register in charge of this area. When a Mobile Station (MS) enters a new location area it starts a registration procedure. The MSC in charge of that area notices this registration and transfers to the Visitor Location Register the identity of the location area where the MS is situated. If this MS is not yet registered, the VLR and the HLR exchange information to allow the proper handling of calls involving the MS.

A VLR may be in charge of one or several MSC areas.

The VLR contains also the information needed to handle the calls set-up or received by the MSs registered in its data base (for some supplementary services the VLR may have to obtain additional information from the HLR) the following elements are included:

- the International Mobile Subscriber Identity (IMSI);
- the Mobile Station International ISDN number (MSISDN);
- the Mobile Station Roaming Number (MSRN), see TS GSM 03.03 for allocation principles;
- the Temporary Mobile Station Identity (TMSI), if applicable;
- the Local Mobile Station Identity (LMSI), if used;
- the location area where the mobile station has been registered. This data item will be used to call the station.

The information is passed between VLR and HLR by the procedures described in TS GSM 03.12.

The VLR also contains supplementary service parameters attached to the mobile subscriber and received from the HLR. The organisation of the subscriber data is outlined in TS GSM 03.08.

3.3 The Authentication Centre (AuC)

The Authentication Centre (AuC) is associated with an HLR, and stores an identity key for each mobile subscriber registered with the associated HLR. This key is used to generate:

- data which are used to authenticate the International Mobile Subscriber Identity (IMSI);
- a key used to cipher communication over the radio path between the mobile station and the network.

The procedures used for authentication and ciphering are described more fully in TS GSM 03.20.

The AuC communicates only with its associated HLR over an interface denoted the H-interface (see clause 5).

3.4 The Equipment Identity Register (EIR)

This functional entity contains one or several databases which store(s) the IMEIs used in the GSM system.

The mobile equipment may be classified as "white listed", "grey listed" and "black listed" and therefore may be stored in three separate lists.

An IMEI may also be unknown to the EIR.

An EIR shall as a minimum contain a "white list" (Equipment classified as "white listed").

3.5 The Mobile-services Switching Centre (MSC)

The Mobile-services Switching Centre is an exchange which performs all the switching and signalling functions for mobile stations located in a geographical area designated as the MSC area. The main difference between a MSC and an exchange in a fixed network is that the MSC has to take into account the impact of the allocation of radio resources and the mobile nature of the subscribers and has to perform in addition, at least the following procedures:

- procedures required for the location registration (see TS GSM 03.12);
- procedures required for handover (see TS GSM 03.09).

3.6 The Gateway MSC (GMSC)

If a network, delivering a call to the PLMN cannot interrogate the HLR, the call is routed to an MSC. This MSC will interrogate the appropriate HLR and then route the call to the MSC where the mobile station is located. The MSC which performs the routing function to the actual location of the MS is called the Gateway MSC (GMSC).

The acceptance of an interrogation to an HLR is the decision of the operator.

The choice of which MSCs can act as Gateway MSCs is for the operator to decide (i.e. all MSCs or some designated MSCs).

See also TS GSM 03.04.

3.7 SMS Gateway MSC (SMS-GMSC)

The SMS Gateway MSC (SMS-GMSC) acts as an interface between a Short Message Service Centre and the PLMN, to allow short messages to be delivered to mobile stations from the Service Centre (SC).

3.8 SMS Interworking MSC

The SMS Interworking MSC acts as an interface between the PLMN and a Short Message Service Centre (SC) to allow short messages to be submitted from Mobile Stations to the SC.

3.9 The Interworking Function (IWF)

The Interworking Function (IWF) is a functional entity associated with the MSC. The IWF provides the functionality necessary to allow interworking between a PLMN and the fixed networks (ISDN, PSTN and PDNs). The functions of the IWF depend on the services and the type of fixed network. The IWF is required to convert the protocols used in the PLMN to those used in the appropriate fixed network. The IWF may have no functionality where the service implementation in the PLMN is directly compatible with that at the fixed network. The interworking functions are described in GSM Technical Specifications 09.04, 09.05, 09.07 and 09.09.

3.10 The Base Station System (BSS)

The Base Station System (BSS) is the system of base station equipments (transceivers, controllers, etc...) which is viewed by the MSC through a single A-interface as being the entity responsible for communicating with Mobile Stations in a certain area. The radio equipment of a BSS may support one or more cells. A BSS may consist of one or more base stations. Where an Abis-interface is implemented. The BSS consists of one Base Station Controller (BSC) and one or more Base Transceiver Station (BTS). The functionality is described in TS GSM 08.02.

A Base Station Controller (BSC) is a network component in the PLMN with the functions for control of one or more BTS.

A Base Transceiver Station (BTS) is a network component which serves one cell.

The split of functions between BSS and MSC is described in the 08-series of GSM Technical Specifications.

3.11 The Mobile Station (MS)

The mobile station consists of the physical equipment used by a PLMN subscriber; it comprises the Mobile Equipment (ME) and the Subscriber Identity Module (SIM). The ME comprises the Mobile Termination (MT) which, depending on the application and services, may support various combinations of Terminal Adapter (TA) and Terminal Equipment (TE) functional groups. These functional groups are described in TS GSM 04.02.

4 Configuration of a Public Land Mobile Network

4.1 General

The basic configuration of a Public Land Mobile Network and the interconnection to the PSTN/ISDN are presented in figure 1. This configuration presents signalling interfaces which can be found in a PLMN. Implementations may be different: some particular functions may be gathered in the same equipment and then some interfaces may become internal interfaces.

4.2 Basic configuration

In the basic configuration presented in figure 1, all the functions are considered implemented in different equipments. Therefore, all the interfaces within PLMN are external. Interfaces A and Abis are defined in the GSM 08-series of Technical Specifications. Interfaces B, C, D, E, F and G need the support of the Mobile Application Part of the signalling system No. 7 to exchange the data necessary to provide the mobile service. No protocol for the H-interface is standardized. From this configuration, all the possible PLMN organisations can be deduced. In the case when some functions are contained in the same equipment, the relevant interfaces become internal to that equipment.

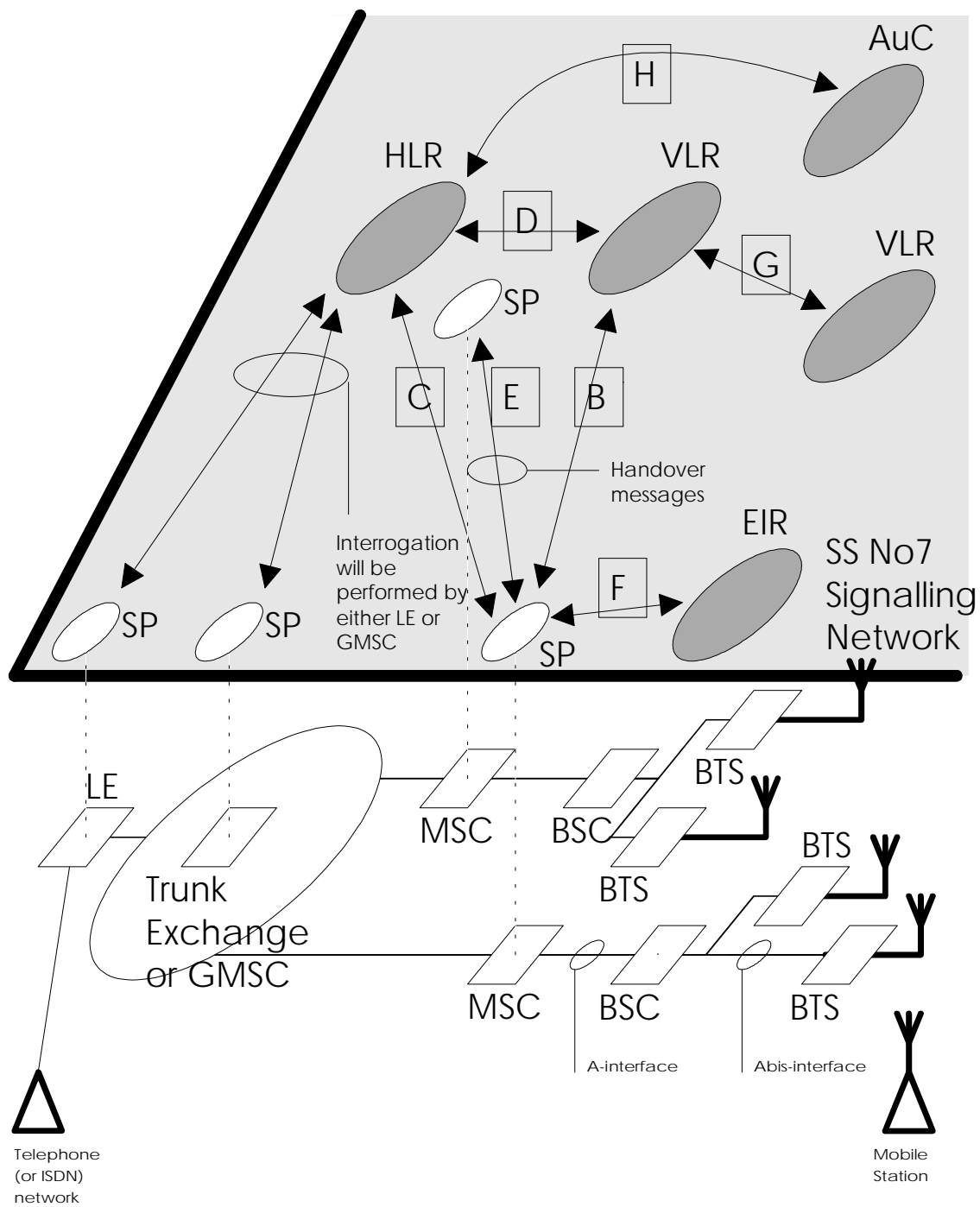


Figure 1: Configuration of a PLMN and interfaces

5 PLMN interfaces

5.1 General

The implementation of the mobile service with international roaming implies the exchange of data between the equipments involved in the service. The same No.7 signalling network should be used to transfer these data and the call-related signalling information. To transfer these data, the Mobile Application Part will use the Transaction Capabilities. See TS GSM 09.02.

5.2 Interface between the MSC and Base Station System (A-interface)

The interface between the MSC and its BSS is specified in the 08-series of GSM Technical Specifications.

The BSS-MSC interface is used to carry information concerning:

- BSS management;
- call handling;
- mobility management.

5.3 Interface between BSC and BTS (Abis-interface)

When the BSS consists of a Base Station Controller (BSC) and one or more Base Transceiver Stations (BTS), this interface is used between the BSC and BTS to support the services offered to the GSM users and subscribers.

The interface also allows control of the radio equipment and radio frequency allocation in the BTS.

The interface is specified in the 08.5x-series of GSM Technical Specifications.

5.4 Interface between the MSC and its associated VLR (B-interface)

The VLR is the location and management data base for the mobile subscribers roaming in the area controlled by the associated MSC(s). Whenever the MSC needs data related to a given mobile station currently located in its area, it interrogates the VLR. When a mobile station initiates a location updating procedure with an MSC, the MSC informs its VLR which stores the relevant information. This procedure occurs whenever an MS roams to another location area. Also, when a subscriber activates a specific supplementary service or modifies some data attached to a service, the MSC informs (via the VLR) the HLR which stores these modifications and updates the VLR if required.

5.5 Interface between the HLR and the MSC (C-interface)

The Gateway MSC must interrogate the HLR of the required subscriber to obtain routing information for a call or a short message directed to that subscriber.

5.6 Interface between the HLR and the VLR (D-interface)

This interface is used to exchange the data related to the location of the mobile station and to the management of the subscriber. The main service provided to the mobile subscriber is the capability to set up or to receive calls within the whole service area. To support this, the location registers have to exchange data. The VLR informs the HLR of the location of a mobile station managed by the latter and provides it (either at location updating or at call set-up) with the roaming number of that station. The HLR sends to the VLR all the data needed to support the service to the mobile subscriber. The HLR then instructs the previous VLR to cancel the location registration of this subscriber. Exchanges of data may occur when the mobile subscriber requires a particular service, when he wants to change some data attached to his subscription or when some parameters of the subscription are modified by administrative means.

5.7 Interface between MSCs (E-interface)

When a mobile station moves from one MSC area to another during a call, a handover procedure has to be performed in order to continue the communication. For that purpose the MSCs have to exchange data to initiate and then to realise the operation.

After the handover operation has been completed, the MSCs will exchange information to transfer A-interface signalling as necessary.

When a short message is to be transferred between a Mobile Station and Short Message Service Centre (SC), in either direction, this interface is used to transfer the message between the MSC serving the Mobile Station and the MSC which acts as the interface to the SC.

5.8 Interface between MSC and EIR (F-interface)

This interface is used between MSC and EIR to exchange data, in order that the EIR can verify the status of the IMEI retrieved from the Mobile Station.

5.9 Interface between VLRs (G-interface)

When a mobile subscriber moves from a VLR area to another Location Registration procedure will happen. This procedure may include the retrieval of the IMSI and authentication parameters from the old VLR.

5.10 Interface between HLR and AuC (H-Interface)

When an HLR receives a request for authentication and ciphering data for a Mobile Subscriber and it does not hold the requested data, the HLR requests the data from the AuC. The protocol used to transfer the data over this interface is not standardized.

5.11 Interface between Mobile Station and Base Station System (Um-interface)

The interface between the MS and the BSS is specified in the 04- and 05-series of GSM Technical Specifications.

6 Interface between the fixed networks and the MSC

The MSC is based on a normal ISDN exchange. It has, for call control, the same interface as the fixed network exchanges. The signalling interface considered in the GSM Technical Specifications is related to the signalling system No. 7 User Parts TUP and ISUP associated to the circuits used for incoming and outgoing calls.

The interfaces with fixed networks, including dedicated networks, are described in the 09-series of GSM Technical Specifications.

History

Document history			
September 1994	First Edition		
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