The basic services to be provided in the PLMN includes teleservices and bearer services, e.g. telephone and data services (for further study) as well as most other services provided in the ISDN (for further study).

The supplementary services to be provided are additional to one or more basic services.

5.List of Acronyms (Additional acronyms will be included)

BS	Base Station
EIR	Equipment Identity Register
GMSC	Gateway MSC
HLR	Home Location Register
HPLMN	Home PLMN
IMEI	International Mobile Equipment Identity
IMSI	International Mobile Station Identity
MAP	Mobile Application Part
MCC	Mobile Country Code
MNC	Mobile Network Code
MS	Mobile Station
MSC	Mobile Services Switching Centre
MSC-A	MSC with call control at handover
MSC-B	MSC to which a handover is done
MSC-B'	MSC to which a subsequent handover is done
MSIN	Mobile Station Identity
MTP	Message Transfer Part
NMSI	National Mobile Station Identity
PLMN	Public Land Mobile Network
SCCP	Signalling Connection Control Part
SP	Signalling Point
TMSI	Temporary Mobile Station Identity
VLR	Visitor Location Register
VPLMN	Visited PLMN

dover is required when a mobile station moves from one MSC area to another during a call in order to continue communication. The MSCs exchange signalling information as a part of the process to determine the best cell for handover and finally to perform the handover if the best cell is in another MSC than the Serving MSC.

3.3.7 Interface between MSC and EIR (F interface)

This interface is used for information transfer between an MSC and the equipment identity register, EIR, related to management of national and international mobile equipment identities.

3.3.8 Interface between VLRs (G interface)

This interface is used for information transfer between VLRs when a mobile station registers in a new VLR using a temporary mobile station identity, TMSI, assigned by another VLR. This interface is used to retrieve the international mobile subscriber identity, IMSI, from the VLR which assigned the TMSI.

3.3.9 Interface between BS and MS (Um interface)

The exact definitions of the interface between base station and mobile station are not part of this specification.

However, the BS-MS interface is characterized by the Um reference point:

-the Um reference point is the traditional over-the-air radio-interface that is RF technology dependent and includes the physical aspects of the interface to the Base Station.

3.3.10 Interface between user and network

The Digital PLMN User-Network interface provides:

The definition of the User-Network interface is for further study.

a) flexibility of user terminals with respect to Digital PLMN network interconnection:

b) flexibility of separate user terminal evolution and PLMN technology evolution; and

c) flexibility of definition and provisioning for PLMN basic bearer services, teleservices and supplementary services.

4. Services in the public land mobile network

The services to be provided in a public land mobile network can be described according to the ISDN service definition principles (see Recommendation I.210) as basic services and supplementary services. Examples of these two types of services are telephone service and call forwarding unconditional respectively.

- Mobility management

- BS management

- Mobile station management

3.3.3 Interface between MSC and VLR (B interface)

The VLR is the location and management data base for the mobile stations roaming in the area controlled by the associated MSC or MSCs. The MSC interrogates the VLR whenever it needs information relating to a given mobile station currently located in the MSC area. 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 a mobile station roams to another location area. The MSC also informs the VLR when a subscriber for instance activates a specific supplementary service or modifies some information related to a service. The VLR stores these modifications and updates the HLR, if required.

3.3.4 Interface between MSC and HLR (C interface)

This interface is used to exchange signalling information for administrative and routing purposes.

In cases where charging information is transferred from an MSC, using Signalling System No. 7, this interface will be used.

In cases where the fixed network is unable to interrogate the HLR, an interrogation from a gateway MSC will be necessary in order to get the call routing information from the HLR, for instance the roaming number (if the mobile station is roaming).

3.3.5 Interface between HLR and VLR (D interface)

This interface is used to exchange the signalling information 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 service area. To support this, the location registers must exchange signalling information. The VLR informs the HLR of the location of a mobile station managed by the HLR and provides the HLR with the roaming number of that mobile station. The HLR sends to the VLR information needed to support the service to the mobile station. The HLR also informs a VLR which previously served the mobile station to delete all relevant information regarding a mobile station, which has roamed to an MSC area served by another VLR. Exchange of signalling information can also occur for instance when the mobile subscriber activates a supplementary service, when the subscriber wants to change some information related to his subscription or when the administration modifies some parameter of the subscription.

3.3.6 Interface between MSCs (E interface)

This interface is used mainly for handover related information exchange between MSCs. A han-

FIGURE 8/Q.1001

Configuration example No. 3

3.2 Interconnection between PLMNs

As the configuration of a PLMN does not have any impact on other PLMNs, the specified signalling interfaces can be implemented between entities within a PLMN or between PLMNs, with or without intermediate interface equipment providing a gateway function at the application level.

A difference in the interface can be found at lower levels (SCCP), since different signalling networks can be involved in the exchange of messages and they are at least independent with respect to the signalling network addressing plan.

A specific interconnection with a PLMN gateway may be needed in cases where the organization and configuration of a PLMN does not meet the international specifications. The specific interconnection is used in this case to mask, from other PLMNs, a national configuration which is not in line with the international specifications.

3.3 PLMN interfaces

3.3.1 General

The implementation of the public land mobile service with international roaming and handover implies the exchange of mobile specific signalling information between the equipment involved in the service. The introduction of Signalling System No. 7 and its signalling network will be an opportunity to transfer the data needed to support the Public Land Mobile Service. Signalling System No. 7 should be used to convey the information, where applicable. In addition some parts of the equipment will have signalling interworking with the fixed network. The descriptions given below are limited to the mobile application. The Mobile Application Part will be supported by the Transaction Capabilities.

3.3.2 Interface between MSC and base station (A interface)

The exact definition of the interface between a base station and its MSC depends on the division of functions between BS and MSC. Call handling as well as mobile station management may be split between the two entities.

However, the BS - MSC interface will in any case carry information concerning:

- Call handling

FIGURE 7/Q.1001

PLMN configuration example No. 2

3.1.4 Configuration example No. 3 (HLR and VLR co-located with a MSC)

This configuration is presented in Figure 8/Q.1001. In cases where the HLR is implemented in the MSC, this MSC will become the HMSC for the subscribers managed by the Location Register. The two functions HLR and MSC are not of the same type: the HLR is a pure network data base function, interrogated when needed and the MSC is mainly in charge of call handling. The HMSC performs the call handling function for all its subscribers, as defined by their allocation to the HLR, when they are located in the HMSC area. Call set-up to mobile stations handled by the HMSC uses only the international mobile subscriber ISDN/ PSTN number and no roaming number is allocated to these mobile stations.

3.1.3 Configuration example No. 2 (VLR co-located with VMSC)

This configuration is presented in Figure 7/Q.1001. The Visited Location Register is co-located with or implemented in the VMSC for the following reasons. The main type of data stored in the VLR is the practical location information (i.e. location area) which has to be updated by the VMSC when the mobile station moves from one location area to another. The VMSC also has to interrogate the VLR at call set-up in order to know the relevant subscriber data (e.g. restrictions and supplementary services).

port of the Mobile Application Part (MAP) of Signalling System No. 7 to exchange the data necessary to provide the mobile service. All PLMN configurations can be deducted from this basic configuration. In instances where some functions are contained in the same equipment, the relevant interfaces become equipment internal to that equipment and the use of the MAP is not necessary. Some examples are given in sections 3.1.3 and 3.1.4.

FIGURE 6/Q.1001

PLMN configuration example No. 1

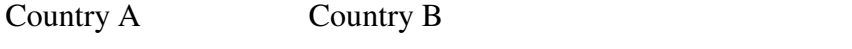

FIGURE 5/Q.1001

An example of interconnections of PLMNs and other networks

3.1.2 Configuration example No. 1 (No co-location of functional entities)

This configuration is presented in Figure 6/Q.1001. All functions are implemented in dedicated equipment. The interfaces within the PLMN are equipment external and therefore need the sup-

FIGURE 4/Q.1001

PLMN entities and associated signalling interfaces

2.3.4MSC-B'

The second (or subsequent) MSC to which a call is handed over.

Note - After the handover is completed and the circuit between MSC-A and MSC-B has been released. MSC-B' will look, from the point of view of MSC-A and the network, like MSC-B did before the handover.

2.3.5Candidate MSC

A Candidate MSC is an MSC which controls cells that could be candidates for receiving a call in case of a handover.

2.3.6Target MSC

The Target MSC is the MSC controlling the cell(s) selected as target(s) for a handover.

2.3.7Serving MSC

The Serving MSC is the MSC which handles the call at the moment.

2.3.8Old serving MSC

The old serving MSC is the MSC which was the serving MSC before a handover, other than MSCA.

3.Architecture of the Public Land Mobile Network

3.1Configuration of a Public Land Mobile Network

3.1.1General

Figure 4/Q.1001 presents PLMN entities and the associated signalling interfaces. The specific implementation in each country (or PLMN, if more than one in each country) may be different; some of the functional entities may be combined in the same equipment and this may result in some interfaces becoming internal. The configuration of a PLMN must in any case have no impact on the relationship with other PLMNs. Example: PLMN entities and associated signalling interfaces are shown in Figure 5/Q.1001. To illustrate some implementation possibilities three examples of configurations are presented in Figures 6/Q.1001, 7/Q.1001 and 8/Q.1001. In addition, it can be mentioned that HLR and VLR can be physically implemented in the same equipment, as an integrated Location Register.

public networks.

The gateway PLMN could be the home PLMN or the visited PLMN or any other.

2.2.11Gateway MSC

The MSC which receives a call from a fixed subscriber, via a public switched network, for extension to a mobile station. The gateway MSC may vary for interconnection with different public networks.

The gateway MSC may be any MSC of the PLMN, including the HMSC or VMSC if the home and visited location registers are implemented in the MSC.

2.2.12Designation method

The calling subscriber must know the actual location area of any mobile station. The call is established according to the dialled information only, i.e. the call is not rerouted by the location register when the mobile station currently is in another location area.

2.2.13Non-designation method

The calling subscriber is not required to know the actual location area of the mobile station. The call is routed according to the dialled information and, if required, rerouted on additional information given by a location register.

2.2.14Mobile station roaming number

The network internal number used for routing of calls to the mobile station. See Recommendation E.213.

2.3Handover definitions

2.3.1Handover

Handover is the action of switching a call in progress from one cell to another (or between radio channels in the same cell). Handover is used to allow established calls to continue when mobile stations move from one cell to another (or as a method to minimize co-channel interference).

2.3.2MSC-A (Controlling MSC)

The MSC which first established the radio connection to or from a mobile station for mobile terminating or originating calls respectively. This MSC will be the call controlling MSC for the duration of the call also in cases where a call is handed over to another MSC.

2.3.3MSC-B

The first MSC to which a call is handed over.

2.2.2Location information

The location register should as a minimum contain the following information about a mobile station:

- international mobile station identity;

-actual location of the mobile station (e.g. PLMN, MSC area, location area, as required).

2.2.3Home PLMN

The PLMN in which a mobile station is permanently registered.

2.2.4Home location register

The location register to which a mobile station is assigned for record purposes such as subscriber information.

2.2.5Home MSC

The term home MSC (HMSC) may be used in cases where the home location register is implemented in an MSC.

2.2.6Equipment Identity Register

The register to which an international mobile equipment identity is assigned for record purposes.

2.2.7Visited PLMN

The PLMN, other than the home PLMN, in which a roaming subscriber is currently located.

2.2.8Visitor location register

The location register, other than the home location register used by an MSC to retrieve information for, for instance, handling of calls to or from a roaming mobile station, currently located in its area.

2.2.9Visited MSC

The term visited MSC (VMSC) may be used in cases where the visitor location register is implemented in an MSC.

2.2.10Gateway PLMN

The PLMN which receives a call from a fixed subscriber, via a public switched network, for extension to a mobile station. The gateway PLMN may vary for interconnection with different

FIGURE 3/Q.1001

Composition of the system area

2.1.14Radio traffic path

The radio communication facility between a mobile station and a base station intended to carry a call and uniquely assigned to the mobile station during that call.

2.1.15Radio control path

The radio communication facility between a mobile station and a base station intended to carry all the information transfer between the mobile station and the MSC, in which area the mobile station currently is located, during the time that no radio traffic path between that base station and that mobile station is assigned.

2.2Roaming definitions

2.2.1Location 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 station is registered at one location register which functions as its home centre for charging and billing purposes and for administering its subscriber parameters.

FIGURE 2/Q.1001

Use of the definitions.
In this example the service area consists of one PLMN

system associated with each service area must thus contain a list of all mobile stations located within that service area.

Figure 2/Q.1001 shows an example of the composition of a service area.

Note - This definition does not take into account any constraints on routing imposed by the international telephone network.

2.1.11 System area

The system area consists of one or more service areas with fully compatible MS-BS interfaces.

Note - The location registers of the individual service areas remain autonomous; updating of the location information is not performed when a roaming mobile station moves from one service area to another. The overall composition of the international land mobile system is shown in Figure 3/Q.1001.

2.1.12 Mobile Subscriber International ISDN Number

The Mobile Subscriber International ISDN Number is defined as the number which has to be dialled in order to reach a mobile subscriber in a service area. See also Recommendations E.164 and E.213.

2.1.13 International mobile station identity

The mobile station's identification uniquely identifies the MS internationally. The identity is composed as defined in Recommendation E.212.

In an automatic system the Mobile Services Switching Centre (MSC) constitutes the interface between the radio system and the public switched telephone network. The MSC performs all necessary signalling functions in order to establish calls to and from mobile stations.

In order to obtain radio coverage of a given geographical area a number of base stations (radio transmitters/receivers) are normally required; i.e.
each MSC would thus have to interface several base stations. In addition several MSCs may be required in order to cover a country. The definition of the MSC may be prefixed by the terms "land" or "maritime" if that is more suitable in a specific application.

2.1.4Base station

The base station (BS) is the common name for all the radio equipment located at one and the same place used for serving one or several cells.

2.1.5Mobile station

The mobile station (MS) is the interface equipment used to terminate the radio path at the user side. It includes terminal functions required to provide services to the user, e.g. terminal equipment and terminal adaptors.

2.1.6Cell

The area covered by a base station, or by a sub-system (sector antenna) of that base station corresponding to a specific logical identification on the radio path, whichever is smaller.
Every mobile station in a cell may be reached by the corresponding radio equipment of the base station.

2.1.7Base station area

The area covered by all the cells served by a base station.

2.1.8Location 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 comprise several cells.

2.1.9MSC area

The part of the network covered by an MSC. An MSC area may consist of several location areas.

2.1.10Service area

The service area is defined as an area in which a mobile station is obtainable by another PLMN, PSTN or ISDN 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 comprise several countries. The location registration

interfaces between the fixed network and a PLMN for call set-up. In the second case, it can be considered as an assemblage of special logic in existing or future PSTN/ISDN stored program controlled digital local exchanges, conceptually integrated within a common numbering and routing plan.
Functionally the PLMNs may be regarded as independent telecommunications entities even though different PLMNs may be interconnected through the 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.

The location register system of a PLMN may be centralized, distributed or segmented. So long as we are concerned with functions of a PLMN, such as routing and interworking, the configuration and operation of the location register system have no influence on external networks.

The use of the concept PLMN is illustrated in Figure 1/Q.1001 where various PLMNs are shown with their interfaces to the fixed networks. It should be noted that a PLMN may have several interfaces with the fixed network (e.g. one for each MSC). Interworking between two PLMNs may be performed via an international gateway.

Figure 1/Q.1001 also shows the information paths between a PSTN and a PLMN and between two different PLMNs. The solid lines indicate a possible physical path between the PLMNs through the PSTN. The dotted line indicates that, for some interactions, an end-to-end information path (established through the physical path) may exist between the two PLMNs.

FIGURE 1/Q.1001

The use of the concept PLMN for country A and country B

2.1.3 Mobile services switching centre

Contents of Recommendation Q.1001

GENERAL ASPECTS OF PUBLIC LAND MOBILE NETWORKS

1. General

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4. Services in the Public Land Mobile Network

5. List of acronyms Recommendation Q.1001

GENERAL ASPECTS OF PUBLIC LAND MOBILE NETWORKS

1.General

This Recommendation covers definitions, architectures and services in Public Land Mobile Networks.

The definition section is subdivided into basic, roaming and handover subheadings.

The architecture section covers examples of Public Land Mobile Network architecture in roaming and handover situations.

The services section covers introductory descriptions of basic and supplementary services that can be provided to the user.

2.Definitions

2.1Basic definitions

2.1.1Public Land Mobile Services

Telecommunications services provided to moving subscribers (terrestrial applications).

2.1.2Public Land Mobile Network

A Public Land Mobile Network (PLMN) is established and operated by an administration or RPOA for the specific purpose of providing land mobile telecommunication services to the public. A PLMN may be regarded as an extension of a fixed network (e.g. PSTN) or as an integral part of the PSTN. In the first case, it can be considered as a collection of mobile services switching centre (MSC) areas within a common numbering plan (e.g. service access codes) and a common routing plan (e.g. definition of crossover point); in this case the MSCs are the functional