# QOS parameter analysis of UMTS networks based on Handovers and Sectorization

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**Abstract-***The third generation was a revolution in telecommunication industry as it provided users with a variety of data services such as internet video conferencing and many multasking services. As the demand for technology increased advancement in features and services is being done. Decreased interference with increased capacity is very necessary for better performance. This paper is based on QOS analysis of umts networks with sectorization using OPNET™ 14.5*

**Keywords -** UMTS, QOS, Handovers, Sectorization.

## 1. Introduction

UMTS(3G) has given a wide range of services to wireless communication such as mobile internet access, video conferencing, pictures, graphics and other multimedia application. The services offered by UMTS are further divided into different classes bases on the QOS requirements. With increasing demand of better performance many problems came up. One of the such problem is handovers. Handover/Handoff basically occurs when user is roaming around the boundaries of the cell. In continuing the services as user moves from one cell to another handovers plays a major role. The procedure of breaking the presented connection with the percent cell and making connections with new cell is known as handover(Marichamy 1999). It is also necessary that handover takes place seamlessly without the interruption of services. Along with uninterrupted services, capacity usage should also be maximum. As bandwidth is scarce so appropriate usage is necessary for maximum quality of services. Sectoring is used to enhance the capacity of network and to reduce the interference. Sectoring is achieved by directional antenna. So any user which is not in the range of antenna cannot interfere with base station signal of that antenna(Prentice 2008).

## 2. Literature Survey

Wireless communication has grown a lot in last two decades. Alot of work is done to meet the demands of user in case of data rates and services.2G technology came into existence in 1980's and s uses time division multiple access (TDMA) in correspondence with Code division multiple access schemes CDMA(Nicopolitidis 2009). It provides data rates of 472kbps but fails support services like voice,sms which leads to creation of 3G. Many standardization bodies came together to form third generation partnership program(3GPP) in 1998. UMTS provided many new services to user one among them is continuity. To deal with continuity in services as user moves across the boundaries of cell handovers are essential(spigoni 2011). Handovers are of many type and occur according to the movement of the user. Hard handover occur when user moves from one cell to another and soft occur when user moves from one base station to another. Different types of handovers and their algorithms where explained by Jayasuriya in 2001. Another major concern after continuity is to provide QOS in UMTS networks. Guenkova-luy in 2004 explained that is essential to improve the performance of UMTS Networks. UMTS support many services like web browsing, video conferencing, VOIP, Email, some are delay sensitive and some needs accuracy. Today wireless networks are heterogeneous in nature so need better system for decision making to provide QOS(D. Niyato 2005). Stojmenovic in 2002 gave the description of UMTS handover and QOS requirements. For multimedia services five traffic services are supported by UMTS that are conversational, streaming, interactive and background. Different applications support different traffic classes so as to have better QOS performance(Sharma 2004). With growth in wireless communication need for better capacity was established . For increasing the capacity new schemes and methods were adopted. One of the method to increase the capacity was maximum use of limited frequency spectrum which leads to the phenomenon of frequency reuse. Frequency reuse scheme results in introduction of co-channel interference(Akella et,al, 2008). This problem of interference from the neighboring cells leads to decrease in capacity as the signal to noise ratio of the system increases. To reduce co-channel interference and to increase capacity Cell Sectoring scheme was introduced(sabharwal et al, 2000). Sectorization leads to division of a cell into different

**Chart -1**: Name of the chart

sectors. Directional antennas are used instead of omnidirectional to make sectors. mainly three or six sectors are made. occurrence of handovers increases with sectoring of cell.

## 3. UMTS Architecture

UMTS system consists of three main elements known as User Equipment(UE), radio access network(UTRAN) and Core networks(CN).UE contains a USIM known as Universal

Subscriber Identity Module) that contains the International Mobile Subscriber Identity Number(IMSI). It gives a unique identity to the user. UTRAN comprise of two elements Radio Network Controller(RNC) and Node-b. Radio Network Controller which controls the node b connected to it, i.e. the radio resource in its domain(Samjani2002). It undertakes resource management and mobile management functions. Node B- is the term used for base station transceiver, which have transmitter and receiver to communicate. The UMTS core network splits into Circuit switched, packet switched and HLR. End to end circuits are made during circuit switching and connections are released after transferring data. During Packet switching packets are sent one by one. serving GPRS support node (SGSN), gateway GPRS support node (GGSN) are the elements used by packet switching. HLR keeps record of all the user and their last known location.

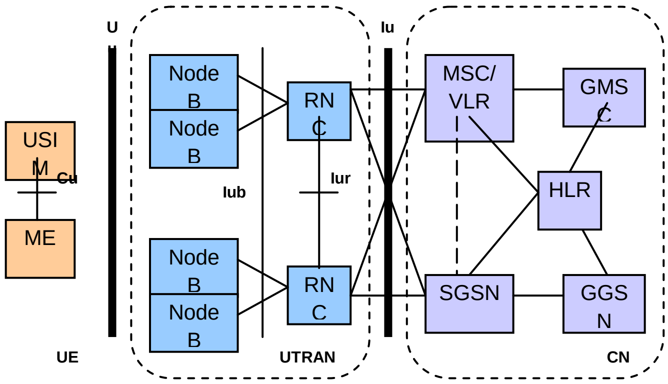


**Fig-1** UMTS Network Architecture

## 4. QUALITY OF SEVICES

Making a reliable network with good and satisfactory performance is always the main priority. Today network should provide quality of services as required. QOS can be defined as the ability of network to provide good services like lesser delay, quality signal, lesser call blocking etc. First and second generation networks were concerned about the voice quality but in UMTS good voice as well as data services both are to provided. Voice services should not have delay and should be real time services whereas data services like text and multimedia can tolerate little delay but should have low loss rate and better throughput. Different priorities are given to different applications. Services provided by the networks should be end to end that is from terminal to terminal. End to End services are support by three bearer services local bearer services, UMTS bearer services and external bearer services.(Garg, Oliver 2000). Throughput, Delay, Jitter, Reliability are various parameters of Quality of Service(QOS).

*UMTS Bearer Services*

Umts bearer services are further divided into two parts Radio Access Bearer Service(RAB) and Core Network Bearer Service.

*Radio access bearer service*: It used to transport data and signals to serving GPRS support node. It involve the air interface between IU interface and UTRAN. It used FDD/TDD services on physical layers. It is realized by Radio Bearer Service. Radio bearer covers all the aspects radio transport like mobility and user's profile. It also offers the unequal error protection.

*Core Network Bearer Service*: It connects Core network edge node(SGSN) to core network gateway node(GGSN) to provide access to external network. It uses Backbone Network Service to provide QOS which covers layer1/layer2 functionality.

### 4.1 UMTS QOS Traffic Classes

These classes can be differentiated based of different Qos attributes like delay, bandwidth, reliability etc. The most important factors is considered is delay. Some applications like video conferencing, audio VOIP are very delay sensitive so cannot tolerate delay while some like Email, FTP, Telnet can tolerate a little delay but should be error free

QOS traffic classes can be divided four classes

*Conversational Class:* It is used to serve real time traffic flows with no or less delay. Services like video telephony, data streams examples of conversational class. To provide better Qos delay should be less 400ms.

*Streaming Class:* This class transfer information in for of streams. Internet browsing comes under this class, with highly tolerant to jitter so as to provide large amount of asymmetry application on internet. This scheme is used for buffering of data while web browsing.

*Interactive Class:* This class is used when delay is not the priority. It depends upon the demand of the end user and the application and amount of delay it needs. Web browsing, database retrieval is the examples of interactive class. A important attribute for this class is round trip delay and accuracy.

*Background Class:* This type of class is used for the applications which runs in the background like email, sms, etc which are not delay sensitive. It does not work most of the time only works when needed. Its traffic depends upon the destination. Though it is not delay sensitive but cannot tolerate large delays. Most important attribute for this is accuracy.

## 5.SECTORING

Due to limited availability of frequency it is necessary that capacity usage should ne maximum. To increase the capacity of system many schemes are adopted. Most common schemes used are cell splitting and cell sectoring. Cell splitting is sub diving the cells into small cells having different sets of frequencies. Every cell has its own base station and antenna of small height. Though it increases the capacity of the system, but it has drawbacks like interference and needed more frequent handovers. To overcome such problems cell sectoring was adopted. Cell sectoring is to divide cell into small sectors. Sectors are cut at some particular angles, like 120°,60°,30° according to the need of the system. In sectoring Omni directional antennas are replaced by directional antennas. Directional antennas are the one which transmit in one particular antenna. So one omni directional antenna is replaced by 3or 6 directional antennas. Sectoring decreases the capacity of system as cells are divided into different sectors(Pertisky 1973). But interference from co-channels are reduced which increases the capacity of the system. when Omni directional antennas transmit a cell receive interference from all neighboring antennas, whereas if sectoring is done cell receive interference from only cells that are in its transmission angle. The reduction in interference means increase of Signal to noise ratio(SIR) which results to increase in capacity of the cell.

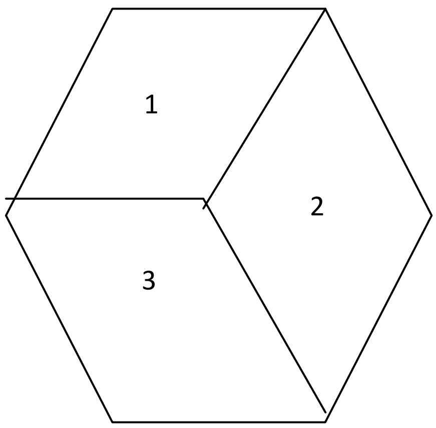


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**Fig-2** 60$^{O}$ Cell Sectoring

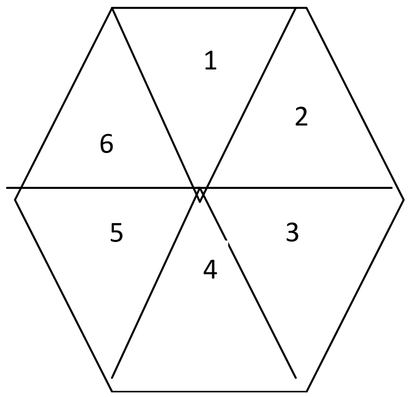


**Fig-3** 120° Cell Sectoring

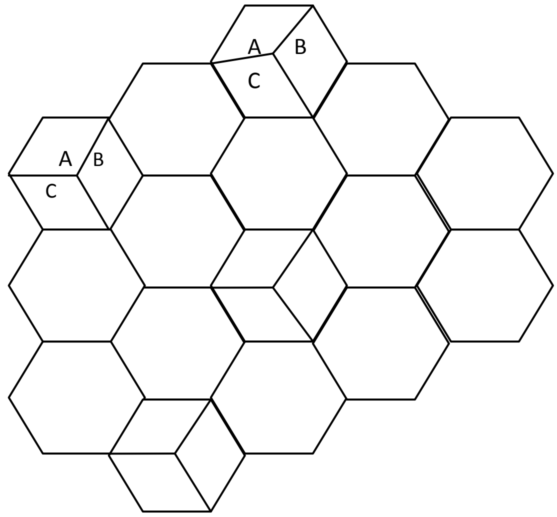


**Fig-4** Handover in sectors

Handover in sectors is done more frequently as cells are divided into small sectors. Handover takes place when user moves from one sector to another. Softer handover are done mostly in case of sectors.

## 6. Simulations

Figure 5 is used to determine the effect of sectoring over handover. Each Node B has three directional antennas covering an angle of 160 degree and sectors are positioned every 120 degree starting from 0 degree(0°, 120° and 240°). An overlap of 40 degree is produced between adjacent cells in the same Node B. UE is initially connected to Node_B_0 cell 0 and has a trajectory which changes during the simulation. As the location of user changes during simulation it comes closer to other cells at certain times, so RNC makes handover as required. Scenarios are same for both hard and soft handover, changes are made in RNC to support different handovers. The server used to create traffic is FTP.

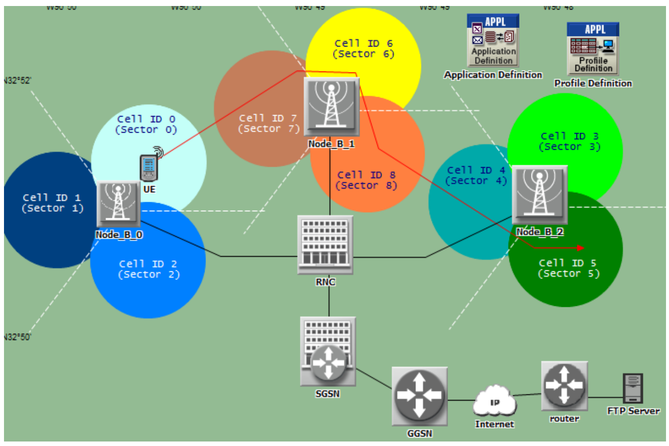


**Fig-5** Sectorization Scenario

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The scenario in figure 6 is used to determine softer and hard handover, when user is surrounded by base station with three sectors. The sectors are at 120° and directional antennas positioned at 160°. User UE follows a trajectory and moves from one cell to another causing RNC to make repeating handovers. HTTP Server supports heavy web browsing to create traffic RNC umts handover parameters are supported in softer handover and not supported in hard handover. Similar scenarios are simulated and comparison between softer and hard handover is analyzed using different multimedia applications, FTP, Email, VOIP.

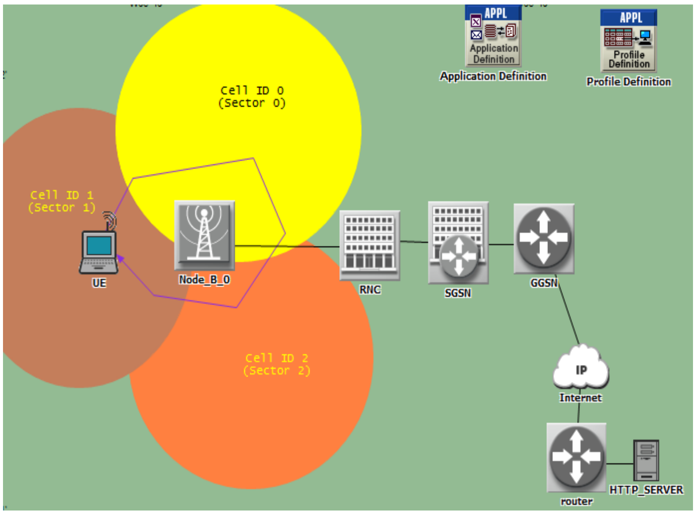



**Fig-6** Sectoring with HTTP Server

## 7 Results and Analysis

### 7.1 Analysis of handover with sectors

Scenario in figure 5 is implemented to analyze handovers. This scenario is simulated to analyze how procedure of handover is implemented when user moves from one sector to another. RNC in this scenario support soft handover. Softer handover procedure is analyzed by moving UE between the sectors. The statistics shows Number of cells in UE's active set, when and how cells are added and removed from the the active set during simulation.

*Procedure of handover*

When the simulation starts, UE is getting the strongest signal from cell 0 so it becomes a member of the initial active set. UE starts moving at 90sec..The signal of cell 0 starts decreasing and the signal from cell 7 gets strong enough to be added in the UE's active set at 160sec. After that at approx 178sec cell 0 is removed from the active set due to a weak pilot channel signal As the UE surrounds Node_B_1 it enters into a softer-handover state when cell 6 gets added (time 230sec.) into the active set. Then at 300 sec UE starts moving again this time towards cell 8. In its transition from cell 6 to cell 8 cell 7 is removed from the active set and adds cell 8 (time 430sec.) and remove cell 6 at 435sec. At 480sec. UE moves toward Node_B_2 results in adding cell 4 to the active set at 525sec.At this time the UE remains in soft-handover between Node_B_1 and Node_B_2 that is between sectors 8 and 4, for a few seconds. After that it drops cell 8 from the active set at 535sec. While the UE surrounds Node_B_2, it adds cell 5 to its active set reaching again a softer-handover state. It stops for some time at the edge of cells 4 and 5. UE starts moving again at 660sec. and it losses cell 4 signal, so it removes it from the active set at approx 696sec. Finally the UE remains in cell 5 coverage area.

Active set cell count, cell added and removed during simulation are shown in figure 7

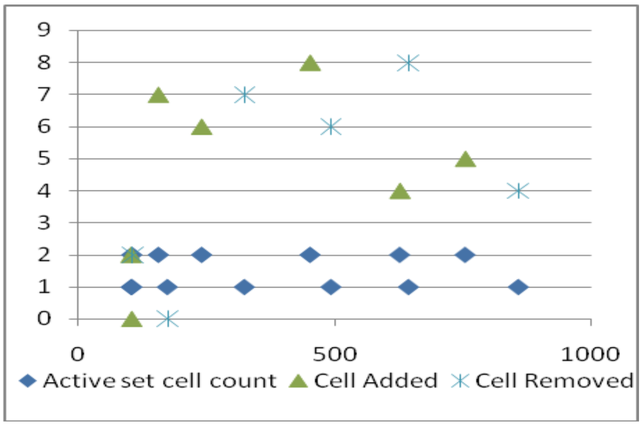



**Fig-7** Active cell count/ Cell added/Cell removed

### 7.2 Analysis of soft and hard handover using different Applications

#### 7.2.1 Sectors with HTTP

The QOS parameters are compared for both handovers to compare the performance of the UMTS system. Object response time and page response time are the parameters analyzed below

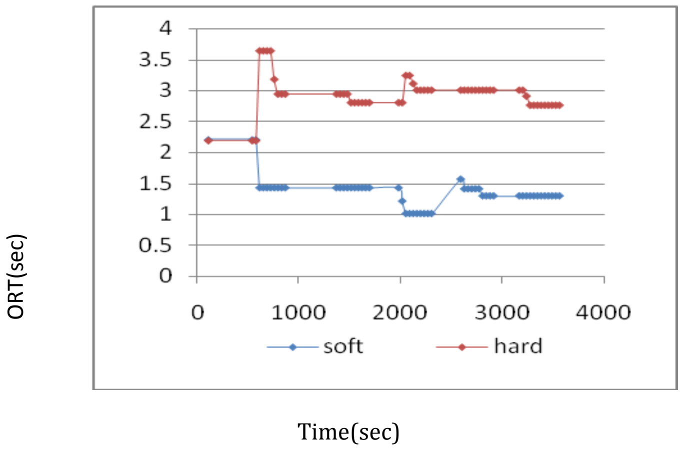



**Fig-8** Object Response Time

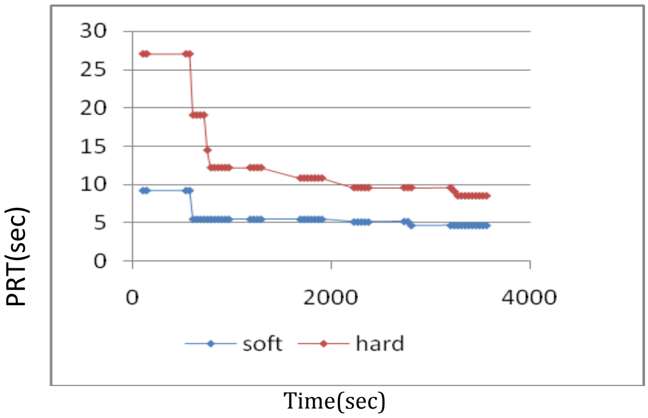



**Fig-9** Page Response Time

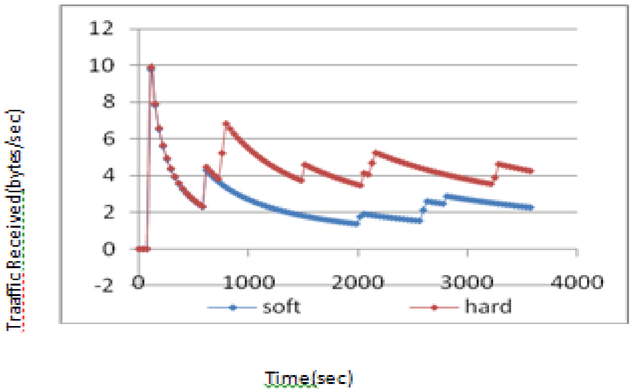



**Fig-10** Traffic Received

Figure 8shows the comparison of Object Response Time for soft and hard handover. From the graph it is clear that response time for softer handover is lesser than hard handover, which means performance in case of softer handover is higher than hard handover.

Figure 9 represents the Page Response Time comparison for both handovers. Initial values of PRT shows that softer response time is 9secs whereas that of hard is 27 seconds.

Figure 10 shows the statistics of traffic received by the server during handover. From the graph it is clear that traffic received during hard handover is higher than the softer handover.

**Table-1** QOS performance comparison (average) for HTTP

| Parameters | Soft | hard |
|---|---|---|
| Object response time(sec) | 1.368059 | 2.94441 |
| Page response time(sec) | 5.595301 | 12.64128 |
| Traffic received(bytes/sec) | 3.9756 | 4.31557 |

The graphs and table above shows that softer handover has respond faster than handover and traffic received during hard handover is higher.

### 7.2.2 Sectors with Email application

QOs parameters compared for email Download Response time ,Upload Response time and Traffic received.

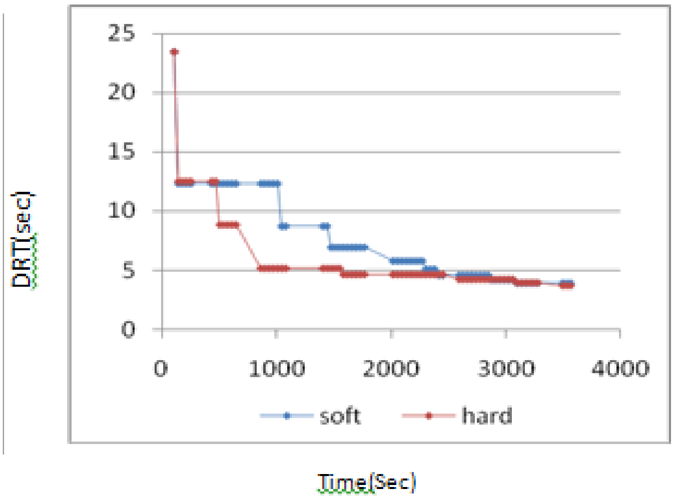



**Fig-11** Download Response Time

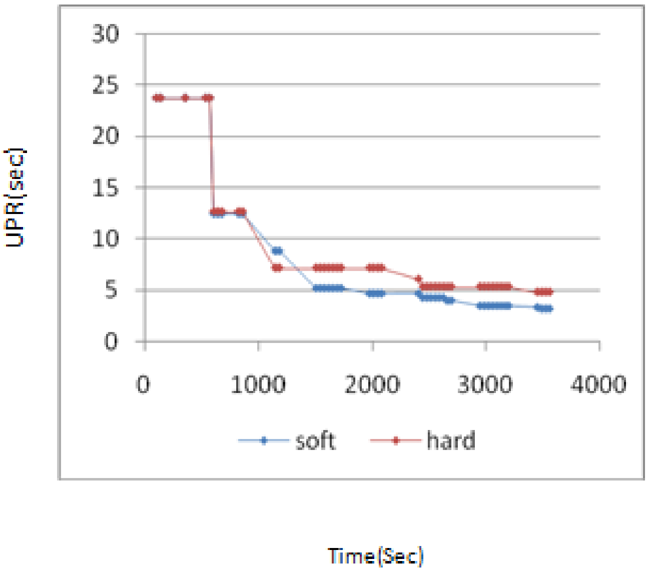
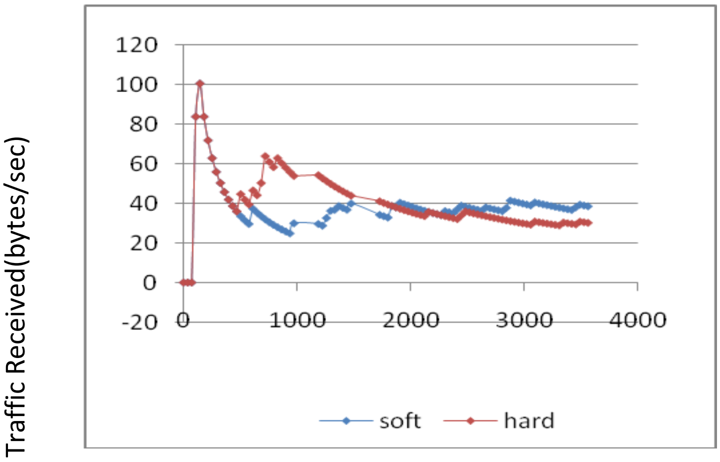



**Fig-12** Upload Response Time




Time(Sec)

**Fig-13** Traffic Received

Figure 11 shows that download response time has no major difference in case email during handover with sector. Though softer handover has slightly higher response time.

Upload response time during softer handover is higher than hard handover as shown in figure 12

Figure 13 shows the statistics of traffic received which is higher during hard handover

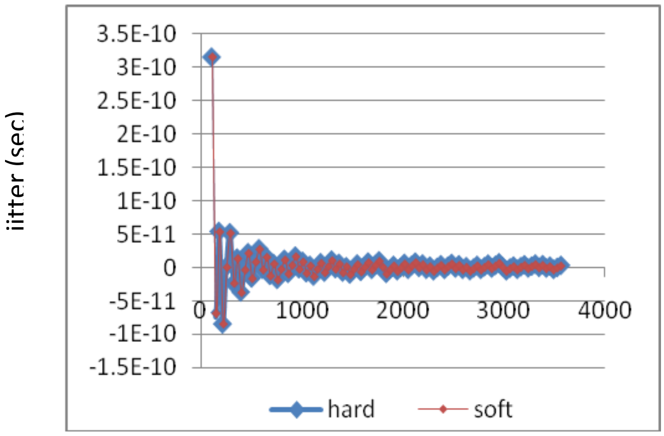
**Table-2** QOS performance comparison(average) for Email

| Email | Soft | hard |
|---|---|---|
| Download response time(sec) | 6.370782 | 5.909847 |
| Traffic received(bytes/sec) | 37.78357 | 39.99107 |
| Upload response time(sec) | 7.610834 | 8.752235 |

Table7.2 and graphs above shows that there is no bigger difference in statistics of both handover for email user with sectors.

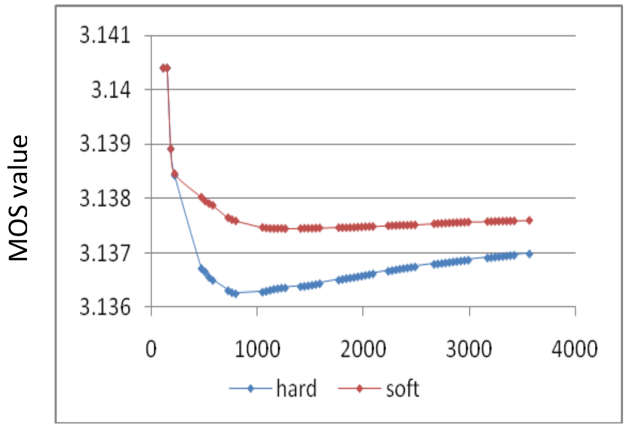
### 7.2.4 Sectors with VOIP

The QOS parameters compared are jitter, MOS of the server.




Time(sec)

**Fig-16** Jitter




Time(sec)

**Fig-17** MOS

Figure 16 jitter experienced by the user supporting voice profile during softer and hard handover. From graph is examined that jitter experienced in both cases are same.

MOS value comparison is shown in figure 18 which shows that though difference in both cases re very little but quality during sifter handover is better than during hard handover.

**Table-3** QOS Performance comparison(average) for VOIP

| Parameters | Hard | soft |
|---|---|---|
| Jitter(sec) | 3.16495E-12 | 3.20619E-12 |
| MOS value | 3.136829 | 3.137684 |

From graphs and table given above it can be summarized that jitter experienced in both case is same while quality is better during softer handover. Therefore softer handovers can be preferred for voice users.

## 8. Conclusion

Comparison of softer and hard handover with sectorization is done using different application. It is observed for HTTP application with sectors, user during softer handover has better performance with lesser response time. For Email user has higher download response time during softer but upload response is lower with lesser received traffic. Jitter experienced during voice call is same during both handovers but quality of signal is better during softer handover. Therefore, qos performancev during Softer handover is better as compared durinh hard handover.

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