INTERNSHIP IN DESIGNING AND OPTIMISATION DOMAIN AT ERICSSON GLOBAL INDIA LTD

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

BACHELOR OF TECHNOLOGY

IN

ELECTRONICS AND COMMUNICATION ENGINEERING

By

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DECLARATION BY THE SCHOLAR

We hereby declare that the work reported in the B.Tech Project Reportentitled **"INTERNSHIP IN DESIGNING AND OPTIMIZATION DOMAINAT ERICSSON GLOBAL INDIA LTD"** submitted at **Jaypee University of Information Technology, Waknaghat, India** is an authentic record of our work carried out under the supervision of **Mr. Ritish Bajaj** (Manager (Core), Ericsson Global India Ltd)**.** We have not submitted this work elsewhere for any other degree or diploma.

Ashish Kumar

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

Head of Department

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SUPERVISOR CERTIFICATE

This is to affirm that the work reportable within the B-Tech report entitled "INTERNSHIP IN DESIGNING AND OPTIMIZATION AT ERICSSON GLOBAL INDIA LTD", submitted by Ashish Kumar at Jaypee University of Information Technology, Waknaghat, India, could be a bonafide record of his original work completed underneath my direction. This work has not been submitted elsewhere for the other degree or certificate.

Signature: 

Mr. RitishBajaj

Date: 25/05/2020

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LIST OF ACRONYMS AND ABBREVIATIONS

ACRONYMS / TECHNICAL TERMS	DESCRIPTION
GSM	Global System for Mobile communication
GPRS	General Packet Radio Service
UMTS	Universal Mobile Telecommunication services
WCDMA	Wide band Code Division Multiple Access
CDMA	Code Division Multiple Access
FDMA	Frequency Division Multiple Access
TDMA	Time Division Multiple Access
EDGE	Enhanced Data rates for GSM Evolution
LTE	Long Term Evolution
VoLTE	Voice over LTE
EPC	Evolved Packet Core
3GPP	3rd Generation Partnership Project
KPI	Key Performance Indicators
MSISDN	Mobile Station International Subscriber Directory Number
IMSI	International Mobile Subscriber Identity
IMEI	International Mobile Equipment Identity
TMSI	Temporary Mobile Subscriber Identity
BTS	Base Transceiver System
BSC	Base Station Controller
HLR	Home Location Register
VLR	Visitor Location Register

EIR	Equipment Identity Register
AuC	Authentication Centre
MSC	Mobile Switching Centre
PSTN	Public Switched Telephone Network
RNC	Radio Network Controller
GGSN	Gateway GPRS Support Node
SGSN	Serving GPRS Support Node
IMS	IP Multimedia Subsystem
PDN	Public Data Network
PGW	Packet Gateway
SGW	Signaling Gateway
PCRF	Policy and Charging Rules Function
MME	Mobility Management Entity
OCS	Online Charging System
OFCS	Offline Charging System
PDCP	Packet Data Convergence Protocol
MAC	Media Access Control
RLC	Radio Link Control
GTP-C	GPRS Tunneling Protocol (Control Plane)
GTP-U	GPRS Tunneling Protocol (User Plane)
NAS	Non-Access Stratum
RRC	Radio Resource Control
SCTP	Stream Control Transmission Protocol
X2AP	X2 Application Protocol
UDP	User Datagram Protocol

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ABSTRACT

This project focuses on circuit and packet switch core design and optimization for service delivery unit (SDU) Bharti Airtel. It is based on Wireless Communication & MobileTechnology.Thevoiceservicesaregivenbycircuitswitchwhichisconnection orientedwhiledataservicesarepacketswitched.Themainfocusoftheprojectisonthe design and optimization of backbone infrastructure of new node planned for any particulararea.Theindepthknowledgeofarchitecturesof2G,3Gand4Gtechnologies serves as foundation for the project and basic idea about 5G technology would help to relateexistingworktotheplannedoneforcomingyears.ThearchitectureofGSM(2G technology) acts as basis for voice calls while GPRS (3G technology) provides data services for GSM and WCDMA (wide band CDMA). GPRS, EDGE and VoLTE have advantage of having data services in addition to that of GSM services. EDGE is enhanced and upgraded form of GPRS which offers 3 to 4 times more data rate as compared to that of GPRS. EPC (Evolved Packet Core) provides packet data services for LTE and non- 3GPP networks. This project aims to explore the usage andpractical implementation of standard terminologies of Mobile Communication mentionedhere.

CHAPTER - 1

INTRODUCTION

1.1) ABOUT THEORGANIZATION

1.1.1) EricssonGlobal

Ericsson Corporation is a leading multinational firm of telecommunications and networking equipment. It's headquarter is situated in Stockholm, Sweden. It was founded in the year 1876 by Lars Magnus Ericsson. Ericsson is a global leader of delivering telecommunication soutions to its vendors. It services provided by the organisation are mobility, broadband and other cloud applications. Ericsson has over 35,000 patents to its name. It also has a large hold on standards patents for mobile communications. It has registered its patents in almost all the mobile technologies. Approximately more than half of the phone calls are made are through Ericsson's systems globally and more than 2 billion people use Ericsson's network directly or indirectly. More than 180 countries are using Ericcson's services which provides services like cloud services and broadband.

Ericsson has more employees in India as compared to other countries. It's regional headquarters in India is in Gurgaon. India has over 18,000 employees working in engineering and R&D in various areas such as revenue management, networking and providing services to its vendors

1.1.2) Bharti Airtel and EricssonGlobal

Bharti Airtel Limited, otherwise called Airtel, is an Indian worldwide media communications administrations organization situated in Delhi, India. It works in 18 nations across South Asia and Africa. Airtel gives Global System for Mobile communication which is commonly known as second generation of wireless communication, Universal Mobile Telecommunication System which is commonly known as third generation of wireless communication, Long Term Evolution which is commonly known as fourth generation of wireless communication versatile administrations, fixed line broadband and voice administrations relying on the nation of activity. Airtel has additionally revealed its VoLTE innovation over all Indian

telecom circles. It is the third biggest portable system administrator in India and the second biggest versatile system administrator on the planet with over 40 crore end users. Bharti has contracted Ericsson to manage its network, leading to a creation of team called Service Delivery Unit, Bharti. It consists of over 1600 people working towards managing the network and its components.

While the network comprises of several components, two of those are packet core(for handling data traffic) and circuit core(for handling voice calls) This project is about the design and optimization of the Core Network components. The team I'm working for is responsible for their upkeep and monitoring. It works with compiling and interpreting performance metrics to recognize dips/flaws in network performance

1.2) MOTIVATION

Starting at 2019, India was the second-biggest broadcast communications advertise over the globe, with a customer base of more than a billion clients. The quantity of send users of the broadcast communications organization Bharti Airtel was around 40 crore by 2019. The organization works across Asia and Africa in several nations. Regarding the end users, the organization positions among the main three mobile service providers.

Spending in the correspondence administrations portion over the south Asian Country was evaluated to reach more than 30 billion U.S. dollars in 2019. Of this sum, in excess of 30 percent of the market was assessed to go to the broadcast communications i.e to the telecommunication division. With a developing customer base, speculations into segment have expanded. The nation saw an outside direct investment value inflow of approximately 2.7 billion dollars in 2019. India turned into the quickest developing business sector for portable based applications in2018.

Ericsson is the main impetus behind the Networked Society - a global head in communication and technology. Our drawn out associations with each significant telecom administrator on the planet permit individuals, organizations and social orders to satisfy their latent capacity and make a progressively feasiblefuture.

Our administrations, programming and framework - particularly in portability, broadband and the cloud - are empowering the telecom business and different

segments to improve business, increment proficiency, improve the client experience and catch new chances.Hence, the amount of experience and knowledge to be gained by working in the centre of one of the biggest partnerships in the market, is insurmountable.

The inquisitiveness to know how it is possible to communicate with our relatives, friends and anyone who is miles away from us, leads us to have an inclination towards Science & Technology and more specifically mobile communication technology. Obviously, the present-day advancements have given us various methods such as mobile calls, text facility using data, social media platforms, and video call options etc. to help us be in constant touch with our loved ones. The advancement in fundamental technological research enabled us to achieve what we consider as basic amenitytoday.

This internship aims to make us familiar practically with the mobile technology and wireless communication that we have studied in our Engineering courses. It gives us an idea of how the concepts we studied theoretically are implemented by the organizations like Ericsson, Nokia, Huawei, ZTE, Cisco e tc. to make the best use of technology for human convenience. The various levels of GSM, GPRS, EDGE, LTE and VoLTE (LTE with IMS to enable voice calls as well) architectures are to be understood from implementation point of view and gather the understanding of various boxes/nodes used and their functionalities. The hands on experience that we would have after the successful completion of this internship would enable us to have understanding of how an organization functions, various ladders of leadership involved in it, the significance of contribution from each team to make a project successful, business code of ethics, importance of professionalism, respect for colleagues andperseverance.

1.3) METHODOLOGY

With in excess of over one lakh experts and clients in almost all the nations across the globe, we consolidate worldwide scale innovation and administrations authority. We encouraging groups of people that interface more than 2 billion end users. 40% of the world's wireless traffic is extended through Ericsson systems. Furthermore, our interests in innovative work guarantee that our answers to various problems and our clients remain in front. The work is done in several steps, with a different team responsible for each of the step. Our work starts after we get the daily reports on the functioning of each hardware and software components that make up the core part of the network. The reports include metrics which we use to measure performance of each component. The metrics are called Key Performance Indicators(KPIs), and each one of them represent an aspect of the network, for example, attach success rate, paging success rates, etc.

Each of the KPIs have a given threshold that defines the normal working of the component. For example, CPU util KPI gives the amount of CPU usage in three different cases, namely, 24 hours, Network Busy Hour (busiest hour of network, when the load is maximum), etc. Then we compile the KPIs in a dashboard and compare them to previously compiled KPIs and regress the quality they indicate. If any of the KPIs cross the threshold or drop down to suspicious levels, we are responsible for discovering the cause of the change.

We forward the compiled KPIs and a description of the component that needs to be examined, to the concerned team. We jot down the problems and possible solutions and then the concerned team is responsible to fix them.

CHAPTER - 2

HISTORY OF TELECOMMUNICATION

2.1) INTRODUCTION

The word Telecommunication means the act of interchanging indication, gesture, notes,expressions,constructions,sketchandsoundsorinformationofanykindby wire, wireless, perceptible or other electromagnetic devices. It occurs when the interchanging of information between the participants comprise the utilization of restructuring. It can be carried through a medium, for example, over material media, for occurance, over electrical link, or by means of EMR over volume, for example, wireless or luminous. Such conveyance ways are everyday isolated into correlation medium which deal with the expense of the advantages of multiple. From the Latin articulation correspondence the popular course of action of information dealing is communication, the word communicate interchanges is regularlyusedinitsdualformbecauseitincorporatesabroadscopeofautomation.

Traditionaltechniquesforpassingonmessagesincludedvisualsigns,forinstance, reference focuses, semaphore transmits, signal pennants and perceptible alarm. Some various specimen of pre-present day important interval correlation involved sound communication, for instance, coded drumbeats, sounds from their mouth, and loud signals. 20th century developments for important distant correlation normally incorporate electrical and electromagnetic move along, for instance, telephone, communicate and teleprinter, framework, microwave transmission, wireless, optical fiber, and tradessatellites.

A revolt in far away correlation began in the fundamental decennary of the 20th centenary with the headways development in wireless trades by Guglielmo Marconi, he won the Nobel Prize in Physics in 1909, and various exceptional leading creator and originator in the field of electrical and electronics communication. Some examples of these minds are Alexander Graham Bell, Edwin Armstrong, etc.

2.2) Telegram andTelephone

In July 1837 the central business electrical message was shown by Englishcreator Sir William Fothergill Cooke, and English scientist Sir Charles Wheatstone. The twotrailblazersconsideredtheirtobeasitprovideduswithanimprovedversionif we compare to early electromagneticmessages.

Samuel Morse openly invented a kind of the electrical message that he pointlessly appearedinSeptember1837.ItwasahugedevelopmentoverWheatstone'shailing device. The principal transoceanic message interface was successfully ended in July 1866, allowing transoceanic media transmission in light of the factthat.

The conventional telephone was introduced by Alexander Bell in the year 1876. Elisha Gray in like manner recorded a proviso for it in the year 1876. Dim abandoned his rebuke because he didn't challenge Bell's need, the inspector supported Bell's patent in March in the year 1876. Dark had recorded his stipulation for the changeable restriction phone, anyway Bell was the first person tocapturethethoughtandthefirstpersontotestitinatelephone.AntonioMeucci made a gadget that permitted the electrical transmission of voice on a line very nearly many years before in 1849, yet his gadget was of negligible viable worth since it relied upon the electrophonic sway anticipating that clients should place the recipient in mouths to "hear". The primary business phone utilities were founded by the Bell Telephone Company in the year 1878 and 1879 on the different urban zones of New Haven andLondon.

2.3) Radio and TV

Starting from 1894, Italian originator Guglielmo Marconi built a structure up a remote correspondencebymakinguseofthenewlyoriginatedwonderofradiowaves,showing up by 1901 that could be carried over the Atlantic Ocean. It was the beginning of remote telecommunication bywireless.

Millimeter waves correspondence was in the starting inspected by a physicist Jagadish Chandra Bose between 1894–1896, when this person showed up at an exceptionally high recurrence of up to 60 GHz in his preliminaries. He similarly presented the utilization of semiconductor convergences to recognize the wireless

waves, when he secured the radio valuable stone identifier in the year 1901.

World War I revived the progression of wireless medium for army exchanges. As the warended,businessradioAMconveyingbegunduringthe1920sandtransformedinto a noteworthy mass vehicle for diversion also reports. World War II again enlivened progression of wireless for the war issues explanations behind plane and land correspondence, radio course and radar. Evolution of sound framework FM transmit of wireless happened since 1930s in the United States and evacuated AM as the transcendent business quality by the 1960s, and by the 1970s in the UnitedKingdom.In March 1925, John Logie Baird had the alternative to show the broadcasting of in motion picture satthe London retail foundation Selfridges.Baird's gadget depended on the Nipkowplate and in this manner go trenownedasthe mechanical TV. It framed the reason of exploratory conveysd one by the British Broadcasting Corporation initially in September 1929. Nonetheless, for most of the 20th century TVs rely on the cathode beam tube. The essential adjustment of this kind of TV to show ensure was made by Philo Farnsworth and displayed to his family in September 1927. After World War II, the assessments in TV which had been meddled which were proceeded, and it in like manner transformed into a huge home delight communicate medium.

2.4) PC frameworks and theInternet

In September 1940, George Stibitz conveyed issues for his Complicated digits Calculator in New York utilizing a print, also recovered the enrolled final output at DartmouthCollegeinNewHampshire.ThisarrangementofaunitedPCwithfaraway silent terminals existed renowned well into the 1970s. Regardless, starting at now during the 1960s, experts initiated to investigate pack trading, a development that imparts something explicit in bits to its objective non simultaneously without facing it through a fused focused server. A four-hub point compose rose in December 1969, setting up the initiating of the ARPANET, which by 1981 had created to 213 center points. ARPANET over the long haul joined with various frameworks to shape the Internet. While Internet improvement was a point of convergence of the Internet Engineering Task Force (IETF) who circulated a movement of Request for Comment archives, different frameworks organization types of progress occurred in present day examine focuses, for instance, the area (LAN) headways of Ethernet in 1983 and the token ring show in the year 1984.

2.5) Wireless transmission

The remote revolt began during the 1990s, with the happening to cutting edge remote frameworks provoking a social change, and an adjustment in context from wired to remote development, including the duplication of business remote advances, for instance, PDAs, flexible correspondence, pagers, remote PC frameworks, the remote Internet, and PC and handheld PCs with remote affiliations. The remote rebellion has been driven by pushes in radio recurrence and microwave designing, and the change fromeasytocuttingedgeradiorecurrence(RF)advancement.Improvementsinmetal–oxide–semiconductor field-impact transistor (MOSFET, or MOS transistor) development, the key piece of the RF advancement that engages computerised remote frameworks, has been vital to this upheaval, including MOS devices, for instance, the power MOSFET, LDMOS, and RFCMOS.

CHAPTER - 3

LITERATURE REVIEW

3.1) CONCEPTS OFTELECOMMUNICATION

3.1.1) Cell

A cell is the geographic territory that is secured by a solitary base station in a wireless network. Cell also posses a certain specific shape i.e hexagonal shape, in every hexagon there is one base station which covers that area. The hexagonal shape of a cell is used because they are closely packed to each other and from this shape we can easily understand the concept of frequency reuse.A system for remote correspondences is contained countless base stations to effectively utilize radio range to cover the administrationterritory.

3.1.2) Concept of FrequencyReuse

Frequency Reuse is a very important concept of mobile communication, it serves as the basis for how we can save frequency bands by reusing them again. By the above mentioned concept we allocate and reuse of channels all through an inclusion area is finished. Each base station is assigned a gathering of different frequency sub-groups to be utilized inside a little geographic region known as a cell. The figure below shows how we can reuse frequency:

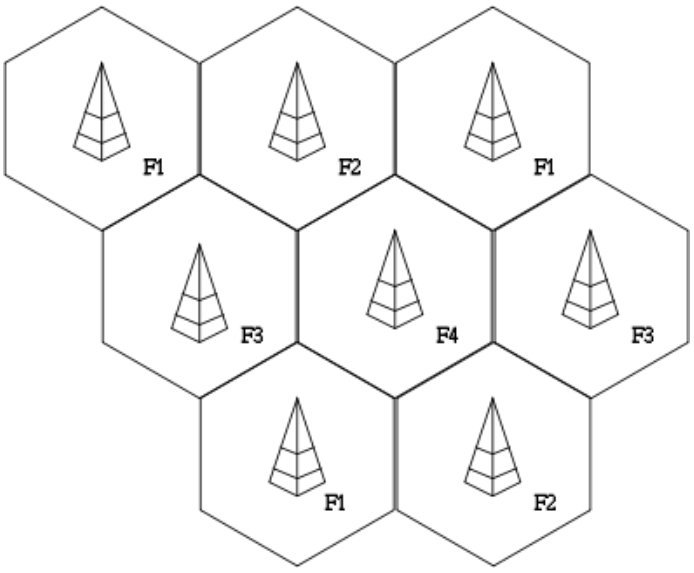

Figure 3.1 : frequency reuse

3.1.3) Handover

The process to handover comes under the very basic concepts of mobile communication, handover in simple words means that keeping on the connectivity of a device when that particular device is continuously moving whether inside the cello r outside the cell. In other words it can be understood as the process of keeping the connectivity of the device when the device is moving. The reason of handover is very simple to understand every base station has a particular area under it and after that area is crossed the area of other base station starts so if the users want a smooth experience then the transition between these base stations should take place without causing any disturbance to theuser.

Types of handover :

- Soft Handover : We will try to understand this concept with the help of an example, suppose you are talking on cell phone with your parents while you are on a road trip to Jaipur, in the whole duration of call your experience was very smooth i.e your call didn't disconnect the thing happened because it was a case of soft handover in this type of handover whenever you are about to enter the area allocated to the new base station before entering that area your device connects to that base station so that you observe a hassle freeexperience.

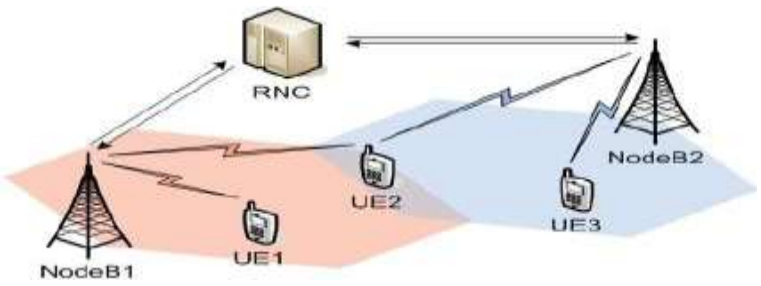

Figure 3.2 : Soft Handover

- Hard Handover : In this case we will understand this thing also with the help of above example. Suppose while talking to your parents after some distance every now and then you observe the issue that your call is getting disconnected. This is because in this scenario the handover which is talking place is hard handover, in this type of handover once you cross the area under a particular base station after this only the device will connect to the new base station, this thing leads to

disconnecting ofcalls.

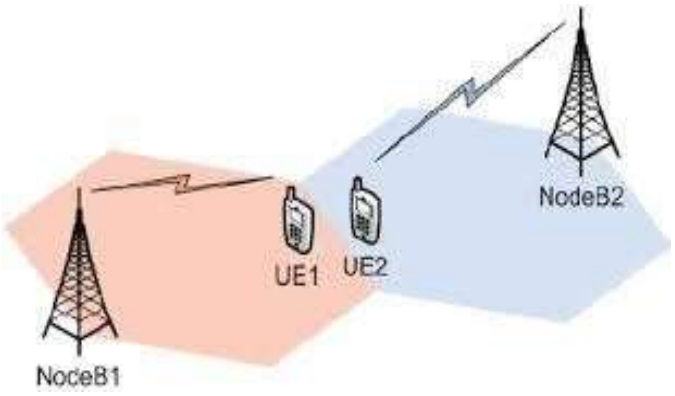

Figure 3.3 : Hard Handover

3.1.4) Circuit Switching and PacketSwitching

Circuit Switching :

Circuit switching is very commonly used concept in mobile communication. In this technique the communication takes place once there is a fixed and dedicated channel between the devices which are to communicate, but this thing brings us to its limitation i.e it can handle limited users only. In the field of mobile communication the technique is more often used to manage voicecalls.

Packet Switching :

Packet switching is a concept which extensively used these days, most of the data traffic is transferred through this technique. According to this technique whenever we need to communicate between two different devices then we need not have a physical connection between them.

3.1.5) CDMA and TDMA

CDMA (Code-Division Multiple Access*)* it is a very common technique used in mobile communication, in this technique we have a code which is known only to the sender and the receiver and our data is multiplied with that code and then send through the channel, at the receiving end the data is decoded using the given code. This technique provides a reliable and secure delivery of the information you want to send.

TDMA (Time Division Multiple Access*)* is a technique which was used in order to increase the number capacityof the channel. In this technique the whole band is

used by various different users on different times depending on the the allocated period. This technique helps to increase the capacity of the channel.

3.1.6) Types of Identitynumbers

There are mainly four types of identity number that relate to mobile stations which are mentioned below :

- MSISDN : It is that number which is dialed to get to a particular device. MSISDN is a 15 digit number. The first few digits are International prefix followed by the country code which is further followed by NDC(National Destination Code) and at last is the subscriber number.
- IMSI : It is the non dial-able number for identifying a subscriber in the GSM network. IMSI is stored on the SIM card. It consists of Mobile Country Code followed by Mobile Network Code and at the last is MSIN (Mobile Subscriber IdentityNumber).
- IMEI : It is a 15 digit number. The function of this is to verify that the mobile station is type approved and not stolen IMEI consists of TAC (type approval code) followed by FAC (final assemble code) followed by serialnumber.
- TMSI : It is an operator specified number of up to 4 octet along. It is used in place of IMSI in a particular network area. With the help of allocating TMSI we can restrict from using IMSI of the subscriber, which helps in providing security to thesubscriber.

3.1.7) Making a Call

Every one of us has at least once in our life thought of the fact that how a phone call is made, now making of a phone call changes from one network to another network. Here we will be discussing about the call flow in general terms, but this call flow will give us an idea how things happen in real life scenarios.

1. The first step involved in this process is very simple and this step is searchingof the strongest signal or network. Whenever we are about to make a call the basic thing in a cell phone we need to make a call is good network so it happens to be the very firststep.

2. There may be several signals from different base stations but they will differ with each other in terms of signal strength, so the second step is choosing the strongest signal so that our experience of that particular voice call issmooth.

3. After this step your device sends a short message in which it has mainly two things, one is the mobile identification number and the other thing is the number you just dialed or the number of the person you want to talkwith.

4. After this step the mobile operator will verify you that whether you are an authorized user or not, after that the user will be allocated a certain channel over which the whole conversation will takeplace.

The above mentioned call flow gives a fairly good idea about how a call is made in a network.

3.1.8) Roaming

Before learning about how a call is made in roaming we must also know about some terms which are important with respect to this topic. These terms are such as home location register, it is a kind of storage hub of all the information related to all the users within a particular area. The other term which we need to know is visitor location register, it is similar to home location register but the only difference is the instead of storing information about users in its area it stores information about the users which are new to a particulararea.

Both these concepts will serve as the basic concepts for the understanding of roaming case, because in case of roaming a particular user moves from home network to foreign network and these above explained stores information regarding both the cases.

1. The first step is similar to that of normal voice call, as in both cases the user sends its mobile identification number to the base station continuously after some fixed time.

2. This information is constantly being compared with the information of home location register. If the user is new to a particular network then that information will be unknown to the home locationregister.

3. Then the user's device tells the foreign network that it is new to the network and its information is stored in the visitor location register of thatnetwork.

4. After that the visitor location register of that network asks about the authentication of that user from its homenetwork.

5. After that the home location register of home network authenticates the user and a tunnel is being made between the foreign network and the homenetwork.

6. Now that user will be able to enjoy all the services in the foreign network, and voice call is also established through that securedtunnel.

3.1.9) CellularNetworks

If we talk about a cellular network then it contains many different base stations, and we know that in a GSM system all these different base stations are connected to a mobile switching centre. And talking about different mobile switching centers they are connected to various other mobile switching centers. And all these mobile switching centers are further connected to a common PSTNnetwork.

3.2) EVOLUTION OF WIRELESSCOMMUNICATION

3.2.1) 1GTechnology

The era of hand-held Mobile communication can be said to begin from 1980s when 1G - analog Cellular came into existence. During this time, Frequency Division Multiple Access (FDMA) technology was used to accommodate users in the channel. This technology worked for voice calls only for about a decade due to its bandwidth limitations and limited numbers of users that could be accommodated.

Introduced in year	1980s
Access technique	FDMA
Maximum possible speed	2.4 Kbps
Carrier Frequency	30 KHz
Bandwidth	Analog
Advantages	Networks of 1G are simple to implement
Disadvantages	Restricted limit, not secure, poor battery life, huge telephone size, interference issues
Application	Voice calls

Table 3.1 : specification of 1G

3.2.2) 2G (GSMTechnology)

Then came 2G GSM (Global System for Mobile Communication) technology which used the concept of both TDMA- Time Division Multiple Access and FDMA. An enhanced form of the previous technology was seen here as it allowed both voice calls and SMS services.

The architecture of GSM is shown below:

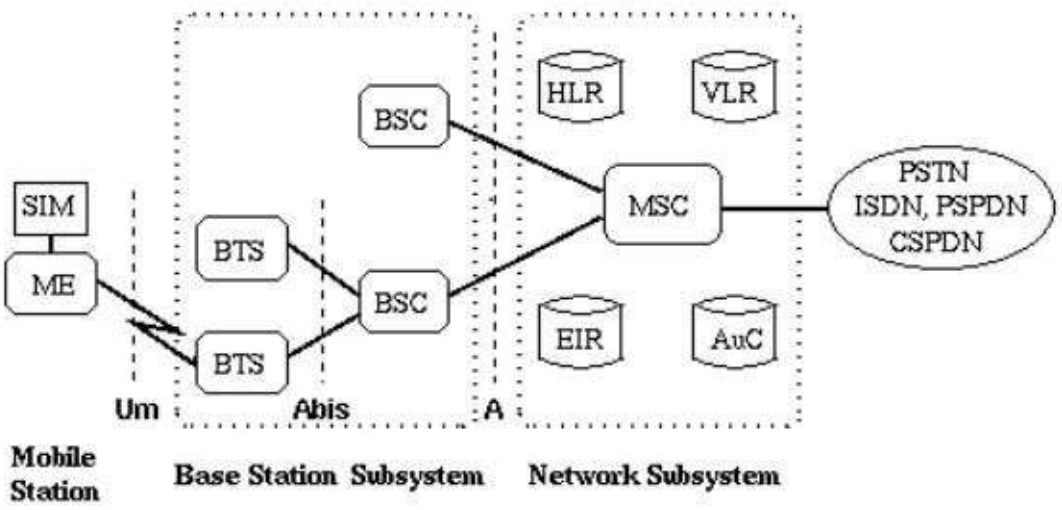

Figure 3.4 : GSM (2G) Architecture

BTS :

- BTS has a set of transceiver to communicate with mobiles in itsarea.
- One BTS covers one or more than onecell.
- The limit of a cell relies on the quantity of handsets in acell.
- BTS is associated with the BSC through AbisInterface.
- BTS orders mobiles to set TX power, timing advance andhandovers.

BSC :

- Several BTS's are associated with oneBSC.

- BSC oversees channel portion, handovers and arrival of channels at associatedBTS's.
- BSC associates with each BTS on Abis interface and to the MSC on Ainterface.
- BSC has the whole database for all cell parameters related with theBTS's..

MSC :

- Exchange where calls are built up, kept up anddischarged.
- Database for all customers and their relatedhighlights.
- Communicates with BSC's on MS side and with PSTN on fixed lineside.
- MSC is weighted on the quantity of customers it canhandle.

MS :

- Mobile equipment and SIM together comprises of mobilestation.
- Mobile station gives client access to GSM technology for Voice andData.
- Subscriber information is perused from a SIM card that connects toMS
- Each MS has Unique number called IMEI number, which is put away in EIR for verification purposes. .
- Mobile examines neighboring cells and reports signalquality.
- Mobile knows whereabouts of mobiles from HLR and VLRdatabases.

HLR : It is a static database, when clients apply for mobile assistance, all information about the supporter will be store at HLR.

VLR : VLR is a unique database use by MSC for data record. It stores all the information of the visitors which are in foreign network.

Introduced in year	1993
Access technique	TDMA/CDMA
Maximum possible speed	14.4 Kbps
Carrier Frequency	200 KHz
Bandwidth	25 MHz
Advantages	Multimedia features (SMS/MMS), internet access, SIM introduced
Disadvantages	Low network range, slow datarates
Application	Voice calls, short messages, browsing (partial)

Table 3.2 : specification of2G

Between the 2G technology and the 3G technology some other technologies were also observed. These technologies are assumed to be the stepping stones in the implementation of 3G technology. These technologies were namely 2.5 G and 2.75G. 2.5G addresses handsets with data capacities over GPRS. Wrap trading territory accelerated to 50-60 Kbps than in common 2G development. 2.75G was acquainted by upgrading GPRS framework with EDGE frameworks with new 8PSK encoding technique. This improved the data rates by 3-4 times. In 8PSK encoding, a single transporter picture used to pass on 3 bits instead of 1 piece used in GPRS. EDGE advancement is a widely inclusive interpretation ofGSM.

3.2.3) 3G (UTMSTechnology)

After about one decade of GSM technology, the need for data services was felt and it started gaining popularity with the emergence of GPRS and EDGE technologies. UMTS is Universal Mobile Telecommunication System. The objective of UMTS is to bring advanced capabilities to enable new services on cellular network. Another objective of UMTS was to have one common technology across all cellular networks around the globe to enable seamless roaming unlike 2G cellular networks (GSM or CDMA).

The architecture of UMTS is shown below :

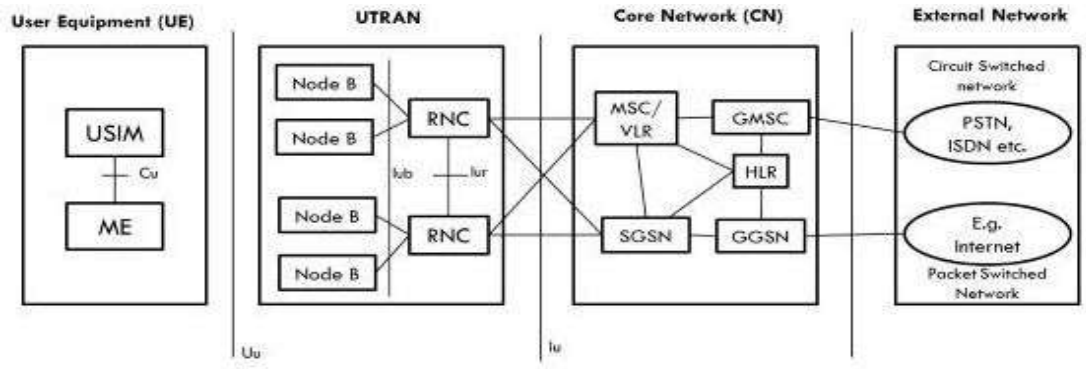

Figure 3.5 : UMTS architecture

Node B

- Node B of UMTS is proportionate to base station ofGSM.
- Its fundamental duty is modulation anddemodulation

RNC :

- The extremely essential function of RNC is controllingNodeB's.
- RNC also has the responsibilty of radio ResourceManagement.
- Some different responsibilities given to RNC's are Mobility Management Function, Handover Management, DataEncryption.

GGSN

- GGSN stands for Gateway GPRS SupportNode.
- It advances uplink and downlink IP bundles among SGSN and the PDN (Public DataNetwork).

SGSN

- SGSN stands for Serving GPRS SupportNode.
- The SGSN forwards IP packets to all GPRS attached UE's within that SGSN service area and the GGSN, PGW andSGW.

Introduced in year	2001
Access technique	CDMA
Maximum possible speed	3.1 Mbps
Carrier Frequency	5MHz
Bandwidth	25 MHz
Advantages	High security, international roaming
Disadvantages	High power consumption, low network coverage, high cost of spectrum license
Application	Video conferencing , mobile TV, GPS

Table 3.3 : specification of 3G

3.3.4) Interfaces of UMTS architecture :

The figure below describes all the interfaces in 3G (UMTS) architecture :

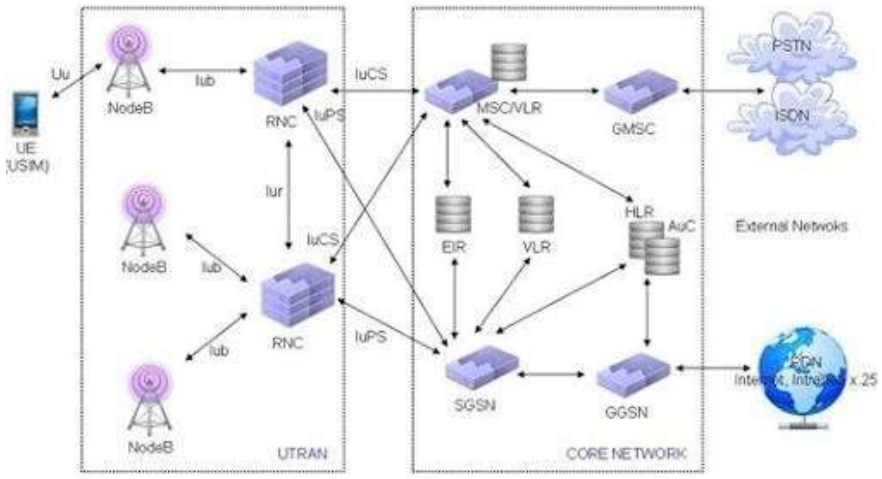

Figure3.6 : interfaces of UMTSarchitecture

Interfaces involved in above figure are :

1. Uu interface - It is an interface between user equipment andnodeB

2. lub interface - It is n interface between nodeB and RNC

3. lur interface - It is an interface which connects twoRNC's

4. luCS - It is an interface between RNC and MSC for circuit data

5. luPS - It is an interface between RNC and SGSN for packetdata

3.2.5) 4G (LTETechnology)

By this time now, researches were pretty sure to come up with new technology every 10 years and they came up with 4G LTE network architecture which supports interactive multimedia, voice, video, wireless internet and other broadband services. LTE can be seen as providing an evolution of functionality, increased speeds and general improved performance compared to 3G. In the initial stages when 4G was implemented it was known as LTE i.e long term evolution, it provided significant increase in data speed but the drawback of this was that in initial stages LTE did not provide any sort of voice call facility.

Later this thing was improved by the bringing VoLTE i.e Voice Over LTE. In this scenario the normal architecture of LTE was modified by including IMS (IP Multimedia System).

The architecture of 4G is given below :

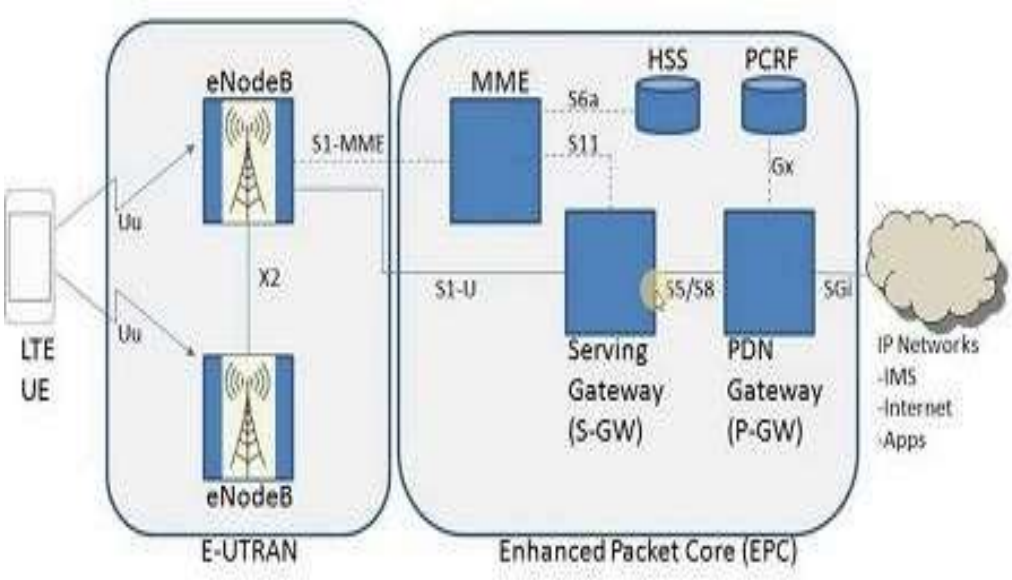

Figure 3.7 : 4G LTE Architecture

MME : It is a key control hub in the EPC. Principle usefulness of MME is attach and detach of client hardware, verification, picking SGW and PGW for the client's device, and the administration of PDN association.

PCRF : It offers a far reaching arrangement that permits another age specialist company to offer various use cases that permits them to more readily manipulate administrations and adjust their income to their assets.

SGW : SGW routes and forwards the user packet data from the user equipment to the PGW or from the PGW to the user equipment. SGW goes about as a nearby mobility anchor for the client plane during inter - eNodeB handovers and gives charging usefulness.

PGW : PGW is the gateway between internal EPC network and external PDN. Example internet or a Wi-Fi. It gives connectivity for the device to packet data network by being the purpose of section and exit of traffic for the client hardware. It also provides IP addresses to the user equipment.

eNodeB : eNodeB stands for evolved NodeB and it has functions such as radio resource management and packet reliable delivery.

3.2.6) Interfaces in 4G architecture:

The following figure will help us in understanding different types of interfaces in LTE architecture :

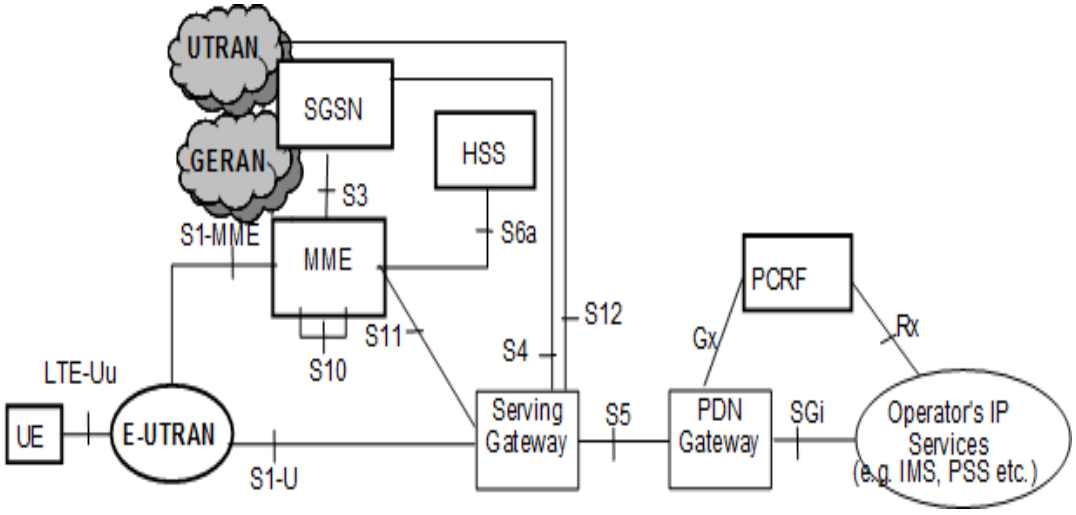

Figure3.8: Interfaces of4G

User Plane Interfaces :

S1-U : It is an interface between eNodeB and serving gateway

Control Plane Interfaces :

S1-MME : It is an interface between eNodeB and MME

S11 : It is an interface between MME and serving gateway

S6a : It is an interface between HSS and MME

S10 : It is an interface between two MME's

Gx : It is an interface between PCRF and PGW

Gy : It is an interface between OCS and PGW

Gz : It is an interface between OFCS and PGW

Also some of the interfaces are those which are for both i.e control plane and user plane, these type of interfaces follow different protocol in user plane and control plane. These interfaces are mentioned below:

SGi : It is an interface between PDN gateway and operators IP services

S5 : It is an interface between serving gateway and PDN gateway.

X2 : It is an interface between two eNodeB's

LTE-Uu : It is an interface between an user equipment and eNodeB

Now let us try to understand through figures how these are connected to each other. Let's start with user plane part first and then we will jump to control plane part, here we will follow the sequence how things actually connect in the network rather than mentioning them randomly which will make it complicated. Also we need to know that some of the above mentioned are interfaces exist both in control plane and user plane so they will be repeated in both the explanation.

User Plane Interfaces :

Starting with user plane first we will discuss about LTE-Uu interface, the figure given below gives an idea how various layer of these two network components are attached together.

1. LTE-Uu interface:

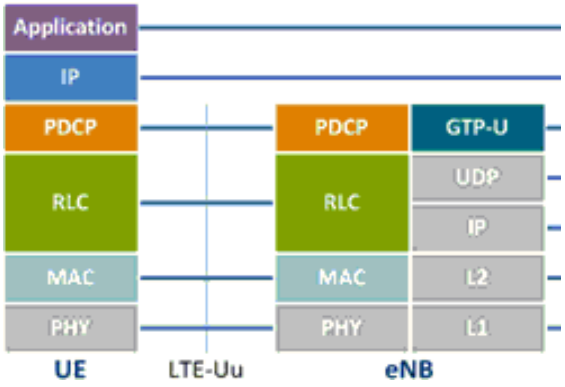

Figure 3.9: protocol stack of LTE-Uu interface

PDCP : the main function assigned to PDCP is of efficient transfer of IP packets. Along with this it also handles various other functionalities such as rearranging and re-transferring of packets during the time of handover, compressing the header of the file.

MAC : The position of MAC layer is such that it is placed between physical layer and RLC layer. The protocol we are discussing also has an important function which is multiplexing and de-multiplexing between different channels.

2. S1-U interface:

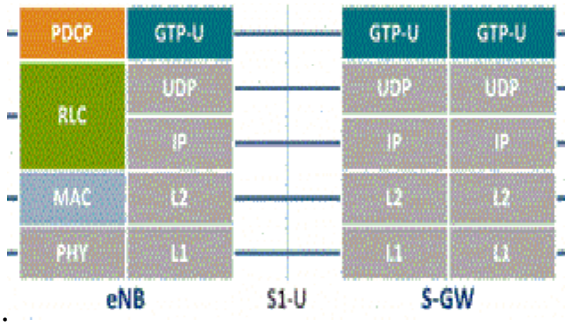

Figure 3.10 : protocol stack of S1-U interface

The main function of GTP-U protocol is that it has to shift the IP packets of the customer through different interfaces. These different interfaces are namely S1-U, S5 and X2. Also GTP-U has one more important function during handover which is after building of tunnel it has to pass data through that tunnel whenever handover is taking place.

3. S5 Interface :

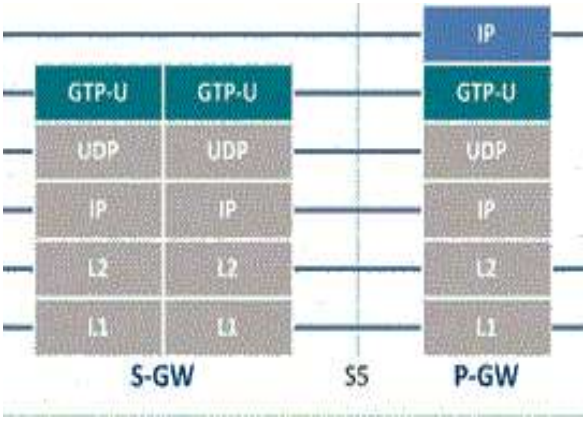

Figure 3.11: stack protocol of S5 interface

S5 interface is an interface between S-GW and P-GW and above figure shows various layers involved. The explanation of GTP-U protocol is same as mentioned above.

4. SGi Interface:

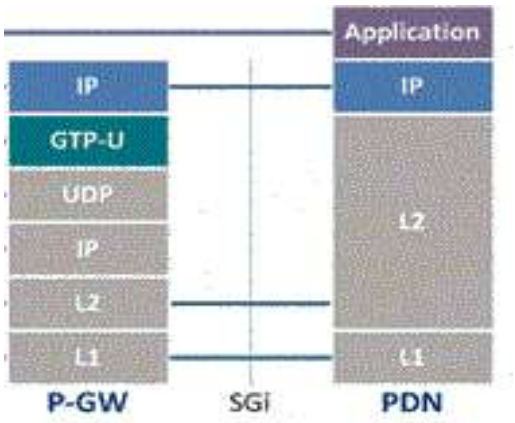

Figure 3.12 : stack protocol of SGi interface

SGi interface is an interface between P-GW and PDN and above figure shows various layers involved. The explanation of GTP-U protocol is same as mentioned above.

5. X2 interface:

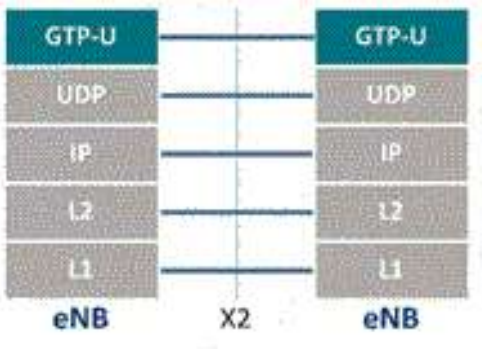

Figure 3.13 : stack protocol o X2 interface

X2 interface is an interface between two different eNodeB's.

Control Plane Interfaces :

Now we will discuss about control plane users, we will try to understand these interfaces between various network components by the protocol stack figures of thesecomponents.

1. LTE-Uu Interface:

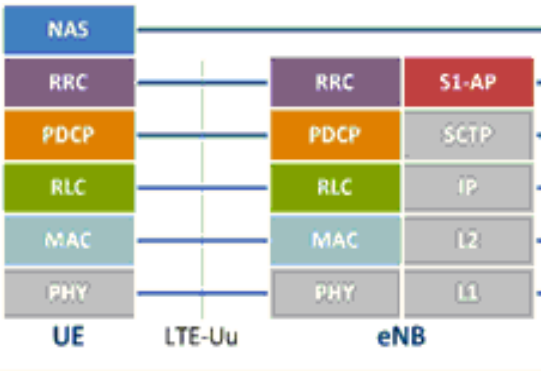

Figure 3.14 : protocol stack of LTE-Uu interface (control plane)

It is an interface in control plane between the customer's device and a eNodeB or in simple words a base station.

NAS : The main function which is allocated to NAS is managing all the devices and bearer management functions.

RRC :The main function of RRC protocol is that it moves the NAS signals. Also it has an important function of properly managing all the allocated radio resources.

2. S1-MME Interface :

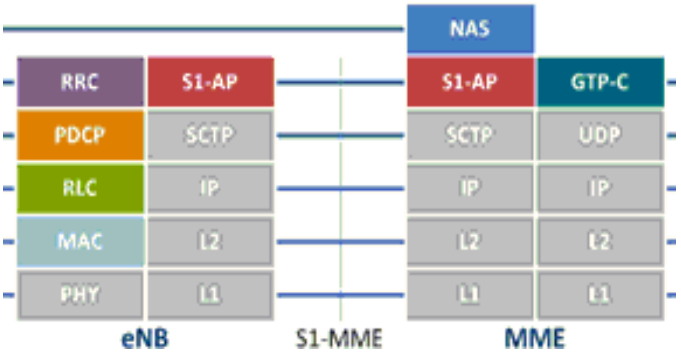

Figure 3.15 : protocol stack of S1-MME interface

It is an interface between eNodeB and MME. The main function of S1-AP protocol is that it manages S1 interface. And also it oversees change or arrival of the user equipment setting from thatpoint.

3. S11 Interface :

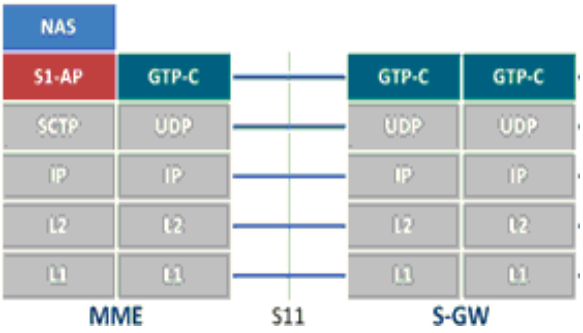

Figure 3.16 : protocol stack of S11 interface

It is an interface between MME and S-GW.

GTP-C (GPRS Tunnelling Protocol for the Control Plane) : It makes information sending through underpass in the event of LTE handover.

UDP : The main function of UDP protocol is convention flagging messages.

4. S5 Interface :

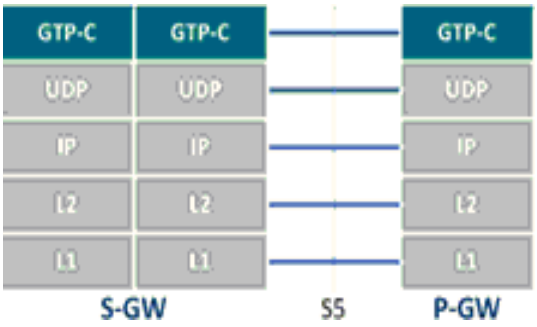

Figure 3.17 : protocol stack of S5 interface(control plane)

It is an interface between S-GW and P-GW.

GTP-C: It makes information sending through underpass between serving gateway and PDN gateway.

UDP: The main function of UDP protocol is convention flagging messages between serving gateway and PDN gateway.

5. S6a Interface:

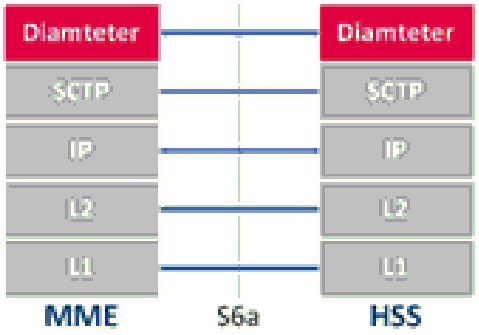

Figure 3.18 : protocol stack of S6a interface

It is an interface between MME and HSS.
Diameter: Diameter convention bolsters trade of membership and supporter verification data between the HSS and MME.
SCTP: This convention moves flagging messages between MME and HSS.

6. S10 Interface :

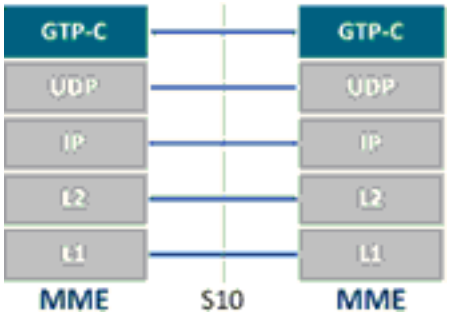

Figure 3.19 : protocol stackof S10 interface

It is an interface between two MME's.

GTP-C : It makes information sending through underpass between two MME's.

UDP : The main function of UDP protocol is convention flagging messages between two MME's.

7. X2 Interface:

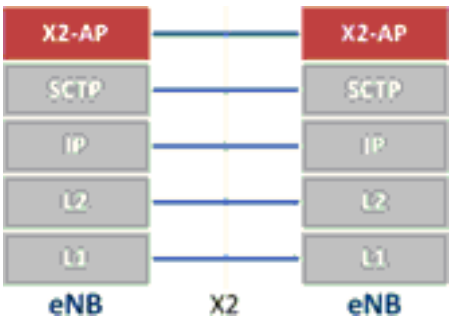

Figure 3.20 : protocol stack of X2 interface(control plane)

It is an interface between two eNodeB's.

X2AP convention gives the usefulness of portability of the end client in a specific eNodeB.

8. Gx Interface:

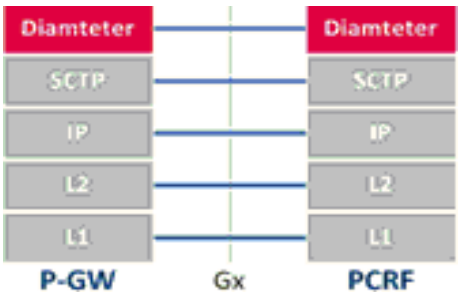

Figure 3.21 : protocol stack of Gx interface

It is an interface between PDN gateway and Policy and charging rules function.

9. Gy Interface:

Figure 3.22 : protocol stack of Gy interface

It is an interface between PDN gateway and online charging system.

10. Gz Interface :

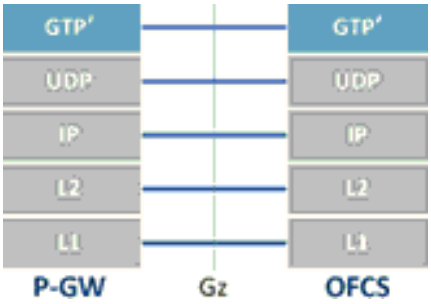

Figure 3.23 : protocol stack of Gz interface

It is an interface between PDN gateway and offline charging system.

Introduced in year	2009
Access technique	CDMA
Maximum possible speed	100 Mbps
Carrier Frequency	15MHz
Bandwidth	100 MHz
Advantages	Speed, High speed hand offs, MIMO technology, Global mobility
Disadvantages	Hard to implement, complicated hardware required
Application	High speed applications, mobile TV, Wearable devices

Table 3.4 : specification of 4G

3.2.7) Circuit Switched Fall Back in 4G:

As operator are moving to VoLTE, a consistent subscriber service delivered via IMS needs to be ensured over different access techniques such as GSM, WCDMA, LTE, Wi-Fi. Some most commonly used concepts in 4G are the concept of CS fallback. This concept is very much needed in case of 4G, if we want to have a hassle-free experience of voice calling then this concept is the building block and it is explained below :

CS fall back :

LTE in its initial stages did not support voice calls rather it provided us with the facility of data services only. So if we are using data services on our devices through LTE it can not take voice calls. Now to solve this problem VoLTE was used but it requires good network coverage. Many a times we have also observed that when we

are using data services our device is on LTE mode while if we get any call and if the VoLTE network is not strong enough then it switches the network mode to either 3G or 2G depending on whichever network is strong enough to take that voice call. This technique of automatically switching the network according to the need without dropping of call is called circuit switched call fallback. Also one such similar concept is SRVCC, it provides voice continuity via handover to 2G/3G. The CS Network prepares to take over the call via handover signaling information between MME and MSC server. The MSC server sets up the call towards the CS domain and the user equipment completes handover and connects the session towards 2G/3G.

3.2.8) Attach in LTE :

The goal of attaching to the network is to obtain an IP address to communicate with the outside world. This is very much necessary in case of 4G because in case of 4G the data delivery or sending is done in the form of packets and for the device to send and receive data packets it should have a specific IP address. Whenever we start any device it tries to find a network connection in which it can register itself and get an IP address. It is a very lengthy process theoretically but whenever in practical scenario its happens in fraction of seconds. If we try to understand in a nut shell then it can be explained in following points:

- The user equipment is authenticated and authorized to send and receivedata.
- Data path is created between user equipment, eNodeB, SGW andPGW.
- User equipment is provided with a IP address.

3.2.9) 5GTechnology

Every new generation of wireless networks provide with faster speed and more functionality. We know that 1G introduced us with the cell phones and the technology of wireless communication and gave us the facility of voice calls. In addition to that when 2G came we saw an improvement over 1G and in case of 2G we were given improved voice quality and also provided with the facility of texting for the very first time. When 3G came along with the good quality voice calls it provided us with high speed data rates and UMTS technology made us familiar with online services for the first time and then came LTE technology which provided with the data rate we experience today.

But as many customers have came online LTE networks have attained the maximum limits of what they were efficient of and as the result of this we face various problems such as call dropping and reduced data rates. So we jumped to the discovery of new technology i.e 5G, it can handle multiple times more traffic than the present systems and furthermore it will be multiple times quicker than LTE. 5G will go about as the establishment for computer generated reality, self-sufficient operate , Internet Of Things (IOT) and some more.

At present 5G is in developing stages but experts can tell us that there are five different technologies which are serving as the stepping stone for 5G namely millimeter waves, small cells, massive MIMO, beam forming, fullduplex.

Millimeter waves : Most of the devices we use today work on a fixed band mostly under 6 GHz, so now it has become crowded and it is difficult to accommodate large devices in that frequency band. So researchers are trying to open more space by using millimeter waves, this will be able to adjust more traffic easily. But it comes with its own limitation, these waves cannot penetrate through buildings and can even be absorbed by trees and clouds.

Small cells : To solve the above problem we use the concept of small cells. In this step we will make smaller cells and in these smaller cells we will require many small base stations which are having comparatively low power than present day base stations. These base stations will be placed much closer to each other so that we can use the concept of millimeter waves and the user gets a smoothexperience.

Massive MIMO : Today's 4G base station have around dozen of ports antennas and these antennas handle the cellular traffic. If we use massive MIMO then it can support hundreds of ports antenna's. this could increase the capacity of present networks b 22 times, but as we increase the number of ports on antenna it will handle much more traffic and also it will lead to serious interference issues to deal with this problem we use the concept of beam forming.

Beam Forming : The technology of bar shaping resembles a traffic signal framework for cell systems. Rather than transmitting in all directions it throws a focused beam in only a particular direction for the particular user. So it avoids interference and increases efficiency.

Full Duplex : The term full duplex means transmitting and receiving at the same time. But in this case if it is done on single or same frequency then it may lead to interference. So, we use full duplex concept by using a switch in order to divert the sending and receiving at the same time on a particular frequency. By doing this efficiency and speed can be increased.

These are some basic concepts which are being used in the development of 5G technology.

CHAPTER - 4

WORK DONE

We started with brushing up of our basic understanding of mobile technologies such as GSM (2G), GPRS, EDGE and UMTS (3G), LTE (4G) & VoLTE and 5G in initial four classes. After this we had cover up the domains assigned to us in detail. The assigned domain to me is CS and PS core which demands in depth knowledge of GPRS and EPC architectures and call flow sequence of MO/MT GSM and VoLTE. As EPC involves the better understanding of LTE & IMS involved LTE (known as VoLTE), we covered this in detail from Ericsson internal document provided. Along with this, we must complete various Web Based Learnings (WBLs) and Instructor Led Trainings (ILTs) assigned to us on the ITM portal of Ericsson. The courses and learnings assigned over here are designed in a way to make us familiar with corporate culture, company policies, data privacy & security, attaining professionalism and enhancing technical knowledgeparallelly.

To analyze the performance of core network, our team closely monitors the KPIs for Bharti Airtel. Therefore, we first understood what KPIs are, their need and various KPIs that are monitored. Some of the KPIs we have gone though and compared them with their threshold values are PSR (Paging Success Rate), Attach success rate of both 2G and 3G, PDP of 2G and 3G, TAU 4G, Attach success rate of 4G, VoLTE paging success rate

Post this, we got exposure of accessing KPIs for live network from one of the 23 circles that Airtel has in India which are monitored and managed by EGI. We understood the monitoring of KPIs for Madhya Pradesh circle using Ericsson dashboard. The KPIs were compared with their threshold values and if there is some dip or any vulnerability was reported through raised tickets.

CHAPTER - 5

FUTURE WORK AND COMPLETION PLAN

In the entire duration of this internship, we would get the opportunity to understand the KPI dashboards and of all circles and once we get comfortable with those dashboards then we may also get a chance to get into to designing part of the network.. Following which we would be assisted by a team member to analyze and monitor the performance of live networks of various circles by KPIs. Once, we become comfortable with it, we would be given a circle to monitor its KPIs individually and we would be responsible for creating all the dashboards mentioned. The future work can be summarizedas:

- Accessing core data from Citrix cloud of Ericsson andHuawei
- Dealing with and nodes of SDU BhartiAirtel
- Analyzing the Performance ofnodes
- Creating the dashboards from fetcheddata

Then finally, our assessment would be based on our understanding and the modifications we suggest for the optimization.

CHAPTER - 6

CONCLUSION

Being a part of the internship provided at Ericsson Global India Ltd was a privilege. As after going to the organization we learned various things and also got an insight of how a telecommunication company works. Being a part of this organization I got an insight of how all the things work and learned the complex processes involved behind the things which look very simple. Example:- How does a device gets attached to the particular networks and what is the process involved in attachment of the device in detail.

The things which I learned at Ericsson gave me an insight of the technology we are using presently. Also I came to know how we manage the whole network by dividing in different teams. I was a part of designing and optimization team where I learned how to closely monitor various performance parameters and once facing any dip in the concerned parameter we try to check where the fault is and then the designing team makes an appropriate design to resolve thatproblem.

Apart from technical knowledge I learned about the corporate culture and through Ericsson's various web based learning I also improved my soft skills. The experience of being a part of such a big organization was full of new learning and opportunities. And this internship acted as a foundation for enhancing my skills in the field of telecommunication and helped in excelling this field.

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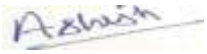

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