STUDY ON INDOOR BUILDING SOLUTION FOR GSM NETWORKS

BY

KHANDAKER ABUL MUSTAKIM
ID: 081-19-865

AND

KAMRUL HASAN

ID: 081-19-878

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

Supervised By

Md. Taslim Arefin

Senior Lecturer

Department of ETE

Daffodil International University

DAFFODIL INTERNATIONAL UNIVERSITY

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APPROVAL

This project titled **"Study on Indoor Building Solution for GSM Networks"**, submitted by Khandaker Abul Mustakim and Kamrul Hasan 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 02 March, 2011.

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Department of Applied Physics,
Electronics And Communication Engineering
University of Dhaka

DECLARATION

We hereby declare that, this project has been done by us under the supervision of **Md. Taslim Arefin**, **Senior 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.

Supervised by:

____

Md. Taslim Arefin
Senior Lecturer
Department of ETE
Daffodil International University

Submitted by:

____

(Khandaker Abul Mustakim)
ID: 081 -19-865
Department of ETE
Daffodil International University

____

(Kamrul Hasan)
ID: 081 -19-878
Department of ETE
Daffodil International University

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ABSTRACT

Communication is the key for any business success; signal coverage is the primary requirement of any communication system. Mobile wireless applications are a good way to increase productivity, improve customer service and streamline business processes. 3G mobile applications, however, bring a unique challenge: ensuring adequate in-building coverage. In Building Solution (IBS) is an indoor signal coverage solution as the extension of the existing mobile network. It distributes the RF signals to different indoor locations via the distributed antenna system, which consists of antenna, power splitter, coupler etc, and improves wireless coverage inside buildings to capture indoor traffic volumes and revenue streams, which would otherwise be lost.IBS in combination with standard and customized wireless applications like GSM technology offer additional value to the buildings can help mobile service providers increase usage of their mobile networks, reduce subscriber churn and promote revenue-generating voice and data services. Indoor Radio Planning provides an overview of mobile networks systems and coverage solutions for cellular networks in buildings.

This project is "**Indoor Building Solution for GSM Networks**". This project will discuss about the mobile signal strength for mobile Cellular users. The project will study about the signal strengths power and why it's needed. There have a several thing why in the big building cannot receive a good signal strength with clearly. The project is going to discuss the Indoor Building Solution (IBS). IBS is one of the telecommunication technique that were used to make the cellular phone can receive any call clearly without worry it will terminate especially when entering the all floors. After a several signal strength testing and doing a hardware installation, the mobile coverage can be improved.

The report contains the technical description of our proposal for the full turnkey mobile telecommunication system design, describing an in building solution that supports GSM1800 services in the **Rajuk Trade Center** building The report provides information on the network architecture, its design criteria and assumptions, equipment description, including issues on capacity and dimensioning, frequency planning, system interference and spillage control.

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IBS Overview

Chapter -1

IBS Overview

1.1 Introduction

Mobile communications is playing an increasingly important role in our business, professional and our personal lives. The demand for mobile communication Services is growing at an unprecedented rate with an expectation that voice, data, Video and internet communications through mobile device could be available anywhere on the globe at all times in the near future.

The increasing use of hand portable mobile telephones, which are operated frequently within buildings, requires the current and the future operators to dimension their networks to provide reliable service in these locations. Initially buildings will be served mainly from external base stations, and so there is a need to understand the penetration losses into a wide range of building types for any orientation of the building relative to the incident field. As demand increases it will be necessary to deploy small cells within buildings, and the key issues here will be the coverage within a room, into adjacent rooms and between floors. Leakage from the building which may cause interference to co-frequency external cells, or co-frequency cells in nearby buildings is also of concern. In buildings with particularly high traffic density it may become necessary to deploy many base stations, some of which may be required to operate co-frequency with one another, and so isolation within a building is also an important issue. Key to the successful control of these demanding requirements is a reliable model for predicting coverage into-and within a wide range of building types.

The signal is received by the outside antenna from cell site. It is then amplified and repeated to user cell phone through the inside antenna. When the phone transmits, the signal is received by the inside antenna, amplified then repeated to the cell site via the outside antenna**.** Indoor-Building Solution (IBS) is one of technology that use in Telecommunication engineering beside Tower Telecommunication and Roof Top antenna. IBS will provide a mobile signal to all users especially in building. It will improve signal strength inside a building when using a cell phone and allowing user to walk around freely during a call. It even allows multi phones to be used simultaneously.

A few [2] different building types and possible mobile applications are mentioned:

• **Offices/industries**: “Wireless office”, Mobile Extension, corporate Intranet, work orders, supervision, production control, etc.

• **Airports and bus/train stations**: travel information, check-in, booking, local transport information, and duty free/shop advertisement, access to Internet via mobile broadband etc.

• **Conference and exhibition centers**: Portal info, info/notifications, voting, enquiries, visitor feedback, access to Internet/Intranet via mobile broadband etc.

• **Hospitals**: staff/patient communication, patient journal management, reminders/notifications to staff, patient supervision, etc.

• **Hotels**: staff and service management, booking, Internet, check-in, etc.

• **Shopping malls**: advertisement, info to visitors, item search, finding friends, staff communication etc.

The IBS may attract new subscribers due to the enhanced mobile network quality and accessibility to mobile Internet applications and other offered services. In-building solutions may be considered a necessity in a highly competitive market where outdoor coverage is no longer the major differentiating factor. In building solutions offer much more than just coverage. Some drivers for in building solutions are noted in below subchapters.

1.2 Problem Statements

According to that situation, researcher propose to do a research and study an IBS technology that can give an advantage to all mobile cellular user to make sure they can receive a mobile signal clearly. When one building is build up, sometime there have a problem to receive a mobile signal in one part of building, for example, transmission mobile signal will terminate when researcher enter the basement floor. In this case, the signal in that area is too low to allow the user to make any call. So there is why IBS is needed in the building.

IBS maximize the digital wireless service inside the facilities by extending coverage into previously inaccessible areas, voice and data communications are improved, resulting in direct increases to all user.

IBS be able to predict the coverage in any room on any floor of a wide range of building types. It also provides signal level plots over the area of a room so that large areas of low signal strength (high penetration loss) can be identified include the effect of furniture within each room.

The benefits from this technology are to dedicated radios allocated for user in the building. This will provide more signal in shadowed area. In most cases, the signal in lift lobbies and car parks area are poor compared to the offices. When signal propagates into the building, it will lose its power as it penetrates through glass windows, concrete wall and etc. By the time the signal research the center of the building or the underground car park, it becomes very weak. Therefore installing antennas inside the buildings can solve the problem.

1.3 Project Objectives

The purpose of this project is to find out signal coverage in a room by determining number and location of the Omni-directional antenna, large rooms. The purpose of the development of a cellular network system Indoor almost the same as regular cell planning or outdoor is to get good coverage. We will identify the week signal strength of rajuk trade center indoor building and we will recovery week signal strength use by Omni-directional antenna with RBS and other necessary equipments for IBS system.

• Improve network coverage

• Increase network traffic capacity

• Compete in the cordless telephony market

• Offer a complete telecommunications service (fixed and mobile voice and data) to firms

1.4 Outline of the project

Part One

The first parts of this project consist of IBS In-Building Solution**.** This is done in Chapters 2, 3,4,5,6 and 7.

Where second chapter discuss about In-Building Solution and required, There Network Problems inside Buildings which that place receive signal is low and no network coverage in this area and General RF Requirements of a customer.

Third chapter briefly discuss about elements of site survey. Where discuss about Physical building survey, required data, Internal building propagation, Test procedure, Required equipment, External building propagation loss, Test procedure and Required equipment.

Fourth chapter briefly discuss about RF Survey Tools. Where discuss about RF Survey Tool, RF Survey with building floor plan, Computer coverage prediction, In building solution proposal, RNP Report Solution Descriptions and Distributed Antenna Systems.

Fifth chapter briefly discuss about Antenna system. Where discuss about the all antenna system which should need IBS.

Chapter six provides RF power budget and Link Budget Element of a GSM Network. The chapter begins RF power budget and Link Budget, The signal strength required, BTS

Power, Radiated EIRP(Effective Isotropic Radiated Power), Link Budget and the Mobile Receiver Sensitivity.

Chapter seven includes Acceptance Testing. Where this chapter begins IBS(indoor building solution) Materials or Accessories Check, Electrical & Ground Check and RF Signal level check.
Chapter eight ends part one conclusion.

Part Two

The second parts of this project consist of IBS In-Building Solution for rajuk trade center. This is provide project overview, In-Building Radio System, Technical Summary of this project, Cell Configuration RBS system, some define Operator System and discuss Frequency Bands, BTS Configuration Details of the Operator, Selection of Passive Components, Empirical Path Loss (Indoor),Grade of service and Number of Subscribers per cell by Erlang Calculation, Traffic capacity allocation for each cell table, Floor plan with cable rooting Of Rajuk trade center, this topics Floor plan with cable rooting of Rajuk trade center and how does create to Floor plan, Trunking or System Diagram we got the output antenna power , link budget calculation for uplink & downlink of all antenna system ,This topics consist of RBS 2206 Commissioning part step to step IDB create ,DTRU configuration and alarm create.

Chapter -2

Customer Requirement and Network Problems inside Buildings

Chapter -2

Customer Requirement and

Network Problems inside Buildings

2.1 What is an In-Building Solution & Why is it required?

It is [2] a process, where in we radiate adequate Mobile signals of one particular Network operator in that entire building. In places like basement floors, higher floors of some high rise Buildings, Airports, Corporate offices, Hotels & Shopping malls we tend to get signals from different cell sites around the building, so subscriber mobile ping-pong from one cell site to another resulting in high CALL-DROPS & High BER (Rx Quality) In some case when the subscriber base increases, the Network operator has difficulty in planning new BTS. So instead of deploying a Macro Site the operator uses a Micro BTS where in the signal from Micro BTS will be distributed throughout the building using Co-axial cables and distributed antenna system. By doing so, we will have uniform signal been radiated all throughout the building providing an error free Network connection to all their valuable subscribers present in that building. In the basement floors there will be absolutely no mobile signals present, so this problem also can be solved using a distributed antenna system in that floor.

2.2 Network Problems inside Buildings

• High Call [2] drops above 4th or 5th floors (Due to Multi cell Hand over)

• High Bit Error Rate - Due to Multi-path propagation, Water refraction, Interference from other cell sites of same operator or other operators

• No network Coverage - Basements, Ground Floors etc. (Penetration loss)

• Subscriber base increases – If deployments of new BTS sites are not possible

2.3 General RF Requirements of a customer

• Quality of [2] Service

• Customer requirements > Rx level must be - 80dBm @ 95% Location Probability

• Server from in building solution in dedicated mode > = 90%

• Call Setup success rate = 98% in the entire building

• Drop Call Rates < = 2%

• DL Rx Quality (0 – 2) > = 90 % in the entire building

• DL Rx Quality (0 – 4) > = 95 % in the entire building

• Spillage of signals must be < = -85dBm, on the street and the adjacent buildings

• Frequency planned for Indoor coverage must be carefully planned

• Parameter settings for IBS must be carefully planned (ex: - hopping frequency, MAIO, HCS etc.

Chapter 3

Indoor building solution site survey

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Indoor building solution site survey

3.1 Introduction

The first [3] activity that should take place when considering the implementation of an indoor coverage system is the site survey. Results of all survey work, whether in paper and electronic form, should be copied at the end of each working day. The original and the copy of the data should be stored in physically separate locations. All survey records (source data) should be forwarded to the design engineer responsible for the project, not just a summary, or the subsequently calculated result. These records should then be added to the project design documentation archive. The importance of thoroughly understanding the requirements, planning, and executing this task in a comprehensive manner cannot be overstated.

Important: GSM systems may operate in either the 900MHz band or the 1.8/1.9GHz bands. At the higher frequency bands, the radio signals suffer greater loss. It is therefore essential that the intended operating frequency band is determined prior to the start of the survey and design processes**.**

3.2 Process flow in building survey & implementation roll - out

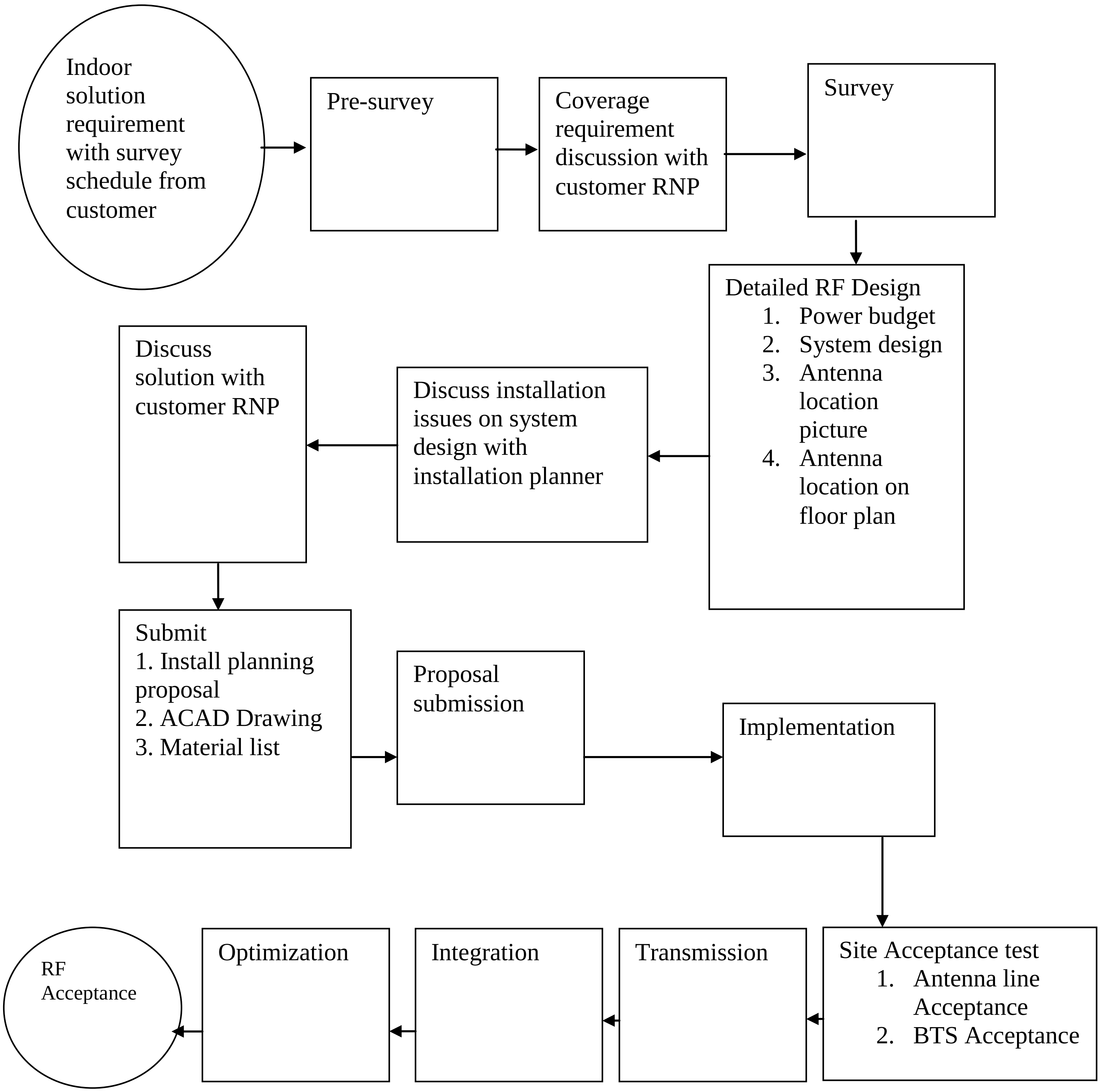


Fig.3.1: Flow in building survey & implementation roll - out

3.3What Type of site survey elements

There are four basic elements to the site survey:

- Physical survey
- Internal building propagation loss
- External building propagation loss
- Signal level received from outdoor cells

3.4 Physical building survey

This activity [3] aims to collect data which can be used to determine in broad terms the type of indoor coverage system that is most suitable for use in the structure concerned. It is therefore necessary to gather as much detail as possible during the first visit, together with contacts associated with the building, which can be used to confirm information, or obtain further details, without the need of subsequent visits. Particular attention should be given to determining the areas of responsibility of staff involved with the building, together with any anticipated changes (even if they may only be encountered as rumours) at this stage.

3.4.1 Required data:

The data listed below should be gathered:

• **Contact details for people /organizations involved with the building:**

- Owner(s), tenant(s), planning (zoning) authority, utilities, and emergency services (security and medical)

• **Location of the building:**

- National Grid Reference (NGR), Universal Transverse Mercator UTM, or geographic co-ordinates

• **External dimensioned sketch**:

- Plan and elevation
- Indicate construction materials used
- Show site boundary and major features
- Mark access and restrictions, loading and parking facilities

• **External site photos:**

- Print in territory and repeat as necessary
- Particular attention to areas where work will be conducted (such as cable routes)
- Ensure state of building is documented before work starts (for later reinstatement)

- **Internal dimensioned floor sketch**
- Plan and elevation
- Particular attention to equipment room
- Show ducts, risers, and capacity, hanging arrangements, fire stops and material etc.
- Indicate construction materials used

- **Internal site photos:**
  - Print in territory and repeat as necessary
  - Particular attention to areas where work will be conducted (such as cable routes, equipment room, antenna sites)
  - Ensure state of building is documented before work starts (for later reinstatement)
- **Specific installation problems:**
  -Building protection, specific working practices, staff training/certification/approval and any preferred materials to be used
  - Security of staff and equipment (official enquiries and informal comments from local staff)
  - Measures to minimize disruption (such as out-of-hours work), access restrictions

- **Fire precautions:**
  - Cable certification
  - Material for fire stops and need for recertification
  - Use of hazardous installation equipment

- **Environmental hazards:**
  - Protection of staff (such as clothing, ear defenders, hard hats, footwear)
  - Need for intrinsic safety, restrictions of type of batteries used in equipment
  - Corrosive atmosphere, radiation, and high voltage barrier zones
  - Building construction material (such as asbestos, glass fibre)
  - Wind-speed, ice, and Ultra Violet (UV) radiation for external installations
- **EMC requirements**
- Existing radiating cable and/or antenna systems:
  - Location, coverage, owner contacts, operating system and so on
- Existing protective bonding, earthing, lightning protection system:
  - Location, coverage, owner contacts, condition, type, connector details, test certificate and so on
- **Predicted traffic load:**
  - Expected growth
  - Location in building and any changes anticipated

• **Power:**

- Availability, reliability, source and voltage (such as mains, UPS, generator)

• **Landline telecommunications:**

- Availability, reliability, source contacts, type (such as analogue or digital services)

• Availability of viable radio path to existing base stations, and PTO fixed circuit Distribution Nodes (DNs) or Points of Presence (PoPs)

The above basic information, in the majority of cases where a straightforward deployment is involved, coupled with data from the existing mobile phone PTO, will allow engineers to produce the first level of system design, using a combination of manual techniques, past experience, and computer coverage prediction software.

3.5 Internal building propagation loss

This activity [3] aims to collect data regarding the extent to which the radio signals suffer loss (for example: shadowing, absorption, field strength reduction with distance) when passing (propagating) through the internal structure of the building. In a building with many rooms and floors, it is likely that the direct path between the base station antenna (whether discrete element or provided by radiating cable) and mobile antenna, will be interrupted by internal walls, partitions, and furniture. The extent to which these internal features of the building reduce (attenuate) the signal level varies according to the construction material and fittings used. Although a rough approximation of the internal building loss can be found from the data gathered during the physical site survey, wherever possible, it is recommended that actual measurements are made. Measurements give a degree of confidence that cannot be gained by other means. Tests are normally conducted on sample areas of the building, which are chosen to be representative of the whole structure. The test results can be used to improve the accuracy of computer predictions, such that it can be used in the rest of the building

3.5.1Test procedure

The basic method used to measure internal building attenuation is to install a test source and conduct practical field strength measurements. This process is outlined below:

• The building is examined and areas categorized according to the different internal Characteristics found:

- Different materials and construction techniques used
- Extent of internal subdivision (rooms and large open areas)
- Extent and nature of internal fixtures and fittings

• A small number of areas of the building are selected for testing, which represent the range of categories of internal characteristics found, and the following tests are conducted in each representative area

• A test source, operating at the intended operating radio frequency of the indoor coverage system, is installed in the test area:

- Although the test signal can be radiated at low power, it is usually necessary to gain approval from the regulatory authority in the territory concerned
- The test signal can either be radiated from an antenna, or from a test length of radiating cable, according to the type of indoor system envisaged
- The test antenna should be installed as close as possible to the intended location for the final deployment
- The characteristics of the test source, cables, and antenna should be recorded (such as transmit power, loss, and location)

• A test receiver, capable of receiving and unambiguously identifying the test signal, is moved through the test area:

- Test routes (or test points) are identified in the test area, which are representative of indoor coverage area required

- Measurements may need to be concentrated in the most populated parts of the building, in areas where coverage is essential for safety reasons (although infrequently used), and areas where coverage is expected to be most difficult to achieve (from the intended antenna/radiating cable sites)

• The level of the test signal received by the test receiver is recorded:

- When measurements are conducted at a series of test points, (rather than continuously along a test route), at each test point three measurements should be taken, at the points of an imaginary triangle of side 1m, centered on the test point.

The average of the three measurements should be used as the received signal level assigned to the test point

- If only a single measurement is made at each fixed point, accuracy will be significantly impaired by marked variations in the received signal level in the vicinity of the test point

• These tests may be performed:

- Following the initial system design stage
- During the detailed design stage (to finalize antenna locations)
- Following installation (to optimize antenna locations)

3.5.2 Required equipment

It is recommended that the following equipment is available for measuring internal propagation loss.

- Test source

  - Ericsson 'TEMS Test Transmitter and Accessories Case' (for use where GSM radio channel is available for test purposes)

  - Ruggedized signal generator, digital synthesized, AC/DC powered (for used where GSM radio channel is not available for test purposes)

- Mileage linear power amplifier (for use with above where higher output power is required)

- Test receiver

  - Safeco 'Walkabout System - Sagem Dual Band' (for use where GSM radio channel is available for test purposes). This system comprises a test mobile phone for measuring received signal level, tablet based portable PC, and logging software. The PC records the received signal level for the test route, using either a Nav-star GPS receiver, or a digital map (for manual entry) to provide the location of the test measurement

  - Portable ruggedized spectrum analyzer (for use where GSM radio channel is not available for test purposes). Depending on the minimum detectable signal this can receive, and the test source transmitted power, a low noise pre-amplifier may also be needed.

3.6 External building propagation loss

This activity [2] aims to collect data regarding the extent to which the radio signals suffer loss (such as screening, absorption, and field strength reduction with distance) when passing through the external walls of the building.

This information is used to determine the extent to which the indoor coverage system may cause interference with any existing outdoor cells. It may be possible to effectively contain the radio signals from the indoor coverage system within the building, by means of using relatively low power, and effective screening by the external building walls. Under these circumstances it may be possible to use the same radio channels indoors and outdoors, without causing unacceptable interference to mobiles using the outdoor cell. The containment of the indoor signals within the building minimizes the chance of outdoor mobiles using the indoor system, which may not be desirable.

As in the case of the internal building loss, an approximation to the external building propagation loss can be found from the data gathered during the physical site survey; however, wherever possible, it is recommended that actual measurements are made.

Again, tests are normally conducted on sample areas of the building that are chosen to be representative of the whole structure. The results from these tests can be used to improve the accuracy of computer predictions, such that it is sufficient for use in the rest of the building.

3.6.1 Test procedure

The method used to measure external building propagation loss is similar to that for internal building propagation loss outlined in the previous section. However, the representative test areas are based on the external wall characteristics of the building, and the test receiver is located outdoors, as follows.

- The building is examined and areas categorized according to the different ground floor external wall characteristics found (such as different materials and construction techniques used)
- A small number of areas of the building are selected for testing, which represent the range of categories of external wall characteristics found, and the following tests are conducted in each representative area
- A test source, operating at the intended operating radio frequency of the indoor coverage system, is installed in the test area:

  - Although the test signal can be radiated at low power, it is usually necessary to gain approval from the regulatory authority in the territory concerned

  - The test signal can either be radiated from an antenna, or from a test length of radiating cable, according to the type of indoor system envisaged

  - The test antenna should be installed as close as possible to the intended location for the final deployment

  - The characteristics of the test source, cables, and antenna should be recorded (such as transmit power, loss and location)

• A test receiver, capable of receiving and unambiguously identifying the test signal, is moved through the outdoor test area adjacent to the building, in the vicinity of test source installed indoors:

  - Test routes (or test points) are identified at different ranges from the external wall of the building

  - Measurements may need to be concentrated in the areas where greatest leakage from the indoor building system, to the outdoor environment is anticipated

• The level of the test signal received by the test receiver is recorded

  - When measurements are conducted at a series of test points, (rather than continuously along a test route), at each test point three measurements should be taken, at the points of an imaginary triangle of side 1m, centred on the test point.

The average of the three measurements should be used as the received signal level assigned to the test point

- If only a single measurement is made at each fixed point, accuracy will be significantly impaired by marked variations in the received signal level in the vicinity of the test point

• These tests may be performed:

- Following the initial system design stage
- During the detailed design stage (to finalize antenna locations)
- Following installation (to optimized antenna locations)

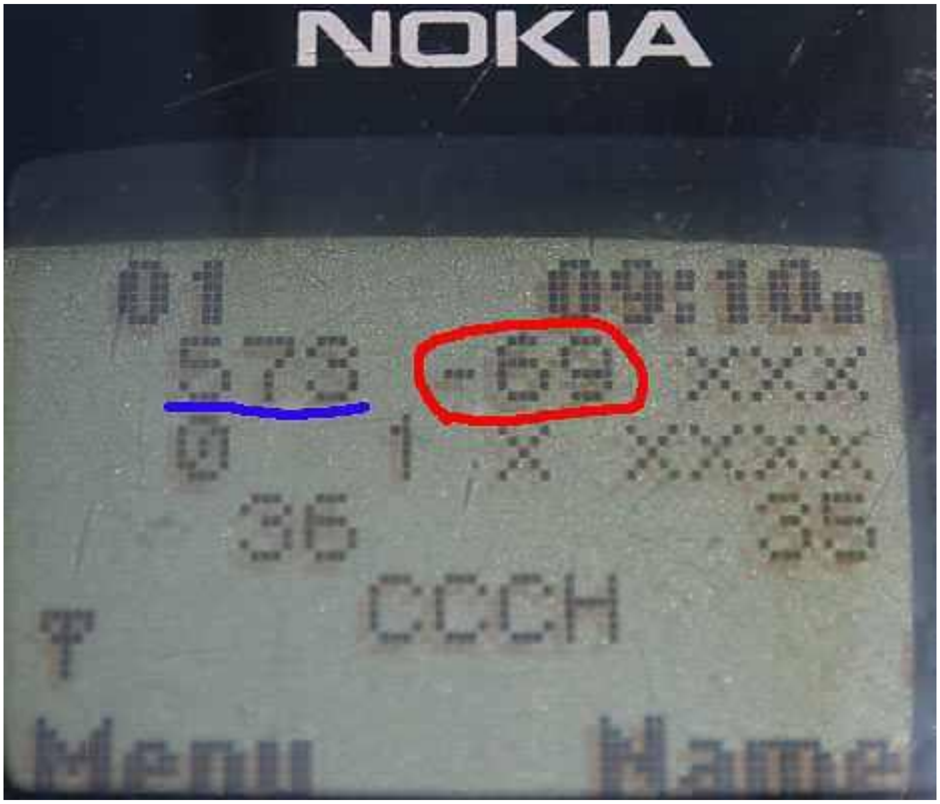
3.6.2 Required equipments

It is recommended that the same equipment is available for measuring the external building propagation loss, as is listed on page 18 for measuring the internal propagation loss.

If a TEMS Test Transmitter is not available, a suitable portable signal generator can be used almost as easily in existing buildings, with readily available electricity supply. The following figure illustrates the use of such a set-up, where the signal generator feeds a test length (~10m) of radiating cable, installed above a suspended ceiling.

Chapter 4

RF Survey Tools



Chapter 4

RF (Radio frequency) Survey Tools

4.1 RF Survey Tools

There are three types of RF survey tools

i. Nokia Net Monitor

ii. TEMS Light Tool

iii. TEMS Transmitter

NOKIA NETMONITOR

TEMS LIGHT TOOL

TEMS TRANSMITTER

Fig.4.1: RF Survey Tools

4.2 RF Survey with building floor plan

Existing Signal level measurements

NOKIA NET MONITOR DESIGN

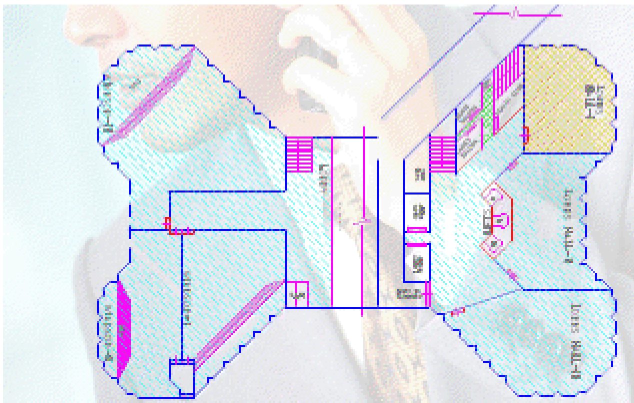


Fig.4.2: NOKIA NET MONITOR DESIGN

• Nokia phones [2] with net monitor software loaded in it

• Readings need to be taken manually in different locations of the floor; the readings can be mapped on the floor plans for easy understanding

• TEMS LIGHT is an Ericsson Indoor walk test tool, connect the TEMS to the laptop, load the software and upload the floor plan of the building. Walk in the floors and record the signal levels, Final report will have signal details super imposed on the pre-loaded floor plans.

4.3 Computer coverage prediction

In cases [2] where detailed building construction plans are readily available and difficult situation sowing to traffic load and frequency congestion, access problems for survey and measurement work, the use of detailed computer coverage prediction techniques may be cost effective.

Wide area coverage prediction software (examples include GRAND, PlaNet, and CellCAD) uses proven radio signal propagation models such as Okumura-Hata and COST 231, together with terrain and ground clutter databases to predict coverage on a statistical basis. This type of large area statistical coverage prediction software is not ideal for use in planning indoor systems, which usually cover a relatively small area.

Small area coverage prediction software (such as WiSE and Predict) is specifically designed for use in confined spaces such as in buildings, and dense commercial areas. These programs use ray tracing techniques, rather than a statistical application of one of the established propagation models. From the base station antenna site, the paths that rays emitted from the antenna would take are determined, and the resulting signal level calculated according to distance, number of reflections and refractions, and the attenuation of the material through which the rays pass The use of ray-tracing programs require detailed three dimensional drawings of the ground clutter in the area concerned. Attenuation values for the frequency concerned are assigned to each structure shown in the drawing. The drawings are generated using Computed Aided

Design (CAD) software such as Autodesk's 'AutoCAD'.

TEMS TOOL DESIGN

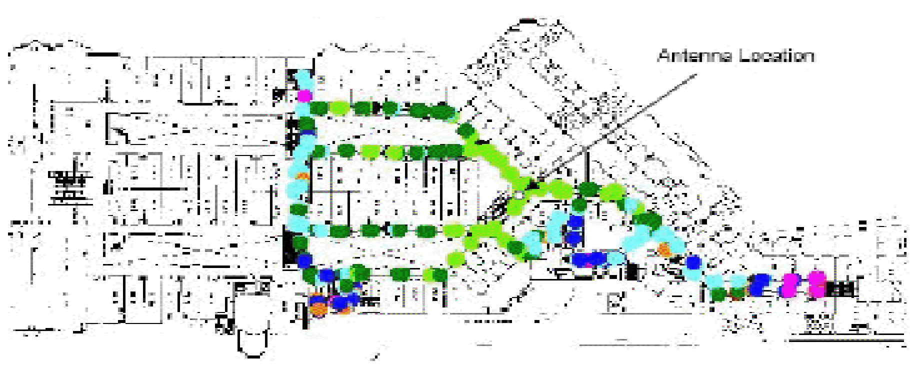


Fig.4.3: Tems Tool Design

4.4 In building solution proposal

Radio Network [2] Plan – RNP Report

• Solution description

i)Passive Distribution

ii) CAT-5 Distribution

• Coverage plan

• System diagram

• Power budget calculation

• Proposed antenna location photograph

• System layout on floor plan (ACAD)

• Measurement results

4.5 RNP Report Solution Descriptions

Over view

Network Solution passive coaxial & Antenna distribution or LGC network

Coverage Plan (i.e.) intended Coverage area

Based on the questionnaire or customers requirement, How many levels? Basement, Car park, Lift lobby, toilets, staff area etc., where all the coverage required

Bill of Materials

Details of How many antennas (Omni, Panel), Cable type (1/2” or 7/8”), Splitters, Couplers

Macro/ Micro BTS Accommodation

Type of BTS (Micro, Macro, flexi talk etc., based on output power)

BTS Location (to be placed in which floor? Is there any other BTS installed by other network operators?)

BTS configuration (1+1+1 or 2+2+2)

Electrical power supply for BTS

Power to be tapped from?

How to bring in E1 connection for the BTS

Should we put a separate electrical meter? MCB required? Etc

4.6 Distributed Antenna Systems

The RBS [1] are usually connected to the mobile operators' networks via copper Wires, optical fibers or microwave link connections. The output ports of the RBS are connected to one or several antennas. An antenna system with several antennas is usually named Distributed Antenna System or simply a DAS. Depending on the implementation, the DAS can serve one or several operators and one/or several bands (e.g. GSM 900, GSM 1800 and WCDMA). In some cases the DAS can be used to concurrently distribute both cellular and non-cellular bands, e.g. both GSM and WLAN in one and the same antenna system. The DAS can consist of either passive or active components. When both active and passive components are used in a DAS, it is often referred to as a hybrid solution. Some advantages of a dedicated RBS connected to a distributed antenna system, DAS, are that it is possible to ensure both dedicated coverage and capacity, confine the signals, prevent spillage and interference and thus enhance the quality for both speech and data services. Except for enabling new traffic in previous non-covered areas, the solution also off-loads the macro network in overlapping coverage areas. The RBS are normally owned by mobile operators. DAS consists of either passive or active components or a mix of passive and active components. The passive DAS are the most commonly deployed and consist of coaxial feeder cables and components such as antennas, power tapers and power splitters. Radiating feeders are used as a combined feeder cable and antenna. They are often used in tunnels and culverts. The distributed antenna systems can be implemented in many different ways and some the most frequently used designs are presented.

Distributed Antenna System:

• Using passive components like (Splitters 2way, 3way, 4way, Couplers 6dB, 7dB, 10dB, 15dB, 20dB etc.)

• Using Active amplifiers (Line amplifiers etc.)

• Using CAT-5 Cable, Main Hub, Expansion Hub and Remote antenna unit (RAU's)

Leaky Cable System: Coupling loss, Attenuation over distance need to be calculated.

Chapter 5

Antenna

Chapter 5

Antenna

5.1 Planning of Accessories

Omni antennas

The Ultra sphere [2] in-building wireless antenna is so surprisingly small in size that it can be hidden anywhere, providing an invisible solution for many applications.

The omni direction pattern is suited to a variety of uses such as in-building systems or other applications where mobility is a factor.

Fig.5.1: Omni Antennas

5.2 Planning of Accessories Directional or Cell-Max antennas

Cell-Max Antennas [2] feature a multi-band design that allows a wide range of frequencies to be covered by one small antenna. Created primarily for office environments, Cell-max Antennas are also ideally suited for parking garages, airports, shopping malls, and other difficult coverage areas.

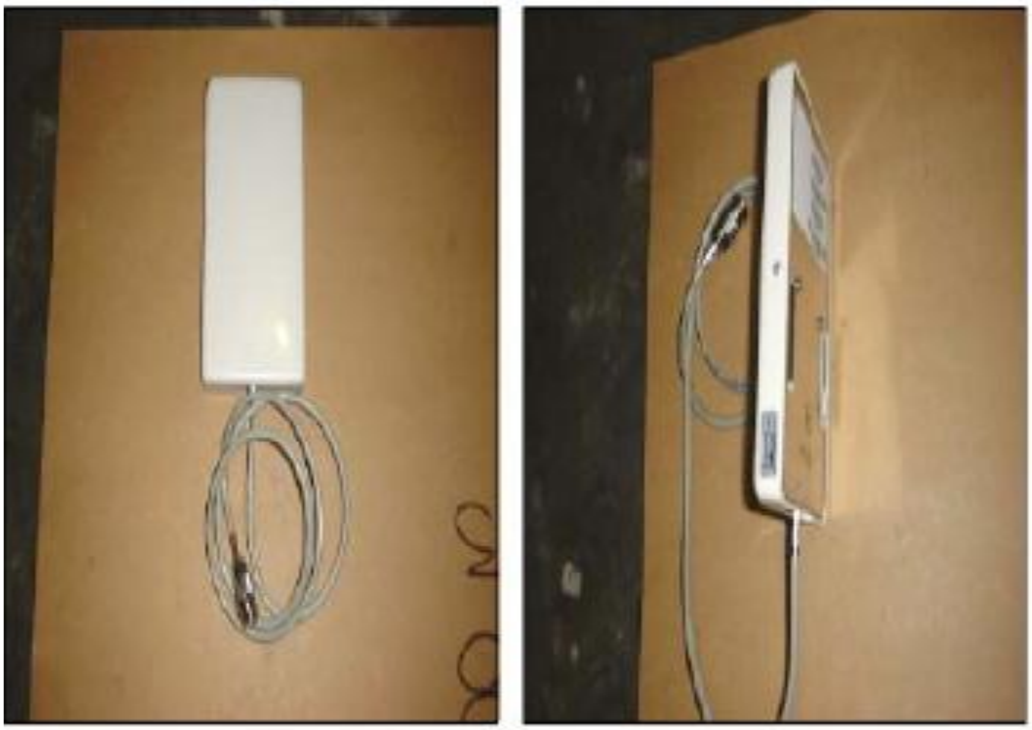


Fig.5.2: Directional or Cell-Max Antennas

5.2.1 Antenna Gain

Antenna	Gain
Omni Antenna	+4dB
Cell max or Panel Antenna	+7.5dB

Table 5.2.1: Antenna Gain

5.3 Planning of Accessories Splitters & Couplers

Fig.5.3.1: Different Type Splitters

Fig.5.3.2: 10 dB Coupler

5.4 Passive Distribution Techniques

• Cable lengths more than 50mts has to be a 7/8" (Less loss)

• Use RF couplers for symmetrical power splits

Coupler values are 3dB, 5dB, 6dB, 7dB, 10dB, 15dB, 20dB & Variable couplers

• Design must have similar power distribution & coupling loss to each antenna

• Best design is to minimize the co-ax length as far as possible.

Feeder cable Loss

Cable	Loss
½' per meter	0.1
7/8' per meter	0.06

Table 5.4.1: Feeder cable Loss per meter

Coupler Loss

Couplers power	Throughput	Coupling put
5 dB	1.5 dB	5 dB
7 dB	1.5 dB	7 dB
10 dB	.5 dB	10 dB
15 dB	.2 dB	15 dB

Table 5.4.2: Different type coupler Loss

Splitter Loss

Splitter power	Loss
2 way	3 dB
3 way	5 dB
4 way	6 dB

Table 5.4.3: Different type Splitter Loss

Chapter 6

RF power budget and Link Budget Element of a GSM Network

Chapter 6

RF power and Link Budget

6.1 Introduction

The RF power [4] budget for an indoor antenna system is calculated in exactly the same manner as for an outdoor system. A passive cable distributed multiple antenna system is limited in extent by the RF power budget. The maximum power available to each antenna form the RF Head, and the power presented to the RF Head from mobiles, is subject to the attenuation of the cable distributed antenna system. This is usually found to be more problematic with the down link as the Power Amplifier (PA) output from the RF Head is divided among multiple antennas on a continuous basis. It therefore suffers the combined effect of the cable loss, power dividing loss, and the insertion loss associated with each power divider in the path to the RF Head. The power radiated from the mobile need only be received by one antenna, and is subject only to the insertion loss associated with each power divider in the path to the RF Head (in addition to the cable loss).

6.2 RF power and Link Budget

Link budget of indoor cells can be obtained by same way with the link budget of outdoor macro cell

6.2.1 The signal strength required

The signal [5] strength required In order for communication to take place pad condition actually it is some margin should be added at MS level of sensitivity such as Rayleigh fading interference and loss of body. So that the signal strength (SSreq) Can be calculated according to equation:

SS req = MSsen + RF marg + IF marg + BL

With:

MS sens =MS sensitivity (dB m)

RF marg =Rayleigh fading margin (dB)

IF marg =Interference margin (dB)

BL =Lss body (dB

6.2.2 BTS Power output

Calculation of [5] power output BTS which will create a balanced system for all types of power class MS, in order to get equation

Pout bale =P out MS + D s

With:

P out bale =Transmitter MS Power (dBm)

Ds =MS sens – BTS sens (dBm)

Ds is the differce of BTS and MS receiver sensitivity

6.2.3 Radiated EIRP(Effective Isotropic Power)

EIRP = Pout bale – (L dupl BTS) – Lf BTS + Ga BTS

With:

Pout bale = Power output is balanced (dBm)

L dupl BTS =Loss duplexer on the BTS (dB)

Lf BTS = Loss liaison and jumpers on BTS (dB)

Ga BTS =Gain of the BTS antenna (dBi)

Link Budget Element of a GSM Network

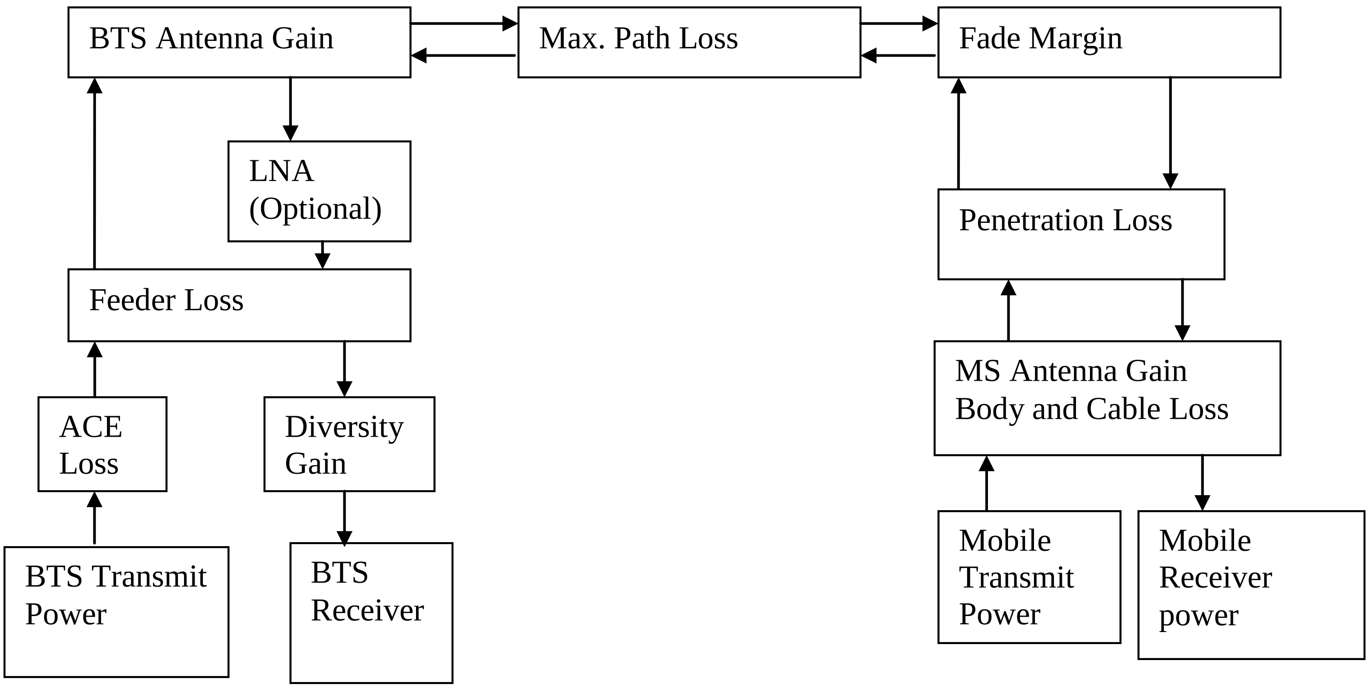


Fig: Block diagram of Link Budget Element of a GSM Network

6.4 Link Budget

BTS Transmit Power

• Maximum [4] transmit power

• GSM900 and 1800 networks use radios with 46dBm maximum transmit power

ACE Loss

• Includes all [4] diplexers, combiners and connectors

• Depends on the ACE configuration

• The ACE configuration depends on the number of TRXs and combiners

No of TRxs	Network	AEC Configuration	Downlink Loss(dB)
1 or 2	**GSM900**	**2 Antennas per cell, diplexer**	**1.0**
1 or 2	**GSM1800**	**2 Antennas per cell, diplexer**	**1.2**
3 or 4	**GSM900**	**2 Antennas per cell, diplexer + hybrid combiner**	**4.4**
3 or 4	**GSM1800**	**2 Antennas per cell, diplexer + hybrid combiner**	**4.4**

Table 6.4: ACE configuration table [5]

6.5 Mobile Receiver Sensitivity

• [4] The sensitivity of GSM900 and GSM1800 mobile = -102 dBm

• The following should be noted:-

– The sensitivity level is not sufficient to achieve

RXQUAL of 4 without frequency hopping

RXQUAL of 5 with frequency hopping

• A mobile receiver that moves at 50km/h averages the fading, but a static one will be under more severe fading influences. Therefore:-

– If the quality of a static mobile needs to be considered, then a quality margin of approximately 4 - 5 dB is used

– The mobile sensitivity would be -97 or -98 dBm.

Chapter 7

Acceptance Testing

Chapter 7
Acceptance Testing

7.1 Materials or Accessories Check

• Physically check [2] the implementation (any loose cabling, physical damage on feeders, antennas Clamped properly etc.)
• VSWR check for sample cables (it is highly impossible to check VSWR for each cable in building Solution, the reason is we have more than 100 pieces of cable in an average building, testing all the 100 will fetch entire 2 days & more over some cables will be inside the false ceiling)
• Check the list of inventory's used in that particular site
• Sample check the implemented cable lengths (Checking all the feeder physically might not be Possible)

7.2 Electrical & Ground Check

• Check the [2] power connections of Micro BTS (Voltage check, Grounding, Fixing etc.)
• Feeder cable connected to the output of micro cell has to be grounded properly using grounding kit
• Ventilation in the room to be checked

7.3 RF Signal Check

• Check the [2] signal levels (Idle mode) at places mentioned in the RNP report
• Check Call Setup, Call quality, Call sustain and Call hand over to Outdoor cells. Available from:

Chapter 8

Conclusion

The conclusion for this part is with In Building Coverage technology it will help people to use the hand portable such cell phone to receive or make a call anywhere and anytime freely even in basement without thinking that the transmission will terminated.

In-building solutions are well-proven methods for an operator to capture new traffic and new revenue streams. One can provide enhanced in-building solutions to off-load the macro network, thus increasing mobile traffic, and attract additional subscribers due to the enhanced mobile network quality and accessibility to mobile Internet applications and other services that require high data-rates and capacity.

There are several different ways to implement in-building solutions. Dedicated Radio Base Stations, RBSs, that are connected to Distributed Antenna Systems, DASs, are commonly implemented solutions. These solutions provide additional capacity as well as covers “black holes” inside different kinds of buildings. A number of different types of both RBSs and DASs are available and the solutions can be customized for different buildings and needs.

Chapter 9

INDOOR COVERAGE ENHANCEMENT PROJECT

RAJUK TRADE CENTER

Chapter 9

Project Overview of Rajuk Trade Center

9.1 INTRODUCTION

An indoor [7] system can be built for different reasons. If the coverage is poor from cells outside the building, leading to bad quality, a solution can be to build an indoor system. Buildings generating a high traffic load, like conference centers and airports, may need indoor systems to take care of the traffic. A different application is the business indoor system with the aim to complement or replace the fixed telephony network.

The aim with indoor cell planning is, as for “traditional” cell planning, to plan for good coverage and capacity and at the same time interfere as little as possible. How this can be achieved is briefly described here. The focus is on antenna and RBS systems,

RF design and antenna configuration but also frequency planning, capacity issues and traffic control are described.

The tools for indoor cell planning, TEMS Prediction, TEMS Light and TEMS Transmitter, are also described with focus on how to use them in the planning process.

9.2 PROJECT OVERVIEW

An extensive [7] technical survey was conducted on 29th August 2009 at **Rajuk Trade Center** building to enhance the capacity and Coverage.

As per the survey, we have designed a solution to provide complete in – building cellular solution at the location. Kindly find enclosed here with the plan regarding the same, which would give excellent coverage and clarity

The Rajuk Trade center building consists of Basement to Fifth Floor. The total area of the building is approximate 11,601 **Sqr. Mtr**.

The plan has been designed considering the configuration in GSM1800 with signal level up to -80 dB throughout the floors. The signal levels inside the lift will be sufficient enough to maintain call continuity throughout the building.

The enclosed document gives details of the distributed antenna system, the exact antenna locations, the cable routing, location of splitters, couplers etc.

The permission from your end or a Contractor Pass, to carry out the work will be useful to carry out our work smoothly, efficiently and promptly within the allotted time.

Your co-operation is the most important thing required to complete our installation.

We will bear the cost of any damages caused during the course of implementation.

The BTS proposed for the Rajuk Trade Center is the RBS output power of 33 dBm will be used for the in building solution. The Micro BTS is proposed to be installed in the Fifth Floor of the building. The picture sample for the same are given figure 1

Figure 9.2.1 : BTS Location (Sample)

The cables proposed to be used are half inch feeder cable The cable runs through the electrical shaft and the ceiling of the different floors. The antenna for the different floors is proposed to be installed at the market corridors, market area and in front of lift .The picture sample for the same are given figure 2

Figure 9.2.2: Antenna Location (Sample)

9.3 In-Building Radio System report

The report [7] contains the technical description of our proposal for the full turnkey mobile telecommunication system design, describing an in building solution that supports GSM1800 services in the **Rajuk trade center** building The report provides information on the network architecture, its design criteria and assumptions, equipment description, including issues on capacity and dimensioning, frequency planning, system interference and spillage control.

The proposal is based on Cellcomm Solutions Ltd (CSL) vast experience in realizing cost effective turnkey RF Coverage solutions in airports, large convention centers, and underground tunnels.

9.3.1 Technical Summary

The solution features the following characteristics:

- Distributed antenna system with passive components
- Adoption of aesthetically pleasing Indoor antennas
- Low output power at antenna port, but using multiple antennas to ensure adequate coverage.

9.3.2 Usage of Equipment Room

The equipment rooms used in the project is at the locations given below

- In the Basement of the **Rajuk trade Center** building

9.3.3 Cell Configuration

Base on the [7] location of the equipment room, expected traffic and signal level Requirement, the total coverage area is divided into 2 major areas, as given below.

1) Sector A of the BTS for Basement to 2nd Floor.
2) Sector B of the BTS for 3rd Floor to 5th Floor [7]

9.3.4 Operator System and Frequency Bands

OPERATOR	SYSTEM	UPLINK IN MHz	DOWN LINK IN MHz
AKTEL	GSM 1800	1727.4to 1732.6	1822.4 to 1827.6

9.3.5 BTS Configuration Details of the Operator

OPERATER NAME	No of BTS	BTS Model	BTS Sectors for IBS	TRX per Sector	O/p RF power per Sector in dBm
AKTEL	1	2308	2	2	33

9.3.6 System Performance Description

The In Building [7] system of **Rajuk Trade Center** after implementation, shall meet the following characteristics

1. Rx Level

   The Rx Level will be better than –80dBm for 95% of public area in the building. The 5% area, which is excluded from the criteria are places like toilets and fire escape staircase. To have – 80dBm coverage level for 90% of concealed area in the building (level below ground level, example basement), which is not sensitive to interference. Lift lobby at car park and inside the lift must fulfill criteria. The coverage level shall also be 5 dBm above the outdoor coverage.
2. The Rx Qual shall to be less than or equal to 3
3. Call setup success rate shall be better than or equals to 99%
4. Call drop shall be less than 1%.
5. The Handover success rate shall be greater than 99% The parameter settings for the neighbor relationship and handover parameters will be optimum so that the in-building system shall not handle calls in places far beyond its intended coverage area and shall not cause excessive signal spillage to outdoor areas. The cell border for the in-building system is normally defined at the building edge and generally the RxLev at the edge will have to be the same as that in the rest of the buildings (unless otherwise specified) and a gradual degradation of the spillage must be allowed. The handover success rate shall be better than 99%
6. SQI shall be Between 16 to 21.
7. SDCCH drop shall be less than or equal to 1%.
8. SDCCH Success rate shall be higher than or equal to 99%.
9. Multi operator support

The possibility of system expansion has been taken into account during the proposal design. There are two possibilities of system expansion, namely area expansion and capacity expansion. Enough capacity has been reserved for system expansion .The entire system can also be easily expanded to support uptill Wireless LAN application, since all components used in the design can operate up to 2,500MHz.

10. EIRP at the antenna output has been planned between 5dBm to 20dBm

11. VSWR

The VSWR limits are as follows: a) Antenna, 1.5 vs. frequency b) Feeder, 1.2 vs. frequency.

9.3.7 Selection of Passive Components

1. Indoor Antennas

All the [7] indoor antennas proposed in the plan is omni and Directional type which is ideal for the **Rajuk Trade Center** building signal coverage.

2. Power Dividers and Couplers

The RF couplers and power dividers for this project needs to satisfy the bandwidth requirements for the GSM1800. The quality of the dividers must be high in order to achieve an excellent system performance.

3. RF Cable

The RF Cable Proposed is ½ "& & 7/8" corrugated cable for this project. The quality of the RF cable must be high in order to achieve an excellent system performance.

4. Handover Analysis

In the **Rajuk Trade Center**, mobile users entering and leaving the indoor areas are slow moving pedestrian traffic. Handover will be smooth under proper signal conditions and network parameter. Additional antennas are planned near the different exits extend RF signal for a larger overlap with the outdoor signals. [7]

9.3.8 Empirical Path Loss (Indoor)

- **Loss A(dB)=32.4+20Log(f/GHz)+10nLog(d/m)+kF+pW**

Where:

- **A = path Loss in dB**
- **f = frequency in GHz**
- **d = distance between transmitter and terminal in meters**
- **k = number of floors**
- **F = attenuation per floor**
- **n = power decay index《from 2 (for LOS to mobile) to 4 (obstructed)》**
- **p = number of walls**
- **W = attenuation per wall**

n=2.5 & 3.0 & 3.8 [6]

9.3.9 Grade of service and Erlang Calculation

We propose a 2 carrier BTS/sector for all the 2 sectors.

All calculations done for this project is after defining the Grade of service at 2%.

Traffic Channels = (No. Of ARFCN channels x 8) – No. Of signaling channels in the cell

Traffic Channels = (2 x 8) – 2 = 14 traffic channels

GOS is defined as the percentage of unsuccessful call setup due to congestion. The operator defines this value. From these two values we can find out the **Erlang traffic** per cell by using the Erlang table. We have a 2 channel BTS with eight signaling timeslot and the GOS defined at 2% then the Erlang traffic will be 8.2003 Erlang.

$$A = \frac{n \times T}{3600} \quad \text{(Erlang)}$$

Where n = number of calls per hour

T = average conversation time per call

A = offered traffic from one or several users in the system

For example, if we have n = 1 and T = 90 seconds the traffic per subscriber

Traffic per subscriber =0.025 erlangs

The subscriber per cell is calculated as below:

$$\textbf{Number of Subscribers per cell} = \frac{\textbf{Traffic per cell}}{\textbf{Traffic per subscriber}} = \frac{8.2003}{0.025} = \textbf{328 subscribers}$$

9.3.10 Traffic capacity allocation for each cell table

System	Sector	UL- Band	Dl-Band	Carriers	Erl/Cell	Sub/Cell
GSM 1800	BTS 1 Sector A	1747.2 to 1752.6 Mhz	1842.2 to 1847.6 Mhz	2	8.2003	328
GSM 1800	BTS 1 Sector B	1747.2 to 1752.6 Mhz	1842.2 to 1847.6 Mhz	2	8.2003	328
			Total	**4**	**16.4006**	**656**

Table 9.3.10: Traffic capacity allocation for each cell table

9.4 Floor plan with cable rooting of Rajuk trade center

9.4 .1 Floor plan with cable rooting of Rajuk trade center(Basement)

BASEMENT

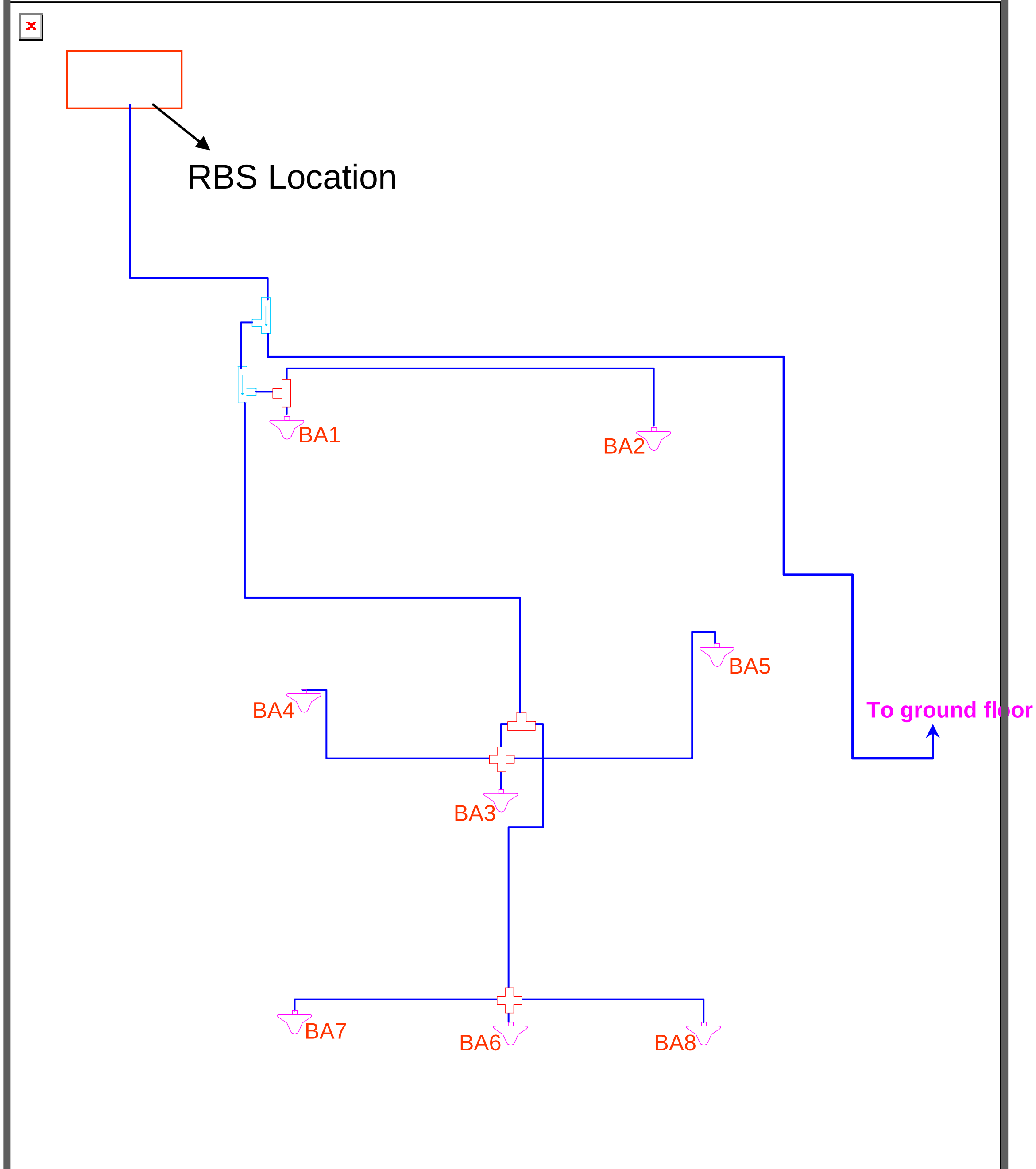


Fig.9.4.1: Floor plan with cable rooting of Rajuk trade center(Basement)

9.4.2 Floor plan with cable rooting of Rajuk trade center(Ground Floor)

GROUND FLOOR

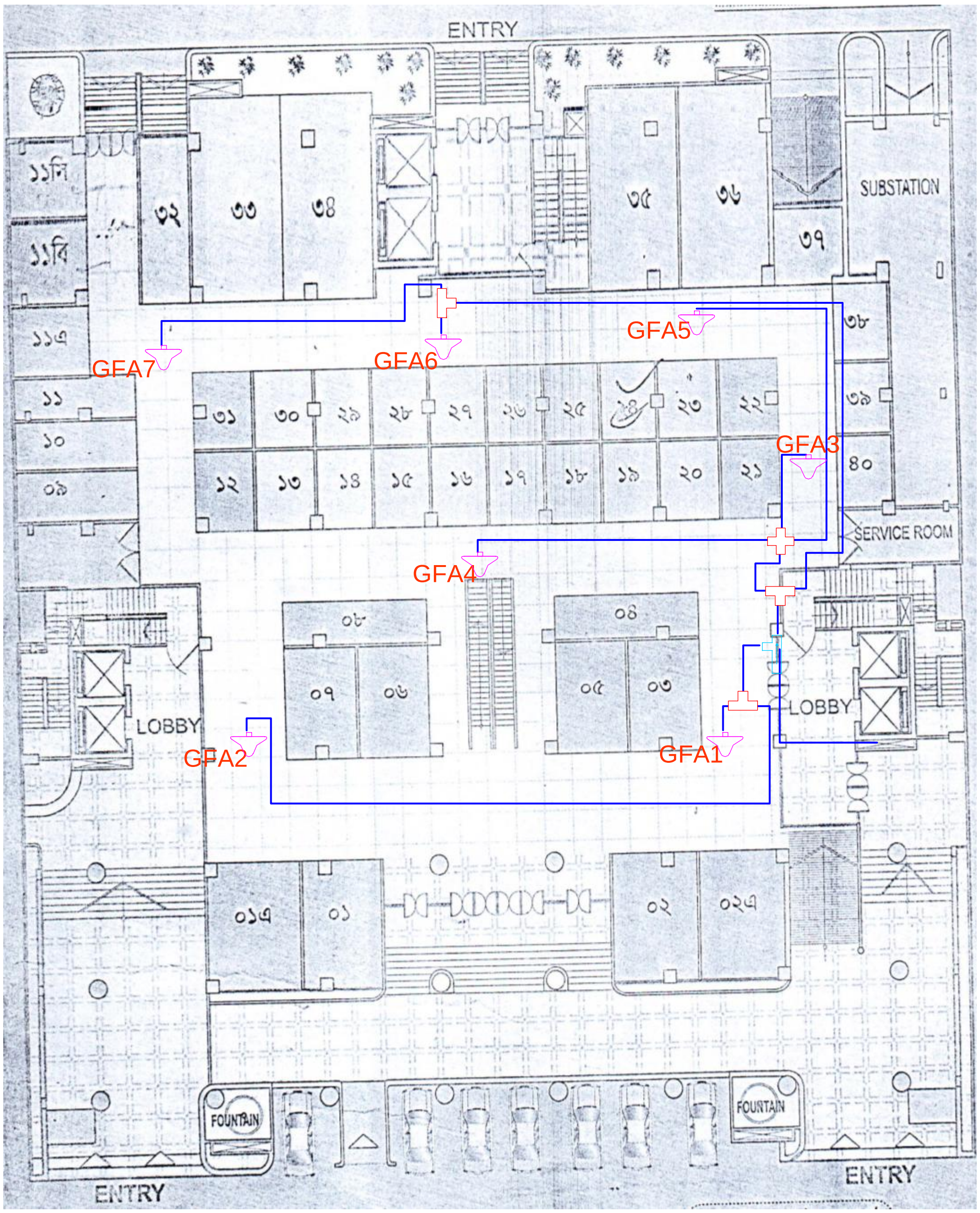


Fig.9.4.2 : Floor plan with cable rooting of Rajuk trade center(Ground Floor)

9.4.3 Floor plan with cable rooting of Rajuk trade center (First Floor)

FIRST FLOOR

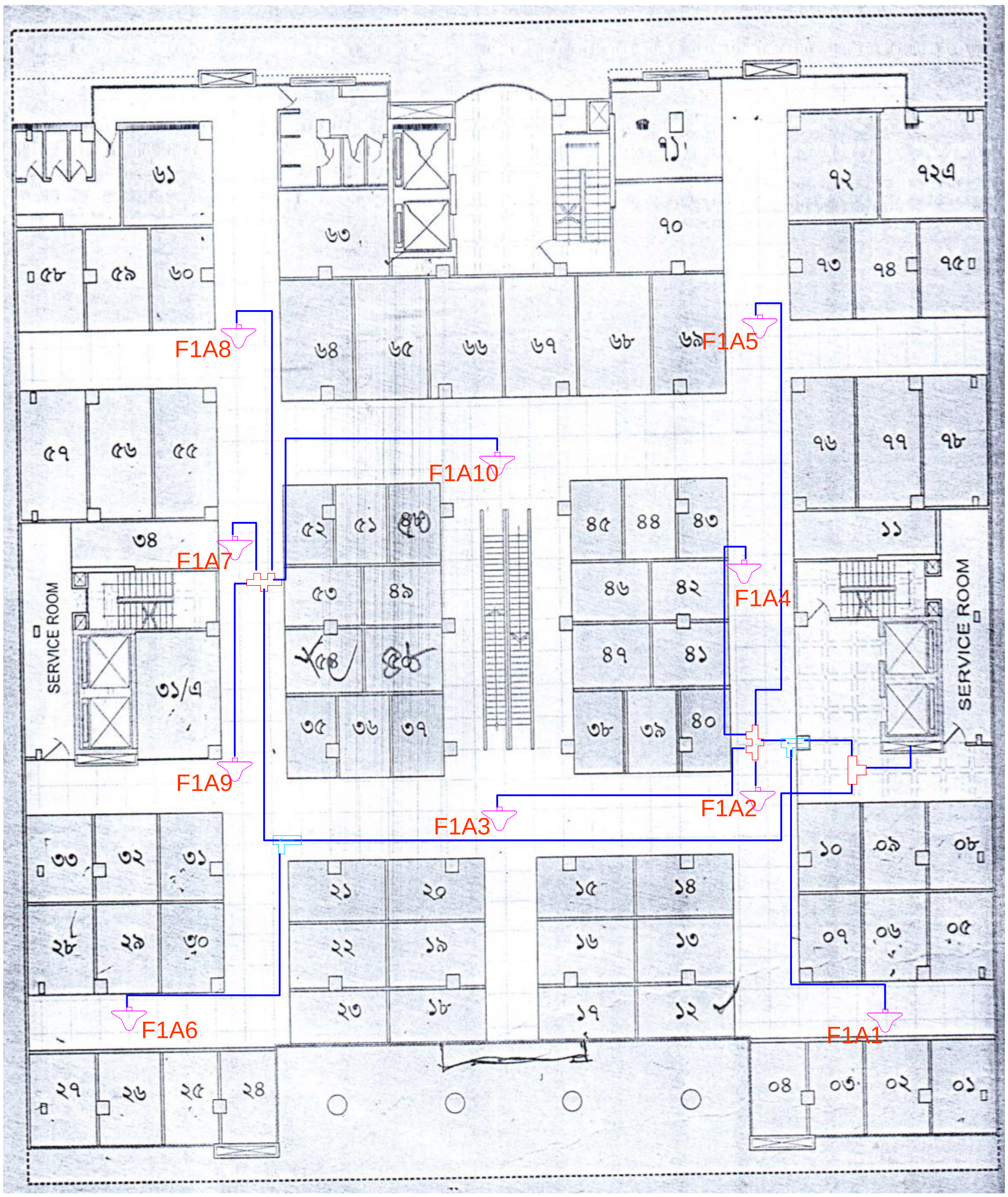


Fig9.4.3:Floor plan with cable rooting of Rajuk trade center(First Floor)

9.5 Trunking or System Diagram

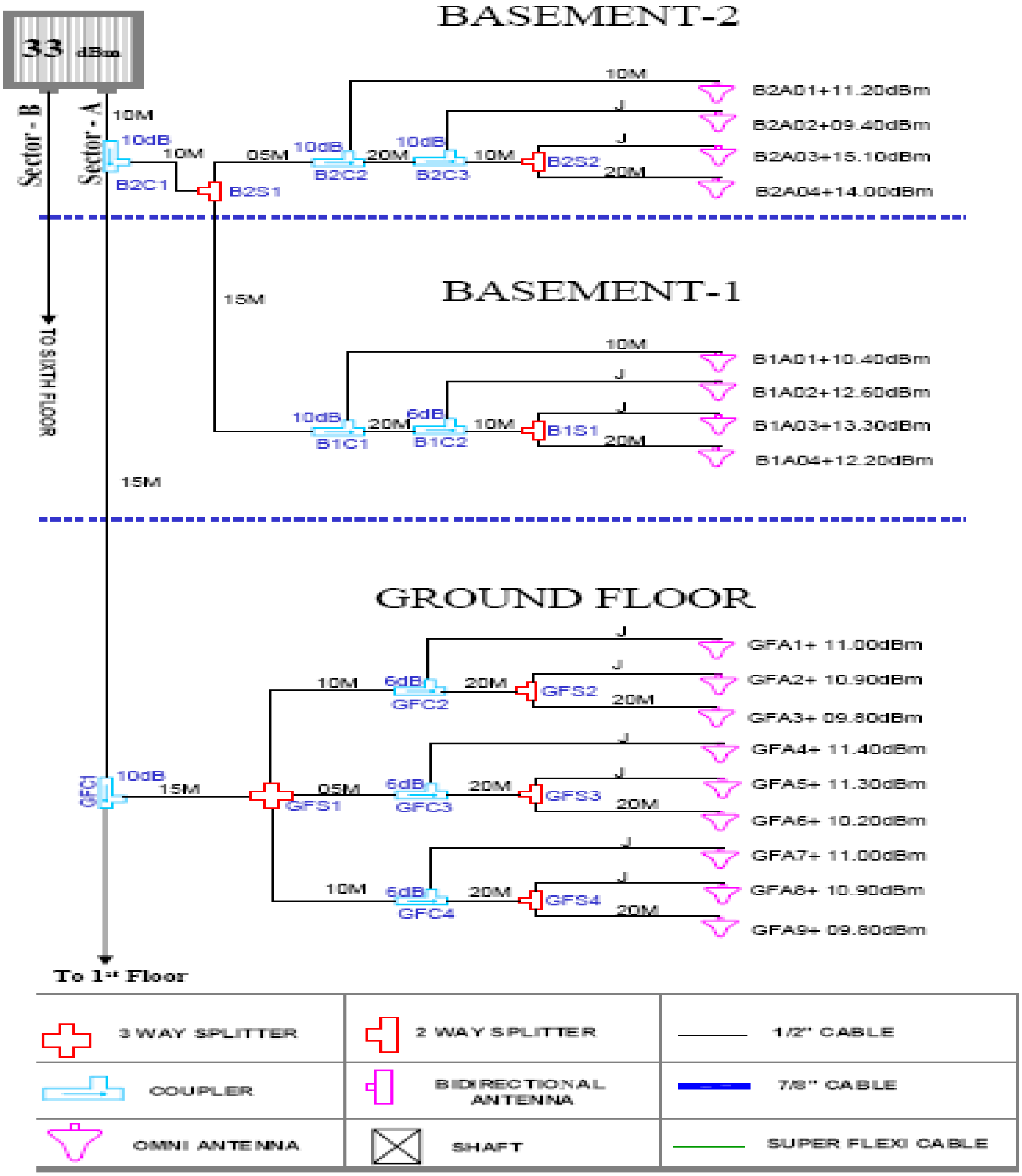


Fig.9.5: Trunking or System Diagram of Basement and Ground Floor

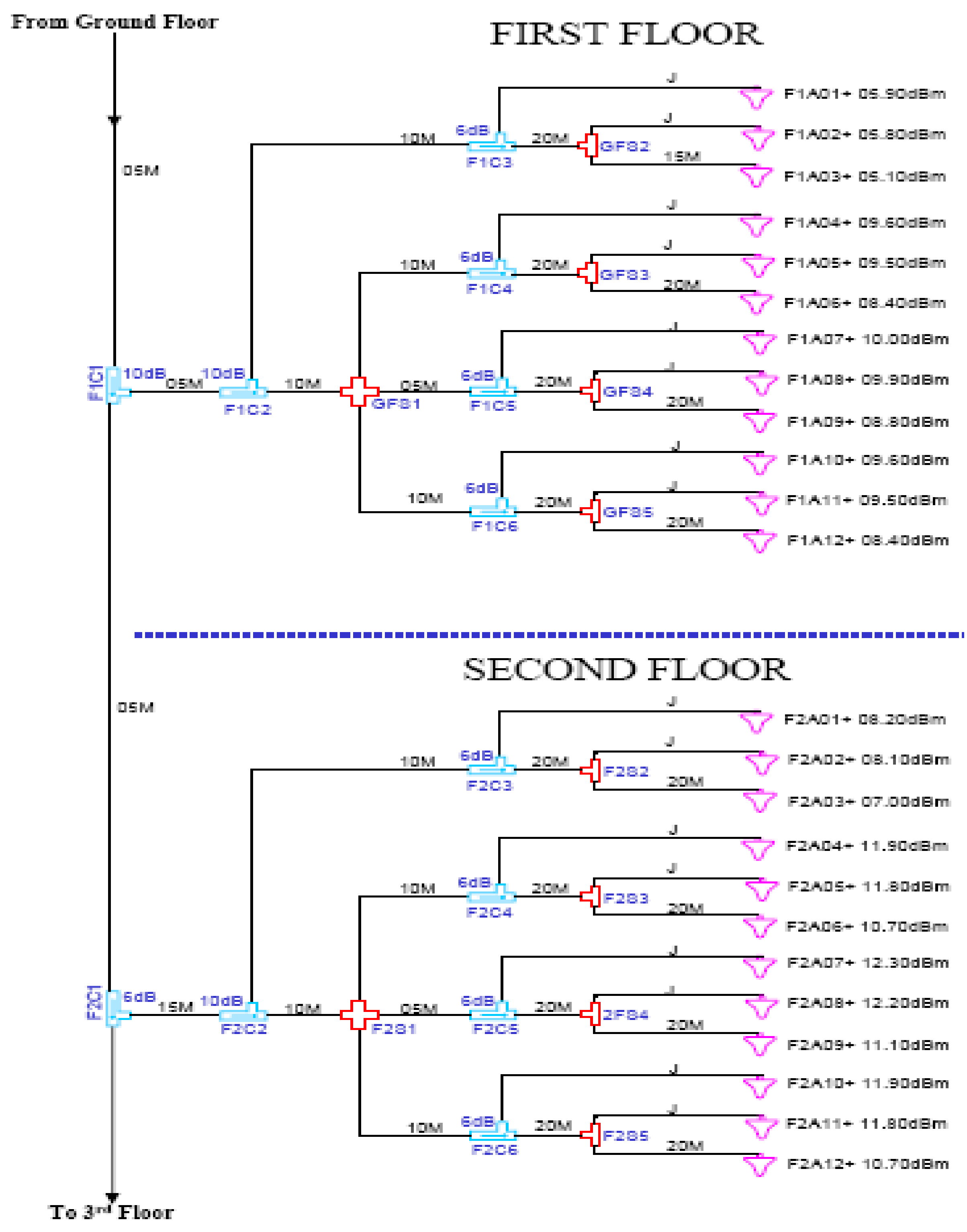


Fig.9.5.1: Trunking or System Diagram of First and Second Floor

9.6 LINK BUDGET CALCULATION FOR UPLINK & DOWNLINK OF ALL ANTENNAS

Uplink & Down link link budget calculation table for RAJUK TRADE CENTER IBS indoor antenna with Highest EiRP				
Uplink link budget calculation on antenna LFA1				
MS output power			**30.0**	**dBm**
Average distance of indoor antenna from MS in meters			15	M
Propagation loss b/n indoor antenna & MS for n=4 environment			84.55	dB
Power level at indoor antenna			-54.5	dBm
	Loss / Gain(dB)	**Quantity**		
Indoor omni antenna gain	4	0	0.0	dBi
Indoor Panel antenna	7.5	1	7.5	dBi
Total Cable Length - Super Flexi (m)	(0.10)	0	0.0	dB
Total Cable Length loss -1/2" (m)	(0.08)	105	-8.4	dB
Total Cable Length loss -7/8" (m)	(0.06)	0	0.0	dB
Coupler 15 dB (Coupling)	(15.00)	0	0.0	dB
Coupler 15 dB (Thru)	(0.20)	0	0.0	dB
Coupler 10 dB (Coupling)	(10.00)	1	-10.0	dB
Coupler 10 dB (Thru)	(0.50)	0	0.0	dB
Coupler 7 dB (Coupling)	(7.00)	0	0.0	dB
Coupler 7 dB (Thru)	(1.50)	0	0.0	dB
Coupler 5 dB (Coupling)	(5.00)	0	0.0	dB
Coupler 5 dB (Thru)	(1.50)	0	0.0	dB
Splitter 2 Way	(3.00)	1	-3.0	dB
Splitter 3 Way	(5.00)	0	0.0	dB
Splitter 4 Way	(6.00)	0	0.0	dB
Jumper Cable	(0.50)	0	0.0	dB
Combiner loss(5:1)	-5.00	0	0.0	dB
Rx level at BTS			**-68.4**	**dBm**

Downlink link budget calculation on antenna LFA1				
BTS output power			**33.0**	**dBm**
	Loss / Gain(dB)	**Quantity**		
Total Cable Length loss -Super Flexi (m)	(0.10)	0	0.0	dB
Total Cable Length loss -1/2" (m)	(0.08)	105	-8.4	dB
Total Cable Length loss -7/8" (m)	(0.06)	0	0.0	dB
Combiner loss(5:1)	-5.00	0	0.0	dB
Coupler 15 dB (Coupling)	(15.00)	0	0.0	dB
Coupler 15 dB (Thru)	(0.20)	0	0.0	dB
Coupler 10 dB (Coupling)	(10.00)	1	-10.0	dB
Coupler 10 dB (Thru)	(0.50)	0	0.0	dB
Coupler 7 dB (Coupling)	(7.00)	0	0.0	dB
Coupler 7 dB (Thru)	(1.50)	0	0.0	dB
Coupler 5 dB (Coupling)	(5.00)	0	0.0	dB
Coupler 5 dB (Thru)	(1.50)	0	0.0	dB
Jumper Cable	(0.50)	0	0.0	dB
Splitter 2 Way	(3.00)	1	-3.0	dB
Splitter 3 Way	(5.00)	0	0.0	dB
Splitter 4 Way	(6.00)	0	0.0	dB
Indoor Omni antenna gain	4	0	0.0	dBi
Indoor Panel antenna	7.5	1	7.5	dBi
EIRP at indoor antenna			19.1	dBm
Average distance of MS from indoor antenna in meters			15	M
Propagation loss b/n indoor antenna & MS for n=4environment			84.55	dB
Rx level at MS			**-65.4**	**dBm**

Table 9.6: Link Budget Calculation for each antenna uplink and downlink for Minimum.

9.7 LINK BUDGET CALCULATION FOR UPLINK & DOWNLINK OF ALL ANTENNAS

GSM1800 Uplink & Down link link budget calculation table for RAJUK TRADE CENTER IBS indoor antenna with lowest EiRP Uplink link budget calculation on antenna F3A3				
MS output power			**30.0**	**dBm**
Average distance b/n indoor antenna & MS in meters			15	M
Propagation loss b/n indoor antenna & MS for n=4 environment			84.55	dB
Power level at indoor antenna			-54.5	dBm
	Loss / Gain(dB	**Quantity**		
Indoor omni antenna gain	4	1	4.0	dBi
Indoor Panel antenna	7.5	0	0.0	dBi
Total Cable Length loss - Super Flexi (m	(0.10)	0	0.0	dB
Total Cable Length loss - 1/2" (m)	(0.08)	130	-10.4	dB
Total Cable Length loss -7/8" (m)	(0.06)	0	0.0	dB
Splitter 2 Way	(3.00)	2	-6.0	dB
Splitter 3 Way	(5.00)	1	-5.0	dB
Splitter 4 Way	(6.00)	0	0.0	dB
Coupler 15dB (Thru)	(0.20)	0	0.0	dB
Coupler 15 dB (coupling)	(15.00)	0	0.0	dB
Coupler 10 dB (Thru)	(0.50)	2	-1.0	dB
Coupler 10 dB (coupling)	(10.00)	0	0.0	dB
Coupler 7 dB (Coupling)	(7.00)	1	-7.0	dB
Coupler 7 dB (Thru)	(1.50)	0	0.0	dB
Coupler 5 dB (Coupling)	(5.00)	0	0.0	dB
Coupler 5 dB (Thru)	(1.50)	0	0.0	dB
Jumper Cable	(0.50)	1	-0.5	dB
Combiner loss(5:1)	-5.00	0	0.0	dB
Rx level at BTS			**-80.4**	**dBm**

Downlink link budget calculation on antenna F3A3				
BTS output power			**33.0**	**dBm**
	Loss / Gain(dB	**Quantity**		
Total Cable Length loss -Super Flexi (m	(0.10)	0	0.0	dB
Total Cable Length loss -1/2" (m)	(0.08)	130	-10.4	dB
Total Cable Length loss -7/8" (m)	(0.06)	0	0.0	dB
Combiner loss(5:1)	-5.00	0	0.0	dB
Coupler 15dB (Thru)	(0.20)	0	0.0	dB
Coupler 15 dB (coupling)	(15.00)	0	0.0	dB
Coupler 10 dB (coupling)	(10.00)	0	0.0	dB
Coupler 10 dB (Thru)	(0.50)	2	-1.0	dB
Coupler 7 dB (Coupling)	(7.00)	1	-7.0	dB
Coupler 7 dB (Thru)	(1.50)	0	0.0	dB
Coupler 5 dB (Coupling)	(5.00)	0	0.0	dB
Coupler 5 dB (Thru)	(1.50)	0	0.0	dB
Splitter 2 Way	(3.00)	2	-6.0	dB
Splitter 3 Way	(5.00)	1	-5.0	dB
Jumper Cable	(0.50)	1	-0.5	dB
Indoor omni antenna gain	4	1	4.0	dBi
Indoor Panel antenna	7.5	0	0.0	dBi
EIRP at indoor antenna			7.1	dBm
Average distance b/n MS& indoor antenna in meters			15	M
Propagation loss b/n indoor antenna& MS for n=4 environment			84.55	dB
Rx level at MS			**-77.4**	**dBm**

Table 9.7: Link Budget Calculation for each antenna uplink and downlink for maximum EIRP

9.8 Antenna And RBS System – Overview

When designing [6] an indoor system, the ambition is (note! this is not a requirement) to get the antenna network as symmetric as possible in order to provide each single antenna within the system with the same output power. It is desirable to place the RBS somewhere in the middle of the building in order to minimize feeder distance to the antennas.

Preparation for any future extension of the indoor system, both from a coverage point of view and from a capacity point of view, shall always be considered before the installation. The RF link budget shall be calculated so that there is a possibility to add power splitters, hybrid couplers, etc. to the antenna system in case of further extension of the antenna network.

Although if the intention is, when planning an indoor system, to be operating on a GSM frequency single-band, it's better to prepare the antenna network for multi-band. The cost of investing in multi-band equipment is marginal compared to what it would cost in the future to replace the single-band equipment with multi-band equipment.

In an indoor cell, the downlink is usually the most critical link in the air-interface. This means that there is no need for using uplink diversity in an indoor system or to use amplifiers for improving the uplink signal.

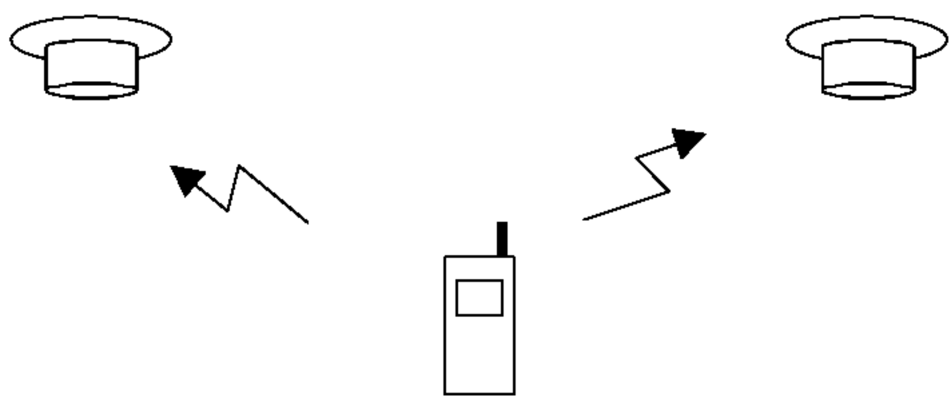


Fig.9.8: Omni Antenna connect to mobile signal (uplink)

9.9 RBS 2206 Commissioning part step to step

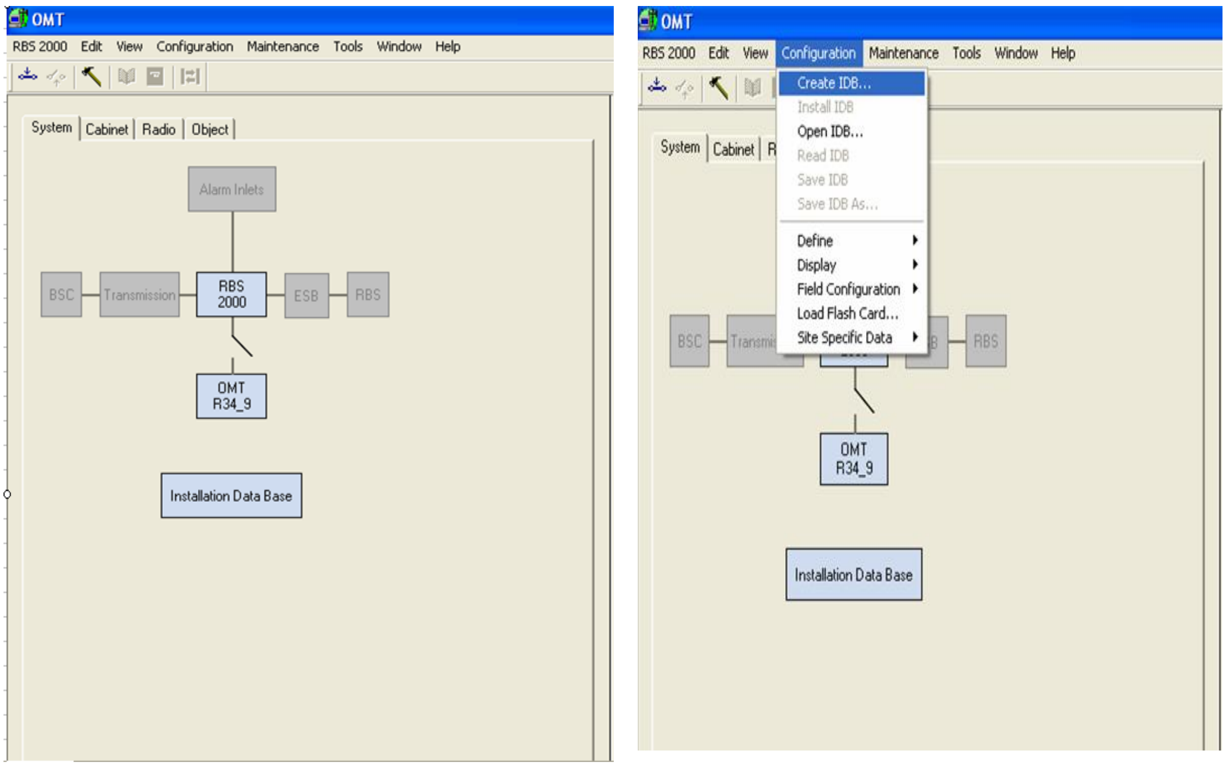


Fig : RBS 2206 Commissioning create IDB

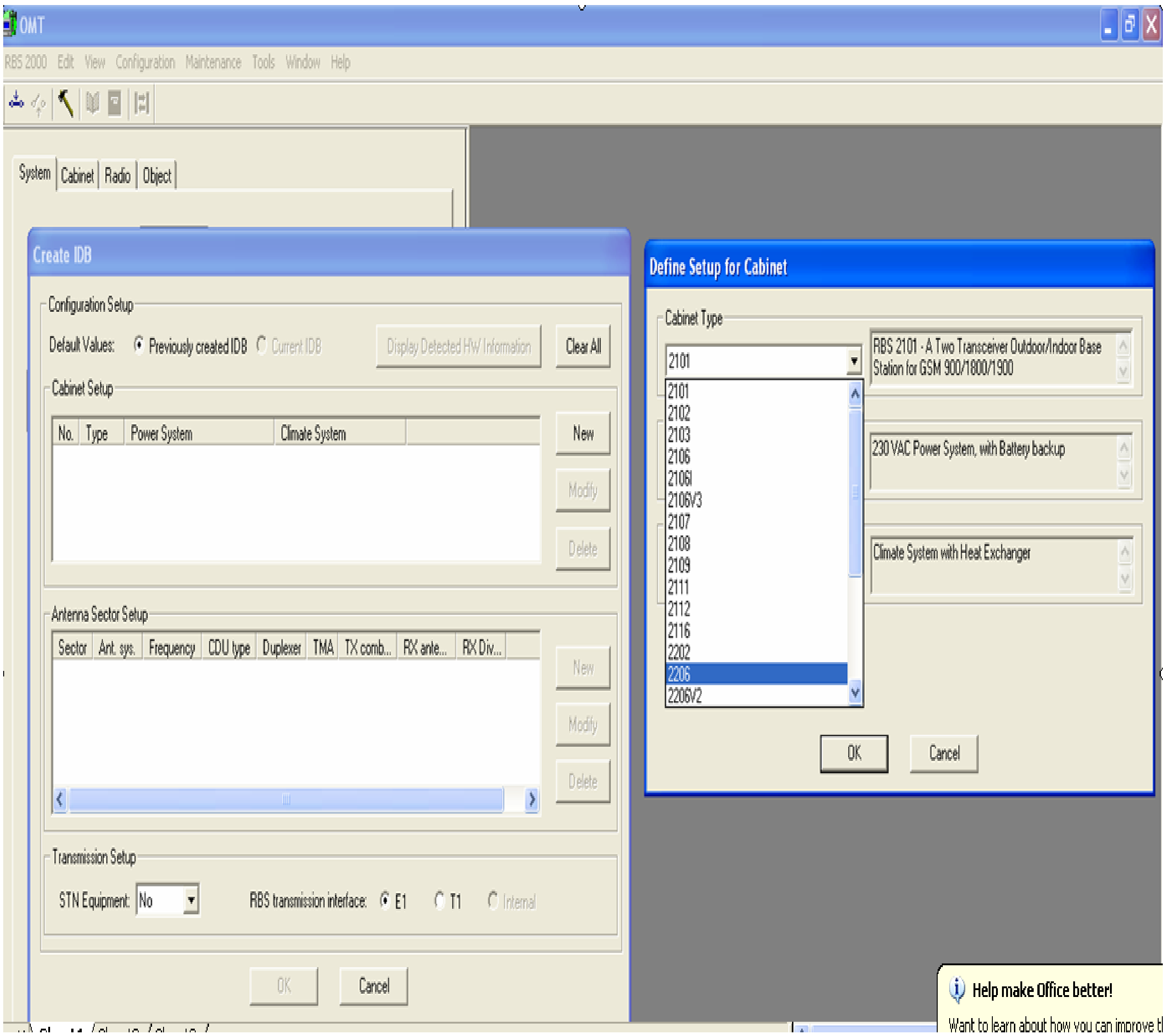
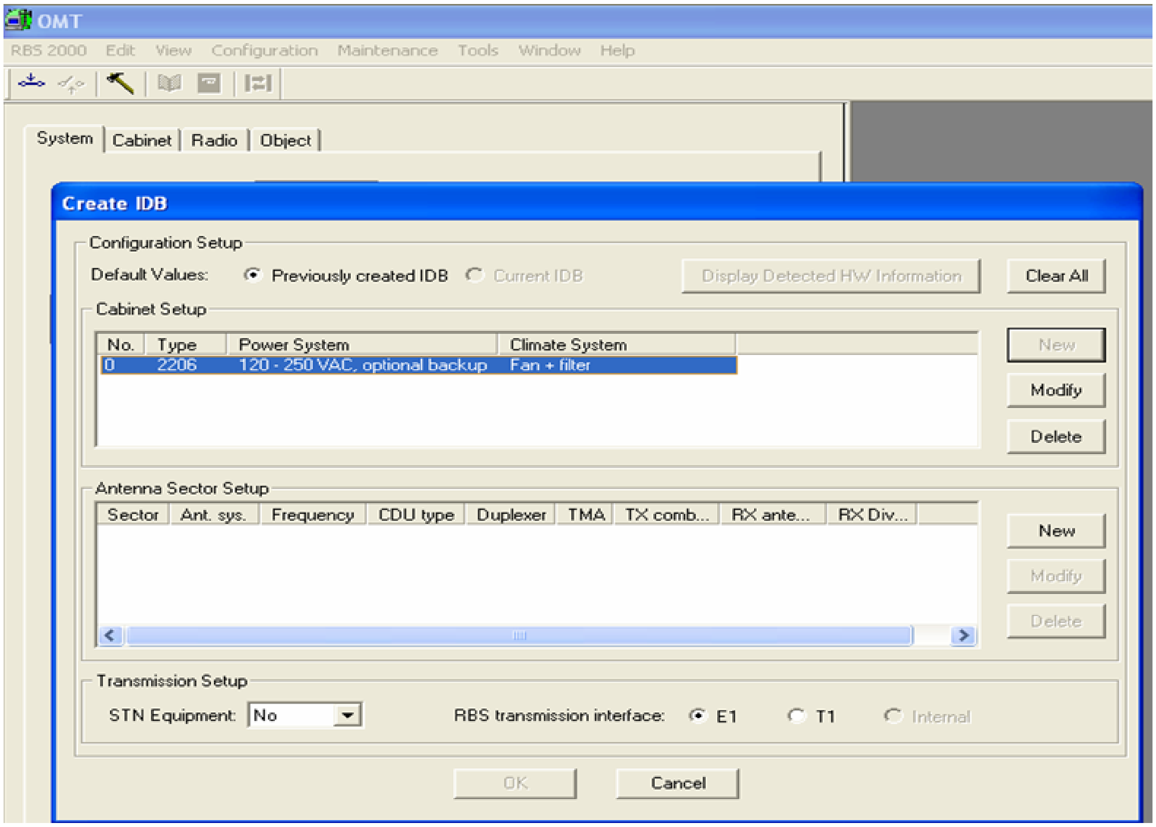


Fig.9.8.2: RBS 2206 Commissioning create IDB



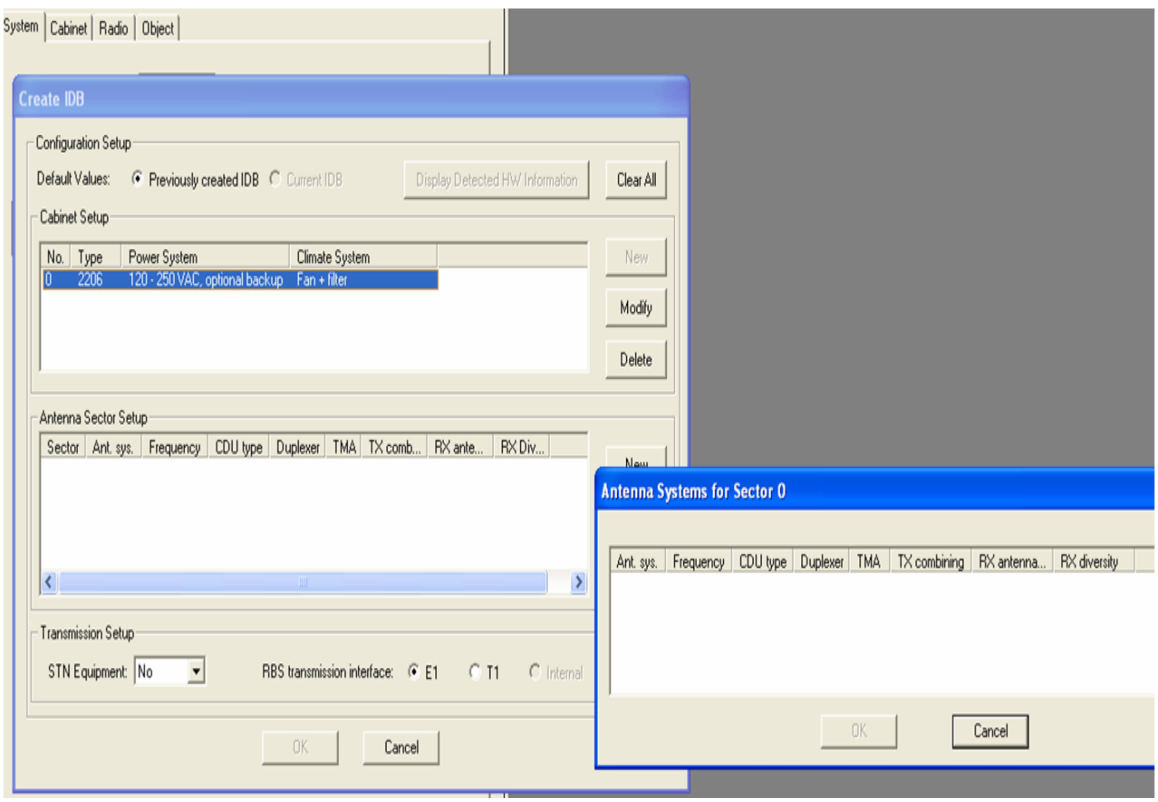
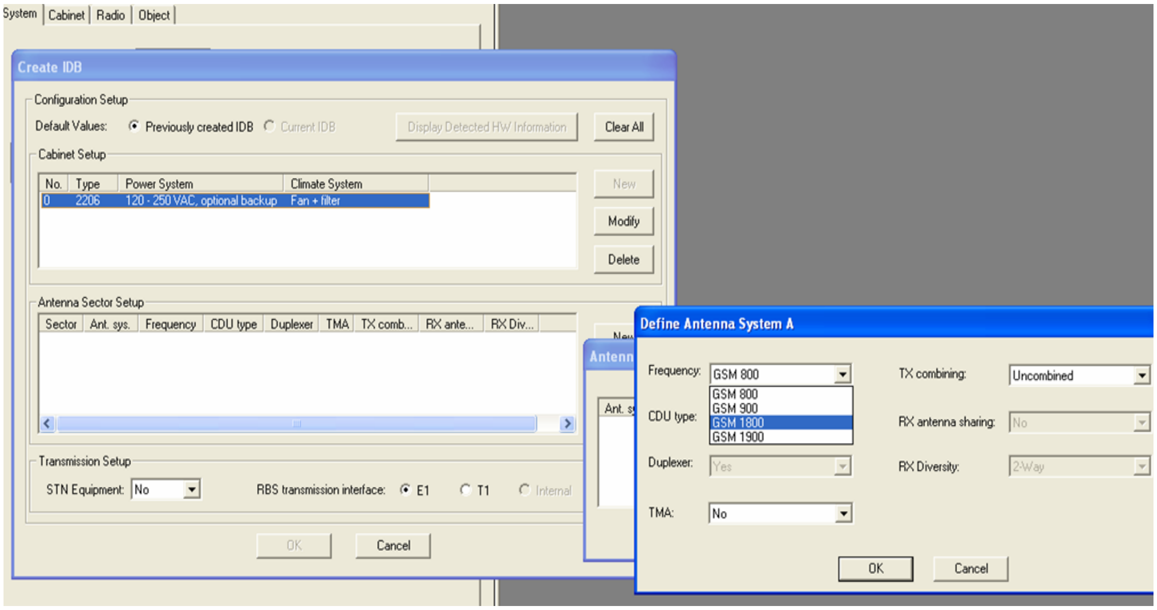


Fig.9.8.3: RBS 2206 Commissioning create IDB



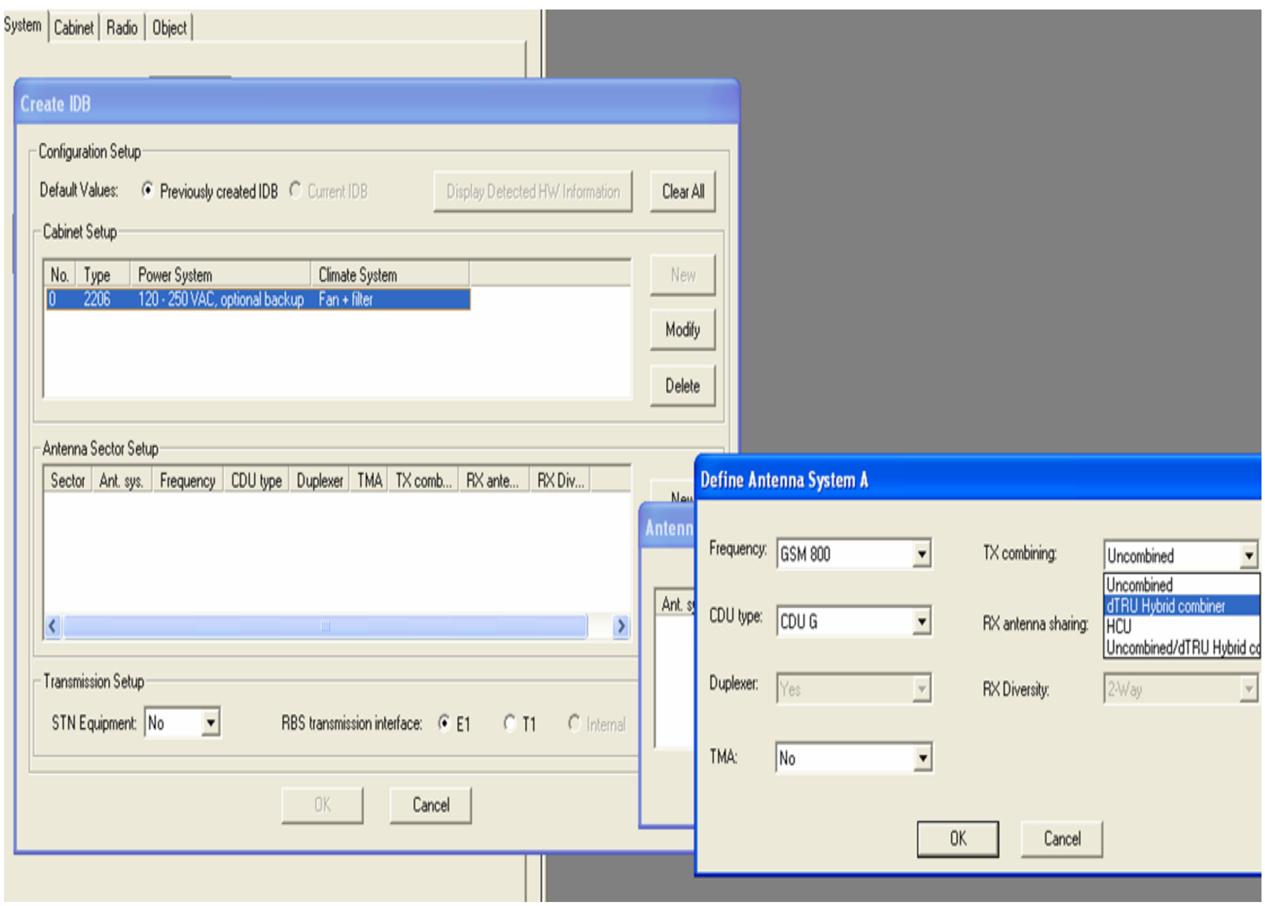
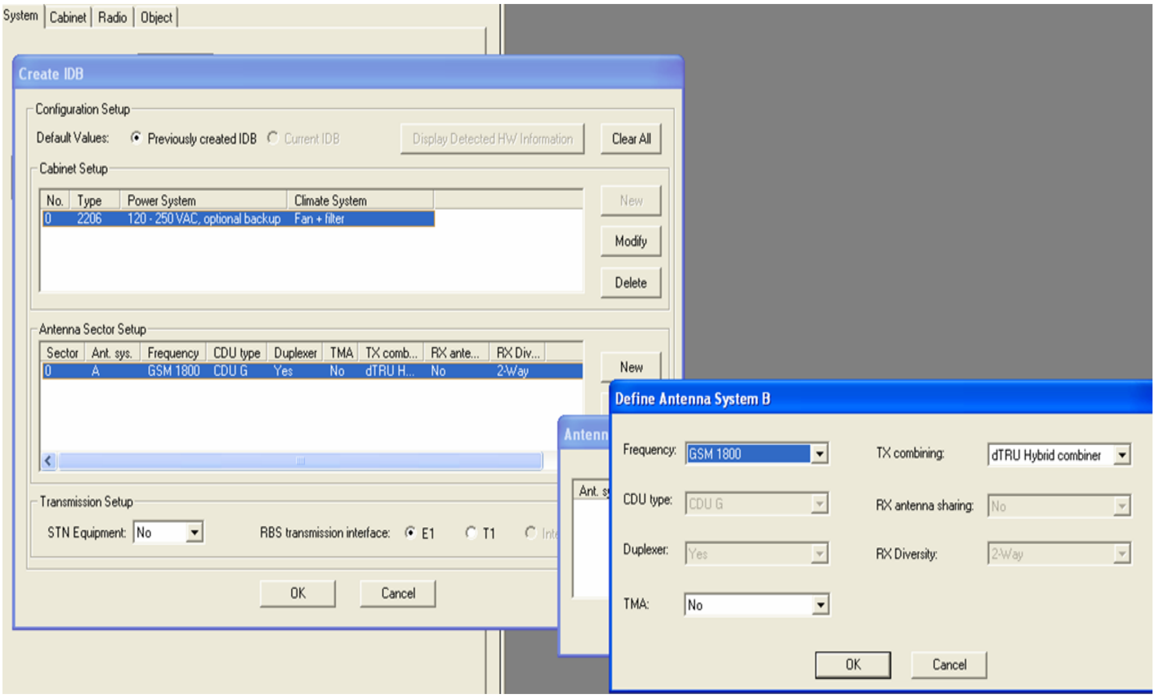


Fig.9.8.4: RBS 2206 Commissioning create IDB



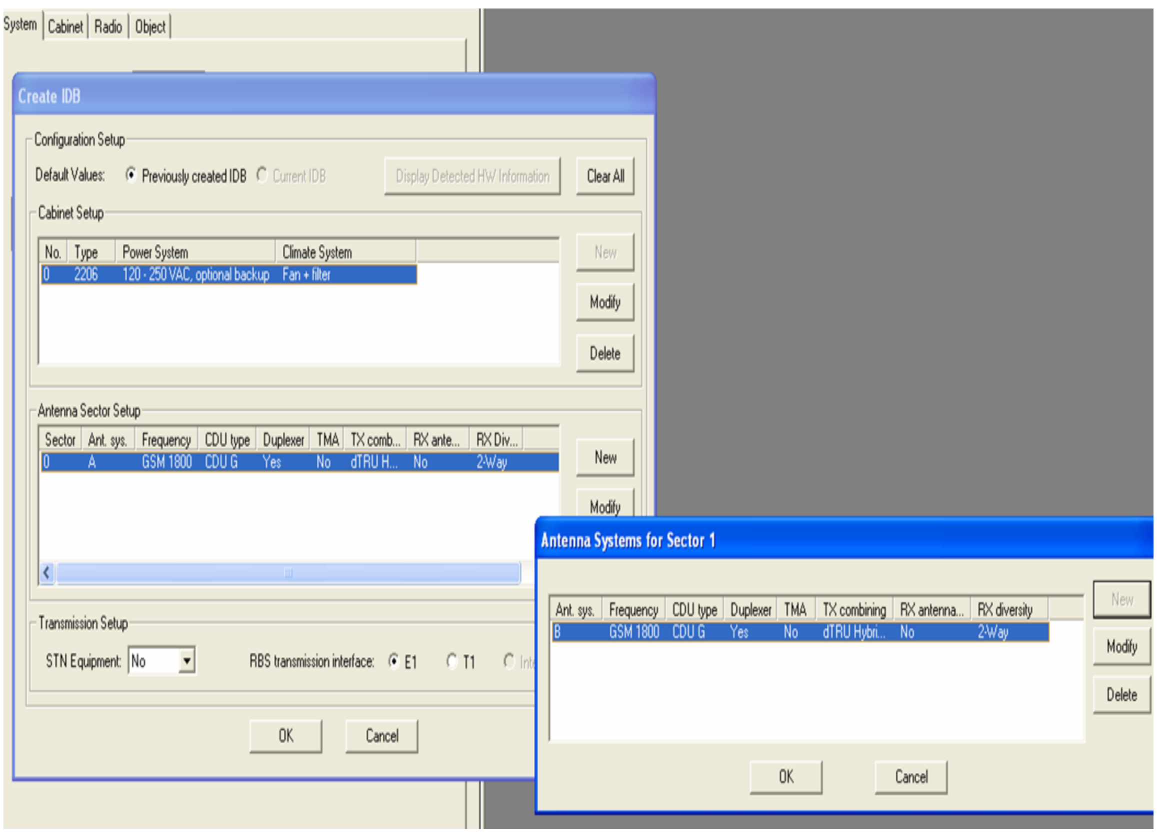
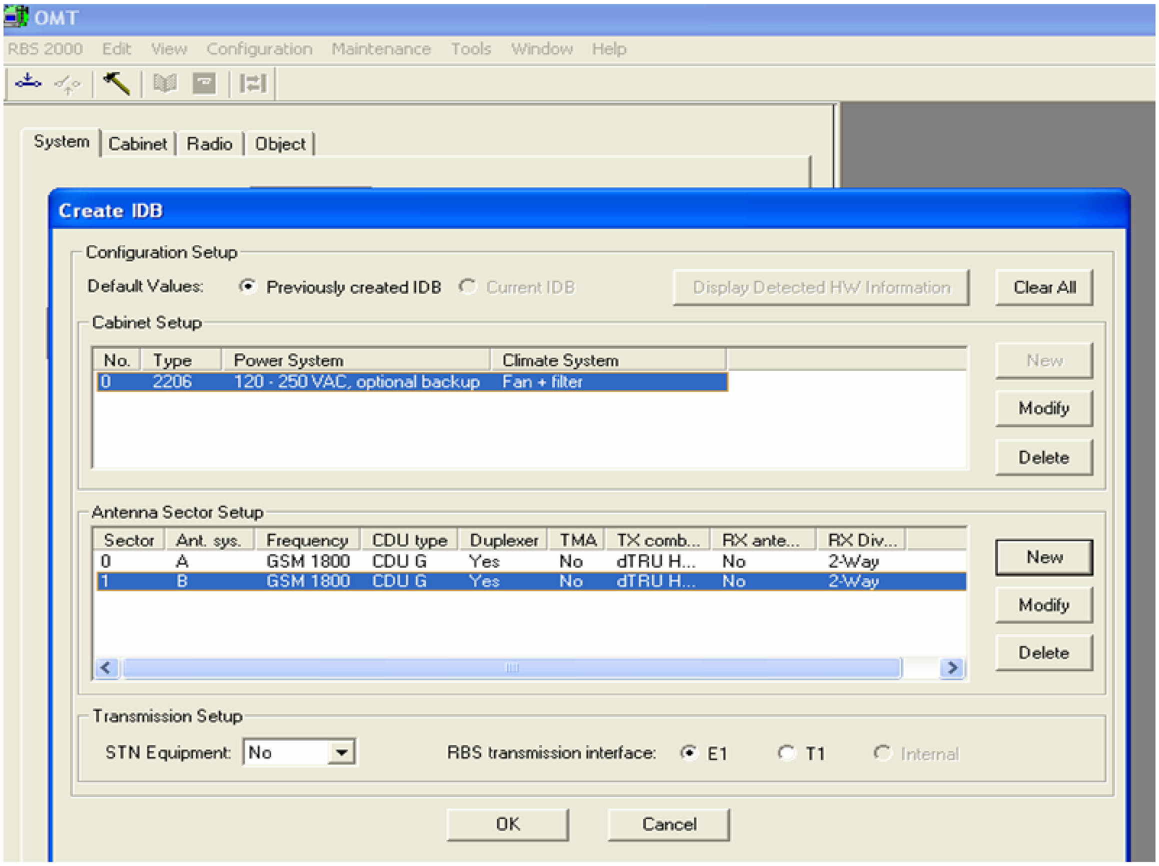


Fig.9.8.5: RBS 2206 Commissioning create IDB



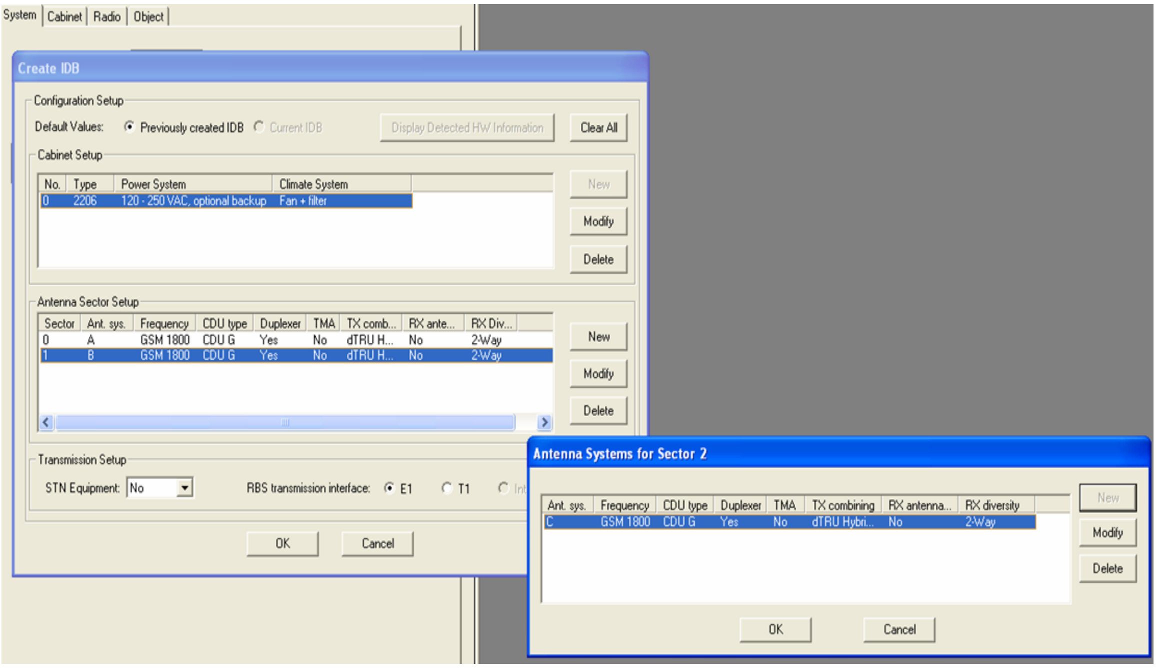
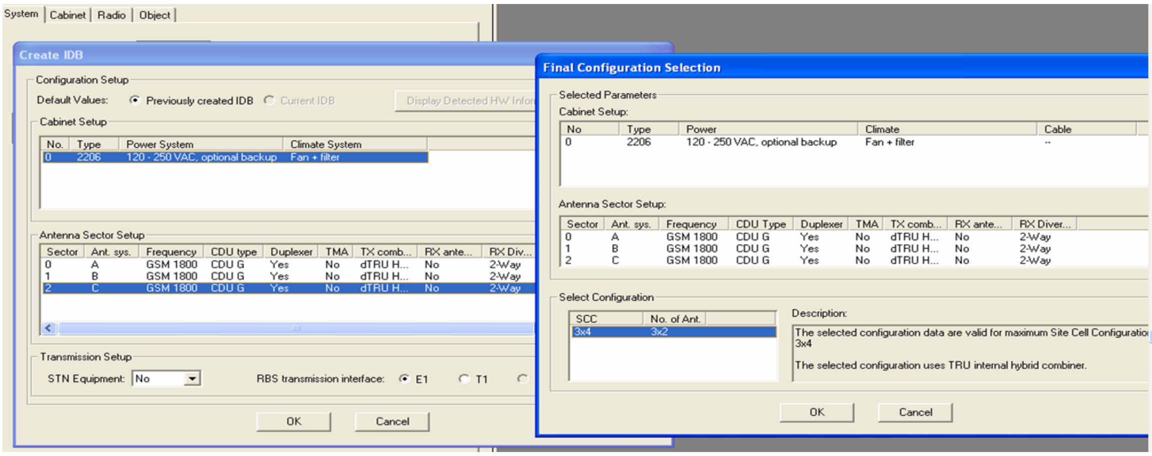


Fig.9.8.6: RBS 2206 Commissioning create IDB



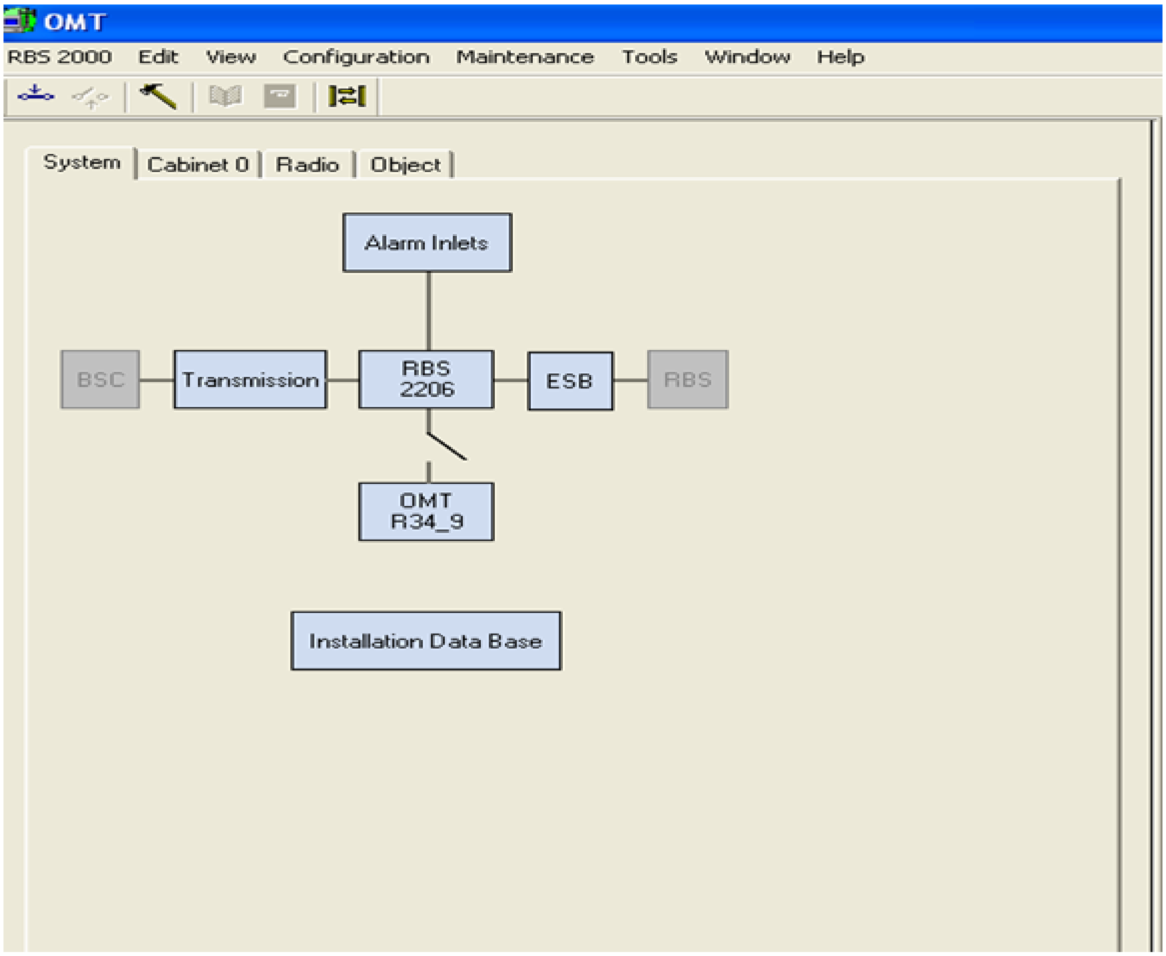
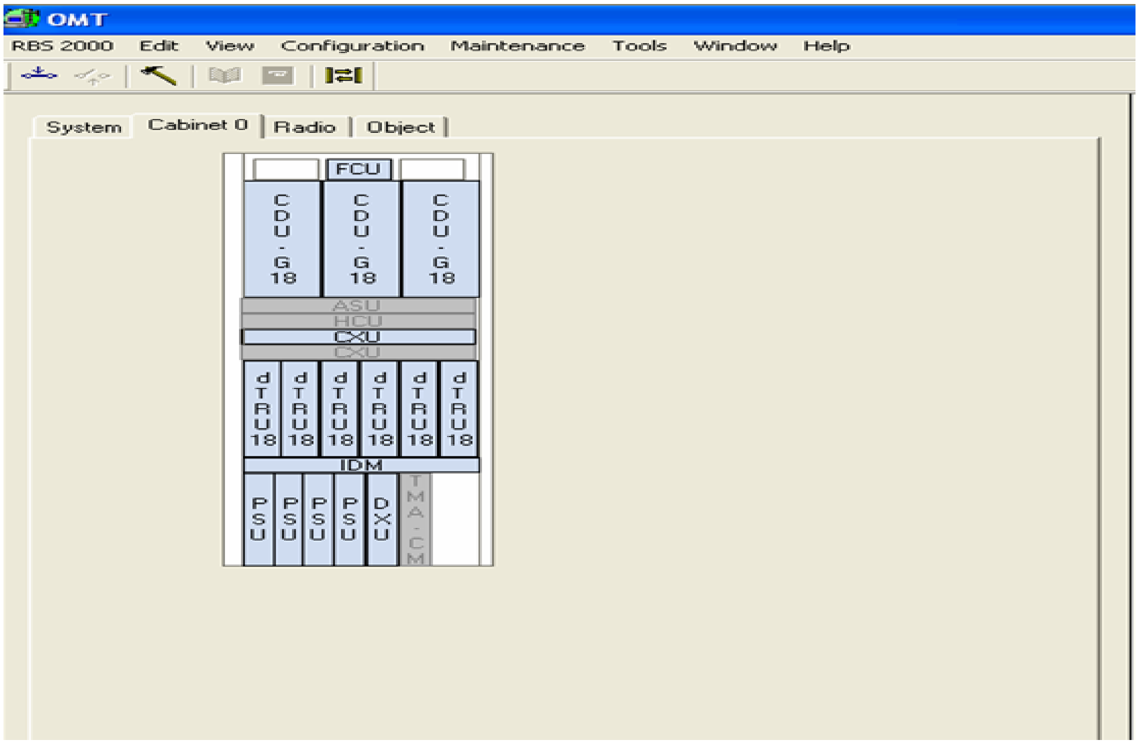


Fig.9.8.7: RBS 2206 Commissioning create IDB complete



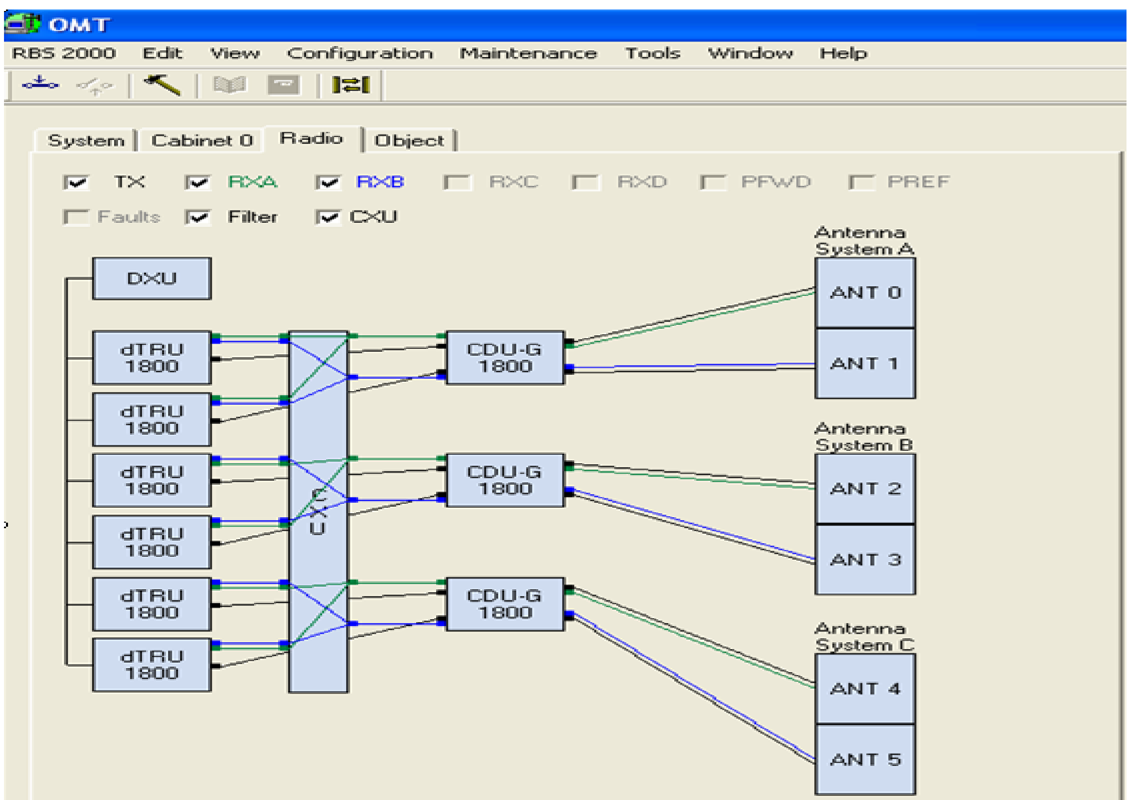


Fig.9.8.8: RBS 2206 Commissioning DTRU configuration for Antenna system

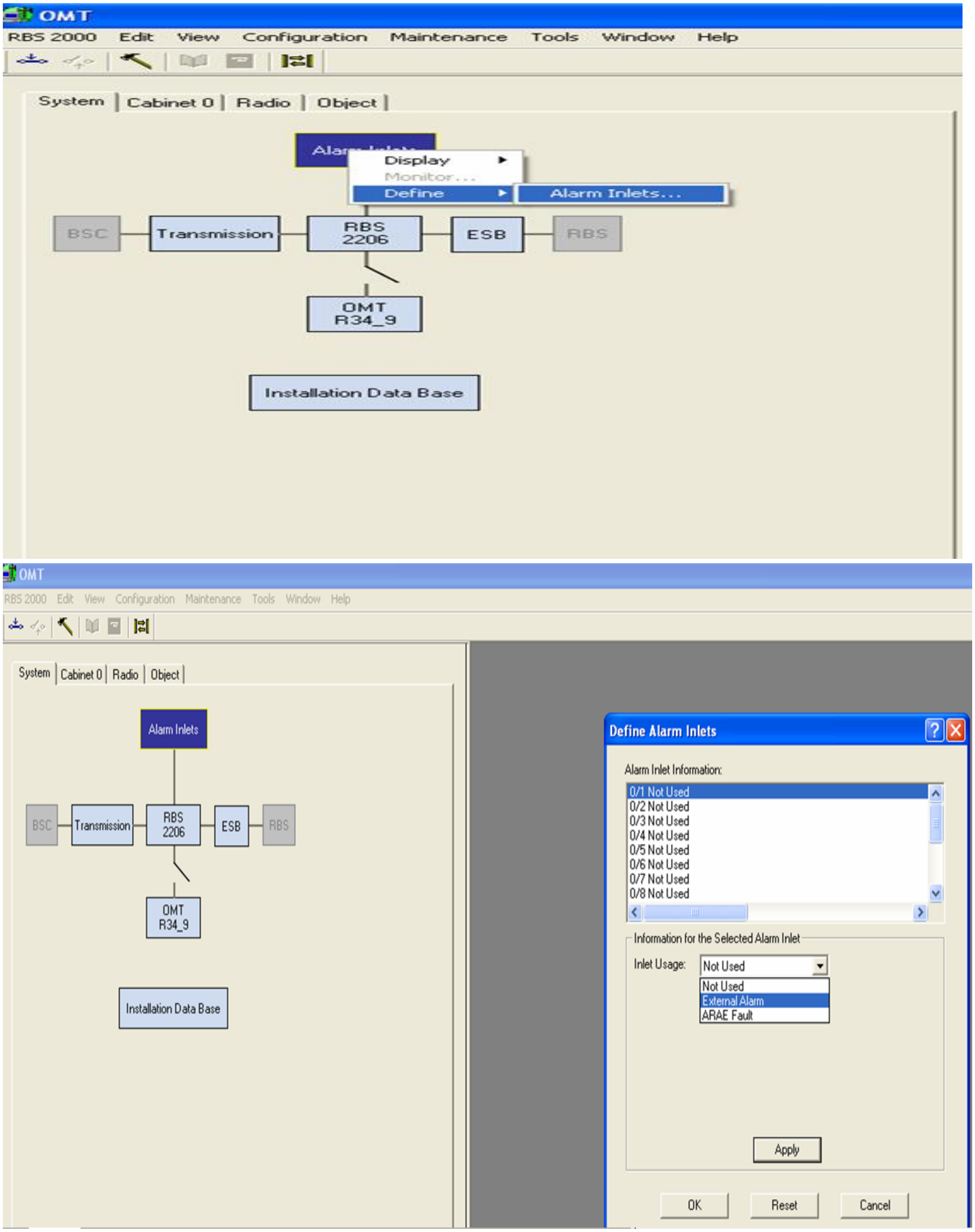


Fig.9.8.9: RBS 2206 Commissioning Alarm configuration for Antenna system

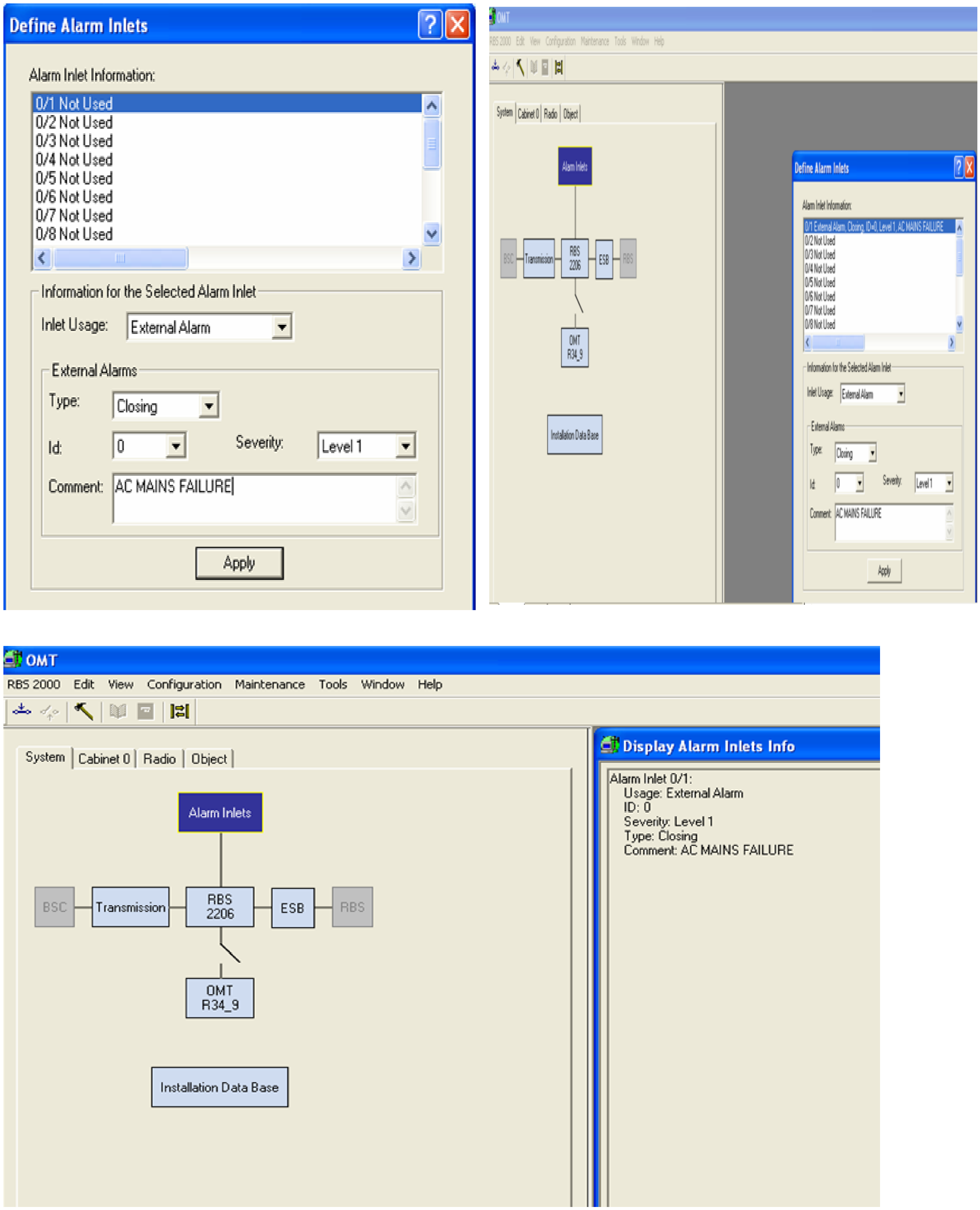


Fig.9.8.10: RBS 2206 Commissioning Alarm configuration for Antenna system

Conclusion:

We have observed that high contraction building carries low signal strength because high construction building has low receive signal, so one man cannot communicate with other mobile network frequently. At Rajuk trade center same problem arises. Here mobile receive signal is very low. When one man speaks to any mobile phone then call drops frequently because of the low received signal. So this place needs an Internal Base Station for a suitable transmission and reception and IBS system can be the ultimate solution.

At first Robi (operator) surveyed Rajuk trade center building . They found that the receive signal is low at Rajuk trade center building which was (-83dB) but normal receive signal is (-40dB), so we proposed that there should be a need of IBS system. So after submitting our proposal we get the permission of Rajuk trade center for setup IBS system.

Firstly, at Rajuk trade center we have made the floor plan and design. We calculate that how many Omni antenna, panel antenna, RBS and other device will need here. Finally we start our work. Currently this project is running successfully.

Operators cannot ignore the importance and advantages of providing dedicated in-building coverage GSM system. Users who try new indoor coverage services expect them to exceed existing services in every respect. Besides, providing excellent local In-building coverage, dedicated in-building systems for in-building coverage GSM-based networks greatly offload the part of the mobile network. Therefore, they give operators a cost-effective way of catering for new subscriber growth. In all likelihood, distributed antenna systems will dominate as the preferred solution for providing in-building coverage. New solutions, such as the distributed RBS solution, are also of interest thanks to overall lower costs—lower transmission cost, greater trunking gain, and the ability to share RBS equipment.

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[7] Project of Rajuk Trade Center project, Date on 29-08-2010

LIST OF ABBREVIATIONS

ACAD	Auto Computed Aided Design
ACE	Adaptive Communication Environment
AC	Alternative Current
BER	Bit Rate Error
BTS	Base Transceiver Station
CAD	Computed Aided Design
CSL	Cellcomm Solutions Ltd
DAS	Distributed Antenna Systems
DNs	Distribution Nodes
DC	Direct Current
DTRU	Double transmitter receiver unit
GPS	Global Position Station
GSM	Global System for Mobile Communication
IBS	Indoor-Building Solution
IDB	Installation Data Base
LNA	Low Noise Amplifier
MCB	Multi Band Cells
MCB	Multi Band Cells
NGR	National Grid Reference
PA	Power Amplifier
PoPs	Points of Presence
PTO	Public Telecommunication Operator
RBS	Radio Base Stations
RF	Radio frequency
RNP	Radio Network Plan
SDCCH	Stands for Stand Alone Dedicated Control Channel
SQI	Speech Quality Index
TEMS	Test Mobile System

VSWR	Voltage Standing Wave Ratio
WCDMA	Wideband Code Division Multiple Access
UTM	Universal Transverse Mercator
UV	Ultra Violet
UPS	Unit Power Supply