REGIONAL OPERATION AND MAINTENANCE IN CONTEMPORARY GSM NETWORK

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APPROVAL

This Internship titled "Regional operation and maintenance in contemporary GSM network" submitted by Md. Rajib Dewan to the Department of Electronics and Telecommunication Engineering, Daffodil International University, has been accepted as satisfactory for the partial fulfillment of the requirements for the degree of Bachelor of Science in Electronics and Telecommunication Engineering and approved as to its style and contents. The presentation was held on December 27, 2010.

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DECLARATION

I hereby declare that the work presented in this project report titled “Regional operation and maintenance in contemporary GSM network” is done by us under the supervision of Mohashin Uddin Pathan, lecturer , Department of Electronics and Telecommunication engineering Daffodil International University , partial fulfillment of the requirements for the degree of Bachelor of Science in Electronics and Telecommunication Engineering. I also declare that this Intern is my original work. As far as my knowledge goes, neither this report nor any part there has been submitted else where the award of any degree or diploma.

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ABSTRACT

Global System for Mobile Communications (GSM) is one of the most widely adopted standards for cellular communication. The internship performed at the Regional Operation and Maintenance (O&M) of Teletalk Bangladesh Ltd. has provided a comprehensive perspective of basic concepts in GSM, as well as issues related to the fault management of GSM network. The fundamental architecture of GSM consists of three major systems which are the Switching System (SS), Base Station System (BSS) and Operation and Support System (OSS). GSM uses Signaling System Number 7 (SS7) for control signal purposes. Within the major systems, functional units such as MSC (Mobile Services Switching Center), BSC (Base Station Controller) and BTS (Base Transceiver Station) actively take part in call set up process. During the internship, the overall work flow and specifics on O&M activities were closely observed and studied. Generally, GSM operators execute planning, implementation and O&M sequentially. As far as the O&M in Teletalk Bangladesh Ltd. is concerned, it acts as a functional group to address faults occurring at various nodes of the network. These faults differ in nature based on the type of network element and its corresponding functions. Therefore, the task of O&M is further subdivided to provide appropriate support for fault management. The common complaints from the users originate mostly due to the performance degradation of the network caused by these faults. Hence, the O&M division undertakes appropriate measures by organizing several subgroups within its functional periphery to manage these faults and reduce the overall prospect of fault occurrence. The basic structure of the Teletalk Network and descriptive information about fault management are given by the co-workers of the Teletalk Bangladesh Ltd. and also from my supervisor.

ACKNOWLEDGEMENT

First of all I would like to thank Almighty Allah for giving me the ability to work hard successfully.

Then I would like to thank the very co-operative faculties in the department of ETE of Daffodil International University have provided significant support and wisdom regarding the approach to be taken during internship and the techniques to apply in writing this report. Most importantly, the experience that they have shared is invaluable. I thank them all very sincerely.

Especially, throughout this internship, my honorable advisor Dr. Golam Mowla Choudhury and my supervisor Mohshin Uddin Pathan have been exceptionally helpful. They have given their valuable time and suggestion regarding the internship activities and the internship report. They have been a great mentor and I thank them from the bottom of my heart.

I would also thank my co-workers in Teletalk Bangladesh Ltd. who extended their helpful hands and demonstrated the key concepts related to the division of operation and maintenance, and in general, regarding GSM network. I thank Mr. Ariful Hasan (System Engineering) and Mr. Faisal Karim (System Operation) who supervised my work at Teletalk Bangladesh Ltd.

Most importantly, I thank Daffodil International University for providing an opportunity in our curriculum which enables a student to be directly associated with practical working situations as part of our academics.

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INTRODUCTION

1.1 Internship Objectives

The objective of this internship was to gain experience and knowledge regarding the existing cellular services and to co-relate the theoretical background given by the university with the practical working environment. In the field of engineering, concepts at application level provide a useful supplement to relevant theories and understandings. This program also bring out more information of official decorum and also fulfill the academic requirement for the under graduating program. Internship gives us the opportunity to learn how to cope up with the real corporate world and also to learn the teamwork.

1.2 Report Objective

The objective of this report is to represent the experience and outcomes gathered during the internship in a formal context. This report discusses the Operation and Maintenance Issues in Contemporary GSM Network for the fact that this writer performed his internship in the Regional Operation and Maintenance Division of Teletalk Bangladesh Ltd. which is a cellular service provider company. The report is arranged in chapters which are laid out in a manner so that the report provides the reader with sufficient background information of GSM network for the understanding of rather advanced discussions and further discussions along with the supporting figures are also given at places so that they complement the text and aid its understanding.

1.3 Internship Profile

The internship placement was at the Regional Operation and Maintenance Division; Dhaka in Teletalk Bangladesh Ltd. Teletalk Bangladesh Ltd. (the "Company") was incorporated on 26 December, 2004 as a public limited company under the Companies Act, 1994. Teletalk has forged ahead and strengthened its path over the years and achieved some feats truly to be proud of, as the only Bangladeshi mobile operator and the only operator with 100% native technical and engineering human resource base, Teletalk thrives to become the true people's phone – "Amader Phone". The internship was done under the supervision of Mr. Ariful Hasan (System Engineering) and Mr. Faisal Karim (System Operation). The task of the Regional Operation and Maintenance Division in Teletalk is to address the faults that are reported by the Network Operation Center (NOC). Therefore, the intern was provided with ample opportunities to physically attend the network nodes and understand the functionality of network components. Furthermore, the performance level of the network could also be assessed with the occurrence and management of faults of different types and of different functional units of the network. These are the reasons why the report's content focuses on the operation and maintenance issues of contemporary GSM network.

Several key particulars of the internship placement are given for convenience:

Internship Placement: System Engineering and System Operation; Teletalk Bangladesh Ltd. Address: Rupayan Golden Age (2nd floor); 99 Gulshan Avenue, Gulshan-2, Dhaka-1212 Phone Number: 880-2-885 1060; Fax: 880-2-883 7386

CHAPTER 2

BASIC CONCEPTS OF GSM NETWORK

The discussion on the basic concepts of GSM network aids further understanding of the following sections of the report. This chapter on the fundamental aspects of GSM network mainly focuses on the background, core technology, architecture, call set up, signaling process and performance concepts related to GSM.

2.1 Background Study of the GSM Network

The background study of the GSM network would suggest that its emergence and standardization was caused by the growing need for capacity and mobility in wireless communication.

GSM is a standard for second generation cellular communication. It is preceded by the first generation standards and the very initial mobile radio networks. While the objective of the early mobile radio networks was to achieve large coverage by using high powered transmitters on tall towers, it was not possible to reuse a frequency over a large area .

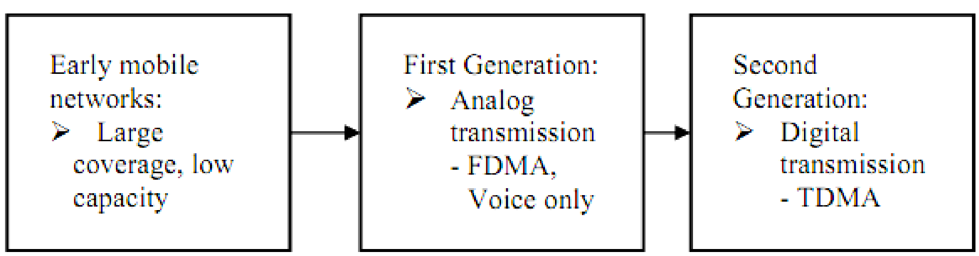


Figure 2.1: The Evolution of Second Generation Mobile Communication

On the other hand, the first generation of mobile communication was in fact the beginning of cellular communication. However, since it used purely analog transmission and FDMA (Frequency Division Multiple Access), the nature of traffic was purely voice and the frequency reuse factor also had limitations. The most successful first generation standard was NMT (Nordic Mobile Telephone) which used the 900 MHz and 450 MHz bands .

2.2 Core Technologies in GSM Network

Core technologies include several important aspects regarding a mobile communication standard. In GSM, the aspects to be discussed are spectrum regulation, modulation scheme, multiple access method and hand off technique.

2.2.1 Spectrum Regulation

There are several frequency bands around the world that are used for GSM. However, in Europe and the subcontinent, the 900 MHz and 1800 MHz bands are used.

GSM-900, which uses the 900 MHz band, operates at 890 – 915 MHz to send information from Mobile Station to Base Transceiver Station (Uplink).The concepts of Mobile Station and Base Transceiver Station are subject to the architecture section. The channels are separated by 200 KHz of bandwidth to avoid interference. This provides a total of 124 channels .

GSM-1800 uses 1710 – 1785 MHz for uplink channels and 1805 – 1880 MHz for downlink channels. The channels are spaced by 95 MHz. This provides 374 channels. This is why; GSM-1800 is opted for high capacity coverage .

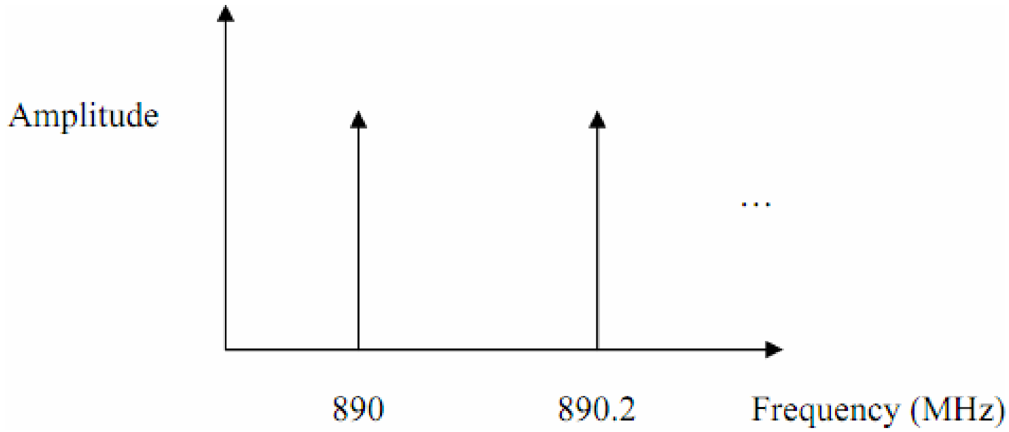


Figure 2.2: Demonstration of channel spacing and spectrum allocation

In GSM-900 for uplink channels

2.2.2 Modulation Scheme

The basic modulation scheme for GSM is GMSK (Gaussian Minimum Shift Keying).This is done on the base band digital pulses to further narrow them to reduce fading which is followed by simple FSK with smooth frequency shifts. GMSK has remained in use from the basic data rate of GSM of 9.6 Kbps to the data rate of GPRS which is 115 Kbps. This has been achieved by making more efficient ways of using time slots by keeping the basic GMSK scheme .

2.2.3 Multiple Access Method

The reason why GSM dominates the first generation is that it makes use of a digital technology called TDMA (Time Division Multiple Access). Each 200 KHz channel is divided into eight time slots. Each time slots uses approximately 0.577 ms [4]. These specifications apply to the most primary TDMA type called Normal Burst . There are variations in time slots as digital carrier systems such as T1 and E1 have arrived. Details on these systems are included in chapter 3.

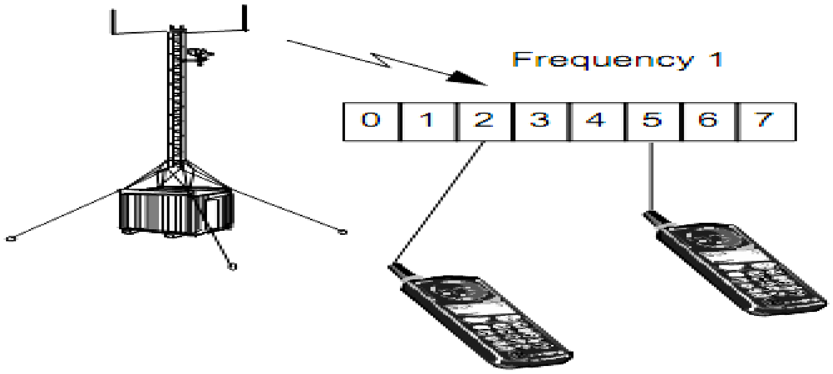


Figure 2.3: TDMA in GSM

2.2.4 Hand off Techniques

Hand off is the process which connects the mobile station to the cell when it moves into a new one. There are basically two types of hand off: Soft hand off and hard hand off.

GSM uses the hard hand off option. It means that it releases connection to the previous cell before connecting to a new one. In contrast, CDMA uses soft hand off, which is, to release the link to the previous cell only after a new one is established. The hard hand off may cause call drops or disconnection. If the signal level of the new cell is not adequate, this would occur. Otherwise, the call continues.

2.3 Architecture of GSM Network

The architecture of GSM network includes key functional units that make up a complete and operational mobile communication network. The specification for GSM network divides this architecture into three major systems .

- The Switching System (SS)
- The Base Station System (BSS)
- The Operation and Support System (OSS)

2.3.1 The Switching System (SS)

The switching system (SS) is responsible for performing call processing and subscriber related functions. It consists of several functional units as shown in figure 2.4 below.

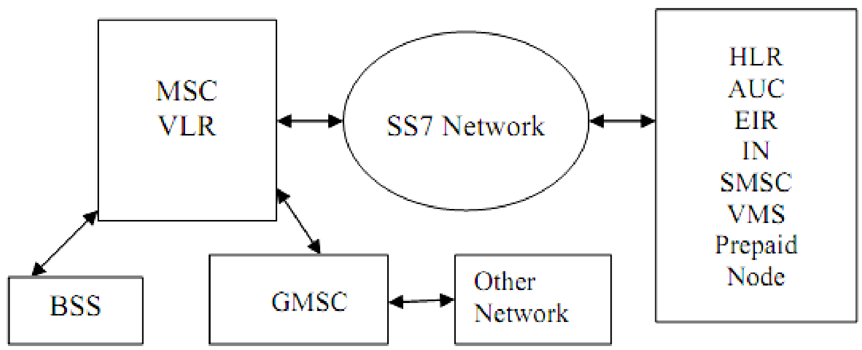


Figure 2.4: Functional units of SS

MSC/VLR: MSC (Mobile Services Switching Center) is a very central component of the GSM network. It performs the switching function of the network and provides connection to other networks .

VLR (Visitor Location Register) is always implemented together with MSC.VLR contains selected information from a subscriber’s HLR (Home Location Register) which are necessary for call control and provisioning .

MSC, with the aid of several other functional units, provides all the facilities to handle a mobile subscriber. These include registration, location updating, authentication, intelligent network services and text and voice message services.

HLR: The HLR (Home Location Register) is a network database that contains all the administrative information of each subscriber registered in the GSM network, along with the current location of the mobile. When a mobile station roams into a new MSC area, the VLR connected to that MSC requests data about the mobile station from the HLR. The subscription data in HLR states the logical identity of each MS (Mobile Station) and the services accessible to it .

AUC: The AUC (Authentication Center) generates authentication and encryption parameters that verify the user's identity and ensure the confidentiality of each call. The support of AUC protects the network from unauthorized use .

EIR: The EIR (Equipment Identity Register) is a database that contains information about the identity of mobile equipment that prevents calls from stolen, unauthorized or defective mobile stations. The AUC and EIR are implemented as stand-alone nodes or as a combined AUC/EIR node .

IN: Intelligent network manages the value added services that a subscriber is eligible for.

SMSC: The SMSC (Short Message Service Support Center) provides services to avail the text messaging services for a mobile.

VMS: Voice Messaging System (VMS) enables the user to send messages in form of recorded audio to another user.

Prepaid Node: The Prepaid Node hosts the services needed to handle users that prepay for their usage. As soon as the credit is empty, the Prepaid Node would act to disable the connection.

2.3.2 The Base Station System (BSS)

The Base Station System (BSS) provides the radio related functions in GSM and acts as an interface between the user and the MSC. To perform these functions, there are two types of base stations:

- Base Station Controller (BSC)
- Base Transceiver Station (BTS).

BSC: The BSC controls a group of BTSs and manages their radio resources. The physical area that a BSC covers consists of one or more location areas under each BTS. BSC handles radio channel set up, handover, frequency hopping and the radio frequency power levels of the BTSs. BSC is also a connection between the mobile station and MSC.

BTS: The Base Transceiver Station houses the radio transceivers that define a cell and handles the radio-link protocols with the Mobile Station. A BTS may be placed at the center of a call with Omni directional antennas. It may also be someplace else in the cell. In such case, directional antennas are used .

Each BTS has typically between one and sixteen transceivers depending on the density of users in the cell. In a large urban area, there will potentially be a large number of BTSs deployed. Thus the requirements for a BTS are: ruggedness, reliability, portability and cost effective. As noted, several BTSs are controlled by a BSC. Therefore, the depiction of BSS can be as follows.

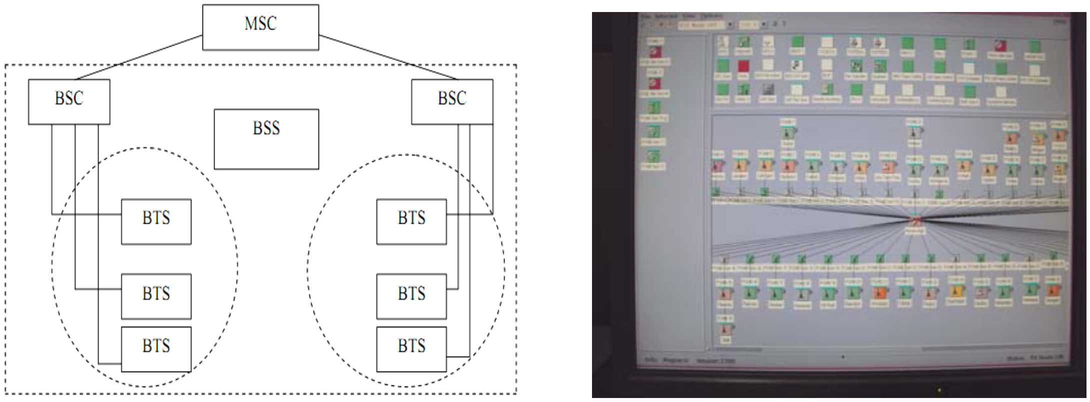


Figure 2.5: (a) Base Station System of GSM network and (b) Base Station System diagram of Teletalk.

In the above shown set up, the BTSs would divide the air interface of its coverage into several cells. Performance related concepts of these links between the mobile station (MS) and BTS would be discussed later in the chapter.

The MS consists of mobile equipment and a smart card called SIM (Subscriber Identification Module). The SIM identifies the user. The mobile equipment can be identified by its IMEI (International Mobile Equipment Identity). The SIM contains International Mobile Subscriber Identity (IMSI). These two are independent of each other. Therefore, any SIM can be used in any mobile equipment.

2.3.3 The Operation and Support System (OSS)

The operations and maintenance center (OMC) is connected to all equipment in the switching system and to the BSC. The implementation of OMC is called the operation and support system (OSS).The OSS is the functional entity from which the network operator monitors and controls the system.

2.4 Call Set Up Process in GSM

The call set up process illustrates the involvement of the overall GSM architecture as each part plays its role.

The figure below provides the outlook of the process. The details are furnished in form of steps taken in the overall process.

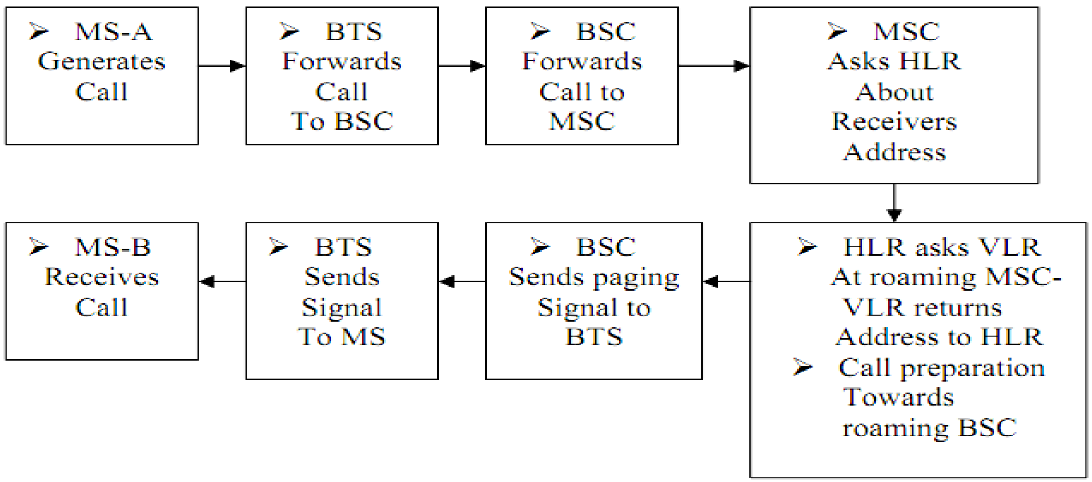


Figure 2.6: The call set up procedure in GSM

Detailed Process:

- Suppose in this case, call is being set up between subscriber A and B. The call request reaches from the MS to BTS using a specific channel called RACH (Random Access Channel).
- BTS forwards the call request to BSC which consequently takes the request to MSC.
- The MSC checks the numbers of user A and B. First of all, it checks with AUC regarding the authenticity of user A.
- Once authenticity is confirmed, MSC checks A's status. It acquires A's account status and any special billing scheme from the IN node.

- User A’s MSC now searches for the MSC under which B is roaming. In order to do that, A’s MSC would need information from B’s VLR via B’s HLR and B’s HLR responds to the interrogation of A’s MSC. It corresponds to B’s current VLR. Then it returns the information to A’s MSC.

- A’s MSC acknowledges B’s HLR and sets up speech connection towards the MCS/VLR where user B is residing.

- The MSC sets up a speech connection towards BSC.

- BSC sends a paging signal through the Paging Channel (PCH) to all the BTS it covers. The paging message contains the identity number of the mobile subscriber that network wishes to contact. The BTSs also uses the PCH to inform the MSs about the incoming call. MSs listen to the PCH at certain intervals. If it identifies its own mobile subscriber identity number one the PCH, it will respond. This response returns the ring tone or busy tone from B.

2.5 Signaling Process in GSM

The communication among various nodes in GSM architecture requires signaling. Examples given in figure 2.3 and 2.5 indicate such communication for respective purposes. In this regard, several signaling channels and associated signals are specified. This section discusses the key signals used in GSM network.

2.5.1 Basic Signals Used in GSM

Each type of signals uses its own TDMA method. Therefore, separate signaling channels exist in GSM. These signals are further placed in T1 or E1 slots, which will be discussed later.

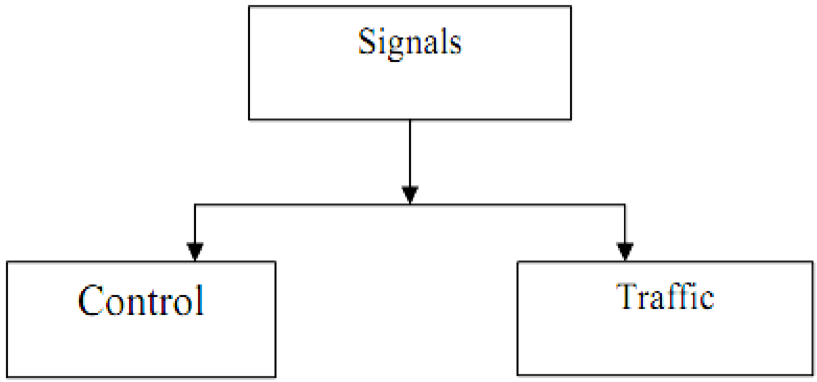


Figure 2.7: General classification of signals

While the traffic signals are basically voice and other traffic carried by the network, the control signals differs in types and tasks. This is given in tabulated form in the followings:

Table 2.1: Different Types of Signals in GSM and Associated Tasks

Signal	Direction	Tasks
Random Access Signal	Uplink, Point to Point	Call set up request From MS
Access Grant Signal	Downlink, Point to Point	Assigns channel to MS
Frequency Correction Signal	Downlink, Point to Multipoint	Transmits the carrier frequency
Broadcast Control Signal	Downlink, Point to Multipoint	Broadcast identity parameters of the cell
Paging Signal	Downlink, Point to Point	Informs MS of incoming Call

2.5.2 SS7 Architecture

The entire SS7 can be divided into different functional units, making up the architecture for SS7. Below is an outlook of this architecture followed by a brief description:

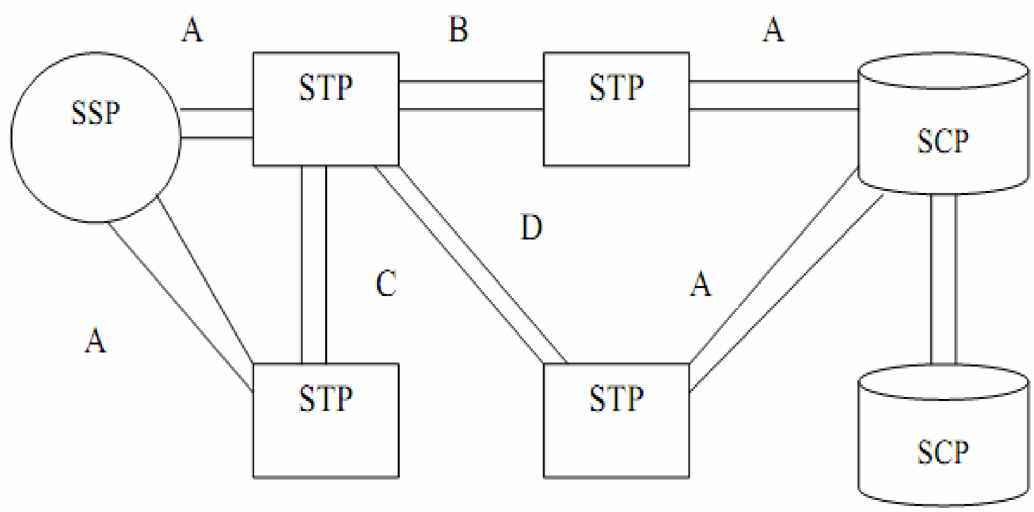


Figure 2.8: SS7 Architecture

The three main functional units of SS7 are: STP (Signaling Transfer Point), SSP (Signaling Switching Point) and SCP (Service Control Point). STP and SCP are deployed in pairs in different hierarchical levels. Paired nodes are called mate to each other. Different links connect these units in different ways.

- A links (Access Links) are used to connect SSP and SCP to STP.
- B links (Bridge Links) connect STPs of same level.
- C links (Cross Links) connect mate STPs.
- D links (Diagonal Links) connect STPs of different level

The role of STP, SSP and SCP are described in brief below:

STP: STPs act as a router for SS7 signals. They do not originate them. SS7 messages travel from one SSP to another via STPs.

SSP: SSP creates SS7 messages. They convert other type of messages into SS7 format.SSP can also send database queries through SS7 network.

SCP: SCP acts as an interface between database and SS7. The database queries from SSP are answered by SCP. These queries can be about subscriber's services, routing of special numbers etc.

It is noticeable that each type of links in SS7 is implemented in pairs. This provides redundancy of the links. Furthermore, SSP and STP are rarely stand-alone system. They are practically in form of adjunct computers to tandem traffic switches.

2.6 Performance Related Concepts in GSM

Since GSM is a standard for cellular communication, its performance related concepts involve both cellular and wireless fundamentals. Any GSM service provider has to address these issues before and after the implementation of their service. Otherwise, its performance deteriorates to quite an extent.

2.6.1 Cellular Concepts

Cellular communications relies on distributing a certain amount of frequency range to a defined locality and then further allow other areas to use the same frequencies without having problems. For this to happen, the frequency reuse must obey certain rules.

- For a cellular system with S number of available channels and k number of channels allocated for each cell, a total of N number of cells would use the total channel range if and only if each of N number of cells is disjoint and unique [1].

  Only at this state, the equation below will be true:

$$S = kN \qquad (1)$$

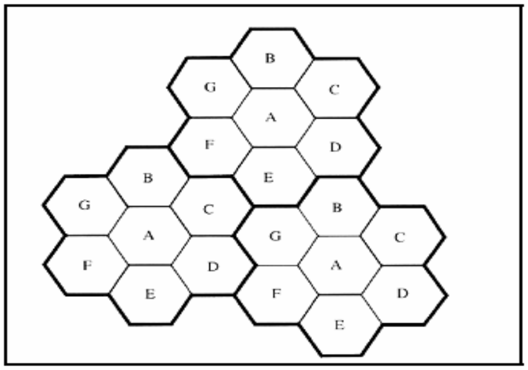


Figure 2.9: Frequency reuse by cells and clusters

- If M number of clusters are formed, as indicated by the bold borders in figure 2.8, with each cluster reusing the entire channel capacity, the total capacity of the system is given by:

$$C = MkN, \text{ or } C=MS \qquad (2)$$

- The hexagonal property of cell determines the cluster size and the frequency reuse factors. If there are N numbers of cells in a cluster, it must satisfy the following condition:

$$N = i^2 + ij + j^2 \qquad (3)$$

Here, i = number of cells taken along any line of hexagon and j= number of cells taken at an angle of 60 degree counter clock wise after traversing i. The illustration is given in figure 2.10:

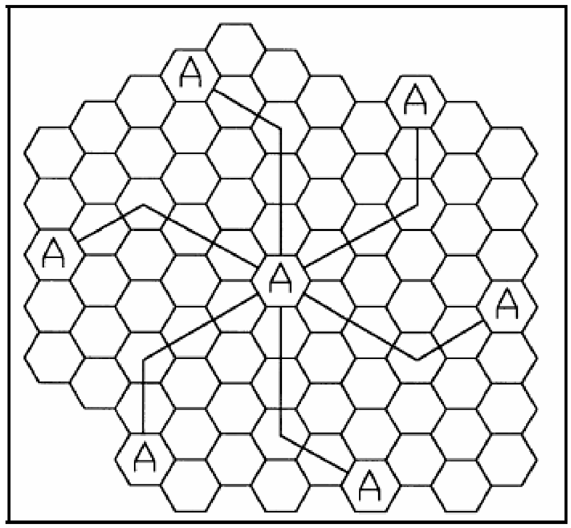


Figure 2.10: Cluster size and co-channel regulations

In above figure, the same letter cells use the same range of frequency or co-channel cells.

- The co-channel noise ratio Q is the ratio of the distance between co-channel cells (D) and the cell radius (R). Hence, Q=D/R, meaning that if Q has a small value, the cluster size is small and the capacity is increased but the transmission quality is compromised. If Q has a large value, then the cluster is large which means capacity is reduced with improvement in transmission .

2.6.2 Wireless Concepts

Wireless communication faces several transmission obstacles due to the propagation properties of the signal. There are mainly two categories of such problems:

- Path Loss
- Multipath Fading

Path Loss: Path loss occurs when the received signal becomes weaker due to increasing distance between MS and BTS [8]. The signal strength at a distance'd' from an isotropic antenna at BTS would be given as:

$$s(d) = \frac{P_t}{4\pi d^2} \qquad (4)$$

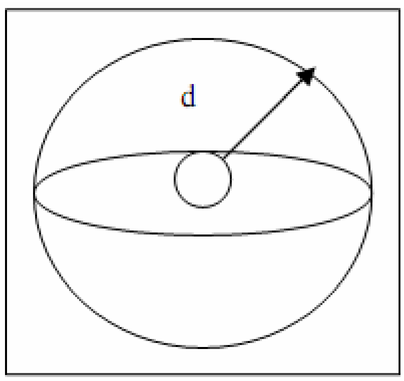


Figure 2.11: Path loss scenario for isotropic signal source

Here, *Pt* is the transmitter antenna power.

Multipath Fading: Very simply, multipath fading occurs since the signal reflects, diffracts and scatters along the way. As a result, two types of fading occur. They are: Rayleigh fading and Time Dispersion. Rayleigh fading results into same signal with phase variations at the receiver end. It is caused by the nearby objects to the receiver. On the other hand, time dispersion is caused by far apart objects. However, it results into the reception of one symbol at another symbol's time slot, causing Inter Symbol Interference (ISI).

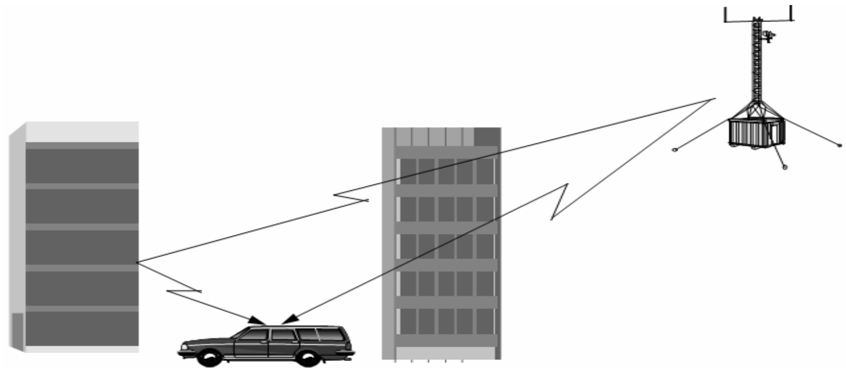


Figure 2.12: Rayleigh Fading

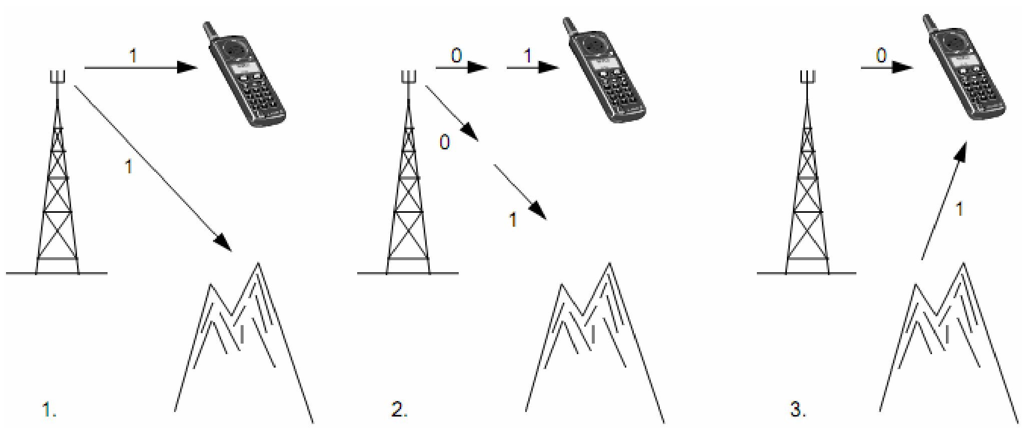


Figure 2.13: Time Dispersion

These problems are combated in GSM by using channel coding, interleaving and antenna diversity. Details on their application are subject to the discussion in the subsection ‘Network Coverage’ in chapter 3.

CHAPTER 3

OPERATION AND MAINTENANCE

IN CONTEMPORARY GSM NETWORK

The operation and maintenance of contemporary GSM network evolves around two major issues: the overall management of the network and the infrastructure of the network itself. They provide the principles of operation and maintenance and the network elements that are needed to be taken care of. This chapter, therefore, discusses the operation and maintenance of GSM network from these two major perspectives.

3.1 GSM Network Management

GSM network management involves three key functional groups:

- Planning
- Implementation
- Operation and Maintenance (O & M)

As the internship placement was at the regional O & M of the company mentioned, detailed discussion on Operation and Maintenance activities will be prioritized while showing the inter-relation of the functional groups at the same time.

Basically, the entire network operates on a very simple sequential relation among these three groups. Every activity begins with planning, then implementation and finally it is handed over to the Operation and Maintenance group which constantly escalades the faults occurring within the network. Figure 3.1 depicts this simple flow of activity:

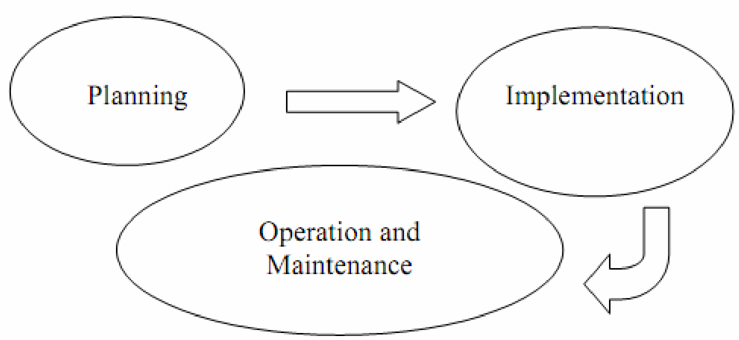


Figure 3.1: Flow of activity among functional groups of GSM

Interestingly, this flow completely represents the standard depiction of the functional groups that is mentioned in network management theories. For example, the following demonstration can be placed here:

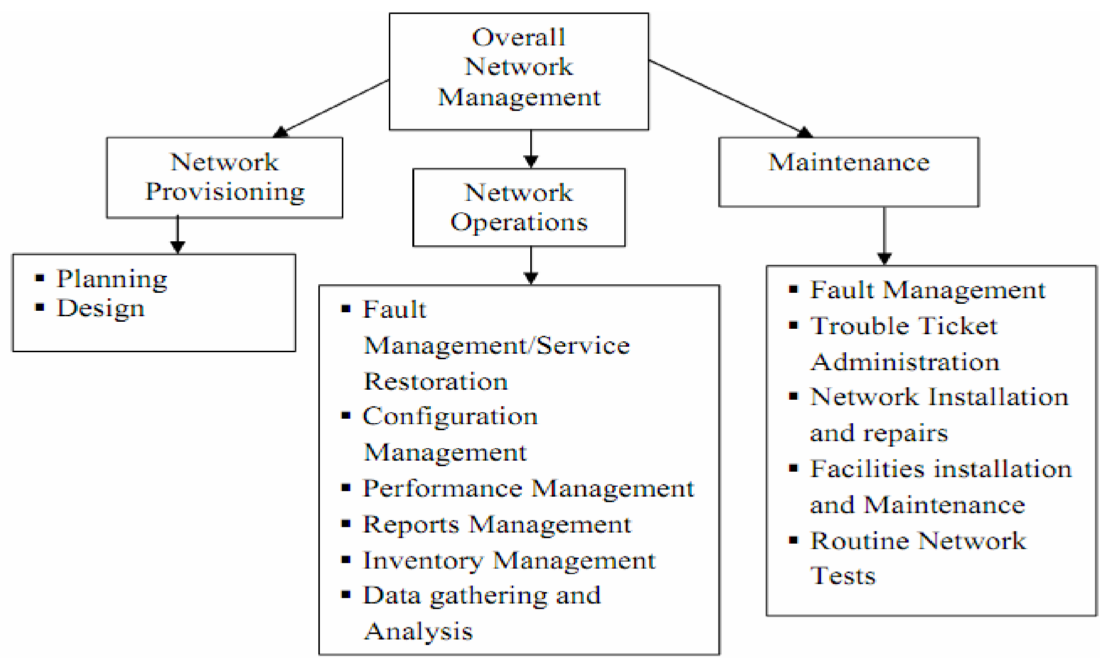


Figure 3.2: Roles of the functional group in network management theory [9]

The contemporary GSM network divides these groups into sub-groups. These sub-groups distribute different aspects of each group's task among themselves. For example, the planning group can be divided to separately work on transmission planning, radio planning etc. A brief description of each group and their sub-groups are furnished below:

3.1.1 GSM Network Planning

The GSM Planning group is sub-divided as shown in the figure below:

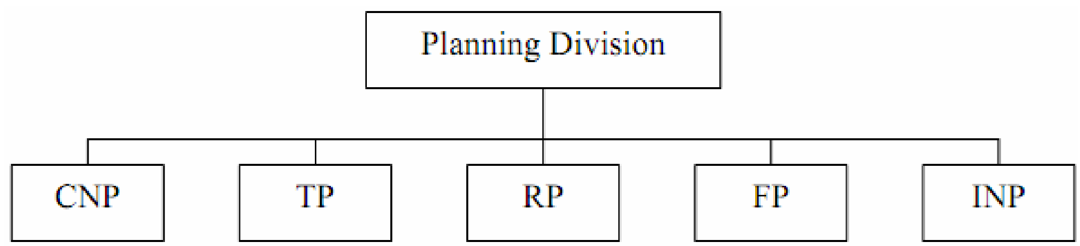


Figure 3.3: Sub-groups under planning division

CNP (Core Network Planning): Designs the core network. Their primary task is to plan out the core switches or MSCs and determine the amount of traffic and their routes through the core network.

TP (Transmission Network Planning): It is the task of TP to plan the frequency allocation and traffic parameters for the transmission links only. This does not include the links between MS to BTS. At industrial level, transmission is a term only used to indicate links among the network nodes, such as: BTS to BTS, BTS to BSC or BSC to MSC links. These links use frequency ranges which are far apart from the user frequency. Usually, these links operate at GHz ranges while user links are at MHz level.

RP (Radio Planning): Radio planning plans the frequency allocation for the user links, often termed in industry as GSM frequency. This interface between the MS and BTS is termed Access Network. Therefore, the air interface is sub-divided as: Transmission

Network and Access Network. It is the sole responsibility of RP to assure the proper reuse of the frequency and reduce co-channel interference.

TP and RP are constantly fed by operation and maintenance group with sufficient data which are to be used with the support of computer aided systems to properly regulate the use of frequency in different links.

FP (Fiber Optic Planning): FP plans the fiber optic backbone that the network uses for carrying data across high capacity links.

INP (Intelligent Network Planning): IN plans for VAS (Value Added Services) and billing schemes for all the subscribers. IN's work is closely related to the management and implementation of database which are required for these services.

3.1.2 GSM Network Implementation (Roll Out)

As an activity is planned and financially cleared, Implementation division, which is more popularly referred as 'Roll Out' division in mobile companies, takes up the responsibility to meet every issue related to the implementation of the task. These issues include land acquisition, civil works, installing network components and regular optimization of network nodes. There are different groups that implement different nodes such as: CNR (Core Network Rollout), BTSR (BTS Rollout) etc. NIC, a sub-group of the O & M group, works with Rollout during deployment. Rollout often takes services from outside companies, termed outsource or third party, to support their work. In case of Teletalk the third parties are NSN (Nokia Siemens Networks), Huawei, Ericsson and ZTE.

3.1.3 GSM Network Operation and Maintenance

The GSM O & M group is generally structured in the following way:

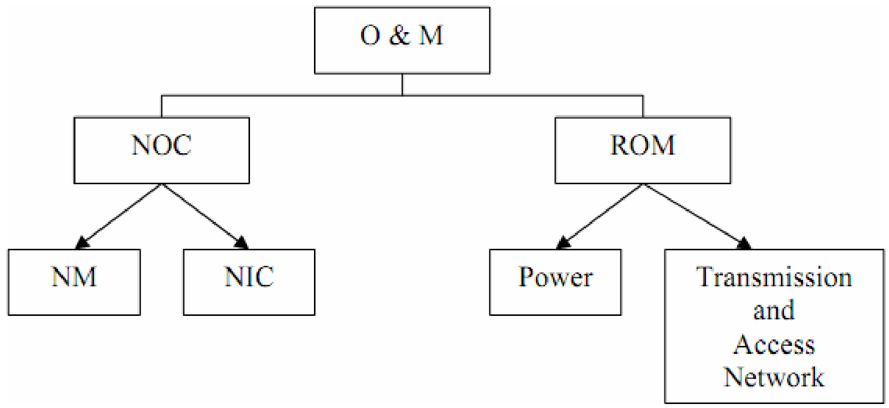


Figure 3.4: Structure of the O & M division

The O & M division is mainly subdivided into NOC (Network Operation Center) and ROM (Regional Operation and Maintenance). The details are as follows:

NOC: Network Operation Center (NOC) constantly monitors the network; issues fault alarms whenever occurred and remotely manages the network. It has full read-write authority and it has remote access to all the manageable components. It can also remotely configure the network elements. NM (Network Monitoring) does the job of issuing alarm while NIC (Network Interface Configuration) remotely configures the devices (also known as soft switching).

ROM: Regional Operation and Maintenance (ROM) escalades the fault alarms or Trouble Tickets (TT) issued by the NOC and carries out all sort of maintenance work for the network. ROM has two separate sub-divisions: Power and Transmission and Access Network. The Power group performs O & M activities related to power issues while the Transmission and Access Network does the telecommunication related O & M.

As mentioned, the placement of the internship was at this very Transmission and Access Network under ROM. Therefore, the types of its activities are mentioned below:

- **Preventive maintenance (PM):** PM comprises of status and parameters checking at hardware, software and other technical levels. Its objective is to regularly monitor network components and prevent possible fault occurrence.

- **Planned Work (PW):** Planned works are pre-defined tasks which include relocation, standardization and shifting of network components.

- **TT Escalation and Customer Complaints:** This involves responding to the TTs sent by NOC and rectifying any faults within the zone. In addition, customer complaints regarding poor performance of the network are also physically attended and resolved.

- **BTS Outage Handling:** One of the most important jobs is to respond to BTS outages in which event, a site might be off air or down causing an entire area go out of coverage.

3.1.4 Network Management Domains

Lastly in this section, network domains will be discussed for a broad understanding of the entire management.

The domain of NIC extends towards both Implementation and O & M. Secondly; the domain of NOC extends to Planning and O &M. The explanation for these domain extensions are provided below:

NIC Domain: The NIC domain extends to both Rollout and O & M because:

- Installation requires logical configuration of the components.
- While Rollout is in action, the physical installation must be complemented by the logical activation of ports and interfaces. NIC performs that task.
- During O & M activities, ports, interfaces and components are changed. The activation of new components is done by NIC, known as soft switching.

NOC Domain: NOC domain needs to extend to all the groups because:

- It feeds the planning division with essential data for change and formation of plan.
- It feeds O & M with TTs and other monitoring data to inform faults and network status.

3.2 Contemporary GSM Network Infrastructure

The network infrastructure in contemporary GSM describes how the network conforms. Hence, it provides information about:

- The parts that the O & M should take care of
- The point of fault origination in the network

The network infrastructure will be looked at from the following perspectives:

- Contemporary Services in GSM network
- Network Coverage

- Network Nodes and Components

- Network Links

3.2.1 Contemporary Services in GSM network

As indicated in chapter 2, GSM has now evolved to GPRS and EDGE technologies. GPRS operates at 115 Kbps and EDGE at 384 Kbps. These higher rates of data services have brought about significant changes in network infrastructure.

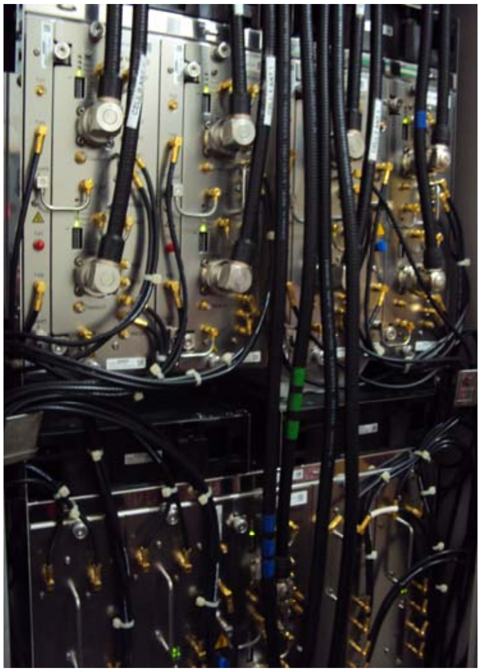


Figure 3.5: Flexi CU EDGE- a doubled capacity transceiver that supports EDGE by Teletalk

The transceiver capacity has been doubled in all BTSs. Microwave antennas capable of operating at GHz level have been introduced. Most of all, fiber optic backbone has been installed around the country with high capacity MUXs as well.

(a) (b)

Figure 3.6: (a) Microwave antennas and A high capacity MUX by Siemens

This MUX support the higher data rate and the bulk of data always potentially increases the possibility of fault occurrence.

3.2.2 Network Coverage

As a contemporary GSM service provider, several aspects can be drawn regarding the network coverage in GSM from the way this company has managed. Based on the work experience, the following sections are given.

3.2.2.1 Cellular Coverage

Mostly, cell sectoring using directional antennas is a common way of cellular coverage and frequency reuse in modern operational GSM networks. Generally, every cell is divided into three sectors named A, B and C.

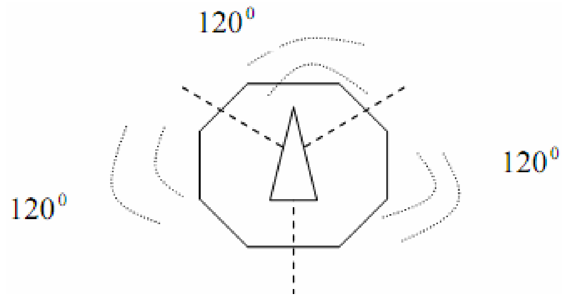


Figure 3.7: Cellular coverage by cell sectoring

It is not always as seen in the figure above. The BTS is not always at the center of the cell. It depends on the radio planning and issues related to interference. Furthermore, GSM operates at 900 MHz and 1800 MHz bands. In a BTS where there are both GSM-900 (NSN's brand name for BTS) and GSM-1800, usually GSM-900 does the part of call set up and then further traffic is handled by GSM-1800. However, GSM-900 is more deployed in less subscribed areas whereas GSM-1800 is in heavily subscribed ones.

Every operator gets to use a certain amount of bandwidth of the whole GSM frequency spectrum. In Bangladesh, BTRC sells and regulates these bandwidths, similar to FCC in North America and ETSI in Europe. For example, from the uplink bandwidth of 890 -915 MHz, and it is not always 124 channels that an operator can use.

3.2.2.2 Premises Coverage

High rise buildings and premises located in congested commercial areas are mostly served by a dedicated IBS (Indoor Base Station), which is a miniature version of BTS, it is also known as nano BTS.

A multistoried building with many floors and buildings in closely spaced to commercial areas are more vulnerable coverage obstacles. In high rise buildings, signal strength becomes weak at lower floors due to signal absorption by walls and floors. On the other hand, in case of commercial zones, frequent obstacles by holdings and locomotives make the worst case scenario for multipath effect.

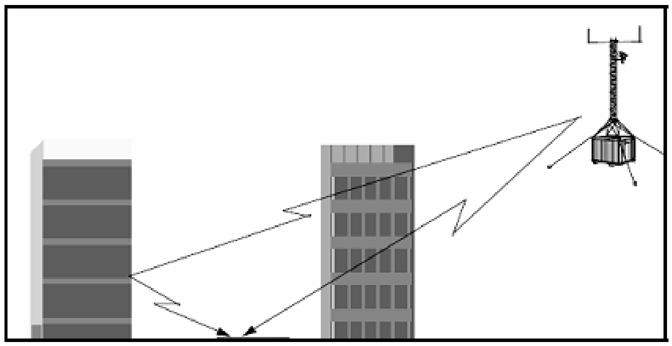


Figure 3.8: Multipath effect in commercial areas

These reasons call for the use of dedicated IBS. Usually, IBS operate at 1800 MHz band. IBS is placed at the top of the building which acts as the signal source to the premises. Later on, microwave coupler and dividers are used to guide the signal down the building. Each floor is covered by a number of small omni directional aperture antennas.

(a) (b) (c)

Figure 3.9: (a) Indoor Base Station (b) Nano BTS for floor coverage in Teletalk office(c) Microwave divider

3.2.2.3 High Demand Area Coverage

Heavily subscribed areas, are mostly served by GSM-1800. While GSM-900 performs the task of call set up, the user traffic is channeled into the 1800 MHz band of GSM. In some cases, an additional GSM-1800 is cascaded with the remaining pair. This is termed as the third cabinet.

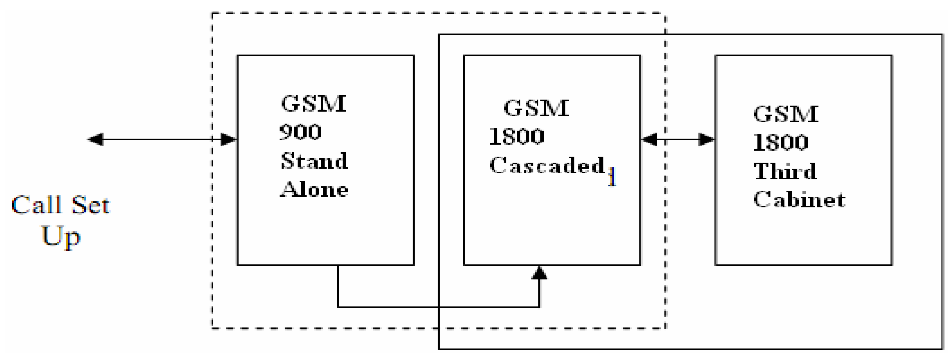


Figure 3.10: BTS set up for high demand area coverage

The prime cause is that GSM-1800 operates at the higher range of the GSM spectrum. Higher frequency offers high capacity, but due to propagation properties such as absorption, scattering etc. and also lower amplitude frequency components, their coverage area is always limited. This enables to reuse the frequency more often. Thus, a high demand area can be served using BTSs operating at 1800 MHz. It is to be noted that, although GPS is usually not used for synchronization until SDH levels, in high capacity coverage sites, GSM-900 is fed by GPS and GSM-1800 also uses its GPS. Thus, GSM-900 is called stand-alone while GSM-1800 is cascaded.

3.2.2.4 Road Intersections and Rural Coverage

Road intersections need dedicated BTS to serve their vicinity. This is caused of vehicles imposing strong impact of Doppler Effect on the signal. Therefore, these coverage sites are called Micro cells. These cells are relatively small and around the intersections.

In contrast, rural areas are less subscribed comparatively. Since the density of the users is low, large cell coverage is required. Hence, BTSs operating at 900 MHz are deployed. Thus, large rural areas with limited users can be served.

3.2.3 Network Nodes and Components

The basic nodes in GSM in principle are BTS, BSC and MSC. At the operational level, however, contemporary GSM network introduces some intermediate nodes for hierarchical distribution of the traffic.

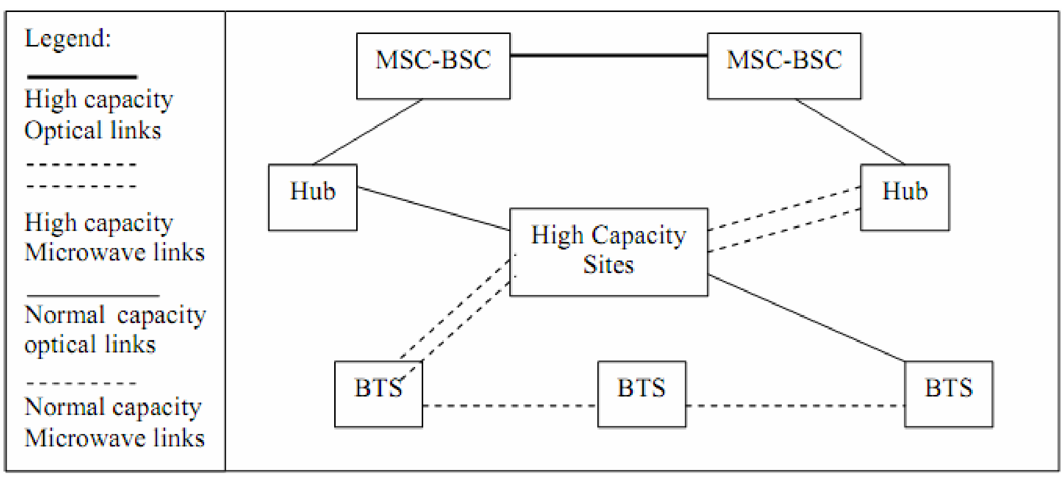


Figure 3.11: Network nodes in contemporary GSM

The above figure shows these variations in nodes. First of all, it has been seen from the work experience that the MSC and BSC are co-located as shown in figure. Secondly, High Capacity Sites and Hub are the two additional nodes. In practicality, MSC and BSC are not directly linked with BTSs. The traffic is aggregated at levels and finally reaches MSC or core switches. The distributive nature is as such:

- High capacity sites aggregate traffic from a number of BTSs using both high capacity microwave links and optical links and forwards them to the hubs.

- Hubs connect to high capacity sites by high capacity microwave links and optical links and forward the traffic to MSC-BSC nodes.

- MSC-BSC nodes are interconnected by high capacity optical links at STM-4 or STM-16 levels.

The inter BTS connectivity are mostly microwave links. These links are termed PDH (Plesiochronous Digital Hierarchy)-meaning that they are locally synchronized, not by master clocks like GPS. The optical links are however, always SDH (Synchronous Digital Hierarchy) which are master clocked by GPS.

The following sections describe few key network components that are used in contemporary GSM at scenarios depicted above:

3.2.3.1 GSM-900/1800 (BTS)

GSM-900/GSM-1800 is the NSN’s product name for the GSM Base Transceiver Station. GSM includes all radio and transmission interface equipments needed on the site to provide radio transmission for one or several cell. The GSM cabinet houses up to 12 TRUs (Transceiver Unit) or CU, plus common equipment needed for serving the cell configuration [10]. The double transceiver, DTRU or Flexi CU, consists of two transceivers in one unit of the same size as classic single TRU [10]. Cable entries for antenna feeders, transmission cables and mains power are concentrated on the top of the cabinet as shown in figure 3.12.

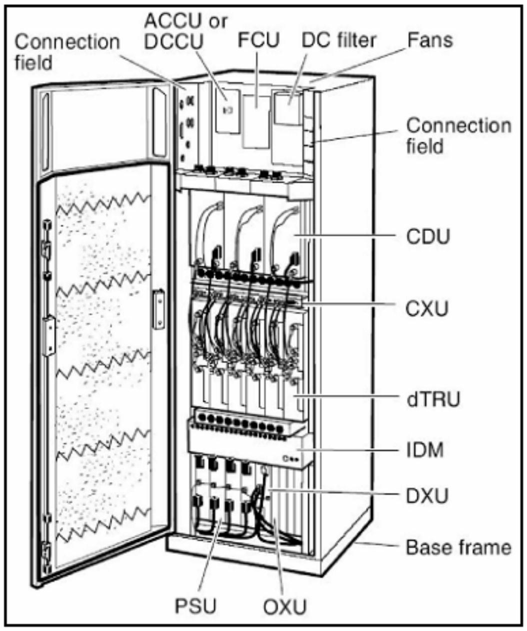


Figure 3.12: GSM-900/GSM-1800 Duel band BTS cabinet by NSN.

BTS cabinet of NSN consists of the following elements:

DXU (Distribution Switch Unit): DXU can be compared to the CPU in a computer. DXU is the main logical controller of an RBS. It takes the signal from TRU, performs the processing needed. If the signal is bound for cells within coverage, it is forwarded to the TRU. Otherwise, the signal is kept in digital E1 carrier form and passed to IDU, which is a MUX/DEMUX device by a PCM cable. DXU also generates all types of fault alarms.

DTRU (Double Transceiver Unit): DTRU performs all kinds of tasks related to transmission and reception of the signal. It is fed by analog signals from CDU. It converts them to digital so that they can be processed by the DXU. It also converts the digital signals from DXU to analog before forwarding it to CDU.

CDU (Combination and Distribution Unit): CDU is completely a passive unit. It is directly fed by RF feeder cables which are connected to the bipolar antennas used for cell coverage. It is a collection of well designed passive filters and other necessary circuitry needed to transmit and receive signals in analog form.

CXU (Configuration Switch Unit): CXU is an interface between CDU and DTRU. It is a newly introduced module that enables remote configuration or soft switching between CDU and DTRU.

DCCU and PSU: DCCU (DC Connection Unit) and PSU (Power Supply Unit) work together for the power supply to different units in GSM cabinet. It runs on 48V DC supply. The 220V three phase supply is converted to DC supply by rectifiers at site. Then the DC voltage is given to DCCU which feeds PSU. PSU regulates and supplies DC power to BTS cabinet units as per required.

3.2.3.2 The IDU/ODU Units

The IDU/ODU units are used to feed transmission links between BTS to BTS or BTS to High Capacity Sites. ODUs (Outdoor Units) are high capacity microwave antennas operating from 7 GHz to 38 GHz ranges. They are capable of transmitting 2 E1 to 16 E1 links simultaneously via microwave links. IDUs are a MUX/DEMUX device that multiplexes the outgoing signals and demultiplexes the incoming signals. The multiplexed signals are mapped onto analog carrier using BPSK and given to ODU by coaxial cables. The ODU then transmits them.

The block diagram below gives a clear idea about this process:

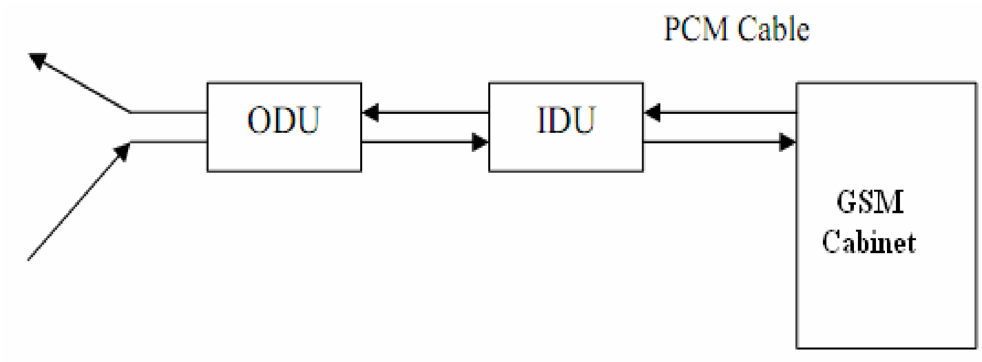
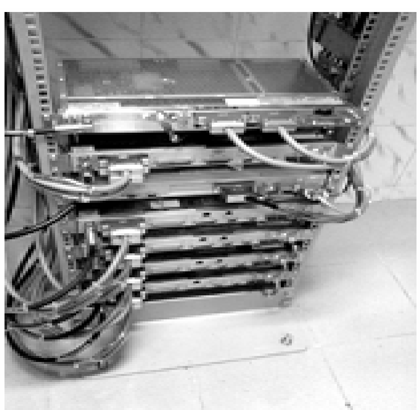


Figure 3.13: The IDU/ODU set up

- The signals bound for outside cells are passed from GSM cabinet to IDU using PCM cable. IDU multiplexes them and modulates using BPSK. The coaxial cable feeds the ODU which transmits finally into air interface.

- The signals from outside cells are received by ODU and passed to IDU. IDU demultiplexes them and passes to GSM cabinet as E1 frames using the PCM cable.



(a)

(b)

Figure 3.14: (a) Stack of IDUs (b) ODU-Microwave antenna pair

3.2.3.3 MSC-BSC Components

Co-located MSC and BSC comprise mainly of: High Capacity MUX and Switching Towers (MSC, BSC, STP).A typical floor layout and configuration of the equipments at an MSC site is depicted below:

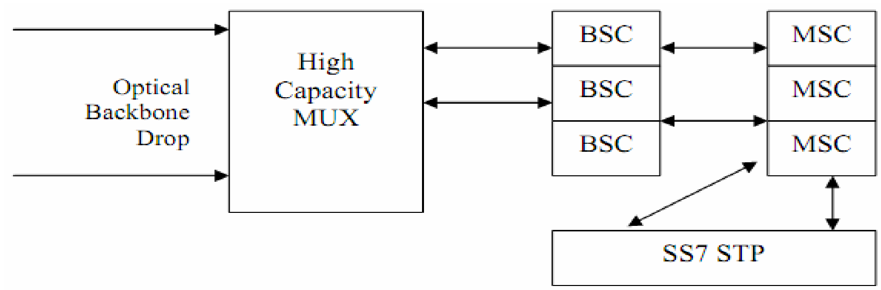


Figure 3.15: A typical core switch layout and configuration

The high capacity optical links are first dropped at the high capacity MUX. During the internship, it was observed that the MUX devices operate at electrical domain. Outputs are taken from the ports of the MUX which are pigtailed with optical to electrical converters. The BSC, MSC and SS7 STP nodes are all switching cabinets in form of towers. As all of these are co-located, the proper interconnections among these nodes are achieved by using PCM cable rigorously. The bulk amount of PCM cables are kept below the surface on which these nodes are installed. The below floor PCM cables are drawn out at each cabinet and fed respectively.

3.2.4 Network Links

Different types of links such as PCM, PDH, SDH, T1, E1 etc. have so far been cited in different sections. This section describes the nature and application of these links.

3.2.4.1 PCM Links

Pulse Code Modulation (PCM) is the most prevalent encoding technique used for digital TDM signals. With a TDM-PCM system, two or more voice channels are sampled, converted to PCM codes and them time-division multiplexed onto a single metallic cable called PCM cable. In both North American and European Standards, PCM encoding with 8 bits is used. This method leads to less quantization error and a globally accepted system [11].

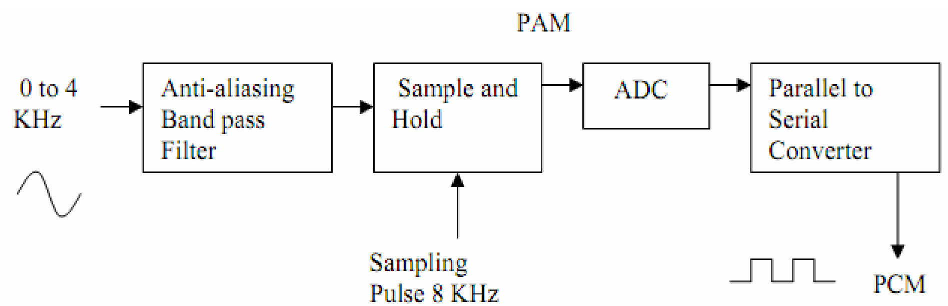


Figure 3.16: PCM encoding process [11]

As seen, PCM are narrow digital pulses which have high frequency component. Therefore, PCM cables are always a bunch of separate coaxial cables. Coaxial cables support PCM data since the signal mostly flows along its metal sheath at the outer surface. High frequencies tend to flow along the surface of a conductor.

3.2.4.2 E1 Digital Carrier System

The 8 bit PCM frames are the fundamental block for digital carrier system E1. E1 is the European version of the North American T1 standard. As most of the subcontinent, Teletalk also uses E1 frame format.

Each E1 frame has time duration of 125 micro second [11]. It consists of 30 eight bit PCM frames and 2 eight bit control frames. Therefore, the data rate of an E1channel is calculated as such:

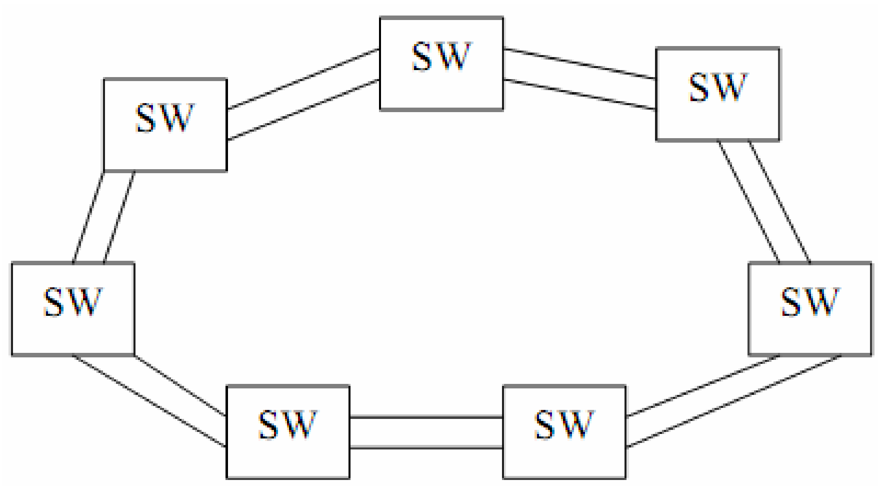
$$\frac{8000 sample}{\sec ond} \times \frac{8 bits}{sample} \times 32 = 2048000 \frac{bits}{\sec ond} = 2.048 Mbps$$

3.2.4.3 PDH Links

These E1 channel bits can either be transmitted by modulating a microwave carrier or using optical links. PDH (Plesiochronous Digital Hierarchy) is a term used to refer to microwave transmission links. They are not synchronized by one master clock; rather locally generated clock pulses are used. Hence, the term PDH is used rather SDH.

3.2.4.4 SDH Links

Synchronous Digital Hierarchy (SDH) is the standard for optical links which are used for high data rates. The minimum industry level optical carriers, STM -1, can accommodate 63 E1 channels which gives a data rate of 129.024 Mbps. The 7 core switches of Teletalk in regional Dhaka are connected by STM-64 level dualring fiber optic backbone.



3.17: Figure Core switch (MSC) interconnection using dual ring fiber optic backbone

CHAPTER 4

FAULT MANAGEMENT IN GSM NETWORK

This chapter extensively discusses different fault types and their management in GSM network. The elaborations that were made in the previous chapter regarding contemporary GSM network's operation and infrastructure would relate to the types of faults mentioned here and their handling process.

4.1 Fault Categories in GSM

The entire range of faults can be categorized based on its relevance to the contemporary infrastructure of GSM. The following figure illustrates the concept:

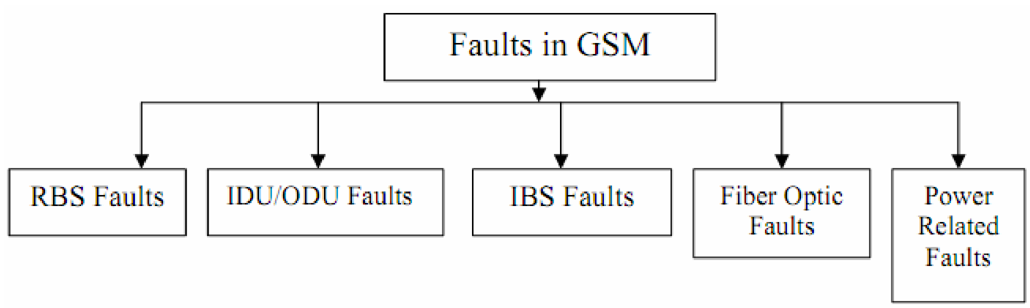


Figure 4.1: Categorization of faults in GSM network

4.1.1 GSM cabinet Faults

GSM cabinet is the main transceiver unit in a Base Transceiver Station (BTS). It carries out the key stages of transmission and reception of the signal. Hence, it sustains steep workloads and susceptible to many faults. These faults are reported by NOC to O & M in form of TT or fault alarms. Some TTs have predefined remedies, whereas some can be caused due to reasons which are subject to on site investigation.

Some of the faults that are can be occurred usually are listed below in tabulated form followed by short description:

Table 4.1 List BTS Faults, Probable Reasons and Relevant Actions

Trouble Ticket	**Possible Reasons**	**Action**
TX Saturation	High temperature	Change TRU
VSWR Limit Exceeded	Faulty cable/connector	Inspect cable and connectors
TRU in Local Mode	BTS to BSC link lost	Reset DXU
Internal power capacity reduced	Faulty PSU	Reload IDB/ Change PSU
Generator Running	Mains failed for more than 5 hours	Turn on battery back up

- **TX Saturation:** This alarm is triggered only when a TRU exceeds its transmission capacity. In most cases, high temperature leads to power dissipation by TRU, resulting into early saturation of capacity.

- **VSWR Limit Exceeded:** Voltage Standing Wave Ratio (VSWR) is a crucial parameter. It is the ratio of the reflected signal to the incident signal on a given TX/RX link. If the reflected signal is more than the incident signal, fewer signals passes causing call drops and TRU blockage. A damaged cable or faulty connectors cause this problem.

- **TRU in Local Mode:** The TRU can no longer be accessed by remote access groups, most importantly, BSC. This state is called the local mode of a TRU. Immediate reset of the DXU is absolutely necessary in such an event.

- **Internal Power Capacity Reduced:** The power supply from PSU to DXU has reduced in this case. Initially, it can be said that the PSU is faulty. On the other hand, a mains power failure can result into this problem. Also, configuration faults can cause it. Therefore, the IDB file should be checked first.

- **Generator Running:** If the mains fail and the generator runs for more than five hours, the generator fuel burns out and triggers the alarm. At this point, power supply can be drawn from the emergency battery backup, turning off the generator.

4.1.1.1 BTS Fault Management

It has been observed from the nature of faults in practical field experience that the Trouble Tickets issued are not always the root cause of a given problem. In most cases, a fault originates at one point and its effects the component's functionality at some other point. For example, the RF diversity failure or VSWR exceed faults may be caused by faults at any point of the circuitry. To pin point a VSWR alarm, the entire path from the antenna to BTS connector needs to be checked.

4.1.2 IDU-ODU Faults

The IDU-ODU segment links up transmissions from outside cells with cells under the local BTS coverage. Therefore, they have only specific tasks to do, such as multiplexing, modulating etc. Their internal configurations support these tasks and the faults occurring here are related to their functionality. In the table below, some major IDU-ODU faults are placed:

Table 4.2: Major IDU-ODU Faults

	Fault	Reason	Action
IDU Faults			
	Cable Problem	IDU-ODU connecting cable is faulty	Repair cable
	Tributary Port Problem	High temperature damaged soldering	Redo soldering
	Synchronization Problem	Hardware malfunctioning	Change IDU
ODU Faults	ODU Card Fail	ODU microcontroller damage	Change ODU
	ODU Disconnect	IDU-ODU cable cut	Replace cable
	Demodulation Alarm	Local oscillator malfunctioning	Check internal circuitry

4.1.3 IBS Faults

IBSs (Indoor Base Stations) are known as nano BTSs that serve one particular premises. The DXU of an IBS is called IXU and a TRU is called an RRU. The signals from IBS at the rooftop are guided down to different floors at the premises using microwave dividers and couplers.

Nano BTS's usual fault list is given below in tabulated form:

Table 4.3: Indoor Base Station Fault List

Fault	Reason	Action
RRU in Local Mode	Link between BSC and IBS is lost	Reset IXU
RF Loop Test Fault	RRU's internal fault	Change RRU
TX Saturation	High temperature	Change RRU
Mains Fail	Main power supply outage	Generator is switched automatically

Specific IBS coverage faults are discussed in the followings:

- Loose connectors cause poor IBS coverage in most of the cases. These connectors connect the omni directional antennas to the waveguide at each floor.

- Improper coupler and divider placement can cause long term poor coverage for IBS. This results mostly from faulty planning. However, often the couplers get old and rusty. In both cases, couplers and dividers need to be changed.

- Some locations require a below ceiling set up for the antennas. Since, organizations often prefer to hide the antennas for attractive interior; the coverage of the IBS gets hampered. These above ceiling antennas are later on made below ceiling.

4.1.4 Fiber Optic Faults

Two major fiber optic faults are severely recurrent. These two are: Fiber cut and poor receive level. The two of them are discussed below:

- **Fiber Cut:** Fiber cuts mostly result from miscreant acts. Most of the cuts occur during the night. The effect of a fiber cut is very damaging. Fibers carry bulk rates of data. Therefore, they need to be immediately repaired. Here, the only option is to make splicing joint. The splicing loss is further added to signal attenuation level as a result.

- **Poor Receive Level:** Poor receive level is frequently reported at receiving ends of fiber links. This means that the receiving signal strength is not adequate. Thus, the attenuation factors in fiber optic communication are to be considered. The attenuation factors in practical situations are: Macro bends, micro bend and splicing loss. Macro bends are very much expected in an operational environment since the structure used to run the fiber cable might often be disturbed. On the other hand, micro bend is very seldom with a greater attenuation factor than macro bend.

Figure 4.2: Micro bend causing signal to come out of the fiber confinement

Splicing loss, as mentioned, is another signal loss factor. Improper and frequent splicing often causes significant signal loss resulting into poor receive level.

4.1.5 Power Related Faults

Power related faults can be categorized into two parts:

- External Power Problems
- Internal power problems

External Power Problems: Indicates problems in components which are not part of the main power module. Examples of these problems are tabulated below:

Table 4.4: External Power Problems

External Power Problems	Cause
Frequent Mails Fail	Recurrent failure of main power supply
Generator Fault –ATS	ATS controller unit of generator is faulty
External Power Problems	**Cause**
Generator/Rectifier Controller Hang	Microcontroller/IC problem
Generator Fault- Fuel System	Fuel is low or the fuel sensor is bad
Generator Fault- Low Battery Back UP	Triggers when the battery backup is insufficient
MDB (Main Distribution Board) breaker trip	A short circuit caused MDB to trip

Internal Power Problems: Indicates problems that occur within the main module of a power device. Examples are given below:

Table 4.5: Internal Power Problems

Internal Power Problems	Cause
Rectifier Fault-CB Trip	Controller Board (CB) has tripped due to a short circuit
Rectifier Fault- Controller Hang	Rectifier IC is faulty
Rectifier Fault- Others	Module burn, Magnetic contact burn

4.2 Complete Overview of GSM Fault Management

Several groups of O & M work together while attending a faulty site. In fact, good co-ordination among these groups is the most crucial factor during the management of faults of any kind. The block diagram below demonstrates this process, followed by its description:

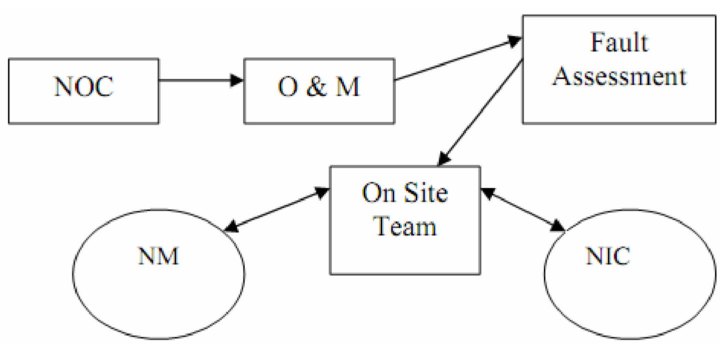


Figure 4.3: Overview of GSM fault management

- At first, the Trouble Ticket (TT) or fault alarm reaches O & M from NOC.

- The O & M division assesses this fault in terms of category and geographical area.

- Once the fault is assessed, it is determined whether its management can be done remotely or it requires on site presence of a working team.

- If physical attendance is needed, the appropriate team assigned for that area is sent to handle the fault.

- The working team reaches site and start the fault escalation process.

- NM and NIC are frequently contacted during the team's activity. The contribution of NM is to provide information about the link and its status. If any ports or interfaces are changed, the physical configuration is done by the onsite team. However, the newly assigned port must be logically activated as well. At this point, NIC is contacted.

- Upon soft switching by NIC is done, the entire fault handling process is complete. Therefore, the overall process requires precise co-ordination among the onsite working personnel, NM and NIC.

Lastly, it is to be noted that NM and NIC would exchange information with planning division at times when needed.

CHAPTER 5

PERFORMANCE ISSUES IN GSM NETWORK

The operation and maintenance aspects in GSM network, especially the fault management process directly correspond to the performance issues in GSM network. Before the conclusion of the report, this chapter therefore dedicatedly analyzes their effects on the different services that are provided by the contemporary GSM network.

5.1 Voice Call Drops

The most noticeable performance index in any mobile service network is the amount of calls which are completed and the number of calls that are dropped or not completed. There are a number of factors that lead to call drops. The diagram below show their relationships followed by relevant discussions:

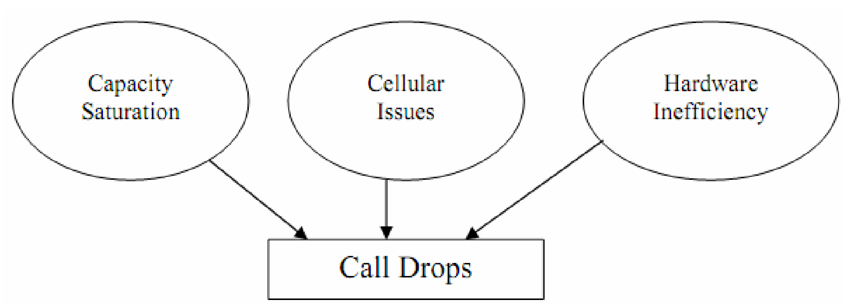


Figure 5.1: Factors in GSM that lead to call drops

5.1.1 Capacity Saturation

Capacity saturation is the primary cause of call rejection or call block. The transmission units have certain capacity limits due to practical reasons. A transmission unit cannot be designed to serve all the calls made by all subscribers. This is neither economic nor practically feasible. Voice calls also differ from data transmission where queuing theories can be applied. In data transmission, call delay concept enables the queuing of incoming data. Therefore, a certain amount of data can wait rather than being rejected while the system is busy.

5.1.2 Cellular Issues

Two main cellular phenomena contribute to call drops. First of them is the frequency allocation aspect. From practical field studies, it has been observed that most of the complaints made by the customers regarding call drops revealed that the neighboring cell is too strong and dominating.

5.1.3 Hardware Inefficiency

The most common hardware inefficiencies that cause call drops are:

- VSWR limit exceed
- TRU saturation due to high temperature

VSWR is the ratio of the reflected signal to the incident signal. The threshold used by contemporary GSM for this ratio is 1.8.

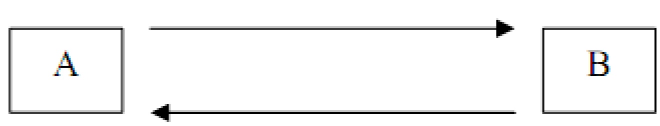


Figure 5.2: Demonstration of the VSWR concept

Let A be the microwave source and B, the receiver. By principle, at any receiving node, a standing wave is formed by the incident and reflected wave as electromagnetic wave needs both paths for its complete propagation. While these waves carry information, this ratio becomes important. If more waves bounce off the reception node, less information passes. Transmission accessories such as cables, connector etc can produce such problems.

5.2 Bit Error Rate (BER)

Similar to all other wireless voice transmission system, GSM also uses Forward Error Correction (FEC) scheme for its channel coding. It was first shown by Shannon that the integrity of the source information can be secured by adding redundant bits, provided that information rate is within the channel capacity .

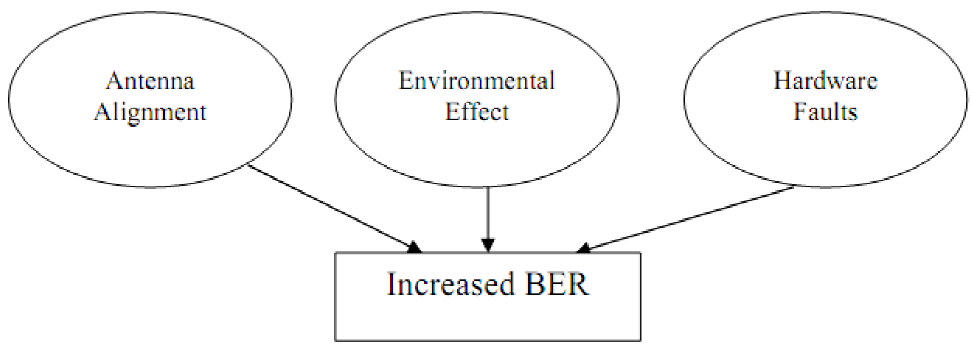


Figure 5.3: BER increasing factors in practical GSM operation

These factors were seen to have their effects on BER during regular site inspection and fault handling situations. As mentioned earlier, the inter-BTS connectivity is mostly microwave links called PDH. In order for a proper transmission between two BTSs, the Line of Sight (LoS) must be maintained between the two microwave antennas. Any alignment fault would increase information loss and inevitably increase BER.

5.3 Poor IBS Coverage

Some of the performance issues regarding IBS or Nano BTS coverage were discussed in the previous chapter. One additional analysis can be noted here.

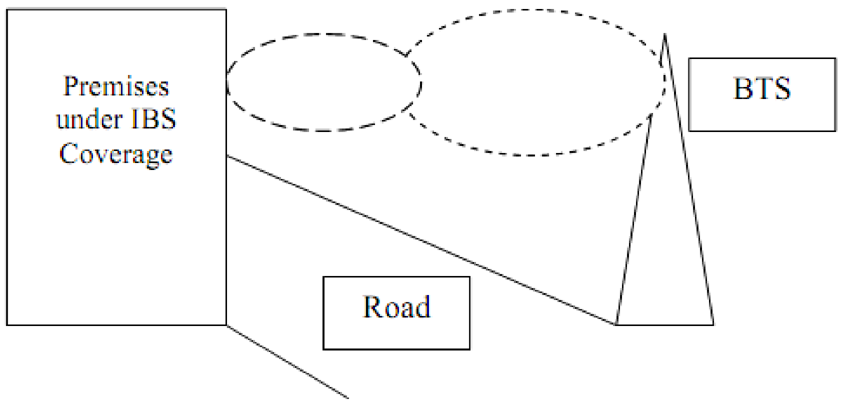


Figure 5.4: Performance complications with IBS coverage

IBSs are placed at the top floor of premises. Its coverage and frequency allocations are for the users residing inside the holding only. However, at the upper floors of a high rise building, one specific type of difficulty arises regarding this coverage.

5.4 Fiber Optic Issues

In contemporary infrastructures, a minimum STM-1 level optical link supports 63 E1 channels (129.024 Mbps), compared to the maximum of 16 E1 channels carried by microwave links (32.768 Mbps). In spite of this advantage, there are some unavoidable disadvantages that accompany fiber optic links. The most crucial ones are:

- Fiber optic links are always longer than the LoS distance required by microwave links. The fiber cables always run along or beside the civil infrastructure that naturally make the link length longer the LoS.

- Optical fibers are mostly made in 3 Km lengths. This results into numerous splicing joints in long links causing more splicing loss. A 22 Km long fiber link would require as under:

  Number of splicing joints = 7 + 2 (additional splicing on both ends of the link)

  = 9 Splicing joints

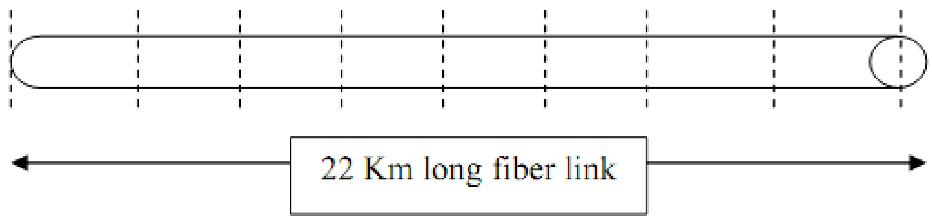


Figure 5.5: Illustration of excessive splicing joints in long fiber optic links

- Poor co-ordination among the Telco groups and development workers often lead to unexpected fiber cuts. Thus, fiber optic communication is degraded which affects the overall network performance.

5.5 Performance Monitoring Flow Chart

The concluding section of this chapter presents an overall flow of events that summarizes O & M activity in contemporary GSM network and relates the different types of tasks performed by O & M to the performance level in GSM.

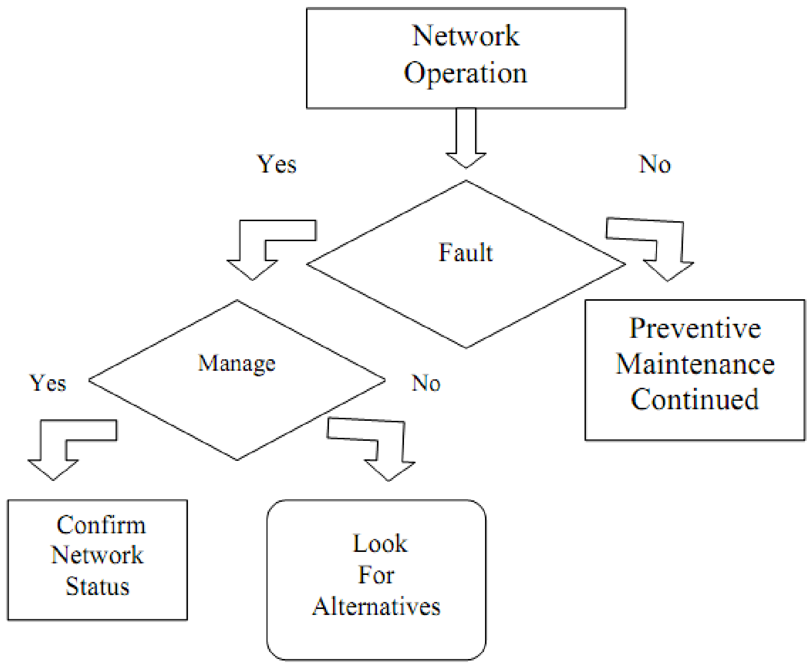


Figure 5.6: Performance monitoring flow chart

The above flow chart suggests in brief that on an event of fault occurrence, it has to be noticed whether the fault may or may not be managed with the resources in hand. If so, then the fault would be managed and network status should be confirmed. If the fault cannot be managed in conventional ways, alternatives must be considered. If no fault is in existence, preventive maintenance must be continued to secure the network from faults.

CHAPTER 6

SITE VISITING

By the connection with Teletalk Bangladesh Limited as an intern I did visit at least four different BTS for the time duration of my internship. I tried to learn about BTS installation and its commissioning. Commissioning was actually a new concept to me so I tried to understand as much as I can. I took so many pictures of the sites and tried to take note as much as I can.

6.1 The BTS Room

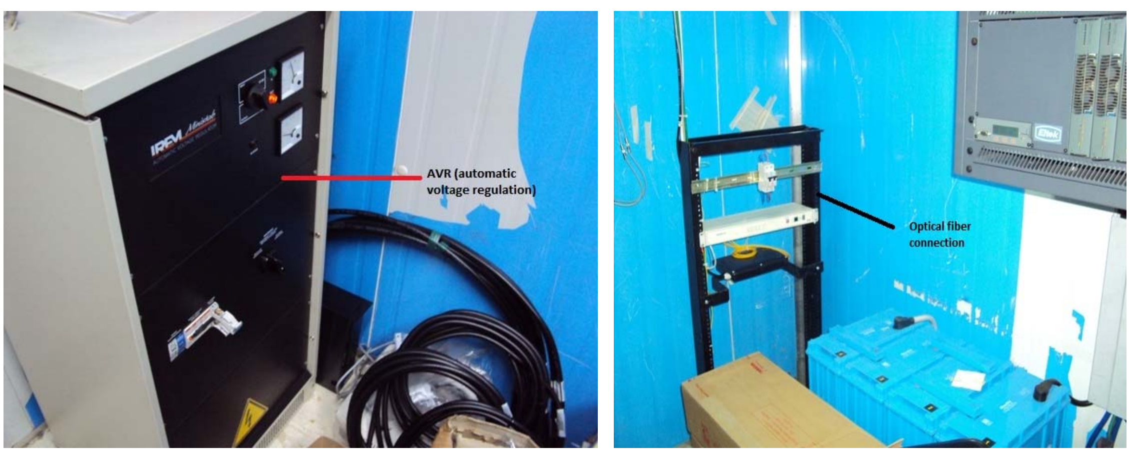
Before I visited any BTS I thought that BTS is nothing but the tower and the antennas hold by the tower. But now I know that the BTS is actually consists with the tower, the antennas, AVR (automatic voltage regulation), Power amplifier, Rectifier, Air conditioner, BTS cabinet, Micro wave antenna and optical fiber link instrument.

The main BTS cabinet is operating with DC voltage so it is require converting the AC voltage into DC. That's why rectifier is needed and for the supporting purpose when national grid's power supply fall then power supply maintained by the IPS (battery). The IPS usually capable at least 72 hours back up.

(a) (b)

Figure 6.1: (a) The inside view of the BTS room (b) Rectifier which rectify the AC voltage into DC.

Sometimes the nation grid’s power is fluctuated, in this case this AVR (Automatic Voltage Regulator) maintain a constant voltage for the operation of the air conditioner. Now a day’s optical fiber connection is mostly used instead of microwave especially in urban area because there are path fading problems and attenuation of the signal is frequently occurred in urban areas because of high rise buildings.



(a) (b)

Figure 6.2: (a) Showing AVR (b) Showing optical fiber connection instrument

6.2 BTS Commissioning

For the BTS installation Teletalk Bangladesh Ltd. contracts with some renowned vendor companies which are mentioned in previous chapter of the report like NSN (Nokia Siemens networks), Huwaei, and Ericsson etc. The contracted vendor company mainly installs the BTS and the O&M doing the commissioning of the BTS.

(a)

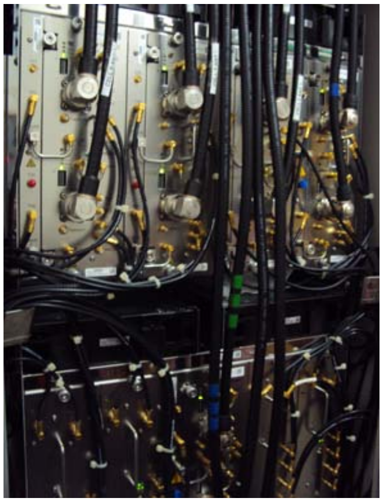

(b)

Figure 6.3: (a) Duel Band BTS cabinet
(b)TX & RX connection and Antenna cables

Before let in the BTS “ON AIR” it has been checked all the connection of the “tx” and “rx” several times. Then the “site master” is an instrument used for checking the calibration, isolation, gain, insertion and the frequency bandwidth of the antennas.


Figure 6.4: Site Master

Then some data are downloaded from the MSC through optical fiber or microwave link. Then the data are put in the software called LTM Evolution for commissioning the BTS. After doing such of things the BTS is now ready for going to "ON AIR".

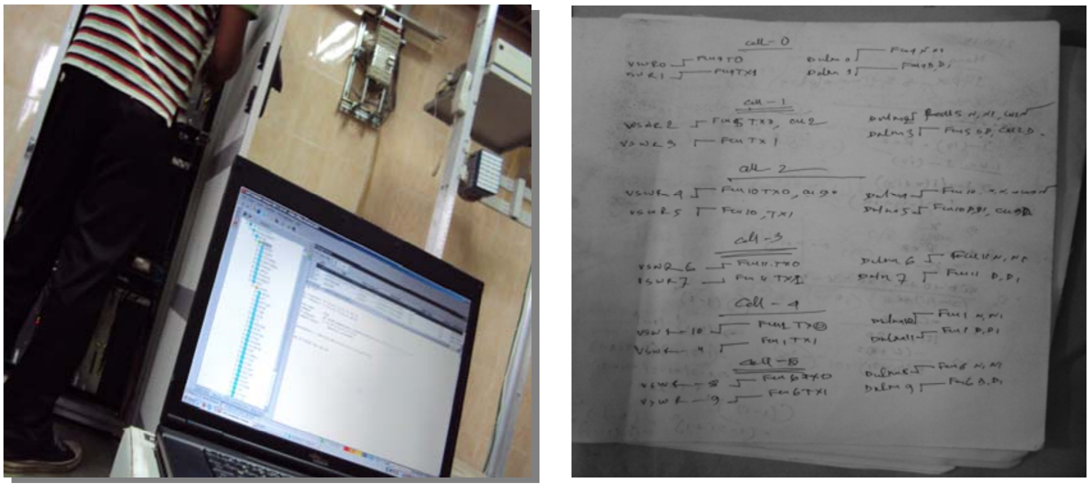


Figure 6.5: (a) Commissioning BTS 1800 by the software name **LMT evolution** (b) Data downloaded from MSC

CHAPTER 7

Transmission Network main Topology of Teletalk

7.1 Transmission Network main Topology of Teletalk

This is the Transmission Network main Topology of Teletalk:

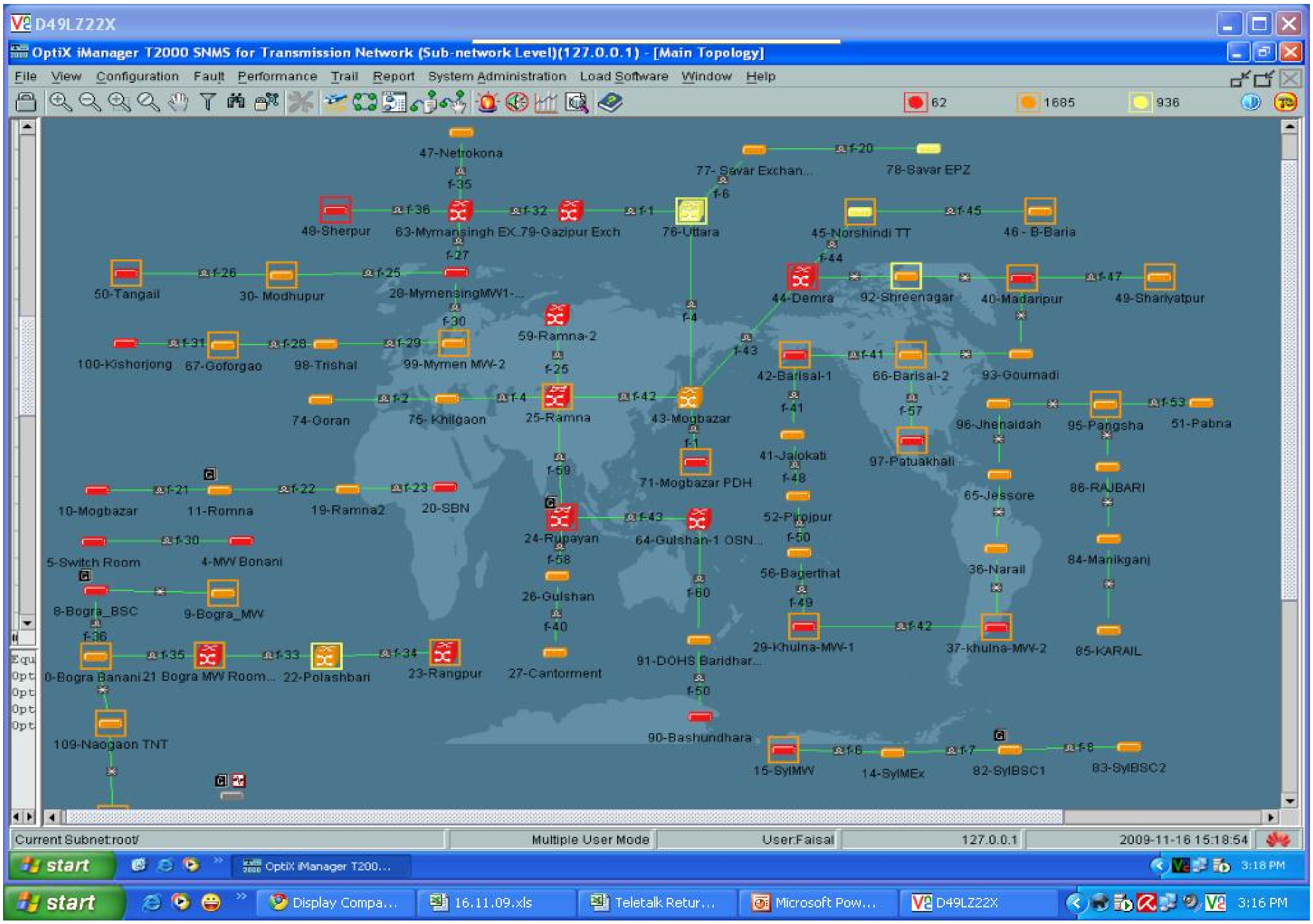


Figure:7.1 Transmission Network main Topology of Teletalk

7.2 ALARMS

There are three types of alarms which are given blew

1. Critical alarm
2. Major alarm
3. Minor alarm

Meanings of the indicators on the cabinet top:

Indicator	Description	Status	
		On	**Off**
Red indicator	Critical alarm indicator	The current equipment has a critical alarm, which is accompanied by an audible alarm.	The current equipment does not have any critical alarm
Yellow indicator	Major alarm indicator	The current equipment has a major alarm, which is not accompanied by an audible alarm.	The current equipment does not have any major alarm
Orange indicator	Minor alarm indicator	The current equipment has a minor alarm, which is not accompanied by an audible alarm.	The current equipment does not have any minor alarm
Green indicator	Power indicator	The power supply for the current equipment is normal (-38.4 ~ -72V).	Power supply of current equipment is interrupted

1. Major alarms

1. TU-AIS:

Reasons:

1. Incorrect cross-connect configuration
2. Fiber broken

2. T - ALOS:

No E1 signal received

Reasons:

Fault on E1 interface board

Fault on the E1 Cable

Fault on switch system

3. TU-LOP:

Reason:

Incorrect service configuration

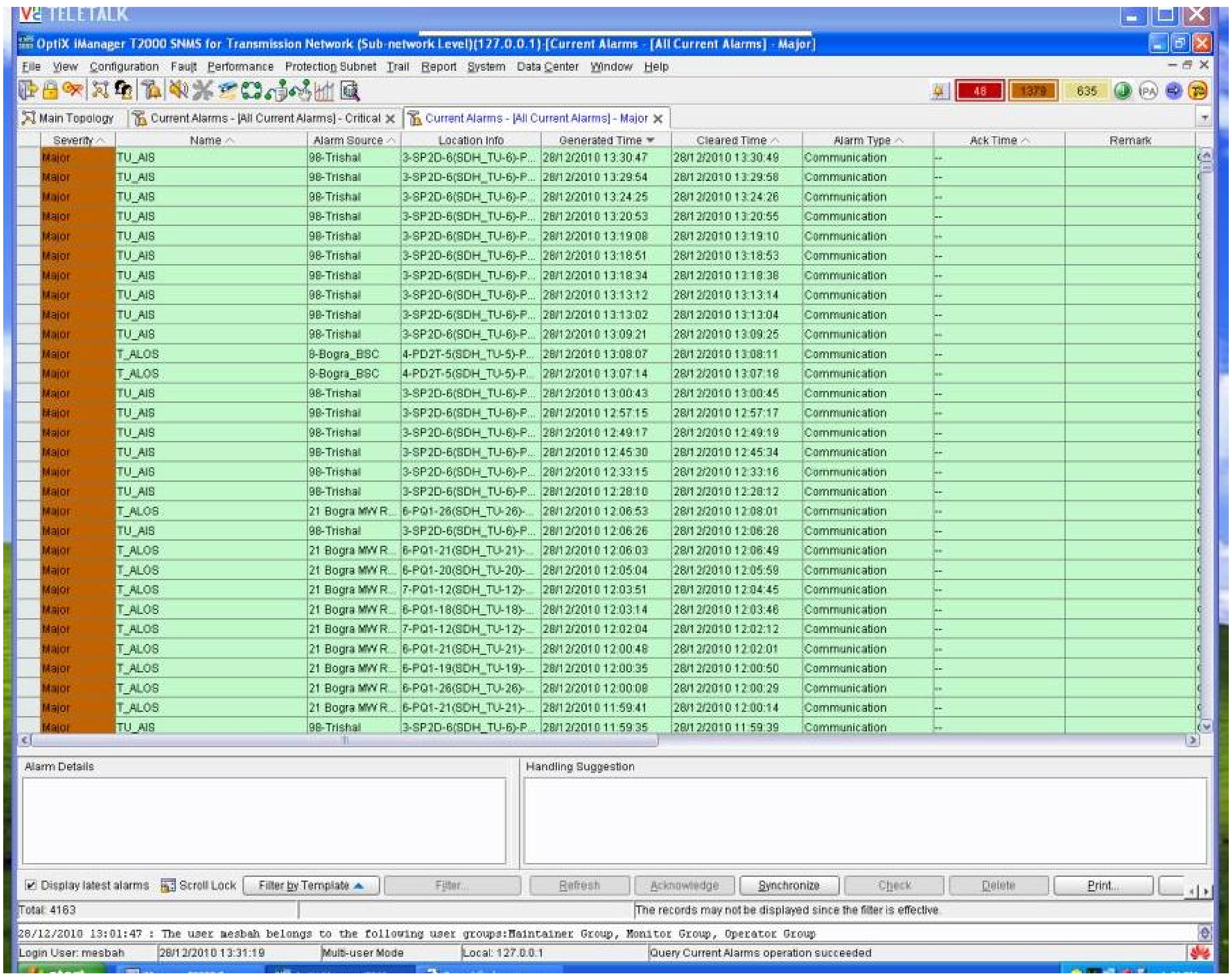


Figure:7.2 Major alarms

2.Minor alarms

1. LP-RDI:

   Remote defect indication

   Reasons:

   Alarms such as TU-AIS and TU-LOP are detected by the Remote terminal

2. **LP-REI:**

   Remote error indication

   Reasons:

   Bit errors are detected by the remote terminal

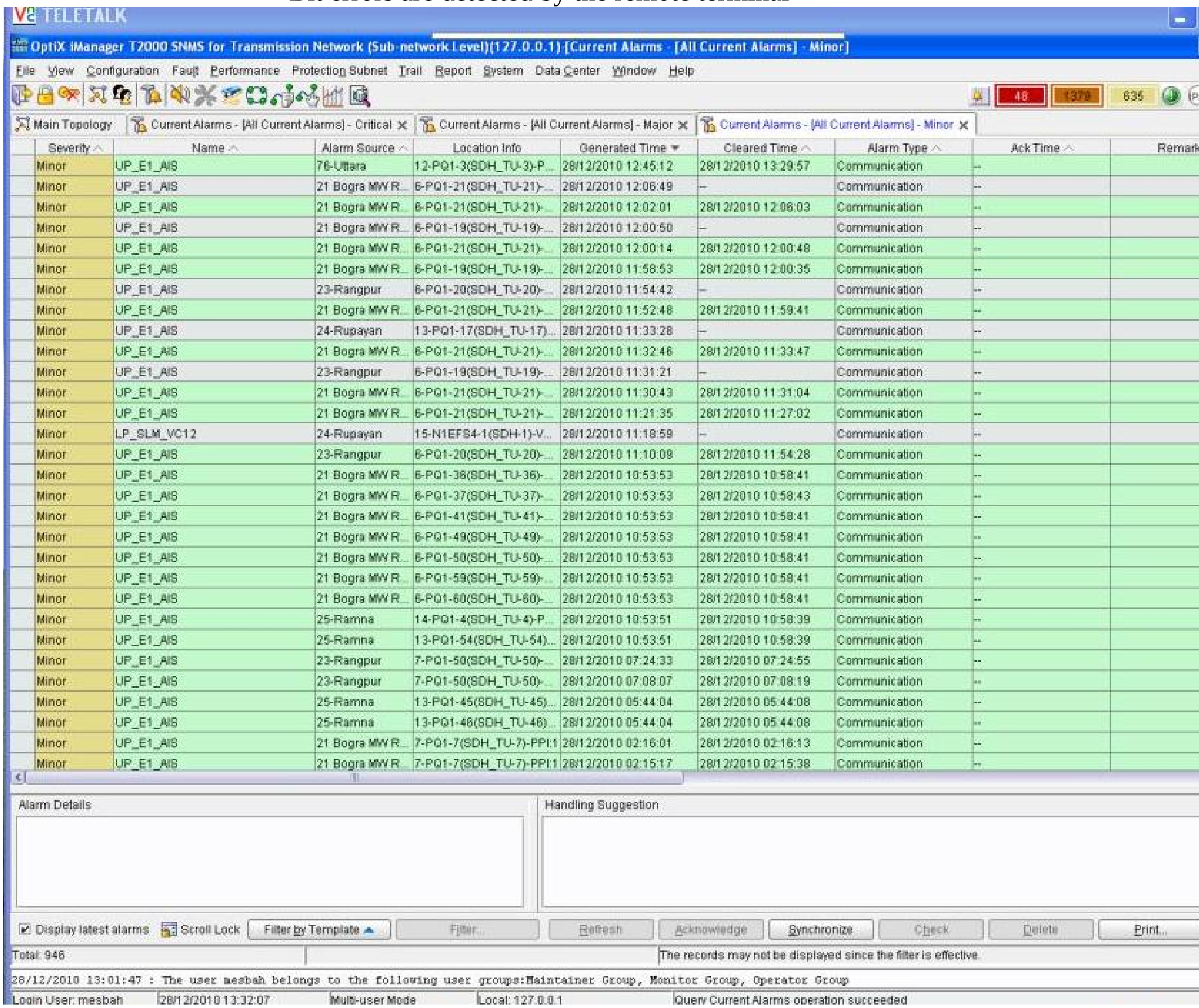


Figure:7.2 : Minor alarms

CHAPTER 8

CONCLUSION

The operation and maintenance related aspects in GSM network were intensely learnt and observed during the work experience in a contemporary GSM operator such as Teletalk Bangladesh Ltd. The outcome of this internship ranges from learning the very basic concepts of GSM network to analyzing the very practical and operational state of affairs like; got the opportunity to observe BTS fault and management procedures and also gathered knowledge about Base Station System.

This program also gives me the opportunity to address with the environment and the management system of a corporate company closely before stepping into the job field. I also benefitted by the experience that, how to work in team as a team member to perform the given responsibility in a limited time at the corporate organization like Teletalk Bangladesh Ltd.

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