iDEN System Integration

Project Report

Submitted in partial fulfillment of the requirements

For Semester-4 of

Master of Technology

In

Electronics & Communication Engineering

(Communication Engineering)

By

Samip Shaileshbhai Christian

(09MECC03)

Department of Electronics & Communication Engineering

Institute of Technology

Nirma University

Ahmedabad-382 481

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May 2011

Declaration

This is to certify that

i) The thesis comprises my original work towards the degree of Master of Technology in Communication Engineering at Nirma University and has not been submitted elsewhere for a degree.

ii) Due acknowledgement has been made in the text to all other material used.

Samip Shaileshbhai Christian

Certificate

This is to certify that the Major Project entitled **"iDEN System Integration"** submitted by **Samip Shaileshbhai Christian (09MECC03)**, towards the partial fulfillment of the requirements for the Semester-4 of degree of Master of Technology in Comunication Systems of Nirma University, Ahmedabad is the record of work carried out by her under our supervision and guidance. In our opinion, the submitted work has reached a level required for being accepted for examination. The results embodied in this project, to the best of our knowledge, haven't been submitted to any other university or institution for award of any degree or diploma.

Date: Place: Ahmedabad

HOD and Internal Guide	Director
(A.S.Ranade) Associate Professor, EC	(Dr. K. Kotecha) Director, IT, NU

Abstract

Integrated Digital Enhanced Network, commonly referred to as iDEN, is a mobile communications technology, developed by Motorola, which provides its users the benefits of a trunked radio and a cellular telephone.Events in a system can be generated so rapidly that they can adversely impact network management system.They may fail to get delivered and critical information may get lost.This problem become more worse in a large network like iDEN.Identifying the problem,that it is associated with network part or wireless part is among main issues in network management.iDEN OMC provides for an advanced fault management along with an enhanced feature known as iDASHBOARD,which generates soft alarms and reduces the number of remote telemetry unit thereby increasing network efficiency.Currently iDASHBOARD is used for EBTS(Enhanced Base Transceiver System) but can be employed for other network elements also.iDASHBOARD is also available on mobile station of a technician,which provides for an additional benefits since alarms generated can be solved by technician remotly also.

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Above all am thankful to Lord Almighty for his abundant blessing in completion of this work.

- Samip Shaileshbhai Christian

09MECC03

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Chapter 1

Introduction

iDEN stands for Integarated Digital Enhanced Network.Five integrated services in one single device gives users more choice on how to communicate.All digital technology provides a solid network platform for ongoing system enhancements, so user always have the benefit of the newest technology by having excess to an enhanced multi-site network users have wider area coverage where they do business.iDEN handsets streamline communications by providing a five-in-one solution that combines the capabilities of

- A digital wireless telephone
- Nationwide and international two -way radio
- Packet data for internet access
- Two-way email and text messages and
- Wireless Modem capabilities

Integrated Digital Enhanced Network, commonly referred to as iDEN, is a mobile communications technology, developed by Motorola, which provides its users the benefits of a trunked radio and a cellular telephone[1]. Sprint Nextel is the largest US retailer of iDEN services. iDEN places more users in a given spectral space, compared

to analog cellular systems, by using time division multiple access (TDMA). Up to six communication channels shares a 25 kHz space; some competing technologies place only one channel in 12.5 kHz.

1.1 iDEN around the world

iDEN is available in other countries through several carriers including Nextel International. Nextel International allows direct connect (PTT operation) between users in several countries including the United States, Argentina, Brazil, Chile, Mexico, Peru and Canada. Countries which have operating iDEN networks not currently connected with the US include Jordan, Israel, the Philippines, Singapore, South Korea, Saudi Arabia, Japan, El Salvador and China (in selected areas). Both data (such as paging, text messaging and picture messaging) and voice communications are supported by iDEN

In order to provide high data rates for packet data, Nextel started to develop a 2.5G technology called WiDEN[2]. WiDEN is a planned expansion on the iDEN system, where instead of using a normal 25 kHz channel for packet data, it will encompass 4 carriers (100 kHz) into one channel. This would have allowed download speeds of 96 kbit/s, which is comparable to the average CDMA2000 1x speeds from American competitors Sprint and Verizon Wireless. iDEN is a technology with no clear path for high speed wireless data. It is thought that as part of the Sprint Nextel merger, 1xEV-DO will become the infrastructure for 3G data to both Sprint and Nextel customers, as part of the transition to CDMA2000. Following Nextel's merger with Sprint, iDEN may be phased out, however Nextel has stated they will support iDEN until at least 2014. There is a smaller subset of the iDEN network called 'Harmony', which has a maximum limit of 30 sites.

Countries operating iDEN networks

Company Name	Country	Push To Talk Name
Airtel Wireless Ltd.	Calgary, Alberta, Ca	Churp
Airpeak	United States	Talk Direct
ARINC	United States	
Avantel	Colombia	Comunicación Inmediata
Boost Mobile	United States	Chirp
Bravo Telecom	Saudi Arabia	Push To Talk
Procall Pvt. Ltd.	India	Digital Push To Talk
China Satcom Guomai Comm Co. L	China	
Iconnect	China Hong Kong(SAR)	
Connect Net	United States	
GRID Communications	Singapore	Push To Talk
Iconnect	Guam	iConnect PTT
Intelfon	El Salvador	RED
Intelfon	Guatemala	RED
Mirs	Israel	
Monttcashire	Ecuador	

Figure 1.1: iDEN around the world

1.2 System Overview

The outgrowth of the wireless communications market has produced vast opportunities to enhance and improve the communications between individuals. Because of this growth the need to optimize Radio Frequency (RF) spectral resources and provide ever-increasing services is essential. To support the increase in wireless services while making best use of available resources, the iDEN system capitalizes on the fact that communications can be: Half-duplex - where one user is transmitting (talking) and other users are receiving (listening) Full-duplex - where there is an open bi-directional link that allows full two way communication.

Many times communication does not require a full-duplex link. Messaging, paging, some forms of data communication and structured voice communication are, or can effectively operate in, half-duplex mode.Traditional telephone conversations and more intensive data links require the ability to interrupt; that requires full-duplex operation .The iDEN system provides both full and half-duplex operations. This melding of communications methods allows much of the voice traffic to be run in half-duplex mode, while providing full-duplex functionality when required.As part of the ongoing effort to support the outgrowth in wireless communication, the iDEN system is an integration of traditional Push-To-Talk (PTT), half-duplex, analog radio technology and feature-rich, full-duplex digital cellular communications. This integration of mobile communication technologies provides state-of-the-art functions and benefits to mobile users while optimizing the available infrastructure resources.

1.3 Reasons for Considering iden

Traditional PTT radio communications in corporate and municipal environments was limited by the number of radios and Federal Communication Commission (FCC) licensing. These restrictions limited the coverage area, contact outside the assigned, licensed mobile units, and provided little privacy. The iDEN system:

Removes end-user FCC licensing requirements Opens communication to other subscriber corporations and all telephones Increases the coverage area Allows private and group calling Optimizes RF resources Improves quality with higher frequencies and digital technology

Because of the finite availability of the Radio Frequency (RF) spectrum and a need to optimize this resource, iDEN technology increases the efficiency of a single 25 KHz RF carrier by applying up to six times the traffic of an AMPS Cellular carrier. In addition to the increased channel efficiency, an iDEN system may be deployed to support communications outside the provider's network (roaming). The telephone style interconnect capability allows users to roam seamlessly throughout

linked service areas. A user may place and receive calls as if the Mobile Station (MS) is on its home system. This also allows the service provider to offer an integrated service that includes:

Messaging (Short Message Service) Private , Two-way and Group Call Cellular Telephony Service Voice Mail Data Networking (Intranet, Virtual Private Network (VPN), Internet).

Since the iDEN system uses digital technology, it provides clear voice quality, interference is reduced and voice quality is enhanced. As the wireless industry grows, subscribers are seeking more services and increased functionality from a single service provider. With iDEN systems, these services and system outgrowth can easily and quickly be provisioned and made available to the end user because the radio link reduces installation time and cost when compared to land-based approaches. land-based approaches

1.4 Organization of System

To support the growing need for emerging telecommunications services, iDEN systems are organized into different levels or areas[2, 3, 12]. These areas are based on geographical areas of decreasing size. The areas are:

- Global
- Region
- Domain
- Service Area
- Location Area
- Cell

- Global- Global refers to the worldwide, multi-provider, Public Telephone Switched Network (PSTN). The telephone services available worldwide may be accessed from the iDEN system using Interconnect calling. When the iDEN system uses the PSTN (Interconnect) system, the rules and procedures of the PSTN are used. Interconnect calling is the access to land-line systems and the services available and emerging in the public switched environment. Global Two-Way (Dispatch) communications, while currently not available, is emerging technology

- Region- A Region is a large geographic area that is usually associated with more than one market or, more than one urban area. Just as urban areas tend to be adjacent and overlap, so do service provider coverage areas. A single service providers provides services by regions. A service provider may have adjacent or overlapping markets that can be linked to provide contiguous service across the areas. Regions may be covered by either Interconnect and Dispatch calling.

- Domain- A Domain is an optional logical division of a region. This is usually defined by marketing and sales strategies as a fleet-based geographical area. The intent is to subdivide the region into smaller areas based on expected usage patterns. Domain 0 is a system-wide domain. The default for Domain 0 is all service areas. There can be up to 50 domains can be assigned

- Service Area- A Service Area is dispatch only and is defined in provisioning by the subscriber and user databases. A service area is a group of Dispatch Service Areas (DLAs) that define a range of operation. Multiple service areas may be defined. Service Areas may overlap. Users in a service area tend to stay within its borders. A business' users that travel outside the service area will not be able to obtain dispatch service.

- Location Area- A Location Area is logical geographical area that is based on the present (most recent) location of a Mobile Station (MS). Each MS on the

iDEN system has Location Area Identifiers (LAIs). As the MS moves, different cell sites may service the MS. The equipment that may service the MS defines the Location Area. Interconnect service locations are not the same as Dispatch locations. Interconnect Location Areas are most often larger than Dispatch Location Areas. In both cases, the Location Area defines the general area where the MS is currently located for paging and call setup.

- Cell- A cell is the area serviced by the RF propagation pattern of the antennas and a radio of a remote tower (cell site). The area is the effective size of a cell. An EBTS cell site may be either omni-directional or sectored. An omni site will have 1 cell. Sectored sites have 2, to 12 sectors (cells). Sectored sites most commonly have three cells. An MS is located by radio link integrity between 1 or more cells. One cell acts as host serving cell until a better radio link is detected from another cell.

1.5 Physical Organization

The iDEN system consists of many components and pieces of physical hardware[7].The components and hardware are located throughout the local service coverage area. To simplify integration, the equipment uses industry standards for physical size, power requirements, and interface connections wherever possible. Each major component listed has sub-systems that perform more specific tasks.

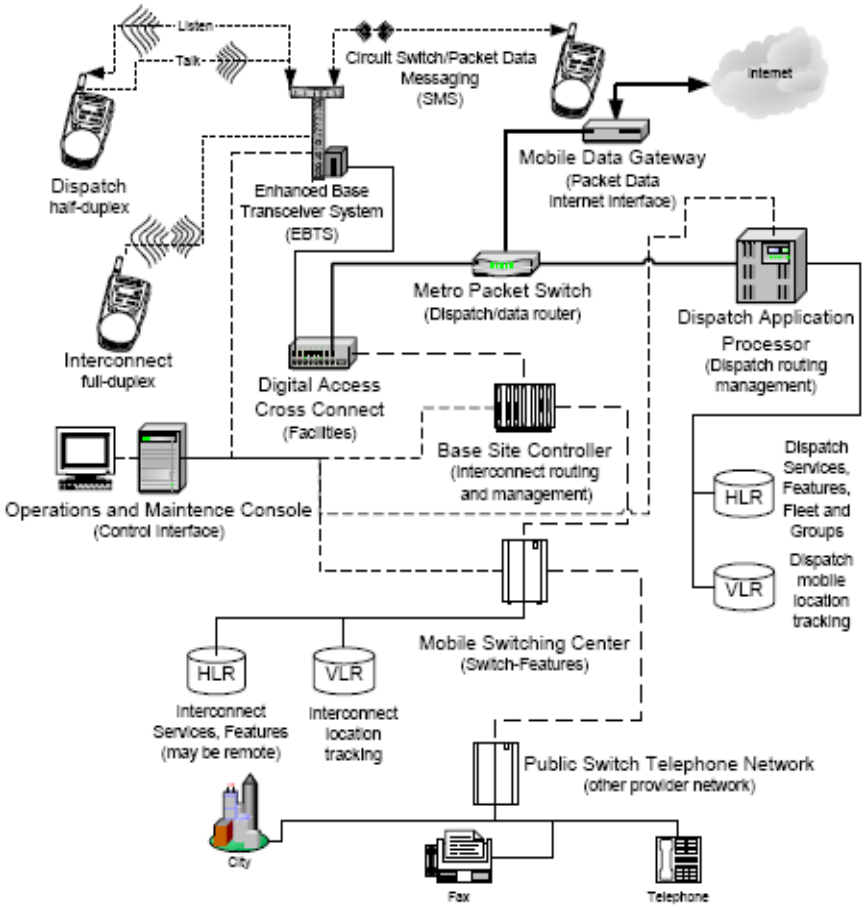

Figure 1.2: Simplified iDEN Communications Network

1.6 Thesis Organization

The rest of the thesis is organized as follows.

In **chapter Two**, all the network elements of iDEN System are described.

Chapter Three describes, Network Management aspects of iDEN system and architecture of OMC.

Chapter Four describes, all the functions of OMC.

Chapter Five gives a description of iDASHBOARD.

Finally, in **Chapter Six** concluding remarks and scope for future work is presented.

Chapter 2

iDEN System

This Chapter describes the iDEN system Network Elements. Network elements are hardware and software that form operational components of the system. Each of the depicted components is described individually.

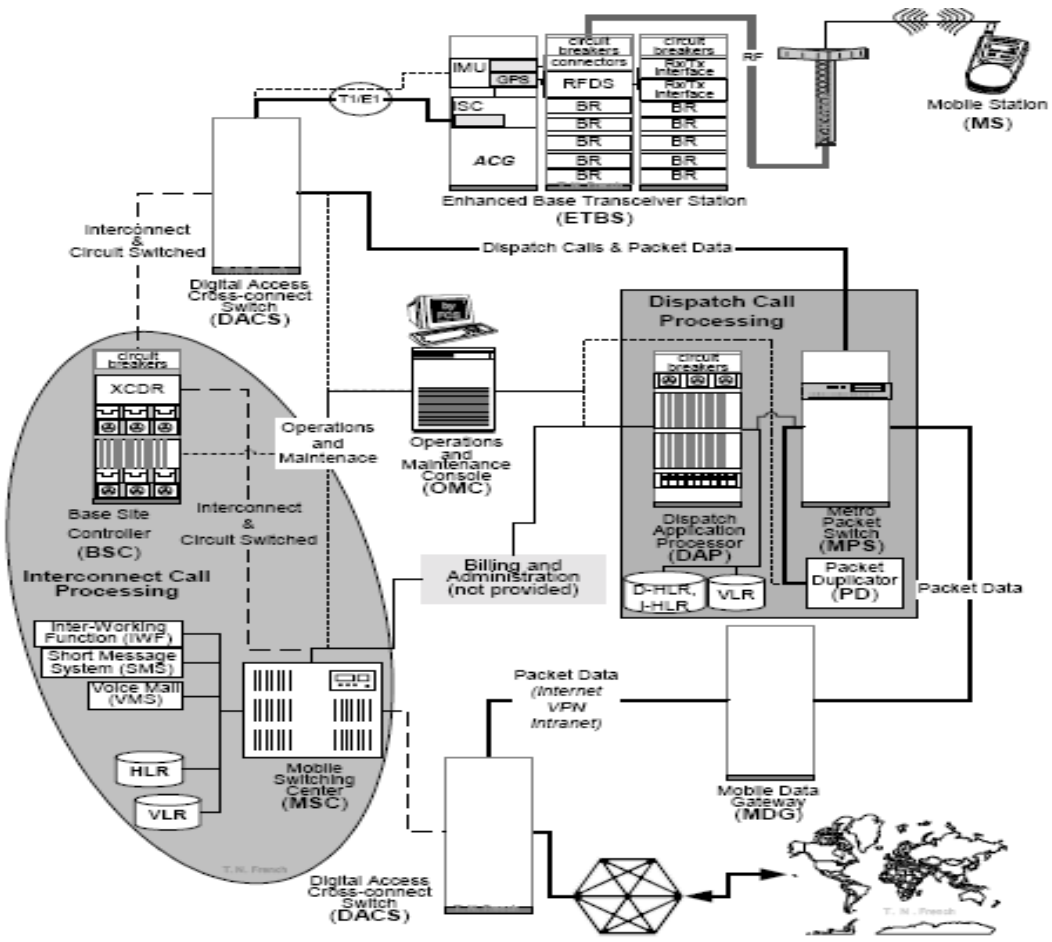

Figure 2.1: Generalized iDEN System Architecture

2.1 Enhanced Base Transceiver System

2.1.1 Physical Components

In the iDEN system, the base station radios and associated control equipment are contained in the Enhanced Base Transceiver System (EBTS) or, more commonly, cell sites. The EBTS provides the Radio Frequency link between the land network and the MSs. The Base Radios (BRs) perform the communications with the MSs, sending both the control information and the compressed speech over a radio channel[4]. EBTS components are rack-mounted.

The EBTS site consists of:

- An Access Control Gateway (ACG), which is an integrated Site Controller (iSC)
- One or more Base Radios (BRs)
- An RF Distribution System (RFDS) (hybrid or cavity)
- A site synchronization Global Positioning System (GPS) receiver

2.1.2 Access Control Gateway

The Access Control Gateway (ACG) is the site controller and the communications gateway between an EBTS site and the System's central network. The ACG exists in two versions. The legacy VME-bus version and the modular iDEN Site Controller (iSC) version. The iSC version of the ACG consists of two units the:

- iDEN Site Controller (iSC) that integrates the access gateway, timing reference and facilities termination functions.
- iDEN Monitor Unit (iMU) that integrates the Environmental Alarm System (EAS) and the Base Monitor Radio (BMR).

The iSC discriminates between Dispatch, Interconnect and Packet Data calls and routes the traffic accordingly. It also controls base radio timing and terminates transport facilities. Network infrastructure facilities (T1/E1s) are terminated at the iSC. The iMU integrates the Environmental Alarm System (EAS) and Base Monitor Radio (BMR) functionality in a single unit. Alarm and status information is reported to the Operations and Maintenance Center - Radio (OMC-R) through the EAS/BMR on VME systems and the iMU on shelf-oriented systems.

2.1.3 Base Radio

The EBTS requires one Base Radio (BR) for each 25 MHz carrier. The EBTS currently supports up to 20 radios when configured as an omni site and 24 radios as a 3-sector site. A BR can be removed from the EBTS and replaced with a new BR

without taking the site off the air (can be hot-swapped). The base radios and the radio link traffic (voice and data) are controlled by the ACG over a LAN.

2.1.4 RF Distribution System

The Radio Frequency Distribution System (RFDS) is the frequency combiner that allows everal BRs to share a common antenna system. The EBTS can be configured with either hybrid or cavity combiners. This creates minor changes in maintenance and operation but does not affect the functionality of the radio link.

2.1.5 Site Timing Reference

Each site requires precise timing and location information to synchronize data across the network. To obtain and maintain this information each EBTS uses GPS satellites obtain a precise, timing reference pulse .

2.1.6 LAN Interface

Each EBTS component is monitored and communicates with each other directly or over a LAN. The LAN interface is the path for traffic flow. The LAN also supports the Alarm and Messaging monitoring functions (iMU or BMR/EAS). Operations and Maintenance uses the iMU and the LAN to access the cell site.

2.1.7 Functional Characteristics

The EBTS can be configured to support multiple RF frequencies in a omnidirectional or sectored configuration. Major functions of the EBTS are:

- Maintenance of the radio link
- Radio link formatting, coding, timing, error control and framing
- Timing control supervision to subscriber units (time advance)

- Radio link quality measurements - Signal Quality Estimate (SQE)
- Recognition and separation of traffic (Interconnect, Dispatch, Circuit Data or Packet Data)
- Site-to-site frame synchronization
- Switching functions between base transceivers

2.2 Digital Access Cross Connect Switch

2.2.1 Physical Components

The Digital Access Cross Connect Switch (DACS) is the attachment point of T1/E1 span lines (trunks) between the iDEN system equipment and the external transport facilities. The DACS is not part of the iDEN network's equipment but is required to connect the remote locations to the Mobile Switching Office (MS)

2.2.2 Functional Characteristics

The DACS is a channel bank/multiplexer that distributes the DS0s (span lines) of the T1s to EBTSs and the Fixed Network Elements that are connected though the external equipment or transport facilities . These may include T1, DS3s DS4s Fiber Optics or microwave.

- Dispatch and Packet Data DS0s (frame relay spans) are routed from the EBTS to the Metro Packet Switch
- Interconnect paths and control signalling is wired from the EBTS spans to the Base Site Controllers
- Operations and Maintenance information on a single DS0 between the EBTS and the OMC

- External transport facilities are often connected to the iDEN system through a DACS Trunking and span line connections.

2.3 Dispatch Application Processor

2.3.1 Physical Components

The Dispatch Application Processor (DAP) is usually installed in a standard rack. DAPs are usually deployed in groups (clusters) of up to 6 DAPs. DAPs and DAP-clusters vary with age and capacity. The DAP exists in several configurations:

- IMP-DAP - that supports 300 EBTS sites and 45,000 users
- N-DAP - that may be a 6-DAP cluster with up to 1000 EBTS sites and 90,000 users
- T-DAP - That supports clusters 1000 EBTS sites and 180,000 users

The DAP consists of:

- Standard System Controllers
- Input Output Controllers
- Central Processing Unit
- Router Controller
- Mass Storage Devices

Standard System Controller

The Standard System Controller (SSC) cards provide the ServerNet communications routing for the:

- I/O controllers

- Internal control and maintenance system
- Small Computer System Interface (SCSI) disk drives
- Host bus adapters (HBAs)
- Configuration and maintenance
- I/O expansion functions for the system

There are two SSCs in the unit for fault tolerant redundancy.

2.3.2 Functional Characteristics

The DAP is the processing entity responsible for the overall coordination and control of Dispatch and Packet Data services[5]. The DAP has been optimized to support rapid response time for services, which include but are not limited to: Group calls, Private calls, Call Alerts, Emergency calls and Packet Data networking. To increase subscriber capacity, the DAP may be expanded to form a six-DAP cluster.

The DAP provides:

- Control for all Dispatch and Packet Data functions
- First-time registration for all Interconnect and Dispatch subscribers
- Maintenance and tracking of MS mobility (Dispatch and Packet Data)
- Alarms and performance statistics for the OMC
- Maintenance of all Dispatch subscriber provisioned information

2.4 Metro Packet Switch

2.4.1 Physical Components

The Metro Packet Switch (MPS) is a subsystem that connects the EBTS frame relay connections to the Dispatch Application Processor and the Packet Duplicators. It

consists of the system cabinet and attachment point for frame relay span lines.

2.4.2 Functional Characteristics

The MPS is a Frame Relay digital data packet switch. The MPS manipulates the paths dispatch voice packets use during a Dispatch call and the data packet paths during a Packet Data networking. For group dispatch calls and data network multicasts, the MPS routes packets to and from the Packet Duplicators (PDs) and Advanced Packet Duplicators (APDs) to the appropriate destination. The MPS also routes control and signalling information between the DAP, MDG and the EBTS sites.

2.5 Mobile Data Gateway

The Mobile Data Gateway (MDG) is the interface to the Internet and the World Wide Web for the iDEN system during Packet Data operation.

2.5.1 Physical Components

The MDG is a Enterprise level switching router. This device is rack mounted and has direct connections to the Internet. The number of ports available will vary according to the provisioning and growth planning of the individual iDEN system.

2.5.2 Functional Characteristics

The MDG isolates the iDEN system for other devices on the Internet. The MDG is programmed and managed as a discreet unit. The Operations and Maintenance Center has no direct control over this device. The MDG has three major functions during Packet Data operation:

- Gateway
- Home Agent

- Foreign Agent

2.6 Base Site Controller

2.6.1 Physical Components

A Base Site Controller (BSC) may be linked to one or more EBTS sites. The BSC manages Interconnect Call Processing between EBTS sites and other network devices. The BSC is divided by function into to physical shelves in a rack or it may be divided into individual racks. The major BSC shelves are:

- Base Site Controller - Control Processor (BSC-CP)
- Base Site Controller - Transcoder (BSC-XCDR)
- Base Site Controller - Control Processor The Base Site Controller - Control Processor (BSC-CP) contains the memory and logic circuits to administer and monitor the routing of Interconnect Calls.
- Base Site Controller - Transcoder The BSC Transcoder (BSC-XCDR) converts the voice packets used on the radio link to the Pulse Code Modulation (PCM) used by local and interconnected Public Switch Telephone Networks (PSTNs).

2.6.2 Functional Characteristics

The BSC provides control and concentration functions for one or more EBTS sites and their associated mobile stations. The functions are segregated into separate circuits to improve the adaptability of the system to the local network requirements. The functions include:

- Link concentration from multiple EBTS sites
- Conversion of the radio link to the land network format

- Handover data collection, preparation, and execution to sites under its control
- Operation, maintenance and administration agent for OMC X.25 network
- Call Processing control of interconnect audio

2.7 Mobile Switching Center

The Mobile Switching Center (MSC) is a GSM-based Mobile Telephone Switch which provides Interconnect services. The MSC provides the interface between the mobile network and other service provider's PSTNs.

2.7.1 Functional Characteristics

The MSC is the telephone switch for mobile originated or terminated traffic. Each MSC Provides service within a geographic coverage area, and a single iDEN network may contain more than one MSC. Major functions of the MSC are:

- Control and Interface to the PSTN
- Call Processing for Interconnect calls
- Echo Cancellation for Voice Calls (with associated equipment)
- Provisioning of Subscriber Supplementary Services
- Authentication of Subscriber Units
- Intra-System Roaming and/or Handover between BSCs
- Inter-System Roaming and/or Handover between MSCs
- Billing Record Collection
- Interface to a customer supplied billing system

- Control of Inter-Working Function for data networking
- Interface to the Voice Mail System

2.7.2 Home Location Register

During an Interconnect call MSs are validated by the Home Location Register (HLR) database. This database may exist as, part of the MSC, as separate computing system,or a provided service. The identity, billing information, usage limitations and active services for each MS are stored in the HLR. The HLR is the source of information on the service provider's network for the users' service profile (identity and services) that is used to assure the subscriber's services follow the MS throughout the network. The HLR:

- Contains the master database for all subscribers
- Supports multiple MSCs
- Contains the basic and active supplementary services for each subscriber
- Contains the location of the current VLR for each subscriber
- Contains information used by supplementary services
- Supports roaming by being remotely accessible to all MSCs and VLRs
- Provides a Fault Tolerant computer platform
- Support interfaces to a customer supplied Administrative Data Center (ADC)
- Contains the Authentication Center (AUC) with MSs Authentication Keys
- Supports SS7 connectivity to network's Signal Transfer Point (STP) switches

The Administrative Data Center (ADC) is the service provider's administrative and business control equipment. The ADC may be used to enter/provision user information and accepts system metrics and call records

2.7.3 Visited Location Register

MS units are tracked via fixed geographic Interconnect Location Areas (ILAs). These areas are defined by the system operator based on the coverage area of the EBTS sites. Location data is stored in the VLR. These records contain current information like most recent location area and the feature provisioning table. The VLR is always integrated with the MSC and the VLR accesses the HLR to download subscriber information as MSs move into the VLRs coverage area

2.8 Operations and Maintenance Center

The Operations and Maintenance Center (OMC) is the network element management subsystem that establishes, maintains, collects information about the network, and presents it to the system operator. This data is used primarily to support the daily operation of the network radio system elements and to provide the system operator with valid information for future planning decisions. As the complexity and control requirements of the iDEN system and its relationship to other systems increases, the need for control and monitoring equipment also increases. The OMC exists in at least one form in every system.

- OMC - Radio (OMC-R) - required for radio system management
- OMC - System (OMC-S) - for possible Switching system management
- OMC - Network (OMC-N) - a possible Network Operation Center (NOC)

Others may be implemented as the need arises.

2.9 iDEN System interface

The iDEN system uses several interface types. The transport facilities between the DACS may include microwave, fiber, and/or copper. The iDEN system uses:

- Air Interface The network link between the mobile (MS) and the Fixed Network Equipment (FNE) is Radio Frequency (RF).

- Coaxial Within the system, coaxial cable is the physical interface between the EBTS BRs and the antenna system. Coaxial cable is also used between the BRs and the cell site (EBTS) distribution and control circuitry.

- Twisted Pair Thin-wire (10baseT) Ethernet may be used between the OMC and the T-DAP. A minimum of Category 5 cable and connections is required. Other elements may be optionally networked by Ethernet.

- T1/E1 The iDEN network has standardized on the T1 as the physical interface. The exchange of information between the various pieces of equipment is over direct link or dedicated facilities using T1 (E1) industry standards. Full or fractional T1s are used. In the MSO, the network devices are interconnected with T1s. Optimization, load balancing and capacity planning will be affected by the physical backbone used. Network and iDEN equipment is ordered with the appropriate hardware to support either E1 or T1 facility. The equipment may be re-configured between the span types by replacing hardware. Since an E1s have a different configuration than T1s, reconfiguring may impact the capacity of network elements.

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Chapter 3

Network Management

The Operation and Maintenance Center - Radio (OMC-R) interacts with iDEN network elements (NEs) to configure, upgrade, optimize, monitor and report on the iDEN NEs[3].These major elements are as follows:

- Enhanced Base Transceiver System (EBTS)
- Base Site Controller -Control Processor (BSC-CP)
- Base Site Controller Transcoder (BSC-XCDR)
- iDEN Call Processor (iCP)
- iDEN Vocoder Processing Unit (iVPU)
- Dispatch Application Processor (DAP)
- High Availability Dispatch Application Processor (HA DAP)
- iDEN Gateway
- VSGW
- 3G-XCDR
- Advanced Packet Duplicator (APD) Through the DAP

- iDEN Dispatch Access Controller (iDAC) Through the DAP
- iDEN Home Location Register (iHLR) Through the DAP
- Mobile Data Gateway (MDG/MDG4) Status Only
- Enhanced Global Title Translation Table Tool (EGT4) Data Download
- Shelf Switch Controller (SSC)

The principle tasks of the OMC-R are as follows

- System Configuration
- Performance Monitoring and Reporting
- Status Monitoring and Reporting

3.1 System Configuration

Configuration of the iDEN network consists of three major tasks.

- System Object Configuration (The definition of operating parameters of logical entities and physical NEs)
- System Configuration Changes (The alteration of system objects in response to operating conditions, new technology and growth.)
- System Version Management (The control of configuration changes.)

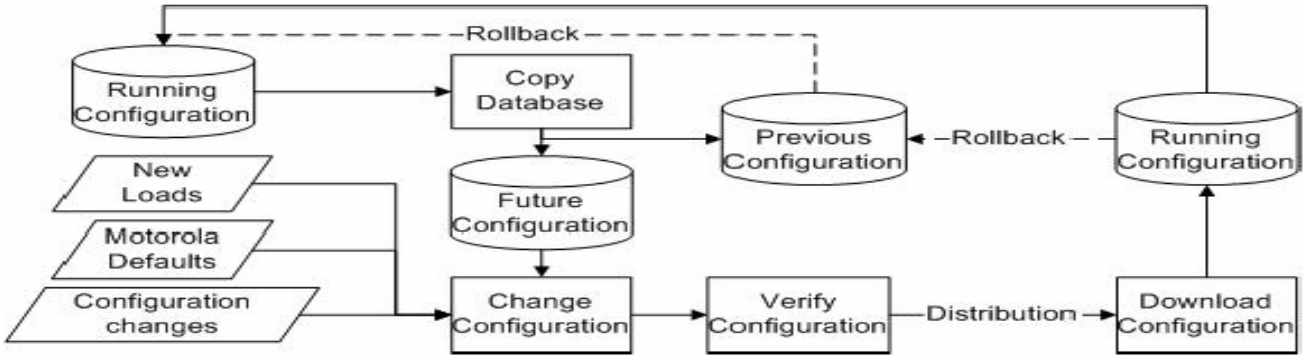

Figure 3.1: Basic Version Management Block Diagram

3.2 Performance Monitoring and Reporting

During normal operation the iDEN network maintains statistics on the operation and efficiency of individual NEs[5]. These statistics help identify portions of the network that may be adjusted to improve performance.

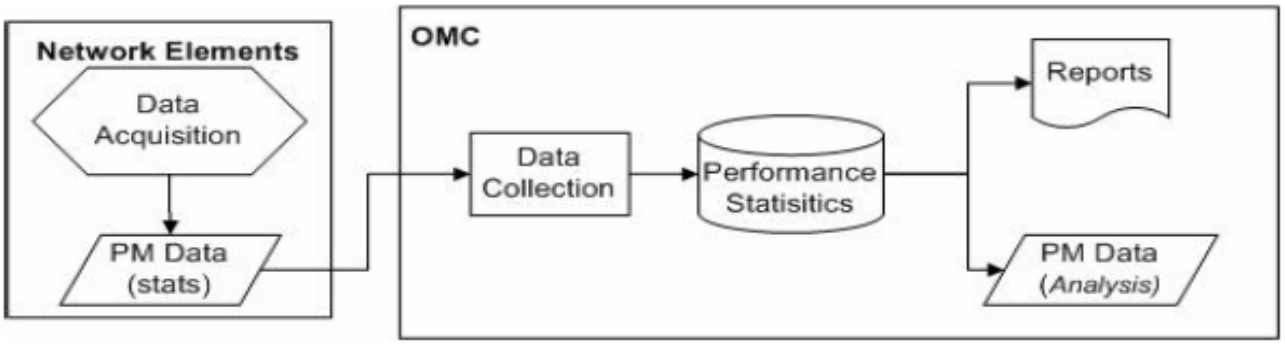

Figure 3.2: Basic Performance Management Block Diagram

3.3 Status Monitoring and Reporting

Changes in the operating state of the network (events) are monitored and processed according to the subscriptions defined by the service provider. If an event is defined as serious, an alarm may be generated.

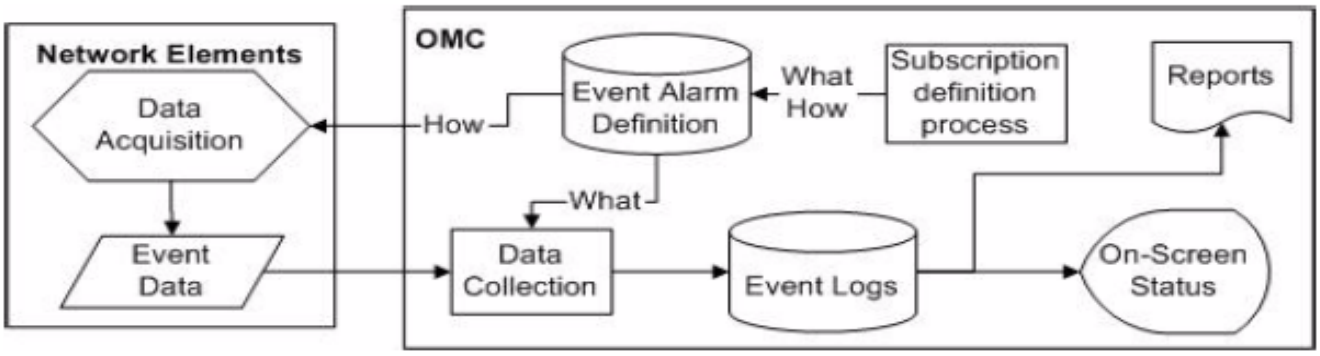

Figure 3.3: Basic Status Management Block Diagram

3.4 Hardware Architecture

The OMC-R may act individually in smaller Urban areas or as multiple-networked OMC-Rs in larger Urban environments[7]. An OMC-R consists of the following:

- Operations and Maintenance Links
- System Processor
- Man-Machine Interface (MMI) Host
- Sun Ray Clients
- OMC-R Network Infrastructure

3.4.1 Operations and Maintenance Links

To maintain communication with the elements of the iDEN network, the OMC-R has several links.

Local Area Network

OMC-R Operators may login to the OMC-R through X-terminals. Each local OMC-R consists of a System/MMI Processor, X-Terminals, a timing server, and ancillary

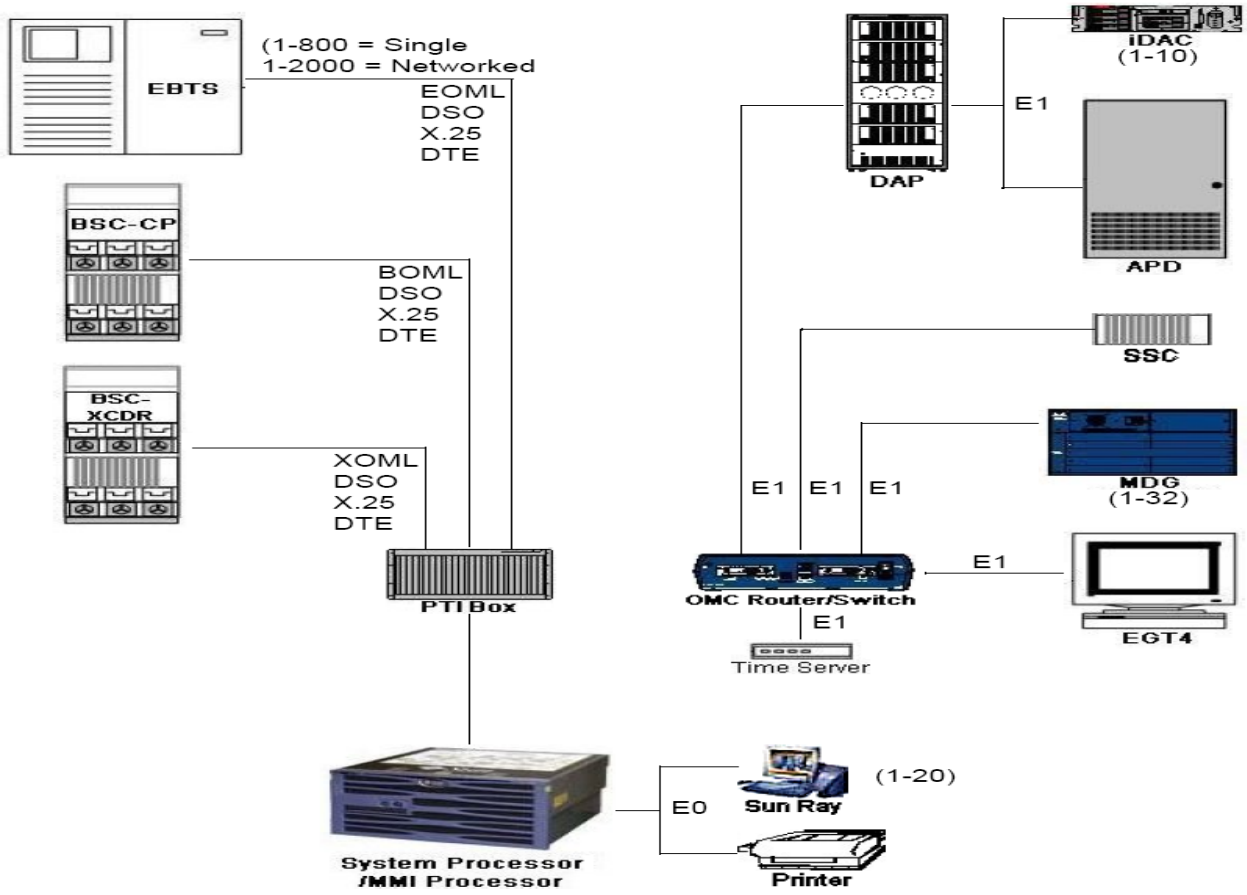

Figure 3.4: Simplified OMC-R Hardware Architecture

equipment (printers). These devices are linked by an Ethernet Local Area Network (LAN).

Metro Packet Switch Links

Each local OMC-R (MSO) has communication links to NEs. This type of maintenance link is through the Metro Packet Switch (MPS).The OMC-R system processor connects to the MPS with V.35 cables running X.25 protocol are 64 kilo-bytes per second (kbps).Each NE connects to the MPS using T1 or E1 facilities. At least span of the facility (T1/E1) is used for operations and maintenance links Two timeslots in one of the T1 span lines is used for OMC network management communications.Requests for

data, configuration commands, and other OMC-related data is transferred through these two timeslots and form Operation and Maintenance Links.

Simple Network Management Protocol (SNMP) Links

Operation and Maintenance Links (OMLs) connect the OMC-R to an NE. Status and event reporting across the OMLs use Simple Network Management Protocol (SNMP). The NEs are identified to the OMC-R with DTE addressing. The NEs with direct OMLs are as follows

- Base Site Controller - Control Processor (BSC-CP)
- Base Site Controller - Transcoder (BSC-XCDR)
- Enhanced Base Transceiver System (EBTS)

The OMLs are grouped by the following functions:

- BSC-CP OML (BOML) for status and event information between the OMC-R and the BSC-CP, and its components.
- BSC-XCDR OML (XOML) for status and event information between the OMC-R and the BSC-XCDR, and its components.
- EBTS OML (EOML) for status and event information between the OMC-R and the EBTS, and its components.

Ethernet Maintenance Links

Other NEs report status information across an Ethernet network using Internet Protocol (IP). They are:

- Dispatch Application Processor (DAP)
- High Availability Dispatch Application Processor (HA DAP)

- Advanced Packet Duplicator (APD)
- iDEN Call Processor (iCP)
- iDEN Vocoder Processing Unit (iVPU)
- iDEN Dispatch Access Controller (iDAC)
- iDEN Home Location Register (iHLR)
- Mobile Data Gateway (MDG/MDG4) Status Only
- Enhanced Global Title Translation Table Tool (EGT4) Data Upload
- Shelf Switch Controller (SSC) Common Agent NE

3.5 System Processor Hardware

The System Processor is the server for the OMC-R.

3.6 Man-Machine Interface (MMI) Processor Hardware

The Man-Machine Interface (MMI) processor controls the analysis and presentation of iDEN network information from the system processor to the end-user and from the user to OMC-R applications[8].The OMC-R MMI Processor runs as a logical entity inside a Solaris Zone container on the Sun Netra 440 or Sun Netra T2000 platform.

The MMI processor uses a Graphical User Interface (GUI) based on X-windows. The principle tasks of the MMI Processor on the OMC Console screen are as follows:

- Sun Ray Interface
- Reports and Query Management

- Event and Alarm Status Definition and Display
- Load and Network Configuration Interface

3.7 Client Terminals

Up to client terminals 20 are supported by the OMC-R. The System Processor and MMI Processor display station has been specifically designed for use with X Windows. The client terminal is normally one of the following:

- Sun Ray 1g Ultra-Thin Client
- Sun Ray 170 Ultra-Thin Client
- Sun Ray 100 Client
- Sun Ray 270 Ultra-Thin Client
- Sun Ray 2FS Ultra-Thin Client

3.8 Networking

Each OMC-R has several levels of networking.

- Operations Network (Linking processors, terminals and support devices. E.g Single OMC-R)
- Maintenance Network (Linking the OMC-R to the managed elements. E.g operation and maintenance links)
- Wide Area Network (Linking multiple OMC-Rs. E.g Multiple OMC-R)

3.9 Architecture of OMC

3.9.1 Single OMC-R

A single OMC-R network architecture applies most often to single MSO Urbans with a maximum of 1000 sites (EBTS), or a maximum of 400 sites.

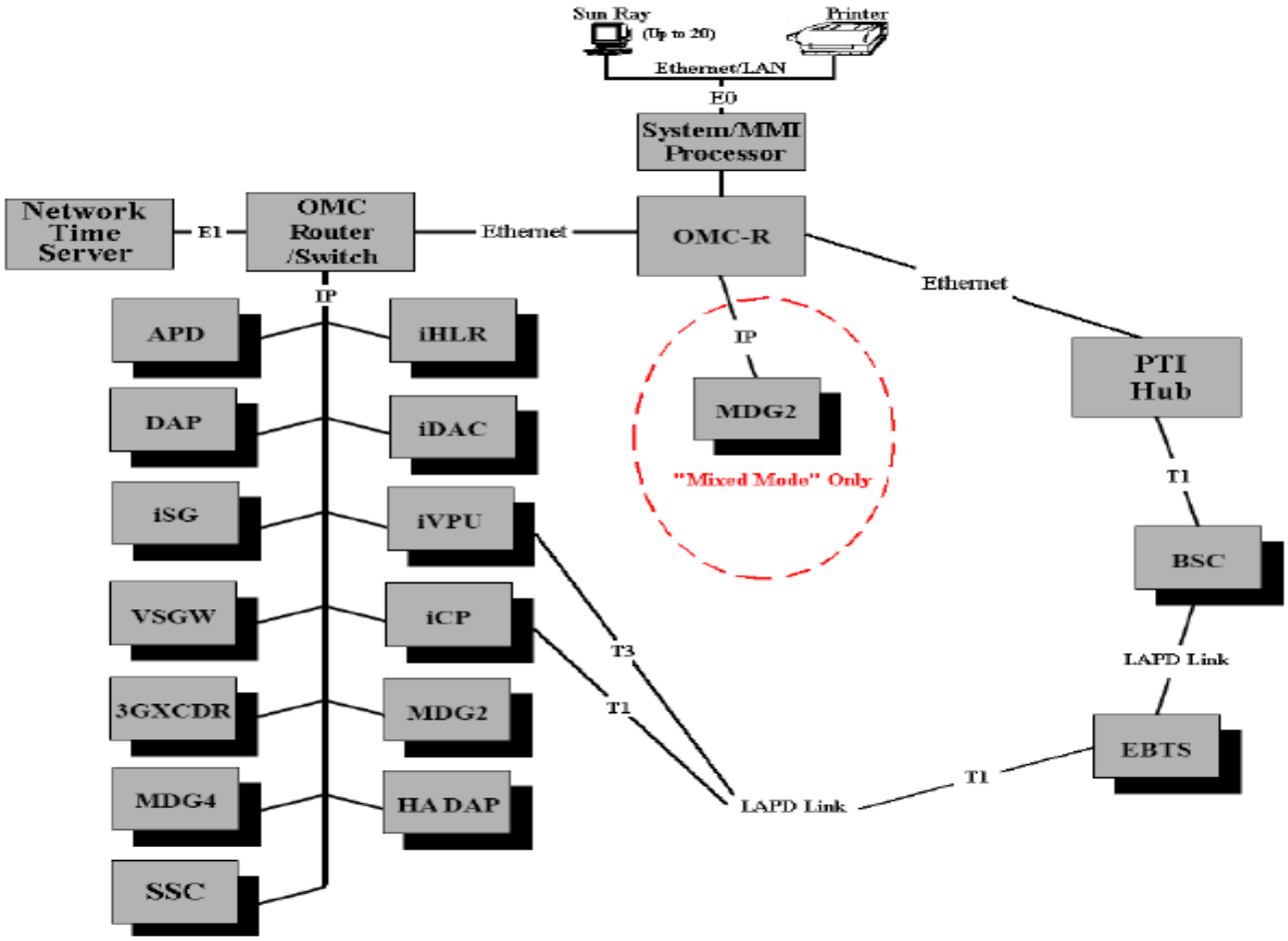

Figure 3.5: Single OMC-R Architecture

3.9.2 Multiple OMC-R

A single Netra 440-based OMC-R can support up to 1000 sites. Additional OMC-Rs are required to support more sites. Up to 5000 sites can be supported with four

Netra 440 OMC-Rs. A T2000-based OMC-R can support a maximum of 400 sites per urban.(When on a OMC-R network, one OMC-R is designated as the Primary and the other OMC-Rs are designated as secondary. The primary OMC-R assumes the administrative, primary storage and high level reporting functions for the OMC-R network)

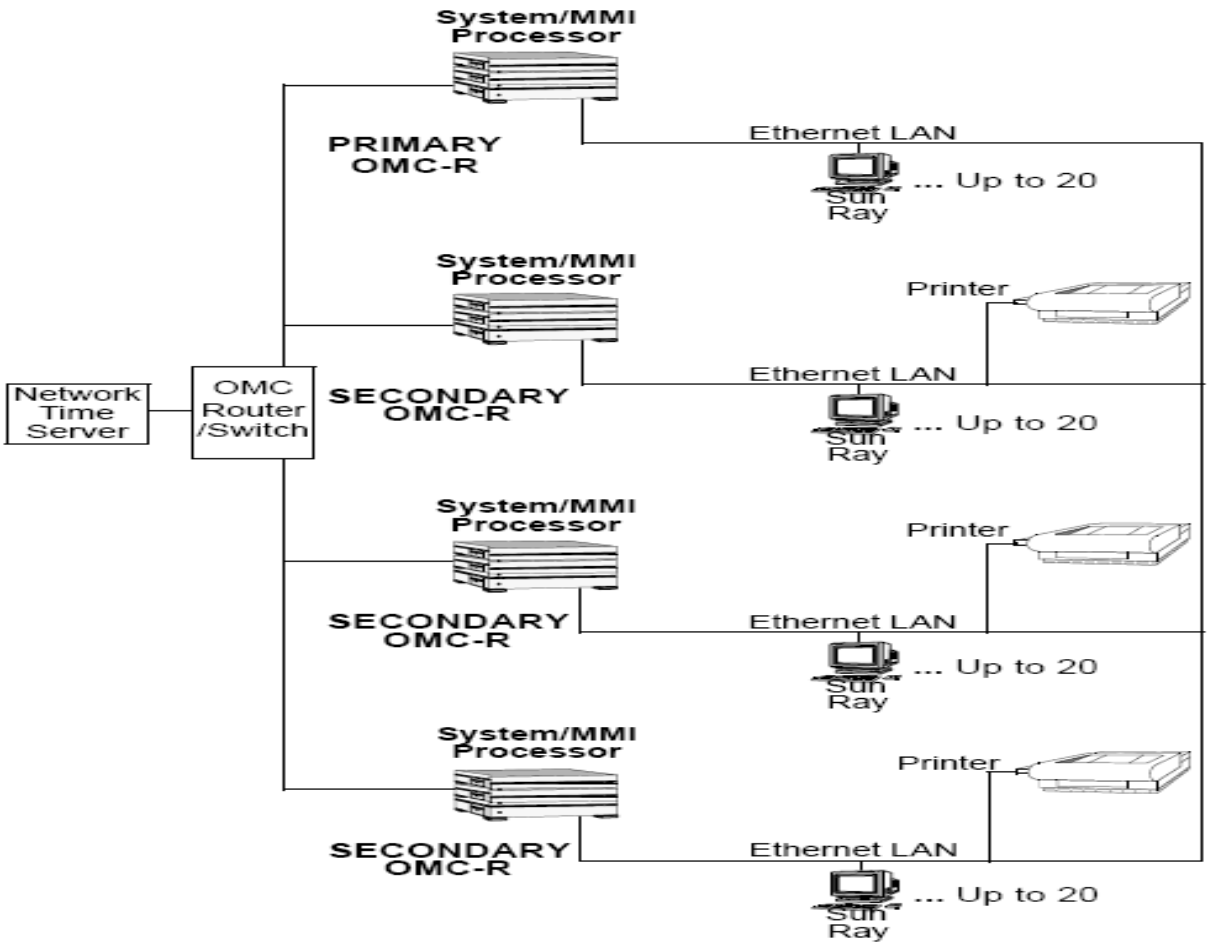

Figure 3.6: Multiple OMC-R Architecture

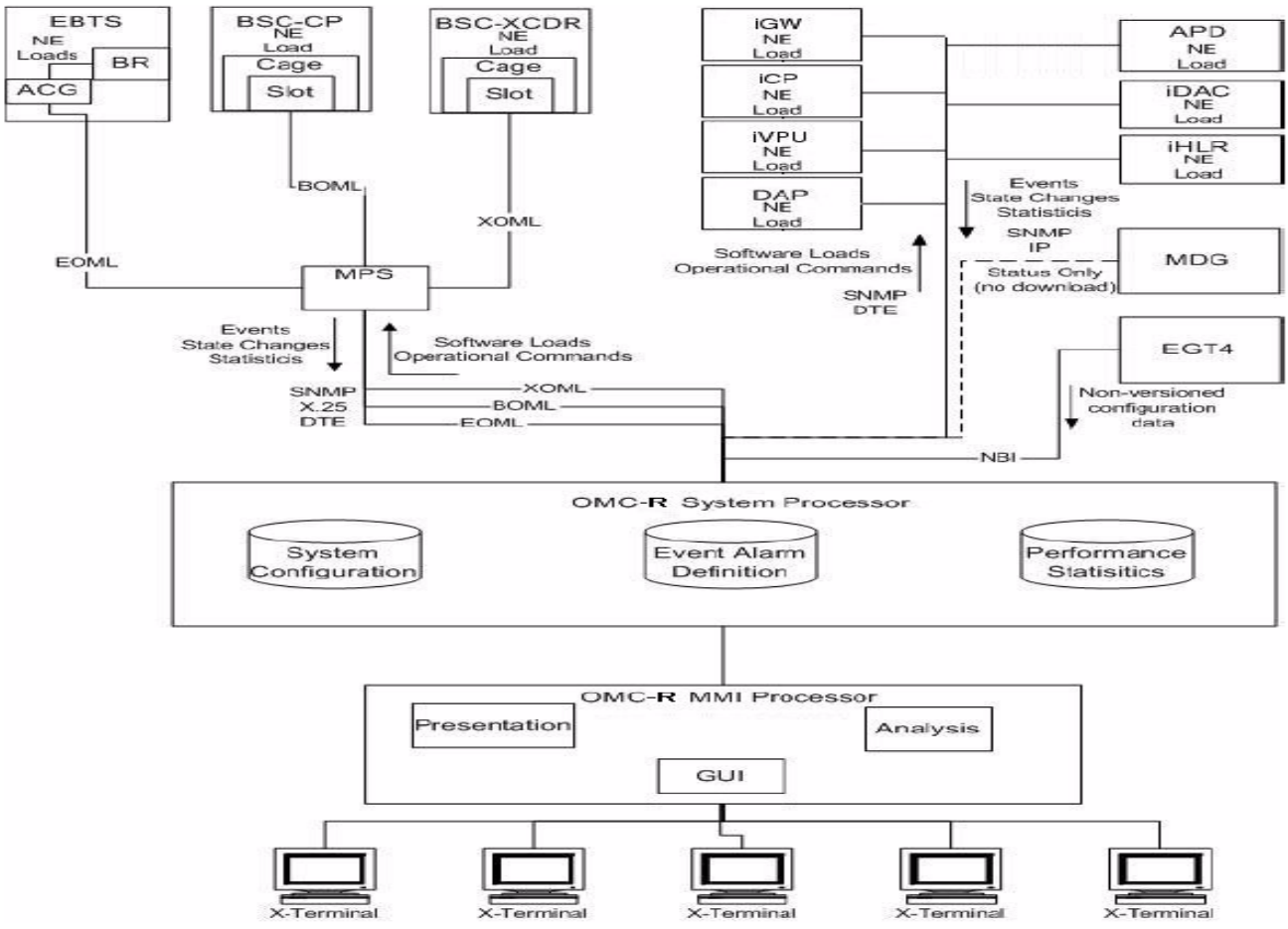

Figure 3.7: Simplified diagram of OMC-R

Chapter 4

OMC-R Function

The OMC control and monitoring functions include:

4.1 Event/Alarm Management

Events/alarms are generated at a specific NE and sent to the OMC-R. The OMC-R collects and stores events and alarms from the NEs to monitor the iDEN network. Each event sent to the OMC-R includes the alarm condition or the informational status report[9].

Alarm conditions are referred to as active events, or events that require immediate attention.

Informational status reports are referred to as passive events that do not need immediate attention, but that provide information regarding the status of a particular NE.Events and alarms also monitor the links that connect the NEs together.

Event/Alarm Management has two main functions:

- To collect and log all events and alarms reaching the OMC-R.
- To present events and alarms to operators according to subscription criteria.

All events/alarms reaching the OMC are logged. Operators can display only those events/alarms to which they have subscribed. Typical events include:

Figure 4.1: OMC-R Function

- Measurement result indication
- Indication of a device change-of-state at a Network Element (NE)
- Information on traffic conditions (e.g., overload)
- Indication of a faulty device condition at an NE
- Utilization of network resources (e.g., threshold exceeded)
- Test result information

4.1.1 Events and Alarms

- Events Defined

  Events are a display of a change in status of a network element or a component of that network element. This change in status may be either good or bad. A base radio coming on line will create an event just as it would if it went off line.

- Alarms Defined

  Alarms are a series of events showing a negative change in status of some component of the network. Alarms allow for a condensing of the events into one single entry. This helps the technician to avoid having to sort through large amounts of data to determine the impact on the network.

- Events and Alarms - Different Processes

  Changes in operating conditions create:

  - Events is a mechanism for transferring information from a network element to the OMC. This information could be an alarm from a network element or information relating to the state of a particular operation or device in the network element.
  - Alarms is a subset of events. Alarms are events that have been designated for more obvious presentation and processing. (Also called Active Events.)
  - Active Events are those events that require a response from an operator.
  - Passive Events are those events that do not require a response from an operator.

  During normal system operation, the OMC continuously accepts and collects events which are considered either passive or active. When any event, active or passive occurs an entry is generated in an Event Log file. A passive event occurs that is generated in the Event Log file.Event messges can be viewed in real time also.

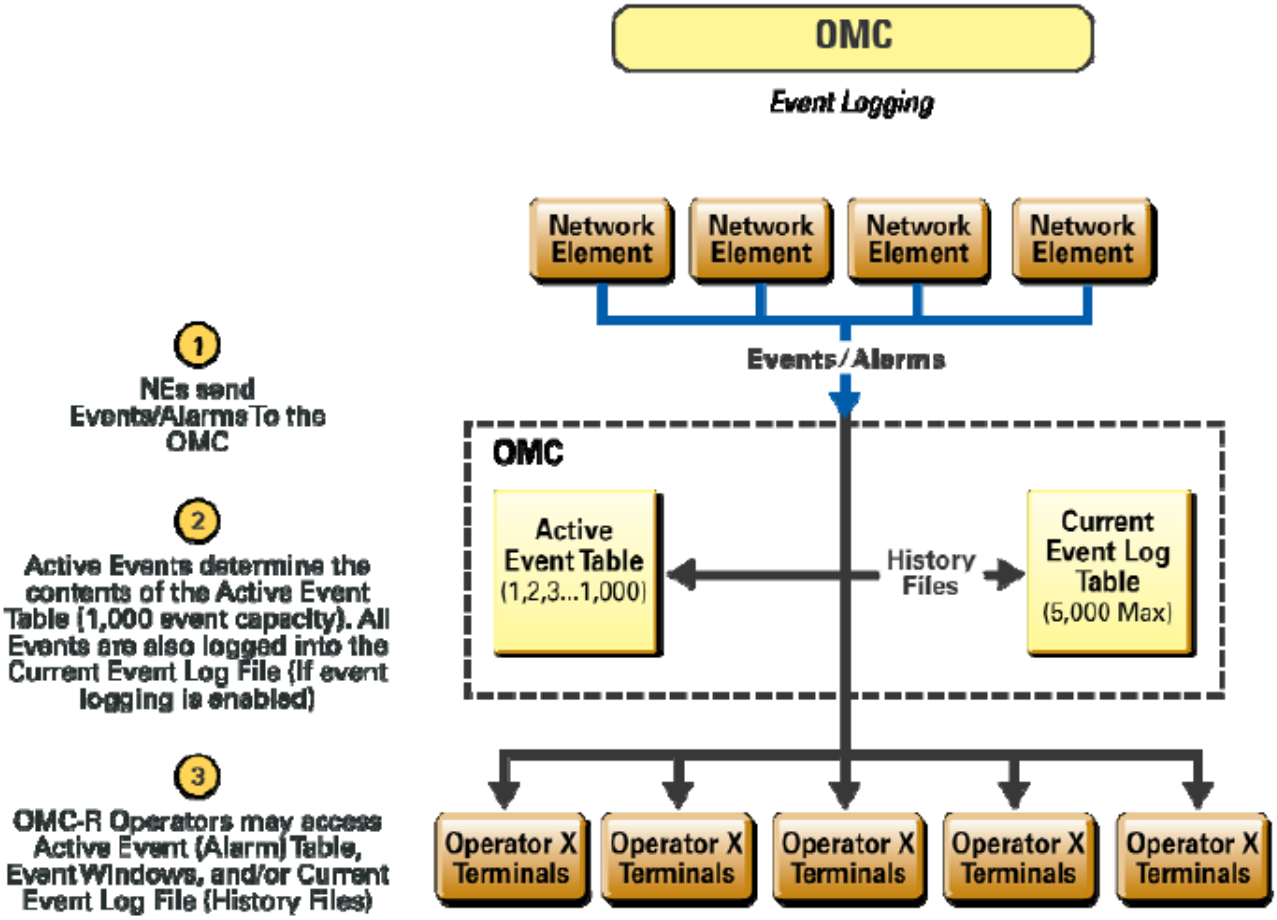

Figure 4.2: Event Logs

- Event Log Files

  If enabled (via Logging menu on OMC Console Screen), all events reported by the network elements are logged into a Current Event Log File. This file has a capacity of 5000 events and resides on the hard disks in the computer. The Current Event Log File serves as an archive to provide a history of events.

Event Management

Event Management feature allows the operator to sort and manage all the events and alarms that are logged. This feature allows to sort by alarm or event,

network element, severity, etc.

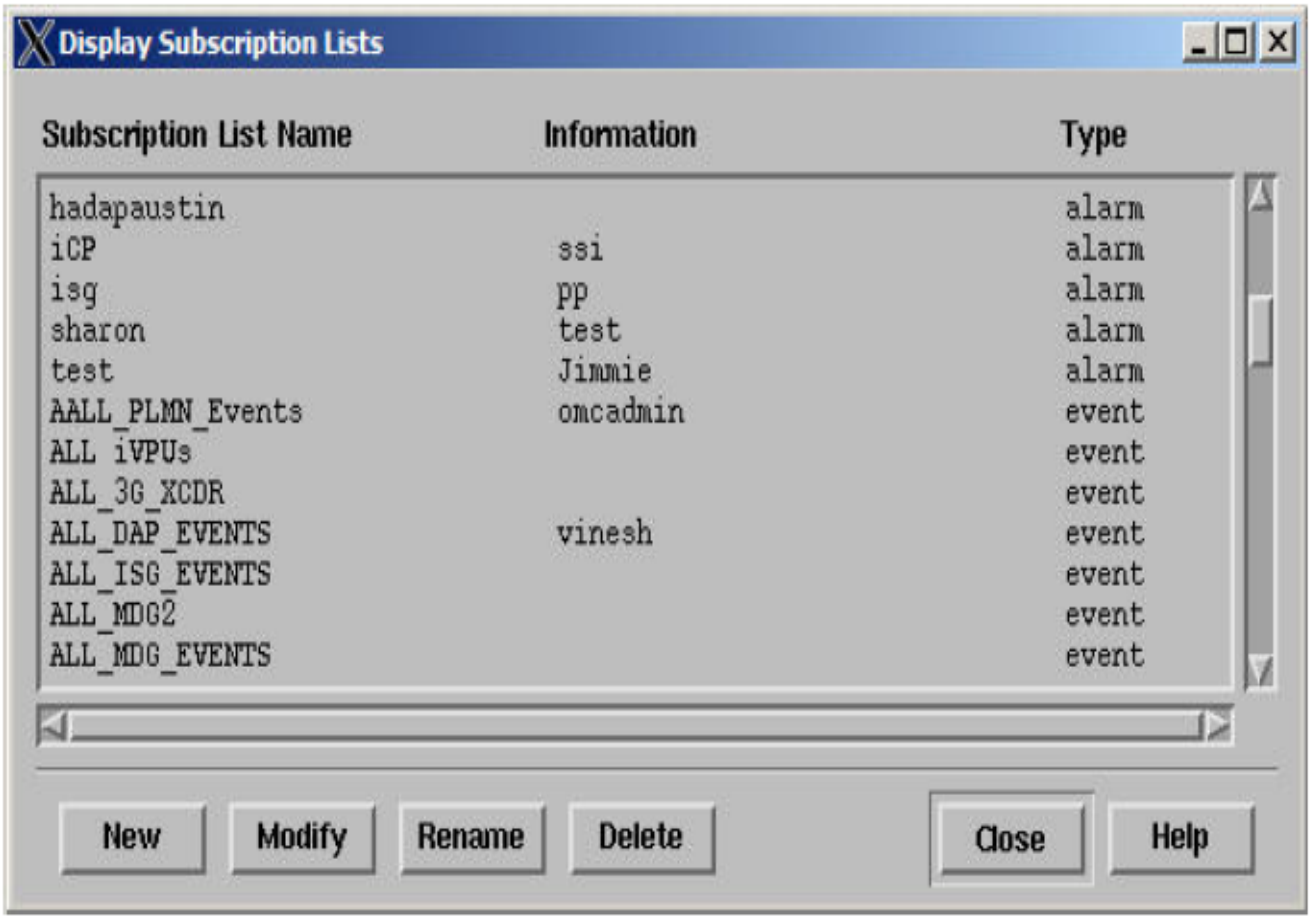

Figure 4.3: Subscription List Overview

A Subscription List is a collection of individual subscriptions which define the types of alarms/events to be displayed.There are two types of Subscription Lists. The type must be specified when the list is created. They are:

Event Subscription List

If a Subscription List is of the Event type, than there is no interaction with the events. The events received are for information only. They are passive events.

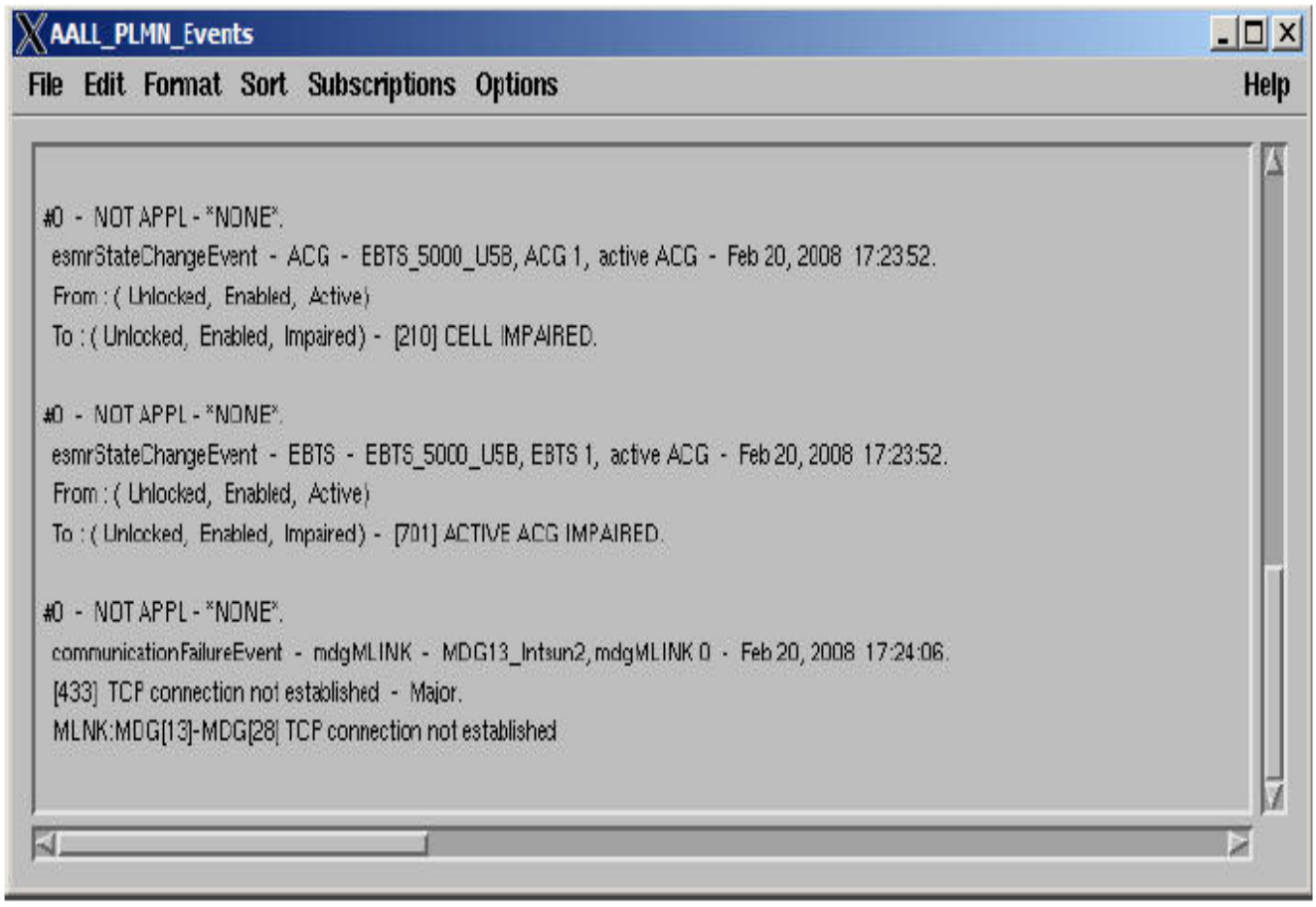

Figure 4.4: Event Display Window

Alarm Subscription List

If the Subscription List is of the Alarm type,action can be taken in regards to the alarms.Interaction ois possible with alarms.

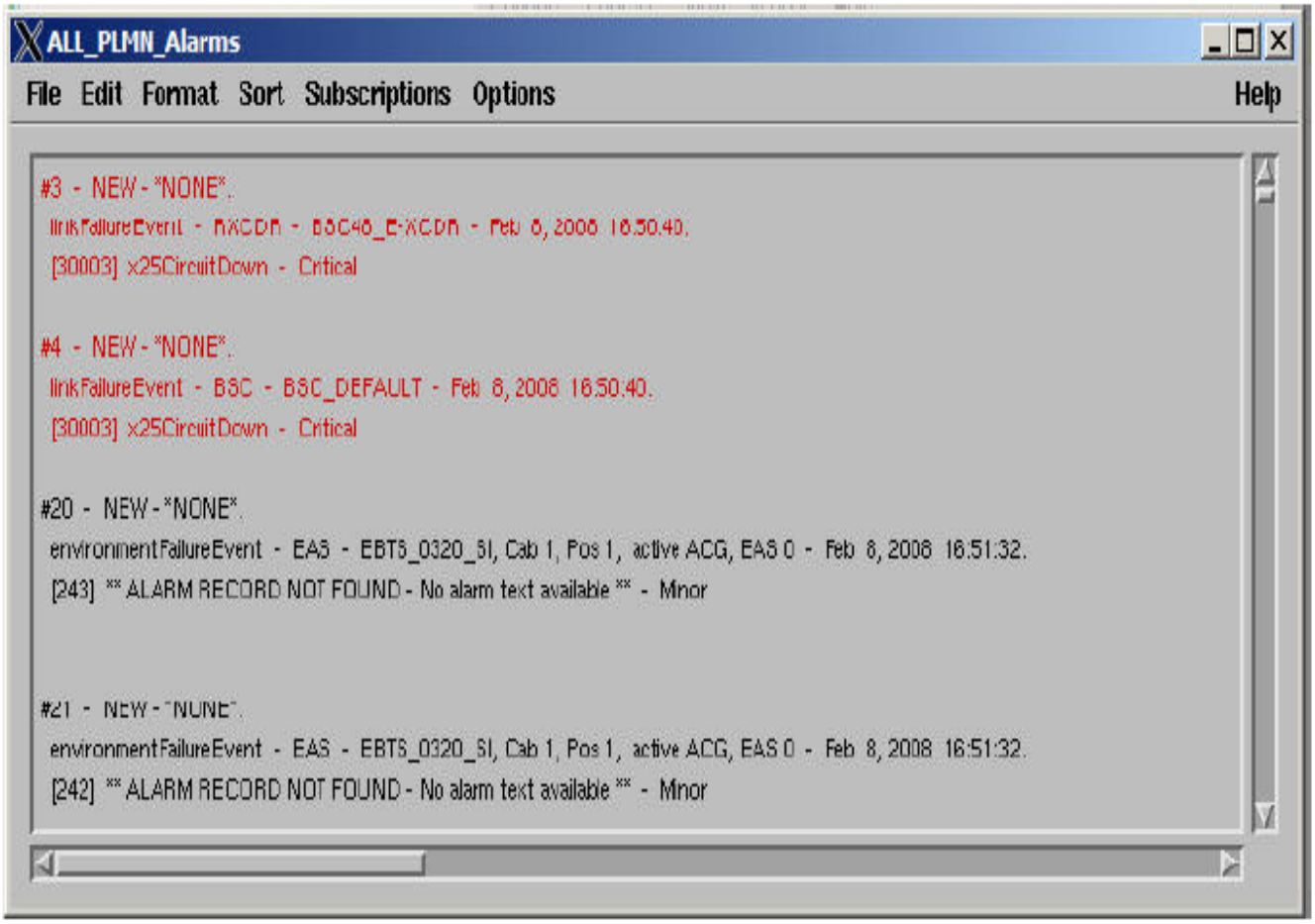

Figure 4.5: Alarm Display Window

4.1.2 External Alarm System (EAS)

Each EBTS site is equipped with a Control Cabinet which contains an External Alarm System (EAS) module. Located on the rear panel of this module are a number of connectors which accepts inputs from a variety of external alarm sensors and/or circuits such as gates and doors at the EBTS site. These alarm inputs (48 maximum) provide a means to report on site and equipment conditions, such as temperature,power failure, smoke, and security violation. (Approximately 20 of the 48 alarm inputs are dedicated to reporting the status of EBTS site equipment.)

The EAS Configuration screens allow the OMC operator to define the display parameters for each of the 48 possible EAS alarms on a site-by-site basis.

The number of alarms, severity level, and alarm description fields are user-editable to define how the alarms appear on the Event and Alarm Displays and in the Event Log.

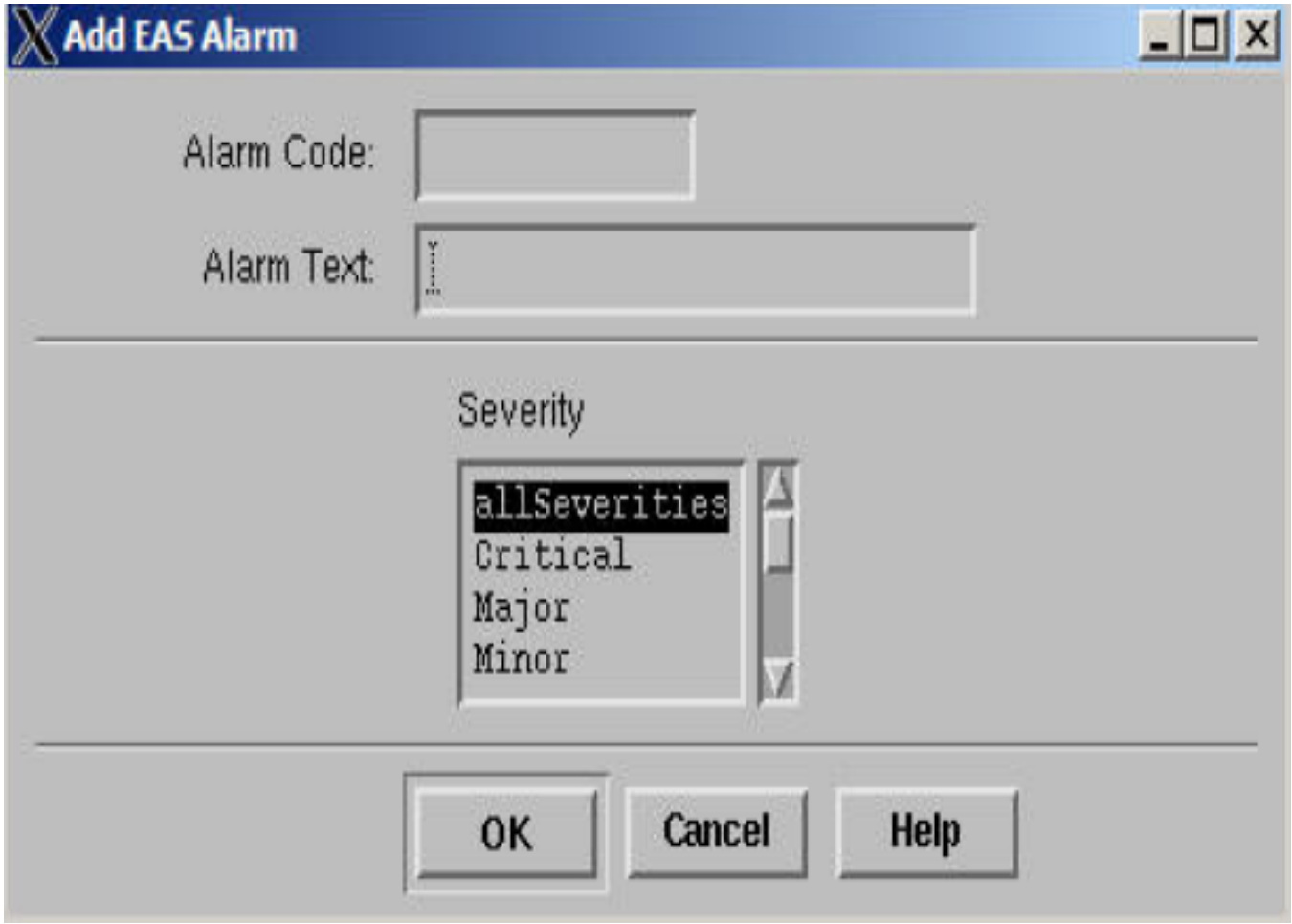

Figure 4.6: Alarm Display Window

4.2 Performance Management

The OMC-R collects performance-related data from all of the NEs that are managed by the OMC-R for network planning and optimization[5]. This data provides the information needed to fine-tune the performance of the NEs in the iDEN network. In addition, statistics are collected by each particular NE and periodically uploaded to

a database on the OMC-R.

4.3 Configuration and Load Management

Configuration Management provides access and control to logical and physical components (objects) for the configuration of the iDEN system. These configuration tools are accessed from the Cfg Mgt (Configuration Management) menu on the OMC Console screen.

4.4 Fault Management

With the fault management function, the technician can determine the location of a fault by running diagnostics, place NEs in or out of service, and display NE status.

Fault Management displays:

- General status of operation and maintenance link to network elements
- General status of general network elements
- Detailed status of individual network elements
- General status of inter-network element links (DAP-DAP only)
- Detailed status of inter-network element links (DAP-DAP only)
- In addition fault management allows the management of automated fault recovery for the Mobile Data Gateway (MDG).

4.5 Security Management

The OMC-R functions are protected by security management, and changes are only performed by authorized personnel. Each authorized technician is given a unique user name and password to gain access to the system. Authorized technicians are assigned

security classes that specify what commands are accessed and what output messages are displayed.

Chapter 5

iDASHBOARD

The iDEN Dashboard feature provides advanced Operation and Maintenance functions to facilitate improved iDEN network capabilities as well as mechanisms to proactively handle network faults[9, 10].

The advantages of iDEN idashboard are as follows-

- OpEx reduction.
- Lower training and learning curve costs through intuitive and common user interface.
- Efficient isolation and localization of network problems through
  - Reporting of incidents as well as incident rating and ranking.
  - Reporting of actionable alarms.
- Proactive fault mitigation through KPI analysis and soft alarm generation.
- Role based dashboards.
- Web accessible clients.

5.1 Enhanced Alarm Processing

The OMC-R receives the alarms and events from the Network Elements, processes them and logs them in event log files. The FM functionality on OMC-R handles only the StateChangeEvents to derive the status of NEs[11, 12]. The alarms are not considered for calculating the status.

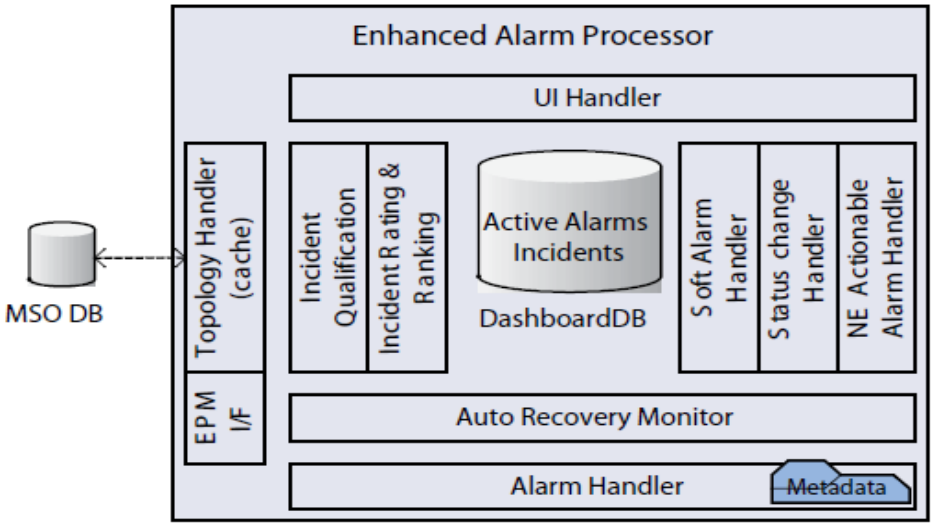

Figure 5.1: EAP High Level Architecture

The EAP proposes the following alarms.

5.1.1 NE Generated Alarms

The alarms generated by NEs are categorized into two broad categories namely actionable alarms and non-actionable alarms.

The actionable alarms are sub-divided into incidents and actionable alarms. Incident indicates a failure which needs immediate operator attention where as Actionable alarm indicates the failure which need operator intervention.

5.1.2 Soft Alarms

It is generated when a KPI exceeds the threshold. These softalarms would be treated as actionable alarms and included in the Active Alarms list.The softalarms cannot be cleared by the user. These alarms would get cleared by a clear alarm which gets generated when the KPI falls below threshold.

5.1.3 Status Change Alarms

The OMC-FM does the state management of the NEs by handling the state change events and scheduled polling. The OMC-FM would be generating the status change alarms whenever there is a status change for the Node.These status change alarms would be treated as actionable alarms and included in the Active Alarms list.

5.2 EPM - Enhanced Performance Management

The OMC-R currently receives the stats from the Network Elements every half an hour and stores them in the OMC-DB[7, 8]. However, it neither calculates the KPIs nor generates the soft alarms when a stat reaches the pre-defined threshold value.

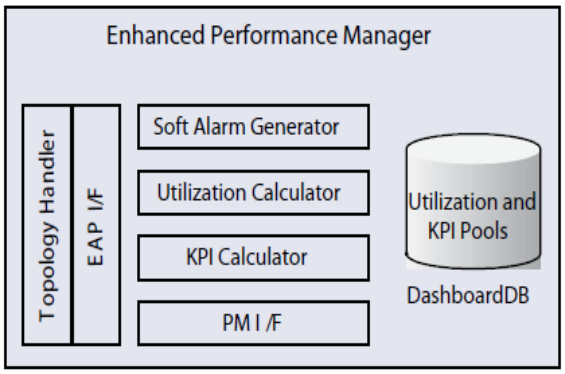

Figure 5.2: EPM High Level Architecture

It handles the following new functionality

- After the statistics are loaded into OMC-DB, start calculating the KPIs for each NE and load the KPIs into Dashboard-DB.
- Generation of soft alarms for thresholds (hi-mark).
- Calculation of the aggregated utilization data based on KPIs.
- After the KPIs and utilization data are calculated, send a notification to EAP for rating and ranking of incidents.
- Clearing of soft alarms when the statistics threshold values falls below the threshold value (low-mark).

Chapter 6

Conclusion

6.1 Conclusion

This study and Work on network management aspects shows that for management of iDEN OMC enhanced features are required apart from the traditional approach of alarms and events.iDASHBOARD feature provides for soft alarms and self defined Key Performance Indicator parameters for monitoring,which reduces load on OMC.iDASHBOARD is currently employed just for EBTS but in future its range of operation can be expanded for other NEs also.Moreover iDASHBOARD feature is available on mobile station also,which provides for an efficient fault management since the technician can analyze and solve the problem remotly.

6.2 Future Scope

The development of iDASHBOARD feature provides for an efficient management of network aspects in an iDEN System.Till now it is successfully tested for EBTS sites.So in future testing its scope can be expanded for efficient maintenance and utilization of other NEs also.The Soft alarms and Key Performace Indicators can be user defined which provides the benits of defining the parameter as per system requirements.

Appendix A

Abbrevations

- ACG - Access Controller Gateway
- AM - Architecture Module
- APD - Advanced Packet Duplicator
- ASG - Advanced Services Gateway
- B-ICD - Box-Level Interface Control Document
- BM - Box Manager
- BR - Base Radio
- BRC - Base Radio Controller
- BSC - Base Site Controller
- CA - Common Agent
- CCP - Common controller Platform
- CM - Configuration Management
- CP - Common Process

- CR - Change Request
- CSpec - Control Specification
- DAP - Dispatch Application Processor
- DLAC - Dispatch Location Area Controller
- DOL - Description Of Logic
- eBRC - Enhanced Base Radio Controller
- EBTS - Enhanced Base Transceiver System
- EPAS - Enhanced Push to Talk Application Server
- FM - Fault Management
- FSpec - Functional Specification
- GTSS - Global Telecom Solutions Sector
- HA-DAP - High Available Dispatch Application Processor
- HLR - Home Location Register
- iBSC - iDEN Base Site Controller
- ICD - Interface Control Document
- iCP - iDEN Call Processor
- iDAC - iDEN Dispatch Access Controller
- iDEN - Integrated Dispatch Enhanced Network
- iGW - iDEN Gateway
- iHLR - iDEN Home Location Register

- IM - Integrated Management
- iMCBTS - iDEN Multi Channel Base Transceiver System
- iMS - iDEN Metrics Server
- IPR - Intellectual Property Rights
- iSG - iDEN Surveillance Gateway
- iVPU - iDEN Vocorder Processing Unit
- KAELOC - Thousand Assembly Equivalent Lines of Code
- KC - Knowledge Champion
- KLOC - Thousands of Lines of Code
- KPA - Key Process Area
- KPI - Key Performance Indicators
- LCL - Lower Control Limit
- LMST - Lifecycle Methodology Selection Tool
- LOC - Lines Of Code
- MA - Measurement and Analysis
- MCP - Motorola Confidental Proprietary
- MDG - Mobile Data Gateway
- MDRS - Metrics Database Requirement Specification
- MIB - Management Information Base
- MOC - Managing Organizational Change

- MOL - Maintenance Of the Line
- MOP - Method of Procedure
- MPMP - Manufacturing Project Management Plan
- MSNTP -Multi-cast Simple Network Time Protocol
- NBI - North Bound Interface
- NE - Network Element (MDG4, iHLR, DAP, iSG etc)
- NCSL - Non-Commented Source Lines (of code)
- NDM - NetDispatch Messenger
- NGD - Next-Generation Dispatch
- NTP - Network Time Protocol
- NTL - Nextel Testing Lab
- OEI - Organizational Environment for Integration
- OID - Object Identifier (used within SNMP payload)
- OMC-R - Operations and Management Center, Radio Subnetwork
- OOD - Object Oriented Design
- OLCC - Online Configuration Change
- PCCH - Primary Control Channel
- PCH - Packet Channel
- PDP - Product Development Process
- PDU - Protocol Data Unit

- PI - Project Integration
- PM - Process Management
- PROM - Programmable Read Only Memory
- PSPEC - Process Specification
- P-SPMP - Project Software Project Management Plan
- PSR - Program Status Review
- PTT - Push to Talk
- PUI - Process Use and Improvement
- QA - Quality Assurance
- QoS - Quality of Service
- QPM - Quantitative Project Management
- QSR - Quality System Review
- RAG - Resource Allocation Group
- RS - Requirements Specification
- SAD - System Architecture Document
- SASD - System Architecture and System Design
- SCCH - Secondary Control Channel
- SCM - Software Configuration Management
- SCMP - Software Configuration Management Plan
- SDL - Specification and Description Language

- SDP - Software Development Process
- SI - System Integration Test
- SQM - Software Quality Management
- SQPMP - System Quality Program Management Plan
- SRD - Software Research and Development
- SSM - Software Supplier Management
- ST - System Test
- STD - State Transition Diagram
- TP - Test Plan
- TR - Technical Review
- TRD - Technical Requirements Document
- TRS - Technical Requirements Specification
- TS - Technical Solutions
- UC - Use Case
- UML - Unified Modeling Language
- VLR - Visitor Location Register
- VOB - Versioned Object Base
- WAN - Wide Area Network

Appendix B

Key Performance Indicators

KPI stands for Key Performance Indicators. Key Performance Indicators are near-real-time measurements of the state of the health of an iDEN system. Based upon key statistics reported from iDEN NEs, they are displayed to the system operator and give indications of the overall loads on the NEs being measured. They are near-real-time because the KPIs are calculated from statistics that are delayed from real-time by at least half an hour, the duration of the stats collection interval.

Some of the KPIs are as follows

- Total Interconnect Call Attempts
  Description: The formula measures interconnect attempts, both failed and successful.
  Device it is reported for: Once per Cell
  Unit of measure: Attempts

- Total Dispatch Voice Call Attempts
  Description: The formula measures dispatch traffic channel requests for service at the cell level.
  Device it is reported for: Once per Cell
  Unit of Measure: Attempts

- Total Interconnect Blocking - RF + Backhaul

  Description: The formula measures the blocking queue rate for interconnect requests for a talk channel due to backhaul resource availability and insufficient RF resources. This includes reconnect requests.

  Device it is reported for: Once per Cell

  Unit of measure: Percent

- Total Interconnect Dropped Call Rate (per call)

  Description: This measures the total dropped calls due to loss of transmission, handovers, and non RF issues like BR resets and T1 service interruptions.

  Device it is reported for: Once per cell

  Unit of measure: Percent

- Total Handover Attempts

  Description: This formula measures total handover attempts, which includes intra-cell, intra-bsc, and inter-bsc handover attempts.

  Device it is reported for: Once per cell

  Unit of measure: Attempts

	Rating Range	Description
RED	500 PLUS	Utilization Incident or Availability Incident
ORANGE	100 - 499	Utilization Incident or Availability Incident
YELLOW	1 - 99	Utilization Incident or Availability Incident
BLUE	Rating = 0	- No Service Impact - Actionable Alarm
GREEN	NA	- No Service Impact - No Actionable Alarm

Figure B.1: Colour Description

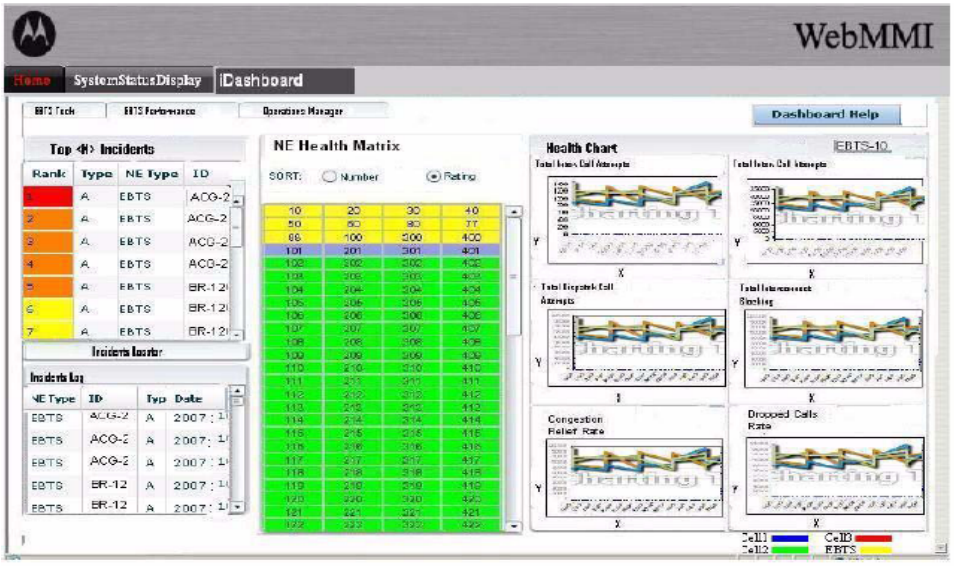

Figure B.2: NE Performance view

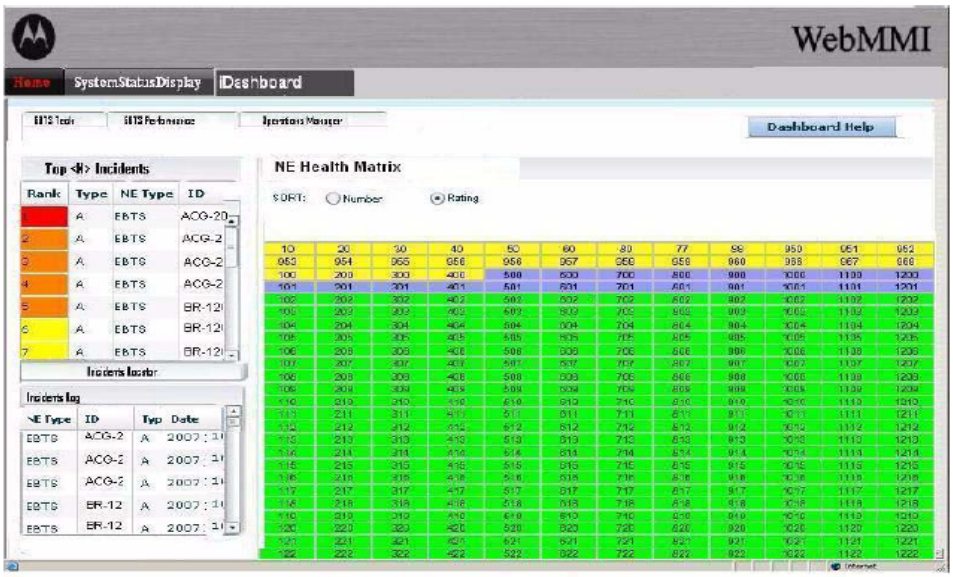

Figure B.3: NE Technician view

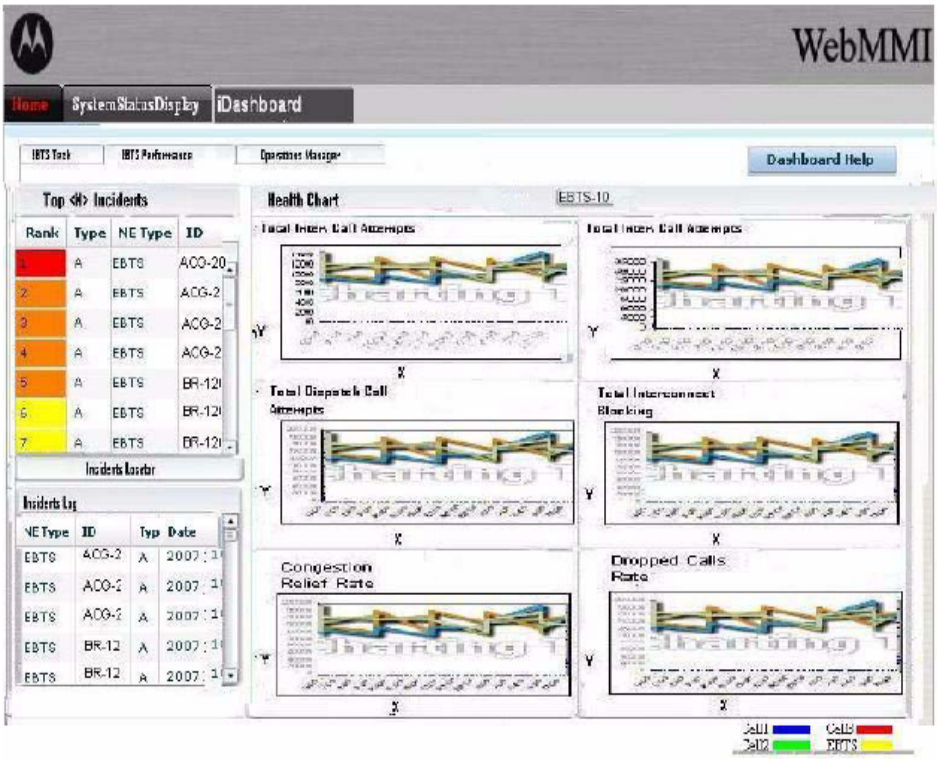

Figure B.4: EBTS Operation Manager View

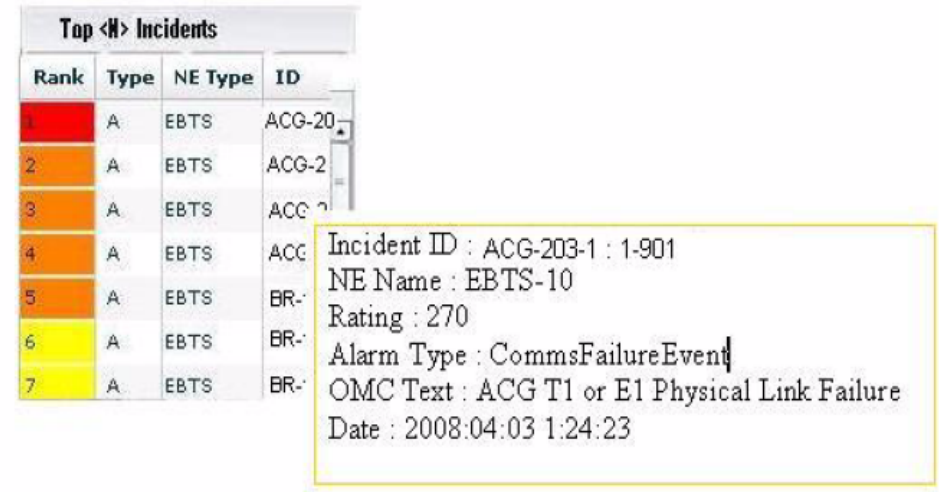

Figure B.5: Top Incident List

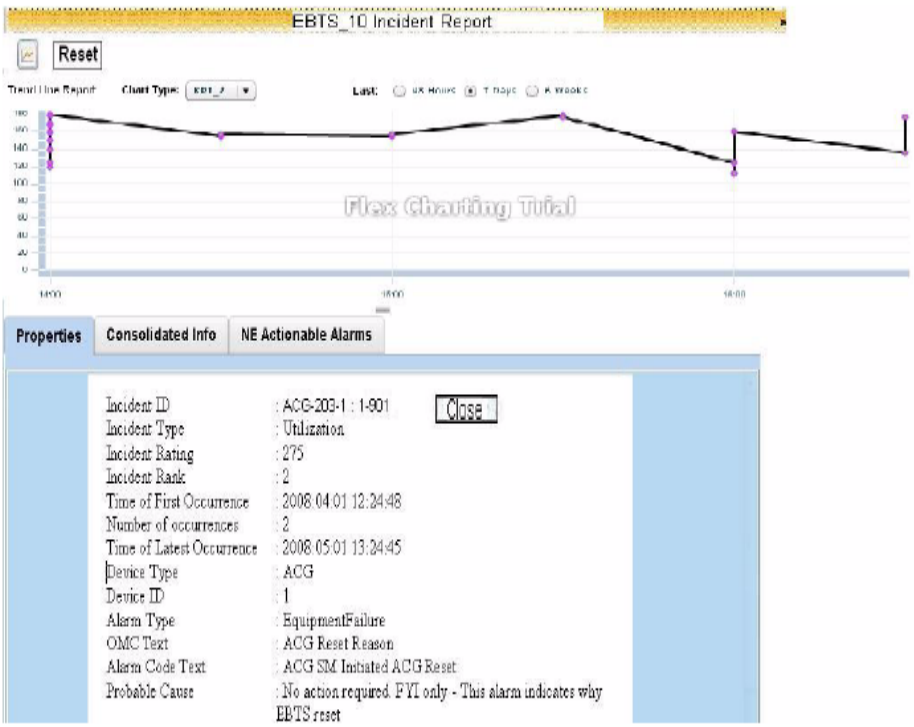

Figure B.6: Incident Report and Chart

Appendix C

Event and Alarms Types

Event and Alarms Types

Events are categorized in different event types. Each type defines the event in terms of the nature, cause, and source of the event. The types that are bold are considered active events while the others are passive events .Events shown in bold are categorized as Alarms (a subset of Events).

communicationFailureEvent
qualityOfServiceFailureEvent
processingFailureEvent
equipmentFailureEvent
environmentFailureEvent
reStartEvent
fileNEavailableEvent
stateChangeEvent
neInfoEvent
SAPEvent
distributionEvent
neReplicationEvent
hwConfigurationEvent
actionStatusEvent
esmrStateChangeEvent
linkFailureEvent
downloadStartedEvent
downloadCompletedEvent
objectDownloadingEvent
bgdownloadStartedEvent
bgdownloadCompletedEvent
bgobjectDownloadingEvent
switchScheduledEvent
switchOnEvent
switchSucceededEvent
bypassSucceededEvent
bgResetdownloadStartedEvent
bgResetdownloadCompletedEvent
bgResetobjectDownloadingEvent
bgdlAbortEvent
uploadStartedEvent
uploadCompletedEvent
filexferStartedEvent
filexferCompletedEvent
filexferAbortedEvent

Figure C.1: Event and Alarms Types

References

[1] iDEN Technical Overview 68P81095E55-A

[2] iDEN System Overview 6871000P02-B

[3] OMC-R ICD Interface Control Document

[4] EBTS ICD Interface Control Document

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[6] AEMS i1.0 Lite High-Level Solution Approach, http://compass.mot.com/go/iems2/AdventNet, D00.00.02, Dec 26, 2006

[7] AEMS Lite SAD-183, http://compass.mot.com/go/iaems

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