Performance Analysis And Optimization Of Hmipv6 And Fmipv6 Handoff Management Protocols

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Abstract : Seamless communication is becoming the main aspect for the next generation of the mobile and wireless networks. Roaming among multiple wireless access networks connected together through one IP core makes the mobility support for the internet is very critical and more important research topics nowadays. Mobile IP is one of the most successful solutions for the mobility support in the IP based networks, but it has poor performance in term of handover delay. Many improvements have been done to reduce the handover delay, which result in two new standards: the Hierarchical MIP (HMIPv6) and the Fast MIP (FMIPv6). In this paper we present an analysis of handoff management protocols HMIPv6 and FMIPv6 in supporting mobility and latency reduction.

KEYWORDS: HMIPv6, FMIPv6, Mobile IPv6, Wireless Networks.

1. INTRODUCTION

Internet mobility support is the keeping of an ongoing communication session without interruption for an IP based mobile device, while it moves from one network to another (changing its point of attachment). Mobility support required handover management, to reduce the service interruption during the handover. Also, it required location management, to identify the mobile device current location, and keep tracking for its movement. In addition, mobility support required multi homing, the mobile device can use many access networks (GPRS, UMTS and WLAN) to access the Internet, and switch links while moving. Besides their advantages, they also have some limitations such as high latency during the handover process. In recent years, various studies have been carried out to enhance MIP protocol so that the latency, packet loss and signalling overhead experienced during handoff can be reduced. Mobile IPv6 (MIPv6) proposed by IETF (Internet Engineering Task Force) provides a basic host mobility management scheme in IPv6 networks. The protocol is developed to facilitate the roaming of mobile devices in different wired or wireless networks while maintaining a permanent IP address. In MIPv6, a MN has two IP address, a home address (HoA) and a care-of address (CoA). HoA is an address in the network that the mobile node belongs to, while CoA is MN's temporary address in the visited network. HoA is fixed but the CoA changes as the MN moves. When a MN moves from its home network to foreign network, a new CoA will be assigned. Following address configuration, the MN informs it home agent (HA) and of such movement by sending a binding update (BU) message. HA is a router in the home network that is used as a redirection point. When a correspondent node (CN) needs to communicate ith mobile node, it sends packets to the MN's HoA. HA then intercepts the packets and forwards them to the MN's current CoA. At this point, the MN may decide to use the route optimization procedure. Route optimization involves packet routing between MN and CN, using shortest possible path. When MN receives tunneled packets addressed to its HoA, it can decide whether it should attempt to optimize the route between itself and CN. If so, the MN informs the CN its current location by sending a signaling message (BU) that contains its current CoA. The CN can then send the packets directly to the MN. However, mobileIPv6 may have problems to support real-time or loss sensitive application because of high signalling overhead and long signaling delay when a MN performs binding update with its home agent or CN.

Whenever mobile node moves from one Access Router to another, it should registers (or binding update) its new CoA to its HA and the distance between HA and MN may be long. While registration, the mobile node lost the connection to CN and it may induces packet loss and latency. So, many extensions to the MIPv6 have been proposed which assist the MN to acquire smooth handover. We discuss here those most relevant to our own works.

Hierarchical Mobile IPv6 (HMIPv6) [iii] and Fast Handovers for MIPv6 (FMIPv6)[iv] are two such micro-mobility solutions.

2. MOBILE IPV6 PROTOCOLS

2.1 HMIPv6

The hierarchical approach separates the mobility support management to micro mobility (intra domain) and macro mobility (inter domain). The mobile node can move inside a specific domain with no need to inform the Home Agent, as long as it moves inside that domain.

A new conceptual entity named Mobility Anchor Point (MAP) is used to support the hierarchical structure. MAP is a router that maintains the binding process with the mobile nodes currently visiting its domain. It is usually located in the network's edges controlling many access routers, and receives packets on behalf of the mobile nodes inside its domain. When the mobile node moves to another network's domain it must register itself with the MAP serving that network domain.

The function of the MAP is to act as a Home Agent for the mobile node. So it intercepts the packets targeted to the mobile nodes address inside its domain and then tunnels them to the correspondent care of address of the mobile nodes in their foreign network. When the mobile node changes its care of address inside the MAP domain, it just needs to register this new address with the MAP and this called Local care of address (LCoA). When the mobile node moves to a new MAP domain, it must acquire a new regional care of address (RCoA) to receive packets from outside the domain and also LCoA for inside domain movement.

The mobile node will use the MAP's address as an RCoA, and it gets the LCoA from the Foreign Agent. After forming the address the mobile node sends a binding update to the MAP, which will bind the mobile node's RCoA to its LCoA. Then the MAP will send back a binding acknowledgement to the mobile node informing the successful registration. Another binding update should be also sent to the mobile node's Home Agent every time it changes its RCoA.

The frequency of the home agent registration will be reduced, because the hierarchical structure helps to minimize the location update signaling. Using HMIP, the mobile node just needs to perform home agent registration when it changes the entire MAP domain. As long as the mobile node moves inside the MAP domain, the HA registration will be avoided. This procedure will minimize the overall handover delay by reducing the HA registration delay.
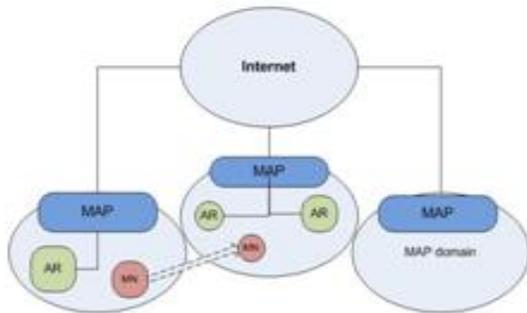

Figure 3 Hierarchical Mobile IPv6

2.2 Fast Mobile IPv6 (FMIPv6)

The fast handover approach reduces the handover delay by reducing address resolution delay. The mobile node will pre-configure a new care of address before it moves to a new network. In the fast handover the mobile node moves among access routers which defined as the last router connects the wired network to the wireless network. The old access router (oAR) is the router to which the mobile node is currently connected, and the new access router (nAR) is the router to which the mobile node is planning to move. Fast handover uses the wireless link layer (L2) trigger which informs the mobile node that it will soon need to perform a handover. The L2 indication mechanism predicts the mobile node's movement according to the received signal strength.

Seven additional messages between the access router and the mobile node will be introduce by the fast handover: the Router Solicitation for Proxy (RtSolPr) from the MN to the oAR, the Proxy Router Advertisement (PrRtAdv) from the oAR to the MN, Handover Initiation (HI) from oAR to nAR and Handover Acknowledgement (HAck) from nAR to oAR. Besides Fast Binding Acknowledgement (F-BAck), Fast Binding Update (F-BU) and Fast Neighbor Advertisement (F-NA). To initiate a fast handover process in a wireless LAN first the mobile node sends *RtSolPr* message to the oAR after it notices the need for a handover; the link layer address is sent to the next access node by the MN with *RtSolPr* message. The oAR response with *PrRtAdv* message, which contains some information about the new point of attachment if it is: known, unknown or connected to the same access router. If the new point of attachment known to the oAR, (PrRtAdv) message will specify to the mobile node the network prefix that should be used to form the new care of address[xv]. After forming the new care of address using stateless address configuration, mobile node sends fast binding update (F-BU) to the oAR as the last message before performing the handover, and then a fast binding acknowledgement (F-BAck) will be sent either by the oAR or the nAR to the mobile node to insure a successful binding, the oAR will send duple F-Back messages to the nAR as well. When the mobile node moves to a new network, it sends a fast neighbor advertisement (F-NA) to initiate the packets forwarding from the nAR [9].

To facilitate packet forwarding, oAR and nAR will exchange some messages between them, which result in reducing the address resolution delay. The oAR sends a handover initiation message (HI) to the nAR, requesting a new care of address registration for the mobile node and also it contains the old mobile node's care of address. The nAR will response by sending handover acknowledgment (HAck) to declare accepting or rejecting the new CoA. Temporary tunnel will be set by the oAR to the new CoA if the nAR accepts the new CoA. Otherwise the oAR will tunnel the packets to the nAR temporarily if it rejects the new CoA, which will take care of forwarding the packets to the mobile node.

Fast Handover for Mobile IPv6 protocol aims to improve the handover performance of the standard Mobile IPv6 protocol by minimizing the latency for establishing new communication paths from the MN to the nAR without any packet loss. However, some packets can still be lost if there is a random and rapid movement of the MN from one AR to another without letting any handover process to be completed..
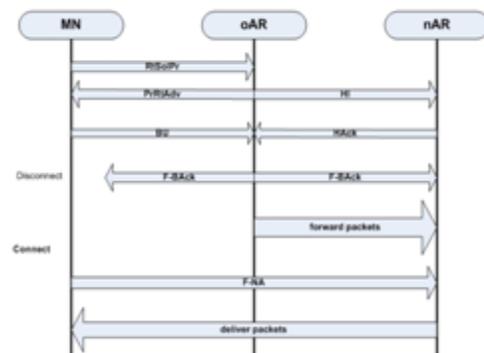

Figure 4 Fast Mobile IPv6

3. ANALYSIS

3.1 FMIPv6 Handoff Delay

The FMIPv6 protocol uses L2 triggers to anticipate the handoff before it actually occurs. This handoff anticipation helps to reduce the overall handoff delay. Under the FMIPv6 protocol, the handoff delay is defined as the time duration from the MN receives the Fast Binding Acknowledgment (F-BAck) from the oAR with which it is currently associated until the MN receives the Fast Neighbor Advertisement Acknowledgment (F-NAack) from the nAR. The total handoff delay of FMIPv6, TFMIPv6, can be represented as:

$$TFMIPv6 = TMN-AR + TAR-MN + Tdis$$

Where: TMN−AR: delay for sending a signaling message from an MN to an AR

TAR−MN: delay for sending a signaling message from an AR to an MN

Tdis: disconnection delay.

3.2 HMIPv6 Handoff Delay

HMIPv6 divides the network into layers and regions. The handoff delay of HMIPv6 is defined as the time after an MN sends out the Local Binding Update (LBU) to a MAP until it receives the first data packet from the new subnet. The total handoff delay of HMIPv6 micro-movements (movements inside a MAP domain) can be represented as:

$$THMIPv6 = TMAP-AR + TAR-MN$$

Where: TMAP−AR: delay for sending signaling messages from a MAP to an AR

TAR−MN: delay for sending signaling messages from an AR to an MN. Similarly, the total handoff delay of HMIPv6 macromovements (movements between MAP domains) can be represented as:

$$THMIPv6 = TMAP-AR + TAR-MN + (TMN-CN + TCN-MN)$$

Where: TMN−CN or TMN−HA: delay for sending signaling messages from an MN to its CN or HA, respectively

4. PERFORMANCE ANALYSIS

A total of 100 samples have been generated for both FMIPv6 and HMIPv6 in MATLAB 7. The outcome is the handoff latency occurring within certain ranges based on the offered traffic load and network conditions. The parameters related to network and traffic conditions are listed in Table 1. TCN−MN or THA−MN: delay for sending signaling messages from a CN or HA to the MN, respectively.

Tab. 1: Network and Traffic Parameters

μ(pkt/sec)	α	One hop distance	N	M
[0,1000]	[0.2,0.8]	1000	2	8

Tab. 2: shows our result analysis of different experimental runs

Protocol	Theoretical handoff delay	Obtained handoff delay	%improvement in handoff delay
FMIPV6	2.1	1.2	42
HMIPV6(MICRO)	1.7	0.1	94
HMIPV6(MACRO)	2.5	2.0	20

5. CONCLUSION

In this paper we have proposed a new analytical model for MIPv6 optimization protocols. Handoff latency is used as a performance measure. The significant results obtained are summarized as below:
A new analytical model for FMIPv6 and HMIPv6 protocols has been proposed which shows a significant reduction in the handoff latency.
The proposed analytical model in corporate the influences of various factors from link layer and network layer.
The probability distribution of handoff latency occurring within a certain range has been generated.
The demonstrated results are consistent with the other simulation results mentioned in the literature

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