Comparison of Mechanisms for Reducing Handover Latency and Packet loss problems of Route Optimization in MIPv6

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***Abstract*— In the last few years tremendous development in the area of wireless and mobile network has been observed. Internet Engineering Task Force (IETF) proposed Mobile IPv6 to provide mobility in wireless networks. In Mobile IPv6, a Mobile Node directly updates its current location information to a Correspondent Node using a Route optimization technique. However, Route Optimization suffers from handover delays derived from the signaling message exchange. Handover latency in Mobile IPv6 plays an importantrole in the performance of a network scenario. It results in packet losses and severe End-to-End performance degradation. This paper analyzes and also compares some of the existing mechanismsthat are used for reducing handover latency and packet loss problem in the current mobile IPv6 Route Optimization environment and gives the overview of this area.**

Keywords: MIPv6 Route Optimization, Handover latency, Packet loss.

I. INTRODUCTION

The major benefit of MIPv6 standard is that without changing the IP address, the mobile nodes change their point-of-attachment to the Internet. This allows mobile devices to move from one network to another by maintaining existing connections. This is achievedprimarily through the Mobile Node (MN) always being reachable at its home address (HoA) via its home agent (HA).The communication through the Home agent is known as Triangle Routing. The main drawback of triangular routing is in increased latency and packet size. Such inefficiency of triangular routing can be eliminated in Mobile IPv6 with the use of route optimization. In route optimization, the MN sends a Binding Update (BU) to its Correspondent Node (CN) to inform the CN of its current location i.e. its Care of Address (CoA). Once the BU has been acknowledged by the CN, then MN and CN can directly communicate with each other rather than going through the Home Agent.The handoff or handover occurs when a MN changes its point of attachment to the network, it moves from one network to another new network. During handover process, MN lost connectivity to the Internet because the MN usually disconnected from the old network before connecting to the new network. The MN cannot receive IP packets on its new point of attachment until the handover finishes. The delay time required to receive IP packets from new access point includes the new prefix discovery on the new subnet, the new care-of address (NCoA) establishment, and the time needed to notify the correspondents and the home agent (HA) about the new location of the MN. This time is called the handover latency.While many researcher designed and developed applications that are based on Mobile IPv6 , to overcome with intermittent loss of connectivity by retransmitting unacknowledged packets and to solve the handoverlatency and packet loss duringhandoff .

In this paper, we analyze some mechanism, which aim to minimize the handover delay and also to eliminate the packet loss of Mobile IPv6 Route Optimization with the comparison of the performance among each method and their features and drawbacks.Also discuss on how to extend performance of existing mechanisms so that it reduce handover latency and packet loss problems of MIPv6 route optimization.The rest of the paper is organized as follows. Section II introduce the concept of handovers and describes the different types and classifications. In Section III describes various mechanisms to reduce Handover latency and Packet Loss for mobile IPv6. The discussion regarding the performance of each existing mechanisms and the comparison of the performance between each method will also be brought up in Section IV; and finally section Ⅴ gives the conclusion.

II. TYPESAND REASONS OF HANDOVER

As Layers of the communication stack are affected by different types of handover.In general, handovers categories asfollows:-

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- Handovers that only affect the link layer (L2) without resulting in a change of IP (L3).
- There are inter-domain handovers or Vertical handovers that are the handovers between different domains.
- Intra-domain handovers or Horizontal handovers which are handovers of the same domain [2].

Mostly handover procedures distinguished into two different types [3].

1. Hard handover: - When all the links in the MN are disconnected before the new links are established. Hard handover scheme does not care about packet loss during the handover process assuming that upper-layers will recover the packets lost [4].
2. Soft handover:- Where the MN is always connected to the network via at least one link. There is an overlap of different link usage during the handovers process.

The Mobile IPv6significantly affect handover delay during an IPv6 handover comprises due to latencyof Movement detection time (td),IP CoA configuration time (ta), Context establishment time (tc), Binding registration time (tr) and Route optimization time (to).
The total IP handover delay is :-
(th) = td + ta + tc + tr + to.
MIPv6 has two mains factors that cause the handover latency.

1. One is the disconnection period during L2 handover. Generally, it takes a short time for the physical interface of the MN to change its single connection from the old AR and to the new AR that means, during this period, the MN cannot send or receive any packets.
2. The other is the signaling latency for a binding update packet from the MN to the HA and CNs. Over Wireless LAN.

III. MECHANISMS FOR REDUCING HANDOVER LATENCY AND PACKET LOSS IN MIPV6

A .Proactive Route Optimization For Fast MIPv6

As the fast Handover method for MIPv6 protocol allowing proactive approach to handover that minimizes packet exchange delay & packet loss. But this method does not reduce handover delays derived from the signaling message exchange. In 2009Jorge Espi et al [5] proposed the proactive Route Optimization for FMIPv6 (PRO-FMIPv6) protocol that is enhancement to FMIPv6. A PRO-FMIPv6 enabled mobile node is expected to switch communication with a CN to the optimized route after handover. For securing the home & care of address PRO-FMIPv6 makes use of different approach than Return-Rout ability. Researcher observed the simulation result and confirm that PRO-FMIPv6 protocol significantly reduces the signaling & improves the overall performance of the handover process.

B. MN's mobility prediction at the CN and a bufferingmechanism at the HA

For reducing the packet loss in Route Optimization in 2011Khan Md et al proposed a scheme that is based on the Mobile Node's mobility prediction at the Correspondent Node and a buffering mechanism at the Home Agent [6]. In this mechanism predict the probability of departure of the MN from its current care of address (CoA). By using this mechanism when MN moves to a new CoA, it will send a BU message to the HA inserting the new CoA and start RRP procedure in order to establish a direct communication with the CN. After receiving the BU message from the MN, the HA will forward the buffered data packets to the new CoA of the MN. Thus, no data packet will be lost while MN is moving from one CoA to another CoA. To evaluate this scheme and compare it with MIPv6 and HMIPv6 the other schemes with respect to packet loss, end-to-end delay and network overhead OPNET (MODELER 14.0) simulator is used. Simulation results show that proposed solution provides significant improvement in case of reducing the packet loss inMIPv6. Also measured the end-to-end delay and network overhead. In terms of end-to-end delay this scheme performs the same as MIPv6 but poor compared to HMIPv6. HMIPv6also suffers from fewer network overhead compared to proposed scheme.

C. Comparison of different Mobility Management Scheme

For the performance of the given network scenario, handover latency in MIPv6 plays an important role. In 2009Xinyi WU and Gang NIE et al. [7] presented a comparative study of HMIPv6 & FMIPv6 scheme for reducing handover latency & packet loss in MIPv6. It is observed that as compared to HMIPv6, FMIPv6 mechanism is even more capable to reduce the delay of time during handover. When we compare HMIPv6 & MIPv6 then HMIPv6 has better performance. FMIPv6 supports for the real time application i.e. video, voice etc.

D.Parallel Duplicate address Detection (PDAD)

MIPv6 handoff latency includes link layer establishment delay, movement delay, address auto-configuration delay & binding update delay. During address auto configuration DAD is performed and it takes around 70% of the time for the total handoff procedures. In 2011 M. Masud et al [8] proposed parallel DAD (PDAD) in order to reduce handoff latency & packet loss. PDAD requests parallel for several CoA to its neighboring network. If the MN moves within the time period, it will configure the cached CoA without delay. In this way PDAD takes time only for initial transition and do not need any time for subsequent transition & address configuration. And the alternate addresses are also ready for this MN. PDAD mechanism saves the configuration time of MIPv6. After the expiration time routers refresh their cache. Every time when MN moves to a new network it needs to start the same procedure from the beginning.

E. Fast Rerouting approach to reduce packet loss

The link state routing protocols when suffer from failure then it is not able to obtain a new route in due time. In 2008 Barreto et al. describe a fast emergency Path approach for aiding IP routing protocols to bypass failures [9]. The Fast Emergency Path Schema (FEP-S) used less Forwarding Information Base (FIB) memory to identify the shorter recovery paths. FEP-S is useful to aid OSPF during its convergence period & avoiding high packet loss rate. Each recovery path is almost always the same as that the OSPF would generate in case the router adjacent to a failure presented a reaction. An evaluation of these recovery paths was conducted and it is observed that these paths are shorter than the other 100% single-failure recovery approaches andit uses less extra information added to the forwardinginformation base per router.This mechanism use only some extra information for adding to the forwarding information base per router.

F. Efficient Fast Neighbor (EFND) Scheme

While processing DAD (Duplicate address detection) and Movement Detection in an access router, MIPv6 has many delay problem .To quickly determine the uniqueness of a new care of address using a modified Neighbor Cache in the Access Router (AR) in 2006 Byungjoo et al [10] proposed a faster movement detection method using new Neighbor discovery & DAD procedure. In this method look up algorithm used in the neighbor cache of new access router(NAR). In MIPv6 Generally DAD process requires up to 1000 msec to determine uniqueness of a link local address. But it is observed that by using EFND method DAD consumes as extremely short amount of time, a few micro second units, such as largest prefix matching speeds in routing tables. In this way by using the lookup algorithm the proposed scheme enhances processing time of the DAD.

G. Fast MIPv6 Handover packet loss Performance

In MIPv6 packet loss occurred because of handover algorithm requires the MN to wait until it receives a multicast router advertisement before starting handover. This packet loss during handover is controlled by the frequency of multicast Router advertisement. In 2003 James K. et al [11] studied three algorithm oSMIPv6, mFMIV6, sBETH to eliminate the wait for the router advertisement. The algorithm has two components i.e. first reconfiguring the care of address when it is known, & second establishing a source route-based tunnel between the old access router the new. Algorithms requires some support from the link layer and mitigate packet loss by using information from the link layer in order to speed up the routing change. It is observed that oSMIPv6 algorithm requires the least link layer support but it does not mitigate packet loss during the link switch and both mFMIPv6 &$_S$BETH provide mitigation for packed loss during the link switch.

H. A Low Latency & Smooth Handover Scheme

For reducing the handover delay & packet loss, it is necessary to optimize handover. In 2008 Li Xia et al [12] proposed low latency & smooth handover optimization scheme. This method based on two factors i.e duplicate address detection and binding update. In duplicate address detection the access router performs DAD by querying the link list for the mobile node. The mobile node sends binding update message in advance to the home agent & the correspondent node. By observing the simulation result it is observed that this mechanism can optimize the performance of the handover in MIPv6.

I. Signaling Time Analysis for Optimal Fast Handovers for MIPv6

For reducing the handover latency in MIPv6, Fast handover for MIPv6 (FMIPv6) was developed.In order to reduce the handover latency FMIPv6 introduce two factors i.e fast movement detection & fast binding update. And for reducing the packet loss that is arise by

handover, FMIPv6 introduce buffer in access routers. As handover latency or packet loss depend on the time in 2004 Seung Hee. Hwang [13] analyze and calculate the optimal signaling time on packet loss and handover latency in FMIPv6. It is observed that by calculating the optimal signaling time improve the handover latency & packet loss performance of FMIPv6.

J. Wireless link delay on Handover latency in MIPv6 Environment

In 2014 A. Tripathi et al analyzed & compared the handover latency & packet loss among the MIPv6 & PMIPv6 by analytical model. For developing analytical model basic assumption & notation among MIPv6 & PMIPv6 are taken into consideration. The delay on wireless link varies and depends on wireless connectivity. The wireless connectivity is maintained between MN to AR, MN to HA and MN to CN. By analyzing the delay on wireless link and its effect on handover latency. It is observed that if route optimization is not the part of MIPv6 then there are six wireless links in communication between MN & CN. On the other hand in case of PMIPv6 only two wireless link between MN & CN. So that MIPv6 has less handover latency than PMIPv6. And the performance of PMIPv6 increases than the MIPv6.

IV. DISCUSSION

In Mobile IPv6, handover mechanism requires the Mobile Node to wait until it receives a multicast Router Advertisement before starting packet handover. And packet loss during handover is controlled by the frequency of multicast Router Advertisements. In above section we have studied Mobile IPv6 handover mechanism, since all the above mechanism try to eliminate the handover and packet loss. But these mechanisms has some drawbacks and require some support. From the above study we prepare a table which help to compare features and drawbacks of each Security Mechanism (Table I). In this table various mechanisms are elaborated.

From the table it is observed A Low latency & Smooth Handover mechanism proposed by Li Xia et al is Based on duplicate address detection and binding update,Optimize the Performance of the handover in MIPv6.The Proactive Route Optimization for Fast MIPv6 mechanism proposed by Jorge Espe et al .is useful to solve the binding update threats like false binding update. Also it is useful for solving Route optimization threats. In Both of these threats unauthorized user try to attract all traffic to itself. Fast MIPv6 mechanism prohibited to redirect the traffic to any other node.But Proactive Route Optimization cannot reduce Denial of Service threat of MIPv6.

Efficient fast Neighbor Discovery (EFND) mechanism by Byung joo et al. Consumes an extremely short time. And as compared to MIPv6 ,Efficient fast Neighbor Discovery (EFND) mechanism has lower Signalling Cost and packet delivery cost .However this mechanism does not provide solution for the packet loss problem.

In order to reduce packet loss problem the MN's mobility prediction at the CN and a buffering mechanism at the HA proposed by Khan ED ,is beneficial.This mechanism reduce Network overhead.But this mechanism support to only host mobility and does not reduce end to end delay.The end to end delay is same as MIPv6.

From above discussion it should be clear that not a above single mechanism has all good features. So how can we choose a mechanism in order to provide better performance? We list out some key issues that may help to develop a high performance mechanism.

- Mechanism that should minimize the latency of movement detection time.
- Should be minimize IP CoA configuration time.
- Should be minimize Context establishment time.
- Should be reduceBinding registration time
- Provide Security for Route optimization and improve route optimization time.
- Improve the signaling latency for a binding update packet from the MN to the HA and CNs

V. CONCLUSIONS

To reduce the communication delay between MN and CN, Route Optimization (RO) technique is used in MIPv6.In RO MN and CN communicate directly without going through the HA. Now the most important issue of MIPv6 Route optimization is handover latency andpacket loss problem. In this paper, we discuss the reasons and types of handoverof MIPv6. Also give review, analysis of various mechanisms for reducing handover latency and packet loss and compared its features and drawbacks.

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TABLE I: COMPARATIVE ANALYSIS OF VARIOUS MECHANISMS FOR REDUCING HANDOVER LATENCY AND PACKET LOSS

SOLUTION PROVIDED FOR	AUTHOR	YEAR	SECURITY MECHANISM	FEATURES	DRAWBACK	SECURITY FUNCTION
Reducing Handover Latency and Packet loss Problem	Jorge Espe et al .	2009	Proactive Route Optimization for Fast MIPv6	If IP address are spoofed ,it is virtually impossible to redirect the traffic to any other node	Denial of Service threat is still present.	MN updates the binding cache of the CN while the link layer handover procedures are being carried out
	Khan Md et al	2011	MN's mobility prediction at the CN and a buffering mechanism at the HA	1)Reducing the packet loss. 2)Reduce Network overhead	1) In terms of end-to-end delay the same as MIPv6 2) Supports the host mobility only	Compare MIPv6 and HMIPv6
	Xing WU, Gang NIE et al.	2009	Comparison of different Mobility Management Scheme.	1.HMIPv6 reduces the signaling load outside the MAP domain. 2.Improves handover performance, reducing handoff latency and packet loss.	Not provide detailed performance evaluation and the integration of vertical handover mechanism between different technologies & domains.	Compare HMIPv6 & FMIPv6
	M. Masud et al	2011	Parallel Duplicate address Detection (PDAD)	PDAD reduces configuration of CoA delay by maintaining a unique address in advance.	Only DAD delay consider . Other delays like link layer delay, Movement detection delay & Binding update delays are not considered.	By requesting for multiple addresses from the neighbor ARs.
	Barreto et al.	2008	A Fast Rerouting Approach	Each recovery path obtained is almost always the same as that OSPF generate path.	Not Support multiple independent failure.	FEP-S approach
	Byungjoo et al.	2006	Efficient fast Neighbor Discovery (EFND)Scheme	1.Consumes an extremely short time. 2.Signalaling Cost is Lower. 3.The Packet delivery cost is lower than MIPv6.	Not provide solution for packet loss problem.	New neighbor discovery and DAD procedure.

	James K. et al	2003	Fast MIPv6 Handover Packet Loss Performance	1.IP layer Security credential Provided by mFMIPv6. 2. mFMIPv6&sBETH provide mitigation for packet loss during link switch.	**1**.mFMIPv6 unsuitable for extremely fast handover when little prehandover notification time is available. **2**.sBETH has no IP layer security credentials to be exchanged to verify the identity of the Mobile Node. **3**.sMIPV6 is not mitigate packet loss during link switch.	oSMIPv6, mFMIPv6, sBETH algorithms.
	Li Xia et al	2008	A Low latency & Smooth Handover Scheme	Optimize the Performance of the handover in MIPv6	Not Providing Solution for Seamless handover in the MIPv6.	Based on duplicate address detection and binding update
	SeungHee Hwang et al	2004	Signaling Time Analysis for Optimal Fast Handover	Improve handover latency &packet loss performance of FMIPv6.	No	Calculate the optimal signaling time FMIPv6
	A.Tripathi	2014	Impact of Wireless link delay on Handover Latency	1.MIPv6 has less handover latency than PMIPv6. 2.The performance of PMIPv6 increases than the MIPv6.	Not Support inter-LMA handover.	Comparison between MIPv6 & PMIPv6