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QoS Architecture for Load Balancing and Routing in Nested NEMO

C.Shahul Hameed[1] , A.Rengarajan[2]

[1]Research Scholor St. Peter's University
shahulhameed0387@gmail.com
[2]Professor Department of Computer Science and Engineering Veltech

Abstract
In this paper, we have proposed a QoS Architecture for Load Balancing and Routing in Nested NEMO. Initially CS scheme is used with the HD algorithm. Next, to attain load balancing two load balancing schemes such as traffic load balancing and node number balancing can be used. Therefore, from this we can achieve larger connection throughput. Followed by this, we are using QoS-incorporated registration protocol and a QoS-handover protocol is used. Here we can achieve route redirection that greatly helps to reduce latency and packet loss during handovers.

1. Introduction
1.1 Network mobility
Network mobility refers to the mobility of an entire network that changes its point of attachment to the internet as one unit by which all, the data packets sent to and from the mobile network are transmitted via one or more designated mobile routers (MR) [1]. The basic concept of network mobility is to keep connectivity whilst the network moves. Therefore, in order to provide the connectivity, the most important issue is to make sure that the visiting network is able to provide sufficient resources to the mobile network. If possible, the reservation process should be done before the handover process. If the visiting network is unable to fulfill the requirements, the mobile network should find the nearest network to attach to which can accept the requirements [2].
Network Mobility (NEMO) Support provides seamless mobility to Mobile Networks, which are defined as network segments or subnets that can move and attach to any points in the Internet topology. A Mobile Network includes one or more Mobile Routers (MRs) which connect it to the global Internet. Nodes behind the Mobile Router, called Mobile Network Nodes (MNNs), are Local Fixed Nodes (LFNs), Local Mobile Nodes (LMNs) and Visiting Mobile Nodes (VMNs). NEMO Basic Support describes protocol extensions to Mobile IPv6 to enable support for network mobility. One advantage of NEMO Basic Support is that the Mobile Network Nodes need not be aware of the actual location and mobility of the mobile network. With some approaches for Route Optimization, it might be necessary to reveal the point of attachment of the Mobile Router to the Mobile Network Nodes. This may mean a tradeoff between mobility transparency and Route Optimization [3].

Issues in NEMO
The general issues in NEMO occur in the form of delay due to handover. Overload is the issue that occurs in this network mobility. Signalling, security, connectivity, reachability, packet overhead, bandwidth, jitter are the most common problems which have to be overcomed in NEMO [12] [13].

1.2 QoS architecture
QoS (Quality of Service) refers to resource reservation control mechanism, instead of the translation of term as achieved service quality. Communication occurs on data flow from source to destination and QoS guarantees a specified level of bit rate, jitter, and delay and packet drop probability to the flow. QoS assurance is important for real time traffics like Voice over IP (VoIP), online gaming, IP TV and video streaming etc. It enables network administrators to avoid network congestion and manage the network resources efficiently [4].
In recent years, the fast-developing IP mobile network technology has led to demands for fast and efficient Quality of Service (QoS) provision. On one hand, the mobility of individual nodes is supported by Mobile IPv4 and Mobile IPv6. With existing QoS mechanisms, e.g., Integrated Services (IntServ) and Differentiated Services (DiffServ), many proposals have been worked out to provide QoS for individual mobile nodes in terms of low delay, low jitter, low loss rate and high bandwidth. On the other hand, the IETF working group NEMO is undertaking research on the mobility of IP moving networks, in which the whole network moves as a single unit.
To improve the scalability and reduce the number of signalling messages QoS architecture is provided. A two-level aggregation-based QoS architecture is used to provide QoS for NEMO network. This architecture is based on modified DiffServ mechanism. A signalling protocol is also proposed to exchange information at both levels (i.e. node-level and network-level) as well as between the NEMO network and the visited network domain [7].

Issues:
A number of Quality of Services issues such as device availability, accessibility and its performance in the applications, occur in order to satisfy the realistic system. Proper end-to-end QoS needs to be provided to the application flows to meet user requirements. But the requirements of seamless mobility of users and scalability further complicate the issue: the provision of seamless end-to-end QoS in such a demanding and heterogeneous scenario is still a major challenge in networks research [5]. As the multimedia applications are very sensitive to the available bandwidth, jitters or delays in the networks, some sorts of service quality guarantees are essential [6].

1.3 Problem identification

In [8] two algorithms with the nested NEMO topology to reconstruct the Internet-based MANET are proposed. Additionally, a novel load balancing solution is proposed. The Mobile Router (MR) which acts as a central point of internet attachment for the nodes, and it is likely to be a potential bottleneck because of its limited wireless link capacity. They also proposed a load-information in the route advertisement (RA) message.

To solve the ad hoc networks clustering problems two algorithms are proposed in this paper. They are Lowest-ID (LID) algorithm and Highest-Degree algorithm (HD). Here in these paper two schemes such as distributed scheme (DS) and centralized scheme (CS) is used. DS uses LID algorithm and in CS HD algorithm is used.

However CS will cause some load balance issue. So they have used two load balancing schemes. One is the traffic load balancing another is node number balancing. So in this paper the load is balanced between the two routers. However the handover which causes reduced latency and packet loss problem is not considered in this paper.

In [10] QoS-handover architecture, HiMIP-NEMO is proposed. This combines the designs of routing and resource allocation with network mobility management and introduces the notion of foreign mobility agent to facilitate fast and reliable QoS handovers. A QoS-incorporated registration protocol and a QoS-handover protocol with several layer 2 and layer 3 messages are also proposed to assure no disruption and performance degradation of the existing services in network mobility services. In this paper, they have focused on the handover procedure between BSs in different subnets.

- When the connection of the access router (AR) and the Internet fails, the communication of a number of nodes in MONET is disconnected. So in case of large MONET, which is having many mobile routers (MR) and mobile network nodes (MNN), it will become a critical issue. So in order to achieve dynamic loading two load balancing algorithms are used.
- Whenever the mobile router enters the network mobility service domain, QoS incorporated registration process is done by using this protocol. This process supports the QoS handover process. After the registration, the mobile router receives route advertisement from the leaf-FMA, and broadcasts its prefix information in the mobile network.
- During the message forwarding, based on the prefixes of the serving and target BSs, a route optimization is performed to find their nearest common ancestor (i.e. the SWF) in the hierarchical Mobile IP backhaul network. This refers to HiMIPv6-NEMO proactive handover. When attaching to a BS, an MR will send BS a registration message (MRreg) containing its information. The BS then sends a HiMIP-NEMO defined layer 3 message, MRinfo, to its connecting leaf-FMA, indicating the presence of the MR. An MRinfo may lead to a HiMIPv6-NEMO reactive handover. Thus this QoS incorporated proactive and reactive handover is done by using the QoS-handover protocol.
- Therefore by this HiMIP-NEMO proactive handover, the long handover latency causing several packet losses is reduced and has almost better system performance.

2. Literature Review

Cheng-Wei Lee et al [1] have proposed a cross-layer hierarchical network mobility architecture and protocol, called HiMIP-NEMO, which is designed for all-IP networks. HiMIP-NEMO optimizes the routing between a mobile network node and the correspondent node, and supports fast QoS provisioning in the network mobility service domain. The advantage of Hi-MIPNEMO is that it reduces handover latency and packet loss, and supports high velocity vehicles. However there occurs degradation in the performance of the system

Long-Sheng LI et al [8] have proposed two algorithms with the nested NEMO topology to reconstruct the Internet-based MANET. Additionally, a novel load balancing solution is proposed. The Mobile Router (MR) which acts as a central point of internet attachment for the nodes, and it is likely to be a potential bottleneck because of its limited wireless link capacity. They have also proposed a load-information in the route advertisement (RA) message. The simulation results show that the proposed solution has significantly improved the connection throughput. However the end-to-end delay and packet delivery ratio is not evaluated.

Hyo-Beom Lee et al [9] have proposed a node mobility supporting scheme with the mobile network. The proposed scheme introduces MAG functions to the MR and extends PMIPv6 network to a mobile network. Therefore MN handovers between the mobile network and PMIPv6 network with only IPv6 stack. They have also implemented PMIPv6 protocol and nmNEMO without any modifications for LMA and MAG. The results shows link layer handover latency is critical to total handover latency. However handover solution is not proposed in this scheme.

Cheng-Wei Lee et al [10] have combined the designs of routing and resource allocation with network mobility management, and introduced the notion of foreign mobility agent in a hierarchical backhaul packet forwarding architecture, referred to as HiMIP-NEMO, to facilitate QoS-handovers and reduce latency and packet loss during handover. Under the architecture, a QoS-incorporated registration protocol and handover protocol with several new layers 2 and 3 message types are also proposed. The results show the effectiveness of the proposed integrated designs in the support of QoS-handover and significant improvements in latency and packet loss performances. However there is a drop in the throughput intially during the handover.

Rafidah Md Noor and Christopher Edwards [11] QoS requirements in network mobility were identified and a dynamic QoS provisioning architecture was designed. The dynamic topology and insufficient resources which degraded the quality of service of the mobile network were highlighted. The resources were provisioned between the mobile router and the mobile network nodes. The traffic was prioritized according to the user classes. The results for average throughput, delay and packet loss rate are presented. The user class mechanism provided bandwidth guaranteed for selected traffic classes even though there were worse link bandwidth utilization. Results have shows the optimal bandwidth allocation for a premium class in the high level user. However the bandwidth is not guaranteed for the low level user regardless of their traffic types.

Szabolcs Nováczki et al [13] have proposed a new approach to handle mobile networks based on HIP. All the major aspects of the idea have been introduced such as basic functions, management of nested subnetwork and handover framework. The main advantage of HIP-NEMO is that it presents network mobility management integration to HIP by extending the usability of the base protocol. On the other hand HIP-NEMO benefits from being derived from HIP. Namely the effective security and mobility multihoming framework of the base protocol is inherited. The major disadvantage of the proposal is that it does not support completely seamless NEMO support for MNNs, as all kinds of these nodes need to delegate their signaling rights to the actual mRVS.

Zohra Slimane et al [14] have proposed a new Infrastructure independent handoff approach combining multihoming and intelligent Make-Before-Break Handoff. Based on required Handoff time estimation, L2 and L3 handoffs are initiated using effective and timely MIH triggers, reducing so the anticipation time and increasing the probability of prediction. MIH service is extended to provide tunnel establishment and switching before link break. Thus, the handoff is performed in background with no latency and no packet loss while pingpong scenario is almost avoided. The proposal saves cost and power consumption by optimizing the time of simultaneous use of multiple interfaces. However there is a decrease in the throughput.

Ravi V Angadi and K.C Shet [15] have proposed a QoS based handover technique for network-based network mobility (N-NEMO). The proposed architecture uses tunnel splitting scheme that establishes the global tunnel among local mobility anchor (LMA) and mobile access gateway (MAG) and local tunnel among mobile router (MR) and MAG respectively. Each mobile node estimates the QoS preferences such as bandwidth, battery power, received signal strength and link quality. Based on the estimated value, the priority list of MAG is build so that the best suitable MAG appears first in the list. The generated priority list is sent to the core network along with the handover request. Based on the handover scenario, core network executes either inter-domain or intra-domain handover technique. The proposed technique is efficient in terms of throughput, bandwidth usage, power conservation and delay. However there occurs energy consumption.

Aisha-Hassan A.Hashim et al [16] have presented an enhanced macro mobility management scheme for NEMO network which integrates improved FHMIPv6 with mobile networks. The main idea of the proposed macro mobility scheme is to apply the improved fast handoff mechanism for the MR handoff with its Local Fixed Node (LFN) in NEMO network in order to achieve seamless handoff in terms of packet loss and delay. The proposed scheme outperforms the standard NEMO BSP in terms of packet loss. However during the handoff, some packets never arrive at the destined receiver because of packet loss or distortion.

Zhao Lei et al [17] proposed a priority based load balancing policy. The home agent of mobile routers calculates the priority level for each mobile router by monitoring the egress and ingress data. Priority levels calculated will be broadcasted to mobile nodes through each mobile router. Using router select algorithm based on priority, each mobile node in the mobile network can recognize and select optimal mobile router as their access router. The proposed scheme provides a significant performance improvement in overall throughput and average delay. However as the number of access nodes increases, there is a decrease in packet delivery.

Yuh-Shyan Chen et al [18] have proposed a novel NEMO protocol for vehicular ad hoc networks (VANETs). In a highway, since every car is moving in a fixed direction at a high speed, a car adopting this protocol can acquire an IP address from the VANET through the vehicle-to-vehicle communications. The vehicle can rely on the assistance of a front vehicle to execute the pre-handoff procedure or it may acquire a new IP address through multi-hop relays from the car on the lanes of the same or opposite direction and thus may reduce the handoff delay and maintain the connectivity to the Internet. The proposed scheme is able to reduce both the handoff delay and packet loss rate. However as the length of virtual bus (hops) increases, the throughput decreases.

Fatimah Abdulnabi Salman and Emad Hassan Al-Hemairy [19] have proposed a handoff scheme for Network Mobility (NEMO) to minimize the handoff delay and packet loss. This scheme is acronymed as MMHM (Multiple mobile router handoff management) scheme that addresses the handoff management in multihomed mobile network. In the proposed scheme, the effect of router discovery and Duplicate Address Detection (DAD) that have direct impact on the handoff procedure is eliminated. The cooperation of multiple mobile routers in carrying the traffic of one another during handoff process results in minimum packet loss. However the packet loss increases during handoff with the increase in data rate.

3. Proposed Work

3.1 Overview

In this paper, we propose a QoS Architecture for Load Balancing and Routing in Nested NEMO. Initially Centralized scheme (CS) is used with the Highest Degree (HD) algorithm for clustering. Next, to attain load balancing two load balancing schemes such as traffic load balancing and node number balancing can be used. Therefore, from this we can achieve larger connection throughput. Followed by this, we use QoS-incorporated registration protocol and a QoS-handover protocol is used. Here we can achieve route redirection that greatly helps to reduce latency and packet loss during handovers.

3.2 Centralized Scheme (CS)

Here in this Centralized Scheme, top-down approach is used. In this Access Router (AR) acts as the root node and Cluster Head (CH) and the neighbor members of ARs acts as Cluster Members (CMs). Therefore, the nodes nearby AR are claimed as CMs. In this figure, node 23, 26, 80, 44 and 51 are the neighbors of AR. Then AR uses HD algorithm to choose the CH of Level-1 (indicated in yellow color). In Figure-2, nodes 26 and 44 are CMs of AR and hence become CH of level-2.

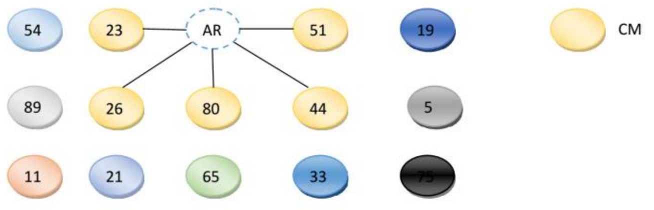

Fig.1 CS arrangement step 1

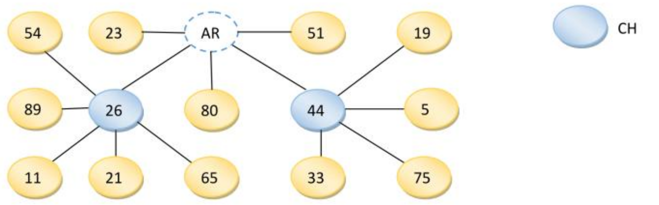

Fig.2 CS arrangement step 2

3.2 Highest Degree (HD) algorithm

AR uses HD algorithm to choose the CH of each level. The below illustration shows the CH selection using HD algorithm.

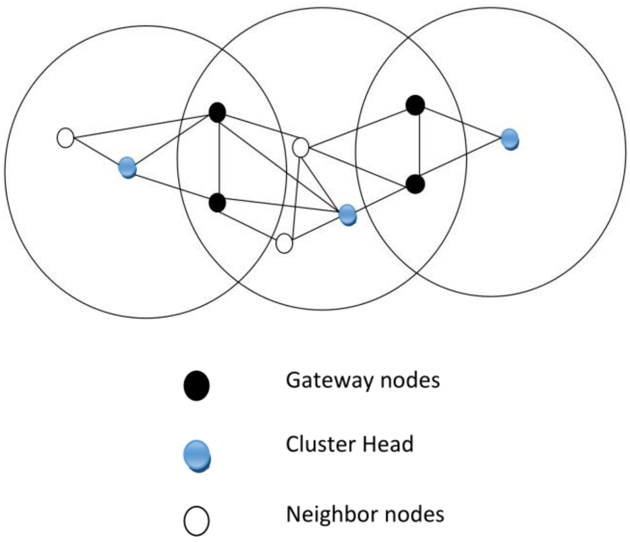

Fig.3 CH selection using HD algorithm

1) The highest degree of node in a neighbor is selected as the CH.
2) HD uses location information for the cluster composition.
3) Here each node periodically broadcasts its degree through a 'HELLO' message.
4) The node which has already elected another node as it's CH gives up its role as a CH.

3.3 Load balancing scheme

In order to accomplish the load balancing, two load balancing schemes such as traffic load balancing and node number balancing are used.

3.3.1 Traffic Load Balancing

The traffic load is the most important criterion. Here, Mobile Router MR1 will send Binding Updates (BU) to MR1's Home Agent (HA) through AR1. To reduce the load between two ARs and to achieve traffic load balancing, AR with smaller load is selected. The following figure shows the traffic load balancing system.

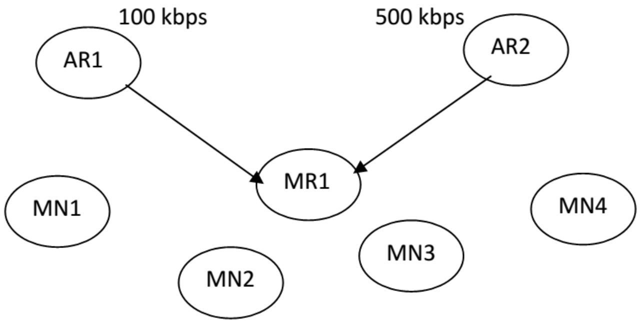

Fig.4 Traffic load balancing

3.3.2 Node number balancing

According to the load information, the node can choose the most appropriate AR/MR to connect.
In the below figure the traffic load of AR1 is 110Kb/s and the traffic load of AR1 is 105Kb/s. The difference between two ARs is too small. If, the traffic load of AR1 is greater than the traffic load of AR1. Here the difference between two ARs is too small.

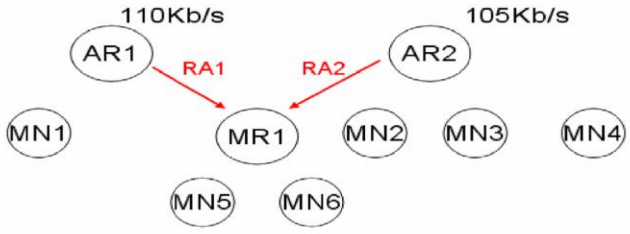

Fig.5 Node Number Balancing

If AR2 has three nodes and AR1 has only node, the MR1 should connect to AR2. Therefore, AR2 will have six nodes and AR1 has only one node. If the MNN2, MNN3 and MNN4 will not increase their traffic load.
In order to reduce this we are using the node number balancing method. If the difference of two AR is less than 10% of total load, the node will connect to the AR/MR with fewer nodes behind it.

3.4 QoS-incorporated Registration Process

In order to support QoS-handover, a registration process is used. Once the Mobile Router MR moves into a network mobility service domain, a radio link is established initially with a Base Station BS.

1. During the MR's registration, an extra field is defined in the registration message (MRreg) to carry MR's prefix ($prefix_{MR}$).
2. Next to this, the MR calculates the aggregate QoS requirements of its attached Mobile Host MH(s), and sends the information to the BS.
3. If the allocation of BS does not have QoS and handover related information of the MR, it will send an MRinfo to its leaf-FMA (Foreign Mobility Agent).
4. It contains the MAC address (MAC_MR), the $prefix_{MR}$, and the QoS parameters of the MR (QoS_{MR}).
5. Next to this the leaf-FMA searches its MR list. If it is not found, it creates a new record for the MR and records all the information into it including the QoS requirements.
6. Then it sends a HiMIP-NEMO defined message, newMRquery, to the root-FMA (step 2.) with MAC_MR, $prefix_{MR}$, and QoS_{MR}.
7. In the meantime, each intermediate FMA on the path will also search its MR list for a record of the MR. If not found, a new one is created and the information in the newMRquery is copied into the record. When the root-FMA receives the message and does not find a record on its MR list, it replies a newMRreply message with the newMR and the QoS_reservation_confirm fields set to "true" to the leaf-FMA.
8. While on the way of passing the newMRreply from the root-FMA back to the leaf-FMA, it will retrieve the QoSMR information from its MR list and make corresponding QoS reservation for the MR.
9. If the reservation succeeds, it simply forwards the newMRreply to the next FMA; otherwise, it sets the QoS_reservation_confirm field to false in the newMRreply to terminate additional unnecessary reservations.
10. If the leaf-FMA receives the newMRreply with the QoS_reservation_confirm field set to true, it means all the intermediate nodes in the HiMIP-NEMO backhaul network. The leaf-FMA then sends a HiMIP-NEMO defined message, MRinfo_reply, to the BS (step 4).
11. Next to the registration, the MR receives route advertisement from the leaf-FMA (step 6), and broadcasts its prefix information (RA_{MR}) in the mobile network. The MH finally performs the normal Mobile IPv6 operations (steps 9 and 10).

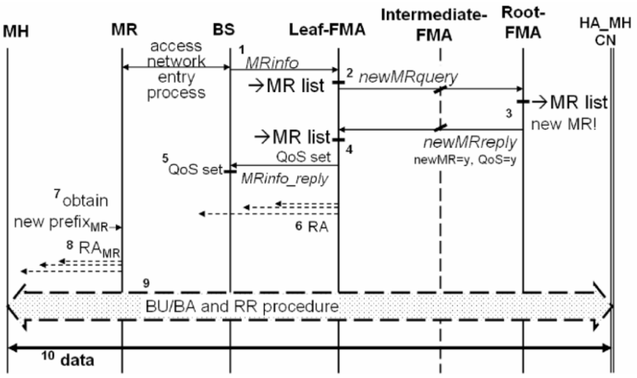

Fig.6 The QoS-incorporated registration process for MR

3.5 QoS – Handover Protocols

Here the messages are exchanged throughout a pro-active handover.

1. Primarily while forwarding the message, handover notification (MRHOnotify) message, the first intermediate FMA that finds both the serving and target BSs are its children, becomes the switching-FMA (SWF).
2. In case of no SWF is found, an expiration function will be executed to release prior QoS reservations (step 3).
3. In step 5, the FMAs on the path from SWF towards target BS will create a new record and routing rule for the MR. When the MRHOnotify reaches the target BS, the latter uses the information of the MR for QoS reservation.
4. After the process finalizes, all MHs in the mobile network continue the communication with CNs (step 8). In this process, the handover delay is minimized.
5. Afterwards, the MR follows the normal handover procedure to complete the process (steps 11 and 12).
6. In addition, HiMIP-NEMO supports an efficient reactive handover procedure. If the target BS does not receive an MRHOnotify, it sends an MRinfo.
7. The FMAs that do not have any information about the MR, it follows the same procedure as step 2.
8. In due course, one of the FMAs will find a record of the MR, and it will become an SWF.
9. The SWF stops the forwarding of newMRquery and peforms the functions such as making QoS reservations for the MR, adding a routing rule to its routing table for the (old) prefixMR and sending a newMRreply with the newMR field set to "false" and the QoS_reservation_confirm field set to "true" to the leaf-FMA.
10. It then creates a newMRreply message and sends along the path back to leaf-FMA. Each intermediate FMA makes corresponding QoS reservation.
11. In the meantime, messages are sent to release the resources allocated at the routers on the old routing path.

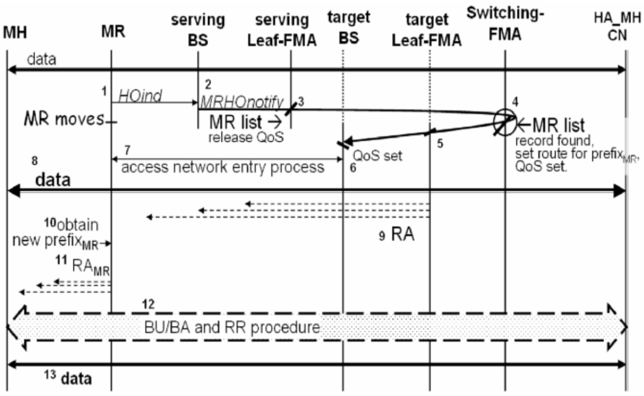

Fig.7 The QoS-incorporated proactive handover

3.6. Overall Process

1. Initially CS is used with HD algorithm for the CH selection.
2. Next, to achieve load balancing two balancing schemes are used.
3. First is traffic load balancing, by which the load is avoided between two AR.
4. Second, node number load balancing, here if the difference of two AR is less than 10% of total load, the node will connect to the AR/MR with fewer nodes behind it.
5. Finally QoS-incorporated registration protocol and a QoS-handover protocol is used.

4. Simulation Results

We will use the Network Simulator (NS2) [ ] to implement the proposed technique and show that the proposed technique is efficient in terms of delay, bandwidth and drop.

Validation of results can be done by comparing the results of our proposed approach with an existing approach by simulating the concept in NS2. By varying different parameters such as the packet sending rate, power level and bandwidth in various scenarios of NEMO, we can conduct various experiments.

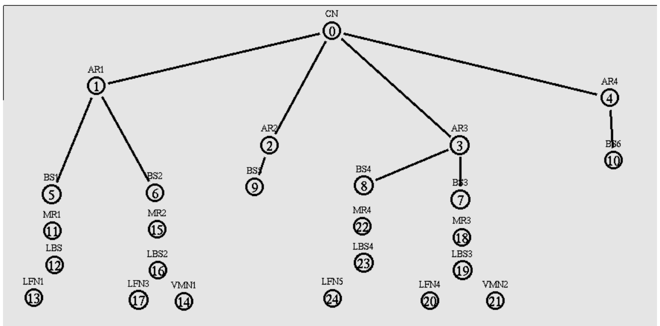

Fig.8 Simulation Topology

The NS2 version is 2.28 with Mobiwan patch included. The simulation topology is given in Figure 8. It consists of 4 mobile routers MR1, MR2,MR3 and MR4 which are connected to the access routers AR1,AR2,AR3 and AR4, respectively. MR1 and MR2 are connected to AR1 whereas MR3 and MR4 are connected to AR3.

We compare the proposed QALBR scheme with the existing HIMIP-NEMO [8] scheme.

We measure the received bandwidth of mobile node at various time intervals using UDP data flows.

A. Based on Rate-MR2

In our first experiment we vary the load value as 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5 and 5 Mb.

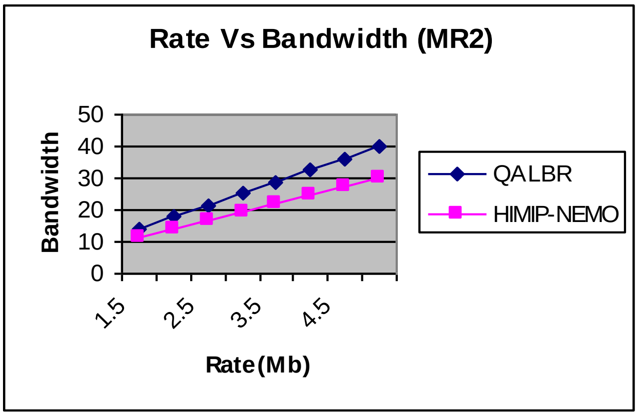

Fig.9: Rate Vs Bandwidth

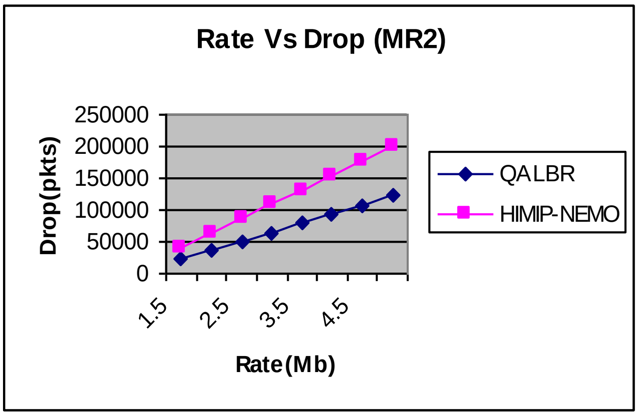

Fig.10: Rate Vs Drop

Figures 9 and 10 shows the results of bandwidth, and drop for the packet sending rate 1.5 to 5 Mbin QALBR and HIMP-NEMO protocols. When comparing the performance of the two protocols, we infer that QALBR outperforms HIMP-NEMO by 23.3% in terms of bandwidth, and 40.6% in terms of drop.

B. Based on Rate-MR3

In our second experiment we vary the load value as 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5 and 5 Mb.

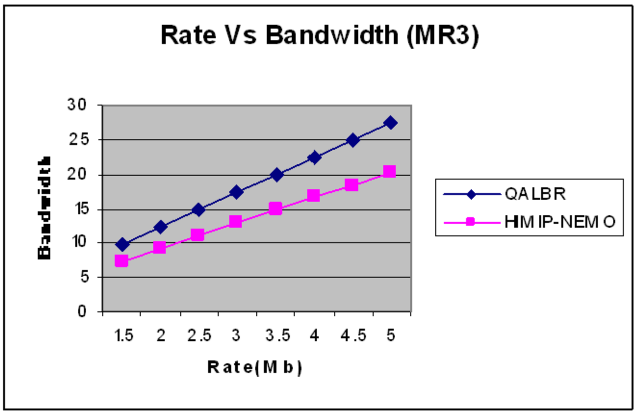

Fig.11 Rate Vs Bandwidth

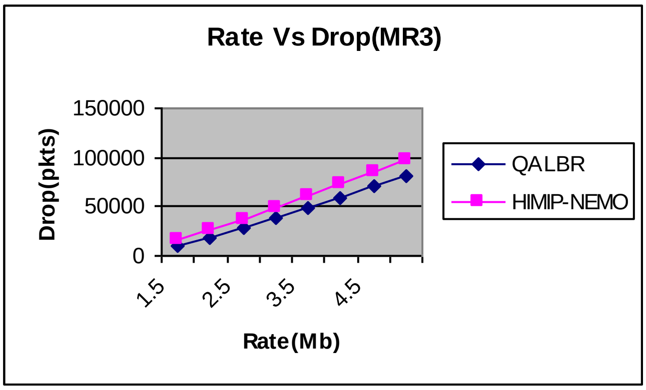

Fig.12 Rate Vs Drop

Figures 11 and 12 shows the results of bandwidth, and drop for the packet sending rate 1.5 to 5 Mbin QALBR and HIMP-NEMO protocols. When comparing the performance of the two protocols, we infer that QALBR outperforms HIMP-NEMO by 26.2% in terms of bandwidth, and 22.7% in terms of drop.

C. Based on Time-MR2

In our third experiment we vary the time value as 1, 3, 5 …. 31 Sec.

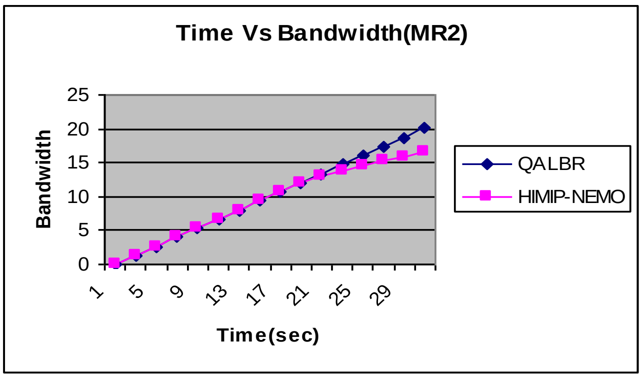

Fig.13 Time Vs Bandwidth

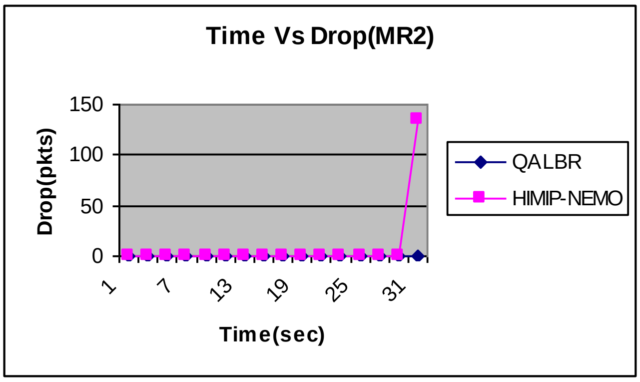

Fig.14 Time Vs Drop

Figures 13 and 14 shows the results of bandwidth, and drop for the simulation time 1 to 31 sec in QALBR and HIMP-NEMO protocols. When comparing the performance of the two protocols, we infer that QALBR outperforms HIMP-NEMO by 4.24% in terms of bandwidth, and 6.25% in terms of drop.

D. Based on Time-MR3

In our fourth experiment we vary the time value as 35, 37, 39 …… 69

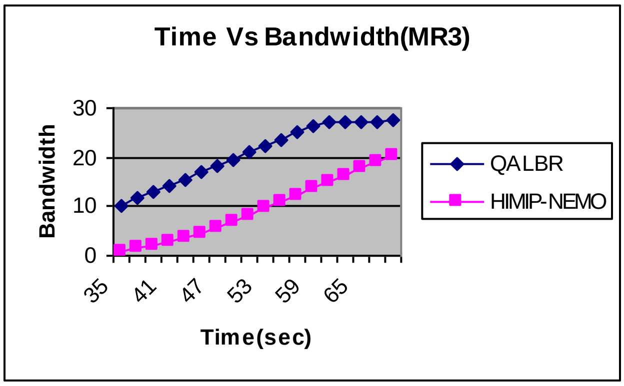

Fig.15: Time Vs Bandwidth

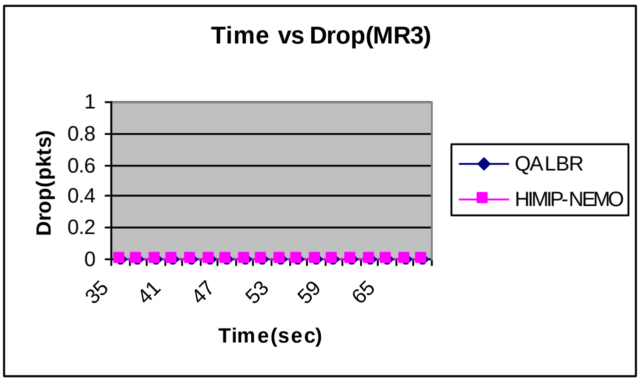

Fig.16 Time Vs Drop

Figures 15 and 16 shows the results of bandwidth, and drop for the simulation time 35 to 69 sec in QALBR and HIMP-NEMO protocols. When comparing the performance of the two protocols, we infer that QALBR outperforms HIMP-NEMO by 60% in terms of bandwidth, and 0% in terms of drop.

5. Conclusion

In our proposal, a QoS Architecture for Load Balancing and Routing in Nested NEMO is proposed. At first the CS scheme is used with the HD algorithm. Next, to attain load balancing two load balancing schemes such as traffic load balancing and node number balancing is used. From this, we are achieving larger connection throughput. Followed by this, we use QoS-incorporated registration protocol and a QoS-handover protocol. Using this we can achieve route redirection that greatly helps to reduce latency and packet loss during handovers.

References

[1] Cheng-Wei Lee, Meng Chang Chen and Yeali S. Sun, “A Network Mobility Management Scheme for Fast QoS Handover”, Proceedings of the 4th Annual International Conference on Wireless Internet, ICST 2008.

[2] Rafidah Md Noor and Christopher Edwards, “A dynamic QoS provisioning model for network mobility”, The 7th Annual PostGraduate Symposium on The Convergence of Telecommunications, Networking and Broadcasting. 2006.

[3] Huu-Nghia Nguyen and Christian Bonnet, “An Intelligent Tunneling Framework for Always Best Connected Support in Network Mobility (NEMO)”, Wireless Communications and Networking Conference, WCNC 2008, IEEE 2008.

[4] Rao, G. Srinivasa, G. Appa Rao, S. Venkata Lakshmi, D. Veerabadhra Rao and D. Rajani. “Enhanced Developments in Wireless Mobile Networks (4G Technologies)”, International Journal of Latest Trends in Computing (E-ISSN: 2045-5364), Volume 1, Issue 2, December 2010.

[5] Gabor Fodor, Anders Eriksson and Aimo Tuoriniemi, “Providing quality of service in always best connected networks”, Communications Magazine, IEEE 41.7 (2003): 154-163.

[6] Hamada Alshaer, Thierry Ernst and Arnaud de La Fortelle, “A QoS Architecture for Provisioning High Quality in Intelligent Transportation Services”, Network Operations and Management Symposium (NOMS), 2012 IEEE Publication Year: 2012.

[7] Yaning Wang, Linghang Fan, Nadeem Akthar, Kar Ann Chew and Rahim Tafazolli, “An Aggregation-based QoS Architecture for Network Mobility”, In 4th IST Mobile Summit Conference.

[8] Long-Sheng LI, Gwo-Chuan LEE, and Li-Keng KANG, “Balanced Topology NEMO Construction for the Internet-Based MANET”, Int. J. Communications, Network and System Sciences, 2009.

[9] Hyo-Beom Lee, Youn-Hee Han and Sung-Gi Min, “Network Mobility Support Scheme on PMIPv6 Networks”, International Journal of Computer Networks & Communications (IJCNC) Vol.2, No.5, September 2010.

[10] Cheng-Wei Lee, Yeali S. Sun and Meng Chang Chen, “HiMIP-NEMO: Combining Cross-layer Network Mobility Management and Resource Allocation for Fast QoS-Handovers”, Vehicular Technology Conference, VTC Spring 2008, ©IEEE 2008.

[11] Rafidah Md Noor and Christopher Edwards, “User class mechanisms for quality of service in network mobility”, Scientific Research and Essays Vol. 5, 18 December, 2010.

[12] Rituparna Chaki and Nandini Guha Niyogi, “An improved scheme towards fast handover in a hierarchical mobile network”, General Assembly and Scientific Symposium, 2011 XXXth URSI, IEEE 2011.

[13] Szabolcs Nováczki, László Bokor, Gábor Jeney and Sándor Imre, “Design and Evaluation of a Novel HIP-Based Network Mobility Protocol”, Journal of Networks, Vol. 3, No. 1, January 2008, © 2008.

[14] Zohra Slimane, Mohamed Feham and Abdelhafid Abdelmalek, “Seamless Infrastructure independent Multi Homed NEMO Handoff Using Effective and Timely IEEE 802.21 MIH triggers”, International Journal of Wireless & Mobile Networks (IJWMN) Vol. 4, No. 3, June 2012.

[15] Ravi V Angadi and K.C Shet, “QoS Based Handover Technique for Network Based Network Mobility (N-NEMO)”, IJCSNS International Journal of Computer Science and Network Security, VOL.13 No.7, July 2013.

[16] Aisha-Hassan A.Hashim, Wan H. Hassan, Shayla Islam, R.A. Saeed, M.K. Hasan, Jamal I. Daoud and Othman O. Khalifa, “An Enhanced Macro Mobility Management Scheme in NEMO Environment to Achieve Seamless Handoff”, World Applied Sciences Journal 21 (Mathematical Applications in Engineering): 35-39, 2013.

[17] Zhao Lei, Li Xiaoping, Dong Qingkuan, Tan Shuaishuai, “Priority based Dynamic Load Balancing for Multi-Homed Network Mobility”, International Journal of Advancements in Computing Technology(IJACT) Volume5,Number8,April 2013.

[18] Yuh-Shyan Chen, Chih-Shun Hsu and Ching-Hsueh Cheng, “Network Mobility Protocol for Vehicular Ad Hoc Networks”, International Journal of Communication Systems 2010.

[19] Fatimah Abdulnabi Salman and Emad Hassan Al-Hemairy, “Minimizing Handoff Latency and Packet Loss in NEMO”, IJCSI International Journal of Computer Science Issues, Vol. 10, Issue 4, No 2, July 2013.