Enhanced Performance and Global Reachability Of Manet Nodes With Multihoming Using Nemo

Wireless Communication

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Abstract—**Wireless technology is widely used as a communication medium in various areas of technology. User demand for high mobility increases daily i.e. the change in their position with respect to the internet blended with persistent connection. These services can be delivered efficiently by using Mobile IP or NEMO. MANET i.e. Mobile Ad hoc Network routing protocols were originally developed and implemented to support the mobility of nodes within a MANET. However, despite getting relative stability of the protocol implementations, seamlessly incorporating MANETs into the internet still remains a major challenge that has held up the deployment and progress in major mobile scenarios. Further to support the mobility, management mechanism; IETF i.e. Internet Engineering Task Force proposed NEMO i.e. Network Mobility which is an extension of MIPv6 i.e. Mobile IPv6. However, it is still not able to provide global reachability and session persistence without packet loss and handover latency. We propose a solution by integrating the existing MANET routing protocol with the NEMO protocol. But it is also unable to completely solve the problem because of congestion which reduces the efficiency of the network and the other issues are handover latency and packet loss. This results in inefficient use of the available bandwidth. So the proposed solution integrates the AODV routing protocol with the NEMO protocol and implementation of pre-registration technique in NEMO. It will enable us to provide the efficient localized communication and robustness of MANETs, as well as the global reachability and the ability to provide structured approach that NEMO is expected to support.**

Keywords- multi-home; NEMO; MANET; stability; IPv6; global reachability; session persistence;

I. INTRODUCTION

In recent years, wireless technology has brought the revolution in the field of communication. Currently, most users depend on wireless technology for any type of communication that encapsulates voice communication, text communication, data communication, etc. As technology advances, user requirements increase every day. To fulfill the demand of mobile communication and the development of technology, IETF (Internet Engineering Task Force) initially established mobile IP protocol.

Mobile IP supports mobility, for communication. When user is outside home network or in other words, i.e. foreign network, mobile IPv6 takes care of the continuity of communication by performing handover process. However, when it comes to mobile devices that are built on various communication equipments, like MRT, a train, a bus or a plane, it is not suitable to go for mobile communication. In this case we have to add another level which resulted in development of network mobility. Therefore IETF established the NEMO, which is an extension of Mobile IPv6, to extend network connectivity.

In this paper we have attempted to address the problems in MANET, can be alleviated through the NEMO network. We have utilized the bi-directional tunneling approach and an innovative HA i.e. Home Agent, similar to that of NEMO BS into a MANET routing protocol, through this we are able to develop a routing technique that provides a comprehensive solution to some of the major issues affecting the uptake of MANETs. This technique aims to ensure that, all nodes within a MANET are able to maintain the persistent global reachability in the internet irrespective of the change in its point of attachment to the internet, every time a node in a MANET has internet connectivity.

The issue at next level is, if a MANET of nodes is roaming in a new network and is connected to that network via a single point of attachment such as Internet Gateway, then the support has to be provided, for mobility and to ensure packet flow into the MANET as well as out of the MANET. This could be achieved through one of two approaches; NAT i.e. Network Address Translation or Auto-Address Configuration based approach.

In the first approach, basic access networks that have only been designed for single host connections would not be able to support the introduction of MANETs. This approach would require potential access routers to be installed on large scale, if a single Gateway with a bigger cluster of MANET nodes attached to it, is roaming in the another network.

The problem that arises in the second approach is, the network efficiency would degenerate with an increase in the number of nodes within a MANET. As the size of MANET increases, the topology information, for each access network, has to travel further more hops away from the access point.

In case of NEMO, the mobile device or the MR i.e. Mobile Router, which behaves as the gateway to the network, controls the incoming and outgoing packets. This can be achieved using the HA situated on the Home Network of the MR. In this case, HA forwards the packets, destined for nodes attached to the MR. When MR is mobile, it configures a new address CoA i.e. Care-of-Address, based on the prefix of the access network to which it is currently connected. Then MR registers the new CoA with it's HA and establishes a bi-directional tunnel. This registration process is known as BU i.e. Binding Update. When a node attached to the MR sends a packet into the internet, these packets are first tunneled via the HA and conversely, the packets that are sent from a node in the internet towards MR, HA intercepts them and then forwards to MRs current location via the bi-directional tunnel.

But it is still unable to provide global reachability and session persistence without packet loss and handover latency. For this one solution is to integrate the existing MANET routing protocol OLSR with the NEMO protocol. In spite of the effort, the bottleneck that still persists is congestion, handover latency and packet loss. Hence the proposed solution integrates AODV routing protocol with the NEMO protocol and extends pre-registration technique in NEMO.

II. SURVEY

The author in the paper [1] the author has proposed a framework for the Ad hoc On-demand Distance Vector (AODV) routing protocol can be used for internetworking between wireless ad hoc networks and the IPv6 Internet. The solution in this paper relies on the signaling the AODV to find an access providing Internet Gateway that is able to distribute a globally routable prefix for the ad hoc network. The author in the paper[2], has proposed a protocol for mobile nodes in an ad hoc network for the mobility that offers quick adaptation to dynamic link conditions, low processing, memory overhead, low network utilization, and determines unicast routes to destinations within the ad hoc network.

The author in the paper [5] has proposed to provide for extended internet connectivity for IP handoff in MANET. We have considered a mobile node to a fixed host that is connected to a network, and the propose architecture enables a mobile node in the MANET to change its IP address more frequently due to the deployment of auto-configuration, global connectivity, and hierarchical addressing schemes.

The author in the paper [4] has explained about the transition mechanism for IPv4 to IPv6 protocol. This solution attempts to provide transparent routing between IPv6 end nodes and IPv4 end nodes. In the paper [6], the author has proposed a method for IPv6 soft handover that can be applied to the network mobility over heterogeneous access networks to reduce the packet loss.

In the paper [7], the Optimized Link State Routing (OLSR) protocol for mobile ad-hoc networks is described. This paper describes an optimization of the classical link state algorithm tailored to the requirements of a mobile wireless LAN. The key concept in this paper is Multipoint Relays (MPRs). It is described here that this technique substantially reduces the message overhead as compared to a classical flooding mechanism, where every node retransmits each message when it receives the first copy of the message. Only the MPR nodes can generate the link state information in this protocol. For the second optimization the number of control messages flooded in the network is reduced.

In the paper [8], the author designed architecture to support the network mobility as NEMO basic support protocol. It is discussed in the paper that it enables Mobile Networks to attach to different points in the Internet and it is an extension of Mobile IPv6 which allows session continuity for every node in the Mobile Network as the network moves from one point of attachment to other point of attachment.

III. PROPOSED SYSTEM

A. System Architecture

As discussed earlier, global reachability of MANET nodes implies a node within mobile ad-hoc network remains reachable whether it is in home network or mobile or roaming i.e. foreign network. To make a MANET node reachable, whenever it is able to establish direct connection to the internet, it sets up a bi-directional tunnel with it's HA. At the same time, all the other nodes in a MANET maintain communication with one another in the network using mobile ad-hoc routing protocol. One of the nodes in the network plays the role of a Gateway, where it has to establish a direct connection to the internet. By extending the node's connection with its HA, all the other nodes in the MANET forward their packets into the internet. When the packets go out of MANET, then the NEMO protocol is activated. Thus a node in the MANET can establish its own direct connection to the internet or it can establish a connection to the internet using existing Gateway.

In case one of the nodes in the MANET establishes direct connection; the immediate next step is to obtain topologically correct CoA. In the other case where the node has indirect connection, the packets are routed in and out of the MANET based on the tunnel that other nodes and the Gateway maintains with its HA. When one of the node performs a Binding Update via a Gateway, the HA must track the tunnel through which the

Binding Update request arrived and the HA has to install routes to the nodes and its associated prefixes passing through the tunnel. Once incoming packets reach the Gateway through its bi-directional tunnel, the packets are routed to the correct node in the MANET using the routes installed by the routing protocol.

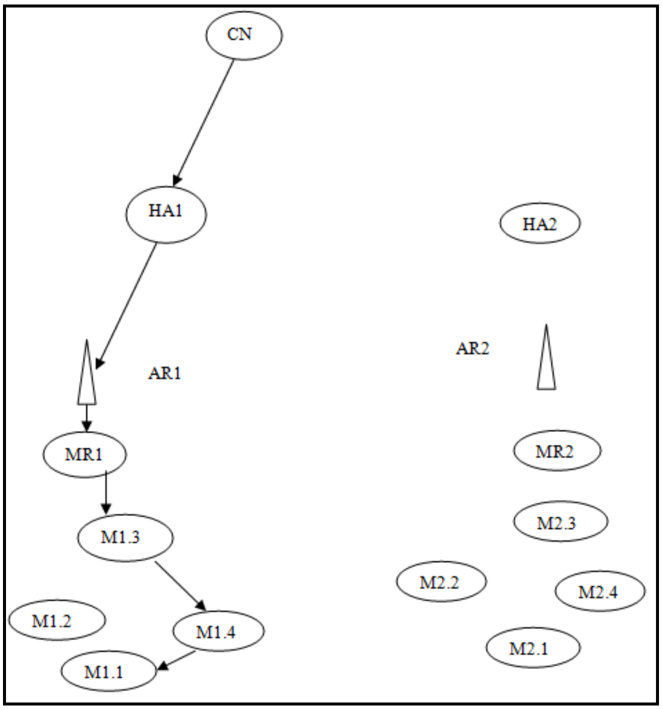

Figure 1. Architecture for Global Reachibility of MANET Nodes.

B. *Global MANEMO Architecture*

In this section, the design of MANEMO architecture is presented as the integration of AODV MANET routing protocol and NEMO protocol. In this architecture whenever a node in the mobile network is able to establish its own direct connection to internet, it will set up a bi-directional tunnel with its Home Agent. The node, with direct connection to the internet works as a Gateway. The Gateway node extends the existing connection to it's HA, and thus extending the connectivity for all the other nodes within the mobile network, enabling packet forwarding to the internet. At the same time, all the nodes within the mobile network also maintain a communication interface using AODV protocol to establish a MANET with other nodes around them. The following section describes the three phases of the architecture.

C. *Roaming Phase*

In the first phase, when a MANET is in roaming or in foreign network then the Gateway node of MANET gets a care of address from the foreign agent. The MANET updates this CoA with it's HA by performing a Binding Update. Upon reception of this Binding Update request message, HA installs route to the MANET and sends an acknowledgement to the MANET through the foreign agent. Thus it forms a bi-directional tunnel which is used for routing the packets to the MANET.

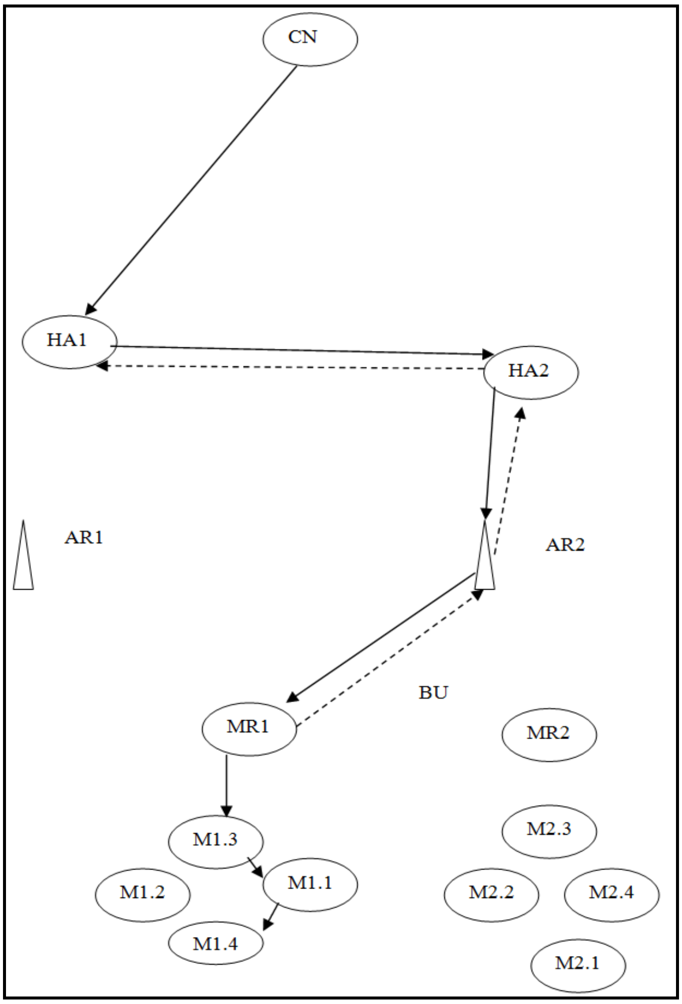

Figure 2. Roaming Phase.

D. *Inter MANET Mobility Phase*

In the second phase, the mobility of a node between two different MANET is considered. After the establishment of connection between Gateway and it's HA, the routing of packets from HA to all of the nodes in a MANET is based on the tunnel id. The translation at the HA, by generating a single route, results in mobility between different MANETs. Consider the example if node 1.0 of MANET1 with HA1 moves from MANET1 to MANET2 then it will result only route modification on the HA2. After joining the MANET2 node 1.0 will communicate through HA2 by updating its tunnel id at this HA only.

E. *Authentication, Authorization and Accounting Phase*

At the time of handoff, the MANET that moves from one network to the other network, it has to register with the new network. The MANET will authenticate the new network, using secure authentication technique. After authentication network has to authorize this MANET and extend the network for the MANET. Once the authentication and authorization are successful, the accounting is begun to track the MANET.

F. Test and Analysis

The proposed architecture is simulated using NS2. The results and analysis discussed in section 5 about the accuracy and efficiency of the response.

IV. IMPLEMENTATION

A. Network Setup

In this simulation, the network setup consists of two MANET, and each MANET consists of four mobile nodes. The Home Agent for the MANET is labeled as HA1 and HA2. The mobile nodes initially encapsulated under HA1 are labeled as M1.1, M1.2, and so on. The nodes under HA2 are labeled as M2.1, M2.2 and so on. The Corresponding Node, labeled as CN that represents the source for the transmission in one case and then acts as destination node for transmission vice versa. The node labeled as AR1 and AR2 represent Access Router, these nodes perform the role of the Gateway node.

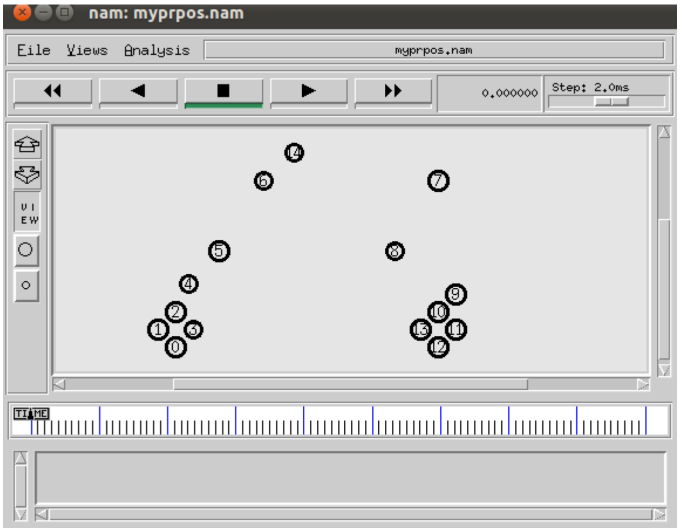

Figure 3. Network Setup to simulate the protocol.

B. Packet Forwarding in Home Network

Figure 4 shows simulation of a mobile node within a MANET, which communicates with the corresponding node when the mobile node is in Home Network. In this architecture, the node in the home network establishes its own direct connection to internet every time, and facilitates a Gateway node. This Gateway node extends the internet connection to it's HA, enabling all the other nodes in the same network to forward their packets into the internet through the existing session. At the same time, all the other nodes within the mobile network also maintain a communication interface using AODV protocol to establish a MANET with other nodes around them. If corresponding node sends packets into the MANET, these are directly forwarded by Home Agent to the MANET through access router or the Gateway node.

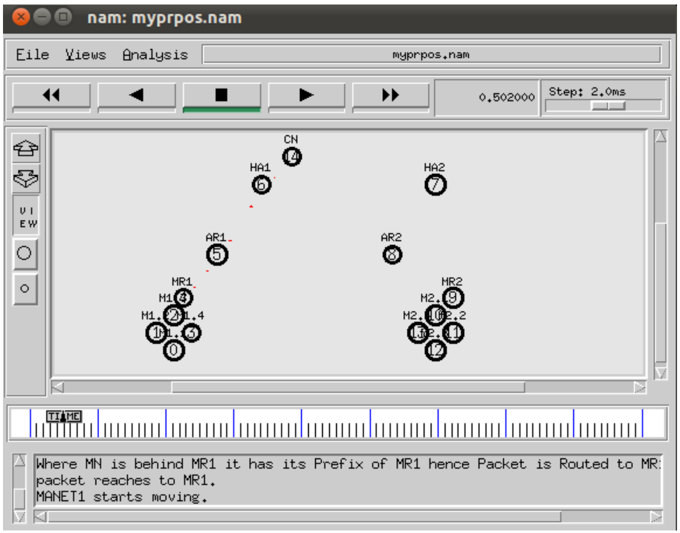

Figure 4. Packets forwarding in home network.

C. Binding Update

Figure 5 depicts the case, the first MANET M1, is mobile after 800 ms, once the node detects diminishing of the signal strength, it initiates handover process. The node continuously senses for a neighboring network.

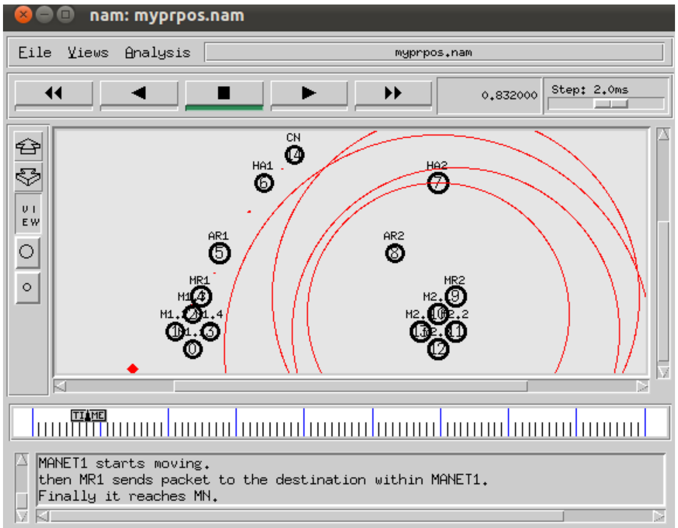

Figure 5. MANET M1 starts moving.

Figure 6 depicts the next stage, at which the MANET M2 has acknowledged positively to the request, and is ready to accept the new connection.

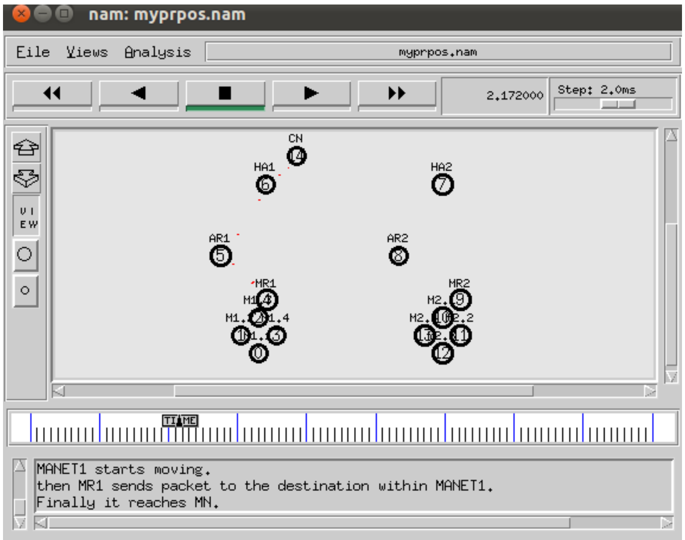

Figure 6. Packet forwarding in home network.

Figure 7, depicts the extension of figure 6, where the signal strength for MANET M1, is further diminishing. In the next section the mobile node moves away from its Home network and connects to another network, foreign network. When a MANET goes under another network, then the Gateway Node of MANET obtains a CoA from this foreign network. The MANET sends this CoA to it's HA using binding update. Upon reception of binding update request message, HA installs routes to the MANET and sends an acknowledgement to the MANET through the foreign agent. Thus it forms a bi-directional tunnel, used for routing the packets to the MANET.

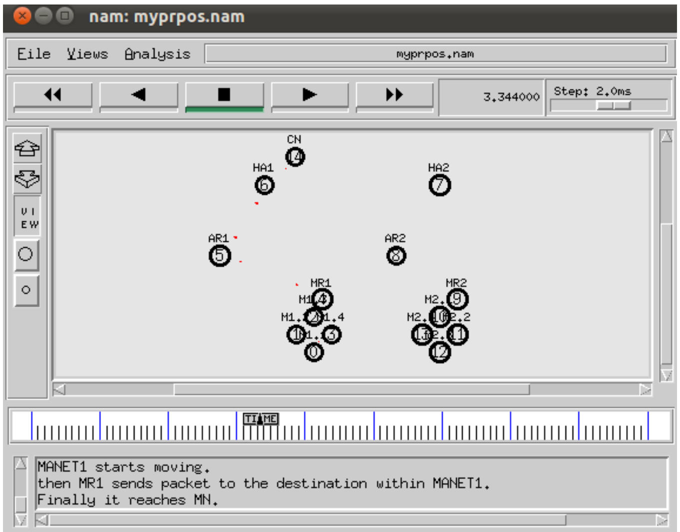

Figure 7. Packet forwarding in home network.

D. *Packet Forwarding in Foreign Network*

Once the Binding Update is complete, MANET gets connection to the foreign network and it also sends its CoA to its Home Agent. Hence it won't lose its data session, initiated with its previous address. Hence forth it can initiate a new connection or new session using the new address.

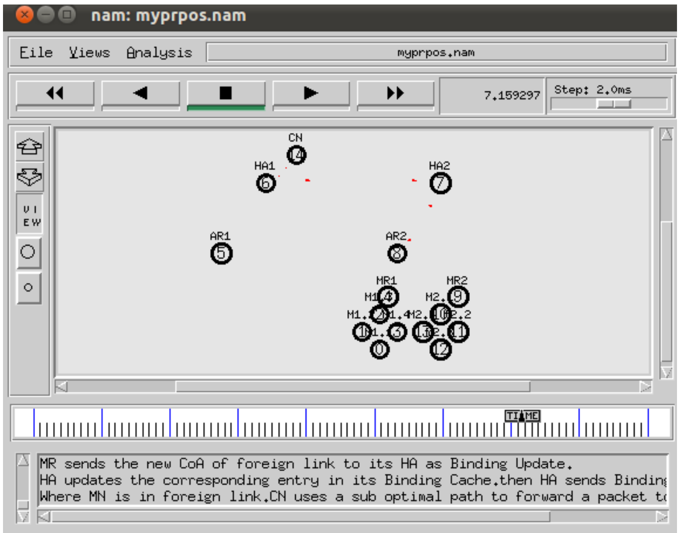

Figure 8. Binding Update completed successfully.

V. RESULTS

Two most important parameters, considered to measure the efficiency of a protocol is Packet Delivery Ratio and the System Efficiency.

Parameters	***Values***
Traffic type	cbr
Channel	Wireless
No. of nodes	15
Network size	500*400m
Protocol	AODV
Mechanism	Nemo
Concept	Pre-registration
Simulation time	9 sec

A. *Packet Delivery Ratio*

In first case, the packet delivery ratio of the system is tested. It shows at different time instants of packet delivery ratio which are displayed in following graph. Here X-axis represents time and Y-axis, number of packets delivered.

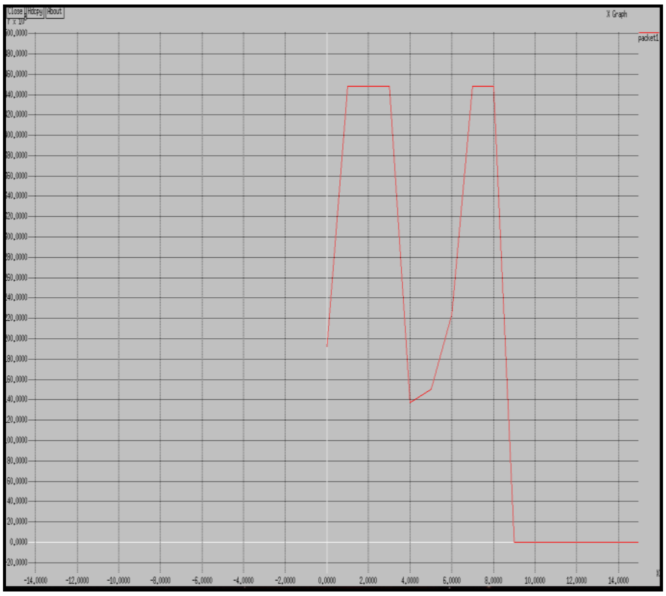

Figure 9. Packet Delivery Ratio

B. *Efficiency of the System*

In second case, the efficiency of the system is tested. It shows at different time instants of efficiency of the system which is displayed in following graph.

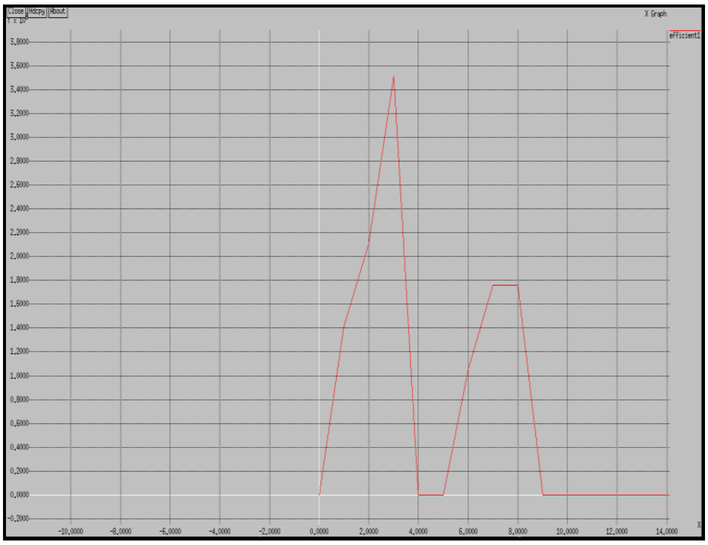

Figure 10. Efficiency of the System.

VI. CONCLUSTION AND FUTURE WORK

In this project, by combining the properties of both MANET (Mobile Ad-Hoc Network) routing protocol (AODV) and NEMO techniques has aided mobile networks, as it has achieved global reachability. On top of that when the pre-registration technique is integrated into NEMO, the results were firstly, the packet loss is reduced, which is one of the major factors to increase the efficiency. Secondly, it has reduced the delay, which is another major factor that decides the network efficiency.

The protocol can be further enhanced by adding security features that can perform authentication, authorization and accounting during the hand-off. This will enable to keep unauthorized at the bay. This will ensure the network is not compromised and used efficiently.

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