# Mobile devices vs Mobile operator's role in internet connectivity



Project Report – Business Project B

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# *ACKNOWLEDGEMENT*

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*Syed Muhammad Sheeraz Kazmi*

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## INTRODUCTION

Mobile phones have revolutionized the world since their advent with their capability to enable people to communicate. They are also revolutionized be it related to the size of the phone, the features incorporated, its exterior, its screen etc. Mobile phone is the most important tools used in communication now days. These are very critical devices which need to follow standards while in making but sometimes due to loose regulations mobile phones having issues are widely available in the open market. Customers are not bound to purchase mobile from the operators they can bring their own devices. Mobile internet connectivity can be divided into two main parts.

➔ The Network End ( Managed by Mobile Network Operators)
➔ The Customer Mobile Device ( Owned by customer)

We will review both parts and their role in the mobile internet connectivity and give recommendation that how the experience of customers can be made better.

## PROBLEM STATEMENT

Voice and SMS has dominated the mobile communication for years but since 3G in launched in Pakistan the data traffic is on the rise and after the launch of 4G last year the growth rate is very high. YoY comparison shows around 250% increase in 2014-15 while around 150% increase in 2015-16. The trend is increasing continuously Figure 1(Data Volume Trend in Pakistan). It demands:

➔ Better Customer Services
  o Increased focus on customer services
  o Resolution of issues quickly

➔ More Operational Efficiency
  o Reduce OPEX
  o Churn Rate Reduction

Customer service is the key focus area of all the service industry companies. They try to provide better services and products. Mobile Phone industry is also very important industry and with time mobile has become a commodity its customer care is also getting demanding day by day.
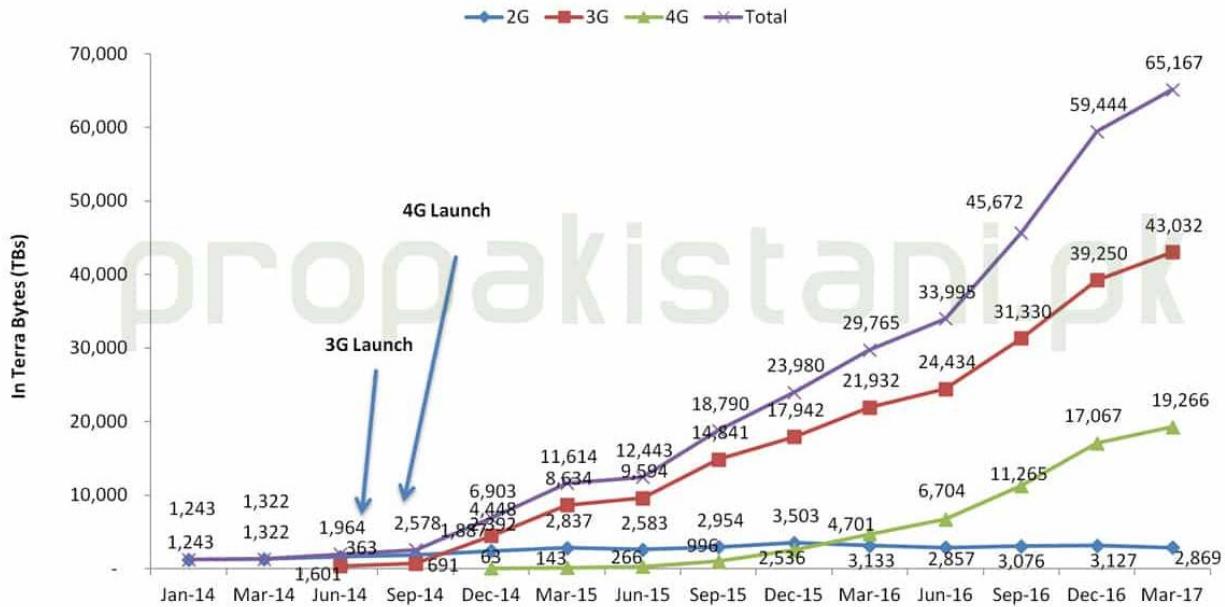
**Figure 1(Data Volume Trend in Pakistan)[1]**

The usage increase also brings increased customer expectation on the services quality and internet speed. The customer complaint trend also increased during these years. In this report we are going to analyse the importance of Mobile Network and Mobile device in internet connectivity.

## SCOPE

In this project we will go through the Internet connectivity value chain and recommend plan to improve the customer experience with new process. This project can be divided in two parts:

➔ Internet connectivity value chain
➔ Recommendations

The project execution steps will require guidance from the basic theories and practices of Budgeting & Financial Controls, HRM and Marketing.

## PROJECT FOCUS

The main focus of the project is to review the role of Mobile Network (owned by the Mobile operators) and Mobile Devices (which are owned by the customers) in the internet connectivity. Based on the analysis we will recommend how the operators can enhance customer experience by providing better

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[1] https://propakistani.pk/wp-content/uploads/2017/04/Data_Usage.jpg

service. The guidelines of EMBA subjects mainly Finance, Marketing and HRM were helpful in process. The recommendations are one of the important outcomes of the project since they can be applied in other areas also where customer services are important to achieve company strategic goal.

## EXECUTIVE SUMMARY

Mobile networks play vital role in our daily life. Mobile networks mainly comprise of four technical domains:

➔ Core network
➔ Radio network
➔ Transmission network
➔ Billing network

While on the other hand customers have use Mobile Station to connect with the mobile networks. Mobile station is very critical as it enable the customer to use complete services of the mobile network. Mobile stations are of mainly two Major types, Feature phone and Smart phone (considering all smart hand held devices here). Customers are free to buy the devices from the market to be used with mobile networks. Mobile stations play very vital role in the connectivity with the network. Mobile operators face lot of challenges related to customer experience even when it is nothing to do with the network. This is very important area which needs dedicated focus from the operators to help customers getting better experience of internet services. Dedicated Mobile Device Management Team is recommended in each mobile operator who should manage the device testing and troubleshooting for better customer experience in their network.

## SELECTION CRITERIA OF THIS PROJECT

I am looking after the operations and maintenance team; we also face lot of challenges in the form of customer complaints mainly complaining the internet speed and experience. We came across with these issues every day, based on our analysis many issues we face are due to the devices. To verify our analysis we want to do complete analysis of mobile device vs Mobile Operator role in the internet connectivity. The analysis in this report will help me for the below mentioned.

➔ Getting Recommendations to improve the user experience.
➔ Will be helpful to make better use of existing tools
➔ Improve existing process based on the recommendation in this report

## OBJECTIVES TO BE ACHIEVED

This report need to fulfil the below objectives after completion of this project:

a. Analysis summary of the issue
b. Give recommendations for the better customer experience
c. Identify any process improvement

## MOBILE INTERNET CONNECTIVITY VALUE CHAIN

Mobile internet connectivity value chain is dependent on two domains mainly.

➔ Mobile Network
➔ Mobile Phone

In below mentioned sections we will view in depth how the mobile network works and what are the main components in the mobile network which are necessary to manage the mobile internet connectivity. Also we will discuss the role and working of the mobile phone.

### MOBILE NETWORK

A cellular data network is composed of cells which connects user to the services. Each cell has beam antennas which connects user to the network. Antennas operate on different frequencies and signal strength level. Cellular operators take license from PTA to operate on these spectrum or frequency bands. For example, 3G and 4G can be on same frequency band or can be on different, depends upon the network provider, how it configures it. Figure 2(Cellular Network) shows how a sample cellular network and all its adjacent cells always have different frequencies for same technology to avoid interference.

Mobile Devices select network either 3G or 4G based on frequency support they have, If a mobile device doesn't support 4G, it will never able to latch on 4G network even if he has all other tools available for it e.g USIM (UMT Subscriber Identity Module) and network support on cellular network. So mobile device is equally important when we are discussing connectivity, anyone can check Mobile supported Technologies and frequency bands from GSMARENA when buying new device to make sure it will not create any problem with your carrier or Data Network provider.
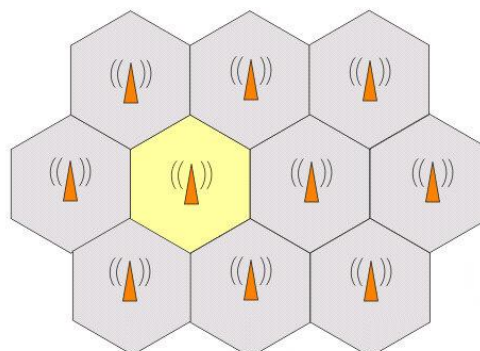


**Figure 2(Cellular Network)**

Mobile Networks comprises of four primary technical domains.

## CORE NETWORK

Core network is the heart of the mobile network. It contains the call switching nodes, Media Gateways, Subscriber data registers and Mobile number portability information. Core network handles all Voice, SMS and Data handling for the subscribers.

## RADIO NETWORK

Radio Network contains all the Base Stations active and passive nodes. The BSC/RNC is also resided under the Radio Domain. Radio frequency management and the subscriber mobility management are the key activities managed in this domain.

## TRANSMISSION NETWORK

The interconnectivity between all the domains in the Mobile network is governed by the transmission network. Transmission domain utilizes technologies like Optical fiber, Microwave, Satellite, IP, etc.

## BILLING NETWORK

Service billing management is managed under billing networks. All the offer and products designed by the commercial teams are mapped on the billing platform to ensure smooth usage and fair deduction for the subscribers.

## EVOLUTION OF DATA NETWORK

Mobile Data wasn't part cellular network providers from beginning; it evolved with the rising need of data services. **1G Network** (First Generation) network was based on analog systems and signals were not strong enough to carry data traffic. Rate of information transfer was only designed to carry voice traffic and data was out of the picture. **2G Network** was the first cellular network which showed support of data transfer but was limited to streamed data like text messages as throughput wasn't enough to support images or videos transfer. Later 2.5G and then 2.75G revolutionize the world with satisfactory data services where customers were able to browse and load images but video playing was still very far from the scope. **3G Network** was provide faster data services with greater upload and download speeds and video calling but still there was lag while playing high definition videos and 3D games which need more data rate. The need for speed never ended here. **4G Network** the goal of 4G was to achieve 1Gps when stationary and 100 Mbps on the move but these values in ideal situations where we have necessary frequency spectrum and have implemented MIMO (Multiple input, Multiple Output) antennas. Not all the phones support 4G and those which support, not all of them support all spectrums of 4G so operators need to be very careful before launch of 4G in any selected area. 4G Mobile handsets penetration and data usage rate is key decision factor to select any area for 4G coverage issuance.
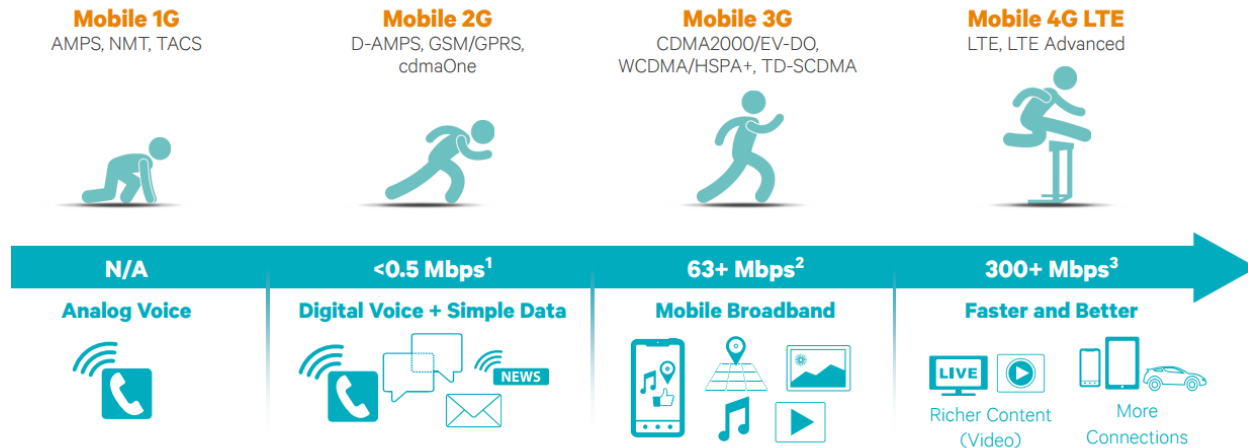
**Figure 3(Evolution of Mobile Technology for better experience)**

## 4G/EPC NETWORK ARCHITECTURE & MOBILE CONNECTIVITY

4G or EPC (Evolved Packet Core) is the latest architecture in production by 3GPP. It has flat architecture to have better and fast data rate to provide user extreme experience they are looking for. Figure 4(4G/EPC Generalized Architecture) showing a simplified diagram of 4G Data network and here is brief description of each node[2].

## ENODEB

EnodeB is radio access node of 4G network, EnodeB (Evolved NodeB) is responsible of radio resources allocation. It is intelligent node which have adaptive modulation scheme and it varies channel modulation according to the weather situation and availability of resources. If you are getting a 4G signal, you are attached to EnodeB.

## MME

MME (Mobility Management Entity) is responsible of signalling related to mobility and security. It is directly attached to the Home Subscriber Server (HSS) to authenticate users. It tracks user location and page it upon incoming service request i.e. for incoming Text message or call or WhatsApp message you can say.

## SERVING GW

Serving Gateway is new node in 4G/EPC network architecture; it is introduced to separate Data and signalling planes. It serves as Gateway to Data Network and directly connected with Packet Gateway (PGW) and MME. Data of roaming subscribers also passes thorough this node.

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[2] http://www.3gpp.org/technologies/keywords-acronyms/100-the-evolved-packet-core

## PDN GATEWAY

PDN Gateway (Packet Data Network Gateway) is last mile of the Packet Data Network you can say. This node is responsible of charging, policy enforcing and routing traffic towards internet.

## HSS (HOME SUBSCRIBER SERVER)

HSS is home of the subscriber, all static data related to user is present in HSS. Like, 4G user, have data services enabled, can use voice and USSD services and much more. Definitions of HSS are static.

## PCRF

Policy and Charging Control Function is responsible of charging rules installation, it tells PGW, which policies are applicable to the user and it also tells billing system, how to bill this user and much more. (3GPP, 2008)
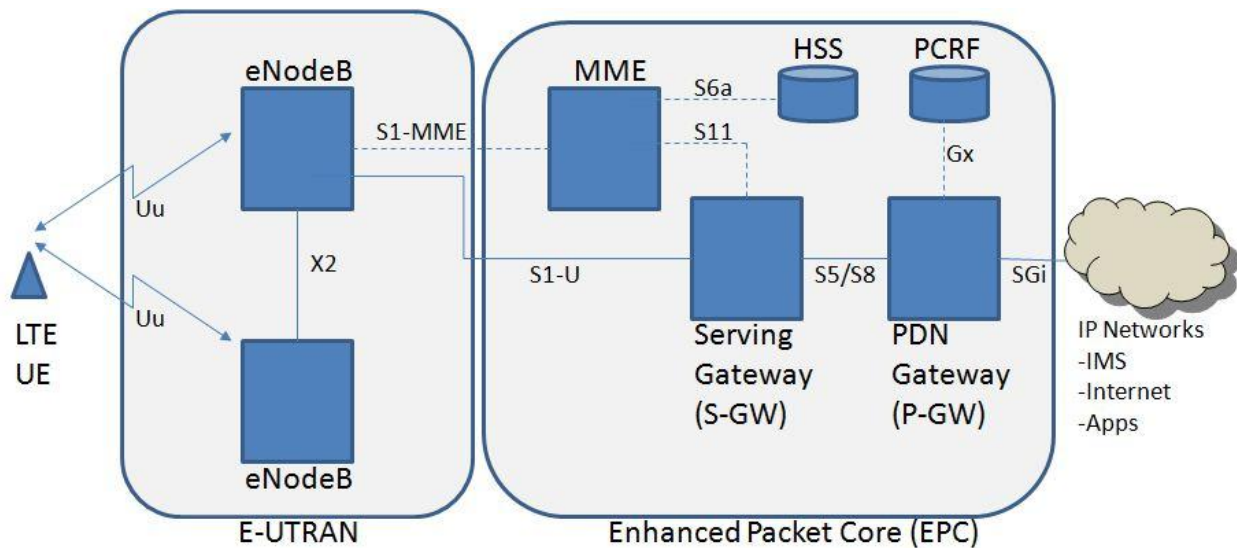


Figure 4(4G/EPC Generalized Architecture)

## CONNECTIVITY OF 4G/EPC/LTE USER

4G, EPC or LTE can be used interchangeably; In LTE user is always connected to the network. Mobility Management (EMM) and EPS Session Management (ESM) functions are two major NAS (Non-Access Stratum) functions. Figure 5(Mobile Connectivity Modes) shows user connectivity modes in 4G Network.
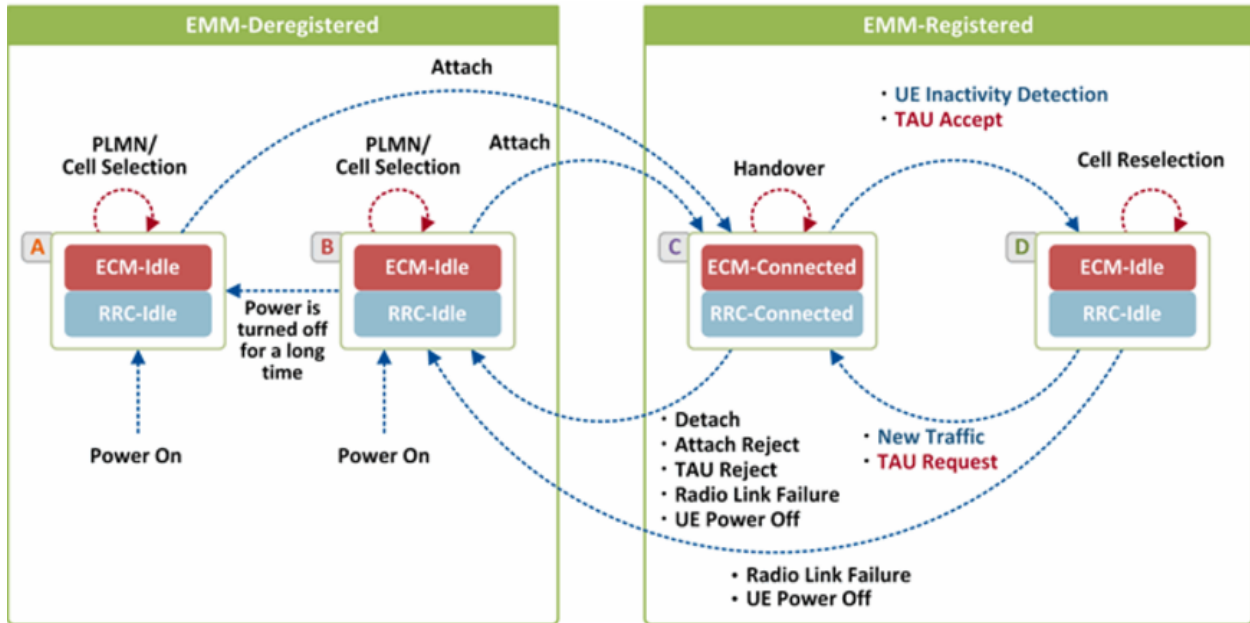
**Figure 5(Mobile Connectivity Modes)**

## 4G USER ATTACH FLOW

When user turns on its mobile phone, Cell phone started looking for the signals. Preferred network information exists in the SIM card. Every Cell in Cellular network advertises its MNC and MCC so that subscriber of cellular network can find them through this broadcasted message. Usually cellular network coverage overlaps so Mobile device make a queue of all available cells based on their Signal to Noise Ratio (SNR) and select the one which has highest SNR or you can say which has less noise or strong signal. (David Amzallag, 2009)

## 4G MOBILE ATTACH FLOW

### INITIAL UE MESSAGE

This is the message which UE sends to ENodeB to initiate attach procedure to the network. This is a type of NAS message. It contains;

   i.    NAS PDU IE (This field contains the NAS message ID)

> ...id-NAS-PDU: 0x1A
>
> ...CRITICALITY: reject(0x00)
>
> ...Number of Octets in IE: 0x3D

   ii.    TAI IE. This message contains the tracking area information of the UE handset

```
CRITICALITY: reject(0x00)
Number of Octets in IE: 0x06
Message Extension: no present(0x00)
IE Extension: no present(0x00)
PLMNidentity: 64 F0 10 (Hex)
TAC: 50 50 (Hex)
```

iii.   EUTRAN CGI IE. This message contains the PLMN ID for initial IMSI attach

```
CRITICALITY: ignore(0x01)
Number of Octets in IE: 0x08
Message Extension: no present(0x00)
IE Extension: no present(0x00)
PLMNidentity: 64 F0 10 (Hex)
CellIdentity: 00 00 10 20 (Hex)
```

iv.   RRC establishment cause. This message contains the information why user has requested network attach to the network.

```
id-RRC-Establishment-Cause: 0x86
CRITICALITY: ignore(0x01)
Number of Octets in IE: 0x01
RRC-Establishment-Cause: mo-Signalling(0x03)
```

## ATTACH REQUEST

This message contains the attach request message to the network. It is NAS message type EMM register. It contains following fields.

i.   Attach Type. This field contains what type of attach request

ii.   EPS mobile ID. This field contains IMSI

iii.   UE network capability. This message tells the network capability

iv.   MS network capability. In this message Mobile Station shows it's capabilities to the network so that network can provide services based on handset specifications. For example, if some device doesn't GEA/1 encryption and support only GEA/2 encryption, network will select GEA/2 encryption method for this specific user. If network doesn't support GEA/2 encryption, this attach will fail or you can configure to allow such attach without encryption, depends upon network configurations. This clearly shows how mobile phones are playing their roles. No doubt Smart Phones are awesome invention. Here is a display from Network showing Mobile station capability when it's trying to attach 4G network.

- Ms Network Capability Length: 3 (Bytes)
- GPRS Encryption Algorithm GEA/1 : Available  (0x01)
- SM Capabilities via Dedicated channels: Support (0x01)
- SM Capabilities via GPRS Channels: Support (0x01)
- UCS2 Support: ME has a preference for the default alphabet over UCS2 (0x00)
- Supplementary Service Screening Indicator: capability of handling of ellipsis notation and phase 2 error handling (0x01)
- SoLSA Capability: not Support (0x00)
- Revision Level Indicator: supporting R99+ protocol (0x01)
- BSS Packet Flow Procedure Feature Mode: Support (0x01)
- GPRS Encryption Algorithm GEA/2-7 (0=notAvailable 1=Available): 100000
- Location request Notification via PS Domain: not Support (0x00)
- PS Inter-RAT HO to UTRAN Iu Mode Capability: not Support (0x00)
- PS inter-RAT HO to E-UTRAN S1 Mode Capability: not Support (0x00)
- CSFB Capability: not Support (0x00)
- ISR Support: not Support (0x00)
- SRVCC to GERAN/UTRAN Capability: not Support (0x00)
- EPC Capability: Support  (0x01)
- Spare: 0x00

    v.      TMSI Status: check if Temporary Mobile Subscriber Identity is Valid or not, if not, assign new TMSI

   vi.      Encryption level support of the network. Before, it was support of handset, now this field shows network encryption support to negotiate

## USER AUTHENTICATION

The MME then uses the S6a interface to the HLR to perform checks if the user is authorized to attach to the network. Before delivering the authentication response the MME will provide UPLINK and DOWNLINK NAS transport messages. These messages contain the MME ID and ENodeB ID.

- MME UE S1AP ID IE
- eNB UE S1AP ID IE
- NAS PDU IE
- EUTRAN CGI IE
- TAI IE

## SECURITY MODE COMMAND

This message contains the type of Algorithm selected for security.

## SECURITY MODE COMPLETE

This message is an ACK of the message sent by the UE to the security mode command message.

## PDN CONNECTIVITY REQUEST

This is an ESM message in which UE requests connectivity/IP from the network.

## UPDATE LOCATION REQUEST AND ANSWER

Location update is performed via the SGs interface for combined attach in case of CS call in which the MS will fall back as EPC/4G network doesn't support voice services so need to update user location on circuit switched network as well to have access to voice calls.

## CREATE SESSION REQUEST

This message is sent by MME to SGW to create data session of the user. Which SGW should be asked to create session? MME knows it by defined static configurations that if request is coming from this Tracking area code select this SGW and if selected SGW is this, this PGW which is nearest. This message contains following details.

- i. GTP Header : Gateway Tunneling Protocol Header
- ii. IMSI : International Mobile Subscriber Identity
- iii. MSISDN : Mobile Subscriber ISDN
- iv. User Location Info : LAC/TAC/Cell ID
- v. RAT Type : Radio Access Type, UMTS
- vi. MME TEID : MME Tunnel End point identifier
- vii. PGW TEID. In this message, Note that TEID GRE will be 0 as it does not know the TEID of PGW of s5/s8 interface yet.
- viii. APN Name : Access Point Name, which is define in Mobile handset
- ix. PDN Type : Packet Data Network Type
- x. Maximum APN restriction and APN-AMBR
- xi. Protocol configuration options
- xii. Bearer Context List : To provide Quality of Service and bearer information

## CREATE SESSION RESPONSE

This message comes in response to MME (Create session Request) message.
- i. Cause: Request Accepted or Rejected?
- ii. S1-U SGW TEID: SGW Tunnel End point identifier

iii. PGW TEID: PGW Tunnel End point identifier because SGW is attached to PGW and SGW has already asked PGW to create new session and got the response with Tunnel end point.

## ACTIVATE DEFAULT EPS BEARER REQUEST.

Sent from MME to ENodeB to tell UE to set up a default bearer for the end user, it contains following information.

i. EPS QoS : QCI Class which network is providing to the mobile subscriber
ii. APN and network Info: APN name which Mobile station will append against already configured APN name. For example, Mobile station has configured **internet** APN and Network provided **mnc001.mcc002.xyz.gprs,** The APN is now **internet.mnc001.mcc002.xyz.gprs.**
iii. Negotiated QoS : Peak Throughput based on negotiated QoS. This is the peak throughput which network can provide to the user but it doesn't mean that Network will surely provide this throughput; it depends upon a lot of factors. Like Radio Conditions, accessibility of the video server or website user is accessing etc.
iv. Protocol Configuration Options

## ATTACH ACCEPT

Sent from MME to ENodeB to acknowledgement of attach request. GUTI is assigned to the UE in this message.

## INITIAL CONTEXT SETUP REQUEST

This is a message sent from MME to ENodeB to setup a EUTRAN Radio Access Bearer. There are many types of Bearers and radio bearers are most important ones as they are scars.

i. MME S1AP UE Id
ii. ENodeB S1AP UE ID
iii. E-RAB to be setup Info
iv. QoS Information
v. Security Parameters

All these Messages are from MME which performs mobility. By this point of time, user has been attached to Data Network (4G) and assigned bearers to access service. However if we look at the messages on Packet Gateway, we can find all the charging policies inserted by PGW based upon the package ID user has subscribed or other location based services. Packet Gateway (PGW) is also responsible to trigger for Online and offline billing as it is directly connected to charging and billing system also called CBS or you can simply say Intelligent Network or IN.

## MOBILE PHONES

Mobile devices are key drivers for data demands. Currently there are almost 7 Billion mobile devices connected to the data networks, close to the total number of people on earth.it is forecasted that mobile devices will be around 25 Billion by the end of year 2020. Why Cellular Network providers moved from 2G to 3G to 4G and now looking towards 5G? Because these connected mobile devices are getting data hungry, each new mobile device shows support for richer media contents and bandwidth handling capabilities so cellular networks are enhancing their network to fulfil the rising demand of Data from such data hungry devices. With each passing day, there is new online 3D game which demands huge data rate with low latency and when users want to play such games, your network must be able to handle this. Here are some Specifications of latest mobile phone devices.



Figure 6(Every gadget a mobile phone or mobile phone combine every gadget?)

## EXTREME PERFORMANCE

Today's mobile phones have processing powers which are even greater than super computers of 1990s. Recent mobile phones are rumoured to come with 8GB of Ram and Octa-Core Snapdragon processors with 2.4 GHz processor in one core. Imagine what this device can do. 6 6G RAM phones with Snapdragon 835 series processors are already in the market.

## JAW-DROPPING GRAPHICS

The need of online 3D gaming is the new trend so the latest handsets are coming with extreme GPU. Current devices support Adreno 550 series GPUs and 16M LED backlight screens which is way smarter than anything on earth.

## HIGH QUALITY MULTIMEDIA

4K videos are no longer a rumour and time has gone when you have to buy extra-ordinary LED TVs to watch a 4K video, now all flagships of main mobile phone manufacturers support 4K videos and not

only this, HD Gaming console, 5.1/7.1 surrounded sound system and high resolution cameras which provide results not lesser than DSLRs are normal new now.

## RELIABLE CONNECTIVITY

Smart Phones have mechanisms now to overcome signal problems which are very weak by using latest technologies built in these devices and ultra-high speed Digital Signal Processors (DSP).

## BROADBAND SPEEDS

Mobile phones are getting bandwidth hungry by showing more and more support to faster data rates. Current handsets in the market support more than 300 Mbps and Cat9 4G/LTE.

## LONG BATTERY LIFE

And you power this amazing device for whole day use in one charge. Current devices also show support to fast charging which charges battery of your phone to 60% in less than 30 minutes. What else you need? And things are getting even better with the passage of time.

## MOBILE PHONE CATEGORIES

Mobile phones can be divided high level in two categories.

➔ Feature Phone
➔ Smart Phone

### FEATURE PHONE

**"Feature phone** is a term typically used as a retronym to describe mobile phones which are limited in capabilities in contrast to a modern smartphone. Feature phones typically provide voice calling and text messaging functionality, in addition to basic multimedia and Internet capabilities, and other services offered by the user's wireless service provider. A feature phone has additional functions over and above a basic mobile phone which is only capable of voice calling and text messaging. Feature phones and basic mobile phones tend to use a proprietary, custom-designed software and user interface. By contrast, smartphones generally use a mobile operating system that often shares common traits across devices". (Wikipedia-Feature Phone)[3]



Figure 7(One of the most famous Feature Phone of all times- Nokia 3310)

### SMART PHONE

"A **Smartphone** is a mobile personal computer with a mobile operating system with features useful for mobile or handheld use. Smartphones, which are typically pocket-sized (as opposed to tablets, which are much larger in measurement), have the ability to place and receive voice/video calls and create and receive text messages, have personal digital assistants (such as Siri, Google Assistant, Alexa, Cortana, or Bixby), an event calendar, a media player, video games, GPS navigation, digital camera and digital video camera. Smartphones can access the Internet through cellular frequencies or Wi-Fi and can run a variety of third-party software components ("apps" from places like Google Play Store or Apple App Store). They typically have a colour display with a graphical user interface that covers more than 76% of the front surface. The display is almost always a touchscreen and sometimes additionally a touch-enabled keyboard like the Private/Passport BlackBerrys, which enables the user to use a virtual keyboard to type words and numbers and press onscreen icons to activate "app" features.

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[3] https://en.wikipedia.org/wiki/Featurephone

In 1999, the Japanese firm NTT DoCoMo released the first smartphones to achieve mass adoption within a country. Smartphones became widespread in the late 2000s. Most of those produced from 2012 onward have high-speed mobile broadband 4G LTE, motion sensors, and mobile payment features. In the third quarter of 2012, one billion smartphones were in use worldwide. Global smartphone sales surpassed the sales figures for feature phones in early 2013" (Wikipedia Smartphone).[4]



**Figure 8 (Popular Smart Phones now a days)**

## HOW MOBILE PHONE WORKS

"On a "complexity per cubic inch" scale, cell phones are some of the most intricate devices people use on a daily basis. Modern cell phones can process millions of calculations per second in order to compress and decompress the voice stream. If you have read How Cell Phones Work, you know that they can transmit and receive on hundreds of FM channels, switching channels in sync with base stations as the phone moves between cells.

If you ever take a cell phone apart you will find that it contains just a few individual parts:

➔ A microscopic microphone
➔ A speaker
➔ An LCD or plasma display
➔ A keyboard
➔ An antenna
➔ A battery
➔ A Printed circuit board containing different key circuits

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[4] https://en.wikipedia.org/wiki/Smartphone

The circuit board is the heart of the system. Here is one from a typical cell phone:
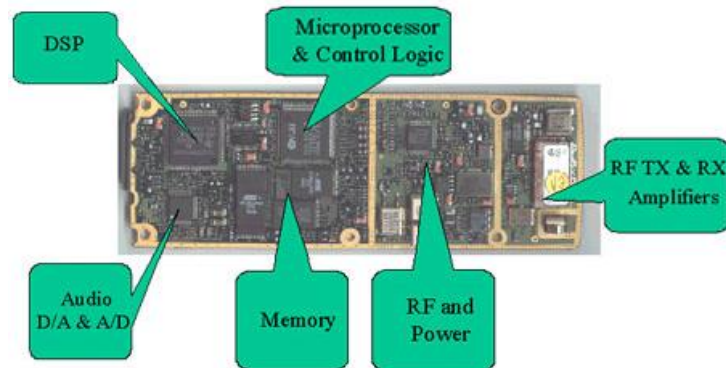
Figure 9(Mobile Phone Electronic Circuit)

In this picture several of the components are identified. Starting from the left you can see the Analog-to-Digital and Digital-to-Analog conversion chips. You can learn more about A-to-D and D-to-A conversion and its importance to digital audio. The DSP is a "Digital Signal Processor" -- a highly customized processor designed to perform signal manipulation calculations at high speed. This DSP is rated at about 40 MIPS (Millions of Instructions per Second) and handles all the signal compression and decompression. The microprocessor (Ericsson phones use an ASIC version of the Z-80) and memory handle all of the housekeeping chores for the keyboard and display, deal with command and control signalling with the base station and also coordinate the rest of the functions on the board. The RF and power section handles power management and recharging and also deals with the hundreds of FM channels. Finally the RF (Radio Frequency) amplifiers handle signals in and out of the antenna.

What is amazing is that all of that functionality -- which only 30 years ago would have filled the entire floor of an office building -- now fits into a package that sits comfortably in the palm of your hand[5]" (How Stuff Works-Inside Mobile device).

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[5] http://electronics.howstuffworks.com/inside-cell-phone.htm

Diagram Showing the Basic Working Principle of Mobile Phone

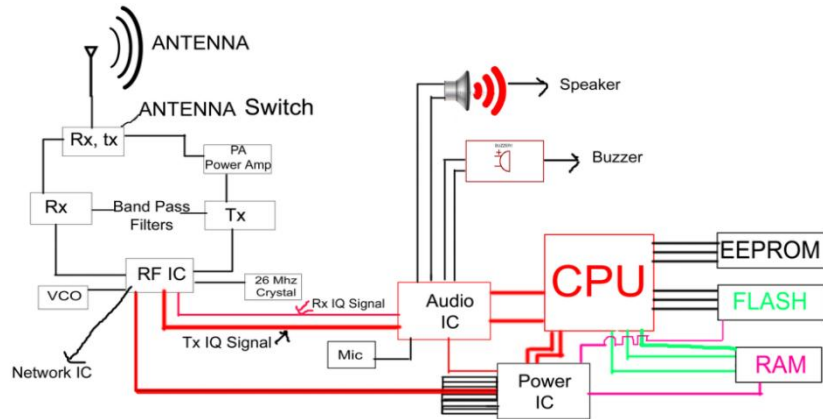© Reviewat8.in                                                                 6

**Figure 10(Block Diagram of Mobile)**

## MOBILE NETWORK VENDORS AND MOBILE PHONE VENDORS EVOLUTION

Eco system establishment and sustainability is the must win battle for all business. There are lot of examples around which emphasis this logic. Mobile Phone and Mobile Networks works hand in hand to ensure the eco system sustain and the customers stay satisfied. Few examples from both vendors which resolve problems faced by the customers are mentioned below.

### MOBILE PHONE VEDNORS SOLVED NETWORK PROBLEMS

The evolution of Mobile devices bring a lot of challenges for network providers too to deal with, not only the network providers but also mobile devices worked together to solve these network problems as it was win-win situation for both to achieve common goals to provide smooth and reliable connectivity experience. Here are few challenges which were faced and resolved by mobile Device manufacturers.

### CELL-EDGE CHALLENGE

This problem aroused when cell phone on the edge of the call is getting equal strength of radio signal on same frequency, it becomes difficult for cell phone to select cell. Mobile phone manufacturer especially QUALCOMM worked closely on this problem and come up with the solution by providing simultaneous communication of phone with more than one cell site and actively measuring signal strength of cells. If signal strength from two cells is same, it will retain old cell unless newer cell exceed in specific amount of signal strength from old one (Make sense).

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[6] http://www.reviewat8.com/2012/10/basic-working-principle-of-mobile-phone.html

Figure 11(Cell Edge Challenge)

## NEAR-FAR POWER CHALLENGE

This was the issue when Mobile phone was generating same power signal either it is close to the network or far from the network. This way, when user was close to the network, it gets huge signal power and when it's far it gets less power. It was solved by introducing continuous control of transmitted power based on received signal strength. If you are close to the tower, transmit less power and if you are far, transmit more power[7]. (Qualcomm, 2010)



Figure 12(Near-Far Power Challenge)
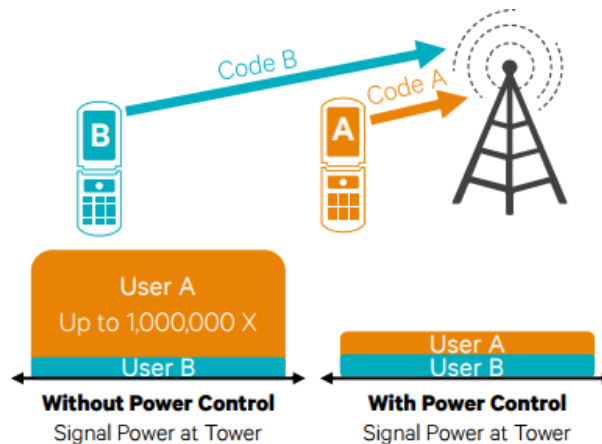
## MULTIPATH FADING CHALLENGE

This problem appears when one mobile phone receives same signal from different paths, either due to reflection or deflection which causes lesser signal to noise ration. It is resolved by reconstructing all signals which improves quality of signal keep same noise level and ultimately providing superior connectivity.

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[7] https://www.qualcomm.com/products
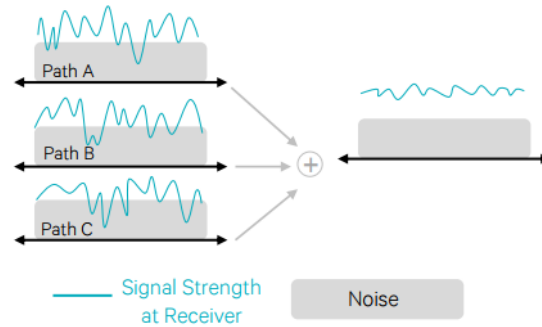
Figure 13(Multipath fading challenge)

## NETWORK VENDORS SOLVED MOBILE PHONES PROBLEMS

Network Providers role is huge in proving solution to problems faced while connecting with mobile devices. Researchers of telecom providers are always looking for the potential problems and their solution. Here are few main problems which are solved by cellular network providers to better and reliable connectivity experience.

## ADAPTIVE MODULATION FOR HIGHER DATA RATES

To provide faster data transfer, mobile networks provides adaptive modulation schemes, higher modulation is able to transfer data on higher rate it means more bits using one symbol when signal quality is good but when user is away and signal quality is not good, you cannot keep same data rate as signal quality is very low and it cannot bear the load. Cell sites automatically fall to lower modulation schemes to provide reliable connectivity.
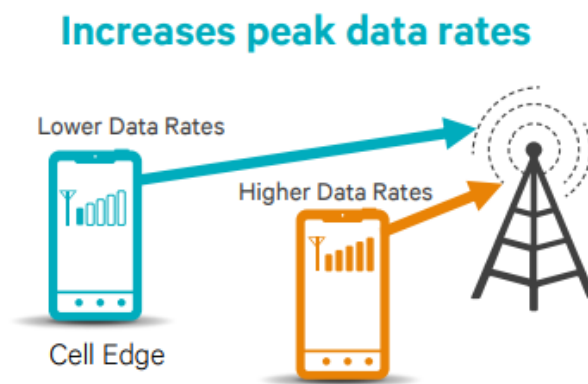


Figure 14(Adaptive Modulation for Higher Date Rates)

## CARRIER AGGREGATION

Higher data rate usage demands pushing network providers away from their boundaries, usually there is only one channel for one user but cellular network providers have adopted techniques of carrier aggregation which binds multiple channels to provide better data rate to Mobile user[8].

(Technology, 2014)
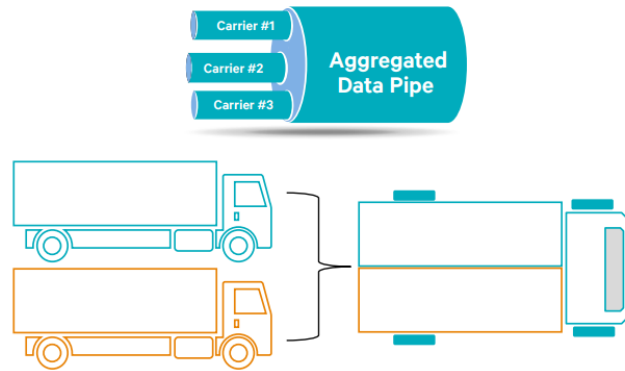


**Figure 15(Carrier Aggregation)**

## USE OF MIMO (MULTIPLE INPUT MULTIPLE OUTPUT)

MIMO support required in both handset and Cellular network provider, in this technique, mobile phone is connected to two antennas at the same time which doubles data rate of users and helps to fulfil never ending data rate desires of users.
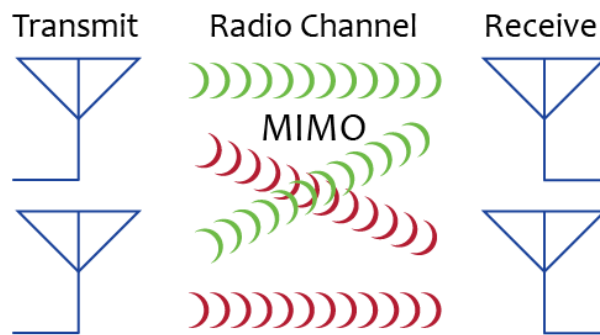


**Figure 16(Use of MIMO)**

## MBTS INTRODUCTION

It was a huge issue for network providers that many devices doesn't show support for all frequency spectrums so even if your device support 4G services, sometimes you were unable to latch on your home network just because your home networks doesn't have your handset supported frequency. The solution to this problems was bring forth by cellular providers by providing MBTS(Multimode base station) which uses all available frequency for all available technologies (2G,3G,4G).

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[8] https://storify.com/qualcomm_tech

## ROLE OF MOBILE NETWORK OPERATOR IN THE MOBILE CONNECTIVITY

A mobile network operator or MNO, also known as a wireless service provider, wireless carrier, cellular company, or mobile network carrier, is a provider of wireless communications services that owns or controls all the elements necessary to sell and deliver services to an end user including radio spectrum allocation, wireless network infrastructure, back haul infrastructure, billing, customer care, provisioning computer systems and marketing and repair organizations.

In addition to obtaining revenue by offering retail services under its own brand, an MNO may also sell access to network services at wholesale rates to mobile virtual network operators.

A key defining characteristic of a mobile network operator is that an MNO must own or control access to a radio spectrum license from a regulatory or government entity. A second key defining characteristic of an MNO is that an MNO must own or control the elements of the network infrastructure necessary to provide services to subscribers over the licensed spectrum.

A mobile network operator typically also has the necessary provisioning, billing and customer care computer systems and the marketing, customer care and engineering organizations needed to sell, deliver and bill for services, however, an MNO can outsource any of these systems or functions and still be considered a mobile network operator.[9]

As an owner of the mobile network all responsibility of issues and troubleshooting for network related problems are handled by the Mobile Network Operators. We are analysing the role of mobile operators in the internet connectivity as per the technical information we have included in the beginning it is evident that Mobile networks plays vital role in the internet connectivity. While in the later report information related to the mobiles shows Mobile Phone role in the internet connectivity. Below is the action plan to build the analysis and recommendations:

## THE ACTION PLAN

The Project analysis is based on the survey from the subscribers to determine their perception of the responsibility for the mobile internet connectivity issue resolution. The survey consists of 10 questions which are show in the Exhibit I.

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[9] https://en.wikipedia.org/wiki/Mobile_network_operator

## SURVEY DESIGN AND LIMITATIONS

The survey is mainly distributed into 2 parts:
➔ Demographics and Basic Information
➔ Customer Perception of Mobile Phone vs Mobile Network in internet connectivity

### DEMOGRAPHICS AND BASIC INFORMATION

Few questions asked related to mobile operator, age, mobile phone category, mobile phone operating system and daily mobile internet usage.

### CUSTOMER PERCEPTION OF MOBILE PHONE VS MOBILE NETWORK IN INTERNET CONNECTIVITY

This part of the survey is they to understand the expectation of the customers related to the mobile internet connectivity. In this part we have asked questions to identify customers knowledge of the internet connectivity issue and in their perception who is responsible of the issues related to the internet connectivity.

### LIMITATIONS IN THE SURVEY

Few limitations faced in the free online survey are below mentioned:

➔ Only allowed to take feedback of first 100 respondents
➔ Maximum 10 questions were allowed to be asked
➔ Limited graphical analytics was allowed
➔ Survey was done in general public and colleagues

## SURVEY RESULTS AND KEY OBSERVATION IN THE SURVEY

The survey was kept simple and focused on the customer perception related to the subject issue. There are multiple factors which impact the internet connectivity. The key observations are below mentioned:

### DEMOGRAPHICS

The Survey was done on social media, office and other colleagues via emails. Survey respondents mainly belong to the age group 25 to 44 years which was approximately 88%. Infographics related to the people viewed the survey via LinkedIn is attached in Exhibit IV.

## What is your age?

Answered: 100    Skipped: 0



**55 to 64**
**1.00% (1)**

**18 to 24**
**9.00% (9)**

**45 to 54**
**2.00% (2)**

**35 to 44**
**32.00% (32)**

**25 to 34**
**56.00% (56)**
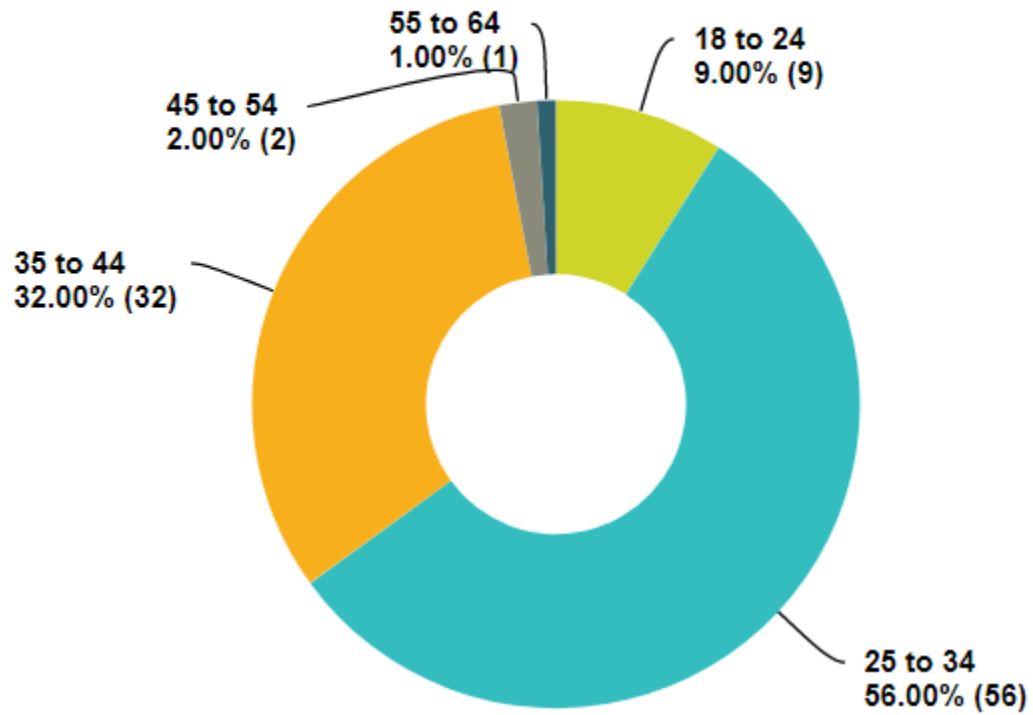
**Figure 17(Survey Question 10)**

## MOBILE INTERNET BOOM

All the people responded to the survey said that they use mobile internet which points to the fact that mobile internet usage is on continuous rise. Other research around the world also proves that mobile internet usage is going to surpass the voice on exponentially high rate.
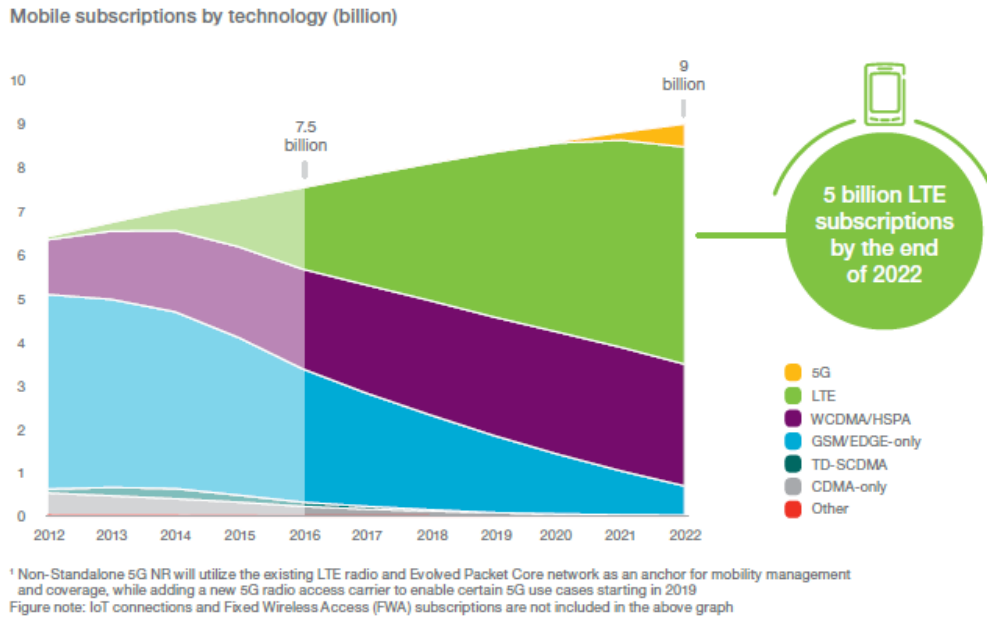


**Figure 18(Mobile subscriptions by technology)**
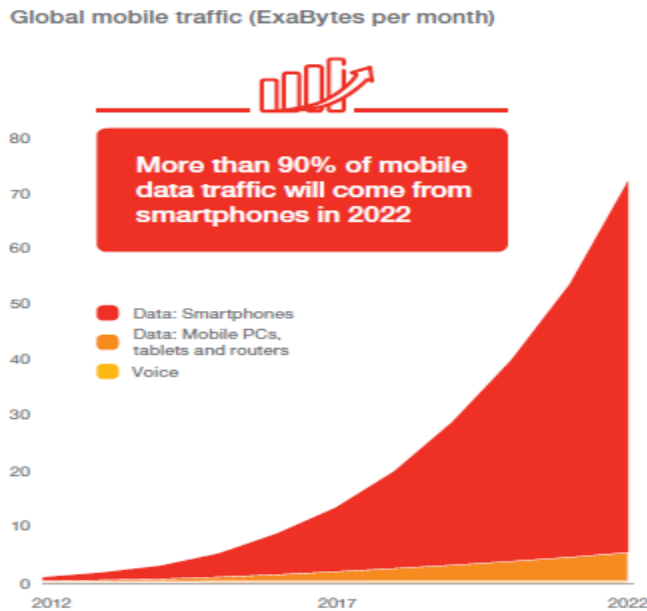


**Figure 19(Global mobile traffic 2022)**
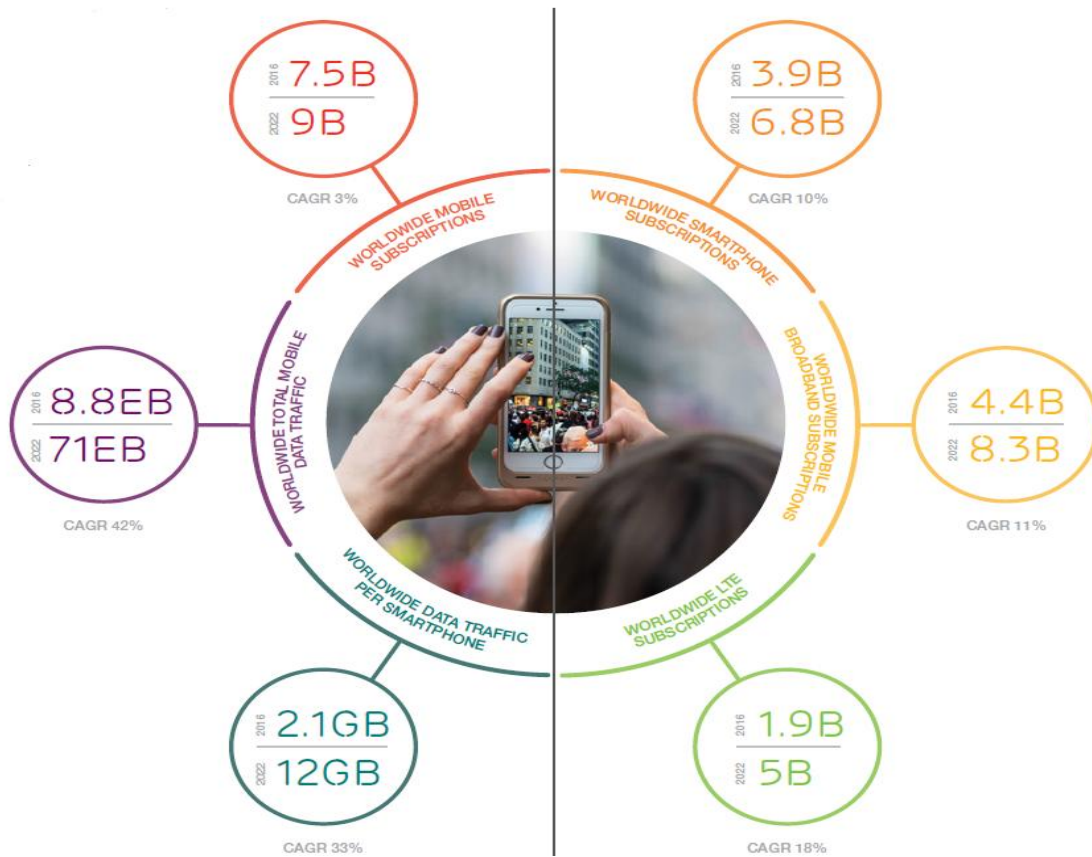
**Figure 20(Ericsson Mobility report June 2017)[10]**

## SURVEY RESULTS
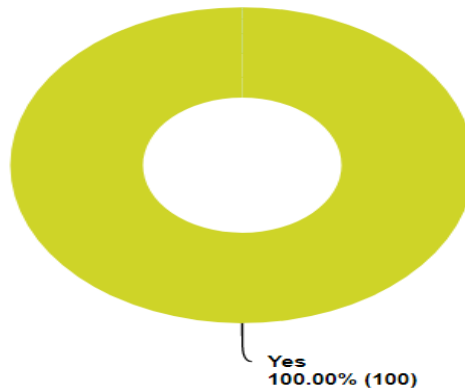


**Figure 21(Survey Question 1)**

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[10] https://www.ericsson.com/assets/local/mobility-report/documents/2017/ericsson-mobility-report-june-2017.pdf

## MOST OF THE PEOPLE ARE USING SMART PHONE WITH ANDROID OS

Survey results shows that most of the respondent are using the Android OS Smart phones. Minority is using feature phone also. Global trends also point in this direction. One of the German research institute report said Pakistan is number 6th market for smart phone growth. Around 97% users are using the smart phone while only 3% users are using feature phone. Survey also shows that 72% of users are using android Mobile OS. While 26% are using Apple ioS.
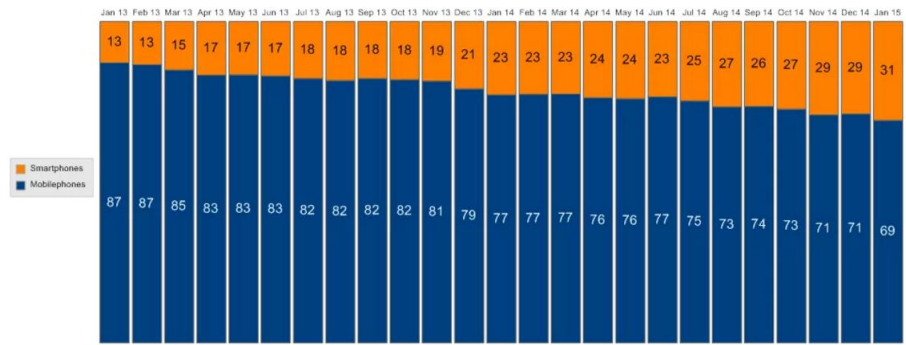


*According to a study by GfK, a German market research institute, Pakistan is 6th on the list of top smartphone markets for growth by value.*

**Figure 22(GfK survey)**

## SURVEY RESULTS



**What kind of mobile phone do you own for mobile Internet?**

Answered: 100    Skipped: 0

Feature Phone 3.00% (3)

Smart Phone 97.00% (97)
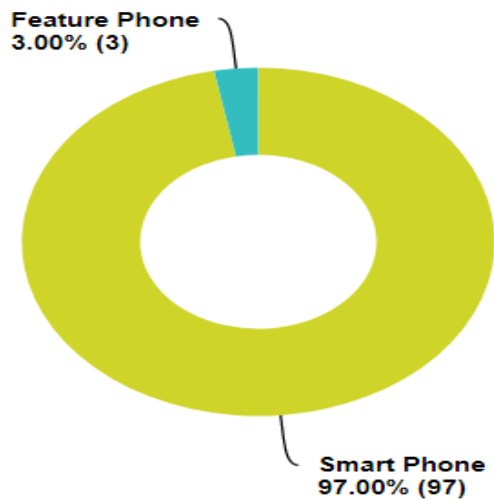
**Figure 23(Survey Question 3)**

## What is the operating system of your Mobile Phone?

Answered: 100    Skipped: 0
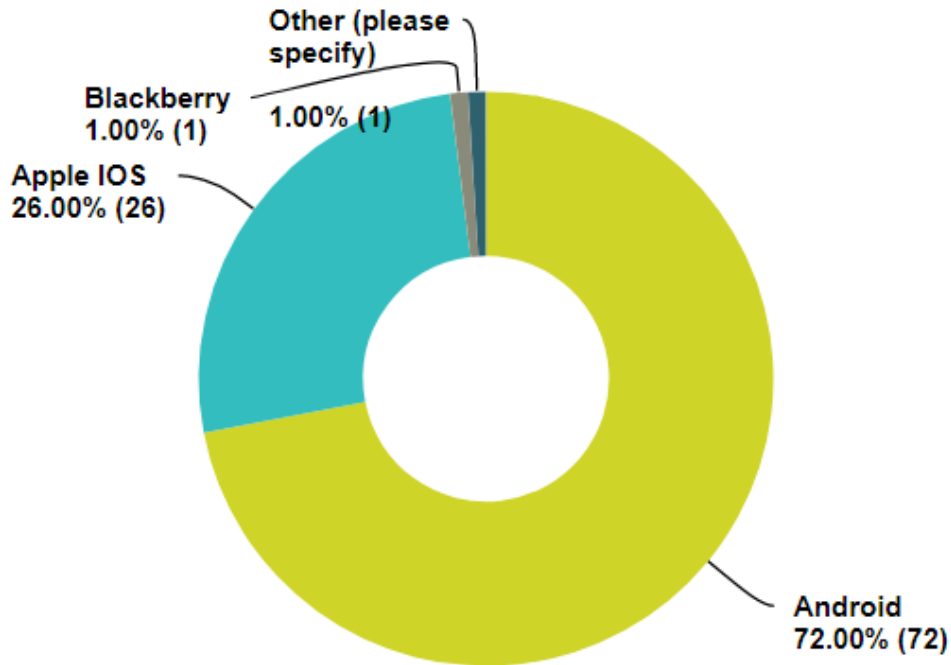


**Figure 24(Survey Question 4)**

## ON AVERAGE 55% MOBILE USER USE DATA FOR MORE THAN 4 HOURS

The internet usage trend is getting higher and higher following the global trends and research forecasts done around the world. The survey shows that more than 55% people are using mobiles for more than 4 hours on average every day.

**How much time do people spend on their mobile phones in 2017?**

*The simple answer is "over 4 hours a day."*

**Figure 25(research website extract)[11]**

One infographics is also shared on the topic from the same website in the Exhibit II.

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[11] https://hackernoon.com/how-much-time-do-people-spend-on-their-mobile-phones-in-2017-e5f90a0b10a6

## On average daily how many hours you use Mobile internet?

Answered: 100    Skipped: 0



More than 12 hours
7.00% (7)

6-12 hours
13.00% (13)

Less than 3 hours
45.00% (45)

4-6 hours
35.00% (35)
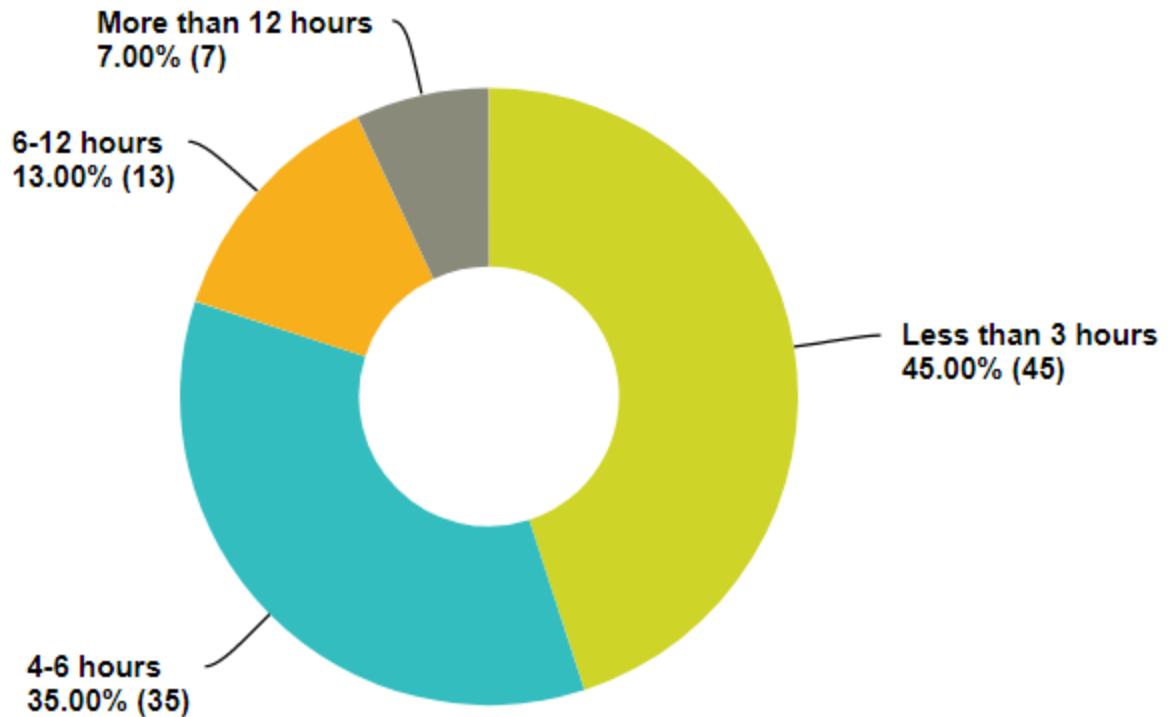
**Figure 26(Survey Question 5)**

### USER PERCEPTION ON THE ROLE OF MOBILE PHONE IN INTERNET CONNECTIVITY

Majority of the survey respondent are aware that the mobile plays critical role in the internet connectivity. But in contrast they don't agree on the resolution coming from the mobile phone in their ownership. Next observation will explain this point more.
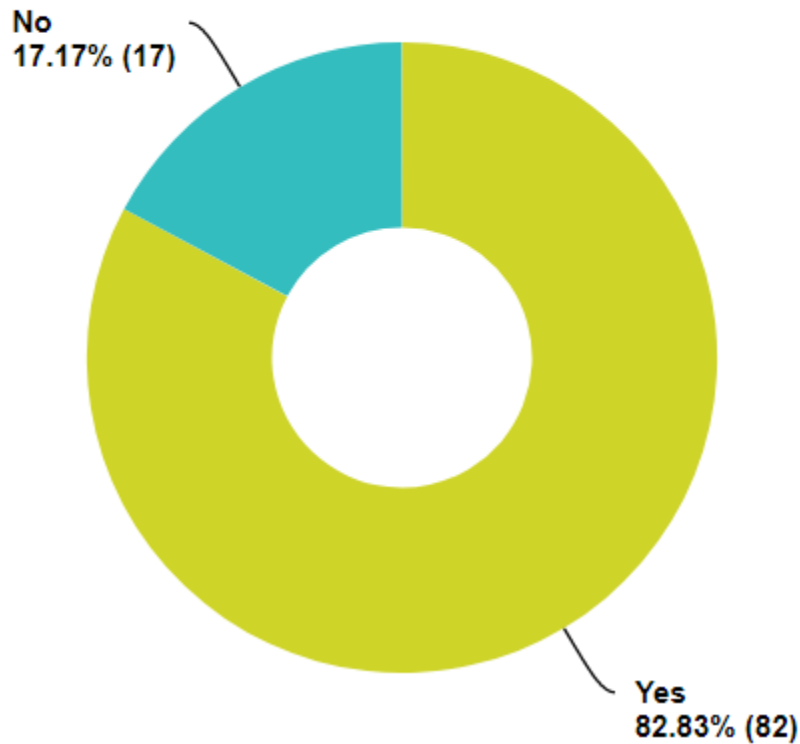
**Figure 27(Survey Question 7)**

## CUSTOMER'S FEEDBACK ON SUPPORT MECHANISM FOR MOBILE PHONE RELATED INTERNET CONNECTIVITY ISSUE

To identify the importance of support mechanism we have asked in question number 8.

➔ Do they need a support system to address mobile devices related internet issues?

As per survey results 91% Respondent have shown agreement for requirement of support system.

### SURVEY RESULTS

In your perspective there should be some support mechanism to address mobile phone related internet connectivity issues?

Answered: 100   Skipped: 0

No
9.00% (9)



Yes
91.00% (91)
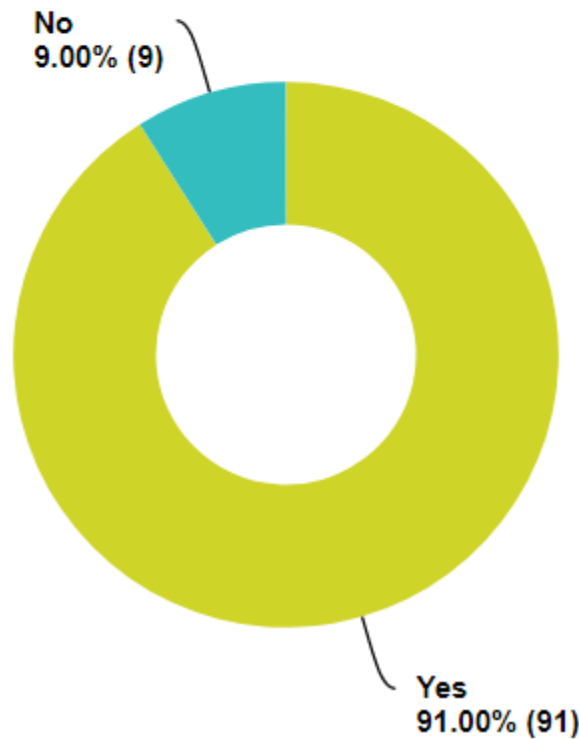
**Figure 28(Survey Question 8)**

## USER PERCEPTION ON THE INTERNET RELATED ISSUE AND RESPONSIBILITY

Based on the survey results it is visible that people understand the role of the mobile phone in internet connectivity. But when it comes to the ownership of the internet related issues more than 80% people held responsible the Mobile network operators.

When it comes to the solution related to this issue the expectation is very clear either it is the Mobile Phone Vendor or the Mobile Network Operator. More than 85% respondent expected resolution from either of two. Out of these more than 62 % people expect the support from the Mobile Network Operator.

### SURVEY RESULTS



**When you face internet connectivity issue who is responsible mostly ?**

Answered: 99    Skipped: 1

100% Mobile Operator issue

44.44% (44)

100% Mobile Phone Issue

2.02% (2)

25% Mobile Phone Issue 75% Mobile Operator Issue

48.48% (48)

75% mobile Phone Issue 25% Mobile Operator Issue

5.05% (5)
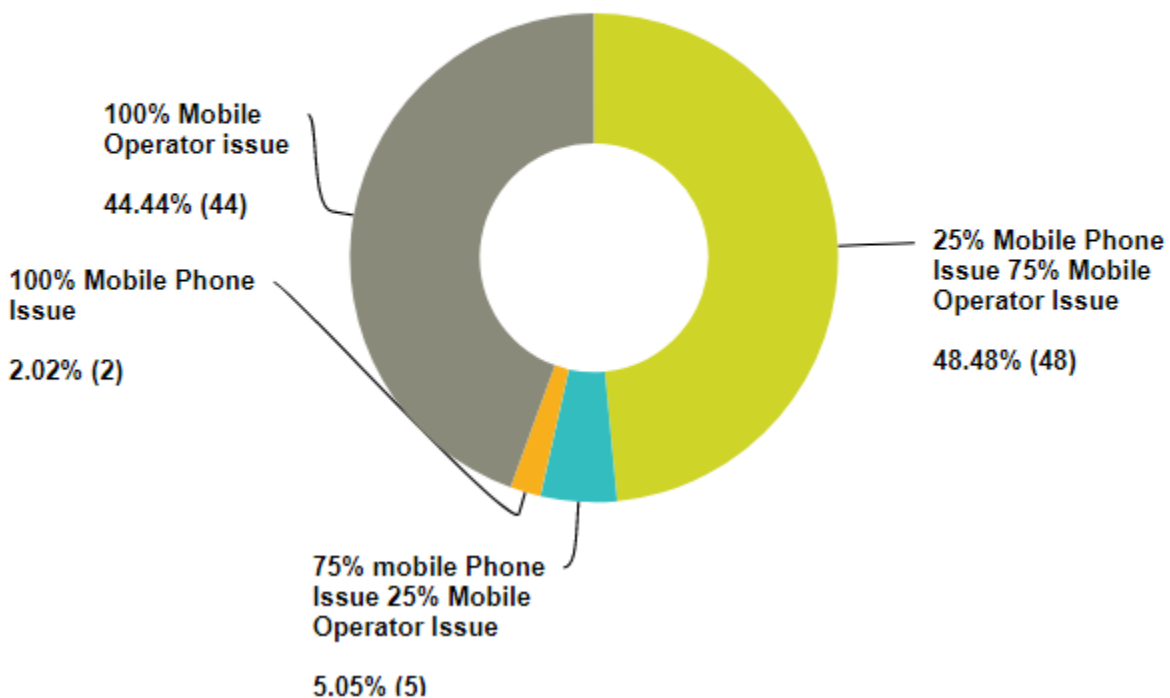
Figure 29(Survey Question 6)
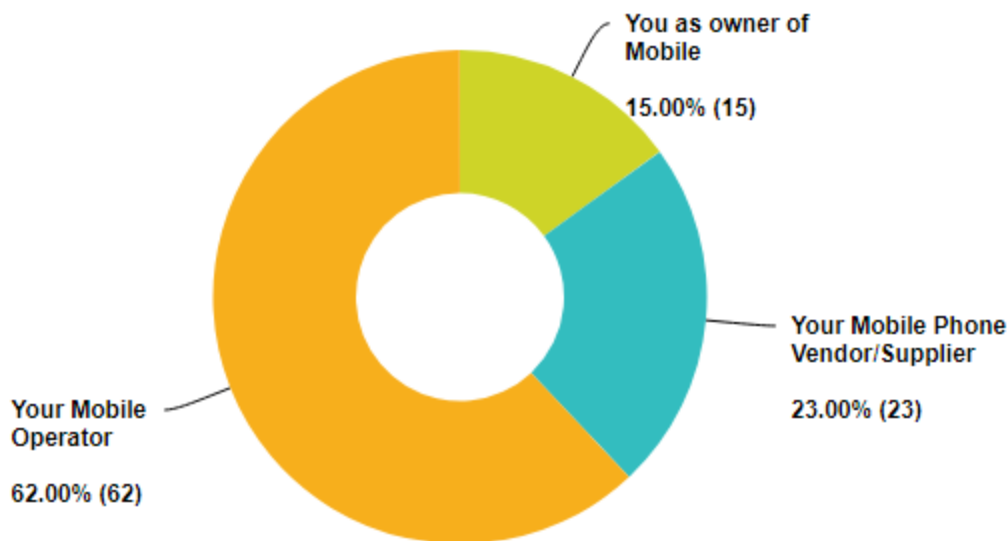
**Figure 30(Survey Question 9)**

## RECOMMENDATION

Based on the survey analysis, Literature review and global trends analysis our recommendations for better internet connectivity are below mentioned:

### CONTENT DELIVERY NETWORKS

Content is the key in the internet usage. With the passing time more and more content is being used by the users. The content delivery is primarily done from the primary host of the website. Network has now acquired content delivery networks in collaboration of the service providers like Google and Facebook. This dramatically reduce requirement of the internet bandwidth while giving the better service due to lower latency.

### FOCUS ON MOBILE DEVICES

Keeping in view the criticality of the mobile data in future, mobile network operators need to have special focus on the devices. Mobile network operators are coming into this arena with their branded mobile phones. In parallel it can not only complement the customer experience enhancement goal but device business itself can turn out to be a lucrative business for Mobile network operators.

## NEED OF ESTABLISHMENT OF MOBILE DEVICES MANAGEMENT TEAM

"Mobile network operators are recommended to have dedicated mobile devices management team. This is very important with the increase in data traffic trend and smart phones exponential growth. As part of its recently-published report on Mobile and Fixed Broadband Business Models, Telco 2.0 highlighted four potential strategic scenarios, one of which was for operators to become "device specialists" as a deliberate element of strategy, either in wireline and wireless domains. This theme was also covered at the April 2010 Telco 2.0 Brainstorm event in London[12].

Clearly, recent years have displayed accelerating innovation in numerous "end-point" domains – from smartphones, through to machine-to-machine systems and a broad array of new consumer electronics products. Yet there has been only limited effort made in mapping this diversity onto the broader implications for operators and their business prospects" (telco Research-Mobile Devices).

Based on the literature review and global trend analysis, few main reasons which lead to the requirement of Mobile Devices Management Team:

## GLOBAL TREND: TELCOS' LAUNCHING DEVICES

"Senior executives at telecommunications companies around the world have heard for several years that their industry is approaching a tipping point. When it hits, they are told, their business might not survive the disruption. And yet they continue to do business. They might well think the warning from telecom industry specialists is overblown. Telecom customers are often locked into a long-term plan; many are loyal to their carrier. Doesn't this suggest that the industry will continue as it is for some time?

To be sure, business upheaval often happens more slowly than people expect, and no one can predict exactly when the moment of truth will strike for any given company. But to judge from several trends that have roiled the telecom sector during the past few years, the time for preparation is over. You must now pick the businesses where you have a competitive edge and focus your strategy on them. Even if you think your current business model has several years of life left, you can't be sure — and strategic focus will help you, no matter how far away the time of change.

How have we come to the conclusion that the tipping point is close enough to warrant change? The conclusion came by continuous observation of the state of the recent industry situation. To a large extent, telecom companies have not succeeded in their efforts to monetize the flood of data running through their networks. Their services have become more commoditized. Their ability to reinvest in network upgrades and digital advances has been severely constrained. At the same time, many carriers have tried to be all things to all people, delivering a wide variety of services to their customers. But as a

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[12] http://www.telco2research.com/articles/EB_Devices-Business-Models_summary

group, they have not managed to excel at any of those services. So now they are vulnerable to competition" (PwC Strategy Telecommunication Trends)[13].



**Figure 31(Local Mobile Operators brands)**

If we look at the average revenue per user (ARPU) trends globally, we observe that it is dropping worldwide and hence creating a need for telecom companies to look for adjacent business opportunities.

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[13] https://www.strategyand.pwc.com/trend/2017-telecommunications-industry-trends
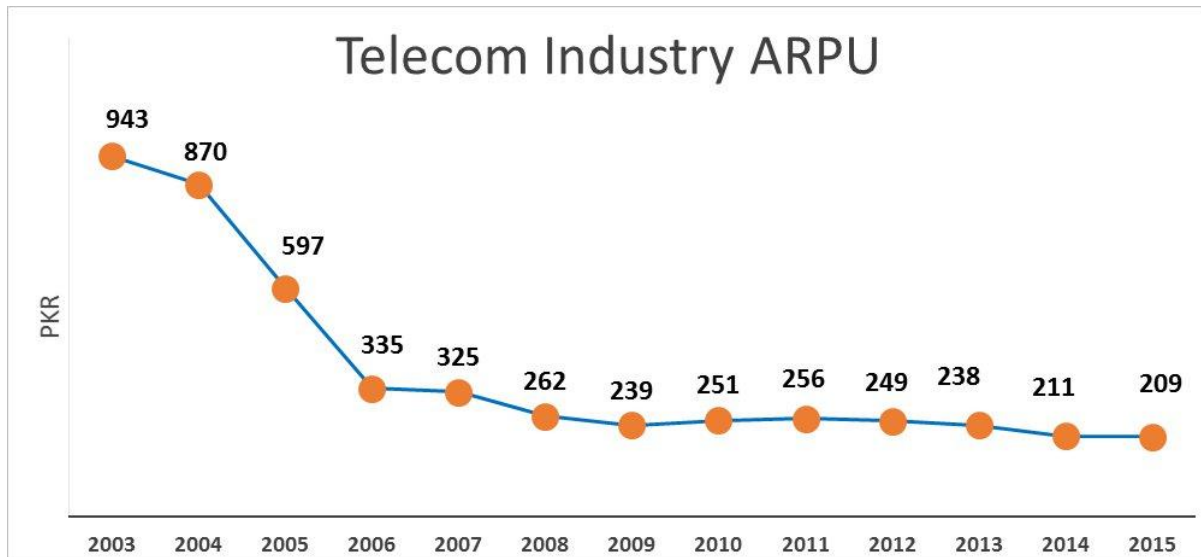
Figure 32(Telecom industry ARPU trend constantly declining)

This creates the need for Mobile Network Operators to jump into adjacent business and at the same time diversify the product mix. It could include introducing new products and developing new markets.

## CUSTOMER COMPLAINTS

Customers complaint call are one of huge OPEX for the mobile network operators as the number of call drives the numbers of people required in the call center to listen to those calls.

Customer feedback helps to improve the services while they are pointing towards a genuine issue. Mobile network operators often receive customer complaints which are totally related to the mobile devices. These complaints are of no use until Mobile network operators do not them routed to the mobile devices experts to handle these issues.

## DEVICES ISSUES ON MONTHLY BASIS

Few customers' complaints received at the customer support centres which are related to the mobile phones are listed as sample.

| Model | Category | HW/SW | Sub-category | Customer Remarks |
|---|---|---|---|---|
| SMART ZOOM | Auto Off | Hardware | Auto Off | Auto On/off + Hang During Use ( Final Check In Lab ) |
| SMART ZOOM | Battery Drains Fast | Hardware | Battery Drains Fast | Battery drain fast # Heat up # Hanging Issue |
| SMART PRO | Application Error | Software | Auto Call Disconnect | Call disconnected ( final check in lab ) |
| INFINITY A | SIM | Hardware | Jacket Damage | Sim card Jacket is not available |
| LITE 3G | Auto Off | Hardware | Auto Off | Auto Off |
| INFINITY A | SIM | Hardware | Not Detect | Sim |
| SMART PRO | Signal | Hardware | No Signal | BOTH SIM SIGNAL DROP SHOW |
| SMART MAX | Keypad | Hardware | Not Working | DAIL BUTTON PROPER NOT WORK 7,8,# |
| SMART MINI | Application Error | Software | Contact Not Show | Contacts not show (warranty valid after diagnosis) |
| SMART 3G(ZTE) | Auto Off | Hardware | Auto Off | Auto File Open + It Vibrate Continiously On Call + Auto On/ Off Issue Final Check In Lab Est Cost 250 |
| SMART ZOOM | Others | Hardware | Heatup | During Call And Charging Set Heat Up+mic Problem software problem |
| INFINITY I | Battery Drains Fast | Hardware | Battery Drains Fast | During Used Heatup, Charging Not Save, Battery Drains Very Fast, Final Check In Lab |
| SMART PRO | Charging | Hardware | Jack Damage | Charging Jack And Battery Required (cost Approved 800) |
| SMART PRO | Charging | Hardware | Not Charging | Not Charging Final Check In Lab |
| SMART PRO | Charging | Hardware | Not Charging | Not Charging Est Cost 400 Final Check In Lab |
| INFINITY A | Charging | Hardware | Not Charging | Unable To Charge ( Final Check In Lab ) |
| SMART ZOOM | SIM | Hardware | Not Detect | Bhot Sim Not Support ( Final Check In Lab ) |
| INFINITY E | Hanging | Software | Hang During Use | Hate Up + Hang During Use ( Final Check In Lab ) |
| SMART MAX | Signal | Hardware | No Signal | Signal Issue |
| INFINITY A | Signal | Hardware | No Signal | Signal Issue |
| LITE 3G | Keypad | Hardware | Not Working | Kypad Not Working, Turn On Issue |
| SMART MAX | SIM | Hardware | Not Detect | Sim 1 Slot Not Working |
| SMART ZOOM | Auto Off | Hardware | Auto Off | Khud Hi Off Ho Jata Hai, Heat Up Ho Jata Hai |

**Figure 33(Sample issues list from Mobile Phone Support Centre)**

Issues raised by the subscribers required lot of support from the mobile phone vendors which is not available to individual customers normally. While the mobile network operators has better customer services arrangement and eco system. If mobile network operators establish Mobile device management team is excellent step in supporting the mobile users to identify the critical mobile phone related issues.

## REAL PROBLEM FACED IN MOBILE NETWORK RELATED TO DEVICES

In one of large mobile phone network operator in Pakistan's technical expert shared few examples of the device related issues which were treated as network issue by the subscribers. But on detailed investigation it was revealed that the issue was with mobile device not in the network side.

## CASE # 1: INTERNET OF THINGS USE CASE WITH ONE OF BIG ELECTRICITY PROVIDER

### SCENARIO

Electricity Provider is fetching data from Automatic Metering Recording (AMR) meters i.e. pull logic used for data fetching in server. They are using scheduler fetching in night time and random manual fetching in day time. In future they use real time monitoring i.e. load shading, other alarms monitoring etc.

### CONNECTIVITY

They are using dedicated static IP provisioning SIMs with dedicated APN for GPRS connectivity. Meter's modem was only 2G supported.

### ISSUE

Data can't fetch on scheduler and some time on manual fetching. As per them ping responses also missing.

### ACTIVITIES DONE ON MOBILE NETWORK OPERATOR END

➢ Last mile established from Mobile Network Operator till Client done. After that overall 200Msec delay improved

➢ Detailed RF survey done on problematic sites and no issue observed on RF coverage

➢ Profiles also verified having proper APN with IPs.

### ISSUE RESOLUTION

After long discussions and combined investigations the Modem vendor was taken on board to support the resolution. They found that the issue is in the module program which handles the connectivity with the network. After providing the bug fixing patch the issue was resolved. While going forward the client was suggested to purchase latest modems to avoid such issue. Client is also informed that they must get the devices tested with the operator before bulk ordering to avoid commercial issues afterwards.

## CASE # 2: CORPORATE CLIENT FACED ISSUE OF SLOW INTERNET CONNECTIVITY

### SCENARIO

One of corporate client using customized app for monitoring their staff movement in the field. The client established the complaint that one of the Specific mobile number series is not working correctly and it's a network issue.

### ISSUE DETAIL

Data missing slow speed issues on provided hand sets and specific mobile network prefixes.

### OBSERVATIONS

➢ Customer using certain (03XX) prefix in Samsung galaxy advance, complain is slow browsing and data missing. Same issue observed in 03XY and other operator numbers 03YY when used same handset.

➢ Same 03XX, 03XY prefix numbers used in other handset like HTC it was working perfectly. No data lost, slow browsing as handsets having better specifications.

### ANALYSIS

➢ Customer application having some flaws as in case of dis-connectivity or slow speed data should not be missed.

➢ The provided handsets are low 2G capability sets. In case of low RAM (may be due to other applications also installed on sets) may cause issues.

➢ Samsung galaxy most common issues are slow browsing and hanging.

➢ From GSMARENA hanging and slow speed are most common issues of galaxy star pro handset.[14]

### WAY PLAN

Customer was satisfied after looking at detailed evidence that the issue was with the mobile phone model but not with the mobile network provider. They have reviewed their customized App and also gone for changing the mobile handset for better internet connectivity.

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[14] **http://www.gsmarena.com/samsung_galaxy_star_pro_s7260-reviews-5749p2.php**

## CASE # 3: AUTO DIALING OF INTERNATIONAL CALLS

### SCENARIO

Customers have logged complaints that their balance is getting deducted without their knowledge. On investigation it was found from the call records that they have dialed international numbers

### ISSUE DETAIL

Investigation was started in the core voice network to find out how the calls are being made, what is the originating number, what are the terminating numbers.

### OBSERVATIONS AND ANALYSIS

After few days of extensive working it was found that the calls are being generated from specific Mobile phone models with a set pattern. Further investigation revealed that this is virus for the mobile phones with low security policies. The calls are being routed to the premium numbers which give benefit to the terminating end while the customers face balance loss due to these automatic calls.

### WAY PLAN

When it was established that the issue is faced because of virus then it was raised with relevant mobile phone vendor to provide bug fix to handle this virus. It is still open issue with the mobile phone vendor to provide the permanent resolution. As interim solution Mobile phone operator has blocked all the identified premium numbers at the network end to avoid any balance loss for the subscribers if the virus dials those numbers the call will be failed.

Above were few examples of the mobile phone related issues which were perceived by the customers as the mobile network related issues. In the end the resolution came from the mobile devices but it was supported and investigated by the mobile network teams. The issue is ad hoc teams with no detailed information about the mobile devices had investigated the issue for lot of weeks. The same task can be managed by the mobile phone experts in few days and hours.

### REDUCING THE CHURN RATE

Dedicated team can help to reduce the customer mobile device specific issues which cannot be resolved without supports of relevant subject matter experts. The dedicated subject matter experts can resolve issues effectively enhancing the customer loyalty towards the brand. Enhanced customer loyalty can help reduction of churn rate which is one of the critical issues being faced by the mobile network operators now days.

## ESTABLISHING MOBILE DEVICES MANAGEMENT TEAM

Mobile Device Management team will be doing below mentioned functions:

➔ Handling Devices Related Customer Complaints
➔ Proactively Testing Popular Devices used by the subscribers to highlight any issues towards the mobile device vendors
➔ Testing Mobile Network Operators branded devices for ensuring the better customer experience
➔ Knowledge sharing on the devices with the Customer Care Teams
➔ Based on the global trends and the reports generate monthly newsletter with information related to devices utilities and bugs fixes.

Key steps for establishment of Mobile Device Management Team are below mentioned:

### IDENTIFYING STAKEHOLDERS

Stakeholder analysis is the review and consideration of the impact stakeholders have on your business. This has becoming increasingly important in the early 21st century, as non-shareholder entities, including customers, employees, communities and business partners, have become more key to business success. Companies need to understand the interests of each stakeholder and strategize on how to address them in business practices.

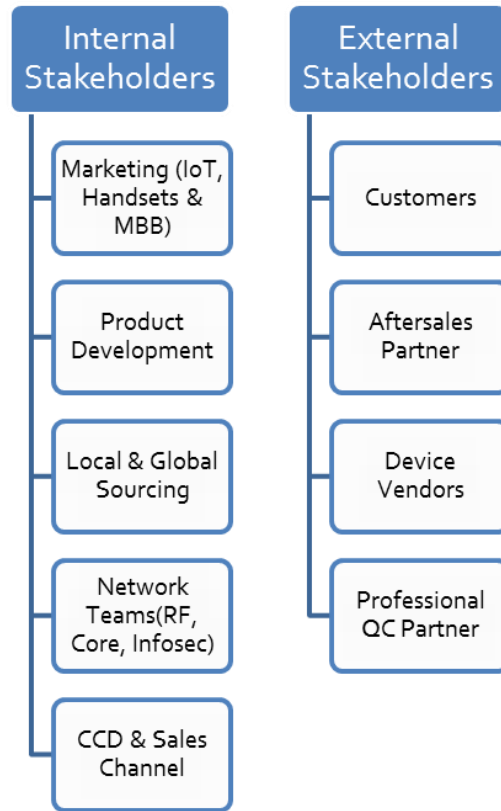Following are the major stakeholders identified during detailed analysis:

Figure 34(Mobile Device Management Team Stakeholders)

## HUMAN RESOURCE REQUIREMENT

When it comes to the hiring process it's not all about finding someone to fill the position immediately such as a family member or loved one who might not meet all the requirements. Being able to dedicate time and resources towards filling positions with employees who are dedicated to the long-term success of a business is paramount to the longevity of any venture[15].

In any business the employees are the most important and valuable asset. Without them there isn't a business on the planet that could continue to operate efficiently and successfully. Main idea of new team is to introduce subject matter experts in the back office teams who receive issues related to Mobile internet connectivity from the Customer complaint handling teams which shall also be investigated with device perspective. Mobile Device management team shall be part of Back Office Teams with Core Networks (including Voice and Data network operations teams) as shown in Figure 35(Proposed Team Placement)Figure 36(Battery Tester).
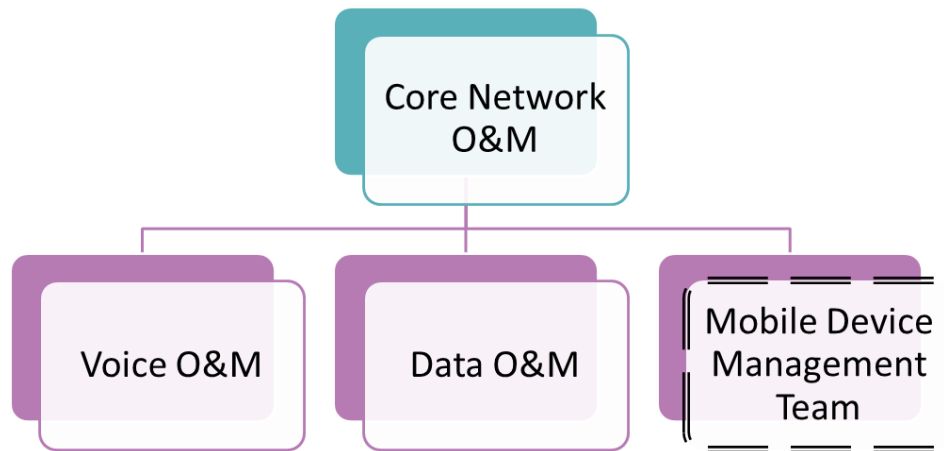
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[15] http://newtohr.com/importance-hiring-right-people/

**Figure 35(Proposed Team Placement)**

It is recommended to add two subject matter experts in 1$^{st}$ two years while adding 3$^{rd}$ resource after procurement of advance mobile device management system. The job description of the resources required is added in Exhibit III.

## EQUIPMENT REQUIRED

Setting up a Mobile Device Testing Lab requires just a few essential pieces of equipment and tools. While specialized equipment may be essential for future requirements, the essential pieces of equipment are the same for nearly any electronics lab.

The following equipment is required to establish a basic device testing lab for telecom operator devices team:

### BATTERY TESTER

A **battery tester** is an electronic device intended for testing the state of an electric battery, going from a simple device for testing the charge actually present in the cells and/or its voltage output, to a more comprehensive testing of the battery's condition, namely its capacity for accumulating charge and any possible flaws affecting the battery's performance and security.



**Figure 36(Battery Tester)**

## DIGITAL RADIO TESTER

Digital radio tester is a device used to test the RF Part of the mobile handset or any other device which interacts with the telecom network



Figure 37(Digital Radio Tester)

## POWER SUPPLY TESTER

A power supply is an internal hardware component that supplies components in a computer with power. The power supply converts a 110-115 or 220-230 volt alternating current (AC) into a steady low-voltage direct current (DC) usable by the Mobile Device and rated by the number of watts it generates.



Figure 38(Power Supply Tester)

## SMD WORKSTATION

Rework (or re-work) is the term for the refinishing operation or repair of an electronic printed circuit board (PCB) assembly, usually involving de-soldering and re-soldering of surface-mounted electronic components (SMD).



Figure 39(SMD Workstation)

## MICROSCOPE

Microscope is used to observe and look closely at the small PCB electronic components and how well a device is soldered on the Printed Circuit Board.



**Figure 40(Microscope)**

## DEVICE DISASSEMBLY TOOLS

Different devices have different tools used for disassembly. It is important that right tools are used to disassemble the devices.
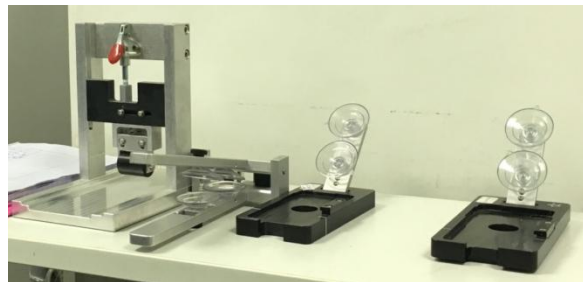


**Figure 41(Device Disassembly Tools)**

## SOLDERING STATION

During the testing phase, it can be required to replace on component on the board to see the effect of installing another component.



**Figure 42(Soldering Station)**

## PROFESSIONAL TESTING TOOLS

There are a lot of professional testing tools also available in the markets which are used mainly by the mobile manufacturer/vendors. When the team get established it is recommended to use the basic tool sets while can go for advance testing tools if the business case for the advance level testing gets positive.



**Figure 43(Rhodes and Swartz Testing Lab)[16]**

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[16] https://www.rohde-schwarz.com/us/news-press/magazin-article-detailpages/r-s-dst200-rf-diagnostic-chamber-for-automated-ota-and-rse-measurements-article_detailpage_229362-6658.html

## SOP FOR DEVICES TEAM TESTING

All organizations irrespective of their functional areas strive to give their best in terms of quality of products and services. This is essential to maintain a competitive edge and keep their clients satisfied.

Each organization has its quality manual which defines its quality policies. The quality manual specifies standard operating procedures (SOP's) which are a set of documents which define practices which need to be followed in word and spirit by all employees strictly and without deviation. It is only through adherence to SOP's that an organization sustains its quality of product and services and sustains its business growth[17]. Generic SOP to be followed for the device testing is below mentioned:
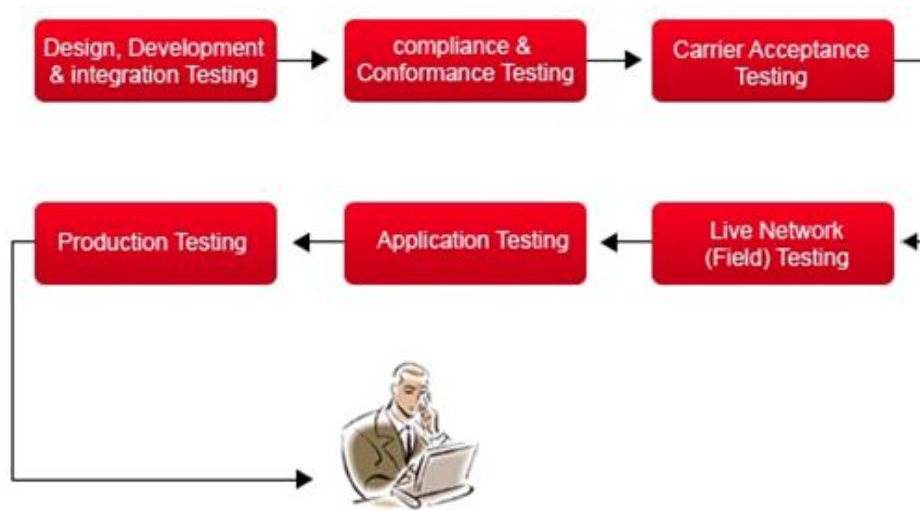

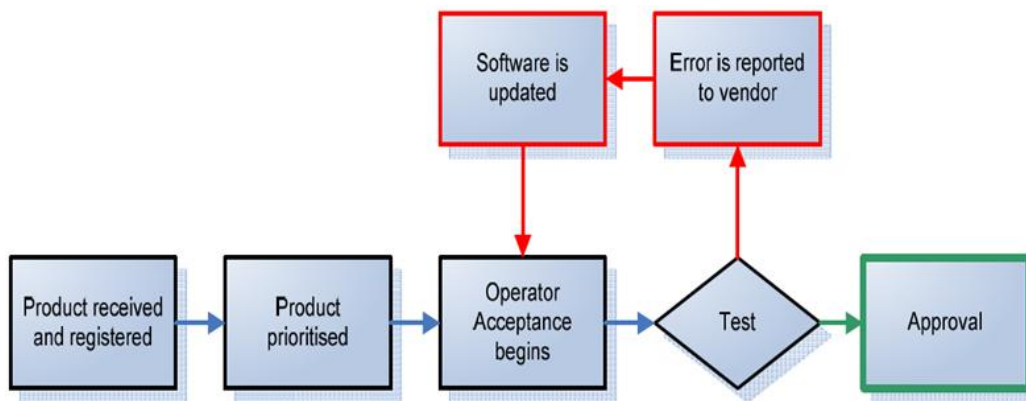
**Figure 44(Generic Device testing SOP)**



**Figure 45(Sample process for Device Testing)**

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[17] http://lab-training.com/2014/06/26/importance-standard-operating-procedures-sops/

## FINANCIAL CAPEX/OPEX MODEL

Financial analysis is critical part for the any new initiative. Below are the assumptions taken for the financial model for Capex/Opex.

➜ Basic Tools to be procured in the 1st year while the advance tools will be purchased in the 3rd year

➜ Human resource requirement in 1st year will be 2 dedicated resources while increase to 3 resources in 3rd year.

The following is the costing detail of required resources:

| | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 |
|---|---|---|---|---|---|
| Tools Capex | PKR 500,000 | | PKR 2,500,000 | | |
| Tools Opex | PKR 50,000 | PKR 50,000 | PKR 300,000 | PKR 300,000 | PKR 300,000 |
| Number of Human Resources | 2 | 2 | 3 | 3 | 3 |
| Human Resources Cost | PKR 1,200,000 | PKR 1,320,000 | PKR 2,178,000 | PKR 2,395,800 | PKR 2,635,380 |
| Total Capex | PKR 500,000 | PKR 0 | PKR 2,500,000 | PKR 0 | PKR 0 |
| Total Opex | PKR 1,250,000 | PKR 1,370,000 | PKR 2,478,000 | PKR 2,695,800 | PKR 2,935,380 |
| Total Capex/Opex | PKR 1,750,000 | PKR 1,370,000 | PKR 4,978,000 | PKR 2,695,800 | PKR 2,935,380 |
| Executive Compensation | PKR 50,000 | PKR 55,000 | PKR 60,500 | PKR 66,550 | PKR 73,205 |
| Inflation/Increment % Yearly | | 10% | 10% | 10% | 10% |

Figure 46(Financial Capex/Opex Model)

## REVENUE CALCULATION FOR THE SUSTAINED SUBSCRIBERS DUE TO CHURN RATE REDUCTION

Benefit calculation model is made based on the churn rate reduction for subscribers after establishment of Mobile Device Management team. Main assumptions taken in the calculation of model are below mentioned:

➜ 0.02% churn rate will be reduced

➜ Average ARPU (Average Revenue per User) taken as 2$ monthly for all the Mobile Network Operators.

➜ May 2017 subscriber count is taken as reference for all the Mobile Network Operators.

➜ No change in the subscriber count during next 5 years.

| | Mobile Operators | Expected Churn Reduction | Approximate ARPU | Expected Revenue from sustained subscribers | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 |
| JAZZ | 52,887,845 | 0.02% | 200 | 25,386,166 | 25,386,166 | 25,386,166 | 25,386,166 | 25,386,166 |
| Telenor | 40,904,945 | 0.02% | 200 | 19,634,374 | 19,634,374 | 19,634,374 | 19,634,374 | 19,634,374 |
| Ufone | 18,509,224 | 0.02% | 200 | 8,884,428 | 8,884,428 | 8,884,428 | 8,884,428 | 8,884,428 |
| Zong | 28,214,245 | 0.02% | 200 | 13,542,838 | 13,542,838 | 13,542,838 | 13,542,838 | 13,542,838 |

Figure 47(Benefit Calculation model)

## SENSITIVITY ANALYSIS

We have also done a sensitivity analysis on the revenue calculations against the base expenditure by varying the values of two assumed number against:

➔ Churn Rate Reduction
➔ Average Usage per User (Per month)

We have taken two additional values for each variable as mentioned below for clarity.

➔ Gross Revenue Assumed with Churn Rate reduction decreased by 50%
➔ Gross Revenue Assumed with Churn Rate reduction increased by 50%
➔ Gross Revenue Assumed with ARPU decreased by Rs. 10
➔ Gross Revenue Assumed with ARPU increased by Rs. 10

This analysis is done for the every Mobile Network Operators which is below mentioned.
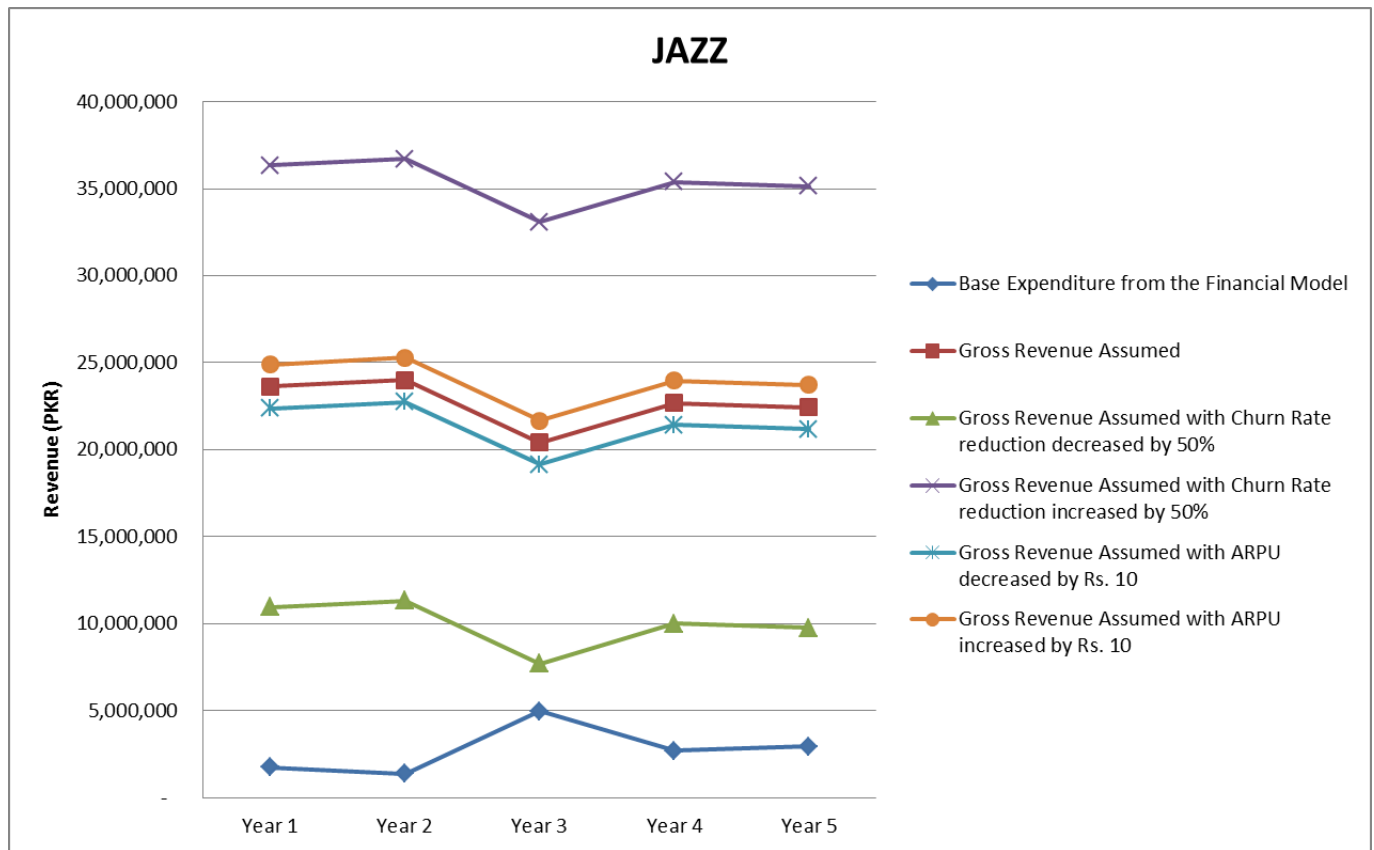
### JAZZ



**Figure 48(JAZZ Revenue for retained customers sensitivity analysis results)**

From the graph it is visible that even reduction in expected churn rate reduction will not impact the positive business case in each year.
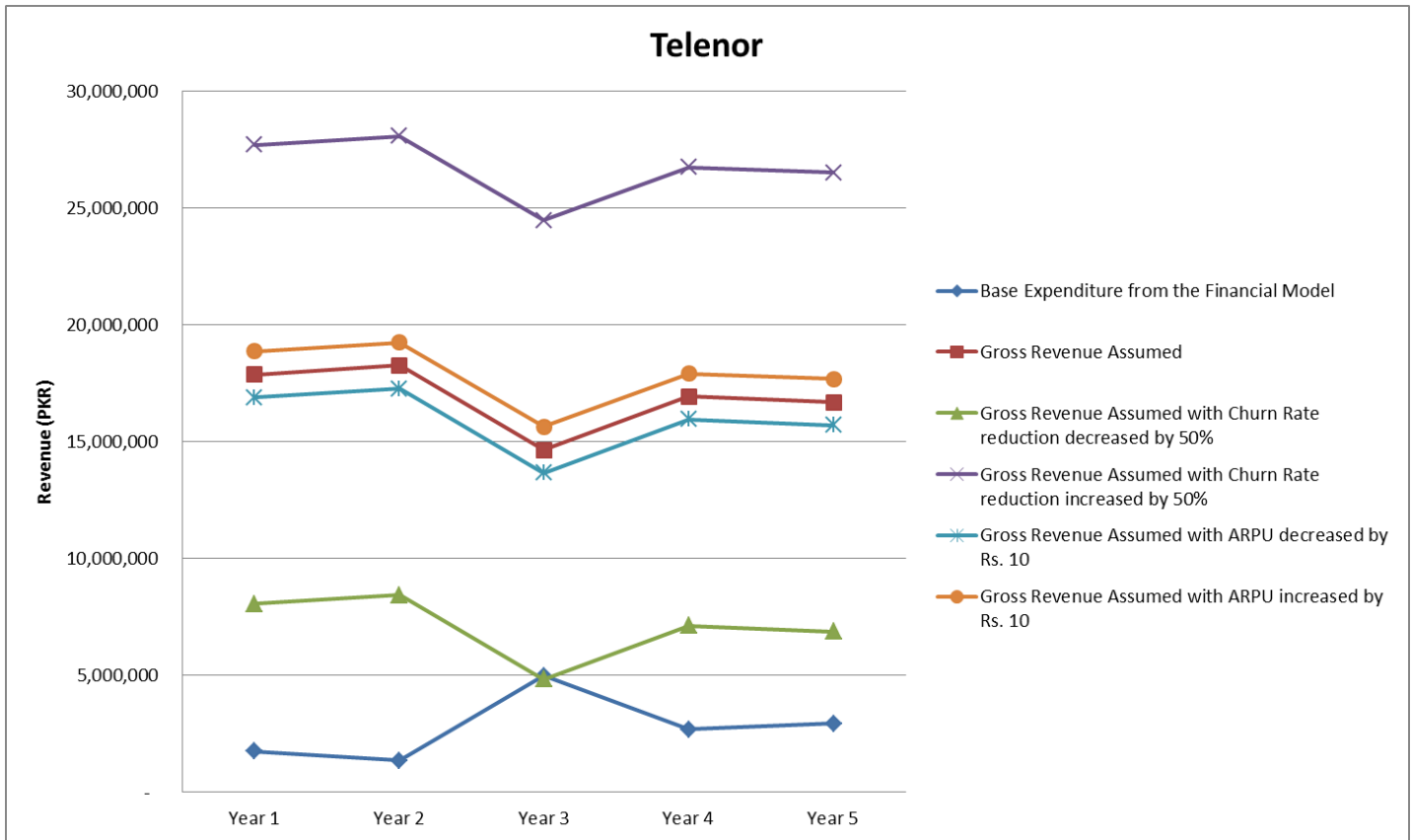
**Figure 49(Telenor Revenue for retained customers sensitivity analysis results)**

From the graph it is visible that even reduction in expected churn rate reduction will not impact the positive business case overall. Only is 3rd year the Revenue is decreased below while overall it remains positive.
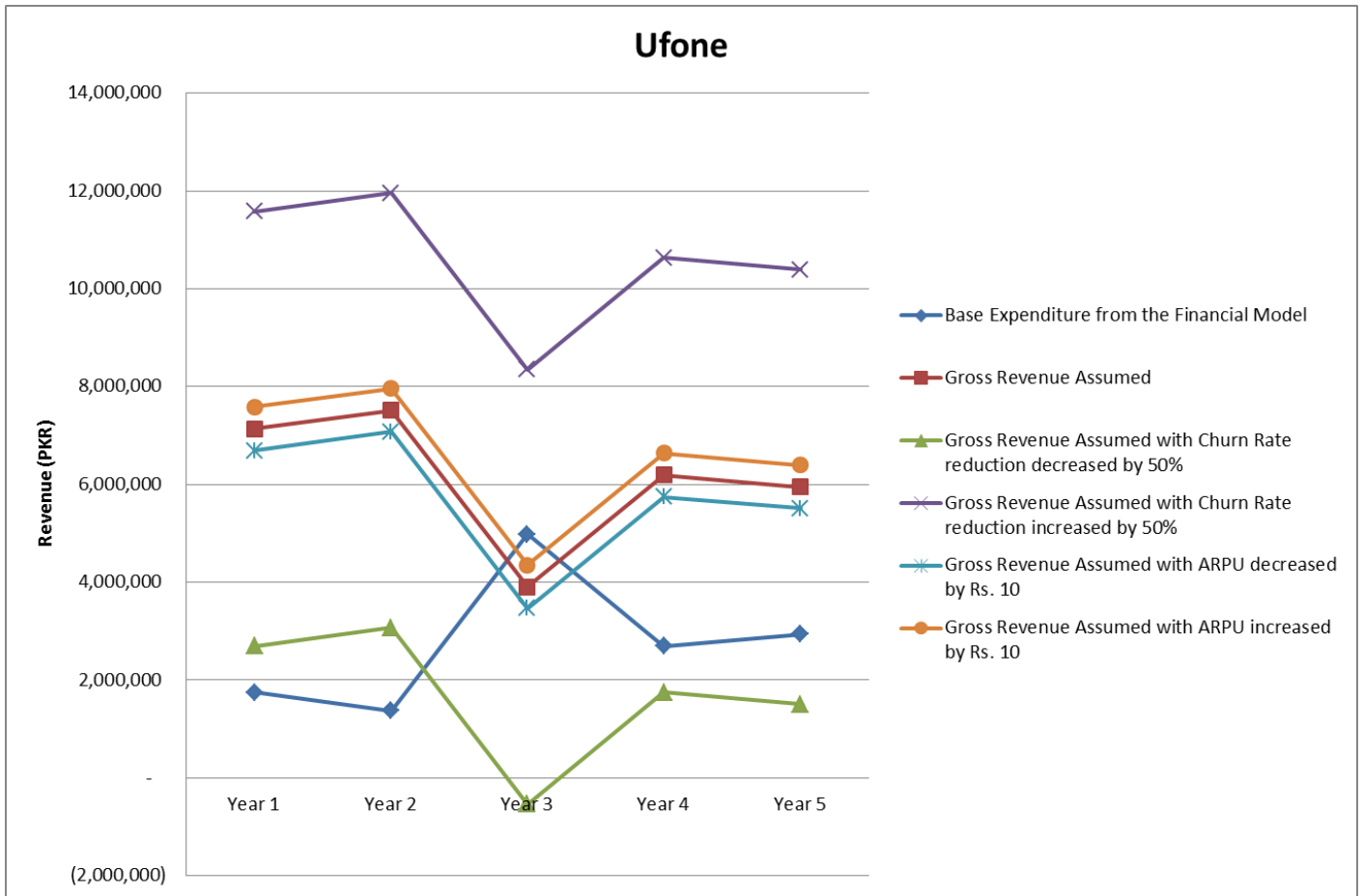
## UFONE



**Figure 50(Ufone Revenue for retained customers sensitivity analysis results)**

From the graph it is visible that in case of 50% reduction in churn rate reduction (assumed value) the business case will be negative. While in remaining three scenarios business case stay positive.
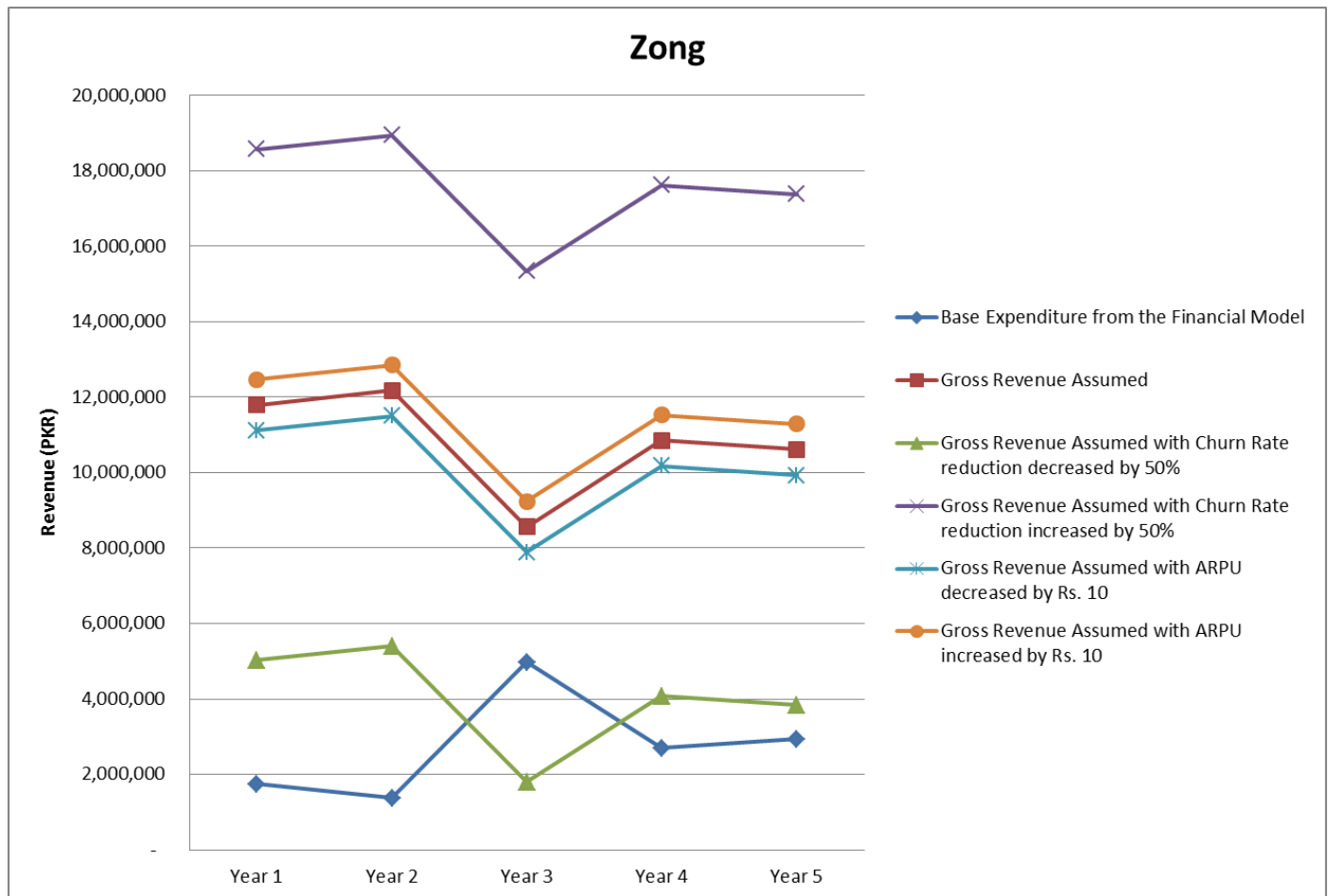
## ZONG



**Figure 51(Zong Revenue for retained customers sensitivity analysis results)**

From the graph it is visible that even reduction in expected churn rate reduction will not impact the positive business case overall. Only is 3rd year the Revenue is decreased below while overall it remains positive.

## CONCLUSION

It is eminent from the study that addition of Device Management team in the Mobile network operators will be useful for the customer services enhancement and reduction in the complaints which are perceived as the network issues by the customers.

## EXHIBITS

### Exhibit I: Survey Questions

**Mobile Internet Connectivity**

Role of Mobile Operator vs Mobile Phone in internet connectivity

The Survey is being conducted for EMBA research project. Your candid response on the survey will be really helpful in the analysis and recommendations to make your internet connectivity experience better.

**1. Do you use mobile internet?**

○ Yes

○ No

**2. Which mobile Operator you use mostly for internet?**

○ Ufone

○ Telenor

○ Jazz

○ Zong

○ Other (please specify)

**3. What kind of mobile phone do you own for mobile Internet?**

○ Smart Phone

○ Feature Phone

**4. What is the operating system of your Mobile Phone?**

○ Android

○ Apple IOS

○ Windows

○ Blackberry

○ Other (please specify)

**5. On average daily how many hours you use Mobile internet?**

○ Less than 3 hours

○ 4-6 hours

○ 6-12 hours

○ More than 12 hours

### 6. When you face internet connectivity issue who is responsible mostly ? 💬

○ 25% Mobile Phone Issue 75% Mobile Operator Issue

○ 75% mobile Phone Issue 25% Mobile Operator Issue

○ 100% Mobile Phone Issue

○ 100% Mobile Operator issue

### 7. Do you think Mobile phone also influence the internet connectivity? 💬

○ Yes

○ No

### 8. In your perspective there should be some support mechanism to address mobile phone related internet connectivity issues? 💬

○ Yes

○ No

### 9. In your perspective who should resolve Mobile Internet connectivity related issues of your mobile Phone? 💬

○ You as owner of Mobile

○ Your Mobile Phone Vendor/Supplier

○ Your Mobile Operator

### 10. What is your age? 💬

○ 18 to 24

○ 25 to 34

○ 35 to 44

○ 45 to 54

○ 55 to 64

○ 65 to 74

○ 75 or older

**Done (Thanks for your Support)**

## Exhibit II: Infographics Time spend using internet



**AVERAGE DAILY TIME SPENT ON SOCIAL**

YOUTUBE — 40 MINUTES
FACEBOOK — 35 MINUTES
SNAPCHAT — 25 MINUTES
INSTAGRAM — 15 MINUTES
TWITTER — 1 MINUTE

**TIME SPENT ON SOCIAL IN A LIFETIME**

18 days — TWITTER
INSTAGRAM — 8 months
SNAPCHAT — 1 year, 2 months
YOUTUBE — 1 year, 10 months
FACEBOOK — 1 year, 7 months

= 5 YEARS, 4 MONTHS ON SOCIAL MEDIA

**Average Time Spent per Day with Mobile Internet Among US Mobile Users*, In-App vs. Mobile Web, 2012-2018**

hrs:mins

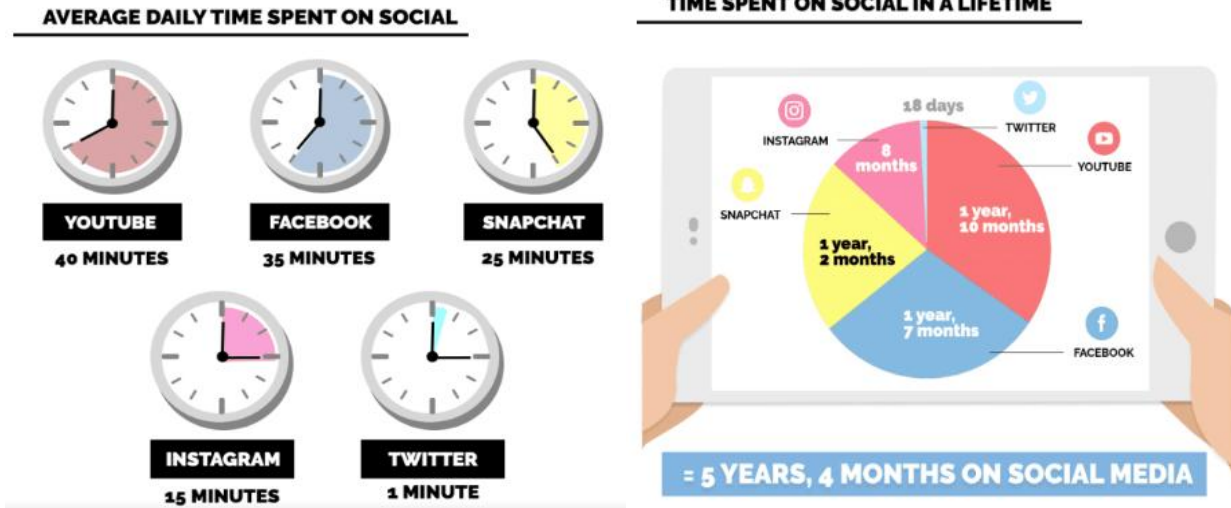| Year | In-app | Mobile web |
|------|--------|------------|
| 2012 | 1:40 | 0:38 |
| 2013 | 2:28 | 0:50 |
| 2014 | 2:51 | 0:51 |
| 2015 | 3:05 | 0:50 |
| 2016 | 3:15 | 0:50 |
| 2017 | 3:23 | 0:50 |
| 2018 | 3:25 | 0:51 |
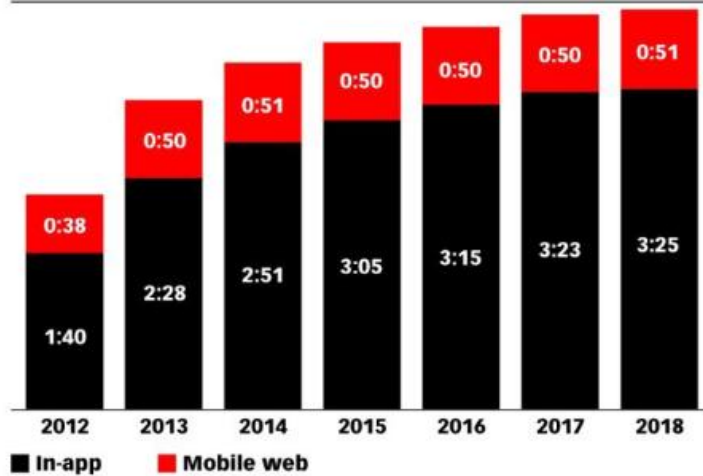
■ In-app   ■ Mobile web

Note: ages 18+; time spent with each device includes all time spent with that device, regardless of multitasking; for example, 1 hour of multitasking on apps while on a mobile website is counted as 1 hour for in-app and 1 hour for mobile web; *smartphone and tablet users
Source: eMarketer, April 2016

212632                                                    www.eMarketer.com

**Exhibit III: Mobile Device Management Executive (Job description)**

**Position Title:**

Mobile Device Management Executive

**Goals**

Committed resource for testing various devices being launched and used in company's network. The selected candidate shall ensure design, execution and reporting of tests for mobile devices in the era of multiple mobile hand held and IoT in the market. He/she should liason with various departments within organization and share expertise in testing, reporting errors and highlighting any issues in devices / versions. This position demands the candidate to ensure smooth and timely execution of test plans along with reporting on various levels within the department and organization

**Your Typical Day at Work**

- Develop, execute and document acceptance, regression and IOT test cases
- Execute and manage device stability testing including creating test environments and automation scripts
- Supporting Technology teams for reporting and troubleshooting related to mobile devices
- Execute and document battery testing, stability, application testing using various tools
- Manage and investigate issues reported by various stakeholders
- Leading mobile (app) test case design, execution, maintenance and reporting
- Present mobile QA/ testing goals and strategies to technology management / leadership team on a regular basis

**Eligibility Criteria**

- Education: BS /BE/B.Sc/M.Sc (Electrical, Electronic, Telecom, Software, Computer, Computer Science)
- Work Experience: 2-4 years experience in Telecom and relevant domain
- Dedication, positive attitude and commitment

**Potential Career Path:**

- Devices Commercial, Customer Services, Device Vendor Testing Team, Core Network Operations, Core Network Planning

**Functional Skills / Knowledge Areas**

- Good knowledge of wireless protocols (GSM/GPRS/UMTS/LTE, Bluetooth, Wi-Fi, WCDMA, etc…)
- Mobile App development and Troubleshooting experience
- Experience making software updates to devices
- Strong developer skills in an object-oriented language and strong software test case design in an agile environment.

- Good Understanding of the different mobile OS's, the device they run on and their respective development environments
- Aptitude and methodology to debug and identify the root cause of technical issues
- Ability to multi-task and prioritize objectives
- High interest of software testing and problem solving
- Programming skill and experience
- Strong Problem analysis, investigation and troubleshooting skills
- Strong Interpersonal and communication skills (Verbal/Written/Presentation).
- Ability to work independently under demanding situations

**Exhibit IV (Survey Infographics)**

Mobile Internet Connectivity Survey

170 views    1 reshare

20 people from Telenor viewed your post

| | |
|---|---|
| Ericsson | 10 |
| Huawei Technologies | 4 |
| Jazz (previously known as Mobilink) | 3 |
| Ufone | 3 |
| Telstra | 2 |
| Saudi Telecom Company | 2 |
| Telenor, Global Wholesale | 2 |
| ZTE Corporation | 1 |

11 people who have the title Operations Specialist viewed your post

| | |
|---|---|
| Project Manager | 10 |
| Consultant | 8 |
| Technology Manager | 5 |
| Information Technology System Administrator / Engineer | 5 |
| Information Technology Support Specialist | 4 |
| Manufacturing / Mechanical Engineer | 4 |
| Creative Designer | 4 |
| Telecommunications Specialist | 4 |

Your biggest audience is from Federal Capial &AJK, Pakistan

| | |
|---|---|
| Northern Punajb Rawalpindi, Pakistan | 6 |
| Sydney, Australia | 6 |
| Oslo Area, Norway | 3 |
| Lahore, Pakistan | 3 |
| Melbourne, Australia | 2 |
| Dallas/Fort Worth Area | 2 |
| Wellington & Wairarapa, New Zealand | 1 |
| Saskatchewan, Canada | 1 |

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