SECOND LEVEL ASSURANCE IN STP/DRA DOMAIN OF CORE 4G NETWORK

Project report submitted in partial fulfillment of the requirement of the degree

Of

BACHELOR OF TECHNOLOGY

IN

ELECTRONICS AND COMMUNICATION ENGINEERING

By

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UNDER THE GUIDANCE OF

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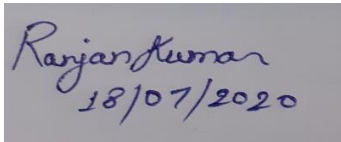
May 2020

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DECLARATION

I hereby declare that the Internship work reported in the B. Tech final semester internship project report entitled **"SECOND LEVEL ASSURANCE IN STP/DRA DOMAIN OF CORE 4G NETWORK"** submitted at Jaypee University of Information Technology, Waknaghat, India is an accurate record of our own work carried out under the supervision of **Mr. SURENDRA BIJWE**, CA-MANAGER, Ericsson global services India Pvt. Ltd.

We have not submitted this work elsewhere for any other degree or diploma.

Ranjan Kumar
18/07/2020

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This is to certify that the above statement made by the candidates is true to the best of my knowledge.

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ACKNOWLEDGEMENT

LIST OF FIGURES

LIST OF ABBREVIATIONS

STP:	Signal Transfer Point
DRA:	Diameter Routing Agent
SS7:	Signaling System No. 7
PSTN:	Public switched telephone network
SEPs:	Signaling Endpoints
WBLs:	Web based learning
OJTs:	On-Job Trainings
OEM:	Original Equipment Manager
RCA:	Root Cause Analysis
AUC:	Authentication Center
BSC:	Base Station Controller
BSS:	Base Station System
BTS:	Base Transceiver Station
EIR:	Equipment Identity Register
HLR:	Home Location Register
MS:	Mobile Station
TTs:	Trouble Tickets
SS:	Switching System
OMC:	Operations and Maintenance Centre
MSC:	Mobile services Switching Center
NMC:	Network Management Center
OMC:	Operation and Maintenance Center
SGSN:	Support GPRS Service Node
GGSN:	Gateway GPRS Service Node
GSM:	Global System for Mobile
LTE:	Long Term Evolution
VLR:	Visitor Location Register

ABSTRACT

In the present time, the telecommunication industry plays an important role to convey an information. Connection is all around us, whether you see it, or not. People are connecting, devices are connecting.

During this internship, tasks in the STP and DRA domain were performed after various Induction sessions, wide-ranging Web Based Trainings consisting of videos, content and documents and the On-Job Trainings.

A STP and DRA is the part of a telecommunications system that transfer the signals to every node in efficient way whereas DRA is diameter routing agent which helps in routing the message to various nodes.

This project is based on telecommunications as the telecom sector is growing at a very good pace. Objective of this internship report is to share my involvement and skills which I gained during this internship duration. This report is the brief description and synopsis of my project work which I performed at Ericsson India Company. It was an incredible learning experience for me to work there. My Theoretical and practical knowledge that I gained in college and during internship period helped me a ton during this internship period and I have also learned numerous new technology, things and skills during this internship period. I have worked as intern under talent development program by Ericsson in STP/DRA Domain of telecom.

Second level service problem restoration is passed on from the team working on the first level service problem restoration. Handling and analyzing of Trouble Tickets will be carried out to recommend timely actions and solutions to the Trouble Tickets with guidance, whenever necessary. Handling and execution of the Change Requests in the stipulated time frame has been done. New nodes which are to be put up are checked and tested properly be for setting up (Acceptance Testing of Nodes). Apart from this Emergency Handling, collaborating with other teams like FO, FM, OSS, CS Core & PS Core, Transmission team, etc., carried out with an ability to perform under time constraints depending upon the business requirements.

It must be made sure that the network uptime availability is maintained. Uptime is one of the most important parts of a service-level agreement (SLA) that a client signs with a vendor. Uptime specifies the amount of time that a given vendor product or service will be available. Distinct focus on Service KPI (Key Performance Indicator) must also be kept. KPI scan be used to ensure that SLA requirements are met and to keep customers informed about their service.

During the internship period, I'll be going through extensive web based learning(WBLs), Web Based Trainings (WBTs), On-Job Trainings (OJTs) and various induction sessions, after which I will be working on STP (Signal transferring point) / DRA (Diameter Routing Agent) nodes. The OJTs will focus on understanding of various STP hardware, functionality, features, associated products like E5MS, E5APPB and PGW (Public Data Network Gateway) servers. We'll going to work on error codes followed by STP and troubleshooting followed by reports will be done as well. They will be reviewed by respective technical heads for better understanding of the product.

I will be working on Oracle and teklec MOS tool to raise problems with OEM (Original Equipment Manager). Subsequent follow-ups with OEM will be done till issue resolution and Root Cause Analysis (RCA).

Trouble Tickets (TTs) reduction drive will be carried out to find out innovative ideas and achieve customer delight. I will be given a chance to work on live networks post OJTs under respective team lead guidance and in case my performance is found satisfactory, I will be provided the opportunity to work independently after the completion of the internship.

CHAPTER-1
INTRODUCTION

The world of communication is constantly evolving, and connected devices are transforming the way we communicate, socialize and do business. In present time, the telecommunication industry plays an important role. Connection is all around us, whether you see it, or not. People are connecting, devices are connecting.

1.1 MOTIVATION

The telecommunications industry in India is very vast and complex. Therefore, it is a matter of utmost importance that the network is carefully maintained and managed. To ensure proper management and maintenance of a Telecommunication network, various things must be kept in mind and worked upon. Monitoring traffic flow and access to a various of signaling nodes of the network is very important to ensure proper and smooth flow of information from one place to another.

Proper investigation of the fault/cause must be done related to the system/network problems, while working within well-defined system support guidelines. Faults must be prioritized to meet the Service Level Agreement and the Work Level Agreement (SLA/WLA). We should attempt to take an interest in inward specialized conversations in view to improve the general system execution and make proposals at every possible opportunity. Additionally, a right working approach must be guaranteed.

STP serves as a dynamic router, which helps us with the same. It gives Centralized Network Management encouraging the conveyance of Intelligent Services all through the system. It prompts a decrease in Signaling Terminal Hardware in SSPs and SCPs. It acts as a Central Database for Global Title Translation (GTT) and minimizes errors. It prompts proficient directing of messages,

adaptable Signaling system no 7 (SS7) to organize the executives and quick reconciliation of new hubs in the system.

1.2   PROBLEM STATEMENT

Problem arises when the above-mentioned tasks are not performed, which causes a hindrance in communication. Alarms are generated in case of any problem faced by customers or network at any node.

To solve those problems, Trouble Tickets (TTs) are generated. By using various software tools, we are required to take action based on the given problem and troubleshoot the problem by performing Root Cause Analysis (RCA). This way, we ensure that the network is properly working, and the information flow is correct.

To deal with and investigate Trouble Tickets and prescribe ideal activities and answers for Trouble Tickets with direction, when important. To deal with and execute the Change Request in specified time span. Capacity to perform under time imperatives relying on the business necessities.

One of the most important parts of a Service-Level Agreement (SLA) is 'uptime', which is signed by a client to a vendor. It specifies the amount of time that a given vendor product or service will be available in. It must be made sure that the network uptime availability is maintained.

Distinct focus on service Key Performance Indicators (KPIs) must be kept. KPIs are used to ensure that SLA requirements are met so as to keep customers informed about the quality of service provided to them. They are also used to handle and analyze TTs and recommend timely actions and solutions to TTs with guidance as and when required.

It also helps in handling and executing Change Requests (CRs) in the stipulated time frame, and makes it possible to perform under time constraints to handle emergency situations depending upon the business requirements. It should be made sure that customer satisfaction is ultimately achieved. The Trouble Tickets closure should be done within the SLA.

1.3 Overview of Ericsson

Ericsson India is one of the main suppliers of Information and Communication Technology (ICT) to specialist co-ops. They empower the total estimation of network in telecom industry by making game-changing innovation and administrations that are anything but difficult to utilize, receive, and scale, to making their clients fruitful in a completely associated world. Ericsson has kept on conveying momentous arrangements and inventive innovation to every one of its clients.

Ericsson is Telecom Giant specializing in the Managed Services, Digital services and IoT industry. Our main focus is to empower the Infrastructures of the telecom operators.

Ericsson is a main worldwide association of media communications and systems administration gear, headquartered in Stockholm, Sweden. It is established in 1876 by Lars Magnus Ericsson. It offers types of assistance in different fields like portability, broadband and other cloud applications. Ericsson is the main organization in telecom who have in excess of 39,000 licenses. It has an outsized hang on gauge licenses for versatile interchanges. Their licenses portfolio covers 2G, 3G and 4G advances.

One report expressed that More than 40% calls are made through their frameworks and in excess of 2 billion individuals use Ericsson arrange around the world. The organization have clients in excess of 180 nations which are given by the different administrations like cloud administrations and broadband.

Ericsson gives start to finish administrations of different versatile interchanges parts and have four significant business portions. These portions are Business Unit Networks, Business Unit Global Services, Business Unit Support Solutions and Business Unit modems. They create, convey and oversee media transmission organizes by giving equipment, programming, and administrations to empower the total estimation of availability.

Some features of Ericsson:

- Ericsson is one of the world leading provider of information and communications technology and services since last 135 years and continuing as well.
- They connect people, places, machines and devices.
- Present in 180 countries out of a total of 196 countries in worldwide.

- By Forbes it is in the list of Top 10 Companies in the U.S. that Do the Most to Make Their Employees Happy – *Forbes*

- Ericsson is ranked 6th overall in the FORTUNE Most Admired Companies ranking.

- Ericsson was awarded for the "2015 Global Mobile Award" in 2015.

Ericsson at a glance shows that how Ericsson is a Telecom Giant specializing in the Managed Services, Digital services and IoT industry.

Ericsson enables the full value of connectivity for service providers and network providers.

The main business area of the Ericsson is: -

- Network Management
- Digital Services
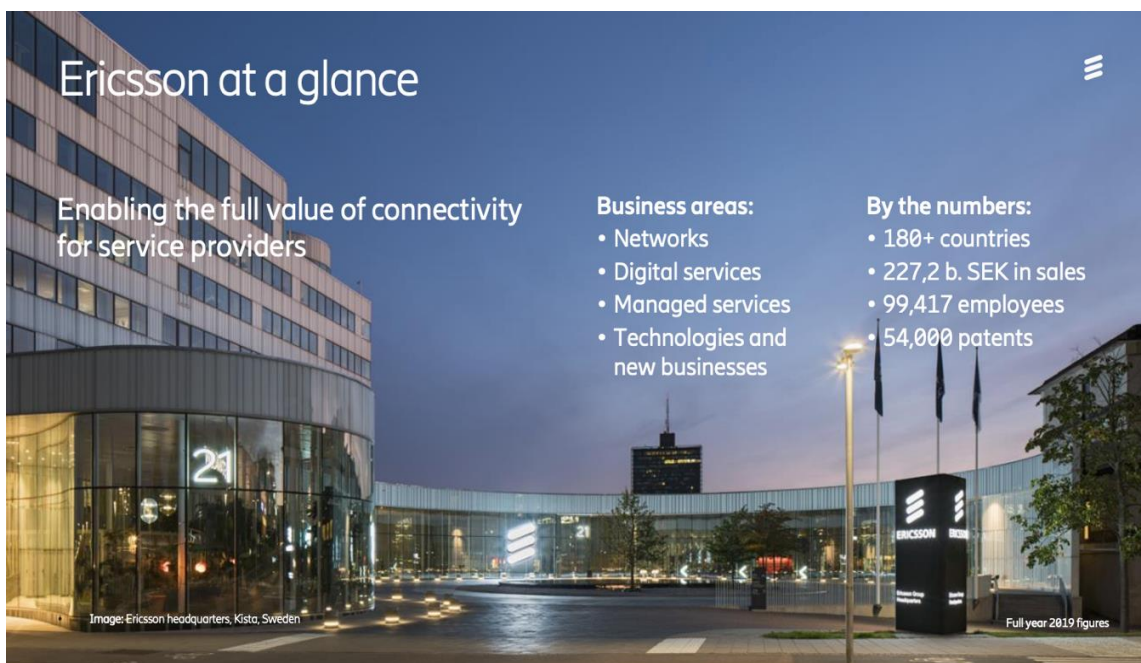- Managed Services
- Innovative Technology and New business

Fig 1.1 Ericsson at a glance

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CHAPTER-2
LITERATURE REVIEW

To gain more knowledge about the domain of work, help was taken from the following IEEE conference papers for better understanding of the topics:

The IEEE paper on "The evolution of the SS7 signaling transfer point in a broadband (ATM) and intelligent network environment" [6] was published in the year 1995, by R.R. Knight. It was published in the IEE Tutorial Colloquium on Signaling for Broadband. The paper discusses about the need for a signaling transfer point (STP) in an ATM i.e. Asynchronous Transfer Mode based broadband signaling network, the role of STP on routing level 3 Message Transfer Part (MTP3) messages within the existing signaling network, including an overview of the use of the originating point code and destination point code.

The type of signaling traffic that a Signaling System 7 (SS7) network is anticipated to transfer in a broadband environment is considered by reference to the ITU Q.73 functional model and an intelligent network environment. The functionality of the routing role of MTP3 is compared with the ATM switch's capabilities and the use for ATM permanent virtual channels (PVCs) to carry SS7 signaling messages beyond adjacent nodes is proposed as an alternative to STPs. An outline is also given, about the benefits and overheads that such a strategy would bring. The links, the procedures and the protocols for message transfer, together with the mechanisms for routing those messages can be collectively termed as the 'Message Transfer Part', which comprises the first three levels of the SS7 protocol stack, MTP1, MTP2 and MTP3.

The above-mentioned IEEE conference paper was able to provide some insight on the working of STPs, which proved to be helpful in gaining more knowledge about the domain of work.

In the present-day information society, life has become unthinkable without the Internet, mobile phones, and services provided through various networks. Institutions that provide such services limit the availability of services and network resources, and it is very significant to keep track and check who can access a particular service, and for how long the service is used. The AAA protocols (Authentication, Authorization and Accounting) were created as a means to meet such specific

demands. They enable us to identify the user, to recognize which service one is allowed to use, and for how long. Diameter protocol as a new AAA protocol plays an important role in next generation network. The IEEE paper on "Comparison of the RADIUS and Diameter Protocols" was published in the year 2008, by Malden Stanke and Mile Sikic. It was published in the ITI 2008-30th International Conference on Information Technology Interfaces. In this research, the differences between the Diameter and the RADIUS protocols were studied on a practical example, and their behavior was tested in real life situation. The Diameter and the RADIUS test environment was created and the reaction time for individual measurements was read from the log file.

Various methods were used to draw a comparison between the two. Some of the methods used were: comparing the RADIUS and Diameter connection times, recording the client reaction time when primary server is not available, comparing the reliability of transport for both the protocols, measuring the quantity of traffic operated in the network during session establishment, and analyzing Diameter's node finding capacity.

The conclusions drawn from the research using above-mentioned methods highlighted the following important points:

- The RADIUS protocol is 40 % faster in execution of the Authentication.
- The RADIUS protocol is 80 % faster in execution of the Accounting.
- The RADIUS protocol requires 8 times less traffics than other to perform the Authentication activity.
- The Diameter protocol reacts 2 times faster than others when the primary server is unavailable.
- Diameter transports 98 % of sent packages and RADIUS transported 74 % of sent packages.
- In networks with congestion Diameter protocol transports 74 % of sent packages and RADIUS protocol transports 43 % of sent packages.
- The Diameter's great improvement is seen when compared to RADIUS lies in the possibility of detecting the neighboring peer and exchanging information with this peer.
- The Diameter protocol is recommended for congestion networks because it can control their traffic, as well as the communication among their peers.

- Compared to RADIUS, the Diameter protocol is better equipped for dealing with problems that are encountered in the present-day networks.
- The RADIUS protocol identifies the user faster and with fewer packages than the
- Diameter protocol. However, its downside is the fact that is unable to control its traffic
- and peers in the communication chain, and has thus been proven ineffective in overly
- crowded networks where frequent client re-authentication is required.

The STP and DRA, both, work on the same principle and basic concept i.e. the exchange of signaling messages between network elements. The major difference between them being the following:

- STP is used for signaling in 2G/3G Circuit Switch Networks i.e. SS7 Signaling
- DRA is used for 4G LTE/VoLTE Packet Switch Network and IMS based systems i.e. LTE Signaling

❖ **Rest of the information is company property and is confidential in nature. Thus, it cannot be shared.**

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CHAPTER-3
GSM OVERVIEW

In this section I'm going to having a brief about Outline of GSM network component in Telecom.

The world of communication is constantly evolving, and connected devices are transforming the way we communicate, socialize and do business. In present time, the telecommunication industry plays an important role. Connection is all around us, whether you see it, or not. People are connecting, devices are connecting.
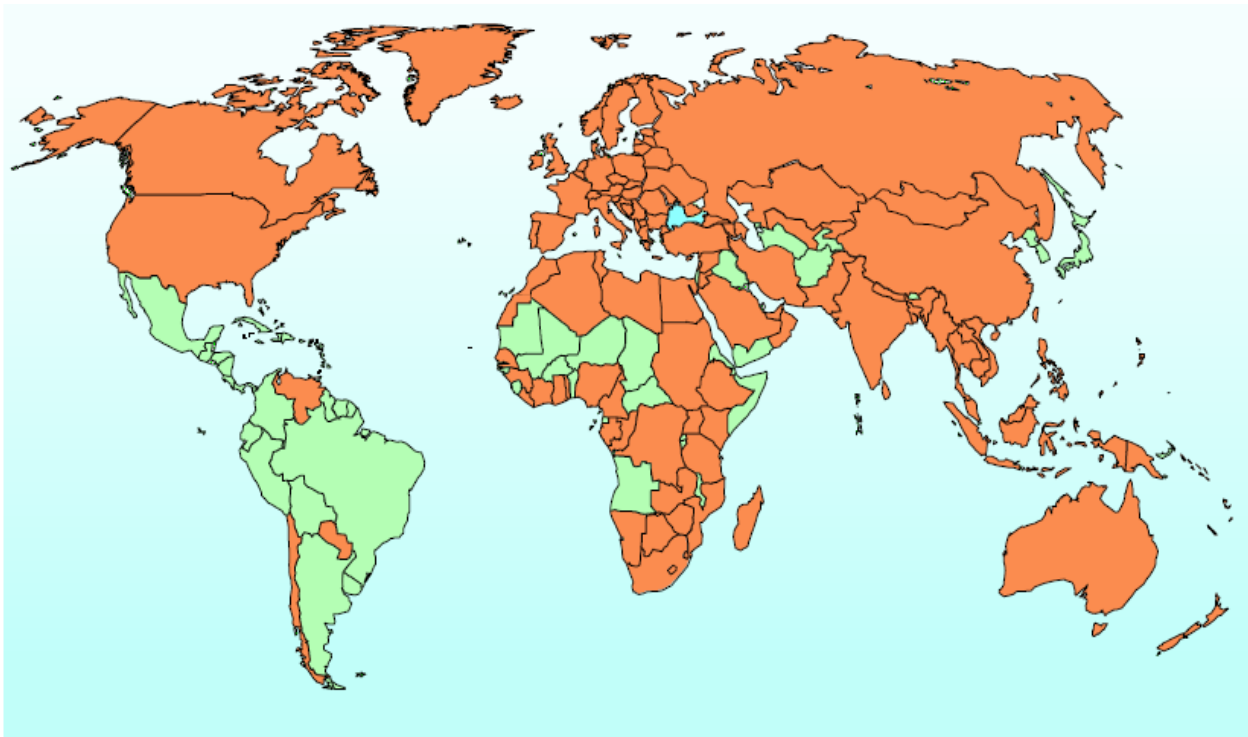
Fig: 3.1- The GSM worldwide (darker areas are GSM Users)

GSM stand for the global standard for mobile communications. GSM provides a standard for cellular subscriber. GSM is used in worldwide, the above figure shows the same, GSM used in worldwide. The darker area in the map are showing the same.

3.1 GSM PHASES

In the late 1980s, the innovative people who are working to improve communication system or building up the GSM Technology get to know that the amount of time allotment to them for for GSM whole details scope can't to be possible so they started highlighting the initially arranged phases.

At that time, it was concluded that GSM would be not in much used in later stages. Each new stage expands on the administrations offered by existing stages.
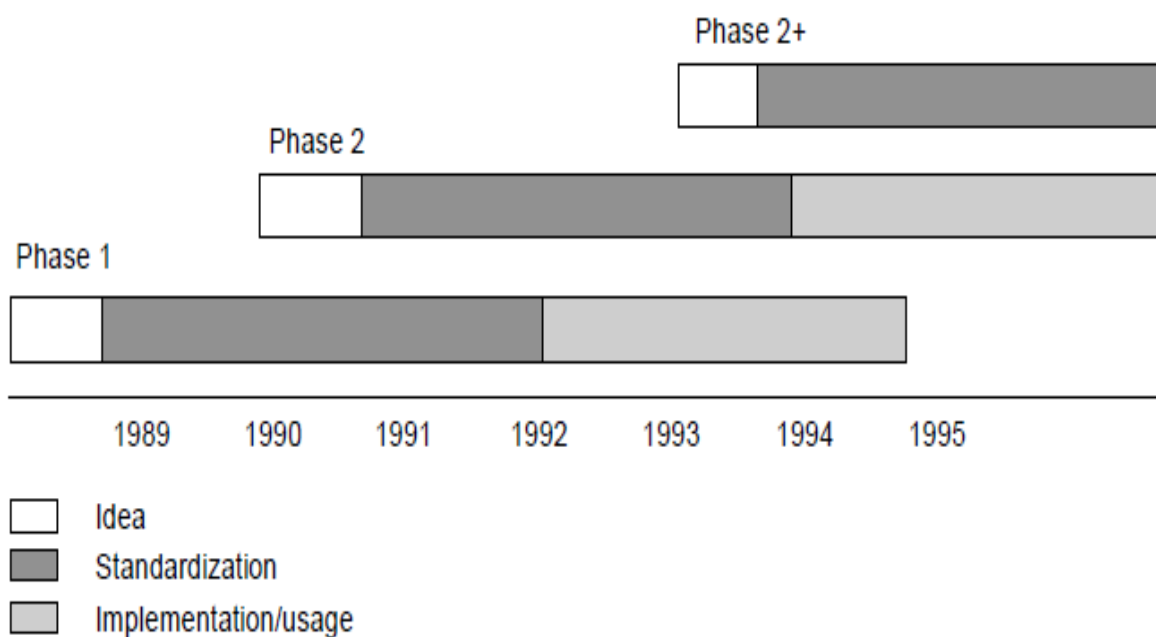
Fig 3.2: GSM phases

Stage- 1

In Stage 1 well-known Activities are included:

• Voice Call

• Call forwarding

• Call barring

• Roaming

• Basic fax/data services up to 9.6 kb

• Short Message Service (SMS)

Stage 2:

Extra highlights were presented in stage 2 which include:

• Advice of charge

• Caller Identification

• Call Pausing/ Waiting

• Call on hold

• Conference calling

Stage 2+:

In Stage 2+, there are various other functions are added in the GSM.
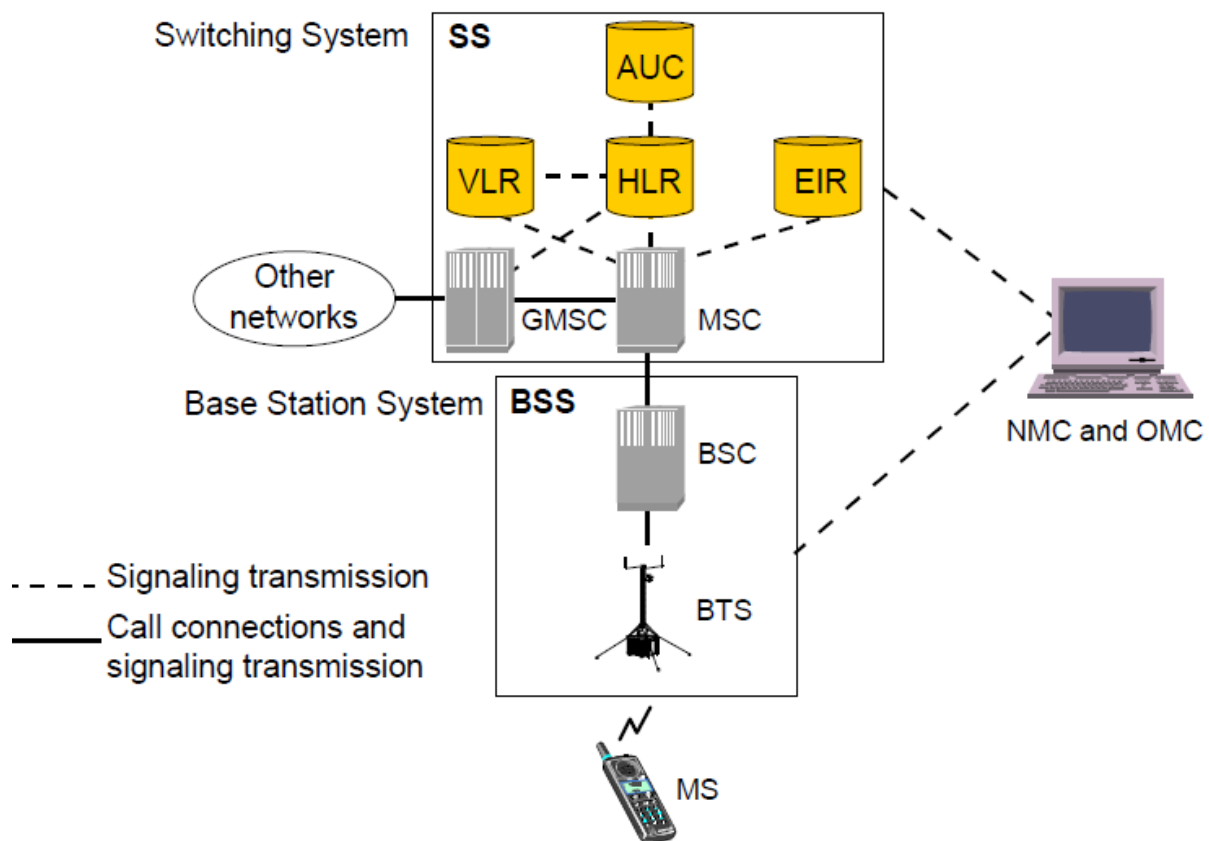
Fig 3.3: GSM System model

3.2 GSM Network Architecture

Below image represent the GSM Network architecture is, A GSM architecture is consist of these various elements like, BTS, BSC, MSC, EIR, HLR, VLR and all.
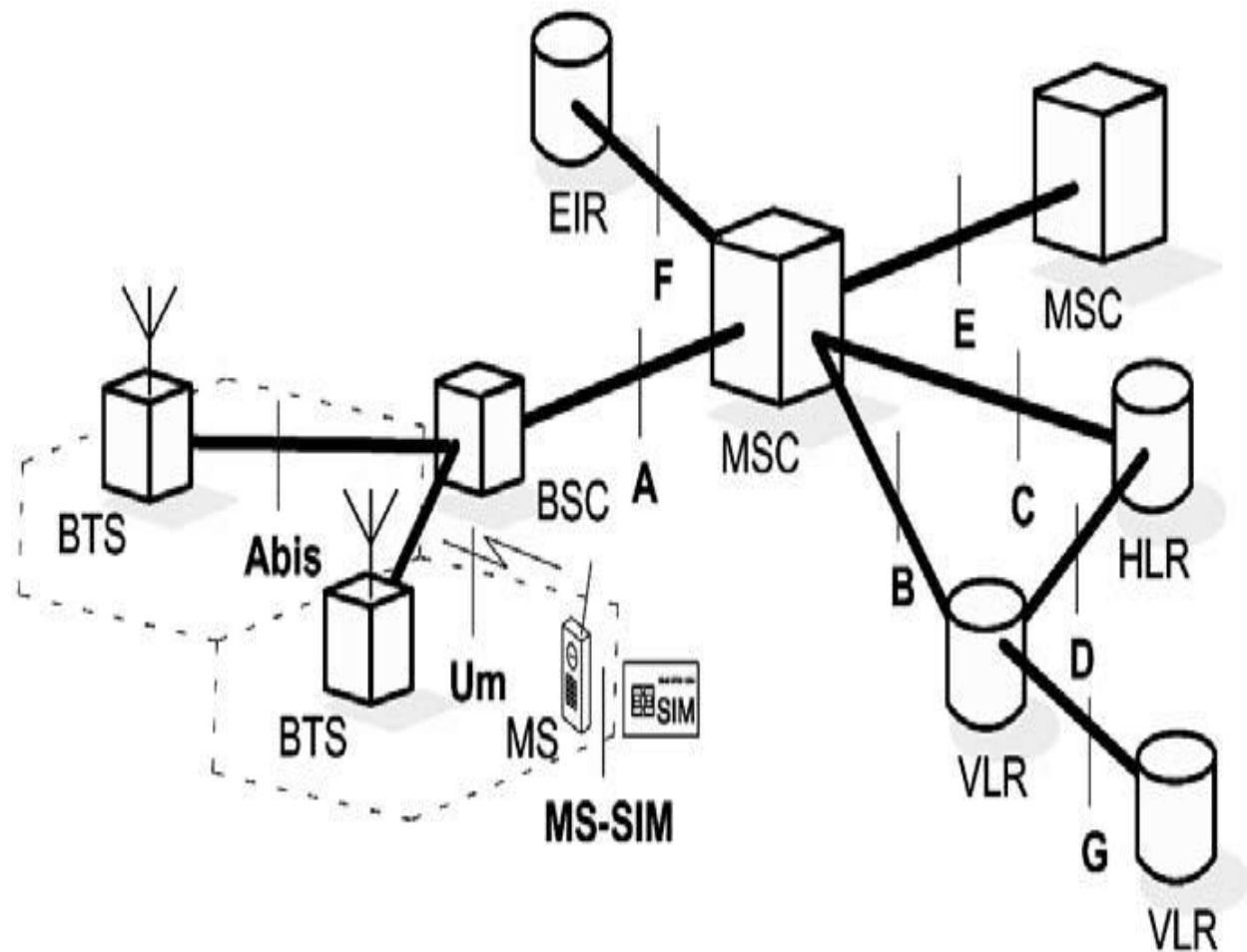
Fig 3.4: GSM Network Architectures

BTS - Base Transceivers Station

Base transmission station is known as Mobile tower in simple words. BTS controls and have capacity to handle radio interface to the mobile stations. Every device or mobile cell is first connected with BTS only. BTS and mobile phone is connected by UM interface.

BSC - Base Station Controller

All the radio information and other stuff are shared to Base station controller from base transmission station. Base station controls all the Base transceivers.

Mostly Radio resources are allocated at base station controller.

Base station controller connected with base transceivers stations by A-bias interface.

MSC - Mobile Switching Centers

It helps in routing and switching the voice call, all information's are stored in MSC and shared from here only. Mobile Switching centers have communications exchanging capacity.

All other Architecture stuff are under MSC, MSC controls every other thing like Home location register (HLR), Visitor Location register (VLR), Equipment identity register (EIR).

HLR - Home Location Register

HLR is a data base of the network where various data are stored and managed accordingly.

HLR manages the subscriber's identity, billing information's location information and authorization information's.

VLR – Visitor Locations Register

VLR is also a database of the network where the information regarding the subscriber's location are stored. Like where the subscribers are currently located in the MSC are informed.

There is one visitor location register are available at one MSC.

Many time VLR is considered as replica of HLR because it contains the data of HLR as well.

EIR – Equipment Identity Register

EIR is also a database of the network which contained the data of equipment which is used in network for authorization or authentications.
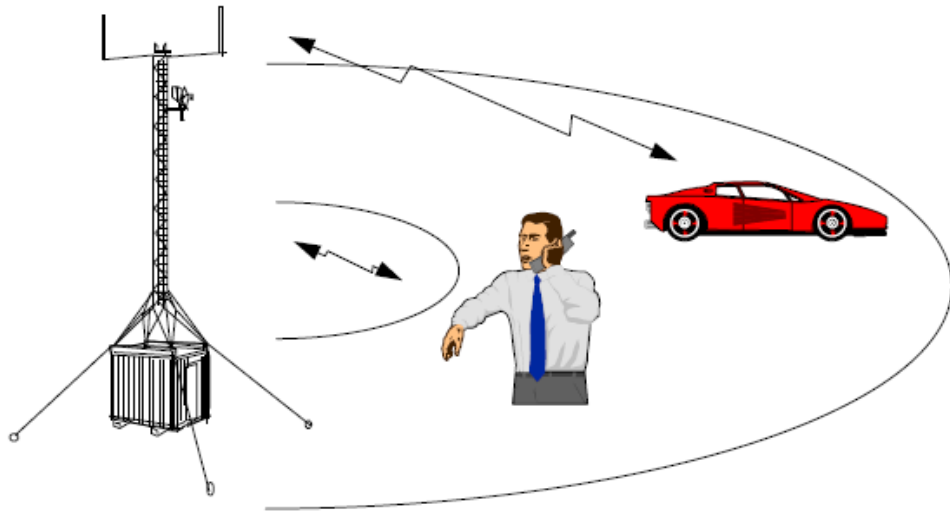
Fig 3.5: Ranges of BTS and MSC

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CHAPTER-4
Introduction to Mobile Core Network

In this section I'm going to having a brief about Outline of 2G, 3G and 4G network component in Telecom.

4.1 All Generation Network Architecturess
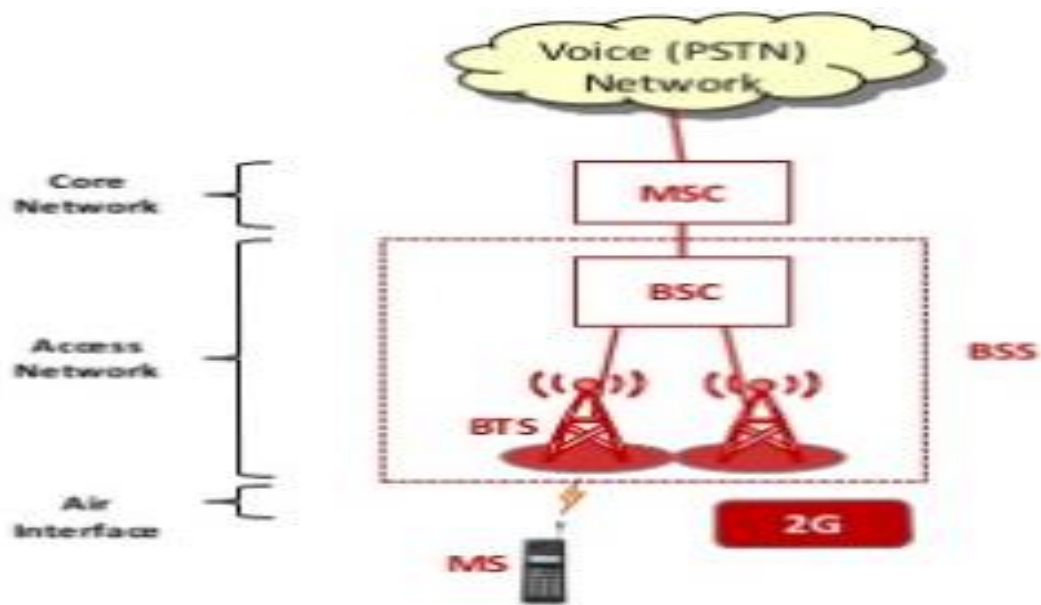
Fig 4.1   2G network architecture
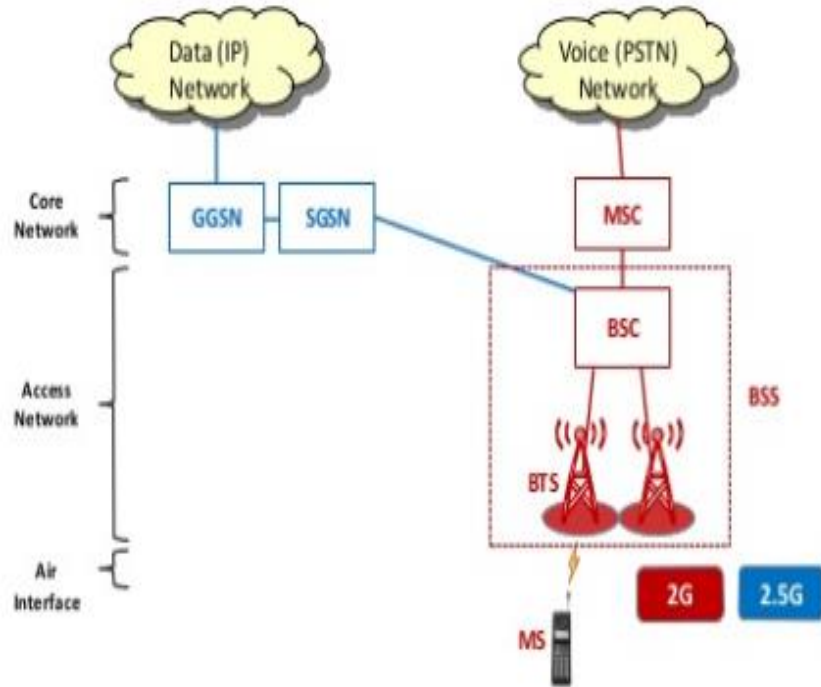
Fig 4.2 - 2.5 G GPRS Enhancement network architecture
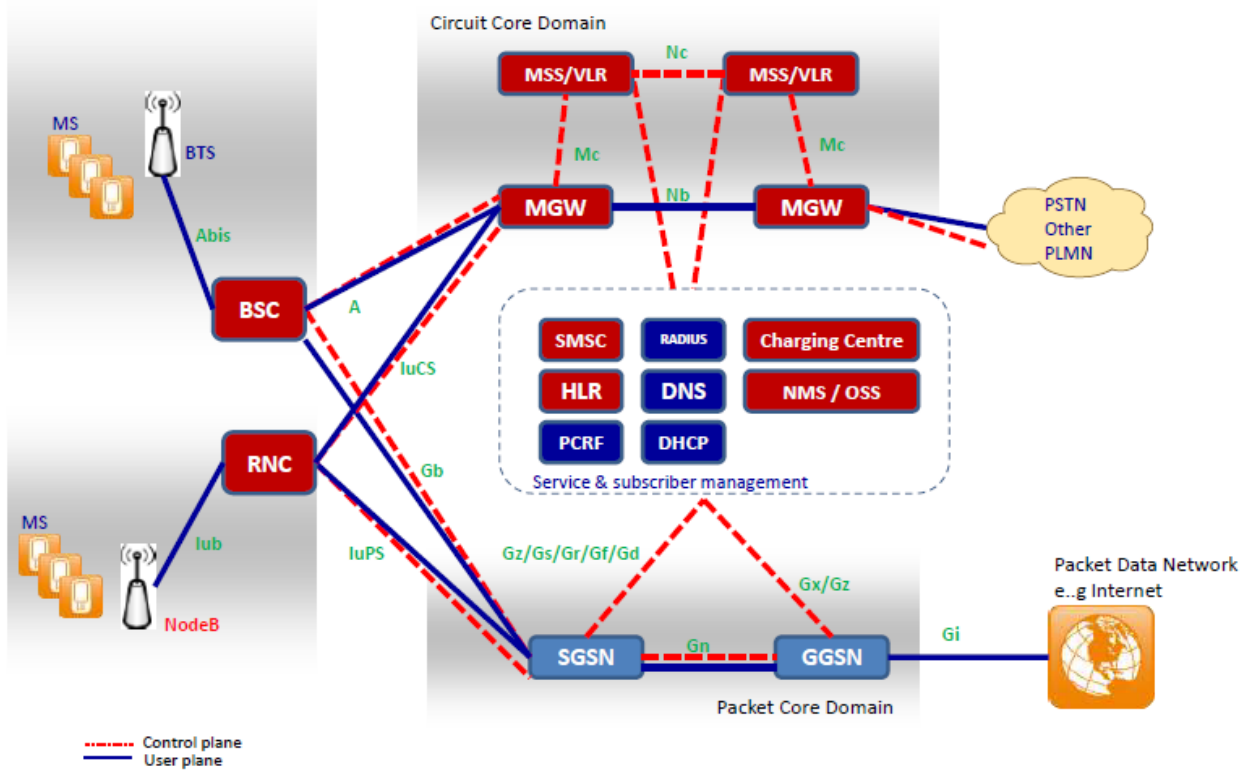
Fig 4.3: 3G Network Architecture
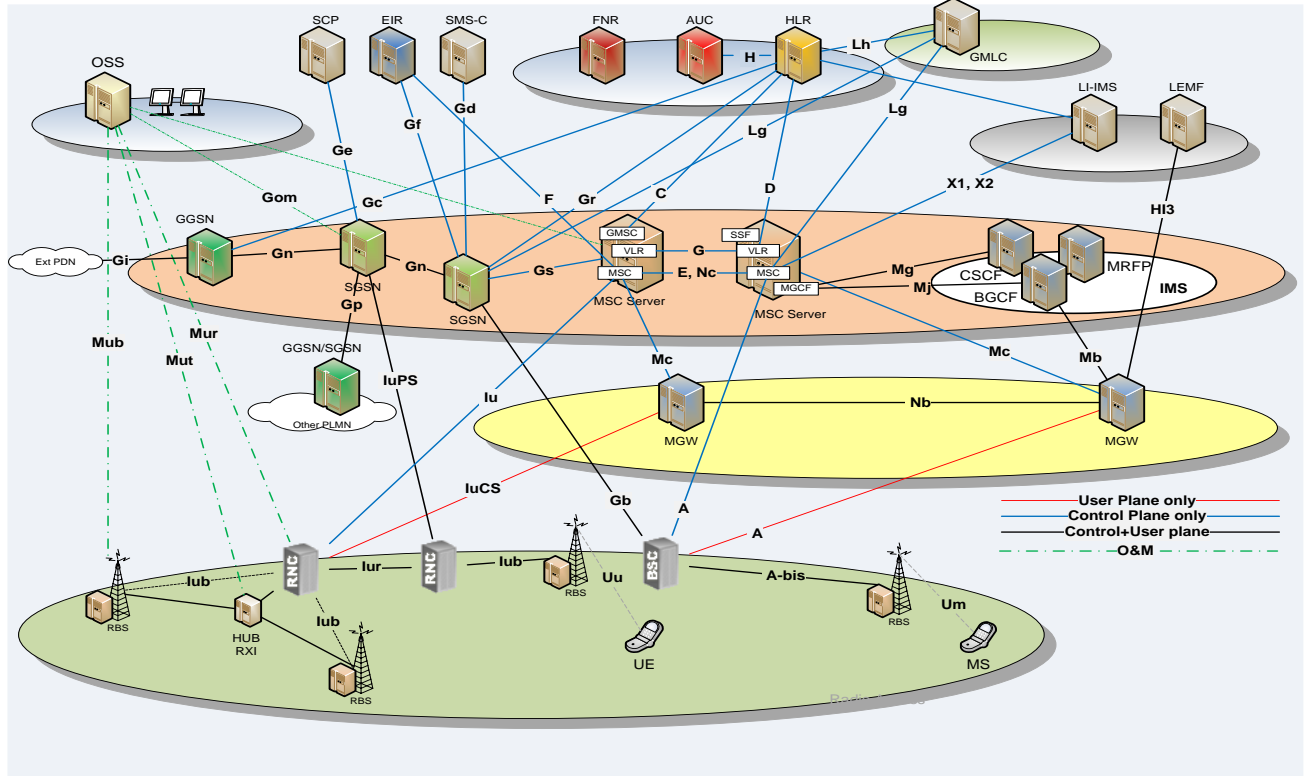
Fig 4.4 - 4G Network Interfaces

	GSM	WCDMA	HSPA	HSPA+	LTE
Data Rate (DL/UL, bps)	14.4K ~ 64K	384K	14.4Mbps 5.7Mbps	21/28.8Mbps 11.5Mbps	~300Mbps ~75Mbps
Bandwidth (MHz)	5	5	5	5	1.4 / 3 / 5 / 10 / 15 / 20
Technology	TDMA	WCDMA	WCDMA 16QAM	WCDMA 64QAM, MIMO	OFDM, SC-FDMA 4x4 MIMO

Fig 4.5 - Comparison of all generation network

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4.2 LTE Overview

LTE is Anywhere, Anytime Access!

LTE means Long term evaluation, LTE comes after 3G with better speed, Latency, Capacity, Flexibility and many new features are added in the same.

Fig 4.6 LTE Features

LTE ARCHITECTURAL ITEMS

• Modulation

• MIMO transceivers are installed in the LTE network for better speed, MIMO stands for Multiple input-multiple output

• Voice is also supported

• IP Multimedia system (IMS)

• Evolved Node-B

• System architecture (SAE and evolution)

• Evolved Node-B interface
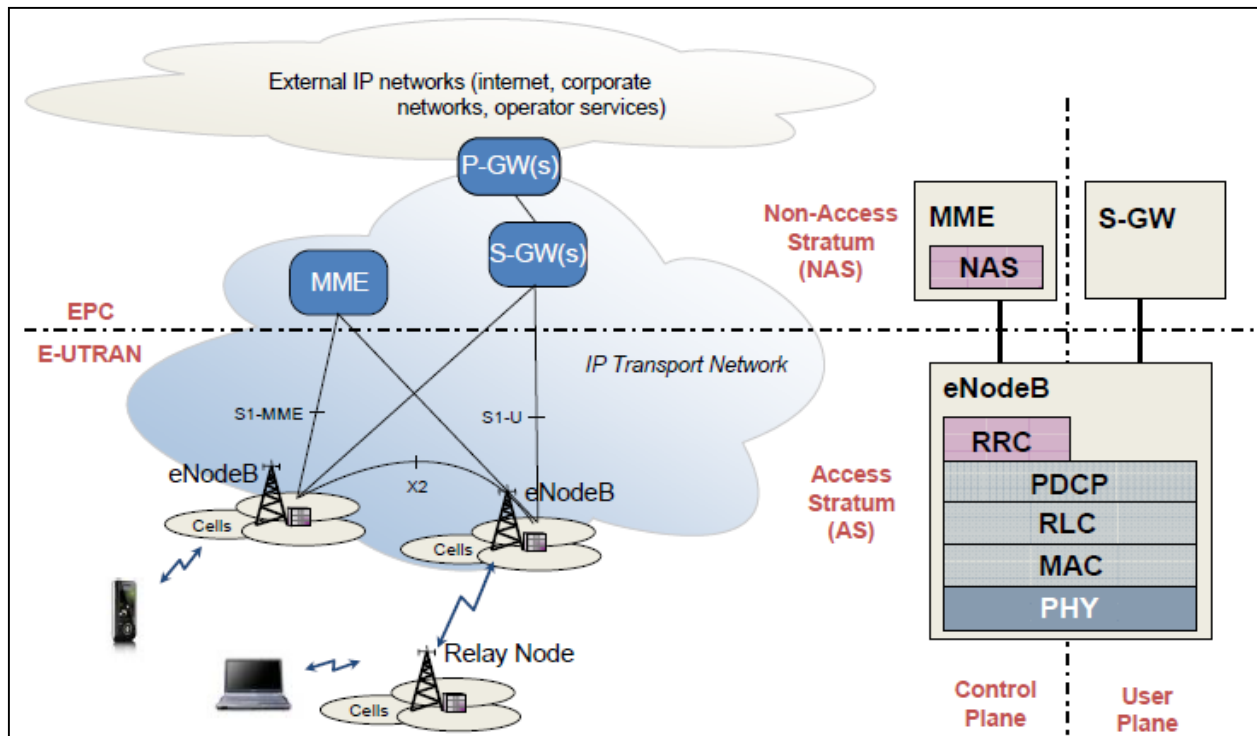
Fig 4.7 - LTE Network Architecture

eNB Key Functions

- terminates the complete radio interface

- Selection of mobility management entity at UE attachment

- Transmission of calling messages
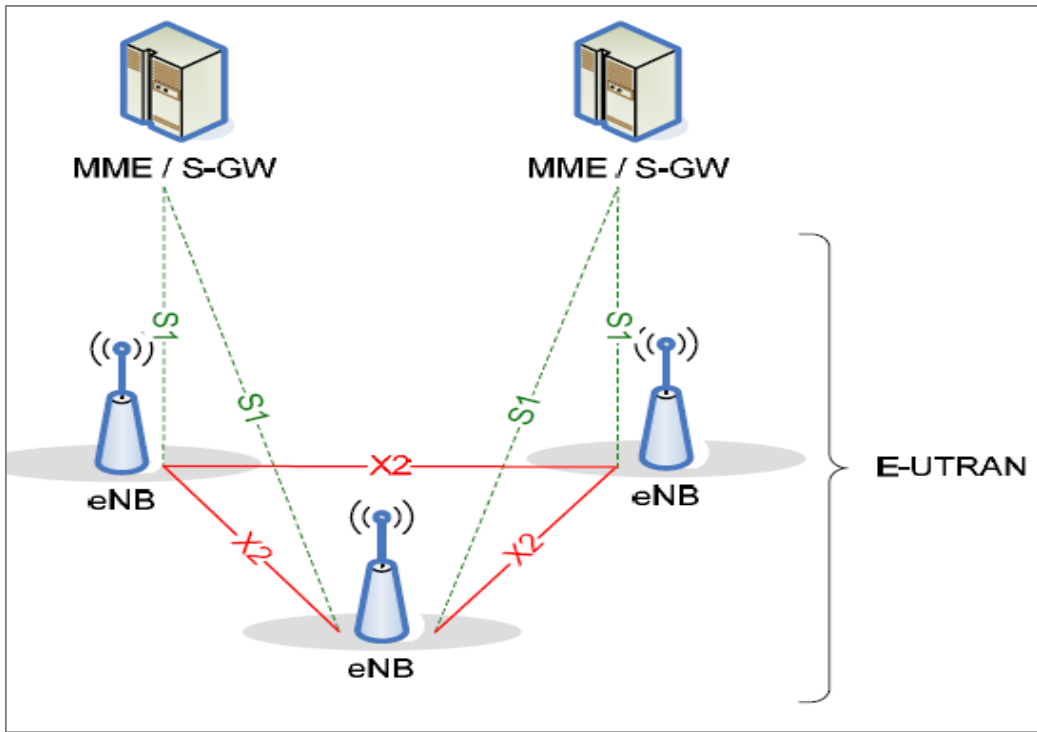
Fig 4.8 - LTE Functions eNB

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CHAPTER- 5
INTRODUCTION TO SS7

CCS7 (Common Channel Signaling System No.7) or SS7 (Signaling System No.7) is a bunch of telephone signaling protocols that are used to set up most of the world's Public Switched Telephone Network (PSTN) telephone calls. Signaling System No.7 basically sets up and tears down the calls. Other uses of SS7 include number translation, prepaid billing mechanisms, local number portability, Short Message Service (SMS), and a spread of mass-market services.

There are three types of signaling points in the SS7 network:

• SSP - Signal Switching Point

• STP - Signal Transfer Point

• SCP - Service Control Point
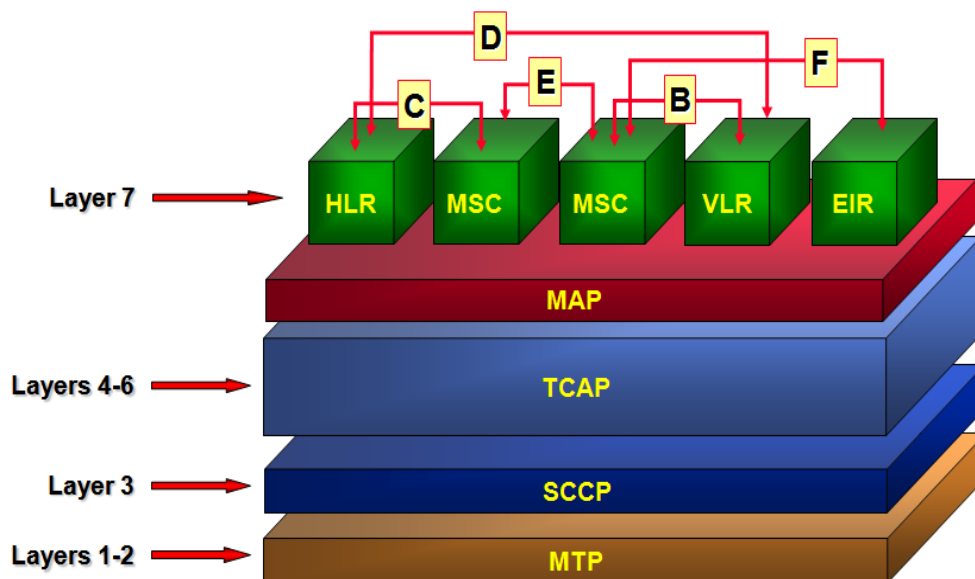
Fig 5.1: SS7 Layers

5.1 Signal Transfer Point (STP)

• A Signal Transfer Point is a router that transmits Signaling Systems 7 (SS7) messages between signaling end-points and other signaling transfer points.

• STPs also routes the message based upon message and body content and provide address translations to transfer the messages.

STPs are typically connected in the mated pairs.

Before the Signal Transfer Point came into functioning, the messages were just transmitted from the source to the destination. Slowly, the network expanded and became more and more complex, therefore there was a need for Signal Transfer Point s which could make communication easier in a large and complex telecommunication network. A Signal Transfer Point is a router or gateway in the SS7 network. Information's are not originated by an Signal Transfer Point Nodes. STPs only switch SS7 messages between signaling points and other nodes.
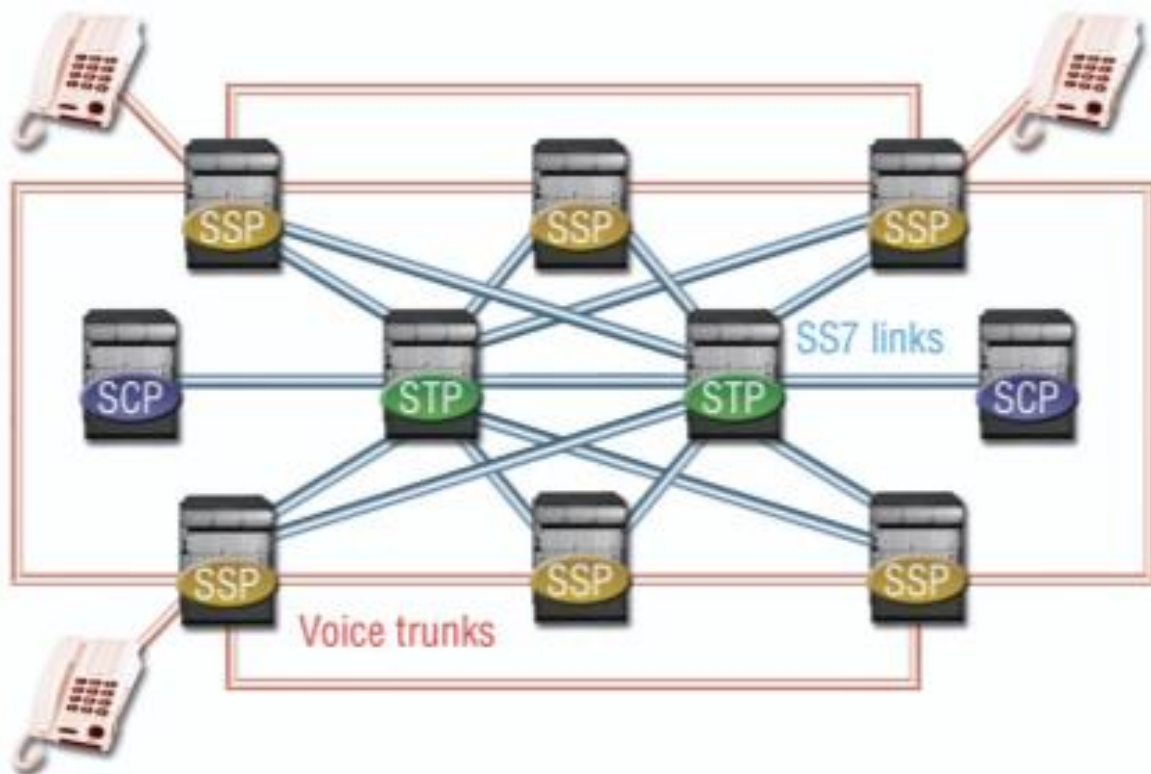
Fig 5.2: SS7 Signaling Points

Fig 5.3 SS7 Network Components

Why STP?

- Signal transfer Point provides overall Network Controlling facilities which helps in the sending of Intelligent Services throughout the network.

- Reduce the Signaling Terminal Hardware in Service Switching Points / Service control points. like mobile Switching center, IN, Home location registers, etc.

- STP Minimizes Errors in the networks. Due to STP Routing of Messages is done in efficient way.

- It gives flexibility in SS7 Network Management.

- It helps in fast Integration of New Nodes in the network.

5.2 Link set and Signaling Link Type

•A (Access) Links provide STP-SSP and STP-SCP connectivity Usually provided as at least two links, one to each of the paired STPs. May be provisioned as a combined link set, or route set, providing a total maximum number of 32 links between an SSP and a pair of STPs.

•B (Bridge) Links connect Signal Transfer Points to other Signal Transfer Points of the same hierarchical level "B" .
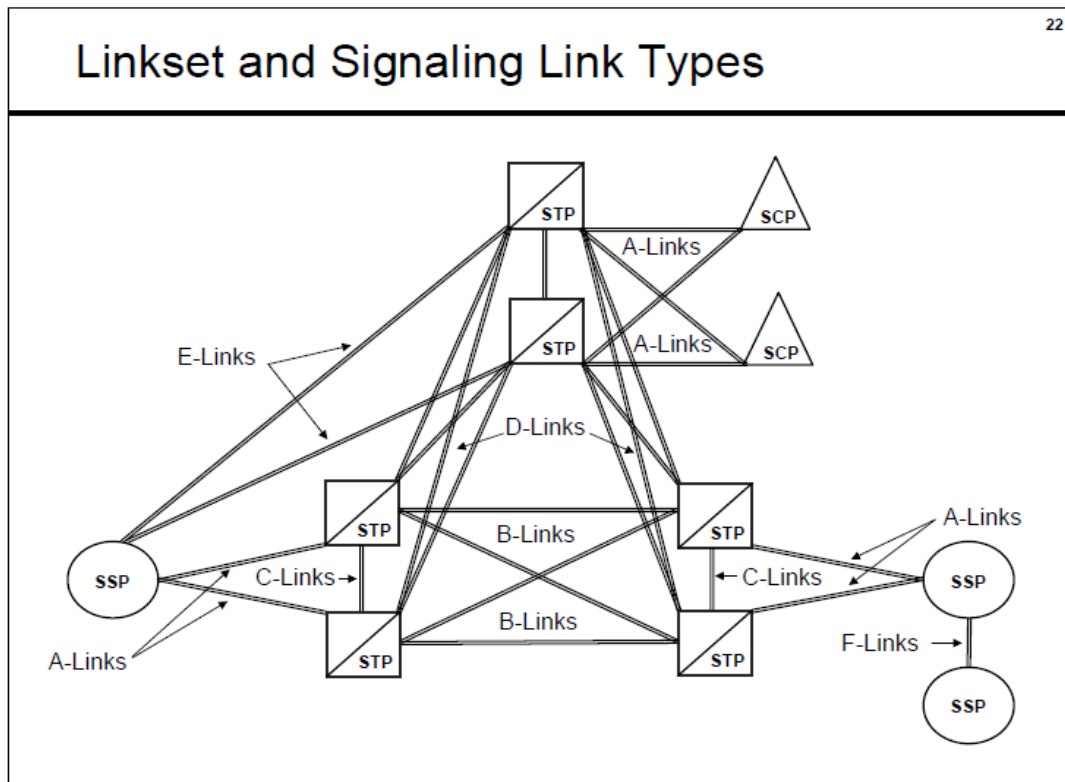
Fig. 5.4 Link-Set and signaling link type

•C (Cross) Links connected between mated pairs of STP, which is Used primarily for network management traffic. May be used as an SS7 traffic path if necessary to provide MSU delivery.

•D (Diagonal) Links connect STPs to other STPs of different hierarchical levels "D" links would interconnect a local STP pair to a Gateway STP pair

.

•E (Extended) Links connects Service switching point to a signal transfer point other than its home STP.

•F (Fully Associated) Links provide SSP to SSP connectivity SSPs must be adjacent Provides only call setup/call teardown capabilities Because of the prevalence of queries through the SS7 network, F links are rarely employed.

STP always works in mated pairs.

- Mated pair of STP is named because both the STP perform identical functions.

- Each SSP has two links or multiple links, which is connected to each STP of a mated pair.

- The STPs of a matched pair are connected by a link or multiple links.
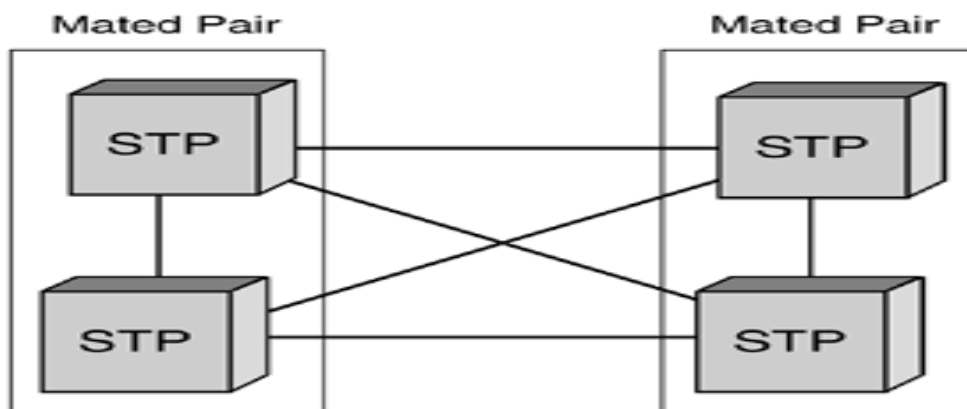
Fig 5.5 Architecture of mated pairs

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CHAPTER- 6
The Diameter Protocol

The Diameter protocol is used for the authentication, authorization, and accounting in the communications networks. Diameter protocol replaces the much less capable RADIUS protocol that headed the communications in it. It belongs to the application layer protocols.

Authentication - Verify identity of a user or Authenticate device from network access

Authorization - Should a user have access to certain resources? This process Authorize user and device for network access,

Authorization - Should a user have access to certain resources? This process helps in collecting information of resource usage.

- Diameter is composed of a base protocol, specified in RFC 3588, and a set of applications that each extends the base protocol capabilities. The Diameter base protocol provides the minimum requirements needed for an AAA protocol, including the following functions:

- Delivery of AVPs:

- AVPs or Attribute-Value Pairs carry the information in the Diameter Message. An example of an AVP is for example the User-Name AVP, carrying an IMS username.

- Capabilities Negotiation between diameter nodes.

- Error Notification

- Basic Services, such as Accounting and User Session handling

- And Extendibility – the possibility to extend the Diameter protocol for specific use.

Diameter is composed of a base protocol and set of applications. Applications allow it to extend it services. Application specifications defined through RFC and 3GPP as well as proprietary. Specifications adds additional messages and parameters and define service logic above the base protocol.

6.1 Diameter Routing Agent (DRA)

DRA is short form for Diameter Routing Agent. It does the same work as STPs in an SS7 Signaling. However, it uses a modern approach and is widely used for LTE signaling, whereas STP is used for 2G and 3G (SS7 signaling). Diameter protocol work as a relay agent or a proxy agent both depending on the needs. when It works as a relay agent then it forwards the message from the nodes based on the host ID and when it works as a proxy agent then it routes the message from the nodes based on the host ID. Diameter is used for the authentication, authorization, and accounting protocol in the communications snetworks. It evolves and replace the much less talented Radius protocol that headed the communications in it. It goes to the application layer protocols.

- It used to process signaling in diameter protocol.

- It does the same work what STP/SPS does in ss7 signaling

- It just forward or route the message from MME—PCRF—HSS—OCS etc.

- It can act as server or client.

- It can work as a relay agent or proxy agent as well, when it works as a relay agent it forward the message based on Host-id

- When it as a proxy agent it routes the message based on Host-id

DRA in short:

- DRA stands for Diameter Routing Agent

- It does the same work as STP in an SS7 Signaling, but for LTE Signaling

- It uses the Diameter protocol to send messages

- It was released after the RADIUS protocol, which had some limitations (reliability, scalability, security and flexibility)

- Diameter is a client-to-server protocol, which contains a base protocol (specified in RFC 3588) and a bunch of applications that each extends base protocol capabilities.

- Used for Authentication, Authorization, Accounting (AAA) and carrying AVPs (Attribute Value Pairs)

- AAA is crucial for the operation of an IP network

- The authentication is used to confirm the identity of the user

- The authorization is used to check whether a user should have permission use to certain resources

- Accounting is to collect information of resource usage (for billing, capacity planning, auditing or cost allocation)

- AVPs carry the data in the Diameter message

6.2 Analogy between STP & DRA

- Diameter Routing Agent (DRA) and Signal Transfer Point (STP) both works on the same principle and basic concept.

- The major difference being:

    - **STP** is used for signaling **2G/3G** circuit switch networks (i.e. SS7 Signaling)

    - **DRA** is used for **4G LTE and VoLTE** packet networks and IMS (IP Multimedia Subsystem) based systems (i.e. LTE Signaling)

- SS7 and Diameter are signaling protocols which are used to exchange signaling messages between network elements

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CHAPTER – 7
TRAINING BACKGROUND

7.1 Organizational Structure

Ericsson is divided into two main SDUs (Service Delivery Units), as follows:

- ❖ SDU Bharti (Service Delivery Unit for Bharti Airtel in India)
- ❖ SDU India (Service Delivery Unit for other global telecommunications companies, for example, Telstra in Australia)

Both SDU Bharti and SDU India are further divided into various domains, as follows:

- ❖ Core
- ❖ Access (Radio Access Network, also called RAN)
- ❖ Design
- ❖ Automations
- ❖ IP & Transmission
- ❖ Operations Support System (OSS)

I had been assigned the 2nd Level Assurance Core domain and my sub-domain is STP/DRA for SDU-Bharti, which is one of Ericsson's largest telecommunication customers and also India's leading telecom services provider. We had been asked to have an in-depth knowledge about the domain and sub-domain. We had also been given reading material, which contains information about the functionality, architecture and protocols used in STPs and DRAs.

7.2 Trainings and Courses

We joined Ericsson as an Intern on 03rd February 2020 which began after completing the condensed semester at the University. Internship began with lots of mentoring on transition from Campus to Corporate.

During the period of 03rd February to 10th February, Induction program was conducted for all interns which made the internship onboarding smooth and easy.

With corporate culture, we were made aware with the Organizational structures and hierarchy of the Ericsson. Generally, the Service Delivery Units have the typical service company structure which is meant to overlook and manage an existing service already developed. Any faults or corrections needed are solved by working on the raised tickets and the allotted team was STP/DRA of core network for Bharti Airtel SDU. So, we were allotted various teams in which the organization is distributed internally for Bharti Service Delivery Unit or the Managed Services Units.

Initially we were given training in person by the Human resources managers at Ericsson and the senior engineers at the Technical trainers FLEX team.

Campus to Corporate – introduction to corporate work culture and finding out the difference between day to day operations in University campus compared to the corporate office.

Next introduced topics were the Basics of telecom which included the Generations of telecom networks, Network architectures of 2G, 3G, 4G/LTE and 5G. Focus was on 2G, 4G and 5G. Most of the revenue of Ericsson/Bharti Airtel are based on the 2G/4G networks while Ericsson is working on 5G for its commercial realization in India.

To augment the knowledge in the concept of the respective domains, a set of WBLs (Web Based Learnings) were asked to be completed, which consisted of wide-ranging videos, domain specific documents and other HR trainings.

Some of the courses are in which we are enrolled:

1. Occupational Health and Safety Induction
2. Health and safety of radio frequency exposure
3. Safe Driving Awareness
4. GSM Radio Access Network Overview
5. GSM RAN SW Licensing
6. GSM Radio Access Network Overview [Old Version]
7. GSM System Survey
8. WCDMA RAN Overview
9. IP Fundamentals
10. IP Routing Overview
11. IP Routing Fundamentals
12. LTE Radio Interface
13. LTE Radio Access Network Protocols and Procedures
14. Auto-integration in LTE
15. LTE L13B Features and Functionality
16. LTE in a Nutshell, WBL
17. LTE/SAE a System Overview, WBL
18. LTE/EPC Introduction
19. LTE/EPC Architecture
20. LTE Radio Network Configuration
21. EVO Controller Overview
22. LTE Fundamentals
23. 5G Overview
24. RAN Architecture Evolution
25. NR Concept
26. What is 5G RAN?
27. 5G Plug-Ins, Ericsson Radio Access Evolution
28. 5G RAN Operations
29. 5G Overview

30. Ericsson 5G RAN System Techniques

31. RAN Architecture Evolution to 5G

There were also a few mandatory trainings, which were assigned to create awareness about the data privacy and security so that one is aware about how to handle subscriber personal information. Some trainings were also based on IMS. In earlier days, mobile phones are provided by voice call services over a circuit-switched network, rather than strictly over an IP packet-switched network. Alternate methods of delivering voice call or other multimedia services become available on smart phones, but they have not become standardized across the industry. IMS is an architectural framework to deliver such standardization with very beautiful success rate. There were also WBLs based on Python Fundamentals, Data Science, Automation, 5G and VoLTE to supplement the knowledge gained before.

Some of the other mandatory trainings that were done are:

1. Data Privacy 2.0

2. Be Security Aware

3. Travel Security

4. Handling of subscriber personal information

5. Service On Element Manager Overview

6. IMS Introduction

7. Knowledge Assessment - Ericsson Microwave Products Overview

8. IMS Signaling Part 3: Diameter in IMS

9. Sustainable Work-Life and Stress Prevention

10. Occupational Health & Safety (OHS) Incident Handling

11. Sustainability and Corporate Responsibility for All

12. Getting to the Root of a Problem,

13. Unconscious Bias

14. Ericsson Network Manager (ENM) - Overview and Highlights

15. EGMS Awareness

16. Ethernet Transport Fundamentals

17. IP Fundamentals

18. MINI-LINK 6352 Fundamentals,

19. 5G RAN Transport Solutions,

20. An Introduction to Trade Compliance,

21. Transport – Microwave

22. BSP Overview

23. ENM Overview

24. VoLTE Introduction

25. 5G core concepts Introduction

26. GSM System Survey

27. VoLTE e2e Call Path Course

28. 5G Core Network Architecture

29. 5G Transport Overview

30. Ericsson Cloud Systems

31. Python: Data Science Fundamentals

32. Ericsson Microwave Products Overview

33. Microwave Transmission Technology Overview

34. Automation 101

35. Optical Transport Technology Overview

36. Transport Evolution

37. Data Science Statistics: Using Python to Compute & Visualize Statistics

38. Ericsson Mobile Backhaul Microwave Reference Solution Fundamentals

39. BMAS Data Science Fundamentals

40. BMAS Automation For ALL

41. BMAS Change Management Basics

42. BMAS 5G Basics

7.3 Managed Services Delivery Platform (MSDP)

I had also completed some MSDP (Managed Services Delivery Platform) courses that were required for us to log into the various STP nodes present across India, to manage the network and ensure smooth functioning. The MSDP trainings include problem solving techniques and actions that need to be taken when trouble arises at any node of a network. It contains information on how

to generate Trouble Tickets, Work Orders, and Change Requests etc. depending upon the problems faced by the customers. MSDP is used whenever a company has been contracted to manage a customer's network. MSDP tools serve end-to-end management of networks in multi-customer, multi-country environments enabling efficient alarm monitoring, troubleshooting, fault restoration etc.
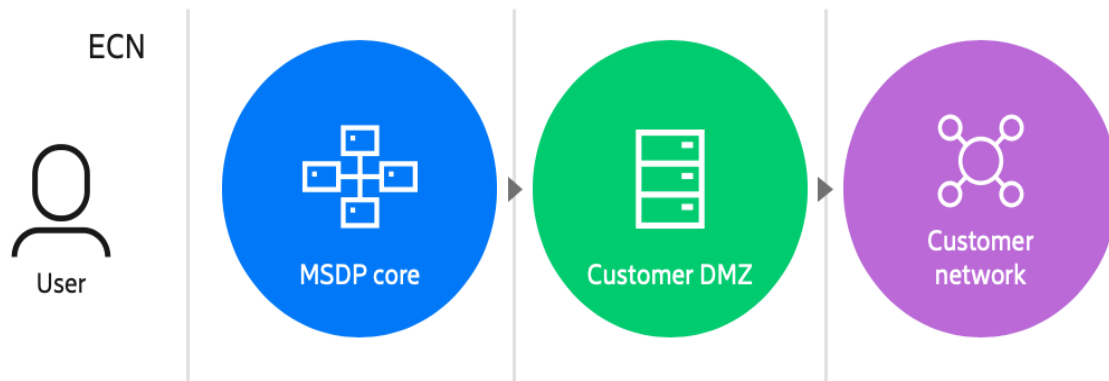
Fig 7.1. MSDP Architecture (Ericsson)

The MSDP platform provides solutions with following key functional building blocks:

- Infrastructure as a service layer
- Connection and Integration layer
- MS Core Service Layer
- Workflow
- Data Management
- Security
- Machine Learning
- Analytics

Some of the MSDP trainings completed are listed below:

1. MSDP Ways of Working
2. MSDP WFM Introduction
3. MSDP OneFM Introduction
4. MSDP OneTM Introduction

5. MSDP OneTM working with change request

6. MSDP OneTM NOC administration

7. MSDP OneTM Assessments NOC administration

8. MSDP OneTM Assessments operators

9. MSDP OneFM Assessments read only user

10. MSDP OneFM Assessments read write

11. MSDP Ways of Working Assessments

To obtain the license and approval for the access of the MSDP Platform (access bundled with OneFM, OneTM and NIM) we had to go through various assessments which could be taken after completing WBL modules (Web based learning modules) and assessment exams. It was necessary because we could access servers and internal data only if we had the access granted after completion of MSDP assessments.
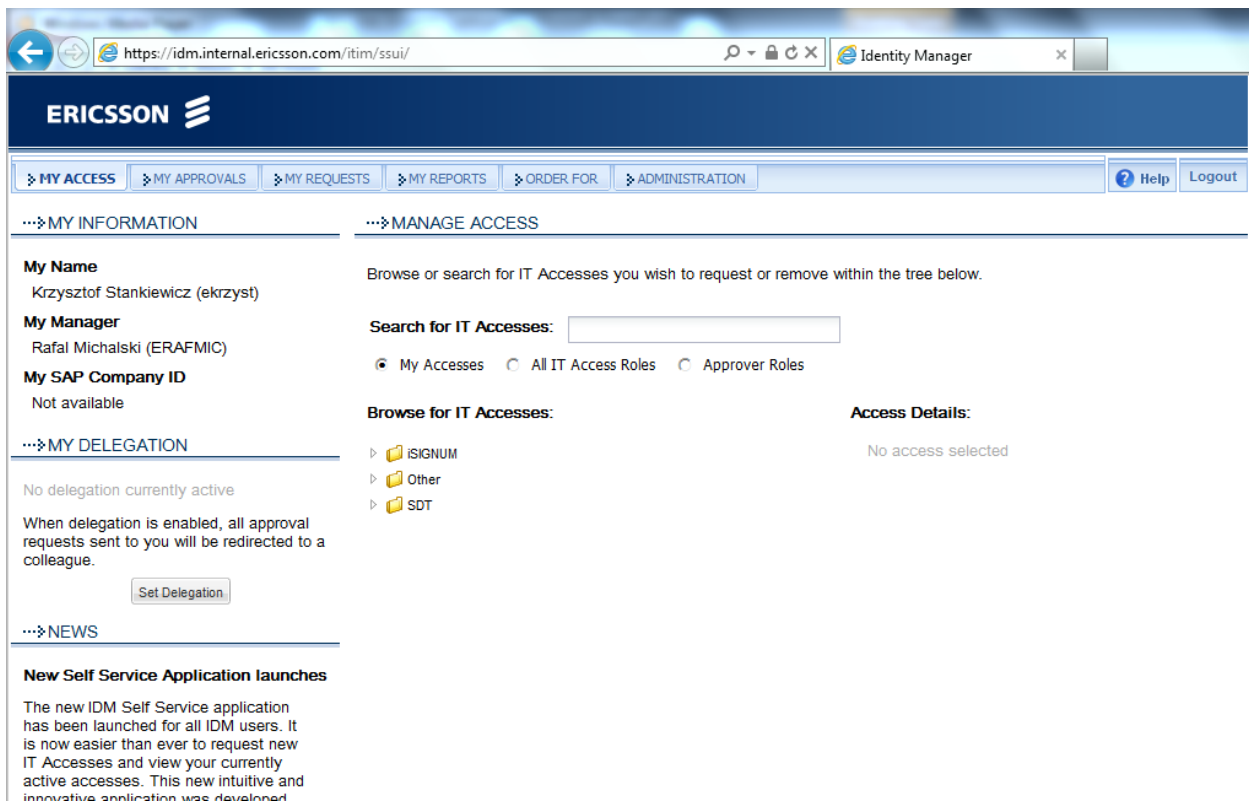
Fig 7.2 MSDP Login Screen and Access (Ericsson)

MSDP contains several solution areas comprising of different tools. Some of the tools are listed as follows:

Workforce Management (WFM)

The workforce management (WFM) is a system for the field operations, which provides scheduling functionality in order to improve the efficiency of the field force. In the WFM system, work orders are used to hold information regarding the requested services, as well as to keep track of the progress of work being done for the same in order to meet the service requirements. For field technicians with proper access rights it is possible to view and maintain the work orders through a WAP interface. The WFM environment can be implemented as Stand Alone or by integration with OneTM.

Fault Management (OneFM)

OneFM, the MSDP Fault Management Tool, is an integrated system that supports Fault Management or Event Management processes. OneFM, within the MSDP tools, acts as an umbrella system, to which all Element Managers of multiple types and vendors (or Network Elements directly) send their alarms and events. It provides a common platform to MSDP NOC users to optimize resources and services and take necessary actions proactively. It tracks alarm/event information in a high-performance, in-memory database, and presents information of interest to specific users through filters and views that can be configured individually. It has automation functions that can perform intelligent processing on managed information.

Trouble Management (OneTM)

The Trouble and Change Management Tool which is used within Managed Services Delivery Platform (MSDP) is called OneTM. It handles the Trouble Tickets, Work Orders and Change Requests in a combined NMS (Network Management System) solution. Reports on some KPIs are also involved. The access of the OneTM is obtained through Citrix clients. OneTM is often used together with a Fault Management system. Tickets can be created based on input from the Fault Management system as well as other sources such as phone calls and emails from end-users. OneTM can also create work orders to be used by Workforce Management (WFM).

After completing the trainings, a handful of assessments related to MSDP need to be passed with a 100% score, on completion of which, one is eligible to raise a request to get access to MSDP and its tools. After getting the MSDP Access, details about the team inventory were given, which gives

knowledge about the different nodes that each team is dealing with. There are about 111 STP/DRA nodes belonging to SDU Bharti all over the country, which are managed by the 2nd LA Core Team, BO Noida.

NIM

NIM Solution enables network inventory functions to the MS customers. The main task for this centralized repository is to ensure that automated and manual processes are driven by accurate data. Depending on a Role and Activities following access rights to MSDP NIM can be distinguished into

- NIM User
- NIM Engineer
- NIM LDA
- NIM Administrator

Before ordering an account MSDP NIM Assessments needs to be passed and which was done accordingly. Access to NIM was ordered using CUP (MSDP Tools/NIM).

Fig. 7.3. NIM Central User Provisioning (CUP).

7.4 OneTM Trouble Ticket Management

The OneTM Trouble Management Tool can be more precisely explained with the working and handling of Trouble Tickets, discussed as follows:

7.4.1 Trouble Tickets

TT is a record of event that is not part of the standard operation that causes interruption or quality reduction of the service. The users experience it when mobile calls cannot be completed in a certain area or there is disruption during the calls. TT describes a network incident that needs to be addressed immediately (especially if the TT is Critical in nature).

To manage Trouble Tickets, OneTM access request has to be made through Citrix clients, after which we get an approval for the access request. The access by the Citrix clients is granted only after a set of mandatory web based courses and MSDP trainings have been completed.

OneTM is often used together with OneFM. Tickets are generated on the basis of the input from the Fault Management system and the other sources of communication such as phone calls and emails from end-users. OneTM can create work orders to be used by the WFM. It also helps in supporting incident management, problem management and helps operation centers.

An overview of the tool was given and we were made familiar with the application page. We were explained about how to launch OneTM and navigate in it. We were also asked to browse and explore the application page to get familiar with the platform. The MSDP Trouble/Problem Management is a part of MSDP Tools Solution. This application is used at Ericsson in its daily support for the customer networks, and gives them complete control over their process of handling the trouble. The following are some of the features of OneTM.

Integration

The most important tools from the perspective of OneTM are OneFM, NIM, and WFM. OneTM Solution provides an interface that any fault manager such as OneFM can connect to. It supports the ability to create Trouble Tickets from the alarms generated. Its integration with NIM provides

the trouble ticket system with all the information about sites. The WFM serves as the system for field operations.

Case Flow

When any problem occurs in the customer's network, an alarm is raised in the customer's Fault Management System. The alarm is forwarded to MSDP OneFM. The alarm then gets the site information from the NIM database. If needed, field force is contacted and a Work Order (WO) is created and forwarded to the WFM system, based on which field force is sent to the site.

Searching Filters

The most common way to search for tickets is to use the various search filters. There are several different filters available which ease the process of searching for tickets that are assigned to a particular person. From the 'Show Trouble Ticket' dropdown list, we can select a filter as required and fill in the required details about the NOC, the region and the type of tickets to be closed. In the trouble tickets field, the list of matching tickets appears. This page shows the most important ticket data which includes the time at which the ticket was raised, the kind of problem that has been occurred and where, etc.

7.4.2 Type and Priority

There are various different types of Trouble Tickets. Mainly they are divided into Critical Tickets, Major Tickets and Minor Tickets depending on the severity level of the situastion / problem. The Critical Tickets hold first priority, then the Major Tickets and then the Minor Tickets. Ticket resolution/reduction has to be done in the above-mentioned order only. All the Critical Tickets are required to be resolved within 3 hours of occurrence of trouble. Major and Minor tickets also have their specific time limit within which they have to be resolved depending on the type of problem.

7.4.3 Handling of Trouble Tickets

Keeping above-mentioned points in mind, an attempt at resolving tickets was made with proper care. We were given a detailed description of the same, and were explained about how to work

with them. We were made familiar with the life cycle and handling process of Trouble Tickets and the different functions available in a Trouble Ticket.

Steps to handle Trouble Tickets:

Before attempting to resolve a TT, it must be accepted first. Then, it must be opened by double clicking on the chosen entry on the Trouble Ticket pane of the resolution start page.

- To accept the ticket, select 'Yes' from the accepted selection list. The ticket will be opened in edit mode.
- To reject a TT, select 'No' from the accepted selection list. The reason for rejection of a TT must also be explained.

A brief introduction of the GNOC India Handbook was given. GNOC stands for 'Global Networks Operation Center'. The handbook lists down the common incidents/mistakes related to trouble tickets and network alarms, which have occurred in the past, so as to avoid them in the future. Resolving such issues is a matter that needs to be handled with extreme care as the consequences of a wrong step can lead to huge business losses.

7.4.4 Work Log

A work log is one of the most important informational fields in any TT. The work log shows the steps that have already been done to solve the problem, the time at which they have been done, and by whom. A notification is sent to the customer who can read the cause of rejection in the work log (if any). Once the work log entry is created and is displayed in the work log table of the TT, the entries can be sorted in ascending or descending order.

If we want the TTs to stay even after the alarms are cancelled from the nodes, in order to update the reason, we apply 'Auto Clear'. We can apply a time frame for the same. For example, we apply a time frame of 30 minutes. In that case, even when the alarm has been cancelled from the nodes,

the TT will be closed after 30 minutes, so that we can update the reason within that time frame. Similarly, any amount of time duration can be applied depending on the situation and the needs.

7.4.5 Service Requests

If TTs are created for the purpose of configuration or resolution in an existing environment, they are called Service Requests.

Apart from TTs, Change Requests (CRs) and Work Orders (WOs) also exist, as discussed in the previous section. These are types of Service Requests.

Work Orders helps in grasping the information regarding the requested services as well as also helps to keep track of the progress if work being done for the same in order to meet the service requirements.

Change Requests are used to bring about a change in the existing setup.

To conclude, TTs are created in OneTM, on the trouble ticket pane, by filling mandatory fields in the TT form. Here, the user can describe the issue, define its priority, type (Critical/Major/Minor), and sub category and specify who the ticket is assigned to. The life cycle of a Trouble Ticket is defined by restricted state transitions. The Trouble Ticket goes through different states from 'New', until it is finally 'Cleared' and 'Closed'.

3.4.6 Service Level Agreement Report

I was required to prepare the TT SLA (Trouble Ticket Service Level Agreement) for the month of April as was done for the month of March and February. A TT SLA summarizes the total number of TTs resolved in a particular month, for each category i.e. Critical, Major and Minor Tickets, the time duration within which they were resolved, the person who resolved them, the region where the ticket was raised etc. This acts as a performance measure for the company as well as the customer and helps the customer to continue the services provided by the company. The SLA is prepared using Pivot Tables and concepts involving Data Analytics.

I was also required to update the inventory sheet for the STP and DRA nodes present pan India. It consists of the details of all the STP/DRA nodes in India. There are about 111 STP/DRA nodes in

India under SDU Bharti (Service Delivery Unit for Bharti Airtel in India). It consists of details like node name, node region, IP address of the node etc. The inventory sheet needs to be updated weekly in order to maintain a correct data sheet for all the nodes.

7.4.7 Parent-Child Correlation

A new concept of Parent-Child Correlation was learned and applied, which highlighted the following important points:

- When Trouble Tickets are too many in number and belong to the same region specifying the same type of problem, then those particular TTs can be closed/cleared in bulk. The only point to keep in mind is to never close Critical TTs in bulk.
- Another way is to group TTs together when they are related to similar kind of problems. This makes use of the concept of Parent-Child Correlation. This correlation is established when same faults are reported several times by different customers.
- The best example to understand this concept is when many different users are complaining about faults in the same site. In this case, the operator can create one single parent ticket that correlates all other problem tickets to it as child tickets.
- This can help save time and effort, as the problem can now be resolved using a single ticket, instead of multiple tickets that ultimately correspond to the same major issue.
- The 'Duplicate Record Correlation' is established to enable the correlation of similar tickets. It is based on field configuration set for the customer. It enables the search for similar records under the 'Duplicate Records' tab.
- To display the non-child records as per the field search criteria configured for that customer, click on the show/refresh button.
- To relate the ticket to a parent record, select one of the non-child records and click on the 'Relate to Parent' button.
- Once this relation is made, the current ticket will be marked as "Child" and the original ticket will be marked as "Parent"

The above-mentioned points make the process of TT reduction a smooth process. Everyone is expected to follow the same in order to get best results within the time constraint specified. More advanced concepts/methods are gradually taken into account as one gains more experience.

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CHAPTER – 8
CONCLUSION & FINAL REMARK

8.1 CONCLUSION

During the internship, knowledge in the following tasks in the STP and DRA domain were acquired:

- 2nd Level assurance Service Problem Restoration of STP and DRA.
- Handling and analyzing the Trouble Tickets (TTs).
- Recommending appropriate actions and explanations for Trouble Ticket reduction after Root Cause Analysis.
- Handling and executing Change Requests in stipulated time frame.
- Capability to achieve the target work under time constraints depending upon the business requirement.
- Acceptance of testing of a node, which is done, in demand to certify that new nodes in the system are appropriately checked and tested before setup.
- Creation of TT Service Level Agreement Report/TT SLA Tracker of Critical, Major and
- Minor Tickets to evaluate BO team performance.
- Emergency handling of STP and DRA nodes.
- Troubleshooting and maintaining performance of nodes.
- Increasing throughput of the network.
- Achieving customer satisfaction.
- Learning more about the functions of each and every network element.
- Gaining knowledge about the working of live networks.
- Updating inventory details of all STP nodes in the country, which are currently being handled by the BO-STP team.
- Audit of users currently configured in the nodes as per audit guidelines.
- Understanding the BO processes, while adhering to the guidelines.
- Using VLookup in MS Excel and concepts of data analytics for preparation of performance reports.
- Understanding the Operator Network Architecture.

- Making/modeling software versions of different Original Equipment Managers (OEMs).
- Meeting minimum base line security requirements.

8.2 Future Planning

After completion of our WBLs (Web Based Learnings), OJTs (On-Job Trainings) and induction sessions, we will be dealing with live networks for SDU Bharti (Service Delivery Unit for Bharti Airtel in India) involving STP/DRA (Signaling Transfer Point/Diameter Routing Agent) nodes pan India.

Our work will mainly involve logging into the STP nodes present across India, using various software tools. After logging into the nodes, we are required to troubleshoot any network problems that arise. This way we can ensure that the network is operating smoothly, and the performance does not degrade.

We will be assisting customers on the 2nd level i.e. 2nd Level Assurance Core, which means that we will not be dealing with customers directly. Any first level problems that are not technical in nature are handled by Customer Care services. 70% of the customer issues can be solved at this level. However, if the problem persists and is technical in nature, it is handled by us.

I will be working on Oracle MOS tool to raise problems with OEM (Original Equipment Manager). Subsequent follow-ups with OEM will be done till issue resolution and Root Cause Analysis (RCA).

In case of any problems that arise in the network, Trouble Tickets (TTs) are raised which need to be resolved by us. Trouble Ticket (TT) reduction drive will be carried out to find out innovative ideas and achieve customer delight.

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