Sindh Univ. Res. Jour. (Sci. Ser.) Vol.45 (4) 689-696 (2013)

SINDH UNIVERSITY RESEARCH JOURNAL (SCIENCE SERIES)

Simulation Based Analysis of Handover Issues Affecting UMTS Performance

H. NAWAZ++, S. SOOMRO*, S. H. ABBAS**, M. S. EHSAN***, M. Y. KOONDHAR ****

Department of Computer Science, Sindh Madressatul Islam University, Karachi

Abstract: This research work is regarding the simulation based analysis of handover issues affecting the UMTS network performance. The mobility is provided by handover to user which is the major subject matter of wireless communication and handover provides the interpretability between different network technologies. However handover is an issue that is focused here, to know the parameters which cause to degrade the UMTS network performance. A radio link disconnection problem occurs when a User Equipment moves from one cell to another. In this study, the interactive and conversational traffic parameters are analyzed by simulation. To accomplish the task of simulation and analysis, OPNET Modeler 14.5 and Matlab are used. It is established through results that Soft handover is better than hard handover because soft handover reduces near far effect; it maintains the connection during handover.

Keywords: UMTS, UMTS Architecture, Handover, Handover Issues, UMTS Performance.

1. INTRODUCTION

UMTS (Universal Mobile Telecommunication System) is a growing cellular technology and it is famously acknowledged as 3G mobile communication system. It offers high data transfer speed, speech, email, web browsing, multimedia, video telephony, and the audio streaming. UMTS offers enhanced video conferencing and high speed internet access and wide range of multimedia services. The QoS (Quality of Service) in UMTS are divided into the classes (Achim, *et al*, 2007), for specific traffic application specific QoS class is used. The QoS Classes are: background class, conversational class, interactive class and streaming class. Call handover without dropping the connection with the Node B is main issue. To cope with this major issue many techniques have been developed. The UE (User Equipment) moves from one location to other that indicates that the user can vary its location any time everywhere with any speed. The function of handover technique is to ensure the user connectivity without disturbing the call. In our survey readings these handover types have been studied those include horizontal handover, vertical handover, hard handover, soft handover, handover, inter system handover, inter frequency handover and intra frequency handover.

The technological improvements in global organization from small companies towards large organization fulfill the modern needs. The mobile user's requirements are enhanced by the development of technology. The user wants mobility and interoperability within dissimilar networks while enjoying the multimedia services. In sequence to accomplish the demand of the users data requirements such as, lesser delay, better quality of service, high data rate, mobility and interoperability with available cellular Networks. It is revolution towards cellular communication. UMTS uses the WCDMA (Wide band Code Division Multiple Access) technology that offers high rate, on demand bandwidth and higher capacity as compared to 2nd Generation technology. UMTS is superior in features such as it offers 2Mbps data rate, sustaining multimedia services Telephony, Fax, MMS, Video, VPN etc.

2. UMTS ARCHITECTURE

The Universal Mobile Telecommunication System architecture has three components, the user equipment, the UTRAN (UMTS Terrestrial Radio Access Network) and the core network. The User Equipment is radio terminal which is the combination of handset and USIM (UMTS Subscriber Identity Module). The Uu interface establishes the communication between Handset and Node B. The users' important information contains USIM that is known as smart card. In UMTS architecture, first time the UTRAN has been introduced. UTRAN has also two components, one is Node B and another is RNC (Radio Network Controller). The Radio Resource Management operation is performed by the Node B. The management of air interface resources of User Equipment on Node-B is performed by RNC. Also, the RNC is responsible to control the hand over. lub air interface is used to connect the RNC and Node B and it is responsible to connect one RNC to another.

The Universal Mobile Telecommunication System's architecture core component has two domains, the Circuit Switched the Packet Switched. The CS

++Corresponding Author: Haque Nawaz Lashari, E-mail: hnlashari@smiu.edu.pk, Cell# +92-333-7588408
*Department of Computer Science, SMIU, Karachi
** Department of Electrical Engineering, FEST, HIIT, Hamdard University, Karachi
*** Department of Electrical Engineering, University of Lahore
**** Information Technology Centre, Sindh Agriculture University, Tandojam,

domain is connected to UTRAN through IuCS interface with MSC, HLR, VLR and GMSC while the PS domain is connected to UTRAN using IuPS interface with SGSN and GGSN. The former is for voice traffic while the later is for data traffic (Zuberi *et al,* 2007).

3. HA NDOVER

In mobile communication, handover is compulsory and play an important role. Every Node B has specific coverage region, when a user enters into the controlling edge of another Node B throughout communication, handover takes place. The major goal of handover is to maintain the mobility of user when user moves from one cell to another and from one access technology to another. From one cell to another cell, initially connection is released then established with target cell and then released from previous cell and with in cell from one sector to another sector the handover takes place. The handover is needed when UE roaming between different networks and it Guarantee QoS and also guarantees the continuity of user communication.

4. HANDOVER TYPES

In Universal Mobile Communication System there are different types of handovers. Handovers handle the efficiency of UMTS Performance. There are two major types of handovers in Universal Mobile Communication System- the hard handover and the soft handover.

4.1 Hard Handover

The hard handover takes place when User moves from one cell to another cell; it means first connection is released then established, or when User moves from the coverage area of one Node B to another Node B, the radio connection to UE first breaks down from one Node B then makes with another Node B that means the hard handover has taken place. For coverage and load reasons, the hard handover is used (Chowdhury ,*et al,* 2010).

4.2. Soft Handover

The soft handover takes place when two cells are supported by two “Nodes B”. In soft handover when the UE moves from source cell to target cell, the radio link or connection is first established to target cell then the radio link or connection is released from source cell. The soft handover is most reliable when the User moves from source cell Node B to target cell Node B, the radio link is established to target cell Node B then the radio link is released from source cell Node B. The soft handover is offering more mobility (Chowdhury *et al,* 2010).

5. RELATEDWORK

Handover issues parameters analysis

As described above, the Universal Mobile Communication System handles two kinds of handover one is Soft handover second is hard handover. The soft handover is establishing the radio link first then releasing the radio link. When communication session is going on between the User Equipment and more than one Node B at a time. The hard handover is on other hand the radio link between user equipment first released than established to another Node B. In hard handover call drop probabilities is greater than the soft handover (A. Mohammed, *et al,* 2007; Silva I. d., *et al,* 2012). Nowadays wireless communication demand has increased. So to fulfill this demand cell size of the network is to be decreased which results in issues during handover.

There are multiple handover issues that UMTS Network facing which affect the performance. Few are analyzed in this research paper.

- ✓ The blocking probability of new calls.
- ✓ Call dropping.
- ✓ Power Control.
- ✓ Coverage.
- ✓ Mobility management.
- ✓ Quality of service.
- ✓ Throughput
- ✓ Delay
- ✓ Path loss.

5.1 New Call Blocking Probability

- ✓ If all channels are busy, the UE is not granted, the channel and the call is blocked.
- ✓ When UE is moving from one cell to another the handover request is not accepted by the system then call is blocked.

5.2 Call Dropping probability

- ✓ When the UE is denied a channel in the cell it is moving to, the call is dropped.
- ✓ Call dropping probability means link failure probability because session is terminated due to handover failure.
- ✓ Call drops due to system failures, which includes Hardware failures, Software failures, and Transmission subsystem failures.
- ✓ Probability of call drop increases as a result of signal strength degradation in the serving cell (Khan M.M.A, *et al*, 2009).
- ✓ The call drop rate is an important metric used to evaluate the QoS in cellular networks.Hardening Handover decision by increasing handover detection threshold is a good choice to reduce

✓ the chance of unnecessary handovers. Reducing unnecessary handovers has a direct impact on reducing Call drop in UMTS side as the probability of underestimating radio conditions in UMTS vanishes. Also it has an influence on reducing ping-pong effect.

5.3 ***Power Control***

✓ The UE and the RNC Transmission power is normalized by the power control. The power control is necessary to compensate attenuation and path loss. When the mobile equipment moves toward or away from the base station, the increase or decrease in the signal level occurs respectively.

✓ UE moves away from the BTS the signal level increases or decreases; that is major problem (Forkel , *et al,* 2003; Razavi., *et al,* 2012).

5.4 ***Coverage***

✓ UMTS provides the small cell radius and low penetration in indoor coverage profile. Small cell radius and low penetration is also a problem.

✓ When a cell is divided into many sub cells that is concept of cell sectorization. This concept is used in UMTS network. The main function of this concept is to minimize interference and maximize capacity. The cells having n sectors have n times greater capacity and the ideal is the radiation pattern of the sector. (Mohammed *et al,* 2007; Silva *et al,* 2012)

5.5 ***Mobility Management***

✓ Due to small cell radius the number of cells is maximum causing handover ratio to increase and mobility management to become difficult (Quddus *et al,* 2008).

5.6 ***Quality of Service***

✓ In UMTS during handover there is an issue of low penetration of signals. It directly affects the quality of service that is great problem.

✓ The QoS and connection state affected by an important factor handover that looses the efficiency of the UMTS network

✓ Cell is divided into many sectors by sectorization the greater figure of overlapping regions will take place and the better performance provides the softer handover approach (Bhuyan *et al,* 2010; Sadek *et al,* 2012).

5.7 ***Throughput***

✓ The UMTS claimed three different throughputs according to geographical profiles (Bhuyan *et al,* 2010). For rural areas is 144Kbps. For urban areas is 384Kbps.For Indoor Communication is 2Mbps.

5.8 ***Delay***

✓ Whenever a handover occurs there is always a handover delay which dictates that we cannot guarantee the service continuity (Kwon *et al,* 2007; Cao *et al,* 2012)

✓ In UMTS two types of delay takes place throughout handover process; one is known as the decision delay and the other is known as the execution delay.

✓ The decision delay means the time consumed to perform handover. On other hand the execution delay mean that the time consumed to switch from one Node B to another Node B. It has been observed that decision delay is less and execution delay is greater in soft handover than hard handover (Cardoso *et al,* 2011)

5.9 ***Path Loss***

✓ UMTS networks provide high path loss therefore need to be adding more fade margin. By using matlab it has been observed that increased distance has increased path loss **Figure: 1-2**.

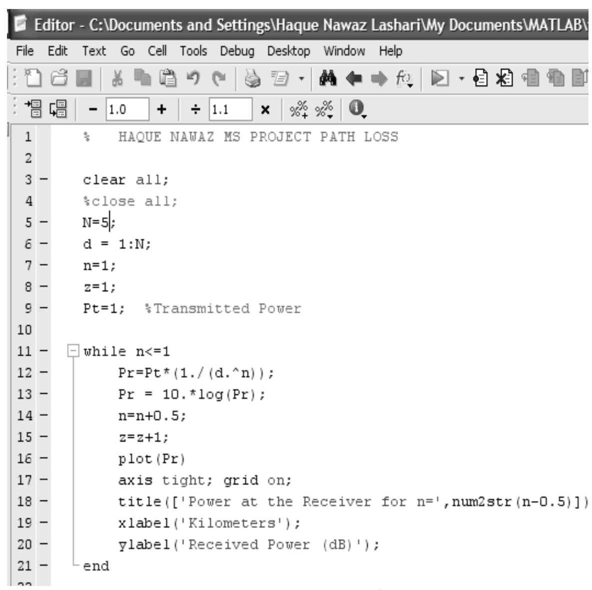

Figure: 1. **Matlab code of path loss**

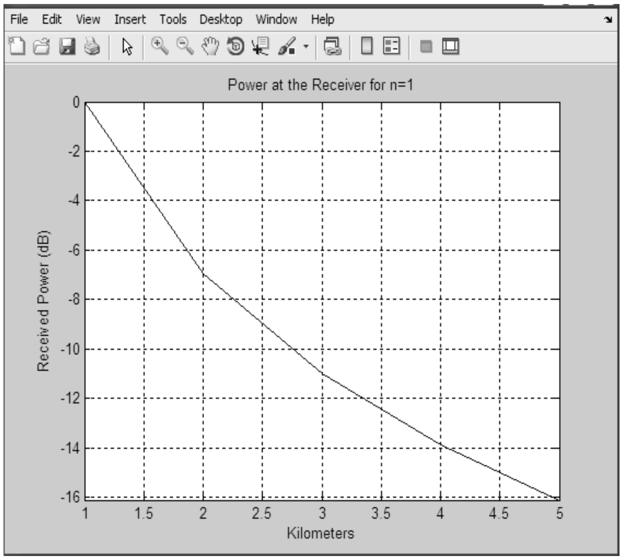

Figure: 2. **Graph of path loss**

The above figure shows that as the distance is increased the path loss is increased due to decrease of power that indicates path loss is also affect the performance.

6. MATERIALS AND METHOD

6.6 Introduction

For the implementation of different scenarios we used the OPNET Modeler 14.5. Users can easily use this tool by simply selecting the different technologies from start up wizard and dragging of different devices like RNC, Node B, etc, interconnecting them with the desired links.

6.7 Handover Scenarios

We implemented two different scenarios for the two types of the UMTS traffic classes, one for the conversational class and other for the interactive class.

6.8 Entities of the Network and their Functions

Here selected and configured different network elements according to the requirement of the scenarios. The following are the entities that are selected from the Object Palette Tree from the OPNET Modeler.

- ✓ Application Definition
- ✓ Profile Definition
- ✓ RNC
- ✓ NODE B
- ✓ SGSN
- ✓ GGSN
- ✓ Hub
- ✓ HTTP Server
- ✓ FTP Server
- ✓ UE
- ✓ Links

All these network entities are configured according to the requirements of the two scenarios. These scenarios are explained in the following sections.

7. HANDOVER WITH UMTS CLASS INTERACTIVE

In this scenario there are two servers as in the interactive class and there are two type of the traffic i.e. FTP and HTTP. So for the support of the two types of traffic, we have configured two types of the servers. The FTP is first discussed which is followed by the HTTP statistics. In the scenario there are two users equipment. The user equipment one is moving with the specified trajectory. Both the FTP and the HTTP is running on the same user equipment one and they exchanged their information with their concerned servers. Different statistics are collected which are discussed in 7.1 simulation results section **Figure: 3-4**.

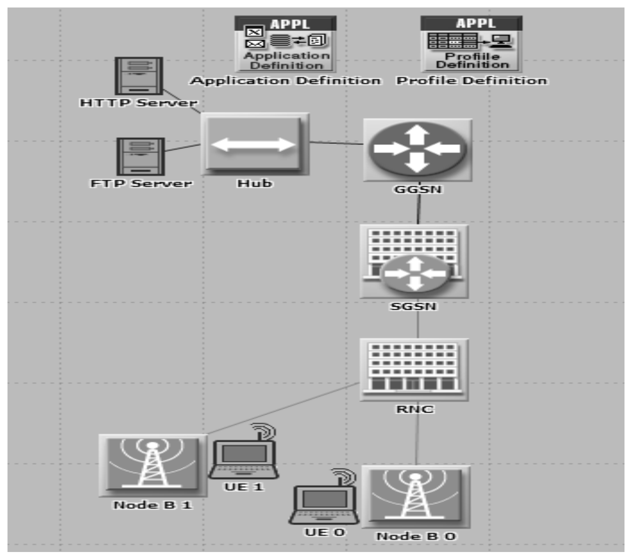

Figure: 3. First Scenario

7.1. SIMULATION RESULTS AND DISCUSSION

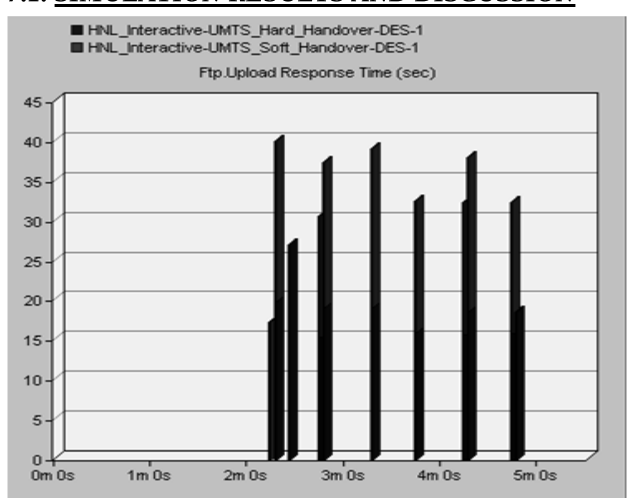

Figure: 4. FTP Upload Response Time (sec)

In the **Figure 4**, it was observed that for the soft handover the peak is at 40 sec and for the hard handover the peak is at the 26 sec, which clearly shows that the Upload response for the soft handover is greater than the hard handover.

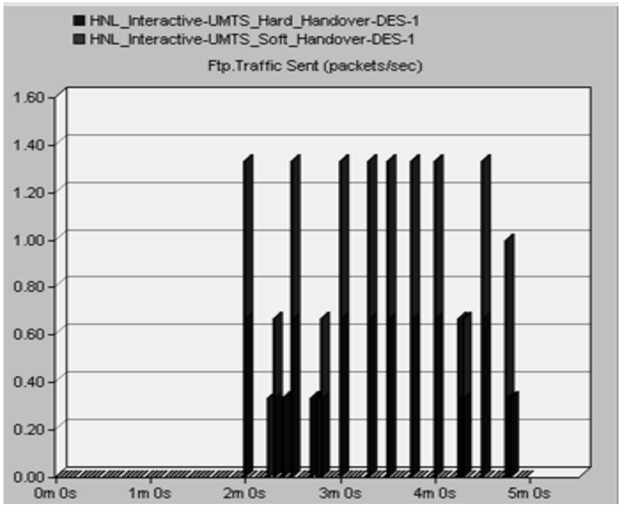

Figure: 5. FTP Traffic Sent (Packet/sec)

The **Figure: 5**, shows sent FTP Traffic. Here we observed that the FTP Traffic sent for the soft handover is higher where as the FTP Traffic sent for the hard handover is lower. The reason for this is that the total upload response for the hard handover is lower than the soft handover.

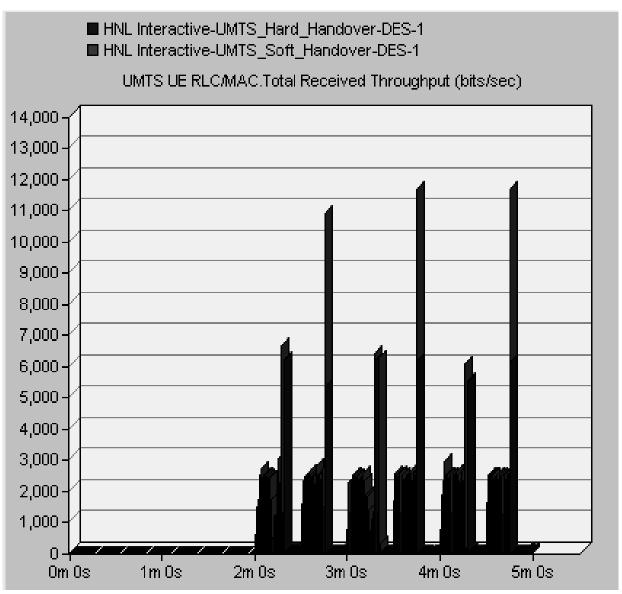

Figure: 6. Total Received Throughput

The F**igure 6,** Shows that the total received through put for the hard handover is low which is responsible for the low response time for the hard handovers whereas for the soft handover it is higher.

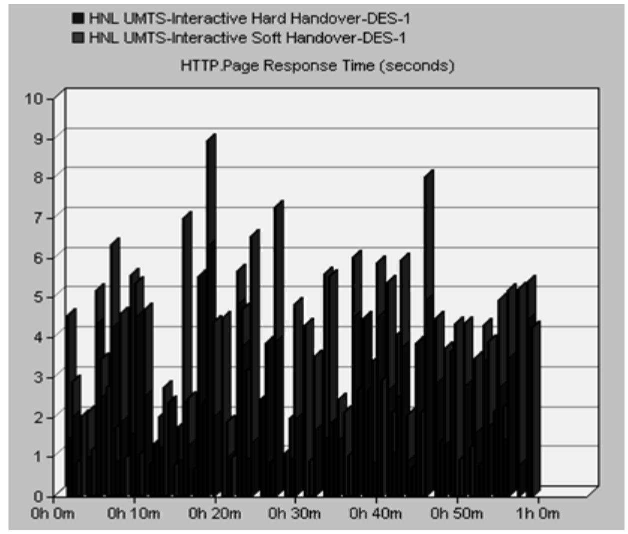

Figure: 7. HTTP Page Response Time

In the **Figure: 7**, it is observed that 9 sec is the peak of the soft handover page response time and the hard handover has the peak of 6 sec which shows that the soft handover has the page response time higher. But this output may change the total receive and sent data and here in this case in hard handover there is a low traffic sent and throughput for hard handover so it is sure that its response time will be low.

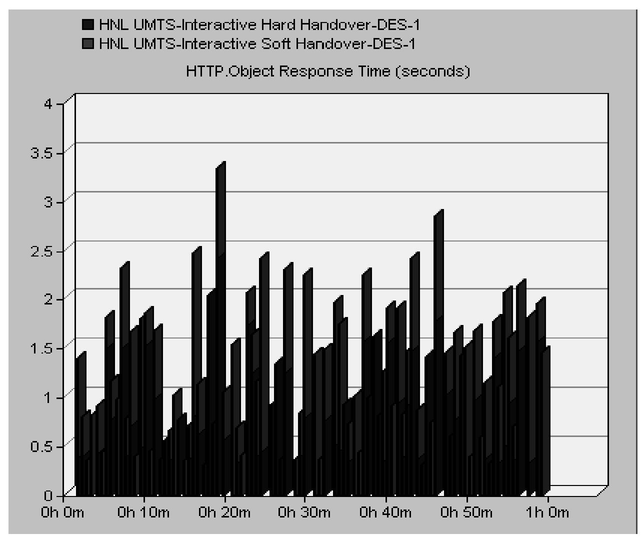

Figure: 8. HTTP Object Response Time (self)

In the **Figure 8**, it has been observed that the peak of the soft handover object response time is greater than the peak of the hard handover object response time.

8. HANDOVER WITH UMTS CLASS CONVERSATIONAL

The scenario for the conversational class is implemented in OPNET. Different statistics are collected for the conversational class is discussed in the 8.1 simulation results section.

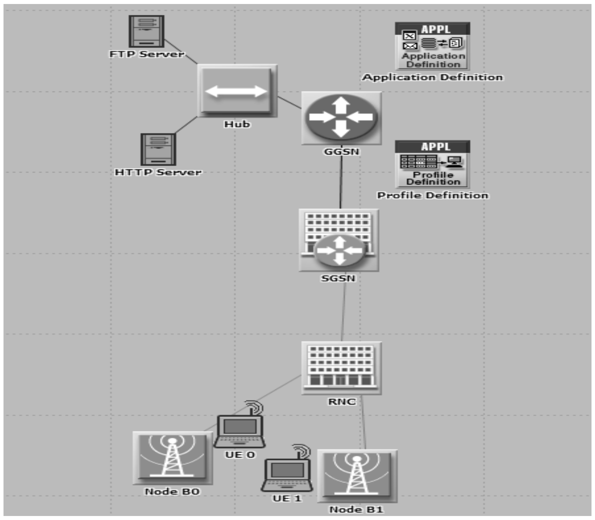

Figure: 9. Second Scenario

8.1 SIMULATION RESULTS AND DISCUSSION

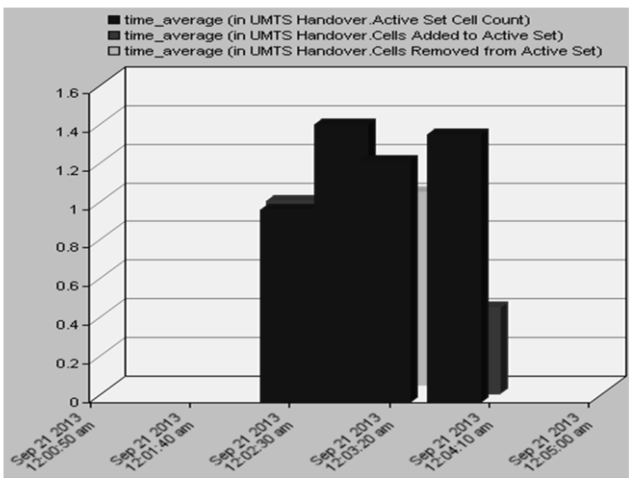

Figure: 10. UMTS Active Cell Count

In the user equipment the active set contains number of the Node Bs from which it is getting the signals or service. There are two Node Bs in this scenario when the user equipment moves along the specified trajectory the cells are removed and added.

The right side small lines in the **Figure 10,** shows that the addition in the active set cell count and the middle thin line shows that from the active set the nodes are removed and their corresponding active set values decreased when the middle line appears which means that the Node B's are removed. The duration in which the thick line is set to value 1.3 is the time when the user equipment is receiving signals from the two Node B's so that the user equipment has the active set of the shown value. That area is called as the overlapping region in which the user equipment has the value of 1.3.

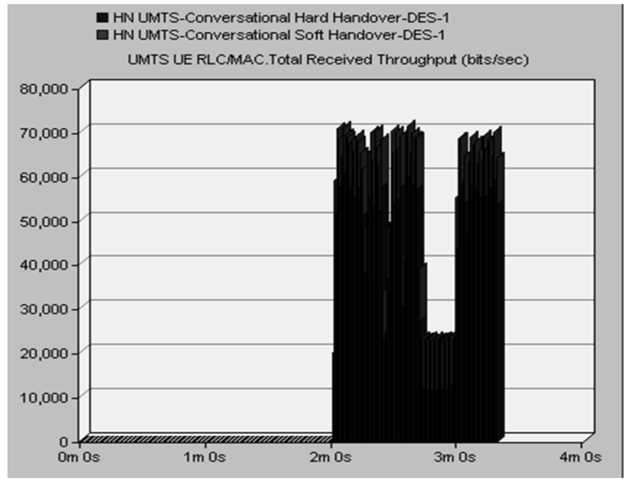

Figure: 11. Received Throughput (bits/sec)

The **Figure 11,** shows the received throughput, which indicates that for the users in the soft handover the received throughput is greater to the user in the hard handover.

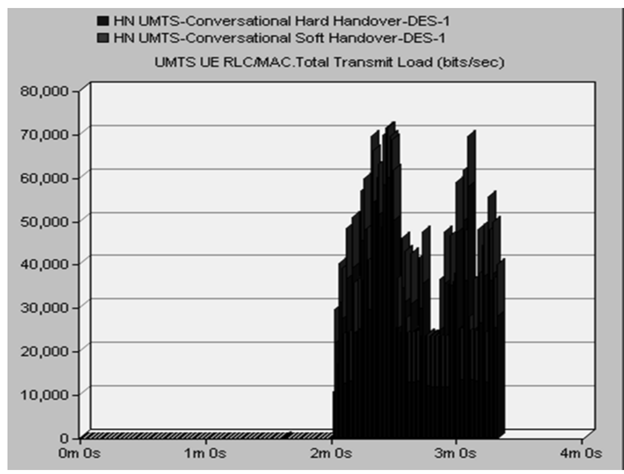

Figure: 12. Total Transmit Load (bits/sec)

From the **Figure 12,** it can easily be concluded that the users in the soft handover has the transmit load grater as compared to the user in the hard handover.

9. CONCLUSION

This research work is analyzed in a sequence by introduction of the UMTS, UMTS architecture, handover, handover Types, hard handover, soft handover, handover issues. The UMTS handover issue is mentioned to know about the, function, application and parameters with degrading UMTS performance.

The overall work shows that what are the handover types and their requirements and what is the process of handover issues that affects the UMTS Performance? The simulation of different scenarios are created and the results are collected, different statistics are calculated and by using Conversational & interactive traffic seen the Soft and hard handover results are achieved. The research work gives a thought of the most important factors and parameters which are being affected by the soft and the hard handovers in terms of the overall UMTS network performance & services. On these measurements, it has been observed that how different types of the traffic is affecting the UMTS system performance.

10. CONCLUSION

The future concentration will be given to the power, capacity and the coverage issues such as the cell breathing, call blocking, call dropping, call congestion and QoS affecting the UMTS performance. Especially specific handovers algorithms and the power control can be implemented and their overall affect on the users and the UMTS network can be monitored for ensuring well UMTS performance.

REFERENCES:

Achim A., (2007) "*Radio Resource Utilisation*", in book : Radio Network Planning and Optimisation for UMTS, Chapter 4, second edition, 197-278.

Bhuyan M.G.S., M.S.H. Mollah, Z.. Ahmad, S.M. Rahman (2009) "*A New Approach of Efficient Soft Handover Management for Proposed UMTS Network Architecture*", Second International Conference on Environmental and Computer Science, Dubai, 353–355

Cao J., C. Zhang, J. Zhang, Y. Deng, X. Xiao, M. Xiong, J. Zhou, Y. Zou, G. Yao, W. Feng, L. Yang, Y. Yu (2012) *"SHAWK: Platform for Secure Integration of Heterogeneous Advanced Wireless Networks"*, 26th International Conference on Advanced Information Networking and Applications Workshops (WAINA), Fukuoka, 13–18.

Cardoso T., P. Neves, M. Ricardo, S. Sargento (2011) "Media Independent Handover Management in Heterogeneous Access Networks - An Empirical Evaluation", *IEEE 73rd Vehicular Technology Conference,* Yokohama, 1 - 5

Chowdhury A. S. , M. Gregory (2010) "*Performance of UMTS Handover by Cell Sectorization Using Opnet Modeller*" Melbourne, Australia, 1-5

Forkel I., M. Schinnenburg, B. Wouters, (2003) "*Performance Evaluation of Soft Handover in a Realistic UMTS Network*", Aachen Univ., 57th IEEE Semiannual Vehicular Technology Conference in Germany, vol.3, 1979 – 1983.

Glabowski, Sobieraj, Stasiak (2007) " *Evaluation Of Traffic Characteristics Of UMTS With Bandwidth Reservation And Handoff Mechanism*" Poznan Univ. of Technol, IEEE International Conference on Telecommunications and Malaysia International Conference on Communications, Penang, 736 – 740.

Khan M.M.A, M. Ismail, K. Dimyati (2009) "*Seamless Handover between WiMAX and UMTS*" Dept. of Electr. Eng., Univ. of Malaya, , IEEE 9th (MICC), Kuala Lumpur, 826 – 830.

Kwon H., K.Y. Cheon, A. Park (2007) "*Analysis of WLAN to UMTS Handover"* IEEE 66th Vehicular Technology Conference, M.D Baltimore, 184 – 188.

Mohammed A., H. Kamal, S. Abdul Wahab (2007) "*2G/3G Inter-RAT Handover Performance Analysis*" Dept. of Signal Process., Blekinge Inst. of Technol., Ronneby, The Second European Conference on Antennas and Propagation, 2007. EuCAP 2007 Edinburgh, 1-8.

Moscholios I. D, J. S. Vardakas, M.D. Logothetis, A. C. Boucouvalas (2011) "*A Batched Poisson Multirate Loss Model Supporting Elastic Traffic under the Bandwidth Reservation Policy*", IEEE International Conference on Communications (ICC), Kyoto, 1– 6.

Quddus A., X. Yang, R. Tafazolli (2008) "*Link-Level Analysis of Downlink Handover Regions in UMTS*", Vehicular Technology Conference, IEEE, Singapore, 2527 – 2531.

Razavi R., C. Androne, H. Claussen (2012) *"Handover optimisation for co-channel WCDMA heterogeneous networks"*, IEEE 23rd International Symposium on,Personal Indoor and Mobile Radio Communications (PIMRC), Sydney, 905 – 909.

Sadek M., S. Aissa (2012) *"Handoff algorithm for mobile satellite systems with ancillary terrestrial component*", IEEE International Conference on Communications (ICC), Ottawa, 2763 – 2767.

Silva I. D., Y. Wang, F. Mismar, W. Su (*2012)* "*Event-based performance monitoring for inter-system cell reselection: A SON enabler*", (ISWCS), Paris, 6 – 10.

Zuberi J. A., M. T. Tasadduq, I. Ali (2007) "*Hand Off Issues in 3G UMTS Networks*" Department of Computer Engineering, Sir Syed University of Engineering and Technology, International Bhurban Conference on Applied Sciences & Technology, 2007. IBCAST 2007 Islamabad 44–48.