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A Simulation Study on the Performance Of Mobile IP

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Abstract

Mobile IP is a new recommended Internet protocol designed to support the mobility of a user (host). Host mobility has become an inevitable phenomenon because of the blossoming of laptop computers and mobile devices and the high desire to have continuous network connectivity anywhere the host happens to be. The development of Mobile IP makes this possible

Since a home agent tunnels the packets from a correspondent node to the mobile node when it is associated with a foreign agent, the total end-to-end delay becomes the sum of the delay time of the packet to travel from correspondent node to home agent, next to foreign agent and finally to the targeted mobile node. This triangle routing increases the end-to-end delay and reduces the throughput.

This Paper discus the results of a project 'Simulation of Mobile IP without route optimization and with route optimization' using network simulator ns-2. The results are compared and the benefits of route optimization are given.

1. Introduction

The proliferation of portable computing devices within the past few years has led to an increase in mobility of such devices and the consequent problems are not encountered with static computing. The problem lies with the need to maintain seamless connectivity to the Internet while the computer moves from one network to another and movement within the same network. The problems encountered arise from the current Internet addressing service itself, which routes data according to the network to which a host is connected. If a host becomes mobile and is connected to a network other than its home network, IP packets addressed to the host continue to be delivered to its home network.

A classic example is the need to retrieve e-mail addressed to the host while connected to any network in the world.

The purpose of this research was to create a simulation of an IP based data network which supports the Mobile IP protocol and to test different approaches to Mobile IP. The route optimization for a Mobile IP network is also simulated and the results are compared with the results of base Mobile IP simulation.

1.1 MOBILE IP

The key feature of Mobile IP design is that all required functionalities for processing and managing mobility information are embedded in well-defined entities -the Home Agent (HA), Foreign Agent (FA), and Mobile Nodes (MN).

1.2. Mobile Node

A host or router that changes its point of attachment from one network or sub-network to another. A mobile node may change its location without changing its IP address; it may continue to communicate with other Internet nodes at any location using its (constant) IP address, assuming link-layer connectivity to a point of attachment is available [1].

1.3. Home Agent

A router on a mobile node's home network that tunnels datagram for delivery to the mobile node when it is away from home, and maintains current location information for the mobile node.

2. Foreign Agent

A router on a mobile node's visited network provides routing services to the mobile node. The foreign agent detunes and delivers datagram to the mobile node that were tunneled by the mobile node's home agent. A simple Mobile IP network is shown in Figure 2.1. For datagram sent by a mobile node, the foreign agent may serve as a default router for registered mobile nodes.

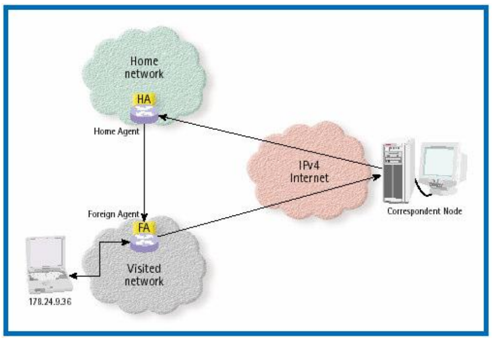

Fig. 2.1 A Simple Mobile Network

Suppose a mobile node moves from its home network to a foreign network, the correct delivery of packets to its current point of attachment depends on the IP address contained within the mobile node's IP address, which changes at new points of attachment. The change of routing requires a new IP address associated with the new point of attachment. Mobile IP has been designed to solve this problem by allowing the mobile node to use two IP addresses. In Mobile IP, the home address is *static* and is used for instance to identify TCP connections. The *care-of-address* changes at each new point of attachment and can be thought of as the mobile node's topological significant address. Whenever the mobile node is not attached to its home network, the home agent gets all the packets destined for the mobile node and arranges to deliver them to the mobile node's current point of attachment.

2.1 How Mobile IP Works

This section explains how Mobile IP works. The Mobile IP process has three main phases which are discussed in the following sections [2].

Agent Discovery

A Mobile Node discovers its Foreign and Home Agents during agent discovery.

Registration

The Mobile Node registers its current location with the Foreign Agent and Home Agent during registration.

Tunneling

A reciprocal tunnel is set-up by the Home Agent to the care-of address (current location of the Mobile Node on the foreign network) to route packets to the Mobile Node as it roams.

2.2 Solution to Network Mobility

Network mobility is enabled by Mobile IP, which provides a scalable, transparent, and secure solution. It is scalable because only the participating components need to be aware of Mobile IP—the Mobile Node and the endpoints of the tunnel. No other routers in the network or any hosts with which the Mobile Node is communicating the need to be changed or even aware of the movement of the Mobile Node. It is transparent to any applications while providing mobility. Also, the network layer provides link-layer independence; interlink layer roaming, and link-layer transparency. Finally, it is secured because the set up of packet redirection is authenticated. Since a mobile user is able to maintain the same IP address even while roaming across networks, a live IP connection can be maintained without having to stop and restart as it would be with a mechanism like Dynamic Host Configuration Protocol (DHCP). This is the real power of Mobile IP that offers the potential to leverage Mobile IP with applications such as voice over IP (VoIP) and streaming media (video) to IP devices while the user is changing location.

INTRODUCTION TO NETWORK SIMULATOR – 2

NS2 is an open-source simulation tool that runs on Linux. It is a discreet event simulator targeted at networking research and provides substantial support for simulation of routing, multicast protocols and IP protocols, such as UDP, TCP, RTP and SRM over wired and wireless (local and satellite) networks. It has many advantages that make it a useful tool, such as support for multiple protocols and the capability of graphically detailing network traffic. Additionally, NS2 supports several algorithms in routing and queuing. LAN routing and broadcasts are part of routing algorithms. Queuing algorithms include fair queuing, deficit round-robin and FIFO [6].

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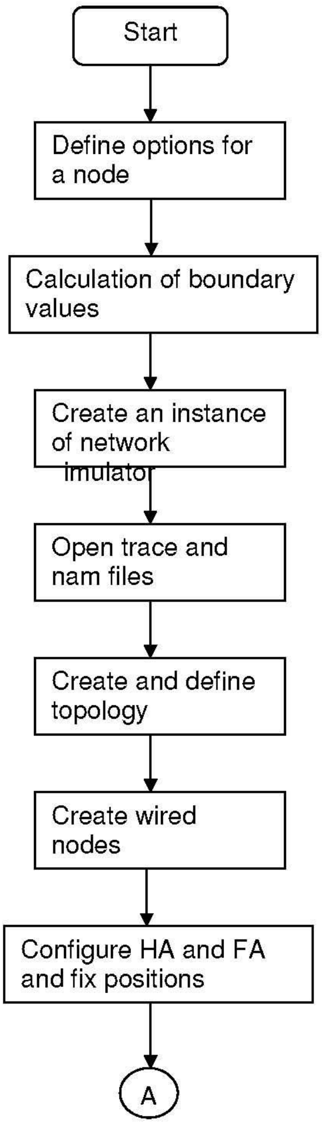
NS2 started as a variant of the REAL network simulator in 1989 [6]. REAL is a network simulator originally intended for studying the dynamic behavior of flow and congestion control schemes in packet-switched data network. Currently NS2 development by VINT group is supported through Defense Advanced Research Projects Agency (DARPA) with SAMAN and through NSF with CONSER, both in collaboration with other researchers including ACIRI [6]. NS2 is available on several platforms such as FreeBSD, Linux, SunOS and Solaris. NS2 also builds and runs under Windows.

SIMULATION DESIGN

4.1 Flow of Simulation

The Flow chart for the simulation of Mobile IP is given in Figure 4.1.



4.3 Post Simulation process

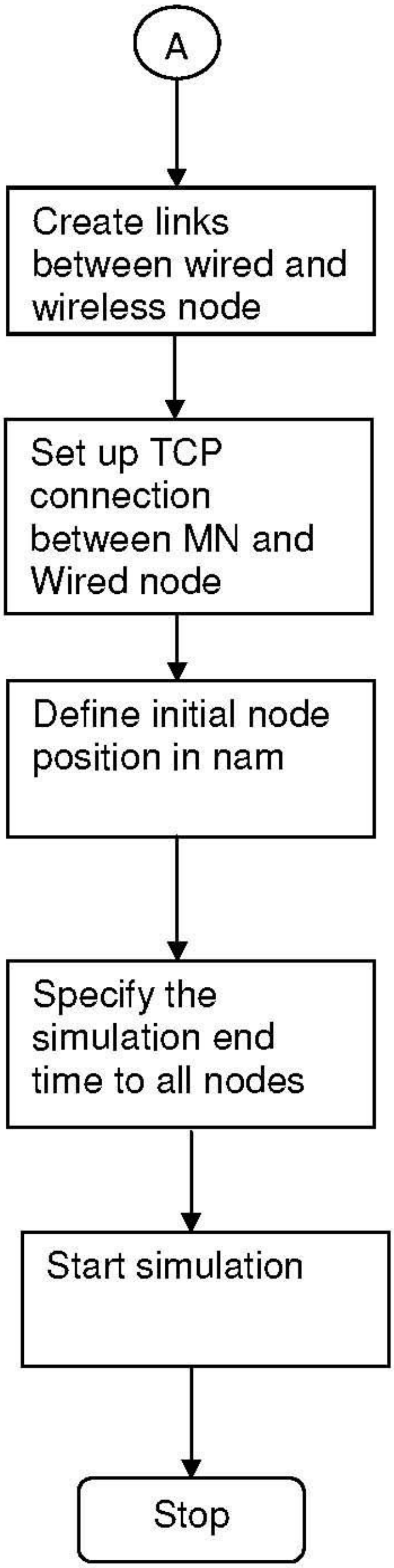


Figure 4.1 Flow chart for the simulation of Mobile IP

The following graphs are drawn

using the trace files

1. One way delay Vs Time
2. Throughput Vs Time

The One way delay is concerned in the project because the packet delay is impacted by the Triangle routing. So, in order to extract the end-to-end delay information from the ns trace file, a trace viewer *nans* [8] is used.

SIMULATION – I: WITHOUT RO

5.1 Scenario – I: Wired cum Wireless network with single FA

In this section, a mixed scenario consisting of a wireless and a wired domain, where data is exchanged between the mobile and non-mobile nodes, is going to be created. For the mixed scenario, a wired domain consists of two wired nodes, W(0) and W(1). Two base-station nodes called Home Agent (HA) and Foreign Agent (FA) are created. The wired node W(1) is connected to HA and FA as shown in the Figure 5.1. There is a roaming mobile node called (MN) that moves between its home agent and any one of the foreign agents. As MN moves out from the domain of its HA into the domain of FA, the packets destined for MN is redirected by its HA to the FA as per mobile IP protocol definitions.

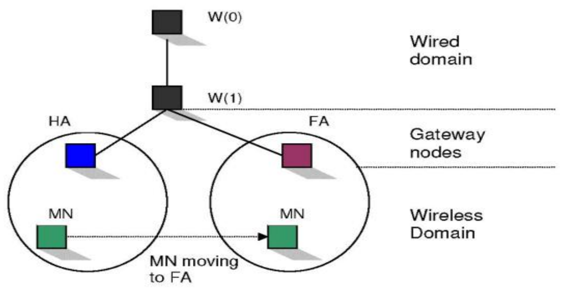


Figure 5.1 Wired cum wireless network model with single FA

	MN in HA	**MN with FA1**	**MN with FA2**
Minimum delay (ms)	38	72	66
Maximum Delay (ms)	205	220	215

5.1.1 Results of Scenario – I

(a) One way delay Vs Time

(b) Throughput Vs Time

	MN with HA	**MN with FA**
Minimum Throughput (Packets)	600	450
Maximum Throughput (Packets)	2700	1600

5.2 Scenario – II: Wired cum Wireless network with two FAs

This is a wired cum wireless network like scenario – I described in section 5.1 with an additional FA (FA2). The Figure 5.2.1 shows scenario – II : Wired cum wireless network with two FAs.

The MN first moves to foreign network – I and then goes to foreign network – II. Hence, the CN that wants to communicate with the MN sends packets to the HA first. The HA will then checks the MN location. If the MN is in the HA network, then it simply sends the packets to the MN. If the MN is in foreign network – I, then HA tunnels the

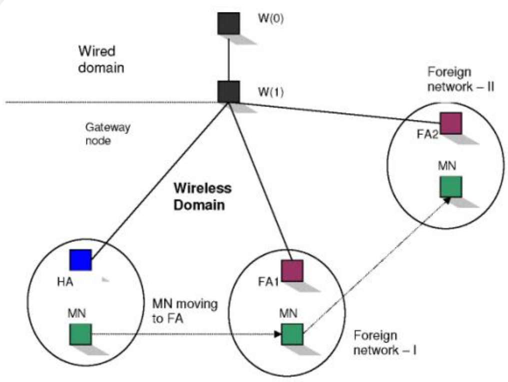


Figure 5.2.1 Wired cum wireless network model with two FAs

packet to the FA1. Similarly, the packet is sent to FA2 when the MN is in foreign network – II.

5.2.1 Results of Scenario – II

(a) One way delay Vs Time

	MN with HA	**MN with FA**
Minimum (ms) delay	38	66
Maximum (ms) Delay	205	237

(b) Throughput Vs Time

	MN with HA	MN with FA1	MN with FA2
Min. Throughput (Packets)	560	500	500
Maxi. Throughput (Packets)	2700	1400	1560

ROUTE OPTIMIZATION

The base Mobile IP protocol allows any mobile node to move about changing its point of attachment to the Internet, while continuing to be identified by its home IP address. The Correspondent nodes send IP datagrams to a mobile node at its home address in the same way as with any other destination. This scheme allows transparent inter operation between mobile node and its correspondent node, but forces all datagrams for a mobile node to be routed through its home agent. Thus, datagrams to the mobile node are often routed along paths that are significantly longer than optimal. For example, if a mobile node is visiting some subnet, even datagrams from a correspondent node on the same subnet must be routed through the Internet to the mobile node's home agent (on its home network), only then to be tunneled back to the original subnet for final delivery. This indirect routing delays the delivery of the datagrams to mobile nodes, and places an unnecessary burden on the networks and routers along their paths through the Internet [7].

Route Optimization Extensions provide a means for nodes to cache the binding of a mobile node and then to tunnel their own datagrams directly to the care-of address indicated in that binding, bypassing the mobile node's home agent. Extensions are also provided to allow datagrams in flight when a mobile node moves, and datagrams sent based on an out-of-date cached binding, to be forwarded directly to the mobile node's new care-of address.

SIMULATION – II: WITH ROUTE OPTIMIZATION

7.1 Scenario – I: With single FA

The scenario – I described in section 6.1 is used to simulate a wired cum wireless network with route optimization. The results of the simulation are illustrated below.

7.1.1 Results of Scenario – I – with single FA

(a) One way delay Vs Time

	MN with HA	MN with FA
Minimum (ms) delay	38	24
Maximum (ms) Delay	210	210

(b) Throughput Vs Time

	MN with HA	MN with FA
Minimum Throughput (Packets)	600	500
Maximum Throughput (Packets)	2700	4500

7.2. Scenario – II – With two FAs

The scenario – II described in section 5.2 is used here to simulate mobile a wired cum wireless network with route optimization.

The results of the simulation – II are illustrated below.

7.2.1. Results of Scenario – II – With two FAs

(a) One way delay Vs Time

	MN in HA	MN with FA1	MN with FA2
Minimum delay (ms)	38	30	24
Maximum Delay (ms)	215	215	173

(b) Throughput Vs time

	MN with HA	MN with FA1	MN with FA2
Min. Throughput (Packets)	560	500	600
Maxi. Throughput (Packets)	2700	3650	4500

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CONCLUSION

The development of Mobile IP has been going on for the past few years. This project simulates two scenarios of a wired cum wireless mobile network with and without route optimization. The results are obtained from the simulator trace files and analyzed. The benefits of route optimization for a mobile network are summarized below.

Scenario	MN with HA	MN with FA
MIP without RO	38	66
MIP with RO	38	24

Table 8.1 Minimum End to End Delay

Scenario	MN with HA	MN with FA
MIP without RO	2700	1700
MIP with RO	2700	4500

Table 8.2 Maximum Throughput without and with RO

From the Tables 8.1 and 8.2 it is concluded that the minimum delay is reduced from 66 ms to 24 ms and the Throughput is increased from 1700 to 4500 packets when RO is implemented in a Mobile IP network.

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