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CHAPTER 5

GSM Architecture and Interfaces

5.1 INTRODUCTION

In this chapter we present an overview of the GSM as described in ETSI's recommendations. The chapter discusses GSM frequency bands, the GSM Public Land Mobile Network (PLMN) and its objectives and services, GSM architecture and GSM subsystem entities, interfaces, and protocols between GSM entities. We address the mapping between GSM protocols and OSI layers and present the architecture of the North American PCS-1900.

5.2 GSM FREQUENCY BANDS

The GSM system is a frequency- and time-division system; each physical channel is characterized by a carrier frequency and a time slot number. GSM system frequencies include two bands at 900 MHz and 1800 MHz commonly referred to as the GSM-900 and DCS-1800 systems. For the primary band in the GSM-900 system, 124 radio carriers have been defined and assigned in two sub-bands of 25 MHz each in the 890–915 MHz and 935–960 MHz ranges, with channel widths of 200 kHz. Each carrier is divided into frames of 8 time slots (for full rate), with a frame duration of about 4.6 ms. For DCS-1800, there are two sub-bands of 75 MHz in the 1710–1785 MHz and 1805–1880 MHz ranges.

5.3 GSM PLMN

ETSI originally defined GSM as a European digital cellular telephony standard. GSM interfaces defined by ETSI lay the groundwork for a multivendor network approach to digital mobile communication. Figure 5.1 shows a GSM PLMN.

GSM offers users good voice quality, call privacy, and network security. SIM cards provide the security mechanism for GSM. SIM cards are like credit cards and identify the user to the GSM network. They can be used with any GSM handset, providing phone access, ensuring delivery of appropriate services to that user and automatically billing the subscriber's network usage back to the home network.

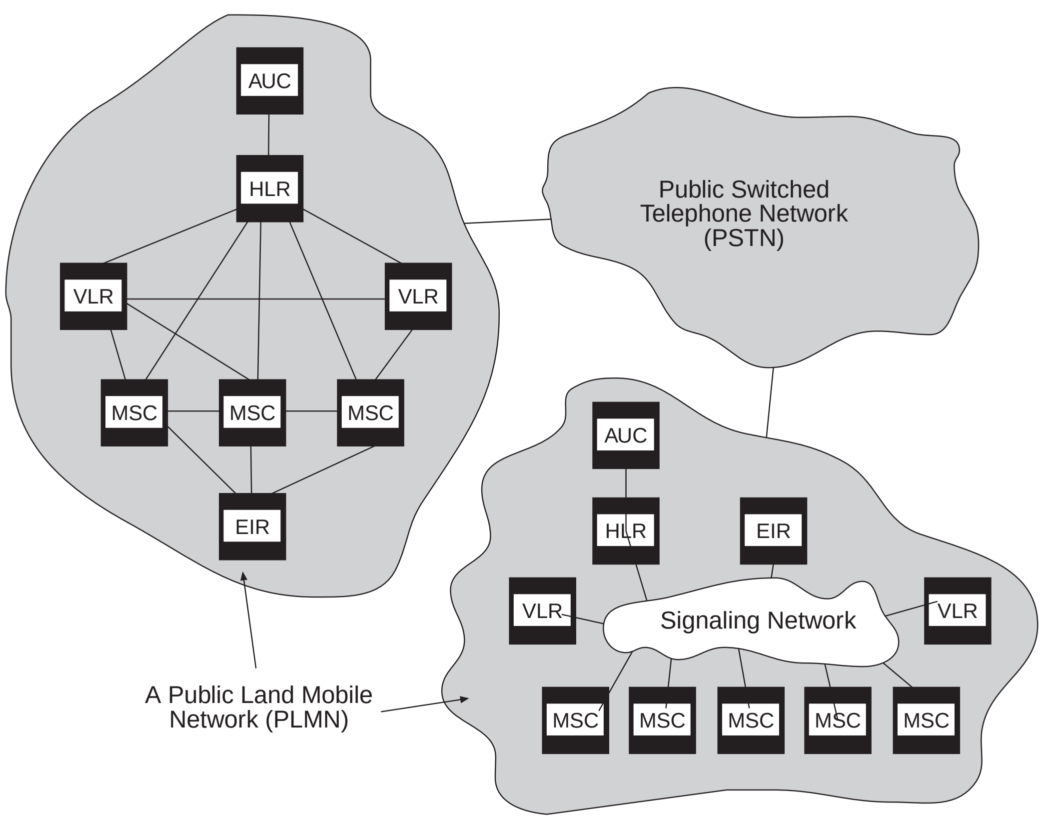

Fig. 5.1 GSM PLMN

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Roaming arrangements between most GSM networks in Europe allow subscribers to have access to the same services no matter where they travel. The real gem of GSM is its MAP and its flexibility. This coupled with the SIM tool kit will allow service providers far more flexibility in the future than anything currently offered even in IS-41.

A major importance of GSM is its potential for delivering enhanced services requiring multimedia communication: voice, image, and data. Several mobile service providers offer free voice mailboxes and phone answering services to subscribers.

The key to delivering enhanced services is SS7, a robust set of protocol layers designed to provide fast, efficient, reliable transfer and delivery of signaling information across the signaling network and to support both the switched voice and nonvoice applications. With SS7 on the enhanced services platform and integrated mailbox parameters, subscribers can be notified about the number of stored messages in their mailboxes, time and source of last messages, message urgency, and whether the messages are voice or fax. Future applications such as fax store-and-forward, and audiotex can also use the platform's voice and data handling capabilities.

5.4 OBJECTIVES OF A GSM PLMN

A GSM PLMN cannot establish calls autonomously other than local calls between mobile subscribers. In most cases, the GSM PLMN depends upon the existing wireline networks to route the calls. Most of the time the service provided to a subscriber is a combination of the access service by a GSM PLMN and the service by some existing wireline network. Thus, the general objectives of a GSM PLMN network with respect to services to a subscriber are

- ☞ To provide the subscriber a wide range of services and facilities, both voice and nonvoice, that are compatible with those offered by existing networks (e.g., PSTN, ISDN)
- ☞ To introduce a mobile radio system that is compatible with ISDN
- ☞ To provide certain services and facilities exclusive to mobile situations
- ☞ To give access to the GSM network for a mobile subscriber in a country that operates the GSM system
- ☞ To provide facilities for automatic roaming, locating, and updating of mobile subscribers
- ☞ To provide service to a wide range of MSs, including vehicle-mounted stations, portable stations, and handheld stations
- ☞ To provide for efficient use of the frequency spectrum
- ☞ To allow for a low-cost infrastructure and terminal and to keep cost of service low

5.5 GSM PLMN SERVICES

A telecommunication service supported by the GSM PLMN is defined as a group of communication capabilities that the service provider offers to the subscribers. The basic telecommunication services provided by the GSM PLMN are divided into three main groups (for additional details on GSM services, refer to chapter 9):

- **Bearer services.** These services give the subscriber the capacity required to transmit appropriate signals between certain access points (i.e., user-network interfaces).
- **Teleservices.** These services provide the subscriber with necessary capabilities including terminal equipment functions to communicate with other subscribers.
- **Supplementary services.** These services modify or supplement basic telecommunications services and are offered together or in association with basic telecommunications services.

The GSM system offers the opportunity for a subscriber to roam freely through countries where a GSM PLMN is operational. Agreements are required between the various service providers to guarantee access to services offered to subscribers.

5.6 GSM SUBSYSTEMS

A series of functions are required to support the services and facilities in the GSM PLMN. The basic subsystems of the GSM architecture are (Figure 5.2) the Base Station Subsystem (BSS), Network and Switching Subsystem (NSS), and Operational Subsystem (OSS).

The BSS provides and manages transmission paths between the MSs and the NSS. This includes management of the radio interface between MSs and the rest of the GSM system. The NSS has the responsibility of managing communications and connecting MSs to the relevant networks or other MSs. The NSS is not in direct contact with the MSs. Neither is the BSS in direct contact with external networks. The MS, BSS, and NSS form the operational part of the GSM system. The OSS provides means for a service provider to control and manage the GSM system. In the GSM, interaction between the subsystems can be grouped in two main parts:

- **Operational.** External networks to/from NSS to/from BSS to/from MS to/from subscriber
- **Control.** OSS to/from service provider

The operational part provides transmission paths and establishes them. The control part interacts with the traffic-handling activity of the operational part by monitoring and modifying it to maintain or improve its functions.

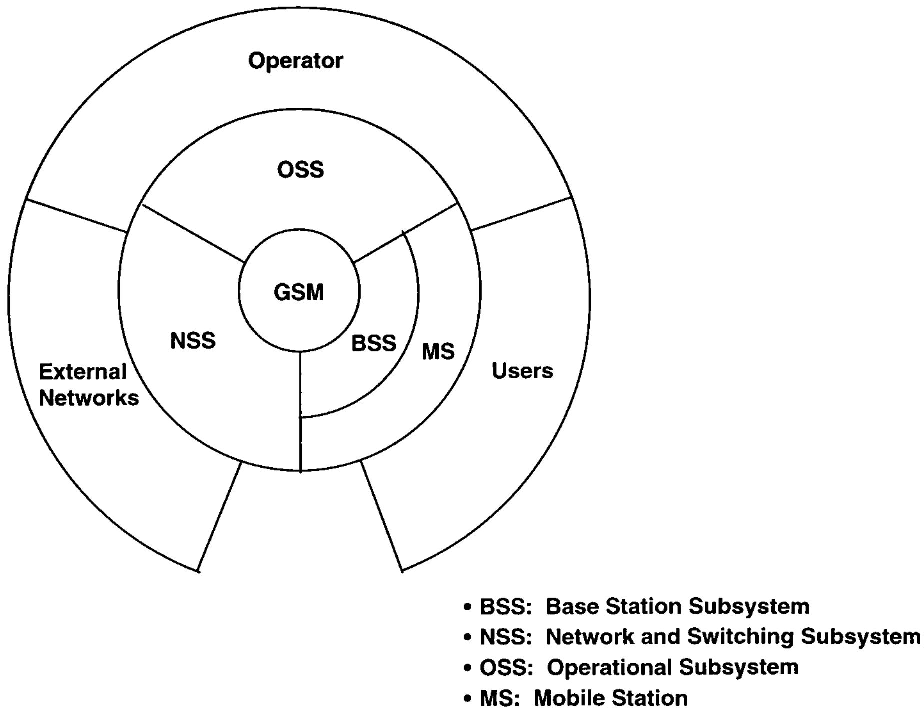

Fig. 5.2 GSM Subsystems

5.6.1 GSM Subsystem Entities

Figure 5.3 shows the functional entities of the GSM and their logical interconnection. We will briefly describe these functional entities here.

5.6.1.1 MS The MS consists of the physical equipment used by the subscriber to access a PLMN for offered telecommunication services. Functionally, the MS includes a Mobile Termination (MT) and, depending on the services it can support, various Terminal Equipment (TE), and combinations of TE and Terminal Adaptor (TA) functions (the TA acts as a gateway between the TE and the MT) (see Figure 5.4). Various types of MS, such as the vehicle-mounted station, portable station, or handheld station, are used.

The MSs come in five power classes which define the maximum RF power level that the unit can transmit. Tables 5.1 and 5.2 provide the details of maximum RF power for various classes in GSM and DCS-1800. Vehicular and portable units can be either class I or class II, whereas handheld units can be class III, IV, and V. The typical classes are II and V. Table 5.3 provides the details of maximum RF power for GSM and DCS-1800 micro-BSs.

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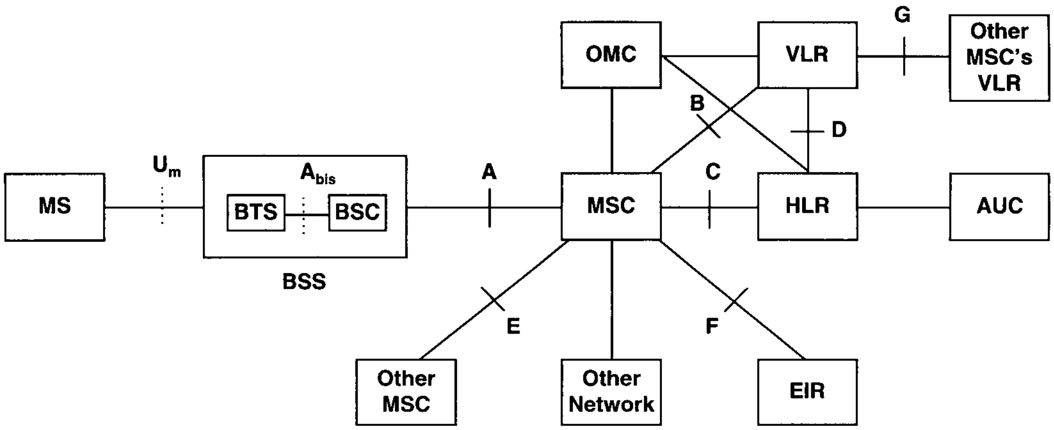

- MS: Mobile Station
- BSS: Base Station Subsystem
- BTS: Base Transceiver Station
- BSC: Base Station Controller
- MSC: Mobile Service Switching Center
- OMC: Operations and Maintenance Center
- HLR: Home Location Register
- VLR: Visitor Location Register
- EIR: Equipment Identity Register
- AUC: Authentication Center

Fig. 5.3 GSM Reference Model

Table 5.1 Maximum RF Power for MS in GSM

Class	MS Max. RF Power (watts)
I	20 (not currently implemented)
II	8
III	5
IV	2
V	0.8

Table 5.2 Power Level in DCS-1800

Power Class	Max. MS RF Power watts (dBm)	Max. BS RF Power watts (dBm)
1	1 (30)	20 (43)
2	0.25 (24)	10 (40)
3		5 (37)
4		2.5 (34)

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Table 5.3 Power Levels for Micro-BS in GSM and DCS-1800

Power Class	Max. RF Power of GSM Micro-BS, watts (dBm)	Max. RF Power of DCS-1800 Micro-BS, watts (dBm)
M1	0.25 (24)	1.6 (32)
M2	0.08 (19)	0.5 (27)
M3	0.03 (14)	0.16 (22)

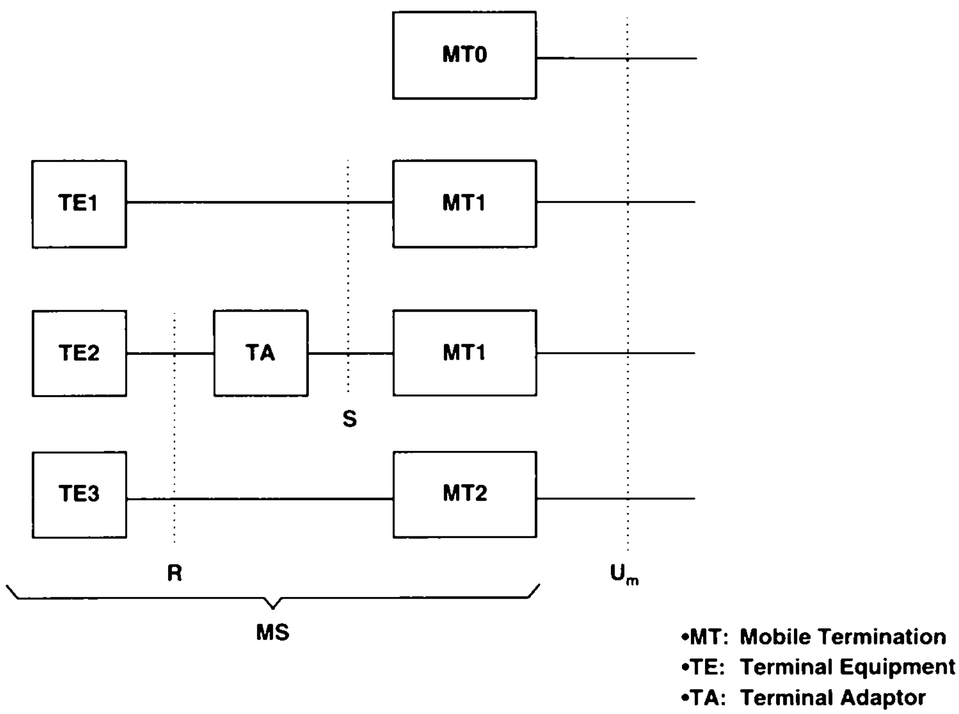

Fig. 5.4 Types of MSs

Basically, an MS can be divided into two parts. The first part contains the hardware and software to support radio and human interface functions. The second part contains terminal/user-specific data in the form of a smart card, which can effectively be considered a sort of logical terminal. The SIM card plugs into the first part of the MS and remains in for the duration of use. Without the SIM card, the MS is not associated with any user and cannot make or receive calls (except possibly an emergency call if the network allows). The SIM card is issued by the mobile service provider after subscription, while the first part of the MS would be available at retail shops to buy or rent. This type of SIM card mobility is analogous to terminal mobility, but provides a personal-mobility-like service within the GSM mobile network (refer to chapter 11 for more details).

An MS has a number of identities including the International Mobile Equipment Identity (IMEI), the International Mobile Subscriber Identity (IMSI), and the ISDN number. The IMSI is stored in the SIM. The SIM card contains all the subscriber-related information stored on the user's side of the radio interface.

- **IMSI.** The IMSI is assigned to an MS at subscription time. It uniquely identifies a given MS. The IMSI will be transmitted over the radio interface only if necessary. The IMSI contains 15 digits and includes
  - Mobile Country Code (MCC)—3 digits (home country)
  - Mobile Network Code (MNC)—2 digits (home GSM PLMN)
  - Mobile Subscriber Identification (MSIN)
  - National Mobile Subscriber Identity (NMSI)
- **Temporary Mobile Subscriber Identity (TMSI).** The TMSI is assigned to an MS by the VLR. The TMSI uniquely identifies an MS within the area controlled by a given VLR. The maximum number of bits that can be used for the TMSI is 32.
- **IMEI.** The IMEI uniquely identifies the MS equipment. It is assigned by the equipment manufacturer. The IMEI contains 15 digits and carries
  - The Type Approval Code (TAC)—6 digits
  - The Final Assembly Code (FAC)—2 digits
  - The serial number (SN)— 6 digits
  - A Spare (SP)—1 digit
- **SIM.** The SIM carries the following information (see chapter 11 for more details):
  - IMSI
  - Authentication Key (K_i)
  - Subscriber information
  - Access control class
  - Cipher Key (K_c)*
  - TMSI*
  - Additional GSM services*
  - Location Area Identity (LAI)*
  - Forbidden PLMN

*Updated by the network.

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5.6.1.2 BSS The BSS is the physical equipment that provides radio coverage to prescribed geographical areas, known as the cells. It contains equipment required to communicate with the MS. Functionally, a BSS consists of a control function carried out by the BSC and a transmitting function performed by the BTS. The BTS is the radio transmission equipment and covers each cell. A BSS can serve several cells because it can have multiple BTSs.

The BTS contains the Transcoder Rate Adapter Unit (TRAU). In TRAU, the GSM-specific speech encoding and decoding is carried out, as well as the rate adaptation function for data. In certain situations the TRAU is located at the MSC to gain an advantage of more compressed transmission between the BTS and the MSC.

5.6.1.3 NSS The NSS includes the main switching functions of GSM, databases required for the subscribers, and mobility management. Its main role is to manage the communications between GSM and other network users. Within the NSS, the switching functions are performed by the MSC. Subscriber information relevant to provisioning of services is kept in the HLR. The other database in the NSS is the VLR.

The MSC performs the necessary switching functions required for the MSs located in an associated geographical area, called an MSC area (see Figure 5.5).

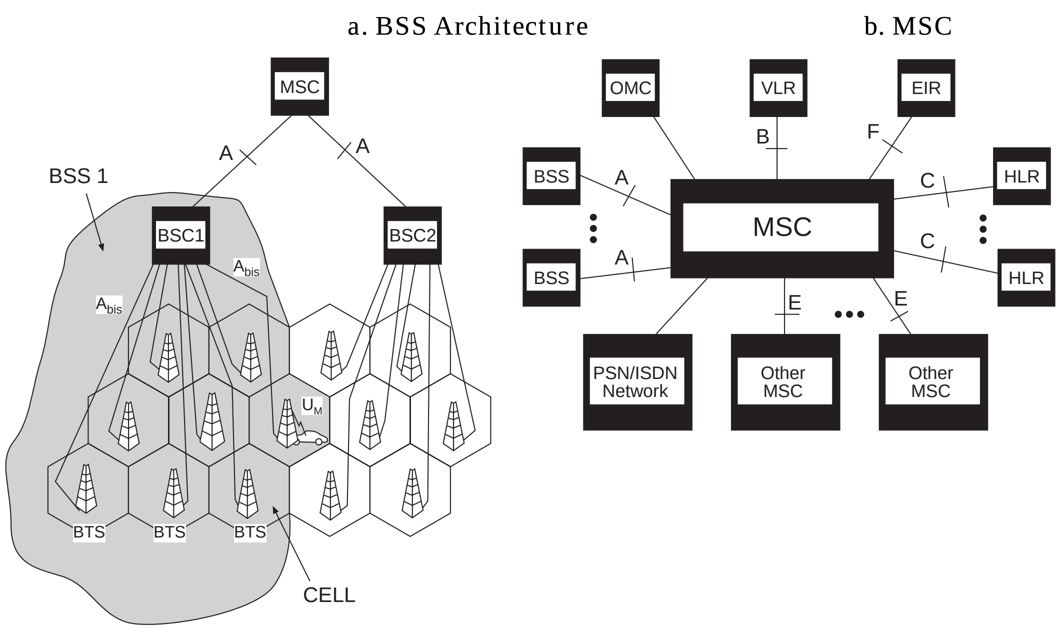

Fig. 5.5 MSC Area in GSM

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The MSC monitors the mobility of its subscribers and manages necessary resources required to handle and update the location registration procedures and to carry out the handover functions. The MSC is involved in the interworking functions to communicate with other networks such as PSTN and ISDN. The interworking functions of the MSC depend upon the type of the network to which it is connected and the type of service to be performed. The call routing and control and echo control functions are also performed by the MSC.

The HLR is the functional unit used for management of mobile subscribers. The number of HLRs in a PLMN varies with the characteristics of the PLMN. Two types of information are stored in the HLR: subscriber information and part of the mobile information to allow incoming calls to be routed to the MSC for the particular MS. Any administrative action by the service provider on subscriber data is performed in the HLR. The HLR stores IMSI, MS ISDN number, VLR address, and subscriber data (e.g., supplementary services).

The VLR is linked to one or more MSCs. The VLR is the functional unit that dynamically stores subscriber information when the subscriber is located in the area covered by the VLR. When a roaming MS enters an MSC area, the MSC informs the associated VLR about the MS; the MS goes through a registration procedure. The registration procedure for the MS includes these activities:

- The VLR recognizes that the MS is from another PLMN.
- If roaming is allowed, the VLR finds the MS's HLR in its home PLMN.
- The VLR constructs a Global Title (GT) from the IMSI to allow signaling from the VLR to the MS's HLR via the PSTN/ISDN networks.
- The VLR generates a Mobile Subscriber Roaming Number (MSRN) that is used to route incoming calls to the MS.
- The MSRN is sent to the MS's HLR.

The information in the VLR includes MSRN, TMSI, the location area in which the MS has been registered, data related to supplementary service, MS ISDN number, IMSI, HLR address or GT, and local MS identity, if used.

The NSS contains more than MSCs, HLRs, and VLRs. In order to deliver an incoming call to a GSM user, the call is first routed to a gateway switch, referred to as the Gateway Mobile Service Switching Center (GMSC). The GMSC is responsible for collecting the location information and routing the call to the MSC through which the subscriber can obtain service at that instant (i.e., the visited MSC). The GMSC first finds the right HLR from the directory number of the GSM subscriber and interrogates it. The GMSC has an interface with external networks for which it provides gateway function, as well as with the SS7 signaling network for interworking with other NSS entities.

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5.6.1.4 Operation and Maintenance Subsystem (OMSS) The OMSS is responsible for handling system security based on validation of identities of various telecommunications entities. These functions are performed in the Authentication Center (AuC) and EIR.

The AuC is accessed by the HLR to determine whether an MS will be granted service.

The EIR provides MS information used by the MSC. The EIR maintains a list of legitimate, fraudulent, or faulty MSs.

The OMSS is also in charge of remote operation and maintenance functions of the PLMN. These functions are monitored and controlled in the OMSS. The OMSS may have one or more Network Management Centers (NMCs) to centralize PLMN control.

The Operational and Maintenance Center (OMC) is the functional entity through which the service provider monitors and controls the system. The OMC provides a single point for the maintenance personnel to maintain the entire system. One OMC can serve multiple MSCs.

5.7 GSM INTERFACES

5.7.1 The Radio Interface (MS to BTS)

The U_m radio interface (between MS and base transceiver stations [BTS]) is the most important in any mobile radio system, in that it addresses the demanding characteristics of the radio environment. The physical layer interfaces to the data link layer and radio resource management sublayer in the MS and BS and to other functional units in the MS and network subsystem (which includes the BSS and MSC) for supporting traffic channels. The physical interface comprises a set of physical channels accessible through FDMA and TDMA.

Each physical channel supports a number of logical channels used for user traffic and signaling. The physical layer (or layer 1) supports the functions required for the transmission of bit streams on the air interface. Layer 1 also provides access capabilities to upper layers. The physical layer is described in the GSM Recommendation 05 series (part of the ETSI documentation for GSM). At the physical level, most signaling messages carried on the radio path are in 23-octet blocks. The data link layer functions are multiplexing, error detection and correction, flow control, and segmentation to allow for long messages on the upper layers.

The radio interface uses the Link Access Protocol on Dm channel (LAPDm). This protocol is based on the principles of the ISDN Link Access Protocol on the D channel (LAPD) protocol. Layer 2 is described in GSM Recommendations 04.05 and 04.06. The following logical channel types are supported (see chapter 7 for the details of logical channel types):

- Speech traffic channels (TCH)
  - Full-rate TCH (TCH/F)
  - Half-rate TCH (TCH/H)
- Broadcast channels (BCCH)
  - Frequency correction channel (FCCH)
  - Synchronization channel (SCH)
  - Broadcast control channel (BCCH)
- Common control channels (CCCH)
  - Paging channel (PCH)
  - Random access channel (RACH)
  - Access grant channel (AGCH)
- Cell broadcast channel (CBCH)
  - Cell broadcast channel (CBCH) (the CBCH uses the same physical channel as the DCCH)
- Dedicated control channels (DCCH)
  - Slow associated control channel (SACCH)
  - Stand-alone dedicated control channel (SDCCH)
  - Fast associated control channel (FACCH)

The radio resource layer manages the dialog between the MS and BSS concerning the management of the radio connection, including connection establishment, control, release, and changes (e.g., during handover). The mobility management layer deals with supporting functions of location update, authentication, and encryption management in a mobile environment. In the connection management layer, the call control entity controls end-to-end call establishment and management, and the supplementary service entity supports the management of supplementary services. Both protocols are similar to those used in the fixed wireline network (for more details refer to chapter 9). The SMS protocol of this layer supports the high-level functions related to the transfer and management of short message services.

5.7.2 A_{bis} Interface (BTS to BSC)

The interconnection between the BTS and the BSC is through a standard interface, A_{bis} (most A_{bis} interfaces are vendor specific). The primary functions carried over this interface are traffic channel transmission, terrestrial channel management, and radio channel management. This interface supports two types of communications links: traffic channels at 64 kbps carrying speech or user data for a full- or half-rate radio traffic channel and signaling channels at 16 kbps carrying information for BSC-BTS and BSC-MSC signaling. The BSC handles the LAPD channel signaling for every BTS carrier. The first three layers are based on the following OSI/ITU-T recommendations:

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- Physical layer: ITU-T Recommendation G.703 and GSM Recommendation 0-8.54
- Data link layer: GSM Recommendation 08.56 (LAPD)
- Network layer: GSM Recommendation 08.58

There are two types of messages handled by the traffic management procedure part of the signaling interface—**transparent** and **nontransparent**. Transparent messages are between the MS and BSC-MSC and do not require analysis by the BTS. Nontransparent messages do require BTS analysis.

5.7.3 A Interface (BSC to MSC)

The A interface allows interconnection between the BSS radio base subsystem and the MSC. The physical layer of the A interface is a 2-Mbps standard Consultative Committee on Telephone and Telegraph (CCITT) digital connection. The signaling transport uses Message Transfer Part (MTP) and Signaling Connection Control Part (SCCP) of SS7 (see chapter 17 for details). Error-free transport is handled by a subset of the MTP, and logical connection is handled by a subset of the SCCP. The application parts are divided between the BSS application part (BSSAP) and BSS operation and maintenance application part (BSSOMAP). The BSSAP is further divided into Direct Transfer Application Part (DTAP) and BSS management application part (BSSMAP). The DTAP is used to transfer layer 3 messages between the MS and the MSC without BSC involvement. The BSSMAP is responsible for all aspects of radio resource handling at the BSS. The BSSOMAP supports all the operation and maintenance communications of BSS (refer to chapter 15 for more details).

5.7.4 Interfaces between Other GSM Entities

Information transfer between GSM PLMN entities uses the MAP. The MAP contains a mobile application and several Application Service Elements (ASEs). It uses the service of the Transaction Capabilities Application Part (TCAP) of SS7. It employs the SCCP to offer the necessary signaling functions required to provide services such as setting mobile facilities for voice and nonvoice application in a mobile network. The major procedures supported by MAP are

- Location registration and cancellation
- Handover procedures
- Handling supplementary services
- Retrieval of subscriber parameters during call setup
- Authentication procedures.

Figure 5.3 shows the various interfaces between the GSM entities. In Figure 5.6, protocols used between the GSM entities are given.

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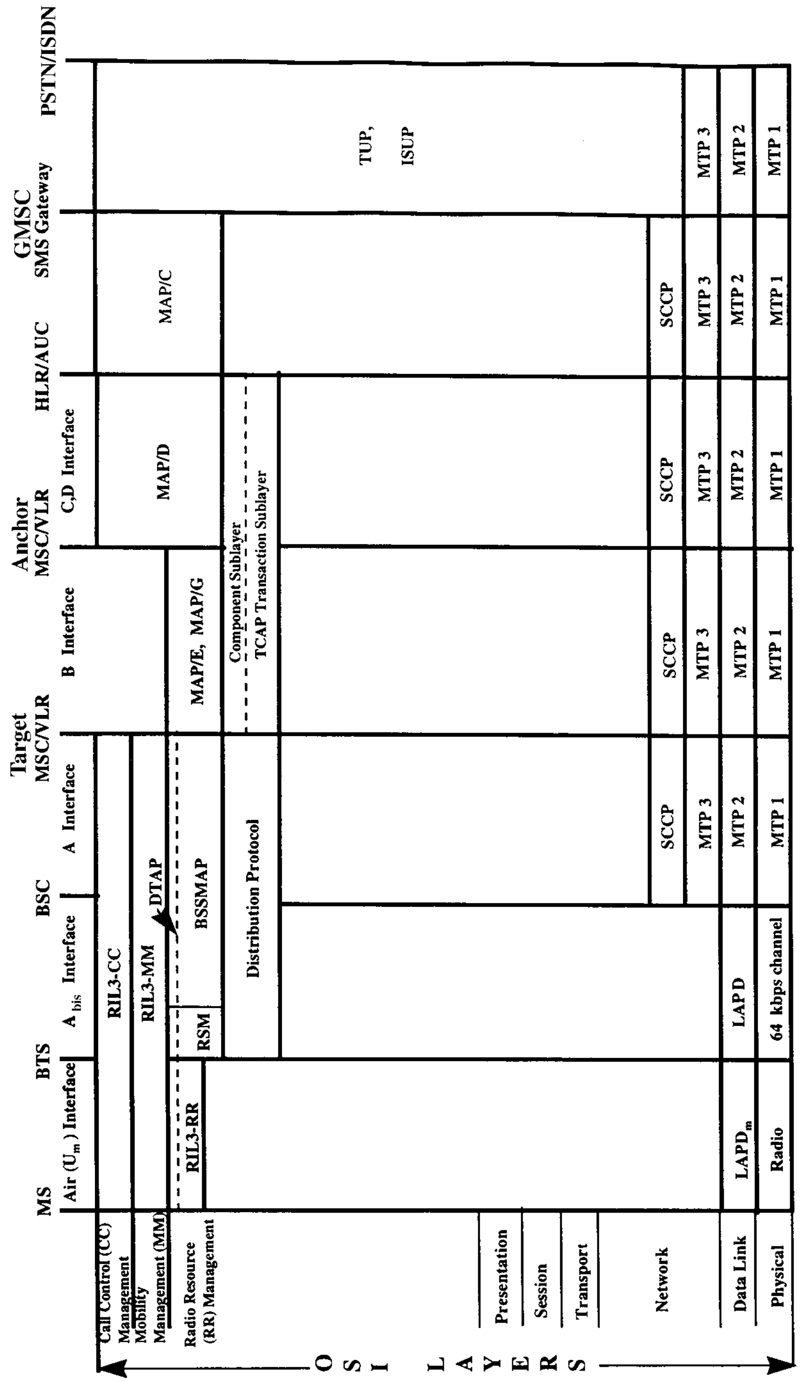

Fig. 5.6 Signaling Protocols between GSM Entities

5.8 MAPPING OF GSM LAYERS ONTO OSI LAYERS

When an MS is switched on somewhere, it first has to determine whether it has access to a PLMN. It initiates a location update to inform its home PLMN about its current location in order to enable the routing of incoming calls to the subscriber. The location of an MS is stored in a central database, the HLR of the PLMN where the customer has purchased service. In addition to other user-specific information, the HLR maintains the routing number to an MSC. The MSC is primarily responsible for switching and mobility management (MM). Once connected to an MSC, a BSS communicates with the MS via the radio interface. Each MS, positioned in a cell of a BSS of an MSC, is registered with a specific database associated with the MSC and the VLR. If a call to a GSM subscriber is generated from an external network, the call is routed to a Gateway MSC (GMSC) first. This GMSC interrogates the HLR of the called subscriber to obtain the routing number of the visited MSC. The latter then initiates the transmission of a paging message within each of its associated cells. If the called subscriber answers, the BSS assigns a traffic channel to be used for the communication, and the link is fully established.

During a call, the MS is allowed to move from cell to cell in the whole GSM service area, and GSM maintains the communication links without interruption of the end-to-end connection. The handover procedure in GSM is mobile assisted and performed by the BSS. The MS periodically measures downlink signal quality and reports it to its serving BTS, as well as to all cells in its neighborhood that are prospective candidates for handover. Different handover types can be performed, changing either a channel in the serving cell (i.e., the serving BTS remains the same) or changing the cell inside the area controlled by a BSC; between two BSCs within a location area; or between two location areas (i.e., MSCs).

The GSM protocol architecture for signaling and mapping onto the corresponding OSI layers is shown in Figure 5.7. GSM uses out-of-band signaling through a separate signaling network.

As discussed in section 5.7, at the data link layer the radio interface of the MS uses LAPDm protocol. The higher-layer protocols of GSM are grouped into the third layer. GSM layer 3 includes functionality of higher OSI layers and OSI management, such as connection management, subscriber identification, and authentication.

At the interface between BSC and MSC, the lower layers are realized by MTP of SS7. It covers functionality of layer 1, layer 2, and part of layer 3 of the OSI reference model. The MTP itself is layered into three levels. The two lower levels are mapped directly onto the corresponding OSI layers, and level 3 covers the lower part of the OSI network layer. The missing functionality of the higher part of the network layer is provided by SCCP. The BSSAP serves primarily as a bridge between the radio resource (RR) management and the MSC, handling for instance the assignment and switching at call setup and

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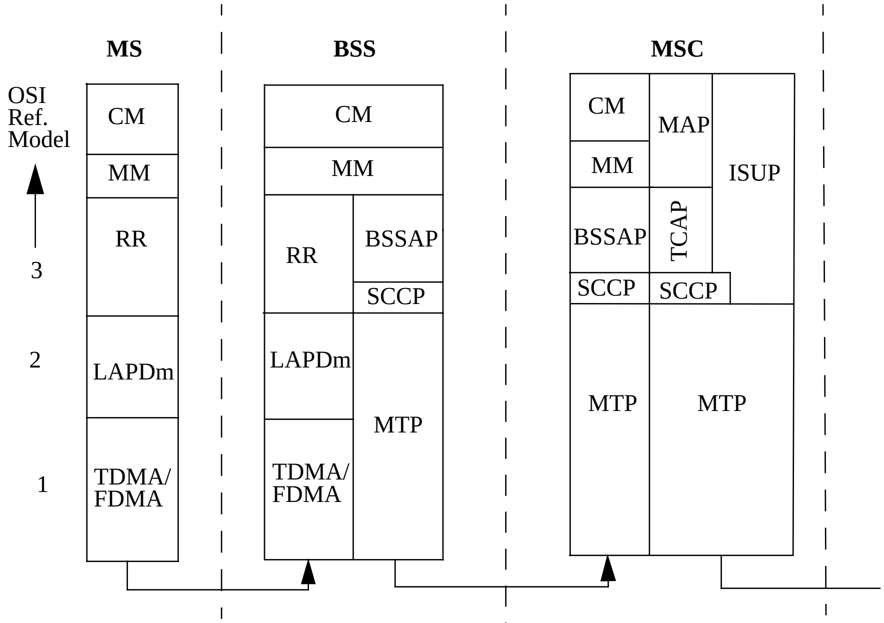

CM = Communication Management
MM = Mobility Management
RR = Radio Resource Management
BSSAP = Base Station Subsystem Application Part

SCCP = Signaling Connection Control Part
MAP = Mobile Application Part
TCAP = Transaction Capabilities Application Part
ISUP = ISDN User Part
MTP = Message Transfer Part

Fig. 5.7 Mapping of GSM onto OSI Layers

handover processing. It therefore provides the functionality typically provided by the transport layer, application layer, and network management of OSI.

The MSC is connected to the signaling network via SS7 and is responsible for exchange of all information required for call setup, maintenance, and management. TCAP contains functions to provide associations between two TCAP users as well as protocols and services to perform remote operations. It is closely related to the Remote Operation Service Element (ROSE) of the OSI application layer. Since TCAP directly uses the services of SCCP, the transport, session, and presentation layers are null layers. Hence, this part of the SS7 is a typical example of a system using a reduced protocol stack where functions of different OSI protocol layers are incorporated into the remaining layers. TCAP provides functionality of the OSI transport layer.

The call-related signaling between MSCs and external networks uses the ISDN User Part (ISUP), while all GSM-specific signaling between MSC and location registers is performed via the MAP. These protocols correspond to the OSI application layer, although their functionality is mainly used to maintain network-level connections. It can be noticed that the network complexity of telecommunication networks seems to yield protocols that combine functionality distributed across the higher layers and management part of the OSI protocol stack (for details of signaling protocols refer to chapter 17).

5.9 NORTH AMERICAN PCS-1900

Figure 5.8 shows the functional model that has been derived from the T1P1 reference model [1]. Several physical scenarios can be developed using the functional entities shown in Figure 5.8. Figure 5.9 shows the Functional Entity (FE) grouping in which the physical interface between the Radio System (RS) and the Switching System Platform (SSP) carries both the call control (CC) and mobility management messages.

- Radio Terminal Function (RTF) FE—it is the subscriber unit (SU). The only physical interface is to the Radio System (RS) using the air interface.
- Radio Control Function (RCF) FE and Radio Access Control Function (RACF) FE—these are included in the RS. Combining these FEs onto the same platform allows air-interface-specific functions (such as those that would impact handover) to be isolated from the other interfaces. OS

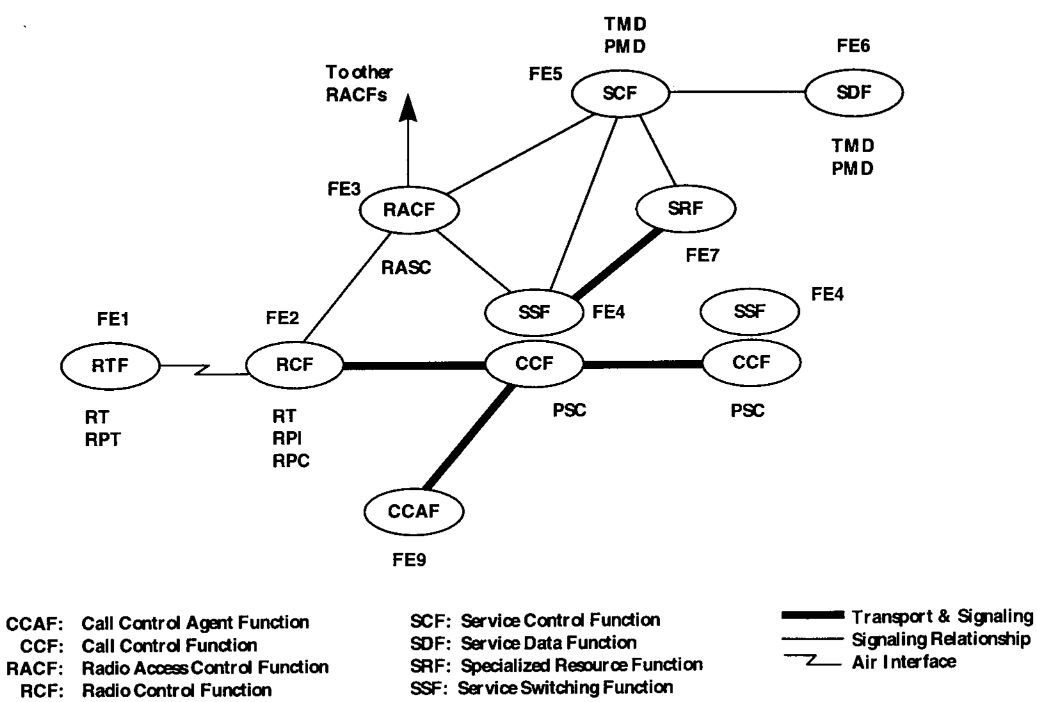

Fig. 5.8 Functional Model Derived from T1P1 Reference Model [1]

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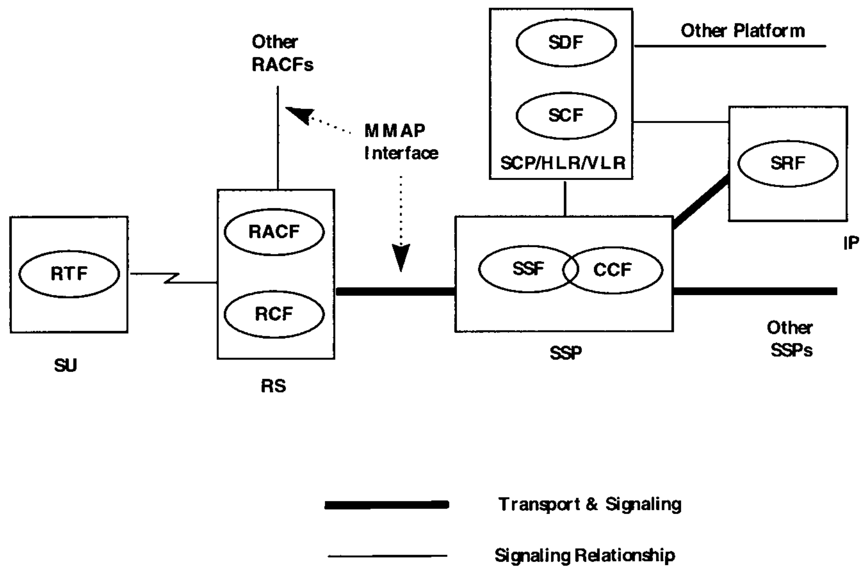

Fig. 5.9 Functional Entity Groupings

information, including performance data and accounting records, is generated, collected, and formatted on this platform. There is only one physical interface to the SSP to carry both the call control and mobility management signaling.

- SSF/CCF FE—it is contained in SSP and provides interfaces to operator services, E911, international calls, and network repair/maintenance centers. Physical interfaces for this collection include: to the RS, to the mobility management platform, to the information provider, and to other SSPs and external networks.
- Specialized Resource Function (SRF) FE and data interworking function—they are contained in the information provider. Physical interfaces for this collection include one to SSP and another to the mobility management platform.
- Individually the SSF/CCF FE and CCF FE represent interswitch and internetwork functional entity collections and physical interfaces.

As shown in Figure 5.9, only the interface to the RS is from the SSP. There is no direct physical path between the RS and the SCP/VLR. All operations to or from the RS pass through the SSP, whether or not the SSP terminates or ignores the operation.

The proposed North American PCS-1900 standard is an extension of the ETSI DCS-1800 that was initially developed for the frequency band of 1800

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MHz. PCS-1900 consists of 200-kHz radio channels shared by 8 time slots, one per terminal. The PCS-1900 standard supports a frequency duplex arrangement for forward and reverse links. It uses a fixed rate Residual Pulse Excitation (RPE) based on a speech coder that operates at 13 kbps.

The North American types of handover are network initiated and Mobile Assisted Handover (MAHO). In the case of the network-initiated handover, both hard and soft handover are supported. The PCS-1900 standard defines support for MAHO and a form of network-initiated handover that applies only to hard handover. For PCS-1900 systems to function as an integral part of the North American PCS environment, handover needs will be supported between PCS-1900 and North American systems.

PCS-1900 supports voice privacy through the encryption capabilities. Encryption (voice privacy) is an air interface capability that can be controlled by the network operator rather than as a service that may not be controlled by the network operator but may also be offered as a service to the end user. The GSM encryption is only an air interface function and does not depend on the GSM MAP function.

The authentication algorithm in the PCS-1900 uses IMSI as one of its inputs. The terminal possesses a "key," which is the same "key" known by the home network. The network computes a signature that is specific for an end user. This signature is used to authenticate the end user through the duration of the service. This authentication scheme has its strength in the authentication algorithm. However, there is no mechanism to recognize clones.

To satisfy the PCS needs and requirements for ubiquity (accessibility) and seamless service, air interface transparency must exist. Transparency implies that an end user can have access to service regardless of the access method.

In the initial phase of PCS, multiple air interfaces may exist, and therefore dual-mode or dual-spectrum terminals may be used. The aim is to attain some level of interoperability with the existing North American networks. If interoperability does not exist between the PCS-1900 air interface and the analog AMPS 800 MHz air interface, the ubiquity of service is precluded. The PCS-1900 air interface may access the network that provides GSM services. The AMPS analog air interface may have access to IS-41 services.

5.10 SUMMARY

In this chapter, we presented an overview of the GSM system, which consists of four subsystems—MSS, BSS, NSS, and OSS. We also described functional entities in each of the subsystems and presented interfaces and protocols used between different functional entities of the GSM system. We included the mapping of the GSM protocols onto the OSI layers and provided the architecture of the PCS-1900 (a derivative of GSM) in North America.

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5.11 References

1. Garg, V. K., and Wilkes, J. E., *Wireless and Personal Communication Systems*, Prentice Hall, 1996.
2. ETSI, GSM Specification Series 01.02–1.06, “GSM Overview, Glossary, Abbreviations, Service Phases.”
3. ETSI, GSM Specification Series 02.01–2.88, “GSM Services and Features.”
4. ETSI, GSM Specification Series 03.01–3.88, “GSM PLMN Functions, Architecture, Numbering and Addressing Procedures.”
5. ETSI, GSM Specification Series 04.01–4.88, “MS-BSS Interface.”
6. ETSI, GSM Specification Series 06.01–6.32, “Radio Link.”
7. ETSI, GSM Specification Series 07.01–7.03, “Terminal Adaptation.”
8. ETSI, GSM Specification Series 08.01–8.60, “BSS-MSC Interface, BSC-BTS Interface.”
9. ETSI, GSM Specification Series 09.01–9.11, “Network Interworking, MAP.”
10. Mouly, M., and Pautet, M., *The GSM System for Mobile Communications*, Mouly and Pautet, Palaiseau, France, 1992.