INTERNSHIP IN HLR AT
ERICSSON INDIA GLOBAL SERVICES PVT 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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UNDER THE GUIDANCE OF

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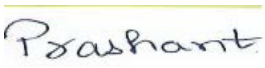
DECLARATION

We hereby declare that the work reported in the B. Tech Project Report entitled submitted at **"Jaypee University of Information Technology, Waknaghat, India"** is an authentic record of our work carried out under the supervision of **Mr. Surendra Bijwe.** We have not submitted this work elsewhere for any other degree or diploma.



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

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I am thankful to “Mr. Surendra Bijwe” for his support, cooperation, and motivation provided to me during the training for constant inspiration, presence and blessings.

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Lastly, I would like to extend my gratitude towards my teachers, who have a great role in defining what I am today and have made me able to adapt to all situations effortlessly.

LIST OF ACRONYMS AND ABBREVIATIONS

- SDM: SUBSCRIBER DATA MANAGEMENT
- One-NDS: Network Directory Server
- HLR: Home Location Register
- SIM: Subscriber Identity Module
- SS7: Signaling System 7
- GPRS :General Packet Radio Service
- CUG: Closed User Group
- MTP: Message Transfer Part
- ISUP:ISDN User Part
- TUP: Telephone User Part
- SCCP: Signaling Connection Control Part
- TCAP: Transaction Capabilities Applications Part
- UE: User Equipment
- EPC: Evolved Packet Core
- PCRF: Policy Control Enforcement Function
- HSS: Home Subscriber Server

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CHAPTER 1

INTRODUCTION

1.1ABOUT THE COMPANY: ERICSSON

Ericsson is a MNC that deals in a sector of networking and telecommunication. The company‘s headquarter is situated in Stockholm. The company provides with infrastructure, services and software in the sector of communication and information technology for telecommunications operators. Generally it provides the client with telecommunications and Internet Protocol (IP) networking equipment, mobile and fixed broadband, operations and business support services, cable television, IPTV, video systems, and an extensive services operation.

Lars Magnus Ericsson founded Ericsson 140 years ago. It was done to access the basic human need of communication. Since then the company started making ground breaking and innovative technology in the field so that the company can fulfill his dream.

The company is always trying to level up the standards in the sector of telecommunication by giving their time and efforts. There few examples set by the company that revolutionized the sector like BLUETOOTH.

The company has become one of the major company to provide service in Information and Communication Technology (ICT) to service providers. The company sees the value of the connectivity so that they can make the game changing technology that is simple and easy to use so that the customer can fully connect to the world.

The company had 27% of the market shares in 2018 in 2G/3G/4G mobile network infrastructures. The company has 95,000 employees and working in 180 countries. The company

has a very good R&D tem due to which it has around 49,000 patents granted as of September 2019 which includes technology that are wireless.

1.2 VISSION:

The vision of the company set by our present President and CEO Mr. Börje Ekholm is:

“Our purpose is to empower an intelligent, sustainable and connected world. For more than a century, we have been putting smart tools in the hands of people in every sector of our society, creating intelligent technologies that drive positive change. We remain committed to this effort, leaving no one behind.”

1.3 OBJECTIVE:

The telecommunications industry in India is extremely vast and sophisticated. Therefore, it's a matter of utmost importance that the network is carefully managed and maintained.

Controlling traffic flow and access to a spread of signaling nodes of the network is extremely important to make sure proper and smooth flow of data from one place to a different HLR is a dynamic router which helps us with an equivalent.

It acts as a Central Database for Global Title Translation (GTT) and minimizes errors. It results in efficient routing of messages, flexible SS7 network management and fast Integration of latest nodes within the network

1.3 WORKING HIERARCHY

Ericsson Noida is split into two main SDUs:

SDU Bharti (Service Delivery Platform for Bharti Airtel in India)
SDU India (Service Delivery Platform for other global telecommunications service companies)

Both SDU Bharti and SDU India are further separated into various domains like:

- Access (RAN - Radio Access Network)
- IP & Transmission
- Core

- OSS (Operations Support System) OSS (Operations Support System)

1.4 SERVICES

The companies has many services such as Networks, Digital Services, Managed Services and Emerging Business;

Figure 1: Networks

Networks

They develop, deliver and manage telecommunication networks. They enable the complete value of connectivity by providing hardware, software, and services. From 5G and IoT to virtualization, they're supporting digital transformation for subsequent generation of mobile services.

Digital Services

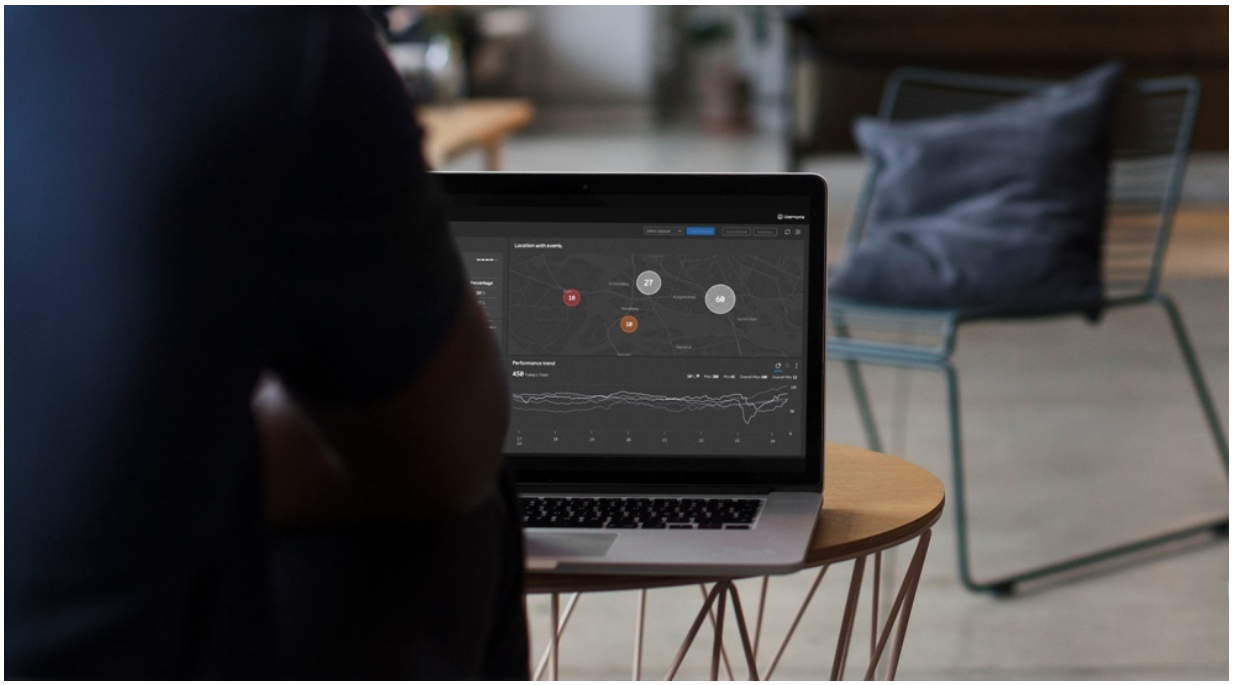


Figure 2: Digital Services

Digitalization is becoming one of the major parts of business that is changing and transforming all the aspect of the business. So to help its customer to have an easy change they are giving services in:

- Management and operations (OSS)
- Revenue and customer management (BSS)
- Communication services in core network
- Network functions virtualization (NFV)
- Infrastructure
- Application development and maintenance (ADM)

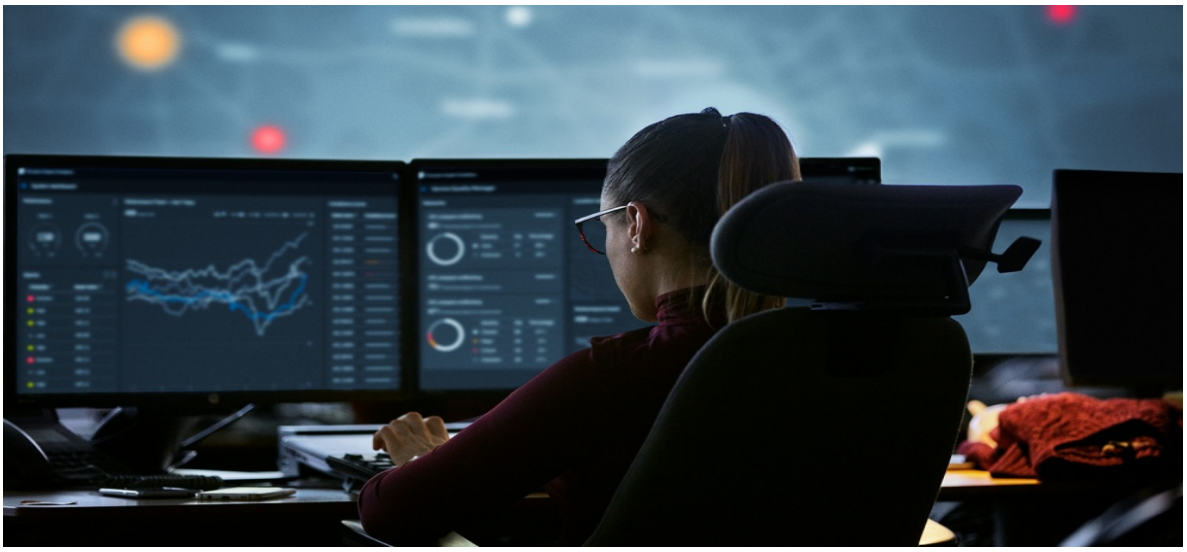


Figure 3: Digital Services

Managed Services

They give this service to cover all the aspect of customer's business by using an integrated approach. They mange and optimize the telecommunication network and IT operation using the industrial processes and a reliable and standard model that not only satisfy the customers expectation rather exceed it.

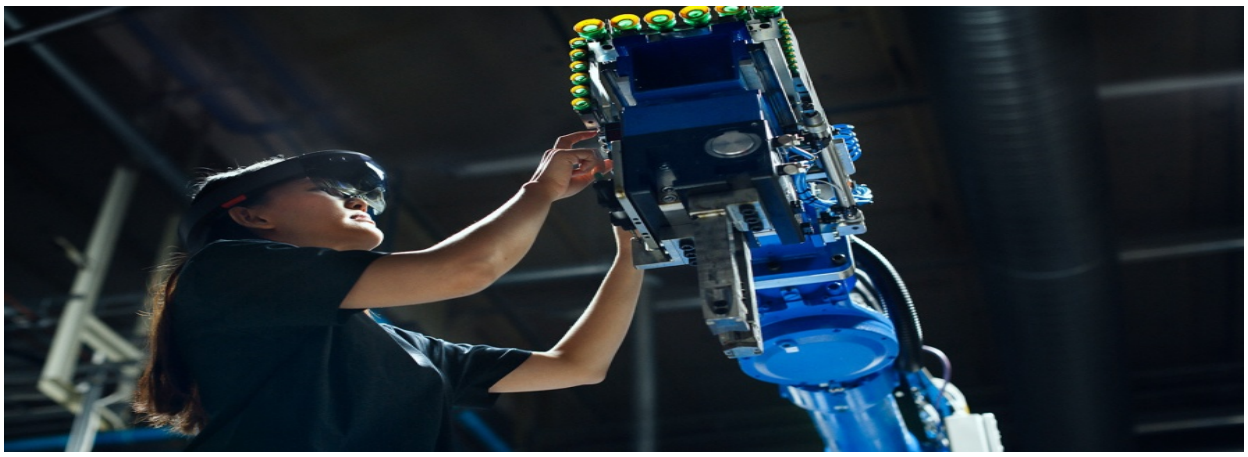


Figure 4: Managed Services

Emerging Business

They didn’t remain the traditional sector. They explored around the new possibilities and also started new in the new sector. As they explored the new sector the technologies like automation, 5G, VR/AR and many more were not only beneficial for them but to their partners and customers as well . The change in sector helped them to target high growth market where these technologies can be used, e.g. Industry 4.0 and smart manufacturing, IoT connectivity, connected vehicles, security and edge computing. One of the core values of the company is innovation and Ericsson ONE is where new, game-changing ideas are delivered to life.

This is helping the company to get a new stream of revenue and increasing the efficiency and improving the digitalization.

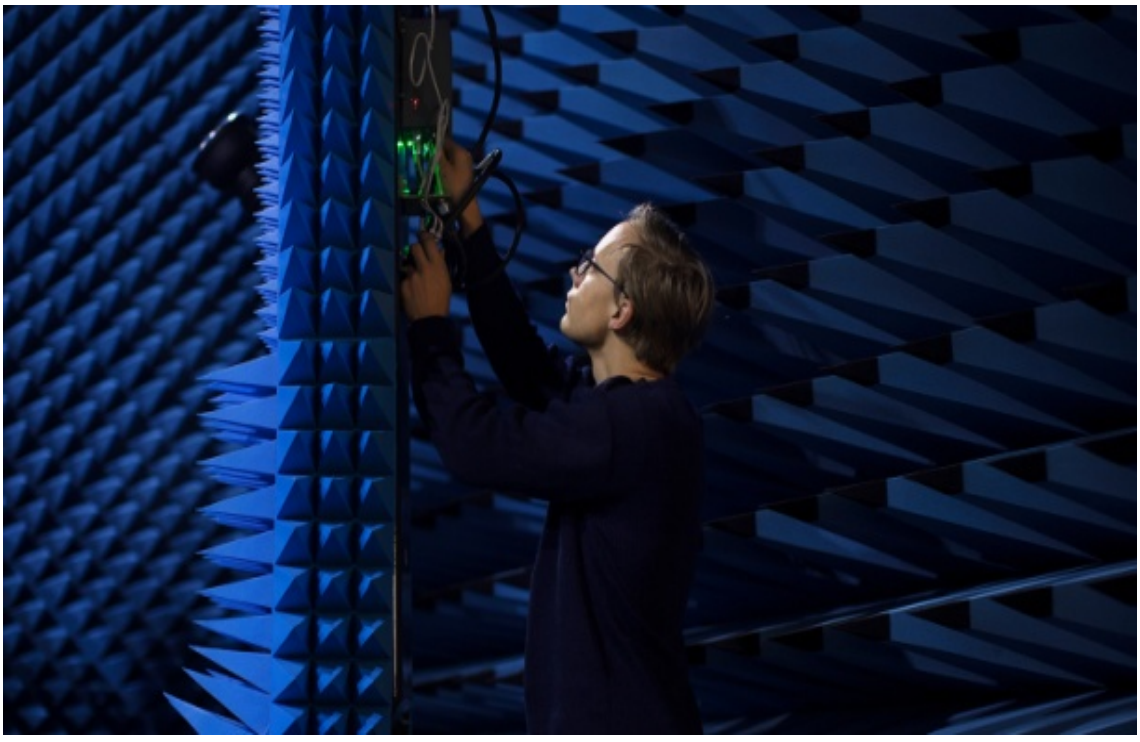


Figure 5: Emerging Business

Chapter 2

EVOLUTION OF WIRELESS COMMUNICATION TECHNOLOGY

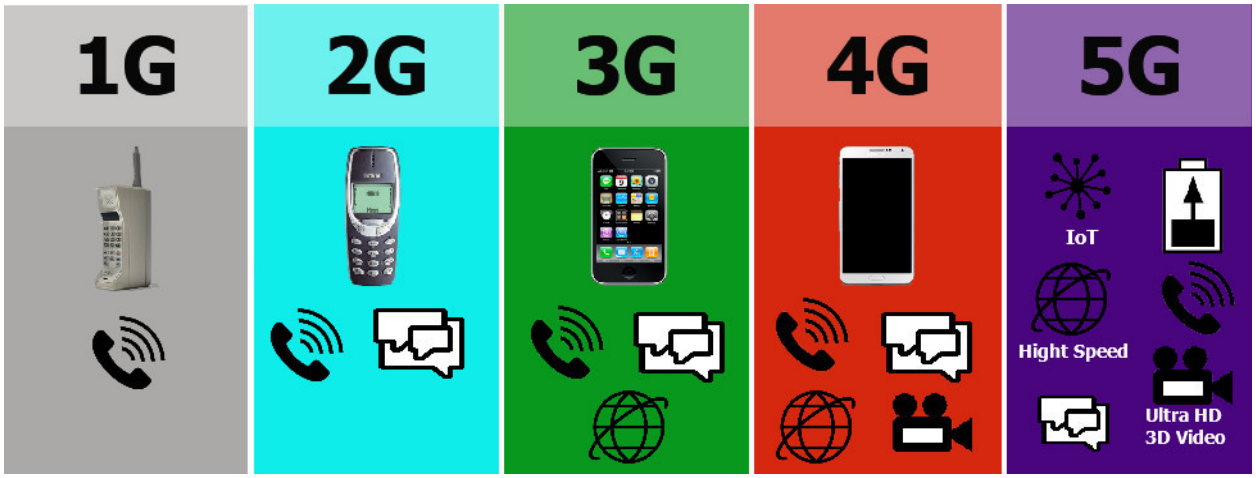


Figure 6: Evolution of Wireless Communication Technology

2.1 0 G: WIRELESS TECHNOLOGIES

This is the first technology from where the wireless technology started. .it was like a radio phone which was installed in vehicles before phones were invented. After the Radio phone then thing that came was cellular phone. Since they were the first step towards the generation of the technology it was known as 0G (zero generation) systems.

Figure 7: 0G

2.2 1G: ANALOG CELLULAR NETWORK

The change and improvement that was in this technology than that of the previous technology was that in this technology was the use of more than one cell site and this resulted in the form of communication that can be from anywhere to anywhere without any fixed place hence can be used while travelling . The first use of this technology for commercial use was done by Japan by NTT in 1979.

The use of this technology in modern cellular tech. was done in 1984 by Bell Labs. They put in many cells sites in the fixed area so that they can give the service to the cell inside the area. The cell sites were put in such a manner that they can overlap the area covered by cell site partially. The system should be put together in such a way that the strength of the signal between the cell site the recipient should be strong enough that the same channel can be used for the conversation in same cells.

As the use of the technology increases the use of phone increases that lead to range of the cell decreased which resulted in increases in the number of the cell. Increase in the number of cells increases the capacity of the cell.

Figure 8: 1G

2.3 2G: DIGITAL NETWORKS

As the time past the new technology unveiled that used GSM standards and was known as 2G system. The improvement of this system to that of 1G and 0 G was that it used Digital Transmission rather than that old analog transmission. This system also brought P to N (phone-to-network) signaling which was more advance and quick than the last technology. This new technology usage resulted in new form of era known as Prepaid as there was increase in the usage of the mobile.

They also came up with a new form of communication known as SMS (Short Message Service).It was first used in this technology of writing the message instead of calling and it was used in all the technology that came after it. This new application was most dominant among the youth but as the time passed it became more dominant than the voice call and was used by every age group of the society. It also reduced the pressure that was put on batteries as Digital transmission used less power as compared to that of analog. It also used the new form of coding that was improved the voice and reduced the noise. It was much safer than that of analog encryption in terms of privacy. It was considered eco-friendly and it required strong signal to work properly.

Improvement on this technology was made before the new technology was invented. This technology was **GPRS** (General Packet Radio Service). It provided with the data between 56 kbps to 115kbps. IT gave the light to new services that become the backbone of the modern world. These services were:

- Wireless Application Protocol (WAP) access
- Multimedia Messaging Service (MMS)
- Internet communication services
    - email
    - World Wide Web (WWW) access.

As these new services were introduced another improvement was made in the technology. This new technology was known as EDGE (Enhanced Data rates for GSM Evolution). It increased the data rate to 384kbps.

Figure 9: 2G

2.4 3G: HIGH SPEED IP DATA NETWORKS

As the improvements were made on the previous technology to meet the demand of the people as they started using the mobile in their daily life. The demand for more data speed came and the technology was not up to the level that they could satisfy the demand so the new technology came known as 3G. The improvement of this technology over the previous technology was it changed its switching method from circuit switch it changed to packet switch. It was done for the purpose of data speed.

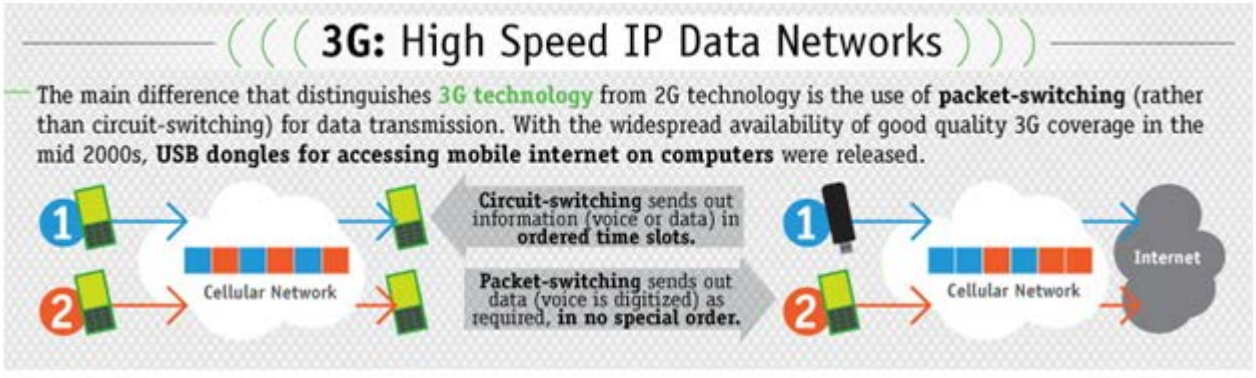


Figure 10: 3G

The improvement of data rate in this system revolutionized the industry. It made possible new things like:

- Live Video
- Media Streaming
- Gaming

In the early 2000 the implementation of this 3G system was done and was called High-Speed Downlink Packet Access (HSDPA). It improved the protocol of the mobile within High-Speed Packet Access (HSPA) family that included 3.5G, 3G+ and turbo 3G. This new protocol helped in giving us a new system known as Universal Mobile Telecommunications System (UMTS). This system increased our data rate and capacity. Today's downlink speed due to this system is of 1.8mbps, 3.6mbps, 7.2mbps and 14.0mbps. This speed can be improved with HSPA+, increase the speed to 42 mbps downlink and 84 mbps with the 3GPP standards

Figure 11: 3G

2.5 4G: GROWTH OF MOBILE BROADBAND

But as the population increased the demand of the speed also increases and 3G was not enough to provide that speed. So the new technology was in demand which would optimize the data and increase it by 10 times over the previous technology. This is only the improvement over the previous technology. It only increased the bandwidth and services in the previous technology. This should provide the people with top quality audio and video over the internet protocol.

The change in this technology over the previous was of to switch from circuit to all IP based network. This change in switching changed the way of communication it broke voice calls into bits like audio video and transfer it using packet switching over internet known as VoIP.

This technology speed of transferring of data is 100 mbps in downlink and 50mbps in the uplink, the first of the commercial 4G WIMAX has a download speed of 128mbps and upload speed of

56mbps.

Figure 12: 4G

CHAPTER 3

GSM & UMTS

3.1 INTODUCTION

GSM known as Global System for Mobile Communications is a second generation mobile phone system. This system was introduced in 1991for voice and data services. It is still used in many areas where there is requirement of low data rate and large coverage. Initially GSM stand for GroupeSpéciale Mobile, but due to worldwide acceptance of this system it was changed to Global System for Mobile Communications.

The use of this technology was firstly purposed within Europe but as the standard become more famous than imagined as it achieved lakhs of customers by 2004. This was a landmark in the telecommunication sector.

As the time has passed we have moved very far from the start of GSM but still there are places where this is still in use. The as the mobile of GSM are low cost and battery used by them is very less that to charge a mobile the interval would be weeks.

The improvement of this system to that of 1G and 0 g was that it used Digital Transmission rather than that old analog transmission. The digital technology used in this system was TDMA (time division multiple access approach). The use of TDMD approach the number of user available bandwidth increased and also the digital encryption was much safer than that of the analog encryption.

The main part of this communication was voice calls and speech. The method to transmit the voice was to first encode it using vocoder than transmit it. There are differ vocoder for different situation.

There was also a new feature in GSM technology that was different kind of data services. As for the data services, they were no match for that of 3G but still they were pretty important in many aspects. Data rate given by GSM technology was 9.6kbps. The features it had was

- Facsimile
- Videotext
- Teletex

They also came up with a new form of communication known as SMS (Short Message Service).It was first used in this technology of writing the message instead of calling and it was used in all the technology that came after it. This new application was most dominant among the youth but as the time passed it became more dominant than the voice call and was used by every age group of the society. This service has become particularly popular, initially people as it were simple to use and reduce the cost.

The GSM cellular technology had a number of aims when the development started:

- Good speech quality
- Low phone cost
- Phones should be handheld
- Support international roaming
- Good spectral efficiency
- ISDN compatibility

All the aims were achieved with the GSM (Global System for Mobile Communications) technology. The system not only tells us about the air interface but also about network technology. This technology also gave us one of the important features of International roaming that helped the world to connect in much faster way and one operator to function from other operators.

This technology works on channel of 200 kHz. It has following equipments:

Base Station Subsystem (BSS)

- Base Transceiver Stations (BTSs): There are many BTSs which are connected to MS and BSC.
- Base Station Controller (BSC): They control BTS and are connected to MSC and BTS.

Core Network

- Mobile Switching Center (MSC): connected to MSC, HLR, VLR, AuC and EIR.
- Home Location Register (HLR): It is the permanent database about the information of operators' subscriber. It is connected to MSC.
- Visitor Location Register (VLR): It is the temporary database about the information of operators' subscriber. It is connected to MSC.
- Authentication Centre (AuC): It helps to authenticate the mobile. It is connected to MSC.
- Equipment Identify Register (EIR): It store equipment identity. It is connected to MSC.

Another feature of GSM was SIM (Subscriber Identity Module). This card had user identity that helps the mobile to get network when it is in another cell. It contains user's phone numbers and other items.

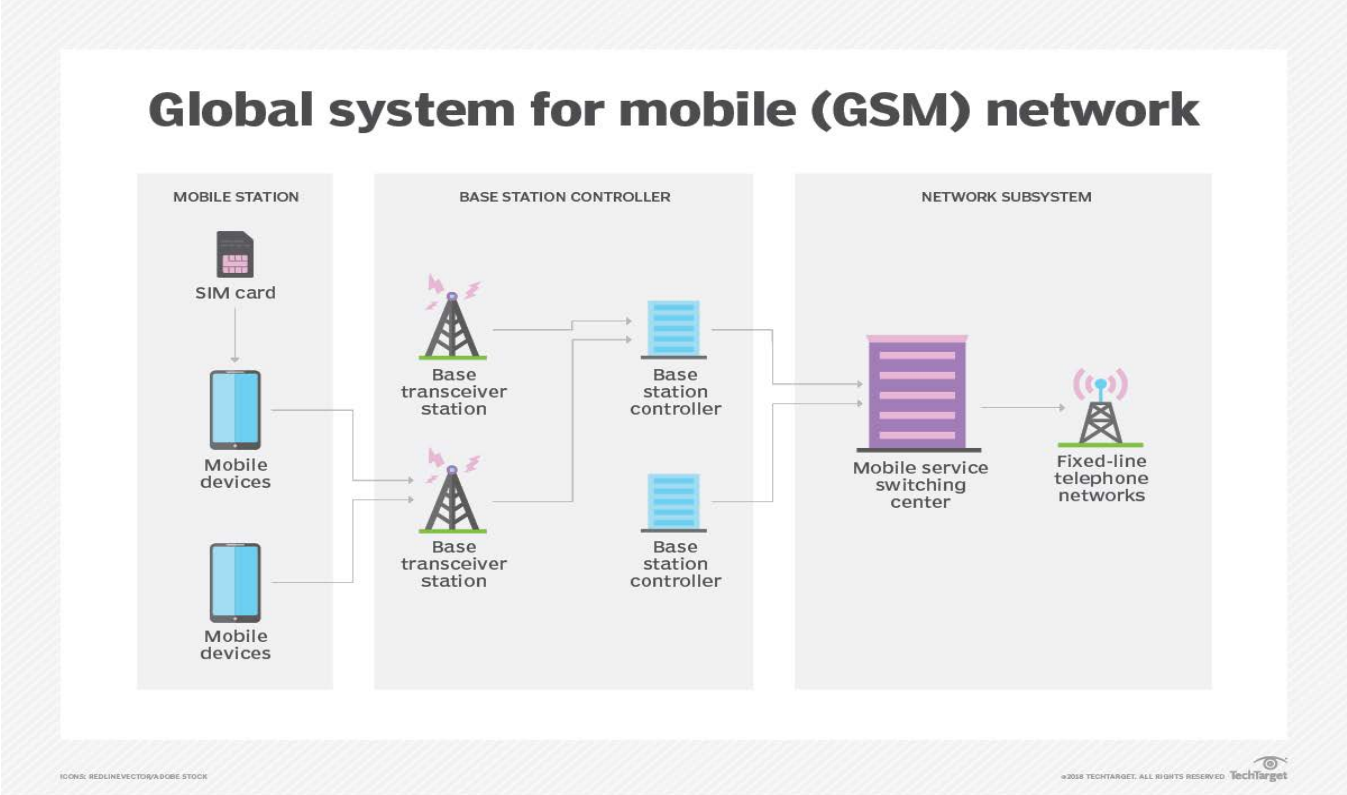


Figure 13: GSM Architecture

The table below summarizes the main points of the GSM system specification.

TABLE 1: SPECIFICATION SUMMARY FOR GSM CELLULAR SYSTEM

Multiple access technology	TDMA
Duplex technique	Full duplex
Uplink frequency band	890MHz – 915MHz
Downlink frequency band	933MHz – 960MHz
Channel spacing	200KHz

This GSM technology was a successful system.

3.2 GSM ARCHITECTURE

3.2.1 INTRODUCTION

The GSM system has 3 main components:

- network subsystem
- radio subsystem
- operation support subsystem

To help with ease of designing the GSM not only tell we about the air inter face but also about the network on how they are connected.

3.2.2 GSM NETWORK STRUCTURE

In a mobile network, there is a well-made structure to pass the arriving call to its route correctly. This importance of this structure is because as the user move the user will change the BTS but change in unit should not affect the call.

So for this purpose the GSM is separated in following areas.

- GSM service area;
- Public Land Mobile Network service area;
- MSC service area;
- Location area;
- Cells.

GSM service area: It is the area under which all the country where we can call comes.

Public land mobile network service area: These are the area within the country that includes the connection between PLMN and PTSN (public switched telephone network), ISDN (Integrated Services Digital Network); this will be at national or international transit exchange. In one PLMN there can be many MSC service areas.

MSC service areas: It controls within specific area of PLMN. In one PLMN there can be many LA service areas

Location areas: it is specified area under MSC service area. In one MSC there can be many cells.

Cell: A cell is contains BTS.IT is the smallest service area.

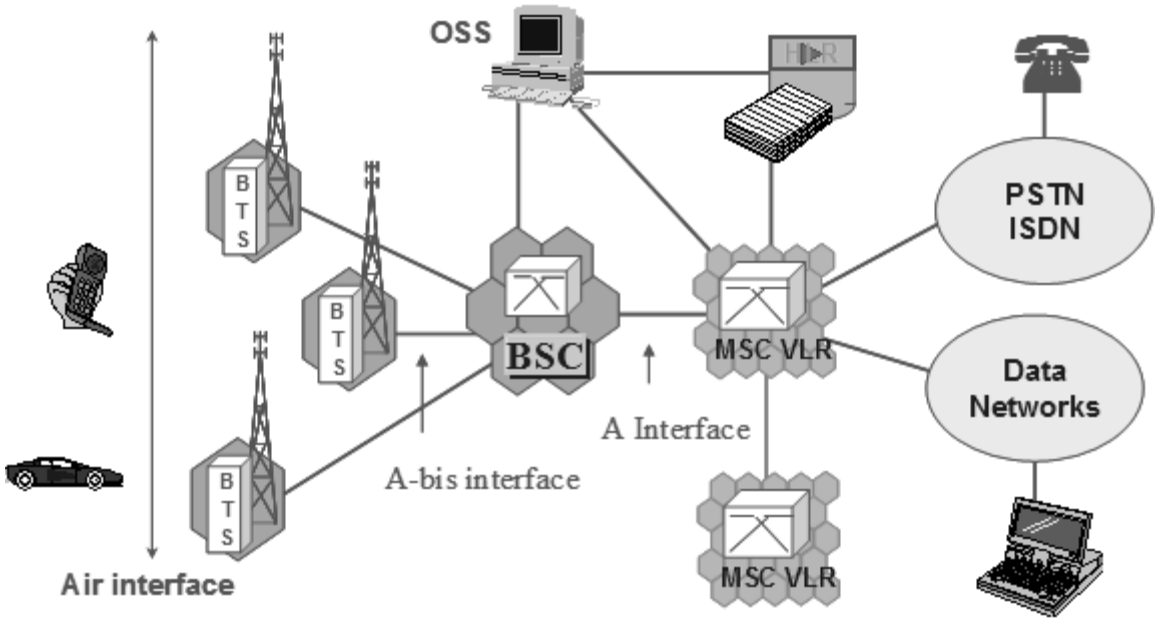


Figure 14: GSM Network Interfaces

TABLE 2: INTERFACES AND DESCRIPTION

GSM interface	**Descriptioon with position**
Um	Between MS and BTS
A or Asub	Between BSC and MSC/VLR
Abis	Between BTS and BSC
B	Between MSC and VLR
C	Between HLR and MSC
D	Between HLR and VLR
E	Between MSC and another MSC or G-MSC
F	Between EIR and MSC and Between EIR and G-MSC
G	Between VLR and another VLR

3.3 GPRS ARCHITECTURE

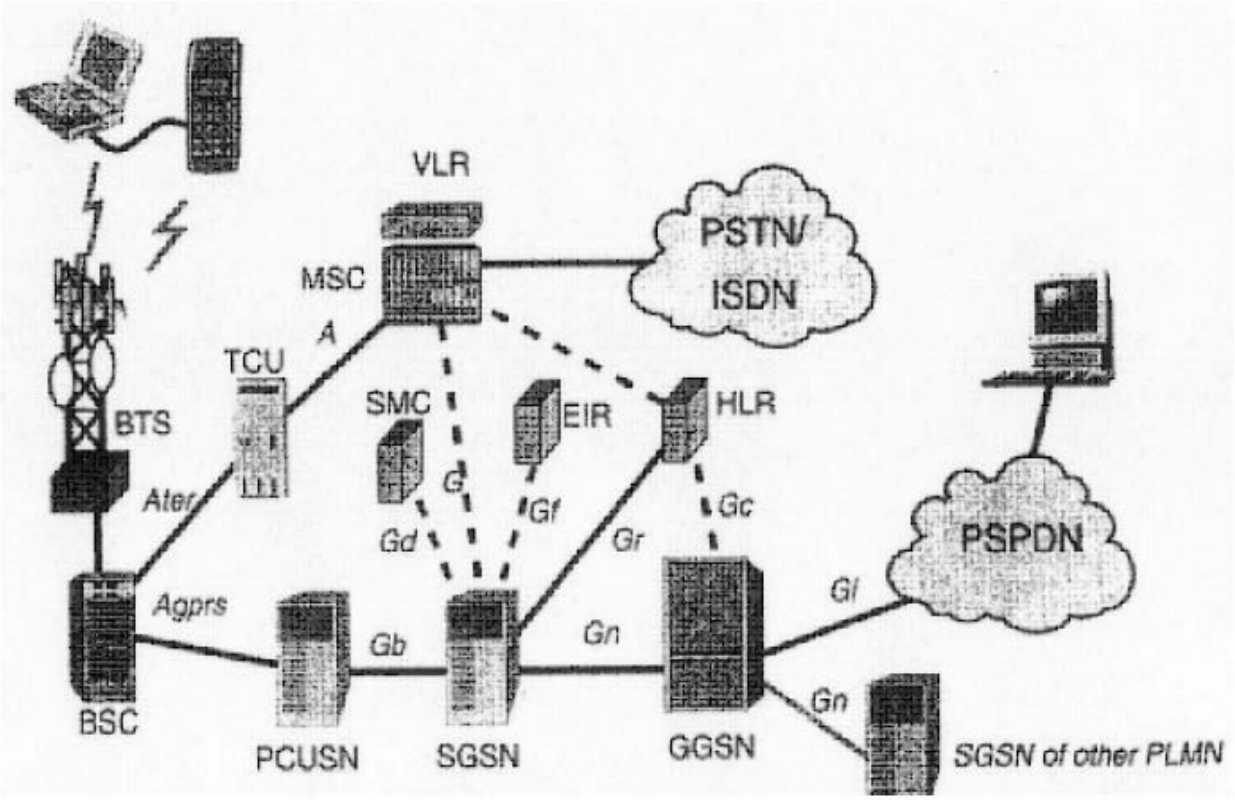


Figure 15: GPRS Architecture

TABLE 3: INTERFACES AND DESCRIPTION

Gb	Between the PCUSN and SGSN
Gr	Between SGSN and HLR
Gn	Between SGSN and GGSN
Gi	Between GGSN and PDNS
Gs	Between SGSN and MSC
Gd	Delivers SMS
Gc	Between GGSN and HLR

This system was improvement over GSM technology. It was done by adding some nodes into the system so that it can use packet switching..

The nodes that were added were:

- Serving GPRS Support Node(SGSN)
- Gateway GPRS Support Node(GGSN)

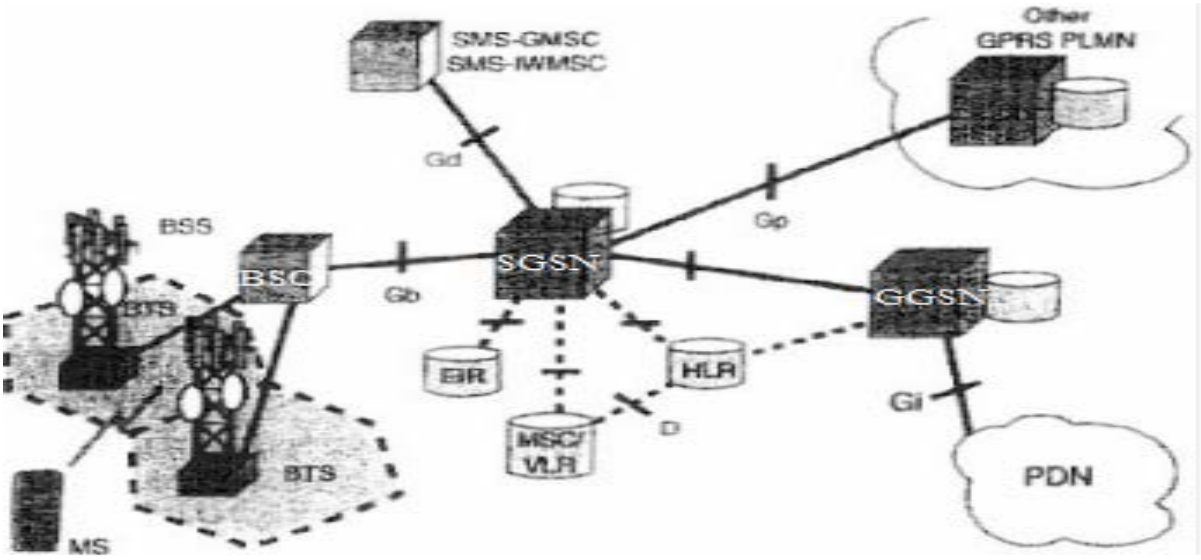


Figure 16: GPRS Network Interfaces

Only GPRS terminals can access GPRS servers. The problem that aroused in this system was how to get packets from user and then send back to the user.

This problem was separated into two parts:

- Data packet routing
- Mobility management

Data Packet Routing

GGSN was connected to SGSN and PDN. So it transfers data from SGSN to external world and vice versa.

Three different routing schemes are:

- Mobile-originated message.
- Network-initiated messages: MS in home network.
- Network-initiated messages MS is not in home network

The GPRS network collects the protocol from all other data network to its own protocol.

It was called the GPRS Tuning Protocol (GTP).

Mobility management

As the GPRS is evolved version of GSM so it depends on its feature for some functioning.

A mobile station has three states in the GPRS system:

- Idle- In this feature the data is not transferred.
- Standby-In this the routing area is recognized.
- Active- Data is transferred. SGSN knows the cell location.

3.4 CHANNELS AND SIGNALING

- **Physical Channels:**
  - TDMA (Time Division Multiple Access)

- This multiplexing separates the time into n parts where n is number of part that you want to separate into. Each part that it is separated into is known as frame. Each frame is than separated in short period known as time slots these time slots are known as Physical Channels. These are called physical channels because they carry information from one place to another in form of bits. The frequency like 890 MHz is separated into these time slots and is transferred from mobile to tower in form of frame.

  One timeslot equals to one physical channel

  GSM has 8 physical channels thus 8Timeslots

- **Logical channels:**
  - A large number of information is transferred from tower to mobile.
  - Logical channels has
    - Common Channels
    - Dedicated Channels.

- **Common Channels:**
  - These are the channels that help the mobile to get signal and transfer its location IMEI like information to the HLR and VLR.
  - These channels are known as Dedicated Control Channels.
  - Traffic channels are also part of Dedicated Channels these channel are use for 1 dedicated work only.

RF channel overview:

The bases of the voice call or any other thing in the mobile is Radio Frequencies

There are 3 types of RF channels:

1. Broadcast channel: This is a broadcast channels. It works from are one point to many point channel, these are dedicated between mobile and tower. They are separated into:

- **BCCH** (Broadcast control channel):

These are used by Traffic Channel. Using the information provided by this channel, Mobile Station chooses the best cell to attach to. It inform about the different parameters of the system to the mobile while acting as a beacon. The information that is given through this channel is list of RF used, neighboring cells, power of the cell etc

- **FCCH (**Frequency correction channel):

  The phone has first synchronized itself to the FCCH channel so than it can synchronize with rest of the channel and listen to BCCH. FCCH keeps on transmitting its frequency so that mobile can correct its frequency when there is some error.

- **SCH** (Synchronization Channel):

  This frequency is used to link mobile with the Frame of TDMA (Synchronization Channel is used to synchronize the Mobile Station in time).SCH has frame number and Base Station Identity Code. After getting the frequency synchronized the mobile get its frame number and BSIC. This process repeats itself after every 10frames

2. Common control channels: These are point to multi-point. They are only uni directional either from up or from down.

- **PCH** (Paging Channel):

  This channel is always working. It is down link from tower to mobile .it has always the information about identity of the cell. It alerts us from incoming call.

- **RACH** (Random Access Channel):

It is the requesting channel. Whenever there is paging on the mobile this station is contacted. The mobile ask for allocation of the channel so that it can be used .it is an up link channel. It is also used when we want to originate some call.

- **AGCH** (Access Grant Channel):

  It is the access granting channel. Whenever the mobile ask any kind of access this channel is used to send the answering of the request. It is the downlink always from tower to mobile. When it receives the request through RACH it sends signal through this channel of the grant of access.

3. Dedicated Control Channels: these are bi directional in nature and has point to point channel. They transfer the signal between BTS and MS. They are separated into:

- **SACCH** (**Slow Associated Control Channel**):

  These are full duplex in nature that helps in traffic control in the channel these are used for different purposes like

  - radio link supervision measurements
  - power control
  - timing advance information

- **FACCH** (**Fast Associated Control Channel**):

  These are used for requesting the signal that are in urgent and that was not allocated by the SACCH. The example of such cases is when handover is taking please and there is urgent need to get the frequencies. In this not only the traffic data but all the data is transmitted over the traffic control channel. This is also known as stealing flag.

- **SDCCH** (**Stand Alone Dedicated Control Channel**):

This is used for signalling higher layer as it is point to many points and is full duplex. All the signals between mobile and BTs are sent through this channel when the mobile is not connected to any other channel. This is good for

- service request
- location updates
- subscriber authentication
- ciphering
- equipment validation
- assignment of a Traffic Control channel

- **4. Traffic Channels (TCH):**

  This channel help in transmitting the voice and data from mobile and to mobile either at full rate i.e.13kbps or at half rate 5.6kbps there is also one other channel known as Enhanced Full Rate (EFR) Traffic Channel.

So, in summary, channels are of the following types:

TABLE 4: CHANNELS AND DESCRIPTION

CBCH	Transmit cell broadcast message
RACH	Used in communication request from the mobile station to BTS
AGCH	Used to SDCCH channel assignment (the AGCH carries IMM_ASS_CMD)
SDCH	Used to exchange of signaling information between Mobile station and BTS when no traffic channel is active
PCH	Carries the PAG_REQ message

BCCH	Used to transmit system information
FCCH	The lighthouse of a BTS
SCH	PLMN/base station identifier of a BTS plus synchronization information

3.5 3G (UMTS)

3.51 SYSTEM ARCHITECTURE

This system is the new technology that came to increase the data rate. This technology contains many elements that are doing the task which 2 or 3 GSM equipments do individually.

These elements are put together on the basis of similar functionality or sub system they belong to. These are separated into following parts

- Radio Access Network (RAN): It is also known as UTRAN it provides with every radio functions like allocating the resources.
- Core Network (CN): It exchanges data and calls with external networks.
- User Equipment (UE): It is link to join user and the radio resources.

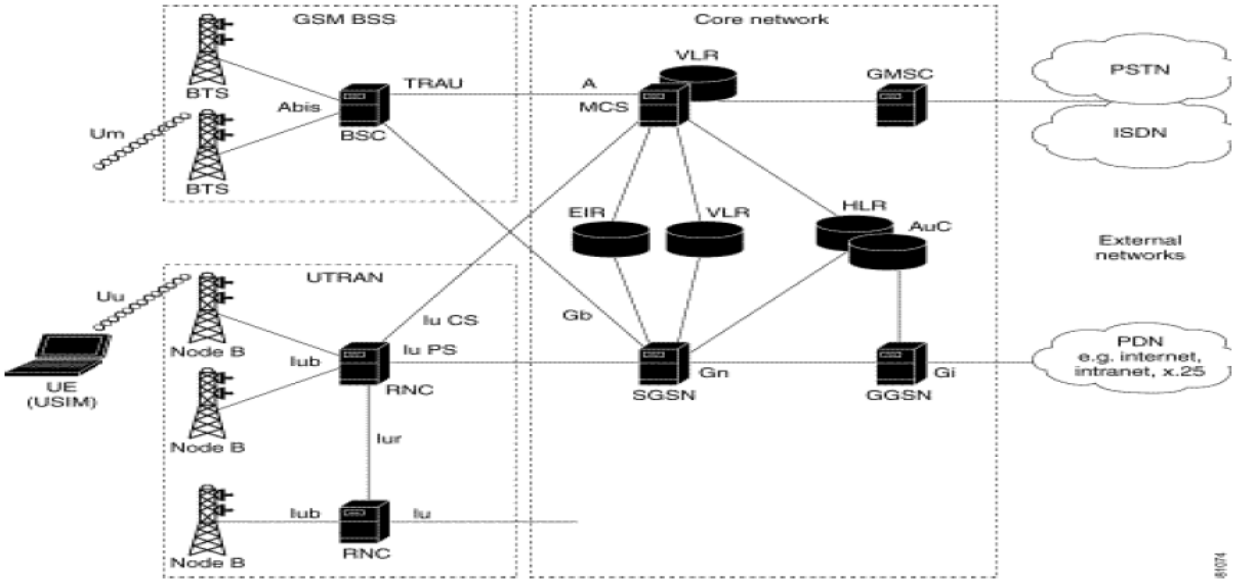


Figure 17: System Architecture

As this technology has two part UE and UTRAN that works on completely different protocols' so from specification and standardization point we needed the new protocol that will help us to link the two different units. The new technology that was created was WCDMA (Wideband Code Division Multiple Access) radio technology.

The other way to group these elements was through sub system they belong to. This technology is modular in nature so these have many similar kind of elements. Typically, one Public Land Mobile Network is operated by a single operator, and is connected to other Public Land Mobile Networks as well as to other types of network, such as ISDN, PSTN, the internet etc.

3.52 UTRAN ARCHITECTURE:

UTRAN can have more than one Radio Network Sub-systems (RNSs). Bt an RNs inside the UTRAN can only have single RNC and more than one Node Bs.

The following open interfaces are the UTRAN interfaces:

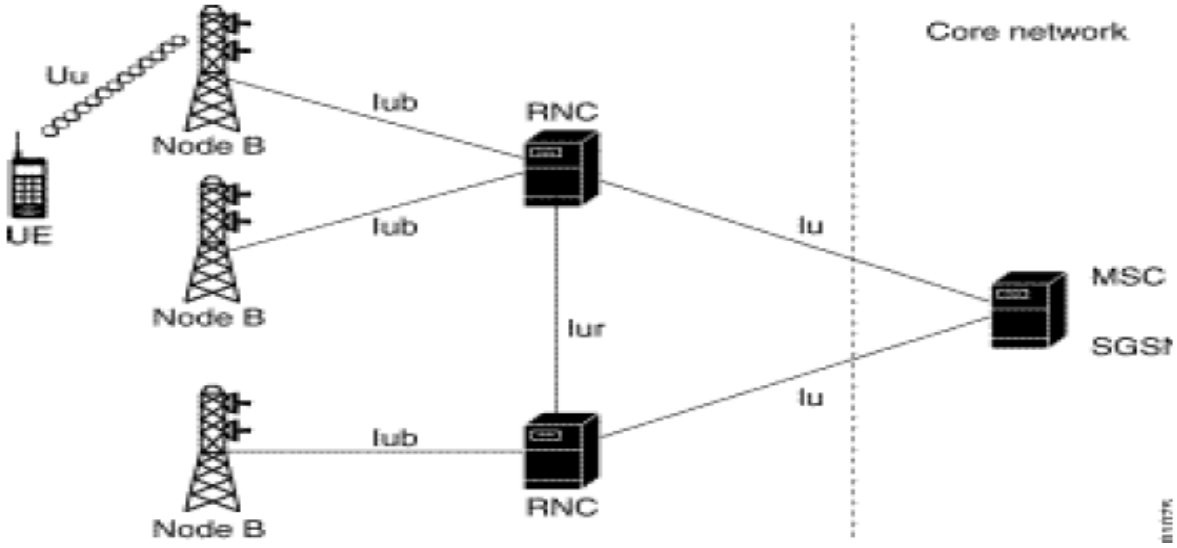


Figure 18: SDM

TABLE 5: INTERFACES AND DESCRIPTION

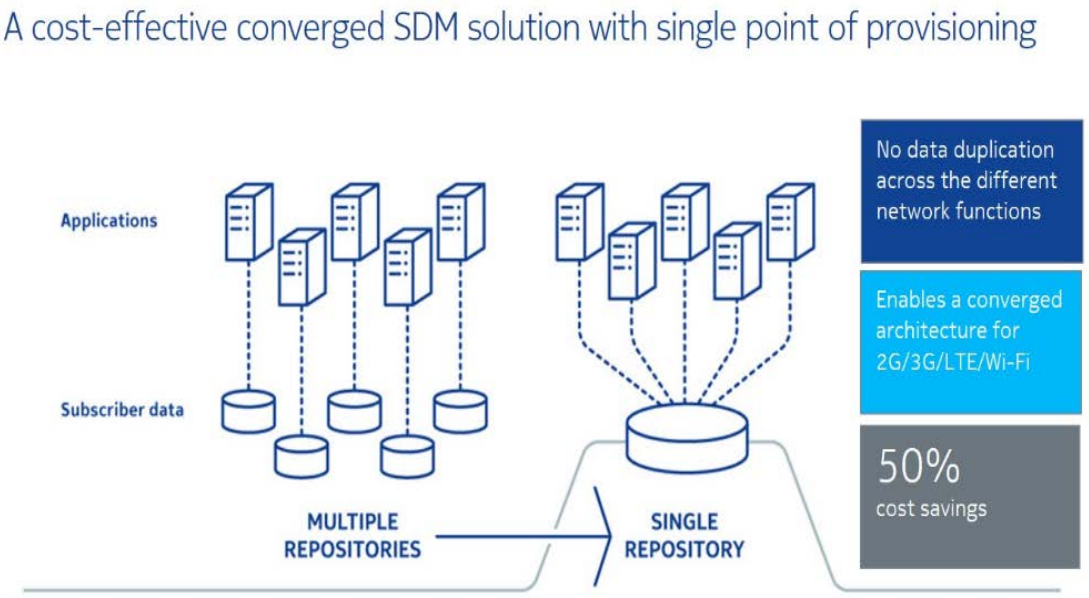
Interfaces	Description with position
Iub interface	Between node B and a RNC
Iur interface	Between RNCs
Iu interface	Between CN and GSM

CHAPTER 4

SDM

4.1 SDM

Subscriber data management (SDM) is the part of the new HLR system that performs the most critical function in telecommunication. It uses 3GPP User Data Convergence standard to put data into single, robust and secure User Data Repository (UDR). This help in creating a single register that it is centrally provisioned. It helps in saving cost, speeding the market time dramatically when there is a new customer in the market or there is some new technology or when there is a new service that is being launched.



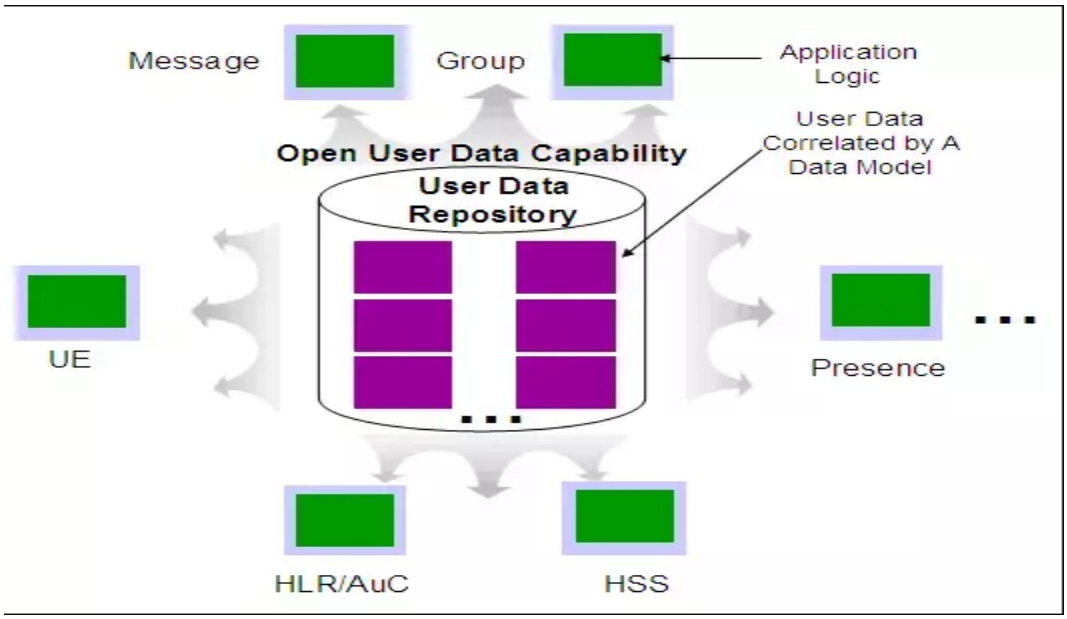


Figure 19: Home Location Register (HLR)

1 Operational excellence

It provides with geo-redundancy and built-in mechanisms, that provides superior robustness

2 Reduce on costs and minimize time to market

As we have single point of provisioning this help us to collect data of same person with different services would be accommodated in the single SDM.

3 Boost revenues with new market opportunities

This help by providing open and flexible and supporting multiple front-end network functions. This also makes easy integration of third party applications. Thus these services help us to boost our revenue.

4 Move to cloud subscriber data management (SDM) and 5G

This has high availability, reliability and performance. Ehen put on cloud these can be used in IOT like services.

5 Modernize your network in confidence

It modernizes your network and prepares you for any other changes

3.2 One-NDS (Network Directory Server)

One-NDS (Network Directory Server)

It is one of the most important component in Subscriber Data Management (subscriber data management (SDM)) solution.

Its features are

- instantaneous
- flexible
- Distributed data and application-hosting environment applicable in any technology.

One-NDS break down the user data into the basic form and the put it in branches that not only consolidate profile, and also set it for the future technology and services on very low cost.

3.2.1 Highlights

- It uses centralized database by multiple applications by open data access protocols.
- It can have 100K to over 250M subscribers.
- It supports multiple applications.

CHAPTER 5

HLR

5.1 INRODUCTION

This main part that controls the flow of the call, it is the heart of the communication system of any technology this as a part of GSM with IMS provides us with better quality in audio and video. To add the SDM (**Subscriber data management**) technology in GSM and IMS subscriber, the data in this has to be viewed in way of single view. To make the data in single view we have to do consolidating the subscriber's data. To console the subscriber data the first thing that is done is to remove the duplicate data from GSM data and IMS data. Home Location Register (HLR) in global system for mobile communication and Home Subscriber Server (HSS) in IMS is the central repository of subscriber data for a given home network.

The way this HLR and HSS are to be put in together is through the 3GPP forum. A user can have data in both the GSM data and ISM data. Some times in special cases the data can have special specification therefore it can be added to both the data i.e. GSM's HLR and IMS's HSS. This will not only reduce the duplication of the data as the data of HLR and HSS will be in same for same subscriber so we can delete one but will also increase the capacity of SDM. This system would also create the system of single view for global system for mobile communication and IMS technologies that was wanted.

5.2 Home Location Register (HLR)

HLR is the permanent database that stores some or all of the mobile subscribers of the HPLMN.It sit at the heart of the Network Subsystem (NSS) part of a global system for mobile communication network. Subscribers within the HPLMN are provisioned to the HLR database. It is connected to several of the opposite NSS elements via the SS7 network (e.g. MSC/VLRs, SMSCs, and SCPs).

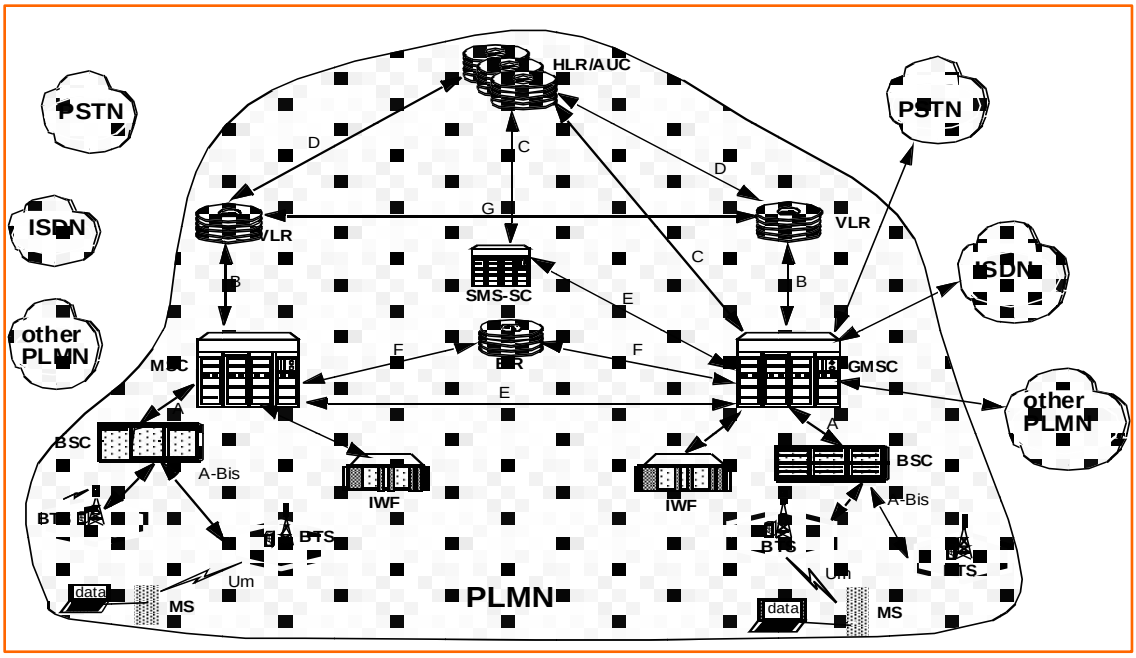


Figure 20: SS7 (Signaling System 7)

5.3 Generic HLR Interfaces

- Provisioning
- SS7
- O&M

4.4 Interfaces

4.4.1 Provisioning:

- **Subscriber Identity Module (SIM) Provisioning**

  This SIM a card provisioning that tells about subscriptionID .The SUBSCRIBER DATA MANAGEMENT (SDM) provides the data about the subscriber so that it can get correct configuration.

- **CAMEL Services Provisioning**

The following are some of the entities provision Camel services:

•O-CSI: provides which card you have

•T-CSI, VT-CSI: what specification are allowed

•D-CSI: in roaming area or not

- **Closed User Group (CUG) Basic Service**

  This help us to create a barrier in which we could call only person who are allowed in it

- **GPRS Services**

  This provide provision for GPRS settings

4.4.2 SS7 (Signaling System 7)

This is the protocol that is used in PSTN and in STP using DRA. This protocol helps us to start the call and terminate the call, but is also useful in many other pars like SMS billing number portability etc.

The signaling point that this protocol has number set to identify the point known as codes. These codes help in taking the message from the source it is Trans mitted to destination it want to reach.

The signaling points in the SS7 networks can be separated into 3 parts:

• SSP (Service Switching Point)

• STP (Signal Transfer Point)

• SCP (Service Control Point)

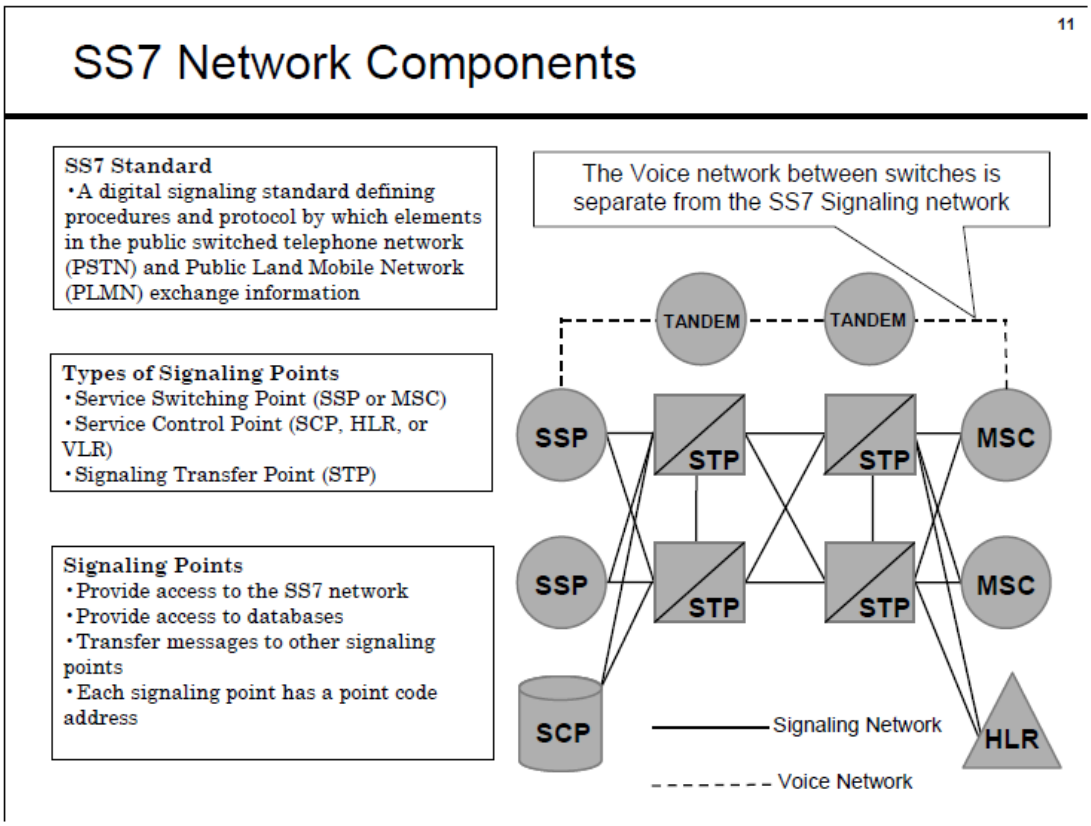


Figure 21: SS7 (Signaling System 7)

Signaling system 7 Signaling Link Types Signaling links are logically organized by link type ("A" through "F") according to their use in the signaling system 7 signaling network.

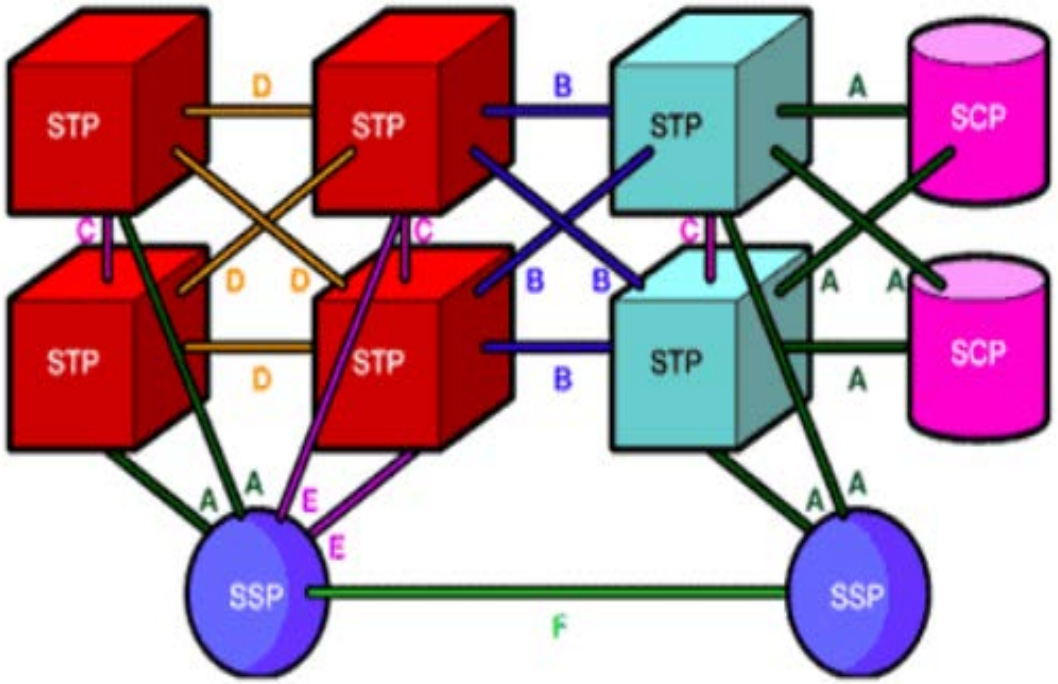


Figure 22: SS 7 Protocol Stack

Link	**From**
A Link	SCP or SSP to an STP.
B Link	STP to a different STP.
C Link	STPs to STPs.
D Link	STP pair to a STP
E Link	SSP to an alternate STP.
F Link	SSPs and SCPs to signaling points

SS 7 Protocol Stack

The hardware and software of the SS& protocol is seperated into two levels

These can be seen table how it is matched with ODI layer.

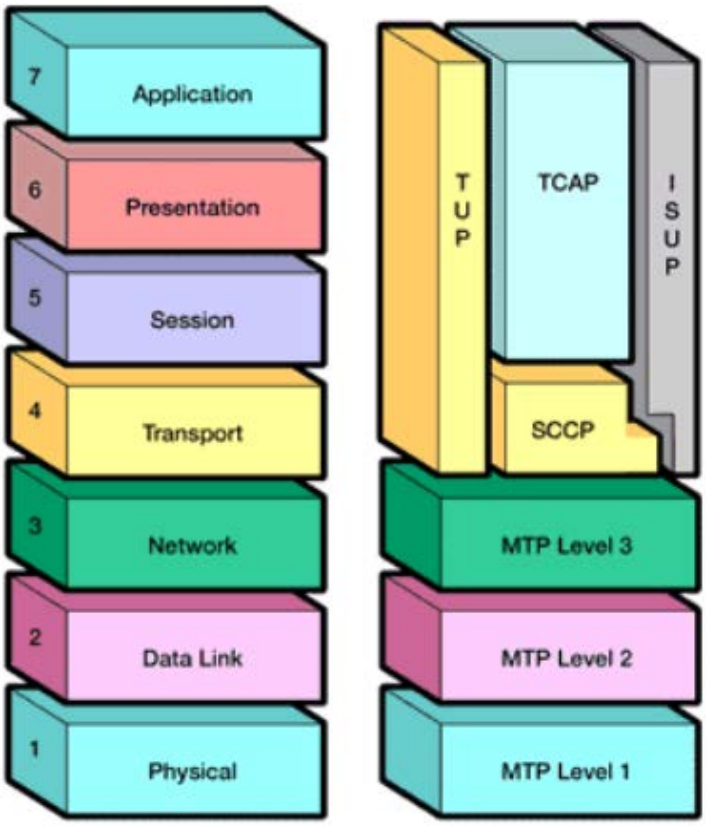


Figure 23:

Message Transfer Part

The Message Transfer Part (MTP) has 3 levels.

- MTP Level 1 is like Physical Layer in OSI model. It checks the physical links that are it system and help in the transmission of the data
- MTP Level 2 is like data link Layer of OSI model it helps in transmission of the message in the form of end to end

- MTP Level 3 is like Network Layer in OSI model. It helps in transferring the message from one part to another using routing table.

ISDN User Part (ISUP)

The ISDN User Part helps in setting up managing releasing trunk circuit. It carries voice and data in terminating exchange.

Telephone User Part (TUP)

In some countries it is used to start and end the call in analog system

Signaling Connection Control Part (SCCP)

Signaling Connection Control Part provides help in transmission of the data above the network link layer through the application. This somewhat similar to transport layer.

Transaction Capabilities Applications Part (TCAP)

Transaction Capabilities Applications Part (TCAP) helps in the trade of between applications that are non circuit related data using the above protocol with wireless SCCCP services. Question and answer are exchanged between SSPs and SCPs are carried in Transaction Capabilities Applications Part messages.

4.4.3 Operation and Maintenance

It checks for any fault in the system in which it is if there is any fault it will give the message in the board.

4.5 HLR Functions

The basic functions of hlr are:

- Authentication – Provides AuC functionality within a global system for mobile communication network.
- Mobility Management – stores subscribers' current location provides subscriber data to VLRs/SGSNs.
- Call Handling – Single point of contact for all terminating calls.
- SMS Handling.
- GPRS – provides PDP context data to SGSNs.
- Supplementary Service function (CF, CB, CW, CH, etc).
- Operator Determined Barring – Allows operators to restrict services to a subscriber.
- CAMEL support.

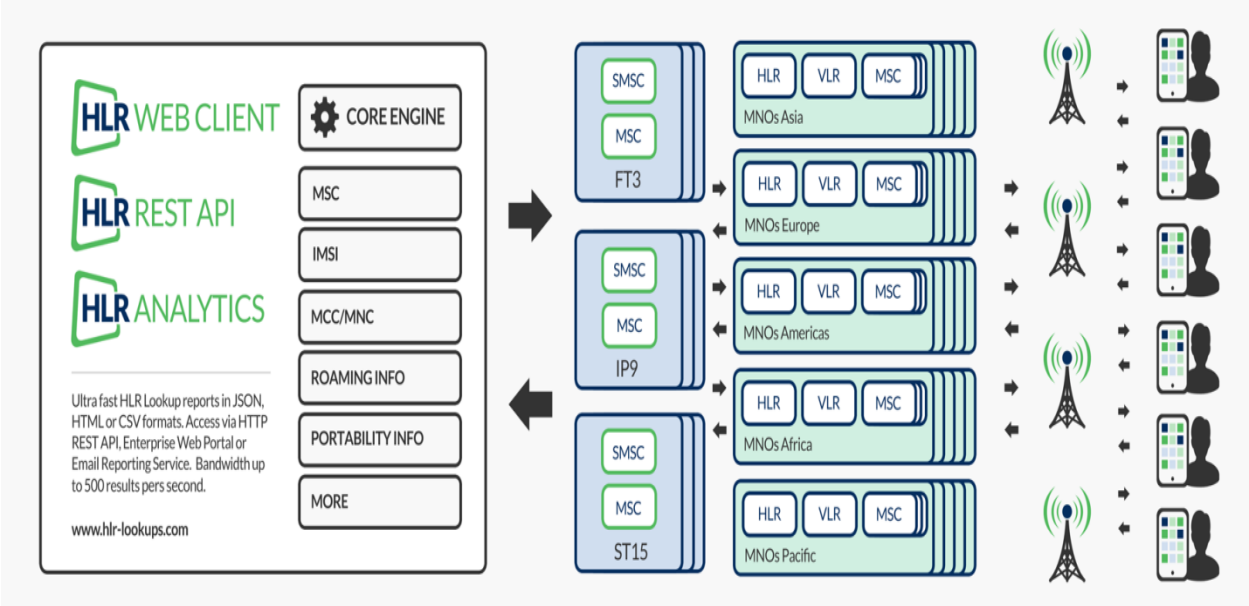


Figure 24: HLR Functions

CHAPTER 5

HSS BASIC

5.1 LTE and EPC Basics

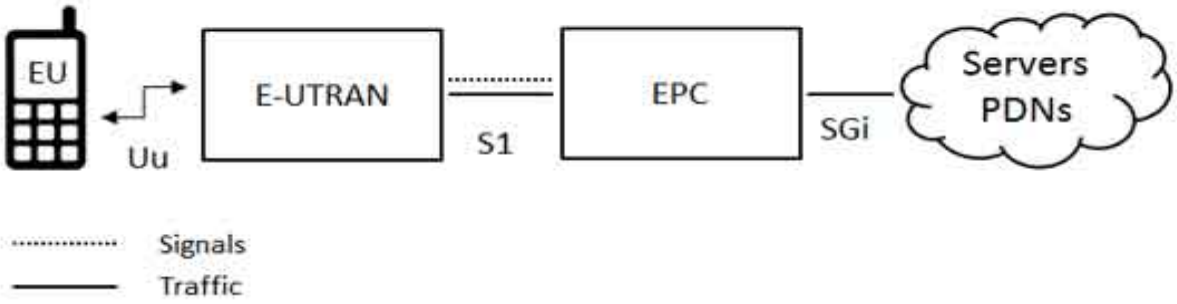


Figure 25: LTE and EPC Basics

5.1.1 The User Equipment (UE)

The architecture of this system is the same to that of Universal Mobile Telecommunications Service and that is similar to Global System for Mobile Communications ME.

The mobile equipment comprised of the subsequent important modules:

- Mobile Termination (MT): This controls function related to communication.
- Terminal Equipment (TE): This ends the use of data.
- Universal Integrated Circuit Card (UICC): This is the SIM of LTE. It uses the technology which is similar to that of SIM so its called the Universal Subscriber Identity Module (USIM).

It works like 3G sim. Like keeping the storing the data like user's telephone number, home location area and encryption keys etc.

The E-UTRAN (The access network)

The E-UTRAN communicates between the tower and mobile system and take care of handover like features so it became evolved Node B hence known as eNodeB or eNB. It is similar to BSC in GSM..

LTE has only one base station and one cell at a time to communicate with.

The two main features of eNB are:

It transmit and collects radio communication to any kind of mobile using either analog or digital transmission technique using interface as air.

It controls the low-level operation of all its mobiles, by sending them signalling messages such as handover commands.

- S1 interface connects eNB with the EPC

  X2 interface, eNB to another eNB for handover.

- A home eNB (HeNB) is the node which is your primary home.

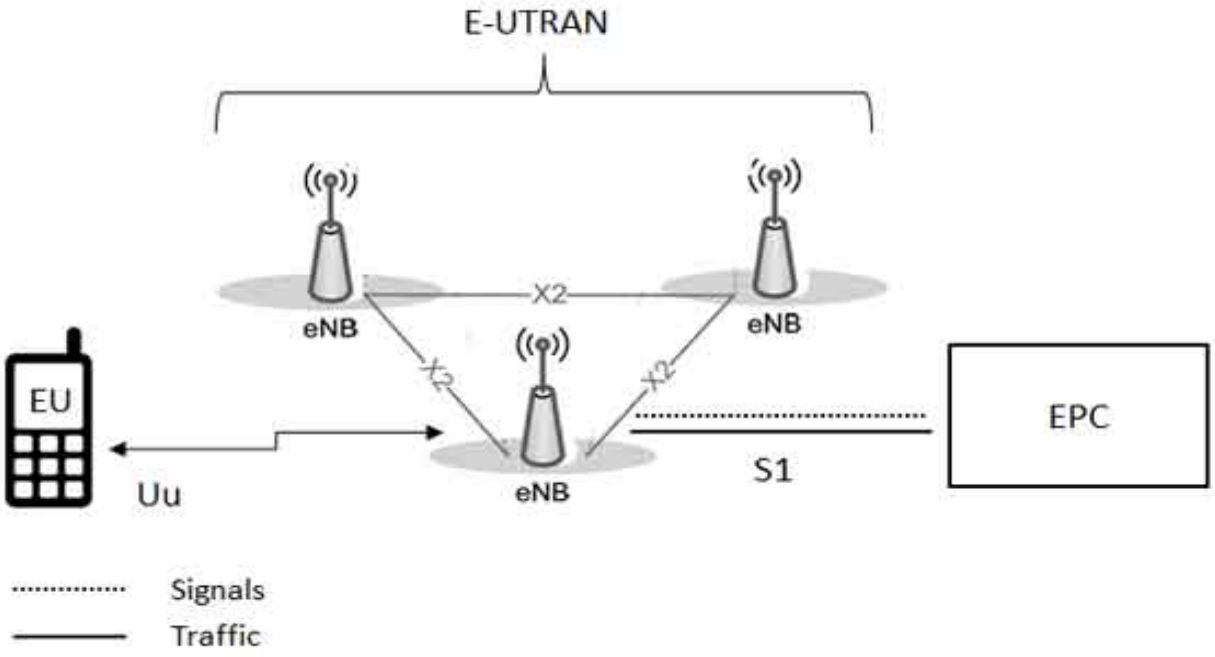


Figure 26: The E-UTRAN (The access network)

5.1.2 The Evolved Packet Core (EPC) (The core network)

The below figure tell us about the architect of EPC.

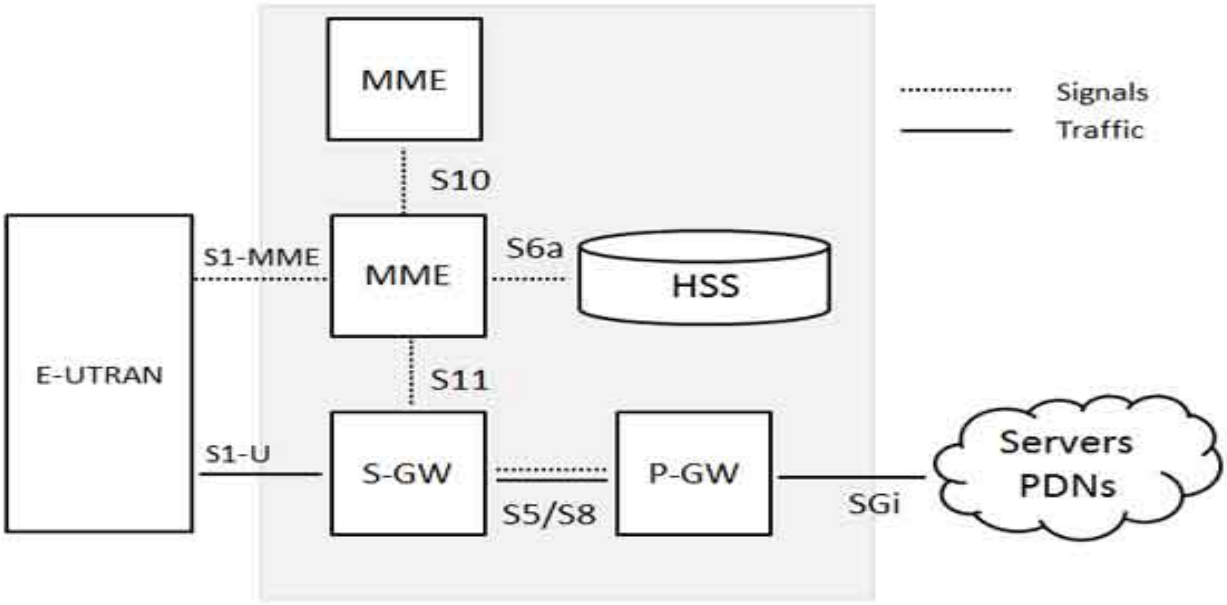


Figure 27: The Evolved Packet Core (EPC)

Brief explanation of components shown in the above architecture:

- Home Subscriber Server (HSS): It contains permanent database that contains information subscribers.
- Packet Data Network Gateway (P-GW): It has same role as the GPRS support node (GGSN) and the serving GPRS support node (SGSN) with UMTS and global system for mobile communication.
- Serving gateway (S-GW): It forwards the data to PGW.
- Mobility management entity (MME): It is like MSC in GSM and is connected to HSS,SGW.

5.2 Interfaces and Protocols Connecting the HSS

The Interface used to connect the Diameter nodes is S6a/S6d

S6a/S6d [MME/SGSN <-->HSS]

S6a interface is between MME-HSS and S6d interface between SGSN-HSS.

HSS (Home Subscriber Server)

It is a permanent record of user's subscriber that contains features of AUC, EIR, and VLR of GSM in one device. The information about the subscriber is sent by MME .Then there is message exchange between MME and HSS.

Four of them are invoked by MME and rest four are invoked by HSS.

AIR/AIA (Authentication-Information-Request/Answer)	MME fetches Authentication data from HSS to authenticate subscriber.
ULR/ULA (Update-Location-Request/ Answer)	MME stores its own identity at HSS, and fetches subscription data from HSS.
NOR/NOA (Notification-Request/ Answer)	MME stores PDN address and other attach information at HSS.
PUR/PUA (Purge Request/ Answer)	MME informs the HSS that UE is inactive for a long period that why MME has deleted the Subscription Data received in previous ULR from its end.
IDR/IDA (Insert-Subscription-Data-Request/ Answer)	It is invoked by HSS only when a subscriber is attached and there is change in subscriber profile at HSS end then same change to be reflected at Subscriber profile at MME (sent in ULA) end as well.
DSR/DSA (Delete-Subscriber-Data-Request/Answer)	It is invoked by HSS only when Subscriber is attached and some data is deleted at HSS. Now HSS informs MME with this message that some part of subscription data is deleted at HSS.
CLR/CLA (Cancel-Location-Request/Answer)	Invoked by HSS to detach the subscriber.
RSR/RSA (Reset-Request/Answer)	Invoked by HSS, to inform MME that HSS goes down for some time, kindly sync the data and send fresh location/PDN information at HSS.

5.3 Diameter Protocol

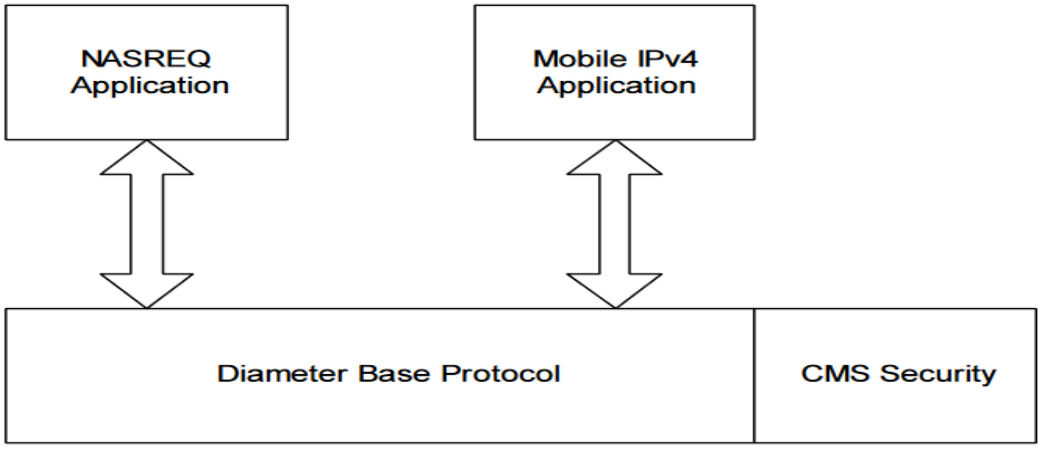


Figure 28: Diameter Protocol

Diameter is a new protocol that uses AAA protocol that is used in the 3G internet like services that includes:

–Network Access Servers for dial-up with PPP/SLIP

–Mobile IPv4 Foreign Agents

–Roaming 3G and Internet users (SIP Application)

–Credit Control

–Vendor specific

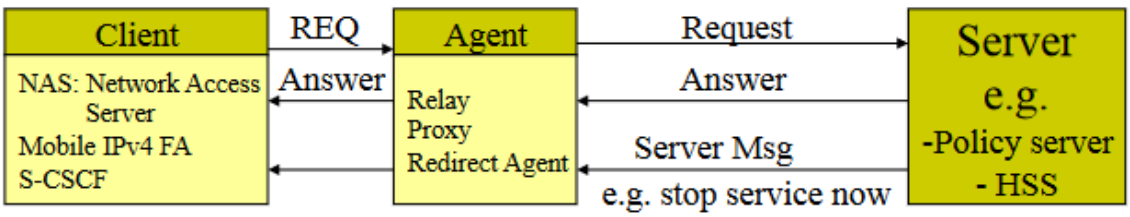


Figure 29: Diameter Protocol Flow

5.3.1 AAA

Authentication

This protocol is used to authenticate the user Identity. To do some kind of credentials are required examples of credentials:

1. Passwords.
2. One-time token.
3. Digital certificates,
4. Or any other information related to the identity (e.g. biometric parameters.)

Authorization

The process helps us in verifying whether a particular user is allowed to access network resources. Only allows legitimate users to have the access.

The malicious users are denied from accessing network resources.

Examples:

1. IP filtering.
2. IP assignment.
3. Routes assignment
4. Encryptions

Accounting

By recording the time that the person has spent on the particular network so the all the things can be taken into account like

1. Id.
2. Service description.
3. Session duration.

It is useful for management, planning, and billing.

5.3.2 WHY DIAMETER OVER RADIUS

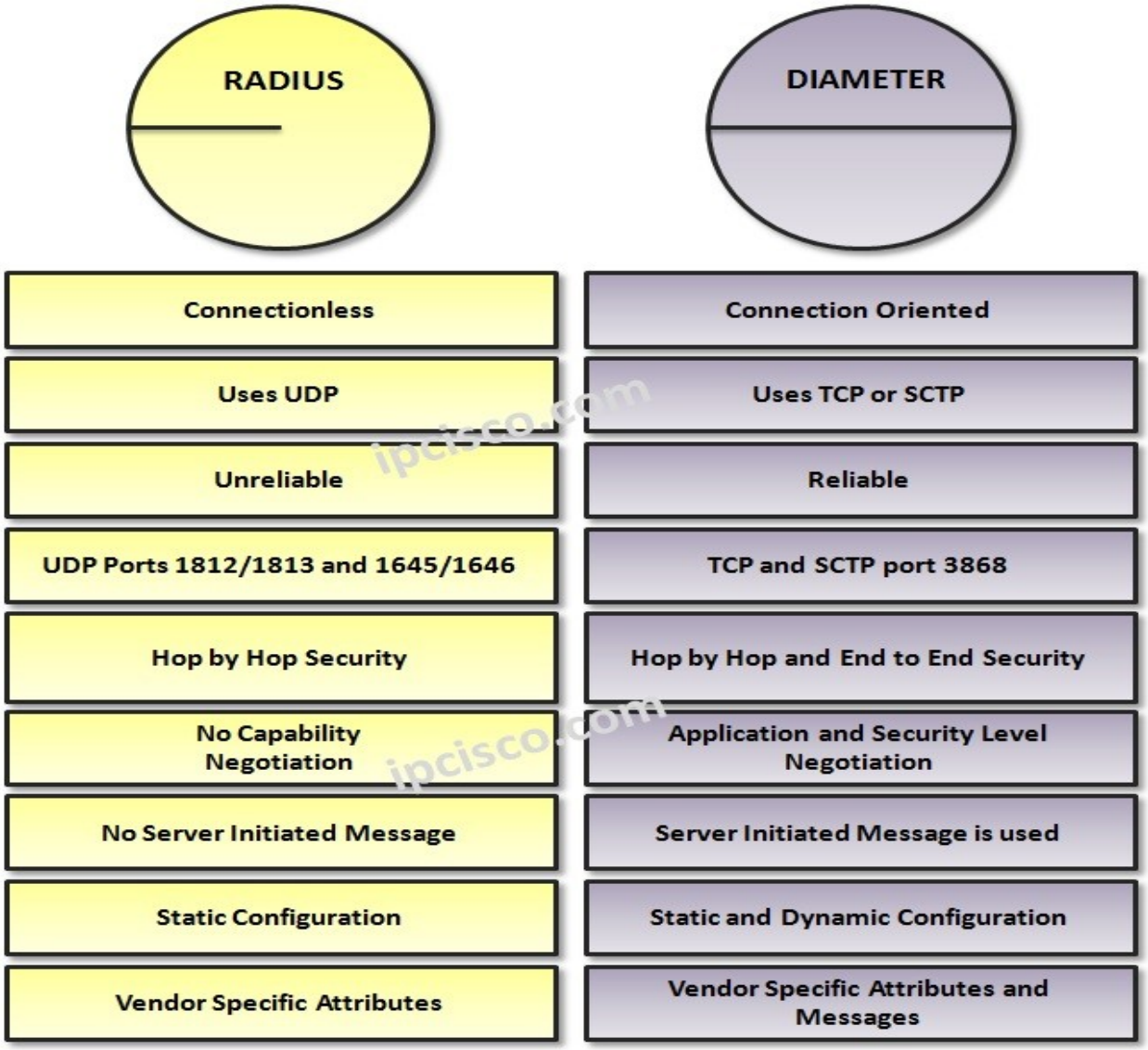


Figure 30: Diameter Vs Radius

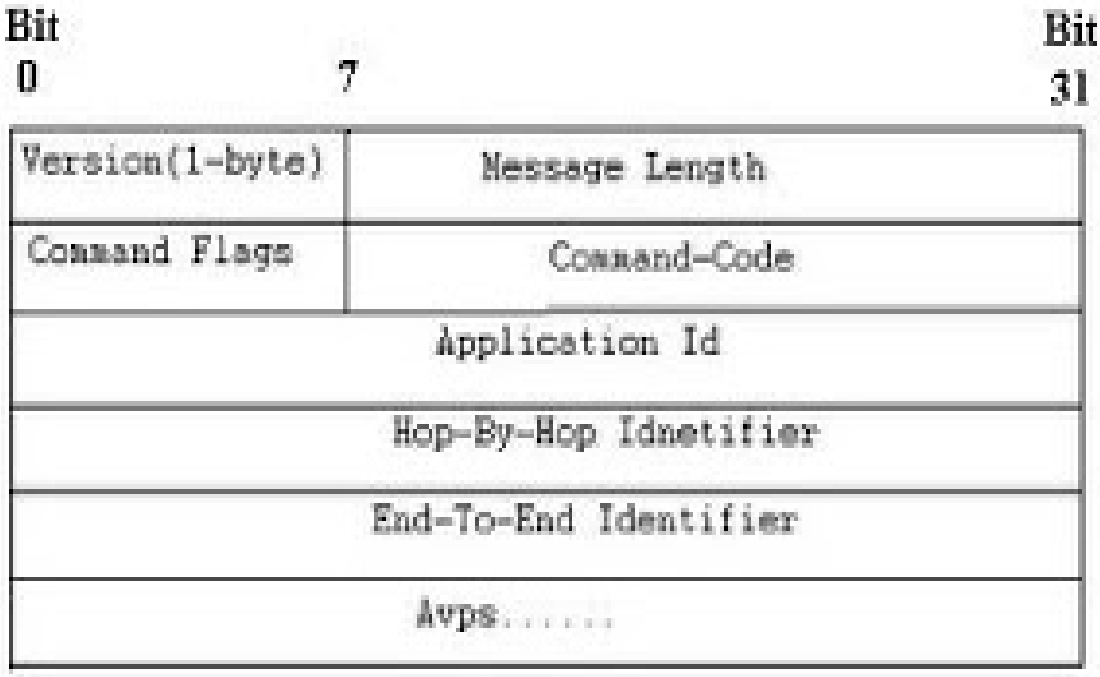
The features that are in diameter not in radius protocol are

- Failover Mechanism
- Transmission Layer Security
- Reliable Transport
- Agent Support
- Server-initiated messages

- Auditability.
- Transition support
- Capability.
- Peer discovery and Configuration
- Roaming Support

5.5.3 Diameter Message Structure and Message Flow

- Diameter is Message (Packet) based protocol. There are two sorts of messages Request Messages and Answer Messages. And the Message structure is of following sort



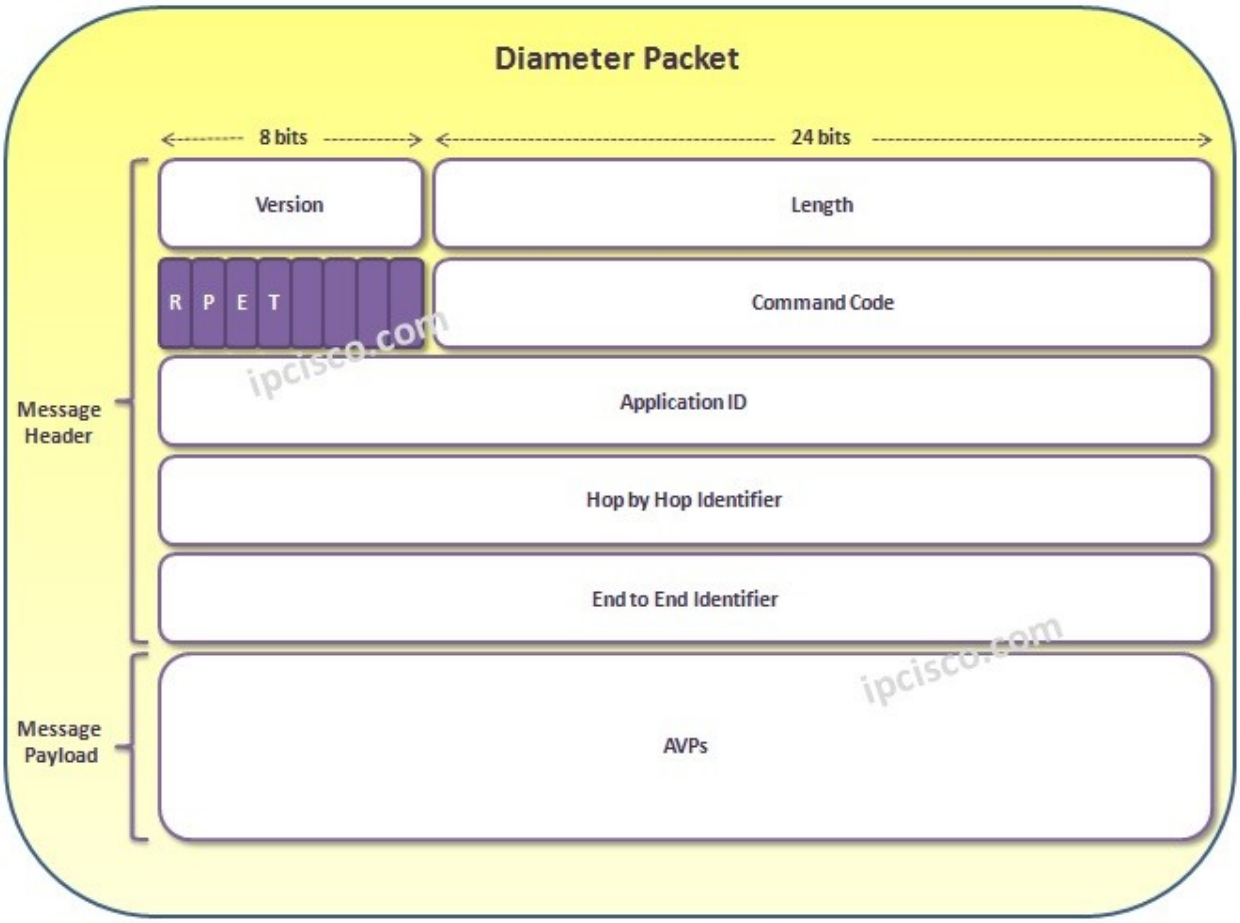


Figure 31: Message Format

.

- **Version:** 1 indicates Diameter Version 1.

- **Message Length** : It contain the length of Message

- **Command Flags:** It has 8 bits.

    - REPT

        - The R stands for Request bit

- The P stands for Proxiable bit
- The E stands for Error bit
- The T stands for re-transmitted message bit

- **Command-Code**

  For every **Command Code** IANA as provided with unique diameter message. When R=0 this will mean that it is a answer command code. The Command-Code field is three octets.

•

Command-Name	Abbr.	Code	Application
AA-Request	AAR	265	Diameter NAS Application - RFC 7155
AA-Answer	AAA	265	Diameter NAS Application - RFC 7155
Diameter-EAP-Request	DER	268	Diameter EAP Application - RFC 4072
Diameter-EAP-Answer	DEA	268	Diameter EAP Application - RFC 4072
Abort-Session-Request	ASR	274	Diameter base

Figure 32: Example For Command-Code

- **Application-ID**

  There is also an Application-ID AVP, so in one application these two fields (Application-ID Avp and Application-ID in structure) will contain an equivalent value. Application-ID is four octets.

For Example: Application Id for S6a/s6d interface is 16777251 and for S13 are 16777252

Application-ID	Abbr.	Full name	Usage
0	Base	Diameter Common Messages	Diameter protocol association establishment/teardown/maintenance
16777216	Cx/Dx	3GPP Cx/Dx	IMS I/S-CSCF to HSS interface
16777217	Sh	3GPP Sh	VoIP/IMS SIP Application Server to HSS interface
16777236	Rx	3GPP Rx	Policy and charging control
16777251	S6a/S6d	3GPP S6a/S6d	LTE Roaming signaling
16777252	S13	3GPP 13	Interface between EIR and MME
16777255	SLg	3GPP LCS SLg	Location services
16777345	S6t	3GPP S6t	Interface between SCEF and HSS

Figure 33: Example For Application Id

- **Hop-by-Hop Identifier**

  The Hop-by-Hop Identifier is an unsigned 32-bit integer helps in providing match of reply with the request.

- **End-to-End Identifier**

  The End-to-End Identifier is an unsigned 32-bit integer field detects if the message is duplicated or not. This identifier should be unique for at least 4 minutes.. Use of End-To-End Identifier is explained below with Example.

- **Message Flow**

  Hop-By-Hop Identifier =H-Id

  End-To-End Identifier =E-Id

CHAPTER 6

WORKDONE

6.1 Work done

Till now, they have been asked to have an in-depth knowledge about the domain and sub-domain. They have been given reading material which contains information about the functionality, architecture and protocols used in HLR and HSS.

I have been enrolled in several courses (WBLs) that I must complete according to the deadlines given. Some of the courses include 5G Core Concepts Introduction, 5G Core Network Architecture, 5G Transport Overview, Data Privacy, Ericsson Network Manager – Overview & Highlights, GLOBAL SYSTEM FOR MOBILE COMMUNICATION System Survey, Handling of Subscriber Personal Information, Diameter Protocol in IMS, LTE evolution, LTE/SAE System Overview, VoLTE Introduction

I have completed some MSDP (Managed Services Delivery Platform) courses that are required for us to log into the various HLR 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 troubles arise at any node of a network. It contains information on how to generate Trouble Tickets, Work Orders, and Change Requests etc. depending upon the problem of the customer.

6.2 Future Scope

After completion of our WBLs (Web Based Learnings), OJTs (On-Job Trainings) and induction sessions, they will be dealing with live networks for SDU Bharti Airtel involving HLR nodes pan India.

My work will involve the following:

- Second level service problem restoration
- Handling and analyzing Trouble Tickets (TTs), recommending timely actions and solutions for TT reduction after Root Cause Analysis (RCA) for customer delight (using Oracle MOS Tool)
- Handling and executing Change Requests (CRs) in stipulated time frame
- Ability to perform under time constraints depending upon the business requirements
- Emergency handling of HLR nodes across India
- Troubleshooting / maintaining performance of nodes and increasing throughput of networks

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8. HSS BASICS View document provided to interns by Ericsson India Global Services Pvt Ltd.
9. Nokia NT-HLR HSS Training a confidential training document provided to interns by Ericsson India Global Services Pvt Ltd.

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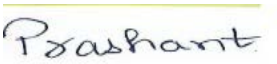
As per procedure I have to submit my project report to the university related to my work that I have done during this internship.

I have compiled my project report. But due to COVID-19 situation my project mentor in the company is not able to sign my project report.

So I hereby declare that the project report is fully designed/developed by me and no part of the work is borrowed or purchased from any agency. And I'll produce a certificate/document of my internship completion with the company to TnP Cell whenever COVID-19 situation gets normal.

Signature 

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