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PREFATORY NOTE

ETSI has constituted stable and consistent documents which give specifications for the implementation of the European Cellular Telecommunications System. Historically, these documents have been identified as "GSM recommendations".

Some of these recommendations may subsequently become Interim European Telecommunications Standards (I-ETSs) or European Telecommunications Standards (ETSs), whilst some continue with the status of ETSI-GSM Technical Specifications. These ETSI-GSM Technical Specifications are for editorial reasons still referred to as GSM recommendations in some current GSM documents.

The numbering and version control system is the same for ETSI-GSM Technical Specifications as for "GSM recommendations".

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1. SCOPE

The purpose of this Recommendation is to present the possible architectures of the mobile system. The first section of this Recommendation contains a definition of the different functional entities needed to support the mobile service. In a second section, 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. The last section of this recommendation contains a brief description of the interfaces involved which shows the principle of the organisation considered.

2. GENERAL DEFINITIONS

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.

A mobile subscriber is registered at one location register which functions as it home centre for charging and billing purposes and for administering its subscriber parameters such as category.

2.2 Home Location Register (HLR)

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

2.3 Visitor Location Register (VLR)

The Visitor location Register 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.

2.4 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 RPOA for the specific purpose of providing land mobile telecommunication service services to the public. A Public Land Mobile Network 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 Recommendation GSM 03.03.

2.7 Location Area

The Location Area 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.

2.8 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.

2.9 Service Area

The Service Area is defined as an area in which a mobile station is obtainable by a 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

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 kind of information are stored there:

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

All the administrative interventions occur on this data base. This data base is used for routing of calls to mobile subscribers managed by this HLR. The HLRs have no direct control of MSCs.

Two numbers are attached to each mobile subscription and are stored in the HLR:

- the International Mobile Station Identity (IMSI) (1)
- the Mobile Station International ISDN number (MSISDN)

The data base contains other information such as:

- teleservices and bearer services subscription information
- service restrictions (e.g. roaming limitation)
- supplementary services; the tables contain the parameters attached to these services. (1)
- when applicable (e.g. for MSs with built-in identity), the characteristics of the mobile equipment used by the subscriber. (2)

(1) 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.

(2) Note: For those subscribers using a "smart card" to operate any card-operated MS, the characteristics of the mobile equipment cannot be stored in the HLR. The relevant data can then be transferred to the VLR when the subscriber inserts the card in a mobile equipment.

The organisation of the subscriber data is detailed in Recommendation GSM 03.08.

3.2 The Visitor Location Register

A mobile station roaming in an MSC area is controlled by the Visitor Location Register in charge of this area. When a mobile station appears in a 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 passes information to the HLR which will enable routing of calls to the MS via the fixed network.

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): in its tables the following elements are included:

- the IMSI
- the Mobile Station International ISDN number (MSISDN)
- the Mobile Station Roaming Number. This number is allocated to the MS either when the station is registered in an MSC area or on a per call basis. It is used to route the incoming calls to that station. See Annex 1 for allocation principles.
- the Temporary Mobile Station Identity, if applicable
- the Local Mobile Station Identity, if used.
- the location area where the mobile station has been registered. This data will be used to call the station.

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

In the tables, data can also be found which is attached to the subscriber and the mobile station and given either by the HLR or directly by the mobile subscriber (see above):

- supplementary service parameters
- possibly technical characteristics of the mobile equipment.

The organisation of the subscriber data is detailed in Recommendation GSM 03.08.

3.3 The Mobile Services Switching Centre

The Mobile Services Switching Centre is an exchange which performs all the switching 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 Recommendation GSM 03.12)
- procedures required for hand-over (see Recommendation GSM 03.09)

3.4 The Base Station System

The Base Station (BSS) is the system of Base Station equipments (transceivers, controllers, etc...) which is in 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 sustain one or more cells. A BSS may consist of one or more base stations. Where an A-bis interface is implemented, it shall consist of one Base Station Controller (BSC) and several Base Transceiver Station (BTS). The functionality is described in Recommendation GSM 08.02.

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

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

The split of functions between BS and MSC is described in the 08 series of GSM Recommendations.

3.5 The Gateway MSC

In the case of incoming calls to the PLMN, if the fixed network is unable to 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 then the routing function to the actual location of the MS is called the Gateway MSC.

The choice of which MSCs can act as Gateway MSCs is a national matter (e.g. all MSCs or some designated MSCs, ...)

See also Recommendation GSM 03.04.

3.6 The Interworking Function IWF

The interworking function 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 Recommendations 09.04, 09.05, 09.07, 09.08.

3.7 The Mobile Station

The mobile station consists of the physical equipment used by a PLMN subscriber, it includes the Mobile Termination (MT) and, depending on the application and services, supports various combination of Terminal Adapter (TA) and Terminal Equipment (TE) functional groups. These functional groups are described in GSM Recommendation 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 all possible signalling interfaces which can be found in any PLMN. The specific implementation in each country may be different: some particular functions may be gathered in the same equipment and then some interfaces may become internal interfaces. To illustrate this implementation possibility 2 examples of configuration are presented in figures 2 and 3. In any case the configuration of a PLMN must have no impact on the relationship with the other PLMNs.

4.2 Basic configuration (figure 1)

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 and need the support of the Mobile Application Part of the signalling system No. 7 to exchange the data necessary to provide the mobile service. 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.

4.3 Configuration NO 2: The Visitor Location Register is collocated with an MSC (figure 2)

The main type of data stored in the Visitor Location Register is the practical location information (i.e. the location area) which has to be updated by the MSC when the MS moves from one location area to another. Also, when a call is set-up by a mobile station, the MSC has to interrogate the VLR in order to know the parameters of the subscriber (e.g. restrictions, supplementary services...). Therefore, a significant message traffic exists between these two entities. It seems therefore rather logical to assume that these two functions can be gathered in the same equipment.

The data contained in the VLR can be compared with the subscriber related data contained in a normal fixed exchange; the location information can be compared with the line equipment reference attached to each fixed subscriber connected to that exchange.

4.4 Configuration NO 3: Both location registers are collocated with the MSCs (figure 3)

It can be envisaged that both the Home Location Register and the Visited Location Register are implemented in the same equipment as an MSC.

In this case, the MSC performs also the call handling function for all the subscribers managed by its Home Location Register when they are located in its area. The set-up of the connection to these subscribers is done by using only the international ISDN number and no roaming number is allocated to these mobile stations.

5. INTERCONNECTION BETWEEN PLMNS

Since the configuration of a PLMN does not have any impact on other PLMNs, the signalling interfaces specified can be implemented both between the entities within a PLMN and between different PLMNs with or without an intermediate interface equipment which provides a gateway function at the application level. A specific interconnection with a PLMN gateway may appear if the organisation of a PLMN does not comply with the specifications: in this particular case the interconnection interface is used to mask, from the remote PLMNs, a national configuration which is not in line with the international specifications. The difference in the interface may be found at the lower level (SCCP) since the signalling networks involved in the exchanges of messages are at least independent with respect to the addressing plans.

6. PLMN INTERFACES

6.1 General

The implementation of the mobile service with international roaming implies the exchange of data between the equipments involved in the service. The same network can be used to transfer these data and the call-related signalling information. The introduction of the N0 7 signalling system and its signalling network will be an opportunity to transfer the data needed to support the mobile service. Where applicable, the N0 7 signalling system should be used to convey the information. To transfer these data, the Mobile Application Part will be supported by the Transaction Capabilities Application Part. See Recommendation GSM 09.02.

6.2 Interface between the HLR and the VLR (interface D)

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 on the location of a mobile station managed by the latter and provides it with the roaming number of that station. The HLR sends to the VLR all the data needed to support the service to the mobile station. The HLR calls then the previous VLR to inform it that it can cancel the location registration of this station because of the roaming of the MS. 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.

6.3 Interface between the MSC and its associate VLR (interface B)

The VLR is the location and management data base for the mobile stations roaming in the area controlled by the associated MSCs. 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 in its tables. 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 the VLR which stores these modifications and updates the HLR if required.

6.4 Interface between the HLR and the MSC (interface C)

At the end of a call for which the mobile subscriber has to be charged, the MSC of this MS may send a charging message to the HLR.

When the fixed network is not able to perform the interrogation procedure needed to set-up a call to a mobile subscriber, the Gateway MSC must interrogate the HLR of the called subscriber to know the roaming number of the called MS.

6.5 Interface between MSCs for hand-over (interface E)

When a mobile station moves from one MSC area to another during a call, a hand-over 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.

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

The specification of the interface between the MSC and its BSS is specified in the 08 series of GSM Recommendations.

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

- BSS management
- call handling
- mobility management

6.7 Interface between Mobile Station and Base Station System

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

7. INTERFACES WITH THE FIXED NETWORKS

7.1 Interface between an exchange of a fixed network and an HLR

When a subscriber wants to set up a call towards a mobile station, his exchange, analysing the number dialled, detects that it has to perform specific procedures in order to know the actual routing address of the called subscriber. According to the ISDN number of the mobile subscriber, the originating exchange performs the interrogation procedure with the HLR of this MS. As an answer of this interrogation, the HLR gives the roaming number allocated by the VLR to that MS: according to that address, the originating exchange can set-up the connection to the actual location of the MS, i.e. the MSC where the MS has been registered.

This interrogation procedure may occur from a transit exchange if the local exchange of the calling subscriber is not able to provide such a facility.

This procedure is described in Recommendation GSM 03.04.

7.2 Interface between the fixed networks and the MSC

The MSC is integrated in the ISDN as any normal fixed ISDN exchange. It has, for call set-up, the same interface as the fixed network exchanges. The signalling interface considered in the GSM Recommendations is related to the signalling system No. 7 User Parts TUP and ISUP associated to the circuits used for the calls set-up or received.

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

8. NETWORK ARCHITECTURE FOR THE SHORT MESSAGE SERVICE

The short message service uses the basic architecture above with some additions as specified in Recommendation GSM 03.40.

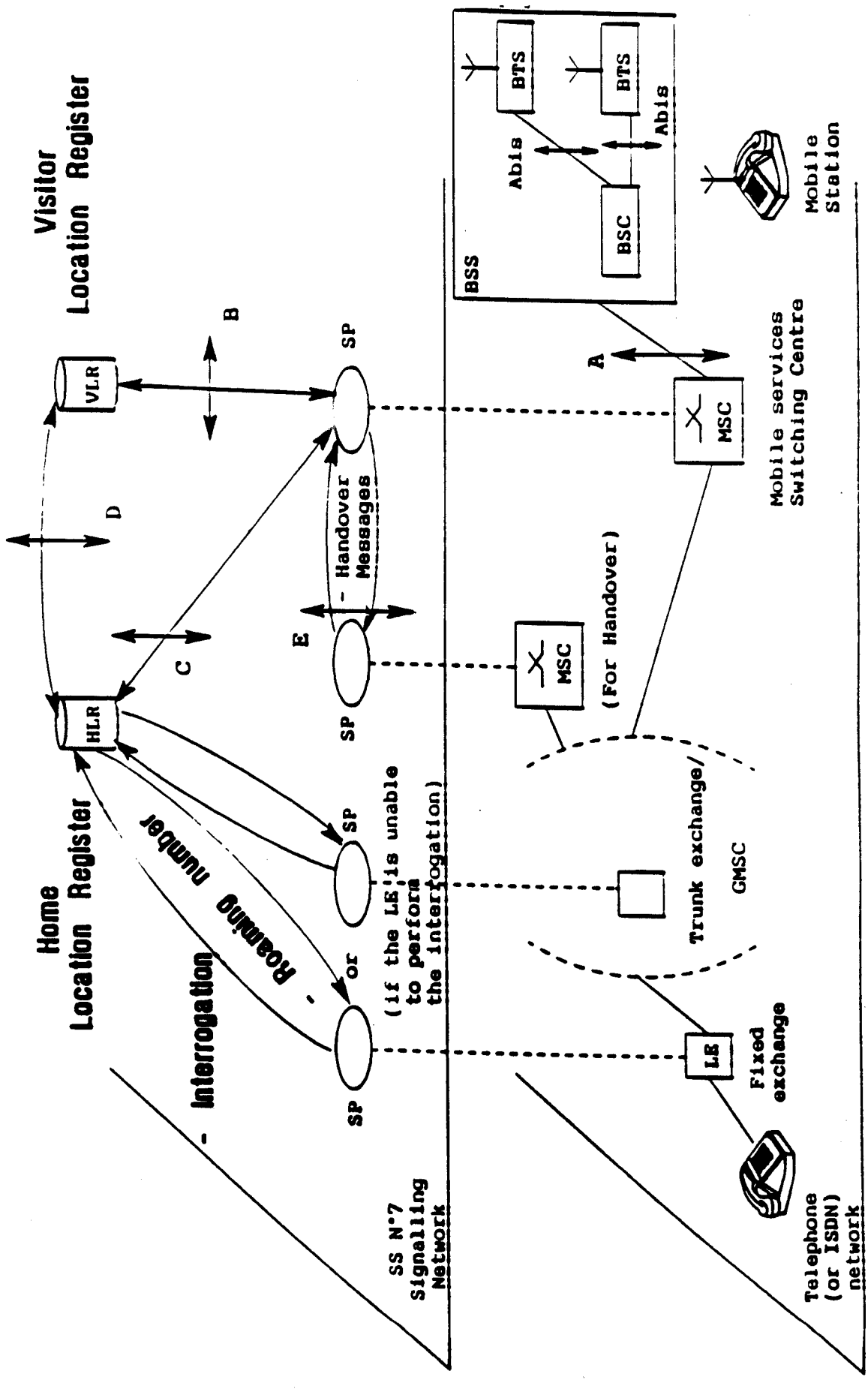

FIGURE GSM 03.02/1 : Configuration of a PLMN and interfaces

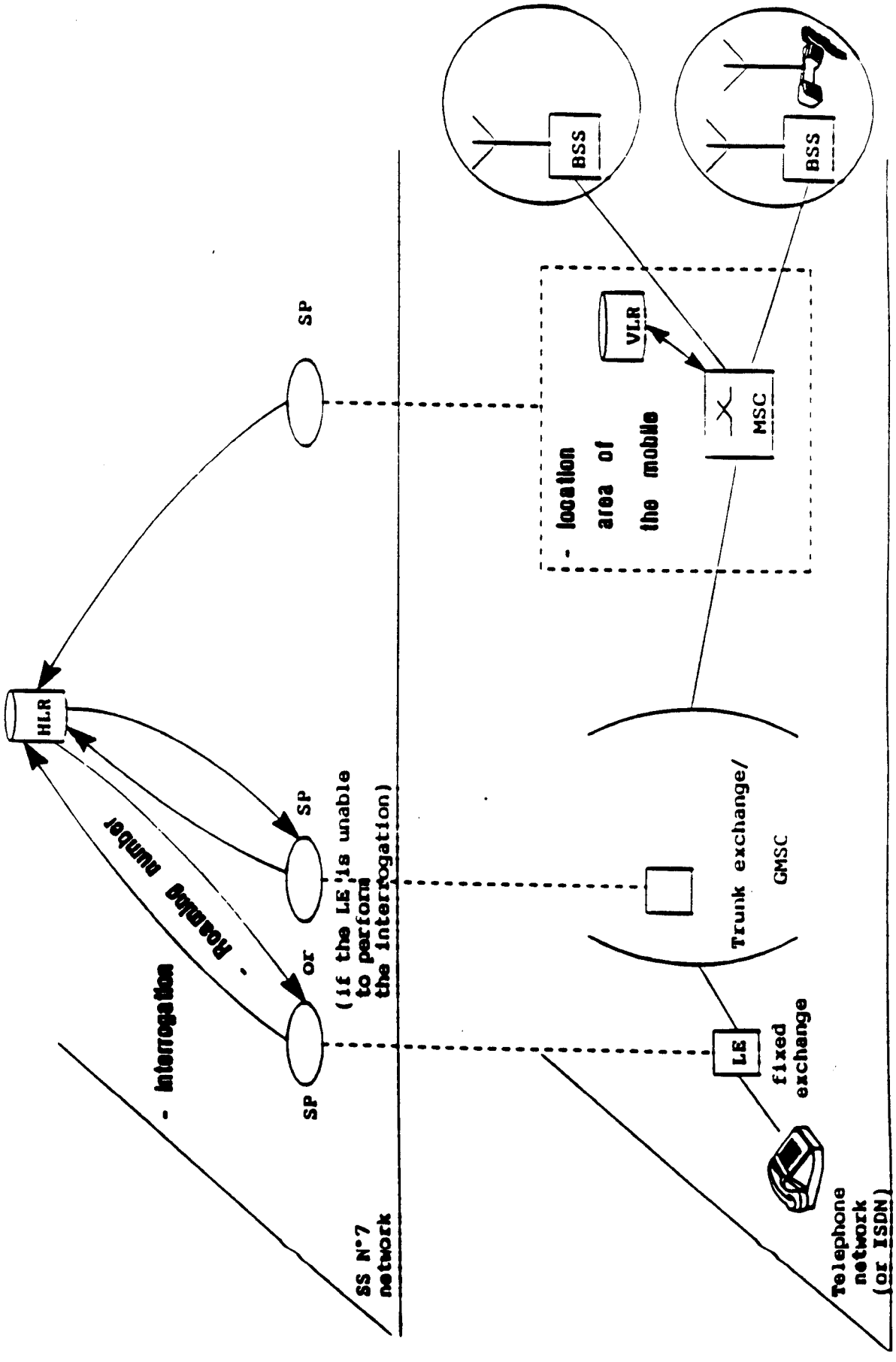

FIGURE GSM 03.02/2

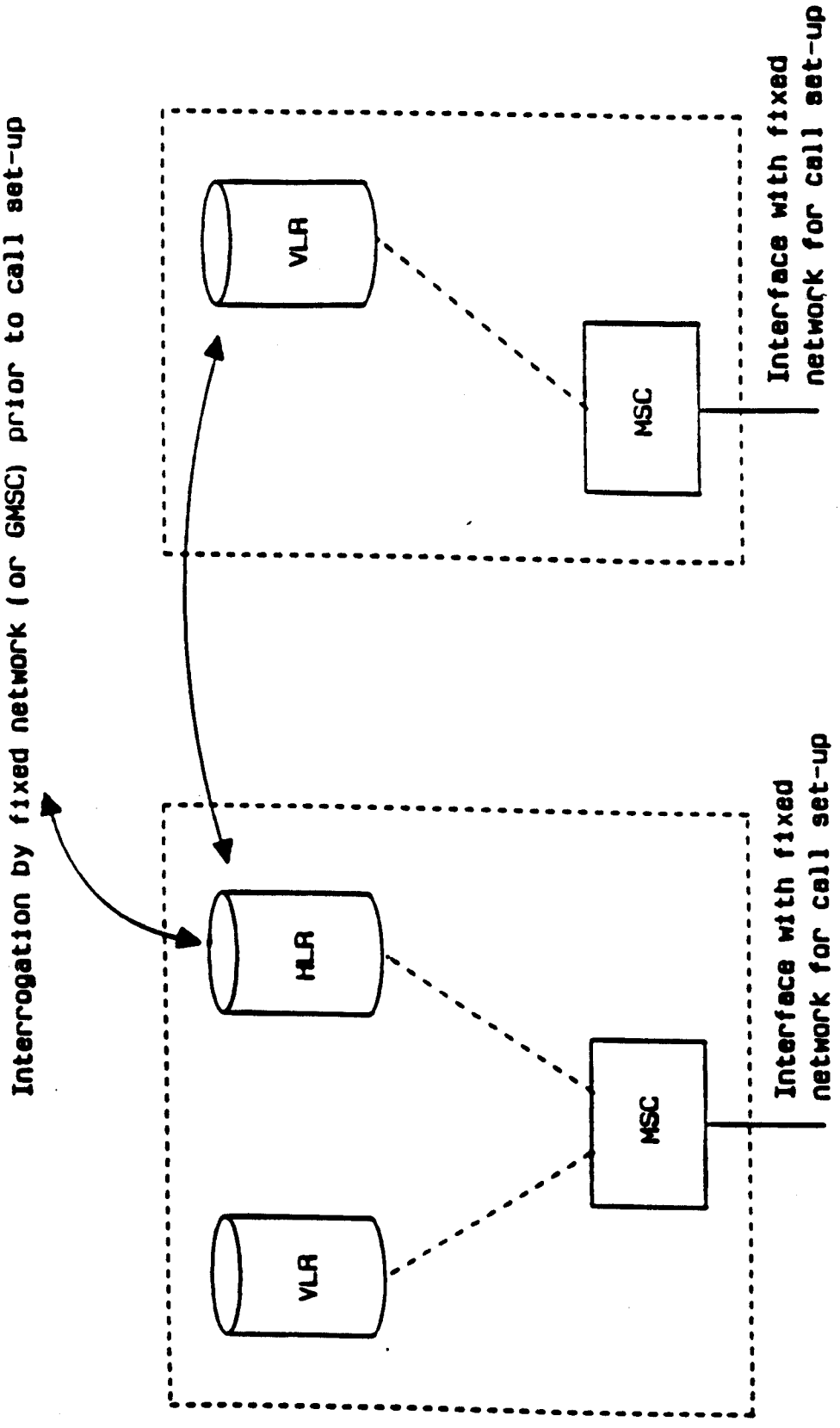

Figure GSM 03.02/3

ANNEX 1

Allocation of the Mobile Subscriber Roaming Number (MSRN)

Two alternatives are available for assigning the MSRN to a roamed MS. These are:

Alternative 1 Assign an MSRN in the visited network upon initial registration or location updating and pass this to the HLR for routing calls to the MS;

Alternative 2 Assign an MSRN in the visited network upon demand by the HLR on a per call basis.

1. VLRs may use either alternative 1 or alternative 2 at the option of the PLMN operator.

2. In the case of a call to a mobile station roaming in a VPLMN where alternative 1 is used, its HLR may perform the interrogation or not.

3. In the case of a call to a mobile station roaming in a VPLMN where alternative 2 is used its HLR will perform the interrogation of the VLR in all cases.

4. The reset message must be correctly handled by all HLRs and VLRs receiving it, according to Recommendation GSM 03.07.