QOS Parameter Analysis of UMTS Networks based on Handovers

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ABSTRACT
A tremendous growth is seen in the field of communication. UMTS also known as 3G technology offers user wide range of data services and voice services. Continuity of services is necessary for mobile user and this continuity is achieved by mechanism called handover. This paper provides a detailed investigation of soft and hard handovers. QOS parameters of handovers using different multimedia application (HTTP, FTP, EMAIL, VOIP) are analyzed. The scenarios of UMTS networks are implemented and simulated using OPNET™ 14.5. and it is concluded that soft handovers proves better in performance for different multimedia applications.

Keywords
UMTS, QOS, Handovers, Opnet™ 14.5, GSM.

1. INTRODUCTION
The demand of mobile and internet is increasing, giving new dimensions to communication industries. A lot of advancement is being done in the field of wireless communication . Evolution of wireless has been seen from 1G to4G. Universal Mobile Telecommunication Service(UMTS) also known as 3G provides multimedia services to the user in mobile domain[1] 3G has brought a huge transformation in the world of communication. The Standard have been projected by 3GPP leading to creation of UMTS that can support web browsing, file transfer, higher data rates, emailing, telnet etc. UMTS fulfils the specifications of International Mobile Telecommunication-2000(IMT-2000) which was meant to provide wireless access to the global telecommunication system. To meet this standard a system should have a required data rate of at least 200kbit/s. UMTS is based on WCDMA technology. The main components of umts includes BS(Base Station) or Node B. RNC(Radio Network Controller) and Core Network. Evolution of GSM network results in formation of UMTS networks . GSM circuit switched network was replaced by packet switched network having better transmission rate and better data services. Along with data rates another main feature needed was continuity in the services that was achieved by technique called HANDOVER/HANDOFF. It is initiated by either crossing cell boundaries or by decrease in quality of signal. Handovers can be either hard handover or soft handover depending on the need[2]. UMTS has better performance than GSM in case of handovers In a heterogeneous network, handover process is classified into two categories: horizontal handover and vertical handover. [3].

2. BACKGROUND
Wireless communication has made a great evolution since its commencement. The need of wireless is not just specific to communication but there is huge demand of wireless communication for internet, web browsing, and many other multimedia applications[4]. First Generation(1G) came into existence in 1980's using analog technology which was adopted by many countries. Every country developed their own system using their own equipments and it was not compatible with other systems. GSM is second generation technology that provides integrated services over mobile using wireless networks. It was first developed in 1980's and deployed in 1990's. It used circuit switched networks to provide services like SMS and other data services. Scheme used was TDMA and FDMA to provide a data rate of less than 50kbps. It evolved further into2.5G introducing General Packet Radio Service(GPRS) and Enhanced Data For Global Evolution(EGDE) for better speed and better schemes of communication. GPRS is a top-effort packet switched service, compared to circuit switching, where there is a given QOS is certified during the connection for non-mobile users. It gives medium speed data transfer, via the use of idle Time division multiple access (TDMA) channels. EDGE has three times better services than GPRS. It handles more subscribers, higher data rates, capacity for voice communication, EDGE allows the delivery of advanced mobile services such as the downloading of video and music clips, multimedia messaging, high-speed Internet access and e-mail on the move[5]. Since demand for transmission rate and other multimedia services increases, UMTS came into existence. A standard was projected by 3GPP for the formation of new 3G technology. 3G has brought great transformation in the field of mobile communication with better data rate video conferencing, mobile television, GPS(Global Positioning System) etc. UMTS fulfils the specifications of International Mobile Telecommunication-2000(IMT-2000), the official International telecommunication union which provides access to the Global telecommunication system. UMTs uses WCDMA(Wideband Code Division Multiple Access) as air interface technology. IT provides higher data rate with low cost services. It has a better architecture which consist on three main parts Base station(BS) Radio Network Controller(RNS) and Core Network(CN). For providing good and continue services and better QOS schemes like handover and sectoring are used.

3. UMTS ARCHITECTURE
UMTS architecture was supposed to be better and flexible than 2.5, as it can support multimedia services like voice and video calling requires different ways to handle different QOS parameters. Its architecture mainly consist three elements known as User Equipment(UE) that is used for talking or a data terminal connected to a computer. Mobile station is the mobile terminal which is the driving factor for handovers, UMTS Radio Access Network(UTRAN) is comprise of two elements Radio Network Controller(RNC) and Node-b. its function is similar to base station subsystem in GSM which is used as an interface between user and core network and the Core Network(CN) is the main or central element of the

system that is used for central processing. The UMTS core network splits into Circuit switched, packet switched and HLR. Circuit switched includes elements that communicates through circuit switching. Packet switching needs entities as Serving GPRS Support Node(SGSN)is interface between RAN and fixed networks and Gateway GPRS Support NODE(GGSN) is the main unit of umts network and act as a interface between network and outside networks. Home Location Register(HLR) contains all the information of the each subscriber along with the last known location.

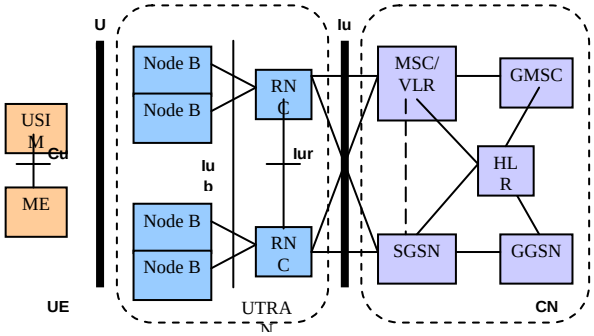

Fig.1 UMTS Network Architecture

4. UMTS HANDOVERS

Handovers are the important part of cellular telecommunication as it provide incessant service to the users. Handovers are performed when a user is moving from m one cell to another. As it moves away from base station of current cell its signal strength decreases and that of target cell increases, so to use resources of new cell handover occurs. There are different types of handovers that handles the efficiency of the networks, It has a great impact on the quality of service of the network. Basically there are two types of handovers, hard handover and soft handover.

4.1Hard Handover

Break before Make is another name of hard handoff as user first break the old radio links then make new one. This type of handover is common in GSM which has different frequency band [6].As user is moving from one cell to another, its signal strengths decreases, on the basis of the calculation of signal strength old connection is broken and then new connection is established with the target cell. These handoffs are designed to be instant in order to less the breaking of call. It usually occur when a user is moving from another cell having different band of frequencies. Hard handover occurs using Time division multiple access(TDMA) or Frequency division multiple access(FDMA). Hard handovers are easy to implement and a very simple algorithm is needed in which decisions are made according to the receiving signal strength. But if execution of process is not done properly termination of call may take place.

4.2 Soft Handover

This handover is also known as "make before break" as new connections are made before old ones are broken. This type of handover occur when mobile user is connected to two or more base station from same or different RNCs. decision of choosing a signal is based on the strongest signal strength. Parallel communication takes place from different Nodes-B so that continuity is maintained. This feature is mainly used by CDMA or WDCMA which is the access method of UMTS[7]. Soft handover occurs when mobile user is in area of overlapping cells. Since connections are made continuously this system is reliable, seamless and calling dropping probability is very less as compared to hard handoffs. But as more connections are made parallels algorithm used should by sophisticated so as to have least call drop probability and system is complex as compared to hard handovers

4.3 Softer Handover

Soft handovers mainly occurs in sectors and if sectors are from same cell site then it is called as softer handover. It is a type of handover in which communication takes place in parallel from same RNCs to different sectors[8]Multi path signals are received by the base station as signal sent by the mobile user/UE is reflected by the obstacle on the way. During softer handovers the uplink direction signals received at the base station are combined in the rake using maximum ratio combining technique[9].

4.4 Inter System Handover

This types of handovers takes place when a mobile user moves from one system to another having different architecture. UMTS uses WCDMA, GSM uses CDMA as access method so when users shifts from one cell having a access technique to another cell having different access technique such handovers occurs. This handover is UMTS-GSM handover. Intra system handovers is common under single system[10]Intra system handover can be inter frequency which takes place when cells have different band of frequencies, and intra frequency when cell has same set of frequency.

4.4.1 Horizontal Handovers

These are the intrasysten handovers which occurs between systems having same access techniques. if handover is GSM-GSM or UMTS-UMTS then it is known as horizontal handover

4.4.2 Vertical Handover

These handovers occurs between system having different access techniques that is inter system handovers. this occurs in UMTS-GSM handovers. It involves automatic switching to the access technology**.**

4.5 HANDOVER PROCEDURE

As user roam a lot of variations occurs in its signal strength, Link quality and interference level which sometimes need change of base station. The phenomenon of changing base station is known as handover.

Procedure of soft handover is divided into three main parts

Measurement Phase: In this phase strength of signal is measured my mobile. The ratio of Ec/No is measured based on the RSCP (Received Signal Code Power)

AND RSSI (Received Signal Strength Indicator)[11] This ratio is sent back to base station which is further sent to respective RNC for decision making.

Decision Phase: The measurement received by RNC is compared with some predefined values. On the bases of results handover is done.

Execution Phase/Channel Assignment: If handover is necessary then mobile station leaves old base station and new base station is added to it. New radio links are added to mobile station.

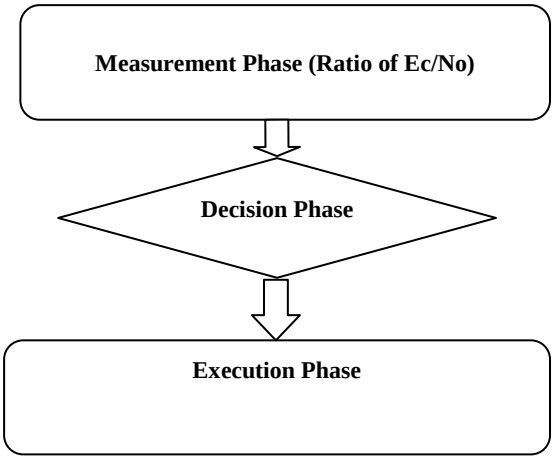

Fig.2 Handover Procedure

5. SIMULATIONS

UMTS model created using OPNET^{TM}14.5. The three main components of UMTS networks are UE, UTRAN, CN. Different scenarios are simulated and comparison of soft and hard handover are based on different QOS parameters. The figure shows two users UE_0, UE_1 are connected to base station Node_B_0 and Node_B_1 respectively. SGSN connects the base stations to core network (GGSN) which is connected to the HTTP server to generate HTTP traffic. The server supports (HTTP 1.1) heavy traffic. Both users follow a zigzag trajectories between both base stations results in repeating handovers from one cell to another. The network configuration for both soft and hard handovers are same except in scenario of hard handover soft handover is disabled. Similarly scenarios are created using different multimedia applications like FTP, Email, VOIP, and both soft handover and hard handover are compared based on QOS for all these applications.

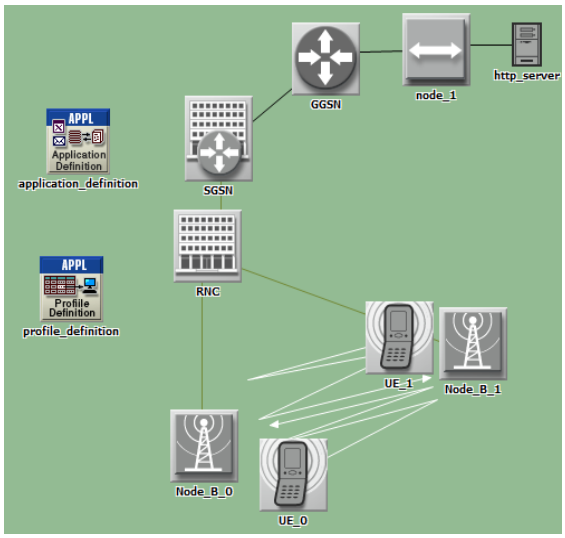

Fig.3

6. RESULTS AND ANALYSIS

Performance analysis of UMTS Handovers For different Applications based on different QOS parameters is done by simulating different scenarios using HTTP, FTP, Email, VOIP application.

6.1 HTTP application

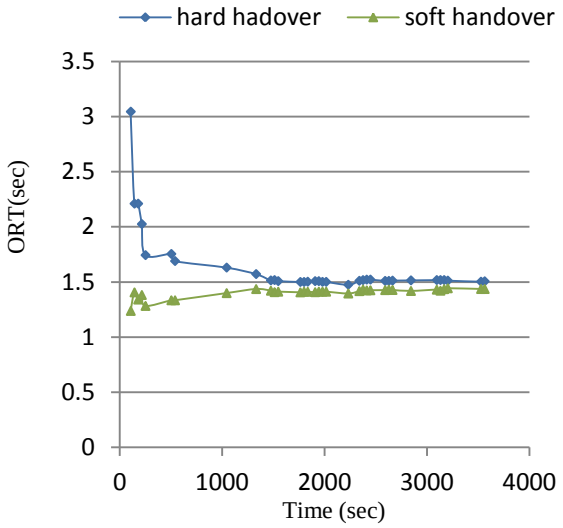

Fig.4 Object Response Time

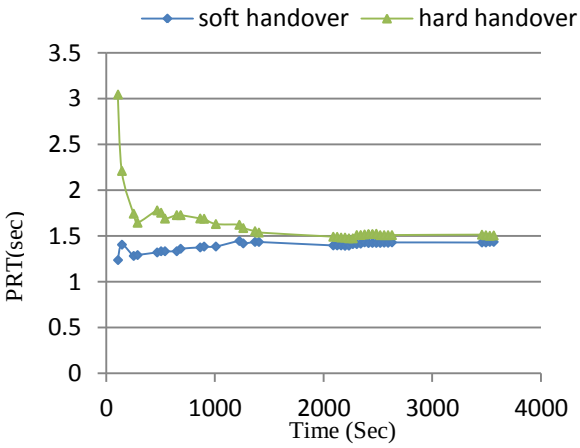

Fig.5 Page Response Time

From figure 4 it is seen that object response time for both soft and hard handover starts at 90sec but OBR time for soft handover is 1.2 seconds whereas for hard handover is 3.1 seconds which is much more than soft. figure 5 shows the page response time and it is clear that PRT of soft handover is nearly equal to 1.1 and that of hard handover is 3.1..

Table1. QOS performance comparison (average) for HTTP

Parameters	SOFT	HARD
Object response time(sec)	1.401	1.63
Page response time(sec)	1.393012	1.630896
Traffic received(bytes/sec)	109.152	88.18433

From the values observed in table 1 soft handovers average response time is lesser than hard So as object response time and page response time should be lower soft handover shows better performance

6.2 FTP application

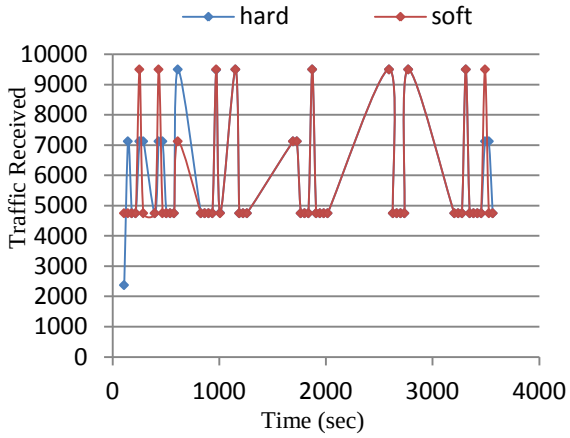

Fig. 6 Traffic Received

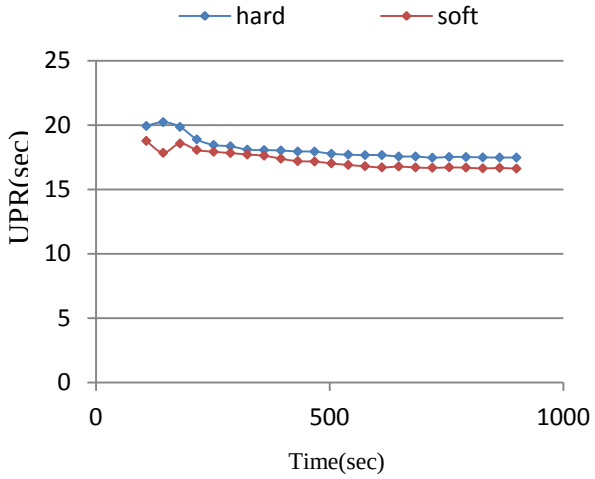

Fig.7 Upload Response Time

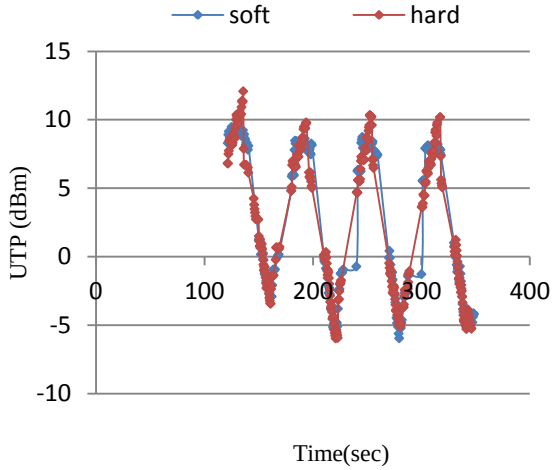

Fig.8 Uplink Transmission Power

The average of traffic received at FTP server is show in figure 6. Traffic received at the server for soft handover is always greater than hard handover.

The graph obtained in figure 7 shows that there is no significant difference in the Upload response time of both handovers

Uplink transmission power of UE_1 is analyzed in figure 8. Smooth edges of curve shows handover as user moves away from base station/node_b causing increase in transmission power and after handover it is again connected to node_b which results in decrease in transmission power. Hard handover shows much higher values of power which reduces the system performance.

Table.2 QOS performance Comparison (average) for FTP

Parameters	HARD	SOFT
TRAFFIC RECEIVED(bytes/sec)	5682.167	5635.595
URT(sec)	17.486	16.663

Table.2 shows that soft handover proves better for FTP application

6.3 Email application

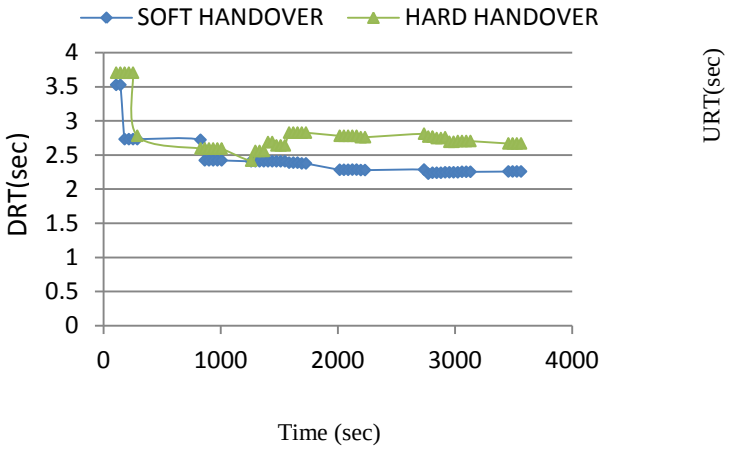

Fig.9 Download Response Time

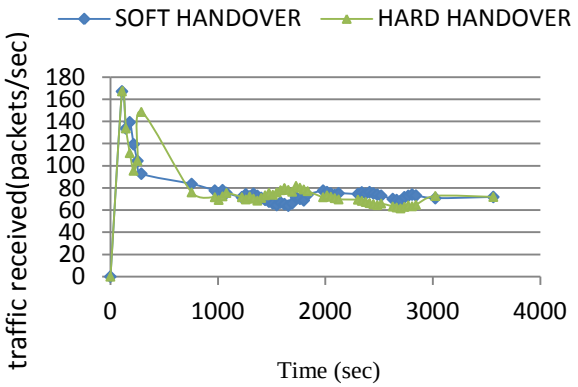

Fig.10 Traffic Received

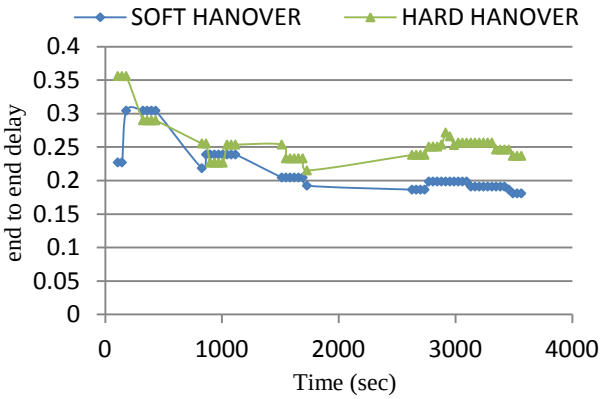

Fig.11 End to End delay

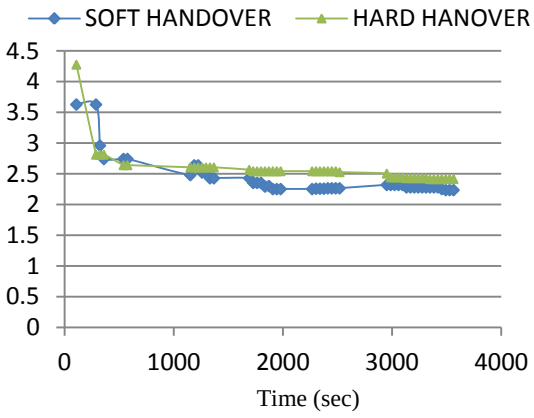

Fig.12 Upload Response Time

As shown in figure 9 Download response time for soft handover is 3.5 and for hard handover is 3.8 initially. As the time passes it decreases gradually for both handovers. The average value for soft handover is 2.41 and that for hard handover is 2.84.

From figure 10 it is clear that first packet received in both case is at 87sec and highest value reaches to 170 packets/ sec. Table of averages shows that both handovers handle traffic with equally with a little difference of 0.16. .

The graph shown in figure11 shows the GMM end to end delay of UE0 during handovers. Initially at 90 sec soft handover shows delay of 0.22 sec and hard handover shows delay of .34 sec. Further delay for both handovers decreases with final delay values of .16sec and 0.22sec for soft and hard handover respectively. Average value for soft handover is 0.21 sec and for hard handover is 0.25sec.

Figure 12 shows the graph comparison Upload response time of both handovers. It seen that value for soft handover is initially 3.7 while for hard handover is 4.3sec. The value of UPR decreases gradually with final value at 3600 sec 2.5 for soft handover and 2.8 for hard handover. Table of averages shows that average value for soft handover is 74.25 and that of hard is 76.27 seconds.

Table.3 QOS performance comparison (average) for Email

Parameters	**Soft**	**Hard**
Download response time(sec)	2.415822	2.802426
Traffic received(packets/sec)	77.25696	76.27251
UPR(sec)	74.25696	76.27251
GMM end to end delay(sec)	0.214024	0.255876

Table.3 shows that performance of soft handover is better than hard handover for Email application

6.4 VOIP application

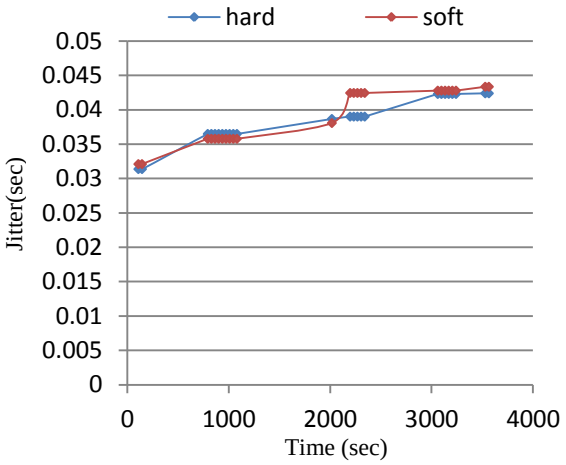

Fig.13 Jitter

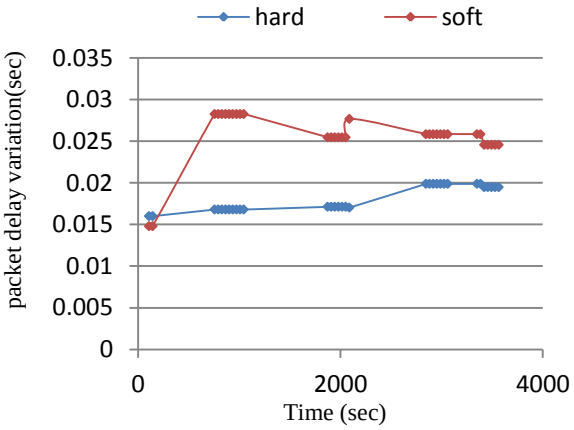

Fig.14 Packet Delay Variation

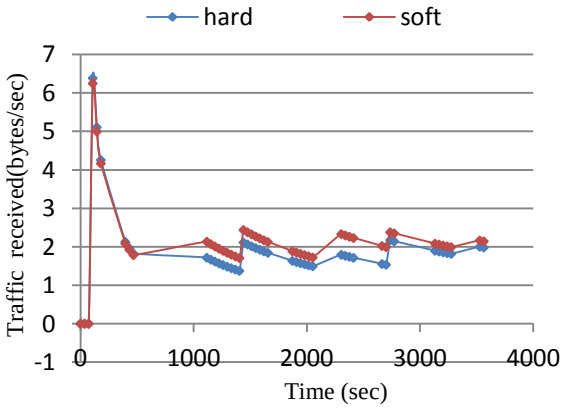

Fig.15 Traffic Received

In figure 13 it is seen that jitter for soft handover is higher than the jitter for hard handover. Initially jitter occurs at 89 sec with same value for both handover but at 2200 sec difference in value is large with 0.38 and 0.42sec for hard and soft handover respectively. Average values of jitter for soft handover is 0.39 and that of hard handover is 0.36. Figure 14 shows the graph comparison of packet delay variation for both handovers. AT 120 seconds value of both handovers are nearly same but at 350 seconds delay for hard handover is 0.015 and that of soft handover is 0.025.The average value for soft handover is 0.025 and for hard handover it is 0.018. As shown in figure 15 average value of traffic received for hard handover is 1.87 and for soft is 2.11.

Table4. QOS performance comparison(average) for VOIP server

Parameters	**Hard**	**Soft**
Jitter(sec)	0.036528	0.039191
Packet delay variation(sec)	0.018116	0.025629
Traffic received(bytes/sec)	1.878284	2.119931

Table 4 shows that hard handover is preferred for VOIP application for lesser jitter and delay but for large traffic soft handover is better.

7. CONCLUSION

For FTP application Traffic received for both is same by URT is 10% better during soft, transmission power during soft handover is lesser. In case of HTTP OBR during soft handover is lesser by 14% and PRT is lesser by 16% and Traffic received during soft handover is higher by 19% Similarly for Email QOS parameters like DRT is lesser by 13% and traffic received during soft is 20% higher, End to end delay is lesser by 16% and URT is lesser by 20% during soft handover. Jitter is both case is same but during soft it is slightly lesser packet delay variation is 13% lesser and Traffic received is higher by 15% for soft handover. Therefore multimedia application shows better performance during soft handovers.

8. FUTURE WORK

There is a ample of scope on analysis of QOS parameters of UMTS networks. Work can be done on Vertical and horizontal handovers to improve performance. Performance of handover on hotspot cells is of great scope. A lot of work is in progress for handovers in UMTS using different types of diversities.

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