



## **Department of Electrical Engineering**

King Fahd University of Petroleum & Minerals

EE399 Summer Training

## **GSM Network Structure and Performance**

Name: Mohammed AlWayeli

(ID#200635420)

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## Abstract

The colleges of science engineering give a chance for the student to spend 8 weeks of training in any of the field of the electrical engineering this report will represent the work I have done during my training at Nokia Siemens Networks in the last summer. During my training I have a lot of thing in compunction starting form how the network work and the element of the network and end by the program I have work with during my training .

# **I. Introduction:**

## **1.1 Introduction:**

The colleges of science engineering give a chance for the student to spend 8 weeks of training in any of the field of the electrical engineering. The training has a lot of objective such as enhance the group work, communication skills and also exposing the student to the industry and business in the region. This Repot will represent the work I have done in my training and what I have learn in my training period in Nokia Siemens Networks (NSN).

## **1.2 Nokia Siemens Networks (NSN) :**

Nokia Siemens network consider as one of largest telecommunication equipment supplier in the world. The company provides a complete, well-balanced product portfolio of mobile and fixed network infrastructure solutions and addresses the growing demand for services with 20,000 service professionals worldwide. In 2008, Zain and Nokia Siemens network signed contract to roll out a state-of-the-art greenfield mobile network in the Kingdom of Saudi Arabia. Nokia Siemens Networks will supply a full turnkey 2G and 3G mobile network, including core and radio networks, operations and business

support systems, applications and a full suite of services, including managed services.

### **1.2.1 Nokia Siemens Networks Departments:**

- 1-Customer care support.
- 2- Device management.
- 3-Fixed-Mobile convergence.
- 4- Integrated provisioning.
- 5- WCDMA frequency refarming.
- 6- Design department.
- 7- Optimization department.

#### **1.2.1.1 Integrated Department:**

I have been assigned at the integrated department. This department consider as the last stage of constructing the GSM network. Our objective at the department is to integrate between the BTS (Base Transceiver Station) and the BSC (Base Station controllers) and then optimization the site till we reduce the error in the site 0 % and we can use it full capacity without error.

## II.GSM Network Structure and Performance:

Global System for Mobile communication (GSM) is the standard system for the mobile communication system in the world. GSM is cellular network that operates in the range of 900-1800 MHz as shown in Table 1:

Table 1:GSM Bands

	GSM 900	GSM 1800
Uplink	890-915 MHz	1710-1785 MHz
Downlink	935-960 MHz	1805-1880 MHz
channel	124 channel	374 channel
Duplex Spacing	45 MHz	95 MHz

During my training I have working with 2G site only.GSM as shown in figure 1 consist of three parts:

- Mobile station (MS).
- Base station subsystem (BSS).
- Network station subsystem (NSS).

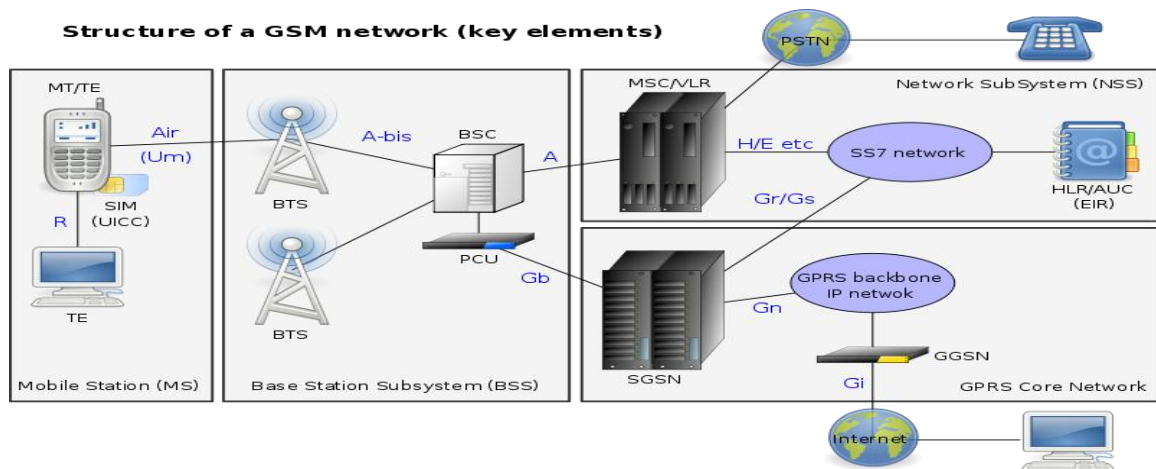


Figure 1: GSM structure.

Mobile Station (MS) are pieces of equipment which are used by mobile service subscribers for access to the services. They consist of two major components: the mobile equipment and the subscriber identity module (SIM).

The base station subsystem (BSS) is the section of a traditional cellular telephone network which is responsible for handling traffic and signaling between a mobile phone and the network switching subsystem. The BSS carries out transcoding of speech channels, allocation of radio channels to mobile phones, paging, transmission and reception over the air interface and many other tasks related to the radio network. They consist of two major components: the Base transceiver station (BTS) where its job is to facilitate wireless communication between the user and the network and Base Station controllers (BSC) which controls one or multiple cell sites' radio signals (BTS), thus reducing the load on the switch, performs radio signal management functions for base

transceiver stations and managing functions such as frequency assignment and handoff. network Station Subsystem (NSS) is Consider as the brain of the network which consist of four major parts: mobile switching center (MSC) is the core of the network which controls the network switching subsystem elements, home location register (HLR) This is a permanent register to keep the profiler for every subscriber (such as the service that he subscribes in), visitor location register (VLR) This is a temporary register to keep the profile need to the mobile network to work and the authentication center (AUC) is the safety part in the network that gives the authorization for the mobile to connect to the network.

In GSM we have three main channel access methods for shared medium network:

- FDMA
- TDMA
- CDMA

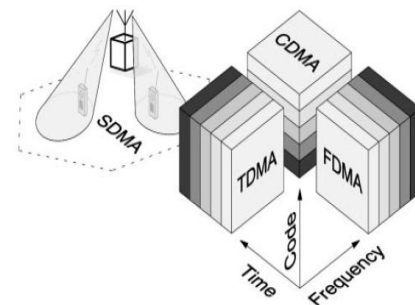


Figure 2 : Multiple access procedures

Frequency Division multiple access (FDMA) is one of the most common multiple access procedure. The idea of FDMA is to divide the frequency band into channel of equal bandwidth such as each conversation is carried in different frequency as shown in figure 2.

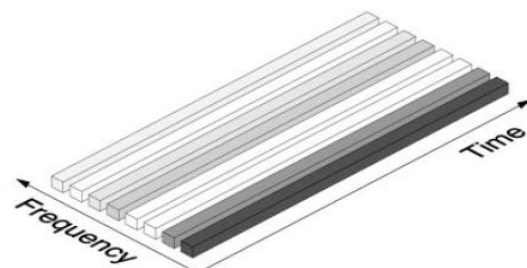


Figure 2 : Channels of an FDMA system (schematic)



Time division multiple access (TDMA) is allows several user to share the same frequency channel by dividing the signal into different time slot. Code division multiple access (CDMA) are broadband system in which each subscriber will use the whole system bandwidth.

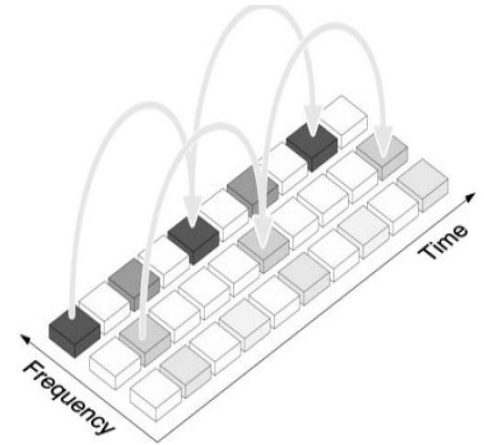


Figure 2.7: TDMA channels on multiple carrier frequencies

### III. Installation and Optimizing the Network

In 2008, Nokia and Zain have signed a contract to install and optimize 2G and 3G network in the center and western region. Our job in the company is to install and optimize the network in Zain and therefor our job goes as the following order:

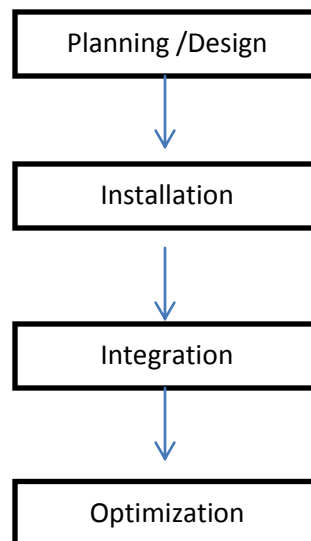


Figure 5: Installation and optimization Order

### **3.1 Planning & Design the Network:**

During my training in Nokia I have assigned in to the planning and design network department where I have learned about the principle they use for planning the stage of design. In Network planning and design at Nokia operation center (NOC) we aimed to that the network and the service will meet the need of the subscriber and the operator Zain .The first thing in planning and design the GSM network is to ensure that we provide our maximum coverage with maximum capacity of the network when its need. Then we define the standard and the specific design requirement. The standard design requirements are:

- Performance.
- Availability.
- Scalability.
- Standards Compatibility.

During my work in design department I have read about the Cellular Network which is important concept to design the GSM network.A cellular network is radio network distributed over land area called cells. Each BTS in the network will represent one cell and by joined together these cells provide radio coverage over a number of advantages such as:

- increased capacity
- reduced power use

- larger coverage area



Figure 2.16: Cell structure of a real network

### 3.2 Installation of the Network:

During my training I have done some field visit to different site where I have learned and work in install BTS system. Installation of the BTS divides into:

- Civil Work
- The Power and Telecom Work

Civil works start by choosing the place which we want to build the station on it. and after receiving the specification of the station such as the height of the tower which is usually goes from 20m to 60m and the size of the shelter which is usually 3 m a side . The shelter consider as the heart of the station. After the civil work finishes then we move to the power and telecom works. The power and telecom work has two parts: indoor work which is the work done inside the shelter. The shelter is a small room that will have the entire electronics device

need in the station. Inside the shelter we start install two split unit as shown in figure 7

where we need to keep the temperature inside the shelter 16-18 degree. Near the door of the shelter we install the fuse box and alarm box. Then we have automatic transfer switch (ATS) it control the power in case of the power



Figure 7: Spilt Unit inside the Shelter

turn off by lunching the external generator. The most important part in the station and heart of it is the BTS .The BTS as shown in figure 8

is connects to two things the antenna through a coaxial cable where we have two types LDF5 and LDF7 and by E1 cable to DDF. The DDF is a combine of the E1 cable as shown in figure 9.The BTS will connected by each other through a microwave After all the indoor works done we



Figure 8: BTS unit inside the shelter

move to the outdoor work. After we finish the indoor work we start the outdoor work by install the antennas where every BTS need a three antennas. Every antenna will covered sector and every sector will covered 120 degree. In total

we have three sectors A, B and C. finally, we program the BTS by program called BTS terminal attach the BTS to the antennas. During my work I have learn about an important things about the site which is the configuration of the site .For every BTS we have a system where we divide the BTS to three sectors A, B and C as shown in figure 5. Every sector will connected by a number of TRX. TRX is hardware inside BTS one TRX can take at a time maximum

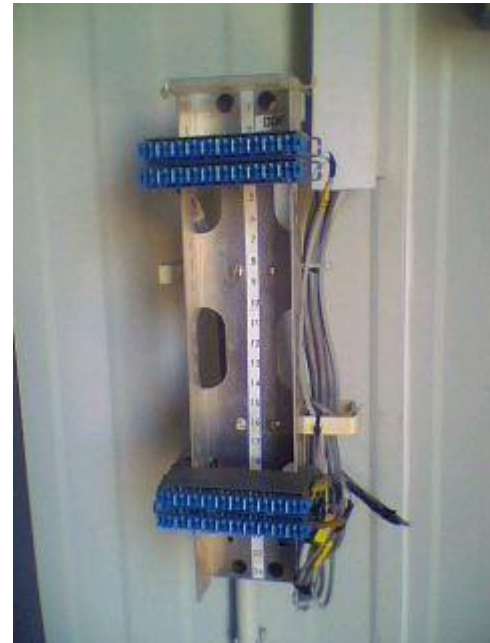


Figure 9: DDF unit inside the shelter

no of 8 calls on full rate. Every site has own configuration which is written as number and plus .For example, (6+5+4) mean sector A has 6 TRX and 5 TRX in B and 4 TRX in C .Knowing the configuration of the site show the capacity of the site. Sample calculation of the capacity of one site with a configuration (6+5+4) Sector A

$6 \text{ (TRX)} \times 8 \text{ (numbers of calls)} = 48 \text{ calls in time for sector A}$

Total of 120 calls in one time for one site.

### 3.3 Integration of the Network:

Most of my training period I have worked in the integrated department. Integrated consider as the last step of the network installation. Our objective in the integrated

department in to integrate between BTS (Base Transceiver Station) and the BSC (Base Station controllers). Integrate the site can be done by 6 steps

- 1) Check the E1 loop (check if there is a loop between the BTS and BSC)
- 2) Attach OMU.
- 3) Unlock the site.
- 4) Install the alarm.
- 5) Check the alarm.
- 6) Check the calls.

After I did all the six steps the site is integrated. During my work in the integrated department I have work with several programs where I was receiving a call from the engineers at the site and I was doing several things such as check the alarm history, check for the loop between the BTS and BSC if it break or not, enable or disable the power in the site or disable some sector to the *Maintenance*.

### **3.4 Optimization of the Network:**

The main purpose of this department is to optimize the performance of the network, the coverage of the radio network and the capacity of the network. The objective of the department:

- Get maximum efficiency out of the existing network

- Achieve an optimal customer experience at all times
- Increase revenue with minimum network investment
- React to customer needs with the right timing & tools

The department provides solution for the network including monitoring, reporting and analysis of network capacity, performance structured problem solving and troubleshooting Identification of needed software and hardware, upgrades reactive and proactive capacity and performance optimization and Solution implementation. During my training I have work in monitoring, reporting and analysis of network where I was supposed to monitor the site locate which site has a fault and check the history of the alarm in site and which site has a break loop.

Figure 10 show top level of BTS.

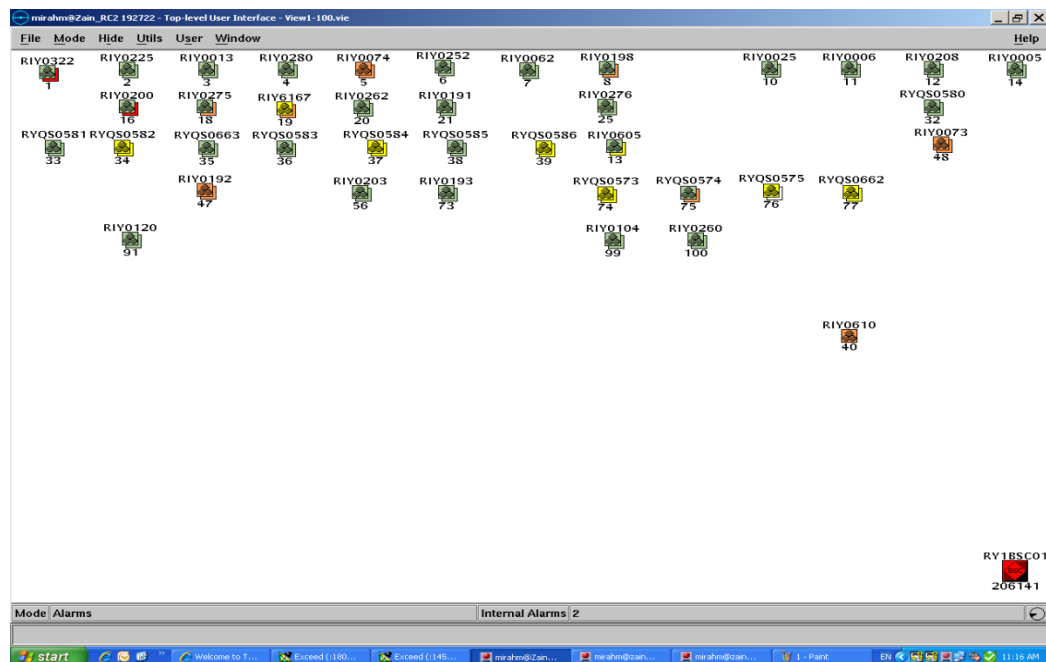


Figure 10 : Top level of BTS

**Conclusion:**

The 8 weeks was very productive. I have learned many things about the communication network. Three things every communication engineering must know .How the network work, the element of the network and last thing is the implementation which the different programs you used.as fresh communication engineering you don't need to be a professional in using different program but without knowing how the network work and the element of the network you can't success as communication engineering.

During the training I have gain some experience in dealing with some software program using the communication. With this program I can control, integrate and monitoring the network. Also the summer training enhance my communication skills.



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