C-DOT DSS MAX-VE

GENERAL DESCRIPTION

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THIS C–DOT SYSTEM PRACTICE REFERS TO THE C–DOT DIGITAL SWITCHING SYSTEM MAIN AUTOMATIC EXCHANGE-VALUE ENGINEERED (ABBREVIATED AS C-DOT DSS MAX – VE IN THE REST OF THIS PUBLICATION).

A COMMENT FORM HAS BEEN INCLUDED AT THE END OF THIS PUBLICATION FOR READER'S COMMENTS. IF THE FORM HAS BEEN USED, COMMENTS MAY BE ADDRESSED TO THE DIRECTOR (SYSTEMS), CENTRE FOR DEVELOPMENT OF TELEMATICS, 39, MAIN PUSA ROAD, NEW DELHI - 110 005

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Chapter 1.

Introduction

1.1. PURPOSE & SCOPE

This document gives an overview of C-DOT DSS MAX-VE family products. The contents of the document include details of hardware, software, signalling, interfaces, subscriber services etc.

1.2. ORGANISATION

The product details are distributed over the following chapters.

Chapter 2 provides a brief description of C-DOT DSS family products. The basic building blocks of C-DOT DSS have been introduced which are explained in detail in subsequent chapters.

Chapter 3 describes the hardware architecture of the MAX-VE switching system in detail. The contents include the architecture of different switching modules and user/network interfaces upto block level. The implementation details of other features like Network Synchronisation, Remote Switching Unit are also included in this chapter alongwith details of Common Channel Signalling No. 7 (CCS7), Integrated Services Digital Network (ISDN) and V5.X implementation.

Chapter 4 explains the software architecture of C-DOT MAX-VE. The contents include the core architecture of different software modules.

Chapter 5 describes the telephony features, supplementary services and system features. Brief description of each service with the constraints of its functioning in a few exceptional cases are included.

Chapter 6 contains details regarding the termination and traffic handling capacity of C-DOT MAX-VE.

Chapter 7 provides details of system packaging, exchange layout, climatic and environmental conditions etc.

Annex - A lists down the technical specifications of C-DOT MAX-VE as a ready reference for network planners.

Chapter 2.

System Architecture

2.1. GENERAL

C-DOT Value Engineered MAX (MAX-VE) is a recent addition to the family of C-DOT Digital Switching Systems. Products in this family cater to a wide range of network requirements with respect to capacity and applications, as described below:

- 256 Port Rural Automatic Exchange (RAX) - for use as local/integrated local cum transit switch in non-air-conditioned rural environment.
- Single Base Module RAX Based on XL Hardware (SBM-XL) - for application as local, transit or local cum transit switch upto 1536 lines.
- Single Base Module RAX based on VE hardware (SBM-VE) - for application as local, transit or local cum transit switch upto 4K lines with 480 trunks. The line to trunk ratio can be configured as needed.
- Multi Base Module exchange based on XL hardware (MAX-XL) - for application as local, transit or local cum transit switch with 56000 lines (including Access Network subscribers working on V5.2 interface) and 8100 trunks. The line to trunk ratio can be configured as needed. This is possible with 14 line BMs and 18 trunk BMs.
- Multi-base Module exchange based on VE hardware (MAX-VE) - for application as local, transit or local cum transit switch with 1,00,000 lines and 15000 trunks. The line to trunk ratio can be configured as needed. This is possible with 17 line BMs and 15 trunk BMs.

The design of these products follows a family concept. The advantages of family concept include standardised components, commonality in hardware, documentation, training, installation and field support for all products and minimization of inventory of spares. The modular design of these products has been consciously achieved by employing appropriate hardware, software, and equipment practices.

2.2. SALIENT FEATURES OF C-DOT MAX-VE

C-DOT MAX-VE is a versatile digital switch which can be configured for various applications e.g. local, ILT or TAX. This is possible due to distributed software architecture & modular hardware. This product provides capacity expansion over MAX-XL and also takes care of the hardware obsolescence in MAX.

Some design features of MAX-VE are described in the following section:

2.2.1. Flexible Architecture

C-DOT MAX-VE is a modular and flexible digital switching system which provides economical means of serving metropolitan, urban, and rural environments. It incorporates all important features and mandatory services required by the user with the option of upgradation to provide additional capacity as well as new features and services in future. The architecture for C-DOT DSS is such that it is possible to upgrade a working C-DOT SBM or MBM Exchange to provide ISDN, CCS7 & V5.2 service by adding minimum additional hardware modules while retaining existing hardware units. Another feature of the architecture is to support PSTN, ISDN and V5 subscribers through Remote Switching Unit (RSU). This unit can provide switching facility locally even in case of failure of the communication path to the parent exchange. The system employs an open-ended architecture for flexibility of configuration and growth. The processor architecture is characterised by distributed control and message-based communication in order to achieve a loosely-coupled network for a flexible system architecture.

Software is written in high level language 'C' and distributed over various processors. The application software is structured as a hierarchy of virtual machines. The software is packaged such that, depending upon the actual switch configuration, it can be distributed over appropriate controllers. The software features are implemented by communicating processes.

For inter-processor communication, messages are exchanged over HDLC links that are implemented either as direct links or switched network paths. This approach hides the physical details of processes from each other and provides a flexible communication network between the processors. New modules can be added and existing modules can be modified without affecting other modules in the system.

Resources are identified as 'global' or 'local' depending upon their distribution in the system. The resources which depend upon the number of terminals are provided within the basic growth unit, the Base Module. Base processors are provided for handling call processing locally. In a small system application, these processors independently support call processing, exchange operation and maintenance functions.

On the other hand, in order to avoid replication of large data and memory intensive functions, some features and facilities are provided centrally. Program backup, bulk data storage, man- machine interface and operations and maintenance facilities are therefore provided centrally in order to provide a means of separating the switch from the operations and maintenance interface.

2.2.2. Technology

The system employs a T-T-T switching configuration and is based on a 32-channel PCM structure. It uses a basic rate of 64Kbps and 2Mbps primary multiplexing rate. Control is distributed over the system by using 32-bit, 16-bit microprocessors. All the critical control circuitry has built-in redundancy.

System hardware utilises advanced concepts in micro electronics for a compact and optimum design. Basic memory unit has been implemented as a 32 to 128MB dynamic RAM board. Single-chip digital signal processors are used for implementing DTMF and MF and tone receivers. This approach reduces costs, power dissipation and saves space on the PCBs.

Customisation based on ASICS/FPGAs has been used to optimize space utilisation and reduce the number of components on various cards.

2.2.3. Redundancy

To meet the stringent availability requirements, C-DOT DSS employs 'hot standby' technique for all processor complexes so that in the event of the failure of any one security-block the duplicate copy takes over.

Hardware cross-links between processors have been planned in such a way that even the failure of two dissimilar processors will not affect system performance. Also, wherever there is no duplication of hardware units, multiple units are provided to work in a load-sharing mode. In the event of failure of one of the units, other units will share its load preventing disruption of service.

2.2.4. Common Hardware Units

Various hardware units such as controller complexes and message switches have been standardised for multiple applications. This interchangeability is an important feature of the system hardware that helps in reducing inventories and increasing system availability. Some of these standardised units are -

- **Module Control Unit**

  Module Control Unit is a 32-bit microprocessor complex with associated memory unit. The same unit can be used as the Base Processor Unit in the Base Module or as the Administrative Processor Unit in the Administrative Module or Central Switch Controller in Central Module. It is also used in the CCS7 unit and the V5.X unit as the CPU.

- **Interface Controller**

  This is a 16-bit microprocessor based unit with a time-switching network that can be used to control either terminal interface in the Terminal Unit or service circuit interface in the Time Switch Unit. In both the cases, its function is to assign time-slots on the 128- channel link between the terminals (subscribers, trunks, etc.) and the time switch.

- **Message Switch**

  Message Switch is implemented as a 32-bit message switch controller which provides upto 39 HDLC links for message communication between controllers. It is used in base modules as well as the central module of an MBM system.

2.2.5. Optimisation

In C-DOT DSS, distribution of functions has been optimised. There are local functions which are entrusted to the growth units, i.e., the Base Modules, for local switching and interfacing. The resources required by these, functions are directly linked with the number of lines and trunks equipped.

These functions are -

- Terminal Interfacing - interfacing analog/ISDN lines, analog and digital trunks, CCM & PBX lines.
- Circuit Switching - switching within the Base Module.
- Call Processing - majority of call processing functions.
- Concentration - for providing upto 4046 subscribers on 1024 time-slots.

On the other hand, the functions that are shared globally over the switch are provided by a central facility which may either be the Central Module or the Administrative Module. These functions are -

- **Inter-module Communication**

  Inter-BM and BM-AM communication via the Central Module.

- **Message Switching**

  Inter-BM and BM-AM control-message communication via the Central Message Switch in the Central Module.

- **Resource Allocation**

  Done by the Administrative Module.

- **Operations and Maintenance**

  Bulk data storage by the Input Output Module and man-machine interface provided by the Administrative Module via the Input Output Module.

- **Services**

  Announcements and conference circuits.

2.2.6. Modular Packaging

The equipment practices provide modular packaging. Common cards and advanced components have been used in the system hardware in order to reduce the number and type of cards. Standard cards, racks, frames, cabinets and distribution frames are used which facilitate flexible system growth. Interconnection technology has been standardised at all levels of equipment packaging. All these features, together with ruggedised design, make C-DOT DSS MAX easy to maintain and highly reliable.

2.2.7. Centralised O & M

Another important feature of the design is the provision of both local and centralised operation and maintenance. Beginning with local operation and maintenance, with the installation of similar digital switches in the network, centralised operation and maintenance will provide maintenance and administration services very economically. All these services are provided through a simple, interactive man-machine interface.

2.3. BASIC GROWTH MODULES

C-DOT MAX-VE architecture is based on the following four basic modules (Fig. 2.1)

a. Value Engineered Base Module (VE-BM)

b. Value Engineered Central Module (VE-CM)

c. Administrative Module

d. Input Output Module

2.3.1. Value Engineered Base Module (VE-BM)

The Base Module (BM) is the basic growth unit of the system. It interfaces the external world to the switch. The interfaces may be subscriber lines, analog and digital trunks, CCM and PBX lines and access networks. Each Base Module can interface upto 6000 subscribers. The number of Base Modules directly corresponds to the exchange size.

There can be various configurations of MAX-VE

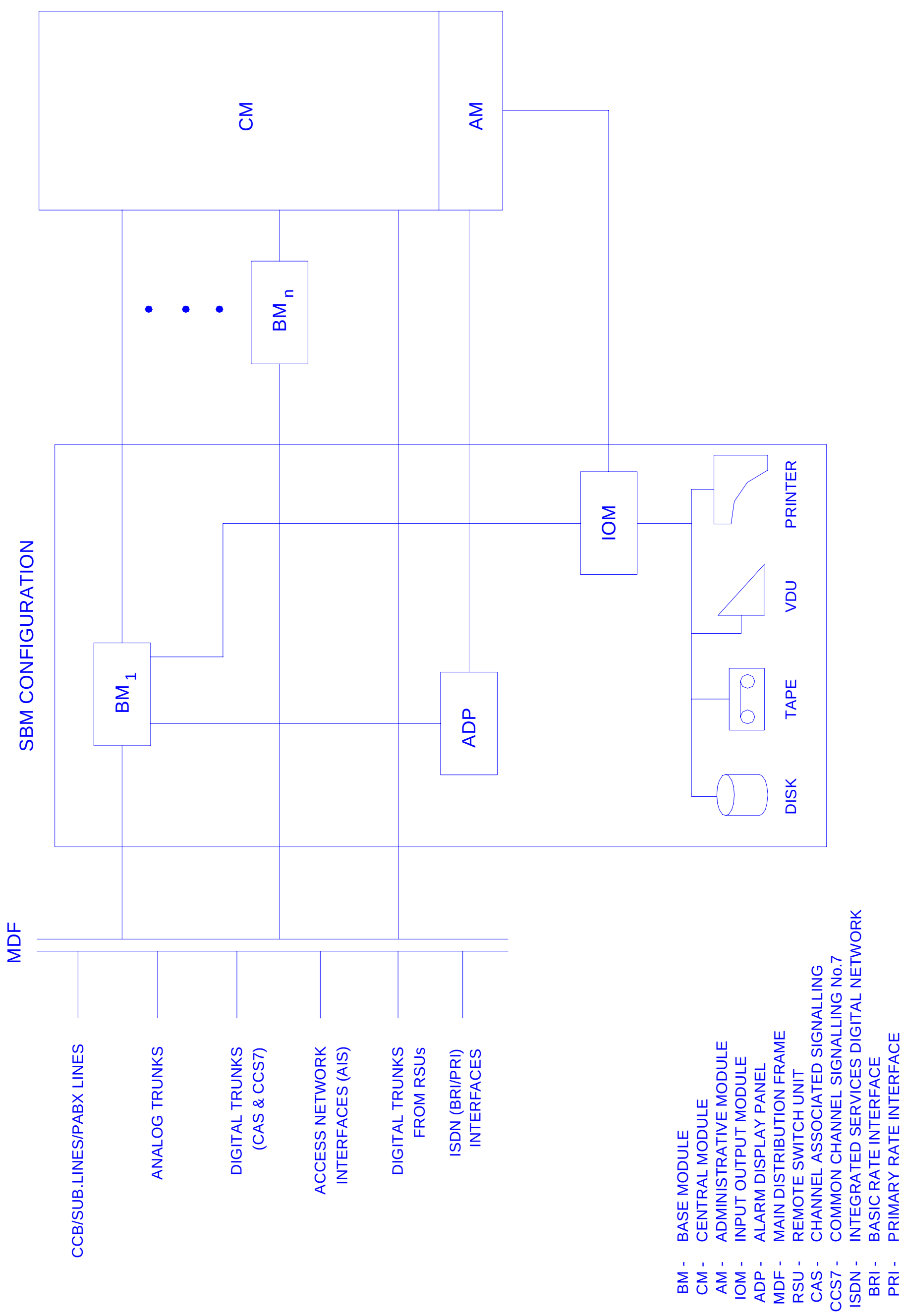

FIGURE 2.1 SYSTEM ARCHITECTURE

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Single Base Module (SBM) **-** In this configuration, the Base Module acts as an independent switching system and provides connections to 4K lines and 480 trunks. It directly interfaces with the Input Output Module for bulk data storage, operations and maintenance functions. Clock synchronisation is provided by an external equipment. It is very useful for rural environments and small urban exchange applications.

Multi Base Module (MBM) **-** In MBM configuration, a MAX-VE exchange can have upto 32 Base Modules (depending upon its size and application), a Central Module, Administrative Module, Input Output Module and Alarm Display Panel. The Base Modules can be co-located or remotely located as Remote Switch Units depending on the requirements.

Remote Switch Unit (RSU) is an integral part of MAX-VE architecture. In order to realise a RSU, any normal BM can be remoted with the host exchange via 2 Mbps/34 Mbps digital links. The number of 2 Mbps/34 Mbps links between the Main Exchange and RSU is primarily determined by the traffic. A maximum of 16 PCMs can be provided between a RSU & Main exchange. Analog and Digital trunk interfaces are also implemented in RSU to support direct parenting of small exchanges from RSU itself instead of parenting it to the main exchange in order to save the media required from main exchange. As far as call processing is concerned, RSU is an autonomous exchange capable of local-call completion. Operation and maintenance functions are handled by the host exchange. In the event of failure of PCM links, RSU goes into standalone mode of operation. In case it is not possible to process a call request due to unavailability of links to the host, the subscriber is connected to appropriate tone or announcement.

During standalone mode of operation, the local and incoming terminating calls in RSU are switched and the metering information of all the RSU subscribers is stored in the RSU. It is sent to the host whenever the PCM links are available again.

2.3.2. Value Engineered Central Module (VE-CM)

The Central Module (CM) consists of a message switch and a Time switch to provide inter-module communication and perform voice and data switching between Base Modules. It provides control message communication between any two Base Modules, and between Base Modules and Administrative Module for operation and maintenance functions. It also provides clock and synchronisation on a centralised basis.

Administrative Module (AM)

Administrative Module performs system-level resource allocation and processing function on a centralised basis. It performs all the memory and time intensive call processing support functions and also administration and maintenance functions and communicates with the Base Modules via the Central Module. It supports the Input Output Module for providing man-machine interface and also supports the Alarm Display Panel for the audio-visual indication of faults in the system.

Input Output Module (IOM)

Input Output Module is a powerful duplex computer system that interfaces various secondary storage devices like disk drives, cartridge tape drive and floppy drive. It supports printer and upto 11 serial ports for video display units which are used for man- machine communication interface. All the bulk data processing and storage is done in this module.

2.4. OTHER UNITS/ADD-ON MODULES & SERVICES

In addition to the basic units described in the previous sections, there are additional hardware units or software modules which can be added to the switch to provide various capabilities. A brief description of each of these units is provided in this section.

2.4.1. CCS 7 Signalling Unit Module (SUM)

The SUM provides SS7 signalling capability in C-DOT MAX-VE exchanges. It is housed and equipped like a terminal unit but is a module by itself with global resources for handling CCS7 protocol. It contains software and hardware for level 2 & 3 functions of ITU-T CCS7 protocol. Only one such unit is installed in the whole exchange to provide SS7 signalling capability in the exchange.

2.4.2. V5.X Unit (VU)

This unit adds V5.x capabilities to C-DOT MAX-VE exchanges. It is packaged into a standard terminal unit frame and can be equipped in any principal or concentration TU position. VU hardware is same as that of SUM.

One VU has to be equipped in each BM where V5.x interface needs to be provided. A maximum of 3072 Access Network (AN or V5) subscribers can be supported per BM. These subscribers are interfaced to the exchange using an Access Network connected to one or more E1 links of Compact Digital Unit (CDU) configured as Access Network interfaces (AIs).

2.4.3. ISDN Terminal Unit (ISTU)

This unit can be equipped as a terminal unit in any BM. A maximum of 256 bearer channels can be provided using ISTU. Out of these 256 channels, any combination of Basic rate/Primary rate interfaces can be configured.

2.4.4. Intelligent Network (IN) Services

C-DOT DSS MAX-VE can be used as an integrated Service Switching Point (SSP) for IN services. This capability can be added to an already working MAX exchange by upgrading the software and providing additional announcements for IN services. Software upgrades add CCS7 protocol for SSP Service Control Point (SCP) interface, the call processing software for processing IN service triggers and the administration interface for creating & modifying the additional data or generating reports for IN services.

Chapter 3.

Hardware Architecture

3.1. GENERAL

The hardware architecture of C-DOT MAX-VE is mapped closely on the system architecture described in the previous chapter. It consists of base modules, central module, administrative module and Input/Output module. Each module is explained below in detail.

3.2. VALUE ENGINEERED BASE MODULE (VE-BM)

Value Engineered Base Module (VE-BM) is the basic building block and growth unit of C-DOT MAX-VE. It interfaces the subscribers, trunks and special circuits. The subscribers may be individual or grouped PBX lines, analog or digital lines. The trunks may be two wire physical, E&M Four Wire, digital CAS or CCS. The basic functions of a Base Module are -

- Analog to digital conversion of all signals on analog lines and trunks
- Interface to digital trunks and digital subscribers
- Switching the calls between terminals connected to the same Base Module
- Communication with the Administrative Module via the Central Module for administrative and maintenance functions and also for majority of inter-BM switching (i.e. call processing) functions
- Provision of special circuits for call processing support e.g. digital tones, announcements, MF/DTMF senders/receivers
- Provision for local switching and metering in stand alone mode of Remote Switch Unit as well as in case of Single Base Module Exchange (SBM)

For these functions, the Base Module hardware is spread over the following types of units -

a) Terminal Units

b) Base Processor Unit

c) Value Engineered Time Switch Unit

Each of these Units is described in the following sections.

3.2.1. Terminal Units

The following terminal units can be used in MAX-VE

- ***Enhanced Terminal Unit (ETU)*** - to interface analog lines/ analog trunks/ digital trunks and to provide special circuits such as conference, announcements and terminal tester.
- ***Compact Digital Terminal Unit(CDU)*** - for interfacing digital trunks i.e. 2Mbps E-1/PCM links.
- **CCS7 Signalling Unit Module (SUM)** : to support CCS7 protocol handling in the exchange.
- ***V5 unit*** - to support V5.2 protocol for access network interface.
- ***ISDN Terminal Unit*** - to support termination of BRI/PRI interfaces and implementation of lower layers of DSS1 signalling protocol.

3.2.1.1. Enhanced Terminal Unit (ETU) (Refer Fig. 3.1)

The enhanced terminal unit (ETU) is used for interfacing 256 terminations. The types of terminations supported are analog subscriber lines, analog trunks and digital trunks. ETU can be concentrated with ISTU/SUM/VU/ CDU. Various card types used in ETU are described in the following sections.

3.2.1.1.1. Controller Card

The controller card in ETU is the Enhanced Terminal Controller (ETC) card. It provides voice and signalling interface for 256 ports and gives out an 8 Mb (128 port) link towards the time switch for inter TU switching. It also has on board provision for 30 MF/DTMF resources.

3.2.1.1.2. Termination Cards

The following card types are supported in ETU :

a) Enhanced CCM Line card (ECL) - This is a 16 port SLIC based line card which can be used to interface ordinary, CCB as well as CCM lines. It provides basic BORCSHT functions as well as reversal, 16KHz and CLIP on all 16 lines. PCM outputs of two ECL cards form one terminal group i.e., 32 channel 2 Mbps link towards the ETC.

b) Analog Trunks - Two wire trunk (TWT) and E&M four wire trunk (EMF) cards can be used in ETU to interface analog trunks.

c) Digital trunks - Two types of trunk cards can be used in this unit.

   i) RAX WLL controller (RWC) card - Each card provides two 32 channel PCM (E-1) interfaces which may be used in CAS/CCS mode. Each interface occupies one terminal group in the ETU.

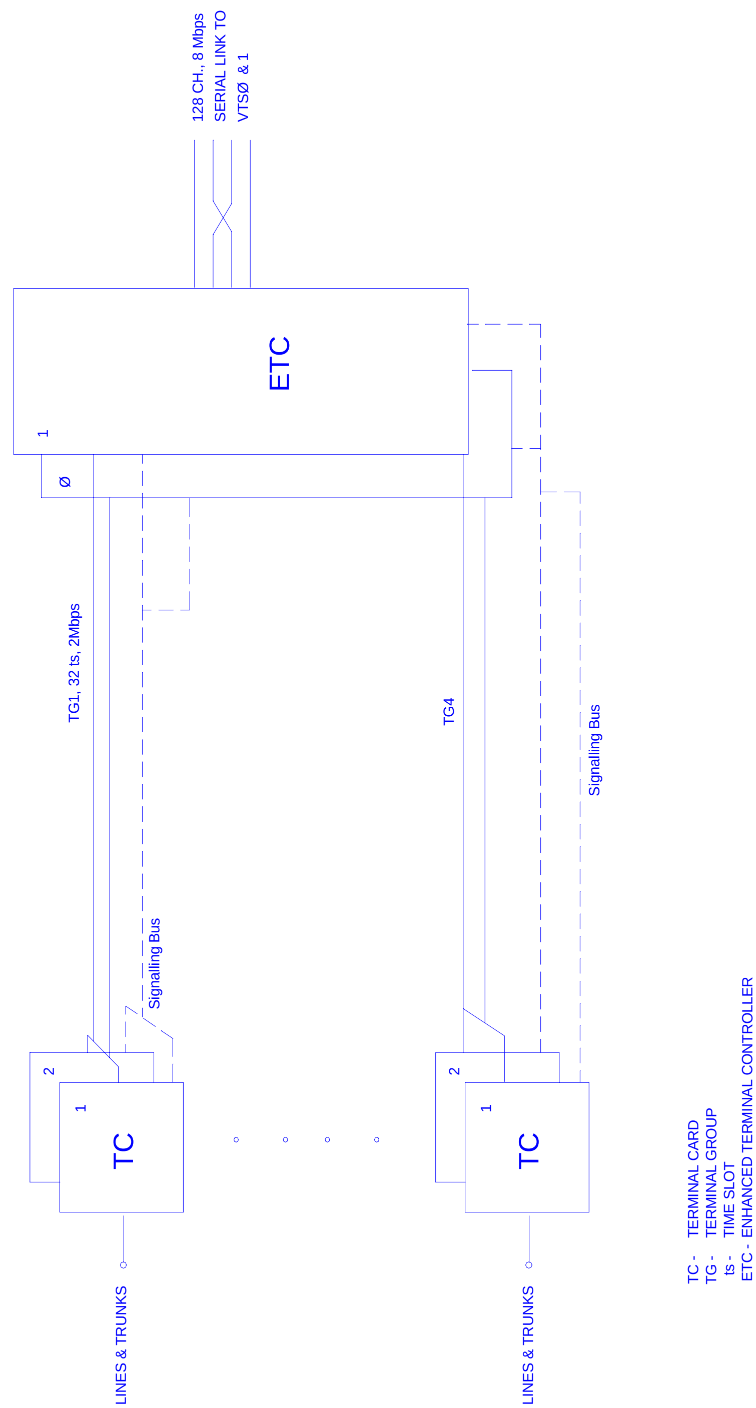

FIGURE 3.1 ENHANCED TERMINAL UNIT

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ii) Enhanced digital trunk (EDT) card - Each card provides four 32 channel PCM (E1) interfaces and takes up four terminal groups.

3.2.1.1.3. Service Cards

a) Advanced service card (ASV) - This card provides upto 14 PSTN announcements or 56 IN announcements. Upto three ASV cards can be used in ETU. One ASV card takes up one terminal group in ETU.

b) Enhanced Terminal Tester (ETT) card - This card is used to test lines/analog trunks in any TU. It occupies 16 time slots or ports in ETU.

3.2.1.1.4. Enhanced Power Supply Unit (EPU)

Two EPU cards in load sharing mode provide +5V, -12V & +12V to the ETU. Ringer voltage (75VRMS) output is supplied by one of the EPUs. This is a continuous voltage and the appropriate cadence for normal/distinctive ring is provided by dynamic software control of ring relays on line cards.

3.2.1.2. Compact Digital Unit (CDU) (Refer Fig. 3.2)

Each CDU can house upto four digital terminal units in one frame, thus providing upto sixteen E-1 links. Each terminal unit of the CDU is known as a complex - thus there can be complex 0,1,2&3 equipped as four principal TUs in a BM. CDU can be concentrated with ETU, SU and VU.

There are three types of cards in CDU :

i) Compact Terminal Controller (CTC) : These cards provide voice & signaling interface for the digital trunks in each complex of a CDU and interface towards the time switch. Each complex has two CTC cards working in hot standby mode.

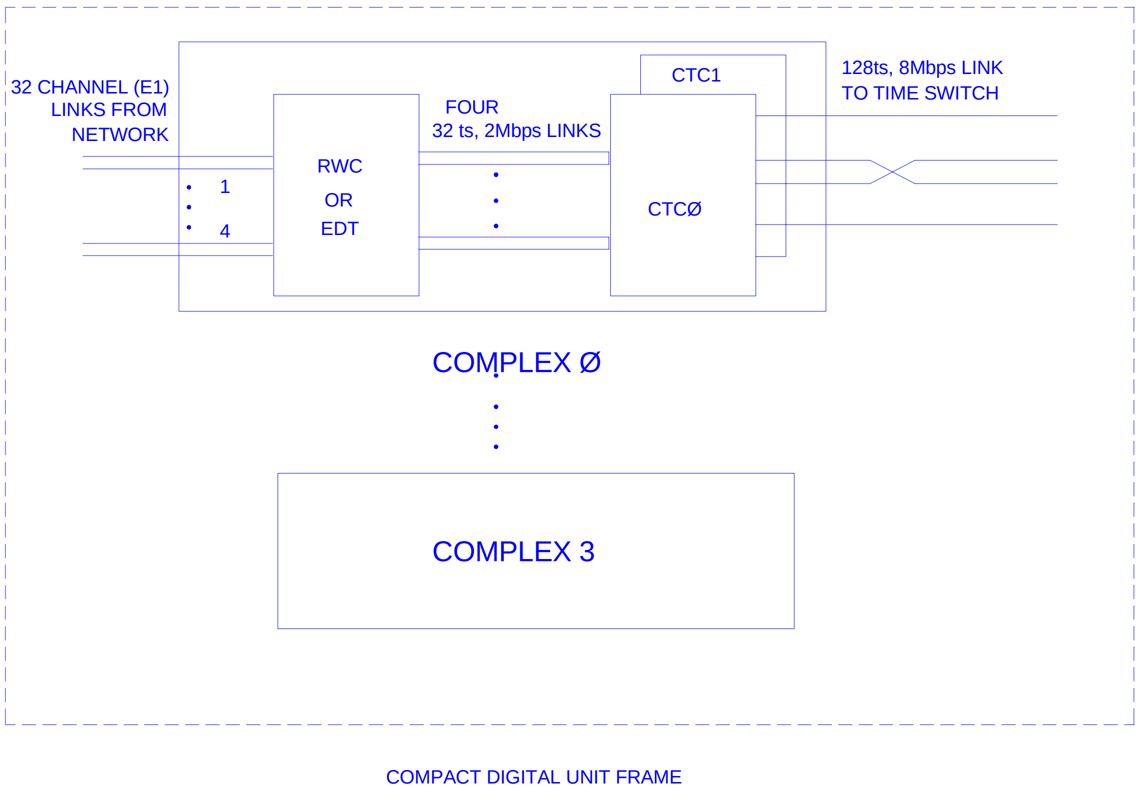
ii) Digital trunk cards : RWC as well as EDT cards (described in section 3.2.1.1.2) can be used in CDU.

iii) Power supply cards : four PSU-II cards provide the required voltages in the CDU.

3.2.1.3. CCS7 Signalling Unit Module (SUM) (Refer Fig. 3.3)

SS7 capability in C-DOT DSS MAX-VE exchanges is implemented in the form of a SS7 Signalling Unit Module (SUM) frame. Only one such unit is equipped in the exchange irrespective of its configuration or capacity. This unit can be concentrated with ETU / CDU but not with V5.X Unit.

CCS7 implementation in C-DOT MAX exchanges is based on ITU-T recommendations and the Indian National Specifications of the Telecom Engineering Centre (TEC). ISDN User Part (ISUP), Signalling Connection



NOTE 1 : EACH COMPLEX CONTAINS ONE TERMINAL UNIT WITH 4 PCMs (2Mbps)

NOTE 2 : EACH RWC CARD PROVIDES 2 PCM LINKS
EACH EDT CARD PROVIDES 4 PCM LINKS

FIG. 3.2 COMPACT DIGITAL UNIT (CDU)

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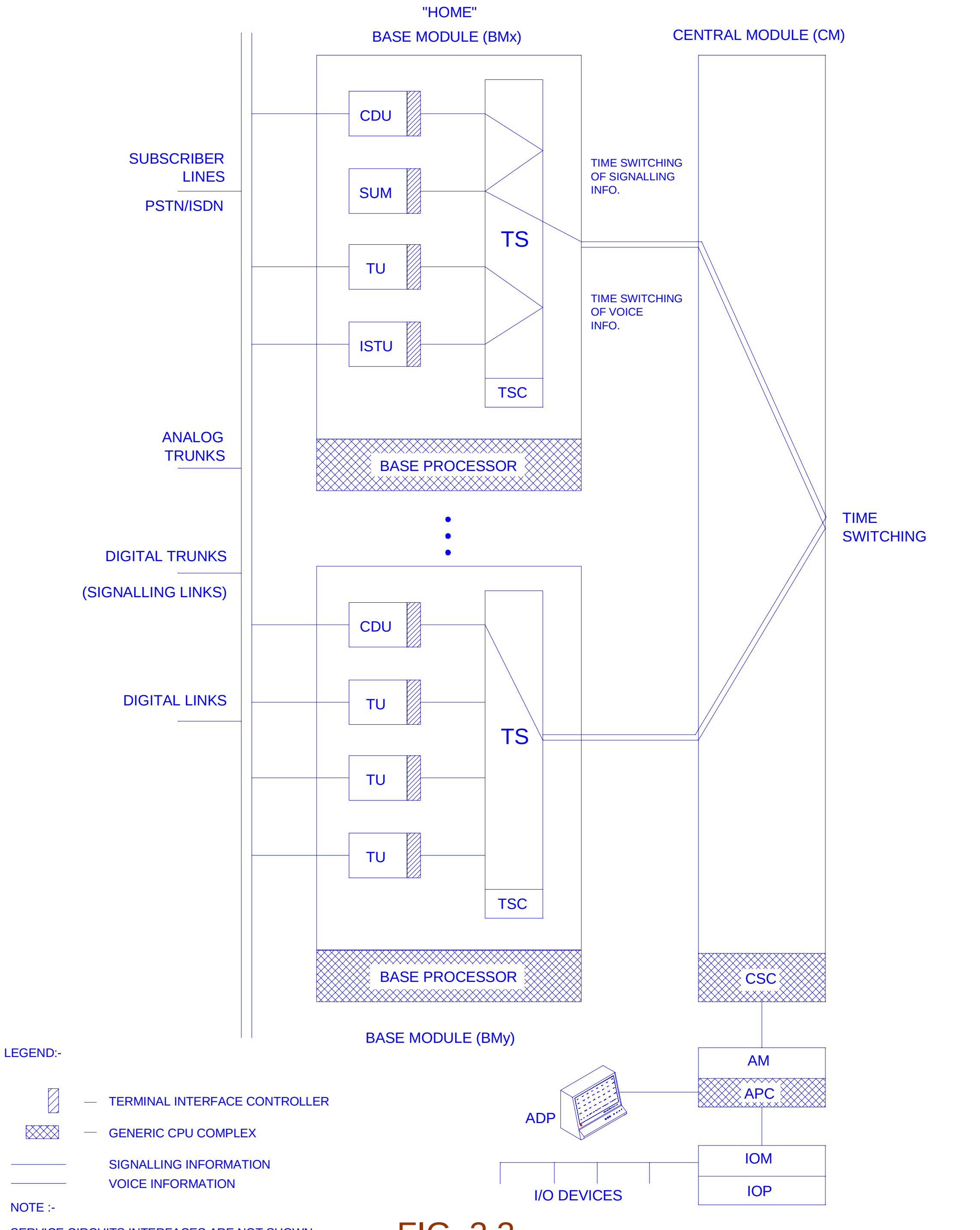

FIG. 3.3
SUM IN C-DOT DSS MAX

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Control Part (SCCP) and Transaction Capabilities Application Part (TCAP) have been implemented in the C-DOT MAX. This enables the switch to provide communications interface between Intelligent Network Application Part (INAP) across the network and to function as an Integrated Service Switching Point (SSP).

3.2.1.3.1. Architecture of CCS7 (Fig.3.4)

The SUM hardware is packaged into a standard equipment frame, similar to that of a Terminal Unit. It can be retrofitted in any Terminal Unit (TU) frame position. The place of SUM in the switch architecture is similar to a Terminal Unit even though it is a module by itself and contains global resources. It interfaces with the Time Switch via a Signalling Unit Interface Card (SUI) on a 128 channel PCM link operating at 8 Mbps.

SUM hardware comprises the following cards:

i) High Power Processor Controller for XME (HPX) Card: This is a 68040 based card which act as the central controller in SUM. There are two copies of this card – one remains active while the other lies in hot standby mode. Some layer 3 protocol functions are also resident on this card. It also handles the communication with the Base Processor of the home BM and between PHC terminals.

ii) Extended memory card (XME) : This card provides upto 128MB of memory in blocks of 32MB.

iii) Signalling Unit Interface card (SUI): This card combines the functions of terminal unit interface (TUI) card and terminal unit controller (TUC) card of MAX-XL and acts as the interface between Signalling Handler Module card and the time switch.

iv) Power Supply Cards: Two PSU-II cards provide the voltages required by various cards in the unit.

v) Enhanced Signalling Handler Cards (ESH): Each ESH card supports upto 16 Protocol Handler (PHC) terminals. Existing 8-port protocol handler cards (SHM) are also supported.

Each terminal of ESH can be soft-configured as SS7 protocol terminal, or as C.85 protocol (C-DOT proprietary protocol, a variation of X.25 protocol) terminal for internal control message communication. Each terminal buffer validates incoming messages and lists them in a receive queue for processing by level 3. The message discrimination and routing functions of level 3 are also implemented here. Similarly, it can send out messages from the transmit queue with sequence control. The terminal handles all the level 2 functions

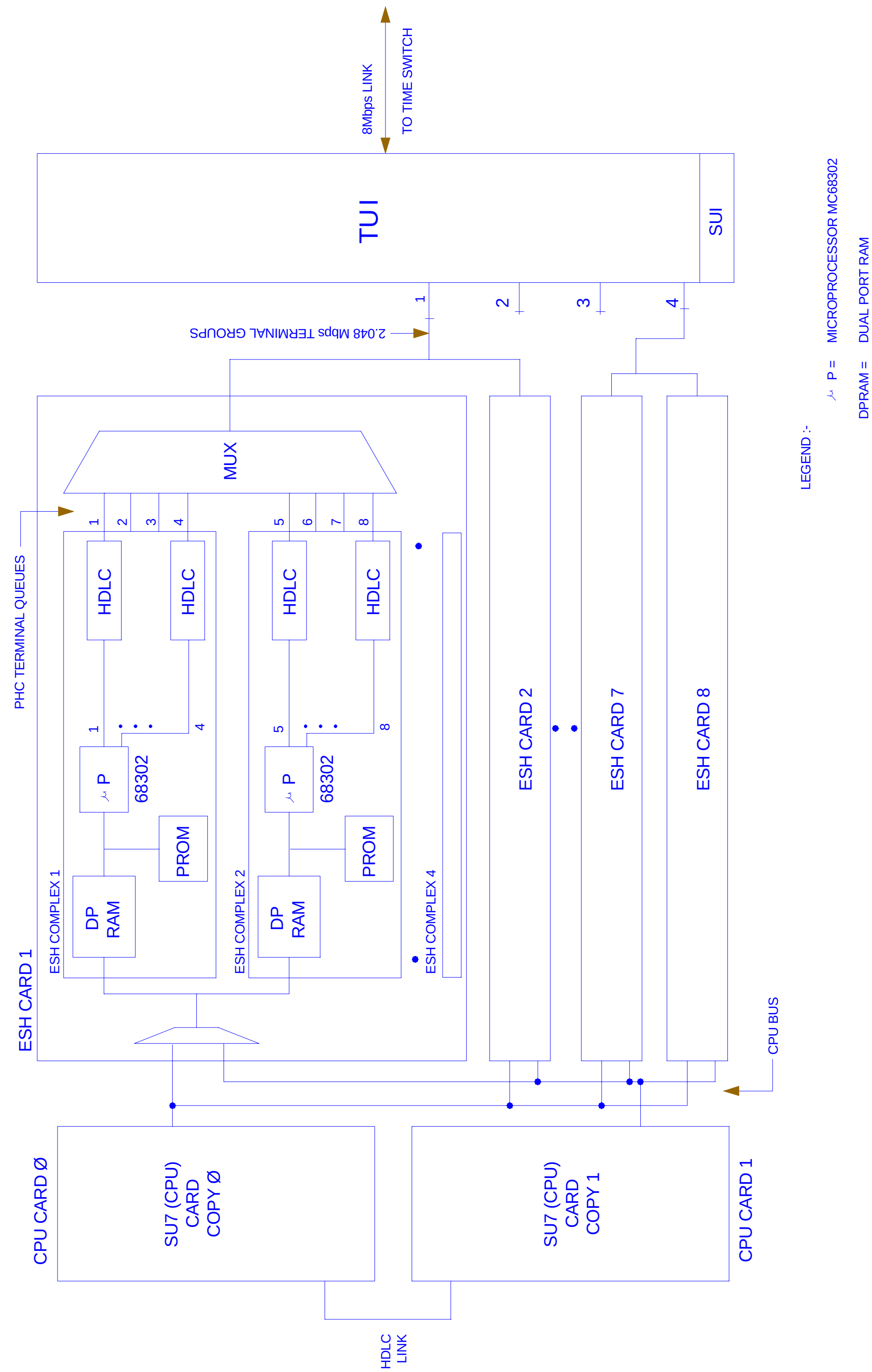

FIGURE 3.4
SUM HARDWARE ARCHITECTURE

LOTUS\VOL1\DESIGN\MAX2315\MX2315GD\MXIGD-HA including initial alignment and error correction by retransmission. As a level 2 terminal, it can handle both the Basic Error Correction (BEC) and the Preventive Cyclic Retransmission (PCR) methods. This can be soft configured at the time of link activation or switchover of a terminal. It also handles level 2 flow control functions.

Two PHC terminals are configured as C.85 terminal at the time of SUM initialisation in order to enable code and data downloading from the Input Output Module. The number of C.85 is however variable and depends upon the switch configuration.

The SS7 protocol software is distributed over the following cards:

- Signalling Handler Module (ESH) and CPU (HPX) cards of SUM
- Base Processor Card (HPX) of Home BM

The #7CPU is implemented using the HPX card based on Motorola 68040 microprocessor and 128 MB memory card (XME) in duplex mode. It can support 128 PHC terminals using eight ESH cards. The level 3 Message Handling (MH) and Signalling Network Management (SNM) functions reside here. The incoming CCS7 messages meant for own point code are routed by MH to the appropriate Base Modules as per the Circuit Identification Code (CIC) where the circuits are terminated and addressed to the relevant software processes in the Base Module, in accordance with the software architecture of C-DOT DSS MAX.

3.2.1.4. *V5.X Interface Unit (VU) (Refer Fig. 3.5)*

V5.X capability in C-DOT DSS is implemented by using a new hardware unit called V5 interface Unit (VU) in each BM where V5.x support is needed. This unit can be equipped as a principal or concentration TU. It can be concentrated with CDU / ETU, but not with SUM.

It has hardware identical to that used in SUM and software for V5 interface. It consists of CPU, memory, SUI, Power Supply cards and protocol handler cards (ESH) for V5.X.

V5 subscribers are connected on access network, which is in turn connected to the Local Exchange (LE) through E1 links, programmed as Access Network Interfaces (AIs). Protocol handling for calls to/from these subscribers is done by the VU using Enhanced Signalling Handler (ESH) cards. Each ESH card provides 16 terminals. Existing 8 port protocol handler cards (SHM) are also supported A maximum of 3072 V5 subscribers can be supported in each BM through one or more AI links.

For more details on VU hardware & S/W, please refer to V5.X User Manual.

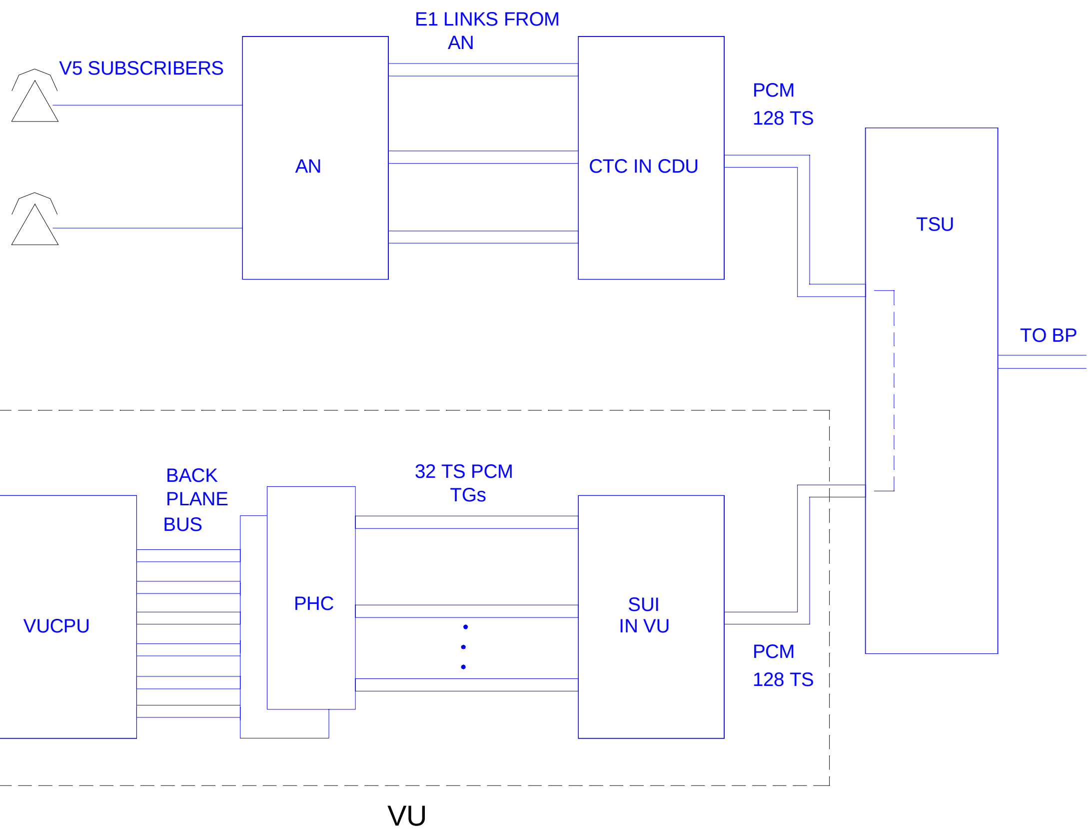

FIG. 3.5 V5.X INTERFACE IN MAX-VE

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3.2.1.5. ISDN - Terminal Unit (ISTU)

ISTU provides BRI/PRI interfaces in C-DOT DSS. By equipping one ISTU in the exchange, a maximum of 256 B-channels are available to the administrator which can be configured as BRI, PRI or any mix as per site requirement. Depending on the requirement of number of ISDN-interfaces, one or more ISTUs can be integrated in C-DOT DSS, either in one BM or distributed across different BMs.

The ISDN-traffic is of two distinct types -

i) Circuit switched voice & data

ii) Packet switched data.

In case of Circuit switched voice & data, the traffic is routed through ISDN/PSTN network. In case of packet switched data, the packet traffic is routed to PSPDN where packet processing takes place. This is an economical solution and meant for quick implementation and deployment of ISDN-Service

C-DOT has implemented ETSI - PHI 300 099 interface to PSPDN - Network (I-NET) which is being expanded as overlay network, across the country to offer wide - range of data communication services including 64/128 kbps frame relay service. Both the cases of routing the packet data traffic on Bd and Bb channels, are supported in C-DOT DSS.

3.2.1.5.1. *Architecture of ISDN Terminal Unit (Figure 3.6)*

In C-DOT DSS architecture, the ISDN interfaces are terminated on an add-on terminal unit called ISDN terminal unit (ISTU). A maximum of 256 bearer channels are provided by integrating one ISTU which can be configured to support any combination of BRI or PRI - interfaces. If the requirement of PRI/BRI interfaces are more than 256 bearer channels, one or more ISTUs can be integrated in C-DOT DSS with the option of equipping them in the same BM or distributed across different BMs in the exchange.

The architecture also supports different level of concentration ensuring the connectivity of every subscriber for signalling and providing uniform allocation of time slots for switching of Bearer channels, carrying data and voice.

The circuit switched traffic is separated at ISTU and routed towards Circuit Switch (Time Switch Unit of C-DOT DSS). Similarly packet switched traffic is routed towards PSPDN on ETSI-PHI interface.

As explained earlier, the core switching element of C-DOT DSS i.e. 'T' or 'T-T-T' functions as 'CS' element for ISDN-traffic.

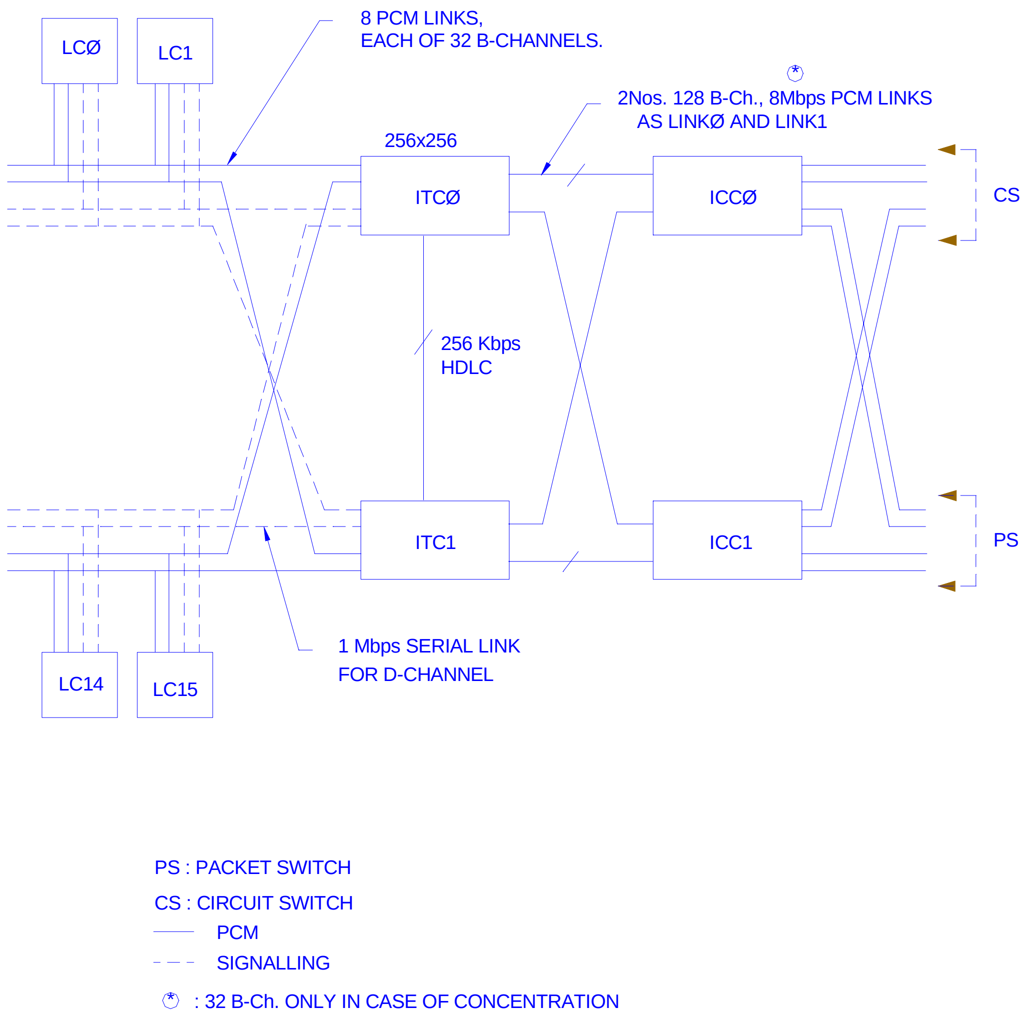


FIG. 3.6
ISTU ARCHITECTURE

LOTUS\VOL1\DESIGN\MAX2315\MX2315GD\MXIGDIA

Basic Rate Interface (BRI) is through a twisted pair of copper cable conforming to G.961 standard. It provides support for continuous powering up of NT and in emergency condition, to support one TE for POTS service with current limiting. The Primary Rate Interface (PRI) is standard 2.048 Mbps link, driven on symmetric twisted pairs with characteristic impedance of 120 ohms, conforming to CCITT I.431 standard.

The ISDN terminal cards are Basic Rate Line (BRL) and Primary Rate Line (PRL) cards.

3.2.1.5.2. *Basic Rate Line (BRL) Card* **(Figure 3.7)**

The Basic Rate Line card (BRL) is an interface to the switching system supporting '8' U-interfaces towards the user. It interfaces with the ISDN Terminal Controller (ITC)/Switching Network for signalling and switching of voice and packet information.

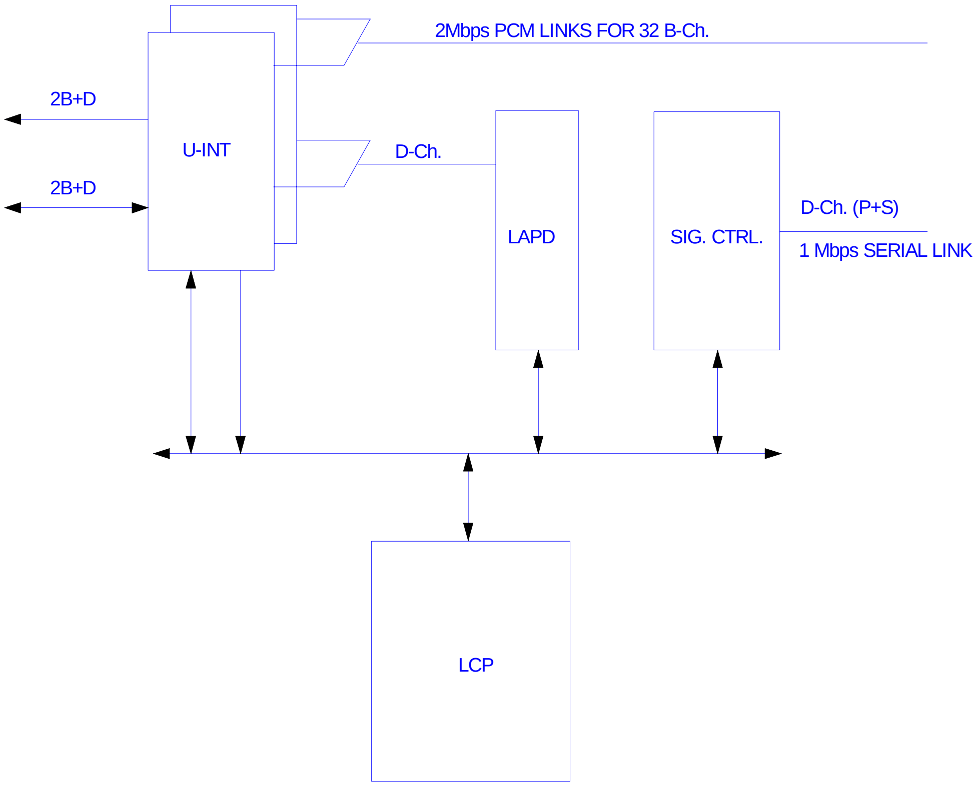
3.2.1.5.3. *Primary Rate Interface Line Card (PRL)*

The PRL Card is an interface to terminate a 2.048 Mbps link, using symmetric twisted pair cable with characteristic impedance of 120 Ohms. It conforms to ITU-T recommendations I.431, I.604, G.703, G.704 and G.706 for functional requirements. The interface can be configured for applications as (30B+D) ISDN-PRI-Interface towards ISDN PBX as well as ETSI-PHI Interface towards PSPDN.

Each PRL card forms a terminal group (TG) and a maximum of 8 PRL cards can be accommodated in each ISTU.

The PRL-Card interfaces to ITC to route signalling and voice information. The B-channels of PRI-interface are mapped on 2.048 Mbps link towards ITC. However, the procedure to handle signalling information is different for each type of interface. In case of (30B+D) interface, the D-channel signalling information is extracted from 16th time slot and converted to HDLC format before sending it to ITC card on 1.024 Mbps signalling link, shared by all the termination cards of the ISTU. It is possible to configure PRI interface as PRI-16 i.e. (16B+D) interface so that each terminal group (TG) consists of one PRL card and one BRL card.

The basic design of PRL-Card and also the implementation of ISDN services in C-DOT DSS, supports H0 and H1 channels in future without adding any additional hardware. This will be achieved by concatenating of 64 Kbps B-channels and they need not be contiguous, but should be progressive. H-channels are used for higher bandwidth requirement e.g. LAN, high speed data communication and Video transmission.



LCP : LINE CARD PROCESSOR

P+S : PACKETS AND SIGNALLING

LAPD : LINK ACCESS PROTOCOL ON D CHANNEL

FIG. 3.7

BRI LINE CARD

LOTUS\VOL1\DESIGN\MAX2315\MX2315GD\MXIGDBLC

3.2.1.5.4. *ISTU Control Unit*

The control unit interfaces BRL and PRL cards on one end and TSU on the other end. It has a 256 x 256 switch. The 256 channels are switched on to a 128 channel, 8Mbps link towards Time Switch Unit.

The D channel data traffic is switched towards ISTU where ETSI-PHI interface has been configured. Signalling data received from BRL/PRL cards, is forwarded to BP after LAPD to C.85 conversion.

The traffic on BP from an ISDN subscriber can be potentially 8-times the traffic of a non-ISDN subscriber. To reduce the load on BP, some of the functions like ISTP (terminal process), overload and concentration control are shifted to the control unit of ISTU.

The active/standby status of control units is communicated to terminal cards through the status information. The control units themselves update the dynamic events at OS/application level so that switchovers are handled properly.

3.2.2. Value Engineered Time Switch Unit (VSU)

VSU implements three basic functions : time switching within the Base Module, routing of control-messages within the Base Module and across Base Modules and support services like MF/DTMF circuits, answering circuits, tones, etc. These functions are performed by three different functional units, integrated as time switch unit in a single frame (refer Fig. 3.8).

3.2.2.1. Service Unit (SU)

Service unit comprises two types of cards: Advanced service card (ASV) & Service Circuit Interface Controller (SCIC). ASV provides tones, answering circuits & MF/DTMF resources. Upto 4 ASV cards can be equipped (two for tones and two for MF/DTMF resources). These cards form three terminal groups towards the SCIC. SCIC multiplexes these with one terminal group from HMS into one 128 channel 8 Mbps link towards the VTS. ETC/CTC cards are used as SCIC in VSU.

3.2.2.2. Base Message Switch (BMS)

Base Message Switch (BMS) routes the control messages within the Base Module, across different Base Modules, and also Administrative Module via the Central Module. It is implemented on one card i.e. High Performance Message Switch (HMS) card. This card provides 9 HDLC links for communication with SCIC, VTS, BP & mate BMS (when used as BMS) and provides a message transfer point between BP & these controllers. When

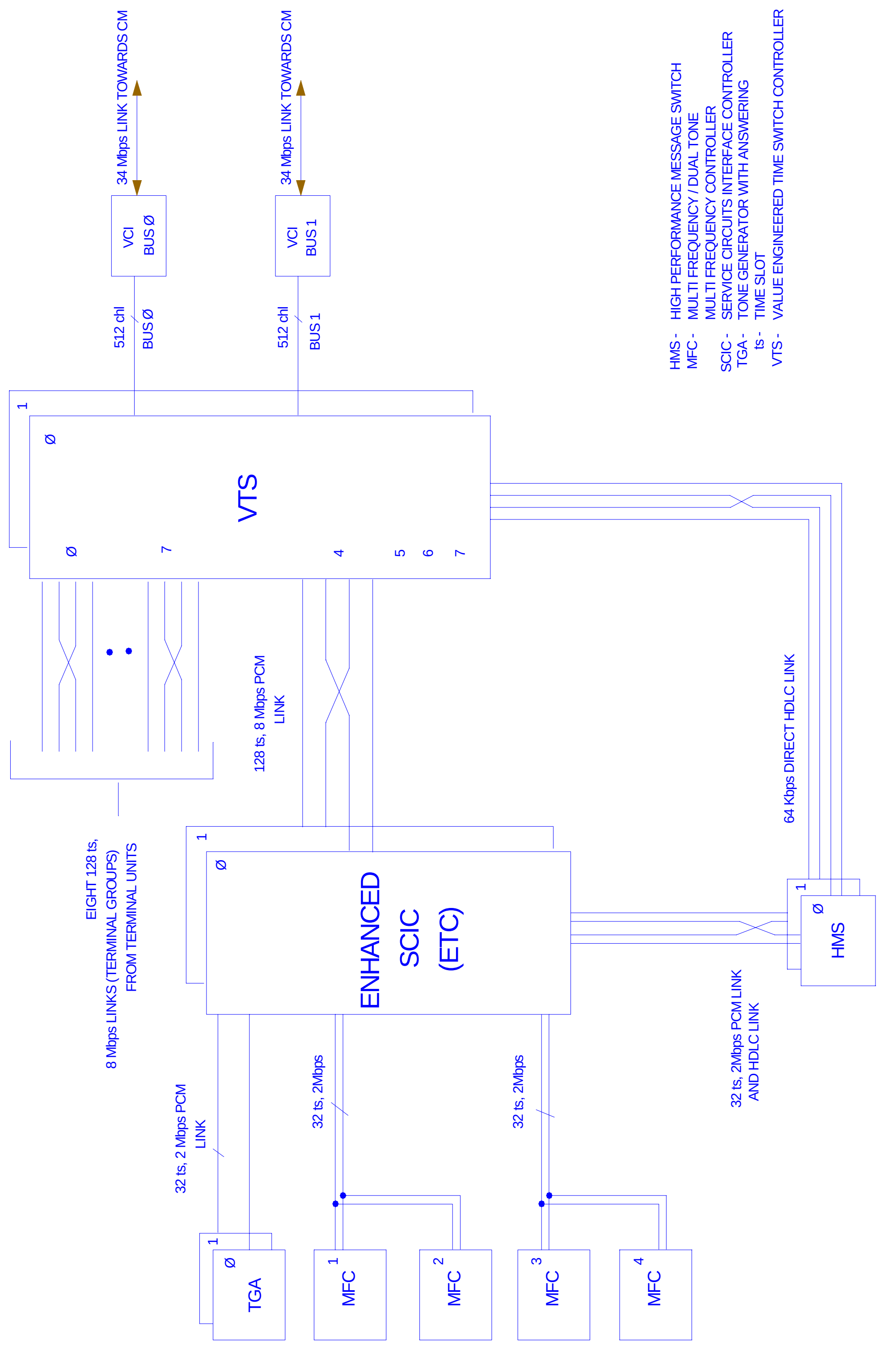


FIGURE 3.8 VALUE ENGINEERED TIME SWITCH UNIT (VSU)

LOTUS\VOL1\DESIGN\MAX2315\MX2315GD\MXISGDTU used as Central Message Switch in a CM, it has 39 HDLC links for communication with BMs, AP, CSC, IOPs, and mate CMS.

3.2.2.3. Value Engineered Time Switch (VTS)

The new value engineered time switch derives its name from its basic functionality of time switching the PCM slots. Time switching is done from TU-TU, TU-CM and CM-TU. It also has a facility of 64 four party conferences.

The card has an on board controller, time switch & communication links.

The time switch complex receives the following PCM links and performs time switching on them for switching within the Base Module :

- Sixteen 128 channel multiplexed links (8Mbps) from different terminal units. (8 each from C0 and C1).
- Two 128 channel multiplexed links from the service circuit Interface controller.

Eight 128 channel 8Mbps serial links from TUs are multiplexed into two 4 Mbps parallel bus 0 & bus 1 outputs of 512 channels each to VCI cards. VCI cards convert these into 34 Mbps (E3) serial links towards CM.

3.2.3. Base Processor Unit (BPU)

Base Processor Unit (BPU) is the master controller in the Base Module. It is implemented as a duplicated controller with memory units. These duplicated sub-units are realised in the form of the following cards :

- High Performance Controller (HPX) Card
- Memory Extender (XME) Card

HPX controls time-switching within the Base Module via the High Performance Message Switch (HMS) and the Time Switch Controller. It communicates with the Administrative Processor via HMS for operations and maintenance functions. In SBM configuration, HPX directly interfaces with the Alarm Display Panel and the Input Output Module.

Figure 3.9 summarises the various units and sub-units of the Base Module.

Any base module can be configured as a Remote Switch Unit (RSU) and connected to central module on 34 Mbps (E3) link or 2 Mbps link as shown in Fig.3.10.

a) 34 Mbps links - VBI cards are used at CM end and all the 32 BMs can be configured as Remote BMs (RBMs).

b) 2 Mbps links - CRS cards at BM end and EMC cards at CM end provide sixteen 2 Mbps links between a BM & CM.

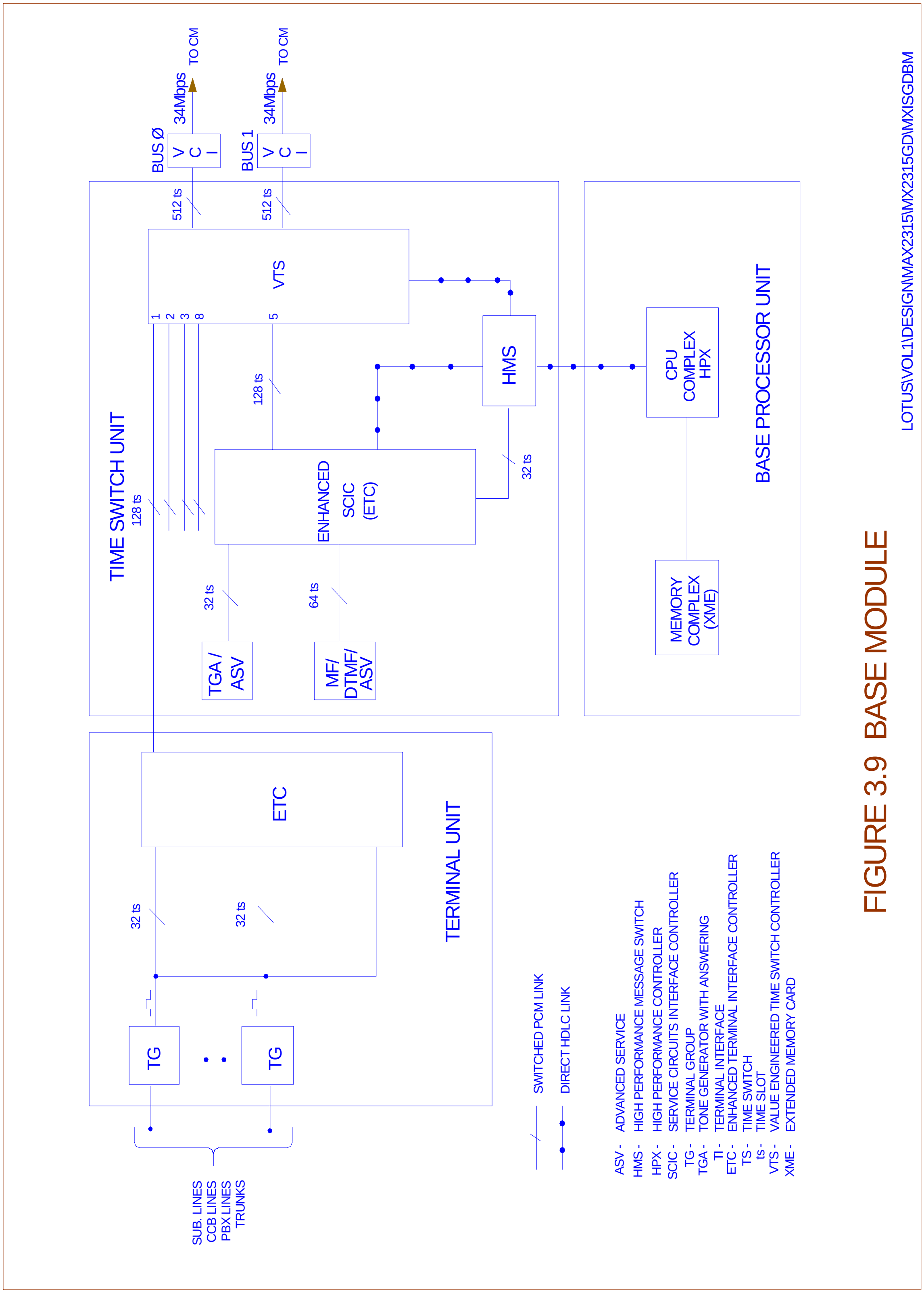
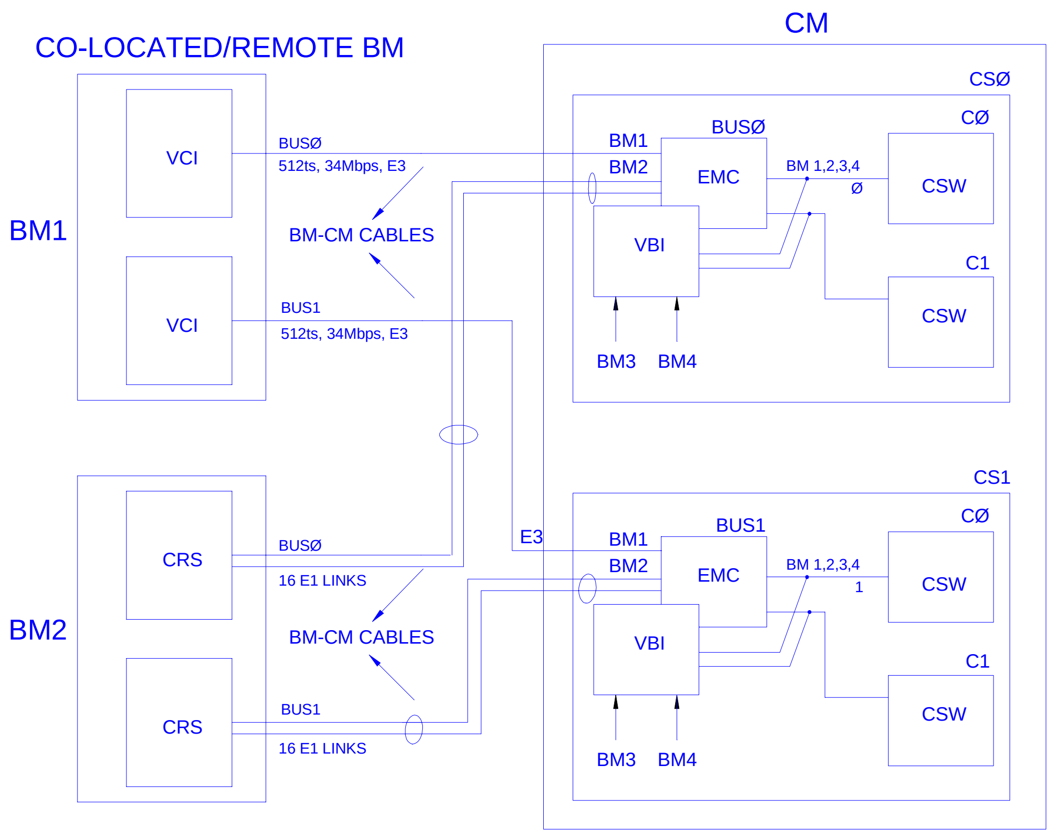


FIGURE 3.9 BASE MODULE



NOTE : FOR CONNECTION OF RBM THROUGH 2Mbps LINKS, CRS CARD WILL BE USED AT BM END AND EMC CARD AT CM END.

CS - CENTRAL SWITCH
CSW - CENTRAL SWITCH CARD
VBI - VEBM INTERFACE
VCI - VECM INTERFACE
VECM - VALUE ENGINEERED CENTRAL MODULE

FIGURE 3.10
INTERCONNECTION BETWEEN COLOCATED/REMOTE BM AND CENTRAL MODULE

LOTUS\VOL1\DESIGN\MAX2315\MX2315GD\MXISGDIB

3.3. VALUE ENGINEERED CENTRAL MODULE (VE-CM)

Value Engineered Central Module (VE-CM) is responsible for switching of inter-Base Module calls, communication between Base Modules and the Administrative Module, clock distribution and network synchronisation. For these functions, Central Module has a Central Time Switch, Central Switch Controller and a Central Message Switch.

VE-CM provides connectivity upto 32 BMs. Each BM interfaces with CM via two 34 Mbps (E3) serial links. These buses carry voice information of 1024 terminations of the Base Module towards CM. In the reverse direction, after switching has been done in the Central Switch under the control of Central Switch Controller (CSC), the same buses carry the switched voice information for 1024 terminations towards BM. Thus, in a 32 Base Module configuration, there are 64 E3 links carrying the voice information from Base Modules to the Central Module, and also the switched information in the reverse direction.

Provision for connection of RBMs to CM through E1 links is also there.

3.3.1. Central Switch (CS) and Central Switch Controller (CSC)

In order to take care of the large number of interface signals, the switch portion of CM is divided into three stages viz. MUX stage, Switch stage and DEMUX stage. The MUX and DEMUX stages are implemented on single card to provide the Base Module to Central Module interface in each direction. Interfacing and switching are controlled by CSC which provides control signals for the MUX/DEMUX cards and the Central Switch cards. Interconnection between MUX/DEMUX cards and the Central Switch is shown in Figure 3.11.

MUX/DEMUX Cards extract the information from time-slots 0 and 1 of Bus0 and Bus1 from the Base Modules. These time-slots carry control message from each Base Module and these messages are sent to the Central Message Switch (CMS). The CMS sends these messages to the Central Switch Controller (CSC) to control switching based upon this information.

Four 512-channel buses from four BMs are multiplexed to form a 2048-channel, 16 Mbps multiplexed BUS which is sent to both copies of the Central Switch (CSW) Card. Switching of these 2048 channels is done based upon the switching information received by CSW from CMS.

Clock Distribution

CM provides the central clock for distribution to the Base Modules. The 16MHz clock may be locally generated by using high stability VCXO crystal or may be derived from an external reference clock using the Network Synchronisation Controller (NSC) card. In the event of failure of external reference or duplex failure of the NSC cards the local clock is fed in the holdover mode, synchronised to last reference value. In any arrangement, the local or external clock is distributed via Central Chock Extender (CCK) cards.

The CBX card provides an interface between CSC and central switch. CSC makes any switch card access through CBX. CBX also handles power supply errors in CSU and BTU. Each CCK-CBX-NSC complex form a security block i.e. CBX0 cannot be used with CCK1. Thus there is a copy 0 complex and a copy 1 complex. The CBX also synchronises all CSC accesses to CSU with the 16 MHz clock as well as BTU.

Fig. 3.12 depicts the clock distribution in C-DOT MAX-VE.

3.3.2. Central Message Switch (CMS)

Central Message Switch (CMS) complex is the central message transfer point of the switch. It is implemented as four different message switches, working in load-sharing mode. Each message switch is a high performance message routing block, implemented by using High Performance Message Switch (HMS) card which has high speed 32 bit microprocessor MC 68040. This card supports 39 HDLC links with flexibility of programming individual HDLC links upto 750 kbps. All Central Message Switches (CMS1,2,3&4) are used for routing of messages across the Base Modules. On the other hand only CMS1 and CMS2 interface with the Administrative Module for routing control message between Base Processors and Administrative Processor. This communication is used to access office data for routing inter- module calls and administration and maintenance functions. Fig. 3.13 depicts the Central Message Switch in C-DOT MAX-VE.

3.4. ADMINISTRATIVE MODULE (AM)

Administrative Module (AM) consists of a duplicated 32-bit controller called the Administrative Processor Controller (APC). It communicates with Base Processors via the Central Message Switch for control messages and with the duplicated Input Output Processors in the Input Output Module for interfacing peripheral devices

Administrative processor is responsible for global routing, translation, resource allocation and all other functions that are provided centrally in C-DOT DSS MAX. The implementation of AM is similar to Base Processor Complex of BM, using the same hardware configuration.

3.5. INPUT OUTPUT MODULE (IOM)

Input Output Module (IOM) consists of duplicated Input Output Processor (IOP). The Input Output Processor (IOP) is a general purpose computer with UNIX Operating System. It is used as the front end processor in C-DOT DSS. It handles all the input and output functions in C-DOT DSS. The IOP is connected to AP/BP via HDLC links. During normal operation, two IOPs interconnected by a HDLC

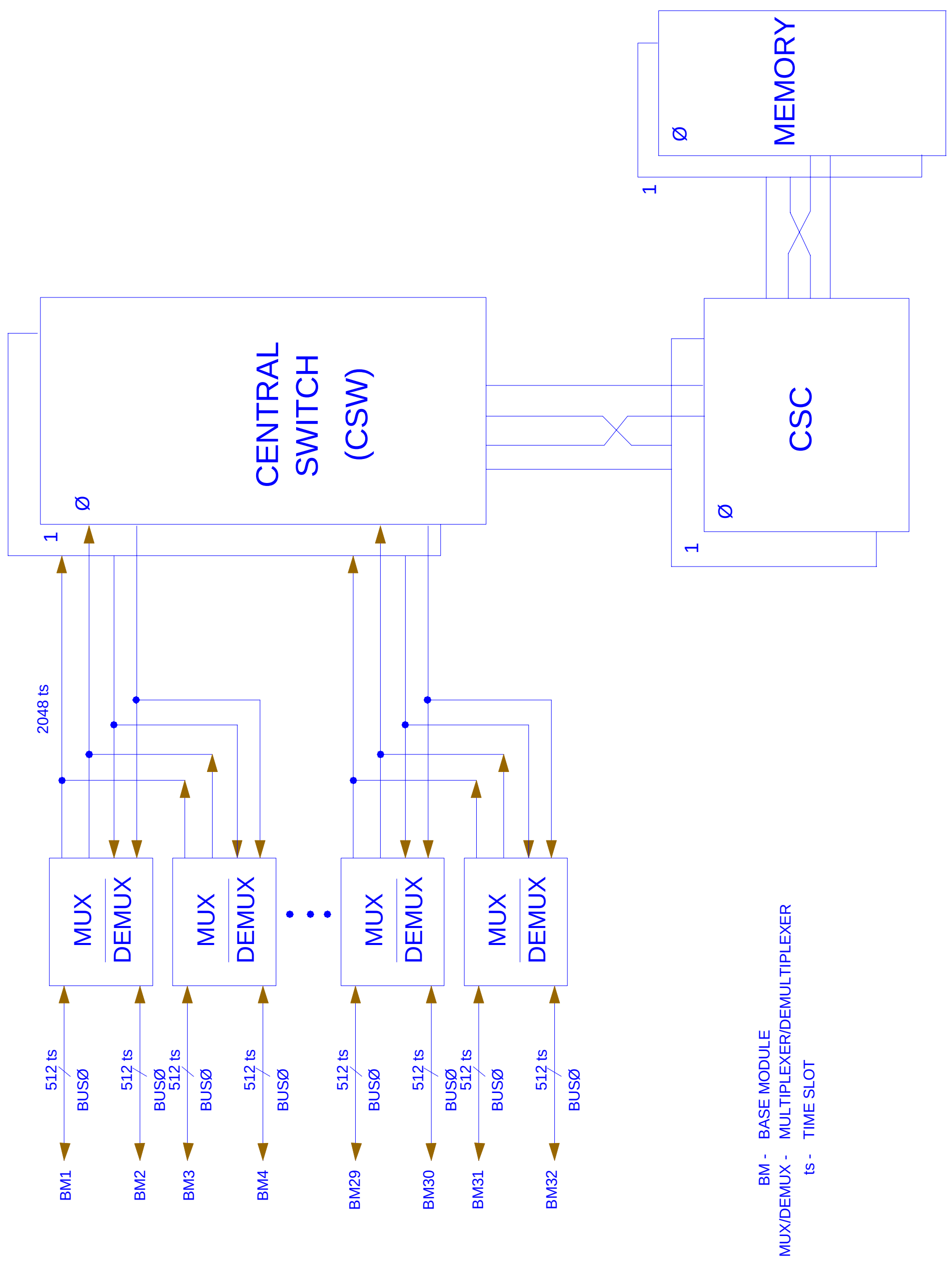
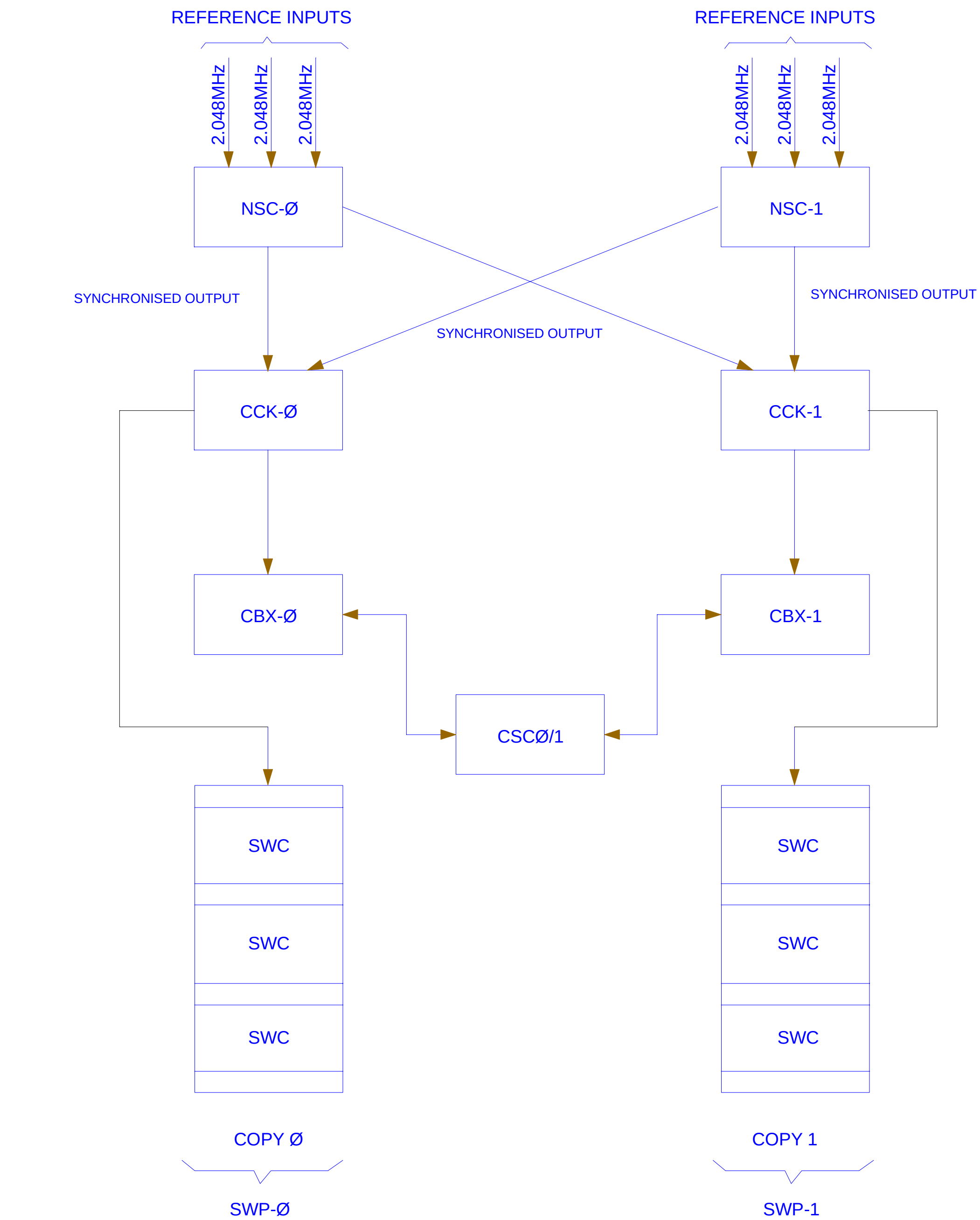


FIGURE 3.11 CENTRAL SWITCH & CENTRAL SWITCH CONTROLLER

LOTUS\VOL1\DESIGN\MAX2315\MX2315GD\MXISGDSS



SWC : SWITCH CARDS
SWP : SWITCH PLANE

FIG. 3.12
CLOCK DISTRIBUTION IN C-DOT DSS (MAX-VE)

LOTUS\VOL1\DESIGN\MAX2315\MX2315GD\MXISGDCD

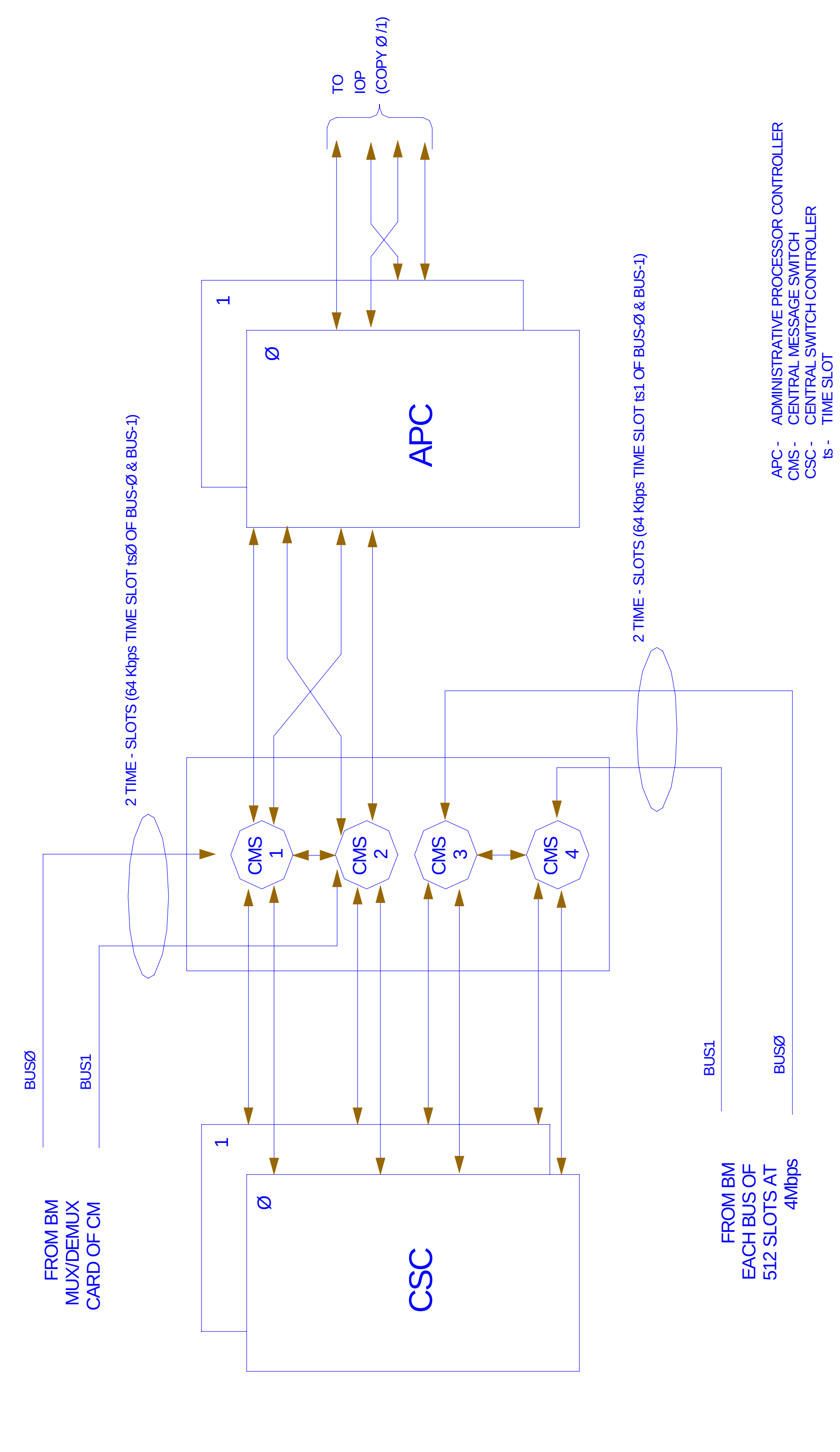


FIGURE 3.13 CENTRAL MESSAGE SWITCH

LOTUS\VOL1\DESIGN\MAX2315\MX2315GD\MXISGDCS link, operate in a duplex configuration. Working as front end processor, it provides initial code down load to the subsystems, man machine interface and data storage for billing and other administrative information. Refer Fig. 3.14 for IOP-VH architecture.

3.5.1. IOP-VH Hardware Architecture

The IOP-VH is value engineered high performance IOP, designed using a single card. The IOP CPU uses MC 68040 (25 MHz) processor on the VHC card. It has 16 MB (expandable to 32 MB) onboard DRAM and 512 KB EPROM. All active IOP processes reside in the dynamic RAM. Also the data being transferred through HDLC links, secondary storage devices and terminals, use the dynamic RAM. The IOP as a module is duplicated to provide redundancy for cartridge and disk drives as well as serial communication terminals and printers.

The system has provision for 7 HDLC channels. Two of these are used to connect the IOP to both the copies of AP/BP. The third link is for connection with mate IOP when the two are working in synchronisation i.e. duplex IOP configuration. The rest four links are spare at present but may be used towards the four CMSs in future. Eight RS-232C Serial Links (through ASIO ports) are also implemented for connecting operator terminals and printer to the IOP in addition to two ports as Console and Host.

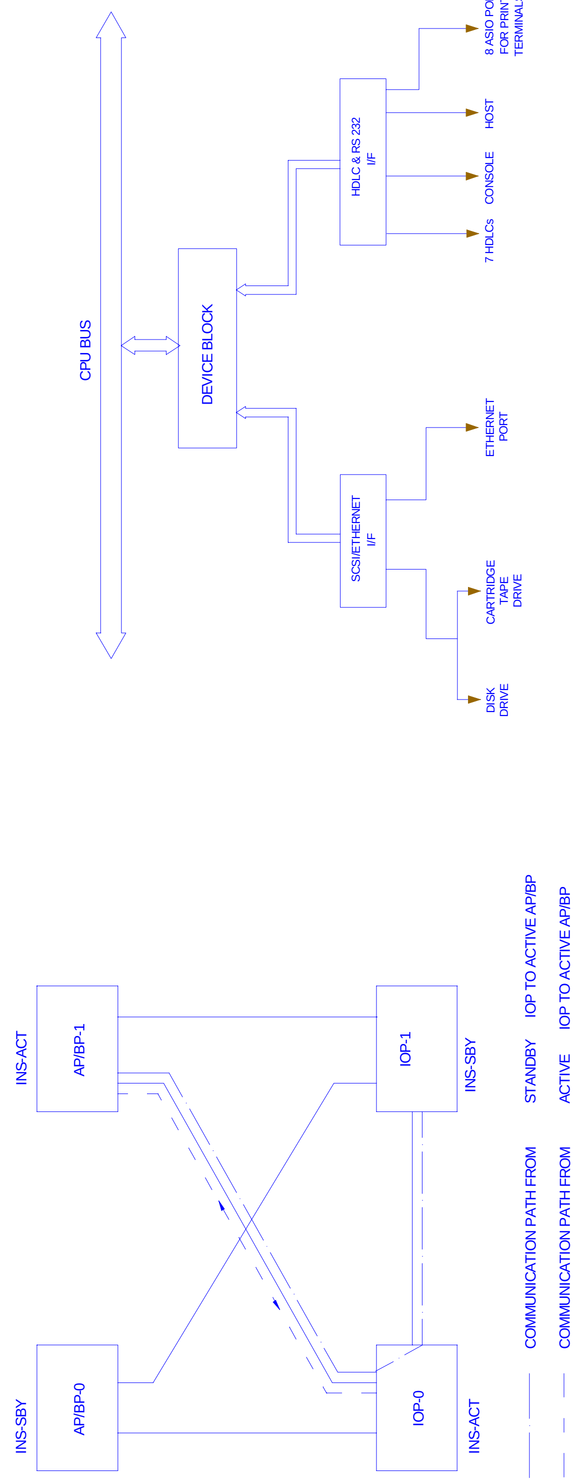
The monitor based operations are performed only from the Console and the same is true in case of login to ‘root’ account. The operations like initial boot-up, software link loading etc. could be performed only from the Console. One X.25 port is implemented for 64Kbps full duplex link to communicate with Centralise Billing/Telecom Management Network Centre. In addition, one 10 Mbps Ethernet port is also implemented in the IOP-VH which has AUI or Co-axial interface support at physical level to allow networking of user terminals in future. A SCSI-2 controller with integrated DMA and SCSI cores is used for interfacing the disk drive and cartridge tape drive.

Note :

Presently the two ports, namely X.25 and ETHERNET are not supported in current UNIX release.

IOP-VH Peripherals

Input Output Processor (IOP-VH) supports three standard SCSI-2 interfaces, on VHC card, one each for Winchester Drive, Cartridge Tape Drive and one as spare. Here, it may be noted that only the peripherals with SCSI-2 interface can be used in IOP-VH.



C-DOT IOP-VH ARCHITECTURE

DUPLEX IOP CONFIGURATION

FIG. 3.14

LOTUS\VOL1\DESIGN\MAX2315\MX2315GD\MXISGDDC

3.6. NETWORK SYNCHRONIZATION IN C-DOT DSS

All the three modes of operation of Network Synchronization are implemented in C-DOT DSS. These are:

i) Locked Mode: When one or more primary reference clocks are available, NSC/ NSE enters into locked mode by selecting one of the available network clocks according to fixed priority and synchronises to it.

ii) Holdover Mode : When NSC/NSE loses the network clock to which it was locked and when no other network clocks are available, it enters the holdover mode in which it synchronises to the last reference value.

iii) Free Run Mode : When none of the network reference clocks are available and no locking to external reference has taken place before. In this mode system works on its local clock.

In C-DOT DSS MAX, Network Synchronisation Controller (NSC) Card synchronises the local clock of the exchange with the network clock. It gets input clocks from digital trunks connected to higher level or same level exchanges. It has an on-board clock source. It gives a network synchronised clock and SYNC signals to the duplicated Central Clock (CCK) card.

The CCK is controlled by the CSC through CBX. It generates its own clock and can be configured to select between the local clock and two copies of NSC clock. Each clock card distributes 16 MHz clock and 8 kHz SYNC to self CSU and 16 MHz clock to all Bus Termination Units (BTUs) which receive switched data buses from all the BMs connected to CM.

In case of SBM exchanges, the function of NSC card is achieved by external add-on synchronization equipment C-DOT-NSE. In this mode of operation, the system works on external clock, received from C-DOT NSE instead of using its own clock. However in exceptional case of failure of both the clock sources from C-DOT-NSE, the system has provision to switch over to its own clock.

A brief description of implementation of Network Synchronization in C-DOT DSS using NSC card along with its functional block is explained below.

3.6.1. Function of NSC Card

- The NSC card forms the interface between EDT (Enhanced Digital Trunk card) and the CCKs (Central Clock Cards). It receives the 2.048 MHz reference input clock from EDT and converts it into a 16.384 MHz clock using a PLL (Phase Locked Loop). This clock is fed to both copies of CCKs. It also generates a sync signal (8 kHz) and feeds it to the CCKs for further distribution to all the BMs.
- The NSC has an On Board Micro Processor (OBMP) to take care of the PLL functions, diagnostics, communication with SSC

3.6.2. Duplication and Security block

The NSC card is duplicated and its access is similar to CBX cards. The NSC and CBX form a security block as there is only one device enable for each

NSC-CBX pair. The 2.048 MHz clock and 8 kHz sync signal are exchanged between the two copies of NSC. Clock selection is done before the PLL block. If all the inputs to the NSCs fail, it runs in the “holdover” mode. If the inputs are not restored till the end of the holdover period, (duration of the holdover period is defined in the Parameteric Specifications), the NSCs go into the "free-run" mode. The NSCs work in mutual synchronisation as the PLLs track each other.

3.7. ALARM DISPLAY PANEL

Alarm Display Panel (ADP) is a microprocessor based hardware unit which is attached to the BP (in SBM configuration) or AP (in MBM configuration) via HDLC links for providing audio-visual indication of system faults. It is a three card implementation. A matrix of LEDs is provided to indicate the maintenance status of the switch units and their level of initialisation. A seven-segment display shows the count of lines and trunks currently faulty. Keys are provided for manual acknowledgment, initiating self test and selective audio disable.

Chapter 4.

Software Architecture

4.1. INTRODUCTION

The software architecture of C-DOT DSS MAX is distributed in nature and has been designed to map onto the distributed control architecture of the system. The switch hardware is surrounded by a number of software layers, each of which presents higher levels of abstractions for the successive upper layers of software. The major design objectives of the C-DOT DSS MAX software and the strategies employed to achieve them are :

- ***Simplicity :*** Layered architecture, loosely coupled modules, and well defined message interfaces between modules.
- ***Maintainability :*** Use of high-level programming language, proper documentation, and modular design. Increased reliability due to fault-tolerant software with automatic audits and recovery.
- ***Efficiency :*** Time-critical processes coded in assembly-level language and very strict checks on execution-times of all software modules.

4.2. SOFTWARE ARCHITECTURE OVERVIEW

C-DOT DSS MAX software is divided into a number of subsystems. Each subsystem consists of a number of modules which are called 'processes'. A process consists of a number of functions which are the smallest units in the software hierarchy.

4.2.1. Processes

There are two types of processes in the system. Eternal processes are created at the time of system initialisation and remain alive throughout the life of the system. Dynamic processes, on the other hand, are created whenever an event requiring the services of that particular type of process occurs. After processing the input, the process dies whenever the logical chain of events come to an end. While only one instance of an eternal process can be active within a processor at one time, multiple instances of a dynamic process may exist at a given time in a processor.

For example, the Status Control Process (SCP) gets a seizure on a particular terminal and does subsequent processing. After validating the origination, if originating calls are allowed from the terminal, SCP creates an Originating Terminal Process (OTP) which manages the terminal till the termination of the call and then kills itself. While there will be only one SCP in the processor, the number of OTPs will be equal to the number of terminals in the call set-up phase at any moment.

4.2.2. Software Subsystems

The main subsystems of C-DOT DSS MAX software are (Figure 4.1):

1. *C-DOT Real-Time Operating System (CDOS)*
2. *Peripheral Processors Subsystem*
3. *Call Processing Subsystem*
4. *Maintenance Subsystem*
5. *Administration Subsystem*
6. *Database Subsystem*
7. *Input Output Processor (IOP) Subsystem*

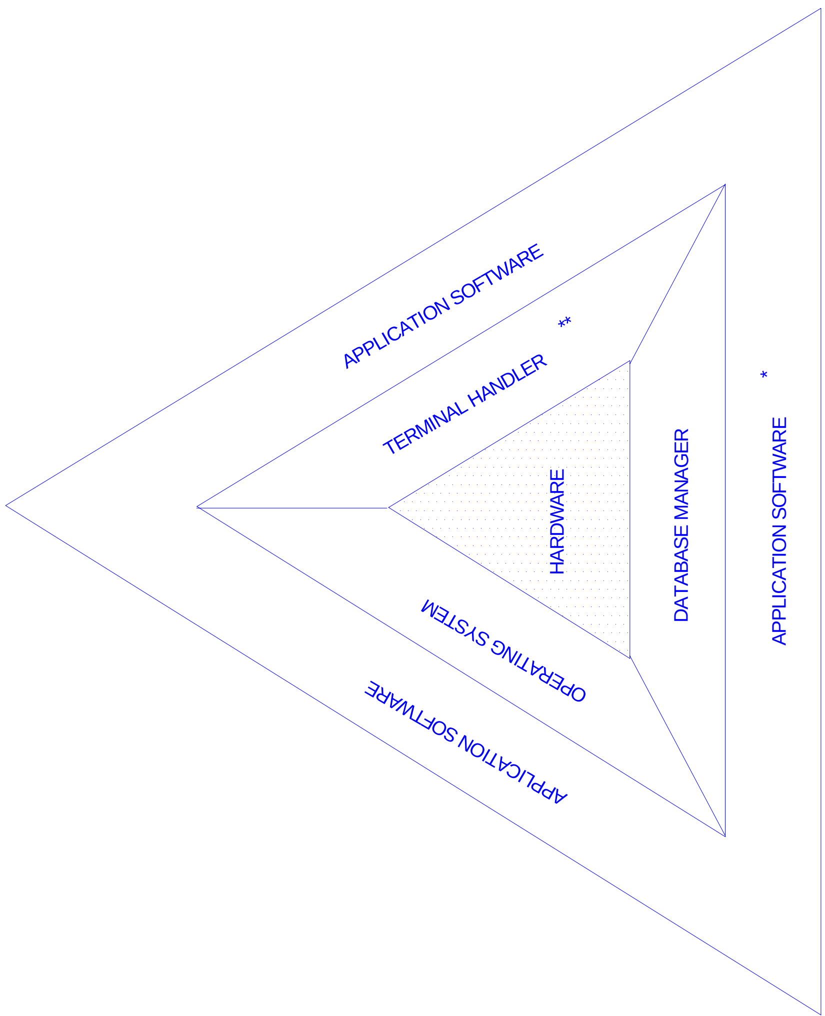
4.3. C-DOT REAL TIME OPERATING SYSTEM (CDOS)

The operating system is primarily responsible for the following functions and services (Figure 4.2) :

- Management of Processes
- Synchronisation and Communication between Process
- Time Management
- Interrupt Handling
- Resource Management
- Memory Management
- Online and Offline Debugging Facility

The operating system has been designed to minimise the overheads in terms of real time. Each set of primitives has a number of options through which additional information can be passed on for synchronization and mutual exclusion.

In the distributed architecture of C-DOT DSS MAX, one of the important roles played by the CDOS is to provide an effective interprocess communication between processes residing in the same or different processors. A sender process is transparent to the fact whether the destination process resides in the same or different processor. For communication between processors, CDOS makes use of C.85 protocol which utilises the HDLC based message network between processors (Figure 4.3).



* APPLICATION SOFTWARE CONSISTS OF CALL PROCESSING, MAINTENANCE, AND ADMINISTRATION SOFTWARE SUBSYSTEMS.

** TERMINAL HANDLER SOFTWARE IS A PART OF THE PERIPHERAL PROCESSORS SUBSYSTEM.

FIG. 4.1
C-DOT DSS MAX LAYERED SOFTWARE ARCHITECTURE

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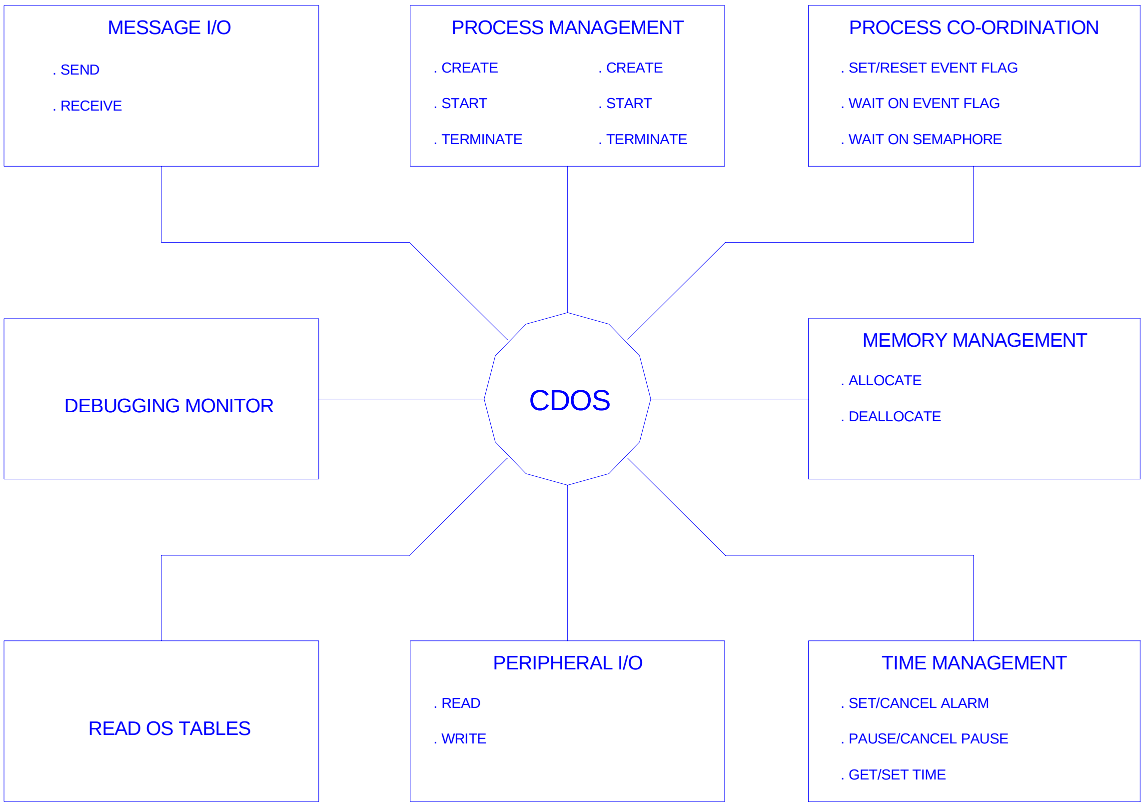

FIGURE 4.2
OS SERVICES IN C-DOT DSS MAX

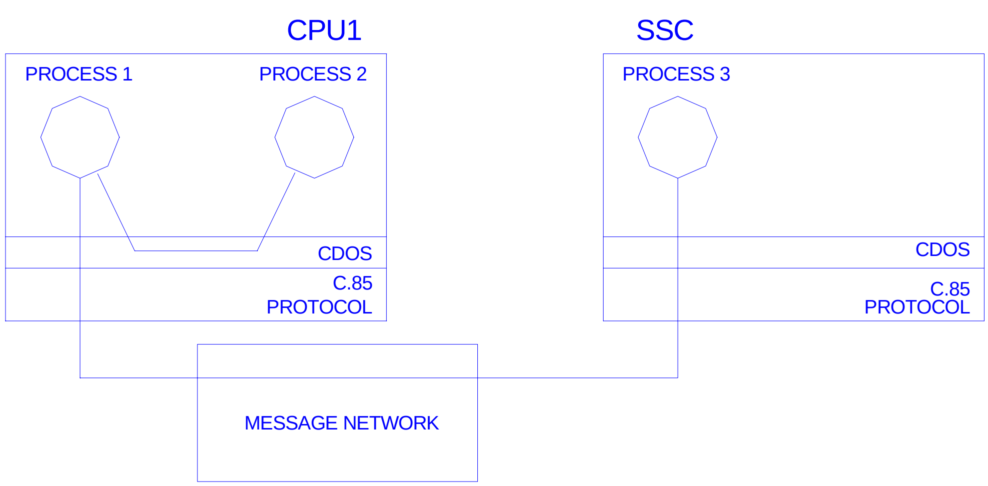

FIGURE 4.3
INTER-PROCESS COMMUNICATION THROUGH CDOS

LOTUS\VOL1\DESIGN\MAX2315\MX2315GD\MXISGDOI

4.3.1. Peripheral Processor Subsystem

The telephony software for handling lines, trunks, and service circuits is controlled by the Peripheral Processors. These are 16-bit microprocessors programmed in assembly-level language. The main activity of the telephony software is to detect events and communicate them to the Base Processor where logical call handling is done. The Peripheral Processors also carry out the commands given by the Base Processor for generating suitable telephony events on the outgoing lines and trunks.

Events like line seizure, answer, disconnection, and signalling information between exchanges, etc., are examples of telephony events which are processed by the Peripheral Processors. These events are converted into a set of pre-defined messages which are sent to the Base Processor for subsequent processing. Transmission of ringing current, outpulsing of decadic digits on a junction and sending MF signals on junctions are some of the examples of the events which are created by the Peripheral Processors under the control of the Base Processor and sent on the outgoing external lines and trunks.

Another important function of Peripheral Processors is to carry out all the maintenance related test functions on hardware. Peripheral Processors operate test functions to be used by the maintenance software resident in the Base Processor.

Since the firmware of the peripheral processors must be real-time sensitive, it is programmed in assembly-level language and fused into EPROMs. The firmware along with the hardware provides a higher logical view to the other software subsystems and effectively insulates the hardware details from the application programs.

4.3.2. Call Processing Subsystem

The Call Processing software subsystem receives the information about telephony events that occur outside the exchange. It processes this incoming information and gives commands to the Peripheral Processors for interconnecting subscribers through the switching network.

The Call Processing subsystem is divided into a number of eternal and dynamic processes. The processing of a call is done on a 'half-call basis', i.e., corresponding to an originating terminal, an Originating Terminal Process (OTP) is created. Similarly, corresponding to a terminating terminal, a Terminating Terminal Process (TTP) is created. To supervise these two processes, a Call Manager (CMR) is created on a per-call basis. Different combinations of originating and terminating terminal processes enable the system to handle local, outgoing, incoming, and transit calls. Figure 4.4 shows the processes involved in handling a call in a Multi Base Module (MBM) configuration. Feature handling is done at the Call Manager level.

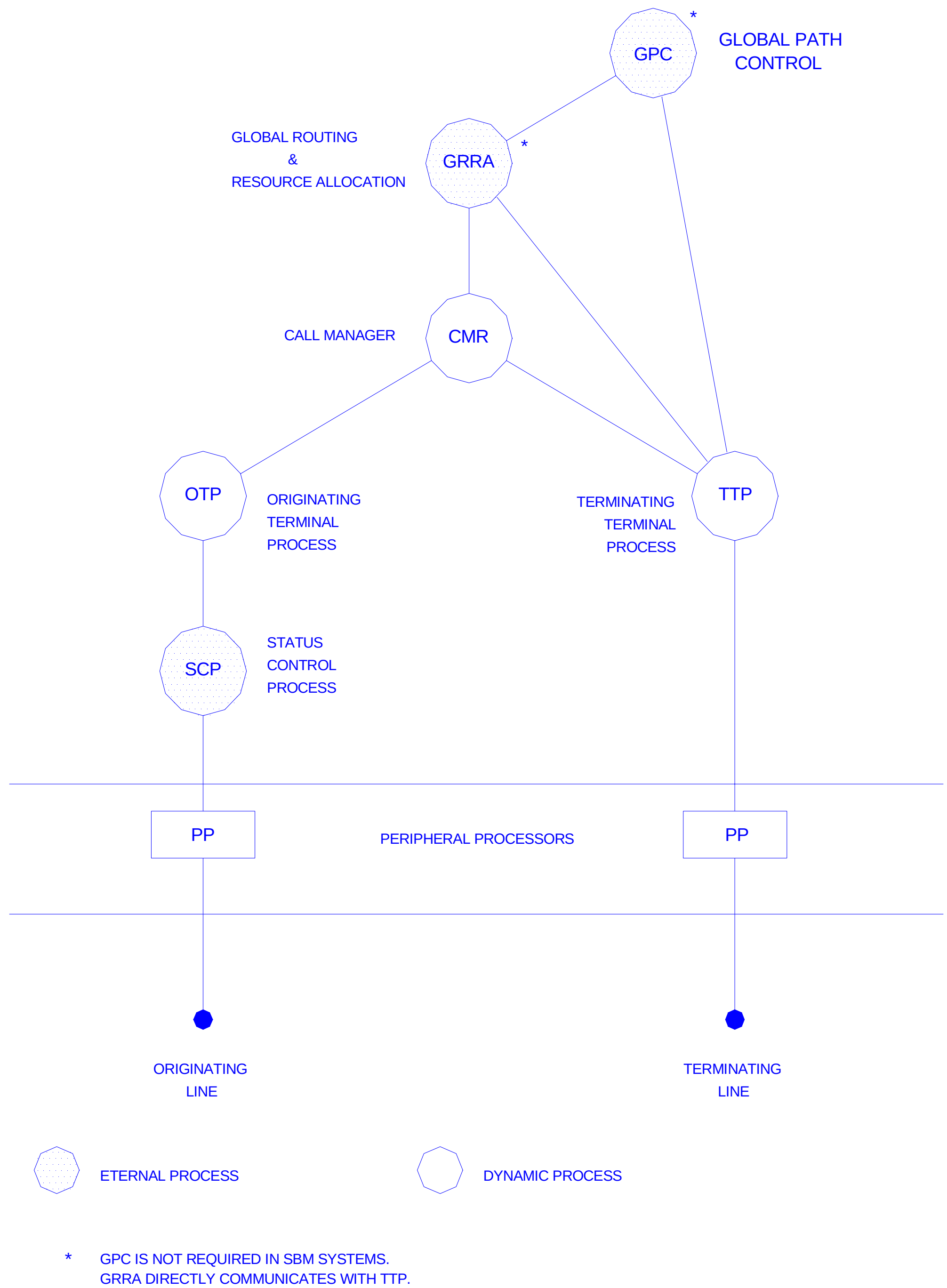

FIGURE 4.4
PROCESSES IN CALL PROCESSING SUBSYSTEM

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Routing is handled by Global Routing and Resource Allocation Process (GRRA) and path allocation is done by Global Path Control (GPC) process. In Single Base Module (SBM) configuration, GPC is not present. All access to the data are made through Data Base Access Routines (DBARs). A special feature of the Call Processing software subsystem is generation of an exhaustive Call Event Record (CER) on every call. This Call Event Record contains the complete detail of a call and is sent to the Administration Software subsystem, at the termination of the call. The Administration subsystem, in turn, processes the Call Event Records for extracting billing and traffic related information in the form of reports. In case the call involves a terminal under observation, a Call Detail Record (CDR) is also generated.

4.3.3. Maintenance Subsystem

The Maintenance software subsystem is responsible for the following major functions:

- Initialisation
- System integrity
- Switch maintenance
- Terminal maintenance
- Human interface

4.3.3.1. Initialisation

Initialisation consists of loading code and data from the IOP onto the System. During initialisation, the Administrative Processor (AP) (under the control of EPROM-based routines) establishes communication with the Initialisation Process (IOPI) in the IOP. IOPI reads code files from the disk and transmits them to AP. Base Processor code is broadcast to all the Base Processors in the system through the Central Message Switch. However, since data files differ from one Base Processor to another, they are loaded sequentially. Five levels of initialisation are offered ranging from initialisation without the dislocation of the single call stable upto higher and higher levels till the entire system is cleared-up and reloaded.

4.3.3.2. System Integrity

When all the subsystems are performing normally, they keep sending periodic sanity messages to the Base Processors. All Base Processors in turn keep sending messages to the Administrative Processor. Loss of sanity of a processor is detected within a very short period of time and corrective action (e.g., reconfiguration) is taken immediately. The most important activity under System Integrity is to keep a check on the general integrity of the system and to keep the system sane by resorting to the appropriate level of initialisation. The integrity is checked by periodic and idle-time audits and also by the numerous defensive checks built into the application processes themselves.

4.3.3.3. *Switch Maintenance*

Switch Maintenance is a five-tiered activity consisting of fault detection, confirmation, isolation, reconfiguration, and diagnostics. The diagnostic procedure pinpoints the faulty element down to the level of one card (in most of the cases). After fault repair, validation of the newly replaced card is carried out before it is brought back in service. High degree of redundancy provided by the architecture is fully exploited to keep the down-time to a minimum. Reconfiguration is done with minimal disturbance to the subscriber. Switch maintenance also ensures periodic automatic tests on all the switch units.

4.3.3.4. *Terminal Maintenance*

Terminal Maintenance involves fault detection, fault reporting, and testing of all the subscriber lines and trunks. Terminal Test Controller (TTC) performs tests on the external lines and trunks as well as on the line and trunk interface circuits within the exchange. Service circuits are also routined periodically and faults are isolated through minimal human interface.

4.3.3.5. *Human Interface*

Human Interface provides man-machines communication between the operator and the system. It supports the maintenance commands that are given by the operator. Human interface also displays alarms via Output Outside Dialogue (OOD) terminal and the Alarm Display Panel (ADP), and prints maintenance reports that are generated as a result of tests, audits, and diagnostics.

4.3.4. Administration Subsystem

Administration subsystem consists of traffic, billing, exchange performance measurement, and human interface functions. It also provides online software patching capability.

Administration subsystem is responsible for maintaining a large number of traffic records on the basis of the information received it through Call Event Records and a large number of traffic-related commands. Similarly, the Traffic and Exchange Measurement Process correlates a number of these traffic records and generates reports on the overall exchange performance. These reports are extremely useful in monitoring the health of the exchange and for network planning.

Billing processes provide billing records and itemised/detailed billing information for local and trunk calls. Detailed Billing Records are made by default for all STD and ISD calls. Detailed billing records for local calls are provided for subscribers under local billing observation. If the exchange is used as a leading TAX, Centralised Automatic Message Accounting (CAMA) can be easily incorporated, provided the signalling supports the required information flow from the originating exchanges.

The exchange is connected with a number of VDUs for providing the human interface. Man-machine communication is extremely user- friendly and provides a large number of forms and menus for carrying out exchange management functions. Over 200 man-machine commands are provided for exchange operation, administration, and maintenance functions.

4.3.5. Database Subsystem

The management of global data, i.e., the data shared between various applications and processes, is done by the Database subsystem. The objectives of this subsystems are :

- ***Easy Access :*** Database software provides uniform and easy access to the database. This access is independent of the data as well as the application to be accessed.
- ***Quick Access :*** Quick access to data is ensured by structuring the data as arrays and using indexing for accessing them. This is specially required for real time sensitive application programs such as call processing processes.
- ***Transparency :*** Database software subsystem makes the application programmer transparent to the actual data structures and data organisation. Thus, a change in data structures or data organisation does not force a change in the application program.
- ***Consistency :*** In order to satisfy real time applications, the database cannot be totally non-redundant. Thus, in order to provide quick access to duplicated data items, the database software maintains consistency between these duplicated data items.
- ***Security :*** Database subsystem keeps the database "locked" to protect it against possible corruption.
- ***Synchronisation :*** In a multi-process environment, special care needs to be taken to maintain data consistency at the end of multiple updations of processes. This synchronisation is provided by the database software subsystem.

Keeping these objectives in mind, physical data is organised as global data structures and resource tables and the global data is accessed via Data Base Access Routines (DBARs). Global data structures are maintained on terminal-related data (fixed office data and extended office data) and centralised routing and translation tables. In addition, linked lists on free global and local resources and a reference memory for unprotected terminal status data are maintained.

4.3.6. Input Output Processor Subsystem

Input Output Processor (IOP) subsystem uses UNIX as the basic operating system. IOP software subsystem is structured as a layer above UNIX and comprises of the following parts as shown in Fig. 4.5.

- ***Command Interpretation Layer :*** A topmost layer, like a shell, to receive, validate, and execute operator commands
- ***Administration Software :*** A layer above UNIX which provides the man-machine interface.
- ***Maintenance Software :*** Used for initializing communication protocol with C-DOT DSS MAX. It also provides software for synchronization of duplex Input Output Processor.

The functions of IOP software subsystem in C-DOT DSS MAX are - downloading and initialisation, performance measurement of processes, provision of man-machine interface and handling billing, traffic and maintenance reports, etc.

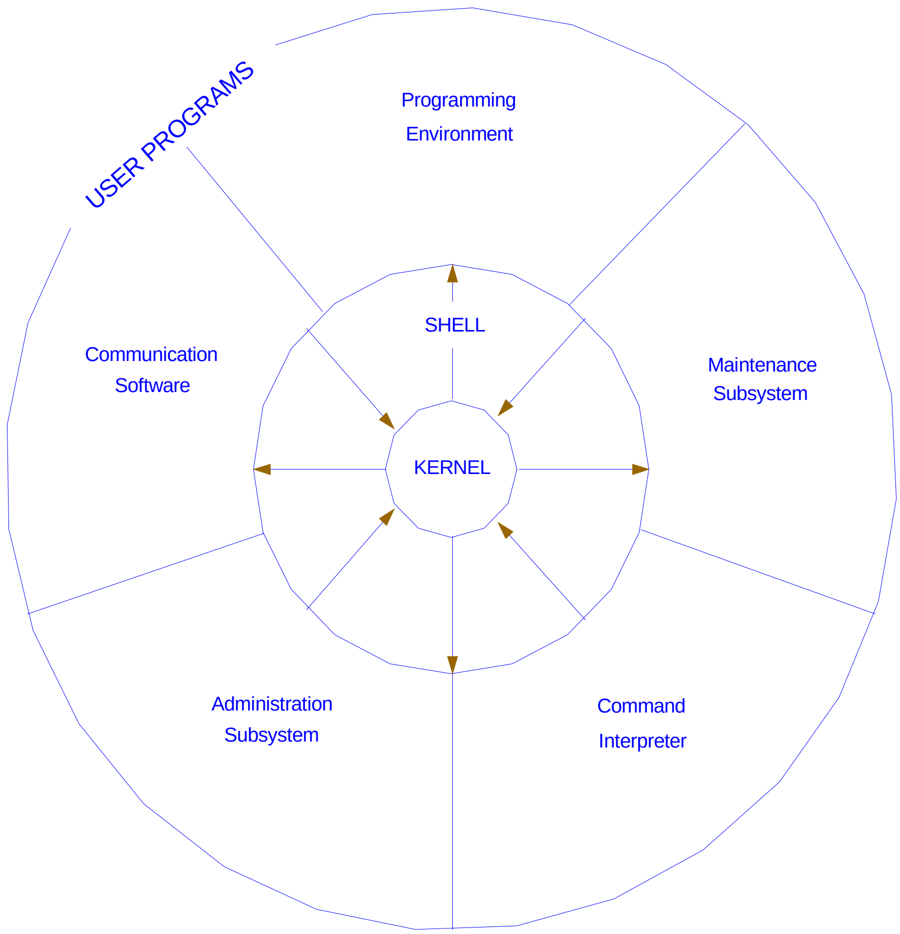

FIGURE 4.5
IOP SOFTWARE ARCHITECTURE
(BASED ON UNIX MODEL)

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Chapter 5.

Subscriber and System Features

5.1. INTRODUCTION

The C-DOT Digital Switching Systems offer a wide range of telephony features and supplementary services. Further capabilities can be developed to meet specific customer needs. Due to mandatory requirement of exchange of messages between the switching systems and user's equipment, some of the services are exclusively offered to ISDN-subscribers. In case of few of the services offered to PSTN and ISDN subscribers, the implementation of services to PSTN subscribers may be partial and invocation procedure may also differ due to the same reason.

5.2. PSTN (ANALOG) AND ISDN SUBSCRIBER SERVICES

The subscriber services provided by C-DOT DSS MAX exchanges for PSTN (Analog) as well as ISDN subscribers are explained as per their logical grouping:

5.2.1. Number Identification Service

i. Calling Line Identification Presentation (CLIP)

When this service is subscribed by a user as terminating facility, all the incoming calls are offered to the user along with the details of calling party's identity.

In exceptional cases, for example if the calling party has subscribed CLIR or due to interworking constraints in the network, it will not be possible to provide caller's identity.

ii. Calling Line Identification Restriction (CLIR)

This service is offered to the calling party to restrict presentation of it's number to the called party.

When CLIR is subscribed, the originating exchange notifies the destination exchange that the calling party's number is not allowed to be presented to the called party. The terminating local exchange may indicate to the called user that the calling user identity is unavailable due to restriction.

iii. Calling Line Identification Restriction Override (CLIRO)

Subscriber with CLIRO as terminating facility instead of CLIP, receives the call with the calling line identification even if the calling party has requested that his (the calling party's) identification should not be presented to the called user.

The CLIRO facility is offered at the discretion of the administration to special category subscribers like the police, hospitals, operator positions and other emergency centres.

iv. Malicious Call Identification (MCID)

This facility is used for ascertaining the origin of malicious calls. During conversation the subscriber has to use suitable procedure to notify the exchange about the malicious call. The detail of the call is recorded in the exchange which can be retrieved later on. If the caller is from an exchange which does not support identification of calling line, "junction identity" is found and an "identification request" may be sent to the originating exchange by the exchange personnel.

5.2.2. Call Offering Supplementary Services

Call offering services permit the served user to request the network to divert the incoming calls to a specific number. In call forwarding, the network forwards the call to a pre-registered number which can be specified by the user or exchange administrator.

i) Call Forwarding Unconditional (CFU)

This service permits the served user to request the exchange to forward all incoming calls to other number. The served user's originating service remains unaffected. The other number could be a fixed pre-determined number or a number specified by the subscriber in the activation request.

ii) Call Forwarding Busy (CFB)

This service permits the served user to request the exchange to forward all incoming calls to other number if the served user's number is not free. The served user's originating service is unaffected.

iii) Call Forwarding No Reply (CFNR)

This service permits the served user to request the exchange to forward all incoming calls which are not replied within ring time-out period to other number. The served user's originating service is unaffected.

5.2.3. Call Completion Services

i. Call Waiting

A subscriber engaged in an existing call, is given an indication (Call Waiting tone or ZIP tone) that another caller is attempting to connect to his number. The caller will hear ring back tone. By flashing the hook-switch the called subscriber can talk with either party while keeping the other on hold (acceptance without clearing). If the called subscriber replaces his handset in response to the tone (acceptance by clearing), the exchange will automatically extend ring to the subscriber and re-establish the connection on answer with the party waiting.

ii Call Hold

This facility is used by the user to put the existing conversation on hold for the time being and initiate a new call or receive a call in waiting. The call, which has been put on hold, is retrieved by the user as and when it is required. The procedure of invocation to put the conversation on hold and its subsequent retrieval is different for ISDN and PSTN subscribers.

5.2.4. Multi-Party Services

i. Three party conference

The three party call service enables the served user to establish, participate in, and control a simultaneous communication involving the served user and two other parties. The served user can request to convert two party conversation into a three party conference. During the three party conversation, the served user can disconnect one party, disconnect the 3-way conversation or choose to communicate privately with one of the parties, in which case the call to the other party is held.

ii. Four party conference

The CONF (Add-on conference) service enables the served user to establish and control a conference i.e. a simultaneous communication, involving of users (max. upto 4).

When the CONF service is invoked, the serving local exchange allocates conference resources to the served user and add any existing call indicated by the served user to the conference. On successful invocation of conference the served user becomes the 'conference controller'. The conference controller may then add, drop, isolate, reattach parties from the conference. The conference controller can also hold and retrieve the conference (e.g. to add parties) and finally end the conference.

It is possible to have 64 simultaneous, four party conferences without conference card.

5.2.5. Miscellaneous Services

i. Hot Line (Timed)

This service is also referred as a Fixed Destination Call with Time-out. This allows a subscriber to establish calls to a pre-registered number. After getting dial tone, if the subscriber does not dial any digit for a specified minimum time, he is automatically connected to the number already registered in the system. If subscriber dials digits before the time-out, a normal connection is established in accordance with the dialled digits. Incoming calls are not affected by this service.

ii. Hot Line (Without Time-out)

This service is also referred a Fixed Destination Call - Immediate. This allows a subscriber to establish calls to a pre-registered number by just lifting the handset. In this service such a connection is set up immediately upon lifting the handset, hence the subscriber cannot dial normal outgoing calls. Incoming calls are not affected by this service.

iii. Reminder Call/Alarm Services

When this service is activated, the subscriber is offered a call initiated by the exchange at a specified time/s. When the alarm call matures and is answered, an announcement follows to notify the alarm call.

This service is available in two forms : (i) In semiautomatic form, the booking is manual through exchange operator and the execution is automatic. In this case, the operator needs to be 'local' operator, connected to the system via a VDU (ii) In automatic form, the booking is done automatically by the subscriber through a control procedure and its execution is also automatic.

iv. Subscriber Controlled Call Restriction Services

- Denying all calls to a line, while allowing it to originate calls as per current access level.
- Denying various level of originations from a line (no ISD calls, no STD and ISD calls, only local calls and selected Level 1 services, etc.) while allowing incoming calls to terminate normally on it.

Subscriber controlled barring offers flexibility to a subscriber to change outgoing restrictions by selecting one access level, using predefined procedure through secret password. To maintain the secrecy of the password, the user can modify the password by using predefined procedure.

v. Intrusion Barring Service

For reasons of call security in terms of fully undisturbed call, subscriber can avail of intrusion barring facility. This can be useful, for example, when data transmission is being done on the line.

vi. Dialling by Terminal Equipment Number

Sometimes, a specific line/trunk, tone or announcement is to be accessed by its Terminal Equipment Number (TEN) in the exchange. This is specifically required for dialling to lines which do not have a directory number or in case of "directed calls" via outgoing trunks. This facility is used by the maintenance personnel as part of routine maintenance activities.

vii. Trunk Offer

This service makes it possible for the operator to interrupt a call in progress, in order to allow another incoming call to be offered. The choice of accepting or rejecting the new call rests with the subscriber.

ix. Queuing Service

This enables the subscriber to have one or more calls placed in a queue when his line/group of lines are busy. When the subscriber line becomes free, the first caller in the queue is connected and the other callers in the queue move one place ahead.

x. Priority Subscriber

During overload and network congestion, priority service assures an improved service level for priority subscribers such as those responsible for maintenance of law and order or essential services. The priority subscribers are served even during overload due to heavy traffic in the exchange via alternate group of trunks. A few trunks may be identified for this purpose which are exclusively used by priority subscribers while normal subscribers are denied access to them. The eligibility of priority subscribers for an alternate group of trunks is programmed by the exchange administrator.

xi. Distinctive Ringing for Long Distance Calls

The PSTN subscribers are connected different ringing cadence to inform them that this call is a long distance STD/ISD call.

5.3. ISDN - SUPPLEMENTARY SERVICES

In addition to the services available for PSTN (Analog) as well as ISDN subscribers, a number of supplementary services are offered only to ISDN-subscribers.

5.3.1. Charging Related Supplementary Services

The Advice Of Charge service provides charging information to the user paying for a call. The option of providing the information at a predefined stage of the call is based on the type of AOC facility, subscribed.

i) AOC-E, Charging information at the end of the call

The charging information is provided by the serving local exchange at the end of a call. It is sent in the charge advice information element of the call clearing message.

ii) AOC-D, Charging information during a call

In this case the charging information is provided by the serving local exchange every time a quantum of charge has been added. The charging information is sent in an appropriate message. When the call is cleared, the remaining number of charge units (incremental case) or the total charge units (cumulative case) is transferred to the user in the call clearing message.

5.3.2. Group Line Supplementary Services

i) Direct Dialling In (DDI)

This service enables a user of ISPBX to be called without attendant intervention. This service is based on the ISDN number. The DDI user, while being a subscriber of an ISPBX, is allocated an ISDN number from directory number set of the serving public exchange. The administration allocates a range of ISDN numbers towards the ISPBX, one for each DDI user.

ii) Multiple Subscriber Number (MSN)

This service provides the facility of assigning multiple ISDN numbers to more than one user on a single interface. This service allows direct dialling to one of the terminals connected to an access and enables the network to determine ISDN number which is applicable for originating calls for subscriber characteristics and charging services. The addressing of terminals is achieved by applying a set of ISDN numbers which need not be consecutive. When a call with one of these ISDN numbers is delivered, the corresponding MSN number is indicated to the MSN user.

iii) Sub - Addressing (SUB)

This service is offered to the called user that expands its addressing capability beyond that provided by the ISDN number. The sub-address is used by the served user to identify a particular terminal on a multi-drop access, or a virtual terminal or process within a terminal. If the calling party provides a sub-address in 'SET-UP’ message, the network delivers this sub-address unchanged and without interpretation to the called user’s installation. It is the called user’s responsibility to interpret the significance of the sub-address.

5.3.3. Number Identification Service

i. Connected Line Identification Presentation (COLP)

It is a supplementary service offered to the calling party to know the complete ISDN number of the connected party, on answer.

It should be noted that if the called user belongs to an ISPBX, the connected number shall only identify the ISPBX and not the called user’s extension. The extension itself can be identified only if the called user has subscribed to the DDI service and has included his DDI digits during call confirmation.

ii. Connected Line Identification Restriction (COLR)

This is a service offered to the connected party to restrict the presentation its identity to the calling party.

When COLR is subscribed, the destination exchange informs originating exchange with a notification that the connected party's identity is not allowed to be presented to the calling party.

iii. Connected Line Identification Restriction Override (COLRO)

Subscriber with the COLRO facility is given the connected line identification even if the connected party has requested that his (the connected party's) identification not to be presented to the calling user (by the invocation of the COLR service).

5.3.4. Miscellaneous Services

i) Terminal Portability (TP)

Terminal Portability (TP) is a supplementary service that allows the user to move a terminal from one socket to another within the same basic access during the active phase of the call. It also allows the user to move a call from one terminal to another with the same basic access in the active phase of the call.

It allows a user with an established call to suspend communication by an appropriate signalling procedure and resume communication at a later time. This service permits the user.

a) To move the terminal from one socket to another within the same basic access.

b) To suspend the call and subsequently resume it at the same terminal & socket.

c) To replace one terminal by another compatible terminal at the same socket

d) To move the call from one terminal to another compatible terminal at the same basic access

This service is used only in the active phase of a call and not in the call establishment and clearing phases. In addition the service shall independently apply to the calling and called user.

Note : *User shall be responsible for ensuring that compatibility of the terminals with the suspended call is retained.*

5.3.5. IN Services

C-DOT DSS MAX offers wide range of IN services that are available to PSTN and ISDN subscribers as follows.

5.3.5.1. *Freephone or Tollfree (FPH/TLF)*

Freephone service is one of the most popular IN service in the world. It allows a subscriber accepting to receive a call to be charged for the whole or part of the cost of the call.

Apart from reverse charging this services also supports features like:

- *Time* Dependent *Routing (TDR)* - route calls to the office number during business hours and to the residence during others.
- *Origin Dependent Routing (ODR)* - all calls originating from a particular geographical area are routed to the nearest customer service location.
- *Originating Call Screening (OCS)* - disallow calls from a particular geographical area.
- *Call Forwarding Conditional (CFC)* - calls forwarded to the specified locations in case of default directory number being busy or not responding.
- *Call Distribution (CD)* - calls distributed on more than one directory numbers based on the percentage defined.

5.3.5.2. *Virtual private network (VPN)*

The Virtual Private Network (VPN) service provides the VPN customer all the features of a private network by using the Public Switched Telephone Network (PSTN) resources.

It allows the VPN customers (with significant long distance traffic between corporate sites) to configure and use switched carrier circuits as if they were dedicated private lines. A VPN customer can define his own private numbering plan and class of service restrictions across closed user groups. VPN service in this sense can be compared with a Centrex or a PBX

The charging for a VPN call can be flexible. The charges are levied to a common "charge number". In this way, a company's travelling salesman can make STD calls while the charges are levied to the organisation's common charge number.

Some unique terms associated with the VPN service are defined below.

On-net Locations

These are authorised network access locations that are logically defined by the customer to be part of the Virtual Private Network. These network accesses are all subjected to the user defined call screening and dialling plan. **On-net locations are directory numbers located on the SSP itself.** On-net directory numbers require subscriber data creation and on-net group creation at the SSP apart from the corresponding data at SCP.

Off-net Locations

Off-net locations are those locations that are not defined by the customer to be part of the VPN. The data corresponding to the off-net directory numbers is neither present at SSP or SCP. These directory numbers emulate on-net or virtual on-net locations by dialling access code, group id of the VPN group and the authorisation code of the subscriber they are trying to emulate.

Virtual On-net Locations

The VPN members for which data is created at the SCP only. These are not resident on the SSP but are subject to VPN defined call treatment, e.g. call screening

VPN User Group

A group of on-net locations and virtual on-net locations defined by the customer as a closed user group. Each user group can be assigned a different set of calling privilege.

5.3.5.3. Virtual Card Calling (VCC)

This service is a part of the Alternate Billing Services class. It allows the users to make calls from anywhere in the network and let the charges to be *debited* from a prepaid card. For holding the card the VCC customer need not have a directory number in the conventional sense.

Virtual Card Calling service is an access code based service. All VCC calls require the dialling of the service key followed by the card number.

The card numbers are first defined in the SCP. VCC cards of appropriate denominations and access barring levels are then printed by the service provider at the time of service subscription on secure stationery.

The cards can also be purchased off-the-shelf by the customer from a reseller.

With each call, the charge is debited from the customer's card.

5.3.5.4. Account Card Calling (ACC)

This service is also an Alternate Billing Service and allows the users to make calls from anywhere in the network and let the charges to be *credited* to an account.

Account Card Calling service is also an access code based service. The service user dials the service key and the ACC account number followed by a Personal Identification Number (PIN) when prompted for it. The PIN is modifiable by the customer.

The credit limit, access barring level and initial PIN of the customer is decided at the time of subscription.

5.3.5.5. Universal Access Number (UAN)

This service enables a person or an organisation to publish one local or national number and have incoming calls routed to different destinations based on the geographical location of the caller.

UAN is similar to Freephone except in the way charging is done. In UAN, the calling party bears the expenses of the call as defined by network. Moreover UAN is available in two modes-local UAN and National UAN.

Local UAN, dialled by 1901YYxxxx (where YY is the SCP ID), connects only to a number in the local network while national UAN, dialled by 0901YYxxxx, is used to access a number anywhere in the national network. A directory number with STD facility can only dial a National UAN number while the local UAN is accessible from every directory number.

Detail billing records of UAN are not available at SCP Local exchanges provide the detailed billing logs and call logs. UAN can be used in conjunction with ODR, TDR, CFC and CD to make it more useful.

5.3.5.6. Premium Rate (PRM)

Premium Rate customers provide value added professional services by advertising a premium rate number. The service users are charged a premium for calls made to the premium rate number. The per call premium rate and the revenue sharing arrangement between the customer and the service provider is agreed upon at the time of service subscription. The premium rate is a multiplier over the normal call charge.

This service can be used in conjunction with features like ODR & TDR. It is quite a popular and useful service and is used for getting medical advice, stock market quotations, astrological advice, etc.

Detailed records of all PRM calls are prepared at the SCP. These contain details such as the date, time, destination (PRM) number and the user's number.

5.3.5.7. Televoting (VOT)

Televoting is a very powerful "mass calling" service used by organisations engaged in psephology and other opinion poll related services. The power of this service lies in the instant availability of the results of voting. The users call one or more televoting number/s advertised by the customer. The last two digits of the televoting number are the *choice* digits. The caller is acknowledged by an announcement.

The televoting period is pre-decided between the customer and the service provider and is advertised before polling. At the end of the specified period, the network provider hands over the poll results (televoting counters maintained at the SCP) to the customer.

Televoting is available in two flavours. One in which for each call the called party is charged and the second in which the calling party is charged for each call.

For picking out lucky callers etc. there is a provision for connecting every n*th* call to a special number or announcement.

5.4. SYSTEM FEATURES

C-DOT DSS family exchanges support a number of networking features to meet the expectations of Network Planners as well as a set of operation and maintenance features for the convenience of O&M personnel. Some of the system features explained in this chapter are listed below :

- Numbering Plan
- Signalling, Routing and Charging
- Exchange Operation Features
- Exchange Maintenance Features
- System Applications

5.4.1. Numbering Plan

MAX-VE supports a local numbering plan of up to 8 digits.

5.4.2. Signalling, Routing and Charging

C-DOT MAX-VE implements standard network interfaces and signalling schemes to avoid add-on equipments e.g. multiplexers. The analog network interfaces i.e., Two Wire Physical Trunk (TWT) and Four Wire E&M (EMF) are implemented. The digital E-1 PCM interface is supported with all the three types of CAS signalling. Register signalling can be configured as Decadic, Indian-R2 and CCITT-R2 signalling with provision to use R2-Signalling in semi-compelled or fully compelled mode. The E-1 links can also be configured as CCS7 links. Trunks are also supported in Remote Switch Unit (RSU)

To meet routing requirement for transit applications, 4000 routes in MBM and 1000 routes in SBM exchanges are implemented with depth of analysis upto 12 digits. Each route can have a maximum of seven alternate choice of grouped resources for routing and a max. of 64 categories for routing and charging of the calls. With additional features like time zone based routing, CLI based routing, priority based routing, filtering of calls for selected emergency/special service routes, it is possible to meet routing/charging requirements of complex networks. Pre-selection and dynamic selection of National Long Distance Operator (NLDO) is available for MAX-VE subscribers.

For CCS7 traffic, Charge Unit (CHU) and Charge Band (CHB) modes of charging are implemented in ISUP. For ISDN traffic, it is possible to charge each bearer service traffic differently i.e. for same interface/subscriber, it is possible to charge “Speech” with one rate and 64 Kbps Unrestricted Data, with different rate. Multiple bearer services on the same interface/subscriber can have different level of access barring i.e., speech call can be restricted to "Normal" whereas Data call can be allowed upto international.

5.4.3. Exchange Operation Features

A number of operation features are implemented in C-DOT DSS for administrators with different level of control mechanisms to prevent un-authorised operation. Some of the features are listed below :

- Single Line and Group Line Administration
- Trunking, Routing and Charging Administration
- Traffic and Performance Measurements
- Data Backups and Restoration
- Calendar Administration
- Password Administration: with different level of password management along with two different level of privileges for operator terminal port as well as for the operator account, the exchange operation in C-DOT DSS is fully secured from unauthorised operation.
- System Reconfiguration/Expansion
- Software Upgradation/Patch Administration

The modular software architecture of C-DOT DSS facilitate easy upgradation to support more value added services to meet the future requirement. Also the upgradation is required to meet specific network requirement as well as bug fixes in exceptional cases. A number of features to support software patch installation through user friendly procedures are implemented :

- Minimum disturbance/No disturbance to services
- Easy and safe patch administration procedure
- Facility to install/remove a software patch, if required
- The propagation of patch through extensive documentation alongwith details of software deliverables, procedures and release highlights
- Downward compatibility for Exchange Operation

It is possible to perform above operation even by the exchange operators with minimum skills. The operation commands are coded in simple English language with in-built checks to avoid destructive operations. A command is executed only after verification of different parameters, input by the operator. The operation commands are classified as per their significance/usage and it is possible for the exchange administrator to allow/restrict a set of commands to the specific operator. A history log of all the operations are maintained at system level and also for each operator separately which can be analysed to trace the details of unauthorised operation.

5.4.4. Maintenance Features

A set of maintenance features are implemented in C-DOT DSS with objective of restricting the need of maintenance personnel to bare minimum. This has been made possible by automatic scheduling of maintenance activities to initiate the corrective measures in case of a fault. Some of the features are :

- Hot stand-by redundancy for all the controllers
- Periodic auditing of process and resources
- Automatic scheduling of fault control mechanism to restrict the fault propagation.

- Automatic system reconfiguration to ensure the best possible configuration.

Depending upon the system configuration and size of the pool of resources, the exchange administration can decide about the thresholds to raise/retire different level of alarms

- Extensive diagnostic features to isolate the fault at card level.
- Multiple ETT support in MAX-VE upto 4 ETT cards can be equipped in each base module for testing of lines and analog trunks.
- Automatic/scheduled routining for Switch Units and Terminals (Subscribers/ Trunks/Resources)
- Remote alarm reporting

The health of all the switch units and terminals are continuously monitored by the system. In case of un-manned operation, the details of all the maintenance related activities are generated in form of alarms/logs which are analysed to take corrective measures. Whenever any alarm (non-urgent/ urgent/critical) is raised in the switch room, the ring will go to a pre-defined telephone number to inform the concerned person. On answer related tones will be heard which will indicate the presence of specific alarm in the switch room.

- Remote alarm monitoring

It is also possible to know the existing status of pending faults/alarms in the exchange, just by dialing the monitoring number from any where in the telephone network. Similarly it is possible to report the critical alarms in form of ring to one of telephone numbers which may be of the office/residence number of the maintenance incharge of the exchange as explained above.

- System Integrity

  The hardware and software architecture of the C-DOT DSS has been designed to ensure highest level of system integrity even in case of extreme environment like, switch reconfiguration due to fault, overload due to spurt in traffic, cleaning up the resources as time slots etc. Some of the important features are listed below:

- Established calls are maintained even in case of switch reconfiguration due to fault or switch plane interchange by the operator.
- In-built periodic audits to release the time-slots that are held up due to different reasons in exceptional cases.
- Over load control mechanism to initiate the blocking of call/traffic originations.
- Different level of call blockings, based on the priority of the originations (Lines or Trunks).

In addition, different level of initialisations are also implemented which are triggered automatically by the system to overcome critical hardware or software faults. The level of initialisation is triggered in such a way that minimum disturbance of the services are affected.

5.4.5. System Applications

The implementation of different features and services are generic and modular, integrated into a common software link.

The same software link can be used for different application as:

- Local Exchange
- Tandem Exchange
- Trunk Automatic Exchange (TAX)
- Integrated Local cum Tandem/TAX Exchange (ILT)
- Support to CCS7, ISDN and V5.X through add-on hardware units
- CCS7 configuration for integrated STP-functions
- IN SSP configration

5.4.6. Local DTMF / MF Resources in ETU / CDU

In MAX-XL, only global MF/DTMF resources of time switch unit were available. In MAX-VE local resources available on controller cards of ETU/CDU can also be used for call processing. Each controller card provides 30 MF/DTMF resources.

Chapter 6.

System Capacity

6.1. INTRODUCTION

The capacity of C-DOT DSS is defined in terms of the following parameters :

- The termination capacity expressed as the number of lines and trunks
- The amount of traffic (in erlangs) that can be switched
- The number of Busy Hour Call Attempts (BHCA) that can be processed with a given call-mix while meeting the overall service quality requirements

This section indicates the maximum capacity of different system elements as well as that of complete exchange, equipped to its ultimate termination capacity. It has been ensured that the specified parameters are valid to meet overall reliability objectives for the C-DOT DSS as specified in ITU-T recommendations.

6.2. TERMINATION CAPACITY

A Terminal Card is the basic system element. It interfaces/terminates the lines and trunks. The next higher element is a Terminal Unit. The types of terminal card and terminal unit, used in C-DOT DSS along with its functions are already explained in chapters 3 and 4. A BM can be concentrated to provide maximum termination capacity of 6000 lines.

Each Base Module has eight principal Terminal Units equipped in two BM racks. The rack containing BPU & VSU is known as Principal BM (PBM) while the additional rack which houses remaining Principal TUs is known as Auxiliary BM rack (ABM). Each line module has 6 Terminal Units. Line module containing concentration TUs of Principal BM TUs is known as principal line module, whereas the line module containing concentration TUs of auxiliary BM TUs is known as Auxiliary Line Module (ALM).

A maximum of 32 BMs can be connected in MAX-VE configurations.

Table 6-1 summarises the termination capacities of the various system elements of C-DOT DSS MAX.

Table 6-1

Termination Capacity of System Elements

Sl. No.	System Element	Termination Capacity Description
1.	**TERMINATION CARD**	
1.1	Enhanced CCM Line Card (ECL)	16 analog subscribers or 16 CCB subscribers with all ports supporting 16 KHz metering pulse & CLIP
1.2	Analog Trunk Card TWT/EMF	8 Trunks
1.3	EDT Card	Four 2 Mbps (E1) links as CAS/CCS trunks
1.4	Enhanced Signalling Handler Card (ESH)	16 Nos protocol handler / signalling links per card for #7 or V5.x (SHM cards which have 8 signalling links are also supported)
1.5	ISDN-BRI Card	8 BRI (2B+D) interface i.e. 16 Bearer Channels
1.6	ISDN-PRI Card	One PRI (30B+D) interface i.e. 30 Bearer Channels
2.	**TERMINAL UNIT/FRAME**	
2.1	Enhanced Terminal Unit (ETU)	ECL - 16 analog subscribers or 16 CCB subscribers with all ports supporting 16 KHz metering pulse & CLIP EDT - Four E1 links per card TWT/EMF - 8 analog trunks per card
2.2	Compact Digital Unit (CDU)	It supports 16 PCMs (with EDT cards)
2.3	#7 Signalling Unit Module (SUM)	128 CCS7 protocol handlers/signalling links
2.4	ISDN-Terminal Unit (ISTU)	256 Bearer channels to be configured as BRI, PRI or any combination of them.
2.5	V5.X Unit	128 V5.X Protocol handlers / signalling links
3.	**BASE MODULE/RACK**	
3.1	Base Module (Line)	Maximum 6000 lines limited to 25K BHCA
3.2	Line Module	1536 analog subscribers
3.3	Base Module (Analog Trunks)	1024 analog trunks
3.4	Base Module (Digital Trunks)	31 2Mbps E1 links as CAS/CCS7 + 32 Annc.
3.5	Base Module (Analog+Digital)	480 Analog+480 Digital trunks + 32 Annc. or any combination of analog & digital trunks subject to maximum of 1K trunks including announcements

6.3. EXCHANGE CONFIGURATIONS

C-DOT DSS MAX can be configured to support any combination of lines and trunks, for different applications in the network as Local Exchange, Local cum Tandem Exchange, Trunk Automatic Exchange (TAX) or Integrated Local cum Transit (ILT) Exchange.

In its maximum configuration, upto 1,00,000 lines and 15,000 trunks limited to 800K BHCA are supported when configured as Local/Local cum Tandem. When configured as TAX, 30,000 trunks are supported.

Table 6-2

Termination Capacity of Exchange Configurations

Sl. No.	Exchange Configuration	Termination Capacity Description
1.	Single Base Module (SBM-VE)	4000 lines and 480 trunks. The trunks may be analog and/or digital. The no. of trunks can be increased at the cost of reducing subscribers.
2.	Multi Base Module MAX-VE	Ideal configuration to support 1,00,000 lines and 15000 trunks with 17 Line BMs and 15 Trunk BMs limited to 800K BHCA.
3.	Remote Switching Unit (RSU)	6,000 Subscriber Lines. Trunk interface at the cost of subscriber lines.
4.	Multi Base Module-VE as TAX	30,000 Trunks

6.4. TRAFFIC CARRYING CAPACITY

The traffic carrying capacity of C-DOT DSS MAX is ideally 16000 erlangs.

This figure is based on the ideal traffic of one erlang per switched circuit. But the actual traffic carrying capacity of one switched path is always less than one in practical application. Accordingly capacity is reduced to 14400 Erlangs.

6.4.1. BHCA Handling Capability

The basic processing element of the exchange is the Base Processor (in the Base Module). Base processor has the capability of handling 25,000 Busy Hour Call Attempts. The C-DOT DSS MAX exchange with 32 Base Modules can handle upto 8,00,000 BHCA.

Various exchange configurations and their traffic capacities are summarised in Table 6-3.

Table 6-3

Traffic Capacity of Exchange Configurations

Sl. No.	Exchange Configuration	Traffic Capacity Description
1.	SBM-VE	450 Erlangs. The BHCA capacity may be 25,000.
2.	Remote Switching Unit (RSU)	450 Erlangs. The BHCA capacity may be 25,000.
3.	MAX-VE	14400 Erlangs. The BHCA capacity is 8,00,000.

6.5. SYSTEM RELIABILITY

The C-DOT DSS MAX is designed to meet the reliability standards as defined in the specifications. The system uses fully digital techniques for switching including the subscriber stage. The system is built using a minimal number of standard units/modules which allow flexible growth of the exchange and easy upgradation in technology and new features.

A very important feature of C-DOT DSS MAX architecture is the extensive duplication of units. All controller units are duplicated or have n+1 redundancy. Software design matches this high degree of redundancy provided by hardware to minimize the system down-time.

To minimize failures caused by human and/or software errors the C-DOT DSS MAX has extensive software maintenance functions. The design of software is such that propagation of software faults is contained and it provides sufficient checks to monitor the correct functioning of the system. The facilities are in-built to ensure automatic software recovery on detection of software faults. Whenever a faulty condition occurs the software provides for the isolation of the faulty subsystem and automatically initiates diagnostic programs for diagnostic purposes. The diagnostic programs have a design objective of localising 95% of the faults to a single PCB level and the rest to a two PCB level. Provision is also made for safety of charge-records. The charging information is dumped at regular intervals to non-volatile duplicated back-up memories automatically. The software maintenance functions include data audits as well as system integrity monitors and controls.

An Alarm Display Panel is provided for a continuous indication of the system status. Audio-visual alarms are provided for monitoring power failures.

6.6. SYSTEM RELIABILITY STANDARDS

For purpose of assessing the service reliability, the period after cutover is divided into a non-stabilised period and a stabilised period. The non-stabilised period covers a running-in period followed by a six-month test period. The service quality figure obtained during the running-in period is not used for assessing the long term reliability of the system. However, this period is kept as short as possible. The service reliability during the stability period is shown in next section.

During automatic reconfiguration only the calls in the set-up stage are lost without affecting the established calls.

6.7. OVERALL SERVICE STANDARDS

Service objectives have been defined for four types of call connections under designed load conditions. The overall service standard is expressed as the probability of not being able to establish a call due to non-availability of circuits, service circuits, internal congestion, internal time-outs or any other internal traffic situations other than those caused by faults.

- ***Line to Trunk Connection (outgoing) :*** The loss probability on line to trunk connection should be less than 0.005 (1 out of 200).
- ***Trunk to Line Connection (incoming) :*** The loss probability on trunk to line connections should be less than 0.0066 (1 out of 150).
- ***Line to Line Connection (intra-office) :*** The loss probability averaged over all line to line combinations should be less than 0.01 (1 out of 100).
- ***Trunk to Trunk Connection (tandem) :*** The loss probability should be less than .005 (1 out of 200) in case of trunk to trunk connections.

Chapter 7.

Packaging, Layout & Environment

7.1. INTRODUCTION

Equipment practices in C-DOT DSS MAX are followed such that the equipment packaging is modular, flexible and provides economy of space. Standard racks, frames, circuit cards and back planes have been used. The salient feature of C-DOT DSS is that only three types of RACKS/CABINETS are used irrespective of capacity or configuration of the Exchange. The brief description of the equipment practices followed in C-DOT DSS MAX alongwith the details of Exchange Layout Plans and Environmental Aspects, are described in this chapter.

7.2. EQUIPMENT PRACTICES FOR PACKAGING

7.2.1. Circuit Cards

Circuit card is the smallest unit of system packaging. Although the cards may be two-layer, four-layer, six-layer or eight layer depending upon the packaging density required, all the cards have the same size - 254 mm x 304.8 mm x 1.6 mm. A circuit card is equipped with a pair of 64-pin, 96-pin or 128-pin female euro connectors on its rear edge.

7.2.2. Card Frames

Circuit cards are packaged into a card frame. Card frame is made of welded mild-steel and has slots and guides on the upper and lower planes. Each set of upper and lower guides provide a path for the circuit card to slide on. On the rear plane of the frame, a back plane PCB is fixed which is also called the "motherboard". The motherboard may be one-piece or split-type. The motherboard has 24 sets of 64-pin, 96-pin or 128 pin male euro connectors for the circuit cards. In order to avoid wrong insertion of cards, plastic padding is provided on the rear edge so as to provide polarisation.

Each card frame has a maximum of 24 circuit cards and a motherboard. The motherboard provides interconnections between cards for signals and power supply. It also provides connectors for interframe connections. Depending upon the function required, a card frame is equipped with appropriate set of circuit cards.

7.2.3. Racks/Cabinets

The card frames are organised into an equipment rack. A rack is the supporting structure for six card frames. On the slide rails provided in the rack, card frames are fixed on the rack in a specific order depending upon the function to be performed by the equipment, e.g., Base Module, Central Module or Line Module. The rack also provides bus bars and power filter boxes for power distribution and runways for interframe and MDF cabling.

The height of a cabinet is 6 feet (1800 mm) in order to facilitate removal and replacement of circuit cards and connectors without using ladders etc. The cabinets are arranged side-by-side in suites. Each suite can have a maximum of 8 or 4 cabinets (i.e. full suite or half suite) interconnected by the supporting ironwork.

Cable troughs carry interconnection cables and run along a suite over the cabinets. Within a trough, there is provision for running power cables and interconnection cables separately. Cable troughs are also run between suites to carry BM-CM cables and MDF cables from the cable entry point to the respective suites.

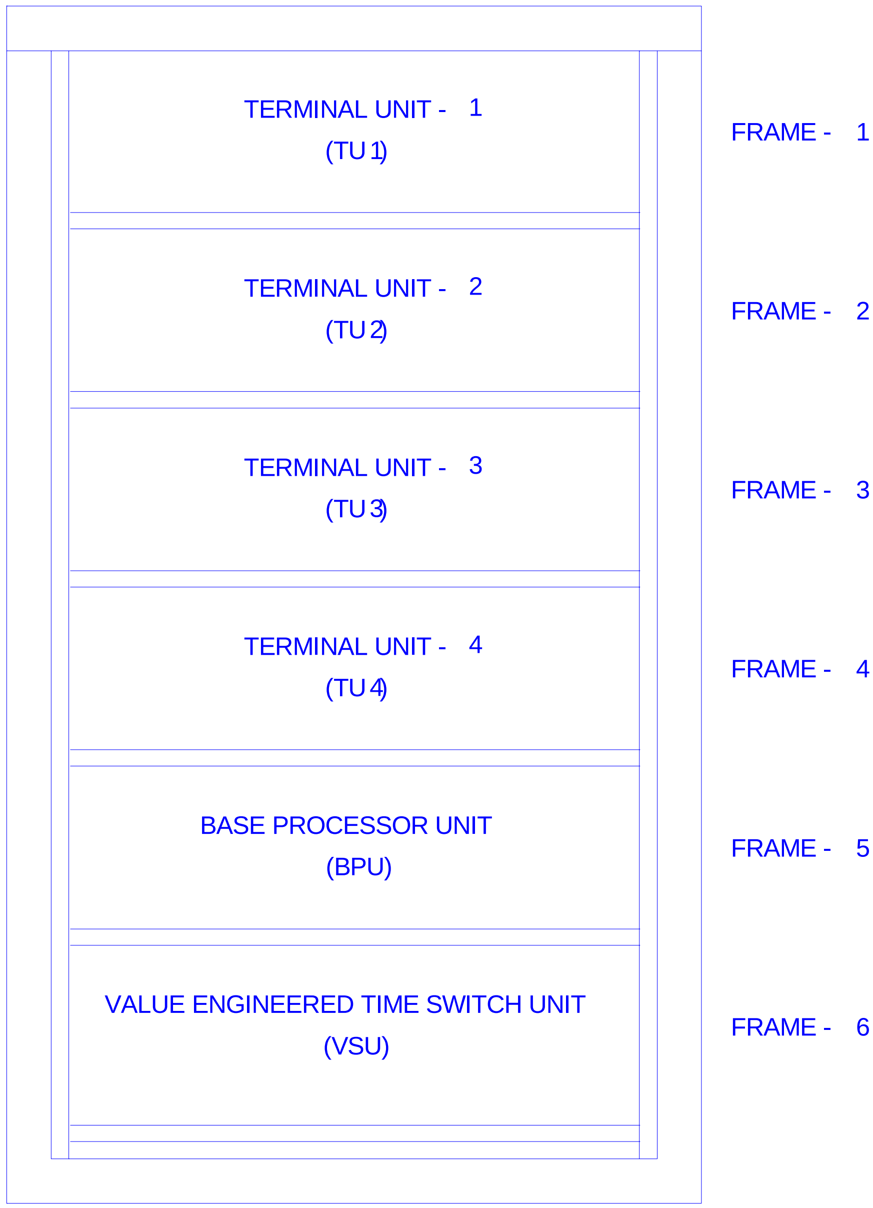
C-DOT DSS MAX equipment is housed in three types of cabinets viz.

1. *Base Module Cabinet*
2. *Line Module Cabinet*
3. *Central Module Cabinet*

*7.2.3.1. **Base Module Cabinet** (Fig. 7.1)*

The Base Module (BM) cabinet houses the following units in the frames :

- CCS7 Signalling Unit Module (SUM)
- ISDN Terminal Unit (ISTU)
- Base Processor Unit (BPU)
- Value Engineered Time Switch Unit (VSU)
- Compact Digital Unit (CDU)
- V5 signalling unit (VU)
- Enhanced Terminal Unit (ETU)



NOTE : TU CAN BE ETU, CDU, ISTU, VU, SU,
IN LINE AND ANALOG TRUNK BMs, ETT/TTC CARD CAN BE EQUIPPED IN SLOT 24 OF TU2,4,6 OR 8

FIG. 7.1

BASE MODULE (BM) CONFIGURATION

LOTUS\VOL1\DESIGN\MAX2315\MX2315GD\MXISGDC1

Depending upon the application, a Base Module cabinet is equipped with a combination of frames containing four principal Terminal Unit frames, a Time Switch Unit frame and a Base Processor Unit frame. The remaining four principal terminal units are housed in a line module cabinet called Auxiliary BM. However, in concentration mode, each BM can support 4 more module line racks, each of them equipped with 6 Terminal Units with lines only.

Equipage of cards in different types of frames are explained in Fig. 7.2A, 7.2B, 7.2C, 7.2D, 7.2E & 7.2F.

7.2.3.2. Central Module Cabinet

Central Module (CM) cabinet is similar in size and shape to the Base Module cabinet. It, however, houses the circuitry of both the Central Module and the Administrative Module. It houses the following units in the card frames as shown in Fig. 7.3.

a) Bus Termination Units (BTU)

b) Central Switch Unit (CSU)

c) Central Switch Controller Unit (CSCU)

d) Administrative Processor Unit (APU)

This Bus Termination Unit (BTU) occupies the first and fourth card frames in the CM rack. Each frame contains the VEBM Interface (VBI) Cards. The number of cards depends upon the number of Base Modules equipped in the system. For connection of RSUs using E1 links, EMC card is used instead of VBI at CM end while CRS card replaces VCI at BM end.

The Central Switch Unit occupies second and third card frames in the CM rack & houses the Central Switch (CSW) cards.

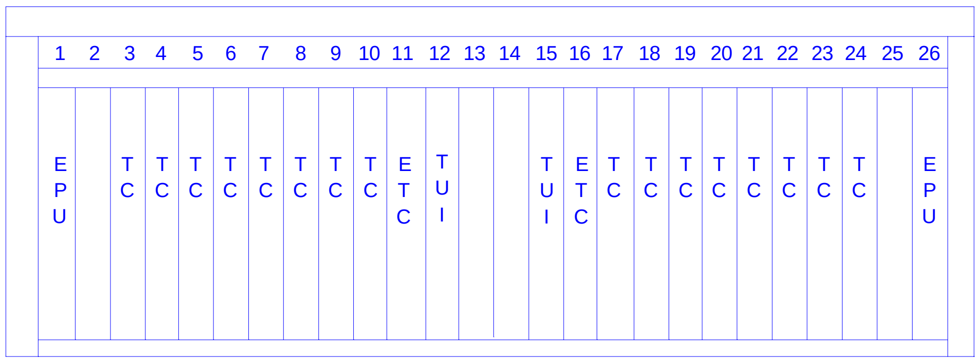
Central Switch Controller Unit (CSCU) occupies the fifth card frame in the CM rack and houses the circuitry for timing control and CSC complex.

Administrative Processor Unit (APU) occupies the sixth card frame in the CM rack and contains the circuitry for the Administrative Processor Controller (APC) complex and the Central Message Switch complexes.

The CM cabinet is equipped with special cooling arrangement for dissipating the heat from the high performance circuitry in various card frames.

7.2.4. Cabling

A standard cabling concept has been used for providing interframe and intercabinet cabling. Cables are used to carry signals and power. The following types of interconnections are possible:



NOTE 1 : TC MAY BE ECL, EDT, TWT OR E&M

NOTE 2 : IN CASE OF TU2,4,6 OR 8 AS ETU, ETT CAN BE EQUIPPED IN SLOT 24.

FIG. 7.2A
ENHANCED TERMINAL UNIT (ETU)

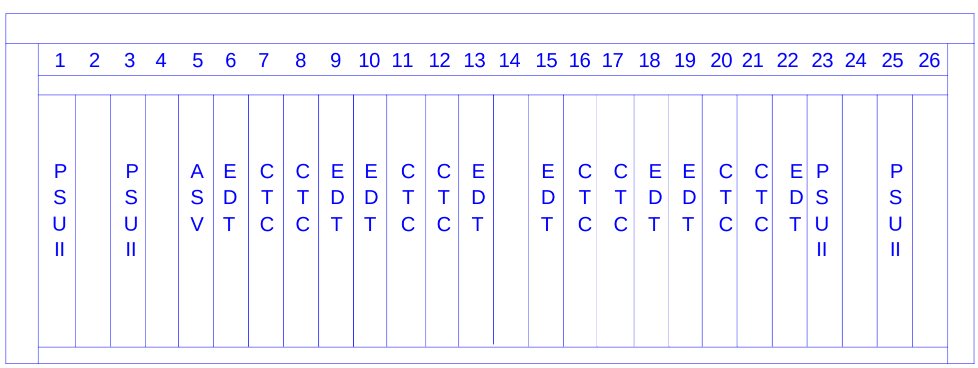
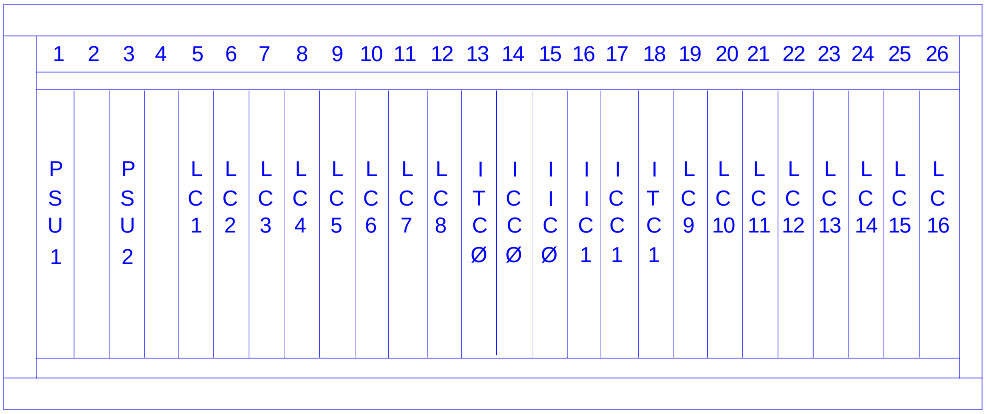


FIG. 7.2B
COMPACT DIGITAL UNIT (CDU)

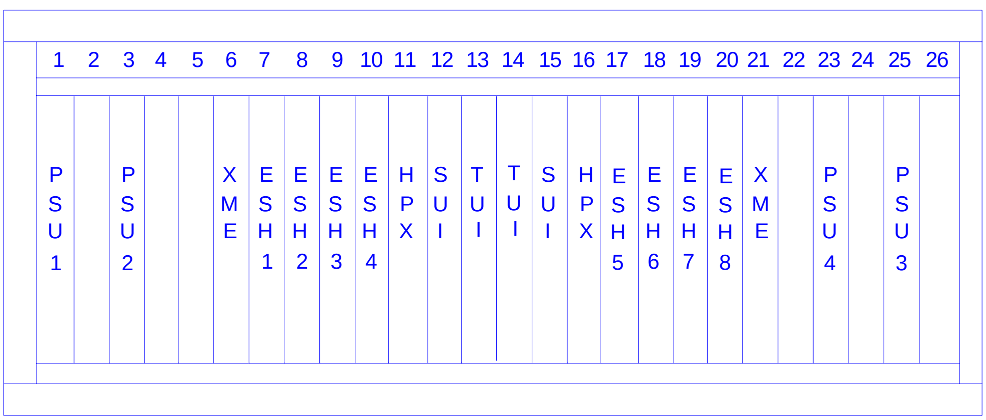
\DESIGN\MXGDISDN\MXISGDCC



LC ⟶ BRL OR PRL CARDS

NOTE : IIC CARDS ARE REQUIRED ONLY IN CASE OF CONCENTRATION OF ISTU

FIG. 7.2C
ISTU CONFIGURATION



ESH ⟶ ENHANCED SIGNALLING HANDLER CARD FOR #7

FIG. 7.2D
#7SU CONFIGURATION

LOTUS\VOL1\DESIGN\MAX2315\MX2315GD\MXISGDCO

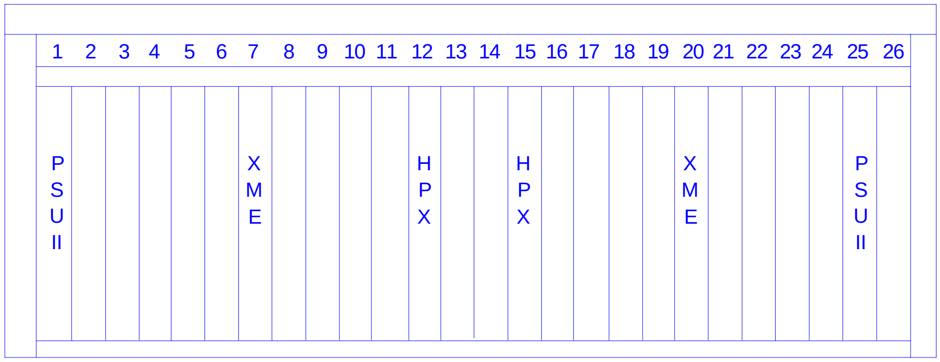


FIG. 7.2E
BASE PROCESSOR UNIT (BPU) CONFIGURATION

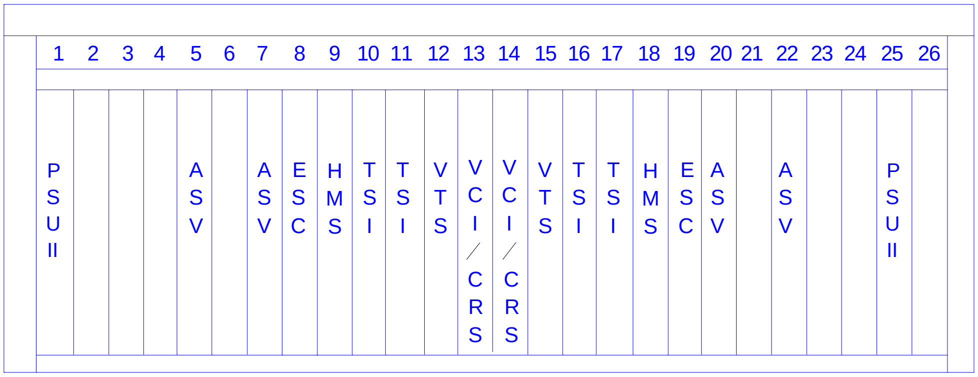
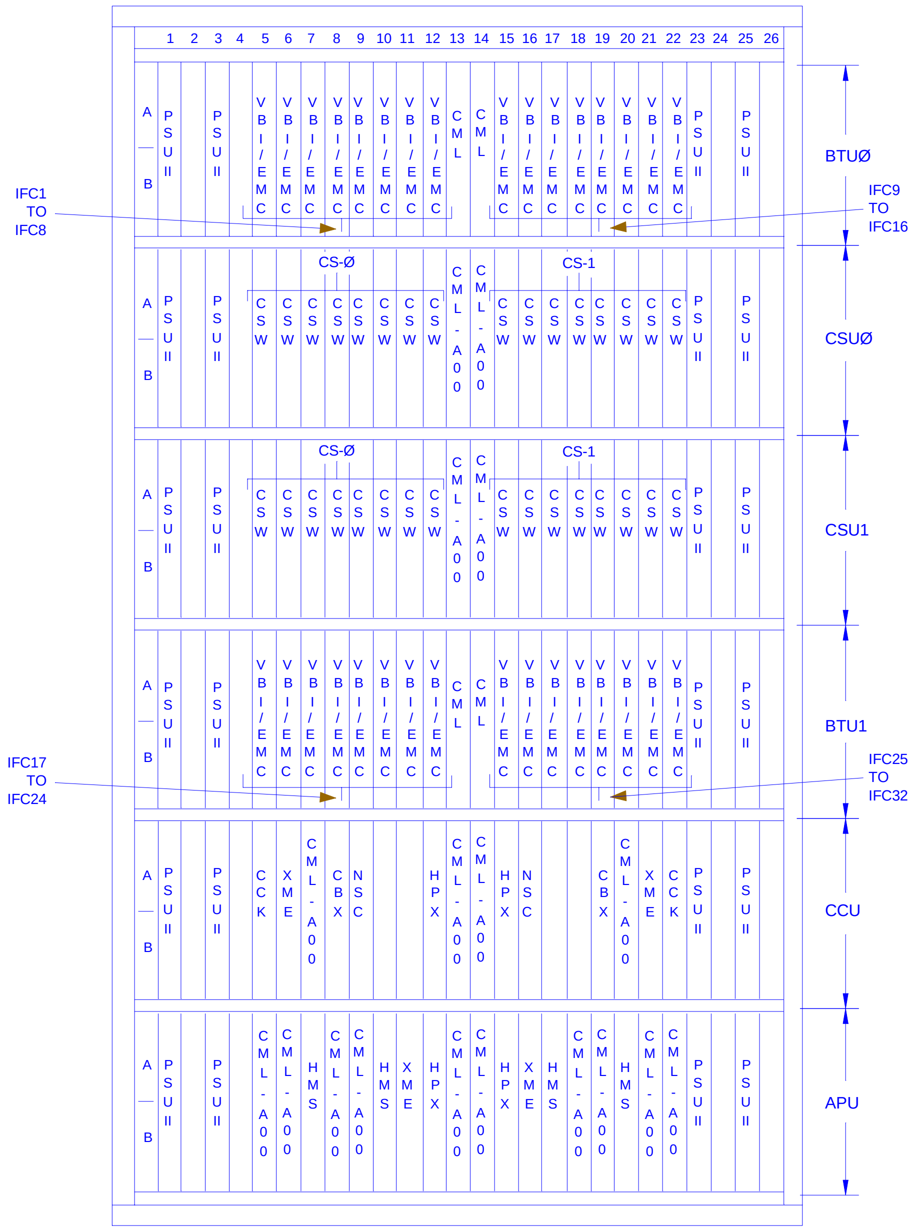


FIG. 7.2F
VALUE ENGINEERED TIME SWITCH UNIT (VSU) CONFIGURATION

LOTUS\VOL1\DESIGN\MAX2315\MX2315GD\MXISGDTS



NOTE : 1) UNUSED PSM CARD SLOT SHOULD BE EQUIPPED WITH THE DUMMY LOAD CARD CML-S00
2) UNUSED PSS CARD SLOT SHOULD BE EQUIPPED WITH THE DUMMY LOAD CARD CSL-S00
3) VBI CAN BE REPLACED BY EMC TO PROVIDE 16 E1 LINKS TOWARDS RBM

FIG. 7.3
CENTRAL MODULE-VE CONFIGURATION

LOTUS\VOL1\DESIGN\MAX2315\MX2315GD\MXISGDAG

- Connections to Main Distribution Frame (MDF)
- Inter-cabinet Connections
- Input Output Processor (IOP) Connections
- Alarm Display Panel (ADP) Connections
- Concentration Mode Connections

7.2.4.1. *Cabling Connections to Main Distribution Frame (MDF)*

Base Module Cabinet

On the motherboard, corresponding to each Terminal Card, there are three 7x2 module connectors with hoods. All such connections from each Terminal Unit are combined to form a pair of 64-pair telephone cables which terminate on a 64-pair connection module on the exchange side of the Main Distribution Frame.

7.2.4.2. *Inter-cabinet Connections*

Base Module Cabinet - Central Module Cabinet Interconnections

This intercabinet connection for communication between each BM and the CM is made via E3 coaxial cables, E3 CXAX. The connection is made between VEBM VCI cards in VEBM and VBI Cards in the CM cabinet. In the case of remotely located Base Modules as RSU, the connection is through E3 PCM links. At the Base Module end, the digital trunk cables are connected from EMC card slot to exchange side MDF from where it is connected to the transmission equipment. In case 2 Mbps links are to be used, VCI card is replaced by CRS card at VEBM end and VBI card replaced by EMC card at CM end.

Input Output Processor Connections

From each of the Input Output Processors (i.e. IOP-0 and IOP-1), the following interconnections are made:

- HDLC Cables (RS422 interface)
  - IOP-0 to IOP-1 (25-pin, D-type connectors with twisted pairs)
  - Administrative Processor Unit copy 0 - IOP-0/1 (Twisted pairs with 7x2 module connector on the APU and 25 pin, D-type connector on the IOP-0/1)
  - Administrative Processor Unit copy 1 - IOP-0/1 (Twisted pairs with 7x2 module connector on the APU and 25 pin, D-type connector on the IOP-0/1)

- Terminals and Printer Cables (RS232C interface).
  - These connections are provided for flexible access to any serial port using 8-pair telephone cables with 9-pin, D-type connectors are used.

Note :

In standalone configuration, IOP directly links with the processor card in the Base Processor Unit. The connectors and cables are same as above.

Alarm Display Panel Connections

In SBM configuration, Alarm Display Panel (ADP) communicates with the Base Processor Unit via an HDLC link. However, in MBM configurations, it communicates with the Administrative Processor Unit via an HDLC link. In both the cases, interconnections to the duplicated copies of the Processor Card, are made via twisted-pair cables, with two 7x2 module connectors with a hood on the exchange-side, and a 25 pin, D-type connector on the ADP- side.

Concentration Mode Interconnections between BM and LMs

In 4:1 concentration mode, each Terminal Unit (TU) Frame of BM is connected to a maximum of three other Terminal Unit Frames in the Line Module. For interconnecting them two pairs of 7x2 module connectors are from each Terminal Unit in the Base Module, and connected to the Terminal Unit in the Line Module by "daisy chaining" .

Table 7-1 summarises all the interconnections in C-DOT DSS MAX.

Table 7-1

Cabinet	Description of Interconnection	Type of Cable and Connectors
Base Module (BM)	Terminal Cards - Exchange-side MDF	7x2 module connectors (with hood) from a TU form a 64-pair telephone cable terminated on 64-pair connection module on the MDF. A 24-pair cable is used in a TU Frame having EMF trunks.
Base Module - Line Module	TU Frame in BM to TU in LM.	"Daisy Chaining" with 7x2 module connectors and twisted pair flat cable.
Central Module (CM)	APU Frame - IOP	11- pair, twisted pair shielded cable with 7x2 module connectors for each plane.
	BTU Frame - CSU Frame	Flat cables with module connectors between CSW and VBI cards on the front side of the cards.
ADP to APU	APU Frame - ADP (MM2) HDLC link	Twisted pair cable with 7x2 module connector on the APU side and 25 - pin, D-type connector on the ADP side.
VE BM-CM	VSU Frame - BTU Frame	E3 Co-axial or E1 cables (8 four pair

Cabinet	Description of Interconnection	Type of Cable and Connectors
		cables)
CM (BTU)-RSU (BM-XL)	CM (BTU frame) to RSU connections	Digital trunk cables. 2 pairs for each DTK.
Input Output Processor (IOP) to APU	APU Copy 0 - IOP and APU Copy 1 – IOP	7x2 module connectors on the APC and 25-pin, D-type connector on the IOP.
Terminals and Printers of IOP	Console, Host, Operator terminals and Printers	RS232C cables with 9-pin, D-type connectors
IOP – IOP	HDLC link	Twisted pair cable with 25-pin, D-type connectors.

7.2.5. Power Supply and Earthing Arrangement

From the power supply busbars, power is tapped through cables to each suite separately. From the float rectifier, which derives -48V DC from 440V AC, power cables are terminated on the DC Distribution Panel (DCDP). From the DCDP, power cables are run along the cable runways and ladders, and terminated on the Power Distribution Panel (PDP). Distribution Panel consists of two busbars for -48V, one each for copy 0 and copy 1 equipment. Similarly, there are two busbars for 'ground'.

For each Base Module cabinet, the power, i.e. -48V, is tapped twice - one for each plane - through a fuse. Whenever the fuse blows off, the LED which is connected in parallel glows on the FBI Card and an audio alarm is given at a centrally located point. The 'ground' cable is run directly from the busbar to the respective Base Module cabinets. The power cables are placed on the cable troughs and terminated on the busbars of the respective Base Modules.

Below the 'ground' busbar, on the Power Distribution Panel, two more busbars are placed on which the cables from chassis and logic 'ground' of each Base Module are terminated. Cables are brought out from the Service Earth Plate to these busbars.

7.3. EXCHANGE LAYOUT

A typical C-DOT DSS MAX installation is spread over the following rooms:

- Switch Room
- Operations and Maintenance (OMC) Room
- Input Output Processor (IOP) Room
- Power Plant Room & Battery Room
- Main Distribution Frame (MDF) Room/Cable Chamber

In SBM configuration, the Switch and IOP are installed in a single room whereas in MBM configuration these are separately provided. Other equipments like power plant, battery, MDF/Cable Chamber and PCM junctions are installed in separate rooms, either on the same or different floors of the exchange building required.

The switch room layout of a sample MBM configuration is shown in Figure 7.4. For other configurations the dimensions and layout are different.

7.3.1. Switch Room

7.3.1.1. Equipment

The C-DOT DSS MAX Switch Room consists of BM and CM cabinets mounted in standard suites. These cabinets are fastened to the Switch Room ironwork and interconnected by cables. The cabinets are organised in groups of four cabinets each. Each such group is called a half suite. Two half suites make one full suite. All exchange configurations can be organised as a number of half suites or full suites. SBM exchange is organised as a maximum of three cabinets put in one row.

Flooring

Floor is generally covered with 2mm thick antistatic vinyl strips to give antistatic property to the floor which is necessary to avoid damage to the sensitive circuitry which incorporate many CMOS devices.

False Ceiling

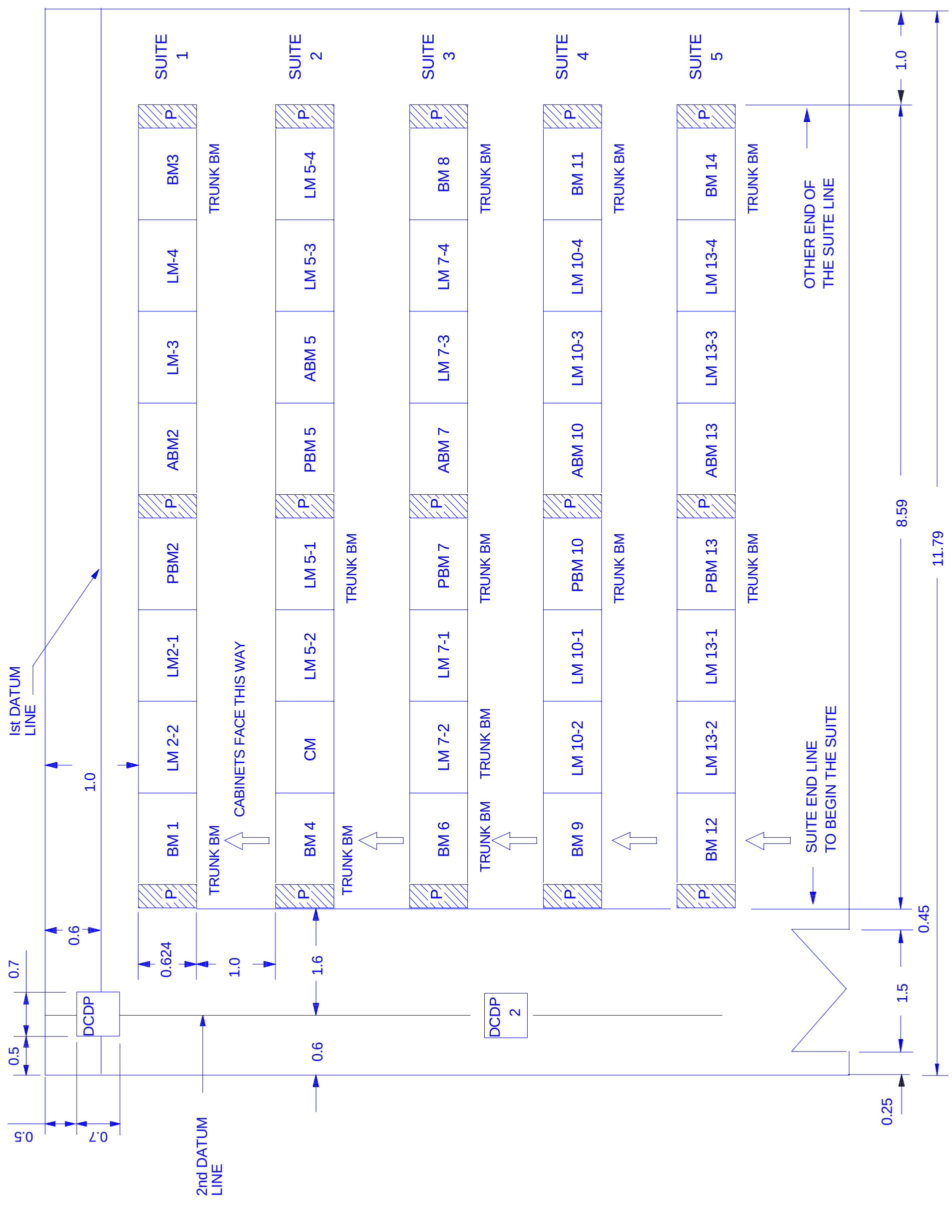
The false ceiling comprises of panels made of "Supersil" (aluminum), some of which have holes for fixing fire detectors and lighting fixtures.

The minimum floor to beam height of the Switch Room should be 3000mm. A false ceiling is not mandatory and is needed only for old telecom buildings.

Switch Room Dimensions

To allow free movement of personnel and access to equipment, the following standard suite arrangement are followed :

- Distance between two suites - 1000mm
- Distance between front suite and wall - 1000mm



BM - BASE MODULE

CM - CENTRAL MODULE

P - PILLAR

DCDP - DC DISTRIBUTION PANEL

NOTE : SOME CABINETS MAY ALSO BE REMOTELY LOCATED

ALL DIMENSION IN METERS

FIG. 7.4

MBM EXCHANGE SWITCH ROOM LAYOUT

LOTUS\VOL1\DESIGN\MAX2315\MX2315GD\MX\SGDME

- Minimum Distance between back suite and wall - 1600mm
- Minimum Distance between suite end and wall (on the power-side end) - 2000mm (on the other side) - 1000mm

Fire Detection

The Switch Room and all other rooms should be equipped with a common fire detection system. The system comprises of detectors connected to a general indicator panel. It detects responses from smoke-detectors spread over the entire technical and non- technical areas of the building which generate both audio and visual alarms indicating fire/smoke and the zone affected. Detectors are attached to the ceiling (or the false ceiling, if provided).

Openings for Cable Routing

Openings should be provided in the walls and floors of the Switch Room for routing cables between the switching equipment and Power Plant, MDF and OMC rooms. All these openings are made before the commencement of exchange installation work. The placement and number of the openings is, however, site dependent.

For an average-sized exchange, openings of following dimensions are required:

- An opening of size - 400mm x 200mm. between Switch Room and Power Plant Room.
- An opening of the size - 500mm x 300mm. between Switch Room and MDF Room
- An opening of the size 200mm x 200mm. between Switch Room and OMC/IOP Room.

7.3.2. Operation and Maintenance Centre (OMC) Room

Equipment

The OMC Room houses mainly the peripheral equipment such as :

- Alarm Display Panel (ADP)
- Operator Maintenance Alarm (OMA) Panel
- Indicator Panel for fire-detection
- Printers (2)

- OOD Terminals (2)
- CRP Terminals for exchange operators

Some spare terminals are also provided for miscellaneous uses. The number of terminals depends upon the exchange configuration.

Dimensions

For an exchange of capacity 5000 ports or more, the dimensions of the OMC Room are approx. 5000mm x 7000mm.

7.3.3. Input Output Processor (IOP) Room

Equipment

The IOP Room houses the two IOPs with one or more video display terminals and printer, kept for the use of system administrator. Rest of the terminals and printers are kept in the OMC Room.

Two inverters of 1 KVA each are required for IOP/OMC rooms to provide uninterrupted power to the VDUs and printers.

Dimensions

For an exchange of 5000 ports and more, the dimensions of the IOP Room are 2500mm x 3000mm, while for smaller exchanges both the IOP and OMC rooms can be put together in a room of dimensions 3000mm x 7000mm.

7.3.4. Power Plant Room & Battery Room

Power Plant Room

The following equipment is provided in this room :

- Float Rectifiers
- Switching Cubicle
- Battery Chargers
- LT Panels
- Intermediate Distribution Panel (IDP)

Dimensions

The dimensions of the Power Plant Room are 10000mm x 8000mm. The cubicles for float rectifiers, battery charger and the switching cubicle are situated within this room and have different dimensions. Their placement, however, depends upon the exchange site.

Battery Room

This room houses an 2x24 cell array of batteries working in parallel (float) with the rectifiers. It is mandatory that the Battery Room be located next to the Power Plant Room. The dimensions of the Battery Room are 7000mm x 12000mm and it houses two sets of batteries.

7.3.5. Main Distribution Frame (MDF) Room

MDF room houses the MDF and one or two VDU terminals which are used as test positions.

Two basic configurations of MDF are standardized. Frame type, wall mounted, extendable, single sided MDF is proposed for exchanges upto 2000 ports. For Main Automatic Exchanges above 2000 ports, an open frame type, double sided, extendable MDF is used. MDF provides easy access to connector blocks used for terminating external cables on line side and equipment cables on exchange side. Facilities for disconnection, interception and testing on either side of the connector block, are available for day-to-day maintenance. Complete flexibility is available through jumper pair for interconnecting any line side cable pair to any equipment number on the exchange side of the MDF.

Note: 1. In case of Switch Room Layout, the dimensions are given for Main Exchange, as per full suite configuration of its ultimate capacity. In smaller configurations, the half suite configurations with different layout, can be considered.

2. Dimensions for other service rooms are only a recommendation and the planner is free to re-organise it to suit site specific requirement..

7.4. CLIMATIC AND ENVIRONMENTAL CONDITIONS

The system is capable of working satisfactorily under the following environmental conditions:

- During the pre-installation period
  - *Temperature* - 10°C to 50°C
  - *Relative Humidity* - Upto 100%
- Switch Room and IOP room Conditions (exchange in operation)
  - *Temperature* - 17°C to 27°C
  - *Relative Humidity* - 45% to 80%
  - *Air Movement* - 3/2 air changes per hour
  - *Dust Filteration* - Particle size above 5 microns excluded (99% exclusion).

C-DOT DSS MAX is capable of operating for four hours after air- conditioning failure in the exchange.

Illumination

Generally, fluorescent lamps for general lighting to a level of 300 lux in equipment rooms should be provided. If special lighting is required for working on the equipment, provision for bay fixtures for bay lighting would be made in the design.

Air-conditioning

Air-conditioning does not require any upward throw of air through the bottom of cabinets. Air supply grills for throwing conditioned air may be conveniently located on the sides or on the false ceiling, if provided (to ensure uniform distribution). Heat load of the exchange due to occupancy and lighting load in the switch room and OMC room is also considered for air-conditioning provisions.

For a typical four full-suite configuration, the heat load is as follows :

Occupancy	- 10
Equipment dissipation	- 35 KW
Lighting load	- 1 W/sq.ft.

Air-conditioning provisions are required to provide adequate temperature and relative humidity control as per the specified Switch Room conditions. Standard air-conditioning practices should be used to take into account the ambient conditions prevailing outside the Switch Room which will depend upon the part of the country for which the C-DOT exchange is being planned.

Annexure - A

Technical Specifications Summary

System Data	
Number of Subscriber lines	upto 1,00,000 with 15000 trunks
Number of trunks (TANDEM/TAX)	upto 30,000
Switching capacity	upto 14400 E
Busy Hour Call Attempts (BHCA)	8,00,000 BHCA (load A) as per ITU-T Rec. Q.504
Processors Memory capacity	upto 32 Mbyte
External Memory	
magnetic tape:	Two devices of 150 Mbyte each
magnetic disk	Two devices with storage capacity up to 9.1 G byte each, with redundancy
Common Channel Signalling links	upto 128 signalling links
Operating voltage	-50V ± 6 VDC
Transmission	ITU-T Rec. Q.507, Q.517, 32 Channel E-1 PCM
Performance and reliability	ITU-T Rec. Q.504, Q.514
Clock accuracy, maximum relative frequency deviation	Plesiochronous 10^{-9}, Synchronous 10^{-11}
Interfaces	
Network / Trunk	All standard signallling systems for different interfaces as Two wire physical (TWT), E&M and E-1 PCM.
Signalling systems	Decadic, CCITTR2, CCS7, Country specific MF Signalling
Subscriber / Access Interfaces	
PSTN Subscribers	Ordinary subscribers, CCB subscribers with reversal, 16 kHZ subscribers with or without reversal
Basic access	144 kbit/s (2B + 1D); B = 64 kbit/s; D = 16 kbit/s
Primary rate access	2,048 kbit/s (30B + 1D); B = D = 64 kbit/s
PSPDN Interface (ETSI PHI 300 009)	Will be made available
V5.X Interfaces	V5.2 interfaces to support Access Networks
Network Interworking	ISDN ←--→ ISDN, ISDN ←- -→ PSTN and ISDN ←----→ PSPDN interworking functions are integrated and no external interface / mediation device is required.
Supplementary Services	
Number Identification Service	CLIP, CLIR, CLIRO, COLP, COLR, COLRO, MCID,

	SUB, MSN
Group Line Service	LH, DDI
Charging Service	AOC-E, AOC-D
Call Completion Service	CH, CW Hot-Line (Timed), Hotline (No delay), Terminal Portability
Call Transfer Service	CFU, CFB, CFNR
Multi Party Service	3-PTY, CNF-MPTY.
Other Service	Dynamic Locking Access Level for O/G Calls. Morning Alarm/Reminder Service, Line Observation, Incoming Call Barring, Intrusion Barring etc.
IN Services	Freephone, VCC, VPN, Premium Rate Service, ACC, UAN, Televoting
Line characteristics	
Subscriber Lines	Subscriber Line: upto 1000 ohm loop at 30mA Leakage Resistance upto 20K ohm.
Rotary Dialling	5-22 pulse/s
Pushbutton Dialling	Dual-Tone Multifrequency (DTMF) as per CCITT Rec. Q.23
Routing	
Alternative Routing	upto 7 alternate choice for resources
Path selection for trunks within a trunk group	Progressive
Number of trunk groups per exchange	upto 512, can be configured as any mix of incoming, outgoing or bothway trunks.
Number of Routes	upto 4000 in MAX & 1000 in SBM
Depth of digit analysis	upto 12 digits.
Prefixing / Digit Replacement	Prefixing of four digits and replacement upto 6 digits.
Charge registration	
Methods	all standard methods such as periodic pulse metering, AMA (CAMA, LAMA)
Total Charge Rate Number	128
Types of Days	8 type of days are possible for different charging
Tariff switching	16 tariff zones in multiple of 15 minutes
Local charge storage	in CP memory
Charge saving	automatic, hourly (MMI programmable) to duplicated magnetic disk drive, AMA/CAMA data more frequently in multiple of 3 records
Charge data processing	output to tape or file transfer to centralised data processing centers
Administration Features:	
Traffic features	Traffic Measurements in conformance to ITU-T E.50X
Password & Security	Security for data base by commands classification
Call Tracing	Tracing of long duration in high revenue call

Junction Billing	Separate counters for Local / STD and ISD calls for all the Trunk Groups with option of detail billing
Alarm Monitoring	Remote alarm monitoring and reporting
Space requirements	Main Exchange for 10,000 subscriber lines: 35m²
Dimensions	
Racks	
Height	2,450 mm
Depth	500 mm
Width	770 mm
Distance between rack rows	min. 1,000 mm (front edge to front edge)
Weight per meter of rack row	450 kg
Flooring	
Ground/Surface	Antistatic Flooring. False flooring is not mandatory.
Height for Ceiling	min. 300 mm. False ceiling is not mandatory. Desirable to reduce in AC Load.
Environmental conditions	
Ambient temperature	17-27°C
Relative humidity	10-80%
Power Consumption	MAX-VE (10K lines) : 390 Amps MAX-VE (40K lines) : 1050 Amps SBM-VE (4K lines) : 8.5.24 Amps
Application	
Local	
Tandem	
Trunk Automatic Exchange (TAX)	
Integrated Local/Tandem/TAX (ILT) and RSU	
Remote Switching Unit RSU	

System Practices

COMMENTS

The following comments pertain to:

Document Name

CSP Section ☐☐☐ - ☐☐☐ - ☐☐☐☐

Issue/Draft ☐☐ , ☐☐☐ - ☐☐☐☐

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Centre for Development of Telematics

Attn: Director, Systems

39, Main Pusa Road
New Delhi 110 005
Tel.: +91-11-25740374
Fax: +91-11-25756378

Your Reference:

Name :
Designation :
Company :
Address :

Tel. :
Fax :