CHAPTER XVIII

MOBILE COMMUNICATIONS – GSM-R

18.0 GSM-R :

18.1 Introduction:

Mobile Train Radio communication is a digital wireless network based on GSM-R (Global System for Mobile Communication-Railway) designed on EIRENE (European Integrated Railway Radio Enhanced Network) Functional requirement specification (FRS) and System Requirement specification (SRS)

The Basic features of GSM-R are

Point to Point call	Allows user to make a distinct call.
Voice Broad cast call	Allows groups of user to receive common information.
Voice Group call	Allows groups of user to make calls within /among the groups.
Emergency call	Allows user to call controller by short code or button during emergency.
Functional addressing	Allows a user or an application to be reached by means of a number, which identifies the relevant function and not the physical terminal.
Location dependent addressing	Provides the routing of mobile originated calls to the correct controller e.g. relative to the geographic area.
eMLPP (enhanced Multi-Level Precedence and Preemption)	Allows resource preemption for priority calls

Fig.1 illustrates the system architecture. In this architecture a mobile station (MS) communicate with a base station subsystem (BSS) through the radio interface. The BSS is connected to the network switching subsystem (NSS) using the A interface.

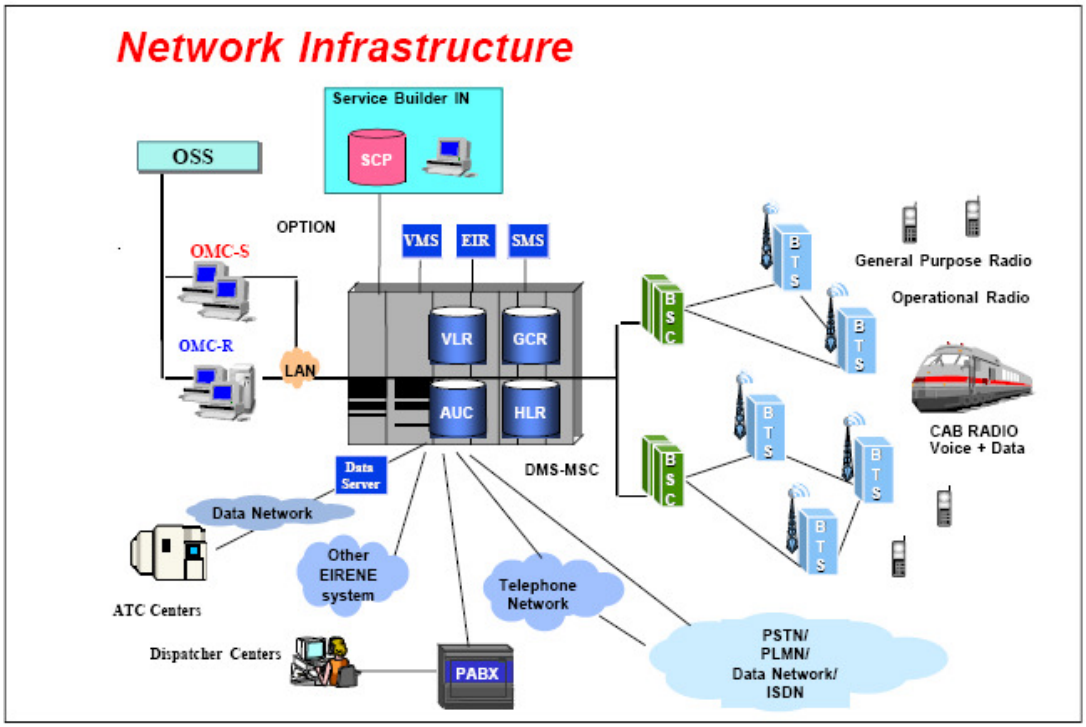


Fig.-1

Interface	Interfaces Description
U_m	Radio link between MS and BTS- Air interface
A_{bis}	Between BTS and BSC, PCM 2 Mb ps
A_{ter}	Between BSC and TCU, PCM 2 Mb ps
A	Between TCU and MSC, PCM 2 Mb ps
B	Between MSC and VLR,
C	Between MSC and HLR
D	Between HLR and VLR
E	Between two MSCs

18.1.1 The system consists of following sub systems :

a) Mobile Station (MS)
b) Base Station Sub system (BSS)
c) Network and switching sub system (NSS)
d) Operating sub system (OSS)
e) Dispatcher
f) Cab Radio
g) Power Supply Arrangement

18.2 Radio interface and frequency used in GSM-R :

The Radio link uses both FDMA (Frequency Division Multiple Access) and TDMA (Time Division multiple Access) . The 900 MHz frequency bands for down link and up link signal are 935-960 MHz and 890-915 MHz respectively.

Frequency Used for GSM-R in Eastern Railway

Spot Frequencie are

Uplink (MS To BTS)	**Dnlink (BTS to MS)**
907.8 MHz	952.8 MHz
908.0 MHz	953.0 MHz
908.2 MHz	953.2 MHz
908.4 MHz	953.4 MHz
908.8 MHz	953.8 MHz
909.0 MHz	954.2 MHz
909.2 MHz	954.2 MHz
909.4 MHz	954.4 MHz

18.3 Numbering Scheme for MS and Cab Radio :

18.3.1 International Mobile Subscriber Identity (IMSI)– It is used to identify the called MS. It is not known to the user and is used by network only. IMSI is stored in SIM, the HLR and the serving VLR. The IMSI consists of three parts : A three digit Mobile country Code (MCC), a two digit Mobile Network Code (MNC) and a Mobile Station Identification Number (MSIN).

The directory number dialed to reach a mobile subscriber is called the mobile subscriber ISDN (MSISDN) which is defined by the Numbering Plan. This number includes a country code and a national destination code which identifies the subscriber's operator. It is stored in the HLR.

International Mobile Subscriber Identity (IMSI) for Railway Network.

Railway	MCC	MNC	MSIN	
			HLR Identification Code	
Eastern Railway	405	48	250	0000000-9999999

18.3.2 Mobile Subscriber ISDN number :

- **Mobile Subscriber ISDN Number (MSISDN) for Railway Network.**

CC (2D)	AC (2D)	MSC Code (3D)				
		CT8(1D)	Zone(2D)	Divn.(1D)	Dept.(1D)	Subscriber Number (4D)
+91	99	8	25	0-9	0-9	XXXX

18.3.3 National EIRENE Numbers :

National EIRENE Numbers are used specifically for Railway purposes and consist of three parts.

i) Call type (CT)
ii) User ID No
iii) Function code (FC)

The call type prefix identifies the user number dialed. The call type distinguishes between the different types of user numbers that are allowed within the national EIRENE numbering plan. The call type prefix tells the network how to interpret the number dialed. It is one digit long.

The user identification Number can be one of the following:

- Train Running Number for TFN (Train Functional Number)
- Engine Number for EFN (Engine Functional Number)
- Coach Number for CFN (Coach Functional Number)
- Shunting team location number
- Maintenance team location number
- Train controller location number

National EIRENE Calls

Functional Numbers [handled by Functional Addressing(FA) service] CT=2-3-4-6

Dialed digits	Description
2+TRN+FC	Train Functional Number
3+EN+FC	Engine Functional Number
4+CN+FC	Coach Functional Number
6+LN+TT+Y+XX	Shunting & maintenance Functional Number

Where:	TRN:	Train Running Number	(5-8 digits)
	EN:	Engine Number	(8 digits)
	CN:	Coach Number	(9 digits)
	FC	Function Code	(2 digits)
	LN:	Location Number	(5 digits)
	TT:	Team Type	(1 digit)
	Y:	Team Member	(1 digit)
	XX:	Team Number	(2 digits)

Train Functional Number is used for calling the driver by its train number. The following numbering scheme is used in the Railway.

Functional Number of driver in Rajdhani Express for Thursday is as follows.

2	4	2301	0	01
↓	↓	↓	↓	↓
Call Type	Thursday	Train Number	Schedule Train	Driver

for link train - 1 for Guard - 80
for special train - 2

User can register itself as a driver / guard of any train from their handset by dialing 091 i.e. Railway access code following the above digits for a specific train .

For details, uniform numbering plan circulated by RDSO may be referred.

18.4 Brief description of sub system :

18.4.1 Mobile Sub system (MS) :

The MS consists of two parts

i) Subscriber Identity Module (SIM)
ii) Mobile Equipment (ME)

The SIM is removable and can be moved from one terminal to another. It is authenticated via a personal Identity Number (PIN) between four to eight digit. This PIN can be deactivated or changed by the user. If PIN is entered incorrectly in three consecutive attempts, the phone is locked for all but emergency calls, until a PIN unblocking key (PUK) is entered.
The SIM contains subscriber information and International Mobile Subscriber Identity (IMSI).

18.4.2 ME is a Mobile hand set equipped with a soft touch key pad and display screen. Some additional key (button) is provided to meet the special features of GSM-R (emergency call etc.). Though ME having a robust structure, it should be kept in safe position to prevent mechanical damage.

18.5 Power Supply :

18.5.1 The ME is equipped with power supply arrangement (Li-ion battery). It is a maintenance free battery having detachable independent charger to recharge the battery after discharge. Charging indication on ME screen shows the status of charging.

18.5.2 The ME can be dynamically registered and deregistered in the network for different functional numbers as per requirement of the subscriber (ME) by keying from the key pad in a programmed manner and monitoring the action in the display unit of ME.

18.6 Base Station Sub system (BSS) :

The BSS connects the MS and the NSS.
The BSS contains of three parts.

i) Base transceiver Station (BTS).
ii) Base Station Controller
iii) Trans Coder Unit.

18.6.1 Base Transreceiver Station (BTS) :

The BTS performs channel coding/decryption. It contains transmitter and receivers, antennas, the interface to the PCM facility and signaling equipment specific to the radio interface in order to contact the MEs. It processes the signaling and speech required for Mes in air interface at one side (via antenna) and with BSC in Abis interface (through PCM 2Mb/s in OFC network) at the other side.

The general architecture of the Base station is based on the following modules:

- The Compact Base Common Function (CBCF) performs all common functions such as concentration, transmission, supervision and synchronization. A CBCF can be dimensioned according to traffic.

- The Power Amplifiers (PA) amplify the RF signal delivered to antenna through the TX combiner. Each PA is physically independent unit, characterized by its frequency band, output power can be controlled independently.

- The Driver receiver units (DRX) amplify the RF signals (two, for diversity), process the TDMA frames and drive the power amplifier. Each DRX is associated with one RF channel, connected to the Frequency Hopping bus (FH bus) in order to allow base band hopping and packed as a physically independent unit. One TRX is then made up of one PA and one DRX. Depending on frequency band , a specific DRX is available to support EDGE (e-DRX).

- The Transmission Combiners (TX combiners) combine the RF signals delivered by several power Amplifiers and duplex them with the received signals. A variety of coupling modules can be selected, depending on the type of combining (duplexer, hybrid), the frequency band and the configuration (number of TRXs and antennas).

- The reception multicouplers (LNAs + RX –splitters) pre-amplify and split the received signal towards the DRX receivers. A variety of RX-splitters can be selected, depending on the frequency band.

- The Alarm module (RECAL) collects internal and external alarms. The number of external alarms is up to 8.

- Fan tray is kept at the bottom of the cabinet for keeping the module inside cabinet cool by air circulation inside cabinet.

- Power supply card to receive 48V DC supply from external source and to cater required supplies to different active modules inside BTS cabinet.

- CPCMI board on front panel inside BTS cabinets equipped with different LEDs to indicate different status of the equipment.

18.6.1.3 <u>System Specification :</u>

Power Supply = - 48 V DC.
PA Tx – Power = 30 W.
Rx Sensitivity = -110 dBm.

18.6.1.4 Power Supply :

48V/16 Amp. DC supply is provided for the BTS cabinet. Low Maintenance lead-acid battery with capacity 300AH with a Battery Charger (230V AC/48V – 50 Amp. DC) shall be kept in float condition with load for this purpose.

18.6.1.5 Cooling Arrangement :

Cooling arrangement is necessary for keeping the ambient temperature below a certain level to prevent system shut down due to high temperature.

For this purpose minimum two window type air conditioning machines are to be installed and run alternatively for 12 hrs. each.

The BTS is a very temperature sensitive equipment. Normally the BTS stations are unmanned. Hence for monitoring the health of the unmanned station some parameters are required to be monitored from a centralized location of the network. For this purpose following parameters are to be monitored from the central maintenance location through OSS.

a) High temperature
b) Battery voltage low
c) Fire alarm
d) AC Machine failed
e) Charger failed
f) AC mains failed.

18.6.2 Base Station Controller (BSC) :

In the BSS network, the BSC performs the tasks related to the BSS equipment management & supervision and to the GSM call processing, mainly:

- BTS supervision
- Radio channel allocation
- Radio channel Monitoring
- Traffic management
- TCU management
- OMC-R link management
- Handover procedures
- Operation and maintenance request from the OMC-R processing
- BSS configuration data and software storage
- BSS performance counters management
- Failure detection and processing

18.6.3 Trans coder unit (TCU)

The TCU carries out speech encoding/ decoding and rate adoption in data transmission. It is designed to reduce the number of PCM links needed to convey radio speech & Data channels

between BTS,BSC & MSC. It enables code conversion of 16 Kbps channel from the BSC into 64 Kbps channels for MSC in both directions.

18.6.3.1 Functional Overview :

It performs the following main tasks related to communication switching and transcoding:

- Switching: the TCU manages a time –division multiplexer connecting the BSC and MSC.
- PCM link management: Using the configuration data provided by the BSC, the TCU configures and monitors the PCM links on the A and Ater interfaces.
- Transcoding and rate adaptation: Coding/decoding of the speech frames and rate adaptation of data frames.
- TCU equipment management: OA&M functions: initialization , startup, clock synchronization from A-interface links, supervision , fault management, software and configuration management.

18.7 Network and Switching Subsystem (NSS):

The NSS supports the switching functions, subscriber profiles and mobility management. The basis switching function in the NSS is performed by the MSC. This interface follows a signaling protocol used in the telephone network. The MSC also communicates with other network elements external to GSM utilizing the same signaling protocol. The current location of an MS is usually maintained by the HLR (Home Location Register) and VLR (Visitor Location Register). When an MS moves to the Home System to Visited system, its location is registered at the VLR of the visited system. The VLR then informs the MS's HLR of its current location. The authentication center (AuC) is used in the Security data management for the authentication of subscribers.
NSS &BSS installed in some sections of Indian Railways are of M/s Nortel or M/s Siemens make.

18.7.1 GSM MSC Configurations and Functions (Typical for –M/S Nortel)

The GSM DMS-MSC is supported in different configurations that allow combining functionalities on a single node. The following configurations are supported;

- An integrated Visitor location Register (VLR) to hold the temporary subscriber data while the subscriber is in the MSC's area as well as authentication and ciphering provided by the AuC.

- An optional integrated Service Switching Point (SSP) functionality to support intelligent Network based services in the most efficient and effective manner.

18.7.2 The MSC is responsible for:

- Call Processing, switching & routing of traffic, supplementary services.
- Connections to external services e.g. PSTN.
- Visitor Location Register (VLR) for subscriber location management.
- Service Switching Point (SSP) functionality for the IN network.
- Billing facilities to feed the billing system (billing system could be proposed if required).

- Switching and Network Management activities.

18.7.3 Data Bases

Home Location Register (HLR)	Data base for management of mobile subscribers, stores the IMSI, Mobile station ISDN number (MSISDN) and current visitor location register (VLR) address. Keep track of the services associated with each MS and HLR may be used by Multiple MSC's.
Visitor location Register (VLR)	Catches some information from the HLR as necessary for call control and service providing for each mobile currently located in the geographical area controlled by VLR connected to one MSC and is often integrated into the MSC.
Authentication center (AuC)	A protected data base which has a copy of the secret key stored in each subscriber's SIM card. This Secret is used for authentication and encryption over the radio channel. Normally it is locate close to HLR.
Equipment Identity (EIR) Register	Contains a list of all valid mobile station equipment within the network, where each mobile station is identified by its International Mobile Equipment Identity (IMEI)

18.7.4 Signalling support

This provides support for the basic signaling functionality as defined by GSM Phase 2+ standards.

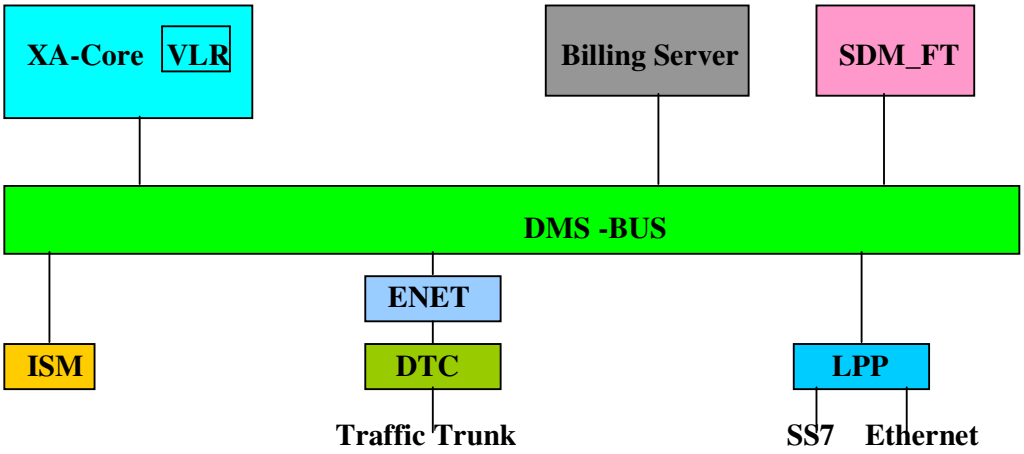
The major protocols supported are:

- DTAP via the Direct Transfer Message. This is the interface between the MSC and Mobile Station.
- RANAP- This is the signaling protocol used between the MSC and BSC
- MAP- This is the interface between the NSS functions (MSC, VLR, HLR, EIR).
- A Interface- is an open interface defined between the BSS network and the MSC.
- ISUP- The MSC conform to the ITU and ETSI standards (Blue Book and White Book) for ISUP interconnects supporting both ETSI v1 and ETSI v2. In addition some National PSTN interconnects are implemented.

18.7.5 Hardware Description (Nortel Specific):

The DMS-MSC is member of the DMS (Digital Multiplex Switch) family of switching products, capable of providing the switching functionality and advanced services required in a GSM and UMTS wireless network.

The major functional components of the DMS architecture are given below.

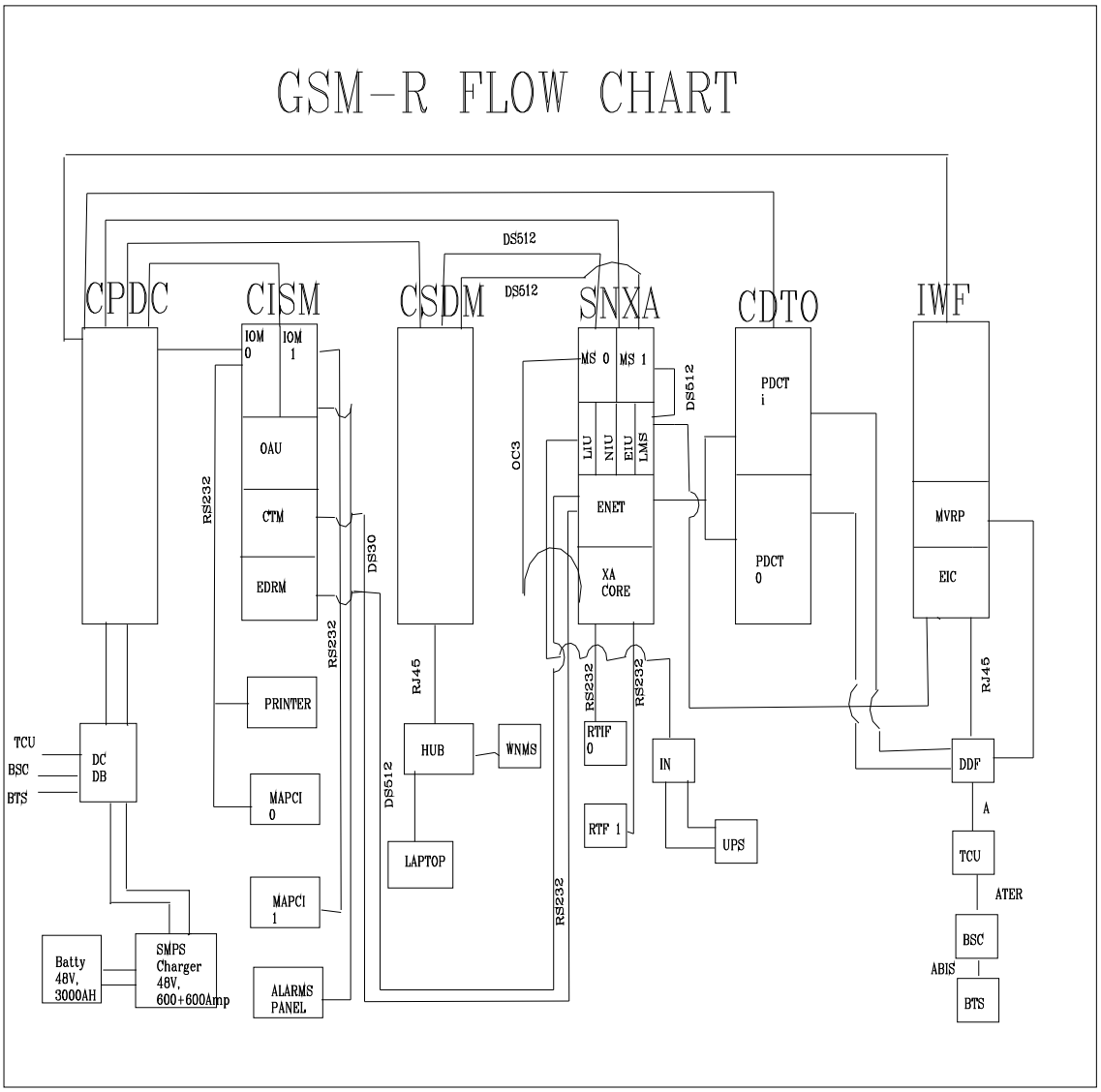


18.7.6 MS functional architecture

XA-Core	The XA-Core (extended Architecture) is the control component of the system and performs call, services, and mobility related processing and maintenance functions. XA-Core is implemented as a multiprocessor system built up of identical processing element (PE's) each running the same software load and with the same software and hardware configuration. These identical but independent PE's access a single shared memory system.
DMS-BUS	The DMS-Bus provides a high capacity communication mechanism between all the DMS components by operating at 128 Mbit/s through put. The DMS-Bus also provides the central system clock for synchronization of the DMS (MSC or HLR) system. The DMS0 Bus consists of duplicated message Switches (MS), which, under normal conditions, operate, in load sharing mode. In the event of a bus failure, the full traffic load is routed via the duplicate bus.
ENET	The Enhanced Network(ENET) and Digital Trunk Controllers (DTC) handle all of the traffic switching and connectivity functionality for the DMS. The ENET is the switching matrix that provides interconnection between peripheral modules using time division multiplexing. It is a single-stage, fully non-blocking n*64 kbits/s switch with constant low delay (128 µs). The ENET is duplicated for reliability and is flexible for provision of a wide range of port connections through modular growth (4K increments)
DTC	The DTC (Digital Trunk Controller) peripheral provides the physical interface to E1 or T1 digital carriers allowing termination of PSTN or BSC trunk connection. The DTC02 generation provides the operator with increased density of E1s (doubled) over the existing DTCOs whilst supporting all the capabilities of the previous system. The DTCOi peripheral provides the physical interface to E1 PRI, allowing termination of PABX and ISDN connection.
LINK PERIPHERAL PROCESOR	The Link Peripheral Processor (LPP) provides support for CCS7 messaging support interface to other UMTS network nodes and to PSTN/ISDN and BSC. Each SS7 connection is terminated by high

	capacity processing units called Link Interface Units(LIU). The LPP also provides LAN connectivity through the use of Ethernet Interface units (EIU). The LPP distributed processing architecture provides support for the MTP and SCCP layers of SS7 allowing the DMS-Core to concentrate on providing call processing and application support.
SDM-FT	The SDM-FT (Super Node Data Manager-Fault Tolerant) is high performance computing platform that provides the operational, administration, maintenance and provides support functions for NSS network. The SDM0FT acts as a data collection, data processing, and local mediation entity between the network element (MSC,HLR) and the management systems.
ISM (Integrated Services Module)	The Integrated Services Module (ISM) provides auxiliary and support functionality such as Recorded Announcement machines, Conference Circuits , plus the Input/Output modules for access and storage.
MSC IWF HOST	MSC connects to the Mobile-side interworking function over a Mobile-side IWF trunk (MIT). MSC connects to the network-side interworking function over a Network-side IWF trunk (NIT). These are Conference of Postal and Telecommunications Administrators (CEPT) 30 channel Pulse Code Modulation (PCM) known as PCM30 trunks that are used for bearer channel connectivity. For signaling connections to the IWF host, MSC connects to the IWF unit through a user Datagram Protocol/Internet Protocol (UDP/IP) application over Ethernet. The IWF is necessary for GSM-R deployment of the ERTMS (European Train Management System)

18.8 **GSM-R FLOW CHART**



18.9 **Function of Intelligent Network :**

i) Mapping the functional number with corresponding MSISDN.
ii) Location Dependent Addressing.
iii) Registration
iv) Deregistration
v) Interrogation
vi) Force deregistration
vii) Virtual Private Network

18.10 **Operating Sub system (OSS) :**

Operating sub system consists of

a) Operation and Maintenance Center for Radio (OMC-R).
b) Operation & Maintenance Center for NSS (OMC-S).

18.10.1 OMC-R Functions :

The OMC-R is made up of servers and work stations. Each WorkStation or X-terminal provides the operating staff with a Graphical User Interface, called Human Machine Interface.

The server centralizes the O&M functions dedicated to the BSS network elements and thus allow consistent management of the BSS network elements.

The following O&M functions are provided:

- **Security Management**: to manage user profiles in order to control the user's. access to functions provided by the OMC-R.
- **Configuration management** : To manage the resources to be supervised. Examples of resources that can be managed: PCM links, SS7 and traffic channel on A interface, cells, list of frequencies allocated in each cell, list of adjacent cells of a given cell, frequency hopping laws implemented in the cells, TDMA frame.
- **Performance management**: Values of counters are collected from the BSS network element and reports are generated and displayed to the users. Thresholds can be defined and associated with the counters to generate alarms for maintenance purpose.
- **Fault management**: the OMC-R handles even reports received from the network elements and related to the anomalies. Alarm messages can be generated with a severity from these reports by using criteria defined by the user.

The following internal functions are provided:

- **Server administration**: Supervision, switch –over and backup of the servers and stations.
- **Common functions**: inter-user mail (running within an SMS-C server), management and execution of commands file, calendar for the deferred or periodic execution of a command or a command file, on-line help.
- **File transfer management**: downloading and activation of the software released dedicated to TCU, BSC, BCF and TRX is centralized via the OMC-R.

18.10.2 OMC-S Functions :

The Operation and maintenance center of the NSS part (OMC-S) is able to achieve different kind of functions.

NSS configuration management:

- BSCs, Location areas, Cells.
- Terrestrial links, etc..

- Software configuration (downloading, file transfer).
- MSRN and handover number management.

Fault management:
- Detection.
- Presentation.
- Re-configuration.

Performance management:
- Traffic control.
- Service quality monitoring.

Security management:
- User Profiles.
- Session monitoring.

OMC-S operation:
- System Management.
- OMN management.
- File transfer operations.

OMC-R windows shows the physical and logical views.
- Physical views means how they are located
- Logical view means how they are connected.

18.10.3 Alarm Display

Alarm can appear on any object. The current alarm classification, colors and letters are:

- Minor (Yellow,m)
- Major (Orange, M)
- Critical (Red,C)

To see the alarm select the object/ hardware then click the right hand mouse button pointing to the menu and select show alarm and click. The window describes time of alarm occured, type and fault number, identity and location of object / hardware from where the alarm is originated.

18.11 Dispatcher :

The D1CORA – P (Dispatcher) fulfill a series of functional requirements :-

(i) Five registers on the display with 55 DA – Keys each.
(ii) Outgoing calls also possible via key pad and telephone book.
(iii) Touch sensitive display.
(iv) Monitoring, Conference, Call Transfer and Call Forwarding.
(v) System status display, error management.
(vi) User specific settings (Volume, Microphone ON/OFF, clearing mode).

(vii) Accept, Send emergency call.
(viii) Functions Management.

It consists of an audio module and a touch panel module.

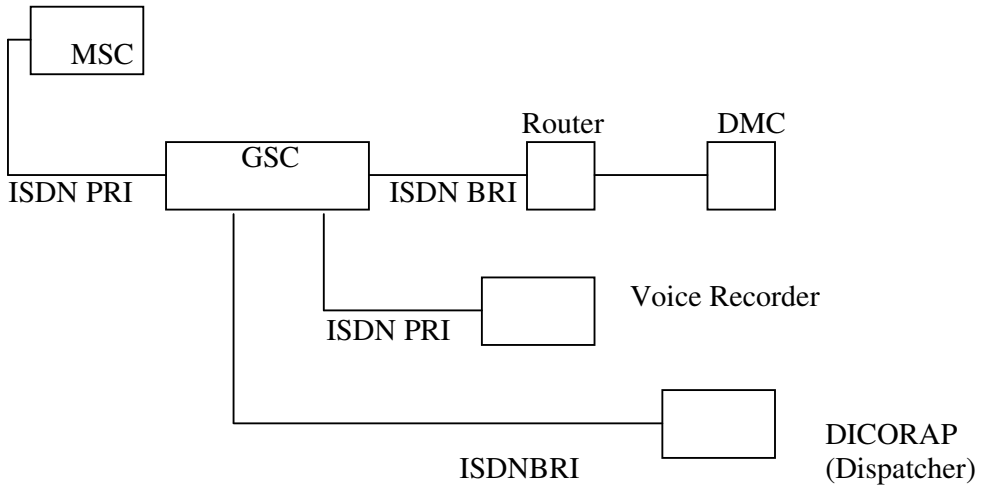
(a) Audio Module :

(i) Hand set.
(ii) Loud Speaker.
(iii) Interlock Key.
(iv) Two Emergency Keys (N1, N2) and an interlock key.
(v) Hands free key.
(vi) Microphone Key (for muting the microphone).
(vii) Key for monitoring Loud Speaker ON/OFF.
(viii) Gooseneck Microphone.
(ix) Head Set.
(x) Interface to the main module.

(b) Touch Panel Module.

(i) Screen Unit.
(ii) Industrial PC.
(iii) ISDNBRI Interface.
(iv) Audio Module Interface.
(v) Voltage Supply.

18.11.1 Block Diagram of dispatcher connection. Dispatcher is connected with MSC through the ground switch (GSC) equipment.



18.11.2 Voice Recorder stores voice that is established through dispatcher. At present 120 voice channels can be directly connected.

18.11.3 GSC consists of the following shelves.

(i) BGT DATA – Connects DMC.

(ii) BGT PSU.
(iii) BGT UIF – ISDN BRI/PRI.
(iv) BGT PRI – Connect Dispatcher.

GSC requires uninterrupted AC Power Supply.

18.12 Cab Radio :

Cab Radio - It is suitable for voice and Data Communication. It can be used with ETCS for train control. It consists of three units.

(i) Radio
(ii) Operating Units MMI
(iii) Antenna

18.12.1 Cab Radio consists of the following components :

(i)	MT2	::	Mobile Termination. 2nd Generation.
(ii)	SCOI	::	System controller with dual serial data port and parallel I/O.
(iii)	GPI	::	General purpose interface: for serial data transmission and control of MMI.
(iv)	PAI	::	Public Address Intercom.
(v)	SV2	::	Power supply, DC/DC converter for internal supply.
(vi)	FCM	::	Filter and connector module.

Key features of MT.
(i) Operation in the R-GSM,E-GSM and P-GSM bands.
(ii) Mobile Station Class 2 (8 watt transmission output).
(iii) All ASCI features.
(iv) All GSM phase supplementary services.
(v) Robust design : electrical and mechanical design for use in Rail road environment.
(vi) Full duplex data communication.
(vii) SIM commands for editing and using EIRENE and ASCI specific fields of the SIM card.
(viii) SIM tool kit.
(ix) Testing and diagnosis are possible both on line during operation and off line.

18.12.2 S.C. (System Controller)

The most important functions of the SC are :
(i) Initialization of the entire Cab Radio.
(ii) Self test and status monitoring.
(iii) Fault and protocol logging.

(iv) Administration of the service interface for diagnosis, configuration and software down load.
(v) Administration of the configuration data.
(vi) Registration and De-registration of the functional numbers.
(vii) Call control functionality for all connected terminal devices i. e. operating components, train loud speaker, train telephone and remote data transmission terminal devices.
(viii) Handling of priority and pre-emption within the scope of eMLPP.
(ix) Automatic acceptance of emergency calls.
(x) Configuration of high priority calls.

18.12.3 General Purpose Interface

The general purpose interface component is used for simultaneous control of up to two operating units MMI with voice and control circuits or a single MMI with one remote data transmission application.

18.12.4 Public Address Intercom

The Public Address & Intercom PAI component services to connect the trains loud speaker and the train telephone to the Cab Radio. It has the following interfaces.

(i) A symmetrical audio output to the train loud speaker.
(ii) A symmetrical input/output to the train telephone – including optical coupler for evaluation of the conditions for the connection to the locomotive driver or the central control station.
(iii) 4 optical coupler inputs for UIC control of the train loud speaker.
(iv) 4 optical coupler outputs for UIC control of the train loud speaker.

18.12.5 SV2 : DC – DC converter.

The DC-DC converter SV2 serves for generation of operating voltages (13V and 5V) that are required for internal supply of power to the components of the Cab Radio. The DC on board supply of locomotive with nominal voltage between 24V and 110V DC serves as the Power source.

The DC-DC converter SV2 offers potential separation and protection against transient voltages. Voltage fluctuations and EM influences according to the requirements of locomotive.

The DC-DC converter has a status LED on the front side of the housing. It lights constantly when both voltage outputs and the internal temperature lie with in the permitted range.

A signal corresponding to the LED is provided as a power fail signal with TTL level at the back panel bus and can be processed by the SC.

Two SV2s can be connected in parallel without external circuitry, where by the tolerances of the output voltages are still met. This increases the redundancy of the system.

18.12.6 Filter and Connector Module FCM.

FCM takes on the following tasks in the Cab Radio voice section :-

(i) Connector panel – the solid connectors for power supply, MMIs, Data Interfaces and UIC interface are connected mechanically and electrically to the panel.
(ii) Power distribution – The on board 24-110V DC power supply is distributed among the two DC converters SV2 and optional SV3.
(iii) The consumer voltage 24V of the battery circuit or optional module SV3 is run to the connectors of MMI and via the coupler relay to the control circuit of the UIC – 568 interface.
(iv) Filter function – The input and output voltages are protected by course protection elements and filters against transients from the locomotive power supply.

18.12.7 Operating Unit MMI (Man Machine Interface)

The operating unit is an important components of the Cab Radio. It serves for input of commands via the keyboard and provides the user with comprehensive information on a display. The inputs are entered via function keys (hard keys) with fixed functions as well as soft keys with functions that can be dynamically adapted.

Components of the MMI.

. Monochrome Display.
. Key Board.
. PC Board.
. LED indicators.
. Audio Amplifier.
. Charging Unit for the driver mobile telephone.
. Housing.

The following hard keys are present :

(i) RESET
(ii) Selection Key Up x DM
(iii) Enter Key
(iv) Emergency Call button
(v) Call to train conductor.
(vi) Call loc-loc
(vii) Call in the train (train announcement)
(viii) Button for calling the Station Master.

18.12.8 Soft Keys

No permanent functions are assigned to the soft keys. The function of the key depends on the currently activated train radio application (GSM-R or analog) and the configured operating level.

18.12.9 LED Indicators :

A total of 7 LEDs are available which are only activated as required.

. Emergency call indicator next to emergency call button.
. One LED next to each of the hard key for SM, train controller.
. Two status LEDs.
. All LEDs can be controlled from the SC via the RS422 interface.

18.12.10 Power Consumption :

The average power consumption is 18W. If the device in the idle made, the maximum power consumption is 3W i. e. dark display.

18.13 Power supply arrangement of GSM-R system :

18.13.1 Power supply arrangement at NSS site. It is a centralized site consists of

a) MSC (D.C. supply)
b) IN (A.C. supply)
c) OSS (OMC-R and OMC-S) (A.C. supply)
d) Dispatcher (A.C. supply)

(N.B. : Dispatcher may be located at some other place also as per the requirement of Railways).

All the equipments are run by a uninterrupted (-)48V DC supply and 230V AC supply.

The network capable to cater up to 500 erlang need –48V supply capable to cater up to 233 Amp. (Typical for a system by M/s.Nortel).

The 230V AC UPS (15KVA) supply for an installation to cater up to 500 erlang (Typical for a system by M/s.Nortel).

18.14.0 Installation of the system :

Installation of the system should be done as per firms guide line and under supervision of Firm's Engineer.

18.14.1 Site selection for NSS equipment Room :

The NSS equipment room should be specious and the floor should be robust and strong enough to carry the equipment loads. The equipment loads are mentioned in the equipment catalog. Site selection should also cater for future expansion, if any.

18.14.2 Cooling Arrangement :

The system is very sensitive to high temperature. So, it is necessary to provide necessary cooling arrangement round the clock for the NSS equipment room.

As the battery & charger require to supply 233 Amp. DC current (-48V DC), the Battery capacity is very high. It should be at least 3000 AH in duplicate and the charger should be selected as SMPS based charger with hardware redundancy.

230V AC UPS supply with 15KVA capacity is also required for running different servers and OMS-S, OMC-R terminals. These servers should not shut down suddenly due to power failure. Hence, UPS supply, 15KVA should have redundancy in hardware also. Load sharing of the UPSs is the preferred mode of operation

18.15 Commissioning of GSM-R

Commissioning of GSM-R requires following steps.

- Uninterrupted DC & AC Power supply should be ensured first
- Software loading should be done for each and every equipment. Proper license of software and operating system used should be handed over to Railways by the firm
- Stand Alone Test (SAT-I)- The test needs to cheek all the NSS & BSS equipments in room separately. The test is to be carried jointly by Railway as well as firms representative. Firm's representative through the OMC-S & OMC-R terminal will exercise and show the stand alone system capability as the equipment should perform. The test procedure should be decided jointly beforehand. Checking of hardware and its redundancy, energisation of any hardware and deenergisation, dumping of data in the MMS devices and rebooting of system etc through OMC-S, OMC-R terminals are some of the tests which are carried out.
- System Acceptance Test (SAT-II) - The system has its own features. All these features and applications are to be simulated and tested jointly by the Railway and firms representative. These tests are also for compliance of the system to EIRENE FRS& SRS.
- Radio Acceptance Test (RAT)- Radio level testing i.e. signal strength. Outside interference, coverage, QPS, handover rate etc through out the geographical area along the Railway track covered by the GSM-R is to be tested with running trains by the firms representative and Railway jointly.
- As and when satisfactory result appear in the above tests in SATI, SAT-II & RAT, the system will be commissioned.
- Installation of fire alarm system & smoke detector.
- The equipment room, Battery room and OSS room at NSS center and equipment room, Battery rooms at other wayside installation should be provided with fire alarm system and smoke detectors.
- Fire fighting system should be also be installed in sufficient quantity at the NSS and other way side installations.

18.16 Maintenance

18.16.1 Network and switching subsystem

18.16.1.1 The system requires stable power supply and controlled temperature. Due to variation of the above two parameters, the system may shut down. Any shut down event may

cause loss of data . Hence reliable power supply AC (UPS) and DC should be ensured by periodical checking of redundancy of hardware as well as its capability.

18.16.1.2 Daily maintenance of NSS site

a. All the racks should be physically viewed for any abnormal, alarm or other indication.
b. The OSS terminals should be monitored for viewing any physical alarm and abnormalities. If any abnormality is observed immediate action will be taken to restore.
c. To exchange signaling information, speech & data from BTS to BSC and vice versa, OFC link or any standard link is to be used. There should be two paths of OFC link (2Mb/s E1), one in forward direction and other in reverse direction to improve system reliability. As and when normal path gets disconnected, the reverse path will take care of the system. To ensure the health of both the paths of 2 Mb/s E1s a daily check sheet should be maintained as below.

Date	E1 number	Normal path disconnected at (Hrs)	Normal path reconnected at (Hrs)	Performance at reverse path	Reverse path disconnected at (Hrs)	Reverse path reconnected at (Hrs)	Performance at normal path	Remarks

d) Recording of daily data regarding equipments, Air-conditioning machine, Chargers, Battery, UPS etc.

e) Management & recording of data of A/C machine performance.

Date	AC machine Numbers										Remarks	Name & Sig. of Technician	Supervisor's remarks
	Time	1	2	3	4	5	6	7	8	9			
	On												
	Off												
	On												
	Off												
	On												
	Off												
	On												
	Off												

f) Equipments (Typical for M/S Nortel installation)

Date	Alarm on physical verifications of different Racks									
	CPDC	CISM	CSDM	SNXA	CDTO	IWF	IN	BTS	TCU	BSC

Alarm on different terminals					
RTIF	MAPCI	WNMS	OMC-R	HUB	IN

Alarm on verifications of different Power Supply Unit								
SMPS Charger	Isolation Tx	UPS	Room Temperature			Remarks	Name of Sig. of Tech.	Name of Sig. of Supervisor
			Bty Room	Eqpt Room	O&M Room			

18.16.1.3 Any defect noticed during daily checking of remote alarms like health of BTS, physical parameters of BTS equipment room (Temperature, Battery voltage, A/C Machine fail etc), health of E1 s etc should be attended immediately by maintenance team and a record should be maintained at NSS center.

Date	Time	Fault	Informed to whom (Time & Date)	Date & Time of rectification	Remarks	Name & Sig of staff	Name & Sig of Supervisor

18.16.1.4 If the MSC is connected to any Railway exchange, the link between MSC & Rly exchange should be monitored daily and the same should be recorded in the following table.If there is backup E1 path for exchange connectivity, same should also be tested periodically.

Date	Call initiated from any exchange phone to mobile		Performance	Call initiated from any mobile to exchange phone		Performance	Name & Sig of Tech/Supervisor tested
	Exchange Tel.No.	Mobile No.		Exchange Tel.No.	Mobile No.		

18.16.1.5 Daily testing of dispatcher

Date	Call initiated from dispatcher to mobile no	Performance	Call initiated from any mobile to dispatcher Normal call & emergency call	Performance	Name & Sig of Tech/Supervisor tested

18.16.1.6 Daily Testing of Group call , Broadcast call.

Date	Group call initiated from Mobile No. to other Mobile Nos. (Record Mobile nos.)	Performance	Broadcast call initiated from Mobile No.	Performance	Name & Sig of Tech/Supervisor

18.17.0 Other periodical checking of GSM-R

18.17.1 Biweekly

i)Taking of back up of MSC & BSC

18.17.2 Monthly

i) Proper health cheek-up of smoke detector (heat detector, control panel.)

ii) Checking of ground connections of all the equipments and earth bars.

18.17.3 Quarterly

i) Checking of antenna coupling point at tower top.

ii) Cleaning of earthing points of tower top.

iii) Testing of VSWR of antenna & cable (should be less than 1.3,
If VSWR is greater than 1.3 then cleaning of power splitter is required).

iv) Signal strength testing at site.

18.17.4 Half yearly

i) Measuring of earth.

ii) Cleaning of filter Pads of fan trays.

For more details refer maintenance manual of a system.