Viable Modifications to Improve Handover Latency in MIPv6

Mr.Purnendu Shekhar Pandey
Department of ICT,
Gautam Buddha University,
Gr.Noida, Gautam Buddha Nagar, Uttar Pradesh India

Dr.Neelendra Badal
Department of Electrical Engineering,
Kamla Nehru Institute of Technology, Sultanpur,
Uttar Pradesh, India

***Abstract*— Various Handover techniques and modifications for Handover in MIPv6 come into light during past few years. Still the problem remains, such as quality of services, better resource utilization during Handover and Handover latency. This paper focuses on such problems within various Handover techniques and proposes some modifications to reduce the Handover latency. This also improves the quality of services related with Handover in MIPv6. Experimental results presented in this paper shows that the Handover latency in MIPv6 will be reduced by applying these proposed modifications. This paper is organized in following sections: section I gives the introduction, Section II presents the Basic operations for MIPv6 Handover, Section III focuses on the related work with background, Section IV proposes modifications and Section V concludes the paper while underlining future prospects in this domain.**

Keywords- Handover; CoA; Home Agent; Foreign Agent; MIPv4; MIPv6.

I. INTRODUCTION

Various Handover techniques for MIPv6 is applied so that the user enjoys continuous internet connectivity and avoids rebooting their application as they move from one subnet to another subnet.

Internet connectivity is based on certain protocols such as Transmission Control Protocol (TCP) and Internet Protocol (IP). Such protocols require a unique IP Address for identifying the physical location of the Mobile Node (MN) for setting up the connection but the mobility of the MN is only achieved if its IP address keeps on changing from one subnet to another. To overcome this problem, Mobile IP was developed which removes the problem by providing MN with two types of addresses, i.e. first, a Home Address (HA) that does not change as the node moves and second, a Care-of-Address (CoA) that keeps on changing as the MN moves from one subnet to other subnet [4].

Mobility support was first incorporated using Internet Protocol Version 4(IPv4) bringing forth MIPv4,later on Internet Engineering Task Force (IETF) developed another Mobile IP that is MIPv6.The major factor that led to switching from MIPv4 to MIPv6 are Route Optimization in MIPv6 and Triangular Routing problem that existed in MIPv4.

Until now, there are approaches to solve the problem of Handover such as L3- Driven Fast Handover which not only uses network layer (L3-layer) information but also uses the link-layer (L2-Layer) information for better Handover process and Resource Efficient CoA Provisioning which makes use of the various caches such as active proxy cache and active garbage cache for better performance in terms of Handover and quality of services.

The basic operations related to Handover are presented in the next section.

II. MIPV6 BASIC OPERATIONS: A QUICK LOOK

MIPv6 protocol was developed which allows MN to be communicated and reachable while moving around in IPv6 internet. MIPv6 performs mobility with the help of three addresses such as HA (static address), CoA and Link Layer Address (Prefix).

Packets are to be transmitted to the MN using HA without actually bothering about MN current point of attachment to the internet. Only HA is not sufficient at all, the CoA generated by the Foreign Agent (FA) is also required. After knowing CoA, a correspondent node or HA can send the desired packets to the MN. So, these two addresses are sufficient enough for the proper flow of the packets. HA is a router on a MN's home network which maintains current location information for the mobile. Now, the question arises as to what for the Link Layer address is used. In brief, it is used for the better Handover. Handover or Handoff refers to the process of transferring an ongoing call or data session from one subnet connected to the next subnet where the mobile node is going to get attached. While, Correspondent Node (CN) is a peer node with which a MN is communicating. It may be either mobile or stationary.

When a MN moves from HA to FA, the actual communication starts between MN and CN after performing the following processes as mentioned also in figure 1.

A. *Agent Solicitation*

It refers to messages that are sent by the MNs which is looking for a Router to carry out its previous communication activity with its HA or Correspondent node [2].

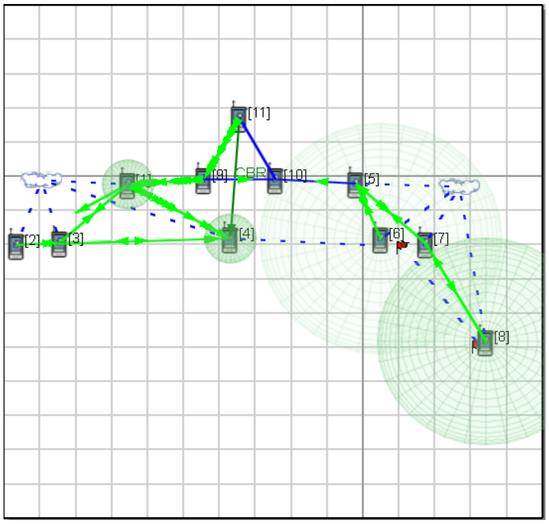

Figure 1: Qualnet Simulated example of Process Involved in Handover

B. Router Discovery

In this process, the Access Router (AR) multicasts Router Advertisement message on a loosely periodic basis and MN senses these messages to determine whether it is in the same AR or it has switched to other Access Routers domain.

C. Address Configuration.

As shown in Fig.1 MN configures a new global IP address called Care-of-Address by the help of prefix received which is present in the Router Advertisement message.

D. Movement Detection.

As shown in Fig.1 the Router Advertisement message contains a prefix that is generated by all the access routers but these prefixes are different for different routers respectively. This allows the MN to check for the change in prefix and, as soon as, it detects the change in prefix, it is able to decide that it has now changed its domain [2].

E. Mobile IPv6 Registration

As shown in Fig.1 After following all these previous processes, the MN comes to know that it has left its previous domain and has entered into domain of new access router. Now, MN has got the responsibility to get its New IP Address i.e. CoA registered with its HA and the Correspondent Node [5].

To make the registration more authentic and appropriate following processes are followed:

a) a) Home Registration

The MN sends a Binding Update Message to the HA after notifying it about the New Care-of-Address (CoA) and, in response, the HA sends a Binding Acknowledgement message.

b) b) Correspondent Registration

As shown in Fig.1 In Correspondent Registration, the Binding Update message are send to the Correspondent Node and, in response, Correspondent Node sends the Binding Acknowledgement message.

III. Related Work and Background

To improve the Handover process various techniques are described in this section to improve Handover process and quality of services. The various techniques are as follows:-

A. L3 (Network Layer) Driven Fast Handover Approach

The Handover is the main concern in MIPv6.The bottleneck of Handover is due to the fact that is that network layer use only the network layer information to detect whether the Handover had taken place or not. To solve this problem several fast Handover approaches came in to lime light which started using link layer information (L2) to speed the process of Handover [12].

There are two sub-processes related to the main Handover approach:

Link-Layer Handover (L2):-In this Handover, the MN comes to know about change of AR as MN detects link layer address change to which it is linked with.

Network layer Handover (L3)

L3 Handover consists of two phases:

Preparation Phase:-In this phase a CoA for mobile is generated as well as Duplicate Address Detection (DAD) protocol is executed.

Signaling Phase:-In this phase the CoA is registered with its HA.

The evolution of L3- Driven Handover was not at all abrupt. First of all Normal Handover Sequence was followed then after some time. Later on Handover Sequence was developed Using L2 information. It was followed for some time and then L3- Driven Handover was developed which was, indeed, more efficient than the other two previous approaches [7].

a) Normal Handover Sequence

First of all L2 Handover will take place, whose functioning is not at all known to network layer. After a while the MN would receive a Router Advertisement and only then the L3 Handover would start its sub phases: preparation phase and signaling phase will occur. However the figure clearly establishes that there is delay of few seconds before L3 Handover starts [6].

b) Handover sequence Using L2 Information

As soon as the L2 Handover is finished, the link layer notifies the network layer of the end of L2 Handover. After getting this notification, the network layer sends the Router Solicitation message to the AR and, consequently, AR starts sending router advertisement message [7].

c) L3- Driven Fast Handover using L2 Information

As shown in the Ref [7] Fig.2 the link-layer senses the link quality and it notifies the network-layer. As soon as the link is down below the threshold the network- layer correspondingly executes the preparation phase immediately.

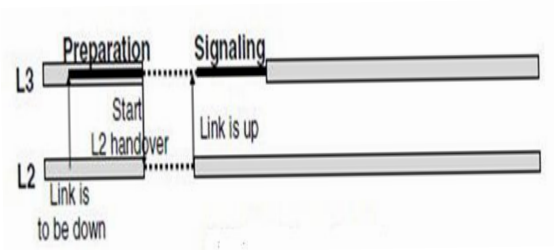

Figure 2: L3-Driven Handover

When the link layer finishes the L2 Handover, it informs the network layer for executing its signaling phase. It is important to know that the bottleneck of L3-Driven approach lies in being subservient to device dependent information. It is manifested through the radio wave strength by which to link layer can judge exact signal strength and notify the network layer that the link is down.

B. Resource Efficient Care-of-Address Provisioning

Duplicate Address Detection (DAD) protocol is followed so that each MN is using a unique address CoA i.e. no other node existed within the same domain subnet using the same global IP address (CoA) but it was found that DAD was a time consuming process ,which might interrupt the seamless Handover. in e.g. RFC 2462 DAD algorithm took more than 1000 millisecond to complete the DAD process which was not at all viable[3].

After that a protocol called aDAD (advance DAD) was developed. The major advantage of aDAD is that it reserves unique New Care–of-Address in advance, as a result, it almost eliminated the latency needed for the Address Configuration and Confirmation .Another major advantage of aDAD is that it follows a concept called “Piggybacking” in accordance with which the MN sends a message called Router Solicitation to the AR and then the AR reverts the same message giving reply in the form of Router Advertisement [4].The major drawback of this protocol is that it uses excessively a lot of network resources such as bandwidth to generate new CoA and verify its uniqueness as aDAD generates New CoA and checks their uniqueness one by one [11].

Third protocol is called Agent-based-DAD (XDAD).It’s the most efficient approach for providing New Care-of –Address ,the advantage of this protocol is that it readily decreases the latency during Handover. Another advantage is that it also reserves New CoA in an optimized and effective way. It generates New CoA and stores them in a cache [10].

XDAD uses two types of cache:-Active Proxy Cache and Active Garbage Cache. Active Proxy Cache contains the newly generated CoA and the Active Proxy Garbage contains the CoA which MN relinquishes as soon as it leaves the subnet.

Actual Processes Involved In XDAD are:-

After receiving a solicitation message AR tries to reuse the CoA from the Active Proxy Garbage. If it doesn’t get it from there, it uses store Active Proxy Cache address subsequently [6]. Access routers then check the uniqueness of the generated CoA. If it is unique, it sends back the CoA within the same message as a Router Advertisement message through Piggybacking process. Otherwise AR drops the CoA and regenerates it [8].

As soon as the CoA is assigned to a MN, CoA is deleted from the cache.

Therefore it is observed while reviewing various paper that there exist following challenges such as for L3 driven approach use of devices to gauge whether the link is down or up and for Resource efficient approach the problem is use of various caches that directly affect the quality of service. Various modifications for challenges are proposed in subsequent sections.

IV. PROPOSED MODIFICATION

There are two modifications proposed in this sections these are described as follows:-

A. Modification 1: In Domain Of L3-Driven Fast Handover Approach

In the previously defined L3-Driven Fast Handover approach, there is need to frequently check whether link is down or not, and if the link is down that means that the present value of signal strength is below than threshold value. It is important to note here that L3–Driven Handover requires some of the devices dependent information. So this dependence on the device for constant measuring and monitoring the signal strength is not at all required as it will frequently create problems such as wrong measurement of signal strength in a real dynamic environment.

To remove this device dependent problem, the internal entities such as MN and AR should decide about the weak signal strength (Link). To know whether the link is down or not MN sends a packet to the AR and starts a timer, the router will revert the same packet back to the MN. This process is done when MN is very much connected to the access router. The running timer will calculate the average time taken by the packet to traverse to and fro i.e. from MN to AR and from AR to the MN. Standard measurement of average time will be calculated by sending the packets at least 5 times. Then the average of separate to and fro dispatching will be calculated and compared if these values remain same in all 5 remittances. Only then it will be set as standard time within the subnet.

Now the MN will keep on moving and sending this packet. After some time, it will happen that packet would start taking more time to reach MN, because when MN moves away beyond the reach of present Access Router, packets will not be able to reach the MN within set standard limit of the time.

Now to enhance the efficiency of proposed modified version of MIPv6, it is also seen that if the to and fro dispatch time is more than standard time and shows increasing trend of delay for 3 subsequent packets, then the device is so customized that it understands the feeble signal strength immediately and starts multicasting solicitation message to the adjacent router. for e.g. in Fig.3.the to and fro dispatch of three consecutive dispatch are 2ms,7ms,10ms as a result it will again watch the another set of 3 to and fro dispatch and if it shows the increasing trend in these values the Handover will take place.

If the to and fro dispatch time of 3 subsequent packet for this router is less than the standard time, the MN is not going to immediately perform the L2 Handover. Whereas in Fig.4 the to and fro dispatch of three consecutive dispatch are 2ms, 10ms, 3ms. So Handover will not take place. This process finally eliminates the need of device-based-signal-based-monitoring system and also overcome the delay on account of it.

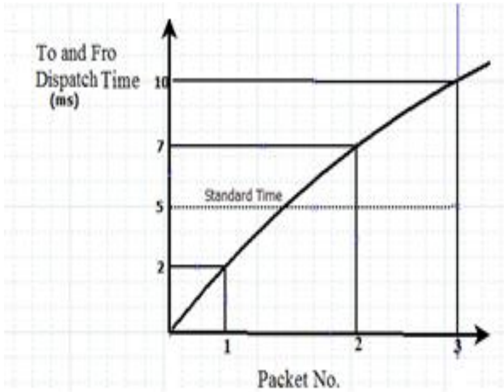

Figure.3 Handover is required as To and Fro Dispatch time keeps on increasing with the time as compared to Standard Measurement

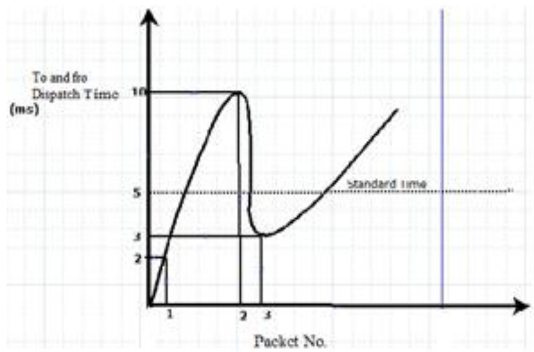

Figure.4 No Handover is required as To and Fro Dispatch time keeps on fluctuating with the increase in time as compared to Standard Measurement

B. Modification 2: In Domain of Resource Efficient CoA Provisioning

In the previously defined Resource-Efficient CoA Provisioning two caches are used:

a) Active Proxy cache.
b) Active Proxy Garbage.

These two caches are being managed by the Access Routers which will definitely increase to its overhead. To subside the overhead, it is recommended to reduce the no. of caches to one. Now, instead of using two caches, scope is reduced to one cache and named this cache as Working Cache. This Working Cache will store and allocate new unique CoA to the MN.

The allocated CoA will be removed from the Working Cache and as soon as the MN leaves the subnet, again that CoA is reallocated to the Working Cache for reuse purpose. The CoA is generated by the help of an algorithm and stored in the Working Cache.

The algorithm will always generate an unique CoA that will remove the need of running DAD protocol and multicasting Neighbor Solicitation messages as every CoA is unique. If the need of running DAD protocol and multicasting Neighbor Solicitation is removed, it will definitely reduce the latency.

Now the question arises that if the same algorithm is used by all the Access Routers to create unique CoA then what will differentiate the CoA if MN moves from one network to another and it will again get the same CoA in another Access Router. To resolve this problem use of the Link-Layer Address Prefix is suggested as it is very much unique for a subnet. The Prefix will be attached to the CoA and that's what will make it Unique within the subnet and outside the subnet.

V. CONCLUSION AND FUTURE SCOPE

This paper focuses on L3 Driven fast handover technique and Resource efficient CoA provisioning techniques and proposes some viable comprehensive modification to enhance the quality of services and resolve the problems of Handover in MIPv6. Experimental results show that the challenges during Handover can be drastically improved by applying the proposed comprehensive modification. Hopefully, if the proposed radical changes are incorporated in the existing MIPv6, it will not only bring about large scale viability in the system but also make it cost-effective, robust, and dynamic all the more.

The work may be further extended in the domain of care-of-address provisioning and fast Handover using the techniques as proposed in this paper.

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AUTHORS PROFILE

Mr.Purnendu Shekhar Pandey is a M.Tech Student at Gautam Buddha University. The author has done his B.Tech from Noida Institute of Engineering and Technology, Uttar Pradesh Technical University, Uttar Pradesh. The author has published and presented various papers in national and international conferences.

Dr.Neelendra Badal is an Asst. Prof. in the Department of Computer Science & Engineering at KNIT,Sultanpur (U.P), INDIA. He received B.E. (1997) from Bundelkhand Institute of Technology (BIET), Jhansi in Computer Science & Engineering, M.E. (2001) in Communication, Control and Networking from Madhav Institute of Technology and Science (MITS), Gwalior and PhD (2009) in Computer Science & Engineering from Motilal Nehru National Institute of Technology (MNNIT), Allahabad. He is Chartered Engineer (CE) from Institution of Engineers (IE), India. He is a Life Member of IE, IETE, ISTE and CSI-India. He has published about 30 papers in International/National Journals, conferences and seminars. His research interests are evinced at Distributed System, Parallel Processing, GIS, Data Warehouse & Data mining, Software engineering and Networking.