

TELECOMMUNICATION NETWORK DESIGNING AND PLANNING OF INTERFACES FOR GSM

*A thesis report submitted for the partial fulfillment of
requirements for the award of the degree of*

Master of Engineering (Electronics and Communication Engineering)

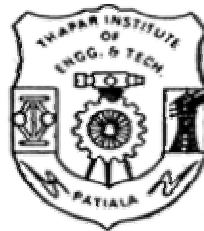
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CERTIFICATE

I hereby declare that the thesis report entitled (“Telecommunication Network Designing and Planning of Interfaces for GSM”) is an authentic record of my own work carried out as requirements for the award of degree of master of Engineering in Electronics and Communication at Thapar Institute of Engineering & Technology (Deemed University), Patiala, under the guidance of Mr. Rajesh khanna , Assistant Professor and Mr. Balwant Singh, Senior Lecturer, Department of Electronics and Communication Engineering, Thapar Institute of Engineering & Technology (Deemed University), Patiala during the session from January to June, 2006.

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It is said that engineers make the world. Time spent in this college has given us the confidence to make world as better, efficient and beautiful place to live in.

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ABSTRACT

Telecommunications sector is growing at a fast rate. The dependence of people on the telecommunications has also increased very much. For building reliable telecommunication systems a lot of engineering and designing is required. An optimized system can only be designed after proper planning and consideration of each and every factor that can affect working of the system. This thesis is divided in two parts. A first part deals with planning of a fixed network. It involves design and engineering of telecommunication network using EWSD switches. These switches are configured and dimensioned according to the requirements of the network. History with structure and advantages of EWSD switch and various parts used in the exchange are also explained in the first part. Basic rules of designing the exchange are also discussed in this part. Practical applications are considered designing an exchange for Thapar institute of engg. and technology and second example for Patiala city. These switches comprises of three regions with their respective RSUs connected to the main exchange. Capacity of RSUs depends upon locality. We designed software that will calculate all the parameter of exchange by simply entering the capacity. Different graphs shows distribution of different parameter.

Second part of thesis is related to the planning of interfaces for GSM mobile network. The core of any GSM network is its switching subsystem. The network consists of two MSCs connected to each other as well as to their respective network elements. Interfaces of GSM system are also considered in this part. Planning of core network interfaces for given traffic model is done by taking the capacity of 600K subscribers and 10000 subscribers. Designing of software is done that will calculate the no. of interfaces by entering no. of subscriber.

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ABBREVIATIONS

APS – Application Program System
ATC – Automatic Train Control
AuC – Authentication Center
BAP – Base Processors
BDCG – Bus Distributor Module with Clock Generator for DLUC
BS – Base Station
BSC- Base Station Controller
BSS – Base Station Subsystem
BTS – Base Transceiver Station
CAP – Call Processor
CB – Channel Bank
CCNC – Common Channel Signaling Network Controller
CMY – Common Memory
DIUD – Digital Interface Unit for DLU
DLU – Digital Line unit
DLUC – Digital Line Unit Control
DLUG – DLU type G
DSB – Digital Switchboard
EIR – Equipment Identity Register
EIRENE – European Integrated Railway radio Enhanced Network
EWSD – Digitales Elektronisches Wähl system
GP – Group Processor
GS – Group Switch
GSM – Global System for Mobile communication
GSM-R – GSM Railways
HLR – Home Location Register
IOC – Input/Output Control
IOP – Input/Output Processor
LIL – Link Interface module between TSM & LTG
LIM – Link Interface module between SGC & MBU: SGC
LIS – Link Interface module between TSG & SSG
LIU – Line Interface Unit
LTG – Line /Trunk Group
LTU – Line Trunk Unit

M.E. – Main Exchange
MB – Message Buffer
MBG – Message Buffer Group
MDD – Magnetic Disk Drive
MMC – Mobile to Mobile Calls
MMI – Man Machine Interface
MOC – Mobile Originated Call
MOD – Magneto Optical Disk
MS – Mobile Station
MSC – Mobile Switching Center
MTC – Mobile Terminated Call
OAMC – Operation and Maintenance Center
OMT – Operation and Maintenance Terminal
PDC – Primary Digital Carrier
PLMN – Public Land Mobile Network
PTT – Push to Talk
RGMG – Ringing and Metering Voltage Generator
RSU – Remote Switching Unit
SDC – Secondary Digital Carrier
SGC – Switch Group Control
SILTG – Signaling Line Trunk Group
SIM – Subscriber Identity Module
SIPA – Signaling Periphery Adapters
SLCA – Subscriber Line Circuit Analog
SLCD – Subscriber Line Circuit Digital
SLM – Subscriber Line Module
SLMA – Subscriber Line Module Analog
SLMCP – Subscriber Line Module Processor
SLMD – Subscriber Line Module Digital
SN – Switching Network
SPMX – Speech Multiplexer
SS7 – Signaling System No.7
SSG – Space Stage Group
SSM – Space Stage Module
SU – Signaling Unit
SYPC – System Panel Control

TRAU – Transcoding and Rate Adaptation Unit

TSG – Time Stage Group

TSM – Time Stage Module

VBS – Voice Broadcast Service

VGCS – Voice Group Call Service

VLR – Visitor Location Register

VMSC – Voice Mail Service Center

1.1 INTRODUCTION

ESWD (Digitales Elektronisches Wahl system) entered the world market in 1981, it was one of the first fully digital switching systems. By 1994 some 85 million ports in EWS technology had been put into service by about 200 operating companies in 85 countries. This international market success is based on the extraordinary reliability and high economic efficiency of ESWD, its continually advancing state of the art technology and ever growing number of features for subscribers and operating .With its universality and flexibility, EWS can be used economically in different network structures as a network node of variable size for switching the most varied types of information and can be adapted flexibly to changing requirements. The dynamic capacity of the system can handle a traffic load of up to 25.600 erlangs with 2.5 million BHCA(Busy hour call attempts). So EWS offers adequate reserves of capacity of any application that may arise in practice.The EWS is a highly successful digital electronic switch system. It is a powerful and flexible for public communication networks and over 250 million EWS switching nodes have been deployed since its introduction in the telecommunications field. The EWS switching system employs a fully digital design concept. It provides a wide and expandable range of features and services, an extensive safeguarding concept and a high data transmission quality. The EWS switching system is designed with a modular approach in every component used in the system. Ref.no.29.The EWS is divided into three parts-software, hardware, and physical structure. The software, hardware and physical units of the EWS are modular in design.

Modules (M:X): Smallest units in the system. The type of module depends on the hardware subsystem in which they are used.

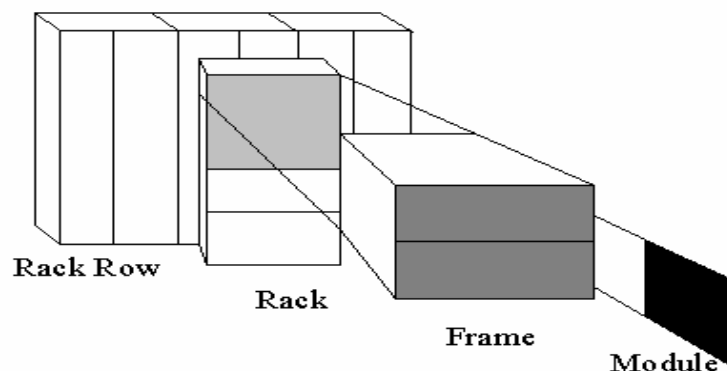


Fig 1-1: Physical Structure

Frames(F:X): Group of modules of certain hardware subsystem form a frame.

Racks (R:X): Frames together form a rack as shown in fig 1-1.

Rack Row: Line of racks form a rack row.

Fig 1-1 clearly shows that the physical structure uses a modular concept. The node is divided into four sections. The hardware architecture is designed in such a way that every subsystem of it has same design i.e. modules, frames, racks.

1.1.2 ADVANTAGES:

- 1) It provides effective safeguarding.
- 2) It gets flexibly adapted to the network environment.
- 3) It provides cost efficient adaptation to the future changes.
- 4) There is a simplification of installation and maintenance.
- 5) It provides a variable range of features.

1.2 LAYOUT OF THESIS

This report is divided in two parts first parts deals with planning of a fixed network. It involves design and engineering of telecom network using EWSD switches. These switches are configured and dimensioned according to the requirements of the network. Chapter one deals with the introduction and advantages of EWSD switch. It also includes physical structure of EWSD switch. Various parts used in the EWSD switch and dimensioning rules are explained in chapter two. Parts used are line trunk groups(LTG),digital line unit(DLU), Primary digital carrier(PDC),Secondary digital carrier (SDC),Coordination processor(CP), Switching network(SN),Common channel signaling network(CCNC). Chapter two also considered how call set up in a exchange. Practical applications are considered in chapter three by designing a exchange for Thapar institute of engg.and technology and second example for patiala city. For patiala city these switches comprises of three region with their respective RSUs connected to the main exchanges.

Second part of report is related to the planning of interfaces for GSM mobile network. Introduction and design of interfaces for GSM is given in chapter four. Chapter four explain different parts of GSM system and there functioning. It also explains types of interfaces and why we go for the designing of interfaces. Chapter five includes practical application i.e.planning of core network interfaces for 600K subscribers. It also includes calculation of traffic, dimensioning of links and no. of channels. Software system is designed that will calculate all the parameter of chapter four by entering the no. of subscribers. All these parameter are calculated for 10000 subscribers through software system.

ARCHITECTURE AND DIMENSIONING

2.1 INTRODUCTION

The hardware of the EWSD is designed to have flexibility of expansion in the system to the future requirements without halting the operation of the switch and to have the simplicity of installation. For these reasons modular concept is used in hardware architecture. The EWSD switch is divided into four major subsystems which are further divided into subparts. The four major subsystems are:

- 1) Access
- 2) Switching Network
- 3) Signaling network
- 4) Coordination complex

2.2 INTERFACES

The interfaces in the EWSD are used to interconnect the subsystems. The interfaces are categorized on the basis of their location w.r.t. switch. Ref.no.26. The two categories of interfaces are:

2.2.1 External Interfaces

These interfaces are used to connect the external environment to the switch. These interfaces can be analog as well as digital. The various external interfaces are

Subscriber Lines: These lines are used to connect the telephone subscribers to the switch. These lines usually carry the analog information. These are directly connected to the DLU for converting them into digital format to have compatibility with completely digitized environment of switch. These lines carry signals of 300Hz to 3400Hz and are also called analog lines.

ISDN Lines: These are the primary and basic access lines for the medium and large sized PBX systems (also known as CENTREX). This interface carry two-wire line that carry B-channels (64Kbps) and D-Channel(16 Kbps).The B-channel carries the information and the D- channel is used for signaling.

Digital Trunks: These are the lines coming from other central offices or switch.

Analog Trunks: The analog trunk lines coming from the other exchanges are connected to the channel bank, which concentrates the 30 analog voice signals into the digital PCM format. The utility of the channel bank is to make the analog trunks compatible with the digital environment.

Digital Switchboards: The digital switchboards are used to provide operator services in hotels, offices and receptions.

Operator and Maintenance Services: These are the connections used for the control and maintenance of the node or switch. These are connected between system panel and coordination subsystem.

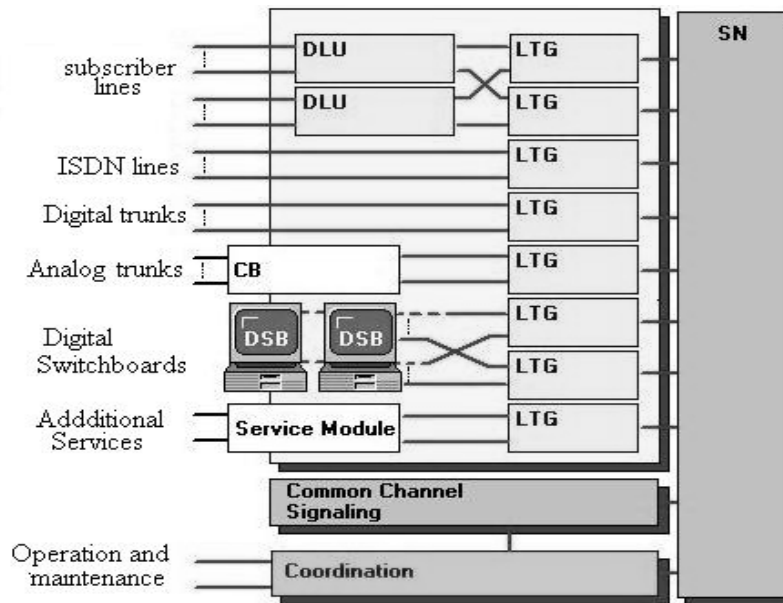


Fig2.1: External Interfaces

2.2.2 Internal Interfaces:

These interfaces are used to interconnect the internal components in the EWSD switch. The internal interfaces are digital as compared to the external interfaces. The various internal interfaces present in the EWSD are:

Primary Digital Carriers (PDC): These interfaces are used to connect the DLU to the LTG.

These carry speech and data channels. The transmission rate of the PDC link is 2048 Kbps. One link can carry 32 channels at a rate of 64 Kbps per channel.

Secondary Digital Carriers (SDC): These are also called Secondary multiplex links and have a transmission rate of 8192 Kbps. The SDC carries up to 128 channels at rate of 64 Kbps. This is four times the transmission capacity of Primary Digital Carrier. These connect the LTGs to the Switching Network. The SDCs are also used to connect the other subsystems like CCNC and coordination complex to the SN.

Bit Parallel: These interfaces are used for connecting the CCNC to the Coordination Processor. The data is transferred using 8 parallel lines and the bits are transferred using parallel data transmission.

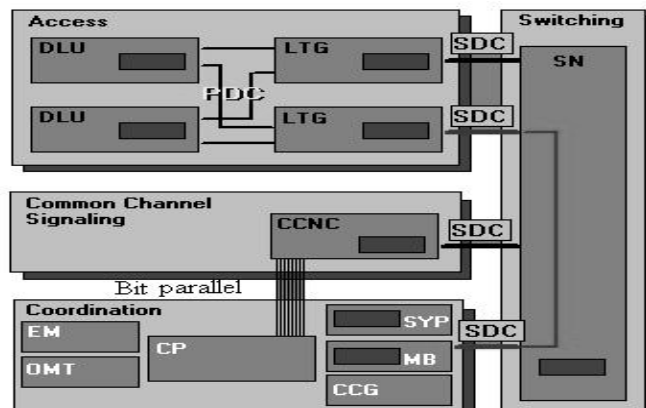


Fig2.2:

Internal Interfaces

2.3 ACCESS

Access is used to

connect the

subscribers, analog as well as digital, to the switch. The external interfaces like subscriber lines, ISDN lines etc. are used to connect the subscribers to the access subsystem. The internal interfaces like PDC links are used to connect the DLU to the LTG. Both are the parts of access resulting in modular approach.

1) Digital Line Unit (DLU)

2) Line/Trunk Group (LTG)

2.3.1 DIGITAL LINE UNIT (DLU)

DLU is used to connect the subscribers to the switch and to concentrate the subscribers' traffic in the direction of the EWSD network node. These can be installed as part of the network node in an exchange (local) or as remote connection units in the vicinity of a subscriber group called as remote DLU. Remote DLUs can be installed in permanent buildings, in containers or in shelters (for small groups of subscribers). The short subscriber lines obtained in this manner and the concentration of subscriber traffic to the network node on digital and fiber-optic transmission links result in an economical subscriber network with optimum transmission quality. The DLU is an intermediate stage for the connection of the external environment to the exchange. The lines that are connected to it are subscriber lines, ISDN lines and digital subscriber lines. On the other side of the DLU, towards the EWSD side, it has PDC links going towards the LTG. These lines are also called external interfaces to the DLU. Besides these there are internal interfaces present in it also which are used to connect its internal components. These interfaces include the voice and data speech highway with a data rate of 4096 Kbps and a control network with a data rate of 136Kbps. These two networks are duplicated for safeguarding purposes.

The DLU and LTG are connected to each other in three different modes via 2, 3, or 4 PDC links namely:

2.3.1.1 Direct:

In this type of the connection a particular DLU is connected to a single LTG with all of its outgoing PDCs to that single LTG only. The disadvantage of this system is that if the LTG fails then all the connections with that particular DLU are lost and they stop working.

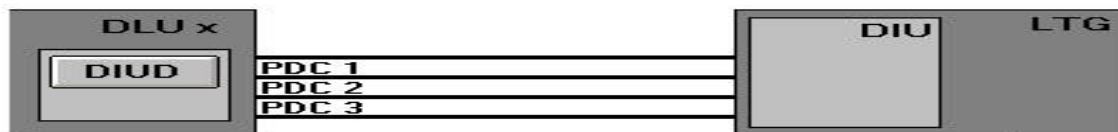


Fig 2.3: Direct connection of DLU and LTG

2.3.1.2 Crossover:

In this mode the connections from a particular DLU are not connected to a single LTG rather half of the connections go to one LTG and remaining half are connected to some other LTG. The advantage of this mode is that if either of the LTGs fails the DLU is not completely

disconnected from the exchange rather the connections can still be made through the other LTG using the second set of PDC links. Refer fig.2.3

2.3.1.3 Random:

This mode uses a random fashion of connecting the PDCs to the LTGs i.e. some PDCs are connected to a particular LTG randomly and the remaining is connected to second one (fig 2-4). The failure of the system in this mode totally depends upon the coincidence whether redundant unit is available for the call processing in case of an LTG or PDC failure.

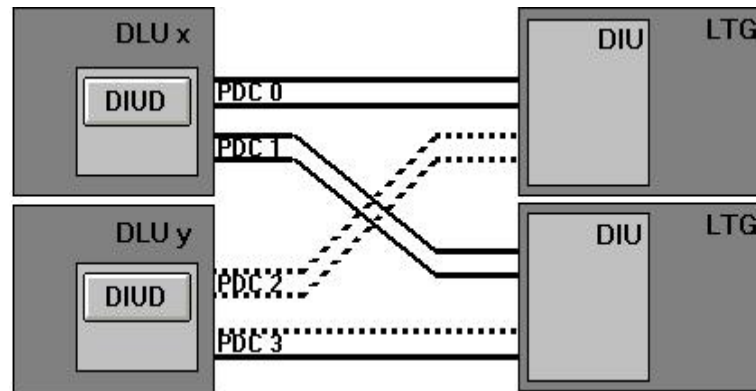


Fig2.4(a): Cross over connection

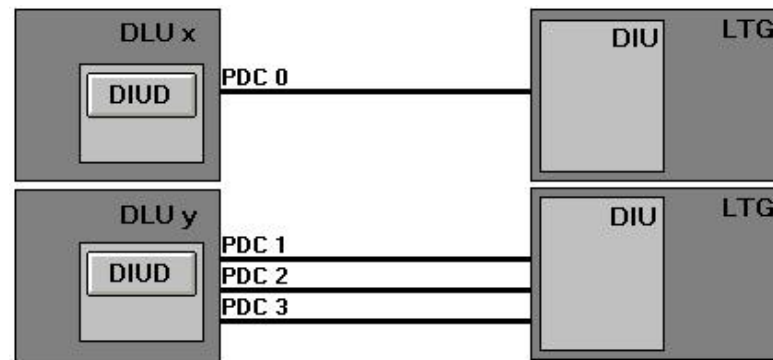


Fig 2.4(b): Random Connection

2.3.2 Architecture of DLU 2.

The hardware architecture of the DLU is divided into three major units depending upon the role individual units play in the working of the DLU. The units present in the DLU are:

2.3.2.1 Peripheral Functional Units:

As the name suggest these units are used in the DLU for connecting the external environment to switch. The various interfaces from the subscriber side terminating towards the exchange are connected to the peripheral units. The various peripheral units are:

Subscriber Line Modules (SLM): The SLM provides ports for connecting the subscribers to the DLU. Both the analog and digital subscribers can be connected to the SLMs. This provision is fulfilled by providing two types of modules known as Subscriber Line Module Analog (SLMA) and Subscriber Line Module Digital (SLMD) for analog and digital subscribers respectively. The SLMA and SLMD have circuits called Subscriber Line Circuit Analog (SLCA) and Subscriber Line Circuits Digital (SLCD) respectively. The number of the subscribers that can be connected to these cards depends upon the number of circuits present in the SLMA and SLMD. The number of circuits in turn depends upon the version of the DLU.

Test Equipment: The test unit is used for testing and monitoring the functioning of the Subscriber Line Circuits (SLC) and the subscriber station. It also tests the analog subscriber sets. It can be used for testing both the analog and digital subscriber lines. The test unit is centrally operated from the operation and maintenance terminal (OMT). The test unit uses the control network having a transmission rate of 136Kbps for performing the testing. The network is duplicated for increasing the reliability of the system.

Ringing and Voltage Distribution: The Ringing and metering voltage Generator (RGMG) generates the sinusoidal ringing and metering voltages required in the DLU for analog subscribers, as well as a synchronizing signal for connecting the ringing tone if necessary. Various frequencies (16 Hz, 23 Hz, 20 Hz or 25 Hz) must be set with the switches on the RGMG module for the ringing voltage and the ringing voltage magnitude (70 Volt or 90 Volt). The ringing and metering voltages are monitored for under voltage conditions. If the monitoring circuit responds, the failure is indicated by the fact that the LED on the front panel of the module goes out and a relay with a relay contact drops out.

2.3.2.2 Central Functional Units:

The central functional units of the DLU are used to control its various functions. Because of the controlling functions they serve in the DLU these units are duplicated, DLU system 0&1, for providing greater reliability in the system. The various control units are:

Control for DLU (DLUC): The DLUC controls the DLU internal sequence of operations and distributes or concentrates the control signals between the subscriber line circuits and the DLUC. The DLUC cyclically polls the SLMCP for messages and directly accesses the SLMCP to transmit command and data. The two DLUCs operate independently in load sharing mode.

Digital Interface Unit for DLU (DIUD): The DIUD receives transmits speech information from and to the SLMs and distributes the information. It also extracts the control information for the DLUC from the PDC that connects the DLU and LTG. It uses the signals from the PDC for pulse synchronization.

Bus Distributor Module with Clock Generator for DLUC (BDCG): The clock generator generates the system pulse required for the DLU and the associated frame synchronization

signal. The DLU clock can be regenerated from the line clock from the LTG in the DIUD (DIU: LDID). In the same way, the frame signal (FS) can be regenerated from the frame alignment signal (FAS) of the PCM link. The clock generator is duplicated for reliability (BDCG0 & BDCG1)

Bus Systems: The exchange of the information in the DLU is handled by the duplicated Bus System. The bus system regenerates signals, distributes signals to the periphery or concentrates signals coming from the periphery. Central and peripheral functional units communicate over a duplicated bus system.

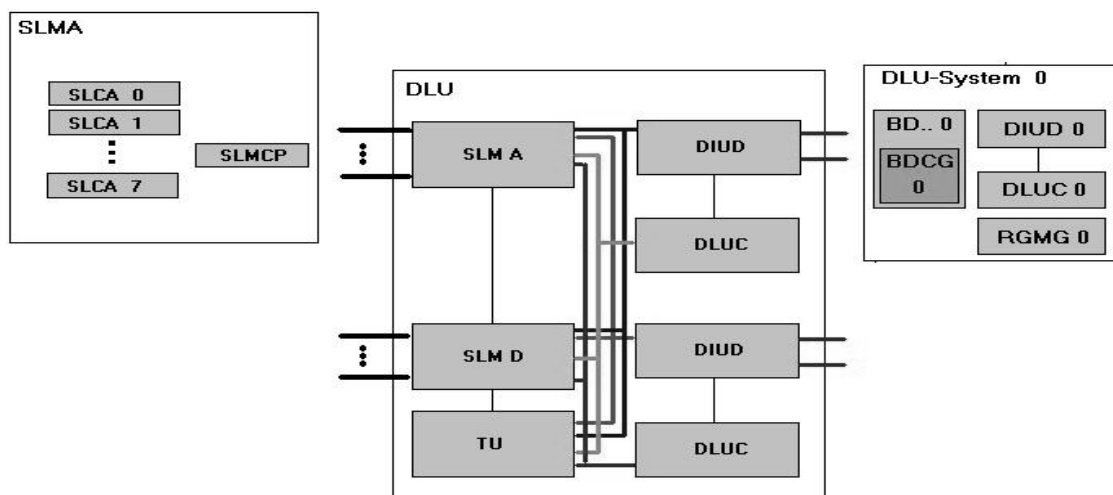
2.3.2.3 Functional Unit for Remote Functions:

The DLU can be installed locally as well as remotely depending upon the external conditions. In case a remote DLU is disconnected from the exchange by any means, may be because of LTG failure or PDC breakage, the operation of the DLU is discontinued. In these conditions it is possible to connect the subscribers served by this particular DLU by using specific software. In this case the billing data is not recorded. Figure 2.5 shows the hardware units in DLU.

2.3.2.4 DLUG

The latest version of the DLU which is used in the EWSD switches these days is DLUG. It is the most powerful subscriber line concentrator unit. The enhancements of the DLUG are in the terms of increased number of subscribers that can be connected to a single module. The increase is both in the digital as well as analog subscribers. Using a single module of SLMA & SLMD up to 32 analog subscribers and 16 digital subscribers respectively can be connected. This is because of the increase in the number of the SLCA and SLCD in the module. In addition to this there is 50% reduction in the space requirements in the per analog subscriber line. The power consumption is also lowered by 30% to 1050W at maximum load.

Fig 2.5: Architecture of DLU



2.3.2 LINE TRUNK GROUP (LTG)

The Line/Trunk Groups are the interfaces between the Switching Network and the network environment of the exchange which maybe analog or digital. It may be connected to trunks as well as a DLU. The LTG is connected to both the planes of the switching network to improve safeguarding. If the link between the LTG and one of the switching network fails, call processing will continue unrestrictedly. The LTG has following functions:

- 1) It receives and evaluates the information of trunks and subscriber lines.
- 2) It also sends signals and tones. It sends and receives messages from and to the coordination processor (CP) and the group processor.
- 3) It adapts the line conditions (transmission format) to the 8Mbits /sec highway of the SN.
- 4) It detects LTG faults.
- 5) It detects faults on the exchange –internal link interfaces during call processing.
- 6) It reports faults and routine messages to the coordination processor.
- 7) It evaluates the faults and initiates processes, such as blocking the LTG.

The capacity to handle different transmission format (PCM 30, PCM 24, and Digital Access) and signaling systems (MFC, R2, pulse coding signaling, CCITT no.7) was optimized through the implementation of the different LTG types. The some of the types of LTGs are:

- 1) Line/Trunk Group A (LTGA)
- 2) Line/Trunk Group B (LTGB)
- 3) Line/Trunk Group C (LTGC)
- 4) Line/Trunk Group G (LTG)
- 5) Line/Trunk Group D (LTGD)

2.3.2.1 Architecture of LTGB

In this section architecture of the LTGB will be discussed only as other LTGs have more or less same hardware architecture. The LTGB consists of:

Group Processor (GP): The GP is an independent periphery controller. It controls all the functional units of the LTGB. It exchanges data with the coordination processor and other LTGs. It also self diagnosis and safeguards the LTG.

Line Trunk Units (LTU): The LTU is used to connect the various units to the LTGB. Depending upon the application, the LTU is equipped with different modules (DIU modules interface DLUs and other exchanges, OLMD interface DSBs). The LTU decides what kind of interfaces can be connected to the LTG.

Link Interface Units (LIU): The LIU is used to connect the LTG to the SN. It duplicates the channels to both the SN0 and SN1. It forwards the commands from CP to the group processor and sends messages from the GP to the CP.

Signaling Unit: The Signaling Unit (SU) provides code receivers for the evaluation of signals (such as dialing information). The SU also contains a tone generator for the generation of tones, frequencies for the MFC signaling.

Speech Multiplexer (SPMX): The speech multiplexer is a non-blocking time stage similar to the time stages in the switching network. The SPMX is used for connecting the trunk lines to the LTGB. The time stage unit switches the sequence of transmission channels.

Group Switch: The Group switch connects the subscribers' lines to the LTGB. The GS also permits the implementation of the conference calls. Thus the DLU and the digital switchboards require the Group switch.

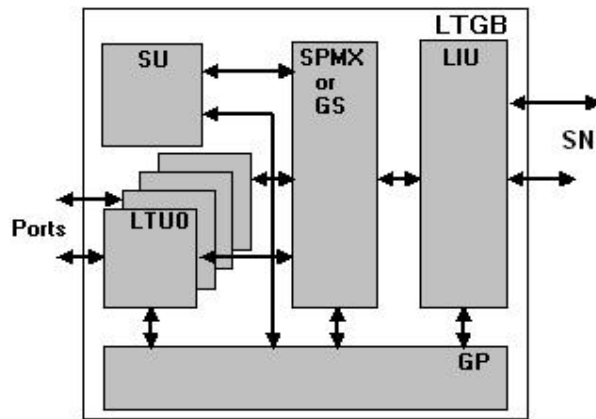


Fig2.6: Architecture of LTGB

2.3.2.2 LTGP

LTGP is the latest one and is characterized by improved performance and a much compact design. In LTGP all the basic functions of four LTGs are combined on the single module. This type has the capacity of receiving 16 PDC links from DLU and other exchanges.

2.4 SWITCHING NETWORK

The actual switching process establishing a call connection between two subscribers takes place in the hardware subsystem called Switching Network. The digital electronic switching system is equipped with a very powerful switching network. By virtue of its high data transmission quality, the switching network can switch connections for various types of service (for example telephony, facsimile, teletext, data transmission). For the safeguarding reasons the switching network is always duplicated. This increases the reliability of the system. The SN's uniform design and expansion modules permit its application in the wide range of exchange types and sizes. The SN type is categorized on the basis of number of the LTGs that can be connected to it for example SN: 15LTG, SN: 63LTG, SN: 126LTG, SN: 256LTG, SN: 504LTG. Amongst these types SN: 15LTG is the smallest. In this section we will take closer look at the SN in a configuration for up to 63LTGs. SN: 15LTG, SN: 63LTG are called switching units and remaining are called switching plane. The SN has negligible internal blocking (10^{-5}) which makes SN available all the times when required. The interfaces of the SN are of two types- External interfaces and Internal interfaces. The external interfaces are used to connect the switching network to other subparts of the EWSD.

2.4.1 Interfaces to the Switching Network

The switching network has two types of interfaces:

2.4.1.1 External Interfaces:

These interfaces are used to connect the subsystems of the EWSD to the switching network. The various external interfaces are SDC: LTG, SDC: CCNC, SDC: TSG, SDC: SGC. The SDC is secondary digital carriers with a capacity of 8Mbps. The names of the SDC links themselves suggest the components which are connected to the SN through these interfaces. These will be briefly discussed only.

SDC: LTG between a time stage group (TSG) and a line/trunk group (LTG). Channel time slot 0 is used for communication between the LTG and the CP. Channel time slots 1...127 are used for the subscriber connections.

SDC: CCNC between the switching network and a common channel signaling network control (CCNC). Common channel signaling (CCS) information is exchanged via the SDC: CCNC.

SDC: TSG between a message buffer unit for LTG (MBU: LTG) and a time stage group (TSG). Items of information are transferred

SDC: SGC between a message buffer unit (MBU) and a switch group control (SGC). Commands from the CP to an SGC and messages from an SGC to the CP are transferred via the SDC: SGC.

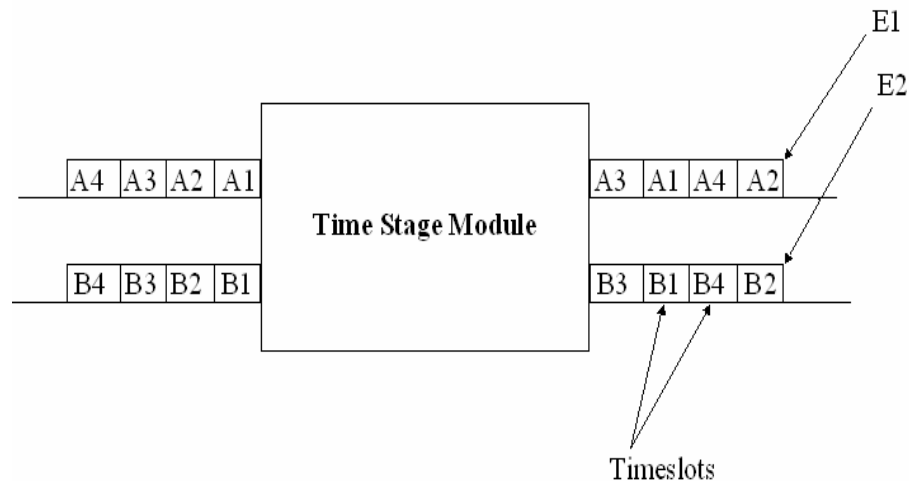
2.4.1.2 Internal Interfaces:

The internal interface in the SN is SDC: SSG – between a time stage group (TSG) and a space stage group (SSG). All types of connection can be carried via an SDC: SSG. Because of the duplicated switching network and because of the changeover-to standby principle in SN: 504 LTG, SN: 256 LTG and SN: 126 LTG, this type of interface is always present in quadruplicate. At an SDC: SSG interface a separate cable is required for each direction of transmission. Each cable contains 8 secondary digital carriers for information (8x128 channel time slots), one exchange clock line and one frame mark bit line.

2.4.2 SWITCHING

The structure and switching in SN will be described by referring to the SN: 63LTG type only.

In the SN two types of switching is occurring:



Time Stage Switching: In this type of switching 8 bit code words , for example coded voice.

Fig 2.7(a): Time switching

information, coming on the multiplex lines is switched randomly to any time slot. In the SN the time stage module (TSM) is responsible for the time switching.

Space Stage Switching: As opposed to the time stage a space stage does not change the timeslot. It is only responsible for switching randomly the 8 bit coded word on any

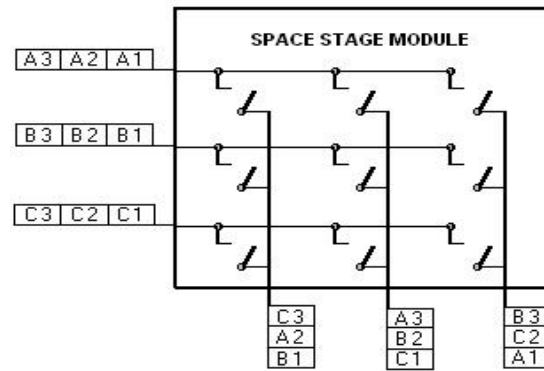


Fig 2.7(b): Space Switching

Multiplex line. In SN space stage module (SSM) is responsible for the space switching.

In the SN the time stage module and the space stage module are organized as shown in the figure 2.7

2.4.3 Structure Of Switching Network

The switching network has the following functional units:

Time Stage Module (TSM): A TSM performs the time switching of the octets. It contains one time stage incoming (TSI) and one time stage outgoing (TSO). The TSI and TSO form one physical unit. A switching network unit in an SN: 63LTG or a time stage group (TSG) in an SN: 504LTG, SN: 252LTG or SN: 126LTG contains a maximum of 16 TSMs. There are a maximum of 4 TSMs in a switching network unit in an SN: 15LTG. The TSM is further connected to the Space stage modules. Each TSM can access each space stage module.

Link Interface Module between TSM and LTG (LIL): The switching network contains one LIL (link interface module between TSM and LTG) for every TSM. Four 8192-kbit/s highways lead from each LIL to the inputs of a time stage incoming (TSI) and four 8192-kbit/s highways lead from the outputs of a time stage outgoing (TSO) to an LIL. An LIL therefore contains four identical circuits. Each of these circuits is connected by a cable to a particular LTG or a particular MBU: LTG. Each cable contains an 8192-kbit/s incoming information line and an 8192 Kbps outgoing information line and associated clock lines.

Space Stage Module (SSM): The SSM performs space switching of the time slots. It is connected to each and every TSM. An SN:63 LTG contains 4 SSMs. Each SSM has 16 inputs and 16 outputs one input coming for each of the TSM. The input and output to the SSM are 8192Kbps highways having 128 time slots.

Link Interface Module Between TSG and SSG (LIS): The link interface modules between TSG and SSG (LIS) are contained in both TSGs and SSGs. The connections between the LISs are duplicated in time and space stage groups. Each of these connections represents 8 separate

8192-kbit/s information lines, one exchange clock line and one frame mark bit line (Internal interfaces). If faults occur in TSGs or SSGs, the extra connection can be used to provide changeover to standby. In the transmit section of a LIS, eight incoming information signals are processed and each is forwarded over a separate 8192-kbit/s highway.

Link Interface Module Between SGC and MBU: SGC (LIM): It is used for the transmission of the setup commands from the CP to the SGC.

Switch Group Control (SGCI): A switch group control with link interface to the message buffer (SGCI) only occurs in capacity stage SN: 15LTG. It contains a complete SGC and the interface to the hardware controller of an LIM. In SN: 63LTG SBCI exists without the direct Connection to the message buffer.

To illustrate the switching process, the Incoming and Outgoing Time Stages (**TSI** and **TSO**), are shown separately. Yet, TSI and TSO are only one physical unit within the SN.

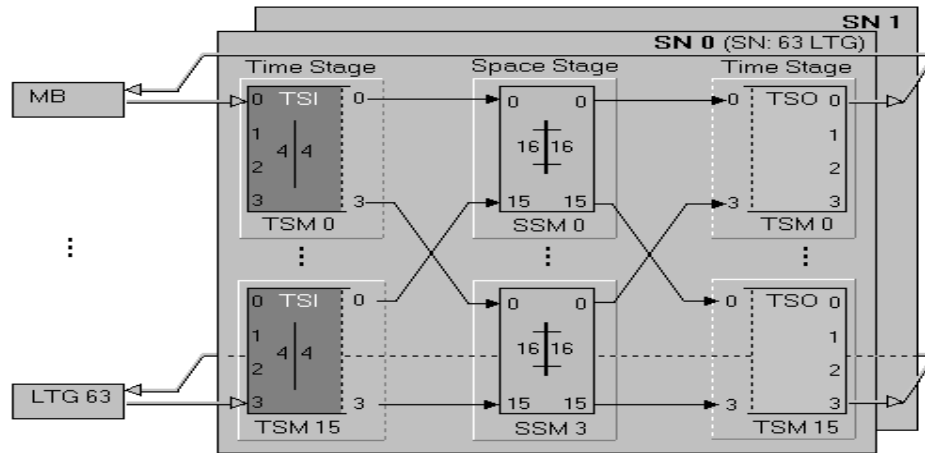
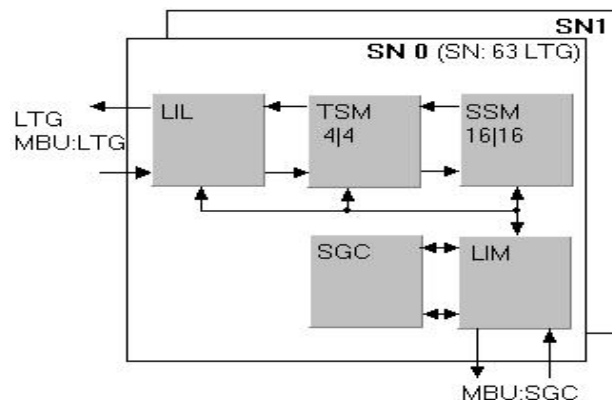


Fig 2.8: Switching Stages in SN

2.4.3.1 SN (B)

A more compact and optimized version SN is SN(B). The basic functions of SN(B) are same as that of the old version. The CP software can thus serve both the switching networks. The advantage of the SN(B) is however the considerable saving of space (Up to 70%). For example if we compare the SN(B) with SN the number of time stage modules are reduced by 50%. Each TSMB has 2 TSCI and 2 TSCO. The space stage modules are also reduced to single module SSM16B from 4 modules in the SN. The SSM16B has 8 space stage circuits out of which only four are needed with switching network variant SN(B): 63LTG. Similar is the case with the



other SN types.

Fig 2.9: architecture of SN: 63LTG

2.5 CO-ORDINATION COMPLEX

The EWSD system incorporates largely independent subsystems with a separate microprocessor control. The coordination processor handles the coordination of these microprocessor controls and data transfer between them. The coordination complex has been divided into different units for coordinating different parts of the EWSD. These parts will be discussed in the following sections.

2.5.1 Message Buffer

The message buffer serves as an interface adapter for the internal information exchange between

- 1) coordination processor
- 2) Switching network
- 3) Line trunk group

The MB has 1-4 message buffer groups (MBG) depending on the system size. The MBG are also duplicated. The latest version of the message buffer is MB (D) after MB (B). The MBB is designed to match the processing capacity of the coordination processor CP113C. The MBB provides a very high transmission capacity, especially in the message buffer for the line/trunk group (MBU: LTG). The MBB has four functional units:

Combined Group Clock Generator/Multiplexer (CG/MUX): The CG/MUX provides clock pulses. Despite of this function is also used for exchanging the messages with the LTGs.

Interface Adapter: The interface adapter is used to receive and send signals from/to the CP. The exchange of the messages between the IOP: MB and MBU via the interface is bidirectional, byte parallel, and asynchronous.

MB: SGC: A message buffer unit for switch group control (MBU: SGC) controls the exchange of messages between a maximum of three switch group controls (SGCB) of the switching network (SNB) and the IOP: MB of the CP113. The MBU: SGC sends the CP113 commands, which are received and buffered via the IOP: MB, to the connected SGCB via the transmit channels of the (max. 3) multiplex lines. The MBU: SGC receives messages from the SGCB via the receive channels of the (max. 3) multiplex lines. It buffers these messages and then forwards them to the CP113.

MBU: LTG: A message buffer unit for line/trunk group (MBU: LTG) distributes incoming messages from the IOP: MB of the CP113 to a maximum of 63 LTGs, and collects messages arriving from the LTGs to forward them to the IOP: MB.

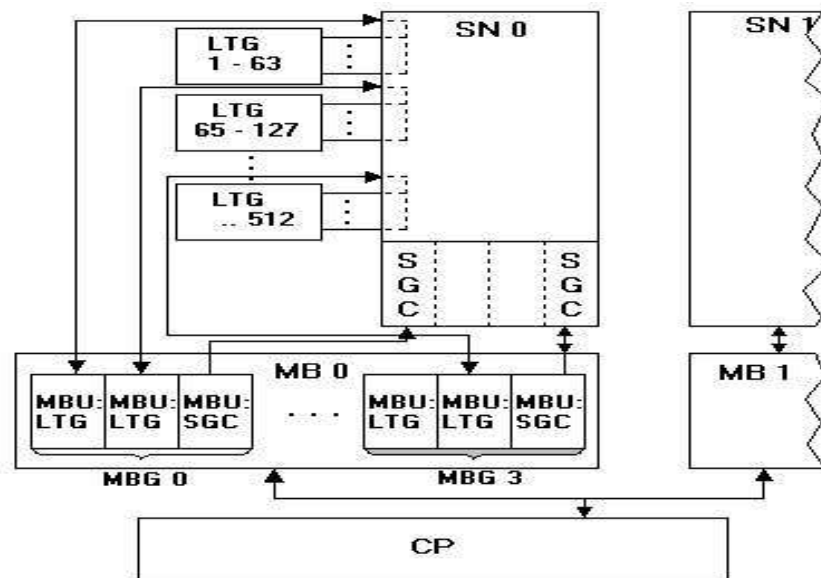


Fig 2.10: Message Buffer

The MB is duplicated and thus has two units MB0 and MB1 (figure 2-12). The MB0 accesses only SN0 and MB1 accesses only SN1. The CP transmits and receives to the MB0 and MB1. The MBG can serve 2x63 LTGs. One MBU: SGC can serve those units in the switching network that Fig 2.10 Message Buffer are required to support upto 2x63 LTGs. In maximum configuration 4 MBGs can serve upto 504 LTGs.

2.6 CENTRAL CLOCK GENERATOR (CCG)

For the transfer of digital information in a network, synchronized functional sequences of all participating units is an absolute requirement. Accurate clock pulses must be provided for all exchanges with in the digital network. This task is handled by the CCG which synchronizes the

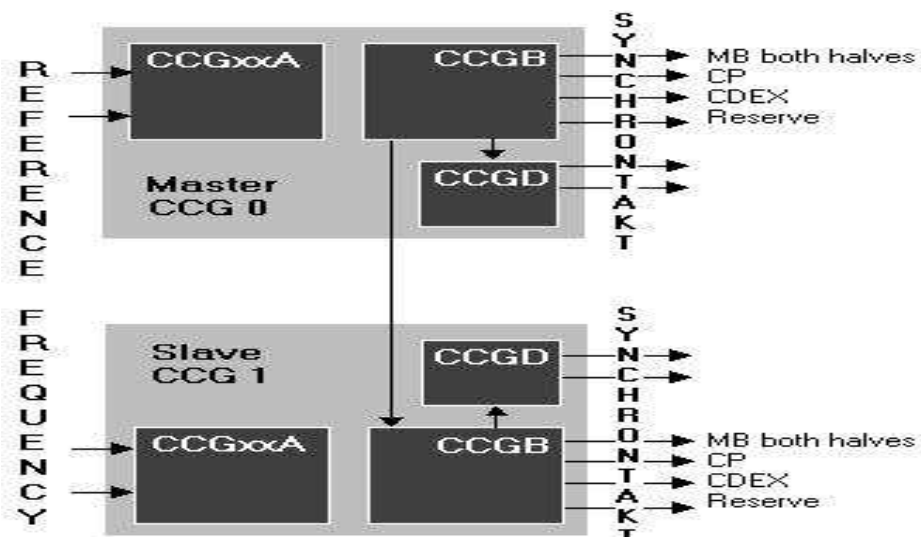


Fig 2.11: Central Clock Generator

clock generators in the functional units. If all the clock generators are failed nothing would work. It would not be possible to operate the exchange from the O&M center, to route speech channels, to record billing data or to display the time at the system panel. Tones would not be generated and above all the evaluation of the dialed information would not take place. For this reason CCG is duplicated. One CCG operates as the master and the other as slave. The slave is phase locked with the master, thus ensuring a continuous clock supply if the master fails. The CCG is synchronized to the external reference frequency. Then the CCG synchronizes all the components of EWSD to the reference frequency.

2.7 SYSTEM PANEL

The system panel provides a continuous overview of the operational status of a EWSD system. The system panel indicates faults visibly and audibly. It also displays the processing load of the CP, the time and the date. The display area includes 7- segment displays, light emitting diodes and keys. It is organized into display areas for LTG, SN, CP & CCNC, external equipment, system internal conditions and the system panel itself. The displayed processor load is a measure for the traffic load handled by the EWSD system. The system panel also displays alarms like critical alarm, major alarm, minor alarm, minor alarm combined with the major alarm. To turn off the alarm simply depress the accept key. Upto eight system panels can be connected to the EWSD exchange. It can be remote and may be connected to the system also. The system panel consists of the following functional units:

System Panel Display: The SYPD is used to display the various parameters of the exchange.

System Panel Control (SYPC): The SYPC handles the input/output control for up to 8 SYPDs, 24 external supervisory units like smoke detectors, 24 external failures signaling units.

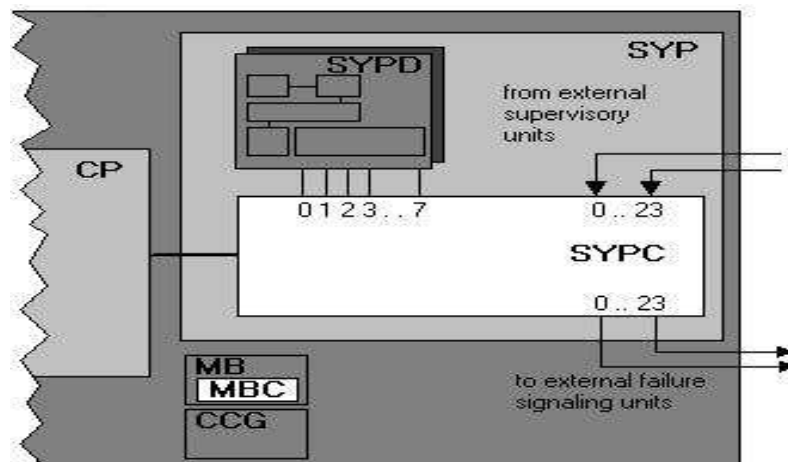


Fig 2.12: Functional Units of System panel

2.8 COORDINATION PROCESSOR (CP113 E)

For making the EWSD a flexible and powerful system the EWSD the different subsystems of the EWSD are designed with their own separate controls. The common control unit CP controls all the common system procedures and coordinates the operating, safeguarding and the switching processes. The coordination processor 113E (CP113E) is characterized by a dynamic capacity of approximately 16 million BHCA. It has also been optimized for the space requirements and the power consumption. The CP113E is the latest version of CP after CPP113C and CP113D. The CP113E contains a total of 16 processors in its maximum configuration. The structure of the CP113E consists of:

Base Processors (BAP): The BAP handles all the tasks (operation and maintenance, safeguarding) including the call processing tasks when the CAP are occupied. In its maximum configuration the CP113E can be equipped with 2 BAPs out of total 16 processors in the CP113E. Out of the two BAPs one operates as master (BAPM) and the other operates as spare (BAPS). The BAPM processes operation and maintenance tasks as well as some of the call processing tasks. The BAP performs the call processing tasks only. The two BAPs operate in task and load sharing modes. If the BAPM fails the BAPS take over the tasks of BAPM.

Call Processors (CAP): The CAP handles the call processing tasks. The CP113E has 10 CAPs out of 16 processors. These CAPs work in load sharing mode. Together with BAPM and BAPS, the CAPs form a pool redundancy. As a result, even if one processor fails (BAP or CAP), the CP continues to handle the full nominal load (n+1 redundancy).

Input/Output Control (IOC): The IOC handles data exchange between the CMY and the peripheral operating and call processing devices. Each IOC has its own bus system (B: IOC). Each bus system links upto 16 Input/output processors (IOP) for call processing and peripheral operating devices. Out of 16 processors in the maximum configuration of the CP113E there are only 4 IOCs. The IOCs are duplicated. If one of the IOCs fails the other IOC carries out the task of the partner unit.

Input/Output Processors (IOP): The IOPs are used to connect various devices to the CP113E. The IOP forms the interface between the CP and the periphery. Some of the devices which are connected to the IOPs are CCNC, message buffer (MB), central clock generator (CCG), system panel (SYP), magnetic disk drive, magnetic tape drive and OMT. A total of 16 IOPs can be connected to an IOC.

The IOPs are dimensioned in such a way that they can perform the tasks of the other unit if one of the units fails.

Common Memory (CMY): The CMY contains all common databases for all the processors, space for the non resident program codes which can be reloaded from the magnetic disk if necessary. It is duplicated. Both the CMYs (CMY0 and CMY1) can be reached by all the processors and the IOC as well the IOP also. In the normal operation the two CMYs perform all the read and write cycles simultaneously. However the two CMYs can also be operated separately in the splitting mode. In addition to all CMY all the processors have their own local memory (LMY). The LMY contains processor specific data and the resident program code of the processor. The other processors can not access the LMY of some other processor. Ref.no.2

Bus System (B: CMY): The bus system allows the processors to access the common memory (CMY) and communicate directly with each other. Both the bus systems transfer the same information simultaneously to both memory banks. Wide ranges of safeguarding measures are taken to ensure high availability of CP113E. The time between the total failures is more than 500 years. The functions of the CP113E include:

Call Processing Functions: The call processing functions include digit translation, routing, zoning, call charge registration, traffic data administration, network management, path selection through the switching network (SN).

Safeguarding Functions: The safeguarding functions deal with errors affecting the CP113E as well as the errors in other EWSD subsystems. As well as responding to the errors, the safeguarding functions also start the tests and diagnostic functions.

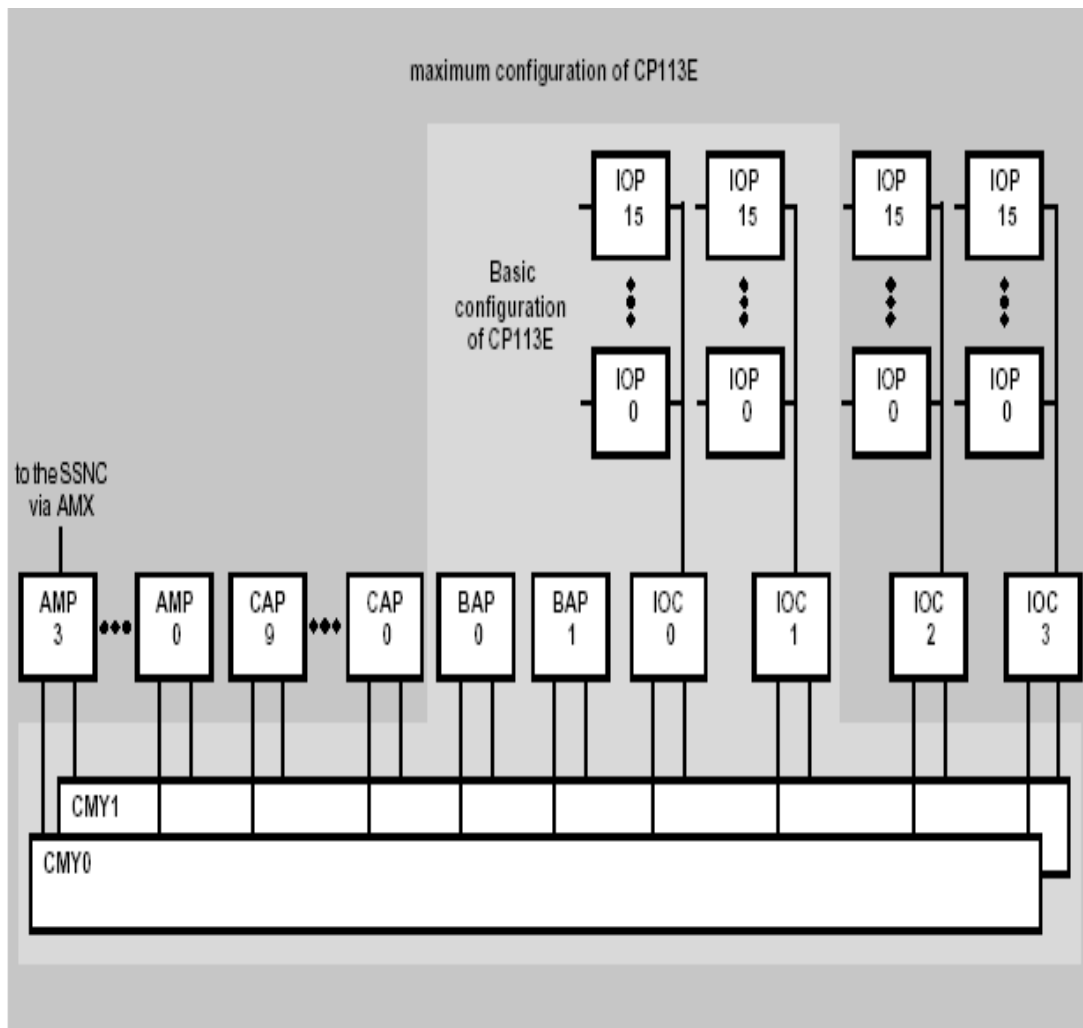


Fig 2.13: Processors in CP

2.9 COMMON CHANNEL SIGNALING NETWORK CONTROLLER (CCNC)

EWSD can control traffic to and from other network nodes with all conventional signaling methods. One method particularly well suited to processor-controlled digital network nodes is the signaling system no. 7 (SS7). It transfers messages separately from the user information (speech, data) along common channel signaling links. The common signaling channels are routed via a separate signaling network whose nodes are generally integrated in the network nodes of the communication network. There are three functionally distinct nodes in a signaling network:

- 1) Node as signaling end point (SEP)
- 2) Node as signaling transfer point (STP)
- 3) Node as relay point (SPR)

A network node functioning as a SEP represents a point of origin or a destination for signaling messages. A network node functioning as an STP receives signaling messages from a SEP and passes them on to a SEP or STP. A network node functioning as an SPR can additionally

perform global title translation (GTT). A network node may function simultaneously as an SEP, STP and SPR.

2.9.1 CCNC Structure

The functional units of the CCNC are divided in three blocks:

Multiplex System: The purpose of the multiplex system (MUX) is to combine all signaling links outgoing from the CCNC onto one secondary digital carrier (SDC) leading to the switching network and to distribute the links incoming to this SDC to the SILTDs in the CCNC. The two-stage multiplex system consists of:

A Duplicated Master Multiplexer (MUXM): The master multiplexer MUXM0/1 consists of the MUXMA module and, depending on the configuration, an expansion module, MUXMB module. The MUXMA module is connected to a maximum of 7 MUXS via 7 inputs/outputs. Up to eight signaling channels can be carried on each of these highways (512Kbps). The signaling channels are multiplexed and demultiplexed in the MUXS upstream from the SILTG. The multiplexer is connected to the switching network (SN) through an input/output by means of an 8-Mbit/s highway over which the 7 x 8 SILTG channels are routed. For a configuration with more than 7 and up to 16 SILTGs, the expansion module MUXMB is used; this can service a further 9 SILTGs. The MUXMB has 9 inputs/outputs to the MUXSs and no connection to the SN. Transmission of the 9x8 channels from the SILTGs to the SN is handled via the MUXMA, which feeds the channels into the 8 Mbps secondary digital carrier to the SN.

This results in the following configurations:

MUXMA 0 1...55 signaling links

MUXMB 0 56...127 signaling links

MUXMA 1 129...183 signaling links

MUXMB 1 184...255 signaling links

32 Slave Multiplexers (MUXS): The slave multiplexer constitutes the transfer stage to the SILTD in the SILTG.

Signaling Line Trunk Group (SILTG): The 254 signaling links (max.) in a CCNC can be divided into a maximum of 32 groups of signaling link terminals (SILTGs).

Common Channel Signaling Network Processor (CCNP): The CCNP is the brain of CCNC. The CCNPs convert messages into EWSD internal format, distinguish whether the messages are intended for this particular signaling point or for another signaling point, route messages, manages the signaling network. It is duplicated and each unit is connected to all the SILTG groups installed in the system. One of the two units is switched to active. An update of the data is made from the active to the standby CCNP.

Signaling Periphery Adapter (SIPA): Upto 8 SIPA. The SIPA and the SILTC together constitute the adapter system between the CCNP and the SILTG.

Signaling Management Processor (SIMP): The SIMP is divided into two units- MH:SIMP module and PMU:SIMP module.

Coordination Processor Interface (CPI): The CPI consists of the modules PMU:CPI, MU:CPI or MU:CCNP, and IOC:CPI. The CPI is connected to each of the two input/output processors for the message buffer (IOP:MB) in CP by the bus system B:CCNC. Modules PMU:CPI and PMU:SIMP have the same layout; they differ only in the address coding. The memory unit MU:CPI acts as a dual-port memory for the processor memory unit PMU:CPI and as a buffer for the exchange of messages between PMU:CPI and MH:SIMP. Module IOC:CPI handles the exchange of data between the input/output processors of the CP (IOP:MB) and the PMU:CPI

2.10 CALL SETUP IN THE EWSD

The call setup in the EWSD switching system involves interaction of the various hardware subsystems. An overview of the call setup and the sequence of various steps are explained in this part. Let us consider subscriber A wants to call the subscriber B. To call subscriber B the subscriber A initiates a number of call processing events by lifting the handset. The various steps involved in completion of the call are:

- 1) When A lifts the handset the analog subscriber line circuit detects the off hook condition.
- 2) The A-SLMCP scans the SLCA and detects request for a connection. The A-SLMCP reports this situation to the DLUC.
- 3) The DLUC then forwards the seizure message via digital interface in the DLU and A-DIU in the A-LTG to the group processor.
- 4) The GP checks its database for the data associated with the A subscriber and assigns time slot on one of the PCM links and reports this information to the A-SLMCP.
- 5) A-SLMCP causes the SLCA to loop back the send time slot to the receive slot (test loop). The A-GP through connects to group switch in order to perform the speech channel loop test from the A-LTG to the A-SLCA in the A-DLU and back to the A-LTG. The test tone for the loop test is provided by the tone generator in the A-SU. After the successful completion of test the A-GP selects the free time slot to the SN and sends the seizure message to the CP. Also A-GP commands the A-SLMCP to set up the speech path in the SLCA.
- 6) In the next step the tone generator in the A-SU sends the dialing tone to the A-SLCA. A code receiver in the A-SU is ready for the receipt of the dialing digits. A subscriber hears this dial tone. The subscriber then dials the number and the A-SU receives the dialed digits.
- 7) The A-SU transfers received digit code to the A-GP. After the first digit is received the A-GP disconnects the dial tone. The data received by the A-GP is then transferred to the CP.

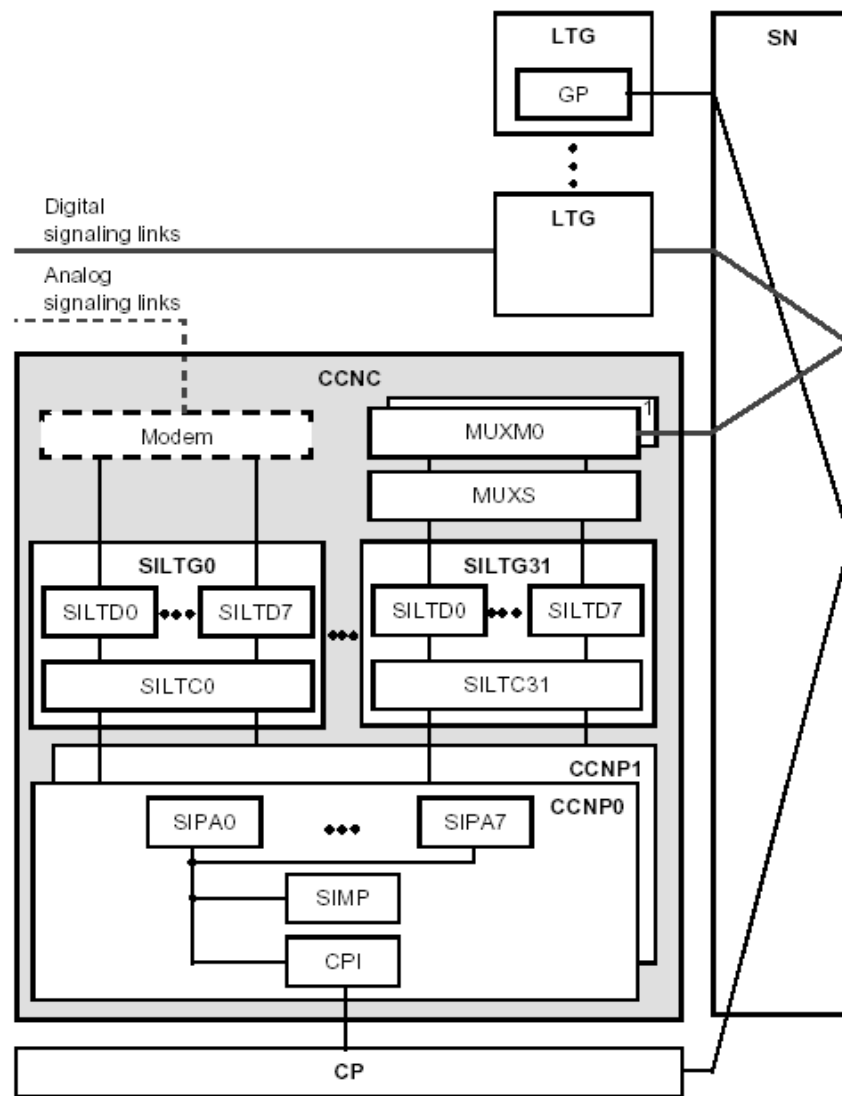


Fig 2.14: Block diagram of CCNC

- 8) The CP then checks its database and checks whether the B-subscriber is idle. The CP identifies the DLU, SLCA and the connection of the B-subscriber selects one of the two LTGs to which DLU is connected and if the line is idle, marks the B-subscriber busy.
 - 9) The CP determines a path through the SN for the connection between the A-LTG and B-LTG and sends the setup command to the SGC. It also informs the B-LTG with the seizure command about the speech channels (A-LTG-SN, SN-B-LTG), B-port number etc. The B-LTG loops the assigned speech channels. The CP informs the A-LTG in a setup command about the zone and the partner's side (port, speech, and channel) and causes the A-LTG to perform a cross office check (COC) between A-LTG & B-LTG. With the aid of a report the A-GP informs the B-GP about the successful COC and connects the subscriber's speech channels through the A-GS.
- So far the call has been setup from the B-LIU. However the connection from the B-LTG to the B-SUB is still missing.

10) Now the connection between the B-LTG and the B-SUB is setup. For setting the connection the same steps are followed from 1 to 5. After step 5 the B-GP sends the ringing command to the B-DLUC. The B-DLUC instructs the SLMCP to apply the ringing voltage B subscriber. The B-GP forwards a switch command to the B-GS to send the ringing tone to the A subscriber. The A subscriber receives the ringing tone from the B-SU.

11) The B subscriber accepts the call by lifting the handset. The B-SLCA detects the loop closure. The B-SLMCP scans the B-SLCA and recognizes that B subscriber wants to accept the call i.e. has gone off-hook. The B-SLMCP reports the loop closure to the B-DLUC. The B-DLUC removes the ringing tone current and forwards the message to the B-GP. The B-GP disconnects the ringing tone and connects the speech through the B-GS.

12) The B-GP reports the answer to the A-GP. Due to this report the initiates the charging procedure.

13) Finally the connection is established. It seems that the process will take time but the experience shows that the connection is set up in few seconds. The A-GP stores the call charges and stores in one of the registers and transfers to the CP at the end of the call.

The whole process involved in establishing requires interaction between the various parts of the hardware as explained in steps. In the daily life establishing the call seems to very simple but the system required to establish this call involves a great complexity both in architecture and the process designed for call set up.

2.11 DIMENSIONING OF EWSD

The deployment of the switch in the field involves first determination of the configuration of the switch. This is also called dimensioning of the switch. The dimensioning of switch involves determination of how many and what types of modules are required in a hardware subsystem to meet the requirements. In addition to the determination of the modules the number of frames and racks required is also a part of dimensioning. The dimensioning depends on various factors some of which are:

- 1) Traffic requirements i.e. traffic per subscriber
- 2) Number of subscribers to be connected to the switch
- 3) Busy Hour Call Attempts (BHCA)
- 4) Number of RSUs required and number of subscribers connected to each RSU
- 5) Services required by the operator in its network like ISDN-BRI, ISDN-PRI etc.

The various parameters and the requirements are provided by the upon these factors the dimensioning of switch is started. The first step in dimensioning of switch involves the dimensioning of DLU and then others subsystems are dimensioned.

2.11.1 DLU (Using DLUG)

The DLU is a subsystem of access part of EWSD. It connects the subscribers to the switch as already described. The configuration of the DLU depends upon the number of subscribers connected and the services like ISDN BRI provided by the operator to the subscribers. The dimensioning of DLU is done as described in the following steps:

Determine the number of analog subscribers and ISDN-BRI subscribers from given data. The need for ISDN-BRI is usually given in terms of number of B-channels. From B-Channels we have to calculate number of subscribers using the formula:

$$\text{ISDN-BRI subscribers} = \text{No. of B-Channels}/2 \dots \dots \dots (1)$$

The formula is logical as each ISDN-BRI subscriber requires 2 B-channels.

Modules (SLMA and SLMD): The number of SLMA and SLMD are calculated from number of analog and digital subscribers. As we are using DLUG so each SLMA provides connectivity for 32 analog subscribers and each SLMD provides connectivity for 16 digital subscribers or ISDN-BRI subscribers. So numbers of SLMA and SLMD modules required are:operator. After deciding

$$\text{M: SLMA} = \text{number of analog subscribers}/32 \dots \dots \dots (2)$$

$$\text{M: SLMD} = \text{number of digital subscribers}/16 \dots \dots \dots (3)$$

It may happen that the number of modules required come out to be a fractional number. So in those cases the number is rounded off to next integer.

Number of DLUG: The number of DLUG required depends on the number of total modules required i.e. both SLMA and SLMD. A single DLUG can accommodate 63 SLM modules

$$\text{Number of DLUG} = (\text{M: SLMA} + \text{M: SLMD})/63 \dots \dots \dots (4)$$

In this case also the number of DLUGs should be an integer.

Number of Racks (R: DLUG): The number of racks required depends upon the number of DLUGs required. Each rack can accommodate 2 DLUGs {DLUG (0) & DLUG (1)}. Thus the number of racks required is given by:

$$\text{R: DLUG} = \text{Number of DLUG}/2 \dots \dots \dots (5)$$

The racks come in two sizes 8 ft. and 7 ft but both have same configuration.

DCC Converter for Analog and Digital Subscribers: DCC modules are required for providing power supply to the modules. For ISDN subscribers each half shelf requires a DCC module. Each half shelf can accommodate 8 SLMD modules. For analog subscribers 2 DCC modules are required for up to 1024 subscribers and 3 are required for subscribers greater than 1024.

Frames [F: DLUG (A) & F: DLUG (B)]: The frames required for housing the modules depend on their number. One DLUG is formed from two frames each divided into two shelves. One of the frames is F: DLUG (A) and other is F: DLUG (B). The F: DLUG (A) can house 15 SLM cards in the top shelf and 16 SLM modules in bottom shelf. The top shelf in addition to SLM modules also houses a DLUC module for controlling the DLUG parts. In F: DLUG (B) both the shelves house 16 SLM modules. Thus total number of modules a DLUG can house is 63 ($15+16+16+16 = 63$). After determining the racks, DLUGs and the modules the distribution of these SLM modules is determined in various racks and DLUGs. The distribution should be such that the traffic is evenly distributed among DLUGs and minimum number of power supply modules should be used. Then the frames are filled one by one according to distribution. It may happen that in a particular DLUG F: DLUG (B) may not be required due to already complete filling of frames and no SLM modules are left.

M: ALEX: This module is used in the remote DLU for supervision and warning purposes. It is used for the alarm transmission. This module is not used in the main exchange and is only used in the remote DLU. One module is required for each RSU.

M: ALEX = 1 (per RSU)

M: SASCG: This module is used for standalone service in remote DLU. The requirement of this module is not in the main exchange. Number of M: SASCG required is equal to the DLUs present in the RSU.

M: SASCG = number of DLUs in RSU

Network Termination Units: The NT units provided to the operator are equal to 10% of the B channels for ISDN-BRI. If the customer requires extra NT units he has to buy on demand. Ref.no.5

Number of NT units = 10% of ISDN-BRI B channels.....(7)

M: DLUC: The number of M: DLUC required is equal to number of DLUs.

M: DLUC = number of DLUG

The above rules are same for both main exchange and RSU except the modules which are only meant for RSU.

2.11.2 Line/ Trunk Group (LTGP)

After the DLU is dimensioned LTG is dimensioned. The dimensioning of LTG depends upon the number of PDC links coming from the DLU, from other exchanges and ISDN PRI subscribers.

The steps for dimensioning LTG are:

For dimensioning the LTG first of all the traffic because of all the DLUs is calculated. This is done on individual DLU basis. The traffic due to DLU is because of both the analog and digital subscribers. The traffic values because of analog and digital subscribers are given. To calculate the traffic the following formula is used:

$$\text{Traffic} = \text{M: SLMAs in DLU} * 32 * t_{\text{analog}} + \text{M: SLMDs in DLU} * 16 * t_{\text{digital}}$$

Where

t_{analog} = traffic due to analog subscriber

t_{digital} = traffic due to digital subscribers

After calculating the traffic due to the DLU the number of PDCs is determined from the data sheets. The above step is repeated for all the DLUs whether in main exchange or in RSUs. After calculating the PDCs coming from all the DLUs to the LTG the sum total of all these PDCs is calculated.

$$\text{PDC}_{\text{DLU}} = \text{Sum total of all the PDC form all the DLUs (M.E. + RSUs)} \dots\dots\dots(8)$$

The next step towards the dimensioning of the LTG is calculation of the E1 required because of the ISDN PRI subscribers. Before calculating the number of E1 required we have to calculate the ISDN-PRI subscribers from the given data. Usually the ISDN-PRI subscribers are given as percentage of B-channels required by these subscribers.

$$\text{Number of ISDN-PRI subscribers} = \text{No. of B-Channels}/30 \dots\dots\dots(9)$$

Each ISDN-PRI subscriber requires full E1 as ISDN- PRI has 30 B channels of 64Kbps each. Thus the number of E1 required is equal to number of ISDN-PRI subscribers.

$$\text{E1}_{\text{ISDN-PRI}} = \text{Sum total of all the E1s required in both M.E. and RSUs}$$

The third factor which contributes to the PDCs or E1s is trunks used to connect other exchanges. These trunks are decided on the basis that 30 % of the total traffic is routed to other exchanges. The number of trunks is first calculated from formula:

$$\text{Number of trunks} = 30\% \text{ of total capacity (subscribers) of exchange}$$

After calculating the number of trunks we know that each trunk uses a 64Kbps channel. From this value we can calculate E1s required.

$$\text{E1}_{\text{trunks}} = \text{Number of trunks}/30$$

Another factor which contributes for the LTGs is number of trunk lines coming from other exchanges. This is determined using the step3 for other exchanges.

$$\text{E1}_{\text{trunks other exchanges}} = \text{E1s coming from other exchanges}$$

After following all the steps we have to calculate sum total of all the E1s terminating at LTG.

$$E1_{\text{total}} = PDC_{\text{DLU}} + E1_{\text{ISDN-PRI}} + E1_{\text{trunks}} + E1_{\text{trunks other exchanges}}$$

After calculating the PDC links to the LTG we will now determine the number of LTGPs required. One LTGP can be used to connect 16 PDC links. So the total number of LTGPs required is given by:

$$LTGP = E1_{\text{total}} / 16$$

After calculating the LTGP we have to calculate the number of F: LTGP required for housing the LTGPs. Each F: LTGP can house upto 8 LTGPs so

$$F: LTGP = LTGP / 8$$

Now the racks required to accommodate these frames is to be calculated. Each R: LTGP can accommodate up to 6 F: LTGP. So racks required are:

$$R: LTGP = F: LTGP / 6$$

Thus after calculating racks, frames and modules we can install the LTG also. So with the dimensioning of DLU and LTG we are complete with the access part of EWSD. The configuration of the LTGP is shown in figure 2.15

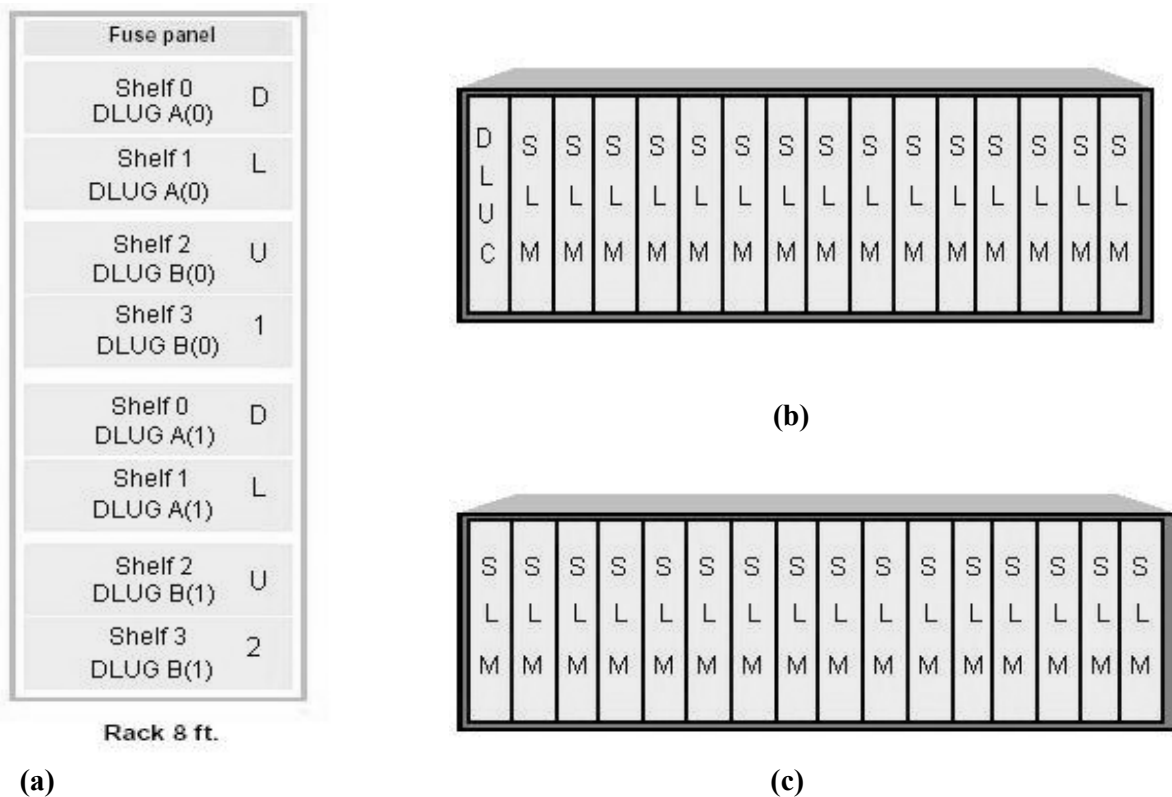


Fig 2.15: (a) R: DLUG (b) F: DLUG A (shelf 0) (c) F: DLUG A (shelf 1), F: DLUG B (shelf 2, 3)

2.11.3 CCNC

The dimensioning of CCNC is based on the requirement of the signaling links in the network. The signaling links then decide the modules, frames, and racks required. The following steps are followed in the dimensioning of the CCNC:

R: CCNC: The R: CCNC can accommodate 5 frames out of which 3 are F: SILTD and the other 2 are F: CCNP {F: CCNP (0) and F: CCNP (1)}. Depending upon the F: SILTD and F: CCNP the number of racks is determined. Usually the 2 frames of CCNP can support upto 254 signaling links but the 3 F: SILTD in the R: CCNC can support 47 links only. So if the number of the links exceeds 47 we have to use another R: CCNC but only two F: CCNP are required.

M: SILTD: The SILTD module is used for receiving a single signaling link. Thus the number of M: SILTD depends upon the number of signaling links and is equal to it.

M: SILTD = Number of signaling links

F: SILTD: The number of F: SILTD required depends upon the M: SILTD. Out of 3 racks the topmost rack can accommodate only 15 M: SILTD but the remaining 2 frames can accommodate 16 M: SILTD each. Thus 3 frames are required for supporting 47 links.

M: SIPA: The module SIPA is present in the F: CCNP. A single M: SIPA can control upto 32 M: SILTD modules. Thus depending upon the M: SILTD M: SIPA is determined.

M: SIPA = M: SILTD/32

M: MUXMA & M: MUXMB: The MUXMA & MUXMB are also a part of F: CCNP. The M: MUXMA & M: MUXMB are determined on the basis of signaling links. The following scheme is used to determine these module

MUXMA = 1-55, 129-182

MUXMB = 56-127, 183-255

F: CCNP: The R: CCNC contains 2 F: CCNP (0 &1). These are duplicated for redundancy purposes. The M: SIPA, M: MUXMA, M: MUXMB are present in this frame. Two of these frames can support up to 254 signaling links. Both of these frames are mandatory. The configuration is shown in figure 2.16

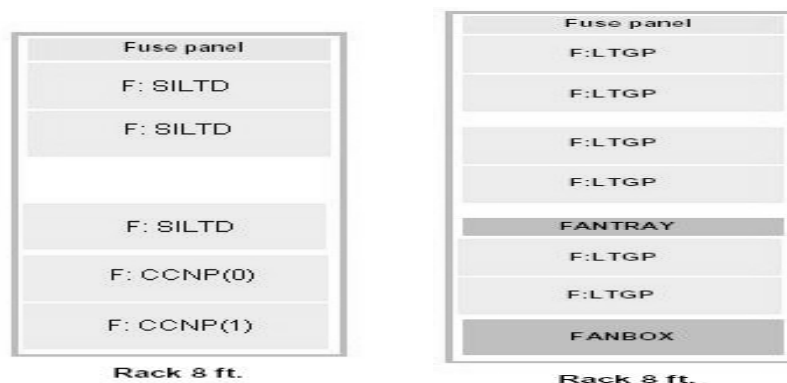


Fig 2.16: R: LTGP and R:CCNC

2.11.4 Coordination Processor (CP113 C)

The coordination processor is dimensioned for various processors like BAP, CAP, IOP, IOC etc which constitute CP113C. The coordination processor controls whole of the switch so it is a very important part. Redundancy is used in each and every part. The various factors which come into play in the dimensioning of the switch are BHCA for call processing, X.25 & V.24 interfaces, systems connected to message buffer units, and the various devices connected to the switch and are controlled by the CP113C.Ref.no.8. The switch has only one R: CP113C. Also in the rack a proper arrangement of cooling using fan boxes is deployed and is a must because failure of this unit will stop the functioning of the switch. Following steps are taken in the dimensioning of CP113C:

R: CP113C: Only single rack is used for the processor. The R: CP113C has in total 7 frames for accommodating different modules. Out of these some frames are mandatory and some are optional.

R: CP113C = 1

F: PIOP: In a single rack there are four F: PIOP (0, 1, 2, and 3). Out of these two {F: PIOP (0) & F: PIOP (1)} are mandatory and other two (2, 3) are optional depending upon the requirements of the processors in the switch. As the name suggests the F: PIOP houses the IOP processors, IOP: MB and IOP: Central tasks. It also houses the IOC0, IOC1 which are mandatory. The IOC0 is present in F: PIOP (0) and IOC1 is present in F: PIOP (1). The CAP (2-5) processors are also present in the F: PIOP (0-3). The other two optional frames are deployed on the basis of additional processors required.

F: PIOP (0 & 1) = 2 (M)

F: PBC: There are two F: PBC (0, 1) present in the R: CP113C. As the name suggests that these house BAP and CAP processors. Both are mandatory. The F: PBC (0) & F: PBC (1) houses the BAP0 & BAP1 processors. In addition to that it also houses the CAP (0, 1) processors. The common memory modules are also present in the F: PBC.

F: DEV (F): This frame is used to accommodate external memory units for the CP113C. This memory is used for storing the call detail records and other programs which the processors can load on requirement. The types of memory devices that accommodated by this frame are MDD & MOD.

F: DEV (F) = 1 (M)

BAP: The two BAP (0 & 1) processors are mandatory in CP113C. The BAP can support the call processing functions with a capacity of 250K BHCA (combined capacity of two). The processors modules that are used for BAP, CAP, and IOC are same. Thus two modules for BAP processors are used. These processors are accommodated in the F: PBC as already explained.

BAP = 2 (M)

CAP: The CAP processors CAP 0-5 are optional and are only deployed depending on the need of call processing. Each CAP can support 200K BHCA. Usually CAP0 & CAP1 are given for safeguarding purposes. CAP0 & CAP1 are present in F: PBC (0&1) respectively.

CAP (0 &1) = 2 (R)

IOC: The IOC processors are placed in the F: PIOP. There are total four IOC processors. The IOC0 & IOC1 are mandatory. Whereas the requirement for IOC2 & IOC3 depend on the devices to be connected to the switch. The IOC 0-3 are placed in F: PIOP 0-3 respectively, one in each frame.

IOC = 2 (M)

M: CMY: The M: CMY is available as a unit of 256MB. Usually 1 GB or 512 MB of memory is provided. The M: CMY are duplicated for safeguarding purposes. Therefore double the modules are required. These modules are housed in F: PBC (0 &1)

M: CMY = 2 * (memory needed, 1GB or 512MB)/256 MB

M: IOP: The IOP is used for different devices to be connected to the CP113C. The IOP: MB is one of the important modules which are used for connecting SYP, CCG, and CCNC. It is also used for different types of interfaces (X.25, V.24) to be connected to the CP113C. These interfaces are used to connect the OMT PC to the CP113C. If the PC is situated at a far distance from CP the X.25 is used and if distance is short than V.24 is used. For X.25 IOP: SCDP is used and for V.24 IOP: UNI is used. The numbers of IOP: MB used are given by

SYP = 2

CCG = 2 (per frame)

MB = 2

CCNC = 2



Fig. 2.17: CP113C

MDD and MOD: These are the external memory units for storing the call detail records. MDD is magnetic disk drive and MOD is magneto optical disk. These are installed in the F: DEV (F). The configuration of CP113C is shown in figure 2.17.

2.11.5 Switching Network

The switching network is dimensioned on the basis of the LTGs required. It is divided into frames: F: TSG & F: SSG. The important part of the dimensioning of SN is to determine the number of frames of TSG (B) and SSG (B) required catering to the needs. The rules for dimensioning SN are:

F: SSG (B): This frame is divided into two parts one is basic and other is extension. The capacity of basic equipment is 126 LTGs and if we use extension then the maximum capacity can be increased to 252 LTGs.

F: SSG (B) = 1 for 126 LTGs (basic equipment) and for 252 LTGs (extension)

F: TSG (B): This frame is also decided by the number of LTGs. One frame is required for 63 LTGs.

F: TSG (B) = 1 for 63 LTGs

R: LTGN: The SN (B) is housed with other LTGs as well as message buffers. The rack LTGN can be configured in following ways:

1. 4 F: LTGN
2. 2 F: TSG(B) + 2 F: MB + F: LTG
3. 2 F: SSG + 2 F: MB

So we can use R: LTGN in two of the ways one to house the LTGs and the other to house SN with MB. The F: TSG (B) and F: SSG (B) are never housed together. So a minimum of 2 racks are required for accommodating both the frames.

R: LTGN for F: TSG (B) = Number of F: TSG (B)/2 (a)

R: LTGN for F: SSG (B) = Number of F: SSG (B)/2..... (b)

Total number of R: LTGN = (a) + (b)

The configuration of the SN is shown in figure 2.18

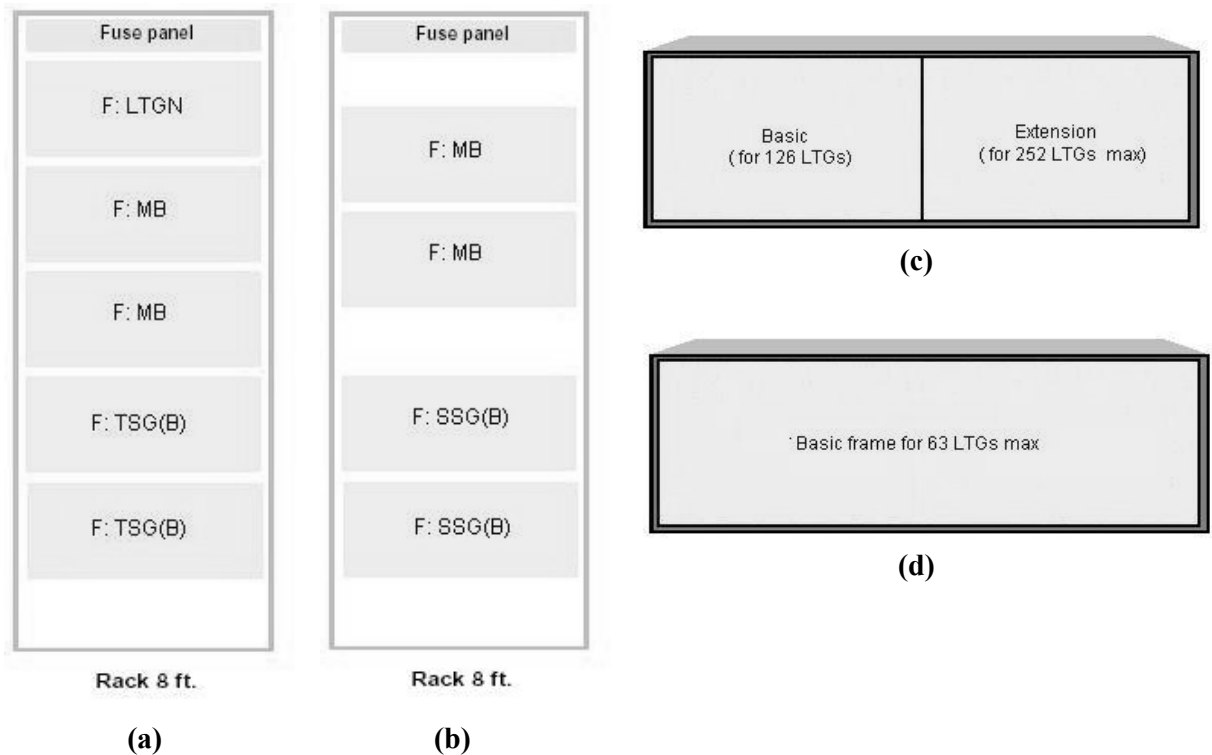


Fig 2.18: (a) R: LTGN with F: LTGN, F: MB, F: TSG (B) (b) R: LTGN with F: MB, F: SSG (B) (c) F: SSG (B) (d) F: TSG (B)

2.11.6 Message Buffer (MB)

The F: MB/CCG (B) basic equipment is used for 63 LTGs. If the number of LTGs is greater than 63 then extension is used for another 63 LTGs resulting in 126 LTGs max. The diagram of F:MB/CCG (B) is shown in figure 2.19

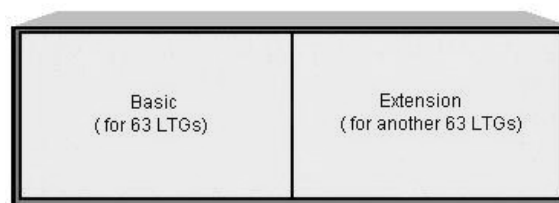


Fig 2.19: MB/CCG (B)

2.11.7 MOMAT

MOMAT constitute the materials which are required in addition to the EWSD hardware for the installation and connection of various components. This includes installation material per rack, cables, connectors and various tools for maintenance of the switch. Dimensioning rules for some of the components of MOMAT are as follows:

- 1) Installation material is defined per rack and total installation material required is equal to the total number of racks required in the switch.
- 2) 16 pair connectorised subscriber cable of 20m between the DLU and MDF.
- 3) 16 pair subscriber cable for every additional 5m between DLU shelf and MDF.

4) Crimping tool

5) Cables per LTGP for 20m between LTG and DDF rack.

6) Cables per LTGP for every additional 5m between LTG and DDF rack.

2.11.8 APS& Database

APS is provided to the customer on the basis of ports the customer is using. The following formulas are used for calculating the ports:

$$\text{Number of ports} = \text{M: SLMA} * 32 + \text{No. of ISDN-BRI} * 32 + \text{No. of ISDN-PRI} * 30 + \text{No. of LTGP} * 480 + \text{No. of STMI} * 1890$$

Application Software = number of ports

Database = number of ports

2.11.8 Power Plant

For providing the backup to the exchange additional battery banks are used. These battery banks provide power to exchange during the power failures. The capacity of battery bank required depends upon the load of the exchange and the backup time for which the battery banks will provide the power. After determining the total capacity battery bank units of standard capacities are provided to support the requirement. The load of the exchange is given in amperes. The battery banks are available in terms of ampere hours, usually 2000AH & 600AH. The following formula is used for calculating the total capacity of battery banks. The load of exchange is expressed in amperes because we know that the exchange works at standard voltage supply of 48V or 60V. Thus the power can be calculated from the product of current and voltage.

$$\text{Battery Capacity (AH)} = \text{backup time (hours)} * \text{load of exchange (amp)}$$

After calculating the capacity battery bank units are calculated.

2.11.9 Tools and Testers

Various tools and testers are also provided along with the switch for various testings and inspections required in the exchange. Some of these tools and testers are:

1) Digital phones

2) Network Termination units for ISDN-BRI

PRACTICAL APPLICATION OF EWSD SWITCH

3.1 INTRODUCTION

In this chapter we designed a telecom network for T.I.E.T Patiala by using EWSD switch. Total capacity of staff and student is 5000.5K is divided in to four parts according to the capacity of locality. Main exchange is situated in the college and RSUs (remote switching units) are for boys, girls, and for giving connection to staff houses. We designed a different parameter manually by using dimensioning rules and also develop software that will calculate all the parameter by entering the capacity. Now if capacity of TIET. will increase to double then we designed a exchange for 10K.another example witch we take for patiala city . Capacity of Patiala is 1000000. Three exchanges are situated in different regions having different capacity of each. Each exchange is having its own RSUs and each RSU is having its own capacity .capacity will depend upon the locality. These three exchanges are connected to each other with the help of trunks line.

3.2 Telecom Network Designing for T.I.E.T Patiala using EWSD Switch

Total capacity of staff and students is 5000

3.2.1 Dimensioning of 5k Switch

Requirements

1. Subscriber Distribution

Total capacity = 5K

Main exchange (M.E.) = 2K

RSU1 = 0.5K

RSU2 = 1K

RSU3 =1.5K

2. Subscriber Capacity (same for M.E., RSUs)

Analog subscribers = 90%

ISDN-BRI subscribers = 5% (in terms of B-Channels required by ISDN-BRI subscribers)

ISDN-PRI = 5% (in terms of B-Channels required by ISDN-PRI subscribers)

3. Traffic

Analog subscriber = 0.15 Erlang\sub

ISDN (BRI & PRI) = 0.44 Erlang\sub

Mean holding time = 90 sec

Only the Subscriber distribution changes with exchange and the subscriber capacity & traffic usually remain same for a particular operator. In this network also only subscriber distribution changes and other two parameters remain same. The dimensioning is started with DLUG and is

done for M.E. and every RSU individually. One thing to note is that number of modules, frames, and racks can not be in fractions so in various calculations direct results in next integer are given.

3.2.2 DLUG

M.E. (2K)

Analog subscribers = 90% of 2K = 1800

ISDN-BRI subscribers = (5% of 2K)/2 = 50

ISDN-PRI subscribers = (5% of 2K)/30 = 4 (rounded off)

M: SLMA = 1800 (analog subscribers)/32 = 57

M: SLMD = 50 (ISDN-BRI)/16 = 4

Number of DLUGs = (57 + 4) (total modules)/63 = 1

M: DLUGC = 1

R: DLUG = 1/2 = 1

Distribution of modules in DLUGs and racks

R (1).DLU (1) = 4SLMD + 57SLMA

Power Supply Modules

M: DCC (ISDN) = 1*1 = 1 (1 per half shelf)

M: DCC (analog) = 1*3 (sub> 1024) = 29

Frames

F: DLUG (A) = 1; F: DLUG (B) = 0

Standalone operation

M: ALEX = 0; M: SASCG = 0

Network Termination Units = 10% of ISDN-BRI Channels = 100* 10/100 = 100

RSU1 (0.5K)

Analog subscribers = 90% of 0.5K = 450

ISDN-BRI subscribers = (5% of 0.5K)/2 = 13

ISDN-PRI subscribers = (5% of 0.5K)/30 = 1

M: SLMA = 450/32 = 15

M: SLMD = 13/16 = 1

Number of DLUGs = 15 + 1/63 = 1

M: DLUC = 1

R: DLUG = 1/2 = 1

Distribution of modules in DLUGs and racks

R (1).DLU (1) = 1SLMD + 15SLMA

Frames

F: DLUG (A) = 1; F: DLUG (B) = 0

Power supply modules

M: DCC (ISDN) = $1 \times 1 = 1$; M: DCC (Analog) = $2 \times 1 = 2$

Stand alone operation

M: ALEX = 1 (per RSU); M: SASCG = 1 (per DLU)

Network Termination units = $26 \times 10 / 100 = 2$

RSU2 (1K)

Analog subscribers = 90% of 1K = 900

ISDN-BRI subscribers = $(5\% \text{ of } 1K) / 2 = 25$

ISDN-PRI subscribers = $(5\% \text{ of } 1K) / 30 = 2$

M: SLMA = $900 / 32 = 29$

M: SLMD = $25 / 16 = 2$

Number of DLUG = $29 + 2 / 63 = 1$

M: DLUC = 1

R: DLUG = $1 / 2 = 1$

Distribution of modules in DLUG and racks

R (1).DLU (1) = $2SLMD + 29SLMA$

Frames

F: DLUG (A) = 1; F: DLUG (B) = 0

Power supply modules

M: DCC (ISDN) = $1 \times 1 = 1$; M: DCC (Analog) = $2 \times 1 = 2$

Stand alone operation

M: ALEX = 1 (per RSU); M: SASCG = 1 (per DLU)

Network Termination units = $50 \times 10 / 100 = 5$

RSU3 (1.5K)

Analog subscribers = 90% of 1.5K = 1350

ISDN-BRI subscribers = $(5\% \text{ of } 1.5K) / 2 = 38$

ISDN-PRI subscribers = $(5\% \text{ of } 1.5K) / 30 = 3$

M: SLMA = $1350 / 32 = 43$

M: SLMD = $38 / 16 = 3$

Number of DLUG = $43 + 3 / 63 = 1$

M: DLUC = 1

R: DLUG = $1 / 2 = 1$

Distribution of modules in DLUG and racks

R (1).DLU (1) = $3SLMD + 43SLMA$

Frames

F: DLUG (A) = 1; F: DLUG (B) = 0

Power supply modules

M: DCC (ISDN) = $1 \times 1 = 1$; M: DCC (Analog) = $3 \times 1 = 3$

Stand alone operation

M: ALEX = 1 (per RSU); M: SASCG = 1 (per DLU)

Network Termination units = $76 \times 10 / 100 = 7$

Fig.3.1 shows distribution of different parameter (M:SLMA, RACKS , M:SLMD,DLUC, DLUG, M:PSD,M:PSA)of main exchange, RSU1, RSU2, RSU3. This fig. shows how many analog and digital modules, no. of racks, and power supply modules required for both digital and analog.

3.2.3 LTGP

Traffic Calculations and PDCs due to all the DLUGs

M.E.

Number of DLUGs = 1

1DLUG with 4SLMD + 57 SLMA modules

Traffic = $4 \times 16 \times 0.44 + 57 \times 32 \times 0.15 = 301.76$ Erlang

PDCs required per such DLUG = 16

Total PDCs due to these 1 DLUG = $1 \times 16 = 16$

PDCs coming out of DLUGs in M.E. = 16

RSU1

Number of DLUGs = 1

1 DLUGs with 1SLMD+15SLMA modules

Traffic = $1 \times 16 \times 0.44 + 15 \times 32 \times 0.15 = 79.04$ Erlang

PDCs required Per DLUG = 16

Total PDCs required = $1 \times 16 = 16$

Total PDCs coming out from DLUGs in RSU1 = 16

Distribution Between the Parameters of Main Exchange , RSU1, RSU2, RSU3

	Main Exchange(2K)	RSU1(0.5K)	RSU2(1K)	RSU3(1.5K)
Rack	2	1	1	1
M:SLMA	57	15	29	43
M:SLMD	4	1	2	3
DLUC	1	1	1	1
DLUG	1	1	1	1
NTU	10	2	5	7
M:PSD	1	1	1	1
M:PSA	5	2	2	5

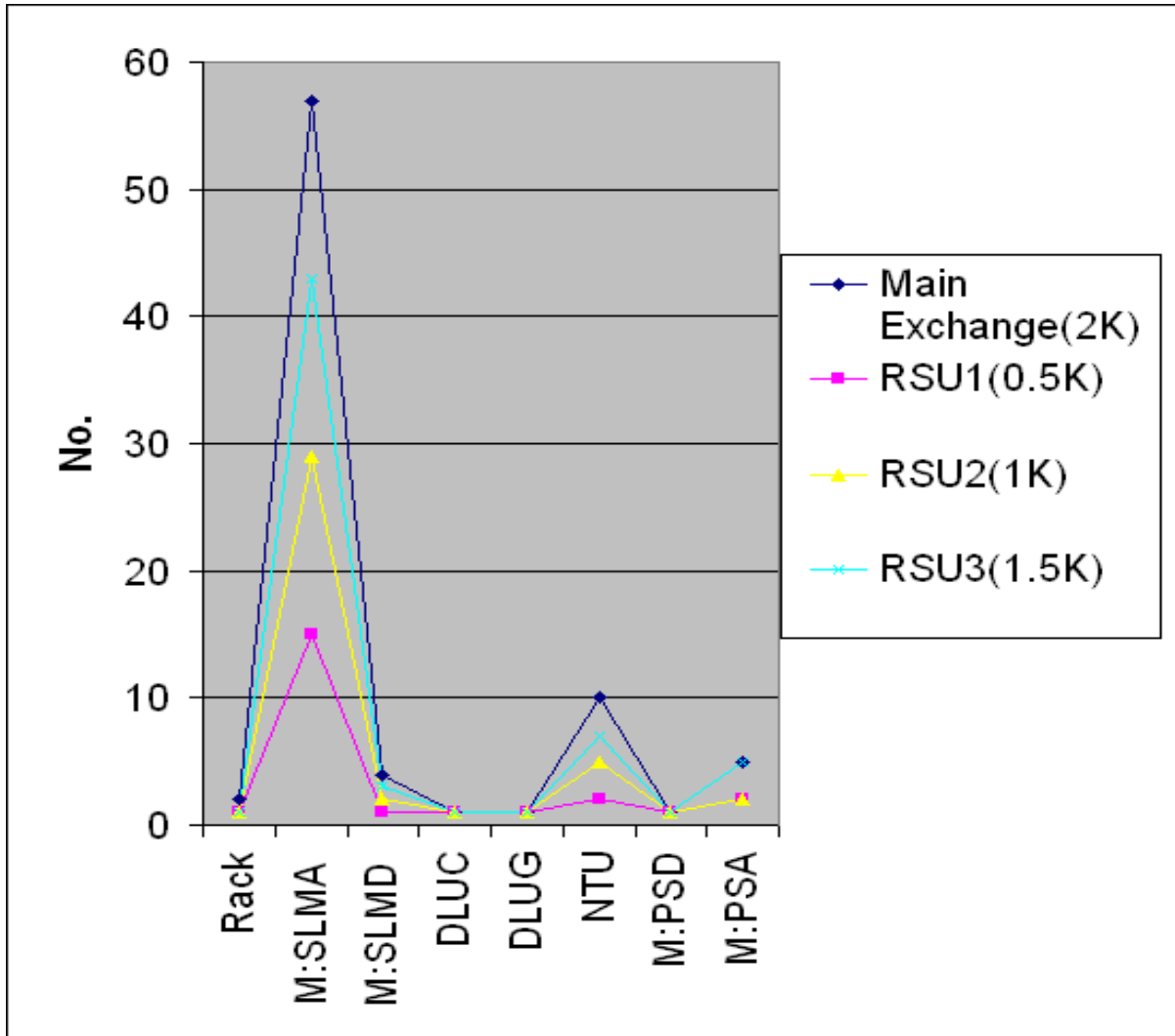


Fig no.3.1:Distribution of different parameters

RSU2

Number of DLUGs = 1

1 DLUGs with 2SLMD+29SLMA modules

Traffic = $2 \times 16 \times 0.44 + 29 \times 32 \times 0.15 = 153.28$ Erlang

PDCs required Per DLUG = 16

Total PDCs required = $1 \times 16 = 16$

Total PDCs coming out from DLUGs in RSU2 = 16]

RSU3

Number of DLUGs = 1

1 DLUGs with 3SLMD+43SLMA modules

Traffic = $3 \times 16 \times 0.44 + 43 \times 32 \times 0.15 = 227.52$ Erlang

PDCs required Per DLUG = 16

Total PDCs required = $1 \times 16 = 16$

Total PDCs coming out from DLUGs in RSU3 = 16

Total PDCs links terminating at LTGP due to all the DLUGs of an exchange = $16 + 16 + 16 + 16 = 64$

3.2.4 E1s due to ISDN-PRI Subscribers

M.E.

Number of ISDN-PRI subscribers = 4

E1s required = 4 (equal to number of ISDN-PRI subscribers as each use 2Mbps bandwidth)

RSU1

Number of ISDN-PRI subscribers = 1

E1s required = 1

RSU2

Number of ISDN-PRI subscribers = 2

E1s required = 2

RSU3

Number of ISDN-PRI subscribers = 3

E1s required = 3

Total E1s terminating at LTGP = $4 + 1 + 2 + 3 = 10$

3.2.5 Trunks

Total trunks due to outgoing traffic from the exchange = 50

Total trunks required = 50

All the possible E1s terminating at LTGP = $64 + 10 + 50 = 124$

Each LTGP can terminate 16 PDCs so total LTGP required = $124 / 16 = 8$

F: LTGP = $8(\text{total LTGPs}) / 8 = 1$

R: LTGP = $1 / 6 = 1$

3.2.6 CCNC

Number of signaling links required = 94

M: SILTD = 94 (1 per signaling link)

M: SIPA = $94 / 32 = 3$ (1 SIPA controls 32 SILTD)

M: MUXMA = 1 (for links 1-55)

M: MUXMB = 1 (for links 56-127)

F: SILTD = $3 \times 94 / 47 = 6$

F: CCNP = 2 {CCNP (0), CCNP (1)}

R: CCNC = 2 (for housing additional 47 M: SILTD)

3.2.7 CP113C

Processor modules for BAP = 2 (BAP0 & BAP1 mandatory)

Processor modules for CAP = 2 (CAP0 & CAP1 as per BHCA requirement)

Processor modules for IOC = 2 (IOC0 & IOC1 as per devices to be connected)

M: CMY = $4 \times 2 = 8$ (for 1 GB of memory)

Processor modules IOP = 9

IOP: MB = 8 (SYP = 2, CCNC = 2, CCG = 2, MB = 2)

IOP: SCDP = 1 (for X.25 interfaces)

MDD = 1

MOD = 1

F: PBC = 2 (PBC0 & PBC1 mandatory)

F: PIOP = 2 (PIOP0 & PIOP 1 mandatory)

F: DEV (F) = 1 (mandatory)

R: CP113C = 1

3.2.8 Switching Network B

Number of LTGP = 8

F: SSG (B) basic = 1 (Basic equipment for 126 LTGPs)

F: SSG (B) extension = 0 (extension for another 126 LTGPs)

F: TSG (B) basic = $8 / 63 = 1$

R: LTGN for F: TSG (B) = $1 / 2 = 1$

R: LTGN for F: SSG (B) = $1 / 2 = 1$

Total R: LTGN = $1 + 1 = 2$

3.2.9 Message Buffer B

Number of LTGP = 8

F: MB\CCG (B) basic equipment = 1 (basic equipment for 63 LTGPs)

F: MB\CCG (B) extension = 0 (extension for another 63 LTGPs)

3.2.10 MOMAT

Total number of racks = 10

Installation material = 10 (1 per rack)

3.2.11 APS and Database

M: SLMA = $57 + 15 + 29 + 43 = 144$

ISDN-BRI = $50 + 13 + 25 + 38 = 126$

$$\text{ISDN-PRI} = 4 + 1 + 2 + 3 = 10$$

$$\text{LTGP} = 8$$

$$\text{Number of ports} = 144 \times 32 + 126 \times 64 + 60 \times 10 + 8 \times 480 = 17112$$

$$\text{APS software} = 17112$$

$$\text{Database} = 17112$$

3.2.12 Power Plant

$$\text{Load of the exchange} = 50\text{A}$$

$$\text{Backup time} = 8 \text{ hr}$$

$$\text{Capacity required} = 8 \times 50 = 400 \text{ AH}$$

$$\text{Battery Banks, } 2000\text{AH} = 0$$

$$\text{Battery Banks, } 600\text{AH} = 1$$

3.2.13 Tools and Testers

For the maintenance of the exchange tools and testers are required.

$$\text{Digital Phones} = 3$$

$$\text{Vacuum cleaner} = 1$$

$$\text{Traffic generator} = 3$$

This completes the dimensioning of 5K exchange. After determining the required modules, frames, and racks the modules are installed in the frames and the frames are installed in the racks. And the connections are made.

3.3 DIMENSIONING OF 10K EXCHANGE FOR T.I.E.T PATIALA

Now in the coming years no. of students and staff will increase approximately up to 10k. Now the

Exchange will have total capacity of 10K which is divided among M.E., RSU1, and RSU2. The subscriber capacity and the traffic parameters for this exchange are same as that of 5K exchange.

The subscriber distribution is of course different and is as:

Subscriber distribution

$$\text{Total capacity} = 10\text{K}$$

$$\text{Main exchange} = 5\text{K}$$

$$\text{RSU1} = 2\text{K}$$

$$\text{RSU2} = 3\text{K}$$

3.3.1 DLUG

M.E. (5K)

$$\text{Analog subscribers} = 90\% \text{ of } 5\text{K} = 4500$$

$$\text{ISDN-BRI subscribers} = (5\% \text{ of } 5\text{K})/2 = 125$$

$$\text{ISDN-PRI subscribers} = (5\% \text{ of } 5\text{K})/30 = 9 \text{ (rounded off)}$$

$$M: SLMA = 4500 \text{ (analog subscribers)} / 32 = 141$$

$$M: SLMD = 125 \text{ (ISDN-BRI)} / 16 = 4$$

$$\text{Number of DLUGs} = (141 + 4) \text{ (total modules)} / 63 = 3$$

$$M: DLUGC = 3$$

$$R: DLUG = 3/2 = 2$$

Distribution of modules in DLUGs and racks

$$R(1).DLU(1) = 8SLMD + 55SLMA ; R(2).DLU(2) = 0SLMD + 23SLMA$$

$$R(2).DLU(1) = 0SLMD + 63SLMA$$

Power Supply Modules

$$M: DCC \text{ (ISDN)} = 1 * 1 = 1 \text{ (1 per half shelf)}$$

$$M: DCC \text{ (analog)} = 2 * 3 \text{ (sub} > 1024) + 1 * 2 \text{ (Sub} < 1024) = 8$$

Frames

$$F: DLUG(A) = 3; F: DLUG(B) = 2$$

Standalone operation

$$M: ALEX = 0; M: SASCG = 0$$

$$\text{Network Termination Units} = 10\% \text{ of ISDN-BRI Channels} = 250 * 10 / 100 = 25$$

RSU1 (3K)

$$\text{Analog subscribers} = 90\% \text{ of } 3K = 2700$$

$$\text{ISDN-BRI subscribers} = (5\% \text{ of } 3K) / 2 = 75$$

$$\text{ISDN-PRI subscribers} = (5\% \text{ of } 3K) / 30 = 5$$

$$M: SLMA = 2700 / 32 = 85$$

$$M: SLMD = 75 / 16 = 5$$

$$\text{Number of DLUGs} = 85 + 5 / 63 = 2$$

$$M: DLUC = 1$$

$$R: DLUG = 1/2 = 1$$

Distribution of modules in DLUGs and racks

$$R(1).DLU(1) = 5SLMD + 58SLMA; R(1).DLU(2) = 0SLMD + 27SLMA$$

Frames

$$F: DLUG(A) = 1; F: DLUG(B) = 0$$

Power supply modules

$$M: DCC \text{ (ISDN)} = 1 * 1 = 1; M: DCC \text{ (Analog)} = 2 * 1 + 3 * 1 = 5$$

Stand alone operation

$$M: ALEX = 1 \text{ (per RSU)}; M: SASCG = 2 \text{ (per DLU)}$$

$$\text{Network Termination units} = 150 * 10 / 100 = 15$$

RSU2 (2K)

$$\text{Analog subscribers} = 90\% \text{ of } 2K = 1800$$

ISDN-BRI subscribers = $(5\% \text{ of } 2K)/2 = 50$

ISDN-PRI subscribers = $(5\% \text{ of } 2K)/30 = 4$

M: SLMA = $1800/32 = 57$

M: SLMD = $50/16 = 4$

Number of DLUG = $57 + 4/63 = 1$

M: DLUC = 1

R: DLUG = $1/2 = 1$

Distribution of modules in DLUG and racks

R (1).DLU (1) = $4SLMD + 57SLMA$

Frames

F: DLUG (A) = 1; F: DLUG (B) = 0

Power supply modules

M: DCC (ISDN) = $1*1 = 1$; M: DCC (Analog) = $3*1 = 3$

Stand alone operation

M: ALEX = 1 (per RSU); M: SASCG = 1 (per DLU)

Network Termination units = $100*10/100 = 10$

Distribution Between The Subscribers Of Main Exchange,RSU1 & RSU2:

Main Exchange=5K

RSU1=3K

RSU2=2K

	Main Exchange	RSU1	RSU2
Analog Subscriber	4500	2700	1800
ISDN-BRI	125	75	50
ISDN-PRI	9	5	4

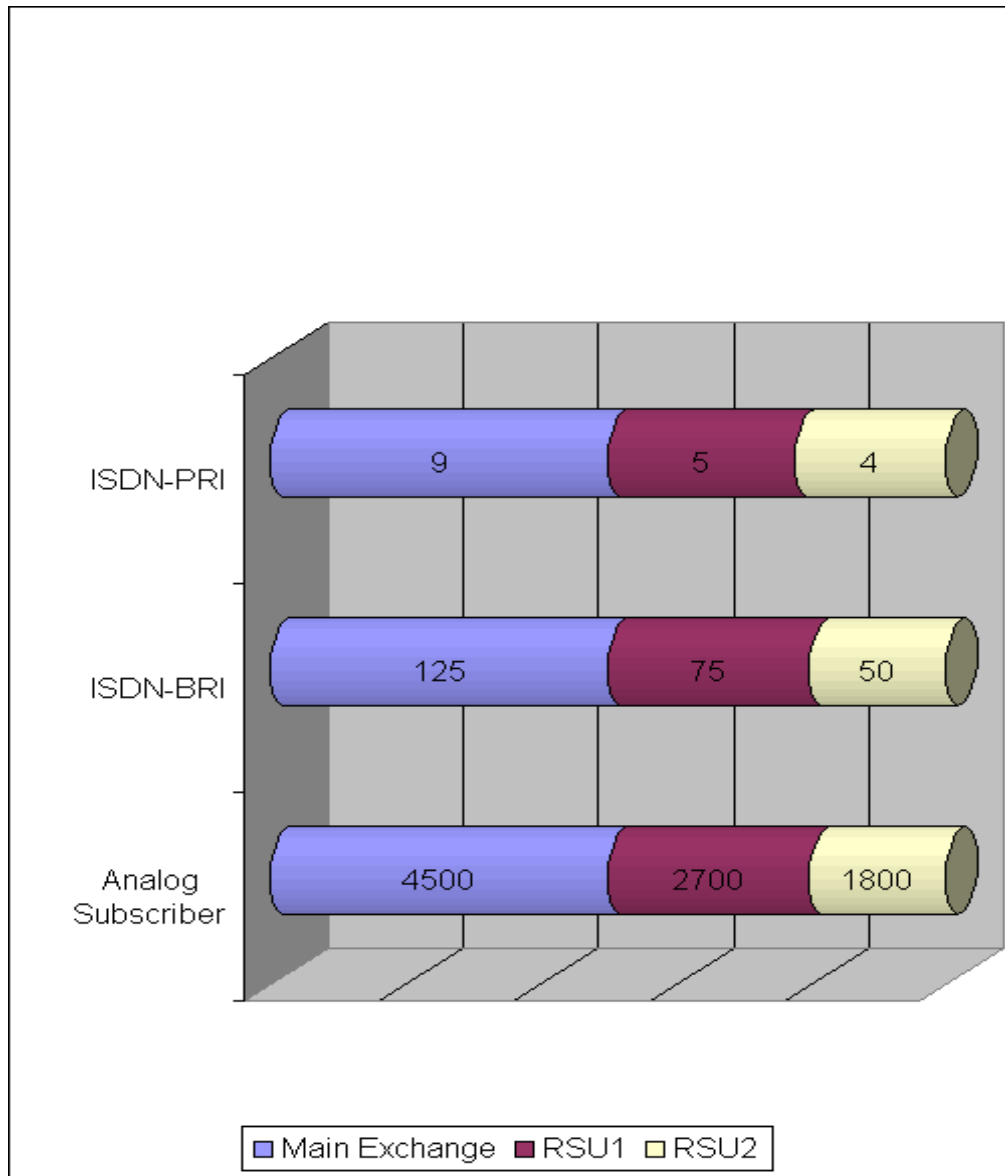


Fig.No.3.2: Distribution of diff. parameter

3.3.2 LTGP

Traffic Calculations and PDCs due to all the DLUGs

M.E.

Number of DLUGs = 3

1DLUG with 8SLMD + 55 SLMA modules

Traffic = $8*16*0.44 + 55*32*0.15 = 320.32$ Erlang

PDCs required per such DLUG = 16

Total PDCs due to these 1 DLUG = $1*16 = 16$

1DLUG with 63SLMA modules

Traffic = $63*32*0.15 = 302.4$ Erlang

PDCs required per DLUG = 16

Total PDCs required by 1DLUG = $1*16 = 16$

1DLUG with 23SLMA modules

Traffic = $23*32*0.15 = 110.4$ Erlang

PDCs required = 8

Total PDCs coming out of DLUGs in M.E. = $16 + 16 + 8 = 40$

RSU1

Number of DLUGs = 2

1 DLUGs with 5SLMD+58SLMA modules

Traffic = $5*16*0.44 + 58*32*0.15 = 313.6$ Erlang

PDCs required Per DLUG = 16

1 DLUGs with 27SLMA

Traffic = $27*32*0.15 = 129.6$ Erlang

PDCs required = 8

Total PDCs coming out from DLUGs in RSU1 = $16 + 8 = 24$

RSU2

Number of DLUGs = 1

1 DLUGs with 4SLMD+57SLMA modules

Traffic = $4*16*0.44 + 57*32*0.15 = 301.76$ Erlang

PDCs required Per DLUG = 16

Total PDCs required = $1*16 = 16$

Total PDCs coming out from DLUGs in RSU2 = 16

Total PDCs links terminating at LTGP due to all the DLUGs of exchange = $40 + 24 + 16 = 80$

3.3.3 E1s due to ISDN-PRI Subscribers

M.E.

Number of ISDN-PRI subscribers = 9

E1s required = 9 (equal to number of ISDN-PRI subscribers as each use 2Mbps bandwidth)

RSU1

Number of ISDN-PRI subscribers = 5

EIs required = 5

RSU2

Number of ISDN-PRI subscribers = 4

EIs required = 4

Total EIs terminating at LTGP = $9 + 5 + 4 = 18$

Trunks

Total trunks due to outgoing traffic from the exchange = 100

Total trunks required = 100

All the possible EIs terminating at LTGP = $18 + 100 + 80 = 198$

Each LTGP can terminate 16 PDCs so total LTGP required = $198/16 = 13$

F: LTGP = $13(\text{total LTGPs})/8 = 2$

R: LTGP = $2/6 = 1$

3.3.4 CCNC

Number of signaling links required = 94

M: SILTD = 94 (1 per signaling link)

M: SIPA = $94/32 = 3$ (1 SIPA controls 32 SILTD)

M: MUXMA = 1 (for links 1-55)

M: MUXMB = 1 (for links 56-127)

F: SILTD = $3 \times 94/47 = 6$

F: CCNP = 2 {CCNP (0), CCNP (1)}

R: CCNC = 2 (for housing additional 47 M: SILTD)

3.3.5 CP113C

Processor modules for BAP = 2 (BAP0 & BAP1 mandatory)

Processor modules for CAP = 2 (CAP0 & CAP1 as per BHCA requirement)

Processor modules for IOC = 2 (IOC0 & IOC1 as per devices to be connected)

M: CMY = $4 \times 2 = 8$ (for 1 GB of memory)

Processor modules IOP = 9

IOP: MB = 8 (SYP = 2, CCNC = 2, CCG = 2, MB = 2)

IOP: SCDP = 1 (for X.25 interfaces)

MDD = 1

MOD = 1

F: PBC = 2 (PBC0 & PBC1 mandatory)

F: PIOP = 2 (PIOP0 & PIOP 1 mandatory)

F: DEV (F) = 1 (mandatory)

R: CP113C = 1

3.3.6 Switching Network B

Number of LTGP = 13

F: SSG (B) basic = 1 (Basic equipment for 126 LTGPs)

F: SSG (B) extension = 0 (extension for another 126 LTGPs)

F: TSG (B) basic = $13/63 = 1$

R: LTGN for F: TSG (B) = $1/2 = 1$

R: LTGN for F: SSG (B) = $1/2 = 1$

Total R: LTGN = $1 + 1 = 2$

3.3.7 Message Buffer B

Number of LTGP = 13

F: MB\CCG (B) basic equipment = 1 (basic equipment for 63 LTGPs)

F: MB\CCG (B) extension = 0 (extension for another 63 LTGPs)

3.3.8 Message Buffer B

Number of LTGP = 13

F: MB\CCG (B) basic equipment = 1 (basic equipment for 63 LTGPs)

F: MB\CCG (B) extension = 0 (extension for another 63 LTGPs)

3.3.9 MOMAT

Total number of racks = 10

Installation material = 10 (1 per rack)

3.3.10 APS and Database

M: SLMA = $141 + 85 + 57 = 283$

ISDN-BRI = $125 + 75 + 50 = 250$

ISDN-PRI = $9 + 5 + 4 = 18$

LTGP = 13

Number of ports = $283*32 + 250*64 + 60*18 + 13*480 = 32376$

APS software = 32376

Database = 32376

3.3.11 Power Plant

Load of the exchange = 100A

Backup time = 12hr

Capacity required = $12*100 = 1200$ AH

Battery Banks, 2000AH = 0

Battery Banks, 600AH = 2

3.3.12 Tools and Testers

For the maintenance of the exchange tools and testers are required.

Digital Phones = 3

Vacuum cleaner = 1

Traffic generator = 3

This completes the dimensioning of 10K exchange. After determining the required modules, frames, and racks the modules are installed in the frames and the frames are installed in the racks. And the connections are made.

Now if no. of RSU is increased in the dimensioning of 10k exchange then parameter will be different.

Total no. of capacity = 10k

Main Exchange Capacity = 5k

RSU1 = 0.5K

RSU2 = 1K

RSU3 = 1.5K

RSU4 = 2K

3.4 DLUG

M.E. (5K)

Analog subscriber = 4500

ISDN-BRI subscriber = 125

ISDN_PRI subscriber = 9

M : SLMA = 141

M: SLMD = 8

DLUG = 3

DLUC = 2

RDLUG = 2

Distribution of Modules in DLUGs and RACKS

R (1).DLU (1) = 8SLMD + 55SLMA; R (1).DLU (2) = 0SLMD + 23SLMA

R (2).DLU (1) = 0SLMD + 63SLMA

Power supply modules Digital 1

Power supply modules Analog 8

Network Termination Units 25

RSU1 (0.5K)

Analog subscriber = 450

ISDN-BRI subscriber = 13

ISDN_PRI subscriber = 1

M: SLMA = 15

M: SLMD = 1

DLUG = 1

DLUC = 1

RDLUG = 1

Distribution of Modules in DLUGs and RACKS

R (1).DLU (1) = 1SLMD + 15SLMA

Power supply modules Digital = 1

Power supply modules Analog = 2

Standalone operation:

Number of ALEX Modules = 1

Number of DLUs in RSU = 1

Network Termination Units = 2

RSU2 (1K)

Analog subscriber = 900

ISDN-BRI subscriber = 25

ISDN_PRI subscriber = 2

M: SLMA = 29

M: SLMD = 2

DLUG = 1

DLUC = 1

RDLUG = 1

distribution of Modules in DLUGs and RACKS

R(1).DLU(1) = 2SLMD + 29SLMA

Power supply modules Digital 1

Power supply modules Analog 2

Standalone operation:

Number of ALEX Modules = 1

Number of DLUs in RSU = 1

Network Termination Units = 5

RSU3 (1.5K)

Analog subscriber = 1350

ISDN-BRI subscriber = 38

ISDN_PRI subscriber = 3

M: SLMA = 43

M: SLMD = 3

DLUG = 1

DLUC = 1

RDLUG = 1

Distribution of Modules in DLUGs and RACKS

R(1).DLU(1) = 3SLMD + 43SLMA

Power supply modules Digital = 1

Power supply modules Analog = 5

Standalone operation:

Number of ALEX Modules = 1

Number of DLUs in RSU = 1

Network Termination Units = 7

RSU4 (K)

Analog subscriber = 1800

ISDN-BRI subscriber = 50

ISDN_PRI subscriber = 4

M:SLMA = 57

M: SLMD = 4

DLUG = 1

DLUC = 1

RDLUG = 1

Distribution of Modules in DLUGs and RACKS

R (1).DLU (1) = 4SLMD + 57SLMA

Power supply modules Digital = 1

Power supply modules Analog = 5

Standalone operation:

Number of ALEX Modules = 1

Number of DLUs in RSU = 1

Distribution Between Various Modules of Main Exchange and RSUs:

TOTAL CAPACITY= 10 K

	Main Exchange(5K)	RSU1(0.5K)	RSU2(1K)	RSU1(1.5K)	RSU2(2K)
Rack	2	1	1	1	1
M:SLMA	85	15	29	43	57
M:SLMD	5	1	2	3	4
DLUC	2	1	1	1	1
DLUG	1	1	1	1	1
NTU	15	2	5	7	10
M:PSD	1	1	1	1	1
M:PSA	5	2	2	5	5

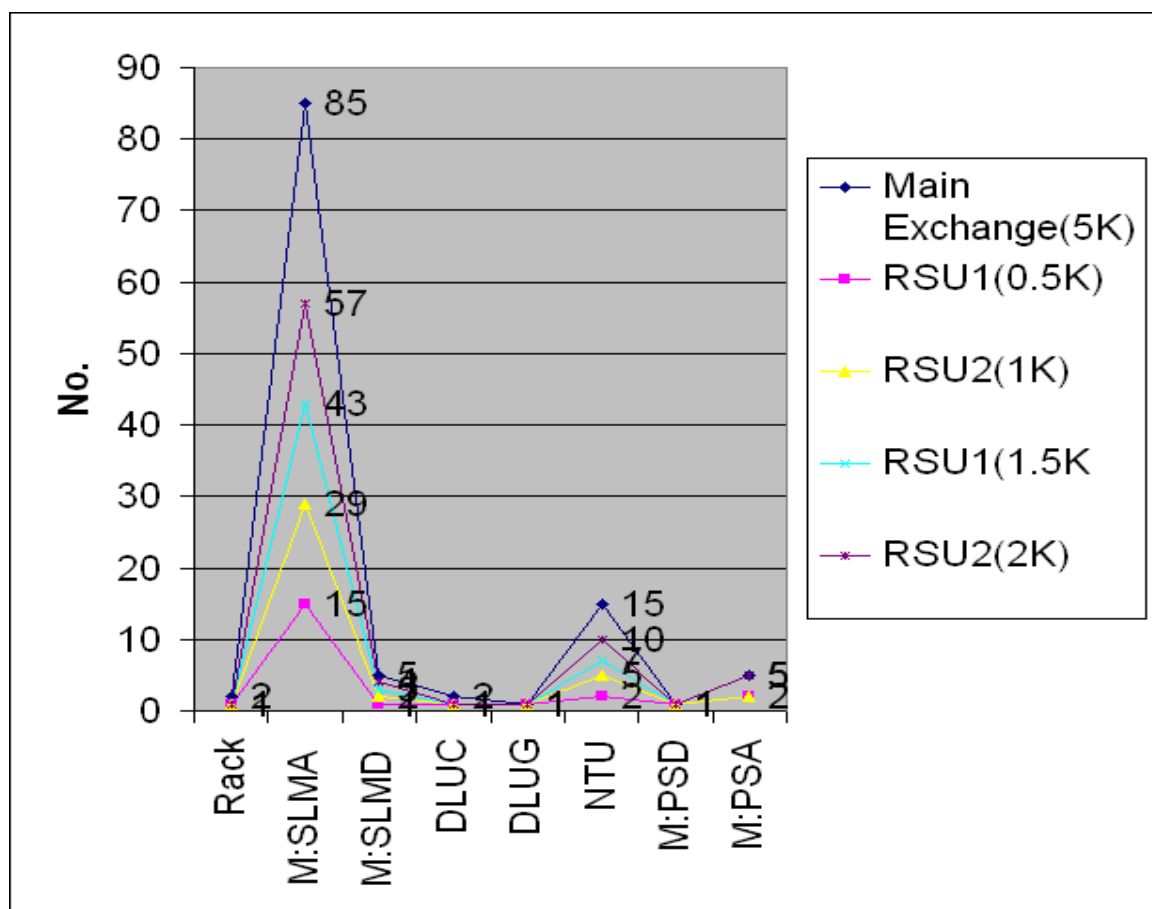


Fig 3.3: distribution of different parameter

3.5 TELECOM NETWORK DESIGNING USING EWSD SWITCH FOR PATIALA

The Exchanges required to build this network will be based on EWSD. The network consist of three exchanges with subscriber capacity of 350K, 250K and 400K.

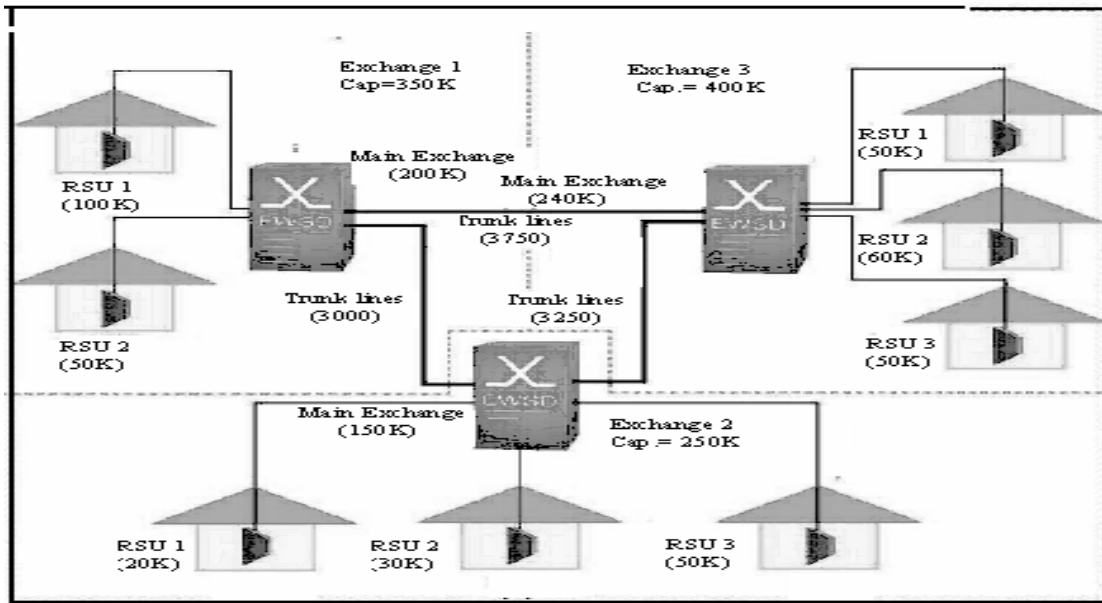


Fig. 3.4: Network Diagram showing three exchange region (1,2,and3) and the interconnection of their main exchange with each other and main exchange to their respective RSUs.

3.5.1 Dimensioning of 350k Switch

Requirements

Subscriber Distribution

Total capacity = 350K

Main exchange (M.E.) = 200K

RSU1 = 100K

RSU2 = 50K

Subscriber Capacity (same for M.E., RSUs)

Analog subscribers = 90% of main exchange

ISDN-BRI subscribers = 5% (in terms of B-Channels required by ISDN-BRI subscribers)

ISDN-PRI = 5% (in terms of B-Channels required by ISDN-PRI subscribers)

Traffic

Analog subscriber = 0.15 Erlang/sub

ISDN (BRI & PRI) = 0.44 Erlang/sub

Mean holding time = 90 sec

Only the Subscriber distribution changes with exchange and the subscriber capacity & traffic usually remain same for a particular operator. In this network also only subscriber distribution changes and other two parameters remain same. The dimensioning is started with DLUG and is done for M.E. and every RSU individually. One thing to note is that number of modules, frames, and racks can not be in fractions so in various calculations direct results in next integer are given.

3.5.2 DLUG

M.E. (200K)

Analog subscribers = 90% of 200K = 180K

ISDN-BRI subscribers = (5% of 200K)/2 = 5K

ISDN-PRI subscribers = (5% of 200K)/30 = 334 (rounded off)

M: SLMA = 180K (analog subscribers)/32 = 5625

M: SLMD = 5K (ISDN-BRI)/16 = 313

Number of DLUGs = (5625 + 313) (total modules)/63 = 954`

M: DLUGC = 94

R: DLUG = 94/2 = 47

F: DLUG (A) = 95; F: DLUG (B) = 94

Power supply modules Digital = 39

Power supply modules Analog = 336

Network Termination Units = 10000*10/100 = 1000

Standalone operation

M: ALEX = 0; M: SASCG = 0

RSU1 (100K)

Analog subscribers = 90% of 100K = 90K

ISDN-BRI subscribers = (5% of 100K)/2 = 2500

ISDN-PRI subscribers = (5% of 100K)/30 = 167

M: SLMA = 90K/32 = 2813

M: SLMD = 2500/16 = 157

Number of DLUGs = 2813 + 157/63 = 48

M: DLUC = 48

R: DLUG = 48/2 = 24

Frames

F: DLUG (A) = 48; F: DLUG (B) = 47

Power supply modules

M: DCC (ISDN) = 19 ; M: DCC (Analog) = 161

Stand alone operation

M: ALEX = 1 (per RSU); M: SASCG = 1 (per DLU)

Network Termination units = 5000*10/100 = 500

RSU2 (50K)

Analog subscribers = 90% of 50K = 45K

ISDN-BRI subscribers = (5% of 50K)/2 = 1250

ISDN-PRI subscribers = (5% of 50K)/30 = 84

M: SLMA = 45000/32 = 1407

M: SLMD = 1250/16 = 79

Number of DLUG = 1407 + 79/63 = 24

M: DLUC = 24

R: DLUG = 24/2 = 12

Frames

F: DLUG (A) = 24; F: DLUG (B) = 23

Power supply modules

M: DCC (ISDN) = 10 = 1; M: DCC (Analog) = 78

Stand alone operation

M: ALEX = 1 (per RSU); M: SASCG = 1 (per DLU)

Network Termination units = 2500*10/100 = 250

3.5.3 LTGP

Traffic Calculations and PDCs due to all the DLUGs

M.E.

Number. Of DLUGs = 94

40 DLUGs with 8SLMD + 55SLMA MODULES

Traffic = $8*16*.44 + 55*32*0.15 = 320.32$ Erlang

PDCs required per such DLUGs = 16

Total PDCs due to these 39DLUGs = $40*16 = 640$

54 DLUGs with 63SLMA modules

Traffic = $63*32*0.15 = 134.4$ Erlang

PDCs required per DLUG = $54*16 = 864$

Total PDCs coming out of DLUGs in M.E. = $640 + 864 = 1504$

RSU1 (100K)

Number of DLUGs = 48

20 DLUGs with 8SLMD + 55SLMA modules

Traffic = $8*16*0.44 + 55*32*0.15 = 320.32$ Erlang

PDCs required Per DLUG = 16

Total PDCs due to these 20DLUGs = $20*16 = 320$

28 DLUGs with 63SLMA

Traffic = $63*32*0.15 = 134.8$ Erlang

PDCs required per DLUG = 16

Total PDCs required per DLUG = $16*28 = 448$

Total PDCs coming out from DLUGs in RSU1 = $320+448=768$

RSU2 (50K)

Number of DLUGs = 24

10 DLUGs with 8SLMD+55SLMA modules

Traffic = $8*16*0.44 + 55*32*0.15 = 320.32$ Erlang

PDCs required Per DLUG = 16

Total PDCs due to these 20DLUGs = $10*16=160$

14 DLUGs with 63SLMA

Traffic = $63*32*0.15 = 134.8$ Erlang

PDCs required per DLUG = 16

Total PDCs required per DLUG = $16*14=224$

Total PDCs coming out from DLUGs in RSU1 = $160+224=384$

Total PDCs links terminating at LTGP due to all the DLUGs of an exchange = $384 + 768 + 1504 = 2656$

3.5.4 E1s due to ISDN-PRI Subscribers

M.E.

Number of ISDN-PRI subscribers = 334

E1s required = 334 (equal to number of ISDN-PRI subscribers as each use 2Mbps bandwidth)

RSU1

Number of ISDN-PRI subscribers = 167

E1s required = 167

RSU2

Number of ISDN-PRI subscribers = 84

E1s required = 84

Total E1s terminating at LTGP = $334 + 167 + 84 = 585$

Trunks

Total trunks due to outgoing traffic from exchange = 3500

Total trunks due to in coming traffic = $1750 + 1250 = 3000$

Total trunks required = $3500 + 3000 = 6500$

All the possible E1 s terminating at LTGP = $6500 + 585 + 2656 = 9741$

Each LTGP can terminate 16 PDCs so total LTGP required = $9741/16 = 609$

F: LTGP = $609/8 = 76$

R: LTGP = $76/6 = 13$

3.5.5 CCNC

Number of signaling links required = 94

M: SILTD = 94 (1 per signaling link)

M: SIPA = $94/32 = 3$ (1 SIPA controls 32 SILTD)

M: MUXMA = 1 (for links 1-55)

M: MUXMB = 1 (for links 56-127)

F: SILTD = $3 \times 94/47 = 6$

F: CCNP = 2 {CCNP (0), CCNP (1)}

R: CCNC = 2 (for housing additional 47 M: SILTD)

3.5.6 CP113C

Processor modules for BAP = 2 (BAP0 & BAP1 mandatory)

Processor modules for CAP = 2 (CAP0 & CAP1 as per BHCA requirement)

Processor modules for IOC = 2 (IOC0 & IOC1 as per devices to be connected)

M: CMY = $4 \times 2 = 8$ (for 1 GB of memory)

Processor modules IOP = 9

IOP: MB = 8 (SYP = 2, CCNC = 2, CCG = 2, MB = 2)

IOP: SCDP = 1 (for X.25 interfaces)

MDD = 1

MOD = 1

F: PBC = 2 (PBC0 & PBC1 mandatory)

F: PIOP = 2 (PIOP0 & PIOP 1 mandatory)

F: DEV (F) = 1 (mandatory)

R: CP113C = 1

3.5.7 Switching Network B

Number of LTGP = 609

F: SSG (B) basic = 1 (Basic equipment for 126 LTGPs)

F: SSG (B) extension = 2 (extension for another 126 LTGPs)

F: TSG (B) basic = $609/63 = 10$

R: LTGN for F: TSG (B) = $10/2 = 5$

R: LTGN for F: SSG (B) = $5/2 = 3$

Total R: LTGN = $3 + 5 = 8$

3.5.8 Message Buffer B

Number of LTGP = 609

F: MB\CCG (B) basic equipment = 1 (basic equipment for 63 LTGPs)

F: MB\CCG (B) extension = 9 (extension for another 63 LTGPs)

3.5.9 MOMAT

Total number of racks = 107

Installation material = 107 (1 per rack)

3.5.10 APS and Database

M: SLMA = $180000 + 2813 + 1407 = 184220$

ISDN-BRI = $5000 + 1250 + 2500 = 8750$

ISDN-PRI = $167 + 84 + 334 = 585$

LTGP = 609

Number of ports = $184220 \times 32 + 8750 \times 64 + 60 \times 585 + 609 \times 480 = 6782460$

APS software = 6782460

Database = 6782460

3.5.11 Power Plant

Load of the exchange = 3500A

Backup time = 10hr

Capacity required = $10 \times 3500 = 35000\text{AH}$

Battery Banks, 2000AH = 1

Battery Banks, 600AH = 3

3.6 TABULATED RESULTS

(250K EXCHANGE)

DLUG	M: SLMD = 32	M: SASCG = 1
M.E.(150K)	M: DLUC = 10	F: DLUG (A) = 14
Analog subscriber=135k	M: DCC (ISDN) = 4	F: DLUG (B) = 13
ISDN-BRI subscriber=3750	M: DCC (Analog) = 29	R: DLUG = 7
M: SLMA = 4219	M: ALEX = 1	NT Units = 150
M: SLMD = 235	M: SASCG = 1	RSU 3(50K)
M: DLUC = 71	F: DLUG (A) = 10	M: SLMA = 1407
M: DCC (ISDN) = 29	F: DLUG (B) = 9	M: SLMD = 79
M: DCC (Analog) = 126	R: DLUG = 5	M: DLUC = 24
M: ALEX = 0	NT Units = 100	M: DCC (ISDN) = 10
M: SASCG = 0	RSU 2(30K)	M: DCC (Analog) = 78
F: DLUG (A) = 71	M: SLMA = 844	M: ALEX = 1
F: DLUG (B) = 70	M: SLMD = 47	M: SASCG = 1
R: DLUG = 36	M: DLUC = 14	F: DLUG (A) = 78
NT Units = 750	M: DCC (ISDN) = 9	F: DLUG (B) = 77
RSU 1(20K)	M: DCC (Analog) = 46	R: DLUG = 12
M: SLMA = 563	M: ALEX = 1	

NT Units = 25 LTGP PDCs due to all DLUGs 1216 +168 +162 + 400 = 1946 E1s due to ISDN-PRI 84 +250 +34 +50 =418 E1s due to trunks Total trunks required =150 +200 +2500 =2850 E1s terminating at LTGP =2850 +418 +1946 =5214 LTGP required =326 F: LTGP =652 R: LTGP = 109 CCNC Signaling links= 94 M: SILTD = 94 M: SIPA = 3 M: MUXMA = 1 M: MUXMB = 1 F: SILTD = 6 F: CCNP (0&1) = 2 R: CCNC = 2 CCG = 2 IOP: SCDP = 1 MDD = 1 MOD = 1 F: PIOP (0, 1) = 2 F: PBC (0, 1) = 2 F: DEV (F) = 1 R: CP113C = 1	SN (B) F: SSG (B) basic = 1 F: SSG (B) ext. = 2 F: TSG (B) basic = 6 R: LTGN = Message Buffer B F: MB\CCG (B) basic= 1 F: MB\CCG (B) ext. = 5 MOMAT Installation material = 177 APS & Database M: SLMA =4219 +563+844+1407 = 7033 ISDN-BRI =3750+500+750+1250 =6250 ISDN PRI =84+250+34+50 =418 LTGP = 326 Number of ports= 806616 APS software = 806616 Database = 80616 Power Plant Load of exchange = 2500A Backup time =10hr Capacity =25000AH Battery Banks, 2000AH=12 600=2	<u>TABULATED RESULTS</u> <u>(400K EXCHANGE)</u> DLUG M.E.(240K) Analog subscriber=216K ISDN-BRI subscriber=6000 ISDN-PRI subscriber =410 M: SLMA = 6750 M: SLMD = 375 M: DLUC = 114 M: DCC (ISDN) = 46 M: DCC (Analog) = 37 M: ALEX = 0 M: SASCG = 0 F: DLUG (A) = 114 F: DLUG (B) = 113 R: DLUG = 57 NT Units = 1200 RSU 1(50K) Analog subscribers = 45K ISDN-BRIsubscribers =1250 ISDN-PRI subscribers = 84 M: SLMA = 1407 M: SLMD = 79 Number of DLUG = 24 M: DLUC = 24 R: DLUG = 12 Frames F: DLUG (A) = 24; F: DLUG (B) = 23 Power supply modules M: DCC (ISDN) = 10
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M: DCC (Analog) = 78 Stand alone operation M: ALEX = 1 (per RSU) M: SASCG = 1 (per DLU) NT = 250 RSU2 (60K) Analog subscribers = 54K ISDN-BRI subscribers =1500 ISDN-PRI subscribers = 100 M: SLMA = 1688 M: SLMD =94 Number of DLUG = 29 M: DLUC = 29 R: DLUG = 15 Frames F: DLUG (A) = 29; F: DLUG (B) = 28 Power supply modules M: DCC (ISDN) = 19 = 1; M: DCC (Analog) = 92 Stand alone operation M: ALEX = 1 (per RSU); M: SASCG = 1 (per DLU) Network Termination units =300 RSU3(50K) Analog subscribers = 45K ISDN-BRI subscribers =1250 ISDN-PRI subscribers = 84 M: SLMA = 1407 M: SLMD = 79	Number of DLUG = 24 M: DLUC = 24 R: DLUG = 12 Frames F: DLUG (A) = 24; F: DLUG (B) = 23 Power supply modules M: DCC (ISDN) = 10 M: DCC (Analog) = 78 Stand alone operation M: ALEX = 1 (per RSU) M: SASCG = 1 (per DLU) NT = 250 LTGP PDCs due to all DLUGs 1952+592 +416+ 592 = 3552 E1s due to ISDN-PRI 410 +84 +100+84 =678 E1s due to trunks Total trunks required =4000 +1750 +1250 =7000 E1s terminating at LTGP = 7000 +3552 +678 =11230 LTGP required =702 F: LTGP =88 R: LTGP = 14 CCNC Signaling links= 94 M: SILTD = 94 M: SIPA = 3	M: MUXMA = 1 M: MUXMB = 1 F: SILTD = 6 F: CCNP (0&1) = 2 R: CCNC = 2 CP113C Modules for BAP (0, 1) = 2 Modules for CAP (0, 1) = 2 Modules for IOC (0, 1) = 2 M: CMY = 8 (1 GB) M: IOP = 9 MB = 8 SYP=2 CCNC = 2 MB = 2 CCG = 2 IOP: SCDP = 1 MDD = 1 MOD = 1 F: PIOP (0, 1) = 2 F: PBC (0, 1) = 2 F: DEV (F) = 1 R: CP113C = 1 SN (B) F: SSG (B) basic = 1 F: SSG (B) ext. = 5 F: TSG (B) basic = 12 R: LTGN = 6 Message Buffer B F: MB\CCG (B) basic= 1 F: MB\CCG (B) ext. = 11
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MOMAT Installation material = 118 APS & Database M: SLMA =6750 +1407 +1688 +1407 = 11252 ISDN-BRI	=6000+1250+1500+1250 =10000 ISDN PRI =410+84 +100 +84 =678 LTGP = 702 Number of ports= 1377704 APS software = 1377704	Database = 1377704 Power Plant Load of exchange =40000A Backup time =10hr Capacity =400000AH Battery Banks, 2000AH=200
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DIFFERENT INTERFACES FOR GSM NETWORK

4.1 INTRODUCTION

The global system for mobile communications (GSM) was introduced in 1982. At that time the GSM stood for Groupe Spéciale Mobile, a committee under ETSI (European standardization organization). The task of the GSM was to define a new standard for mobile communications in 900 MHz range. It was decided to use digital technology for the implementation of this mobile communication system. In 1991 acronym for GSM was changed to present name. Also in 1991 the first GSM system was introduced. Ref.no.11

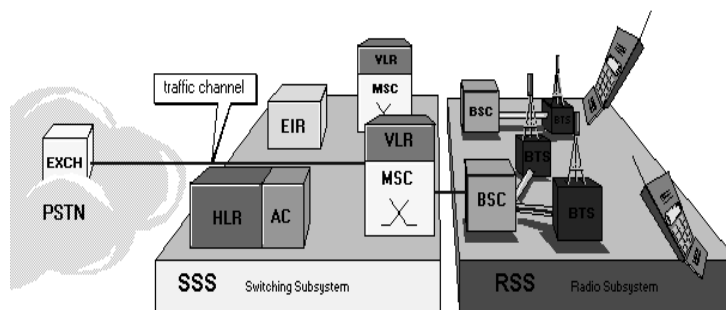


Fig 4.1: Global System for Mobile Communication

The basis idea of a cellular architecture is to partition the available frequency range, to assign only parts of the frequency range to a Base Transceiver Station (BTS), and to reduce the range of a Base Station (BS) in order to reuse the scarce frequencies as often as possible. One of the major goals of network planning is to reduce interference between different BS. Besides the advantages of having a cellular structure to reuse frequencies, it also comes with the following disadvantages:

- 1) An increasing number of BS increases the cost of infrastructure and access lines.
- 2) All cellular networks require that as the mobile station moves from one cell to the other, call is transferred, a process known as Handover.
- 3) The network has to keep constantly updated of the location of the subscriber, even when a call is not in progress, in order to forward incoming call to the mobile station (MS).
- 4) The above two items require extensive communication between the MS, the BS and various other network elements. This type of communication is called signaling, and goes far beyond that in fixed networks.

4.2 INTERFACES IN THE GSM NETWORK

The network elements in the GSM network are connected with each other through various interfaces. These interfaces are defined in the standards designed by the ETSI. Thus the BTS and BSC designed by different manufacturers can not be connected with each other. The network diagram showing interfaces and the network elements present in the GSM network is shown in the diagram below. Ref.no.13

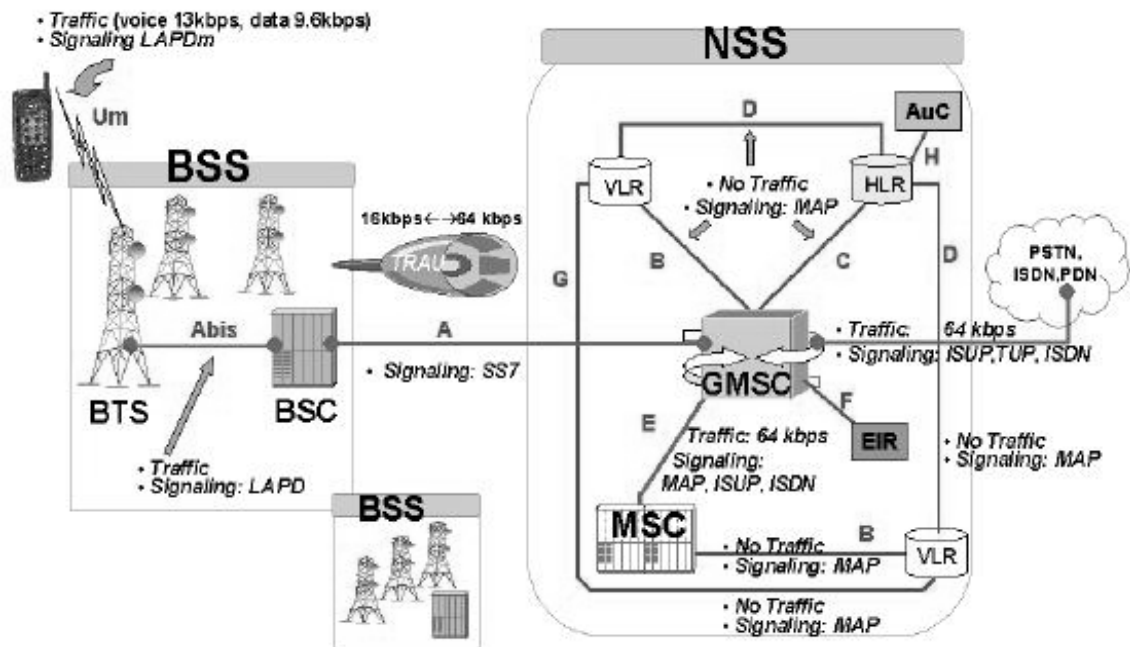


Fig 4.2: GSM network diagram showing interfaces and various subsystems

4.2.1 AIR INTERFACE, U_M

The air interface in the GSM network is also called U_m .

GSM900

Uplink: 890-915MHz

Downlink: 935-960MHz

The radio spectrum is a limited resource shared by all the users. The method chosen by GSM is a combination of time- and frequency-division multiple access (TDMA/FDMA).

4.2.2 Traffic Channels:

traffic channel is used to carry speech and data traffic. Traffic channels are defined using the 26 frame multiframe or a group of 26 TDMA frames. The length of the multiframe is 120ms. Out of the 26 frames, 24 are used for traffic, 1 is used for the slow associated. Multiframe is 120ms. Out of the 26 frames, 24 are used for traffic, 1 is used for the slow associated control channel (SACCH) and 1 is currently unused. In addition to these full-rate TCHs (TCH/F, 22.8 Kbps), half-rate TCHs (TCH/H, 11.4 Kbps) are also defined. Half-rate TCHs double the

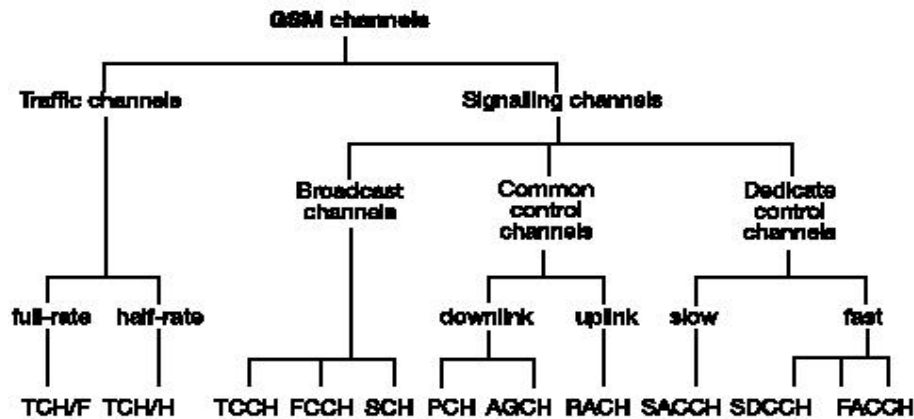


Fig 4.3: Traffic Channel

Capacity of a system effectively by making it possible to transmit two calls in a single channel.

4.2.3 Signaling Channels: The signaling channels on the air interface are used for call establishment, paging, call maintenance, synchronization etc. There are three groups of the signaling channel.

Broadcast Channels: Carry only downlink information and are responsible mainly for synchronization and frequency correction. This is the only channel type enabling point-to-multipoint communications in which short messages are simultaneously transmitted to several mobiles. The broadcast channel is divided into three categories namely BCCH, FCH, and SCH.

Common Control Channels: A group of uplink and downlink channels between the MS card and the BTS. These channels are used to convey information from the network to MSs and provide access to the network. These channels are also divided into PCH, AGCH, and RACH.

Dedicated Control Channel: These channels are responsible for handovers, roaming and encryption etc. These channels include channels like SDCCH, SACCH, and FACCH.

4.2.4 A_{bis} INTERFACE

The A_{bis} interface lies within the BSS and defines the dividing line between the BSC and BTS. The A_{bis} interface is not properly defined in every detail in the GSM standard and thus is proprietary which means that it totally depends upon the manufacturer. This is the reason why the BSC of a particular manufacturer can not be connected to the BTS of some other manufacturer because of the lack of compatibility. The A_{bis} interface is a PCM30 interface with a transmission rate of 2Mbps which is partitioned into 32 channels of 64Kbps each. The data transmitted on the A_{bis} interface is in compressed form after passing through the TRAU. The data carried by the A_{bis} interface (single PCM30) is equivalent to the data which will be carried

by the 4 PCM30 links. This means that single time slot on the A_{bis} interface can carry the data of four time slots in the normal operation. The A_{bis} interface carries mainly two types channels:

Traffic Channels (TCH): The traffic channels are used to transfer the user data. The traffic channels can be configured in 8, 16 and 64Kbps formats. The TRAU frame is a transport unit for a 16Kbps TCH on A_{bis}. It uses 13.6Kbps for the user data and for 2.4Kbps for inband signaling, timing and synchronization.

Signaling Channel: These channels are used for the signaling purposes between the BTS and the BSC. These channels are configured in the 16, 32, 56, 64 Kbps formats. Each transceiver requires a signaling channel on the A_{bis} interface.

4.2.5 A INTERFACE

The A interface is the interface used to connect the MSC with the BSC. This interface is also a PCM30 links on the physical level with a transmission capacity of 2Mbps. The TRAU which is located between the BSC and MSC has to be considered when examining this interface. The traffic on the A interface is compressed to one fourth on the A_{bis} interface. Thus four A interfaces are converted into one A_{bis} interface by the TRAU. The number of the A interfaces depends upon the traffic per subscriber and number of the subscribers served by the particular BSC connected to the MSC. A single MSC can serve more than one BSC and thus total number of the A interfaces terminating at the MSC also depends upon BSC number. The A interface also carries both traffic channels and signaling channels. The signaling on this interface is SS7 signaling and the traffic channels uses PCM30 interface. Ref.no.16&17

4.2.6 INTERFACES TO PSTN

The PSTN is connected to PLMN at the MSC or GMSC. The traffic from/to PSTN subscriber To/from PLMN subscriber is carried on the interfaces between the PSTN and PLMN. The interfaces between the PSTN and PLMN are realized using a PCM30 link with a transmission capacity of 2Mbps. The number of PCM30 links depends on the traffic and the routing schemes. An STM-1 link can also be used to connect the MSC and PSTN. The STM-1 is equivalent to the 63 PCM30 links. The connection between the PSTN and MSC carries both traffic and signaling channels. The traffic channels use the PCM30 scheme with each channel having a capacity of 64Kbps. The signaling used is SS7. The user part used in the signaling is ISUP, TUP, and ISDN. The interfaces connected to the PSTN require echo compensation. So DEC modules are used for this purpose. For each line a DEC is required for the compensation.

An MSC can also be connected to more than one PSTN. The different interfaces coming from these PSTNs can be multiplexed to STM-1 links if a later extraction of the VC12 signals is ensured. For echo compensation in this case a DEC480 is available which can compensate for 16 PCM links.

4.2.7 E INTERFACE

This interface is used to connect MSCs with each other. It can be used to connect MSC to an MSC or a GMSC. This interface is physically realized using the PCM30 links. The inter MSC links are used to carry traffic which may be coming from mobile subscribers of the same PLMN or it may be from PSTN. The E interface carries traffic and signaling channels. The traffic channels are 64Kbps channels. The signaling channels use MAP, ISUP, ISDN protocols.

4.2.8 C INTERFACE

The C interface connects the home location register to the MSC. This interface is organized as PCM30 interface with a 2Mbps transmission rate. This interface does not have any kind of traffic channel rather it consists of signaling channels only. It uses CCS7 signaling with MAP, TCAP, SCCP protocols.

4.2.9 MSC-VMS INTERFACE

This interface is used to carry the forwarded traffic to the voice mail service center. The calls are forwarded to the VMSC from various MS. The calls may be conditionally or unconditionally forwarded to the VMSC. In the conditional forwarding the calls are forwarded from the MS to the VMSC based on some conditions like busy, not reachable etc. Whereas the unconditional forwarding involves the calls to be forwarded to the VMSC directly after interrogation with the VLR. The MS which has subscribed the voice mail service can also retrieve the calls stored in the VMSC. Thus bidirectional traffic exists on this interface.

4.3 CORE GSM NETWORK PLANNING

The core of any GSM network is the switching subsystem in the network. The core is also known by the name of network switching system (NSS). The switching subsystem involves the mobile switching centre (MSC). The MSC is the heart of any core which is used mainly to provide the circuit switching with some other functions also. The other network elements which are also a part of the core are HLR, VLR, AUC, VMSC etc. The network planning of the core involves the planning of the interfaces used to connect the network elements, dimensioning of the hardware required in the MSC, HLR, and VLR etc. Only the dimensioning and planning of the interfaces will be discussed i.e. the number of the interfaces required that will support the required traffic conditions will be determined. The hardware is dimensioned according to the interfaces planned in the above process. The configuration of the hardware is not planned in India rather it is planned only in Bangkok for whole Asian continent. For any network that has to be established or needs to be expanded the first step is to plan the interfaces according to traffic model and mobility model which define the traffic conditions required by the operator. After designing the interfaces the hardware is determined from these interfaces. The traffic on the interface consists of both the payload traffic which is voice traffic and the signaling traffic which is used in the call processing. The signaling traffic in the GSM is very high as compared

to the fixed network traffic because of the mobility management, radio resource management and the handovers. The interfaces are designed keeping the MSC as the center of the network and all the interfaces going out of it to the other network elements.

4.3.1 Network Designing Parameters and Terminologies

The network is designed from certain parameters which describe the traffic requirements of the network. The values of these parameters are known before designing the network. The parameters and the terminology related to the network designing will be defined in this section. To dimension the network appropriate mathematical models are needed. For the circuit switching network standard blocking theory as originally developed by the Agner Krarup Erlang is used. All the parameters used in this theory are related to the busiest hour of the day. The other things that are used to design the network are traffic models and mobility models. These are the starting points of any network.

4.3.2 Erlang Blocking Theory

The parameters defined in this theory are related to the busiest hour of the day.

Call Attempt: Any attempt on the part of the traffic source which is a subscriber to obtain the service. The attempts to obtain the service can be successful or unsuccessful.

Call: Any attempt that is processed and makes a bid for the service. So the calls $\leq$ call attempts.

Busy Hour Call Attempts (BHCA): It specifies the total number of call attempts during the busy hour. This factor covers all the successful and unsuccessful call attempts for all kind of calls (originating, terminating).

Mean Holding Time t_m : It is the average duration for the call attempt, no matter whether the call is successful or not. The units of the mean holding time are seconds. Usually the BHCA per subscriber and the traffic per subscriber are given so we can calculate the mean holding time from these two parameters using the formula given in the offered traffic below.

Maximum Allowable Blocking Probability, P: This value represents the major quality criterion. It specifies an acceptance rate with which call attempts can be blocked by the network due to the lacking resources. This value can either be defined as an end to end value or for an individual interface.

Offered Traffic, A: This value specifies the amount of traffic that would be generated if all call attempts could be served by the network. This parameter has actually no unit but Erlang is used to honor A.K.Erlang for the development of this theory. Strictly speaking one Erlang is equal to one permanently used channel during the busy hour. As in communication networks a channel is allocated to a certain call and then relocated to another call, the value of 1 Erlang per channel is only theoretical as gaps between the release of the first call and the occupation by the second call occur. The formula for the offered traffic is given as:

$$A = \text{BHCA} * t_m / 3600 \text{ sec}$$

Number of Channels, N: It specifies the needed amount of channels between two entities in order to serve the offered traffic A with the required blocking probability P. the relation between the A,P,N cannot be given by a resolvable formula but can be described only by the recursive formulas. N can be determined by the Erlang tables or appropriate algorithms as defined in the tools like Teltraf.

4.3.3 Traffic Model

The network is designed on the basis of a model called traffic model. The traffic model gives the information about the call activity in the busy hour, mean holding time per call, call split of MTC, MOC and MMC and their success rate. Other than these parameters the traffic model also gives information about the call forwarding i.e. about the percentage of the total calls that are forwarded and the conditions under which the call forwarding is governed. The different parameters that are given in the traffic model are defined below.

Traffic per MS: This parameter provides the value of the traffic contributed by the MS. The units are Erlang /sub. The traffic the MSC has to support thus depends upon the number of subscribers that particular has.

BHCA per Subscriber: This is one of the ways how the BHCA encountered by the MSC is defined. The parameter defines the BHCA on the basis of the number of subscribers. Thus total BHCA will change depending on the number of subscribers. The peculiar thing about the traffic model is that it defines the different parameters such that the model is general for all the MSCs in the network.

Call Forwarding: One of the features of the GSM is that calls to the MS can be forwarded to some other destination like other MS, PSTN or voice mail center. The calls can be forwarded on the basis of some conditions laid by the subscriber such as busy, not reachable etc. These kinds of the calls are conditionally forwarded and forwarding technique is called conditional forwarding. The subscriber can also opt to forward the calls unconditionally i.e. to forward all the calls directly to some other destination like MS, PSTN or VMSC.

Call Retrieval: The calls that are forwarded to the VMSC can be retrieved by the MS. In this case messages are the retrieved stored information. This process is called call retrieving.

Mobile Terminated Calls, MTC: The MTC is defined as the call from the PSTN to PLMN. The MTC given in the traffic model gives its distribution out of total calls. This distribution includes successful as well as unsuccessful calls. Also it includes the forwarded calls whether conditional or unconditional. The MTC involve the calls from the PSTN subscriber to MS as well as calls from MS of other PLMN using PSTN as transition network.

$$MTC = MTC_{\text{remain}} + MTC_{\text{uncond}} + MTC_{\text{cond}}$$

Mobile Originating Calls, MOC: The MOC is defined as the call from the PLMN to the PSTN. As like the case of MTC the MOC are also given as distribution of the total calls.

Similarly it also has successful, unsuccessful calls. The MOC does not have the contribution because of the forwarded calls because the destination is the PSTN subscriber. From the definition of the MOC it appears that the call will be only for PSTN subscriber but the PSTN network can also act as the transition network for the calls to MS of other PLMN. Thus MOC involve calls for PSTN subscriber and calls for other PLMN users. The MOC also involves the retrieving calls from the MS to the VMSC for receiving the stored messages.

Mobile to Mobile Calls, MMC: MMC is defined as the call from one mobile subscriber to other mobile subscriber in the same PLMN. Due to the reason that the two parties are in the same network the two parties share common resources i.e. only one traffic channel as compared to the MOC and MTC. The MMC also involves the calls which are forwarded either conditionally or unconditionally. Contrary to MTC and MOC MMC involve the calls only between the users of the same PLMN. The MMC are further distributed into inter MSC and intra MSC calls.

4.4 Network Diagram

The network diagram which will show all the network elements present in the network, the various sites and nodes the network will have. The elements are decided on the requirements laid by the operator. For the simplest network MSC, HLR, VLR, PSTN, BSC, VMS, SMSC will be definitely present. Now after deciding upon the network elements that will be present the next step is to determine the number of these nodes required for serving all the subscribers in the PLMN and the geographical area in which subscribers are to be served. As far as the core planning is concerned the geographical area is not a big consideration. The geographical area is required in the planning of the radio subsystem of the PLMN which is not the concern here. Usually one node each of HLR, VLR, and VMS serve more than one MSC. So in our network design only one node each of the HLR, VLR, and VMS will be considered. Now at last only the MSC is left. The number of MSCs depends upon the number of subscribers. A thumb rule used in determining the number of the MSCs is that a single MSC can support approximately 500K-520K subscribers. The number of BSCs required is not the concern of core planner. Usually core planner assumes the number of BSCs on the past experience before actual requirement is determined by radio planner. This approach is helpful as the core planner needs only total traffic from all the BSCs to determine the total number of A interfaces and not the individual BSC traffic. If after planning of the BSCs if there is some discrepancy in the number of the BSCs assumed, which is usually there, only thing which is to be done is just to redistribute the calculated A interfaces among BSCs.

Now after determining the nodes the interconnection between the several nodes is to be decided. The interconnection of the network nodes is done by using various interfaces. Thus after connecting the network nodes we get a final network diagram.

4.5 Determination of Traffic on Various Interfaces

The next step towards the planning of the network is to calculate traffic on various interfaces present in the network. The interfaces are indicated in the network diagram. The traffic calculated will determine the number of various interfaces required in the network. The correct calculation of the traffic is very crucial because the calculated traffic determines the number of interfaces and the number of interfaces will in turn decide the configuration of the hardware which is to be deployed in the network. It is the most computing intensive part of the network planning. Factors which are to be taken care of while calculating the traffic are:

The first step in the calculation of the traffic is to choose the interface. Usually the traffic is calculated on the interfaces between PSTN and MSC first. This is done because most of the traffic parameters that will be required in the calculation of the traffic on other interfaces get calculated automatically in this interface only. Thus this interface provides reference for the other interfaces also. But it is not always necessary that PSTN and MSC interface traffic is to be calculated first.

The second factor which is to be taken care of is the routing of the calls. Traffic due to each and every possible call that can be routed on that particular interface is to be calculated. The routing of the calls can lead to a number of cases to be considered. One of the techniques that can help in calculating the cases is to write down all the cases using the permutation and combination theory in mathematics. While considering any of the interfaces take out the cases which will contribute to the traffic on that particular interface thus in this way almost all the cases will be taken into consideration. The other technique which can be used is to construct a traffic matrix. In this a table is formed in which the traffic from all the possible source nodes to all the possible sink nodes is tabulated. The important thing about the traffic matrix is that it does not give any information about the routing of the calls. After calculating the traffic one has to still consider the routing cases.

While deciding the routing of the calls the shortest path is to be considered.

So while calculating the traffic these factors should be taken into account. The traffic on interfaces depends on various factors.

PSTN Interface: The connection to the PSTN exchanges is a PCM30 line. A detailed determination of the traffic flow and routing is essential for the calculation of PSTN interfaces. This also includes a determination of the number of PSTN exchanges connected to a MSC/VLR and the number of paths for each of these connections as well. In most cases, a PSTN connection is a bi-directional trunk group carrying incoming plus outgoing traffic.

Inter MSC Interface: The number of trunks by which a MSC/VLR is connected to other MSC/VLRs depends on the traffic on the individual MSC/VLR interconnections that are

influenced by the network size, switch locations, network structure, traffic routing strategy etc. The traffic on this interface is also determined by the mobile to mobile traffic.

Interface to VMSC: The voice mail service enables GSM and UMTS subscriber to forward incoming calls e.g. conditionally or unconditionally to his voice mail box, e.g. when he is not attached to the network or when his line is busy. After attaching to the network he can retrieve one or more messages from his voice mail box with one call to his voice mail box.

Interface to BSS: There are two possibilities for the planning of the A-Interface. These are:

a) Bottom-up approach:

In the case of a bottom-up planning the configuration of the Radio Subsystem (RSS) is done before the Switching Subsystem (SSS) will be dimensioned. An output of the BSS planning is the amount of A-interfaces. The actual amount of the interfaces towards the RSS depends on parameters like coverage, urban or rural area, subscriber distribution, etc. Moreover, the mobility of the subscribers has an impact on the traffic on air. From a statistical point of view, the traffic fluctuation is higher in small areas than in large areas. Consequently, the RSS normally has a higher subscriber capacity than the SSS.

b) Top-Down approach:

If no detailed planning of the RSS configuration has been carried out or in case of budgetary offer, the total traffic occurred in the BSS part should be split on a suitable number of BSCs connected to one switch. Assumptions on the BSC-individual traffic could be done on the basis of subscriber location, size and topography of the area to be served, etc.

5. Interface to HLR: The interface to HLR contains the signaling information so only the CCS7 links are to be calculated.

There are mainly three types of traffic: MMC, MTC and MOC. The definitions of these parameters are already defined in the above discussions. The traffic on any interface will be because of these three types only except in the case of data traffic. After the determination of the all the cases that will contribute to traffic on a particular interface determine category of traffic whether it is MMC, MTC or MOC. The determination of the traffic type helps in calculating value of the traffic. Then traffic due to each case is calculated and the total traffic is the sum total of traffic due to all cases. Some of the cases how to calculate traffics will be given in this section. Except these cases some other cases can also be present. Thus the examples help in understanding the underlying concept for calculating the traffic.

The examples are according to the traffic types.

MTC Traffic: The term MTC has been already discussed in the previous section. The total MTC traffic consists of three types- MTC_{uncond} , MTC_{cond} , MTC_{remain} . MTC_{uncond} , MTC_{cond} come under the category of forwarded calls. The total traffic due to MTC is given by the formula:

$$\text{MTC} = (\text{MS} * \text{BHCA} * p_{\text{MTC}} * t_m) / 3600$$

Where

MS = number of subscribers

BHCA = busy hour call attempts per subscriber

p_{MTC} = share of MTC traffic

t_m = mean holding time

MTC_{uncond} is defined as calls from the PSTN directly being forwarded to the target after performing interrogation to the HLR. It is applicable on the supplementary service CFU (Call forwarding unconditional). The target can be voice mail service centers or other mobile or fixed subscribers. The formula for calculating this traffic is given by:

$$\text{MTC}_{\text{uncond}} = (\text{MS} * \text{BHCA} * p_{\text{MTC}} * p_{\text{uncond}} * t_{\text{Forward}}) / 3600 \dots (1)$$

Where

p_{uncond} = share of unconditionally forwarded MTC traffic

t_{Forward} = forwarding time, e.g. duration of the occupation of VMSC including greeting message and left message.

MTC_{cond} is defined as calls from the PSTN interrogated and routed to the subscriber current MSC/VLR. Due to certain conditions the call will be forwarded from this subscriber's location (MSC) to the forwarding target. It is applicable on the supplementary services CFB (Call forwarding on mobile subscriber busy), CFNRy (Call forwarding on no reply) and CFNRc (Call forwarding on mobile subscriber not reachable). The target can be voice mail service centers or other mobile or fixed subscribers.

$$\text{MTC}_{\text{cond}} = (\text{MS} * \text{BHCA} * p_{\text{MTC}} * p_{\text{cond}} * t_{\text{Forward}}) / 3600 \dots (2)$$

Where

p_{cond} = share of conditionally forwarded MTC traffic

MTC_{remain} is simply the MTC subtracted by the forwarded traffic conditional and unconditional, i.e. the traffic that is treated in the normal defined way as mobile terminated traffic. It is the remaining traffic.

$$\text{MTC}_{\text{remain}} = \text{MTC} - \text{MTC}_{\text{cond}} - \text{MTC}_{\text{uncond}}$$

MMC Traffic: MMC is defined as calls from one mobile subscriber to another mobile subscriber. Due to the fact that two parties in the same network are involved they share one resource (traffic channel) in comparison to MOC and MTC, where one subscriber inside and one subscriber outside the network share this resource. The call is part of both subscribers MMC attempt, e.g. having 0.1 MMC call attempts means it could be originated and terminated. The channel sharing is covered by the factor 2 in the denominator. The formula for MMC is given by:

$$\text{MMC} = (\text{MS} * \text{BHCA} * p_{\text{MMC}} * t_m) / 3600 * 2 \dots (3)$$

Where

p_{MMC} = percentage of MMC traffic

MMC_{uncond} is defined as MMC directly being forwarded to the target after performing interrogation to the HLR. It is applicable on the supplementary service CFU (Call forwarding unconditional). The target can be voice mail service centers or other mobile or fixed subscribers.

$$MMC_{uncond} = (MS * BHCA * p_{MMC} * p_{uncond} * t_{Forward}) / 3600 * 2$$

MMC_{cond} is defined as MMC interrogated and routed to other subscriber current MSC/VLR. Due to certain conditions the call will be forwarded from this subscriber's location (MSC) to the forwarding target. It is applicable on the supplementary services CFB (Call forwarding on mobile subscriber busy), CFNRy (Call forwarding on no reply) and CFNRc (Call forwarding on mobile subscriber not reachable). The target can be voice mail service centers or other mobile or fixed subscribers.

$$MMC_{cond} = (MS * BHCA * p_{MMC} * p_{cond} * t_{Forward}) / 3600 * 2 \dots (4)$$

MMC_{remain} is simply the MMC subtracted by the forwarded traffic conditional and unconditional, i.e. the traffic that is treated in the normal defined way as mobile - mobile traffic.

$$MMC_{remain} = MMC - MMC_{cond} - MMC_{uncond}$$

MOC Traffic: MOC is defined as calls from the PLMN towards the PSTN. The following formula shows the total MOC caused by all subscribers in this particular MSC. It doesn't show anything about the distribution of this outgoing traffic among the PSTN nodes connected to the network. The formula for calculating the MOC traffic is given below:

$$MOC = (MS * BHCA * p_{MOC} * t_m) / 3600 \dots (5)$$

Where

p_{MOC} = percentage of MOC traffic

Unlike MTC the MOC does not have any forwarded calls as the calls are destined to PSTN and call forwarding is a facility provided by the PLMN and GSM network. But the MOC calls consist of retrieving of calls and messages from the VMSC stored in it because of forwarded calls.

MOC_{retrieval} is defined as the traffic caused by retrieving messages stored on the voice mail service center. These stored messages are originated (forwarded) by the traffic types MTC_{uncond}, MTC_{cond}, MMC_{uncond} and MMC_{cond}.

$$MOC_{retrieval} = (MS * BHCA * (p_{uncond} + p_{cond}) * p_{MOC} * t_{retrieval}) / 3600 \dots (6)$$

Where

$t_{retrieval}$ = retrieving time, e.g. duration of the occupation of VMSC including greeting message and play of the left message(s).

Due to the distinct input parameters of retrieval time ($t_{\text{retrieval}}$) and forwarded time (t_{forward}) the result of the retrieved traffic could be different than the sum of the MMC and MTC forwarded traffic. This can be explained with different greeting lengths.

$$\text{MOC}_{\text{retrieval}} = (\text{MMC}_{\text{cond}} + \text{MMC}_{\text{uncond}} + \text{MTC}_{\text{cond}} + \text{MMC}_{\text{uncond}}) * (t_{\text{retrieval}} / t_{\text{forward}})$$

In case of equal times the equation becomes:

$$\text{MOC}_{\text{retrieval}} = (\text{MMC}_{\text{cond}} + \text{MMC}_{\text{uncond}} + \text{MTC}_{\text{cond}} + \text{MMC}_{\text{uncond}})$$

MOC_{remain} The remaining traffic is simply the MOC subtracted by the retrieved traffic, i.e. the traffic that is treated in the normal defined way as mobile originated traffic.

$$\text{MOC}_{\text{remain}} = \text{MOC} - \text{MOC}_{\text{retrieval}}$$

4.6 Determination of Traffic Channels

After the calculation of the traffic on individual interfaces the next step is to calculate the traffic channels required to support or carry the required traffic. The traffic channels required are calculated using a tool called Teletraf. The inputs required by the tool are traffic and blocking probability of particular interface. The traffic channels can also be calculated by the Erlang tables. Actually the formulas that are used to calculate the traffic channels from the traffic and blocking probability are recursive formulas and it is not easy to calculate the answers from these formulas manually. So special softwares like Teletraf or excel sheets are used for calculating the traffic channels. The general recursive function for calculating the traffic channels for an interface is given by

$$\#TCH = f(P, \text{traffic})$$

Where

f = recursive function

P = blocking probability of the interface

Traffic = traffic on the interface

4.7 Calculating the Signaling Links

Logically, signaling network and the payload network are two networks. However, often signaling links are simply transported associated with the payload, thus the impression might exist that signaling and payload network are one entity. If this associated transport is the case, bandwidth for signaling must be provided and considered when dimensioning the payload links between the nodes. The signaling links depend on the interface we are considering. Usually while calculating the signaling links thumb rules are used and no detailed discussion as to why these result only is discussed. The thumb rules are nothing but the results of the theories implemented in the calculation of signaling links. Thus thumb rules fast up the planning process with fair amount of accuracy. The rules for different interfaces are mentioned below:

4.7.1 MSC-BSS: The C7 links required for the A interface depends on the traffic channels calculated for it on the basis of traffic and blocking probability. One C7 link is required per 240 traffic channels.

$$\#CCS7_A = \#TCH_A / 240$$

$$\#TCH_A = \#TCH_{out, BSC} = f(B; Traffic_{out, BSC})$$

Where

$\#TCH_A$ = traffic channels required

$\#CCS7_A$ = signaling channels or links

The function $f(x, y)$ is a recursive formula for calculating the traffic channels.

4.7.2 MSC-PSTN: For MSC-PSTN interface the number of CCS7 links depend upon the PCM links required for the speech information. One CCS7 links is required per 30 PCM links. In case of MSC-PSTN signaling links there should be redundancy because of the criticality of the interface in the network. Thus redundancy of one CCS7 link is provided as also shown by the formula given below.

$$\#TCH = f(B; Traffic_{out, BSC})$$

$$\#E1 = \#TCH / 30$$

$$\#CCS7 = \#E1 / 30 + 1 \dots \dots (7)$$

Where

UR = Utilization Rate (0.8 or 1)

4.7.3 MSC-HLR: The number of signaling links required in this case depends on the number subscriber. The requirement also depends on one factor in the hardware i.e. whether we are using CCNC or SSNC. In this case also one extra C7 link is provided for redundancy. Thus signaling links required are given by:

For CCNC:

$$\#CCS7 = \text{Number of subscribers} / 20000 + 1$$

For SSNC:

$$\#CCS7 = \text{Number of subscribers} / 40000 + 1$$

The difference between CCNC and SSNC is that SSNC is newer version.

4.7.4 MSC-VMS: For the interface between MSC-VMS two signaling links are required. In general this value is sufficient irrespective of any other factor.

$$\#CCS7 \text{ Links Between the PLMN Switch and VMS} = 2 \dots \dots (8)$$

4.7.5 MSC-MSC: The signaling links required for the inter MSC interface depend on the number of subscribers in the PLMN. One signaling link is required per 20000 subscribers. One channel for redundancy is provided if requested by operator.

$$\#CCS7 = \text{number of subscribers} / 20000 \dots \dots (9)$$

These five interfaces are to be planned in our report only. So this data will be sufficient for designing the network.

4.8 Determination of Number of Interfaces

After following the steps mentioned above now we have to calculate the number of interfaces required between the network nodes in the network. All the interfaces between different network nodes are PCM interfaces. The rules for calculating the number of interfaces are discussed in this section one by one for each of the interfaces.

4.8.1 PSTN Interface: The PSTN interface with the MSC is a PCM30 interface. The number of PCM lines required for supporting the traffic and signaling depends on the traffic channels and signaling links calculated. The other factor which plays an important role in determining the PCM lines is utilization factor (UR). The UR is used to consider the percentage of total capacity of PCM used in the network. The value of UR can be 0.8 or 1. Usually the value of UR is taken to be 0.8.

The number of PSTN interfaces can be obtained with

$$\# \text{PSTN - IF} = \frac{\# \text{TCH}_{\text{PSTN}} + \# \text{C7}}{\# \text{TS} * \text{UR}} \dots\dots(10)$$

Where

#PSTN-IF = number of interfacing lines

#TCH_{PSTN} = number of traffic channels required for speech

#C7 = signaling links

#TS = number of time slots = 30 (as standard, in exceptional cases also 31)

UR = Utilization rate (0.8 or 1)

Basically speaking, a single PCM line offers 31 time slots that can be filled with payload. However, very often a further time slots remains reserved. In this case the number of available time slots reduces to 30. If this is the case and the reserved time slots are blocked for signaling, it is necessary to remove the term #CCS7 from above equation as signaling bandwidth has already been foreseen. If 30 or 31 time slots are used needs to be clarified project specific. If no other information is available, use 30 as default.

4.8.2 Inter MSC Interface: The E interface is a TDM based interface and uses PCM30 links. As E interface also use PCM30 lines thus for calculating interfaces it has similar kind of calculations as in the case of PSTN interfaces.

The number of MSC-MSC interfaces can be obtained with

$$\# \text{MSC - MSC - IF} = \frac{\# \text{TCH}_{\text{MSC-MSC}} + \# \text{C7}}{\# \text{TS} * \text{UR}} \dots\dots(11)$$

Where

#MSC-MSC-IF = number of interfacing lines

#TCH_{MSC-MSC} = number of traffic channels required for speech

#C7 = signaling links

#TS = number of time slots = 30 (as standard, in exceptional cases also 31)

UR = Utilization rate (0.8 or 1)

Now whether 30 or 31 time slots are to be used has already been explained in PSTN interfaces.

4.8.3 Interface to BSS: The A interface is also a PCM30 interface but the number of interfaces is determined in a different manner as compared to PSTN or MSC.

$$\#A-IF = \frac{\#TCH_{out,BSC} + 4 * \#CCS7 \text{ links on A-IF} + 4 * OMC - Links_{NUC}}{\#TS * UR} \dots\dots(12)$$

Where

#A-IF = number of A interfaces

#TCH_{out, BSC} = number of traffic channels

#CCS7= number of signaling links

OMC-Links = 1 for BSC-OMC nailed-up-connection, 0 otherwise

#TS = number of time slots = 30 (as standard, in exceptional cases also 31)

UR = Utilization rate (0.8 or 1)

This rule has to be applied for each BSC connected to the switch. Above rules leads to the minimum number of A interface which are necessary to handle the entire traffic. However, this approach is somewhat simplified as with the introduction of AMR codecs in GSM the setup of A interface pools becomes necessary. One pool is e.g. reserved for classical codecs like HR, FR and EFR whereas a second pool is responsible for the handling of all calls using the AMR codec. The biggest impact lies in the BSS, as the TRAU must be split according to the pools. The core effects of pooling might be negligible for offer planning but become very relevant when integrating a node in a real network.

4.8.4 Interface to VMSC: The connection of PLMN with the VMSC is realized using PCM30 lines. The number of PCM30 interfaces are calculated by using the formula

$$\#VMS-IF = \frac{\#TCH_{VMS} + \#CCS7}{\#TS * UR} \dots\dots\dots(13)$$

Where

#VMS-IF = number of interfaces form the MSC to the VMSC

#TCH_{VMS} = number of traffic channels

#CCS7= number of signaling links

#TS = number of time slots = 30 (as standard, in exceptional cases also 31)

UR = Utilization rate (0.8 or 1)

4.8.5 Interface to HLR: The number of interfaces required between the HLR and MSC depends only upon the signaling links as no speech traffic exists on this interface. The PCM30 can

support 31 signaling links. For redundancy an extra line is provided. Thus the number of interfaces required are given by:

$$\# \text{PCM30}|_{\text{MSC/VLR-HLR/AC}} = \frac{\# \text{CCS7 links}|_{\text{MSC/VLR-HLR/AC}}}{31} + 1 \dots (14)$$

Where

$\# \text{PCM30}|_{\text{MSC/VLR-HLR/AC}}$ = number of links required.

$\# \text{CCS7}|_{\text{MSC/VLR-HLR/AC}}$ = number of signaling links required

PLANNING OF CORE NETWORK INTERFACES

5.1 INTRODUCTION

Planning of the core network having a capacity of 600K subscribers. A network with a capacity of 600K which is divided into two MSCs, MSC0 and MSC1, with equal capacity of 300K subscribers each. Different types of traffic i.e. MTC (mobile terminating call), MOC (mobile originating call), MMC (mobile to mobile call) are calculated. No. of channel is calculated by a software or a excel sheet. Different dimensioning links are calculated. Finally we calculate no. of interfaces required. A software is developed that will calculate all these parameter by entering the Capacity. Different graphs shows distribution of various types of traffic and dimensioning of links.

The requirements and parameters of the network are:

5.2 Requirements

1. Network with a capacity of 600K which is divided into two MSCs, MSC0 and MSC1, with equal capacity of 300K subscribers each.
2. The traffic requirement per subscriber is 30m Erlang.
3. The BHCA per subscriber is 2.6 BHCA.

5.2.1 Traffic Model

TRAFFIC MODEL	VALUES
Traffic per MS	30 m Erlang
Number of BHCA per MS & busy hour	2.6
Mean holding time per call	41.53 sec
MOC	40%
Successful calls	65%
Unsuccessful calls	35%
No traffic channel engaged	60%
No answer	40%
MTC	40%
Successful calls	55%
Unsuccessful calls	45%
MS detached /no paging response	70%
No answer	30%
MTM calls: MSC internal	10%
To other MSC's	10%
FAX or data calls	1%of total
Subscriber controlled input per MS & busy hour	0.1
SMS(MO+MT) per MS & busy hour	0.2
Call forwarding of MTC & MMC	10%
Unconditional	100%
To VMS center	100%

Table 5.1: Traffic Model

5.2.2 OTHER PARAMETERS:

1. Call forwarding time, $t_{\text{forward}} = 50 \text{ sec}$
2. Call retrieving time, $t_{\text{retrieve}} = 50 \text{ sec}$
3. Blocking Probabilities:
A- Interface = 0.5%, UR = 0.8
PSTN interfaces = 1%, UR = 0.8
E- Interface = 1%, UR = 0.8
VMS-MSC blocking = 0.1%
4. Distribution of MTC & MOC calls:
MTC for MSC0: 50 % from PSTN0, 50 % from PSTN1
MTC for MSC1: 50 % from PSTN0, 50 % from PSTN1
MOC of MSC0: 50 % to PSTN0, 50 % to PSTN1
MOC of MSC1: 50% to PSTN0, 50% to PSTN1
5. Distribution of forwarded calls
Forwarded calls to PSTN: 50% to PSTN0 & 50% to PSTN1
Forwarded calls to MS: 50% to BSC0 & 50% BSC1

Network Diagram

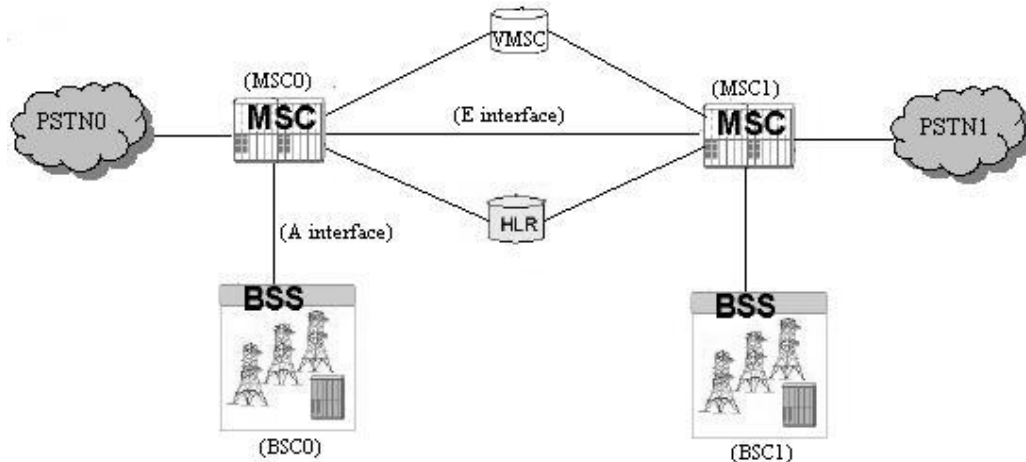


Fig 5.1: Core Network for 600K subscribers

The network diagram for 600K subscribers is shown above. The network has two MSCs, MSC0 & MSC1, with a capacity of 300K each. The MSC are connected to the PSTN network. MSC0 is connected to PSTN0 and the MSC1 is connected to the PSTN1. It is assumed that MSCs will be connected to a single PSTN network only. the MSCs are connected to the BSS through the A interfaces. MSC0 is connected to the BSC0 (BSS) and the MSC1 is connected to BSC1 (BSS). The number of BSCs in the BSS network is also assumed according to the top down approach. The MSCs are connected to each other through E interfaces as shown in the diagram. In addition to these there are two another network elements namely- HLR and VMS. The HLR is a static

database meant for the subscriber management and mobility management so it is also to be connected to MSCs. The VMSC is used for storing the forwarded messages for subscribers.

Following conventions are used in this section:

PSTN0 = P0 BSC0 = B0 MSC0 = M0 VMSC = VMS

PSTN1 = P1 BSC1 = B1 MSC1 = M1

5.3 Calculation of Traffic

VMS Traffic

Forwarded MTC Traffic

Dedicated for subscribers belonging to MSC0

$$\begin{aligned} \text{PSTN0-VMS} &= 2.6 * 0.4 (\text{MTC}) * 0.1 (\text{forw}) * 0.5 (\text{Dist.}) * 300,000 * 50/3600 \\ &= 216.67 \text{ Erl} \end{aligned}$$

$$\begin{aligned} \text{PSTN1-VMS} &= 2.6 * 0.4 (\text{MTC}) * 0.1 (\text{forw}) * 0.5 (\text{Dist.}) * 300,000 * 50/3600 \\ &= 216.67 \text{ Erl} \end{aligned}$$

Dedicated for subscribers belonging to MSC1

$$\begin{aligned} \text{PSTN0-VMS} &= 2.6 * 0.4 (\text{MTC}) * 0.1 (\text{forw}) * 0.5 (\text{Dist.}) * 300,000 * 50/3600 \\ &= 216.67 \text{ Erl} \end{aligned}$$

$$\begin{aligned} \text{PSTN1-VMS} &= 2.6 * 0.4 (\text{MTC}) * 0.1 (\text{forw}) * 0.5 (\text{Dist.}) * 300,000 * 50/3600 \\ &= 216.67 \text{ Erl} \end{aligned}$$

Forwarded MMC traffic

$$\begin{aligned} \text{MSC0} &= 2.6 * 0.2 (\text{MMC}) * 0.1 (\text{Forw.}) * 300,000 * 50/3600 \\ &= 216.67 \text{ Erl} \end{aligned}$$

$$\begin{aligned} \text{MSC1} &= 2.6 * 0.2 (\text{MMC}) * 0.1 (\text{Forw.}) * 300,000 * 50/3600 \\ &= 216.67 \text{ Erl} \end{aligned}$$

Retrieved MTC traffic

The retrieved MTC traffic is proportional to the ratio of retrieval time over forward time

$$\begin{aligned} \text{VMS-MSC0} &= (216.67 + 216.67) * 50/50 \\ &= 433.34 \text{ Erl} \end{aligned}$$

$$\begin{aligned} \text{VMS-MSC1} &= (216.67 + 216.67) * 50/50 \\ &= 433.34 \text{ Erl} \end{aligned}$$

Retrieved MMC traffic

$$\text{MSC0} = 216.67 \text{ Erl}$$

$$\text{MSC1} = 216.67 \text{ Erl}$$

Land to Mobile Traffic (MTC_Remaining)

$$\text{PSTN0-MSC0} = 300,000 * 0.03 (\text{traff.}) * 0.4 (\text{MTC}) * 0.5 (\text{dist.}) - 216.67$$

$$= 1583.33 \text{ Erl}$$

$$\begin{aligned} \text{PSTN1-MS0} &= 300,000 * 0.03 (\text{traff.}) * 0.4 (\text{MTC}) * 0.5 (\text{dist.}) - 216.67 \\ &= 1583.33 \text{ Erl} \end{aligned}$$

$$\begin{aligned} \text{PSTN0-MS1} &= 300,000 * 0.03 (\text{traff.}) * 0.4 (\text{MTC}) * 0.5 (\text{dist.}) - 216.67 \\ &= 1583.33 \text{ Erl} \end{aligned}$$

$$\begin{aligned} \text{PSTN1-MS1} &= 300,000 * 0.03 (\text{traff.}) * 0.4 (\text{MTC}) * 0.5 (\text{dist.}) - 216.67 \\ &= 1583.33 \text{ Erl} \end{aligned}$$

Mobile to Land Traffic (MOC_Remaining)

$$\begin{aligned} \text{MS0-PSTN0} &= 300,000 * 0.03 * 0.4 (\text{MOC}) * 0.5 (\text{Dist}) - 650 (\text{VMS total}) * 0.5 (\text{dist.}) \\ &= 1475 \text{ Erl} \end{aligned}$$

$$\begin{aligned} \text{MS0-PSTN1} &= 300,000 * 0.03 * 0.4 (\text{MOC}) * 0.5 (\text{Dist}) - 866.68 (\text{VMS total}) * 0.5 (\text{dist.}) \\ &= 1475 \text{ Erl} \end{aligned}$$

$$\begin{aligned} \text{MS1-PSTN0} &= 300,000 * 0.03 * 0.4 (\text{MOC}) * 0.5 (\text{Dist}) - 866.68 (\text{VMS total}) * 0.5 (\text{dist.}) \\ &= 1475 \text{ Erl} \end{aligned}$$

$$\begin{aligned} \text{MS1-PSTN1} &= 300,000 * 0.03 * 0.4 (\text{MOC}) * 0.5 (\text{Dist}) - 866.68 (\text{VMS total}) * 0.5 (\text{dist.}) \\ &= 1475 \text{ Erl} \end{aligned}$$

Mobile to Mobile Traffic

Remaining MMC traffic

$$\begin{aligned} \text{MS0} &= 300,000 * 0.03 * 0.2 - 216.67 \\ &= 1563.33 \text{ Erl} \end{aligned}$$

$$\begin{aligned} \text{MS1} &= 300,000 * 0.03 * 0.2 - 216.67 \\ &= 1563.33 \text{ Erl} \end{aligned}$$

Local Traffic

$$\begin{aligned} \text{MS0} &= 1563.33 * 50 / 100 \\ &= 791.66 \text{ Erl} \end{aligned}$$

$$\begin{aligned} \text{MS0} &= 1563.33 * 50 / 100 \\ &= 791.66 \text{ Erl} \end{aligned}$$

Inter MMC

$$\begin{aligned} \text{MS0-MS1} &= 1563.33 * 50 / 100 \\ &= 791.66 \text{ Erl} \end{aligned}$$

$$\begin{aligned} \text{MS1-MS0} &= 1563.33 * 50 / 100 \\ &= 791.66 \text{ Erl} \end{aligned}$$

5.4 Traffic on Interfaces

Total VMS Traffic

Traffic to VMS

$$\text{MS0-VMS} = 216.67 + 216.67 + 216.67$$

$$= 650 \text{ Erl}$$

$$\text{MSC1-VMS} = 216.67 + 216.67 + 216.67$$

$$= 650 \text{ Erl}$$

Traffic from VMS

$$\text{VMS-MSC0} = 216.67 + 216.67 + 216.67$$

$$= 650 \text{ Erl}$$

$$\text{VMS-MSC1} = 650 \text{ Erl}$$

Total Traffic

$$\text{MSC0-VMS} = 1300 \text{ Erl}$$

$$\text{MSC1-VMS} = 1300 \text{ Erl}$$

Total PSTN Traffic

This interface handles MOC_Remaining, MTC_Remaining, and MTC_Forward

$$\text{MSC0-PSTN0} = 1475 + 1475 + 1583.33 + 1583.33 + 216.67 + 216.67$$

$$= 6550 \text{ Erl}$$

$$\text{MSC1-PSTN1} = 1475 + 1475 + 1583.33 + 1583.33 + 216.67 + 216.67$$

$$= 6550 \text{ Erl}$$

Total Inter MSC Traffic

This interface has to handle the following traffic shares: MMC_remaning traffic and MTC_Remaining traffic entering the network at the wrong MSC. Note that the MMC traffic must be weighted with a factor of 50%.

$$\text{MSC0-MSC1} = 0.5 * 791.66 + 1583.33$$

$$= 1979.16 \text{ Er}$$

$$\text{MSC1-MSC0} = 0.5 * 791.66 + 1583.33$$

$$= 1979.16 \text{ Erl}$$

$$\text{Total Traffic} = 3958.32 \text{ Erl}$$

5.5 Dimensioning of Links

PSTN Interfaces

$$\text{MSC0-PSTN0}$$

$$\text{Traffic} = 6550 \text{ Erl}$$

$$\#TCH = 6548$$

$$\text{PCM30} = 219$$

$$C7 = 219/30 + 1 = 9$$

$$\text{PSTN-IF} = (6548 + 9)/30 * 0.8 = 274$$

$$\text{MSC1-PSTN1}$$

Same as MSC0-PSTN0

MSC0-MSC1 Interfaces

Traffic = 3958.32 Erl

#TCH = 3976

PCM30 = 133

$C7 = 600,000/20,000 = 30$

$MCS-MSC\ IF = (3976+30)/30*0.8 = 167$

MSC-VMS Interface

MSC0-VMS

Traffic = 1300 Erl

#TCH = 138

$C7 = 2$

$MSC-VMS\ IF = (1380+2)/30/0.8 = 58$

MSC1-VMS

Same as above

MSC-HLR Interfaces

$MSC0-HLR = 300000/20000+1 = 16$

$MSC1-HLR = 16$

Interface

MSC0-BSC0

Total Traffic = $300,000*.03$
= 9000 Erl

Traffic per BSC = $9000/3$
= 3000 Erl/BSC

#TCH = 3057

$\#C7 = 3057/240 = 13$ per BSC

A – Interfaces = $(3057+4*13)/30*0.8 = 130$ per BSC

Total A interfaces = $3*130 = 390$

Total C7 links = $13*3 = 39$

MSC1-BSC1

Same for this case also

This completes the dimensioning and planning of the interfaces for core network. The call forwarding in this case has been taken only unconditional with 100% forwarding to VMS.

Distribution Between Various Types of Traffic

Total Subscriber Capacity=600K

Forwarded	Retrieved	Retrieved	Land to	Mobile to	Mobile to	Local	Inter	Traffic on
MTC & MMC	MTC	MMC	Land to	Mobile to	Mobile to	Traffic	MMC	Interfaces
Traffic (Er.)	(Er.)	(Er.)	(Er.)	(Er.)	(Er.)	(Er.)	(Er.)	(Er.)
216.67	433.34	216.67	1583.33	1457	1563.33	791.66	791.66	650

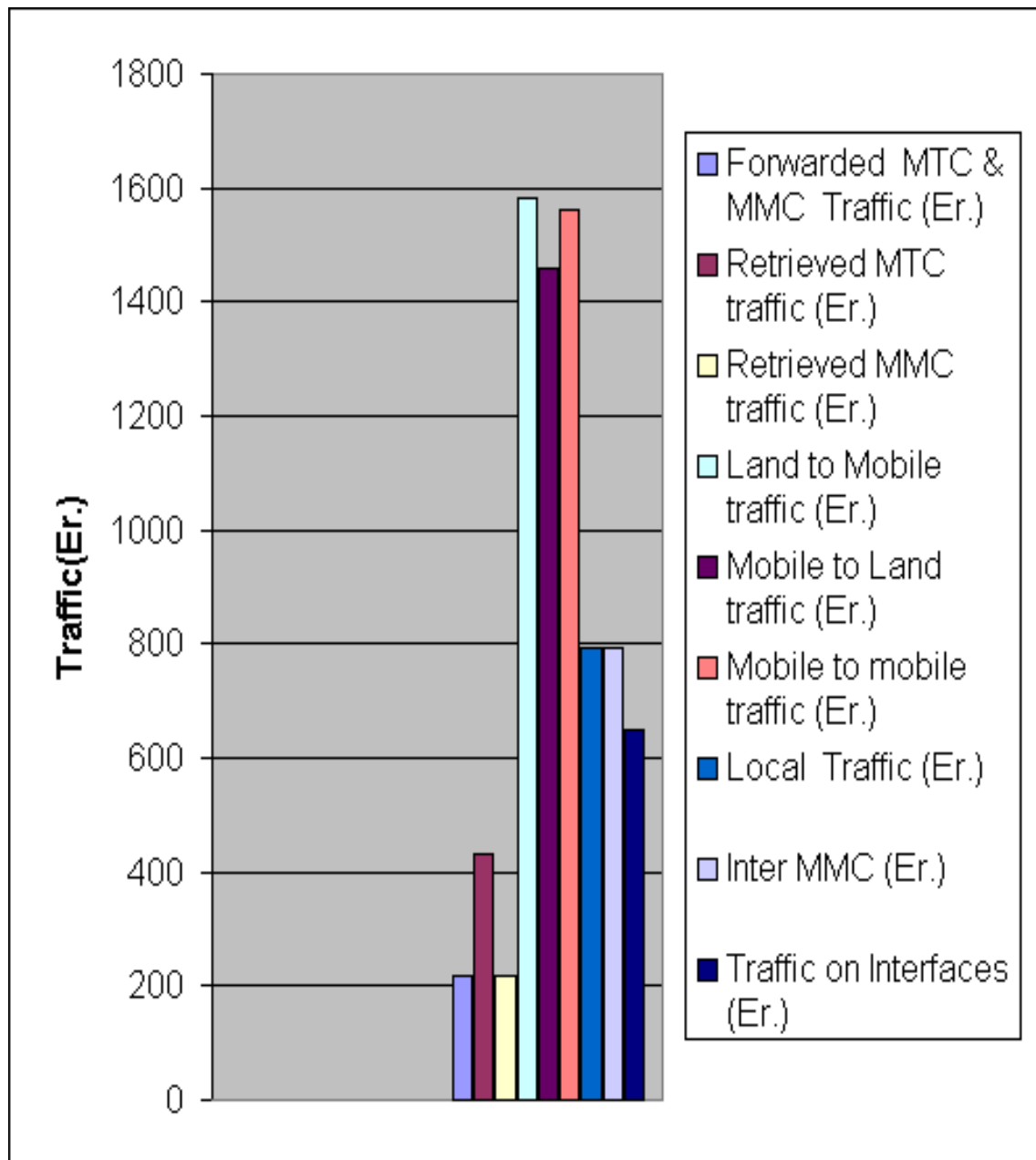


Fig:5.2 Distribution between various types of Traffic

DIMENSIONING OF LINKS(600k)

PSTN-IF	MCS-MSC IF	MSC-VMS IF	MSC-HLR IF	TOTAL A IF
274	167	58	16	390

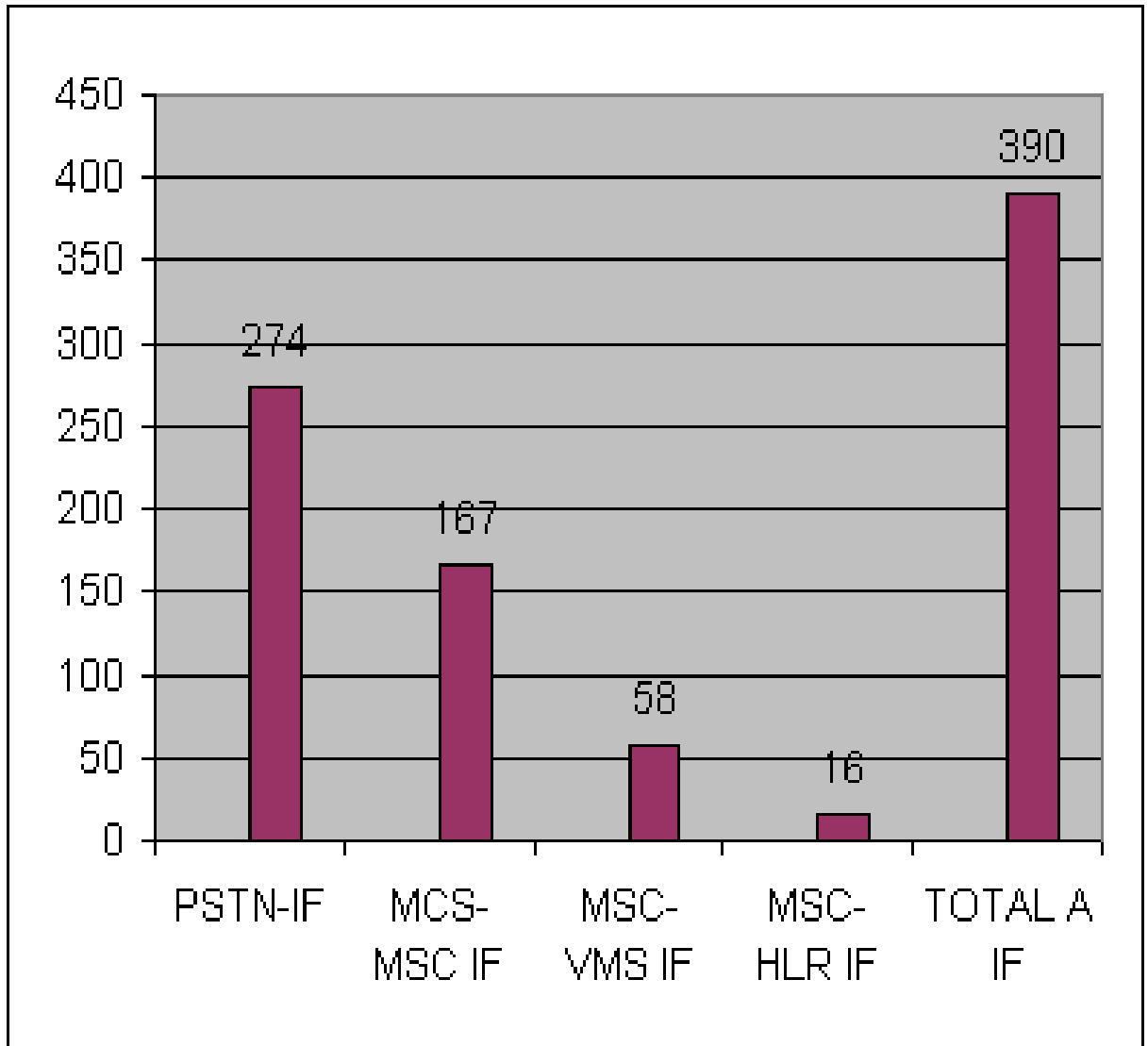


Fig:5.3: Dimensioning of Links

5.6 Planning of core network interfaces for 10000 subscribers:

Enter the capacity: 10000 Forwarded MTC Traffic PSTN0_VMS_MSC0 = 7.222222 Erl PSTN1_VMS_MSC0 = 7.222222 Erl PSTN0_VMS_MSC1 = 7.222222 Erl PSTN1_VMS_MSC1 = 7.222222 Erl Forwarded MMC Traffic MSC0 = 7.222222 Erl MSC1 = 7.222222 Erl Retrieved MTC Traffic VMS_MSC0 = 14.444444 Erl VMS_MSC1 = 14.444444 Erl Retrieved MMC Traffic MSC0 = 7.222222 Erl MSC1 = 7.222222 Erl Land to Mobile Traffic(MTC_Remaining) PSTN0_MSC0 = 52.777778 Erl PSTN1_MSC0 = 52.777778 Erl PSTN0_MSC1 = 52.777778 Erl PSTN1_MSC1 = 52.777778 Erl Mobile to Land Traffic(MOC_Remaining) MSC0_PSTN0 = 49.166667 Erl MSC0_PSTN1 = 49.166667 Erl	MSC1_PSTN0 = 49.166667 Erl MSC1_PSTN1 = 49.166667 Erl MOBILE TO MOBILE TRAFFIC Remaining MMC Traffic MSC0 = 52.777778 Erl MSC1 = 52.777778 Erl Local Traffic MSC0 = 26.388889 Erl MSC1 = 26.388889 Erl Inter MMC MSC0_MSC1 = 26.388889 Erl MSC1_MSC0 = 26.388889 Erl TOTAL VMS TRAFFIC Traffic to VMS MSC0_VMS = 21.666667 Erl MSC1_VMS = 21.666667 Erl Traffic from VMS VMS_MSC0 = 21.666667 Erl VMS_MSC1 = 21.666667 Erl Total Traffic MSC0_VMS = 43.333333 Erl MSC1_VMS = 43.333333 Erl
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Total PSTN Traffic

MSC0_PSTN0 = 218.333333

MSC1_PSTN1 = 218.333333

Total Inter MSC Traffic

MSC0_MSC1 = 65.972222 Erl

MSC1_MSC0 = 65.972222 Erl

Total Traffic = 131.944444 Erl

DIMENSIONING OF LINKS**PSTN Interfaces**

Traffic = 218.333333 Erl

Enter the value of TCH : 260

PSTN_IF = 11.000000

MSC0_MSC1 Interfaces

Traffic = 131.944444 Erl

Enter the value of TCH: 166

MCS_MSC_IF = 7.000000

MSC_VMS Interfaces

Traffic = 43.333333 Erl

Enter the value of TCH: 64

MSC_VMS_IF = 3.000000

MSC_HLR Interfaces

MSC0_HLR = 1.500000

MSC1_HLR = 1.500000

A-interface

Enter the value of TCH: 73

A Interfaces = 4.000000 per BSC

Total A Interfaces = 12.000000

Total C7 Links = 3.000000

Total subscriber capacity=10000

Forwarded	Retrieved	Retrieved	Land to	Mobile to	Mobile to	Local	Inter
MTC & MMC	MMC	MTC	Land to	Land	mobile	Traffic	MMC
TRAFFIC (Er.)	traffic	traffic	Mobile	traffic	mobile	(Er.)	(Er.)
(Er.)	(Er.)	(Er.)	traffic	(Er.)	traffic	(Er.)	(Er.)
7.22	7.22	14.44	52.77	49.16	52.77	26.38	26.38

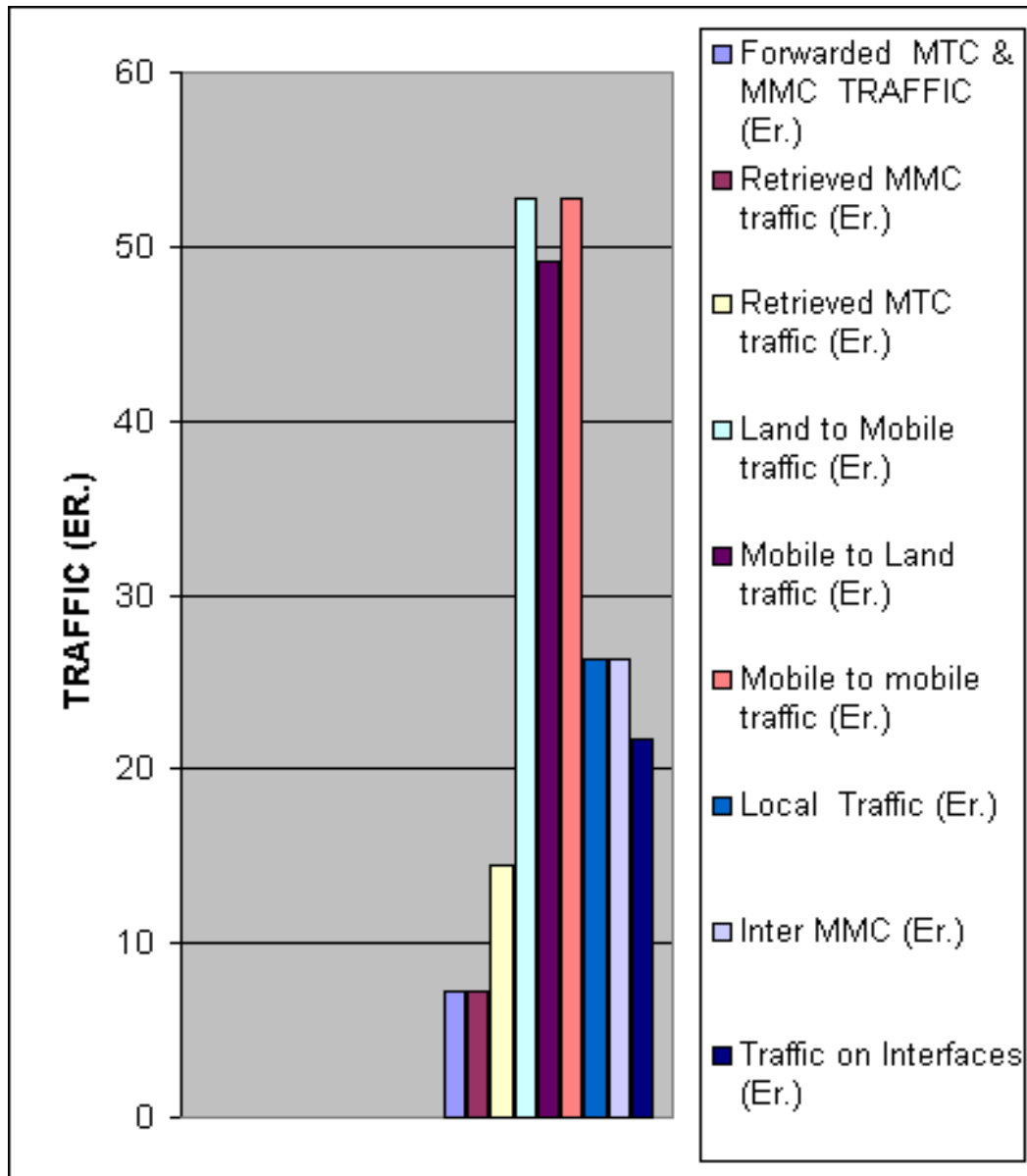


Fig.5.4: Distribution between various types of traffic

DIMENSIONING OF LINKS

PSTN-IF	MCS-MSC IF	MSC-VMS IF	MSC-HLR IF	TOTAL A IF
11	7	3	1.5	12

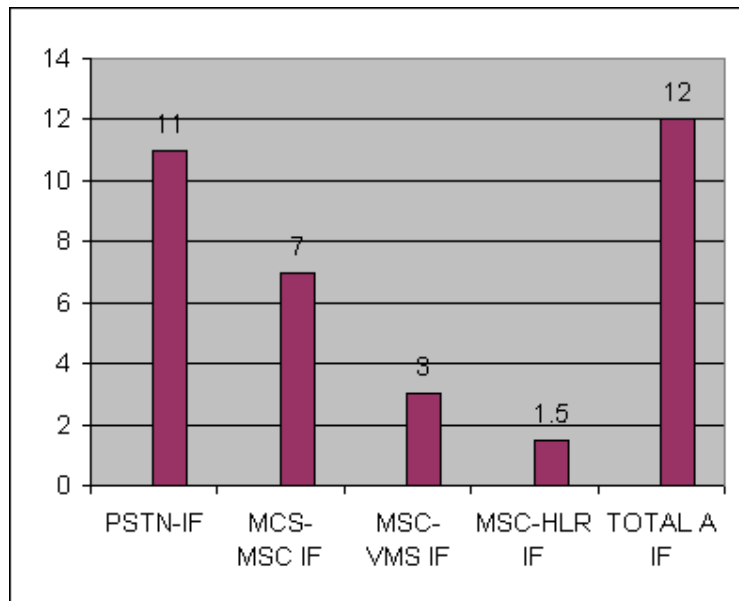


Fig.5.5: Dimensioning of links

CONCLUSIONS

Telecommunications sector is growing at a fast rate. The dependence of people on the telecommunications has also increased very much. For building reliable telecommunication systems a lot of engineering and designing is required. An optimized system can only be designed after proper planning and consideration of each and every factor that can affect working of the system. The infrastructure used for network elements in the network must also be capable of meeting real time requirements like traffic variations due to time of the day (day or night) of the network etc. For increasing the reliability and capability of network elements the infrastructure involved becomes very complex and sophisticated. Due to the rising complexity in the system it is desirable that the systems should be divided into modules or subparts. These modules or subparts will help in reducing the complexity of whole system and limiting the complexity of a particular subsystem to that part only. This kind of approach can be seen in EWSD system where whole system is being divided into many subsystems. This also helps the switch designer while configuring the switch. In addition it also helps in increasing the flexibility of the system in terms of easy expansion whenever required. By making the individual network elements modular we can design and implement a complex network with much more ease. This makes whole network modular as network is nothing but the collection of all these network elements. Thus the approach to design a network is to recognize the network elements and design parameters based on the needs required in the network and then start configuring the elements on the basis of parameters given. From the first part of thesis we can easily recognize these approaches. As EWSD is a modular approach we can expand the capacity of exchange by increasing the no. of modules. For increasing the capacity we need not to change the whole design of exchange. RSU is a variable unit & its capacity will be different for different locality. I have designed an exchange for TIET PATIALA and for PATIALA city. In similar way we can design such an exchange for any city.

Telecommunication industry has brought a great change in the life of people. With newer services introduced, subscribers can take a lot of advantage of these in their daily lives. As an example we can see how mobile communications has brought changes in our lives. Newer services based on concept “anywhere anytime” are bringing revolution. This concept adds to our mobility and the services are available to us where we need them. If we just take a simple example of voice communications, traditionally because of fixed telephones we must have a fixed phone near us to use the service but now because of mobile communication we can stay connected everywhere. The next step towards the planning of the network is to calculate traffic on various interfaces present in the network. Core planning for 600K Subscribers shows that land to mobile traffic is more as compared to other types of traffic and A-interfaces require more dimensioning link than to other interfaces .

Further work

The first part of thesis can be further expanded. In the first part we can connect the exchanges to a TAX exchange for providing the connectivity to other exchanges for national and international calls. We can also configure the EWSD switch to work as a TAX exchange.

In second part we have planned interfaces for circuit switched network. The work can be further expanded to planning of interfaces for packet switched network i.e. GPRS. Another thing we can do is to configure the hardware of MSC on the basis of interfaces planned.

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