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**TELEPHONE NETWORK AND ISDN
QUALITY OF SERVICE, NETWORK MANAGEMENT
AND TRAFFIC ENGINEERING**

**REFERENCE CONNECTIONS FOR
TRAFFIC ENGINEERING OF
LAND MOBILE NETWORKS**

ITU-T Recommendation E.751

(Previously "CCITT Recommendation")

FOREWORD

The ITU-T (Telecommunication Standardization Sector) is a permanent organ of the International Telecommunication Union (ITU). The ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Conference (WTSC), which meets every four years, establishes the topics for study by the ITU-T Study Groups which, in their turn, produce Recommendations on these topics.

The approval of Recommendations by the Members of the ITU-T is covered by the procedure laid down in WTSC Resolution No. 1 (Helsinki, March 1-12, 1993).

ITU-T Recommendation E.751 was revised by ITU-T Study Group 2 (1993-1996) and was approved under the WTSC Resolution No. 1 procedure on the 19th of February 1996.

NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

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SUMMARY

This Recommendation provides some reference architectures for existing and future public land mobile telecommunication networks (PLMN) and also provides a high level reference connection for Future Public Land Mobile Telecommunication Systems (FPLMTS) call/connection setup. The primary purpose of the reference connection is to provide a basis for developing traffic Grade of Service (GOS) Recommendations for networks supporting mobile services. The underlying FPLMTS call flow model in the reference connection should be used as a basis for more implementation-specific configurations for detailed performance analysis and GOS target setting.

REFERENCE CONNECTIONS FOR TRAFFIC ENGINEERING OF LAND MOBILE NETWORKS

(revised in 1996)

1 Objective and scope

This Recommendation provides some reference architectures for existing and future PLMN and also provides a high level reference connection for FPLMTS call/connection setup. The primary purpose of the reference connection is to provide a basis for developing traffic Grade of Service (GOS) Recommendations for networks supporting mobile services. The underlying FPLMTS call flow model in the reference connection should be used as a basis for more implementation-specific configurations for detailed performance analysis and GOS target setting.

A mobile service is provided by means of a network which supports:

- radio transmission;
- switching;
- mobility management functions.

The elements which constitute the network may be owned and operated by one or more system operators. Likewise, mobile services may be provided by one or more service providers. The type of network elements owned by each type of operator and the type of services provided by each service provider, may vary in different (national and/or commercial) frameworks.

2 References

The following Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision: all users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published.

- CCITT Recommendation E.201 (1991), *Reference Recommendation for mobile services*.
- CCITT Recommendation E.723 (1992), *Grade-of-service parameters for Signalling System No. 7 networks*.
- ITU-T Recommendation F.115 (1995), *Service objectives and principles for future public land mobile telecommunication systems*.
- CCITT Recommendation Q.1001(1988), *General aspects of public land mobile networks*.
- CCITT Recommendation Q.1002 (1988), *Network functions*.
- CCITT Recommendation Q.1003 (1988), *Location registration procedures*.
- CCITT Recommendation Q.1201 (1992), *Principles of intelligent network architecture*.
- ITU-R Recommendation M.687-1, *Future Public Land Mobile Telecommunication Systems (FPLMTS)*.
- ITU-R Recommendation M.817, *Future Public Land Mobile Telecommunication Systems (FPLMTS) – Network architectures*.

3 Abbreviations

For the purposes of this Recommendation, the following abbreviations are used.

BSS	Base Station System
CCF	Call Control Function
DB	Database
FPLMTS	Future Public Land Mobile Telecommunication Systems
GOS	Grade of Service
GSM	Global System for Mobile Communications
IN	Intelligent Network
ISDN	Integrated Services Digital Network
LE/TE	Local or Transit Exchange
LES	Land Earth Station
MCPN	Mobile Customer Premises Network
MMF	Mobility Management Functions
MSC	Mobile Switching Centre
NADC	North American Digital Cellular
PLMN	Public Land Mobile Networks
PSTN	Public Switched Telephone Network
SCF	Service Control Function
SCP	Service Control Point
SDF	Service Data Function
SSF	Service Switching Function
SSP	Service Switching Point
TE	Terminal Equipment
UMTS	Universal Mobile Telecommunication System
UPT	Universal Personal Telecommunication

4 Functional and physical architectures

Whereas existing PLMNs tend to use physical architectures to indicate the interconnection of various subsystems, FPLMTS uses an IN-based functional architecture to indicate the relationship between various functional entities to support the mobile services. The key IN functions involved in such functional architectures include the SSF/CCF, SCF and SDF where these functions are defined in Recommendation Q.1201.

For FPLMTS, these functional elements will support such features as registration, paging, location tracking as well as basic call and connection control and radio resource management. Further, the above functions will have to be mapped onto a range of physical elements for specific implementations. One possible mapping used in this Recommendation is shown in Table 1.

TABLE 1/E.751

Possible mapping of functional elements onto physical elements

Functional element	Physical element
SSF/CCF	MSC/SSP
SCF	SCP
SDF	DB
CCAF(R)	BSS

5 Reference architectures

5.1 Reference architecture for interconnection of fixed and stand-alone mobile networks

This subclause provides some example reference architectures for interconnecting public land mobile networks to fixed (PSTN/ISDN) networks.

A reference architecture for the case of a stand-alone mobile network is given in Figure 1. This reference architecture considers interaction between functions in the land mobile and the fixed domains. The land mobile domain may be terrestrial or satellite based.

It is envisaged that FPLMTS will be implemented either as stand-alone systems providing all required terminal mobility functions or as a system integrated with the fixed (PSTN/ISDN) network where some of the terminal mobility functions are implemented in the fixed network.

Within this reference architecture traffic engineering is concerned with traffic flows (in the user as well as in the control plane) across the teletraffic interfaces in the land mobile domain and the interface A between the mobile and the fixed network domain.

In Figure 1, within the land mobile domain, the common equipment units perform the following functions:

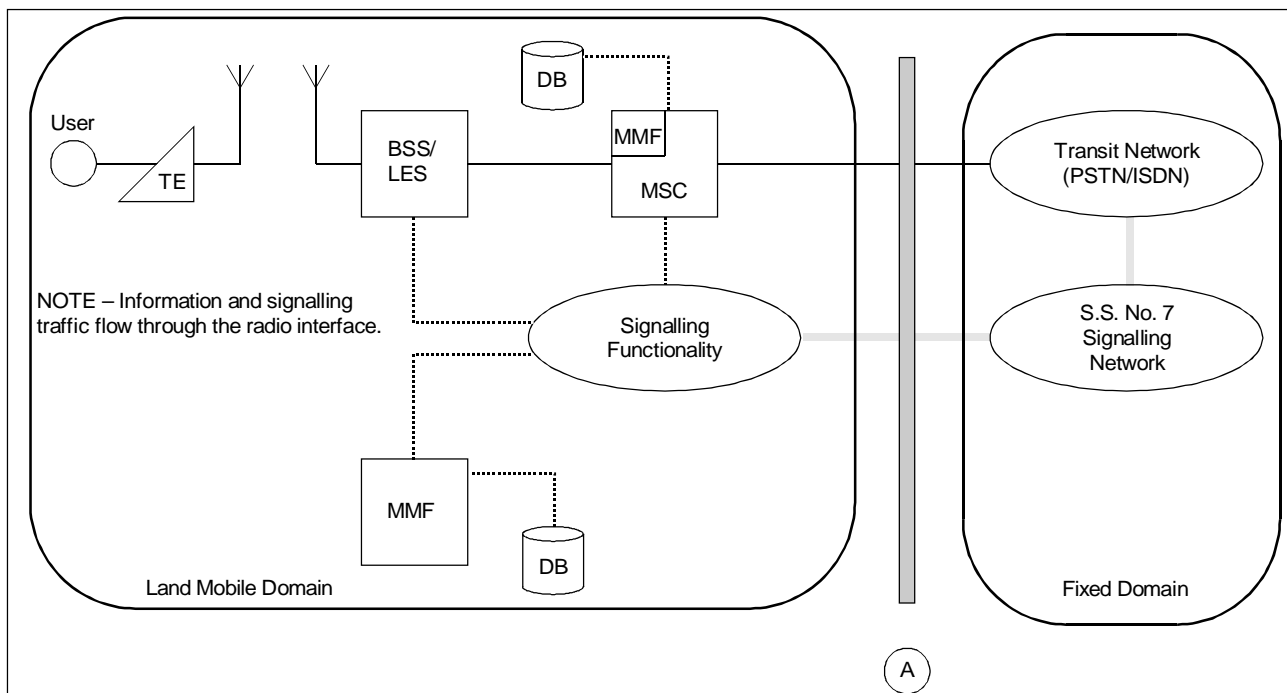
- Mobile Switching Centre (MSC): all the switching functions to its particular area (MSC area);
- Mobility Management Function (MMF): the handover and location registration functions for mobile terminal equipments (TEs) in the MSC area;
- Base Station System (BSS): radio transmission and radio channel control. Note that BSS may include several radio equipments under the supervision of one controller equipment;
- Database (DB): storage for user data (service and mobility management).

As a variation of the reference architecture in Figure 1, the boundary between the mobile switching centre and the transit network (PSTN/ISDN) may only be logical. This variation is represented in Annex A.

Depending on the mobility behaviour of the users and the radio coverage architectures (terrestrial or satellite based), a partitioning of the mobile switching centre functions into more sophisticated arrangements than those in Figure 1 may be envisaged. An example of hierarchical arrangement is shown in Annex B.

5.2 Reference architecture for interconnection of mobile networks integrated with fixed networks

An architecture which envisages integration of mobile and fixed network functions and operation is shown in Figure 2. In Figure 2, MSC/SSP, SCP and DB are specialized units handling respectively switching, mobility management and control and database functions. Note that the boundary between land mobile and fixed domain lies between BSS and MSC/SSP; this involves an adequate characterization of the traffic processes relevant to the engineering of the fixed network.



T0205360-95/d01

- Logical relationship
- User plane traffic
- Control plane traffic

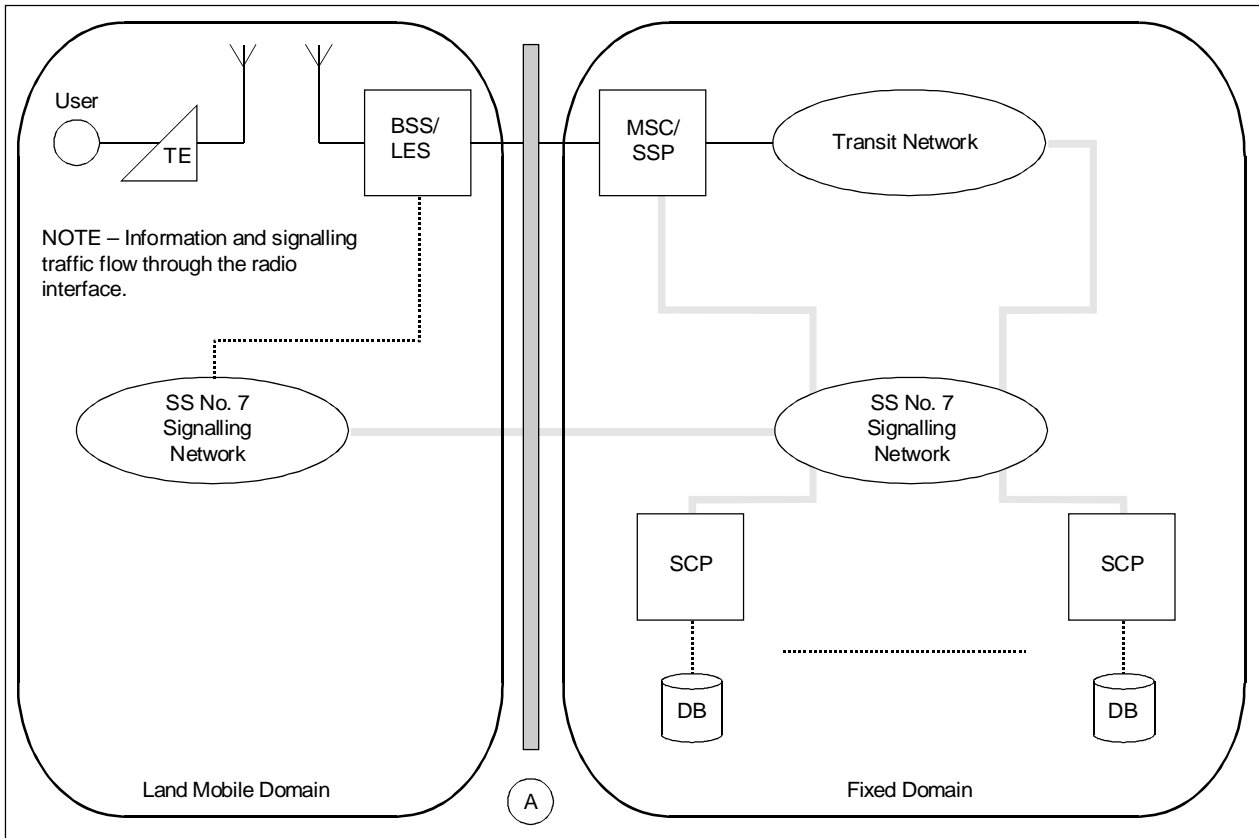
A	Teletraffic interface between mobile and fixed network domain
BSS	Base Station System
DB	Database
LES	Land Earth Station
MMF	Mobility Management Functions
MSC	Mobile Switching Centre
TE	Terminal Equipment
User	Originating/Terminating user

NOTES

- 1 MMF can be contained in the MSC or operated separately.
- 2 In some cases no protocol adaptation functions are required between the signalling functionality in the mobile and in the fixed domain.

FIGURE 1/E.751

**Reference architecture for separate mobile and fixed networks,
and mobile originated/terminated circuit-switched services**



T0205370-95/d02

- Logical relationship
- User plane traffic
- Control plane traffic

- A Teletraffic interface between mobile and fixed network domain
- BSS Base Station System
- DB Database
- LES Land Earth Station
- MSC Mobile Switching Centre
- SCP Service Control Point
- SSP Service Switching Point
- TE Terminal Equipment (mobile station)
- User Originating/Terminating user

NOTE – SCP provides service data function (processing).

FIGURE 2/E.751
**Reference architecture for integrated mobile and fixed networks,
 and circuit-switched services**

Note that for integrated mobile and fixed networks it is envisaged that SS No. 7 would be used in both land mobile and fixed domains.

More sophisticated arrangements than those in Figure 2 may be envisaged, e.g. those resulting in a two-hop radio interface as shown in Annex C.

6 Existing and planned systems and reference architecture

The reference architectures described in clause 5 apply to existing or planned systems. For the purpose of providing examples, interconnection of fixed and “stand-alone” land mobile networks are represented by the NADC and the GSM system.

The emerging standards for FPLMTS, the European UMTS and some North American advanced mobile systems consider that functions for supporting terminal mobility may be allocated to either the mobile (“stand-alone” implementations) or the fixed network. Depending on the actual implementation, interconnection of separate or integrated fixed and land mobile networks, including satellite based systems, will result.

7 Reference connections

Reference connections are aimed at identifying representative cases without involving the specifics of actual realizations. (For example, databases should be considered – as far as practicable – at the functional level, without considering the specifics of actual partitioning and distribution.)

7.1 Reference connections for FPLMTS

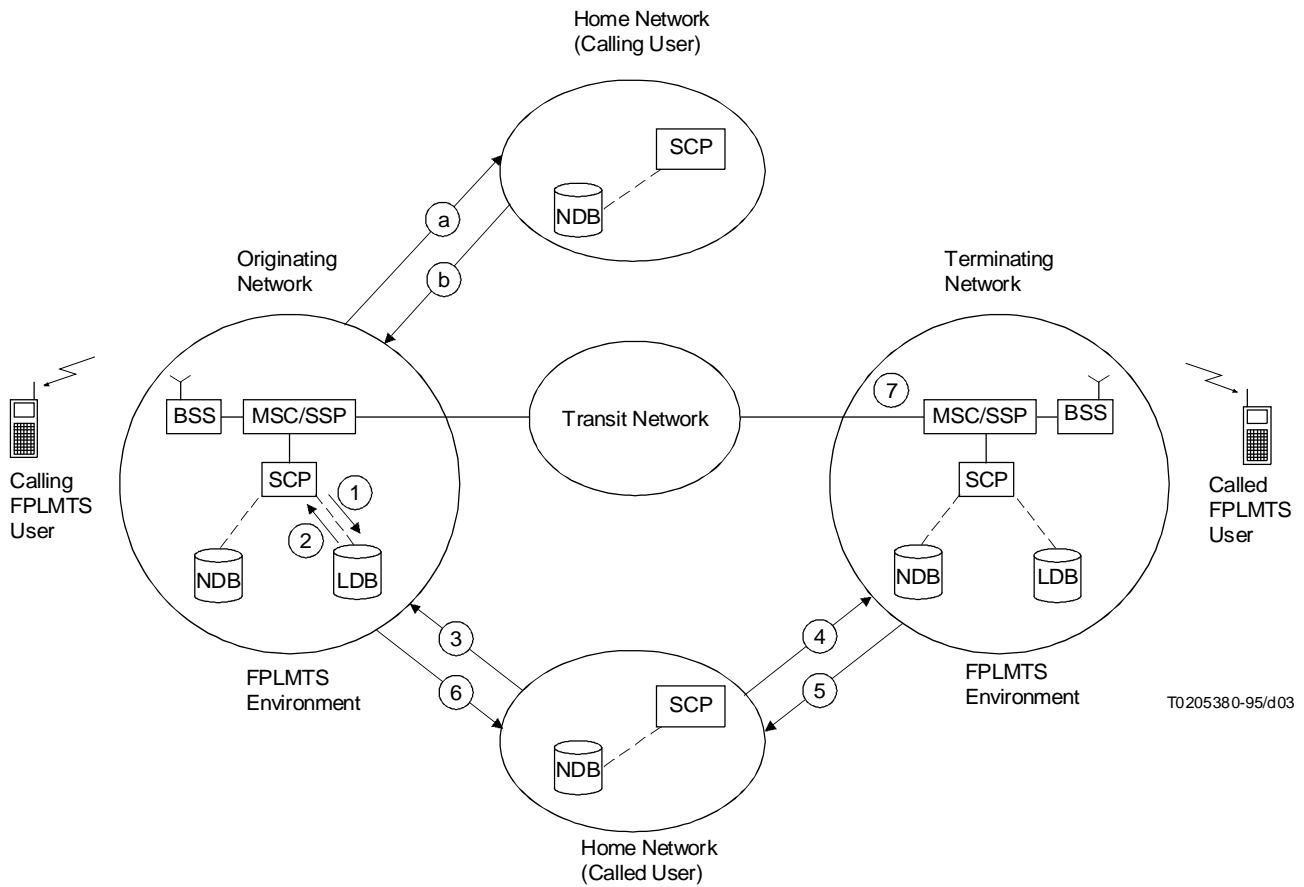
A reference connection for FPLMTS for setting traffic GOS parameter values providing a view of end-to-end call/connection setup is given in Figure 3. Further, the reference connection selected for this purpose considers a (near) worst-case scenario in terms of the delay and blocking encountered in setting a call/connection, so that traffic GOS targets based on the reference connection should be satisfied in almost all practical implementations.

In the reference connection of Figure 3 the following assumptions are implicit:

- i) Both called and calling parties are FPLMTS users.
- ii) Both FPLMTS users are outside their respective home networks.
- iii) The home network NDB maintains FPLMTS user’s service profile on a permanent basis.
- iv) The FPLMTS user’s service profile (including information for user/terminal authentication) is transferred to the LDB of the visited network as a part of location registration.
- v) When locations of the originating and terminating users are registered, their home NDBs receive the addresses of the appropriate LDBs that provide call routing.
- vi) Full SS No. 7/IN capabilities are assumed.
- vii) Routing number is transferred from the visited network of the called user to the home network on a call-by-call basis.

8 History

Recommendation first published in 1993, revised in 1996.



T0205380-95/d03

..... Signalling connection
 ——— Bearer connection

BSS Base Station System
 LDB Local Database
 MSC/SSP Mobile Switching Centre/Service Switching Point
 NDB Network Database
 SCP Service Control Point

NOTES

- 1 Bearer and signalling circuits in each network may consist of terrestrial and/or satellite facilities.
- 2 Numbers 1 to 7 indicate the sequence of operations. In particular, 1 and 2 indicate authentication of calling user/terminal; 3 and 6 indicate obtaining the routing number; 4 and 5 indicate transferring the routing number; 7 indicates bearer connection to MSC/SCP.
- 3 Normally location registration (a and b) is not a part of the call setup phase and the related non-call-associated messages will contribute to the background traffic load on the signalling network.
- 4 MSC/SSP indicates that the mobile switching function may be integrated into the fixed network.

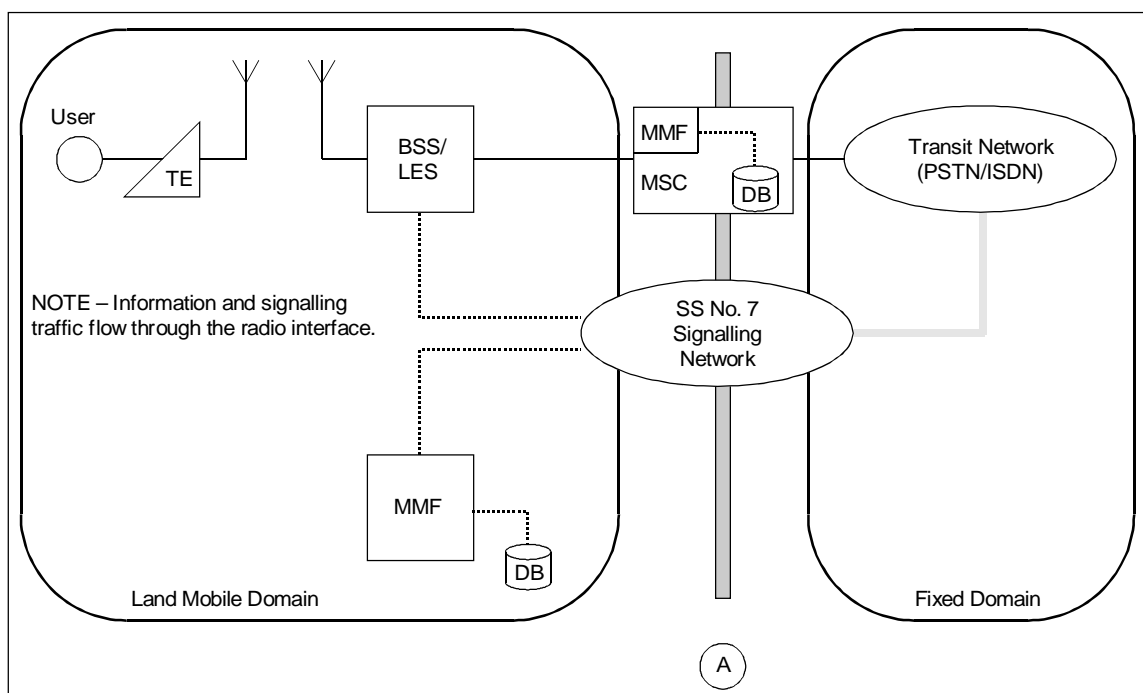
FIGURE 3/E.751
 A reference connection for FPLMTS traffic performance and GOS

Annex A

Reference architecture for mobile-fixed interconnection with mobile switches integrated within the fixed network

(This annex forms an integral part of this Recommendation)

As a variation of the reference architecture in 5.1, the boundary between the mobile switching centre and the transit network (PSTN/ISDN) may only be logical. In fact, the functions for managing mobile services may be physically associated with fixed network local or transit exchanges, as represented in Figure A.1. The boundary between land mobile and fixed network runs then across the local or transit exchange. Further study is required to clarify the traffic implications of this boundary location.



T0205390-95/d04

..... Logical relationship

———— User plane traffic

———— Control plane traffic

A	Teletraffic interface between mobile and fixed network domain
BSS	Base Station System
DB	Database
LES	Land Earth Station
MMF	Mobility Management Functions
MSC	Mobile Switching Centre
TE	Terminal Equipment
User	Originating/Terminating user

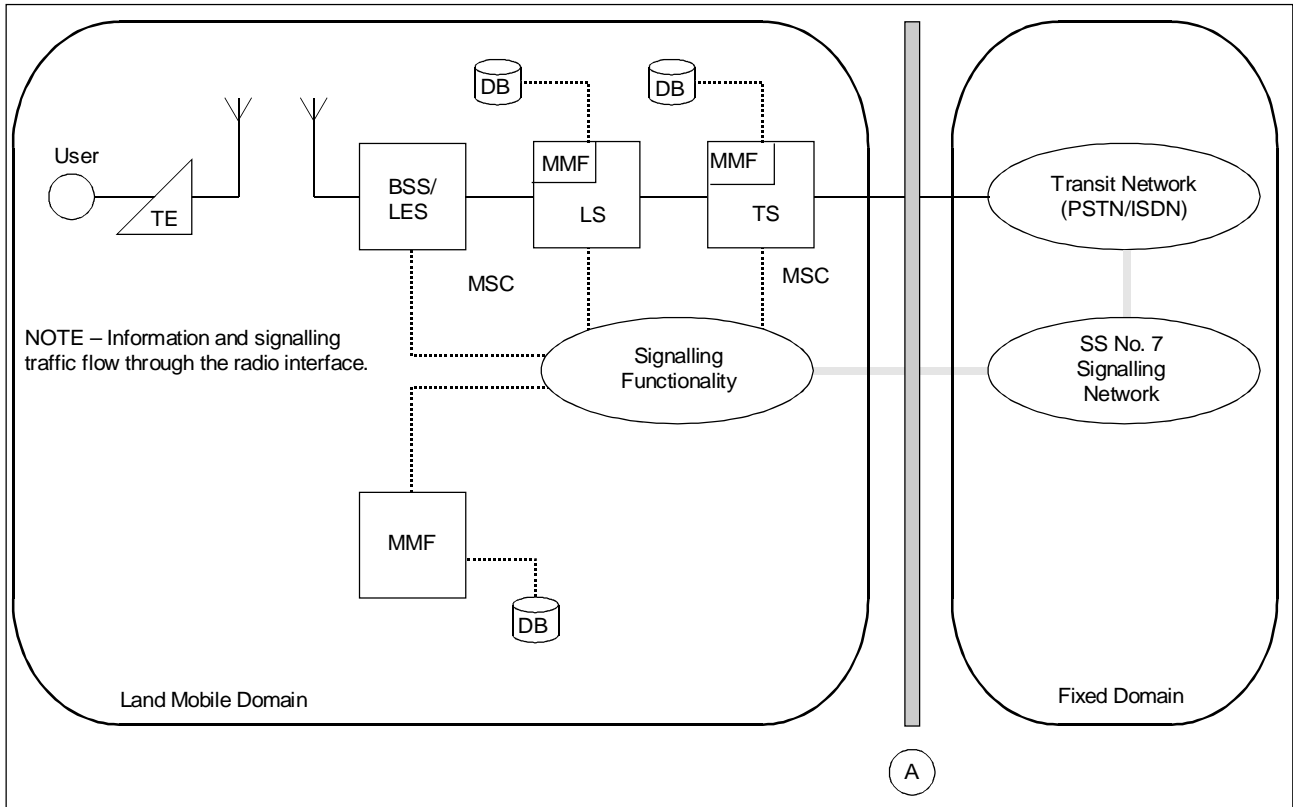
FIGURE A.1/E.751

Reference architecture for mobile switches integrated within the fixed network and mobile originated/terminated circuit-switched services

Annex B

Hierarchical arrangement of mobile switching centre functions for the reference architecture of Figure 1

(This annex forms an integral part of this Recommendation)



T0205400-95/d05

..... Logical relationship

———— User plane traffic

———— Control plane traffic

A	Teletraffic interface between mobile and fixed network domain
BSS	Base Station System
DB	Database
LES	Land Earth Station
LS	Mobile local switching function
MMF	Mobility Management Functions
MSC	Mobile Switching Centre
TE	Terminal Equipment
TS	Mobile transit switching function
User	Originating/Terminating user

NOTES

- 1 MMF can be contained in the MSC or operated separately.
- 2 In some cases, no protocol adaptation functions are required between the signalling functionality in the mobile and in the fixed domain.

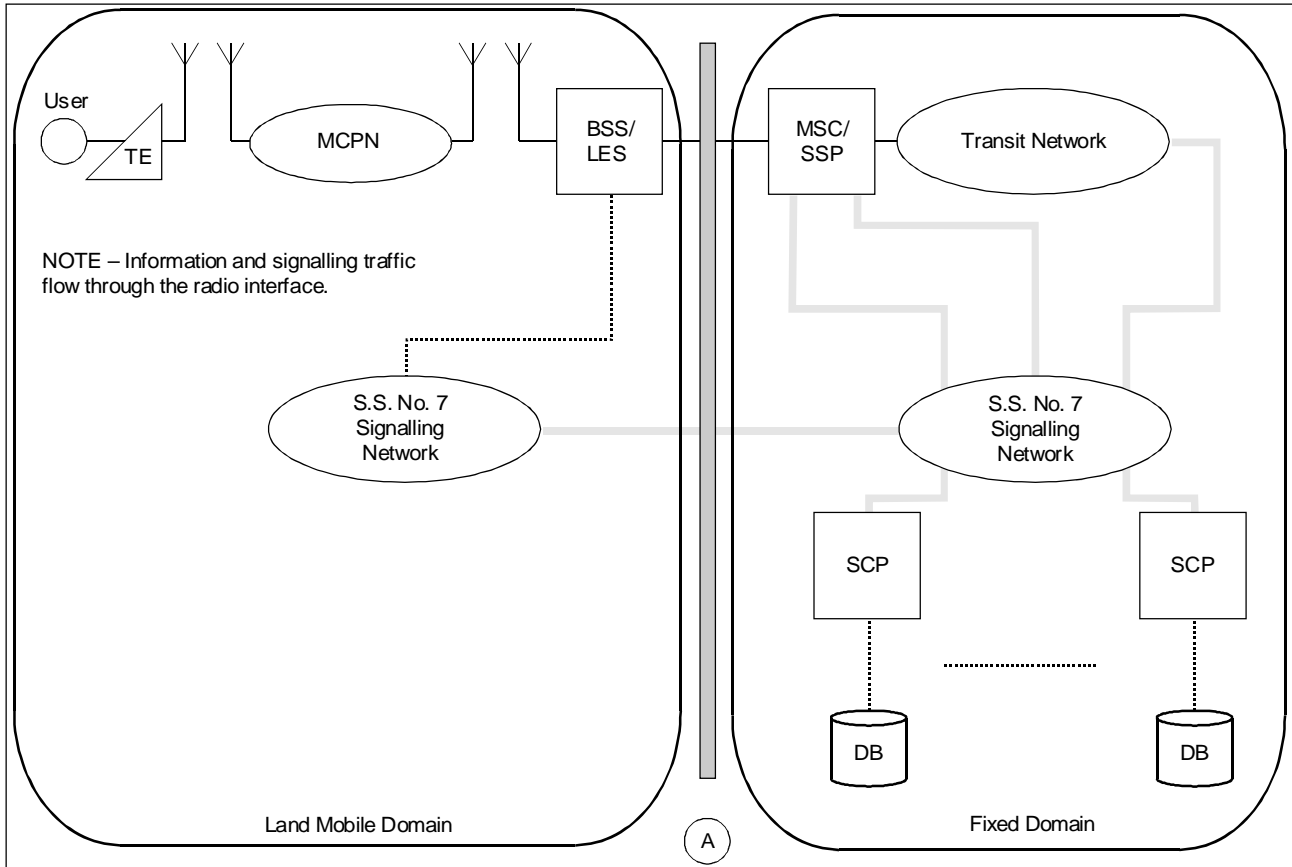
FIGURE B.1/E.751

**Reference architecture for separate mobile and fixed networks,
hierarchical arrangement of mobile switching functions,
and mobile originated/terminated circuit-switched services**

Annex C

Two-hop radio interface arrangement for the reference architecture of Figure 2

(This annex forms an integral part of this Recommendation)



T0205410-95/d06

- Logical relationship
- User plane traffic
- Control plane traffic

A	Teletraffic interface between land mobile and fixed network domain
BSS	Base Station System
DB	Database
LE/TE	Local or Transit Exchange
LES	Land Earth Station
MCPN	Mobile Customer Premises Network
MSC	Mobile Switching Centre
SCP	Service Control Point
TE	Terminal Equipment (mobile station)
User	Originating/Terminating user

NOTE – SCP provides service data function (processing).

FIGURE C.1/E.751

Reference architecture for integrated mobile and fixed networks with two-hop radio interface arrangement and circuit-switched services

NOTE – A Mobile Customer Premises Network (MCPN) is a subnetwork in a mobile vehicle (e.g. train, ship, car, etc.). Thus MCPNs involve radio interfaces at both the terminal and the network side.