CONFIGURING EGSM OVER THE EXISTING GSM NETWORK

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This Report Presented in Partial Fulfillment of the Requirements for the Degree of Bachelor of Science in Electronics and Telecommunication Engineering

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APPROVAL

This Project titled **"CONFIGURING EGSM OVER THE EXISTING GSM NETWORK"**, submitted by A. K. M. Ashraful and Mohammad Neamat Ullah Rubel 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 B.Sc. in Electronics and Telecommunication Engineering and approved as to its style and contents. The presentation has been held on 27th February 2011.

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DECLARATION

We hereby declare that, this project has been done by us under the supervision of **Ms. Poppy Siddiqua , Lecturer, Department of ETE** Daffodil International University. We also declare that neither this project nor any part of this project has been submitted elsewhere for award of any degree or diploma.

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ABSTRACT

This project is on "**Configuration EGSM Over the Existing GSM Network**". Wireless cellular communication is witnessing a rapid growth in markets, technology, and range of services. A major current thrust for cellular communication systems is improved economics through enhanced coverage early in the life cycle of a network and high spectrum efficiency later in the life cycle. An attractive approach for economical, spectrally efficient, and high quality digital cellular is GSM (Global System for Mobile Communication).

The primary goal of cellular radio systems is to provide communication services to a large number of mobile users. Due to the rapid expansion of the market in this area, the available resources have to be used efficiently. The main goal in this project is to assign appropriate cellular network optimization, in order to meet the quality requirements from the users despite various disturbances.

The report is composed two areas. One is background study and another is E-GSM activity. A detailed study about GSM network has been carried out in the background study part. This part discussed about the GSM architecture including the subsystem (RSS, BSS, NSS, OSS) and the network elements (BSC, BTS, TRAU, MSC, VLR, HLR, AC and OMC), GSM transmission problem and solution, Schematic Signal Procession between mobile station and GSM network, cell concept, different logical channel, GSM antenna and the second part discussed about IDB load & Install in BTS.

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LIST OF ABBREVIATION

AC	Authentication Centre
AUC	Authentication Centre
AMPS	Advance Mobile System
BCCH	Broadcast Control Channel
BCH	Broadcast Channel
BSC	Base Station Controller
BER	Bit Error Rate
BS	Base Station
BTS	Base Transceiver Station
C/I	Carrier to Interface
CDMA	Code Division Multiple Access
CS	Circuit Switched
CEPT	Committee of European Post& Telephone
Db	Decibel
DTX	Discontinuous Transmission
EIR	Equipment Identity Register
ETSI	European Telecommunication Standards Institute
FDD	Frequency Division Duplex
FDMA	Frequency Division Multiple Access
FSL	Free Path Loss
FSPL	Free space Path Loss
GHz	Gigahertz
GP	Guard Period
GMSC	Gateway Mobile Services Switching Center
GSM	Global System for Mobile Communication
GMSK	Gaussian Minimum Shift Keying
HLR	Home Locator Register
HSCSD	High Speed Circuit Switched Data

LIST OF ABBREVIATION

HW	Hardware

HF	High Frequency
ISDN	Integrated Service Digital Network
IMSI	International Mobile Subscriber Identity
ISI	Inter Symbol Interface
IMEI	International Mobile Equipment Identity
IEEE	Institute of Electrical and Electronics Engineers
KHz	Kilohertz
MSS	Mobile Multimedia Service
MHz	Megahertz
ME	Mobile Equipment
MSRN	Mobile Service Roaming Number
MS	Mobile Station
MSC	Mobile Service Switching Center
MSK	Minimum Shift Keying
NSS	Network Switching Subsystem
OSS	Operation Subsystem
OMS	Operation Maintenance Subsystem
PCH	Paging Channel
PS	Packet Switched
PDN	Public Data Network
PSTN	Public Switched Telephone Network
PIN	Personal Identification Number
PCM	Pulse Code Modulation
RSS	Radio Subsystem
RF	Radio Frequency
RFC	Radio Frequency Carrier
SIM	Subscriber Identity Module
SQL	Speech Quality Index

LIST OF ABBREVIATION

SMS	Short Message Service

TRA	Transcoding and Rate Adaption Unit
TRx	Transceiver
TMSI	Temporary Mobile Subscriber Identity
TS	Time Slot
TRC	Transcoder Controller
TDMA	Time Division Multiple Access
UMTS	Universal Mobile Telephone System
VSWR	Voltage Standing Wave Ratio
VLR	Visitor Locator Register
WAP	Wireless Application Protocol
WWW	World Wide Web
WLAN	Wireless Local Area Network
Wi-Fi	Wireless Fidelity

CHAPTER 1

INTRODUCTION

1.1 Introduction

GSM stands for **Global System for Mobile communications**. The name GSM came from the name of the small group who was entrusted to develop a global mobile system for European countries. This group was called **Group Special Mobile.** GSM as defined by the GSM Association: "GSM is an open, non-proprietary system that is constantly evolving. One of its greatest strengths is the international roaming capability. This gives the consumers seamless and same standardized same number contact ability in more than 142 countries". This is the leading digital cellular system existing in the planet today.

1.2 Definition of GSM

GSM is a globally accepted standard for digital cellular communication. It's also the name of a standardization group founded in 1982 to create a common mobile telephone standard in Europe. This group was among the first to choose a digital standard over an analog standard. Original system operated at 900 Mhz.

Some characteristics of GSM are:
* GSM is a fully digital system
* Voice is digitally encoded via a unique encoder, which emulates the characteristics of human speech.

- Most secured system available today
- Only system allowing international roaming

1.3 Pre-GSM era

First generation cellular system was analog. Some of the major systems were AMPS originated in USA, NMT 450 / 900 system developed in Nordic was also very popular in Europe and then in other parts of the world; TACS in UK; C-Netz in West Germany;Radio COM 2000 in France; RTMI/RTMS in Italy. So there were too many systems, with no harmonization. No common system existed.**GSM (Global System for Mobile communication)** is a digital mobile telephone system that is widely used in Europe and other parts of the world. GSM uses a variation of time division multiple access (TDMA) and is the most widely used of the three digital wireless telephone technologies (TDMA, GSM, and CDMA). GSM digitizes and compresses data, then sends it down a channel with two other streams of user data, each in its own time slot. It operates at the 900 MHz, 1800 MHz or 1900 MHz frequency band.

Two main standards are followed:
1. GSM 900 (global system for mobile communications in the 900 MHz band)
2. DCS 1800 (digital cellular system for the 1800 MHz band)

GSM 900 is a designed for extensive radio coverage even in rural areas. DCS 1800 is designed for radio coverage in areas with very high subscriber density.

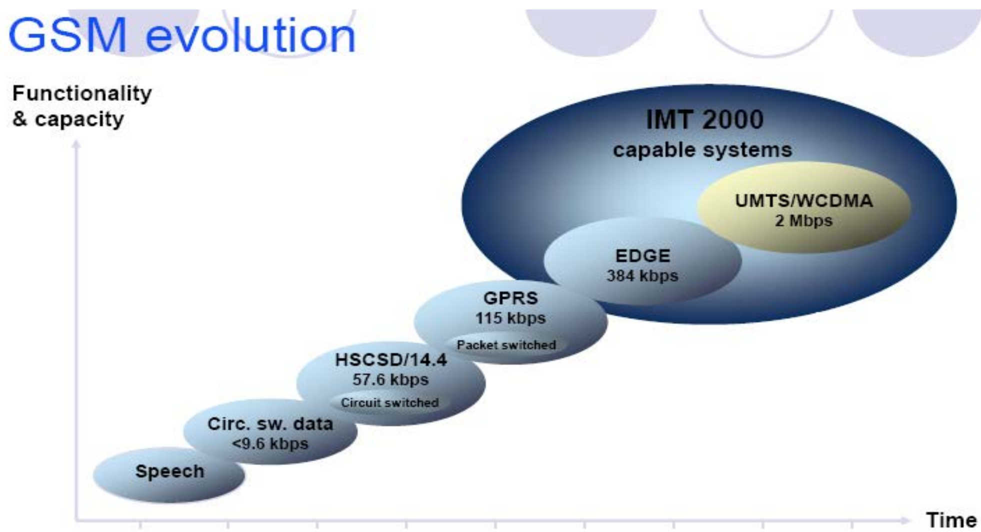


Figure1.1 : GSM Evolution

1.4 Current GSM World Status

GSM has more than quarter of a billion subscribers now. This represents more than 50% if the total 400 million mobile subscribers worldwide. In August 1999 alone there were 400 million international roaming calls world wide, making GSM a true global choice for the mobile users. Now GSM is available in 142 countries or areas of the world. Seamless roaming is available in almost every corner of the world now.

1.5 GSM technology at present:

1.5.1 High Speed Circuit Switched Data (HSCSD)

- Available in some markets. Requires a special GSM terminal.
- Allows you to utilize more than one timeslot on the air interface, thus increasing the transmission capacity.
- Dynamic resource allocation. As a result data rate will vary, but still be considerably higher than 9.6 kbps.

1.5.2 MMS

- Mobile Multimedia Service
- Send and receive sound, text and picture in one message
  (Even in color given the right terminal).

1.5.3 Other value added services

- 'My webpage', administrate your own subscription, bill, email, short messages, address list and more on the internet.
- Hundreds more.

1.6 The GSM History

The foundation for the GSM Standard was laid already in 1978, four years before the name GSM was established. In 1978 the CEPT reserved a frequency range round 900 MHz for mobile communications in Europe. The limits of analog mobile communications in Europe were recognizable in the early 80s. At that time the first analog cellular networks were just beginning their operation and were still far from their maximum capacity. Despite this group of experts was formed to establish the longer-term challenges of mobile communications and to develop a new binding international standard for digital mobile communications in Europe. Thus the GSM Standard became undoubtedly one of the most successful European products of the past decades; its sphere of influence is extended far beyond the originally planned European scope.

1.7 Milestones of the GSM Standards:

1982: The CEPT forms a team of experts, the Group Special Mobile (GSM) with the purpose of developing a binding international standard for mobile communications in Europe.
1984-86: Various technical possibilities are compared in order to achieve an optimal utilization of the predefined frequency ranges.
1986: A permanent core of experts is employed.
1987: Main transmission principles are selected; 13 countries agree in the MoU (Memorandum of Understanding) to start GSM networks until 1991.
1988: The ETSI (European Telecommunication Standard Institute) is founded; most of the standardizing activities of the CEPT, including GSM, are assumed by this new body. Along with state-owned operators, industry, private network operators and consumers groups participate in the ETSI, too.
1989: GSM is renamed from "Group Special Mobile" to "Global System for Mobile Communications".
1990: GSM900 Standard (Phase 1) is adopted. DCS1800 Standard (Phase 1) is developed as first GSM adaptation. The first GSM systems are in test operation.
1992: Commercial introduction of many large GSM900 networks.
1993: Work begins on updating the GSM900/DCS1800 standards: GSM Phase 2.
1995: GSM-R (Railway): The ETSI reserves further frequency range for a railway networks; first test projects are started. GSM Phase 2 work is completed.
1996: Worldwide success of GSM Standard; used in more than 50 countries. PCS1900 (Public Cellular Systems) as further GSM adaptation in the USA.

1.8 GSM-MILESTONES:

1978 CEPT reserves 2×25 MHz in 900 MHz range
1982 CEPT founds “Groupe Special Mobile” GSM
1984-86 Comparison of technical possibilities
Goals: - free roaming
- incoming accessibility under 1 number (International roaming)
- large network capacity (bandwidth efficiency)
- flexibility –> ISDN
- broad service offering
- security mechanisms

1986 Core of experts meets continuously
1987 Selection of central transmission techniques
Memorandum of understanding: Mou
1988 ETSI founded
1989 GSM –> Global System for Mobile Communication
1990 GSM900 Standard
1991 DCS800 Adaptation
Trials/ “friendly user” operation
1992 Start of commercial operation
1993 Beginning of work on phase 2
1995 Completion of work on phase 2 (GSM900/DCS1800)
Reservation of GSM-R frequencies (ETSI)
1996 PCS1900 adaptation (USA)

1.9 WHY GSM?

1.9.1 SMART AND SECURE

GSM is so secure and flexible with its functionalities and so easy to manipulate that there are all sorts of uses for it that we haven’t even thought of yet. One of the most attractive features of GSM is that it is a very secure network. All communications, both speech and data, are encrypted to prevent eavesdropping. In fact, in the early stages of its development it was found that the encryption algorithm was too powerful for certain technology export regulators. This could have had serious implications for the global spread of GSM by limiting the number of countries to which it could be sold. Fortunately, the MoU reacted promptly to this threat. Alternative algorithms were developed that enabled the free dissemination of the technology worldwide.GSM subscribers are identified by their Subscriber Identity; Module (SIM) card. This holds their identity number and authentication key and algorithm. While the choice of algorithm is the responsibility off individual GSM operators, they all work closely together through the MoU to ensure security of authentication.

1.10 Development of GSM:

The GSM standard is designed to establish compatibility among competing standards. GSM has more than quarter of a billion subscribers now. This represents more than 50% if the total 400 million mobile subscribers worldwide. GSM achieved unprecedented growth – 'every second GSM attracts 4 new customers' .In August 1999 alone there were 400 million international roaming calls world wide, making GSM a true global choice for the mobile users. Now GSM is available in 142 countries or areas of the world. Seamless roaming is available in almost every corner of the world now.

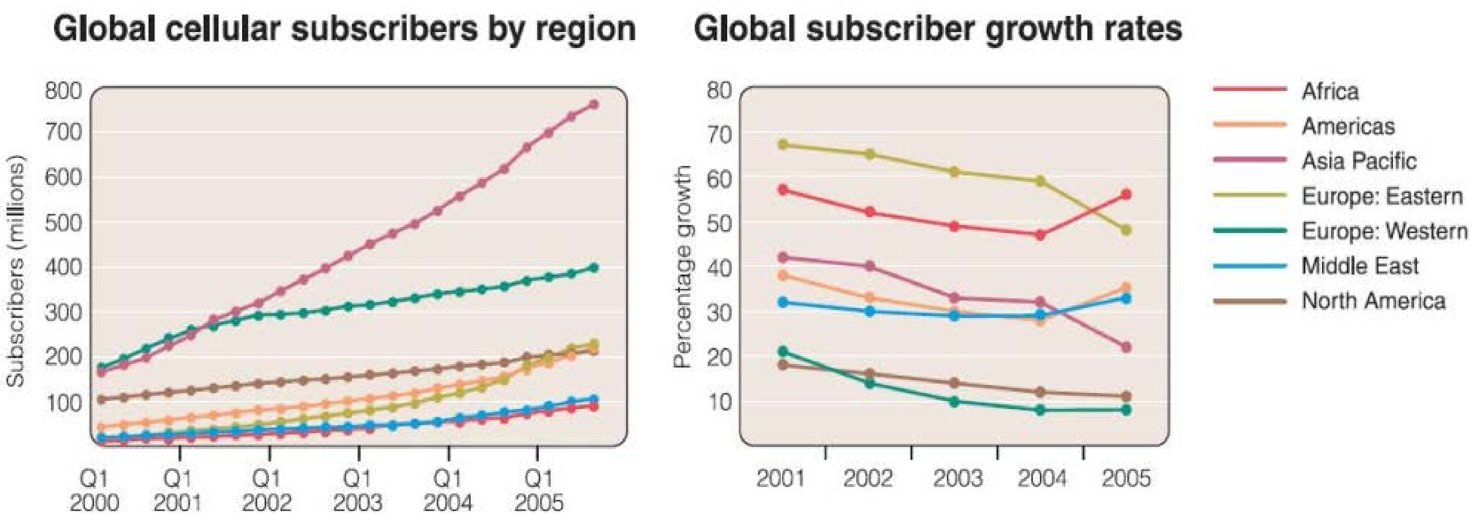


Figure1.2: Increasing Rate of GSM

1.11 THE GSM RECOMMENDATIONS:

The GSM Standard is a consistent open standard for cellular mobile communication systems established by the ETSI. All aspects of the realization of the GSM Standard have been established in now more than 150 Recommendations (technical specifications). Subsystems, network components, interfaces, signaling, tests and maintenance aspects etc. are described. This allows a harmonious interaction of all elements of a mobile communication network designated as PLMN (Public Land Mobile Network). At the same time the Recommendations are flexible enough for the different realizations of various vendors. The Recommendations are organized into 12 series according to different aspects. This structure reflects the structure of the PLMN system and its interfaces.

GSM Specification:

GSM Specifications

Carrier Separation	-	200 kHz
Duplex Distance	-	45 MHz
No. of RF Carriers	-	124
Access Method	-	TDMA/FDMA
Modulation Method	-	GMSK
Transmission Rate	-	270.833 Kbps
Speech Coding	-	Full rate 13 Kbps Half rate 6.5 Kbps

1.12 Frequency bands

The following table lists the frequency spectrum that has beenallocated for GSM900, GSM1800 and GSM1900 frequency bands.

Description	GSM900	GSM1800	GSM1900
Uplink band	890-915 MHz	1710-1785 MHz	1850-1910 MHz
Downlink band	935-960 MHz	1805-1880 MHz	1930-1990 MHz
Channel spacing	200 kHz	200 kHz	200 kHz
Total # channels	124	374	299
# Time slots	8	8	8
Duplex spacing	45 MHz	95 MHz	80 MHz

Table: GSM frequency band

1.13 Performance characteristics of GSM

• Communication
– mobile, wireless communication; support for voice and data services
• Total mobility
– international access, chip-card enables use of access points of different providers

]• Worldwide connectivity
– one number, the network handles localization
• High capacity
– better frequency efficiency, smaller cells, more customers per cell
• High transmission quality
– high audio quality and reliability for wireless, uninterrupted phone calls at higher speeds (e.g., from cars, trains)
• Security functions
– access control, authentication via chip-card and PIN

1.14 Disadvantages of GSM

• no end-to-end encryption of user data
• no full ISDN bandwidth of 64 kbit/s to the user
• reduced concentration while driving
• electromagnetic radiation
• abuse of private data possible
• roaming profiles accessible
• high complexity of the system
• several incompatibilities within the GSM standards

1.15 GSM TELECOMMUNICATION SERVICES:

GSM system offers a wide range of services. Here the services of the GSM systems are described as seen by a user, neglecting the implementation of the services.

The GSM specifications defines three types of services:

- Bearer services (for data only)
- Tele-services (for voice and data)
- Supplementary services

These functions are not specific to GSM; most of them are directly inherited from the fixed network with minor modifications. Bearer services and tele-services are also called basic telecommunication services. The use of GSM telecommunication services is subject to subscription. A basic subscription permits participation in those GSM telecommunication services that are generally available.

1.15.1 Bearer Services:

GSM system has been designed from the start to offer most of the data services that are available to users of fixed telephone network and ISDN. Therefore, a large number of different bearer services have been accommodated to enable different modes of data transmission. Due to the speed limitation of the voice path in GSM, the data communication provided by GSM is up to 9.6 KBPS.

1.15.2 Tele Services

Telecommunication services that enable voice communication via mobile phones .All these basic services have to obey cellular functions, security measurements etc.

The following tele-services have already been realized:

- Telephony
- Emergency call
- Short message service (SMS)
- Short message cell broadcast
- Automatic facsimile/Fax (group 3)
- Alternative speech and facsimile/Fax(group 3)
- voice mailbox (implemented in the fixed network supporting the mobile
- electronic mail
- etc.

1.15.3 Supplementary Services:

Besides bearer services and Tele-services, GSM defines supplementary services also that modify and enrich the basic services by allowing a user to choose how incoming or outgoing calls are treated in the network or by providing information that permits intelligent use of the services.

Some of these services are number identifications(caller id display, etc.)

- Call forwarding.
- Call divert.
- Call waiting.
- Call hold.
- Conference calls.
- Closed user group.
- Charging information.
- Call restriction, etc.

Since GSM MS are highly sophisticated computational machines with computational power that easily exceeds the power of ordinary PCs, they can provide locally a number of user friendly functions, such as short number dialing, storage of received calls, short message, automatic repetition of failed calls, etc. Since this kind of functions does not require participation of the GSM network, they are not covered by GSM standards/specifications. Manufacturers of GSM phones can include these features to their products without restrictions from the GSM standardization.

1.16 Introduction to microwave:

In telecommunications, information can be transmitted between two locations using a signal that can be either analog or digital in nature.

1.17 Microwaves/RF waves:

Microwaves are radio waves of very short wavelength. Basically radio waves are electromagnetic waves the term radio being introduced from the concept of radiation of electromagnetic waves. Accordingly there should not be any lower or higher limits of the wavelengths. It is usual to confine the wavelength of radio waves within certain limits to have electronics systems to generate, radiate and detect the radio waves.

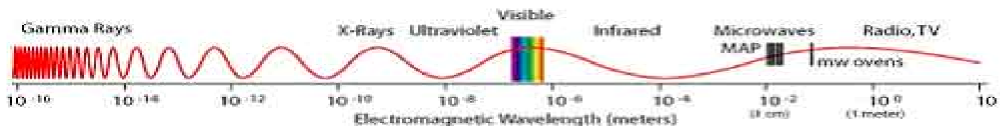


Figure 1.3: Radio Frequency Spectrum-1

Microwaves have wavelength which are limited to include wavelengths in the centimeter and millimeter wavelength regions. The entire frequency spectrum of radio waves up to microwaves and millimeter waves is in fact divided into a number of frequency bands. The term *microwave* refers to alternate current signals with frequencies between 300 MHz ($3*10^8$ Hz) and 300 GHz ($3*10^{11}$) with a corresponding electrical wavelength between $\lambda = c/f = 1$ m and $\lambda = 1$ mm respectively.

- IEEE Microwave Range 300 MHz to 300 GHz.
- In Practical field Microwave Range 2 GHz to 60 GHz.
- But Microwave Range for Mobile Communication 3 GHz to 40 GHz.

Why Microwave link communication?

The use of microwave links has major advantages over cabling systems:

- **Freedom from land acquisition rights:**

The acquisition of rights to

- lay cabling,
- repair cabling,
- have permanent access to repeater stations
- cost less over cable communications.
- simplifies the maintenance and repair of the link.

- **Ease of communication over difficult terrain.**

CHAPTER 2

THE GSM NETWOK

2.1 Introduction:

This chapter describe the GSM network elements and their main functionality and explain the geographical structure used in GSM.

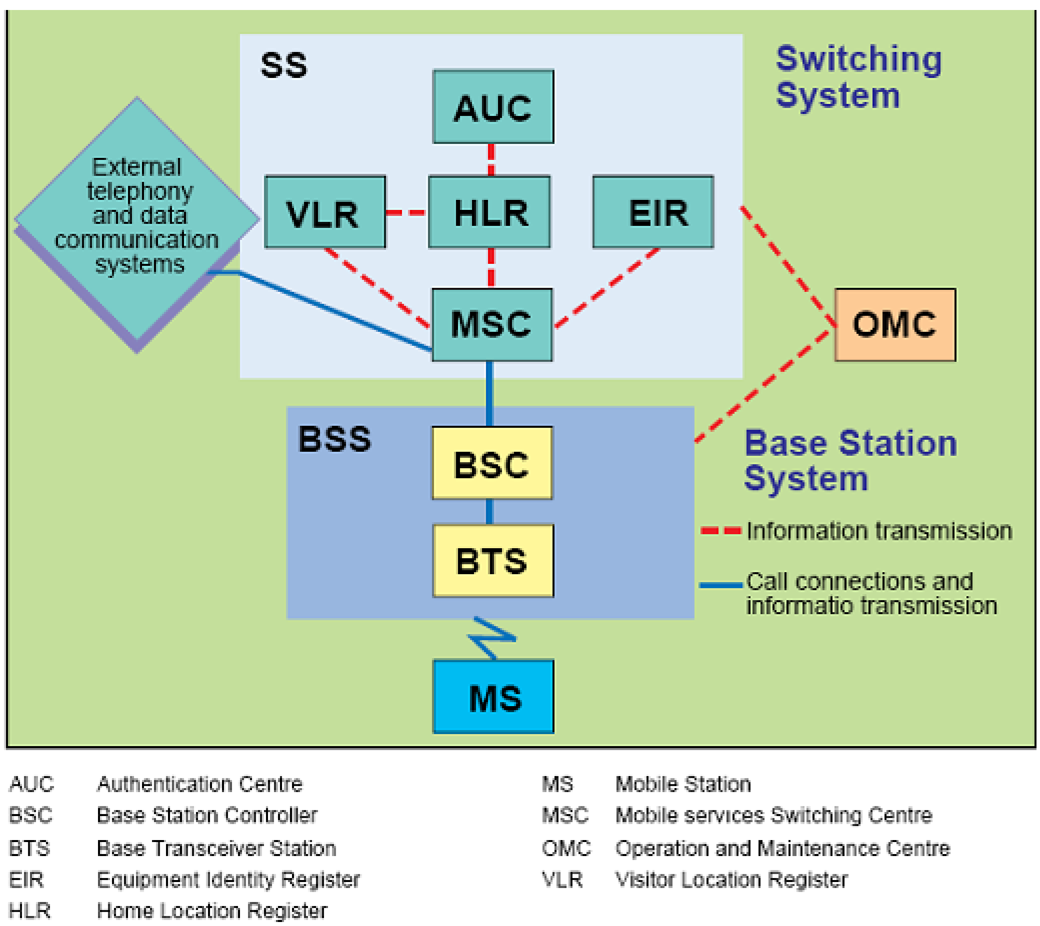


Figure 2.1: The GSM Network

2.2 Architecture of the GSM network:

The GSM technical specifications define the different entities that form the GSM network by defining their functions and interface requirements.

2.2.1 GSM PLMN: Subsystems

- A GSM-PLMN is subdivided into the following subsystems:
- Radio SubSystem RSS
- Network Switching Subsystem NSS
- Operation SubSystem OSS

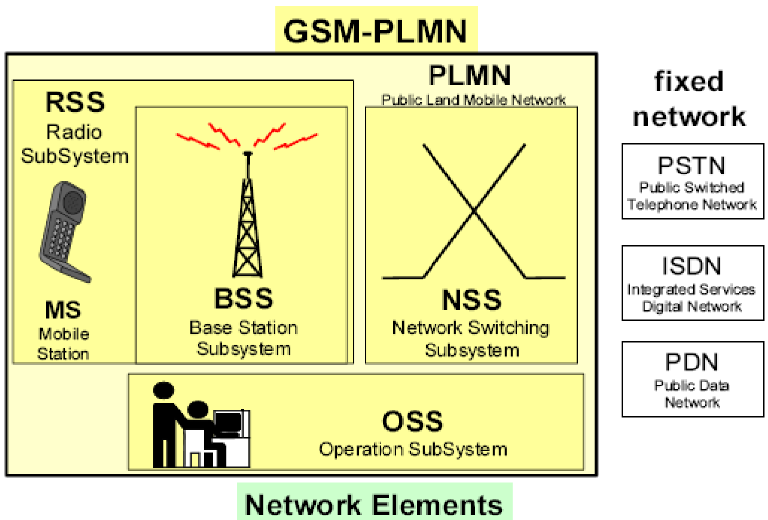


Figure2.2 : GSM-PLMN

2.2.2 Network Elements:

The subsystems functions are grouped into functional units or network elements. Functional units may be realized either as standalone Hardware HW units or associated with other GSM functional units in one HW unit.

The Radio Subsystem RSS consists of the mobile stations MS and the Base Station Subsystem BSS, which is composed of the following functional units:

- Base Station Controller BSC
- Base Transceiver Station BTS
- Transcoding and Rate Adaption Unit TRAU

The Network Switching Subsystem NSS (Phase ½) consists of the following functional units:

- Mobile services Switching Center MSC
- Visitor Location Register VLR

- Home Location Register HLR
- Authentication Center AC
- Equipment Identity Register EIR

The Operation SubSystem OSS consists of Operation & Maintenance Centers OMC; in the Siemens solution:

- Operation & Maintenance Center for the Base Station Subsystem OMC-B
- Operation & Maintenance Center for the Switching Subsystem OMC-S

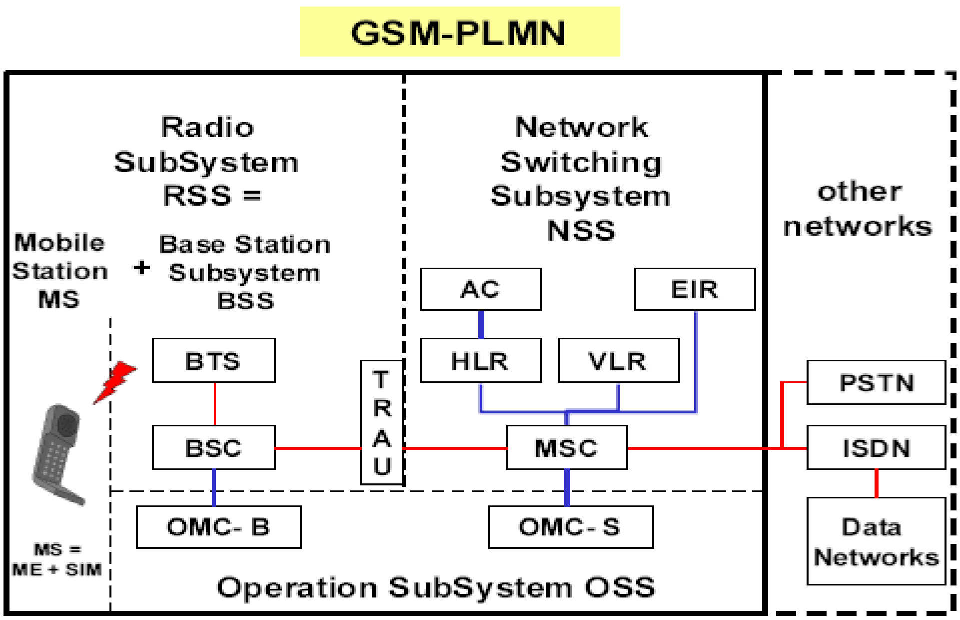


Figure2.3 : GSM PLMN.

2.3 The Radio Subsystem (RSS)

2.3.1 Interfaces

– *Um:* radio interface

– Abis: standardized, open interface
With 16 Kbit/s user channels

– *A*: standardized, open interface
With 64 Kbit/s user channels

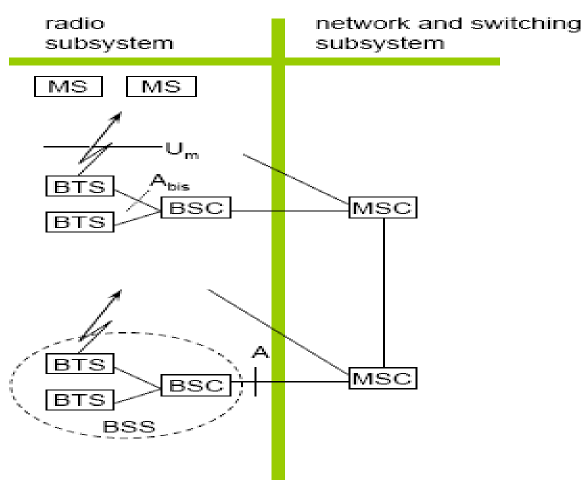


Figure2.4 : The Radio Subsystem (RSS)

The **Radio Subsystem (RSS)** consists of:

– MS (Mobile Station)
– BSS (Base Station Subsystem):consisting of
• BTS (Base Transceiver Station):
sender and receiver
• BSC (Base Station Controller):
controlling several transceivers

2.3.1 Mobile Station

In GSM there is a difference between the physical equipment and the subscription. The Mobile Equipment (ME), which can be vehicle installed, portable or hand–held is separated from the small unit called the Subscriber Identity Module (SIM) containing the subscription. The SIM and the mobile equipment together make up the mobile station. Without SIM, the MS cannot access the GSM network, except for emergency calls. As the SIM–card is connected to the subscription and not to the mobile equipment, the subscriber can use other equipments as well as his own. The authentication of the subscription is done by parameters from AUC. The ME is identified by the International Mobile Equipment Identity (IMEI).

A Mobile Station consists of two main elements:

- The mobile equipment or terminal.
- The Subscriber Identity Module (SIM).

2.3.2 Functions of Mobile Station

- Voice and data transmission
- Frequency and time synchronization
- Monitoring of power and signal quality of the surrounding cells
- Provision of location updates even during inactive state, Equalization of multi path distortions

Figure2.5: Mobile Station

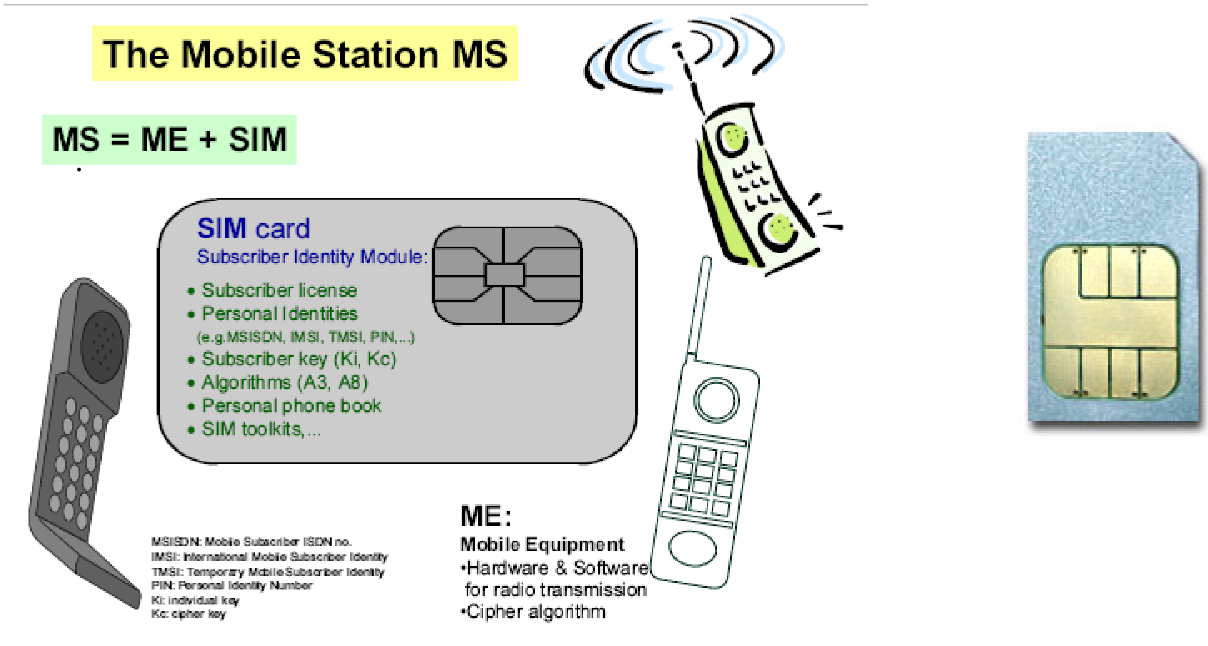


Figure2.6 : Mobile Station and SIM

2.3.3 The SIM

The SIM is a smart card that identifies the terminal. By inserting the SIM card into the terminal, the user can have access to all the subscribed services. Without the SIM card, the terminal is not operational.

A four-digit Personal Identification Number (PIN) protects the SIM card. In order to identify the subscriber to the system, the SIM card contains some parameters of the user such as its International Mobile Subscriber Identity (IMSI).

Another advantage of the SIM card is the mobility of the users. In fact, the only element that personalizes a terminal is the SIM card. Therefore, the user can have access to its subscribed services in any terminal using its SIM card.

2.3.2 Base Station System (BSS):

The BSS is a set of BS equipment (such as transceivers and controllers) that is in view by the MSC through a single A interface as being the entity responsible for communicating with MSs in a certain area. The radio equipment of a BSS may be composed of one or more cells. A BSS may consist of one or more BS. The interface between BSC and BTS is designed as an A_{bis} interface. The **BSS** includes two types of machines: the **BTS** in contact with the MSs through the radio interface; and the **BSC**, the latter being in contact with the MSC. The function split is basically between transmission equipment, the BTS and managing equipment at the BSC. All radio-related functions are performed in the BSS, which consists of base station controllers (BSCs) and the base transceiver stations (BTSs).

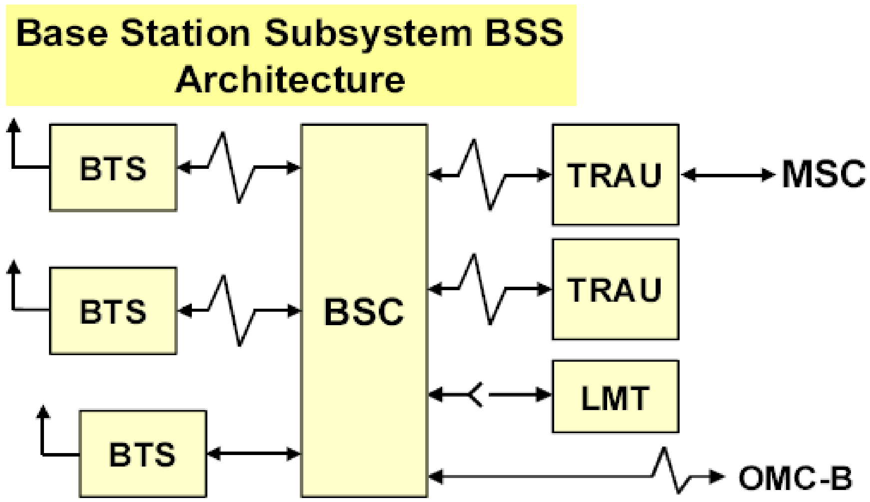


Figure2.7 : Base station Subsystem(BSS)

- The BSS is mainly responsible for all radio–based functions in the system.
- It manages radio communication with the mobile units.
- It also handles the handover of calls in progress between cells controlled by the BSC.
- The BSS is responsible for the management of all radio network resources and cell configuration data.

The BSS consists of two or three nodes depending on how the functions are implemented, they are

- The BSC (Base Station Controller),
- Transcoding and Rate adaption Unit(TRAU) and
- Base Transceiver Station (BTS).

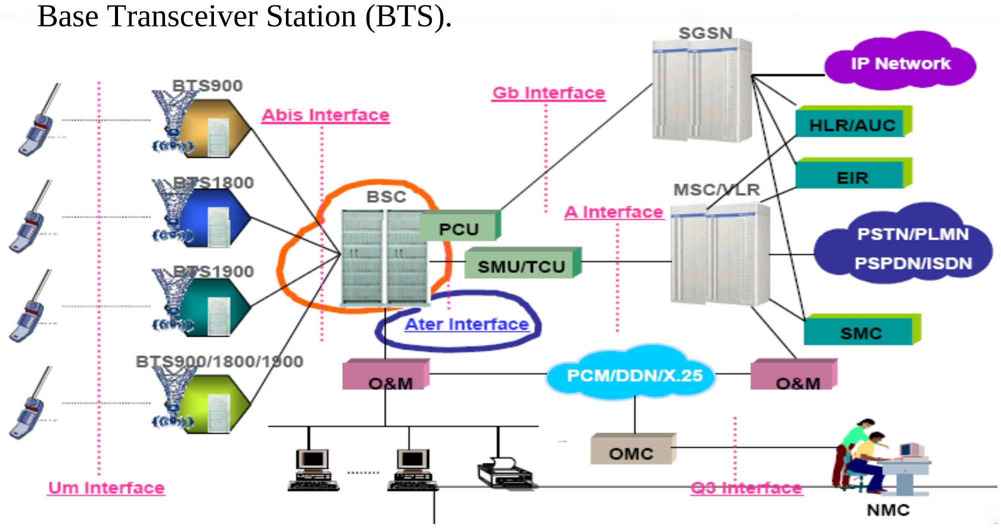


Figure2.8 : BSS in GSM Network

2.3.2.1 The BSC

A BSC is a network component in the PLMN that function for control of one or more BTS. It is a functional entity that handles common control functions within a BTS. BSC within a mobile network is a key component for handling and routing information. The BSC provides all the control functions and physical links between the MSC and BTS. It is a high-capacity switch that provides functions such as handover, cell configuration data, and control of radio frequency (RF) power levels in base transceiver stations. A number of BSCs are served by an MSC.

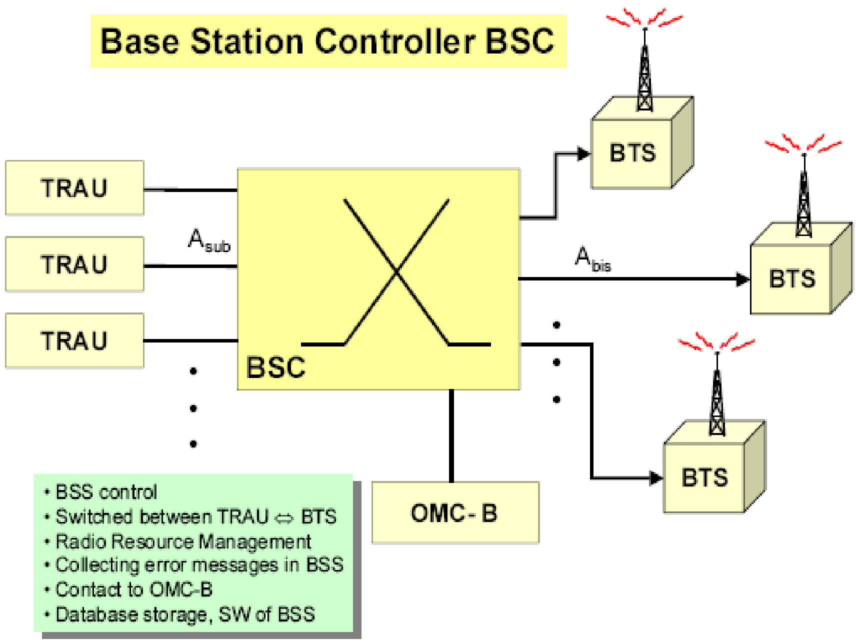


Figure2.9 : Base Station Controller BSC

2.3.2.1.1 The basic functional responsibilities assigned to the BSC are –

- Radio network management
- Radio network performance monitoring
- Operation, maintenance and administration of BTS
- Speech coding and rate adaptation
- Transmission management towards RBS
- Handling of the radio resources during mobile station connection

2.3.2.1.2 Functions of BSC

- It is connected to BTS and offloads MSC
- Radio resource management
- Inter-cell handover
- Reallocation of frequencies
- BSC handles radio-channel setup, handover, frequency hopping and the radio frequency power levels of the BTSs.
- Time delay measurement of the received signals from MS with respect to BTS clock.
- Performs traffic concentration to reduce the number of lines from BSC to MSC.
- BSC performs call processing
- TRAU are generally located at the site of MSC.
- BSC- BTS configurations as per requirement.
- Data from OMC and can be down loaded to BSC
- Before transmitting speech or data to the MSC the information is transformed and coded in an TRANSCODER.
- The physical area the BSC covers is divided into one or more Location Areas.

2.3.2.1.3 Service Function:

Voice service

- Full Rate Service (FRS)
- Enhanced Full Rate Service (EFRS)

Short message service

- Point-to-point short message, as called
- Point-to-point short message, as caller
- Cell broadcast service originating from SMC

Circuit type data service (basic service)

- Full rate data service and half rate data service
- Enhanced data service (4.8kbit/s, 9.6kbit/s, 14.4kbit/s)

GPRS service

- Point-to-point interactive telecom service
- Point-to-multipoint telecom service.

2.3.2.1.4 Technical Performance:

- Handover
- Power control

<u>2.3.2.1.5Rack Structure of BSC :</u>

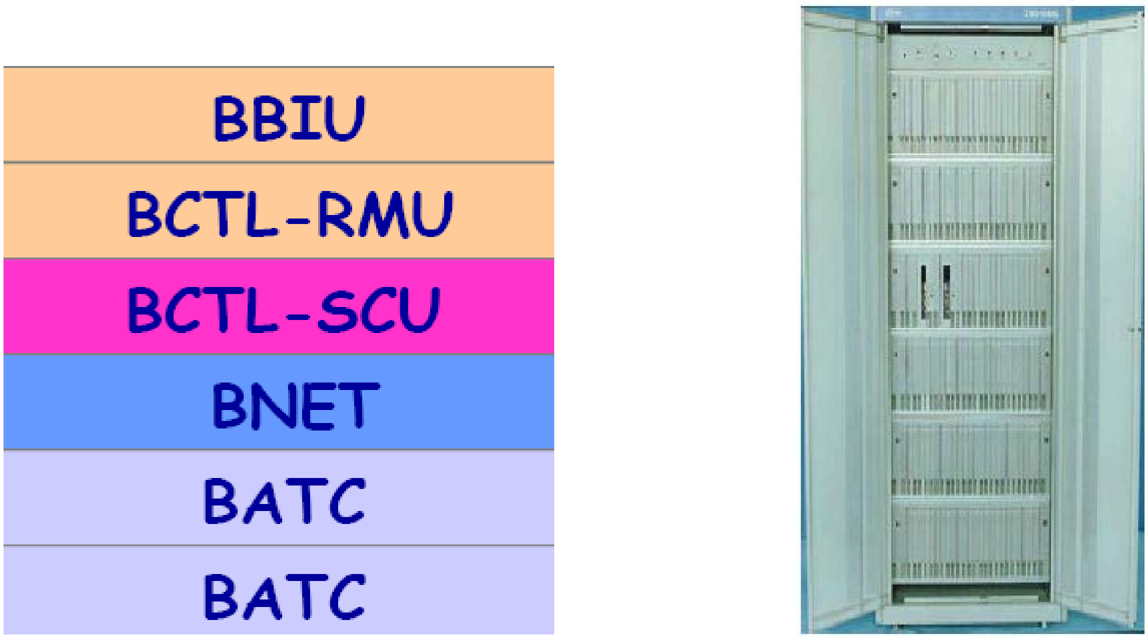


Figure2.10 : BSC Cabinet

- **Back plain of Abis interface unit (BIU)**
- **Back plain of Radio management unit (RMU)**
- **Back plain of System control unit (SCU)**
- **Network switch unit (NSU)**
- **Trans-coding and rate adaptation unit (TCU)**
- **An interface unit (AIU)**
- **Packet control unit (PCU)**

2.3.2.2 Transcoding and Rate Adaptation Unit (TRAU):

An important component of the BSS that is considered in the GSM architecture as a part of the BTS is the Transcoder/Rate Adaptation Unit (TRAU). The TRAU is the equipment in which coding and decoding is carried out as well as rate adaptation in case of data. Although the specifications consider the TRAU as a subpart of the BTS, it can be sited away from the BTS (at MSC), and even between the BSC and the MSC. The TRAU adapts the 64 Kbps from the MSC to the comparatively low transmission rate of the radio interface of 16 Kbps.

The interface between the MSC and the BSS is a standardized SS7 interface (A-interface) that, as stated before, is fully defined in the GSM recommendations. This allows the system operator to purchase switching equipment from one supplier and radio equipment and the controller from another. The interface between the BSC and a remote BTS likewise is a standard the $A_{bis.}$ In splitting the BSS functions between BTS and BSC, the main principle was that only such functions that had to reside close to the radio transmitters/receivers should be placed in BTS. This will also help reduce the complexity of the BTS.

2.3.2.2.1 Function Transcoder Controller (TRC):

- The primary functions of a TRC are to perform transcoding and to perform rate adaptation.
- Transcoding: The function of converting from the PCM coder information (following A/D conversion) to the GSM speech coder information is called transcoding. This function is present in both the MS and BSS.
- Rate Adaptation: Rate adaptation involves the conversion of information arriving from the MSC/VLR at a rate of 64 kb/s to a rate of 16 kb/s for transmission to a BSC (for Full Rate call). This 16 kb/s contains 13 kb/s of traffic and 3 kb/s of inband signaling information.

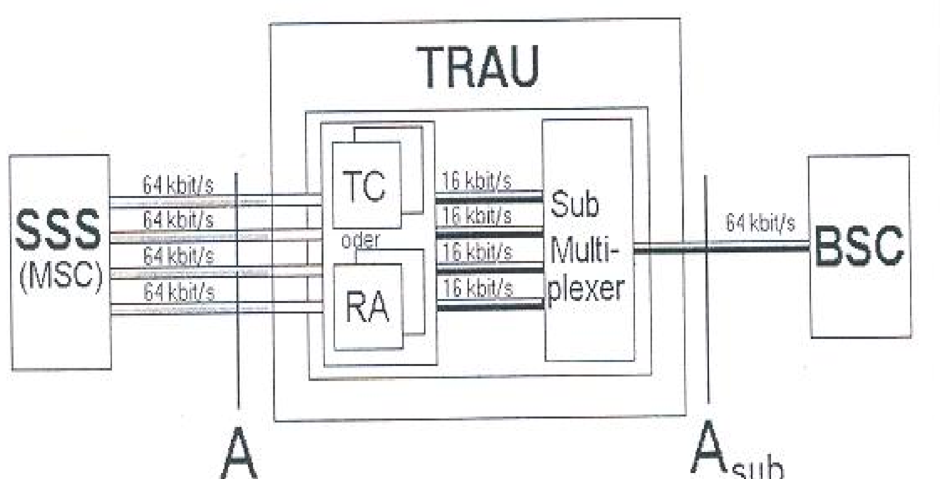


Figure2.11: TRAU

2.3.2.3 Base Transceiver Station (BTS):

The primary responsibility of the BTS is to transmit and receive radio signals from a mobile unit over an air interface. To perform this function completely, the signals are encoded, encrypted, multiplexed, modulated, and then fed to the antenna system at the cell site.

- The BTS corresponds to the transceivers and antennas used in each cell of the network.
- It handles the radio-link protocols with the Mobile Station.
- A BTS may be placed in the center of a cell (omni-directional) Or shooting in one or more specific directions (sectorized). Its transmitting power defines the size of a cell.
- 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 minimum cost.

2.3.2.3.1 Function of BTS

- Encodes, encrypts, multiplexes, modulates and feeds the RF signals to the antenna
- Transcoding and rate adaption Functionality
- Time and frequency synchronization signals transmission.
- 11 power classes from .01 watts to 320 watts
- Frequency hopping
- Random access detection
- Uplink radio channel measurements
- BTS mainly consists of a set of transceivers (TRX).

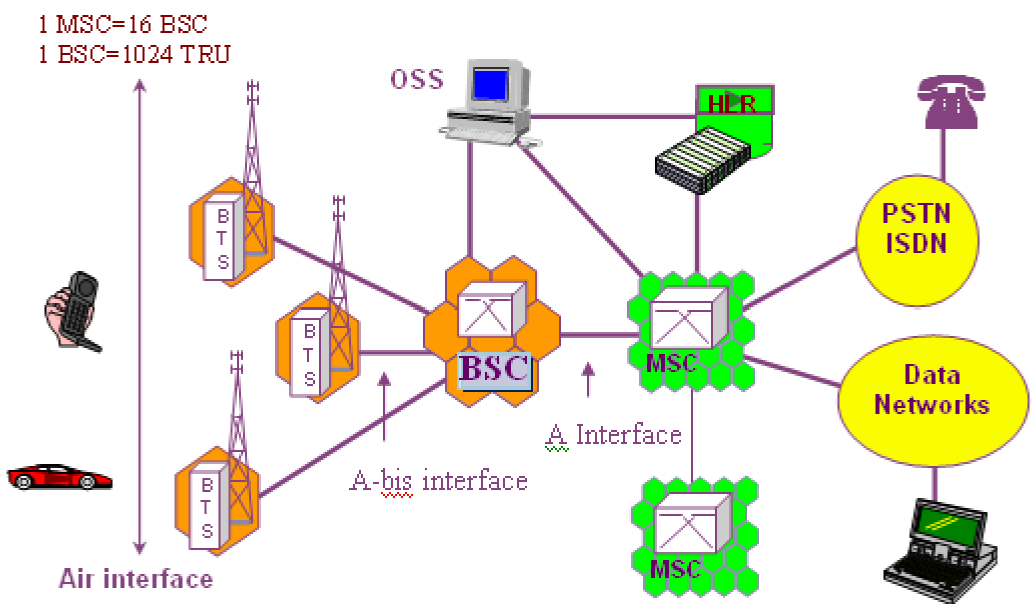
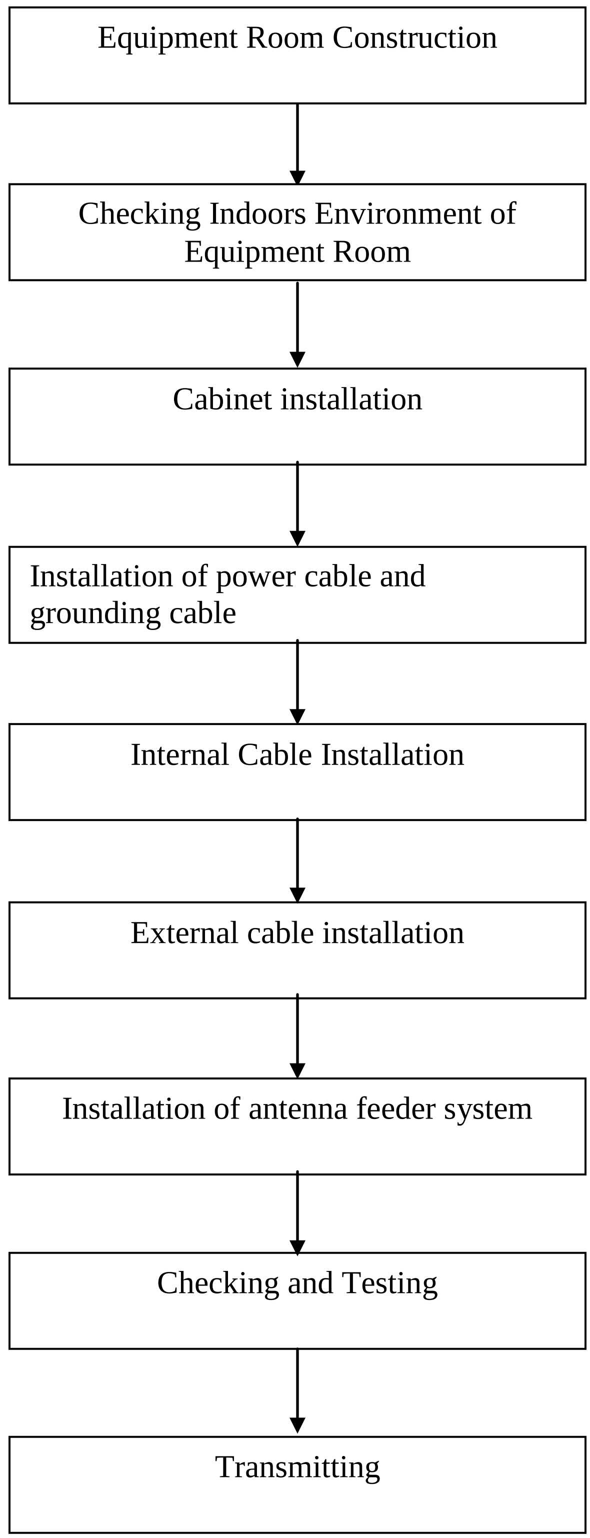


Figure2.11: Network architecture

2.3.2.3.2 BTS Tower Installation Flow Chart:



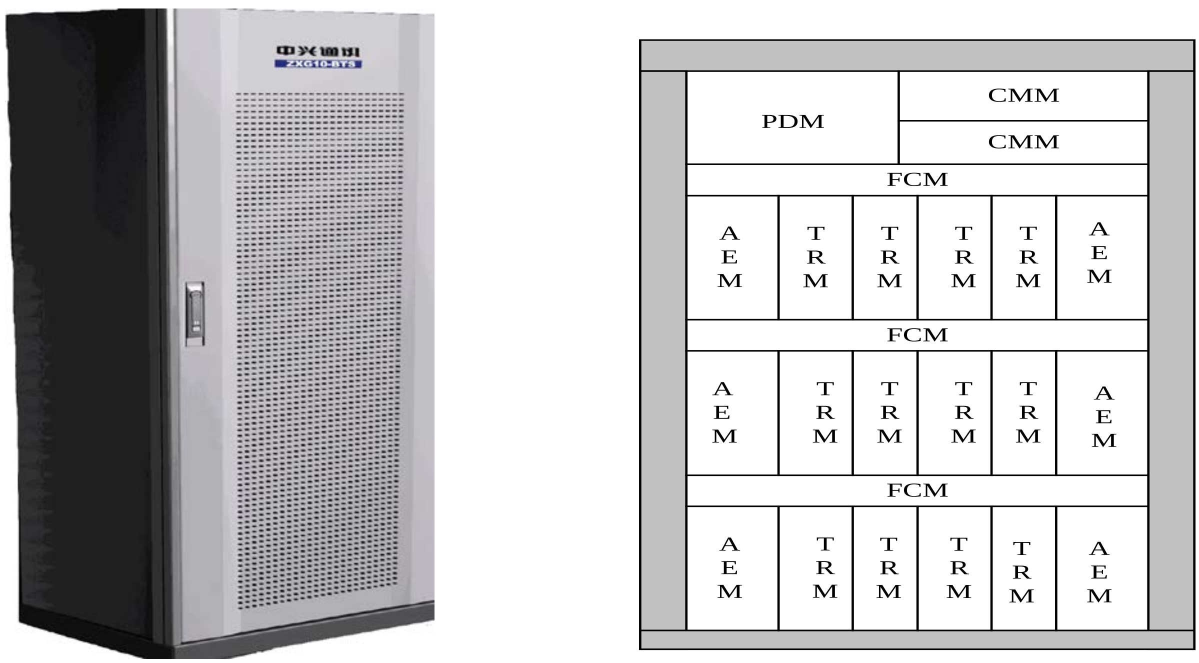


Figure2.12 : The BTS CABINET and the CARD

Controller & Maintenance Module (CMM)
Power Distribution Module (PDM)
Fan Control Module (FCM)
Antenna Equipment Module (AEM)
TRX Module (TRM
CMM =Control & Maintenance module
TRM =Transceiver Module
PDM =Power Distribution Module

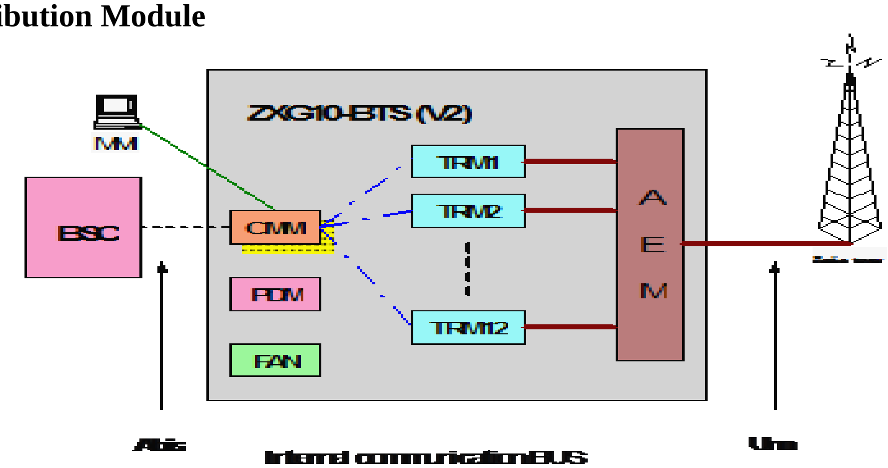
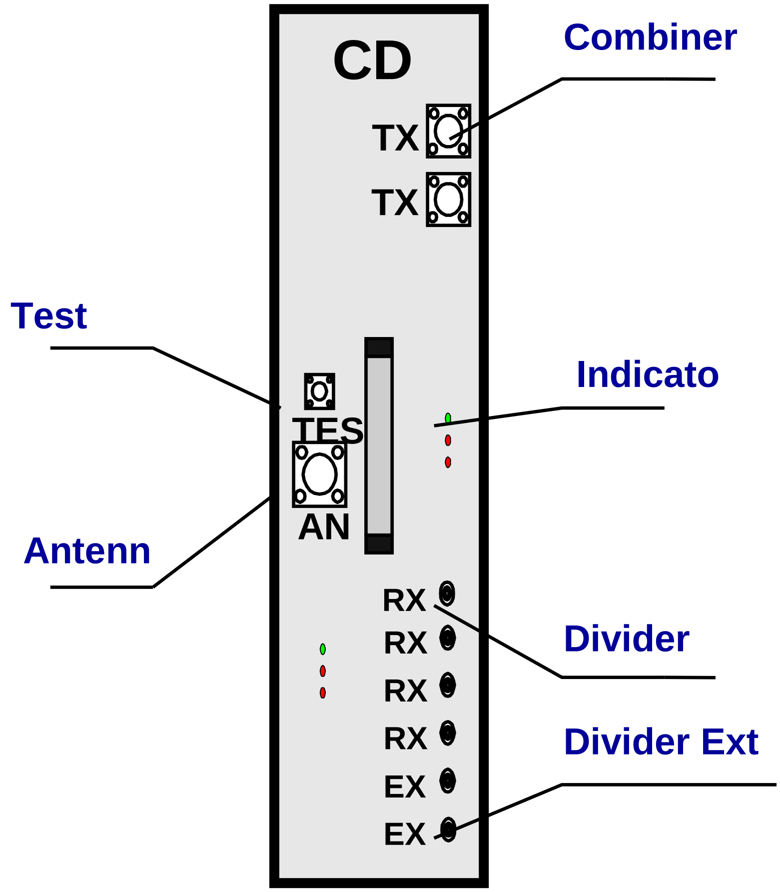


Figure2.13 : Internal communication of



TRM structure

CDU (Combiner Distribution Unit)

Figure2.13: TRM and CDU

<u>BTSV2 Power Consumption</u>
TRM: 140W
AEM: 70W
CMM (2): 20W
Fans and others: 80W
One frame when full configuration: 700W
One rack when full configuration: 2200W

2.4 Network Switching Subsystem (NSS)

The network and the switching subsystem together include the main switching functions of GSM as well as the databases needed for subscriber data and mobility management (VLR). The main role of the MSC is to manage the communications between the GSM users and other telecommunication network users. The basic switching function is performed by the MSC, whose main function is to coordinate setting up calls to and from GSM users. The MSC has interface with the BSS on one side (through which MSC VLR is in contact with GSM users) and the external networks on the other (ISDN/PSTN/PSPDN). The main difference between a MSC and an exchange in a fixed network is that the MSC has to take into account the impact of the allocation of RRs and the mobile nature of the subscribers and has to perform, in addition, at least, activities required for the location registration and handover.

The MSC is a telephony switch that performs all the switching functions for MSs located in a geographical area as the MSC area. The MSC must also handle different types of numbers and identities related to the same MS and contained in different registers: IMSI, TMSI, ISDN number, and MSRN. In general identities are used in the interface between the MSC and the MS, while numbers are used in the fixed part of the network, such as, for routing.

The **Switching Subsystem (SS)** comprises of:

- Mobile services Switching Centre (MSC)
- Home Location Register (HLR)
- Visitor Location Register (VLR)
- Authentication Centre (AC)
- Equipment Identification Register (EIR)

2.4.1 Mobile services Switching Centre (MSC)

An MSC is the point of connection to the network for mobile subscribers of a wireless telephone network. It connects to the subscribers through base stations and radio transmission equipment that control the air interface, and to the network of other MSCs and wireless infrastructure through voice trunks and SS7. An MSC includes the procedures for mobile registration and is generally co-sited with a visitor location register (VLR) that is used to temporarily store information relating to the mobile subscribers temporarily connected to that MSC. The MSC performs the telephony switching functions of the system. It controls calls to and from other telephone and data systems. It also performs such functions as toll ticketing, network interfacing, common channel signaling, and others.

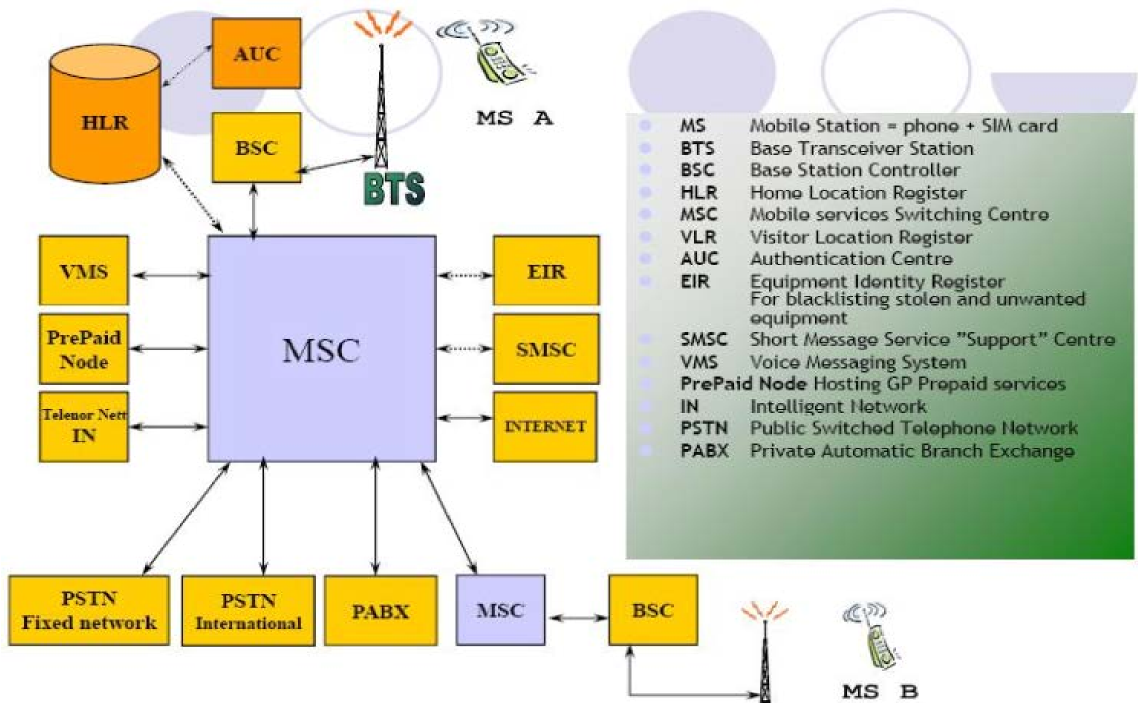


Figure2.14 : MSC with other network elements.

2.4.1 MSC Functions

- Paging, specifically call handling
- Location updation
- Handover management
- Billing for all subscribers based in its area
- Reallocation of frequencies to BTSs in its area to meet heavy demands
- Echo canceller operation control
- Signaling interface to databases like HLR, VLR.
- Gateway to SMS between SMS centers and subscribers
- Handle interworking function while working as GMSC

2.4.2 Home Location Register (HLR)

The VLR is a database that contains temporary information about subscribers that is needed by the MSC in order to service visiting subscribers. The VLR is always integrated with the MSC. When a mobile station roams into a new MSC area, the VLR connected to that MSC will request data about the mobile station from the HLR. Later, if the mobile station makes a call, the VLR will have the information needed for call setup without having to interrogate the HLR each time.

 The HLR 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.

 Subscription data states the logical identity of each subscriber (MS) and which services those are accessible or barred for the respective subscriber.

 The location of the mobile is typically in the form of the address of the Visitor Location Register (VLR) associated with the mobile station. This information is used to route calls and SMS to the MSC/VLR where the mobile station is currently located.

 The HLR also contains a number of functions for managing these data, controlling services and enabling subscribers to access and receive their services when roaming within and outside their home GSM network.

2.4.3 Visitor Location Register VLR)

The HLR is a database that permanently stores data related to a given set of subscribers. The HLR is the reference database for subscriber parameters. Various identification numbers and addresses as well as authentication parameters, services subscribed, and special routing information are stored. Current subscriber status including a subscriber's temporary roaming number and associated VLR if the mobile is roaming, are maintained.

The HLR is a database used for storage and management of subscriptions. The HLR is considered the most important database, as it stores permanent data about subscribers, including a subscriber's service profile, location information, and activity status.

 The MSC is a very central component of the GSM network. The MSC performs the switching functions of the network and also provides connection to other networks.

 It additionally provides all the functionality needed to handle a mobile subscriber, such as registration, authentication, location updating, handovers, and call routing to a roaming subscriber.

 The VLR is always implemented together with a MSC; so the area under control of the MSC is also the area under control of the VLR.

 The VLR contains selected information from a subscriber's HLR necessary for call control and provisioning of the subscribed services to the visiting user.

 Signaling between functional entities in the Network Subsystem uses Signaling System Number 7 (SS7).

2.4.4 Authentication Centre (AUC)

A unit called the AUC provides authentication and encryption parameters that verify the user's identity and ensure the confidentiality of each call. The AUC protects network operators from different types of fraud found in today's cellular world.

The AUC stores information that is necessary to protect communication through the air interface against intrusions, to which the mobile is vulnerable. The legitimacy of the subscriber is established through authentication and ciphering, which protects the user information against unwanted disclosure. Authentication information and ciphering keys are stored in a database within the AUC, which protects the user information against unwanted disclosure and access.

In the authentication procedure, the key Ki is never transmitted to the mobile over the air path, only a random number is sent. In order to gain access to the system, the mobile must provide the correct Signed Response (SRES) in answer to a random number (RAND) generated by AUC.

- The AUC generates authentication and ciphering data.

- The purpose of the authentication security feature is to protect the network against unauthorized use. It also protects subscribers by denying the possibility for intruders to impersonate authorized users.
- The ciphering data is used to ensure that confidentiality and integrity is kept on the physical radio channels. Ciphering prevents user information and signaling to be available or disclosed to unauthorized individuals.

2.4.5 Equipment Identity Register

The EIR 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.

EIR is a database that stores the IMEI numbers for all registered ME units. The IMEI uniquely identifies all registered ME. There is generally one EIR per PLMN. It interfaces to the various HLR in the PLMN. The EIR keeps track of all ME units in the PLMN. It maintains various lists of message. The database stores the ME identification and has nothing do with subscriber who is receiving or originating call. There are three classes of ME that are stored in the database, and each group has different characteristics:

2.4.5.1 White List:
Contains those IMEIs that are known to have been assigned to valid MS's. This is the category of genuine equipment.
2.4.5.2 Black List:
Contains IMEIs of mobiles that have been reported stolen.
2.4.5.3 Gray List:
Contains IMEIs of mobiles that have problems (for example, faulty software, and wrong make of the equipment). This list contains all MEs with faults not important enough for barring.

2.5 OPERATION AND MAINTENANCE SUBSYSTEM (OMS)

An OMS consists of one or more Operation & Maintenance Centre (OMC).

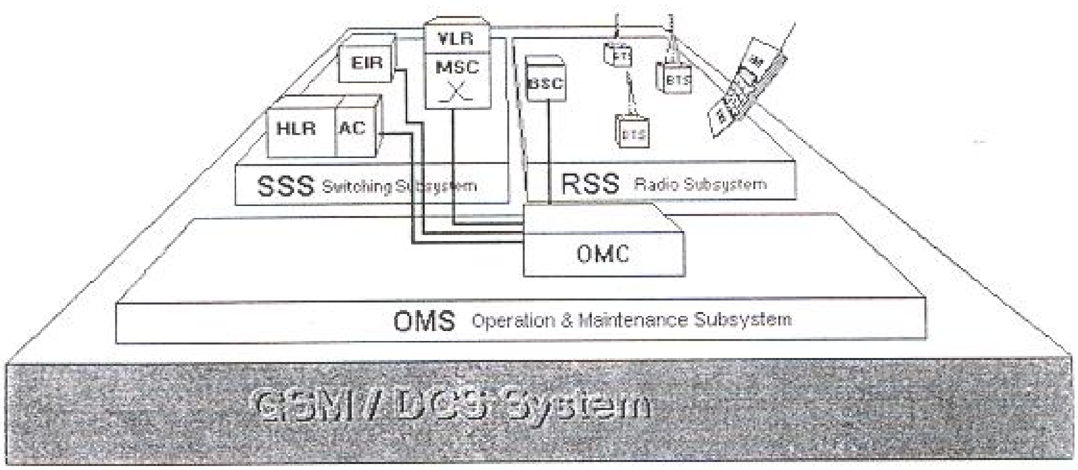


Figure2.15 : Operation Sub System

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. The purpose of OSS is to offer the customer cost-effective support for centralized, regional and local operational and maintenance activities that are required for a GSM network. An important function of OSS is to provide a network overview and support the maintenance activities of different operation and maintenance organizations.

The OMC provides alarm-handling functions to report and log alarms generated by the other network entities. The maintenance personnel at the OMC can define that criticality of the alarm. Maintenance covers both technical and administrative actions to maintain and correct the system operation, or to restore normal operations after a breakdown, in the shortest possible time.

The fault management functions of the OMC allow network devices to be manually or automatically removed from or restored to service. The status of network devices can be checked, and tests and diagnostics on various devices can be invoked. For example, diagnostics may be initiated remotely by the OMC. A mobile call trace facility can also be invoked. The performance management functions included collecting traffic statistics from the GSM network entities and archiving them in disk files or displaying them for analysis. Because a potential to collect large amounts of data exists, maintenance personal can select which of the detailed statistics to be collected based on personal interests and past experience. As a result of performance analysis, if necessary, an alarm can be set remotely.

The OMC provides system change control for the software revisions and configuration data bases in the network entities or uploaded to the OMC. The OMC also keeps track of the different software versions running on different subsystem of the GSM.

CHAPTER 3

ANTENNA

3.1 Introduction:

An antenna is a transducer designed to transmit or receive electromagnetic waves. In other words, antennas convert electromagnetic waves into electrical currents and vice versa. Antennas are used in systems such as radio and television broadcasting, point-to-point radio communication, wireless LAN, radar, and space exploration. Antennas usually work in air or outer space, but can also be operated under water or even through soil and rock at certain frequencies for short distances .

Figure3.1: Microwave Antenna

Figure3.2 : GSM Antenna

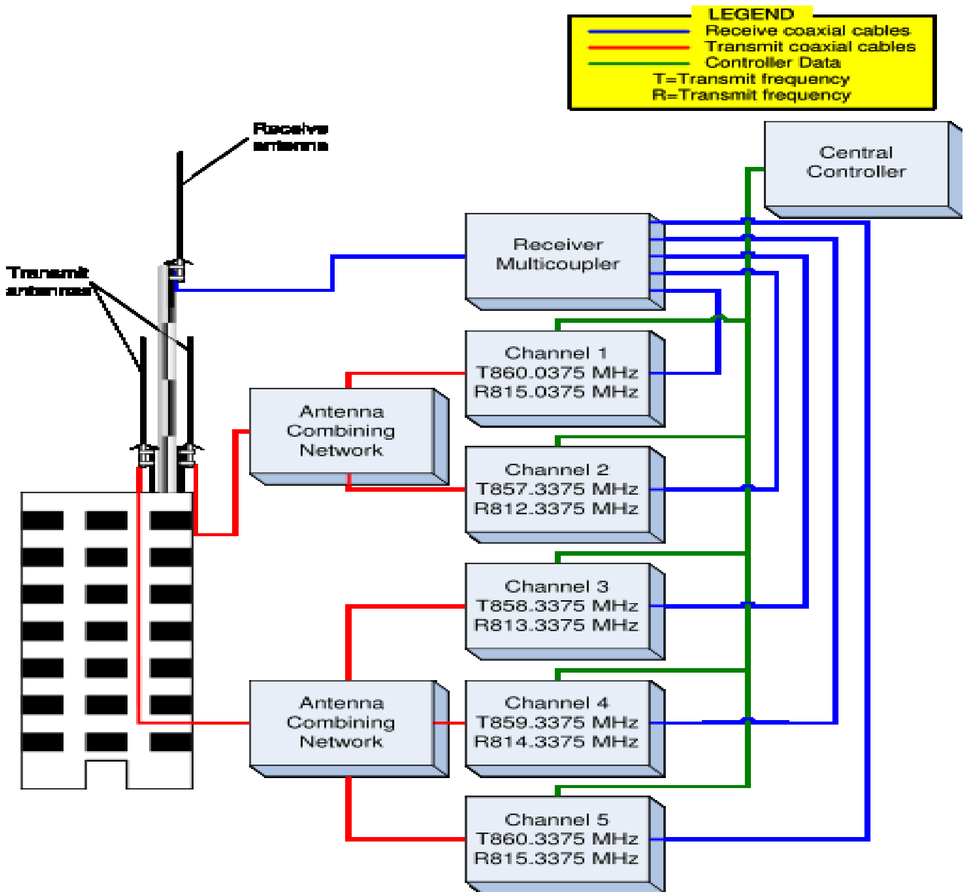


Figure 3.3: The Transmitter and Receiver Block Diagram

3.2 Antenna properties:

3.2.1 Electrical properties

- Operation Frequency Band
- Input impedance
- VSWR
- Polarization
- Gain
- Radiation Pattern
- Horizontal/Vertical beam width
- Down tilt
- Front/back ratio
- Side lobe suppression and null filling
- Power capability
- 3rd order Intermediation
- Insulation

3.2.2 Mechanical properties

- Size
- Weight
- Random material
- Appearance and color
- Working temperature
- Storage temperature
- Wind load
- Connector types
- Package Size
- Lightening

3.3 Antenna parameters

There are several critical parameters that affect an antenna's performance and can be adjusted during the design process. These are resonant frequency, impedance, gain, aperture or radiation pattern, polarization, efficiency and bandwidth. Transmit antennas may also have a maximum power rating, and receive antennas differ in their noise rejection properties. All of these parameters can be measured through various means

- Resonant frequency
- Antenna gain
- Radiation pattern
- Impedance
- Efficiency
- Bandwidth
- Polarization
- Transmission and reception

3.4 Transmission and reception

All of the antenna parameters are expressed in terms of a transmission antenna, but are identically applicable to a receiving antenna, due to reciprocity.

Antenna tuning is done by adjusting an inductance or capacitance combined with the active antenna (but distinct and separate from the active antenna). The inductance or capacitance provides the reactance which combines with the inherent reactance of the active antenna to establish a resonance in a circuit including the active antenna. Components, which may require larger and heavier supporting structures. This is a concern only for transmitting antennas, as the power received by an antenna rarely exceeds the microwatt range.

3.5 Antenna aperture

As a receiver, antenna aperture can be visualized as the area of a circle constructed broadside to incoming radiation where all radiation passing within the circle is delivered by the antenna to a matched load. (Note that transmitting and receiving are reciprocal, so the aperture is the same for both.) Thus incoming power density (watts per square meter) x aperture (square meters)= available power from antenna (watts). Antenna gain is directly proportional to aperture. An isotropic antenna has an aperture of

$$\frac{\lambda^2}{4\pi}$$

where λ is the wavelength. An antenna with a gain of G has an aperture of

.

$$\frac{G\lambda^2}{4\pi}$$

Generally, antenna gain is increased by directing radiation in a single direction, while necessarily reducing it in all other directions since power cannot be created by the antenna. Thus a larger aperture produces a higher gain and narrower beam width.
Large dish antennas, many wavelengths across, have an aperture nearly equal to their physical area [5].

3.5.1 Antenna effective area

In telecommunication, antenna effective area is the functionally equivalent area from which an antenna directed toward the source of the received signal gathers or absorbs the energy of an incident electromagnetic wave.

Note 1: Antenna effective area is usually expressed in square meters.

Note 2: In the case of parabolic and horn-parabolic antennas, the antenna effective area is about 0.35 to 0.55 of the geometric area of the antenna aperture.

$$A_{\text{eff}} = \frac{P_0}{P}$$

Where P0 is the power absorbed by the antenna in watts, and P is the power density incident on the antenna in watts per square meter. It is assumed that the antenna is terminated with a matched load to absorb the maximum power.

3.5.2 Relationship to antenna gain

The effective area is related to the antenna gain by

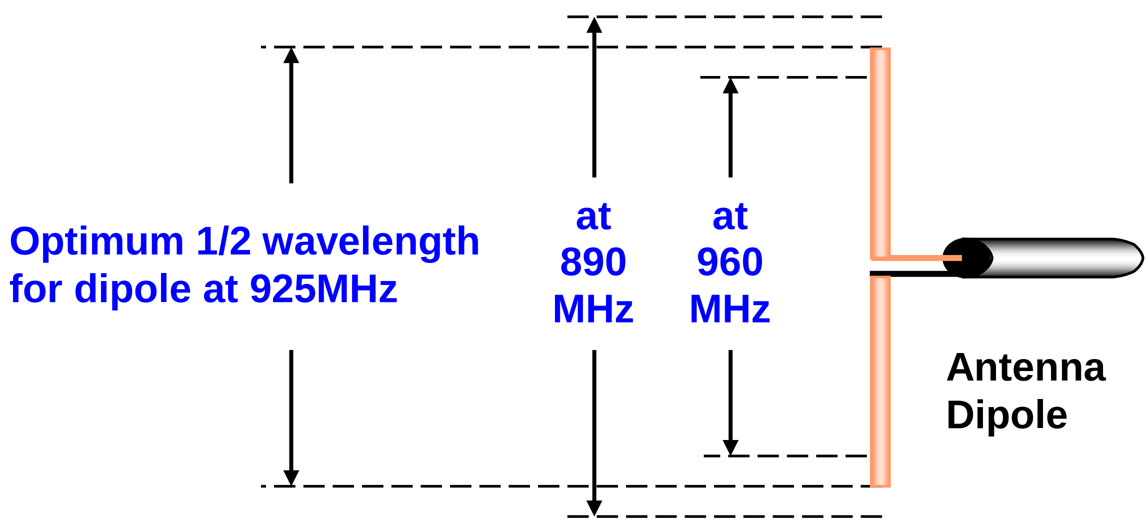
$$A_{\text{eff}} = \frac{\lambda^2}{4\pi} G$$

where G is the antenna gain (not in decibels) and λ is the wavelength. This formula can be derived as a consequence of electromagnetic reciprocity which relates the transmit properties of an antenna to the receiving properties. It may not hold if the antenna is made with certain non-reciprocal materials. Like the antenna gain, the effective area varies with direction. If no direction is specified, the maximum value is assumed.

3.6 Frequency Range

- GSM 900 : 890-960MHz
- GSM 1800 : 1710-1880MHz
- GSM dual band : 890-960MHz & 1710-1880MHz
- eg.824-960MHz, 1710-1900MHz

3.7 Bandwidth of GSM Antenna



***BANDWIDTH* = 960 - 890 = 70MHz**

3.8 Impedance:

The Impedance of GSM antenna is 50Ω

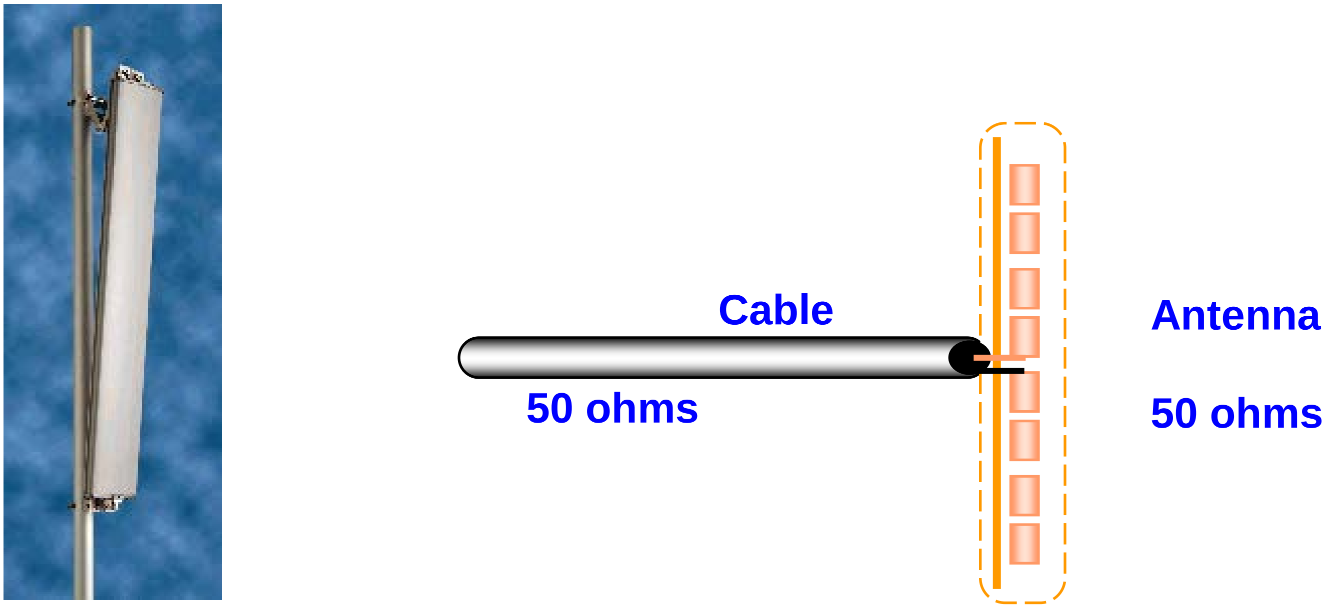


Figure 3.4 : GSM antenna

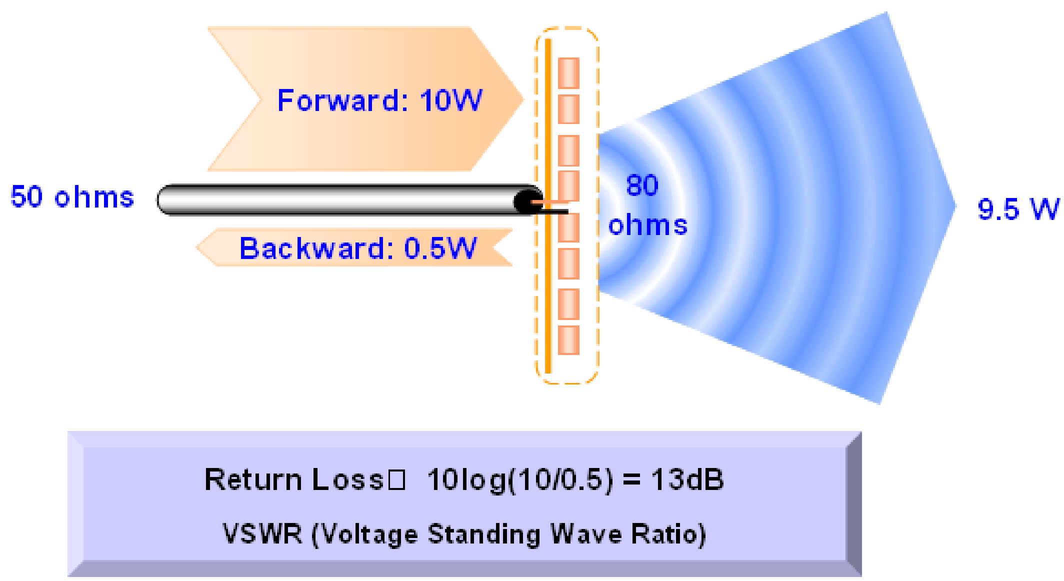


Figure 3.5: Return loss of GSM antenna.

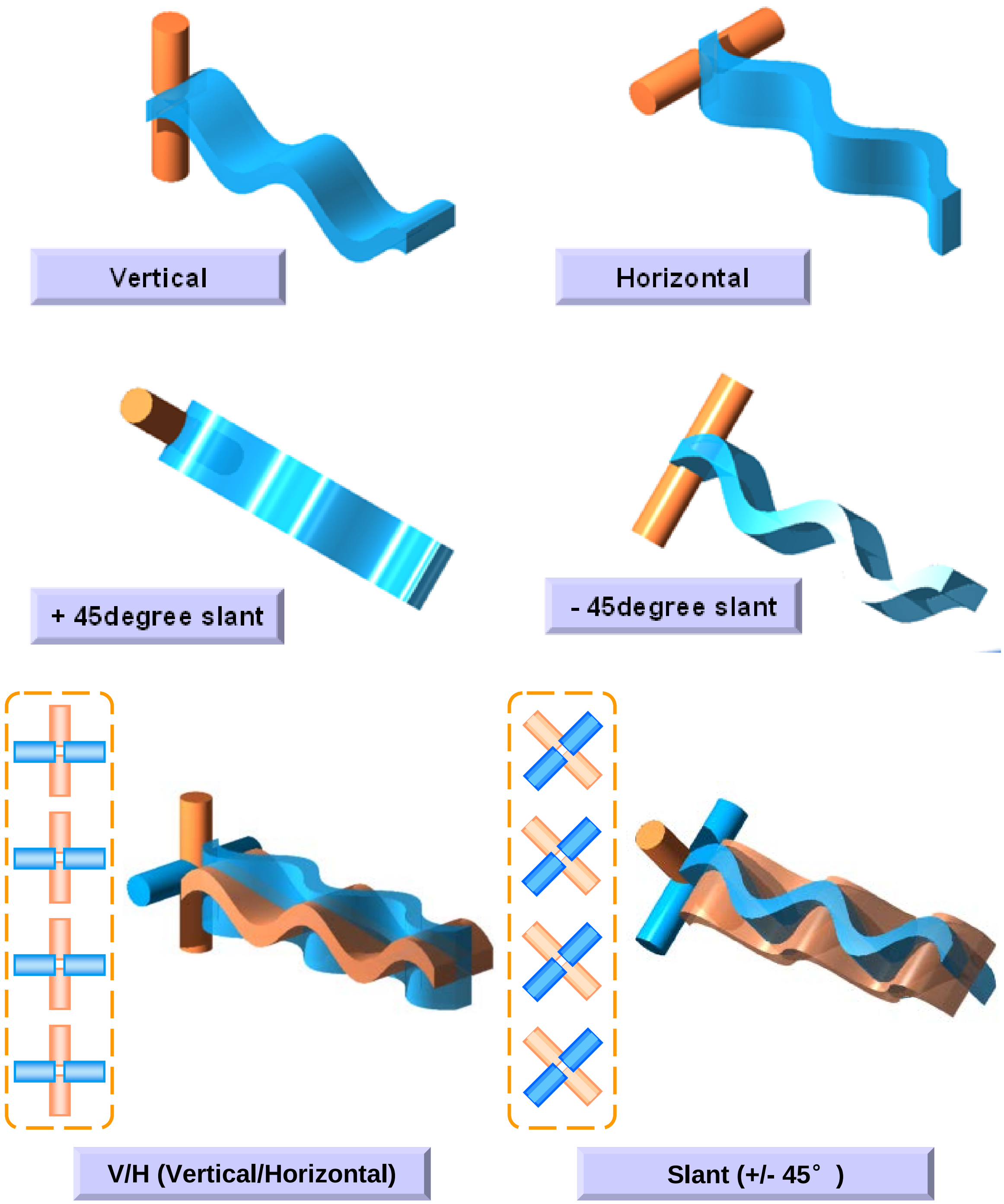


Figure 3.6 : Polarization

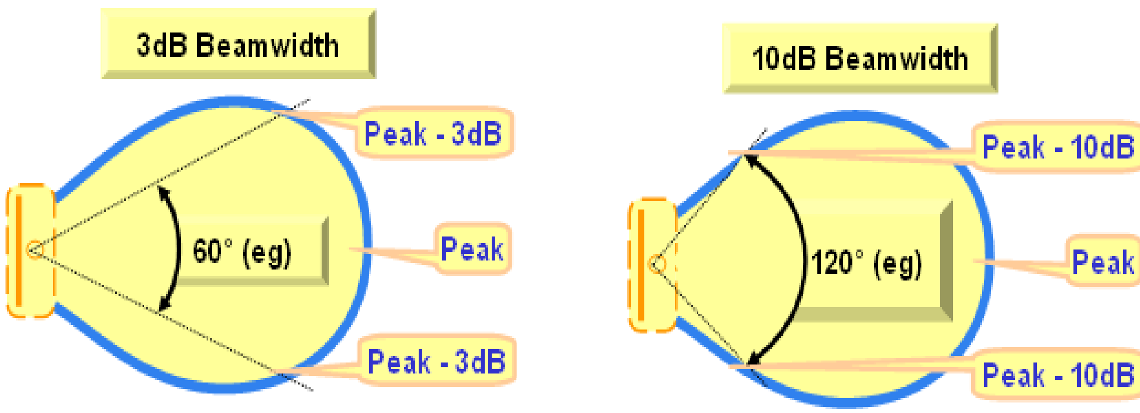


Figure 3.7: Beamwidth

3.9 Uses of GSM antenna considering the gain:

- 1 From 0dBi to 20dBi used in locale
- 2 0-8 dbi used indoor
- 3 The OMNI antenna is off from 9 to 12dbi,the sectoring antenna used often the gain is from 15.5dbi to 18.5dbi
- 4 The antenna Gain more than 20dbi only used for the road.

CHAPTER 4

Transmission

4.1 Introduction:

The GSM use radio equipment to transfer information between the mobile station and the GSM network. Anyone who has travelled in a car while listening to a radio broadcast has surely noticed that the quality of the received signal changes from time to time, for example when go through a tunnel or between two hills. This particular effect is called shadowing or log normal fading and is only one of many annoying facts one has to deal with in the wireless world. In this chapter cover some of the major problems involved in the cellular radio environment, together with some actions taken to reduce these problems. Additionally, describe some principles of digital communications in general terms, speech coding, channel coding.

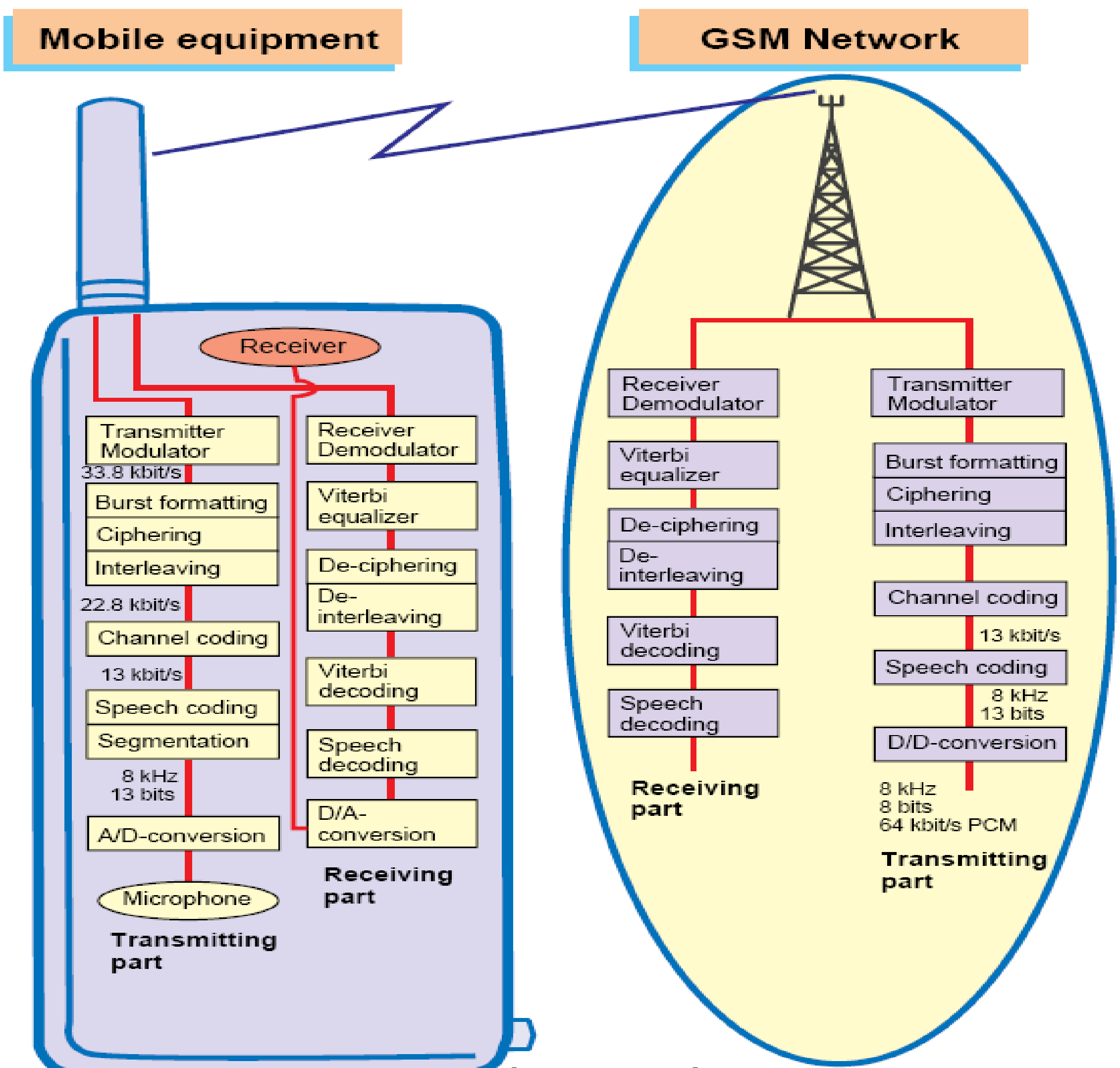


Figure-4.1: Schematic Signal Processing

Figure-7 shows the signal processing blocks very schematically. We can see that signal processing is performed both in the mobile equipment and on the network side.

4.1.1 Mobile transmitting side :

First the analogue speech is digitized by the A/D–converter (analogue–to–digital). Then it is divided into segments of 20 ms, which are fed into the speech coder for reduction of the bit rate. The next step is channel coding and interleaving (processes enabling error correction and error detection on the receiving end). Ciphering of the speech (to protect from eavesdropping), and burst formatting (adding start and stop bits, flags etc.) is carried out. The last step is to modulate the bit stream on a carrier and then to transmit the signal.

4.1.2 Receiving side:

On the receiving side the corresponding procedure is performed. The difference between the mobile equipment side and the network side is mainly that the speech is not A/D– or D/A–converted on the network side. The network will transmit digital signals through the network while the mobile equipment has to convert it to understandable speech directly. If we have data instead of speech to transmit, of course no A/D– or D/A–conversion is performed on the mobile side, neither is the data fed through the speech coder. There is also another type of channel coding, since data is much more sensible to transmission errors.

4.2 SPEECH CODING:

If we look at PCM–coded speech, (see Figure 1) we see that each speech channel delivers 64 kbit/s. 8 such channels would then give rise to a bit rate of 512 kbit/s over the air interface. That is with no transmission reliability added.

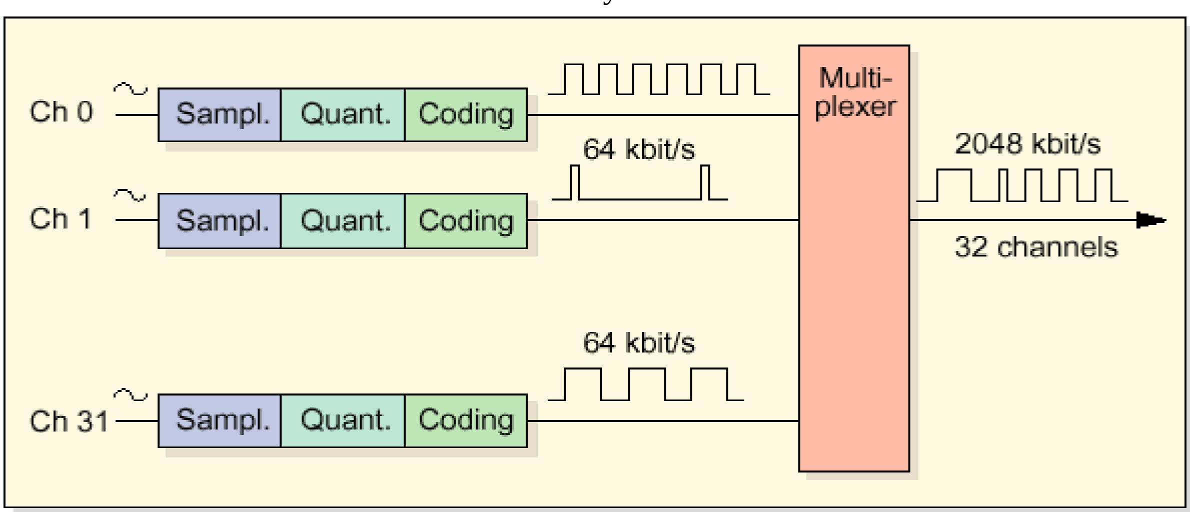


Figure 4.2: Multiplexing 32 channels on to one PCM link

- We must somehow lower the bit rate significantly for each speech channel to be able to keep within the allowed frequency band. This is accomplished by ***speech***

coding. Since we know how speech is created - we can create all parametric model of the speech. Speech coders are such equipments.

There are mainly three types of speech coders, these are-

- Waveform coders.
- Vocoders.
- Hybrid coders

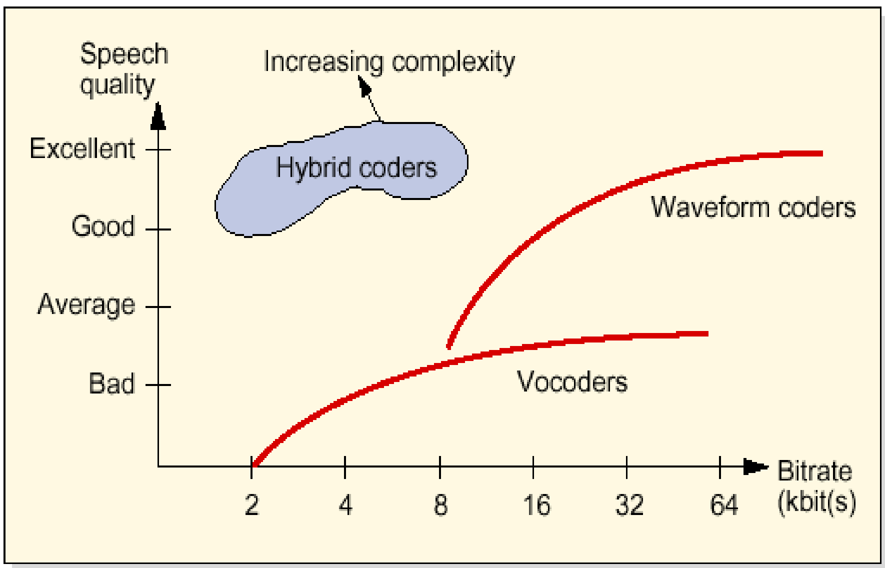


Figure 4.3: Speech Quality vs. Bit Rate

4.2.1 Channel coding:

With digital transmission, the quality of the transmitted signal is often expressed in terms of "how many of the received bits are correct" leading to the expression Bit Error Rate (BER). BER says how many percent of the total number of bits are wrongly detected. Of course we want this number or rate to be as small as possible. It is, however, not possible to reduce it to zero, due to the constantly changing transmission path. This means that we have to allow a certain amount of errors and yet be able to restore the information, or at least be able to detect errors so that we do not use the information as if it were true. This is especially important when we send data - we can accept lower quality for speech. With channel coding, we can detect and correct errors in the received bit stream. This means that there is some redundancy in the bits - we spread out the information from a few bits to a larger number of bits.Error control codes can be divided into two categories, *block codes* and *convolution codes*

4.3 Modulation:

The modulation method used in GSM is Gaussian Minimum Shift Keying, (GMSK). It is a digital modulation form, i.e. the information to be sent is digital. It could be data or digitized speech. The modulator could be looked upon as a phase modulator. The carrier changes phase depending on the information bits sent into the modulator. GMSK includes the desirable feature of a constant envelope modulation within a burst. To get smooth curve shapes when changing the phase, the base band signal is filtered with a Gaussian pass band. With GMSK we get narrower bandwidth compared to ordinary MSK, but the price for this is less resistance against noise

4.4 Transmission problem:

The signal strength variation of the received signal is called *fading*- time, distance and frequency dependent attenuation over the air interface.
The most important fading types are:

- Path Loss Fading.
- Log-normal-fading (due to shadowing).
- Rayleigh fading (multi-path fading).
- Time dispersion.
- Time alignment.

4.4.1 Path Loss:

Path loss is the phenomenon which occurs when the received signal becomes weaker and weaker due to increasing distance between mobile and base station. There are no obstacles between transmitting (Tx) and receiving (Rx) antenna. For the free space case we say that for a given antenna the received power density is inversely proportional to the square of the distance, d, between the Tx– and Rx–antennas. The received power is also said to be inversely proportional to the square of the transmitting frequency, f.

Free Space Path Loss

- In telecommunication, free-space path loss (FSPL) is the loss in signal strength of an electromagnetic wave that would result from a line-of-sight path through free space, with no obstacles nearby to cause reflection or diffraction.

- For typical radio applications, it is common to find *f* measured in units of MHz and *d* in km, in which case the FSPL equation becomes

4.4.1.1 Free-space path loss in decibels

A convenient way to express FSPL is in terms of dB:

$$\begin{aligned}\mathrm{FSPL(dB)} &= 10\log_{10}\left(\left(\frac{4\pi}{c}df\right)^2\right) \\ &= 20\log_{10}\left(\frac{4\pi}{c}df\right) \\ &= 20\log_{10}(d) + 20\log_{10}(f) + 20\log_{10}\left(\frac{4\pi}{c}\right) \\ &= 20\log_{10}(d) + 20\log_{10}(f) - 147.56\end{aligned}$$

where the units are as before.

For typical radio applications, it is common to find *f* measured in units of MHz and *d* in km, in which case the FSPL equation becomes [8]

$$\mathrm{FSPL(dB)} = 20\log_{10}(d) + 20\log_{10}(f) + 32.44$$

4.4.2 Log-normal-fading:

The number and size of hills, buildings and other obstacles between the transmitter and receiver change when the MS moves around. This gives rise to log-normal-fading due to shadowing. Too heavily shadowed areas cause a decrement of quality. By an appropriate cell planning, problems with shadowing can be solved.

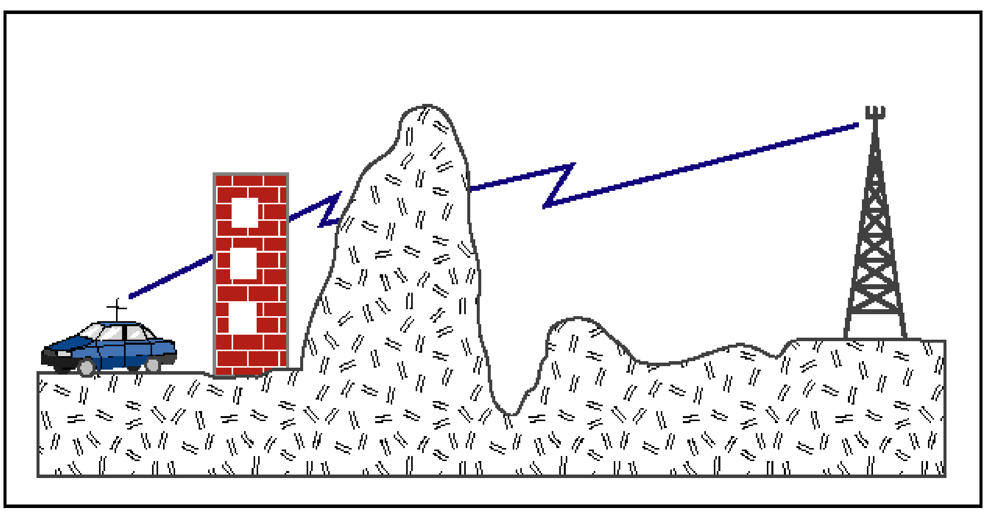


Figure4.4: Log-normal-fading

Transmission

4.2.3 Rayleigh (Multi-path) fading:

Rayleigh fading is a city problem and occurs when the signal goes more than one way from the transmitter to the receiver (due to bouncing on buildings).

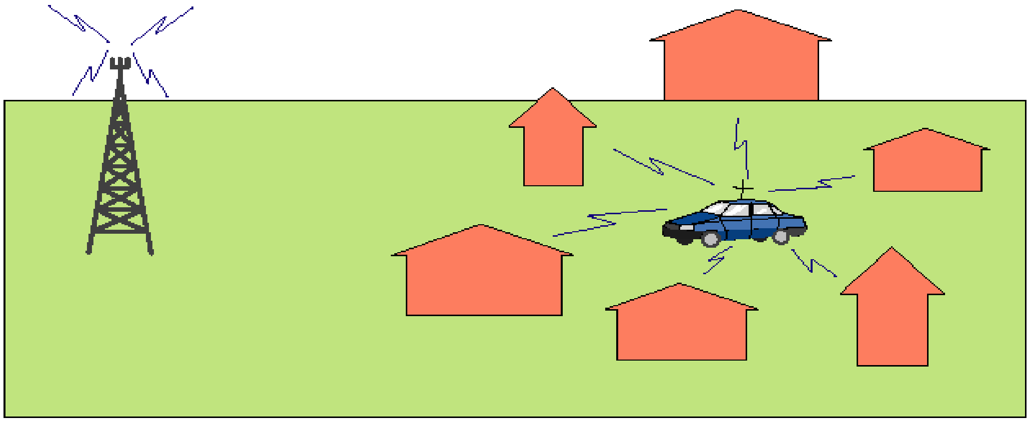


Figure-4.5: Multi path (Rayleigh) fading

The received signal is a sum of many identical signals which differ only in phase (and to some extent in amplitude). While we add signals like vectors, it can unfortunately mean that the vector sum turns out to be very close to zero which means that the signal strength also becomes very close to zero - a very severe fading dip indeed.

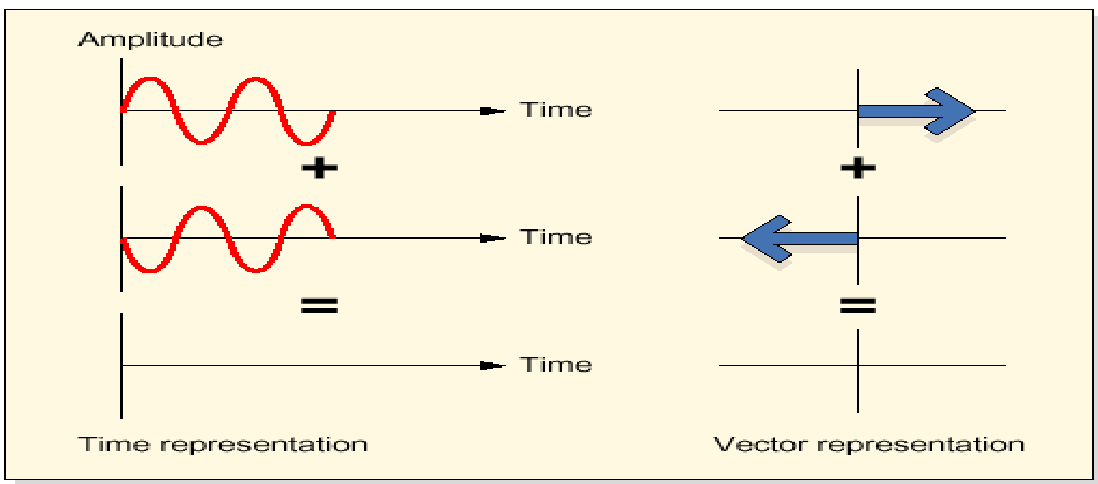


Figure-4.6: Adding two anti-phase signals

An illustration of how the signal strength may look like at the MS Rx–antenna as move away from the BTS Tx–antenna is shown in Figure-5. It covers all the fading types discussed so far.

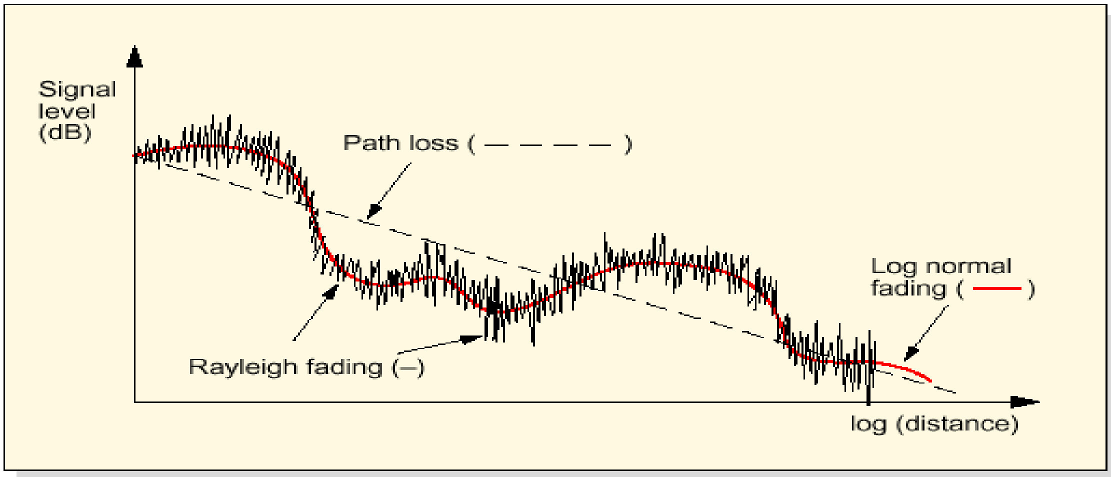


Figure-4.7: Rx signal strength versus distance

4.2.4 Time Dispersion:

The introduction of digital transmission brings another problem: time dispersion. This also has its origin in reflections, but in contrast to multi-path fading, the reflected signal comes from an object far away from the Rx–antenna, say in the order of kilometers. The time dispersion causes Inter Symbol Interference (ISI). ISI means that consecutive symbols interfere with each other and it gets difficult on the receiver side to decide which actual symbol is detected (or actually, sent).An example of this is shown in Figure-6 . The sequence 1, 0 is sent from the base station. If the reflected signal arrives exactly one bit time after the direct signal, then the receiver will detect a 1 from the reflected wave at the same time, as it detects a 0 from the direct wave. The symbol 1 interferes with the symbol 0.

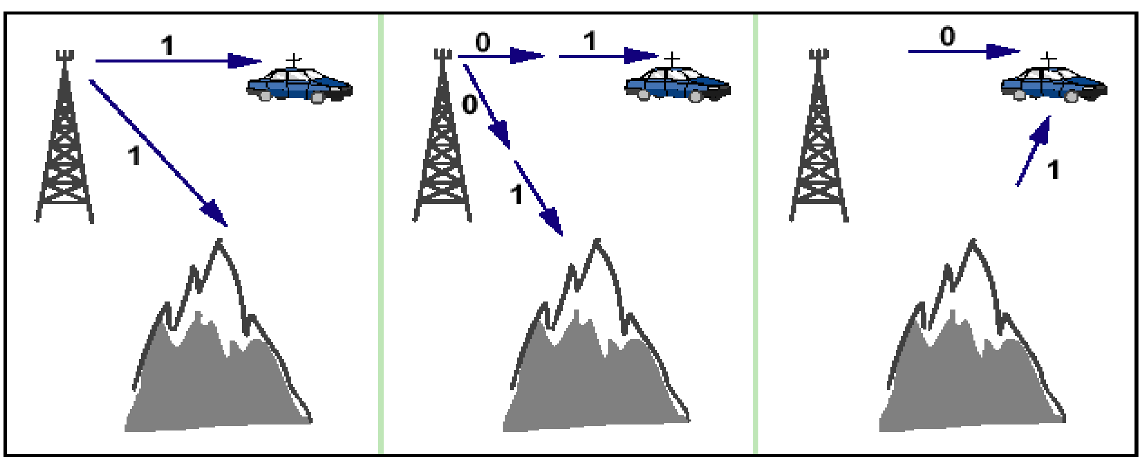


Figure-4.8: Time Dispersion

- In GSM, the net bit rate over the air interface is 270.8 kbit/s, which leads to a bit time of 3.7 µs.
- One bit therefore corresponds to 1.1 km, so if we have a reflection from 1 km behind the mobile station, the reflected signal will have a 2 km longer path than the direct one.
- This means that the reflection will mix a signal coming two bit–times later than the wanted signal, with the wanted signal.
- Time dispersion would appear to be a tricky problem, and it is, but further on in this chapter we will discover that it might not be as bad as it seems.

4.2.5 Time alignment:

Using TDMA means that the mobile must transmit only during the allocated time slot and be silent the rest of the time. Otherwise it will interfere with calls from other mobiles using different time slots on the same carrier. Say that a mobile is very close to the base station. It is allocated time slot 3 (TS 3) and is only using this time slot for the call. During the call, the mobile moves away from the base station so whatever is sent from the base station arrives later and later to the mobile and the answer from the mobile also arrives later at the base station. If nothing is done, the delay will eventually be so long that what this mobile transmits in TS 3 will overlap what the base station receives in TS 4 - another call.

4.2.6 Solution Of Multi-path Fading:

The communication channel used in GSM is a Fading Channel. Multi-path fading results from a signal traveling from a transmitter to a receiver by number of routes. This is caused by the signal being reflected from objects, or being influenced by atmospheric effects as it passes for example the layers of air of varying temperatures and humidity.

GSM offers five techniques which combat multi-path fading:

- Equalization.
- Diversity.
- Frequency hopping.
- Interleaving.
- Channel coding.

4.2.6.1 Equalization:

Due to signal dispersion caused by multi-path signals the receiver cannot be sure exactly when a burst will arrive and how to distorted it will be. To help the receiver to identify and synchronize to the burst, a training sequence is sent at the center of the burst. This is a set sequence of bits that is known by both the transmitter and receiver.

An equalizer is in charge of extracting the 'right' signal from the received signal. It estimates the channel impulse response of the GSM system and then constructs an inverse filter. The receiver knows which training sequence it must wait for. The equalizer will then, comparing the received training sequence with the training sequence it was expecting, compute the coefficients of the channel impulse response. In order to extract the 'right' signal, the received signal is passed through the inverse filter.

4.2.6.2 Diversity:

Signals arrive at receiver antenna from multiple paths. The antenna therefore receives the signals at different phases, some at peak and some at trough. This means that some signals will add together to form a strong signal, while others will subtract causing weak signal.

When diversity is implemented, two antennas are situated at the receiver. These antennas are placed several wavelengths apart to ensure minimum correlation between the two receive paths. The two signals are then combined and the signal strength is improved.

4.2.6.3 Frequency hopping:

The propagation conditions and therefore the multi-path fading depend on the radio frequency. In order to avoid important differences in the quality of the channels, the slow frequency hopping is introduced. The slow frequency hopping changes the frequency with every TDMA frame(4.615 ms). A fast frequency hopping changes the frequency many times per frame but it is not used in GSM. The frequency hopping also reduces the effects of co-channel interference.

There are different types of frequency hopping algorithms. The algorithm selected is sent through the Broadcast Control Channels.

4.2.6.4 Channel coding and interleaving:

Channel coding and interleaving reduce the error of received signal the BER curves will get better after using interleaving and channel coding.

CHAPTER 5

GSM RADIO NETWORK PLANNING

5.1 CELLULAR CONCEPT

In order to guarantee a seamless coverage, in a cellular network the service areas of the individual cells partially overlap. As a result, if the same frequency is used in these overlapping areas, interference between neighboring cells will occur. The subscribers' mobile stations will not be able to distinguish the different signals reaching that area from different base stations. For this reason all cell surrounding one cell in the cell structure must use frequencies differing from those used in the one central cell.

Frequency channels are a limited resource; each operator has only a limited number of channels, so there cannot be used different channels in all cells over the whole network. For these reason cellular networks are commonly organized according to the principle of cellular systems, frequency re-use. Examples of cellular network not using frequency re-use are the IS-95 and the UMTS network. They are CDMA networks, where cells are distinguished by codes and not by frequency.

In GSM the narrow available frequency range is divided into individual frequencies (channels) .Only some of these channels are used in a certain cell, the remaining channels are used in the adjacent cells. The same frequency is used again in cells, which are sufficiently far apart from other to avoid inter-channel interference. This means that any area can be covered and thus an enormous increase in network capacity can be achieved with a small supply of channel frequencies.

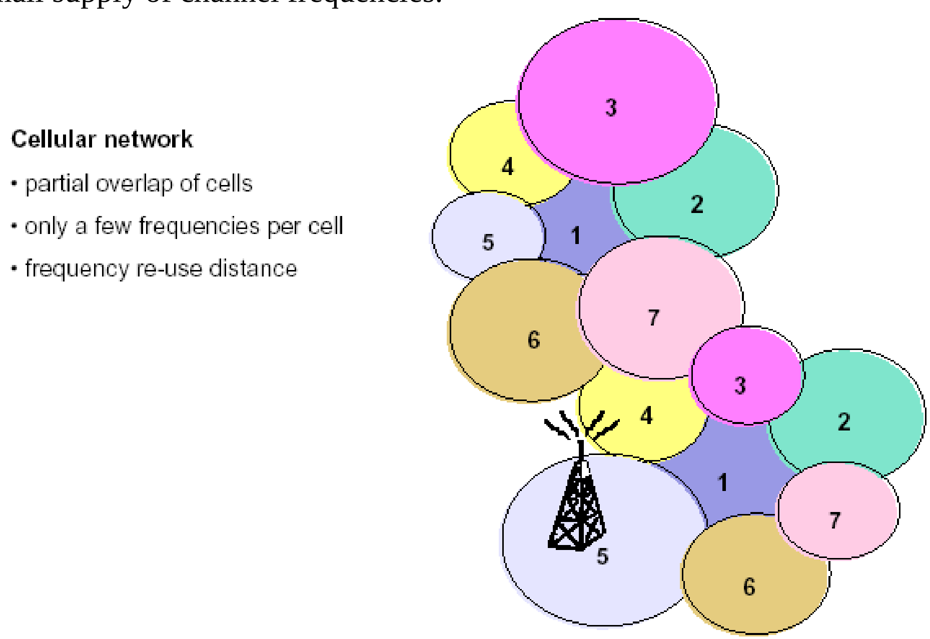


Figure 5.1 : Cell

5.2 CLUSTER

A certain minimum distance must be maintained between cells using the same frequencies in order to prevent interference or at least keep it to a bare minimum. This minimum distance, the so-called frequency re-use distance, depends on the concrete network planning and corresponds to approximately 4 times the cell radius. On this principle, the available channels can be dividing e.g. into 7 parts and distributed over the PLMN area in such a way that each cell contains one of these 7 sets of frequency channels. The minimum area in which the whole ranges of HF channels are used is described as a cluster. Planning a concrete network implies that the population/ traffic density, the topography of the area to be supplied, etc. must be taken into account.

The honeycomb structure represented here would apply to the deserted flat area of our example only; in real life frequency planning is such a difficult matter that in any case a sophisticated network planning software is needed.

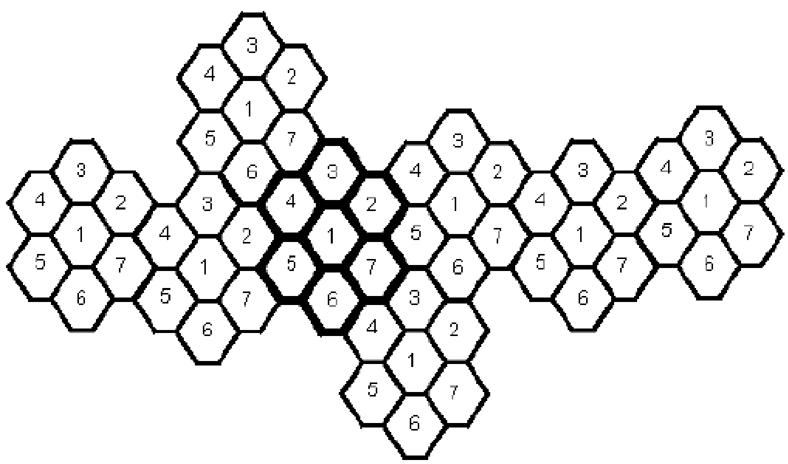


Figure 5.2 : Cluster

5.3 GSM 900/ GSM 1800/ GSM 1900 FREQUENCY BANDS

A specific frequency range is assigned to GSM 900/ GSM 1800/ GSM 1900 systems. Each frequency range is divided into two sub-bands-

1. Uplink (UL) for the radio transmission between the MS and the BTSE
2. Downlink (DL) for the radio transmission between the BTSE and the MS

The fact that different frequency bands are used for uplink and downlink transmission is called frequency division duplex (FDD).

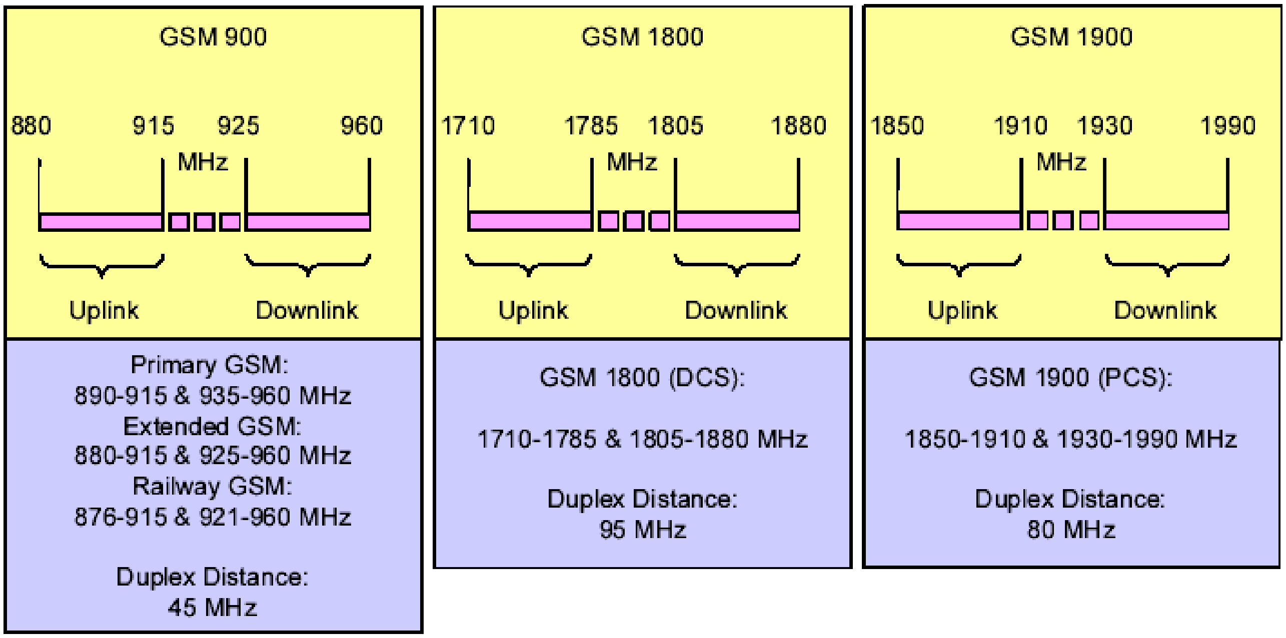


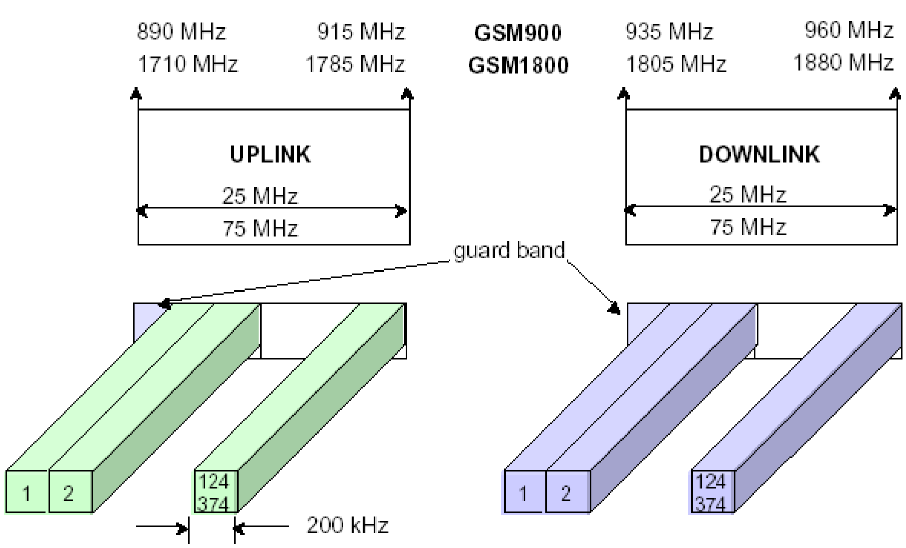
Figure 5.3: GSM Frequency Bands

5.4 RADIO FREQUENCY CARRIERS (RFC)

Both sub-bands (UL and DL) are divided into radio frequency carriers with a bandwidth of 200 kHz each called Frequency Division Multiple Access (FDMA).

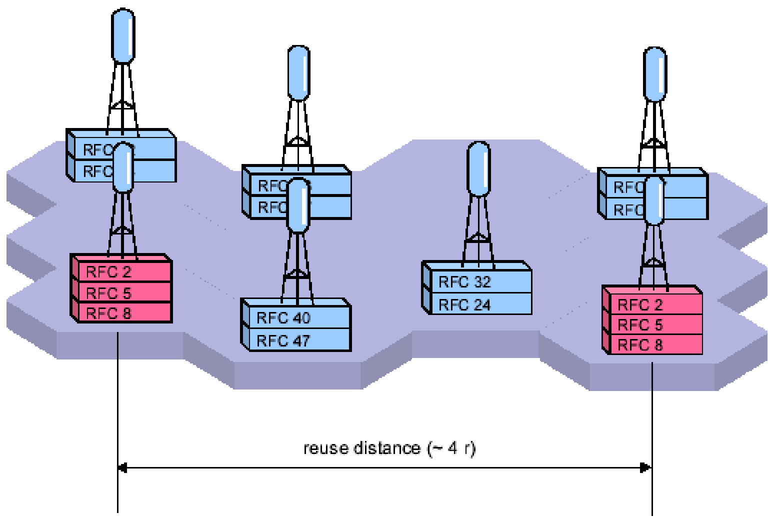
The differences between GSM 900, GSM 1800 (DCS) and GSM 1900 (PCS) relate to:

- Operating frequency
- Bandwidth of the sub-bands
- Number of radio frequency carriers RFC available



Depending on traffic volume, every radio cell uses one or more RFC. Since the number of RFC is limited, the same RFC must be used several times. To avoid co-channel interference, a safe distance is required between the BTSE using the same RFC. This safe distance is called reuse distance.

The size of the single cell depends on topology and on traffic volume. In hilly regions or in densely populated areas with high traffic volume the cell radius is kept small. A small cell radius can be achieved by reducing the output power of the base station.



5.5 PHYSICAL CHANNEL

One RFC is divided into eight times slot called Time Division Multiple Access (TDMA). This is comparable to pulse code modulation (transmission) technology where PCM 30/24 frames are composed of 32/24 time slots, respectively.

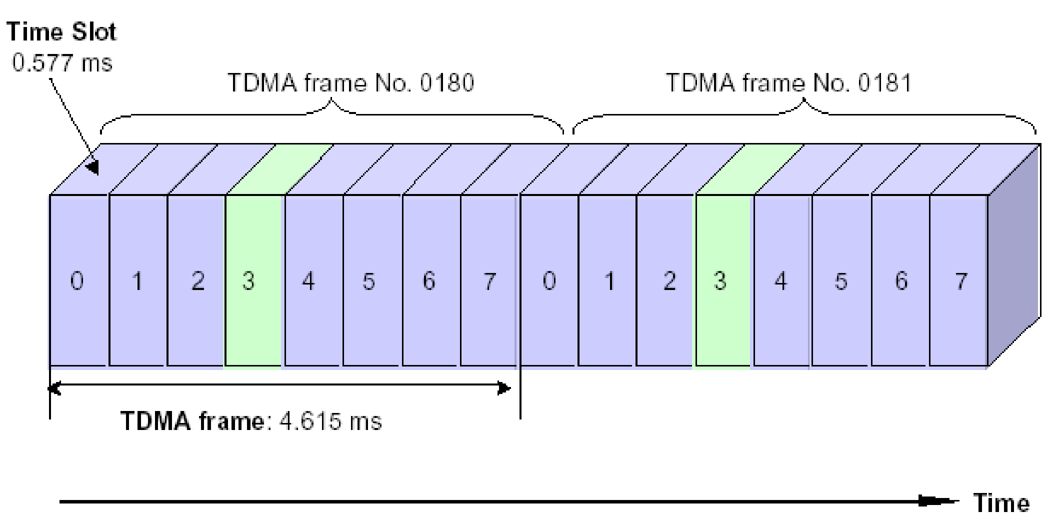
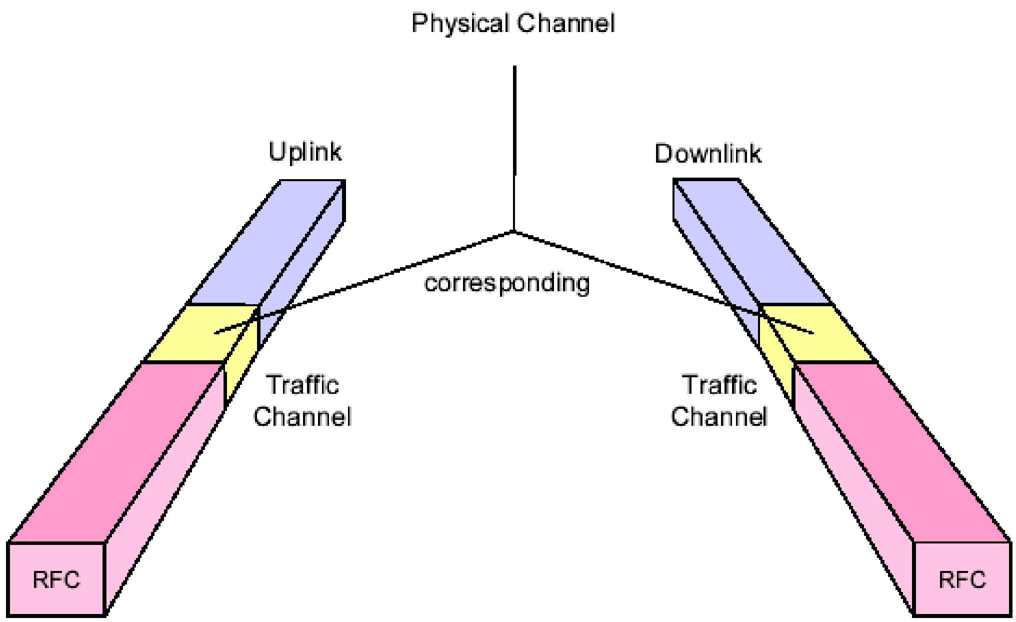


Figure 5.4 : TDMA frame

A physical channel is defined by the timeslot number (in the TDMA frame) on a specific carrier (RFC) in the uplink band and the corresponding carrier in the downlink band.

A physical channel may carry only one or several logical channels (multiplexing).



5.6 CELL COVERAGE

5.6.1 Omni cells:

- The BTS is equipped with omni-directional antenna and serves a 360^0 angle.
- Omni cells are often employed in the countryside or in general areas with a low traffic density.

5.6.2 Sector cells: The BTS supplies the cells with directional antenna. The cell shape is circular segment. Sectors of e.g. 180^0 or 120^0 but also 60^0 are covered.

- 180^0 sector cells are usually employed along major communication roads as highways or urban thoroughfares.
- 120^0 sector cells are typical for urban areas.
- 60^0 sector cells have been developed for extreme traffic situations as for example urban hotspots like railway stations or particular indoor solutions.

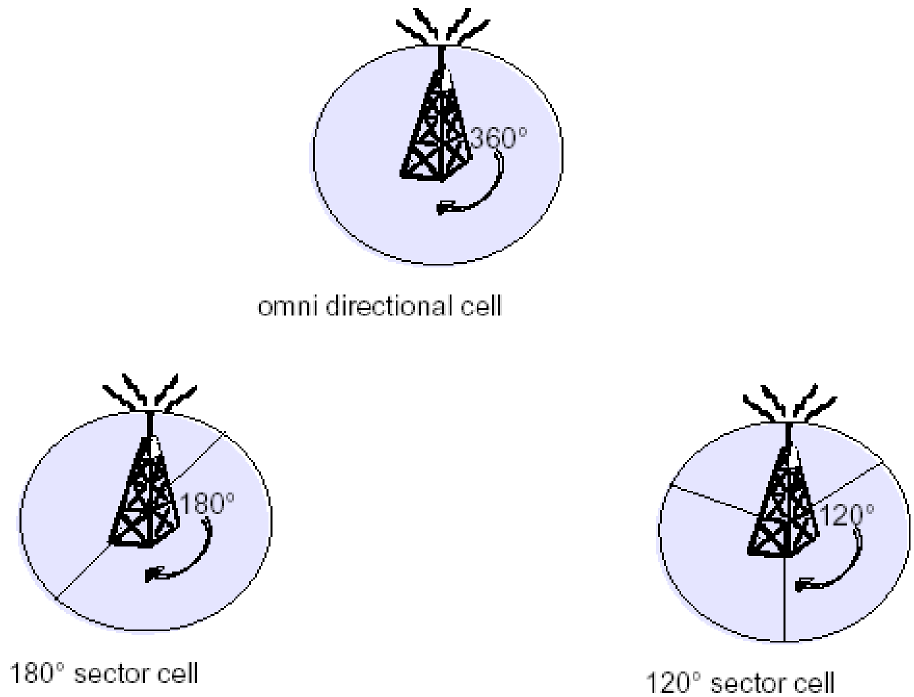


Figure 5.5: Sector Cell

5.7 CELL SIZE

The size and shape of the cell depend on:

- The range of the MS radio contact (MS output peak power); topography (e.g. mountains, buildings, vegetation etc) and climate play a role here.
- Traffic density

The maximum radius of a cell broadcast channel is 35 km the GSM900 system, 8 km in the GSM1800 system. The possibility of setting up “extended range cells” with a radius of up to 100km has been integrated into GSM phase2+ for GSM900 systems. This should allow coverage of sparsely populated areas and especially coastal regions. The extended cell concept results in a reduced capacity.

Transmit power is limited for higher traffic densities in order to achieve a high degree of re-use of frequencies over smaller cells: the size of clusters is inversely proportional to the capacity of the radio system.

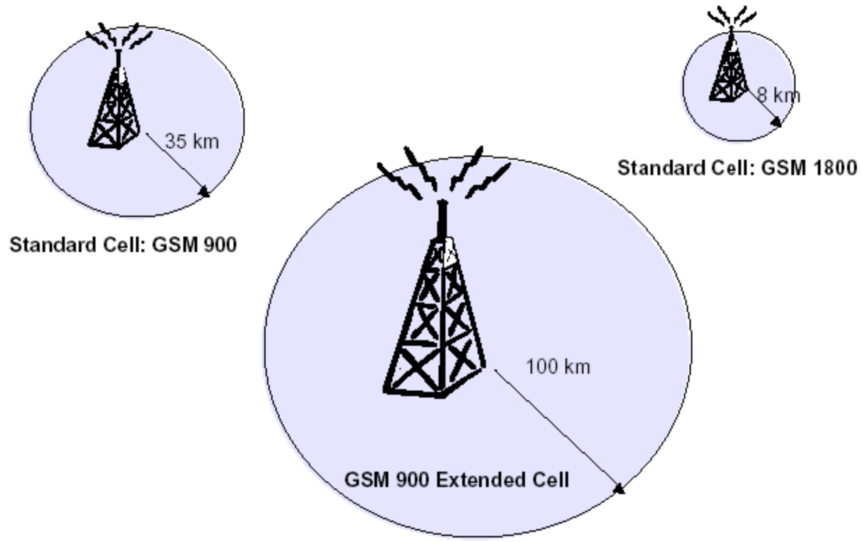


Figure 5.6: Cell size corresponding frequency bands

5.8 HIERARCHICAL CELLULAR STRUCTURES

A hierarchical cell concept is planned for towns with an extremely high density of mobile subscribers

5.8.1 Macro-Cell: The normal cells are called macro cells. They have ranges from approximately one km to several (extended cell concept :100km)

A macro cell superimposed to an existing network structure such that it covers a certain number of cells is commonly appealed as umbrella cell. Umbrella cells are hierarchical floating above the network and can be used as a traffic buffer for urban network cells. In case of a traffic overflow in one or more cells, some running traffic connection can be handed over to the umbrella cell so that the existing connection requests can be accepted by the hierarchical lower cell.

5.8.2 Micro-Cell: Typical urban cell. Sometimes used in restricted areas with very high mobile user density, e.g. shopping malls, railway and subway stations, airport terminals. Their radius ranges from some 100 meters to approximately 1km

5.8.3 Pico-Cell: Cells for the support of indoor applications, e.g. offices. Their range should be several 10km

A Pico cell can be implanted inside a hierarchical lower position in a micro or macro cell. This is typically done in high traffic density locations where a micro cell is not sufficient for handling all the connection requests. This kind of implantation can also be temporary, by using mobile base stations. A typical example could be the Oktoberfest, where for a limited period the amount of traffic rises dramatically in a restricted area. After that period the mobile base station are uninstalled again

Velocity dependent handover are necessary in the hierarchical cellular structures.

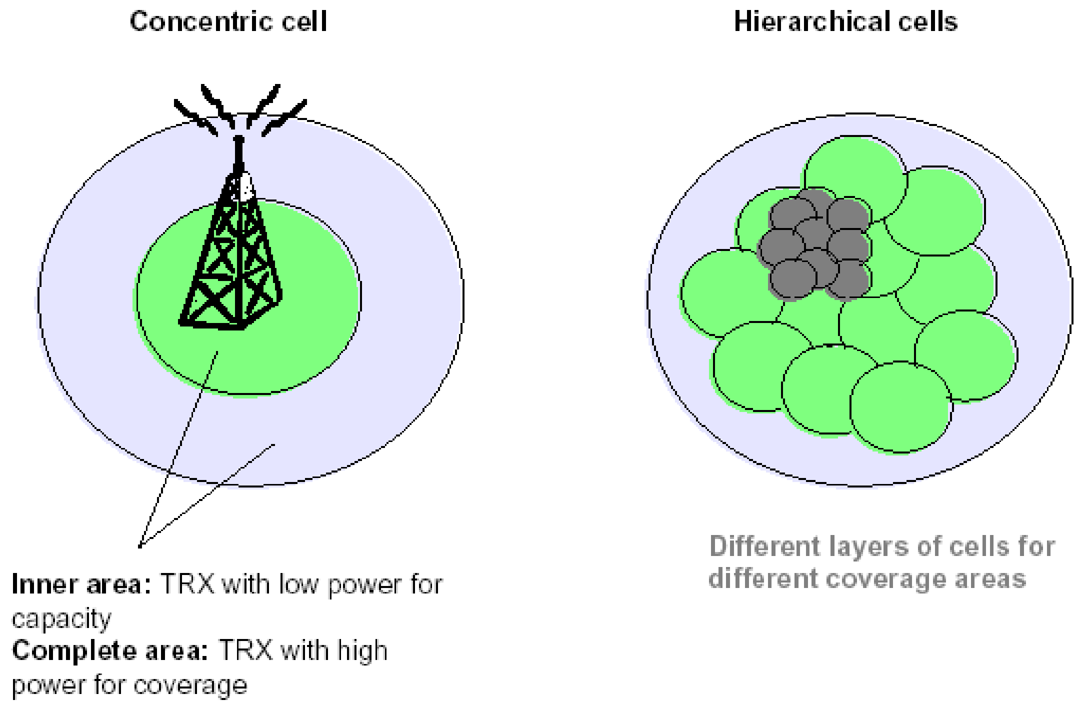


Figure 5.7: Concentric and Hierarchical cells

5.9 BSS TRANSMISSION PLANNING

Connecting a base station to the local BSC may become a challenging task in certain areas. The necessary bandwidth must be estimated and then a convenient transmission line must be determined. In urban areas microwave links with directional antennas are very popular as an alternative to leased lines but for example they have a poor performance in areas characterized by frequent heavy rainfalls or their use in certain areas is forbidden by local regulations. In some very particular cases as for example in deserts, also satellite connections are used.

When connecting all base stations of one area to a BSC, several possible configurations can be chosen:

- **Star:** All base stations are connected one by one the BSC
- **Multi-drop chain:** One base station is connected to the BSC and all the other base stations are connected one to another forming a chain. This configuration is used mainly for road coverage and helps saving on connection lines. Connecting the same base stations with a star configuration would be much more expensive.
- **Loop:** Similar to the multi-drop chain, but with the particularly that the chain ends at the BSC again. This configuration is safer that the multi-drop chain. If in the multi-drop chain one link is down all of

the following base stations in the chain will be disconnected and the traffic lost. With the loop, those base stations will be still connected to the BSC on the other end and the traffic will be not lost.

- **Redundant:** Same as star, but with loop advantage. For every important sites
- **Cross connect**: A hub or similar cross-connect equipment can be integrated at the BTS site to allow the connection of more base stations over that one site.
- **Multi-drop loop**: Another possible use of cross-connect equipments, with loop advantages.

All combinations of the configuration are possible.

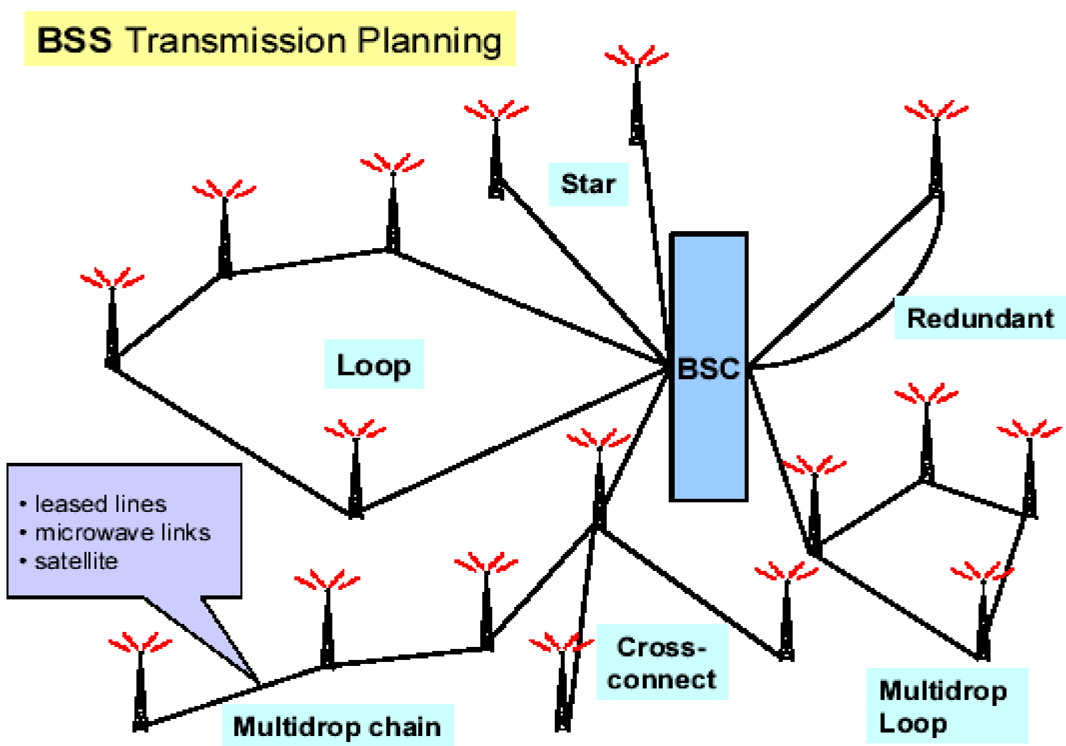


Figure 5.8: BSS Transmission Planning.

5.10 LOGICAL CHANNEL

Logical channels carry payload (speech or data) or signaling

- For circuit-switched CS traffic there is a clear separation between the physical channels used for payload and those used for signaling
- For packet-switched PS traffic, the same physical channel may carry both signaling and payload.

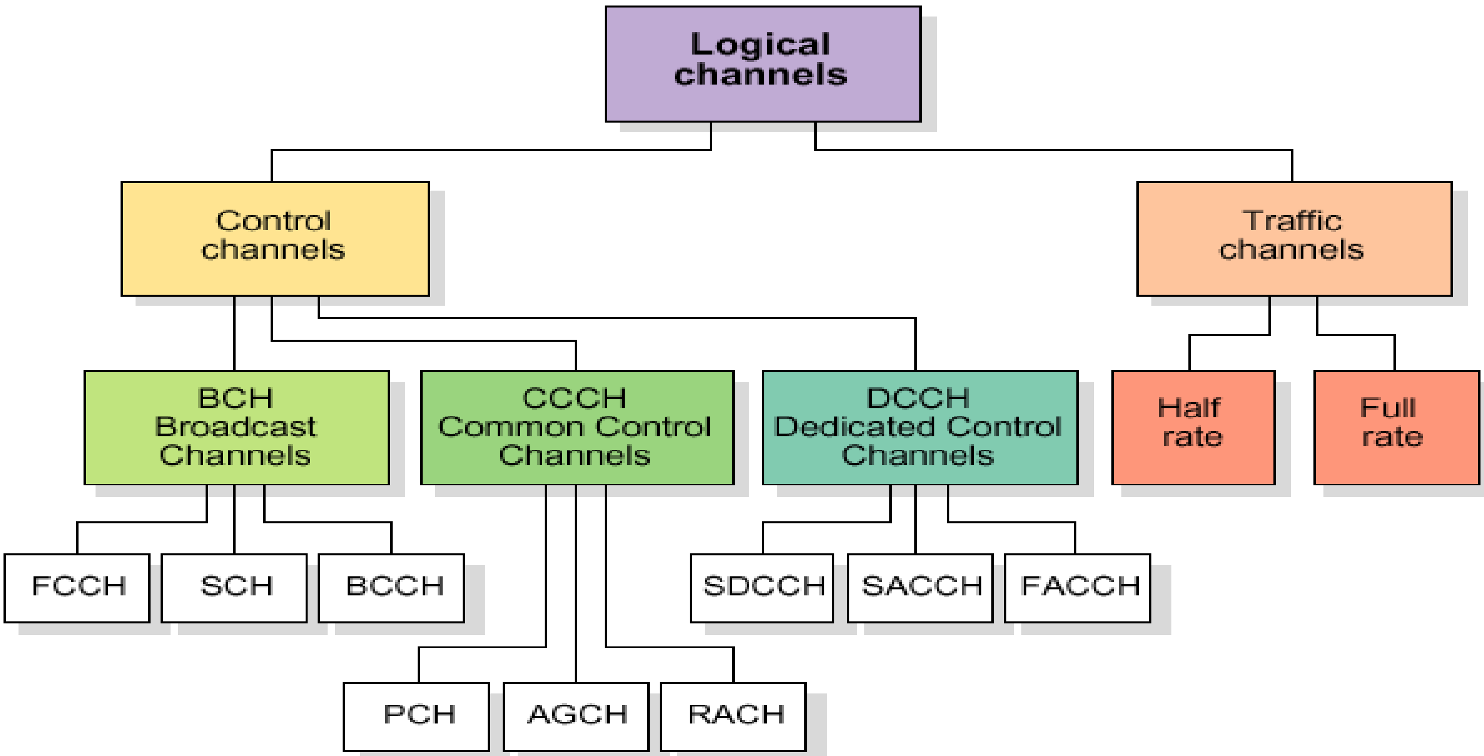
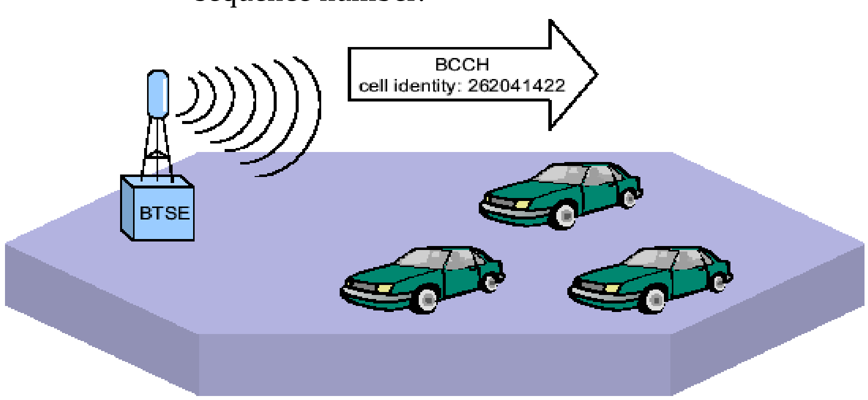


Figure 5.9 : Logical Channel.

5.11 Control channel or signaling channel:

5.11.1 Broadcast Channel (BCH) : The broadcast channels are defined for the BTSE to MS direction (DL) only and are subdivided into the:

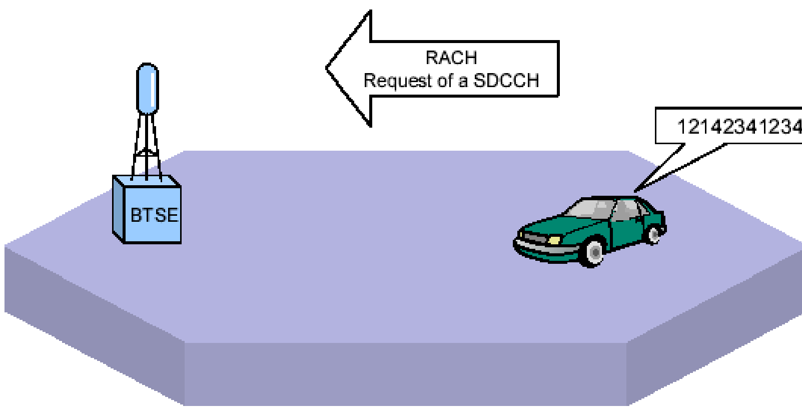
a. **Broadcast control channel (BCCH):** Defined per cell which informs the mobile station about various cell parameters including country code, network code, local area code, and PLMN code, RF channels used within the cell where the mobile is located, surrounding cells, and frequency hopping sequence number.



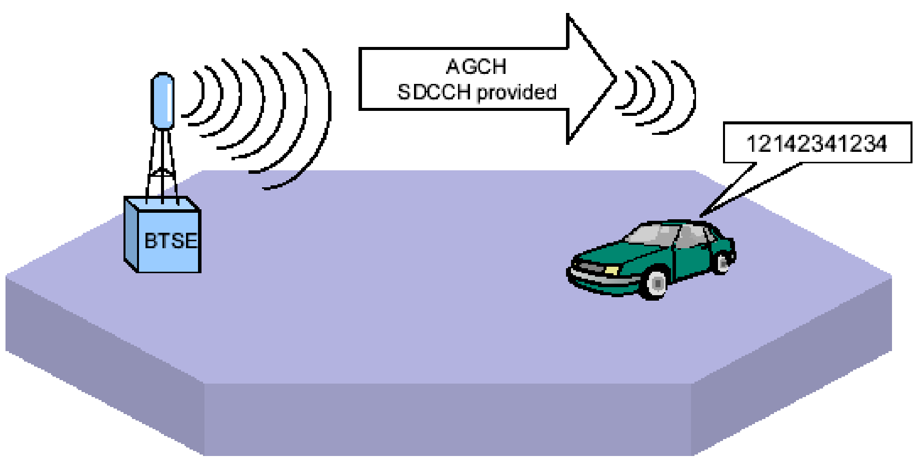
b. **Frequency correction channel (FCCH):** Carries information for frequency correction of the MS downlink (“ fine tuning” of MS to BTS)
c. **Synchronization channel (SCH):** Provides information about the frame number and BTS identification code BSIC
d. **Cell broadcast channel (CBCH) :** Used by the cell broadcast service for distributing e.g. weather information

5.11.2 Common Control Channel (CCCH): Common control channels are specified as unidirectional channels, either on the downlink or the uplink. The following sub-channels are distinguished:

a) **Paging channel (PCH):** Which is used DL to page mobile stations.
b) **Random access channel (RACH):** Which is an UL channel to indicate a mobile station’s request for a dedicated channel



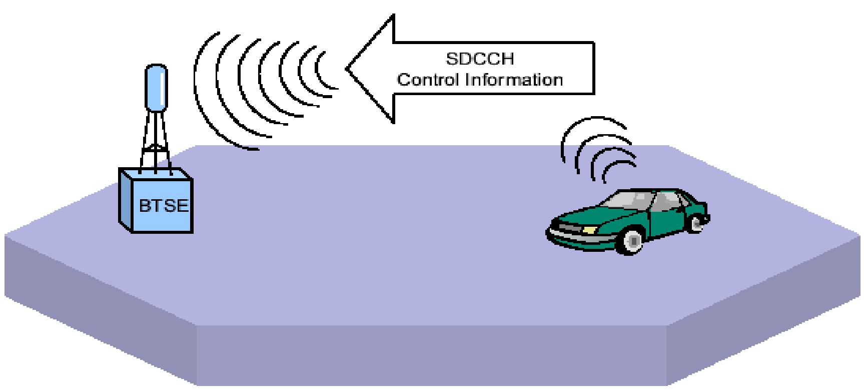
c) **Access grant channel (AGCH):** Also used DL, to assign a dedicated channel to a mobile station. The BSC assigns a SDCCH to the MS via the AGCH.



d) **Notification channel (NCH):** Which is used in ASCI (advanced speech call items, paging MS using voice group call service/voice broadcast service VBS)

5.11.3 Dedicated control channel (DCCH): Dedicated control channels are full duplex (bi-directional) channels. They are subdivided into:

a) **Slow associated control channel (SACCH):** Which is always associated with a TCH or SDCCH (embedded with the same frame structure). The SACCH is used for the transmission of radio link measurement data.
b) **Fast associated control channel (FACCH):** This is always associated with a TCH and is used for the transmission of signaling data, after the set-up of the call, when the SDCCH has been already released. The FACCH data are inserted into the TCH burst instead of traffic data (bit stealing), indicated by a "stealing flag" (i.e. the FACCH may contain handover information).
c) **Stand-alone dedicated control channel (SDCCH):** Which is assigned after the MS access request has been granted and is used for signaling purposes (set-up of the calls). All of the signaling information (i.e. dialed digits, authentication, and traffic channel assignment) for call setup is exchanged over the SDCCH.



5.12 Traffic channel:

- The traffic channels are of two types: full rate and half rate.
- One full rate TCH occupies one physical channel (one TS on a carrier), while two half rate TCHs can share one physical channel

5.13 MULTI FRAMES

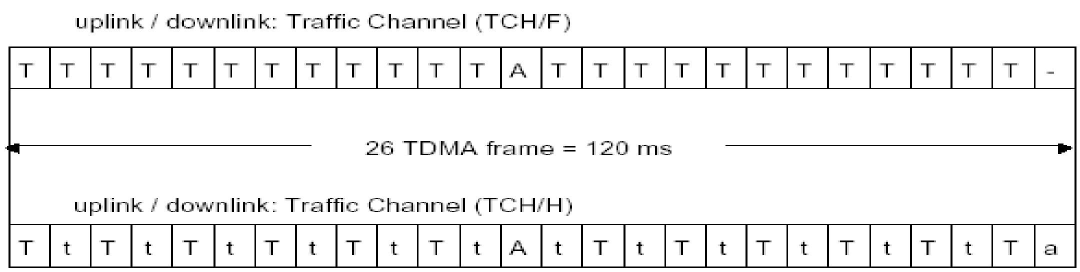
5.13.1 Control channel or signaling multi-frame:

For circuit-switched traffic, fifty-one TDMA frames (=235.5 ms) are grouped together to form one signaling channel multi-frame.

5.13.2 Traffic channel (TCH) multi-frame:

For circuit-switched traffic, a TCH is always allocated together with its associated slow-rate channel (SACCH). Twenty-six TDMA frames (=120ms) are grouped together to form one multi-frame for speech/data. TCH are sent on 24 timeslots; one slot is used for SACCH signaling information and one slot remains unused (for full rate).

Not only subscriber information (speech / data) can be transmitted in a traffic channel TCH. If the signaling requirement increases (e.g. for a handover), a signaling information FACCH is transmitted instead of TCH. A so-called stealing flag in the normal burst indicates this.

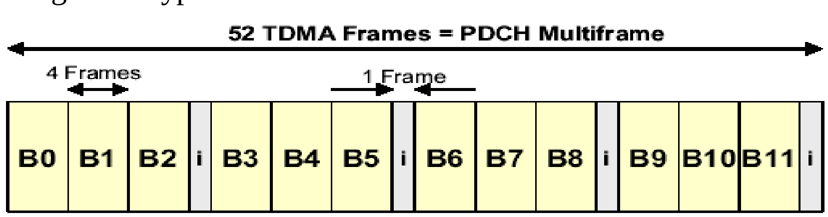


T - TCH - Traffic Channel
t - TCH - Traffic Channel
A - SACCH - Slow Associated Control Channel
a - SACCH - Slow Associated Control Channel

5.13.3 GPRS multi-frames:

The GPRS packet data traffic is arranged in 52-type multi-frames. 52 TDMA frames are combined to form one GPRS traffic channel multi-frame which is subdivided into 12 blocks with a 4 TDMA frames each. One block contains one radio block in each case (4 normal burst, which are related to each other via convolution coding). Every thirteenth TDMA frame is idle. The idle frames are used by the MS to determine the various base station identity codes BSIC to carry out timing advance updates procedures or interference measurements for power control.

For packet common control channels PCCH, conventional 51-type multi-frames can be used for signaling or 52-type multi-frames.



B0 – B11 = Radio blocks (data / signaling), i = idle frame

5.14 TIME SLOT STRUCTURE

The RF signal sent in a timeslot is called "burst". Depending on the type of logical channel transmitted, different kinds of burst are used:

- Normal burst
- Access burst
- Frequency correction burst
- Synchronization burst
- Dummy burst

The modulation is applied for the useful duration of the burst. In general, the useful duration of the burst is equivalent to 148 bits excluding the access burst that has a useful duration equivalent 88 bits. To minimize interference, the mobile station is required during the guard periods to attenuate its transmission amplitude and to adjust possible time shifts and amplitudes of the bursts.

- **The normal burst** is used to carry information on traffic channels and on signaling channels (exception: random access channel, synchronization channel and frequency correction channel). Its structure is shown below:

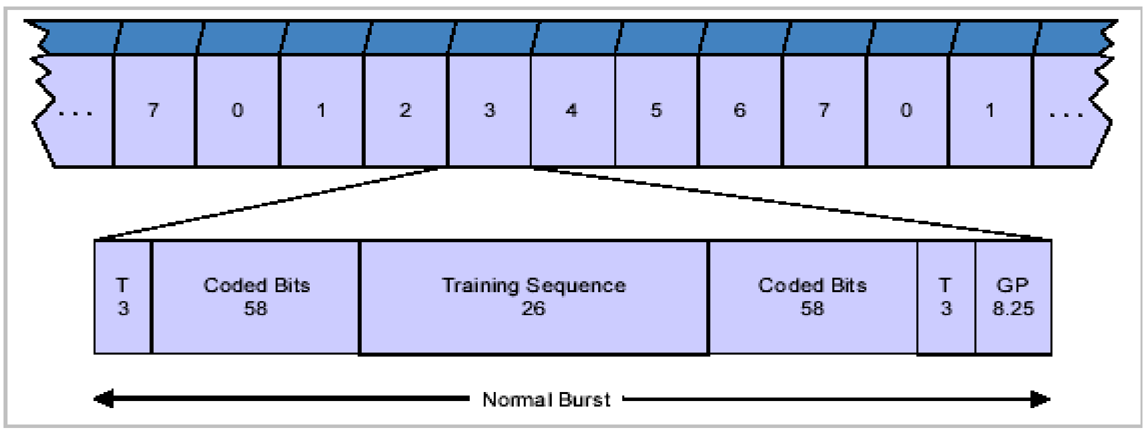
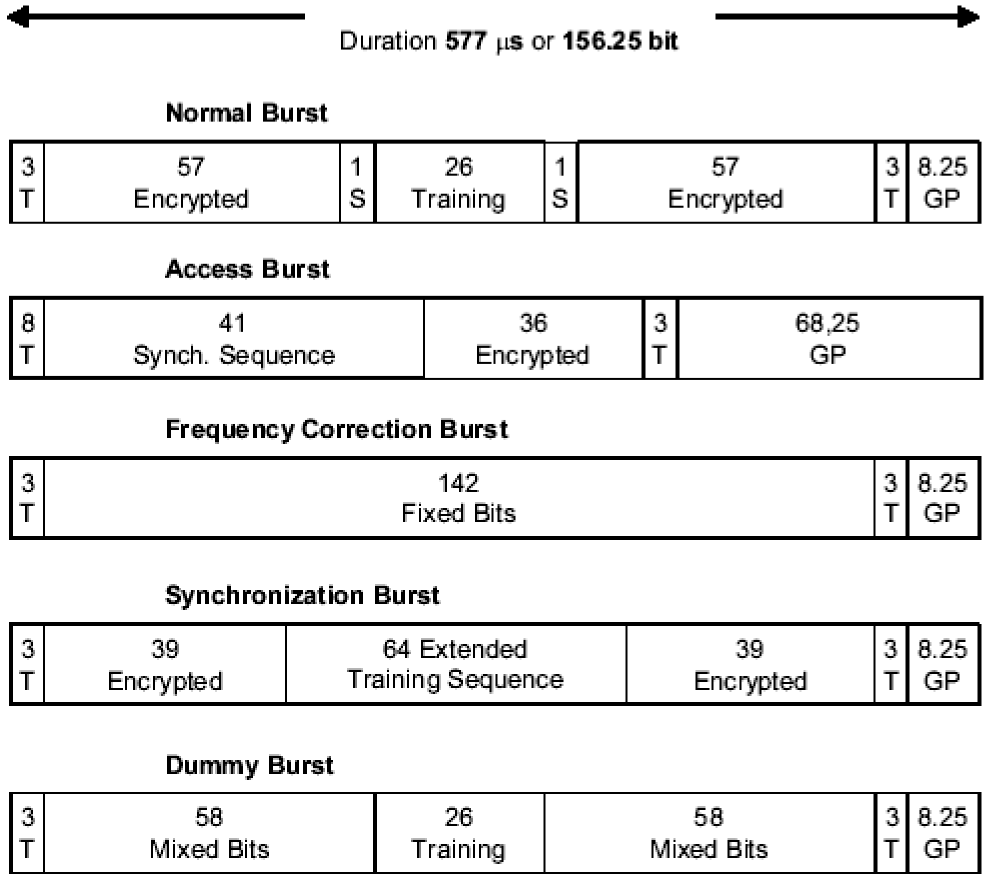


Figure5.10 : Normal Burst

- **Tail bits (T):** This burst section consists of three bits (always coded with "000") and is needed for synchronization at the receive side.
- **Coded (encrypted) bits:** There are two burst sections, which contain the coded and encrypted traffic information (speech or data) in 2 * (57+1) bits. This 1 bit is called stealing flag and indicates whether the 57 bits are really user data or FACCH signaling information.
- **Training sequence:** This burst section contains 26 bits used for synchronization. Eight different training sequences have been defined by GSM.
- **Guard period (GP):** These "8.25" bits serve to guard phase deviations (due to moving MS) and to reduce the transmission power.



- **The access bursts** has an extended guard period that helps to control the initial time lag of the signals due to the distance between mobile station and BTSE. Once the time lag has been corrected (timing advance), the remaining time lag resulting from the alternation of distance of a moving mobile station is controlled with the aid of the normal guard period of 8.25 bit duration.

- **Frequency correction bursts** are sent by the BTSE and are used by the mobile station to adjust its receiver and transmitted frequencies (frequency synchronization).

- **Synchronization bursts** are used to establish an initial bit and frame synchronization (time synchronization).

- **Dummy burst** are inserted if TCH timeslots on the BCCH carrier are not filled with user data to reach a constant level of the BCCH carrier. This is necessary because the level of the BCCH carriers is evaluated for handover decisions and also for the decision, which is the serving cell (for call setup).

CHAPTER6

EXTENDED GSM

6.1 What Is E-GSM?

A small radio frequency band used in Europe to provide added network capacity for GSM 900 networks.

If you are using one of the European GSM carriers that uses EGSM, then using an EGSM phone may improve coverage and/or reduce "network busy" messages.

EGSM spectrum is 880-890 MHz paired with 925-935 MHz, which is just below the original GSM 900 band.

- P-GSM, Standard or Primary GSM-900 Band
- E-GSM, Extended GSM-900 Band (includes Standard GSM-900 band)
- R-GSM, Railways GSM-900 Band (includes Standard and Extended GSM-900 band)
- T-GSM, TETRA-GSM

6.2 EGSM frequency band:

System	Band	Uplink (MHz)	Downlink (MHz)	Channel number
E-GSM-900	**900**	**880.0–914.8**	**925.2–959.8**	**975–1023, 0-124**

6.3 EGSM Installation Procedure:

- All DRU’s power off.

- Remove DRU 18 (from DRU position 0,2,4
- Insert DRU 9 (for DRU position 0,2,4)
- Insert DRU 18 (for DRU position 1,3,5)
- Install GSM900 or GSM900&1800(Dual band) Antenna .
- All DRU’s power ON
- Create and Load IDB
- Check E1 or Port A
- Total TRx Configuration Check.
- Integration from BSC and that time check VSWR and DTF
- On air from BSC
- RBS fault checking and remove
- Save IDB, RBS log file, inventory list, RBS Software information.

6.4 Configure Multiband Idb for 2216,2116,2106,2206 Single Cabinet With OMT:

Step1: Connect OMT port in DXU & open OMT software.

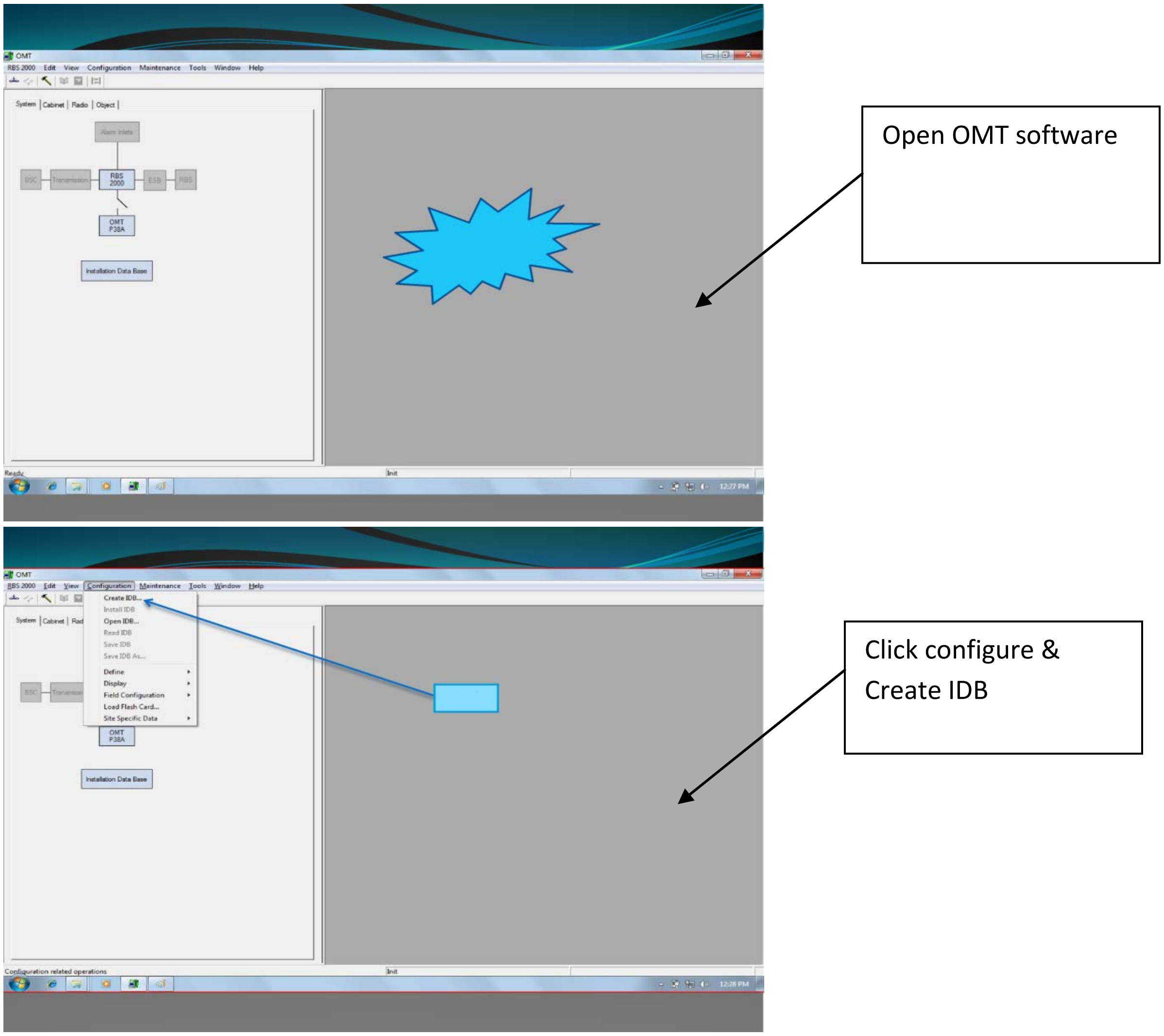
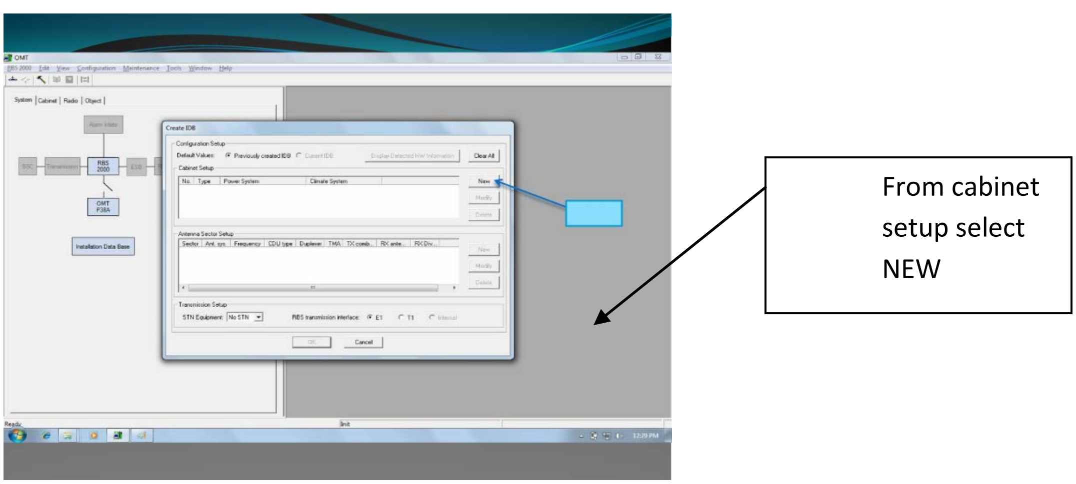
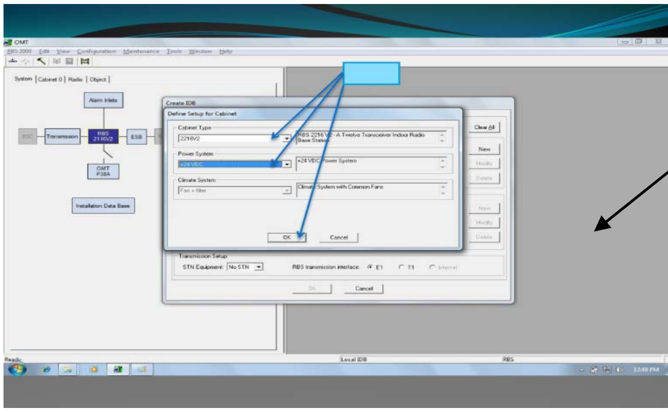


Fig: Configure IDB

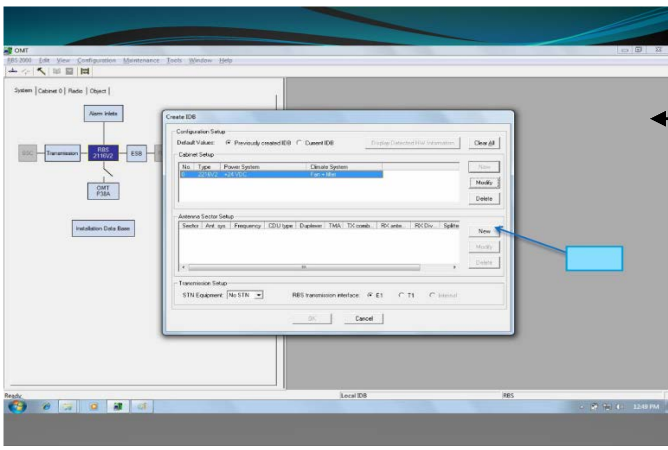


Step2: From Cabinet setup slect new.



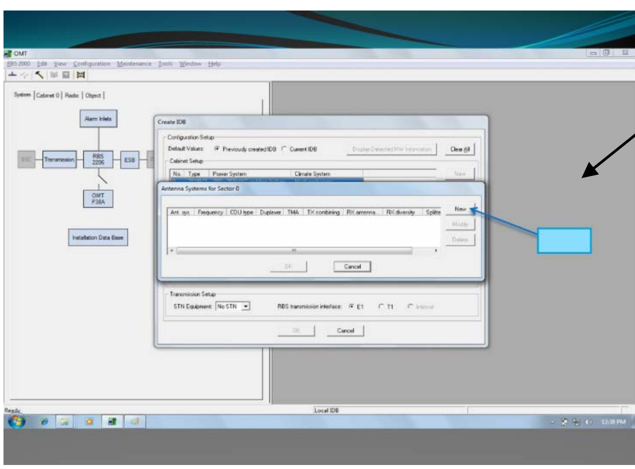
Select 2216/2116 from POP-UP window&VDC

Step3: Select RBS model, +VDC than click ok.



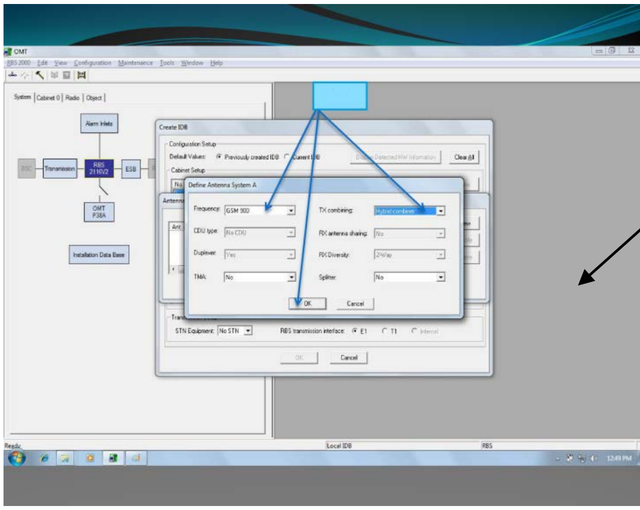
Select New for antenna sector

Fig: Configure IDB



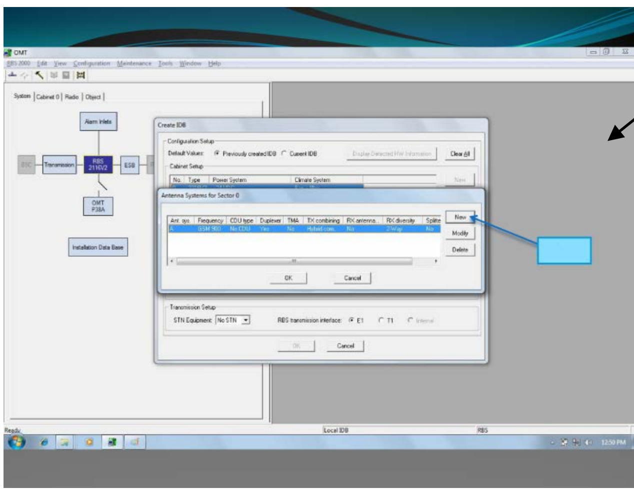
1. From create idb window select new from antenna sector setup
2. This POP UP will come UP
3. Select new

Step4: From Antenna sector O select Antenna GSM 900, Hyb Combined & select no TMA.

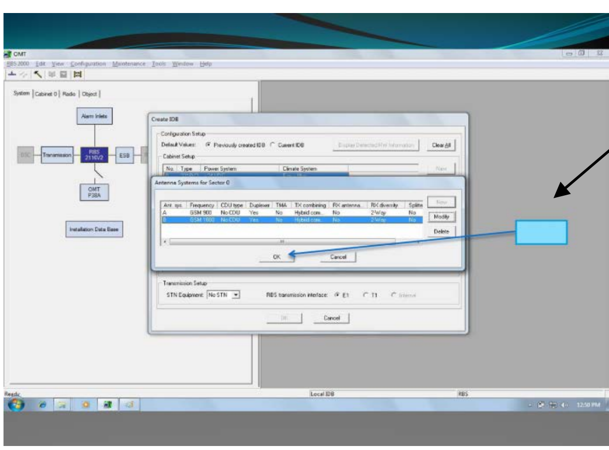


For Antenna setup

1. This POP UP Window Will Come
2. Select Gsm 900
3. Select Uncombined / Hyb. Combined.



Step5: From Antenna sector O select Antenna GSM 1800, Hyb Combined & select no TMA.



Under Sector 0, there are two antenna systems now

1. GSM 900
2. Gsm 1800

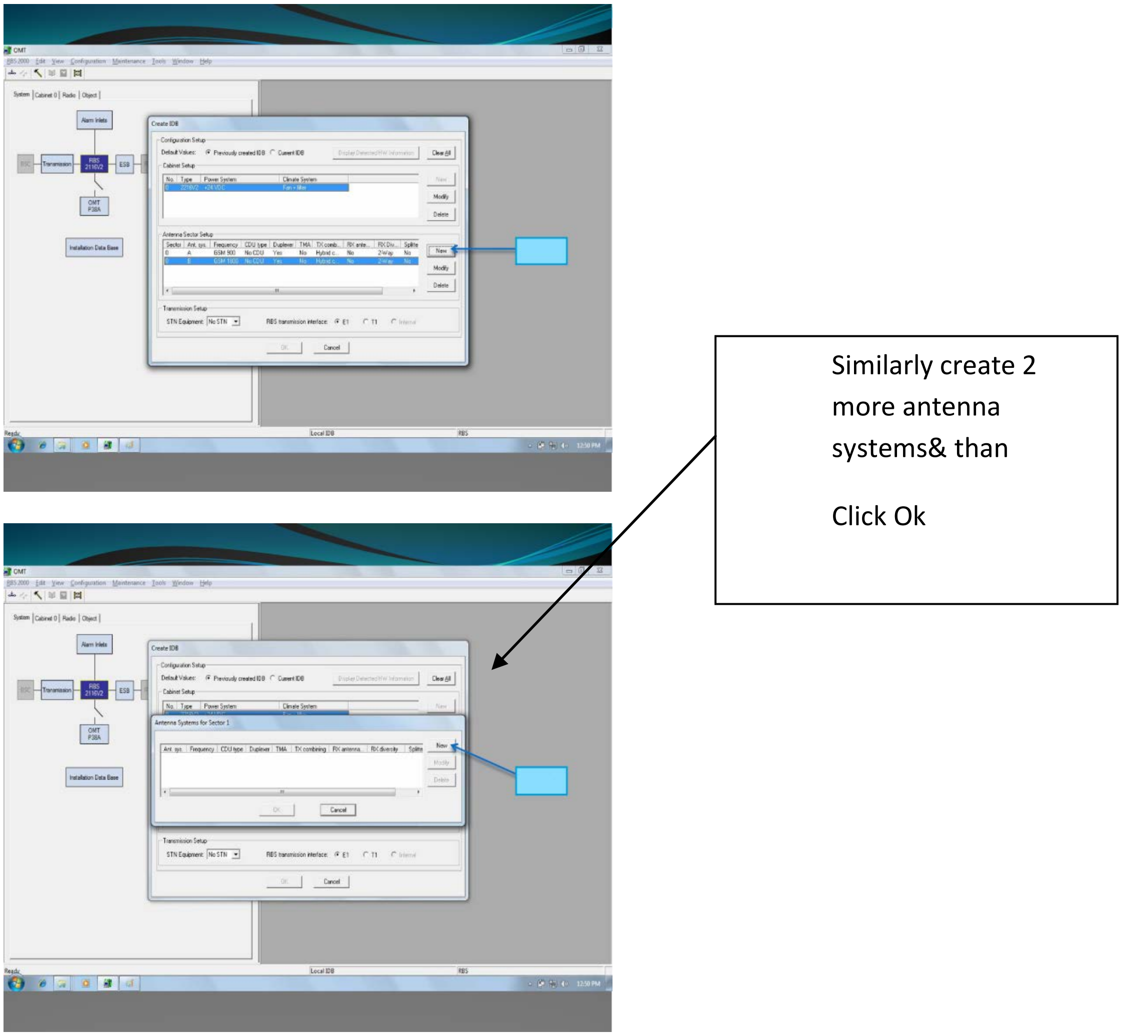


Fig: Configure IDB

Step6: From Antenna sector 1select Antenna GSM (900,1800) Hyb Combined & select no TMA.

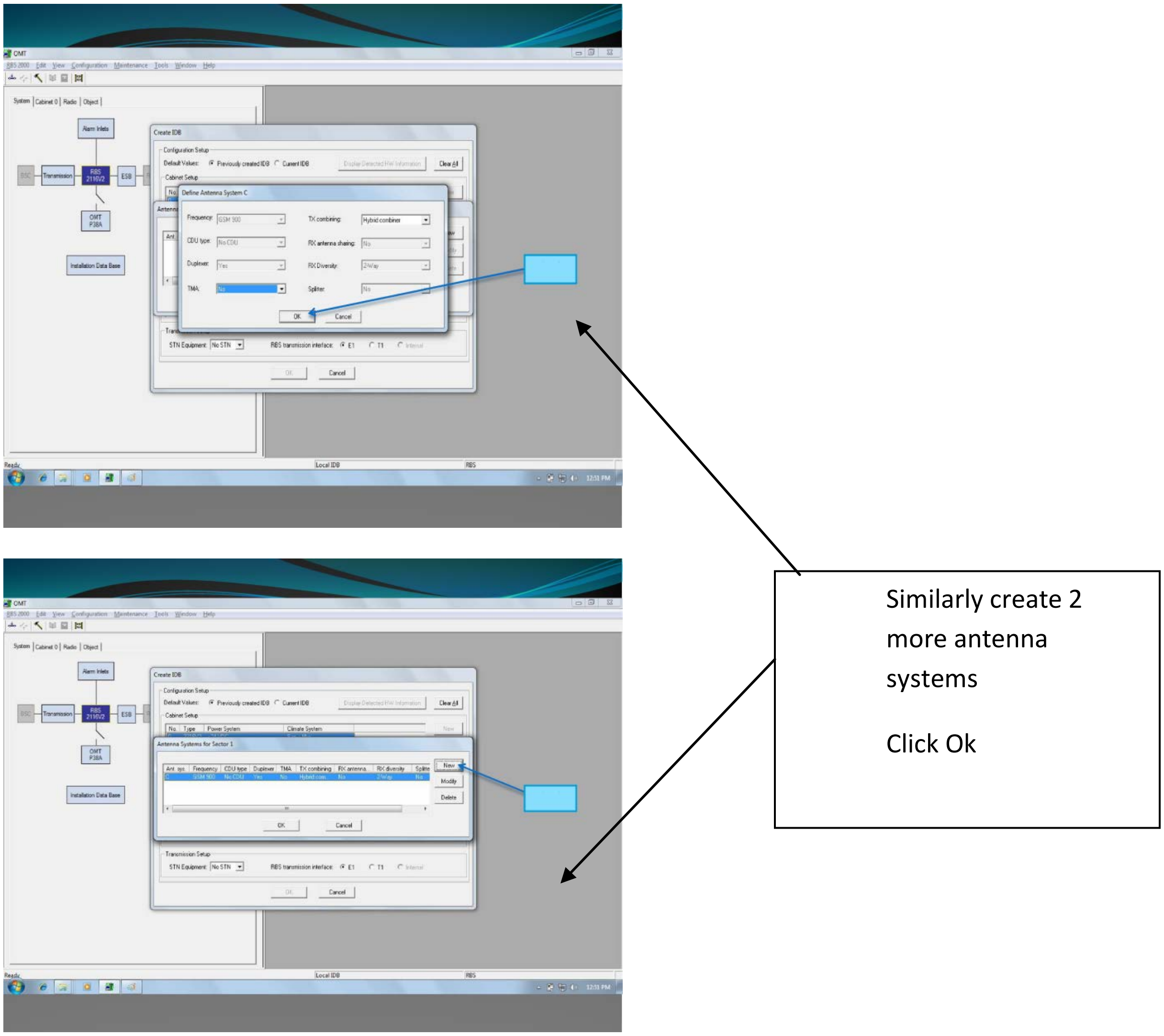
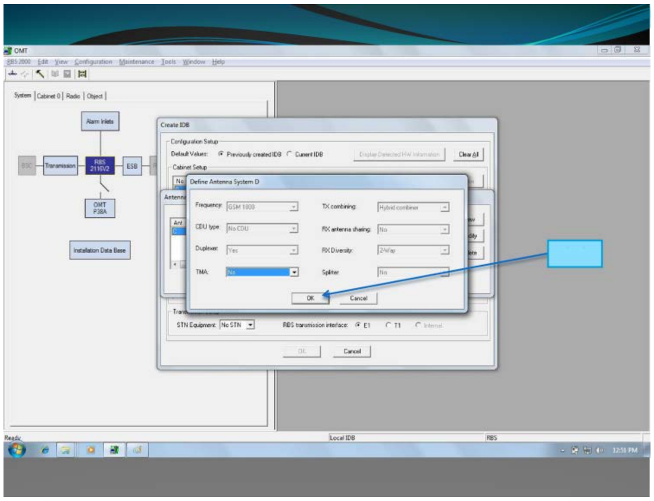
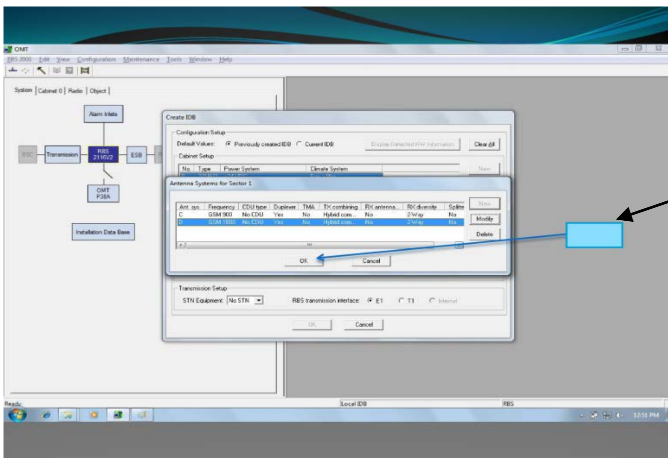


Fig: Configure IDB



Click ok



Click ok

This Window Will Come

TWO different Systems are there, Configured as 3x2 and 3x2 : One 900 and another 1800

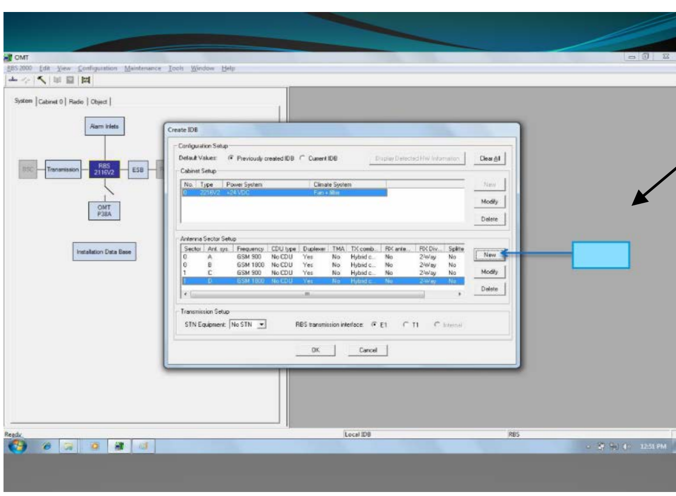


Fig: Configure IDB

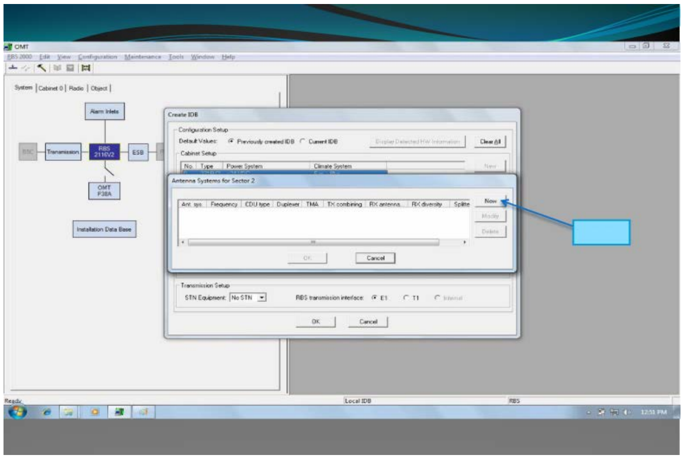
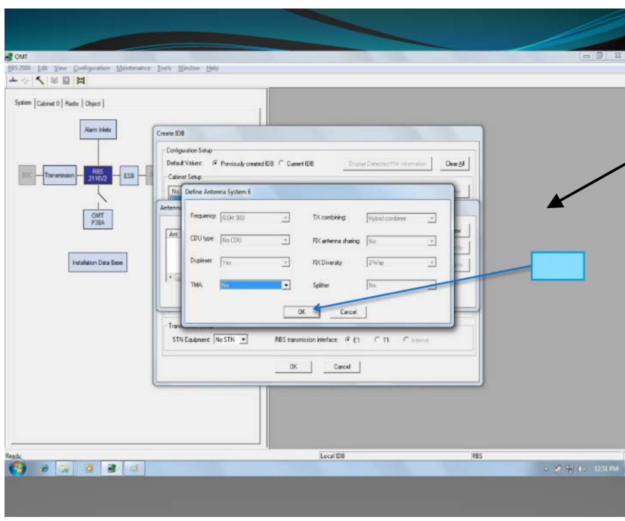


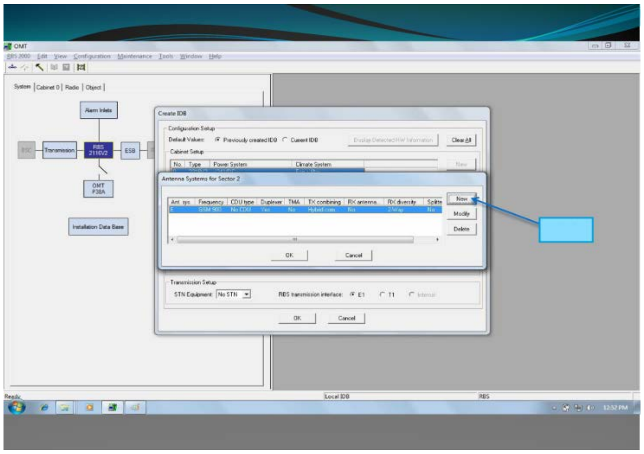
Fig: Configure IDB



Similarly create 2 more antenna systems

Click Ok

Step7: From Antenna sector 2 select Antenna GSM (900,1800) Hyb Combined & select no TMA.



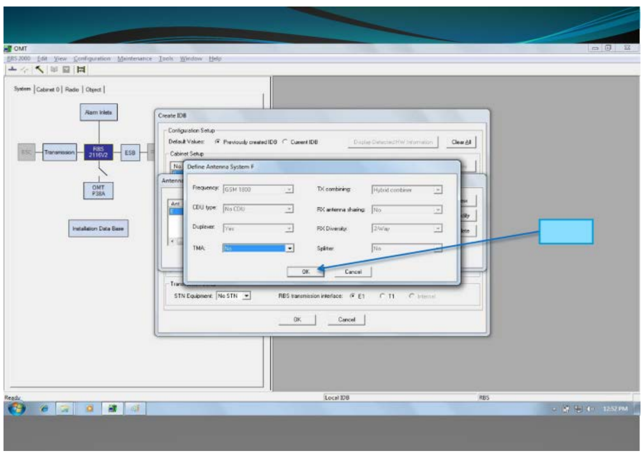
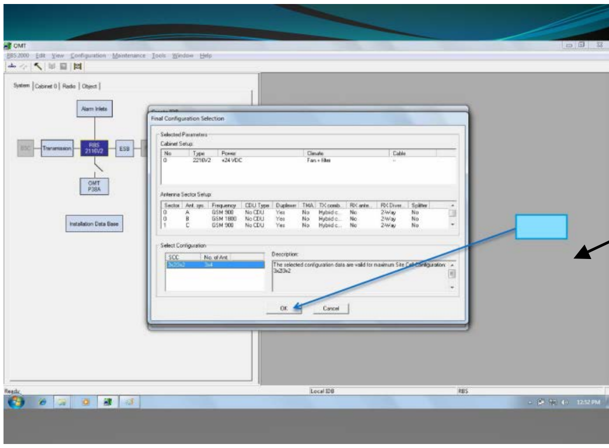
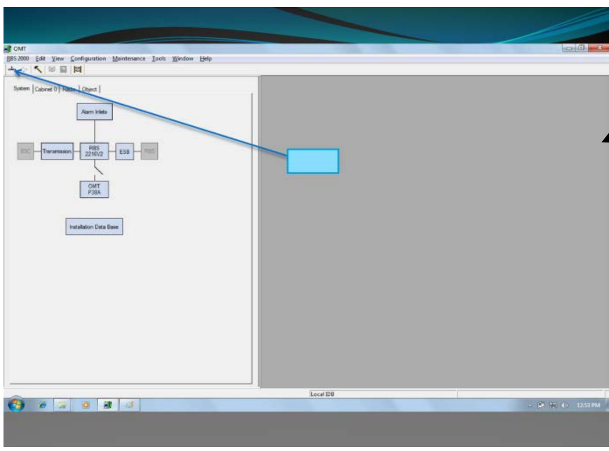


Fig: Configure IDB



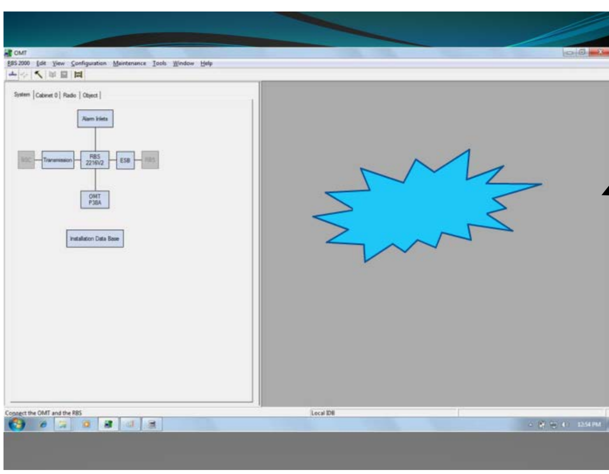
This Window Will Come

TWO different Systems are there, Configured as 3x2 and 3x2 : One 900 and another 1800



Step8: Click for Local State

& Install IDB

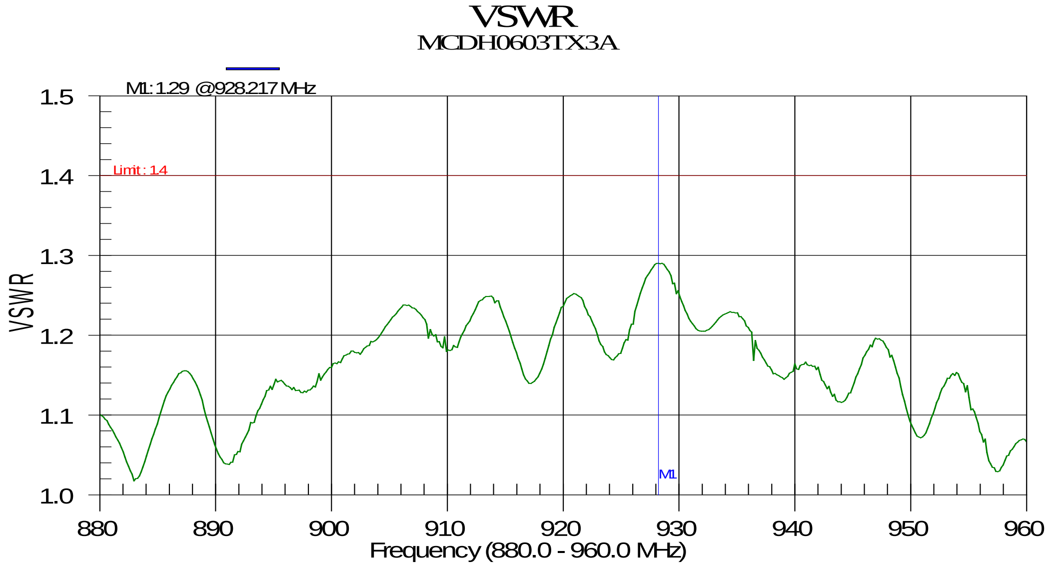


Step9:

- Click for Remote State
- Call BSC & than going Operation Mode.

Fig: Configure IDB

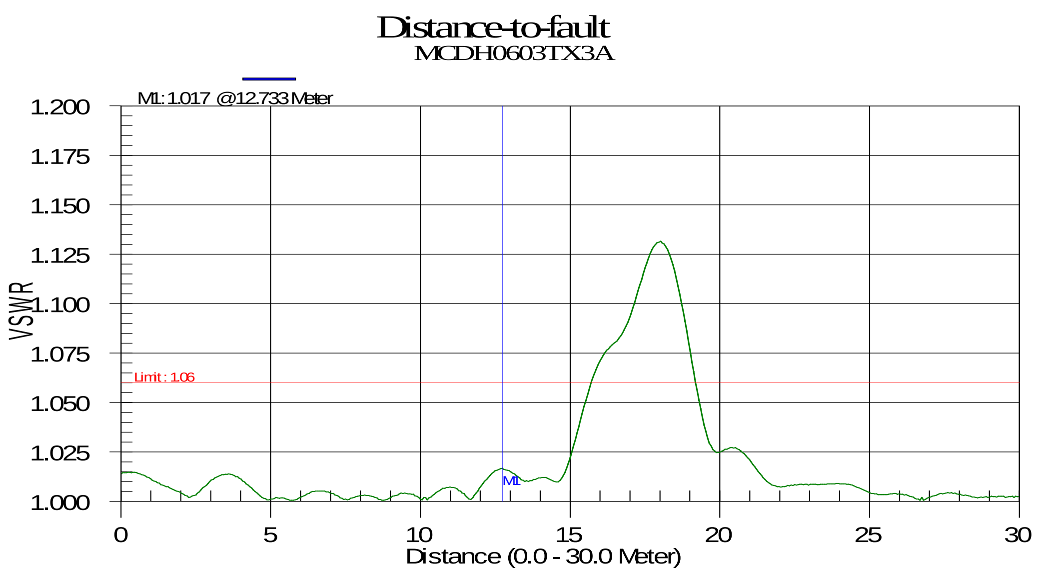
6.4 Antenna Measurement for GSM:



Resolution: 517
Std: GSM 900 (_)
Date: 11/09/2010
Model: S331D

CAL:ON(COAX)
Channel: N/A
Time: 04:02:14
Serial #: 00624137

CW: ON

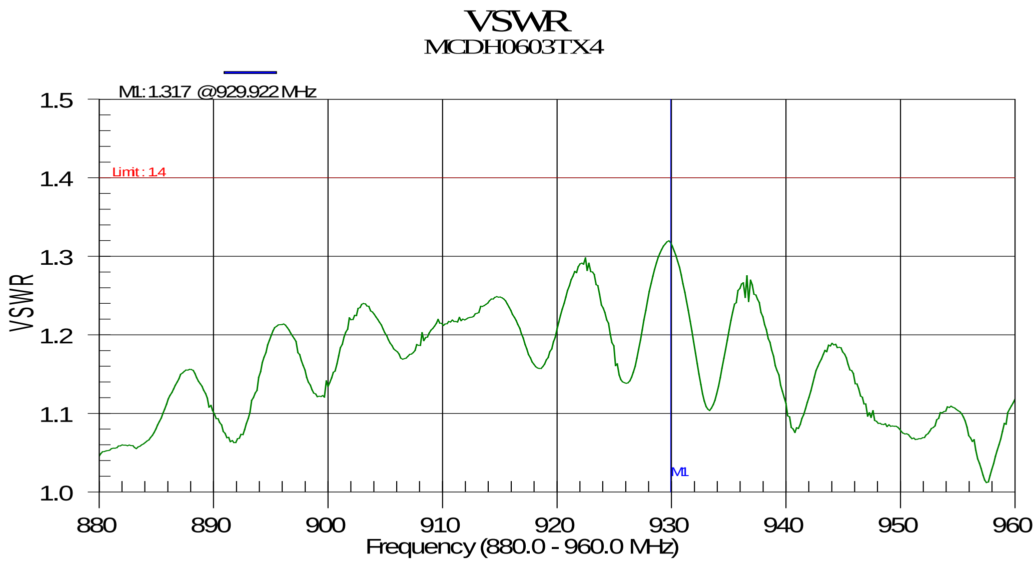


Resolution: 517
Std: GSM 900 (_)
Date: 11/09/2010
Model: S331D

CAL:ON(COAX)
Channel: N/A
Time: 04:07:04
Serial #: 00624137

CW: ON
Ins.Loss:0.000dB/m
Prop.Vel:0.800

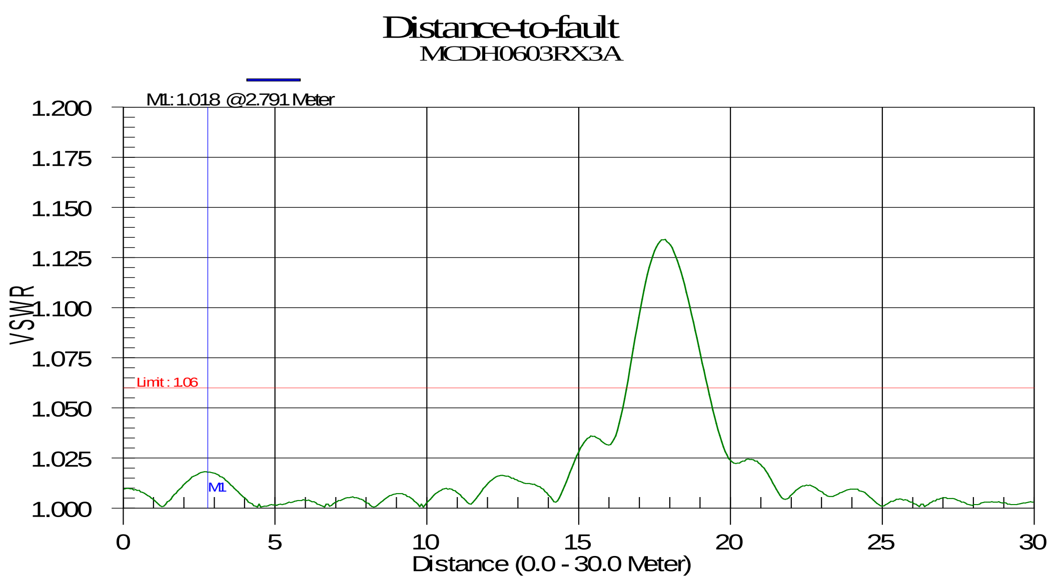
FOR CELL A



Resolution: 517
Std: GSM 900 (_)
Date: 11/08/2010
Model: S331D

CAL:ON(COAX)
Channel: N/A
Time: 23:53:42
Serial #: 00624137

CW: ON



Resolution: 517
Std: GSM 900 (_)
Date: 11/09/2010
Model: S331D

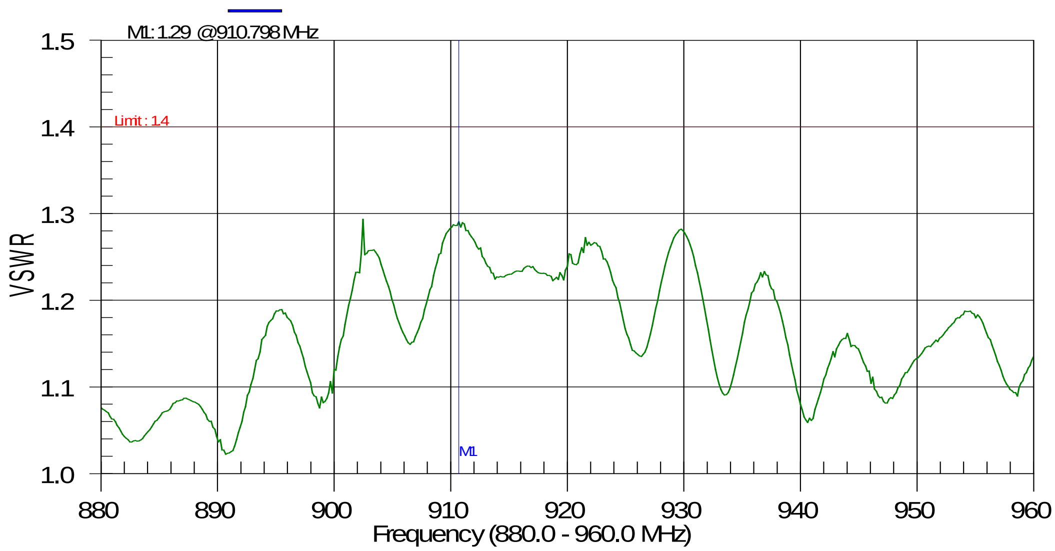
CAL:ON(COAX)
Channel: N/A
Time: 04:04:08
Serial #: 00624137

CW: ON

Ins.Loss:0.000dB/m
Prop.Vel:0.800

FOR CELL A

VSWR
MCDH0603TX3

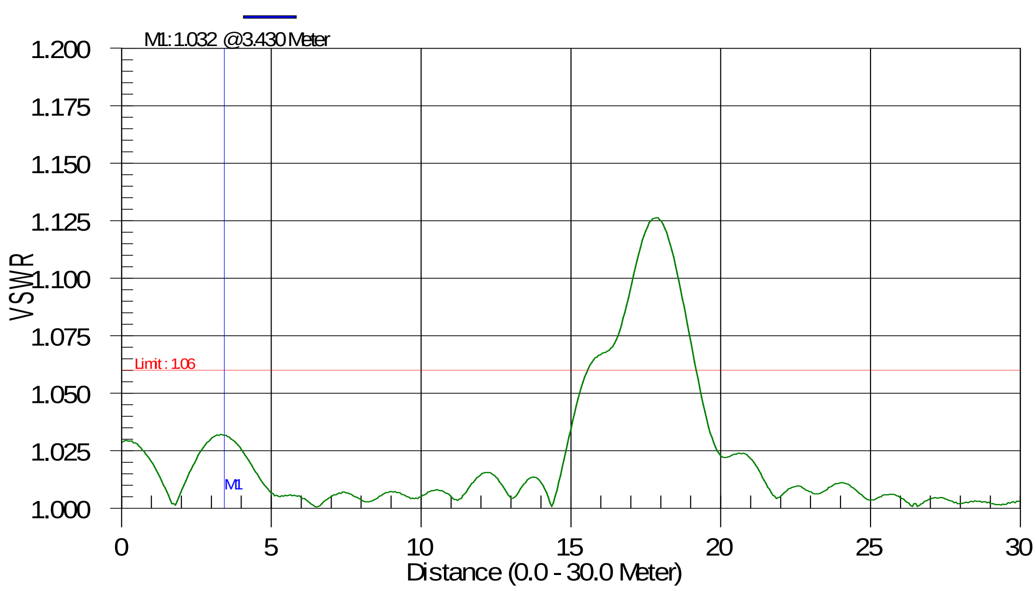


Resolution: 517
Std: GSM 900 (_)
Date: 11/08/2010
Model: S331D

CAL:ON(COAX)
Channel: N/A
Time: 23:48:32
Serial #: 00624137

CW: ON

Distance-to-fault
MCDH0603TX3



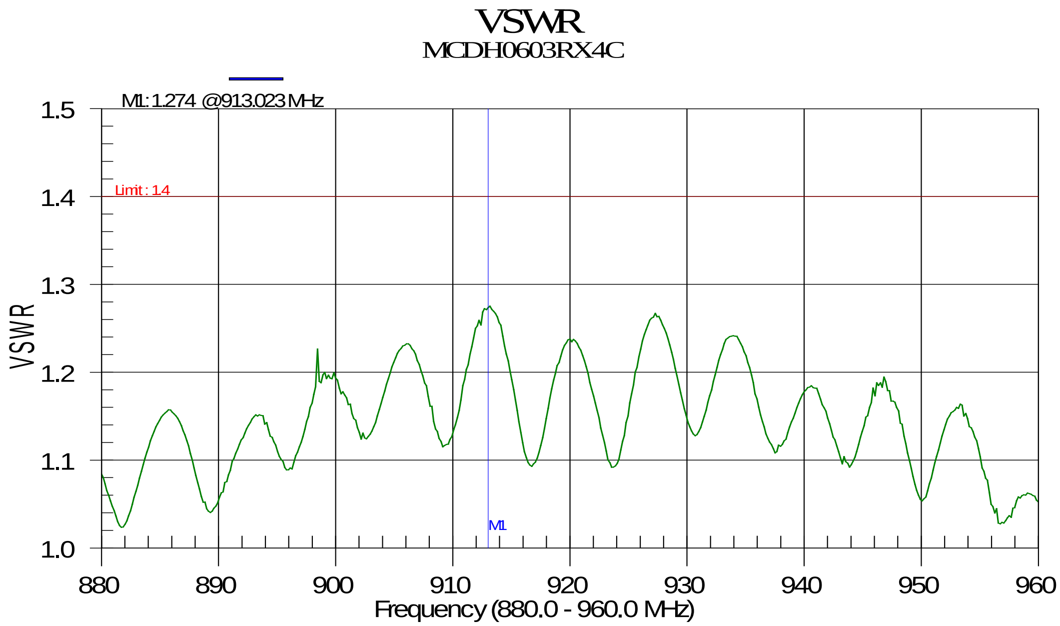
Resolution: 517
Std: GSM 900 (_)
Date: 11/08/2010
Model: S331D

CAL:ON(COAX)
Channel: N/A
Time: 23:49:07
Serial #: 00624137

CW: ON

Ins.Loss:0.000dB/m
Prop.Vel:0.800

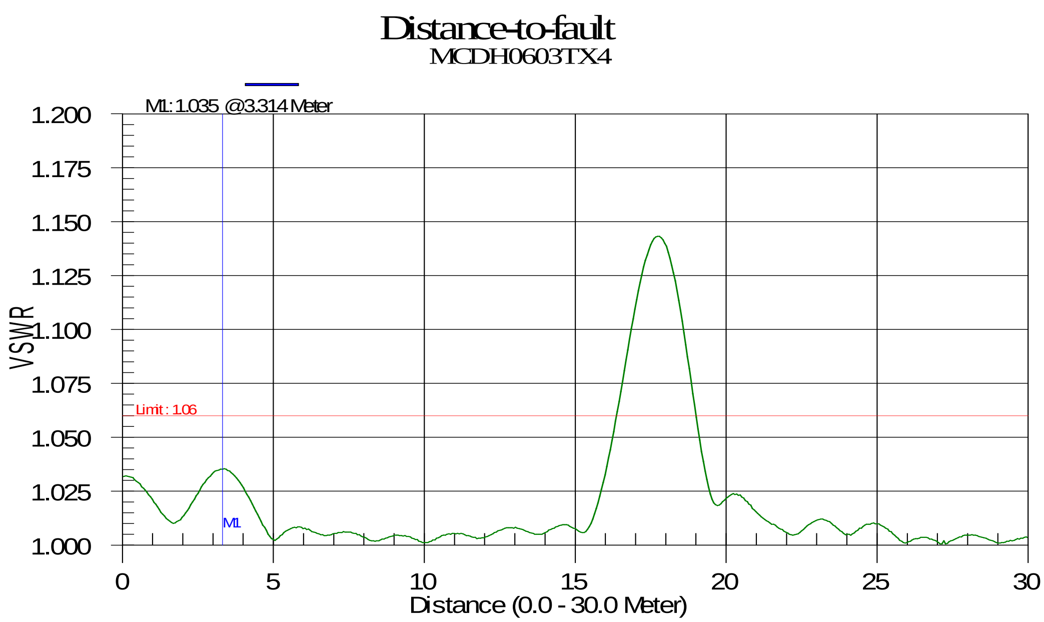
FOR CELL C



Resolution: 517
Std: GSM 900 (_)
Date: 11/09/2010
Model: S331D

CAL:ON(COAX)
Channel: N/A
Time: 04:08:58
Serial #: 00624137

CW: ON



Resolution: 517
Std: GSM 900 (_)
Date: 11/08/2010
Model: S331D

CAL:ON(COAX)
Channel: N/A
Time: 23:53:17
Serial #: 00624137

CW: ON
Ins.Loss:0.000dB/m
Prop.Vel:0.800

FOR CELL C

CHAPTER 7

CONCLUSION

7.1 Conclusion:

The standard cellular communication is something that takes for granted as today's modern world. The telecommunication network provides reliable and highly accessible service-subscribers have high expectations react strongly when the service is unavailable. To meet the demand for high reliability to provide service economically, the GSM Network is being progressively upgraded.

Extended GSM - extension to the GSM 900 MHz spectrum. The additional 10 MHz (880-890) provide 50 more communication channels. EGSM phones support both the original 900 MHz spectrum as well as the extended one. The E-GSM bands can thus be made available to the telecoms market in line with market requirements as soon as the relevant sub plans regulating frequency usage have been modified, and military use has been replaced by civil use under the Frequency Usage Plan.
EGSM has been performed faster than the GSM network.

Performance

- Reduce the number of "no trouble-found" phones with comprehensive testing and troubleshooting.
- Tx/Rx, spectrum, power, and dc current measurements quickly locate faults, and at the same time, power the phone through the built-in dc power supply.
- Automatically create a database for trend analysis on phone failures and identification of network trouble spots.
- Easy to install due to light weight, small dimensions and auto gain functionality, Easy commissioning via web- based OMT, Automatic level control (ALC), Variable bandwidth Led's for local alarm indication and RSSI, Optional remote alarm monitoring, Connection to LAN, Multi-functional mini Repeater Family Modularity.

The process of EGSM Install in RBS with the OMT (Operation & Maintenance Technology) software. It reduces frequency hopping.

Reference

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4. http://www.gsmworld.com/(10.10.2010)
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