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Quick Predictive Handover to ensure Optimal QoS in Heterogeneous Mobile Network Platform

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ABSTRACT
Recently these days Mobile IPv6 based Mobile Networks are increasing with the widespread popularity of cutting edge wireless internet connectivity. As Internet users are moving away from fixed connections to mobile connections in dealing with their day-to-day activities. In order to remain connected to the Internet while on the go, the Mobile Node must be handed over from one Access Router to another. During this process, there is a time period when the Mobile Node is unable to send or receive IPv6 packets both due to link switching delay and IP protocol operations, this time period referred to be handover latency. The intent of this paper is to implement the enhancements in NS-2 and execute simulations to verify the handover latency could be reduced, also able to reduce the average delay and achieve an optimum level of throughput by employing active queue management techniques that supports better QOS during fast handover.

Keywords: Heterogeneous networks, Fast handoff, throughput, Reverse routing header protocol.

1. INTRODUCTION

A heterogeneous network here means a combination of several networking technologies and access to these technologies when needed, taking into account different kind of communication requirements at specific situations and user needs. In other words A heterogeneous (or hybrid) network can be defined as a network which comprises of two or more different access network technologies (VANET, WLAN, UMTS, CDMA, MANET) to provide ubiquitous coverage. By using these kinds of networks, users are more flexible where several technologies are available to be used within the same coverage, or area of presence. It is well known that different technologies provide different characteristics like cost of service, bandwidth offered, security levels, converge and so on [1]. Heterogeneous Networks will be based on a federation of multiple networks of different operators and technologies. On the other hand, networks will have to integrate the capabilities of different technologies to an end-to-end, seamless and secure solution for the user. Ambient Networks take a new approach to embrace heterogeneity visible on different levels, such as link technologies, IP versions, media formats and user contexts [2]. Diversity of access links, especially of links provided by mobile networks, is supported by a generic link layer concept, which will efficiently enable the use of multiple existing and new air interfaces. Heterogeneous Networks also consider the implications of heterogeneous wireless systems on the overall network, especially the impact on end-to-end QoS and multimedia delivery. In particular, the novel concept of network composition will include the negotiation between different networks regarding their capabilities, e.g. regarding quality of service. All the systems differ in terms of coverage, bandwidth, delay, cost etc. However, using multiple wireless network interfaces it is possible to avail the advantages of different types of network simultaneously. However, roaming across the heterogeneous networks creates many challenges such as mobility management and vertical handoff, resource management, location management, providing QoS, security and pricing etc.,
Fast Handoffs are extremely important in heterogeneous network, as the generation changes, the wireless technology and networks try to find the new innovative ideas for the purpose of offer the better and efficient services to the users. The family of IEEE802.11 standards is the most popular technology which support Wireless LANs (WLAN), which have been widely deployed for the broadband wireless access due to their low cost and high capacity and along with this, there are number of different kind of network on which the user can switch during the users travelling. In this scenario, the handoff process will be initiated and it is of two types, Horizontal handoff (HO) and Vertical Handoff (VO).

2. HANDOVER PROCEDURE

The process by which a Mobile Handoff that is in the WLAN service area leaves out from the area and connects to the CDMA in vertical Handoff system and in same service for horizontal handoff. Its signal flow is shown in Figure 1.

As the MH leaves the WLAN AP (Access Point), the strength of the beacon signal that is received from the AP periodically weakens. If its strength decreases below the threshold value, then the CDMA Cellular card is activated and starts to synchronize with the system to prepare the handoff. Based on different factors used in the handover decision process, handovers can be classified in various ways.

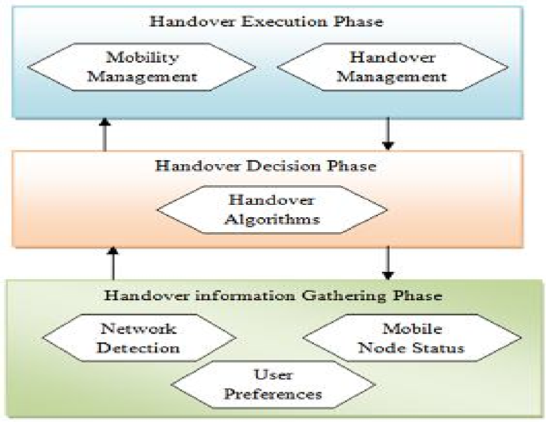

Figure 1 Handover Steps

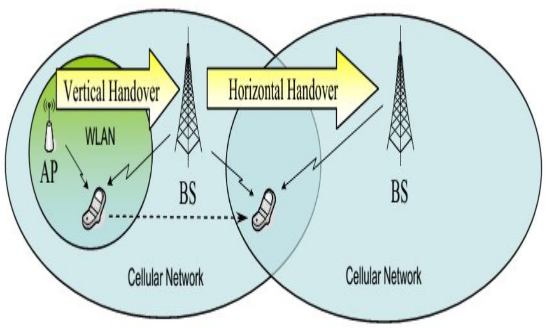

Figure 2. An example of horizontal and vertical handovers in heterogeneous wireless networks.

A horizontal handover or intra-system handover takes place between PoA (Point of Attachment) supporting the same network technology, e.g., two geographically neighboring BSs of a 3G cellular network. On the other side, a vertical handover or inter-system handover occurs between PoA supporting different network technologies, e.g., an IEEE 802.11 AP and a 3G BS. An example of horizontal and vertical handovers is illustrated in Figure.2 where a horizontal handover happens between two cellular BSs and a vertical handover takes place between an AP of a WLAN and a BS of a cellular BS.

Vertical handovers are implemented across heterogeneous cells of access systems, which differ in several aspects such as bandwidth, data rate, frequency of operation, etc. The different characteristics of the networks involved make the implementation of vertical handovers more challenging as compared to horizontal handovers. The terms horizontal and vertical follow from the overlay network structure that has networks with increasing cell sizes at higher levels in the hierarchy.

3. LITERATURE REVIEW

Handoff scheme for management the data loss in mobile communication has been proposed. In proposal handover method [3] had incorporated RSS (received signal strength) measurements are done besides BSS power budgets and its threshold distance is considered to improvise overall handoff management process.

They explained that the Wireless Heterogeneous Networks are integrated within fourth generation recently. The 4G wireless communication system should assure a few of QoS related facilities such as offering high data rates, seamless mobility, strong RSS. When accomplishment and requisite of a user is acknowledged the system gets succeed in handoff and seamless connectivity [4].

In [5] traditional mobile management protocols like proxy Mobile IPV6, Modified fast MIPv6 and also HMIPv6 its handoff performance have analyzed and compared. Here MIPv6 protocols were initially developed to support mostly mobility in individual hosts, rather than the network in its entirety.

For the above discussed issues in [6] they have proposed NEMO to support network mobility which discusses mainly on several routing optimization technique's in MANETS to balance inefficient routing and delay owing usage of basically Bi-Directional Tunnel (BDT) that enlists to solve pinball routing problem efficiently. On the other hand it suffers any testing done in real time to support those issues.

In paper [7] author proposed an improvised FHMIPv6 in which MAP prevents redundant binding updates not to take place during fast handoff scheme, To improve handover process MAP reuses some portion of hand over information by tracking mobile nodes movement.

Finally in paper [8] author analyzed and proposed new cross layer scheme with service management scheme, called it as Dynamic Mobile Anchor Point with Smart Router (DMAPwSR) in Mobile IPv6 that minimizes the service management cost as well as mobility with diverse mobility and service for serving the mobile users i.e. at same time balances its associated cost with mobility services that of packet delivery services.

4. SYSTEM DESCRIPTIONS

Consider the network architecture depicted in Figure 3.There is three entities in the network architecture:

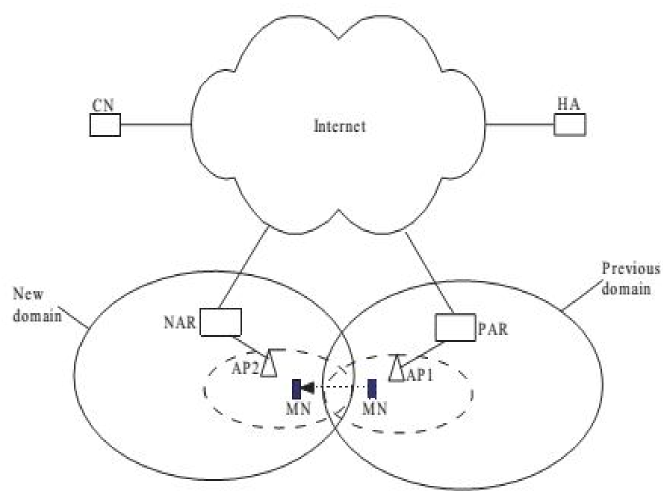

Figure 3. System architecture for Mobile IPv6.

HA (Home Agent), AR (Access Router), AP (Access Point). Besides these, there are two kinds of nodes, CN (Correspondent Node) and MN (Mobile Node). The MN connects to the Internet via AP and AR.
To describe the handover scheme, we address the common situation where handover happens. There are two access points, AP1 and AP2, in the network, which connect to different access routers, PAR (Previous Access Router) and NAR (New Access Router), respectively. As the figure illustrates, when the MN moves from the radio region of the AP1 to that of the AP2, the handover happens.
When the handover induced by moving between different domains happens, the MN should perform layer 2 handover and Layer 3 Handover. Layer 2 handover is the process with which the mobile node changes from one access point to another, here from AP1 to AP2. Layer 3 handover is the process that the MN changes the attachment from one access router to another, here from PAR to NAR. The layer 3 handover includes three operations: movement detection, new CoA (Care of Address) configuration, and binding update which is explained in detail in section V.
.

5. PROPOSED SYSTEM

For better understanding of the framework of the handover optimization method, an example is given to demonstrate a scenario as follows:
Figure .4 shows our proposed system architecture to have fast handoff scheme in which solid lines are treated as wired link and dashed links as wireless links. Here MAP (mobility anchor point) divides boundary of sub networks where routers connected to it belongs to one sub network that localizes the signaling traffic and hence reduces the handoff latency.
The function of proposed system starts from CN (Correspondent node) when it delivers packets that were accepted by HA(Home agent) and forwards them to corresponding AR(Access router) where its binding cache is done on packet basis by HA and RRH(Reverse routing header) protocol is used for acknowledgements purpose on its reverse path.

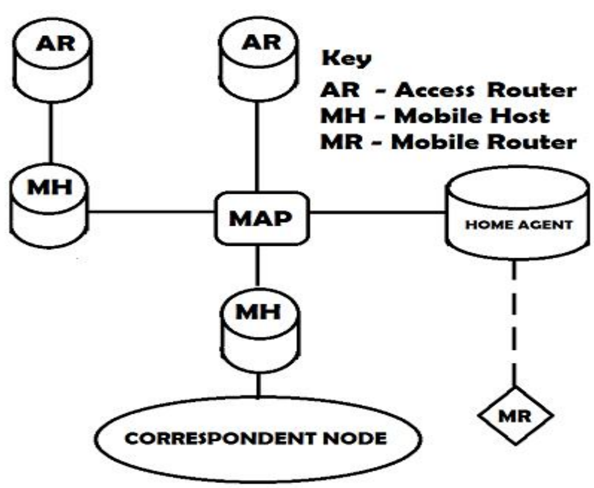

Figure 4. The proposed architecture

Figure.5 depicts main steps involved during handoff process and also shows how RRH protocol sets latest address of MR (Mobile router by the NAR (Next access router) with help of sequence diagram.

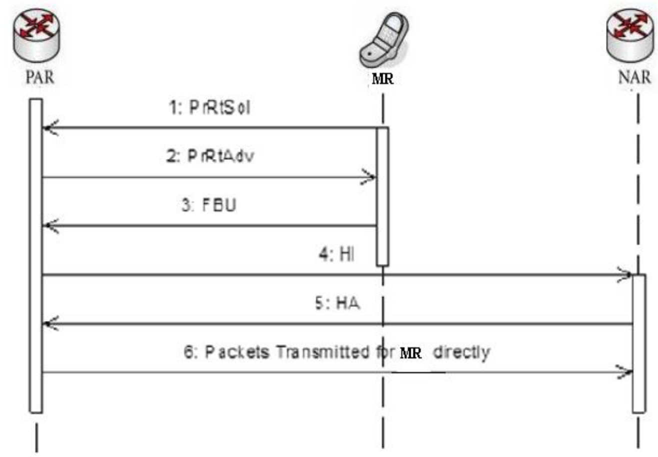

Figure 5. Sequence diagram depicting fast handover in Mobile IPv6.

As discussed earlier layer 3 handover includes three operations:

i. Movement detection,
ii. New CoA configuration, and
iii. Binding update

So therefore in order to reduce layer 3 handoff latency we employed 4 new message types along with MIPv6, that lets the data traffic to be moved to MR's new location (network) before it reaches that location (network). So in order to have these Router Solicitation for Proxy Advertisement (PrRtSol) and Proxy Router Advertisement (PrRtAdv) messages will be helpful for movement detection that reduces packet loss during this period.
As mentioned these messages could be used in between the MR (Mobile Router) and AR (Access Router) and also between PAR (Previous Access Router to which previously MR is attached before handoff takes place and NAR (Next Access Router to which MR will be attaches after handoff takes place. Similarly the PrRtSol and PrRtAdv messages, the MR also introduces new care of address (NCoA) when MR is still present on the PAR's (Previous access Routers) link. By this latency due to this new prefix discovery subsequent to handover is eliminated.

5.1 Operation of sequence diagram

1. Initially MR (Mobile router) sends a message PrRtSol to the PAR (Previous access Router) that may also contains link layer address.
2. In response PAR sends a message PrRtAdv to the MR then the MR forms CoA (Care of Address) according to IPv6 auto configuration.
3. Now to reduce binding update overall latency the proposed protocol labels a binding between

Previous CoA (PCoA) and Next (NCoA) .Then immediately MR issues a Fast Binding Update (FBU) message to its PAR to establish this tunnel.

4. Now PAR transfer Handover initiate (HI) message to the NAR directly with help of protocol employed.
5. Now in response, NAR sends Handover Acknowledge (HA) message to the PAR.
6. Finally packet delivery starts from PAR to MR (Mobile router) directly with access control, Quality of Service (QoS), and header compression facilities.

5.2 Reverse Routing Header

As we require no.of Bi-Directional Tunnels (BDT's) between MR and HA (Home agent) which results in usage of valuable network resources. To overcome this new Reverse Routing header (RRH) protocol is proposed where its functionality is to employ single bidirectional tunnels between first MR and HA(Home agent) for packet transfer. The job of RRH is to records the route from nested mobile network convert into a routing header for packets destined to the mobile network. Here an RRH is inserted by the first MR as part of reverse tunneling encapsulation process where it is removed by its associated HA (Home agent) when tunnel packet is decapsulated. Due to different format of packet formation in RRH it solves problem of Networks in mobility (NEMO) thus MR sends an FBU (fast binding update) to bind its New CoA as last message before handoff process takes place. Now immediately PAR starts delivering packets to destined MR to its New CoA.

6. SIMULATION RESULTS AND ANALYSIS

In this Section, we present computer simulation results and their analysis for the proposed scheme. The Tool Command Language (TCL) scripts were written to specify the network topologies. Additionally, awk and shell scripts were then used to find the values of desired performance gains. Each simulation result is derived from the average of several simulations. The performance metrics that were analyzed in our simulations are defined as follows:

1) ***Handover Delay***: the time interval from when a disconnected node lost its communication with previous router until it establishes a new connection with target router.
2) ***Network throughput***: the measure of the amount of packets that can be transmitted over a *given time interval to desired destinations.*
3) ***Packet loss***: number of packets lost during handover processing.

Table 1 shows the simulation parameters. In this simulation, each packet starts its journey from a random location to a random destination with a randomly chosen speed (uniformly distributed between 0–10 m/s). Simulations are run for 50s, 100s, simulated for 8 nodes under CBR traffic pattern.

Table 1. Simulation Parameters

Parameter	**Values**
Dimensions type	1000m×1000m
Traffic	CBR
Number of nodes	8
Simulation Time	300s
Maximum Speed of Node	10m/s
Packet size	1000bytes
Mobility model	Random Waypoint Model

Parameter	**WLAN**	**CDMA**
Bandwidth(MHz)	20	40
Multiple access	CSMA/CA	OFDMA
Mobility	Portable	Nomadic
Coverage	Small	Ubiquitous
Bit/Hz	2,7	Up to25
Frequency Band	4GHz	850MHz

In our system we considered total 8 nodes in which 7 nodes are treated as wired and 1 node treated as mobile router that has mobility nature as depicted in figure 6. As shown in figure 7 data is transfer from one correspondent node (CN) and mobile router (MR) in which total simulation time is setup to 100 sec.
Here CN communicates with the MN inside the mobile network via home agent (HA), which clearly shows that the MN is within the coverage of home network. Also MN got registered with HA that keeps track of location updates of mobile network and also its corresponding entities (MNs and/or sub routers).

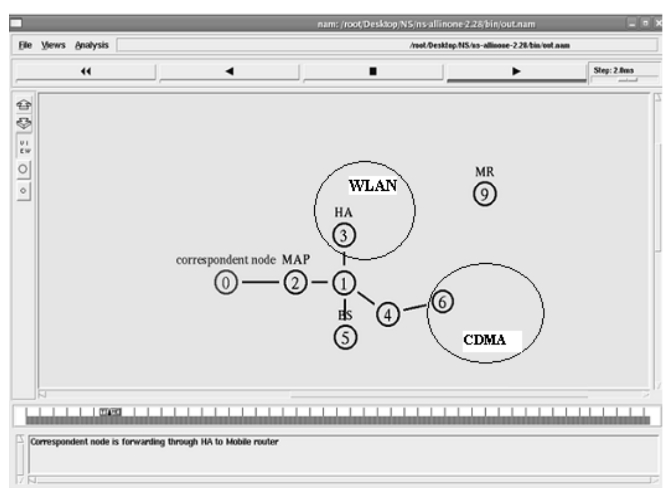

Figure 6. The initial system setup

Generally WLAN supports high data rates but low mobility, so we add CDMA to it for enhancing mobile data rates and supports ubiquitous data services for higher data rates especially in hotspots.

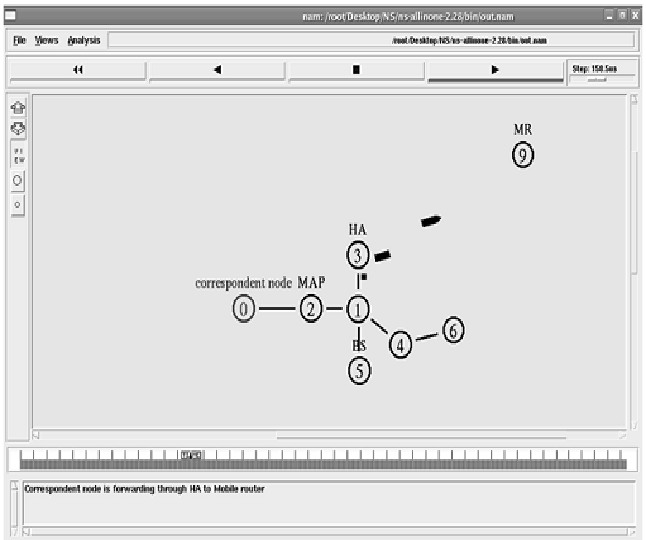

Figure 7. Packet transfer before Handoff process

Here MAP (mobility anchor point) divides total network into sub domains so that all entities that are under MAP administrated by itself rather to HA directly which in turn distributes loan on HA (Home agent).Also now Home agent will become default access router for mobile network but have capable of accepting other base stations as access routers when particular MR is far away from transmission range of HA.

Consequently packet transfer before handoff is via HA to the MR when the destined node is available.

- As all the intermediate routers that are in present network insert their own IP addresses to the incoming data packet and it reaches the HA then its corresponding whole path recorded as present header from which packet been travelled.
- Now the HA immediately removes off the header and encapsulates the packet thus establishes a BDT (Bi-Directional Tunnels) to the MR (Mobile router).
- Eventually MR decapsulates the packet and then reverses the header and interchanges their source and destination addresses, i.e., the source now becomes the destination and the destination in the RRH becomes the source of the packet.

Figure 8 shows the packet transfer after the handoff has occurred.

- When the MR dislodges out of the transmission range of the Home agent, it immediately broadcasts the router solicitation message.
- Here the receipt of above operation by present AR indicates that the transmission of the packets are intended for mobile network cannot be forwarded through it, so it sends a handoff initiation (HI) message to the nearby routers
- So at least one of the routers accepts this invitation request and sends back its Handoff Acknowledgement (Hack).
- Finally HA sends its acknowledgement back and the handoff is completed.

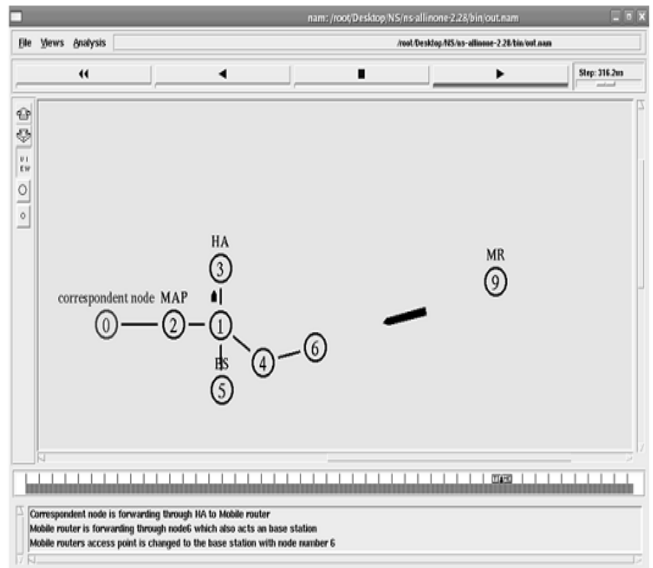

Figure 8. Packet transfer after handoff

During fast handover operation, the changeover point of attachment of the mobile router carried out without the loosing of the valuable data. Our observation from the above simulation is that:

i. Initially the fixed router number 3(HA) acts as the AR for the packet transfer with the mobile router number 9(MR).

ii. When the MR number 9 moves out of the range of the router 3, then router 6 acts as the new access router (NAR).

iii. Due to the bypassing of the HA from the network, the number of packets being dropped is very minimal.

Due to the mobility of the users across different networks, the high bandwidth required, and possible network congestions, it is shown that the handover may cause sudden degradation of the quality of the communication if the process is not correctly controlled.

To overcome these problems, the solution is proposed is to have active queue management that acts at the transport network with an active queue management. Simulation results, obtained by an extension of the ns-2 simulator, show that the proposed solution with the active queue management increases TCP performance significantly.

Drop Tail doesn't perform well for large bursts of traffic, it causes the congestion window to decrease and start over from the beginning. RED prevents synchronization in TCP congestion window. In case of Drop Tail all the tcp flows kept increasing and resetting their congestion window sizes at the same time. Whereas with RED, this was prevented and different flows reset their windows at different times. This ensures better bandwidth utilization.

6.1 Handover Delay

From figure 9 it shows delay is constant entire simulation which can be controlled and predicted during handoff in proposed RRH protocol scheme where it is bursty in case of basic protocol system can't tolerable.

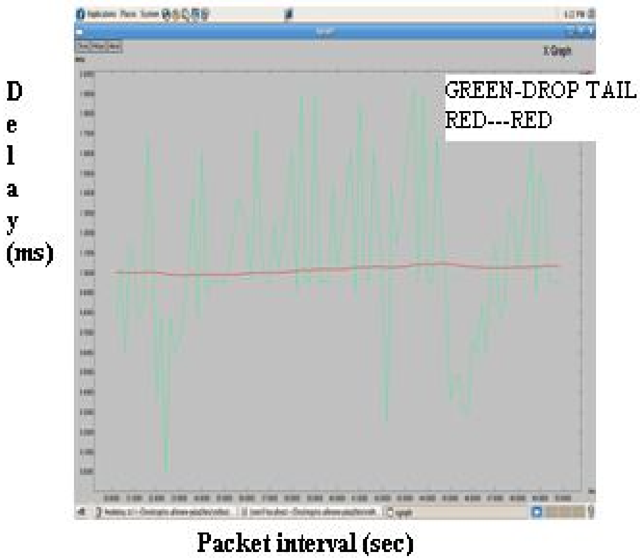

Figure 9. Handover Delay

6.2 Packet Loss

Our proposed solution gave the lowest packet loss rate because it resulted in the lowest handoff latencies, hence minimized the number of lost packets.

From figure.10 it shows clearly RED does not allow the average queue size to increase much. The variation in queue size is within a limited range, determined by the threshold values set.

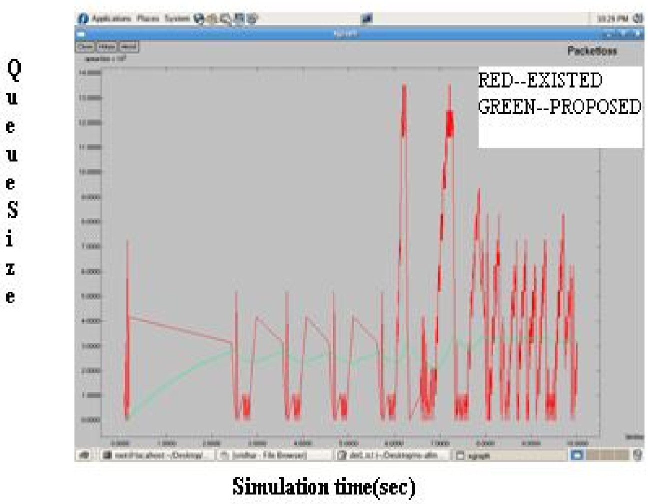

Figure 10. Packet Loss

Queuing delay in RED is lower. This follows from figure 10. Since, the average queue size is controlled well by RED, it ensures that the delay for the packets is low.

6.3 Network Throughput

To calculate the network throughput, we used the algorithm and awk program.

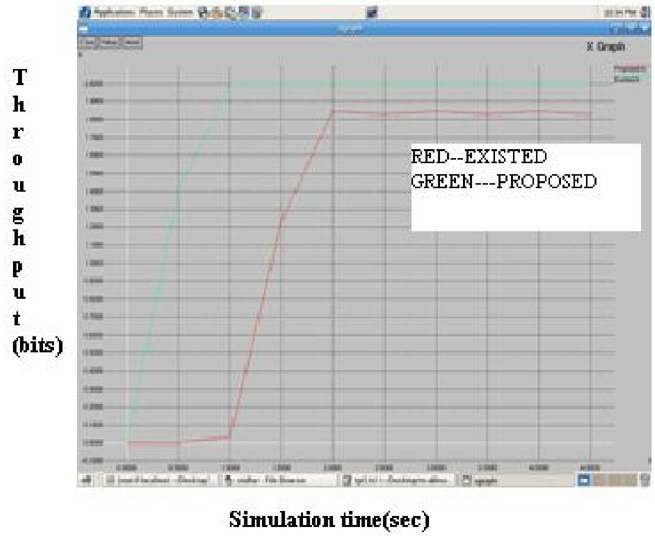

Figure 11. Network Throughput

CONCLUSION

Our proposed scheme ensures the TCP to implement a fast handover, by overcome the reverse tunneling and high data loss drawbacks of basic network protocol, the RRH protocol has been proposed as an extension, which allows for acknowledgments to be sent until the session completes. The performance of the proposed system is analyzed with NS2 simulator in terms of throughput and average delay. This proposal can be further applied to real world architectures in both wired networks and mobile environments to test the fast handoff by employing active queue management techniques to improve QOS in heterogeneous networks.

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