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# Performance Evaluation of Mobility Management using Mobile IPv4 and Mobile IPv6 protocols.

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**Abstract : Mobile networking is becoming increasingly popular but the underlying IP technology has built-in restrictions which impose barriers for mobility .Mobile IPv6 is the next generation protocol and in the near future, routers are going to become more faster and new technologies are going to reduce the Internet delay (delay incurred in transmitting packets from one network to another). It overcomes the problems of Current Mobile IPv4, which is the most promising solution for mobility management in the Internet. In this paper, we present performance evaluation of Mobile IPv4 and Mobile IPv6 using various parameters such as handoff latency, Throughput, packet end-to-end delay, and packet delivery ratio. The study was carried out using an open source Network Simulator NS-2 to study and analyse the behaviour of Mobile IPv4 and Mobile IPv6 protocols**

**Key words: Mobile Networking, Mobile IPv6, Mobile IPv4, Throughput, handoff latency.**

## 1. Introduction

Internet has been developed all over the world and many people have been accessing the data easily. In day today life Internet grows in speed, capacity, data traffic, makes the connection to the Internet very important for a lot of people. The Transmission Control Protocol plays a major role in the Internet service. The TCP/IP protocol was originally designed for fixed Internet without mobility in mind.

The wireless access to Internet applications is extraordinary success of wireless communication networks and it has the sudden increase in the growth of the Internet. Internet protocol applications are becoming more popular in packet based wireless networks. The integration of these wireless phones requires the support of mobility. The future generation wireless networks target to provide users with high-speed Internet access and multimedia services. The user mobile devices such as wireless laptops, cellular phones make it possible for mobile users to access the Internet applications that are based on Internet protocol. Many researchers have an idea that Internet protocol is the correct layer to implement the basic mobility support. In other words, it is required to keep uninterrupted connections among nodes when they change their IP addresses during the movement. Mobile IP has been designed within the IETF to serve the needs of the growing population of mobile computer users to connect to the Internet and maintain communications as they move from place to place. Mobile IPversion4 is a popular mobility protocol used in the current IP4 networks.

In MIPv4, the MN obtains a new IP address from a foreign router (foreign agent (FA)) in the visited network or through some external assignment mechanism and registers with the FA. To maintain continuous connectivity, the MN needs to update its location with its home agent (HA) whenever it moves to a new subnet so that the HA can forward the packets.

## 2 Problem Definition

In MIPversion4 the Mobile node obtains a new IP address from a foreign router in the visited network or based on some task mechanism and registers with the Foreign agent to maintain continuous connectivity, the Mobile node needs to update its location with its home agent whenever it moves to a new subnet so that the Home agent can forward the packets. But MIPversion4 is not a good solution for users with high mobility because it suffers from extra-delays due to the routing of each packet through the HA lack of addresses and high signaling load. Verion4 will not be able to provide the functionality required by the mobile wireless information services because it follows 3rd generation IP-based services of today. According to next generation IPversion6 networks are emerging .version6 is designed for dealing with mobility support and overcomes the problems of MIPv4 networks. The integration of mobile phones with Internet based multimedia services is inevitable. The number of potential users of such services within business, industry and the private sector will force to follow the next generation version of mobile ipv6 networks. Different companies and countries are forecast to build the packet based network infrastructures to provide these services to version6 network rather than IPv4. IPv6 will provide the basis for flexible, scalable, efficient, and manageable solutions to the problems presented by 3G system. MIPv6 deployment is delayed rather than MIPv4. In order to apply Mobile IP in current internet environment, the performance of MIPv4 and MIPv6 networks is evaluated and compared in this thesis by simulation studies using NS-2.

## 3. Implementation

### 3.1 Mobile IPv4 architecture and operations

The basic architecture of Mobile IPv4 is illustrated in Fig.3.1; the IP address originally assigned to the MN in its home network (HN) is called as home address, as an unique MN's identifier, to ensure application transparency. (1)As long as the MN stays in the HN, it is treated as any other fixed node of that network, thus not requiring any kind of mobility support. (2)Whenever the MN moves out of the HN and gains the access to a foreign network (FN), it obtains a care-of address (CoA). The CoA can be acquired either from agent advertisements sent by a foreign agent (FA) (a so-called foreign agent CoA; this is the preferred method and all further considerations presented here scope around this option) or by some external assignment mechanism such as DHCP (a co-located CoA; the FA functionality is not needed). (3)This CoA serves to capture the location of the MN in the FN, and such a location update must be communicated by sending a registration request message to a dedicated entity in the HN called home agent (HA. The HA maintains an up-to-date list of the mobility bindings (i.e., pairs of MN's home address and its current CoA) and confirms any recently made change with a registration reply message sent to the MN. An important security consideration is that both registration messages (from MN and from HA) must be authenticated to prevent packet hijacking. (4) HA intercepts any packet arriving at the HN, e.g., using Proxy Address Resolution Protocol (ARP). (5)HA forwards the intercepted packets to the MN at its current CoA using IP tunneling. The IP encapsulation is removed at the FA. (6)FA then delivers the packet to the MN. (7) However, in the opposite direction, the MN sends packets to the CN they are diverted along a direct path through FA to CN.

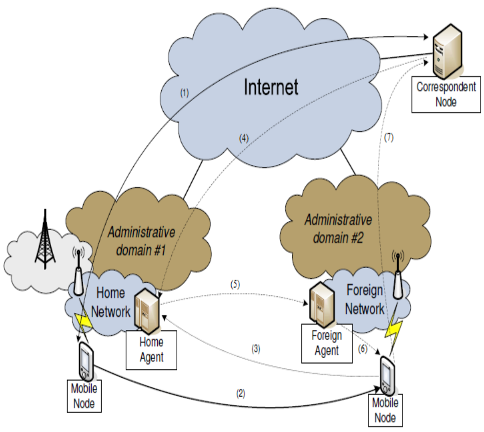


Fig 3.1 Basic Architecture of Mobile IPv4

## 4. Simulation And Result Analysis

### 4.1 Simulation Scenario

The Network Simulation 2 (NS2.33) has been used for the running the simulation of MIPv4 and NS2.33 extension MOBIWAN has been used to run the simulation of MIPv6.Regarding the current MIP architecture in ns-2 , it is contributed by both CMU's Monarch Group and SUN Microsystem Inc.. Monarch group extended the mobility support in ns-2 while SUN introduced the mobile IP into ns-2. But, since the original CMU wireless model only allows simulation of wireless LANs and ad-hoc networks, the wired-cum-wireless feature was then developed in order to use the wireless model for simulations using both wired and wireless node. Also, SUN's Mobile IP was integrated into the wireless model, although it was originally designed for wired nodes. MHs could interact with base stations that were connected to wired nodes, to bring together wired and wireless topologies, Destination-Sequenced Distance-Vector (DSDV) routing protocol is used for this purpose.

The typical Mobile IP scenario consists of Home-Agents (HA), Foreign-Agents (FA) and Mobile-Hosts (MH). In the current ns-2 system, HA and FA are basically the same kind of node - Base- Station Node in the ns-2 system and they use the same Agent – MIPBSAgent to handle the packets. Since the HA and FA play the role to interconnect the wired and wireless nodes, they are implemented as Hybrid nodes of both wired nodes and wireless nodes. In MOBIWAN extension, In order to support functionality of Mobile IPv6, the header size was modified , Router Advertisements and Solicitations between BSs and MHs, encapsulation and decapsulation at all nodes, like modifications were made. The MNs rely on Class Mobile Node as contributed by CMU. For Base Station, the ad-hoc routing Agent is replaced by the Network Agent. As for CNs, we make use of Class Node.

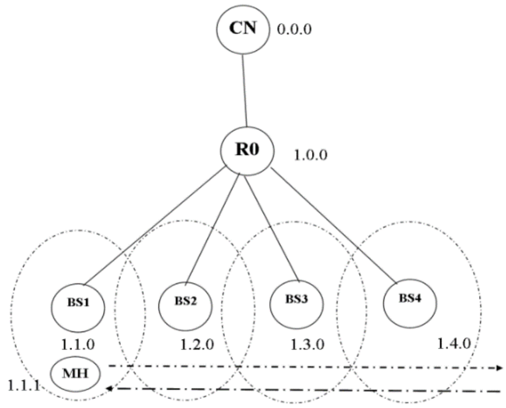


Fig 4.1: Simulation Topology

The simulation scenario with hierarchical topology of one mobile host (MH), one correspondent host and one wired node and In case of MIPv4 the BS1 acts as HA, BS2 as FA, BS3 as FA1, BS4 as FA2 , whereas In MIPv6 the BS2,BS3,BS4 acts as foreign links. During simulation, an MH travels randomly between one base station ranges to another base station range with variable speed.

The Network Simulation 2 (NS2.33) has been used for the running the simulation of MIPv4 and NS2.33 extension MOBIWAN has been used to run the simulation of MIPv6.After running the simulation for both MIPv4 and MIPv6, simulation events were generated in the trace file. The trace files were analysed using the result analysis scripts (any scripting language).In this study AWK scripts were used for analysis.

The parameters such as the following are used for the comparison of the both protocols

- Throughput
- Handover Latency
- Average End-to-End Delay
- Packet Delivery Ratio

**Throughput:** The Throughput is one of the performance metrics to evaluate the performance of Mobile IP Protocol. Generally it is defined as the amount of data processed in a specified amount of time. From the trace file generated by running the simulation the throughput values were captured and plotted graph with the values of “*Throughput of receiving bits Variation with Simulation Time*” as shown in Fig 4.2 and Fig 4.3

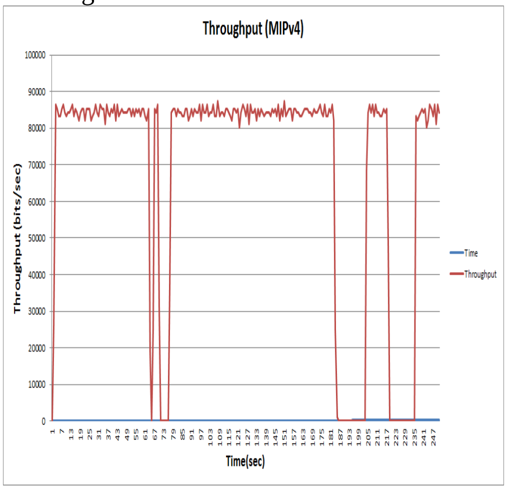


Fig 4.2: Throughput of MIPv4

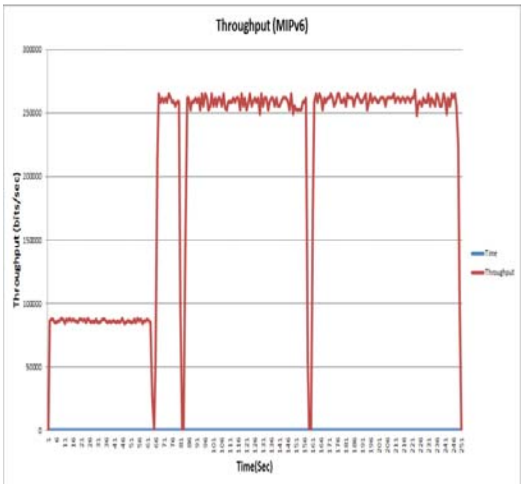


Fig4.3: Throughput of MIPv6

Each packet generated by a source is routed to the destination via a sequence of intermediate nodes. From Fig 4.2 and Fig 4.3, *it can be observed that the throughput of receiving packets in Mobile IPv6 is approximately 268128 bits/sec (*33516 bytes/sec), whereas for mipv4 is 87360bits/sec (10920 bytes/sec).*The throughput of mobile IPv6 is obviously high compared to that of Mobile IPv4; throughput has the* direct proportional relationship with handover latency. During the handover period the throughput falls to zero and reaches to maximum when handover finishes. After the handover process the mobile node attains high signal strength level so the throughput reaches maximum when compared to its previous throughput level

| Handover No | MIPv4 Delay | MIPv6 Delay |
|---|---|---|
| 1 | 1 | 1 |
| 2 | 5 | 2 |
| 3 | 18 | 2 |
| 4 | 16 | 0 |

Table 1: Throughput of MIPv4 &MIPv6

**Handover Latency**

The process of where the mobile node moves away from the range of the HA and enters into the range of Base Station or foreign agent is called Handover. The time taken to acquire Care of Address from new BS or FA and registering to Home agent of Mobile Node is termed as Handover Latency.

***Handover latency of MIPv4:***

During the simulation time of 64 seconds the connection breaks between Mobile Node and Home Network and the connection re-establishes at 65 seconds with another Base Station (i.e., FA). So, here *handover latency is One second*.

Again Mobile Node leaves the present FA at 70 seconds and connects with new FA at 76 seconds and resulting in *handover latency of 6 seconds.* Third Handoff occurs at 185 seconds and connection reestablishment takes place at 203 seconds. So, here *handover latency is 18 seconds.* Fourth handoff occurs at 220 seconds and connection reestablishment takes place at 237seconds. So, here *handover latency is 16 seconds.*

***Handover latency of MIPv6:***

During the simulation time of 64 seconds the connection breaks between Mobile Node and Home Network and the connection re-establishes at 65 seconds with another Base Station. So, here *handover latency is One second*.

Again Mobile Node leaves the present BS at 81 seconds and connects with new BS at 83 seconds and resulting in *handover latency of 2 seconds.*

Third Handoff occurs at 158 seconds and connection reestablishment takes place at 163 seconds. So, here *handover latency is 2 seconds.* Fourth handoff occurs at 250 seconds and continues up to end of the simulation time (250seconds) Total delay= 1 second

| Protocol | Max. Throughput (bytes/sec) |
|---|---|
| MIPv4 | 10920 |
| MIPv6 | 33516 |

Table 2: Handover Latency of MIPv4 &MIPv6

Total Handoff Latency of MIPv4= 1+5+18+16 = 40 sec
Total Handoff Latency of MIPv6= 1+2+2+0 = 5 sec

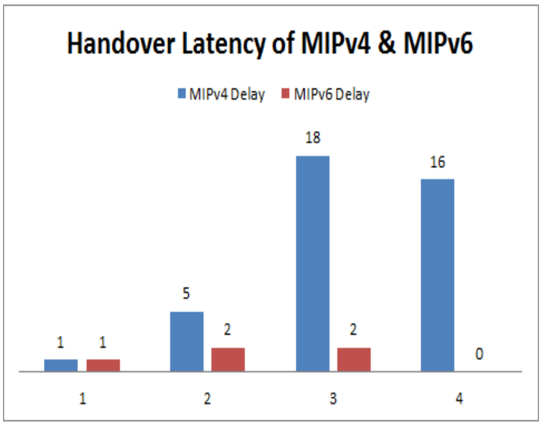


Fig 4.4: Handover Latency of MIPv4&MIPv6

From the various handover delay values of MIPv4 and MIPv6, it is concluded that the handover latency of

MIPv6 is very shorter than that of MIPv4 handover latency. This is mainly due to the route optimization mechanism of MIPv6. Hence shorter handover latency gives better protocol performance.

**Average End to End Delay**

$$\text{Average End to End Delay} = \frac{\text{Sum of End to End delays of all packets}}{\text{Total No.of Received Packets}}$$

The End-to-End delay is the sum of the delays experienced at each hop on the way to the destination of each packet. If this value is lesser, then the packets will be delivered faster from source to destination. The average End-to-End delay is computed as below,

The following is the experimental values

| Protocol | Average End to End Delay(seconds) |
|---|---|
| MIPv4 | 23.6109 |
| MIPv6 | 8.7785 |

Table 3: Average End to End delay of MIPv4 and MIPv6

The average End-to-End delay of MIPv6 is less than that of MIPv4. This is because of there is no foreign agent functions and route optimization procedure in MIPv6 operations. And therefore, home agent directly sends the data packets to the mobile node when binding updates obtained from correspondent host. The decrease in end-to-end delay is due to the low handoff latency by localizing the location update messages up to the mobile agents. Thus decreases the handoff latency, results lower end to end delay in MIPv6.

**Packet Delivery Ratio (PDR)**

The Packet Delivery Ratio is the ratio of received packets to sent packets. The PDR is computed as below,

$$\text{Packet Delivery Ratio (\%)} = \frac{\text{Total No.of received packets} - \text{Total No.of Dropped Packets}}{\text{Total No.of sent Packets}} \times 100$$

| Protocol | Packet Delivery Ratio (%) | No.of Packets Lost |
|---|---|---|
| MIPv4 | 97.8551 | 68 |
| MIPv6 | 97.9191 | 13 |

The following is the experimental values

Table 4 : PDR & Packet Loss of MIPv4&MIPv6

The PDR of MIPv6 is 0.064% more than that of MIPv4.However, in both the cases of MIPv4 and MIPv6 the delivery ratio is almost same. Also, the packets are delivered faster in MIPv6 when compared to MIPv4 as explained in average End to End delay.in case of Packet Loss the MIPv6 has the lowest no. of packet loss when compared to MIPv6 is due to lower handover Latency of MIPv6.In case of MIPv4 ,the higher is the Handover Latency ,so there occurs large no. of packet loss. Packet loss is not only affected by handover latency but also signal fading, noise like characteristics. Again these lost packets are retransmitted in case if we use TCP traffic. That’s why the PDR performance is almost same in both MIPv4 and MIPv6.

## 5. Conclusion

Mobile IP is a protocol developed by the IETF Group, which provides mobility support to wireless Internet users. In this master thesis, the Mobile IPv4 and Mobile IPv6 protocols are evaluated and their performances are presented. Simulation results and performance analysis are carried out by using NS-2. From the results analysis, MIPv6 shows very much improved performance than that of MIPv4 network in terms of Throughput, Handover Latency, Average End-to-End Delay and Packet Delivery Ratio and dropped packets.MIPv6 has very less Handover Latency in comparison with MIPv4. In MIPv6, the Mobile Host obtains care of address. This binding update process reduces the Handover Latency. Due to lower Handover latency the Packet losses are also minimized in MIPv6 in comparison with MIPv4. Finally from the analysis in this paper it is concluded that MIPv6 is the most preferred Protocol for

Time sensitive applications. In MIPv6, the Mobile Host obtains care of address through either stateful (obtains a care of address from a DHCPv6) or stateless address auto configuration (MH extracts the network prefixes from the Router Advertisements and adds a unique interface identifier to form a care of address).

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