NEAR EAST UNIVERSITY

Faculty of Engineering
Department of Electrical and Electronic Engineering

Mobile Communication Using Siemens D900

Graduation Project
EE- 400

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LIST OF ABREVIATIONs

AC	Authentication Center
ACOM	Antenna Combiner
AMA	Automatic Message Accounting
AOC	Advice of Charge
AOCC	Advice of Charge - Charging level
AOCI	Advice of Charge - Information level
APS	Application Program System
ATM	Asynchronous Transfer Mode
ATOP	Automatic Operator
BA	Basic Access
BAIC	Barring of All Incoming Calls
BAOC	Barring of All Outgoing Calls
BAP	Base Processor
BBSIG	Baseband and Signal Processing
BDCG	Bus Distributor Module with Clock Generator for DSU
BIC-Roam	Barring of All Incoming Calls when Roaming outside home PLMN country
BMML	Basic MLL
BOIC	Barring of All Outgoing International Calls
BOIC-exHC	Barring of All Outgoing International Calls except to Home PLMN Country
BSC	Base Station Controler
BSCI	**BSC** Interface Card
BSIC	Base Station Identity Code
BSS	Base Station System
BSSAP	Base Station System Application Part
BSSMAP	Base Station System Management Application Part
BTS	Base Transceiver Station
BTSE	Base transceiver station equipment
CAP	Call Processor

CCBS	Completion of Call to Busy Subscribers
CCG (A)	Central Clock Generator A
CCNC	Common Channel Signaling Network Control
CCNP	Common Channel Signaling Network Prozessor
CCS7	Common Channel Signaling System No. 7
CCTRL	Core Controller
CD ROM	Compact Disc Read Only Memory
CDA	Circuit Duplex Asynchronous
CDS	Circuit Duplex Synchronous
CFB	Call Forwarding on mobile subcriber Busy
CFNRc	Call Forwarding on mobile subscriber Not Reachable
CFNRy	Call Forwarding on No Reply
CFU	Call Forwarding Unconditional
CLIP	Calling Line Identification Presentation
CLIP	Calling Line Identification Restriction
CM	Configuration Management
CMISE	Common Management Information Service Element
CML	Command Manual
CMY	Common Memory
CNI	Comfort Noise Insertion
COU	Control of Use
COUB	Conference Unit, Module B
CP113C/CR	Coordination Processor 113C/CR
CRP8	Code Receiver for Pushbutton Dialing, 8 Receiver Modules
CSC	Combined Switching Center
CSDN	Circuit Switched Data Network
CT	Call Transfer
CUG	Closed User Group

CW	call Waiting
D1800	Digital Mobile Radio Communication Network, DCS Standard
D900	Digital Mobile Radio Communication Network, GSM Standard
DCS	Digital Communication System
DEC	Digital Echo Compensator
DIU: LDIM	DIU for local DLU Interface, Module M
DIU120A	Digital Interface Unit, 4x2046bit/s, Module A
DLU	Digital Line Unit
DLUB	Digital Line Unit B
DLUC	Control for DLU System (in DSU/DLUB)
DPPS	Data Post Processing System
DSU	Data Service Unit
DTAP	Direct Transfer Application Part
DTLP	Line Interface
DTMF	Dual Tone Multi-Frequency Signaling
DTX	Discontinuous Transmission
DTX	Discontinuous Transmission
DLJCOM	Duplex Combiner
EDSS.1	European Digital Subscriber Signaling System No. 1
EIR	Equipment Identity Register
EM	External Memory
EMCYMN	Emergency Manual
ETSI	European Telecommunications Standards Institute
EWSD	Digital Electronic Switching System
EX	Exchange
F: xxx	Module Frame for **xxx**
FAC	Final Assembly Code
FDMA	Frequency Division Multiple Access
FM	Fault Management

FPH	Freephone Service
FTAM	File Transfer and **Access** Management
GCG:DLUB	Group Clock Generator for DLUB
GMSC	Gateway MSC
GMSK	Gaussian Minimum Shift Keying
GP	Group Processor
GPL	Group Processor for LTGM
GS	Group Switch
GSM	Global System for Mobile Communication
GSM	Group Switch for LTG, Module M
HEPP	Hardware Engineering Product Plan
HLR	Home Location Register
HPLMN	Home PLMN
HYCOM	Hybrid Combiner
IARAMA	Inter Administration Accounting with AMA
IARSTAT	Inter Administration Accounting with Statistic
EMEI	International Mobile Equipment Identity
IMSI	International Mobile Subscriber Identity
IN	Intelligent Network
INAP	IN Application Part
IOC	Input/Output Control
IOP	Input Output Processor
IOP: AUC	Input/Output Processor for Authentication Center
IP	Intelligent Peripheral
ISDN	Integrated Services Digital Network
ISO	International Organization for Standardization

ISUP	SDN User Part
ITU-T	International Telecommunication Union, Sector Telecommunication Standardization
IWE	Interworking Equipment
IWF	Interworking Function
IXLT	O&M Interface
LAI	Location Area Identity
LAN	Local Area Network
LI	Link Interface
LIU	Link Interface Unit between LTGandSN (B)
LMSI	Local Mobile Subscriber Identity
LMT	Local Maintenance Terminal
LTG	Line/Trunk Group
LTGB	Line/Trunk Group B
LTGG	Line/Trunk Group G
LTGM	Line/Trunk Group M
MAH	Mobile Access Hunting
MAP	Mobile Application Part
MB (B)	Message Buffer B
MF	Mediation Function
MFC: R2	Multifrequency Code Signaling (R2)
MIC	Mobile Internal Call (intra MSC)
MMC	Mobile to Mobile Call (inter MSC)
MMI	Man Machine interface
MML	Man Machine Language
MMN	Maintenace Manual
MOC	Mobile Originated Call
MPCC	Main Processor Control Card
MPM	Multiple Pulse Metering
MPTY	Multi Party Service

MS	Mobile Station
MSC	Mobil-Services Switching Center
MSC3	MSC Interface Card
MSRN	Mobile Station Roaming Number
M-SSP	Mobile SSP
MTC	Mobile Terminated Call
MTP	Message Transfer Part
NDC	National Destination Code
NMC	Network Management Center
OCANEQ	Operationally Controlled Equipment for Announcement
OCE: MUP	Operationally Controlled Equipment for Announcement, Memory Unit (PROM)
OCE: SPC Program	Operationally Controlled Equipment for Announcement, Stored Control
ODB	Operator Determined Barring
OEM	Original Equipment Manufacturer
OGL	Operator Guide Line
OMC	Operation and Maintenance Center
OMN	Operation and Maintenance Manual
OMP	Operation and Maintenance Processor
OMP-B	Operation and Maintenance Processor for BSS
OMP-S	Operation and Maintenance Processor for SSS
OMS	Operation and Maintenance Subsystem
OMT	Operation and Maintenance Terminal
OMTS	OMT local to SSS Node
OMTX	X Terminal
OS	Operations System
OSD	OMS Status Display
OSF	Open System Foundation
OSI	Open Systems Interconnection

PA	Power Amplifier
PA	Primary Access
PABX	Private Automatic Branch Exchange
PAD	Packet Assembler/Disassembler PCS Personalization Center for SIM
PH	Packet Handler
PLMN	Public Land Mobile Network
PM	Performance Management
PPCC	Peripheral Processor for CCS7
PPLD	Peripheral Processor for LAPD Channels
PPM	Periodic Pulse Metering
PPS	Prepaid Service
PPSC	Prepaid Service Center
PSDN	Packet Switched Data Network
PSTN	Public Switched Telephone Network
R: xxx	Rack for xxx
RAND	Random Number
RF	Radio Frequency
RSS	Radio Subsystem
RX	Receiver
RXAMOD	Receive Antenna Module
RXFIL	Bandpass Filter for Receive Path
RXMUCO	Receiver Multi Coupler
S/N	Signal to Noise
SAS	Secure Application Service
SCI	Subscriber Controlled Input
SCM	Mass Calling Service
SCP	Service Control Point
SDL	Specification and Description Language
SGCB	Switch Group Control B
SILTG	Signaling Link Terminal Group

SIM	Subscriber Identity Module
SIVAPAC	Siemens Variable Packaging System
SLMA: FPE	Subscriber Line Module Analog for DLUB, Feature programmable, Module E
SLMD	Subscriber Line Module Digital
SM	Security Management
SMC	Security Management Center
SMD	Surface Mounted Device
SMP	Service Management Point
SMS	Short Message Service
SN (B)	Switching Network B
SN64	Switching Unit
SPM	Single Pulse Metering
SRES	Signed Response
SSP	Service Switching Point
SU	Signaling Unit
SYP	System Panel
TAC	Technical Assistance Center
TAG	Type Approval Code
TCAP	Transaction Capabilities Application Part
TCP/IP	Transmission Control Protocol/Internet Protocol
TDMA	Time Division Multiple Access
TDPC	Telephony and Distributor Processor Card
TED	Technical Description
TIS	Teleinfo Service
TMSI	Temporary Mobile Subscriber Identity
TPU	Transceivr and Processor Unit
TRAC	Transcoding and Rate Adaption Card
TRAU	Transcoding and Rate Adaption Unit
TRXA	Analogue Signal Processing Part

TRXD	Digital Signal Processing Part
TU	Test Unit
TUP	Telephone User Part
TV	Televoting
TX	Transmitter
TXAMOD	Transmit Antenna Module
TXFIL	Bandpass Filter for Transmit Path
UN	Universal Number
USC	Universal Supervisory Center
USSD	Unstructured Supplementary Service Data
VAD	Voice Activity Detection
VLR	Visitor Location Register
VMS	Voice Mail System
VPN	Virtual Private Network
WAN	Wide Area Network
WLL	Wireless Local Loop

LIST OF FIGURES

ABSTRACT

Communication, It goes without saying that it is a basic need of this world. There are many ways of communication such as phone, Internet, mobile, pager etc. Mobile it is a very easy way to communicate you don't need a computer or wire line, so mobile have become very important part of our life. There are a big growing number of customers of the telecommunication administration and operators would like to have modern communication facilities at their disposal wherever and when ever they need them.

In order to meet this demand on an international scale, the European Telecommunication Standards Institute (ETST) has specified the Global System for Mobile Communication (GSM) and the Digital Communication System (DCS) on the basis of the Global System For Mobile Communication (GSM).

CONTENTS

CHAPTER ONE

Network Survey

Overview

The D900 system concept offers the components-

• GSM/DCS PLMN (cellular mobile radio system), for "connecting" PLMN mobile subscribers

• CSC (combined switching center), for additional connection of wireless local loop mobile subscribers (WLL mobile subscribers) and wired ISDN/Analog subscribers

• IN network functions in the GSM/DCS PLMN and CSC (for mobile subscribers in the GSM/DCS PLMN and for wireless local loop mobile subscribers or wired ISDN/Analog subscriber in the CSC)

1.1 GSM/DCS PLMN Coverage Areas

D900 is a cellular radio system. The whole public land mobile network (PLMN) area is covered by a great number of radios cells, as is usual with mobile radio systems (Fig).

Cell

A cell (radio cell) is the smallest service area where particular radio channel equipment is used for a connection and the telecommunication services are supplied by a base transceiver station (BTS). Within the radio cell coverage area a defined quality of reception is provided.

One or more cells form a **location area.**

Location Area

A location area is a service area in which a mobile subscriber may move freely without updating a location (or visitor) register. The size of a location area is determined by the operator to meet the demands imposed by traffic density and flow, population density and subscriber mobility.

One or more location areas form a coverage area of mobile services switching center/visitor location register (MSC/VLR area).

One or more MSC/VLR coverage areas form the PLMN **area.** This is the geographical area inside which an operator provides telecommunications services. Several areas may geographically overlap.

A PLMN country may consist of one or more PLMN areas. A **GSM/DCS system area** comprises one or more PLMN countries.

A 'service area' is defined as an area in which a mobile subscriber can be reached by another subscriber without the subscriber's knowledge of the actual location of the mobile subscriber within the area. The location registration system associated with each service area must thus contain a list of all mobile subscribers located within that service area.

D900 is a system that serves "mobile" user stations. A mobile station can be carried practically anywhere by the mobile user, for example in the car or as a pocket portable. The D900 detects when a mobile station crosses the border between two radio cells during a call and ensures handover of the call from one radio cell to the next.

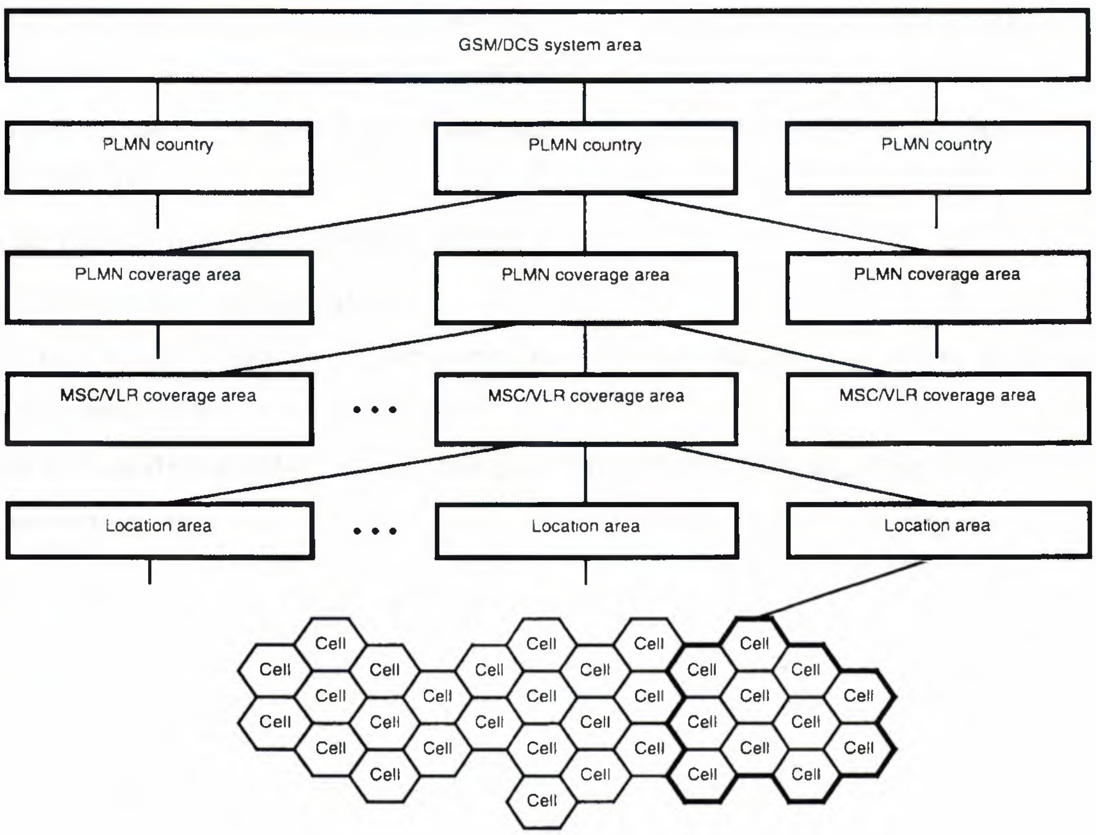


Fig 1.1 Subdivision of the D900 PLMN coverage areas.

1.2 D900 PLMN Subsystems

By realizing the switching subsystem (SSS) network elements on the basis of the Digital Electronic Switching System EWSD with its very powerful multiprocessor CP113C/CR, and by integration of the base-station controller (BSC) and the base transceiver station (BTS) into this system, Siemens offers with D900 an outstanding mobile communication system which is characterized by high traffic power and great simplicity in the configuration of its components.

The mobile communication system D900 realizes a GSM/DCS PLMN and consists of three subsystems (Fig):

• **The switching subsystem (SSS)**

Which offers all switching functions, also fixed-network-specific switching functions, that are necessary either for independent operation of the D900 network or for combined operation of the D900 network and a fixed network (e.g. PSTN/ISDN) or another mobile radio network

• **The radio subsystem (RSS)** divided into:

- **The base-station system (BSS)**

Which offers all functions necessary to provide both the radio coverage of the service area and an extensive distributed intelligence

- **The mobile station (MS),** which is not part of the D900; offers all subscriber operating functions

- **The operation and maintenance subsystem (QMS)** which offers all functions necessary for operation of the D900 network and for the acquisition of information about the performance of the D900 system.

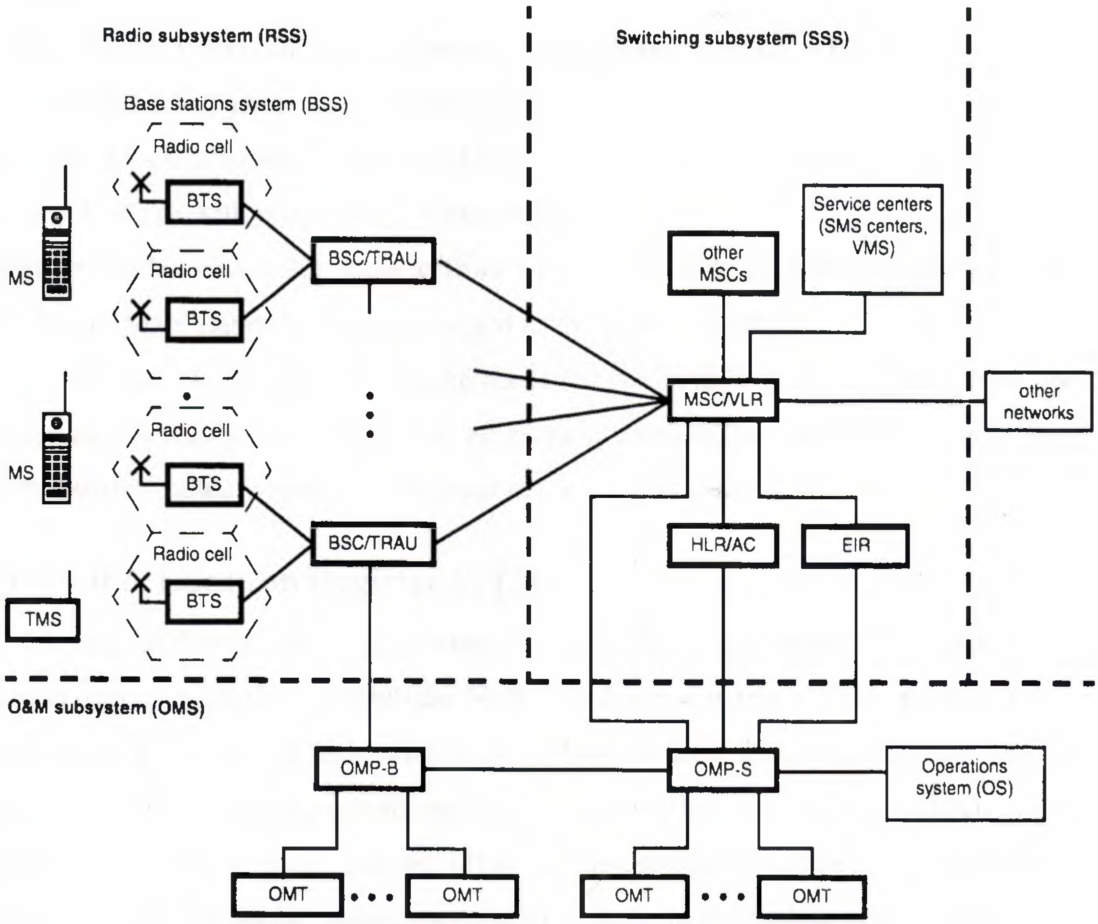


Fig 1.2 Structure of the D900 PLMN

1.2.1 Switching Subsystem (SSS)

The switching subsystem (SSS) consists of the following network elements:

- Mobile-services switching center (MSCs)
- Visitor location register (VLR)
- Authentication center (AC)
- Home location register (HLR)
- Equipment identification register (EIR).

1.2.2 Mobile-Services Switching Center (MSC)

The MSC establishes radio calls

- Between the D900 mobile radio network and a fixed network (e.g. PSTN/ISDN, PSDN)
- Between the D900 mobile radio network and another mobile radio network
- Within the D900 mobile radio network between mobile subscribers

In the case of mobile to mobile calls within the D900 network a connection from one MSC to another MSC or within one MSC is established.

In addition, the MSC switches calls to/from wired ISDN stations that are connected to the MSC. These ISDN station data are managed in the MSC database.

Interworking functions in the MSC make the D900 compatible with other networks. The MSC can be physically located either in an exchange site of the fixed network or in any other convenient place within or even outside the service area.

1.2.3 Visitor Location Register (VLR)

The VLR is a database containing information about all mobile subscribers currently active in its area of responsibility. In D900 the VLR is collocated with the MSC at a physical network node, for which the abbreviation MSC/VLR is used. When a subscriber checks in with the VLR, this information is forwarded to the home location register (HLR).

In response the VLR receives from the HLR the corresponding mobile subscriber data. For incoming calls for the mobile subscriber the VLR delivers the mobile station roaming number (MSRN) at the request of the HLR. This number **serves** to establish the traffic channel connection to the visited MSC.

1.2.4 Home Location Register (HLR)

The HLR is the main database for mobile subscriber data. It contains the relevant data of its registered subscribers. Included in the relevant data is information about the VLR coverage area in which the mobile subscriber is temporarily roaming. This information is needed for directing calls to the mobile subscriber. In D900 the HLR is collocated with the AC in a physical network node, for which the abbreviation HLR/AC is used.

1.2.5 Authentication Center (AC)

The AC contains several security boxes with keys and algorithms required for the production of authentication parameters. In the AC several sets of authentication parameters, called 'triples', are generated for each mobile subscriber generally before the subscriber's access to the mobile radio network. The triples are used by the VLR for authentication checks, i.e. to prove whether a subscriber is authorized to enter the network and set up a call. After the check the used triple is abolished and after reaching a certain threshold In the VLR, the VLR will request a set of new triples from the AC via the HLR.

1.2.6 Equipment Identification Register (EIR)

The EIR is another database containing Information about the device types and identity numbers of all mobile stations (MS) admitted in its area of responsibility. The EIR can be organized in relation to network areas, e.g. with reference to one or more MSCs. In addition there may be a supra-regional master EIR outside of the PLMN. If requested by the MSC, the EIR checks the admission of mobile equipment. In the event of a suspected defect or misuse of the mobile equipment the EIR decides that the mobile equipment must be observed. The EIR can bar defective or illegal mobile equipments. Service centers, e.g. for the short message service (SMS center) or voice mail system (VMS) for the called mobile subscriber can be connected directly to the MSC or via the fixed networks. Service centers are commercial computer centers and are not a part of the D900 system.

1.2.7 Base Station System (BSS)

The base station system (BSS) is the D900 part of the radio subsystem (RSS). The BSS consists of the following network elements:

- Base station controller (BSC)
- Base transceiver station (BTS)
- Transcoding and rate adaptation unit (TRAU)

The BSS network elements are GSM/DCS Phase ^ compatible.

The product name for the BSS is D900 SBS, The Siemens base station system (SBS) product includes the BSS network elements and the corresponding operation and maintenance subsystem for BSS (OMS-B),

1.2.8 Base Station Controller (BSC)

The BSC forms the intelligent part of the base station system. They control the radio connections, local safeguarding functions, and local operation and maintenance functions. One or more BSCs are connected with one MSC. They also performs the radio processing functions, such as administration of the radio resources, radio channel administration, decentralized call processing and safeguarding functions. One BSC administers several base transceiver stations (BTSs).

The BSC supports various BSC-BTS configurations (e.g. star, multidrop and loop) and has a separate transcoding and rate adaptation unit (TRAU).

1.2.9 Base Transceiver Station (BTS)

The BTSs are radio stations, which provide all functions necessary at the antenna site. They support the radio interface, i.e. the radio link between the D900 network and the mobile stations (MS). They are working for D900 in the GSM primary and extended frequency bands and for D1800 in an own DCS frequency band. The BTS are integrated In BTS equipments (BTSE). With D900 one BTSE can serve one radio cell (Omni directional radio cells) or several radio cells (sectorized radio cells) if necessary. The radio cells are the smallest service areas in the D900/D1800 network. Together they cover the whole service area of a D900/01800 system .The BTSs are also prepared for halt-rate Introduction.

1.2.10 Transcoding and Rate Adaptation Unit (TRAU)

For each traffic channel (16 kbit/s) the TRAU adapts the different transmission rates for speech and data connections on the radio side (BSC interface) to the standardized 64 kbit/s transmission rate at the SSS network side (MSC interface) of the system. It also performs the allocation between the different speech coding algorithms used within the SSS network side and on the radio side. Additionally, the TRAU serves as a multiplexer between the 64 kbit/s traffic channels of the SSS network side and the 16 kbit/s traffic channels on the radio side. The TRAU thus fulfills the TRAU functions defined in the GSM/DCS standards. Therefore the TRAU is usually located at the MSC site In order to save transmission line costs to the remote BSC locations.

1.2.11 O&M Subsystem (OMS)

The OMS largely corresponds to the structures of a telecommunications management network (TMN). The network elements of the OMS are formed by the operation and maintenance center (OMC).

Operation and maintenance center (OMC)

There are an OMC-S for **SSS** network elements and an OMC-B for BSS network elements. The OMC consists of the O&M processors (OMP) for BSS and SSS and the O&M terminals (OMT), which are connected via a local-area network (LAN) to the OMP. It may be necessary to provide server-processor stations in order to realize a client-server LAN.

- O&M processors (OMP-B for BSS and OMP-S for SSS) The OMPs are commercial computers. In addition to their O&M functions (central administration of the network elements of the BSS and SSS) they handle communication with the SSS network elements via a packet-switched data network (PSDN) and with the BSS network elements either via PSDN or via MSC PCM 30 links (nailed up connections (NUCs)). Moreover, an OMP has mediation functions (MF) that make a connection between specific network elements of the **SSS** and the operations system (OS) (e.g. personalization center for SIM (PCS) or data postprocessing systems (DPPS)). The OMP may be duplicated for redundancy (load sharing or hot standby).
- O&M terminals (OMT)

The OMTs are commercial workstations or optionally X-terminals. They are the man-machine interface between the PLMN operator and the OMP, and hence the network elements of the BSS and SSS. Laptop computers may be connected as local maintenance terminals (LMT) to the BSC on site.

- LAN routers

The LAN routers permit the coupling of remotely operated LANs, on which further OMTs and/or support computers are operated,

1.3 Connections between PLMN Network Elements

D900 is a fully digital system. The user Information, e.g. the voice transmission signal, is transmitted on the radio interface as a digital signal. One of the advantages of digital transmission is the ability to encrypt the signals in such a way that even an expert would be unable to monitor them illegally. The radio transmission includes additional (redundant) data for the reconstruction of defective signals, for measures to correct accumulated radio transmission errors, for synchronization and for the signaling Information on the TRAU/BSC/BTS/mobile station.

The D900 PLMN uses three different types of digital connections between network elements:

- Traffic connections (speech and data of MS)
- Common channel signaling connections (CCS7)
- Operation and maintenance connections (X.25)

The D900 PLMN can be connected to the following fixed networks:

- Public switched telephone networks (PSTN)
- Integrated services digital networks (ISDN)
- Packet-switched data networks (PSDN)

1.3.1 Traffic Connections

Traffic connections are used for the transmission of the user Information (voice, data), and as control channels for the exchange of messages between transcoding and rate adaptation unit (TRAU) and base station controller (BSC) and base transceiver stations (BTS), and between BTS and mobile stations (MS). Fig. 2.3 shows a typical configuration of network elements of the D900 PLMN along with the traffic connections. On the fixed network side fixed network exchanges (EX, exchange) are shown,

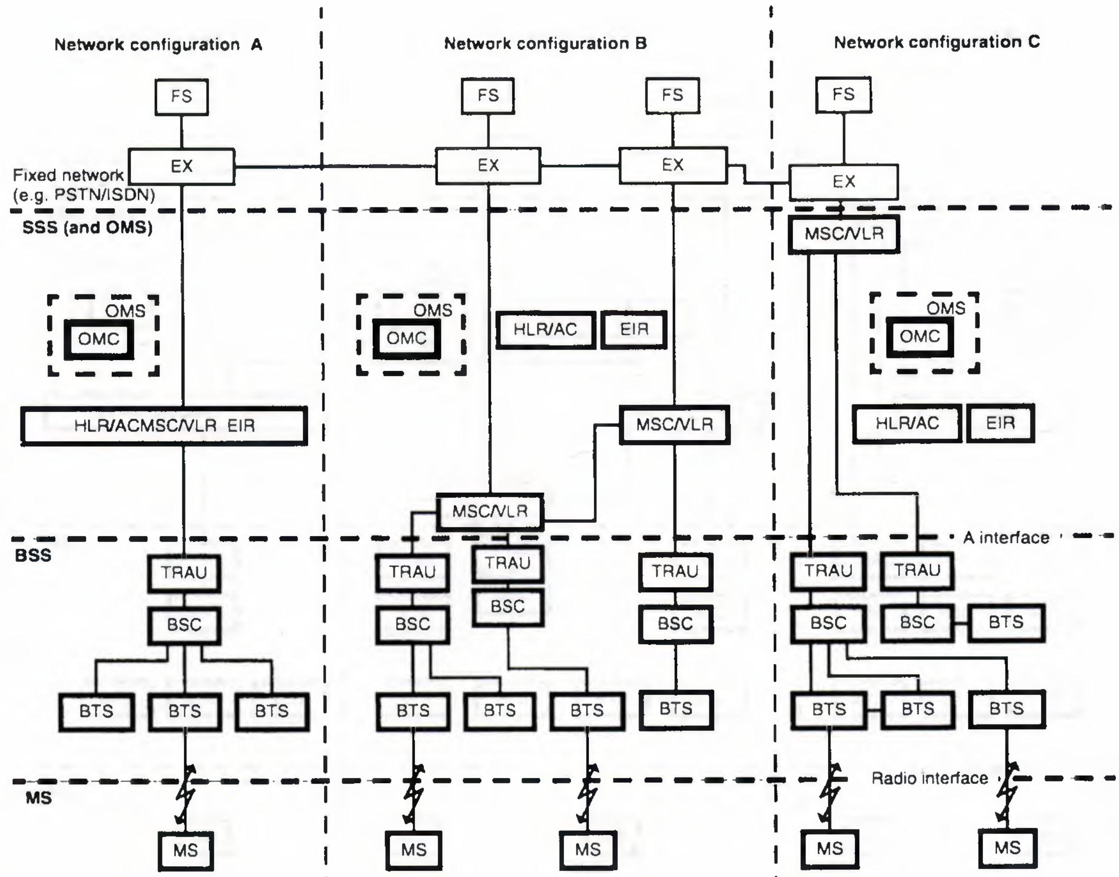


Fig 1.3 The D900 PLMN with its digital traffic connection.

1.4 Common Channel Signaling Connections

Common channel signaling No. 7 (CCS7) links are used for the exchange of messages within fixed networks (e.g. PSTN/ISDN), between fixed network and MSC/VLR, between MSC/VLRs, between MSC/VLR and HLR/AC and EIR, and between MSC/VLR and BSCs, Fig. 1.4 shows a typical configuration of network elements of the D900 PLMN along with the common channel signaling connections.

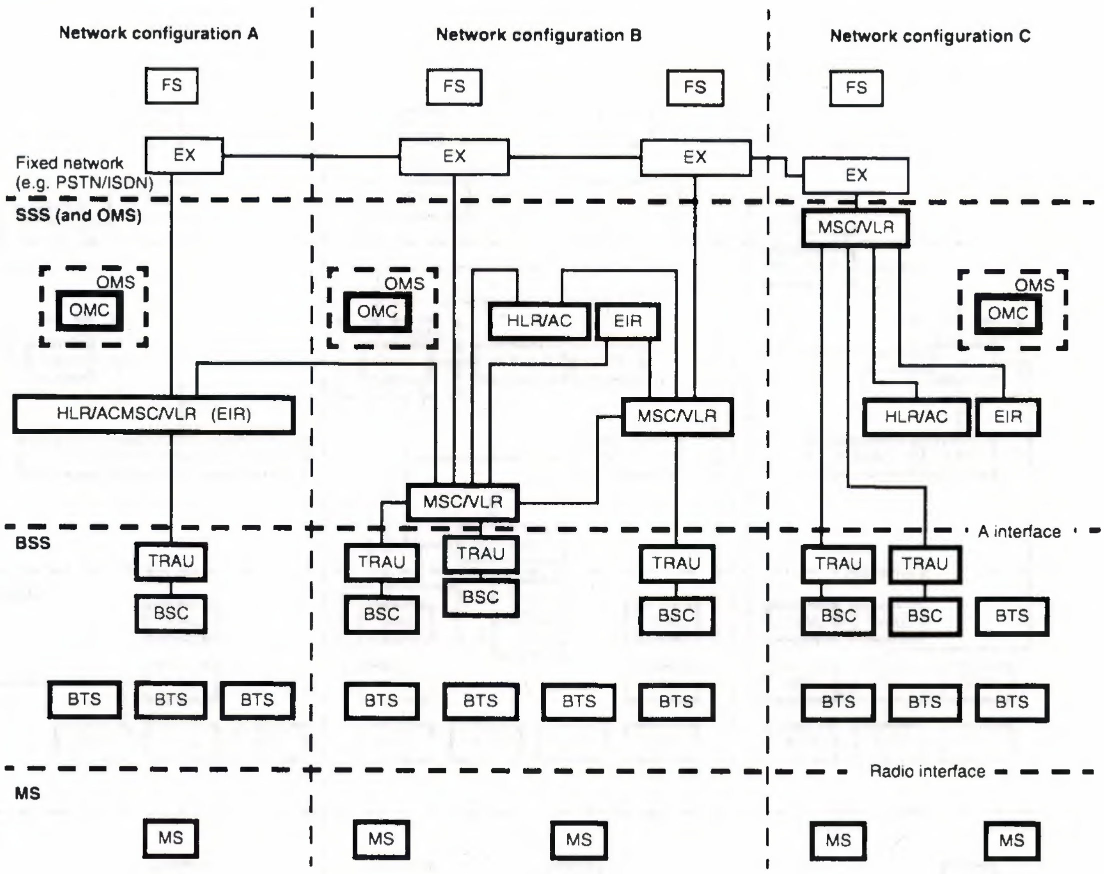


Fig 1.4 The D900 PLMN with its digital CCS7 connection

O&M Connections

The O&M connections from the OMC (OMC-S and OMC-B) of the QMS are Implemented for BSS and **SSS** by a PSDN with **X.25** interfaces. As an option the O&M connections from OMC-B to BSS network elements can be handled by PCM 30 nailed-up connections via MSC. In the SSS the network nodes MSC/VLR, HLR/AC and EIR have such Interfaces; in the BSS the BSC and via the BSC the BTS and TRAU. Fig. 1.5 Shows a typical configuration of network elements of the D900 along with the O&M connections.

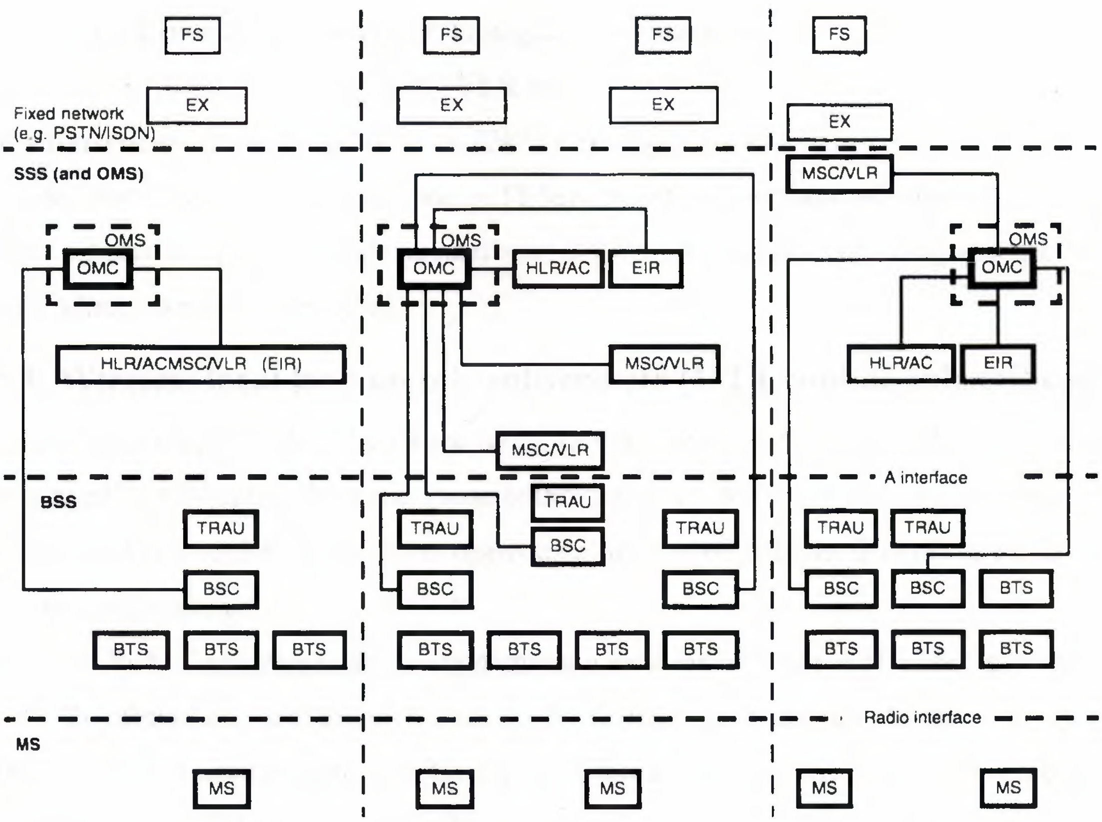


Fig 1.5 The D900 PLMN with its digital O&M connections

Note:

1) OMC consists of an OMC-S (for SSS network elements) and an OMC-B |for BSS network elements)

2) O&M connection from OMC (OMC-S/OMC-B) to SSS and BSS network Elements shown above are only drawn with type PSDM (X.25) in this figure.

3) There are also O&M connections between BTSs and BSCs realized by a timeslot in a PCM 30 connection

1.5 Combined Switching Center (CSC)

The combined switching center (CSC) integrates the functions

- Of PLMN-network elements (MSC, VLR etc.)
- Of a fixed network exchange (EX, an EWSD exchange for example)

In a CSC network element, in addition to PLMN mobile subscribers, wireless local loop mobile subscribers (WLL mobile subscribers) and wired subscribers (analog and ISDN) can be administered or connected.

1.5.1 Wireless local loop mobile subscribers (WLL mobile subscribers)

Wireless local loop mobile subscribers (WLL mobile subscribers) are largely administered like normal PLMN subscribers. I.e. those without any restriction on their movements. Introducing WLL-mobile subscribers opens up a number of options, depending on the network environment:

- CSC in a PLMN environment: To supplement a local fixed network (PSTN) "pseudo-PSTN subscribers" can be connected via the telecommunications network.
- CSC in a PSTN environment: Within a normal fixed network (PSTN) subscribers can be connected as WLL mobile subscribers to the telecommunications network.

From the CSC's standpoint, WLL mobile subscribers are mobile subscribers who are only distinguished from "normal" PLMN mobile subscribers by a few typical feature. A typical service feature is restriction of roaming to a defined location area. Another feature subscriber directory number that corresponds to a directory number from the directory number volume for fixed network subscribers. The CSC network node for these WLL mobile subscribers can include all typical PLMN network elements (i.e. MSC, HLR, AC, VLR and where necessary, EIR too) and thus represent an isolated "quasi-PLMM" within a PSTN, in which all typical PLMN execution sequences (e.g. interrogation, location update etc.) then take place. It Is not however possible to distribute the network elements (e.g. within a PLMN) to different network nodes.

The telecommunications services of a PLMN mobile subscriber are also valid for WLL mobile subscribers.

Fig and Fig show examples of how WLL mobile subscribers are incorporated into typical network environments.

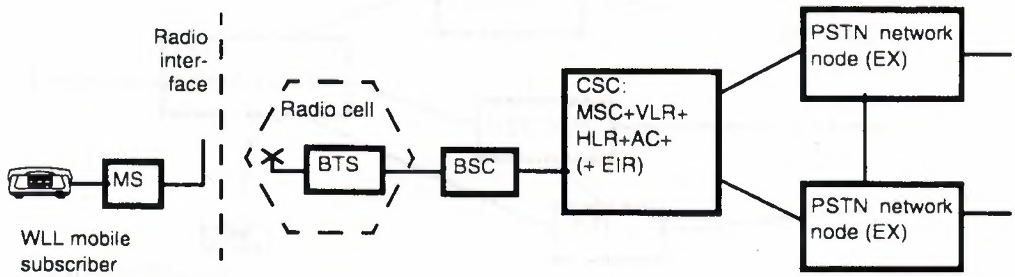


Fig 1.6 CSC with WLL mobile subscribers within a PSTN environment

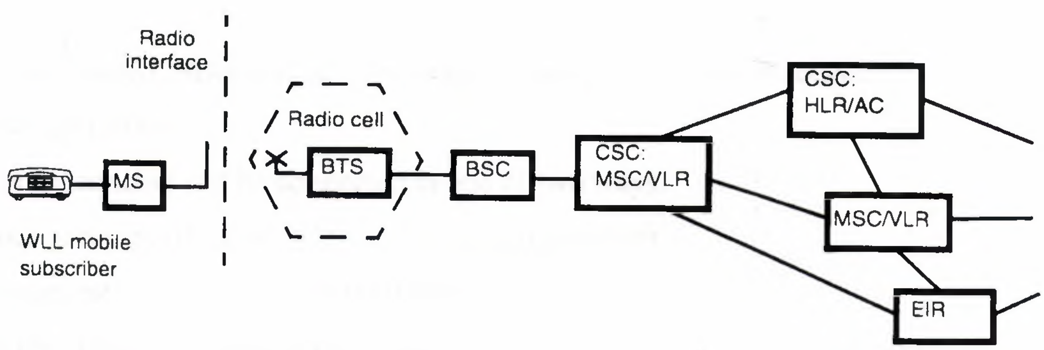


Fig 1.7 CSC with WLL mobile subscribers within a PLMN environment

1.5.2 Wired ISDN/analog subscribers

D900 allows wired ISDN/analog subscribers to connect to a combined switching center (CSC) (Fig).

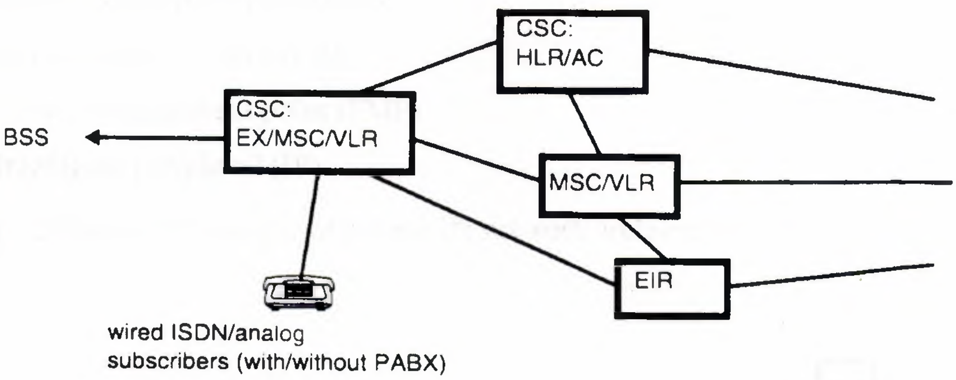


Fig 1.8 CSC with wired ISDN/analog subscribers within a PLMN environment.

CSC with wired ISDN\analog subscribers within a PLMN environment.

ISDN subscribers:

ISDN subscribers can be connected in one of two ways:

- Basic accesses (BA) for ISDN individual connections
- Primary rate access (PA) for ISDN-PABX

Like the GSM/DCS telecommunications services for the mobile subscribers, telecommunications services can be assigned to wired ISDN subscribers in the in the PLMN, This assignment is undertaken in the relevant **CSC.**

Analog subscribers:

As well being assigned to wired ISDN subscribers, the telecommunications services can also be assigned to wired analog subscribers in the CSC of a PLMN (known as analog features).

1.6 Intelligent Network Functions in the PLMN and CSC

The term intelligent network (IN) stands for the concept of network architecture, which is applicable to all telecommunications networks. The basic idea is to introduce a control layer which contains the service logic or service data at a centralized location and thereby more effectively controls the handling of existing and new services.

The following components are available for handling IN services:

- Service switching points (SSP)
- Service control point (SCP)
- Service management point (SMP)
- Intelligent peripheral (IP)

Fig 1.9 shows an example of a basic IN network architecture.

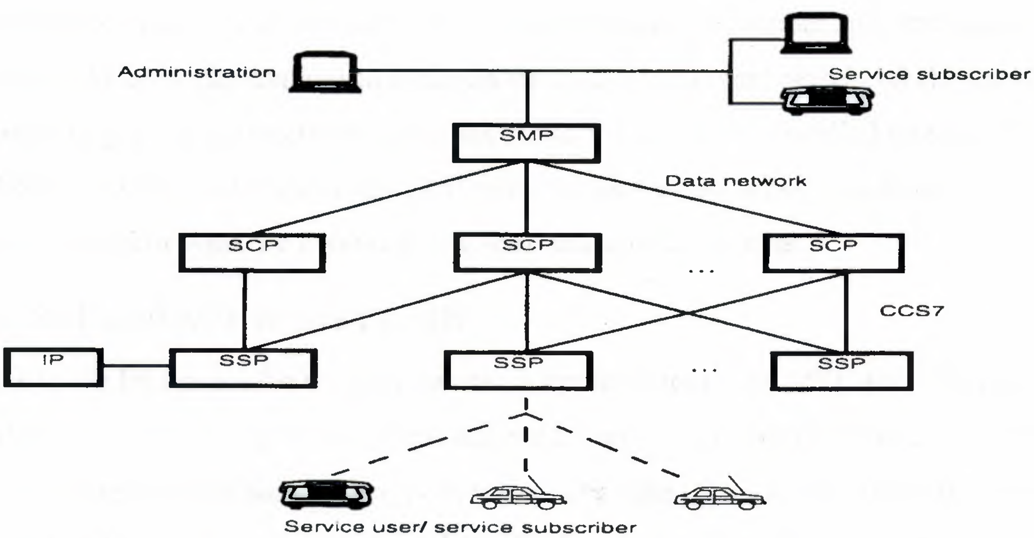


Fig 1.9 Underlying architecture of a intelligent network

Four groups of users are characteristically involved in an intelligent network:

- Service users,

Are callers who request an IN service, by dialing the sequence of digits defined for this service for example.

- Service subscribers,

are generally the called parties; they have subscribed to a service provided by the service provider in order to offer it to their service users. (An exception is an IN service such as "prepaid service") since here the service user and the service subscriber are identical).
- Service providers,
make agreements with the network provider to use the network, offer their services to potential service subscribers and administer these services.

- Network providers, provide the network and administer the basic network functions.
The SSP forms the gateway from the basic network to the intelligent network node (SCP). The SSP detects whether a service is to be processed by the SCP and requests the appropriate service-specific information from the SCP in the relevant case. The SCP forms the intelligent network node that exercises central control over the various services. The SCP database is supplied with input by the "service subscribers" or by the administration via the SMP. The individual service subscribers thus have the opportunity to control an IN service in accordance with specific criteria. For example a subscriber can limit traffic or direct it to different destinations at different times. An intelligent peripheral (IP) provides resources (e.g. IN announcements, mailbox server). Currently a so-called internal IP with an M-SSP network node is used in D900 and this can provide tones, standard announcements or what are known as user-defined announcements.

1.6.1 SSP and SCP in the PLMN

Access to the IN service for the service user is implemented in an MSC (or CSC in a PLMN environment) with IN-functions dependent on the network environment. The solution for an implementation of this type is provided by the IN network architecture (Fig): the SSP function is integrated in every MSC/VLR or CSC of a PLMN. Within the PLMN, a network node of this type, which combines an SSP with an MSC, is then known as an **M-SSP** (mobile SSP). The SCP is part of the PLMN.
A CSC in a PSTN environment can be logically regarded just like an MSC in the PLMN: The SSP function can be integrated into the own CSC or reached via an SSP within or outside the own network.

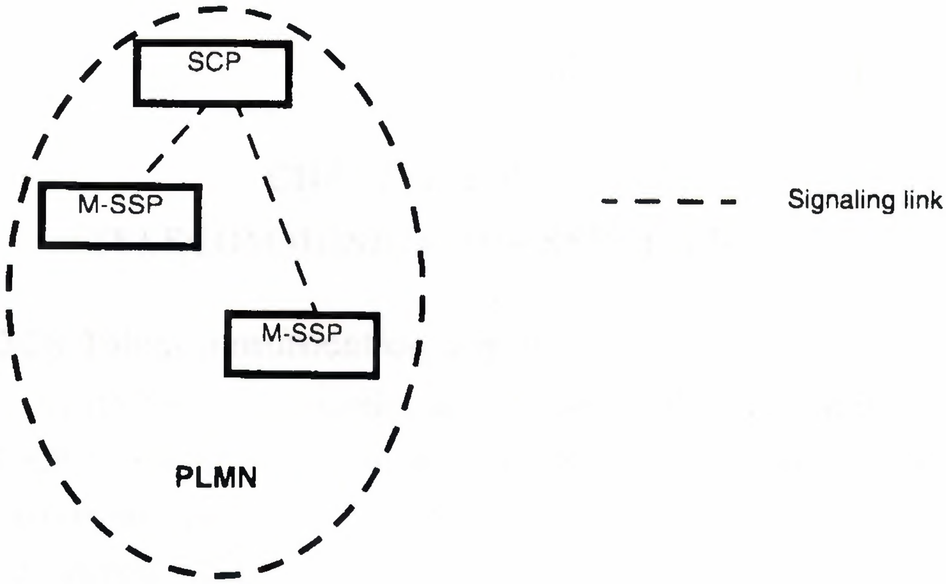


Fig 1.10 Access to IN function in the PLMN with integrated IN network architecture

1.6.2 IN triggering

Access to the intelligent network is effected via a trigger function within the context of digit translation and zoning. The mechanism with which the SSP recognizes an in service is known as IN triggering. With Integrated IN network architecture a trigger profile containing data for addressing the SCP is set up for each IN service.

CHAPTER TWO

TELECOMMUNICATION SERVICES

2.1 GSM/DCS Telecommunication Services

With D900 the GSM/DCS telecommunication services offered to the mobile subscriber (PLMN mobile subscriber and CSC WLL mobile subscriber) are subdivided as follows:

- Bearer services (for data only)
- Teleservices (for voice and data)
- Supplementary services

Bearer services and teleservices are also called basic telecommunication services. The use of GSM/DCS telecommunication services is subject to subscription. A basic subscription permits participation in those GSM/DCS telecommunication services that are generally available. Additional specific subscription(s) is (are) needed for those GSM/DCS telecommunication services that are not generally available. The application in the subscription is handled by the PLMN operator, or its agents, of the country where the subscriber is resident (home PLMN). The regional entitlement is handled within the switching subsystem. If a mobile subscriber roams out of the entitled area there is no possibility of establishing communication (roaming not allowed), except the use of the teleservice emergency call.

2.1.1 Bearer Services

The bearer services are pure transport services for data and thus only the lowest three layers of the OSI reference model (concerning the ISDN reference points in the terminal equipment) are defined. Some of the transmission modes and rates already used in modern data networks are implemented; others are planned.

The following, already implemented, bearer services provide unrestricted information transfer between the reference points in the mobile stations.

Data CDA (circuit duplex asynchronous) + basic PAD (packet assembler disassembler) access

Data CDS (circuit duplex synchronous)

PAD CDA (dedicated PAD access)

Alternate speech/data CDA (circuit duplex asynchronous)

Speech followed by data CDA (circuit duplex asynchronous)

2.1.2 Teleservices

Teleservices use both low layer and high layer functions for the control of communication from terminal to terminal. The protocols are related to layers 4 to 7 of the OSI reference model. The following teleservices have already been realized:

2.1.3 Telephony

The telephony teleservice is used to transmit voice information and audible tones in the PLMN and between a mobile subscriber in the PLMN and another subscriber in a fixed telephone network (PSTN/ ISDN). Transparency for telephone signaling tones is ensured. The transmission of dual-tone multifrequency signals (DTMF) is possible for a mobile originating call (MOC).

2.1.4 Emergency call

The emergency call teleservice is used to establish a voice connection from a mobile station to an emergency center allocated to the location where the call originated. It can be defined on a project-specific basis whether the emergency call is to be possible with or without inserting a chip card. The barred state of a mobile station is overridden by the emergency procedure. Emergency calls also supersede all restrictions caused by supplementary services or mobile station features used by other teleservices or bearer services. Emergency calls are routed to the emergency center in agreement with the na-tional regulations.

2.1.5 Short message service (SMS)

(Mobile terminated, point-to-point) (Mobile originated, point-to-point)

The teleservices short message service are data telecommunication services The mobile terminated type permits a PLMN subscriber to receive a short alphanumeric message (text) from a fixed-network or mobile subscriber, if the mobile station Is equipped to handle this telecommunication service. The mobile originated type allows a PLMN to send short messages to other mobile subscribers or fixed-network subscribers (ISDN/PSDTN, PSDN). For this teleservice a short-message service center must be connected to the D900, which receives and redistributes the short messages.

2.1.6 Automatic facsimile (group 3)

The facsimile (group 3) teleservice provides a reproduction of all forms of graphical, handwritten or printed material at a distant location, within the limits and characteristics specified by the ITU-T. It belongs to the data teleservices.

2.1.7 Alternative speech and facsimile (group 3)

This teleservice permits alternation during a call between voice transmission and facsimile (group 3).

2.2 Supplementary Services

Supplementary services are services, which extend beyond the normal bearer services and teleservices (basic telecommunication services) and can be subscribed to separately.

In the following a supplementary service is called simply service, in contrast to basic telecommunication service.

A distinction must be made between "pure" GSM/DCS supplementary services and non-GSM/DCS supplementary services.

Number Identification Services

Calling line identification presentation (CLIP)

Calling line identification restriction (CLIR)

2.2.1 Non-GSM/DCS Supplementary Services

Hot billing

Hot billing allows a network operating company to create short-term call charge records for every call, regardless of the normal accounting interval for other mobile subscribers. The flow of call charge Information goes from the charge-computing MSC to a DPPS (data post-processing system) in the operations system (OS) and thence to the mobile subscriber or e.g. to the lessor of a mobile station.

Following non-GSM/DCS supplementary services may be added on a project-specific basis:

2.2.2 Call back (call diversion service)

Call back a) lows a mobile subscriber who is temporarily not available (e.g. busy) to divert incoming calls to a personal voice mailbox. The personal voice mailbox is a computer box in the PLMN (voice mail system, VMS) and acts as a kind of call answering machine in the PLMN. The mobile subscriber can retrieve the recorded messages from the external computer box using an access code. These supplementary services are implemented with USSD.

2.2.3 "Explicit" call transfer (CT)

"Explicit" call transfer (shortened to call transfer, CT) allows a mobile subscriber to transfer an established incoming or outgoing call to a third party (not the same as call forwarding). The established call is put into the Hold State; the call to the third party is set up; the call can then be transferred. These supplementary services are implemented with USSD.

2.2.4 Subscriber Control of Supplementary Services

- Subscriber controlled inputs (SCIs)

Subscriber controlled inputs (SCIs) represent the control procedures, defined in the GSM/DCS standards, between the mobile station and the HLR. SCIs let a mobile subscriber control the supplementary services and if necessary modify the respective subscriber database in the HLR.

- Control with container messages

For the signalization of non-GSM/DCS standard defined (PLMN-specific) supplementary services there are unstructured supplementary service operations based on unstructured supplementary service data (USSD). A USSD handler in the mobile station detects the USSD-MMI format structure. This USSD-MMI format structure has a predefined different character set. The USSD-MMI procedures are transparently transported by a container principle from the mobile station to the stations in the PLMN at which an application for the non-GSM/DCS supplementary service is present (MSC, VLR, HLR).

Fixed Network Telecommunications Services at the CSC

ISDN subscribers at the CSC:

Like mobile subscriber telecommunications services, wired ISDN subscribers in the PLMN can be assigned CSC telecommunications services.

Tab.2.1 Telecommunications services for the wired ISDN subscribers at the CSC

ISDN bearer services, teleservices
Circuit mode speech
Circuit mode 64 kbit/s unrestricted digital
Circuit mode 3.1 kHz audio line
Packet mode, semipermanent B channel access, case B
Packet mode, D channel access, case B

Packet mode, switched B channel access, case B
Packet mode, B channel access, case A
ISDN teleservices
Telephony 3.1 kHz
Telephony 7 kHz
Telefax, group 3
Telefax, group 4
Videotex *
* Are possible for mobile subscribers with GSM/DCS bearer services BS2.X

Analog subscribers at the CSC:
In addition to the wired ISDN subscribers the wired analog subscribers in the CSC of a PLMN can also be assigned telecommunications services (known as analog features).

2.2.5 Telecommunications Services in the M-SSP

Categories of IN Services

A distinction must be made in the M-SSP between basic IN services and mobile-subscriber-specific IN services. Only the basic IN services are also available to wired ISDN/analog subscribers in a CSC.

Basic IN services can generally be reached by prefixing the number with a special basic IN directory number. Mobile subscriber-specific IN services are initiated implicitly, without a special number. This is achieved by setting IN marks (known as service class marks (SCM) in the mobile subscriber database of the HLR, which describe the class of service for accessing such IN services.

The following **Basic IN services** are available:

- **Freephone service (FPH)**

Service, which allows no-charge calls to be made, i.e. calls at the expense of the called party.

- **Teleinfo service (TIS)**

Teleinfo service allows value-added services with flexible charging to be used between service user and service subscriber.

- **Universal number (UN)**

Service which allows a universal directory number in a network or in a country

- **Mass calling service (MCS) or Televoting (TV)**

Service with which opinions can be offered for surveys with each call paying.

All basic IN services are reached exclusively via trigger and signaling procedures.

2.3 Mobile subscriber-specific IN services

Must be defined in the HLR and assigned to the mobile subscribers. During call setup the same basic procedures (triggering, signaling) are then used as are used for basic ISDN services.

2.3.1 Mobile Subscribers with Prepayment

D900 allows administration of mobile subscribers with prepayment (prepaid service (PPS) subscriber/debit subscriber) in the form of an IN solution. The basic Idea behind mobile subscribers with prepayment is to minimize the administrative operating costs by direct booking of the call charges from a prepaid mobile subscriber account. Charges are booked out for mobile subscribers with prepayment by using the "prepaid service center (PPSC)" service in the SCP. The mobile subscriber does not generally receive a bill for these charges.

A specific amount is normally stored In the SCP for the mobile subscriber for this service and this amount is then reduced by the charges accrued for the call.

While a call is in progress the SCP makes regular checks on the account balance. The mobile subscriber can interrogate the SCP account balance by entering a control procedure (USSD or DTMF) at the mobile station.

CHAPTER THREE

SWITCHING SUBSYSTEM (SSS)

Overview
System Architecture

PLMN SSS

The switching subsystem (SSS) is responsible for call processing and the administration of mobile subscriber and mobile equipment data. The SSS contains the following network elements (see Fig.):

- The mobile-services switching center (MSC)
- The visitor location register (VLR) the home location registers (HLR)
- The authentication center (AC)
- The equipment identification registers (EIR)

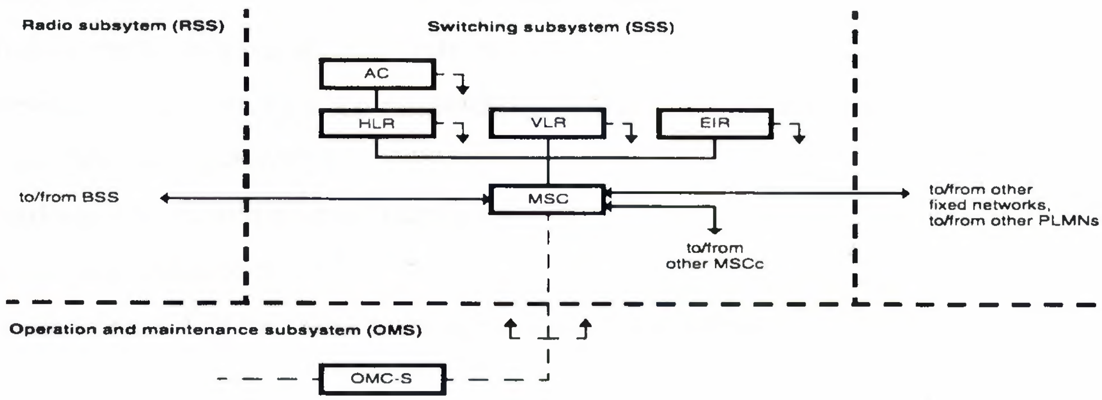


Fig 3.1 Network structure of the SSS

Network nodes house the network elements of the switching subsystem. One or more network elements may be located in one network node. The composition of network elements in a network node depends on the operational and geographical network requirements of the PLMN operating company. The dynamic load, interworking and reliability aspects also have to be taken into account. All these requirements and factors

Combining all network elements (MSC, VLR, HLR, AC, and EIR) provides the most common solution in one network node. The advantage here is that the dynamic load, caused for example by interworking via CCS7 signaling links, is kept to a minimum. Another approach is to combine the network elements in accordance with the requirements of the PLMN operating company. Combinations MSC/VLR and HLR/AC (where an EIR is combined with the combination MSC/VLR or HLR/AC, or can be self-contained if necessary) are a suitable solution mainly concerned with the most flexible way of structuring the D900 PLMN.

The network nodes in the switching subsystem are realized with the proven Siemens Digital Electronic Switching System (EWSD). The advantages of EWSD include:
- Fully digital design
- Compliance with ITU-T and ETSI
- Completely modular
Hardware, autonomous subsystems with there own controls software, functionally divided into software shells, subsystems and modules
- Mechanical construction, flexible in combining modules, frames and racks
- Clear-cut function organization
- Standardized internal and external interfaces
- Mature CHILL technology
- Extensive safeguarding measures to ensure trouble-free operation

Combined switching center (CSC)

The system architecture of a combined switching center (CSC) is determined by how it is used within the network environment concerned (i.e. as regards use of WLL mobile subscribers in a PLMN or PSTN environment) by the following network elements (Fig.):
- Fixed network exchange (EX))
- Mobile switching center (MSC)
- Home location register (HLR)
- Visitor location register (VLR)
- Authentication center (AC)
- Equipment identification register (EIR)

These network elements are produced by the subsystem configuration described in (hardware and software).

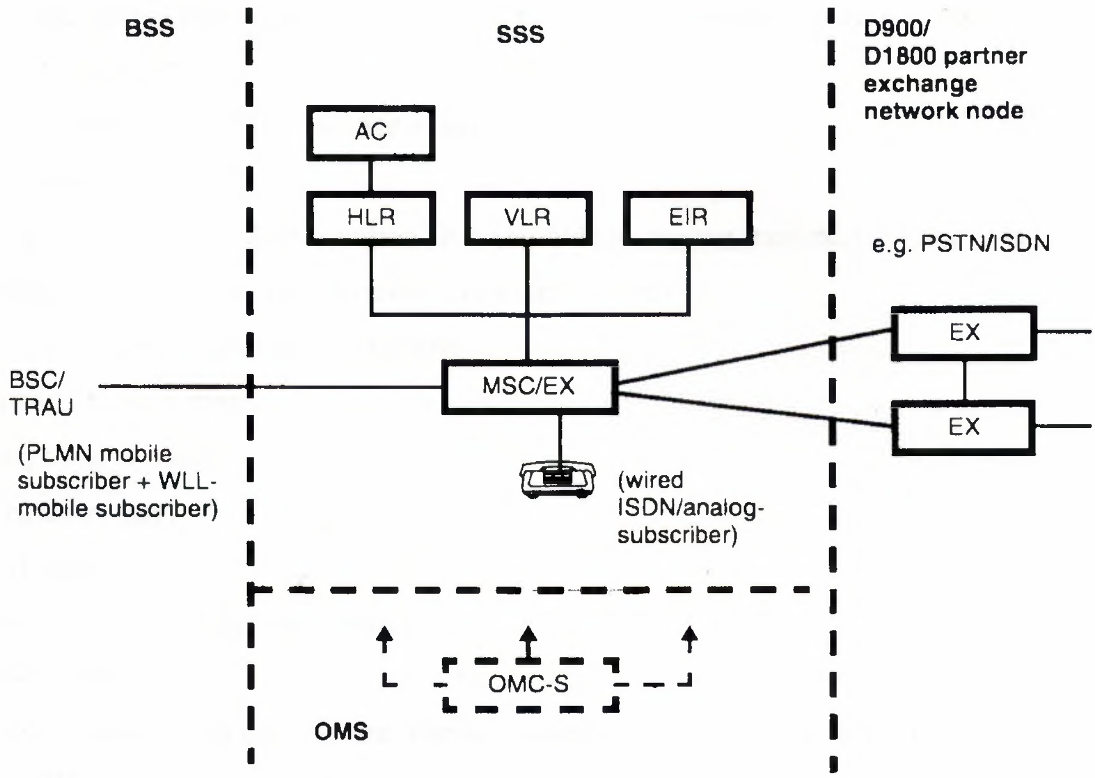


Fig 3.2 Network elements of a PLMN-SSS with CSC.

3.1 Network Elements

3.1.1 Mobile-services switching center (MSC)

The MSC is a stored-pro gram controlled digital switching center. The MSC is the switching center in the PLMN, which

- Acts as a gateway to other networks,
- Is linked to other MSCs in the PLMN,
- Connects the network elements of the **SSS** with the network elements of the BSS in the coverage area of the PLMN.

The MSC has functions that are familiar from the switching centers of the fixed networks as well as special functions that are not necessary \n the switching centers of the fixed networks. The mobile communication-specific functions are provided because of the mobility of the subscribers.

The basic functions of the MSC are, for example:

- Choice of routes

(E.g. with the function "trunk reservation" it is possible to reserve transmission channels for the routing of emergency calls to emergency call centers)

- Setting up traffic and signaling connections
- Supervision of connections
- Call charge registration
- Traffic measurement
- Overload handling
- Support of telecommunication services
- Juridical interception

Other network elements of the **SSS** can also be implemented in the MSC network node (e.g. the VLR).

The mobile-specific call processing functions in the MSC are:

- Expansion of basic functions into the PLMN

(E.g. cell-oriented routing with abbreviated directory numbers; routing with ADNs, depending on the number of the calling mobile)

- Mobility administration: interrogation, paging. Handover, location update
- Handling of operating resources (e.g. half-rate support)
- Access to PLMN databases (VLR, HLR, EIR)
- Control of queuing with priority levels for the BSS
- Special safety functions (e.g. processing of the authentication, testing the IMEI)
- Interworking function (IWF) for GSM/DCS data services

3.1.2 Combined switching center (CSC)

Within a PLMN SSS one of the CSC's functions is to perform all the tasks of a MSC/VLR network node for PLMN mobile subscribers, another is to perform the functions of an exchanged for wireless local loop (WLL) mobile subscribers and wired ISDN/analog subscribers. When included in a GSM/DCS PLMN the **CSC** links the other network elements of the PLMN SSS with the BSS for PLMN mobile subscribers and WLL mobile subscribers. The CSC also forms the access network node for wired ISDN/analog subscribers.

Examples of underlying functions, i.e. those that extend beyond the MSC functions of the CSC are:

- Routing for wired ISDN/analog subscribers
- Supporting telecommunications services for wired ISDN/analog subscribers
- ISDN/analog subscriber database in network element EX in the **CSC** charge recording for wired ISDN/analog subscribers

Additional mobile-radio-specific functions of the CSC which extend beyond the MSC functions are as follows:

Mobility administration (particularly location registration specifically for WLL mobile subscribers, Le. roaming only within a defined location area identification and addressing (fixed network directory number specifically for WLL mobile subscribers) access to WLL mobile subscriber databases (VLR, HLR, AC)

3.1.3 Mobile service switching point (M-SSP)

Within a PLMN SSS one of the M-SSP's (SSP combined with an MSC/VLR-network node or CSC) functions is to perform all the tasks of an MSC/VLR-network node or CSC. When included in a GSM/DCS PLMN the M-SSP (mobile SSP) links the other network elements of the PLMN SSS with the BSS. The M'SSP also forms the interface to the other network elements of the intelligent network (IN), that is to the service control points (SCP) and from there to the service management points (SMP). In an M-SSP there is what is known as an internal IP (intelligent peripheral) which provides such features as user-defined IN announcements.

Typical examples of additional MSC functions which extend beyond IN'specific functions of the M-SSP are:

- Call setup and cleardown (transaction setup and cleardown to the SCP)
- Routing (IN triggering)
- Identification and addressing (basic IN directory number for basic IN service, service class mark (SCM) for mobile subscriber-specific IN service)
- User information (e.g.- IN tones, IN announcements via the internal intelligent peripheral (IP))

3.1.4 Visitor location register (VLR)

The VLR is essentially a database that holds all information on those mobile subscribers currently roaming in the VLR area it controls.

On connection setup, the VLR can recognize a mobile subscriber by the following identifiers:

- The international mobile subscriber identification (IMSI)
- The local mobile subscriber identification (LMSI)
- Mobile station roaming number (MSRN) or
- The temporary mobile station identity (TMSI) together with the local area identity (LAI).

When a mobile subscriber checks into a VLR service area, this information is forwarded to his home location register (HLR). An authentication check may have gone before. The HLR then sends to the VLR information about the authorization status of this mobile subscriber.

For the duration of call setup the VLR allocates a mobile station roaming number (MSRN); as soon as this is requested in a mobile terminating call (MTC) by the network-access MSC (GMSC) via the HLR. The connection is set up via this number.

The VLR service area covers one or more location areas. As long as an MS only moves within one location area, it is not necessary to update the visitor location register VLR.

The VLR database is split into a semipermanent and a transient part. The semipermanent part is imaged on double disks.

The signaling-routing database resides in the semipermanent part of the VLR database. It contains the IMSI and the LAI digit translator, which supply the HLR address and the address of the previous VLR.

The national roaming database stores in its semipermanent part the data for the areas in which mobile subscribers are allowed to set up a connection in accordance with national agreements.

The mobile subscriber database resides in the transient part of the VLR database. It contains the call processing data of the mobile subscribers currently roaming in this area. Its memory is allocated dynamically and separately for each mobile subscriber. The data are distributed in several pools, e.g.-

- In the common data pool with IMSI, ISDN, TMSI, LAI and the registered services

- In the basic telecommunications data pool with the registered and activated supplementary services (eg. call forwarding data)
- CUG data pool (e.g. CUG index)

Another transient database contains the temporary mobile subscriber identities (TMSI). With these an individual mobile subscriber is addressed and identified.

The VLR database contains the current ciphering key (Kc) and the ciphering key sequence number sent to the MS during authentication.

The VLR is realized in the MSC network node in the D900/D1600 SSS standard configuration.

3.1.5 Home location register (HLR)

The HLR contains the main database of the mobile subscribers. The database entries may be generated, deleted and read by the PLMN operator, remotely by the OMS or by a PCS, personalization center for SIM) via the OMS or on the local OMT. By SCl, subscriber controlled input, the mobile subscriber can also remotely input specific subscriber data (for supplementary services).

At call setup, the HLR can identify a mobile subscriber with the aid of the following identifiers:

- International mobile subscriber identifier (IMSQ
- International mobile subscriber identifier (MSISDN)

The HLR participates in setting up a mobile terminating call (MTC). On setup of an MTC the HLR is requested by the network **access** MSC (GMSC), to retrieve the mobile subscriber roaming number (MSRN) of the mobile subscriber from the current VLR, The HLR does this and sends the MSRN to the GMSC.

During a location update the HLR supports the current VLR of the mobile subscriber by supplying the necessary data, and the VLR in turn supplies its VLR address.

The HLR database contains both semipermanent and transient data,

The semipermanent data include:

- HLR mobile subscriber data
- Signaling data (network data of the HLR)

The transient data include:

- HLR mobile subscriber data

- Traffic measurement data

The semipermanent HLR mobile subscriber data are split into the following data modules and tables:

- Common data module
- Basic telecommunication service data module
- Supplementary services data module
- MSISDN bearer capability data module
- CUG data module
- GSM/DCS bearer capability information element (BCIE) table
- Roaming restriction table
- SIM chip card exchange table (IMSI exchange)
- HLR services table (for mobile subscribers with access authorization to specific service centers, e.g., for routing dependent on the directory number of the calling mobile subscriber)

The transient HLR mobile subscriber data are split into the following data modules-

- Mobility data module

(E.g. authentication data, MSRN, relation to VLR address and local mobile subscriber identifier (LMSI), detach from the IMSI short message waiting data module

3.1.6 Authentication center (AC)

The AC is equipped with several security boxes, in which the authentication keys and algorithms required for generation of the authentication parameters of a mobile subscriber are stored, in the AC for each mobile subscriber a number of authentication parameters RAND (random number), authentication response (SRES, signed response) and Kc (cipher key) are generated, before the mobile subscriber obtains access to the network. The authentication parameters are used by the VLR for authentication tests, i.e. to determine whether a mobile subscriber is authorized for access to the network and call setup.
For testing, authentication parameter sets (triples) are sent to the VLR and a new parameter set is generated.

The AC administers all together the following safety-related functions

- Administration of the secret individual authentication keys (Ki) of the mobile subscribers
- Generation of n triples (RAND, SRES, Kc) for each mobile subscriber

- Storing the PLMN operator-specific algorithms A3/A6 (and A2, A4, A7) in the security box

The AC database is divided into a semipermanent and a transient part. The semipermanent part is Imaged on duplicated disk devices and is updated by each data change.

The semipermanent part of the database consists of the sections:
- AC mobile subscriber database
Contains the individual authentication key (Ki) in A2 encrypted form, the version number of the algorithms A3/A6, and the A2 identification for calling up the A2 algorithm.
- Triple table contains a triple set for each mobile subscriber.
- Key database contains key organization data (for K2, K4, and K7) and encrypted and marked keys for data protection purposes. The transient part of the database consists of the sections:
- Triple database
Contains 5 sets of triples (RAND, SRES, and Kc) at each instant for each IMSI.
- Triple status table states for each mobile subscriber whether valid triples are present.
- Key reference table for storing K4 keys for the duration of a communication connection,
The AC is collocated with the HLR in a network node in the D900 -SSS standard configuration.

3.1.7 Equipment Identity (EIR)

The EIR stores the equipment identity of the mobile stations. Using this ^formation, the MSC can check whether the equipment of a mobile subscriber is approved, whether it is to be observed or whether it is even to be barred from service.

In the EIR the mobile stations are arranged in three lists:
- The white list for approved mobile stations
- The Grey list for mobile stations to be observed the black list for barred mobile stations
The EIR test is requested by the MSC. When the EIR receives a request from the MSC it looks for the international mobile equipment identity (IMEI) concerned in the database (white, Grey, black list) and sends back an acknowledgment to the MSC indicating whether the IMEI is unknown, or whether it is in the white, Grey or black list. Subsequent actions taken by the MSC **are** dependent on this result.

The EIR (IMEI) database contains semipermanent data. The database is imaged o-double hard disks, which are continuously updated and kept consistent.

The white list contains the type approval code (TAC) and the final assembly code (FAC), both of which are known as "number series" (and a serial number range). The gray and the black list are realized in a further section of the database. Access to these is obtained via the 15-digit IMEI number. The IMEI is considered to be unknown, if it does not appear in any list,

In the D900 -SSS the EIR can be implemented in a network node together with HLR/AC or MSC/VLR or where necessary in a self-contained network node.

3.2 Hardware

The hardware represents the physical components of a system. In a modem switching system such as D900 SSS the hardware is modular, reliable, flexible and of high quality. It also permits adaptation to new technologies and economic manufacturing (also in the country of use). This is achieved by:

- Clear and easy-to-understand, future-oriented hardware architecture
- Modular mechanical design
- Use of modern hardware technologies
- Painstaking hardware quality assurance

Hardware Architecture

The hardware architecture of D900 SSS permits many flexible combinations of switching subsystem elements and has clearly-defined interfaces. This forms the basis for cost-effective use of D900 in all areas of the broad spectrum of applications. The line trunk groups (LTGs) handle functions determined by the network environment. The common channel signaling network control (CCMC) handles the message transfer part (MTP) of signaling system CCS7. The function of the switching network (SN (B)} is to interconnect the trunks in accordance with the call requirements of the subscriber and the network administration. The controls of the subsystems involved carry out practically all the tasks arising in their area independently (e.g. the line/trunk groups handle digit reception, charge registration, supervision and other functions). Only for system-wide and coordination functions, such as routing and zoning for example, do they require the assistance of the coordination processor (CP113C/CR). Fig Shows how the most important controls are distributed throughout a network node. This principle of distributed control reduces the amount of coordination involved and the necessity for communication between the processors, and contributes to D900's very high dynamic performance standard. The flexibility inherent in distributed control also makes it easy to introduce and modify features and to assign features to specific subscribers.

For inter-processor communication, the switching network sets up 64-kbit/s connections in the same way as connections between subscribers. However, the connections between the processors remain established and are therefore referred to as semipermanent connections. This avoids the need for a separate interprocessor control network.

The structure of an SSS network node comprises the following main hardware components (Fig.):

- Line trunk groups (LTG)
- Data service unit (DSU) and digital line unit (DLU)
- Switching networks (SIM)
- Common channel signaling network control (CCNC)
- Coordination area with coordination processor (CPU 3)

With the current software version the hardware components described in the next: sections are used for new equipping of the SSS network node. These components are,

- Line/trunk groups (LTG) of type B (for DEC use), Type G (for internal IN intelligent peripheral) and type M (for trunk use)
- Data service unit (DSU) and digital line unit B (DLUB)
- Switching networks (SN (B))
- Common channel signaling network control (CCNC)
- Coordination area, with coordination processor (CP113C/CR)

For an existing **SSS** network node within a PLMN the current software version can continue to be operated with the following, existing (not described any further in the document hardware components). Typical examples are;

- Line/trunk groups (LTG) of type B (for DEC use), Type G (for trunk use)
- Data service unit (DSU) and digital line unit B (DLU)
- Switching networks (SN)
- Common channel signaling network control (CCNC)
- Coordination area, with coordination processor (CP113A/B)

3.3 Line Trunk Groups (LTG)

The different LTGs control and supervise the incoming and outgoing trunk traffic (MTC and MOC) to and from:

- The base station system (BSS)
- Other public networks (e.g. other PLMNs or fixed networks (PSTN/ISDN etc.)
- Other D900-SSS network nodes
- Wired ISDN/analog subscribers at the CSC
- Digital announcement systems (DAs) in the MSC/CSC
- Short message service centers (SMSC)
- Service center for subscriber-related routing of service numbers
- Voice mail system centers (VMSC)
- IN network node (SCP)

In addition, the LTG controls the connection traffic to special functions, such as:

- Interworking function (IWF) in the DSU (for mobile data services)
- Trunk loop function (for connections with ISDN/analog subscribers on the CSC and mobile internal calls (MIC)/mobile to mobile calls (MMC))
- Trunk loop function (for connections with juridical Interception)
- Conference function (when using the supplementary service multi-party service)
- User-interaction (Ul) function (with IN; implementation of an internal IP)

The LTGs support all normal signaling systems (e.g. CCS7, MFC: R2). Digital echo cancellers (DEC) are used on the connection to/from subscribers of the PSTN and for mobile internal calls (MIC)/mobile to mobile calls (MMC).

Although the signaling methods on the lines may differ, the line/trunk groups (LTG) have an internal signaling-Independent interface to the switching network. This simplifies:

- Flexible introduction of additional or modified signaling procedures
- A signaling-independent software system in the CP113C/CR for all applications

The bit rate on the multiplex lines linking the line/ trunk group (LTG) and the switching network is 8192 kbit/s (8 Mbit/s). Each 8-Mbit/s highway contains 128 channels at 64 kbit/s each. Each LTG is connected to both planes of the duplicated switching network (SN).

Depending on the use of the LTG the following three different LTGs may be used:

- LTGB (for trunks to fixed networks and where necessary for trunk loop LTG)
- LTGG (for implementing an internal IP for IN; user-Interaction LTG)
- LTGM (for all other types of trunk)

Each LTGB has the following functional units (Fig)-

- Group processor (GP)
- Group switches (GS)
- Link interface unit (LIU) between LTG and SN (B)
- Signaling unit (SU)
- Line/trunk unit (LTUO ... 7)

(With max. 4 digital Interface units (DIU30) and digital echo cancellers (DEC) or where necessary conference units (COUB))

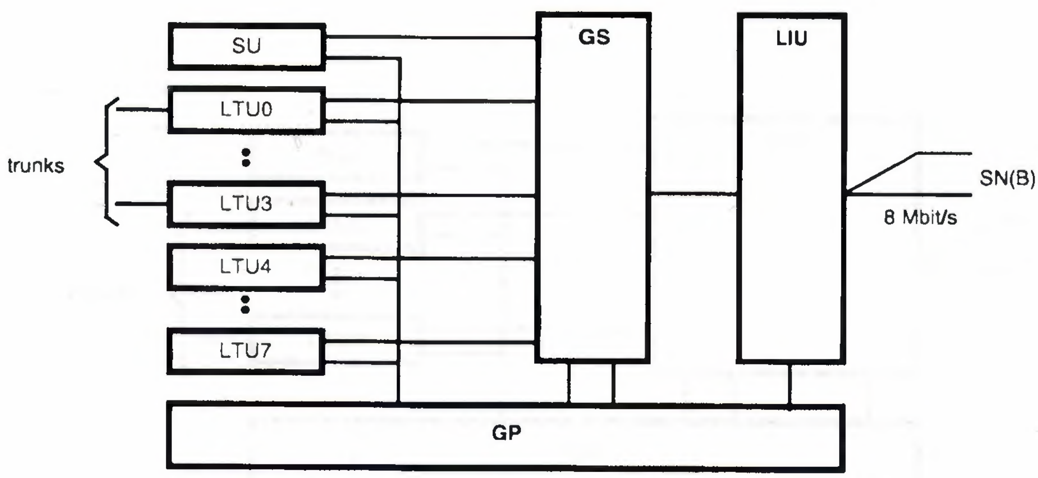


Fig 3.3 Line/trunk group B (LTGB)

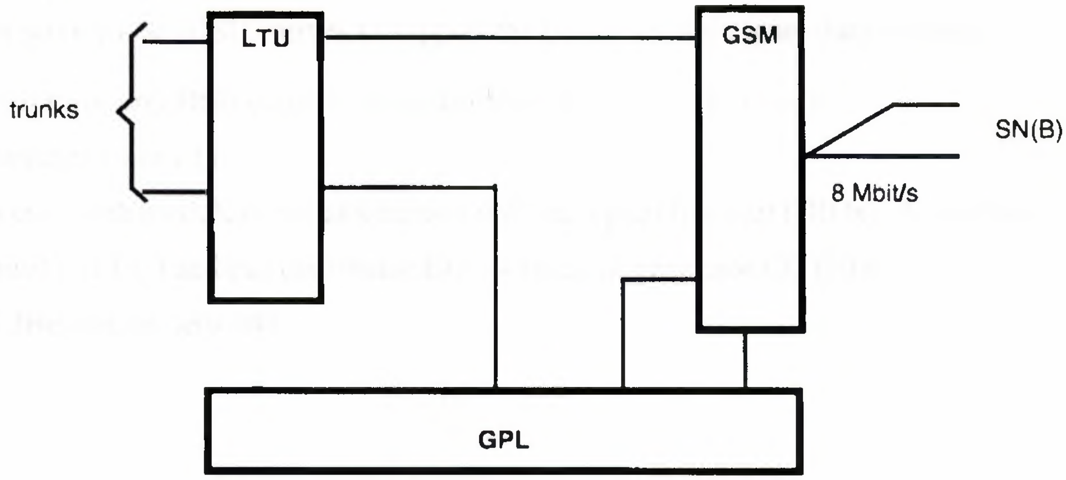


Fig 3.4 Line/trunk group G (LTGG)

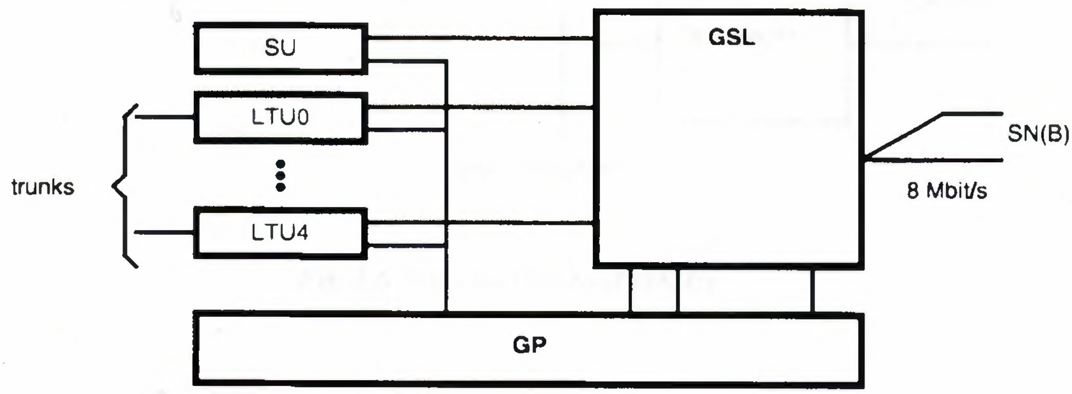


Fig 3.5 Line/trunk group M (LTGM)

3.4 Data Service Unit (DSU)

The data service unit (DSU) serves to support the bearer services (pure data services).

The data service unit DSU consists of the central functional units (Fig.):

- DLU systems (0 and 1)

(In each case with modules: digital interface unit for digital line unit (DIUx), digital line unit control (DLUC) and bus distributor BD., with clock generator CG (BDCG))

- Signal distribution networks

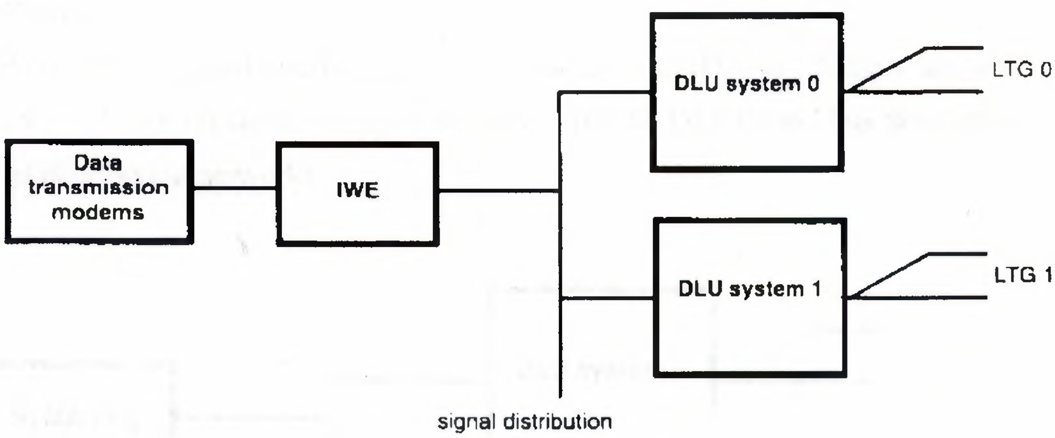


Fig 3.6 Data service unit (DSU)

The "peripheral" units join the central functional units:

- Interworking equipment (IWE)
- Data transmission modems (multi modems according to V.21, V.22, V.22bis, V.23, V.32)

For data transmission and the associated bearer services it may be necessary to match the radio side to the fixed-network side (e.g. PSTN/ISDN). For this reason in the MSC interworking functions QWF) are provided. The IWF are introduced into the connection via line/trunk groups.

They perform the following functions:

- Mapping the GSM/DCS signaling to the ISDN signaling and vice-versa
- Synchronization of the traffic channel

- Matching the bitrate to the radio side and to the fixed-network side (in areas where digital connectors are used throughout)

Modem and codec functions, in case digital connections cannot be guaranteed on the whole route

3.5 Digital Line Unit B (DLUB)

Digital line unit B (DLUB) is used to connect wired ISDN/analog subscriber lines (incl. analog access lines for analog PABXs) at the **CSC.**

Digital line unit B (DLUB) consists of the following central functional units (Fig.): - DLU systems (0 and 1)

(Each with modules "digital interface unit for digital line unit (DIUx)", "digital line unit control (DLUC)", central clock generator for DLUB (GCG: DLUB) and bus distributor BD) signal distribution networks

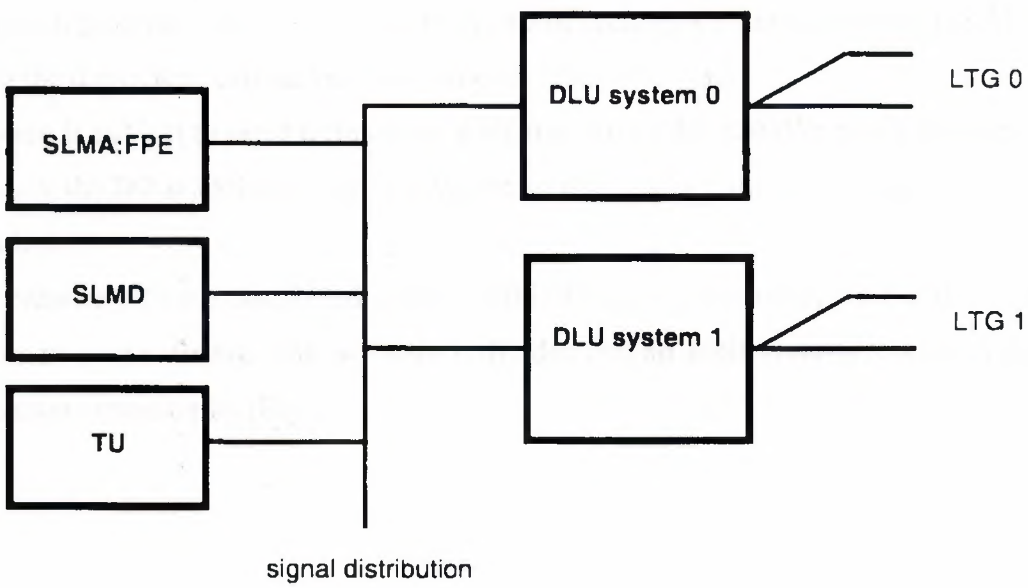


Fig 3.7 Digital line unit B (DLUB)

As well as the central functional units there are peripheral" units:

- Subscriber line module, analog (SLMA: FPE) for connecting analog subscribers
- Subscriber line module, digital (SLMD) for connecting ISDN subscribers

- Test unit (TU) for running tests and taking measurements on the subscriber lines.

3.6 Software

D900 SSS software is characterized by high quality and reliability, extensive dynamic capabilities (real-time requirements) and flexibility for implementations of additional functions. These characteristics have been achieved in a cost-effective manner by:
- Flexible, modular software architecture
- Efficient CHILL-based software technology
- Consistent software quality assurance

3.6.1 Software Architecture

The great flexibility of D900 SSS stems from the extensive use of reloadable software. Only a few processors, namely those with a narrow range of functions and not dependent on the application, such as the switching network and message buffer controls, contain programs which are stored in read-only memories.

The reloadable software for an D900 **SSS** node including the node-specific data forms the application program system (APS). For reasons of security a current image of the APS is held in the duplicated external memory in each D900 SSS node,

Hardware Is subject to rapid technological change. To enable D900 to profit from this evolution, the D900 **SSS** software is designed so that only a minimum of it is hardware-dependent.

In accordance with the distributed control within D900 SSS each processor in the system requires its own software. This software is divided into an application-independent and an application-specific part (Fig.).

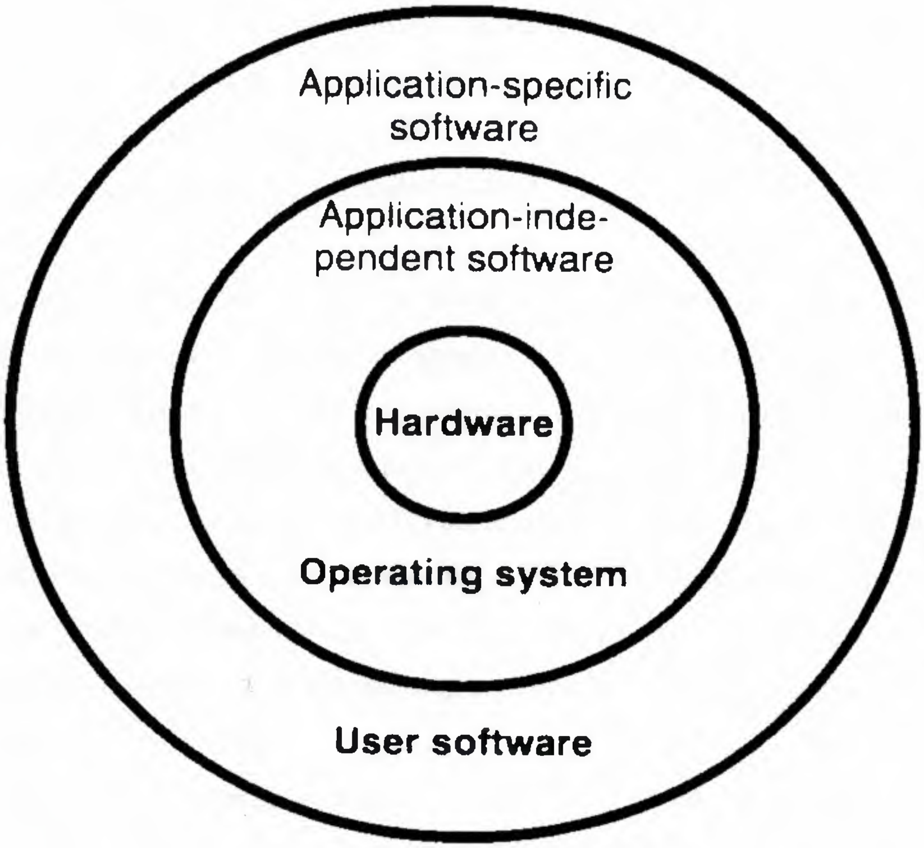


Fig 3.8 Software shells for a processor.

The application-Independent part always contains the operating system, which is tailored to the functions of a particular hardware subsystem. The application-specific software -also called the user software - Implements the functions for the various applications. The operating system provides all the programs in the user software with a uniform convenient interface via which they can make use of operating system functions and thus the resources of the processor.

The software of the individual processors normally contains a wide variety of functions. It is accordingly divided into subsystems. Each subsystem generally contains several modules. These represent the smallest units for compilation.

The various types of data are an essential component of the D900 SSS software. The data can be classified according to type, scope, lifetime and storage location. Node-specific data are held in the database of the CP113C/CR. Its size and contents depend on the equipment and the network environment of the node involved. The database is part of the user software.

The call processing programs control the establishment of connections in accordance with subscriber requirements. Apart from the appropriate hardware resources, these programs require Information on the network termination characteristics and the network environment (e.g. for routing). This information has to be provided by the operating company. Man-machine language (MML) commands can be used to incorporate such Information Into the system and to administer if there. Commands of this type are evaluated by the administration programs. The call processing programs also provide charge data and traffic data; the administration programs edit these data, save them and output them on demand.

Safeguarding and maintenance programs guarantee unimpaired system operation. The safeguarding programs are part of the operating system and are executed automatically. In contrast, the maintenance programs - like the call processing and administration programs - are user programs. Some of them only run after the appropriate MML commands have been entered. They make use of safeguarding program functions.

3.7 Operating Systems

Each processor In D900 SSS has its own operating system with capabilities dependent on the tasks to be performed by the processor and the resources, which it manages. All operating systems have to perform their functions under real-lime conditions. They are therefore interrupt-driven and work according to priorities. The coordination processor (CP113C/CR) operating system consists of executive and safeguarding programs.

3.7.1 Executive programs

The integral parts of the executive programs are:

- Scheduler
- Timer administration
- Memory management
- Input and output

Safeguarding programs

The functions of the safeguarding programs are:

- Determination of a functional system configuration on start-up and establishing this configuration
- Recording and processing safeguarding messages from the periphery and from CPU 3C/CR processes
- Controlling the execution of periodic checks
- Evaluating alarms from supervision circuits In the CP113C/CR
- Collecting error symptoms and saving them
- Analyzing and locating errors — reestablishing an operable system configuration after hardware faults, and
- Rectifying, by means of adequate recovery measures, the effects of software errors, which cannot be, neutralized by the user programs themselves

3.7.2 User Software

The user software implements the call processing, administration and maintenance functions and the associated database required for the specific application. New features, e.g. a specific signaling system for trunks, and whole feature packages can be easily implemented In D900 SSS by means of appropriate subsystem variants or by adding new subsystems.

Database

Call processing programs

Administration programs

Maintenance

3.7.3 Software Technology

The D900 SSS software technology is characterized by:

- A software engineering production plan (SEPP)
- Powerful standardized description and Implementation languages (SDL, CHILL)
- Extensive and convenient hardware and software support (support software also based on CHILL)

3.7.4 Software Engineering Production Plan

The D900 SSS software is developed in accordance with a software engineering production plan (SEPP). It ensures a uniform and systematic approach and therefore guarantees cost-effective development, complete documentation and above all high-quality software.

3.7.5 Description and Implementation Languages

An Important design aid for D900 SSS software is the specification and description language (SDL) standardized by the ITU-T. It Is particularly suitable for providing unambivalent descriptions of processes and execution sequences which are characterized by states, events and by the ensuing actions and state transitions. The D900 SSS development environment allows the developers to design modify and administer computer-aided SDL diagrams and their graphic symbols. The SDL diagrams are the basis for coding in CHILL or Assembler. A special software tool allows Assembler code to be generated directly from the SDL logic.

3.7.6 Support Software

Efficient development and quality of software are greatly influenced by the support available, For D900 SSS software development, commercial computer systems, personal computers and switching processors are used. Commercially available software is only able to support development activities to a limited extent. An extensive package of D900 SSS support software is therefore needed to support rapid development, production and updating of application program systems. This software, including the CHILL compiler, is written in CHILL and is thus portable. It supports all phases of D900 SSS software development from analysis to application,

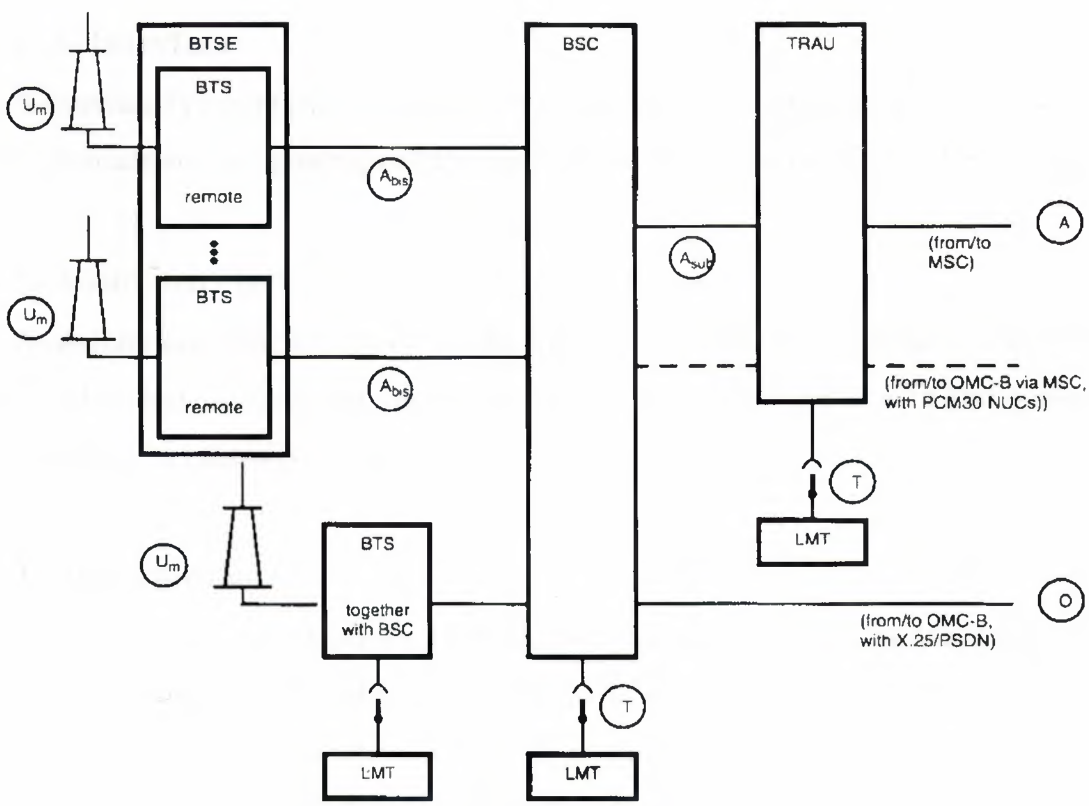
CHAPTER FOUR

BASE STATION SYSTEM (BSS)

4.1 System Architecture

4.1.1 Network Elements

The base station system (BSS) and the corresponding operation and maintenance subsystem (OMC-B) form the Siemens base station system (SBS). The base station system (BSS) consists of base station controllers (BSCs), base transceiver stations (BTSs) integrated In BTS equipments (BTSEs), transcoding and rate adaptation units (TRAUs) and local maintenance terminals (LMTs) as shown in Fig. 4.1. The structure with an intelligent centralized controller part and several low cost transceiver stations is well appropriate to both smallest cell networks, as preferably used in urban areas, and large-cell rural networks. The advantage of smallest cell networks is the internal handover offered by the BSCs, the advantage of large-cell networks is the coverage of large areas by low-cost BTSs.



4.1.2 Base station controller (BSC)

One or more BSCs are linked to an MSC. Physically the BSCs can be grouped together al a central point on MSC sites or remotely in a shelter or in a confined space. The BSC can then act as a concentrator for the links between the Abis and Asub interfaces. A BSC serves one or more BTSs

4.1.3 Base transceiver station equipment (BTSE)

BTSEs are distributed over the whole radio service area. Each BTSE supports generally more BTS but at least one BTS. Each BTS serves a radio cell.

4.1.4 Transcoding and rate adaptation unit (TRAU)

Although the TRAU is logically part of the BSS it is designed to be physically located al the MSC site. This helps to save transmission capacity on the Asub-interface.

4.2 Interfaces

The interfaces shown In Fig are defined as follows.

4.2.1 A-Interface

The A-interface Is the Interface of the BSC towards the MSC. The Interface comprises traffic channels and as signaling link the common channel signaling No.7 (CCS7) system.

4.2.2 A sub-interface

The Asub-Interface is the interface from the TRAU to the BSC. The interface comprises traffic and control channels. Sub-multiplexing of the traffic channels (4 x 16 kbit/s on a 64 kbit/s channel) is generally applied.

4.2.3 Abis-Interface

The Abis-interface is the interface of the BSC towards the BTSs. Physical transmission is realized with 2046 kbit/s or multiples of 64kbit/s. Submultiplexing Is performed with full-rate channels for 6 traffic channels onto 2 x 64-kbit/s and with half-rate channels for 16 traffic channels onto 4 x 64 kbit/s or 2 x 64 kbit/s. Even if the BSC and the BTSs are collocated the Abis-interface Is implemented.

4.2.4 0-Interface

The 0-Interface Is the Interface of the BSC towards the OMC-B. It is a packet-switched data network (PSDN) interface based on the **X.25** interface specification of the ITU-T Optional the O&M connections from OMC-B to BSS network elements can be handled by PCM30 nailed-up connections (NUCs) via MSC.

4.2.5 T Interface

The T interface is the interface of the BSC, BTS and TRAU towards the LMTs. It is also based on the X.21/V.11 Interface specification of the ITU-T.

4.2.6 Um-Interface (radio interface)

The Um-interface is the radio Interface between the BTS (-antenna) and the mobile stations. This interface provides a number of logical channels. Mobile user Information (voice, data) is transmitted via traffic channels, control signals and short messages are transmitted via control channels. Such control channels are:

- Broadcast channels for frequency correction, synchronization
- Common control channels for paging, random access and access grant
- Dedicated control channels for slow associated control fast associated control and stand-alone control
- Radio frequency channels and bands of D900. The **D900** provides the GSM primary band (890-915 MHz for uplink, 935-960 MHz for downlink) as well as the GSM extended band G1 (880-915 MHz for uplink, 925-960 MHz for downlink). The radio channel assignment for the D900 BSS (GSM primary band) is shown In Fig, and (GSM extended band G1) is shown in Fig.

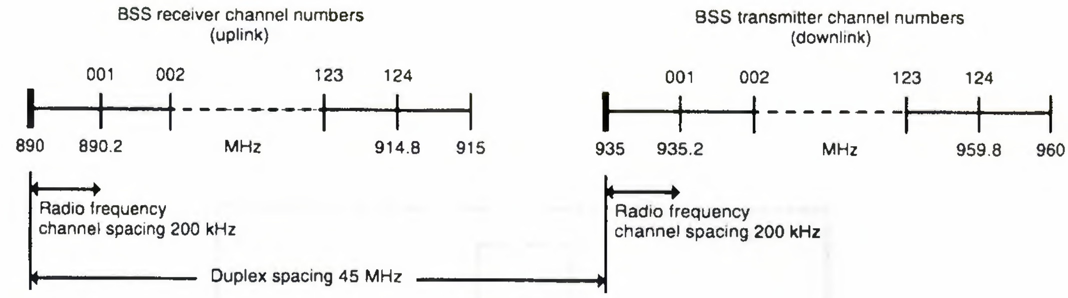


Fig. 5.2 Radio channel assignment for the D900 BSS (GSM primary band)

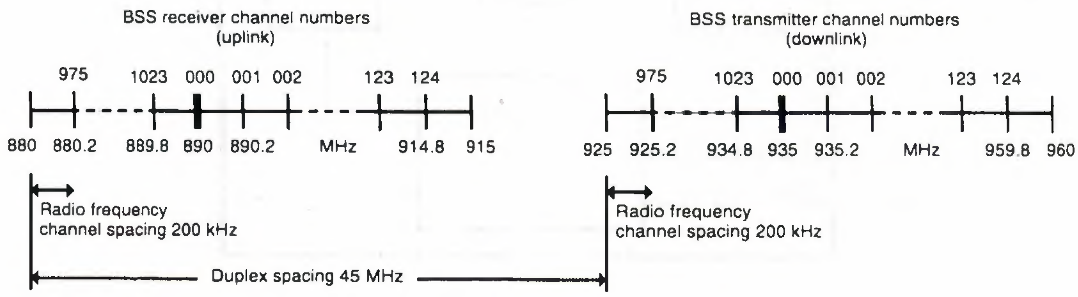


Fig 4.2 Radio channel assignment for the D900 BSS (GSM extended band G1)

BTSs of adjacent cells use non-adjacent radio channels In order to avoid mutual interference. The mobile stations can use any pair of the 124 (174 for extended band G1) radio channels on the uplink or on the downlink. The decision as to which frequency pair is used for a particular connection is taken by the BSC and transmitted to the mobile station as a radio command via a signaling channel.

4.3 Hardware

4.3.1 Hardware Architecture

The BSS consists of base station controllers (BSCs) and base transceiver station equipment's (BTSEs) and transcoding and rate adaptation units (TRAU) as shown in Fig. A maximum of 60 BTSEs can be connected to one BSC, One BTSE can serve up to 6 TDMA systems, but not more than 120 TDMA systems can be connected to one BSC. Thus one BSC can serve up to 960 full-rate traffic channels.

4.3.2 Base Station Controller (BSC)

The BSC is the central component of the BSS. Fig 4.3 shows the functional structure of the BSC.

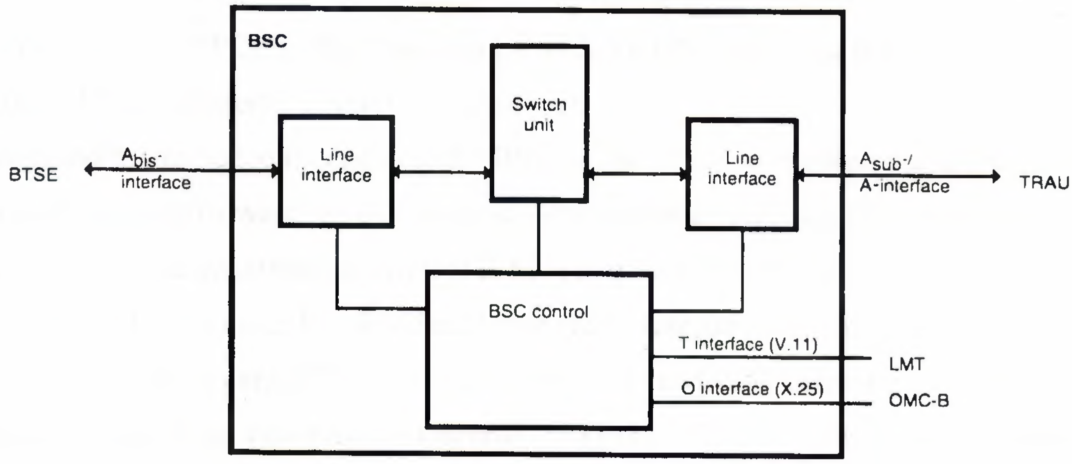


Fig 4.3 Functional structure of the BSC

The BSC consists of

- BSC control
- Line interface switch unit

4.3.3 BSC control

The BSC control is a multiprocessor system. It contains two main processors performing call processing and O&M tests, and a set of slave processors for peripheral tasks and for the communication between the components of the BSS. To achieve a high degree of reliability, the main processors are duplicated. As a background storage device a hard disk is provided.

One of the two main processors is the so called administrative processor represented by the main processor control card (MPCC), which controls the connections of the switching unit on the basis of the telephony processor messages. The other of the two main processors is the so called telephony processor represented by the telephony and

Distributor processor card (TDPC), which is responsible for message exchange with the other network, entitles via the peripheral p re-processors.
There are two types of peripheral processors. One of them Is the peripheral processor for LAPD channels (PPLD) which is responsible for handling the OSI level 2 LAPD protocol (used for signaling on the Abis- and Asub-interfaces), The other type is the peripheral processor for CCS7 (PPCC), which handles CCS7 MTP OSI layer 2 for the signaling towards the MSC (A-Interface, via Asub-interface).
Operation and maintenance functions of the BSS can be accessed remotely via a dedicated interface (0-lnterface) towards an operation and maintenance center for BSS (OMC-B). Additionally, a local maintenance terminal (LMT) may be connected allowing for operation at the BSC on site. For this there Is the O&M Interface (IXLT), which allows the main processor control card (MPCC) to be connected to the O&M center by a ITU-T X.25 interface and to the local maintenance terminal (LMT) by ITU-T X.21/X.11 interface using the LAPB protocol.

4.3.4 Line interface

The line Interface (DTLP) provides the connections towards the BTSs (Abis-Interface) and TRAU (Asub-interface) via standard 2 Mbit/s digital lines.
Each line interface handles two 2 Mbit/s PCM lines; each PCM line has two physical inter-faces (terminal); the active physical Interface Is selected, on a per channel basis, under software control.
In order to reduce the use of PCM lines and to obtain cost-effective operations, 4x16 kbit/s sub-multiplexed traffic channels are Inserted in one PCM-slot.
If required, the DTLPs can be distributed deliberately between Abis- and Asub-inter-faces.

Switching unit

The switching unit (SN64) comprises a single-stage-switching matrix for 3072x64 kbit/s time slots. It provides, under the control of the main processor control card (MPCC), traffic connections by linking mobile station time slots with the assigned MSC trunk lime slots. This allows, for example, to manage the handover among BTSs covering adjacent radio cells still belonging to the same BSC service area without directly involving the MSC resources.

4.4 Transcoding and Rate Adaptation Unit (TRAU)

Although the transcoding and rate adaptation unit (TRAU) logically is part of the BSC, it is designed to be physically located at the MSC site. This helps to save transmission capacity between BTS and MSC site. Fig 4.4 shows the functional structure of the TRAU.

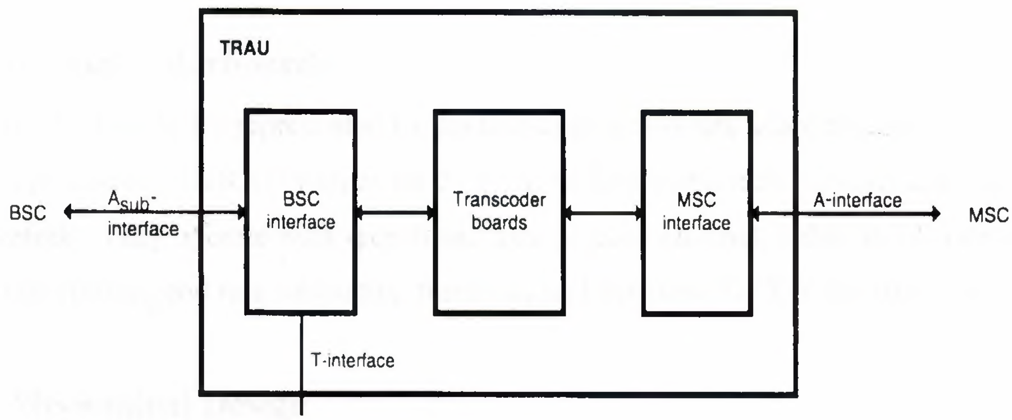


Fig 4.4 Functional structure of the TRAU

The TRAU consists of the following functional blacks

- BSC interface
- MSC interface
- Transceiver boards

4.4.1 BSC interface

The BSC interface card (BSCI) which houses the central controller of the TRAU and includes an interface towards the BSC using normal PCM links represents the BSC

Interface. It multiplexes the serial lines generated by the TRAC boards to build the whole lines to be sent to BSC and is transparent for the CCS7 channel (64 bit/s channel) and for the **X.25** link between BSC and OMC-B (64 kbit/s channel).

4.4.2 MSC interface

The MSC Interface is represented by the MSC Interlace card (MSCI) which multiplexes the serial lines generated by the TRAC boards to build the whole lines to be sent to the MSC and processes the LAPD protocol residing in the control link of the BSC. By using a dedicated serial communication link. It sends to BSCI the messages received from the BSC (directly or via another TRAU) and receives the messages from BSCI that are to be inserted in the link towards the BSC.

4.4.3 Transcoderboards

Transcoder boards are represented by the transcoding and rate adaptation card (TRAC) which processes 24 TRAU frames for 24 PCM 64 kbit/s channels (uplink) and vice versa (downlink). They operate with speech and data on each channel, either at full-rate or at half-rate (coding and rate adaptation function) and performs DTX/VAD function.

4.5 Mechanical Design

Rack Layout

Base station controller (BSC)

The BSC Is contained In a subrack 724 mm high (with base module), 1448 mm high (with base + extension module), 300 mm deep and 600 mm wide. Thanks to Its compact design occupying a space of less than 0.26 cubic meters and its low power dissipation the BSC is operated without any fans or air condition. Therefore, the operator has the choice of locating the BSC centrally in telecommunications rooms or remotely in a shelter or in a confined space. These BSC subracks are inserted into Siemens ON standard dimension racks (h x w x d = 2000 x 600 x 300 mm) for adaptation to the MSC.
The BSC core module is always equipped with the necessary boards to provide the real time processing performance for the maximum BSC configuration. BSC system capacity with respect to the number of link Interfaces (DTLP) or pre-processing boards for LAPD

signaling (PPLD) can be expanded. This can be done by expanding the base module with the expansion module and inserting additional boards into an already Installed expansion module.

This allows a very easy and gradual network growth to more complex and powerful configurations without traffic interruption. Fig shows a front view of a BSC rack (R: BSC) with basic module and expansion module.

CHAPTER FIVE

O&M SUBSYSTEM (OMS)

Overview

The D900 network provides the features of a GSM/DCS system; it consists of:

- A telecommunication system composed of the base station system (BSS) and *the* switching subsystem (SSS)
- A telecommunication management network (TMN), represented by the O&M subsystem (OMS)

The open concept of the TMN permits flexible adaptation of the OMS to the needs of the network operators. The D900 OMS supports centralized and decentralized (i.e. local) operation and maintenance of the nodes of the PLMN.

Protection against faults has been achieved to a great extent by means of built-in measures. If simple faults occur they are eliminated by automatic recovery procedures and the PLMN operator does not need to intervene. In the **case** of more serious faults, information is supplied to enable the operator to recognize and remove the fault source. In severe cases the affected network element or network node is taken out of operation and the operator is warned. Whenever possible, the system adapts its configuration and continues operation.

5.1 System Architecture

The OMS is realized in operation and maintenance centers (OMCs), which consists of an OMC-B for administration of BSS network elements and an OMC-S for administration of SSS network elements within the PLMN. The operation and maintenance for SSS and BSS are independent of each other. The OMC-B and OMC-S can be combined in the same location. The OMC can also be

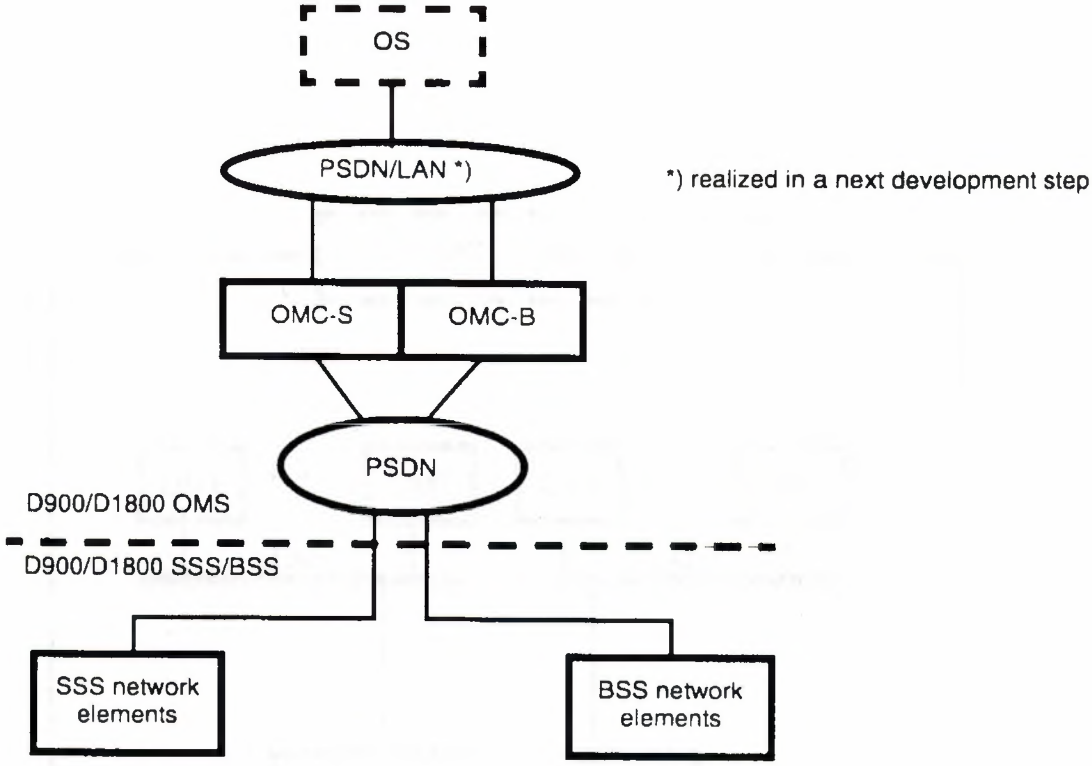


Fig 5.1 OMS network architecture.

connected with network elements of an operations system (OS) via a PSDN or LAN (Fig). Elements of an OS are, for example, the personalization center for SIM (PCS), security management center (SMC) or data post processing system (DPPS).

5.2 Network Elements

5.2.1 OMC for the SSS and BSS

The structure of the OMC-S and OMC-B is shown in Fig. 5.2.

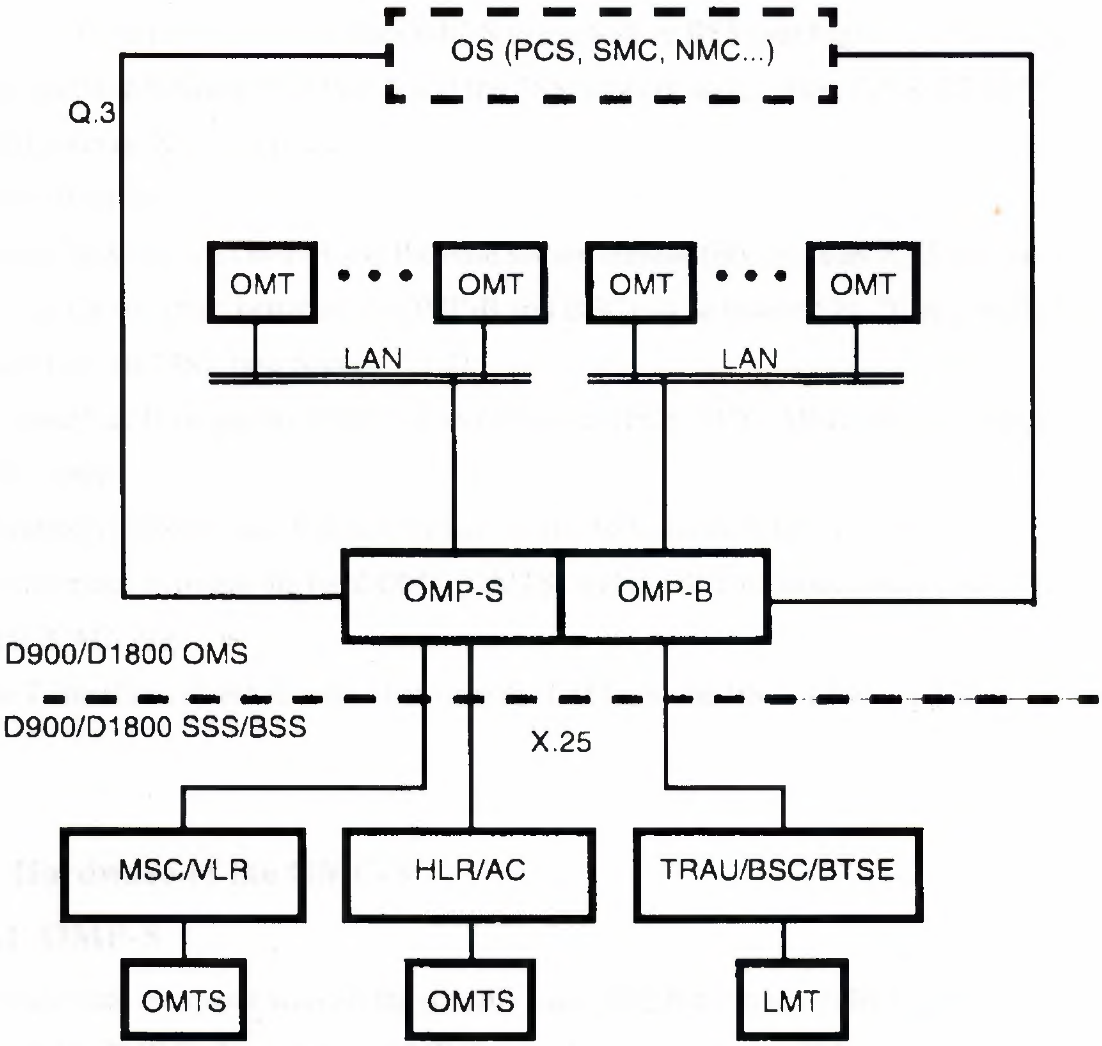


Fig 5.2 OMC for the SSS and BSS

The operation and maintenance terminals (OMT) and the O&M processors (OMPs) are connected to local area networks (LANs) In the OMC. The OMP-S has access to the network nodes of the SSS and the OMP-B has access to the network nodes of the BSS (the BSCs) via the packet-switched data network (PSDN). As an option the access of the OMC-

B to network nodes ol the **BSS** can be realized via MSC PCM30 links (nailed-up connections, NUC). All connections to the PSDN are ITU-T Standard **X.25** connections.

5.3 Interfaces of the OMS

There are three interlaces from the OMC-S to the SSS or BSS (see Fig):

- The interface between the OMP-S and the SSS network nodes (MSC/VLR, HLR/AC, EIR) via an X.25 interface
- The 0-lnterface:

Interface between the OMP-B and the base station control (BSC) via an **X.25** interface. Optional the Interface between the OMP-B and BSC can be realized by PCM30 nailed-up connections via MSC (see Section 5.1.2).

- The interface between the OMP and an OS center (PCS, SMC, MMC etc.) via a 0.3-interface

Additionally there are two O&M interfaces in the SSS and BSS network nodes:

- The interface between the local OMT (OMTS) and the SSS network nodes (MSC/VLR, HLR/AC, EIR)
- The T-interface: direct interface between the LMT and the BSC, TRAU and BTS

5.4 Hardware of the OMC-S

5.4.1 OMP-S

A commercial computer with all the security measures that can normally be provided is used as the OMP-S. A number of OMP-Ss can also be used in an OMC-S In order to operate the connected network elements or to guarantee system redundancy. Each **OMP-S** can be configured for dedicated functionalities, e.g. as file server, mediation server or performance management (PM) server. Mirrored disks are used to hold identical data on two magnetic disks. This makes it possible to provide a failsafe database in a client-server system (needed with software upgrade for example). A subfunctlon here is OMP-S switchover on failure of an OMP-S to allow access to important data,

5.4.2 OMT

There are various types of operation an maintenance terminal available. They differ in the hardware used and the type of connection to the OMP-S:

The types of operation and maintenance terminal used are as follows:

- Workstation (OMT) A workstation is a commercially-available computer with a color screen.
- X-terminal (OMTX)

An X-terminal is a color X-terminal. It is connected to the LAN. An OMP-S is used as a server,

- TAC terminal

The TAC terminal is available as an option. It gives the manufacturer remote access for maintenance purposes In emergency situations. For the network provider remote diagnosis by the manufacturer can save a great deal of time and money. Local terminals in the SSS network nodes.

5.4.3 OMTS

Personal computers are used as local OMTs (OMTS) for installation purposes
And for local operation and maintenance work.

5.5 Hardware of the OMC-B

5.5.1 OMP-B

The OMP-B used is a commercially available computer with standard multibus structure The OMP-B can be optionally duplicated with hot standby redundancy.

OMT

Following different types of OMTs are available:

- Graphical workstations
- X-terminals

The standard configuration has up to 2 graphical workstations connected to OMP-B (to both OMP-Bs In case of redundancy) locally via (duplicated) LAN. A remotely OMT can be connected via LAN bridges to the local LAN, LAN bridges will be used in pairs of connections of remote workstations with the OMP-B, They are used in conjunction with modems.

5.5.2 LMT

Local maintenance terminals (LMT) are available for operation and maintenance work at the BSS network element (BSC, BTSE. TRAU) site. They are implemented in the form of laptop computers (Intel 80386 or higher, AT bus, V.11 Interface) and running under MS-DOS 5.0 or higher. These portable terminals can be connected locally to the BSC, BTSEorTRAU.

The LMT has the capability to identify the mode itself by communicating with the connected BSS network element (BSC mode, BTSE mode. TRAU mode). The LMT is used for first installation of SBS software and configuration, fault repairing and removing.

5.6 Software Architecture

5.6.1 Software Architecture of the OMC-S

The software supplied for the components of the OMC-S consists of a software platform, basic system and application software (Fig). This application software is adapted to the needs o1 a telecommunication management network (TMN). It consists of processes (In the UNIX sense) for the various requirements of the operation and maintenance applications; e.g. operator inputs or messages from the network nodes of **SSS.**

5.6.2 Software platform

The software platform consists of commercially available software systems complying with international standards. The main components are:

- Operating system UNIX®/SINIX®, System V
- Network file system
- Database management system Informix
- Graphics program WINGZ
- Window manager OSF-Motif
- Window system X/Window
- Communications software:

For WAN communication: CMISE, FTAM in accordance with OSI standards (I.e. based on X.25); for LAN communication: TCP/IP

5.6.3 Basic system

The basic system includes the following parts

- Installation
- Recovery
- Central functions which allow general access to utilities
- LAN and WAN communication
- File transfer functions to the network elements of the SSS or to the OS

5.6.4 Application software

The application software is divided into the following groups:

- Basic applications
- Applications for the QMS
- Applications for the SSS
- Mediation functions (MF)

• Basic applications

The basic applications include:

- Graphical user interface (GUI)
- Online help system
- Command logging
- Security management (SM)

• QMS applications

OMS applications include:

- Configuration management (CM)
- Fault management (FM)
- OMS status display (OSD)

• SSS applications

SSS applications include:

- MML management

Containing among other things the input of extended MML (EMML) or basic MML (BMML), which is used for operation of the SSS network nodes and the automatic operator (ATOP), which supports the recording of input commands in a prepared file

- Fault management (FM)

Containing among other things the graphic system status display (SSD), which is used to monitor the SSS network nodes

- Performance management (PM) Analysis and graphical display of the traffic measurement data of the SSS
- SSS manual on PC (OMT)

• Mediation Functions (MF)

The mediation functions (MF) convert the **Q.3** Interface (TMN) between OS and OMC-S into the Qx interface between OMC-S and the network elements. Due to the mediation functions, the OS has access to the necessary data of the network elements or network nodes of the SSS.

There are mediation functions for the following, for example:

- Subscriber administration

(Dialog of subscriber data between the SSS network elements HLR/AC and the OS with the dialog service CMISE)

- Fault management

(Dialog of alarm messages between the **SSS** network elements and the OS with the dialog service CMISE)

- Control and administration of data for call charging (transfer of call charge data between MSC and the OS with the file transfer method FTAM supported by CMISE)
- Transfer of S-tickets for juridical interception (between MSC and the OS with dialog service CMISE)

5.6.5 Software Architecture of the OMC-B

The software supplied for the components of the OMC-B has nearly the same structure as the software supplied for OMC-S (see also Fig. 6.3). The structure of the software platform and basis system is the same in principle. Differences are given in the application software like shown in the following.

5.6.6 Application software

The application software is divided into the following groups:

- Basic applications
- Applications for the OMS
- Applications for the BSS
- Mediation functions (MF)

- Basic applications

The basic applications Include:

- Graphical user interface
- Online help system
- Command logging

- QMS applications

QMS applications Include:

- Configuration management (CM)
- Fault management (FM)
- Security management (SM)

- BSS applications

BSS applications include

- Configuration management (CM) which contains the management of the network resources (e.g. radio channels)
- Fault management (FM) which contains the measures necessary to detect and remove faults
- Performance management (PM)

Which contains the supervision and evaluation of the traffic load and the performance of the BSS network software management (SWM)

Which contains the management and control of the software and the databases of the BSS

The Above mentioned BSS applications are managed by the graphical user interface universal supervisory center (USC) at the OMTs for BSS. The basis of the OMC-B application is a hierarchiy of geographical maps, functional panels and rack layouts on which current status of all "managed objects" is displayed. Further this gives the possibility to step in every fault management, configuration management or software management application with the most user guidance.

- Mediation Functions (MF)

The mediation functions (MF) convert the Q.3 Interface (TMN) between OS network elements (e.g. a network management center (NMC)) and OMC-B into the Qx interface between OMC-B and the network elements. Due to the mediation functions, the OS has access to the necessary data of the network elements or network nodes of the BSS.

CHAPTER SIX
FUNCTIONS

The network functions support the services of the PLMN, They cover
- Basic functions of call handling
- Mobile-specific functions of call handling

6.1 Basic Functions of Call Handling

6.1.1 Connection types

• Mobile subscriber

The basic call handling functions establish connections between a mobile subscriber (PLMN mobile subscriber and on CSC WLL subscriber) and another subscriber in a PSTN, an ISDN, a PSDN or a mobile subscriber In the same or another PLMN.

The following call types are possible: — mobile originated call (MOC)

- Mobile terminated call (MTC)

In addition, further special cases based on the two basic call types are possible:

- Mobile to mobile call (MMC)
- Mobile internal call (MIC)

• Wired ISDN/analog subscribers at the CSC

With this subscriber type only the conventional call handling functions for fixed network subscribers are needed, I.e. no mobile-specific functions.

• IN call handling

All subscriber types of a PLMN or CSC are provided with call handling functions for various IN applications.

6.1.2 Full-rate and halt-rate connections

In a GSM/DCS Phase-1 PLMN only full-rate connections are supported, i.e. the useful data is transmitted on the radio interface at a speed of 22.6 kbit/s. GSM/DCS Phase 2 will support half-rate connections (transmission speed of 11.4 kbit/s).

The D900 SSS supports the half-rate channels for voice services but not for data services. The question of whether the entire D900/D1800 will support half-rate connections depends

6.1.3 Handling of mobile subscriber (GSM/DCS) telecommunications services

The bearer services are used only for pure data services. They provide the necessary fundamentals for the operation of these pure data services. The teleservices define both voice and also data services. Supplementary services expand the functionality of the basic telecommunications services (bearer services and/or teleservices).

The GSM/DCS telecommunications services that are possible In the D900 are listed.

GSM/DCS Phase 2/Phase 1 (Fallback)

The D900 offers the range of features of both GSM/DCS Phase 2 and GSM/DCS Phase 1. In the case of GSM/DCS Phase 2 this means the support of typical Phase 2 telecommunications services such as multi-party service (MPTY) or closed user group (CUG), The GSM/DCS Phase 2 signaling method Is carried by the CCS7 user parts BSSAP, MAP and TCAP. The D900 detects on the BSS side a Phase 1 mobile station and signals this to the MSC with the CCS7 BSSAP. The MSC offers a "fallback" from Phase 2 handling to handling in accordance with the Phase 2 features.

User information

Audible tones, announcements and displays inform the calling subscriber in the D900 network (mobile subscriber or wired ISDN/analog subscriber) and the subscriber In the ISDN/PSTN about the status of the call setup.

6.2 Generation of call data records

During each call transaction detailed call data records are created for PLMN mobile subscribers or in the CSC for the WLL mobile subscribers and wired ISDN/analog subscribers. Recording of call data can be employed for the purposes of call, charging, network administration and supervision. After the call data records have been generated they can be subjected to customer-specific data formatting.

• Automatic message accounting (AMA)

The call charges for all subscriber types In **D900** can be recorded using automatic message accounting (AMA). An exception to this rule is the prepaid mobile subscriber (PPSC subscriber/debit subscriber). Automatic message accounting (AMA) generates at least one regular charge data record for each successful call or each time a service is used.

• Pulse metering

For ISDN/analog subscribers at the CSC meter pulse can be generated for each call or for activation/use of supplementary services.

In the CSC the pulse metering methods employed are as follows:

- SPM (single pulse metering)
- MPM (multiple pulse metering)
- PPM (periodic pulse metering)

• IN charge data

The introduction of highly-developed intelligent network (IN) services In a GSM/DCS PLMN requires an expansion to the previous D900 charging concept. The basic Idea Is for both parties Involved, i.e. the IN service user (calling line) and the service subscriber (called line) to share the charges accrued In a variety of very flexible ways. The question of "Who pays for what?" must always be answered in a service-independent and service-subscriber-specific arrangement.

There are basically two ways of charging for IN connections:

- Charge recording via the SCP/SMP
- Charge recording based on the M-SSP

• Customer-specific data record formatting

If necessary the regular charge data (AMA or pulse metering data) can be converted into a customer-specific data record format before being transferred to a particular data post-processing system (DPPS). In the data post-processing system the data records are handled according to their use (e.g. for calculating the total charges to the mobile subscriber served or to monitor the location of the mobile subscriber).

• **Hot operation**

The term hot operation covers all cases in which AMA data records are additionally generated and/or formatted and transmitted to a dedicated processing center via the packet switched public data network (PSPDN) while a call Is sill! In progress or immediately after it has ended. There are the following two applications for this:

The four applications involved here are as follows:

- Hot billing data record recording
- Emergency call (race data record recording
- IMS! Trace data record recording interception data record recording

6.2.1 Juridical interception

Juridical interception means using a monitoring function to trace calls from/to a subscriber so that user and signaling information is provided In uncorrupted form via separate stub connections to a monitoring center in the ISDN/PSTN. It also entails recording what are known as s-tickets.

Juridical Interception is possible for PLMN mobile subscribers and for WLL mobile subscribers or ISDN/analog subscribers in the **CSC.** For PLMN mobile subscribers these monitoring methods extend to PLMN mobile subscribers of the own PLMN and to "roamers" from other PLMNs,

Interadministrative revenue accounting (IARA)

IARA is available as a way of providing a flexible method of charge accounting between different PLMNs and fixed networks of a country or between different countries. It can therefore be used either in the GMSC or in the gateway exchanges of the PSTN/ISDN.

IARA registration allows the output of connection data:

- In sum data records for a large number of individual connections (IARSTAT)
- In AMA data records for an individual connection (IARAMA)

6.3 Mobile-Specific Functions of Call Handling

The mobile-specific functions of call handling comprise the functions which result from the architecture of the GSM/DCS PLMN network. These functions apply to PLMN mobile subscribers and to WLL mobile subscribers provided a function is not explicitly mentioned for one particular type of mobile subscriber.

They include:

• Security functions

- Authentication
- Confidentiality
- Checking the international mobile equipment Identity

• Mobility management

- Roaming
- Location registration IMSI attach/detach
- Handover
- Interrogation, paging for an MTC

- Speed sensitive handover algorithms for introducing overlay/underlay BSS network layer
- Frequency hopping
- Transmit it-power control
- Discontinuous transmission (DTX)/voice activity detection (VAD)
- Functions resulting from special identification handling (single and multi-numbering, double subscriber, multiple NDC for a PLMN)
- Cell-oriented routing of service numbers
- Subscriber-related routing of service numbers
- Queuing and priority
- Overload handling

6.3.1 Authentication

Authentication is an important part of the security measures which prevent unauthorized access of mobile subscribers to the GSM/DCS network and its telecommunications services. The following subscriber-specific algorithms and keys are used for authentication: A3, A8. Ki, **Kc.** Authentication means that each individual mobile subscriber is assigned parameters (Ki and triples, consisting of RAND, SRES, Kc) and version numbers of A3 and A8. And in particular SRES for the actual authentication comparison in the VLR.

6.3.2 Confidentiality functions

The confidentiality functions ensure

- Subscriber Identity confidentiality (TMSI reallocation)
- Confidentiality of the user data on the radio Interface (encryption). The following subscriber-specific algorithm and key are used: AS, Kc. Kc changes with each authentication and is thus individual to the subscriber. A5 is present In the PLMN in a maximum of 3 versions (no ciphering Included).

6.3.3 Checking the international mobile equipment identity

Checking the international mobile equipment identity (IMEI) In the PLMN for an MOC or MTC establishes whether the mobile equipment used is registered and approved In the PLMN.

Roaming

• PLMN mobile subscribers

Roaming means that the PLMN mobile subscriber can move freely within a public land mobile network (PLMN) or in the international GSM/DCS service area.

The following roaming restrictions are possible within the framework of what is known as a subscriber:

- Roaming in all GSM/DCS PLMNs nationally and Internationally
- Roaming only for the MS's own national GSM/DCS PLMN and all other international GSM/DCS PLMNs
- Roaming exclusively in the own PLMN (HPLMN)
- Roaming In a defined selection of PLMNs' Roaming areas are defined which each contain one or more PLMNs. Assigning this type of roaming area to a PLMN mobile subscriber restricts the subscriber to precisely the given PLMNs.

The following further roaming restrictions are possible:

- Fully regional roaming

In addition to the above roaming restrictions, roaming can be restricted within a PLMN to specific areas (fully regional roaming, in accordance with GSM/DCS Phase 2). For this the PLMN mobile subscribers for a PLMN are assigned to up to 10 roaming zones. A roaming zone is project-dependent and is either defined as a combination of radio cells or location areas.

- National roaming

National roaming includes the option of restricting the use of telecommunications services for PLMN mobile subscribers who are domiciled in another PLMN in the own VLR area.

• WLL mobile subscribers

For WLL mobile subscribers in a CSC roaming is basically governed by the same principles as for PLMN mobile subscribers. The only difference is the roaming restrictions applicable from the outset for all WLL mobile subscribers; e.g. roaming is only allowed within a defined location area.

6.3.4 Location registration

The main function of roaming is location registration, which involves the following procedures: location update location cancellation

The location update procedure provides the VLR and HLR with the information on the current location of the mobile subscriber.

The location cancellation procedure removes the mobile subscriber data from the old VLR,

6.3.5 IMSI attach/detach

If the mobile subscriber has inserted/removed his chip card (and hence his IMSI) into/from the mobile station or switched the mobile station off/on, the IMSI attach/detach function Informs the VLR of the activated/deactivated status of the mobile station.

Handover

Handover is the passing on of a connection from radio cell to radio cell. The physical connection path between MS and base station system (BSS) or between MS, base station system and switching subsystem (SSS) is changed. A distinction is drawn between the following types of Handover:

Internal handover (BSC-controlled handover)

- Intra-cell handover
- Inter-cell handover

External handover (MSC-control led handover)

- Intra-MSC handover
- Inter-MSC handover

6.3.6 Mobility management for a MTC

The following additional mobility management functions must be performed for an MTC:

- Interrogation

I.e. the gateway MSC requests the location data of the mobile subscriber from the VLR

Paging and searching i.e. the radio cell in which the mobile subscriber is currently located is found

Speed sensitive handover algorithms for introducing underlay BSS network layer (with micro radio cell geometries) or overlay BSS network layer (with umbrella radio cell geometries)

To expand the capacity of radio networks which already provide a good overall area coverage a new approach Is chosen: the hierarchical BSS network architecture.

While the already existing network serves as the overlay BSS network and gives blanket coverage of virtually the whole BSS network area, the underlay BSS network consists of a large number of small cells in order to cope with local traffic loads and slow moving subscribers. The base of such an eased network integration builds a "speed" sensitive handover algorithm to detect the "speed" of the MS and keep the "fast" ones in the umbrella radio cells and the "slow" ones in the micro radio cells.

6.3.7 Frequency hopping

The frequency hopping function permits the dynamic switching of radio links from one carrier frequency to another. With frequency hopping every logical channel changes the physical channel transmission frequency from one TDMA frame to the next. As a result, slow fading is reduced and the effect of interference frequencies is keep low. Frequency hopping also improves the S/N ratio allowing to increase the radio cell size and improve service quality.

6.3.8 Transmit-power control

The transmit-power control should minimize the transmit power required by MS and BTS and at the same time guarantee good reception quality. The transmit-power control reduces the noise when there are connections on neighboring channels.

Discontinuous transmission (DTX)/voice activity detection (VAD)

The discontinuous transmission (DTX) and its functions voice activity detection (VAD) and comfort noise Insertion (CM!) for full rate channels are specified with the purpose to minimize the power consumption of the MS and, at the same time, to reduce the Interference level on the radio interface. During a normal conversation, the participants alternate so that, on the average, each transmission direction is occupied about 50% of the time-If transmission is switched on only for those frames that contain speech and Is switched off during all other intervals then the power consumption in the MS Is reduced considerably and the interference level In the network is reduced.

6.3.9 Functions resulting from special identification handling

• Single numbering and multi-numbering

There are basically two possibilities for assigning a mobile subscriber several tele-communications services:

- Single numbering

I.e. all the MTC-capable services (e.g. telephony and telefax, but not the short message service) are assigned to a mobile subscriber's directory number

- Multi-numbering

i.e. each telecommunications service is assigned its own mobile subscriber number

• Double subscriber

The function of double subscriber allows two different mobile subscriber numbers (MSISDN and IMSI) to be set up. The numbers are different as far as numbering schemes and telecommunications services are concerned, but are linked administratively in the PLMN to represent one double subscriber.

• Multiple NDC for a PLMN

The function of multiple NDC for a PLMN allows the PLMN operator to introduce MSISDN with different NDCs in one or more HLR/AC nodes.

• Dialing without national destination code NDC (for PLMN mobile subscribers at the MSC)

It is possible to define for a particular project whether any PLMN mobile subscriber within the own PLMN can dial any other PLMN mobile subscriber with the same NDC without having to dial the NDC.

• Dialing without local **area** code LAC (for WLL mobile subscribers or wired subscribers at the CSC)

It Is possible to define for a particular project whether within the own local network defined by the LAC any subscriber (who was created with an LAC) can reach any other subscriber who has the same LAC without actually dialing the local area code.

Cell-oriented routing of service numbers

Cell-oriented routing of service numbers (with special short codes) offers the possibility of routing certain MOCs to different destination numbers depending on the location 01 the mobile subscriber (i.e. originating cell of the MOC).

Subscriber-related routing of service numbers

Subscriber-related routing of service numbers (with short codes) offers the facility of routing certain MOCs to a personal service application in a service center, depending on the number of the calling mobile subscriber.

Queuing and priority

Queuing is performed in the BSS when a traffic channel is requested if all traffic channels In the BTS are busy. The traffic channel assignment is marked and assigned as soon as a traffic channel becomes free in the BTS, In this way the traffic channel capacities In the BTS are used more efficiently by increasing successful assignment of call attempts. Queuing requests for traffic channels are not handled on a "first come, first served" basis, but using a tar more beneficial procedure based on a priority strategy.

Overload handling

Several overload levels are defined for overload control. The countermeasures to be taken depend on the prevailing overload level, the type of connection and the authorizations of the mobile subscriber. The highest overload level restricts all traffic. It is applied during a system recovery.

The maintenance functions observe the events which influence traffic volume conditions. The PLMN operator is informed of the existing overload condition.

6.4 Special Operation and Maintenance Functions

These operation and maintenance functions enable the PLMN operator to manage data throughout the network in a simple manner and to influence functions which affect or control mobile subscriber traffic.

6.4.1 Administrative functions

One example of administrative functions Is subscriber administration in the SSS network nodes HLR/AC. The administrative functions are performed with MML commands or command files generated by MML commands. These commands can be entered either locally or in remote mode. Remote entry means using the OMC or operations system (OS). TMN interfaces are available for this purpose with the corresponding services (e.g. CMISE, FTAM).

6.4.2 Security-related Ac-operator functions

In addition to the security measures for setting up calls (e.g. subscriber authentication, confidentiality of user data on the radio interface) there are further security procedures available on the system operator side with regard to the AC. One important measure is intended to prevent unauthorized access to security-related data In the AC by means of encryption. The following additional algorithms and keys are used for this AC-key-management:

- A7, K7p. K7s, A9 (for security application service (SAS))
- A4, K4, A2, K2 (for (re)encryption of Ki)

6.4.3 Operator-determined barring of GSM/DCS functions

The PLMN function "operator-determined barring (ODB)" allows the PLMN operator to regulate mobile subscriber access to the GSM/DCS network with its service functions. This is done by barring certain call categories initiated by the mobile subscriber,

6.4.4 Exchange procedure for new mobile subscriber chip cards (SIM)

Some chip cards have a useful life of only 3 years. The PLMN operator can replace old chip cards and their data records with chip cards containing new data records I! Required. To support this, the D900 provides an automatic exchange procedure for new chip cards.

Additional operation and maintenance functions:

- Display of current mobile subscriber data In the VLR
- Removal of mobile subscriber data from the VLR

6.5 Signalling Functions

Common channel signaling system CSS7 is used In the D900 network for the signaling functions between the SSS network node (MSC/VLR, HLR/AC, EIR) and between MSC/VLR and BSC. To connect PLMN subscribers or WLL subscribers of a CSC. A special signaling system complying with the GSM/DCS standard is used on the radio interface between MS and BSS. The EDSS.1 signaling system is used for connecting wired ISDN subscribers via a primary rate access (PA) to ISDN PABXs or via an ISDN basic access at the CSC. The CCS7 user part INAP (IN user part) provides signaling functions needed for exchanging messages between in network elements M-SSP (MSC/VLR with IN functionality) and the SCP (signaling control point). The X.25 signaling system with OSI layer structure Is used for signaling between the OMC In the OMS and the network elements of the BSS and SSS and to the OS.

6.6 Functional Sequence of Basic Call Types

The basic call types of the D900 are illustrated here in the form of examples to explain in more detail the functional sequence and the flow of information in D900.

6.7 Mobile originated call (MOC) of a PLMN mobile subscriber to the fixed network

Before an MOC begins, a location registration and with it an authentication must have taken place. The MS sends the call setup information dialed by the mobile subscriber to the MSC (1), The MSC requests call information from the VLR (mainly about any relevant restrictions) concerning the mobile subscriber Identified by the IMSI or TMSI (2).
After assigning a traffic channel, the MSC then sets up the connection to the next exchange (GMSC) and from there to the called subscriber in the PSTN (3). Fig. Shows the call sequence of an MOC to a subscriber in the fixed network.

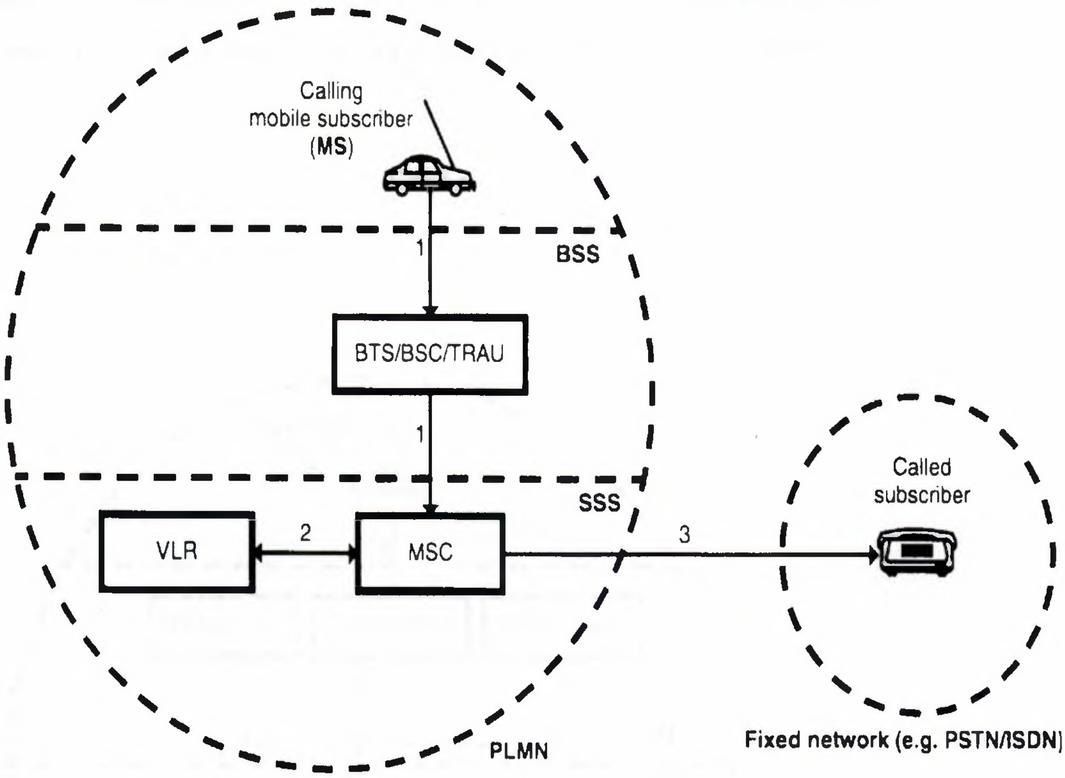


Fig 6.1 Call Sequence for an MOC to a PSTN/ISDN subscriber.

6.7 Mobile terminating call (MTC) of a PLMN mobile subscriber from the fixed network

A call for a mobile subscriber arrives at the GMSC (1). The GMSC uses the dialing information (MSISDM) to establish the HLR and sets up a signaling connection to it (2). The HLR sends a request to the VLR in whose area the called subscriber is currently roaming (3), The VLR sends the requested MSRN back to the HLR. The HLR forwards the MSRN to the GMSC (4). On the basis of the MSRN the GMSC sets up the connection request to the MSC, i.e. the MSC in whose area the mobile subscriber Is roaming at this point In time (5).

As the MSC does not know the mobile subscriber up to this point, the MSC requests the mobile subscriber information for the call setup from its VLR (6). The MS is now called by means of paging to all BTS/BSCs in the location area, as the radio cell in which the MS is located is not known to the MSC (7). If there is a response to the paging, this

Information is transmitted to the MSC (8). Finally the connection to the MS is set up (9). Fig shows the call sequence of an MTC (originated in the PSTN/ISDN).

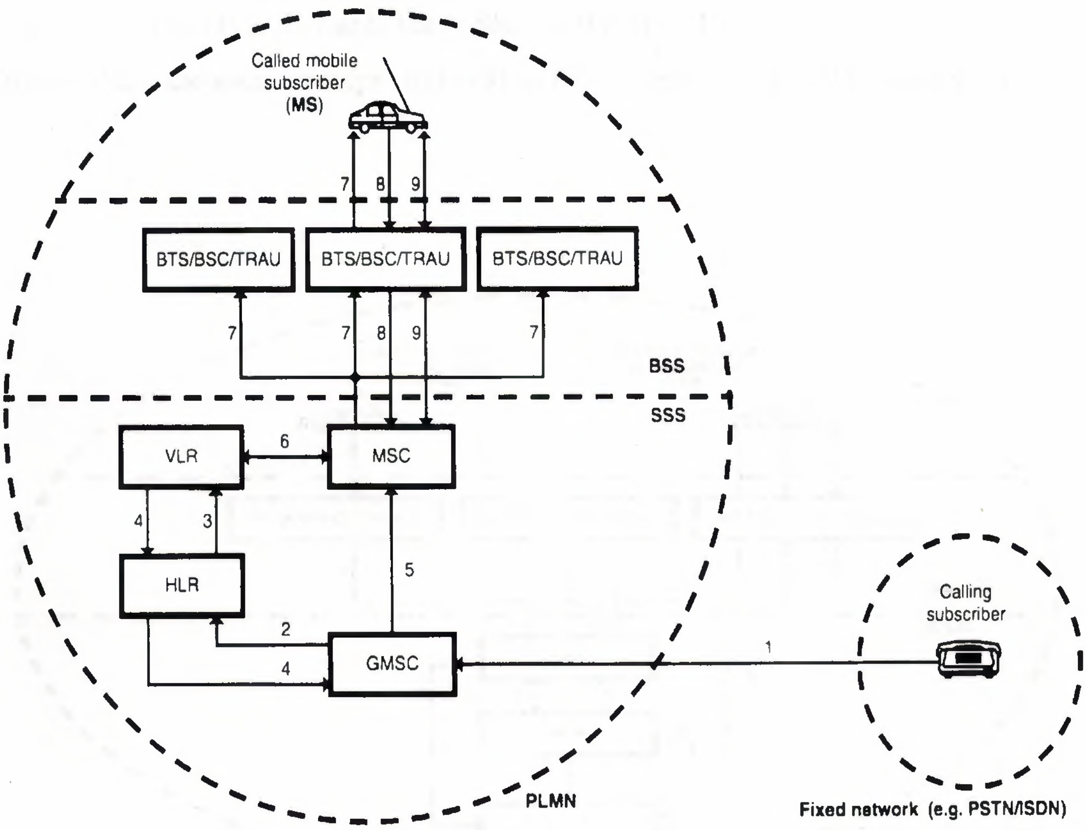


Fig 6.2 Call sequence for an MTC (Originated in the PSTN/ISDN).

6.8 Mobile internal call (MIC) of a PLMN mobile subscriber

The MS sends the call setup information dialed by the mobile subscriber (MSISDN) to the MSC (1). The MSC requests Information about the calling mobile subscriber from the VLR (2). The MSC uses the dialing information (MSISDN) to establish the HLR and sets up a signaling connection to it (3). The HLR sends a request to the VLR in whose area the called mobile subscriber is currently roaming (4). The VLR sends the requested MSRN back to the HLR. The HLR forwards the MSRN to the MSC (5).

Steps (6) to (9) are the same as steps (6) to (9) in Fig. Fig shows the call sequence for an MIC.

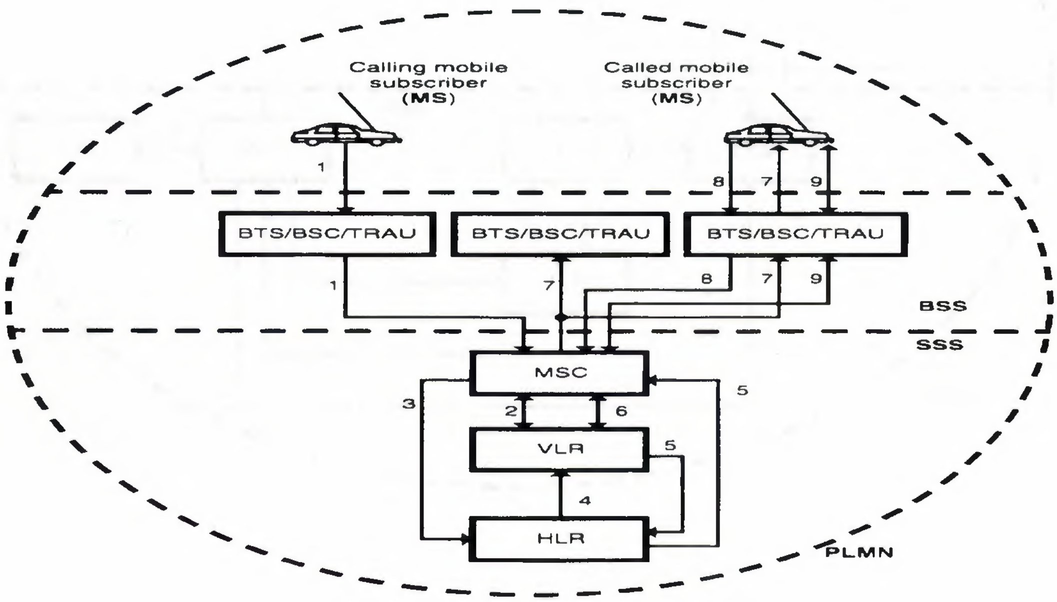


Fig 6.3 Call sequence for an MIC.

6.9 Mobile-to-mobile call (MMC) of a PLMN mobile subscriber

The MS sends the call setup information (MSISON) dialed by the mobile subscriber to the MSC1 (1). The MSC1 requests call information from the VLR1 (2). The MSC1 uses the dial Information (MSISDN) to establish the HLR and sets up a signaling connection to it (3). The HLR sends a request to the VLR2 in whose location area the called mobile subscriber is currently roaming (4). The VLR2 sends the requested MSRN back to the HLR. The HLR forwards the MSRN to the MSC1 (5). On the basis of the MSRN. The MSC1 sets up the connection request to the MSC2 in whose area the called mobile subscriber is currently located (6). Steps (7) to (10) are the same as steps (6) to (9) in Fig. Fig shows the call sequence of an MMC.

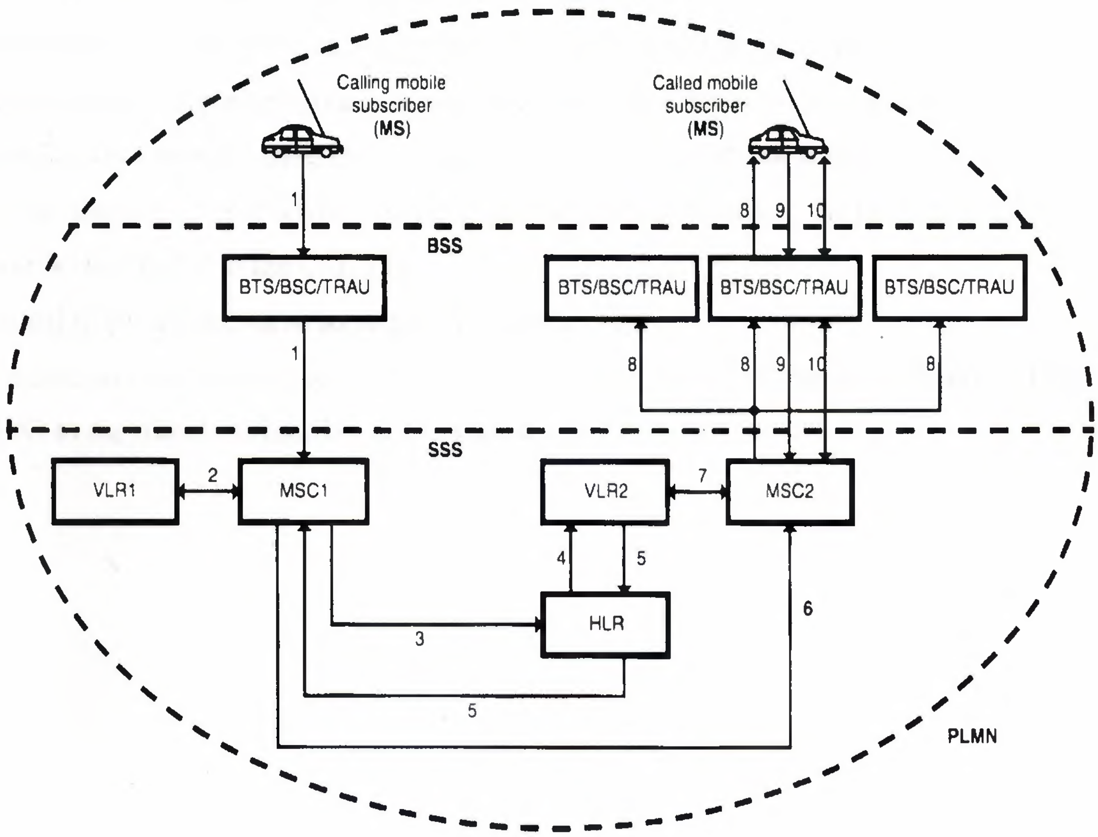


Fig 6.4 Call sequence for an MMC.

Connections to/from WLL mobile subscribers in the CSC

For wireless local loop (WLL) mobile subscribers in the combined switching center (CSC) the setting up of connections is basically governed by the same procedures as those employed for PLMN mobile subscribers. The sequences described above also apply to WLL mobile subscribers without restriction. The difference between WLL mobile subscribers and PLMN mobile subscribers is merely in the roaming restrictions. For WLL mobile subscribers roaming is only allowed within a defined location area.

6.10 Connections to/from Wired ISDN/analog subscribers in the CSC

Following sequence describes the connection of a fixed ISDN subscriber (via PABX) to the mobile subscriber at the shared CSC. The ISDN terminal sends the call setup Information (MSISDN) dialed by the subscriber to the CSC (1). The CSC checks the subscriber authorization (2). The MSC ascertains the HLR from the dialing information (MSISDN) and establishes a signaling connection to it (3). The HLR transmits a request to the VLR in whose location area the called mobile subscriber is located at that time (4). The VLR sends the requested mobile subscriber roaming number (MSRN) back to the HLR. The HLR forwards the MSRN to the CSC (5).

Steps (6) to (9) are the same as steps (6) to (9) In Fig.

Fig shows an example of a connection sequence of a wired ISDN/analog subscriber (via PABX) to the mobile subscriber at the shared CSC.

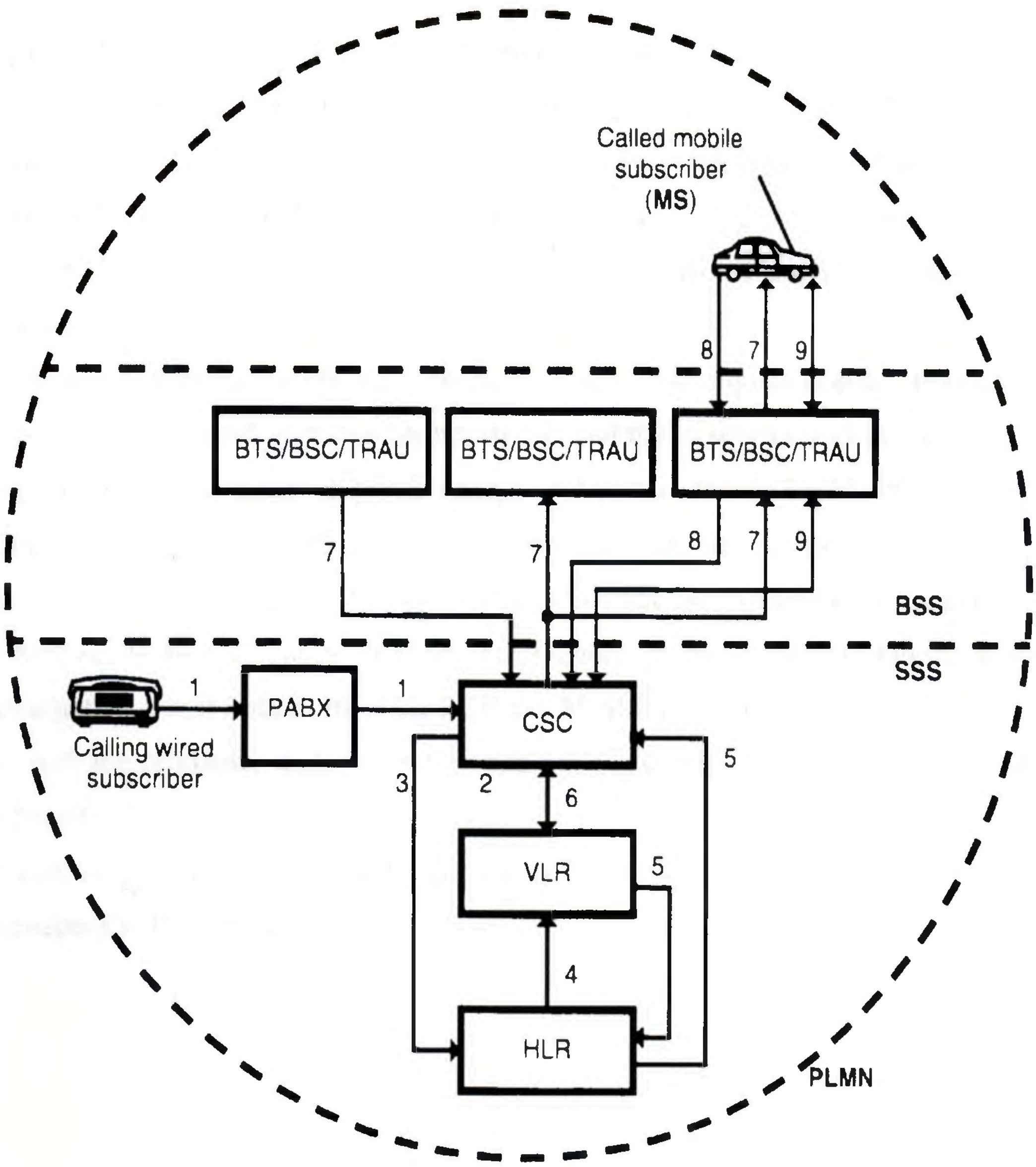


Fig 6.5 Connection sequence f a fixed ISDN/analog subscriber f the mobile Subscriber at the shared CSC.

Connections to IN applications

Depending on the IN service category the IN service request for a basic IN service is by dialing an IN number (e.g. a freephone (130) number) or for a mobile subscriber-specific service within the context of call setup by internally setting what is known as the service class mark (SCM) (1). The M-SSP requests the SCM in the HLR (2). The triggering takes place in the M-SSP; i.e. an IN service is detected (3). In the M-SSP such things as whether the IN service is allowed and activated are

Checked. Depending on the result of the check the connection request Is either rejected (e.g. IN service not allowed) or taken further. If rejected the In service user is informed with an appropriate announcement (4), In exceptional circumstances the M-SSP initiates the transaction dialog to the SCP (In the case of the televoting service the vote is passed on from the IN service user to the SCP for processing) (5). The SCP interrogates the database (6). The SCP sends the result of its database interrogation to the M-SSP (7). On the basis of the information that it obtains from the SCP, the M-SSP executes normal routing, generally with the originally-dialed directory number and continues with call setup to the called subscriber (8).

Fig shows an example of a connection sequence for a basic IN service or for a mobile subscriber-specific IN service.

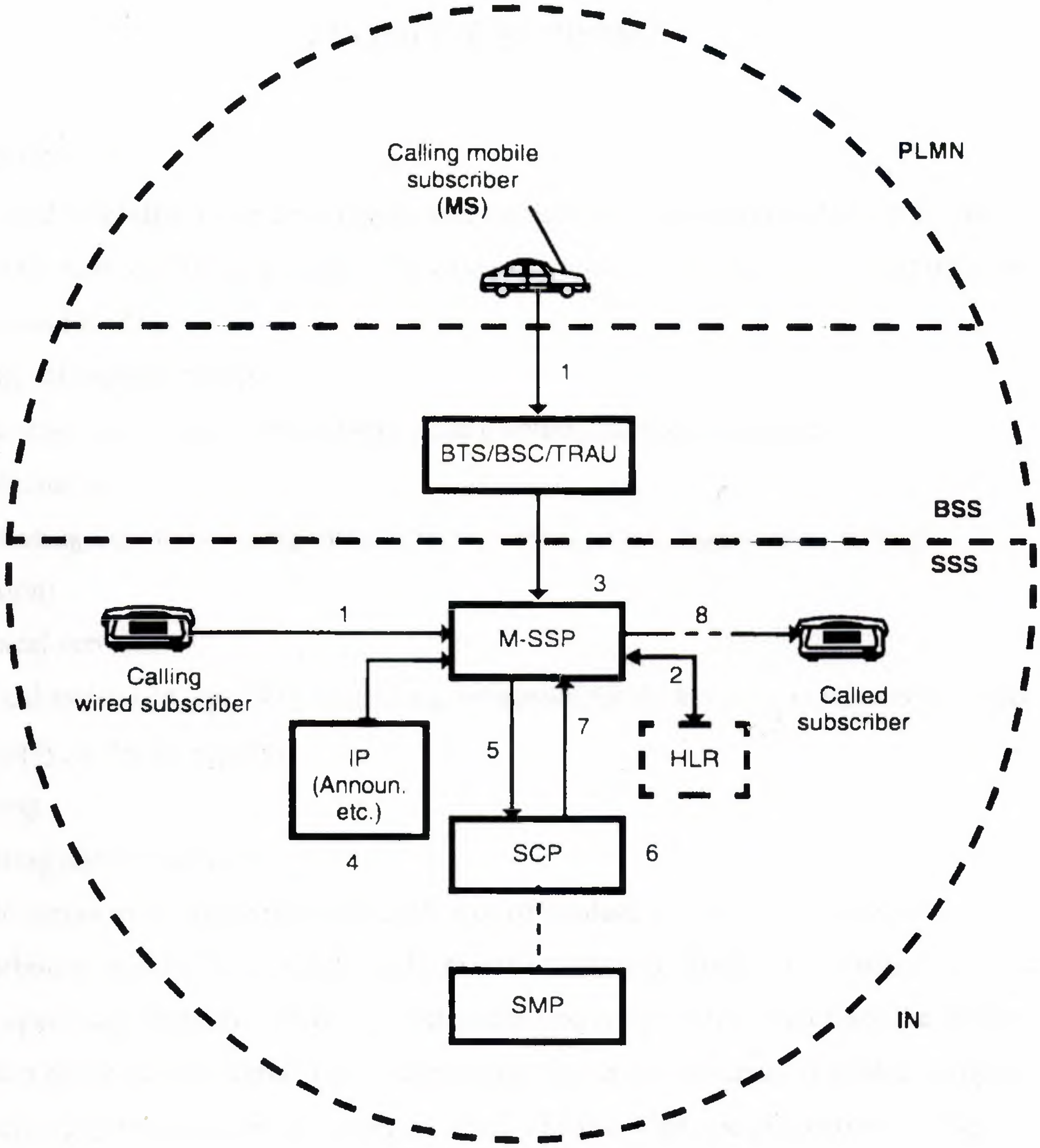


Fig 6.6 Connection sequence to IN application.

CHAPTER SEVEN
PRODUCT SUPPORT

7.1 Overview

Quality and reliability alone do not guarantee successful introduction and durability of a system in a network. There also has to be extensive product support, such as that offered by Siemens for D900.

The range of support covers:

- Project engineering (network/network node planning, project execution)
- Manufacturing

Installation and commissioning (installation, commissioning, acceptance, network Integration)

- Technical services

(Technical assistance, updating, upgrading, Inventory record keeping, repairservice, spare parts supply, software supply)

- Training
- Operating documentation

Separate agreements can be made for each area of product support, defining which responsibilities will lie In the hands of the manufacturer and which will be assumed by the PLMN operating company and to what extent the operating company requires the advice or support of the manufacturer. These agreements also cover the areas of product support for which separate centers are to be set up In the PLMM, what documentation will be supplied to the PLMN operating company and how much training is to be given.

A number of typical areas of product support are described briefly below as examples.

7.2 Project engineering

- Network/network node planning

The more carefully networks and nodes are planned, the greater the benefit that can be achieved with the available Investment. Siemens possesses a wealth of experience and software tools specific to D900 for planning nodes and networks. If the operating company

- Project execution

Siemens project engineers produce project plans for nodes, coordinate the details of the project with the operating company and draw up an Implementation schedule for the project. This covers the ordering of all hardware and software components and organizational tasks In connection with delivery, installation and cutover as well as generation of the data base and provision of documentation. If appropriate, the parts of the project for which the operating company is responsible and other project support tasks described in this section are also included in this schedule.

7.3 Manufacturing

D900 hardware is designed as a modular system consisting of modules, module frames, racks and plug-In cables, and production is to a large extent automated. This allows whatever proportion of manufacturing is most cost-effective to be transferred to the country of the operating company-Siemens offers support In all phases of planning, introduction and execution of manufacturing as well as In procurement of automatic production and testing equipment and the related data processing facilities (software tools).

Installation and commissioning

The racks are delivered equipped with modules; the cables fitted with connectors. All these units have already been tested before leaving the factory. As a result, rapid and error-free installation work is ensured in the node where no soldering or wire-wrap connections will be necessary. Cutover of a **SSS** node involves loading the application program system (APS) and the database from magnetic tape to the system. The cutover of a BSS network element involves downloading the software images and database via OMC-B (central) or via LMT (local). Before the system is ready for acceptance, all system functions are tested thoroughly by means of test programs in accordance with the procedures documented in the Installation Test Manual (ITMN).

- Acceptance

At the delivery of the D900 from Siemens to the operating company an Acceptance Test Manual (ATMN) is available, describing the recommended method for carrying out the acceptance test. The test steps specified in the ATMN cover all hardware and software functions and include a visual inspection of the entire installation of hardware and software and the faultless of the installed hardware. The ATMN is splitted in a unit acceptance and a system acceptance. The acceptance test of the software in a BSS or SSS node can then be restricted to the node-specific data in each case. For this purpose a Unit Acceptance Test Manual (ATMN) is available.

Since the application program system (APS) In SSS nodes and software images In BSS network elements are always the same in all nodes with the initial feature packages, it is sufficient for the operating company to perform a once-only system acceptance lest.

Technical services

The main purpose of technical services is to maintain the quality of service, ensure system availability and introduce new service features in existing nodes. Technical services cover the following areas:

- Technical assistance
- Updating
- Upgrading
- Inventory record keeping
- Repair service
- Spare parts supply
- Software supply

Software tools (service toolsets) provide data processing support for these areas.

To meet the needs of the customer as quickly and economically as possible, the technical services are offered at three levels:

- Operating company
- Manufacturer's regional agent
- Central services, Munich

As an example, technical assistance is used here to indicate the cooperation between the three levels of technical assistance center (TAG):

- The TAG 1 (at the operating company) detects faults, records them, saves error symptoms and continuously analyzes the performance of the system. If the operating company requires assistance from the manufacturer's regional agent, faults are reported to the latter.

- The TAG 2 at the Siemens regional agent analyzes the faults reported by the operating company's TAG. If central services in Munich are needed to clear the fault, the TAC performs a preliminary diagnosis enabling the fault to be reproduced.
- The TAC 3 ensures a thorough fault diagnosis, determines, in conjunction with the system development department, the corrective measures to be taken and arranges for any necessary changes to be incorporated. In this way, the worldwide experience of the technical assistance personnel in Munich can be employed to the benefit of the operating companies.

- ***Repair***

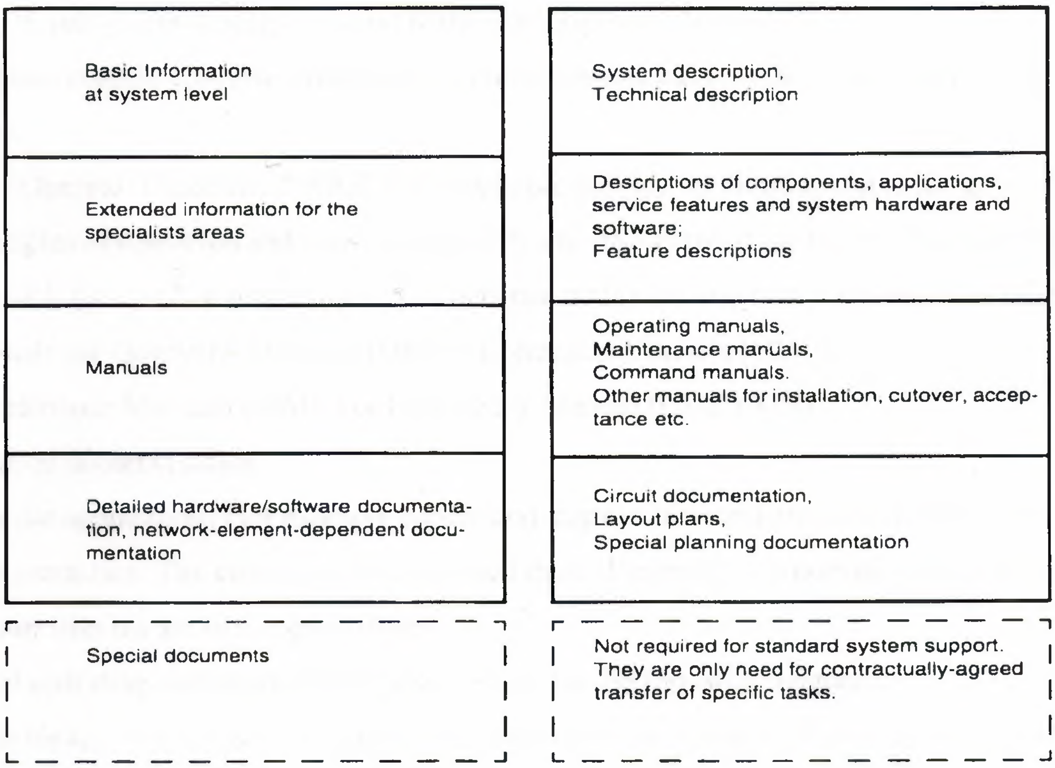
For repair of defective modules, the most cost-effective method is to carry out exact fault location using the appropriate test procedures and test equipment and to replace the faulty component in parallel with the manufacturing operation. If It Is In accordance with the plans of the operating company, a repair center separate from module manufacturing can be set up,

Training

For the operating company's personnel involved with D900 there are training programs tailored to the activities which they will be undertaking. This training takes the form of both courses and on-the-job training. The communication networks training center In Munich offers a wide range of courses. In addition to System D900, these courses also deal with narrowband and broadband networks (e.g. ISDN, ATM network nodes), telecommunications cable networks (e.g. glass fiber networks), transport networks, access networks and intelligent networks or TMN networks. Depending on what is agreed with the operating company, the courses can also be held in the country concerned. In a number of countries there are already regional training centers set up by the operating companies. Siemens trainers can also be posted to the country where D900 is to be used or the trainers from the operating country can attend courses in Munich.

Operating documentation

In addition to highly optimized hardware/firmware and software, In additional to future-oriented service features for reducing operating costs and improving profits, operating documentation, even in a monetary sense, has become an inseparable part of the product. The structure and usability of the operating documentation must grow to precisely meet the various requirements and changing circumstances in which it is used. In addition to the historically-evolved media of paper and microfiche, modern operation of communications systems requires use of CD-ROM and other electronic Information media on a variety of operating platforms no just in the operation and maintenance OMC. But also locally in the network elements concerned. The operating documentation concept is based on a top-down (Fig.).



Top-down structure of the operating documentation.

- ***Documentation types***

The mobile radio operating documentation consists of the following types of document, for which the characteristics are tailored to how the documentation is to be used:

- Descriptions
- Manuals
- Detailed documentation *Descriptions*

Descriptions provide information about the system, about the network elements and about configuration components, i.e. overview and background knowledge of the system to the depth required for understanding the system and the operating concept.

Examples of descriptions are this System Description (SYD) or Technical Description (TED), subsystem descriptions and feature descriptions. *Manuals*

Manuals contain concrete instructions, procedures and commands for executing O&M tasks.

The "Operator Guidelines" (OGL)" for example provide an introduction to the general principles of operation and maintenance SSS and BSS network nodes and describe the way in which the relevant manuals for SSS network nodes are organized. Examples of other manuals are Operating Manuals (OMN), Command Manuals (CML), Maintenance Manuals (MMN) or Emergency Manual (EMCYMN).

Detailed documentation

Specific applications (for example production, repairs services) are dealt with in detailed documentation. The customer does not need these documents for normal operation; they remain with the service organizations.

D900 operating documentation is also notable for the following features:

- It is clearly laid out and written in an educational way to make for ease of understanding and learning
- It is always up-to-date by virtue of an well-organized modification service
- It uses uniform English abbreviations in ail languages It is sensible for the operating company to set up a documentation center so that operating documentation can be continuously updated and distributed as efficiently as possible.

CHAPTER EIGHT
QUALITY ASSURANCE

8.1 Overview

One of our company goals is to provide the market with products and services which offer our customers the greatest benefits throughout the entire useful life of the products. The term "products" covers devices, equipment, systems with hardware and software (including OEM products) and the related services such as the technical service, documentation, training, etc. In order to achieve the targeted objective, the appropriate quality assurance measures have been taken in the product management, sales, development, production and service process. The quality assurance measures applied enable statements to be made about quality at an early stage, for example during the development phase. The most important quality assurance measures are:

- Management commitment
- Definition of quality aims
- Definition of quality figures
- Definition, qualification and monitoring of processes provision of resources
- Improvement of quality by means of preventive measures
- Product and market observation
- Training
- Quality audits

Documentation of the quality assurance system

The requirements for documentary evidence of quality assurance are described in the requirements standards for quality assurance systems drawn up by the International Organization for Standardization (ISO 9000 Series). The requirements of the ISO **9000** Series are contained in the guidelines for demonstration of implementation, which is demanded for a quality assurance system. The standards are divided into quality assurance

- Processes/procedures
- Tools and resources
- Documentation and results interfaces to other organizational units

In the Public Networks Group ON our quality is regulated by ISO standard 9001. The Business Units in the ON Group, particularly Mobile Networks have been very successful in obtaining the quality certificate from the German Institute for Quality Management Systems Certification DOS.

8.2 Hardware Quality Assurance

Development guidelines and Siemens quality specifications, which define among other things the requirements for the components employed, together with the system specifications and the precisely-defined hardware engineering production plan (HEPP), constitute the instruments of quality assurance during development. A systematic inspection monitors the quality of incoming components. The fully equipped and soldered modules undergo a visual check and a series of electrical tests on computer controlled automatic test equipment. The automatic test equipment is also available for simple and low-cost fault clearance on replaced modules. Racks are equipped as required prior to delivery and also tested automatically In the system lest bed. The subsequent run-in test subjects the system to thorough tests under extreme operating conditions. This excludes the possibility of premature failures during actual operation.

For transport of the fully equipped racks to the site, special protective covers are employed and these also prevent damage when the racks are being installed. If equipment is shipped abroad, additional packaging is used to protect the racks from climatic effects, A transportation device is provided so that the racks can be moved around safely at the installation site. The protective covers are not removed until the racks have been correctly positioned.

8.3 Software Quality Assurance

SSS software

The use of the ITU-T high-level languages CHILL and SDL during development and testing is a significant factor in the excellent quality assurance of the extensive D900 software. The use of CHILL makes all aspects of producing software much easier and much faster. The administrative separation of development and test departments ensures that software is evaluated objectively.

BSS (e.g. BTSE) software

In BTSE the languages ANSI-C and ITU-T SDL are used. Extremely time critical-parts such as digital signal processing are written in assembler. The usage of SDL and automatic code generators simplify and accelerate the production of software products. The organizational separation of the development and testing departments ensure that the software is checked objectively.

8.4 Software development stages

Software development is governed by a precisely defined software engineering production plan (SEPP). Inspections are undertaken after each of the predefined development stages. This target-oriented procedure goes a considerable way towards ruling out software errors. The inspection phases after individual development stages are as follows:

- **Design verification SSS software**

For each software product, specialists perform precise checks on whether the detailed feature specifications have been adhered to. All interfaces are then coded in CHILL, compiled and stored by the compiler in the project library. This contains all available parameters, procedures and other interface-defined objects.

The Inherently consistent project library constitutes an important prerequisite for creation of an error-free APS, ***BSS*** *(e.g. BTSE) software*

The messages interchanged within the system are coded in the C languages, translated from the compiler, and stored in the project library. This contains the bit-precise description of all messages interchanged in the system. Checking of coded modules Software modules undergo a code review and an off-line test. (N the code review, specialists check whether the code is functionally correct and whether it adheres to programming conventions. Where necessary, they identify possible malfunctions or Incompatibilities with real-time conditions and suggest possible reductions of memory requirement and runtimes. **SSS** *software*

The code review is followed by the off-line test of the modules on a commercial data processing system and a bit-by-bit comparison with the interfaces stored in the relevant project library. This completes the development and testing of the Individual software modules, BSS *(e.g. BTSE) software*

Off-line lest: The off-line test is realized in several steps. First every module is tested in a commercial data processing system to check that it is functioning and that the interface is upheld. In a "whitebox integration lest" the software runs in a real hardware environment. Test tools developed for this purpose only simulate the interfaces and observe the software. The interchanged messages are recorded automatically and compared with the messages stored bit-precisely In the project library. In this way the Interworking of all modules in the software is checked. System Integration test SSS *software*

In this stage of development, experienced test engineers use carefully constructed test specifications to check that the APS as the sum of its modules runs without error. The system integration test is undertaken partly on a commercial data processing system, partly on the switching processor, and represents the final stage of actual software development.

BSS *(e.g. BTSE) software*

In this stage of development, experienced test engineers use carefully constructed test specifications to check that the software image as the sum of its modules runs without error. The system integration test is carried out in the real hardware environment. System Interfaces are simulated by commercial interface simulators. The system Integration test is the last step in the actual software development-System test

The system test is undertaken by a department independent of the developers and is run on the coordination processor. The system test shows how the complete software behaves in the system. The system behavior must remain stable under load and react in a controlled manner when hardware faults are simulated- Load generators generate all types of call, simultaneously checking and measuring the call failure rate.

In the automated regression test, programs simulate operating devices; process command files and check system reactions for correctness. The coordination processor and a data processing system run in parallel for this test. The data processing system compares outputs from the coordination processor with its stored nominal outputs and records any deviations.

Conclusion:

As of my project was about the GSM (D900) architecture working machinism and general layout.

It goes without saying that the development of the bord band and the revolution of microchip opened up new horizons for the GSM industry to step out of their boundaries and become global to meet the grounding demand of the market.

The current system is fully equipped with all the technicalities to integrate within the GSM operators aboard to create international rooming, messages, internet, and e-mail services which gives all the research in technological and services sectors, it demand high level of expertise in different fields because of complex nature.

By the data provided by TELSIM and their important magazine of every month I have found that now more than half of the world is using GSM (D900) and others are using different like wise Dual GSM, NMT 450, NMT 900 Networks.

Supplier of base-station and switching system can be of different.
As in Turkey there are three main operators Turk Telecom, Telsim, Turkcell and for that they are using Nokia, Motorola and Ericsson.
Turk Telecom is using Nokia's base-station and its switching system instead the Telsim is using Nokia's switching system and Motorola's base-station.

Also the Siemens D900/1800 its base-stations and switching systems are famous and still using by many countries.

Reference:

1. FAKHRDDIN MAMEDOV, Telecommunications (Lecture Notes).

2. SIEMENS catalouge, D900 Mobile Communication System.