Fast Mobile IPv6 Handover Using Link and Location Information

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Abstract

There are two causes of latency in mobile handover: the move detection latency and registration latency. This delay is inherent in the round-trip incurred by Mobile IP as the registration request is sent to the home agent and the response sent back to the foreign agent. Throughout the time between Mobile Node (MN) leaving the old foreign network (oFN) and Home Agent (HA) receiving the MN registration message, HA does not know MN's latest Care of Address (CoA), and therefore it still forwards the packets destined for MN to the old foreign network. These packets will be discarded and lost.

This paper present an improved link layer mechanism with Location information Provider. Global position systems GPS used to assist FMIPv6 for fast handovers and reduced packet loss during handover. We introduce a new link layer combined with Location information Provider signalling in this algorithm accordingly. Further, we report the implementation details performed through simulations.

Therefore, link layer information and Location information Provider allows an MN and FAs to predict the loss of connectivity more quickly than the L3 advertisement based algorithm. The simulations evidence performance improvements in terms of latency and packet loss. It is also shown that by enabling Location information Provider inside the FA discovery method and improving link layer event services, an MN can be well prepared for handover and perform faster movements.

Keywords- Mobile IP, Link Layer Information, Global Position Systems, Fast Handover, Handover Latency, Packet Loss.

1. INTRODUCTION

The primary purpose of IP is to keep data packets delivering between hosts in the Internet. Mobile IP is an Internet standards protocol, proposed by the Internet Engineering Task Force (IETF), which enhances the existing IP to accommodate mobility [1, 2].

The most important functions in mobile IP is the addressing. Because host in the Internet must has a unique IP address, which species its location. Such an address consists of a network address and a host address. Mobile IP allows a MN to communicate with other nodes after changing its link-layer point of attachment from one Access point to another without changing the MN's address [2,3]. The MN perform handovers between access Points while still using the preserving IP Address. Therefore, packets may be routed to it using this address regardless of the MN's current point of attachment to the Internet [1,4].

Mobile IPv6 [1] is a protocol proposed to develop as a subset of IPv6 to support mobile connections; Mobile IPv6 allows mobile nodes to change their point of attachment whilst not breaking existing application sessions. Each MN is always identified by its home address, regardless of its current point of attachment to the Internet. While situated away from its home, a MN is also associated with a Care-of-Address (CoA), which provides information about the MN's current location. Packets destined to the MN's home address are transparently routed to its CoA. When the MN changes its point of attachment to the Internet, a handover occurs. The handover mechanism provided in the Mobile IPv6 causes latency, which makes the MN unreachable for a period of time [16, 17].

The protocol allows IPv6 nodes to cache the binding of a MN's home address with its CoA, and then to send any packets destined for the MN directly to it at this CoA. MIPv6 offers a solution to solve the IP mobility, but due to intolerable high data lost rate and long handover latency. A new protocol, called Hierarchical Mobile IPv6 has been proposed by the RFC 4140 [3] document, which spread out Mobile IPv6 to allow for both micro mobility and macro mobility handling. Hierarchical Mobile IPv6 (HMIPv6) proposal suggests a Mobile Anchor Point (MAP) to act as a local HA to reduce signalling delays in handovers. However, the handover delays still remain unacceptable for some applications.

When a MN changes its point of attachment to the network, it moves from one network (Old network) to another new network and this process is known as handover. During the handover process, the MN usually has disconnected from the old network before connecting to the new network and thus there is a time when the MN has lost connectivity to the Internet. During this period time, it cannot send or receive IP packets to maintain existing application sessions, because of the link switching delay and this time period known as handover latency, it is the primary cause of packet loss.

The latency due to a handover using basic MIPv6 is directly proportional to the minimum round-trip time necessary for a binding update (BU) to reach either the home agent (HA), the correspondent node (CN) or old location in case forwarding from old location is allowed. The interruption time starts in the moment that the mobile node (MN) does not listen to the old location anymore and finishes when the first packet arrives via the new location either from the HA, CN or old location [2].Therefore, these packets may be lost and need to be retransmitted [3, 4].

There are two causes of latency in mobile handover: the move detection latency and registration latency. This delay is inherent in the round-trip incurred by Mobile IP as the registration request is sent to the home agent and the response sent back to the foreign agent. Moreover, there is a high Mobile IP handover delay because of the agent discovery and registration periods, eventually Mobile IP handover can cause significant performance degradation, especially in large-scale mobility environments. Mobile IP can use link layer information to force a handover to a new access network before any mobility at the network layer detected [2]. The Handover decisions based on movement calculation eliminate the need to wait for beacon signals from other FAs. In this paper, we propose the use of link-layer information combined with the global position systems (GPS) in every FA (Location Information of FAs) that can detect the direction of the MN to the new network agent. The link-layer trigger and the Location information of FAs enhance the overall performance of the Mobile IP handover [9].

2. MOVEMENT DETECTION

Movement detection is one of the most important operations performed by the MN, because it is used to discover the handover. To achieve this goal the MN will use any mechanism to detect its movement from one link to another. The Standard movement detection mechanism defined in Mobile IPv6 uses services defined in IPv6 Neighbor Discovery. Additional information provided by other mechanisms can be used besides the one provided by the standard mechanism in order to facilitate the movement detection [2]. The movement of the MN can be detected by using Location information that install inside all FAs. Therefore, FAs can discover the direction of the mobile node and the address of the new foreign agent that MN will move. This will reduce the delay of the registration [10].

3. HANDOVER LATENCY

The Handover latency is the most important issue in mobility network. It refers to the ability of the network to allow a call in progress to continue as the MN continues to travel and change its point of attachment. The handover refer to the time between the reception of the last packet through the old FA (oFA) and reception of the first packet through the new FA (nFA) [5, 6, 7]. During this time the MN, start disconnecting from the old network and start new registration with the new network while packet still forwards to the old network; these packets will be discarded and lost. The packet losses could cause impossible disruptions for real-time services, degrade the QoS and lead to severe performance deteriorations of upper layer protocols, especially when the handover is frequent and the distance between MN and the HA is great [8,9,10].

In general, handover can be classified as either proactive or reactive. Proactive handovers utilize link layer triggers to support the MN in determining that a handover is about to happen and establish packet flow to the target access point prior to the handover event, i.e. requires link layer coupling. This covers a hybrid of mobile assisted and mobile controlled handover types. Reactive schemes only follow the base mobile IP movement methods [13].

4. LINK LAYER INFORMATION AND LOCATION INFORMATION PROVIDER

The main reason to use the link layer to improve the handover delay and packet lost. This can be achieved by providing the information of the link layer; the MN can predict its connectivity more quickly than Network Layer advertisement-based algorithms. Therefore, it used this information to predict the breakdown of the link layer before is broken. This facilitates the execution of the handover, and the elimination of the time to detect handover. [11,12].

The Location information Provider built inside of FAs is now being used in most of the mobile networks to determine the location of any FAs address. GPS is used in different areas and is becoming more commonly used because it is integrated in various devices. Moreover, it can also be used in MN and other wireless access devices to facilitate good handover due to its accurate location-trace [18].

Building Location information Provider in the MN and FAs means the MN and FAs are able to track the position constantly. By using L2 and Location information Provider in MN and FAs, it is possible to decrease latency and packet loss. Handover decisions based on movement calculation remove the need to wait for beacon signals from other FAs and to discover handover target areas in advance. The link layer and GPS information Provider used in this paper to reduce the delay and Packet lost [20].

5. RELATED WORKS

In the past few years, different proposals have been presented to minimize the handover delay in Mobile-IPv6 networks. Many of the proposed methods require modification of the Access Routers (ARs). Two slightly different handover solutions using multicast routing are presented in [7] and [8].

The Post-Registration proposal involve Link layer [L2 triggers]. [15] The handover method is based on a network-initiated model of a handover, which does not require any MN involvement until the actual Layer 2 (L2) connection with the new Foreign Agent (nFA) is completed. Such a trigger is a signal related to the L2 handover process. Two types of triggers can be received: a source trigger at the oFA (L2-ST) and a target trigger at the nFA (LS-TT). The first trigger that is used is an early notice of an upcoming change in the L2 point of attachment of the MN, referred to as anticipation trigger. A second trigger, the Link Down trigger (L2-LD), indicates that the L2 link between the MN and the oFA is lost. The Link Up trigger (L2-LU) occurs when the L2 link between the MN and the new FA is established. A trigger initiated at the old FA is referred as a source trigger and a trigger initiated at the new FA is referred as a target trigger.

This approach uses Bi-directional (BET) edge tunnels to perform low latency change in the L2 without the MN involvement. A handover occurs when the MN moves from the oFA, Where the MN performed a Mobile IP registration to nFA. The MN delays its registration with the nFA, while maintaining connectivity using the BET between the oFA and nFA.

The other proposal is Pre-Registration [15], realizes an anticipated L3 handover. This handover method allows the MN to communicate with the new Foreign Agent (nFA) while still connected to the Old Foreign Agent (oFA). This way, the MN is able to pre-build its registration state on the nFA prior to an underlying L2 handover.

The network assists the MN in performing an L3 handover before the L2 handover is completed. Both the MN (mobile-initiated) and the FAs (network-initiated) can initiate a handover. A mobil-initiated handover occurs when the L2 anticipation trigger is received at the MN informing it that it will shortly move to the nFA. The L2 trigger contains information such as the nFA's IP address [14].

The standard Mobile IPv6 procedures have to deal with the same handover latency problem as Mobile IPv4. In [3], Koodli species a protocol to improve handover latency in Mobile IPv6 as [2] does for Mobile IPv4.The Fast Handover method is an extension proposed for Mobile IPv6 and resembles a combination of Pre-Registration and Post-Registration. The Fast handovers for Mobile IPv6 [FMIPv6] Handover can be either Network-Initiated or Mobile-Initiated, depending on whether one of the ARs or the MN initiates the handover. The two main possibilities are router discovery performed by MN on Layer 3 and a link-specific event (L2 trigger) occurring in the MN or in the network. In [8], HMIPv6 a proposal suggest to an extension to Mobile IPv6, which aims to reduce the amount of signalling between the MN and its CNs during a handover, and to improve the performance in terms of handover speed.

In an IETF draft, which expired in April 2006 [19], Jung et al. propose a combination of the Fast Handovers and Hierarchical Mobile IP extensions to Mobile IPv6. The scheme is called Fast Handover for Hierarchical Mobile IPv6" (F-HMIPv6). The MN enters a new MAP domain, it first performs the HMIPv6 registration procedures with HA and MAP. Later, when the MN moves from a PAR to a NAR within the MAP domain, it will follow the local Binding Update (BU) Procedure of F-HMIPv6. During the handover, data packets sent by CNs will be tunneled by the MAP toward the NAR via a bi-directional tunnel, similarly to the FMIPv6 procedure. Optionally, the MAP may start bi-casting packets to PAR and NAR simultaneously. It should be noted that no bi-directional tunnel is established between PAR and NAR.

6. PROPOSED ALGORITHM

The Predictive handover for FMIPv6 (P-HMIPv6) provides a different approach for resolving the timing ambiguity problem. Link layer information such as signal strength is continuously available, providing important information about the availability of new links, and the FAs will use the location information's of MNs and all neighbours (FAs) to facilitate handover. Therefore, the handover can be predict in advance before MN moves out of the coverage area of the oFA. The main idea behind the proposal is to apply link layer information and Location information of the FAs to predict a breakdown wireless link before the link is broken. The use of Proactive will significantly reduce handover latency and reduces packet loss in handover.

The proposal will consider the handover to start when it is predict that the link layer association to the oFA will lost. The handover will completed when the registration reply message received from the HA to the MN. Figure 1 describes the overall P-Mobile IP protocol message flow.

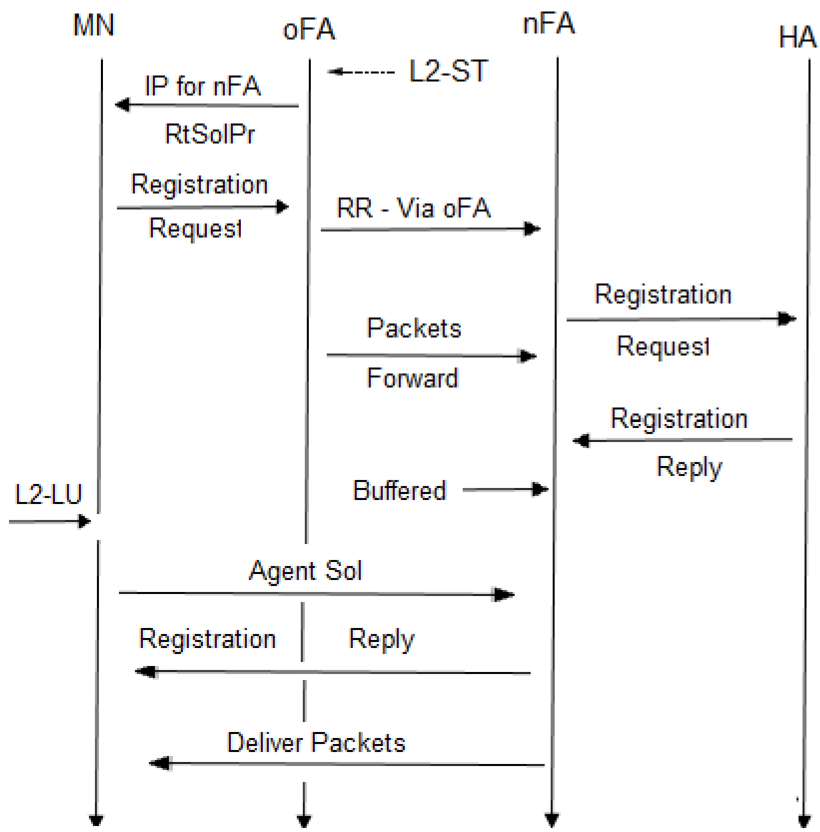

FIGURE 1: P-Mobile IP Protocol Message Flow.

1. The handover process starts when the MN become leavening the oFA and entering the overlap area between nFA and oFA.
2. The Foreign Agent receiving an L2 trigger informing that MN is about to move from oFA to nFA.
3. The oFA provided location information for nFA include MN home Agent address and that include by oFA, which include the direction that based on Layer 2 information.
4. The oFA sends a handover Initiation (HI) message containing the MNs home Agent address.
5. The nFA sends a handover Acknowledgement (H-Ack) message to oFA.
6. Tunnelling then establish between oFA and nFA.
7. The oFA will forward all packets received through the tunnel to the nFA.
8. MN then will receive fast acknowledgment (FB-Ack) via nFA.
9. The nFA will buffer packets that received from the oFA, and this packets will forwarding after the MN send FNA message to ask nFA to forward all buffered packets,

7. SIMULATION SCENARIO and CONFIGURATION

In this section, we evaluate the performance proposed for the FMIPv6 using the link and location information algorithm. We compare our algorithm against a Mobile IPv6 and Mobile IP We assume that the MN on area (A) and start handover to (B or E) the area for the overlapping is 25m, the Handover decisions based on movement calculation eliminate the need to wait for beacon signals from other FAs and also to discover handover target areas in advance.

We use network simulator CIMS NS-2 version ns-allinone-2.31 as a simulation tools in order to simulate FMIPv6 handover [21, 22]. The simulator is modified to emulate IEEE 802.11 infrastructured behaviours with multiple disjoint channels. This modification forces L2 handover operations, where stations only receive data packets via one FA at a time.

The network features three MNs connected to it; the first will move sequentially from oFA to nFA, starting at overlap of the nFA1, performing handovers at a rate of a 30 handovers/min. In each test, the MN1 will be the receiver of a CBR or FTP traffic source, generating either UDP or TCP packets. This traffic originates from the CN1 outside the network, or inside the domain from CN2. All presented results are taken as the average of multiple independent runs, coupled with a 95% confidence interval. The best possible handover point occurs at position A, as shown in Figure 2.

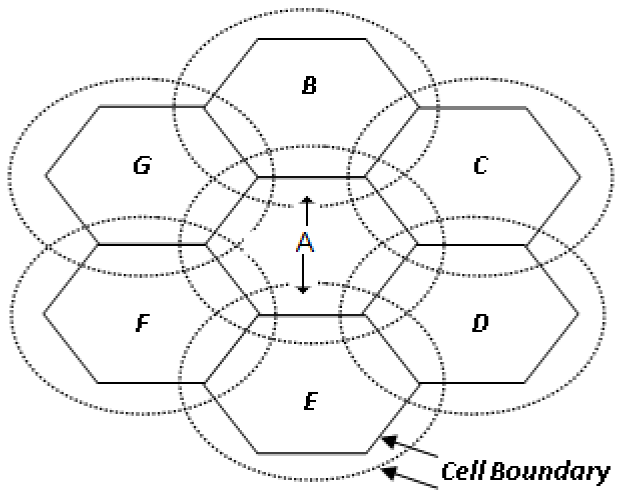

FIGURE 2: Overlapping Coverage Area.

8. PERFORMANCE ANALYSIS and EVALUATION

In our simulation, we use a 500m × 500m and a 1000m × 1000m area with a 3 to 7 MNs [5, 11]. The network bandwidth is 2 Mbps and the medium access control (MAC) layer protocol is IEEE 802.11 [19]. The packet size is 10p/s which will generate enough traffic when we increase the number of connections for example at 40 connections of source-destination pairs, it will generate 400 packets per second for whole scenario. Other simulation parameters are shown in Table1. These parameters have been widely used.

TABLE 1: Simulation Parameters.

Simulation parameter	Value
Simulator	Ns-allinone-2.31
Network range	600m×600m and 1000m×1000m
Transmission range	25m
Mobile nodes	3 and 5
Traffic generator	Constant bit rate
Bandwidth	2Mbps
Packet size	512 bytes
Packet rate	10 packet per second
Simulation time	750s and 1100s

Figure 3 and 4 showing the relation between the handover latency and packet loss, as we observe that the P-FMIPv6 performs better in terms of handover latency and packet loss compared to the others, although the fast handover protocol is proposed and design to minimize the latency and the packet loss during a handover while the worst case observed Mobile IP and Mobile IPv6.

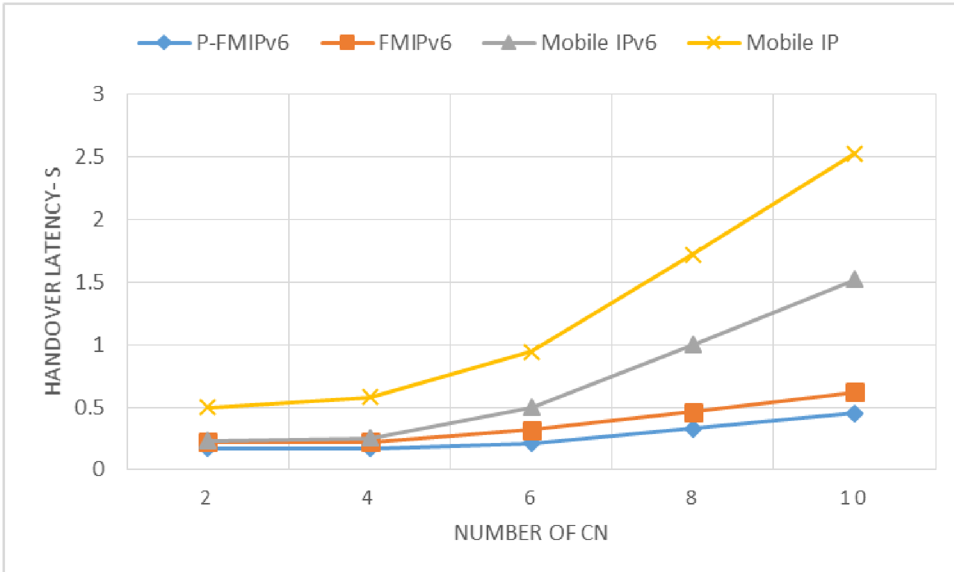

FIGURE 3: Impact of Handover Latency.

We observe in figure 4, that the number of packet loss increase with increase of CN, the P-FMIPv6 showing better performance comparing to the wars case of MIP and MIPv6.

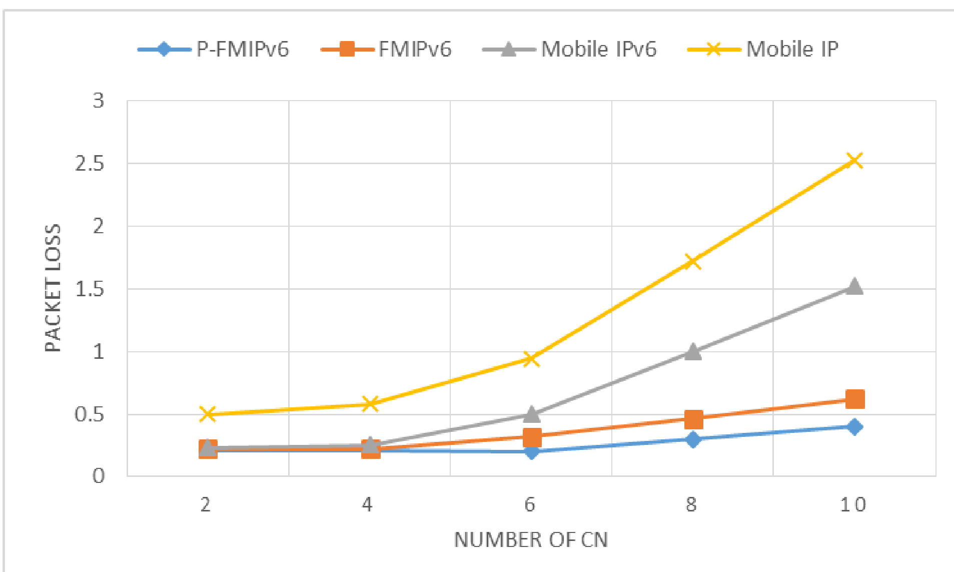

FIGURE 4: Impact of Packet Loss.

The overall throughput graph showing in Figure 5. The figure shows that as the number of sending rate increase the throughput increase. The P-FMIPv6 performs better than all other proposal. The reason for the throughput increase is that more packets are sent overall, although the number of packets lost increase as the sending rate increase. The P-FMIPv6 slightly performs well compared to the other three proposals. We can see that at rate of 10 the MIPv6, FMIPv6 and P-FMIv6 very close.

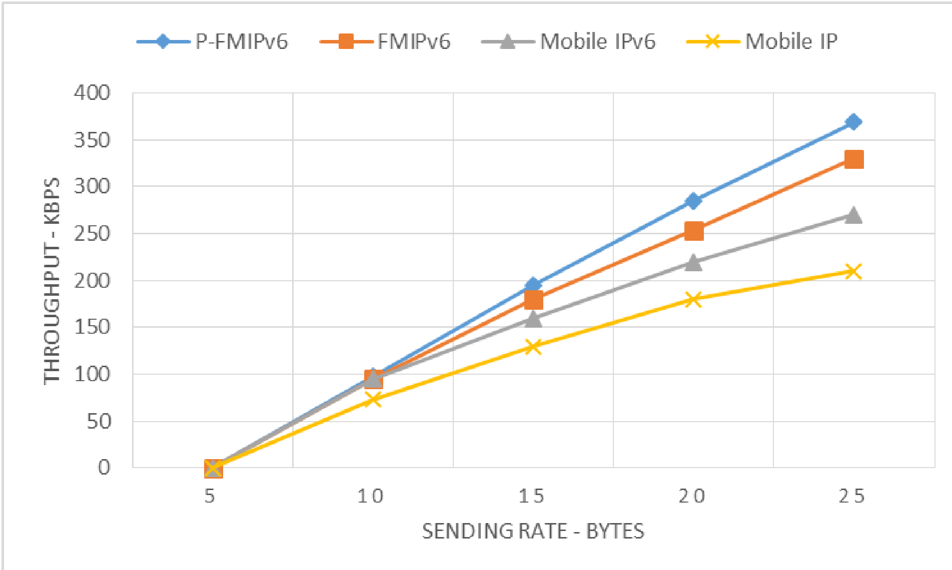

FIGURE 5: Throughput Versus Rate.

Obviously, the loss in the buffer increases when the buffer size is increased. The number of packets lost depends both on the size of the buffer used to store packets for potential handovers and the sending rate as seen in figure 6. The number of packets lost increases for Mobile IP since no buffer is used and increases as the sending rate increase since more packets are sent, while MN is unable to receive them during handover. While on the other hand, the number of packets lost decreases as buffer size increase for P-MIPv6 and FMIPv6.

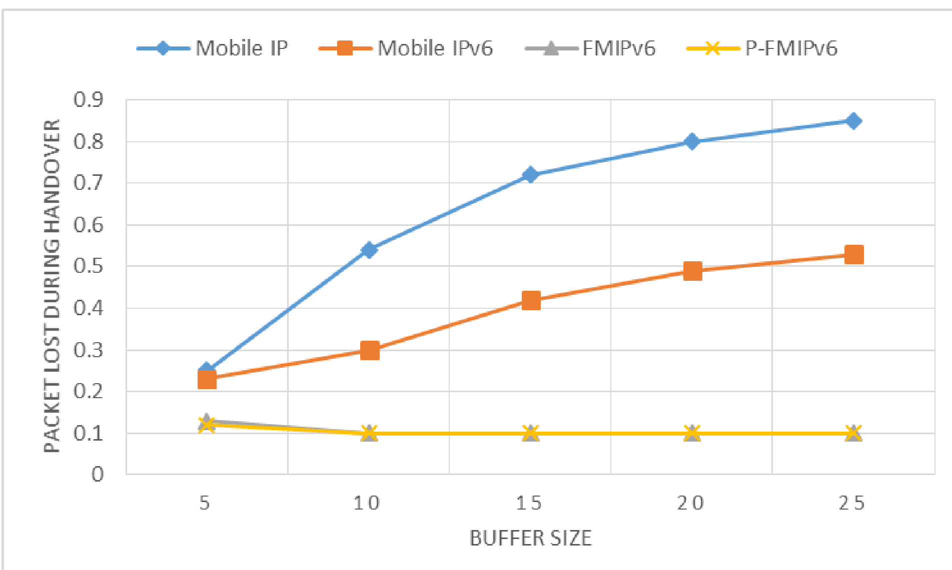

FIGURE 6: Packet Loss vs Buffer Size.

The result graph shows the uplink of MN to CN transmission behaviour with sixe handover in unit time of all four schemes. The result graph shows the transmission bit rate of each handover protocol. The MIPv6 and Mobile IP receive less data than other schemes because their time period take to finish the registration, while the FMIPv6 and P-FMIPv6 shows the highest transmission rate.

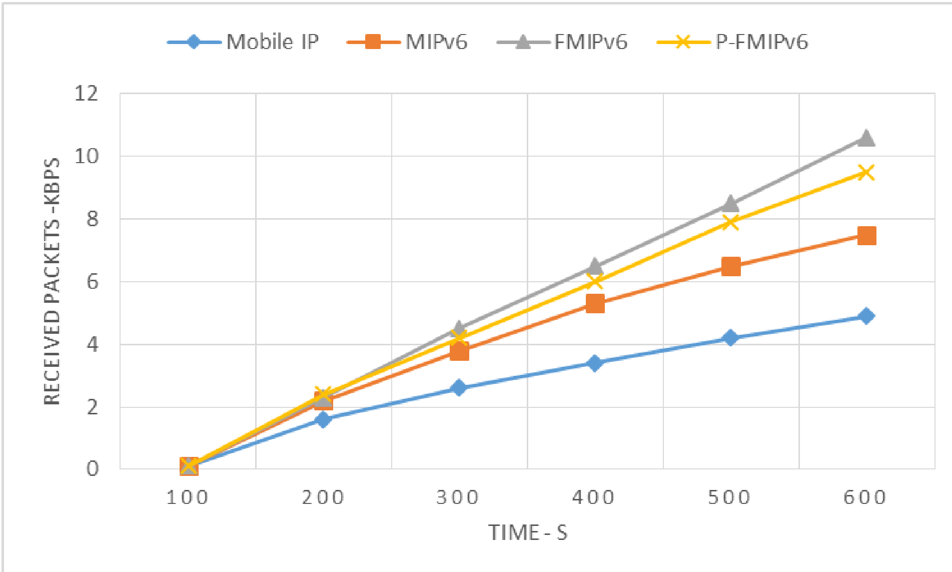

FIGURE 7: Handoff Behaviour.

9. CONCLUSION

In this paper, we developed and analyzed the proposed scheme of the P-Mobile IPv6 handover using link layer and location information scheme. The performance study in this paper indicate that the use of link layer and location information helps to minimize packet loss and improver the throughput. In our scheme, we analysed the performance by simulating the proposed scheme in ns-2 to get fast mobile handover for FMIPv6.

We then compared the experimental results with the results of the Mobile IP and Mobile IPv6 and FMIPv6. The performance study in this paper indicates that the use of link layer information with location information helps to minimize packet loss and improve the throughput of Mobile IP handover. We have seen that the starting point for packet loss could happen in two ways: first, packets may get lost in the oFA when the forwarding buffer overflows and secondly, packets may get lost in the nFA when, upon their arrival, the *ReRep* from the HA has not arrived in the nFA. The first reason for loss may be avoided by appropriately dimensioning the forwarding buffer. This buffer should be able to store arriving packets at least during a time equal to the delay on the nFA and oFA path. The second loss is more difficult to deal with. It is determined by the difference between the delays of the paths oFA, nFA and nFA, HA.

In addition, we evaluated the impact of L2 setup on different performance measures of Mobile IP, together with handover latency, packet loss and throughput. The simulation results show that P-Mobile IPv6 handover latency is not too sensitive to L2 setup latency and beacon periods compared to the other schemes of Mobile IP. Moreover, P-Mobile IPv6 can achieve a fast and seamless handover if MN's moving speed is not too high, but is within reasonable limits.

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