Simulation of Mobile IP with MobiWAN

Sussan Moazzeni
Researcher of Iran Telecommunications Research Center (ITRC)
smoazeni@itrc.ac.ir

Abstract - Mobile IP is a protocol to support the mobility of a host, changing its point of attachment to the Internet. This protocol introduces different mechanisms, to successfully route packets destined to the mobile node [5]. But, some of these introduced mechanisms suffer from the lack of proper efficiency. One of these mechanisms is triangle routing. In this method; packets are routed to the home network of MN and then tunneled to Mobile Node (MN) by Home Agent (HA) [1]. This indirect routing is far from optimal, because of the existence of great delay in delivery of the packets to MN. Route optimization is a protocol to overcome delay in triangle routing. In route optimization, MN informs Correspondent Node (CN) with its current location and then, the packets are directly sent to MN by correspondent node [1], [4]. In this simulation, we have compared linear and star topologies with & without route optimization. We have used Network Simulator (NS) and MobiWan, to verify simulation results [2], [3]. It is noticeable that, different simulations regarding delay performance of route optimization, have been done by different groups, but most of them have used unreal topology models. Topology model has important effects on results of the simulation. GT-ITM model has been used in our topologies for having a better judgment on performance of route optimization. Features of this model will be discussed in this paper [6]. By evaluating the results of the simulation, we found that, jitter is not just the function of route optimization. The structure of topology also, has some important effects on it. Finally we concluded that, route optimization strategies in star topology, reduces jitter, but the same strategies in linear model increase jitter. Note that route optimization improves delay, regardless of the topology used.

Keywords- Mobile-IPv6; Route optimization; NS; MobiWan; Linear & star topologies.

I . INTRODUCTION

With recent advances in manufacturing portable computers, PDA (Personal Digital Assistance) and wireless devices, demand for wireless Internet access has increased.

The most important problem of wireless Internet access is the mechanisms, which IP uses to route packets to their destinations. In IP routing, each IP address is assigned to each node corresponding to location of the nodes. Thus, this method isn't useful in wireless networks, since by changing mobile node, its network it should take a new IP address [5].

For mobility support in wireless networks, MIPv6 assigns two addresses to mobile nodes: one is home address that is permanent and the other is IPv6 link-local address which is temporary and reflects the current location of MN [4].

In the basic Mobile IP, packets addressed to MN, are sent to HA and then, tunneled to MN's Care-of Address (CoA). Then MN routes the packets directly to CN. This routing method is called " triangle routing " [1]. When the destination node is close to mobile node, the non-efficiency of this method is more evident. Route optimization has been developed by IETF group to modify the basic Mobile IP. In this routing method, MN obtains CoA by using address auto configuration mechanism. After obtaining CoA, MN sends binding update message to HA and other CNs [4].In conclusion, CN gets the information about current MN's CoA and sends packets directly to MN's home address with no assistance of HA. This approach makes HA to be less involved in transmission of the packets to MN. This function provides scalability and reduction in the network's overhead. We are going to evaluate this approach.

Due to the lack of MIPv6 support in current NS-2, MobiWan has been used in simulating MIPv6 [2], [3].

MobiWan is an enhanced platform to support MIPv6 in NS-2.1b6. Motorola and INRIA PLANETE developed the codes of MobiWan. The format of packets and routing mechanisms are implemented in MobiWan, followed by standards in MIPv6 [2]. As previously mentioned, GT-ITM topology model is used in our simulation. In our model, linear and star models connect nodes of the stub domains. Finally, packet loss and average delay will be compared in these topologies with and without route optimization. In section 2, Internet topology and GT-ITM model will be discussed [6], [7].

In section 3, two scenarios in our simulation will be examined and their results will be discussed.

In section 4, the results of simulation will be evaluated.

II . MODELING INETERNET TOPOLOGY

The rapid growth of the Internet has caused several challenges related to routing, resource reservation, and administration. Simulation of the real large networks is a proper choice for their performance evaluation. It should be noted that the applied models in the simulation are very important for having the best evaluation. It is clear that if the models are more realistic, simulation will give more valuable and accurate results. But choosing of a completely real model is not possible. So we should choose a proper and efficient model with regard to the parameters to be evaluated. The structure of the GT-ITM topology is one of these models that have a very important role in the results [6].

Internet can be viewed as a collection of interconnected routing domains. Each routing domain consists of a group of nodes (routers, switches, host nodes) that their functions are under a similar policy and administration and also they use similar routing information. We can consider GT-ITM, as a model, which is close to Internet topology. This model has a hierarchical structure and is defined based on different concepts such as transit domain and stub domain. Each routing domain in the Internet can be classified as either a stub domain or a transit domain. The traffic can be generated or terminated in Stub domains. Transit domain, does not have this limitation and the purpose of it is designed the optimal connection between stub domains. Stub Domains connects groups of LANs. Transit domains are MAN or WAN networks. A transit domain has a number of backbone nodes and each of these nodes can be connected to a number of stub domains via border routers. Moreover the backbone nodes can be connected to the other nodes in other transit domain [6], [7].

It seems that GT-ITM model is a proper model for the Internet topology. This topology is used in our simulation to study the effect of the route optimization on delay and jitter. This model has been used for a more accurate evaluation.

Figure 1, shows the GT-ITM model.

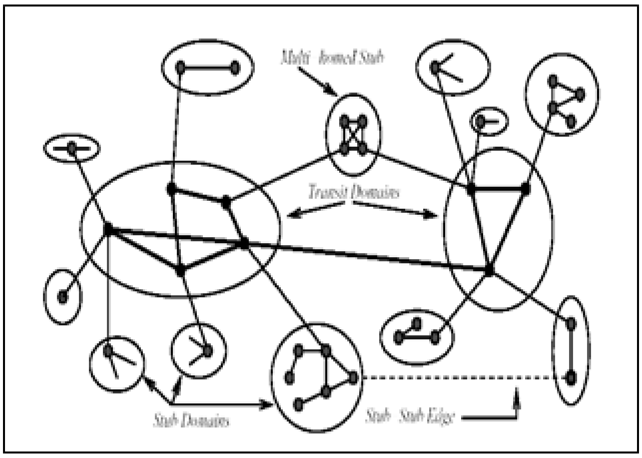

Fig.1. GT-ITM model

III . SIMULATION SCENARIOS

Our simulation is used to evaluate the performance of route optimization in two different topologies. These two topologies (linear and star) are based on GT-ITM model and differ just in configuration of the nodes in stub domains of the topology. In one of the topologies, the model of configuration is star and in the other one is linear.

In the linear model, each node is directly connected to its neighbors. But in the star model, all of the nodes are connected to a central node.

The number of links, which is passed by packets, could be a criterion for network resource consumption. So it is clear that resource consumption in the linear model is more than that of the star model.This discrimination in the structure of the stub domains provides some different and useful results, which will be noticeable.

The star and linear models are shown in Figures 2 and 3.

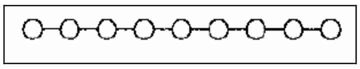

Fig.2. Linear model

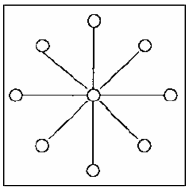

Fig.3. Star model

Features of the topology are presented in table 1.

TABLE1. TOPOLOGY FEATURES

No. Of nodes	No. Of MNs	No. Of Transit domain	No. Of Stub domain
538	1	3	8

We have used NAM to show the chosed topology model, having star model in its sites. Figure 4 shows this topology.

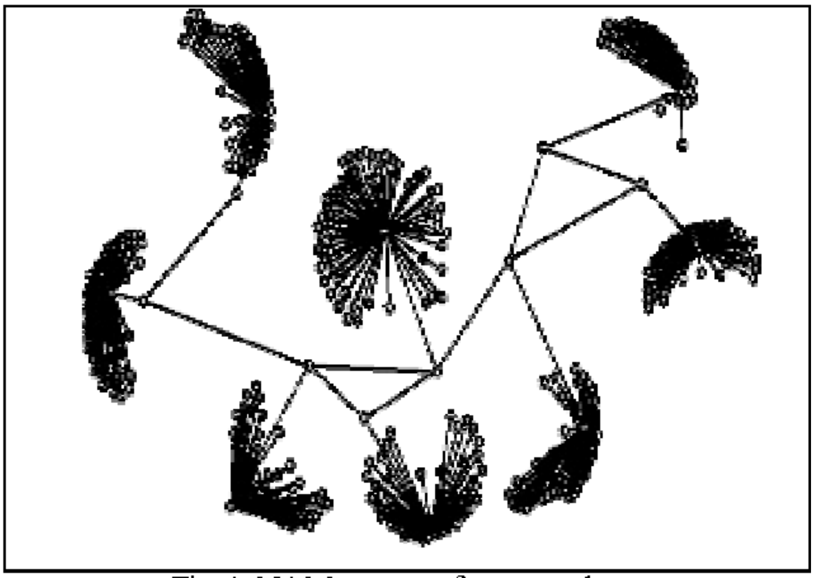

Fig.4. NAM output of star topology

First site is the home network of the mobile node and the BS, which is located in this site. First site is used as the home agent of the mobile node. Note that , each site has one BS. The MN moves randomly between sites, but it has been configured in a way, to enter all of the sites. While MN is roaming between sites, CNs are attached to some stub nodes, which are selected randomly.

A CN is selected for a permanent amount of time for the simulation, and an additional one is added regularly. These CNs are added in specified times. For example if we define ***"stop"*** as a parameter, representing duration of the simulation, and ***"n"*** as the number of CNs, at *k*stop/n* ***(****k =1,2…****)*** a new CN will be added. The reason to choose this scenario is to observe the performance of the network (especially the delay), while adding new CNs and increasing the traffic.

Tables 2 and 3 indicate the results of simulation with and without route optimization, for linear model.

Tables 4 and 5, show the results of route optimization in star model.

End-to-end packet delay in each topology, with and without route optimization, is shown in Figs. 4,5,6 and 7 respectively. The parameters, which have been compared, are: drop, average end-to-end packet delay and jitter. Ping packets are data packets and the end-to-end delay is just corresponded to ping packets.

"*rt*" is a parameter representing usage of route optimization (*rt=1*) or triangle routing (*rt=0)* and ***"mt"*** (movement interval) notifies the movement interval of the mobile node. So if we consider ***"nb-sites"*** as the number of sites in the topology, ***"mt"*** can be calculated by the following formula:

mt=stop/nb-sites

As the results in the tables show, by using route optimization, the number of sent BU's and BU drops are increased. This is due to this fact that MN sends BU messages regularly, indicating the current binding of mobile node. It is obvious from delay charts, that by using route optimization, we can overcome the delay in triangle routing. It is obvious that, the number of BU messages (and also the BU drops) is decreased and end-to-end delay is increased, without using route optimization. This is due to in fact that all of the packets should be sent to this home agent first, and then tunneled to MN.

In the linear model, nodes are connected to each other like a chain. So traveling packets are more likely to drop or have a great delay. Quantitative comparison of above results has been summarized in the tables.

As we previously mentioned, we have investigated the route optimization effect, in two topologies by using linear and star models in stub domains.

A noticeable result, which we observed was the jitter. We found that using route optimization in star model decreases the jitter. But this is not the case for the linear model. In this case, using route optimization, causes increases jitter. So it is concluded that, the effect of route optimization on jitter, is not independent of topology (delay is independent) and it is affected by both topology model and route optimization.

TABLE 2. RESULTS OF SIMULATION FOR LINEAR MODEL WITH RT=1

Transit Domain	Sites	Total Nodes	Total BS	CN	Movement Interval	BU Drop	Ping Drop	Ping Packets	Total Delay	Average Delay
3	5	538	5	5	50	15	0	1200	52.5873	0.04382
				5	40	15	0	960	42.2007	0.04395
				10	40	25	70	1760	75.5151	0.04290
				5	30	11	12	720	31.5499	0.04381

TABLE 3. RESULTS OF SIMULATION FOR LINEAR MODEL WITH RT=0

Transit Domain	Site s	Total Nodes	Total BS	CN	Movement Interval	BU Drop	Ping Drop	Ping Packets	Total Delay	Mean Delay
3	8	538	8	5	40	0	0	960	37.3243	0.03716

TABLE 4. RESULTS OF SIMULATION FOR STAR MODEL WITH RT=1

Transit domain	Sites	Total Nodes	Total BS	CN	Movement Interval	BU Drop	Ping Drop	Ping Packets	Total Delay	Mean Delay
3	8	538	8	10	50	20	1	2200	23.7275	0.01123
				10	40	20	1	1760	17.8742	0.01147
				10	30	20	1	1320	15.8962	0.01187

TABLE 5. RESULTS OF SIMULATION FOR STAR MODEL WITH RT=0

Transit Domain	Sites	Total Nodes	Total BS	CN	Movement Interval	BU Drop	Ping Drop	Ping Packets	Total Delay	Mean Delay
3	8	538	8	1	50	0	1	2200	27.375	0.01584

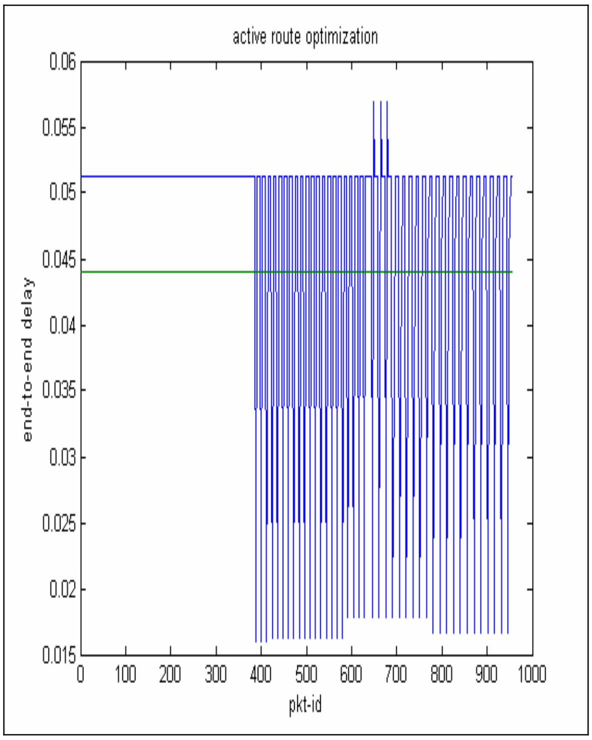

Fig.5. Delay chart for linear model with rt=1

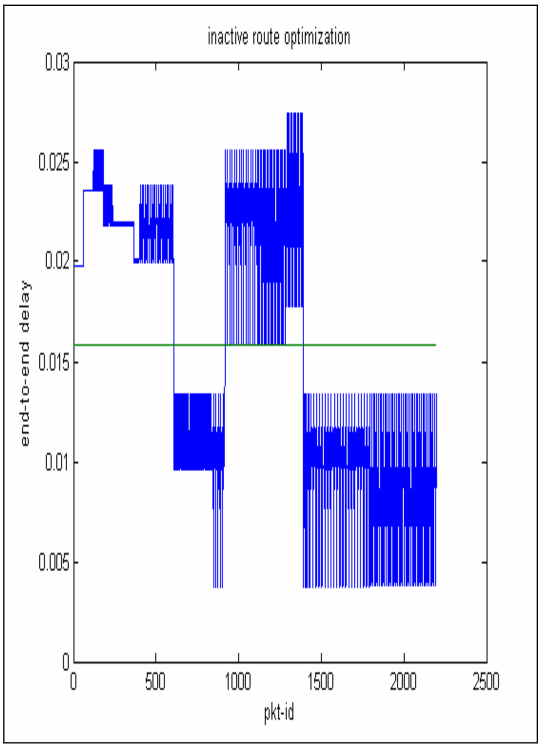

Fig.7. Delay chart for star model with rt=0

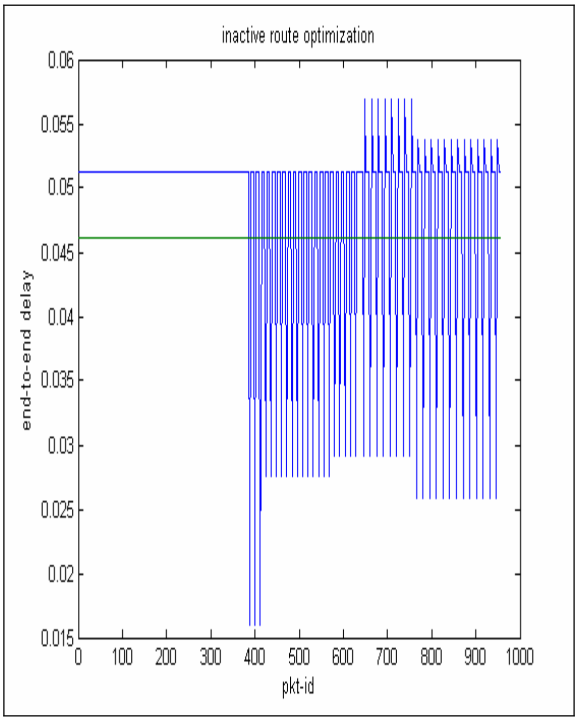

Fig.6. Delay chart for linear model with rt=0

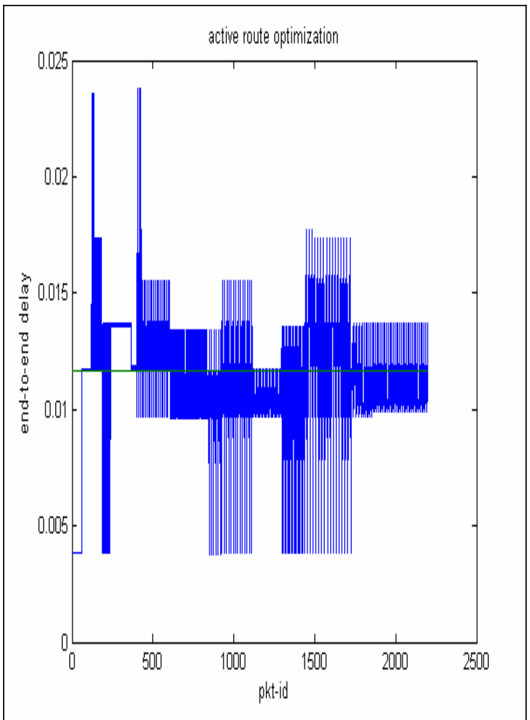

Fig.8. Delay chart for star model with rt=1

IV . CONCLUSION

We used MobiWan to simulate route optimization for star and linear models. We tried to use an approximately real topology in our simulation. The number of drops of the Traffic packets (Ping packets) and the delay in delivery of the packets to their destinations is parameters used for comparing effect of route optimization on two topologies. As we expected, star topology has a smaller packet loss and delay, in comparison with linear topology.

Route optimization increases the number of BU packets and decrease in delay. But without route optimization, we will have reduction in number of BU messages and supplement in delay amount. Our simulation shows improvement in jitter effect in star topologies with route optimization, while this is not true for linear topology. So jitter is dependent on the structure of topology.

The improvement of MobiWan to support several Mobile Nodes simultaneously, moving in the network, can be the subject of the future work.

In addition, security and QoS and neighbor discovery in MIPv6, are important issues for future work.

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