



Improved Handover Performance with Quality of service support using mobile IPV6 for Real-Time Applications

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Abstract

Mobile IPv6 enables a mobile node to maintain its connectivity to the Internet when moving from one Access Router to another. Fast handover uses trigger information based on link layer (L2) anticipation; it increases additional signaling between the new Access Router and the Previous Access Router, thus increasing network costs compared to the Mobile IPv6 protocol. This paper proposes an enhanced fast handover scheme for Mobile IPv6. A mobile node allows to select an address using modified fast handover for Mobile IPV6 Internet Control Message Protocol (ICMP) header format and transfer the address configuration functionality from the mobile node to the previous access router, thus preventing duplicate address detection of new address. The proposed scheme is depending on implementing duplicate address detection process in previous access router instead of mobile node comparing with existing Fast Handover scheme. From numerical analysis and MATLAB R2007b, the performance shows that proposed scheme generated less signaling compared with the existing Fast Mobile IPv6.

Keywords: Mobile IPv6, Quality of service (QoS), Fast handover scheme, Duplicate Address Detection (DAD)

1. Introduction

Rapid development of wireless networks has made it possible for people to communicate while they are moving referred to as handover. The handover operation occurs when mobile node changes its network point of attachment from previous access router to a new access router and it should achieve three operations: Movement detection, new CoA configuration and binding update. During handover, there is a period which the mobile node is unable to send or receive packets because of link-switching delay and IP protocol operations this is called handover latency which is resulting from standard Mobile IPv6 procedures is often unacceptable to real-time traffic such as Voice over IP (Gelogo and Park, 2012).

The support to mobility raises new issues related not only to hand off management but also the Quality of Service (Masud et al., 2012). The most important factor that can affect the quality of service is the efficiency of mobile network (Prasanna and krishnaiah, 2013). A mobile node sends a router request to get an advertising response from a router when switching from one network to another. These requests and advertisements help discover router, prefix and parameter as well as auto address configuration introduce another type of delay known as router advertisement delay (Koodli, 2005). The signals and notifications exchanged between the node and its home network introduces the binding update delay.

This paper proposes an Enhanced fast mobile IPv6 scheme, a mobile node allow to selects an address using modified fast handover or IPv6 Internet Control Message Protocol (ICMP) header format and transfer the address configuration functionality from the mobile node to the previous access router.



2.0 Related works

Masud et al.,(2012) Proposed a parallel duplicate address detection mechanism for minimizing handoff delay in advance. The mechanism addresses the limitations of conventional duplicate address detection by requesting for multiple addresses from the neighbor Access Routers. It works like advanced duplicate address detection and maintains a pool of addresses in its cache. The configuration of multiple Care of Addresses and duplicate address detection procedures may affect the neighboring Access Routers. However, bandwidth, memory capacity and address consumption of IPv6 are less important issues compared to seamless communication when enhancing the QoS of mobile IP applications. Furthermore, Initiate Handover (HI) and Handover Acknowledge (HACK) protocol header format has been modified. The modification was used when a mobile node is required to perform IP-layer operations in order to reduce the delay due to handovers. The mobility header is used for the purposes of mobile node signaling, Internet Control Message Protocol was used for inter-access router communication. The study does not alter the procedures related to communicating with a mobile node's home agent or corresponding node (Wozniak,2016). Kusin and Zakaria (2011), proposed a dynamic speed detection mechanism that integrates with the load control mechanism. This overload is due to the increased data traffic to be tunneled as well as Binding Update (BU) signaling and maximum number of mobile node connected.

The speed mechanism adapted in Hierarchical MIPv6 selection scheme, load control was measured based on Mobile Node and mobility anchor point (MAP) properties. From the experimental results shows that proposed scheme gives better distribution in MAP load and reduces binding update cost. Quraish and Hussain,2014 describe that, delay occurs when an MN moves from one network to another. The node figures out this movement by matching its IP address prefix with the prefix of the network. This is known as the movement delay detection. Once the movement is detected, the node has to wait for a router advertisement. If the node receives no such advertisement, the node itself sends a router solicitation to get a router advertisement message immediately. These advertisements and solicitations help in router, prefix and parameter discovery as well as address auto configuration introduces another kind of delay known as the router advertisement delay (Chulhee et al, 2017). Mansour and Alnas (2015) proposed Improved link layer mechanism with Location Information Provider to Minimize Handover latency and packet loss of FMIPv6 protocol still suffer from high signals.

3. The Proposed Enhanced Fast Handover Scheme

The procedure of the proposed design starts with the modification of the Internet control message protocol header by embedding R bit to indicate the address to be use by mobile node in the next domain, that method reduces the delay of new care of address configuration; the configuration of new care of address capability of mobile node moved to previous access router. Also, the binding updates to home agent and correspondent node are to be performed from the time point when the previous access router sends fast binding acknowledgement to mobile node and new access router simultaneously. When a mobile node anticipates that the handover to a new domain is imminent, that is, the handover anticipation trigger occurs, the mobile node selects an address and send to previous access router, previous access router should now initiate the Duplicate Address Detection to test the uniqueness of the Care of Address, by exchanging handover initialization message with new access router and send a Proxy Router Advertisement[R] to mobile node.

3.1 Proposed modified Router Solicitation for Proxy with FBU embedded inside, RtSolPr [R,FBU]

The Proxy router solicitation (RtSolPr) signal is modified as RtSolPr [R, FBU] for a proposed fast handover for mobile IPV6(pFMIPv6) as shown in figure 1 below. Mobile node sends Router Solicitation for proxy in order to inform for proxy router advertisements. The Source address which is an address assigned to the sending interface. The destination address is the address of the Access Router. Here the hop limit is 255. Due to IPv6, the type field value is 152. Out of reserved fields, one bit is used to indicate the routers and new care of address about to follow new message formats, if the Bit 'R' is set. Rest all bits are set to Zero. The provision has been utilized to embed FBU message into RtSolPr message. A Proxy Router Advertisement (PrRtAdv [R]) is an acknowledgement message received by the mobile node in response to RtSolPr [R, FBU].

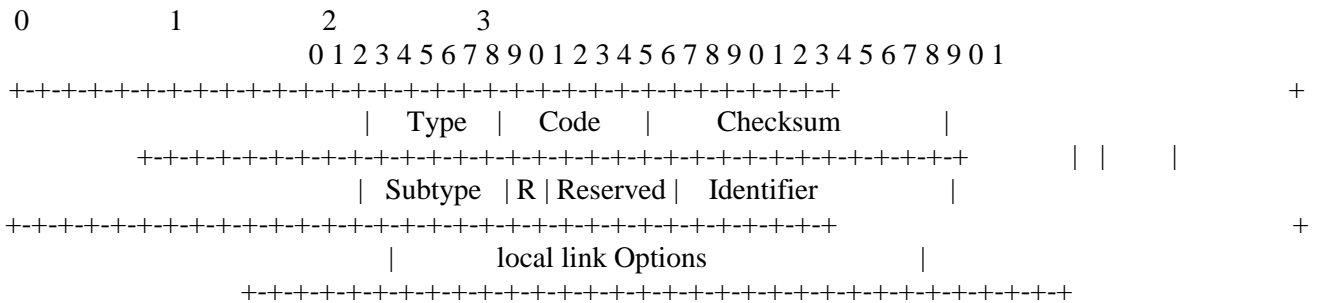


Figure 1: Proposed Modified Router Solicitation for Proxy (RtSolPr [R, F-BU]) message format

3.2 Proposed modified Proposed Modified Proxy Router Advertisement with R bit (PrRtAdv [R])

The Proxy Router Advertisement (PrRtAdv) signal is modified as PrRtAdv [R] for pFMIPv6 as shown in figure 2 below. It sends acknowledgement including bit R and newly formed Care of address. Here the old access router need not to wait for F-BU as it is already sent to old access router. This optimization makes the binding operation faster as F-BU is available. The mobile node is aware about the new address, so the operations like sending a request to get a prefix followed by forming a new care of address is eliminated in this phase. It provides the link layer address, IP address and subnet prefixes of neighboring routers. The source address must be a link layer address assigned to the interface from which the message is sent. To accommodate bit R, one bit from the reserved field is used similar to RtSolPr. The code is set to 0, means that the old access router has already formed [AP-ID, AR-INFO] for movement detection and the newly formed care of address is embedded into option field.

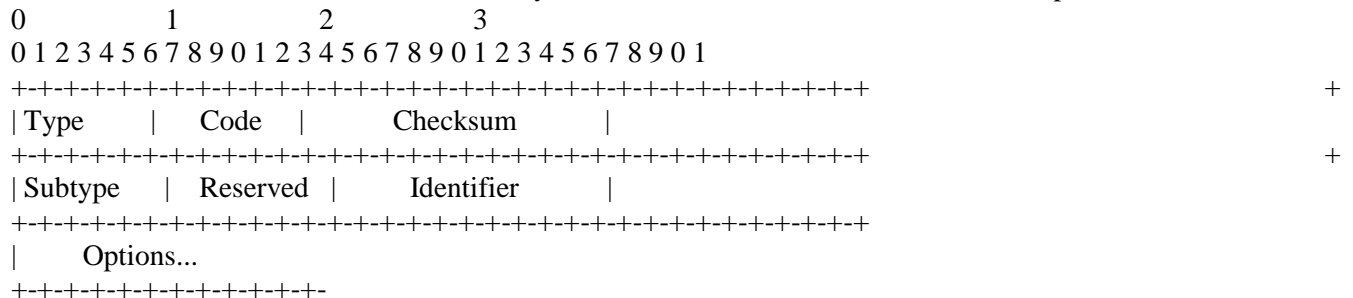


Figure 2: Router Advertisement for Proxy (RtSolPr [R, F-BU]) message format.

3.3 Sequence of Operation of the Proposed Fast Mobile IPV6

The proposed sequence of operations for the proposed fast handover for MIPv6 (pFMIPv6) is as follows. The fast binding update (FBU) is embedded into Proxy router solicitation (RtSolPr) and sends it across to old access router. The old access router need not to send any prefixes to form a care of address to mobile node as it was formed at old access router only. Once the care of address is formed, it informs to mobile node through PrRtAdv and handover initialization signal is sent immediately to new access router as it needs not to wait for FBU to come from MN. This particular latency is saved and eventually improves the overall handover latency. A bit 'R' is used to indicate the router to use p-FMIPv6 as a handover protocol otherwise it uses Fast MIPv6 as a handover protocol. The address formation period is shortened by allowing old access router to form a new care of address on behalf of the mobile node. Since New care of address is formed at old access router, it sends handover initialization immediately to new access router to start handover operation, as old access router need not wait for any signal from mobile node. The new care of address is formed at old access router so the period for disconnection is lesser as compared to fast mobile IPv6. Furthermore, below is a sequence flow of the proposed FMIPv6.

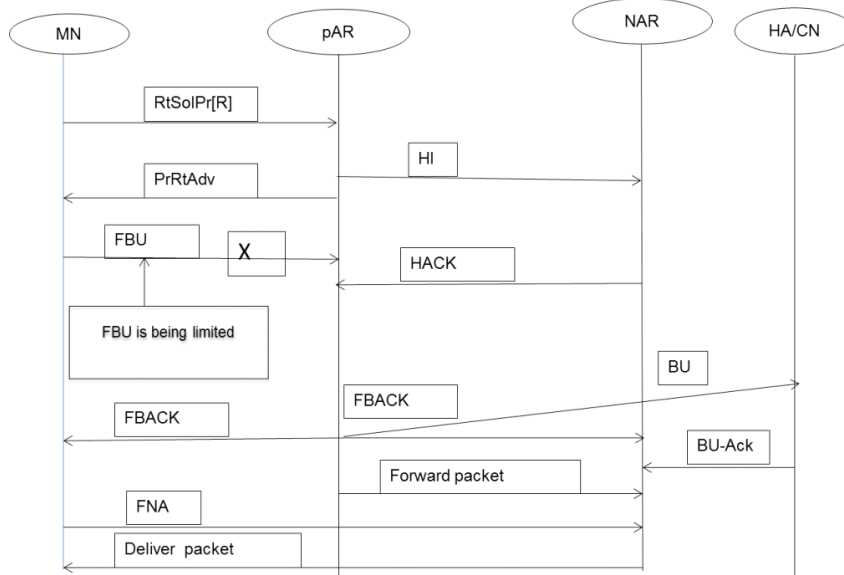


Figure 3: The proposed signaling flow for Fast Mobile IPv6

4. Analytical Models

TOTAL COST (C_{TOTAL}) Total cost is classified into two types:

$$(C_{signal}) \text{ and packet delivery cost } (C_{packet}) \quad 1$$

The signaling cost (C_{signal}) is incurred by the signaling message used for a handover process. Signaling Cost (C_{signal}) Fast Handover suffers from the drawback of increasing signaling costs. Therefore, we analyze the signaling costs incurred in the existing Fast Mobile IPv6 (predictive) and proposed Fast Mobile IPv6 (predictive). The message flows associated of the proposed Fast Mobile IPv6 (predictive) are described in figure 3 above. Since existing Fast Mobile IPv6 (predictive) and proposed Fast Mobile IPv6 (predictive) is based on anticipation using the link layer trigger, signaling costs due to additional messages may vary according to the probability that the handover anticipation is correct.

Generally, since the transmission cost is proportional to the number of hops in the link, TC_{MP} and TC_{PN} can be expressed as $\rho\theta u$ and $l_{PN}\theta u$, respectively. Where:

- l_{PN} is the average hop counts between PAR and NAR.
- θ is unit update cost.
- ρ is the weighing factor for the wireless link.
- δ_C is constant

4.1 Signaling cost for a successfully anticipated handover (M_s)

$$\begin{aligned} M_s(FMIPv6-pred) &= 4TC_{MP} + 3TC_{NP} + 2TC_{MN} + 3PC_P + 2PC_N \\ &= (6\rho + 3l_{NP})\theta_S\delta_C + 3PC_P + 2PC_N \end{aligned} \quad 2$$

$$\begin{aligned} M_s(FMIPv6-prop) &= 3TC_{MP} + 3TC_{NP} + 2TC_{MN} + 3PC_P + 3PC_N \\ &= (5\rho + 3l_{NP})\theta_S\delta_C + 3PC_P + 3PC_N \end{aligned} \quad 3$$

4.2 Signaling cost for a failure anticipated handover (M_f)

Fast mobile IPv6 uses this parameter because of handover anticipation using signaling before start on L2, while in basic MIPv6 don't uses this parameter because handover anticipated directly without using any signaling before start on L2. Hence, this parameter for FMIPv6

$$\begin{aligned} M_f(FMIPv6-pred) &= 3TC_{MP} + 2TC_{NP} + 3PC_P + PC_N \\ &= (3\rho + 2l_{NP})\theta_S\delta_C + 3PC_P + PC_N \end{aligned} \quad 4$$

$$\begin{aligned} M_f(FMIPv6-prop) &= 2TC_{MP} + 2TC_{NP} + 2PC_P + PC_N \\ &= (2\rho + 2l_{NP})\theta_S\delta_C + 2PC_P + PC_N \end{aligned} \quad 5$$

M_s and M_f only take into account the additional costs incurred when Fast Handover is used. In company with these two costs, the normal signaling cost associated with basic MIPv6 handover also needs to be considered. We let the signaling cost of the basic Mobile IPv6 scheme as M_n . In other words, C_{signal} in the basic MIPv6 scheme is equal to M_n . Since this signaling cost is common to both FMIPv6 and basic Mobile IPv6, we assume the normal case signaling cost (M_n) as being a specific constant in our numerical analysis for the simplicity of analysis. In Equation 6 α , β and γ are weighting factors.

$$C_{signal} = \alpha M_s P_s + \beta M_f P_f + \gamma M_n \quad 6$$

4.3 Definition of Success Probability P_s .

To calculate the signaling cost referred to in the above section, we need to define the success probability (P_s). According to Figure 1, t_{L2} is the time taken from the Occurrence of the L2 trigger event to the start of the real L2 switching process. This time consists of three times: t_{newCoA} , the time between sending NCoA address and receiving FBU, and t_{L2} which is the time between sending FBU message and the really occurrence of L2 handover. Therefore, a small t_{L2} value means that the L2 trigger occurred at a time which which close to the start of the real link switching process. In this case, the value of P_s , which indicates the probability that L3 handover really occurs after the L2 trigger, will be larger. Therefore, we assume the success probability to be dependent on the timing of the L2 trigger. Taking this relationship between t_{L2} and P_s into consideration, we used the following proportionality for the determination of the success probability.

$$P_s \propto \frac{1}{e^{\tau t_{preL2}}} \quad 7$$

If $t_{new CoA}$ consider as constant time and the time between sending NCoA address and receiving FBU is very small the Equation above can be written as Equation 8 . In the Equation τ is a decreasing factor, which is introduced to consider a variety of decreasing patterns.

$$P_s = \frac{1}{e^{\tau t_{L2}}} \quad 8$$

Two cases are discussed here:

1. The success probability will be 1, when t_{L2} is 0, (In the ideal case).
2. The success probability will be 0, If the value of t_{L2} approaches ∞ . This means that handover anticipation is done too early without any exact information as to the link condition.

4.4 Definition of Failure Probability P_f : According to the main role in the probability we will define the Failure Probability P_f as Equation 9 .

$$P_f = 1 - P_s = 1 - \frac{1}{e^{\tau t_{L2}}} \quad 9$$

Total Signaling cost:

$$C_{Signal} = \alpha M_s P_s + \beta M_f P_f + \gamma M_n$$

$$C_{Signal} (FMIPv6-pred) = \alpha \{ (7\rho + 3l_{NP}) \theta_s \delta_C + 3 PC_P + 2 PC_N \} P_s + \{ (3\rho + 2l_{NP}) \theta_s \delta_C + 3 PC_P + PC_N \} P_f + \gamma \{ 2\rho \theta_s \delta_C \} \quad 10$$

$$C_{Signal} (FMIPv6-prop) = \alpha \{ (5\rho + 3l_{NP}) \theta_s \delta_C + 3 PC_P + 2 PC_N \} P_s + \beta \{ (2\rho + 2l_{NP}) \theta_s \delta_C + 2 PC_P + PC_N \} P_f + \gamma \{ 2\rho \theta_s \delta_C \} \quad 11$$

In the proposed fast mobile IPv6, like existing fast mobile IPv6 but since duplicate address detection process and Binding Updates will implement in advanced so, the proposed fast mobile IPv6 will finished when UNA process finish and packets will deliver to MN in new Domain directly from HA/CN.

5. Experimental Setup

Analytical analysis and MATLAB R2007b was used to compare the proposed fast handover algorithm with the existing algorithm. Demonstration of some numerical results in order to analyzed the proposed algorithm and the existing algorithm was conducted. For the numerical analysis of handover, the values of parameters set as $a = 0.8$, $\beta = 0.2$, $t_L = 50$, $\varepsilon = 0.8$, $\theta_s = 1$, $\rho = 10$, $\lambda_p = 1$, $p_{cp} = 5$, $\delta_c = 0.1$.

In existing Fast Mobile IPv6 (predictive), a mobile node detects its movement by Router Solicitation and Router Advertisement message exchanges triggered by Link layer events. Therefore, t_{MD} is 14 msec. In existing FMIPv6 (predictive), t_l and t_p are 14 msec, and 78 msec, respectively.

In proposed Fast Mobile IPv6 (predictive), a mobile node detects its movement by $RtSolPr[R]$ $RtSolAdv[R]$ message exchanges triggered by L2 events between MN and PAR. Therefore, and like Fast Mobile IPv6 (predictive), t_{MD} , t_l and t_p are 14 msec, 14 msec, and 78 msec, respectively. By resolving equations (10) and (11) using values above we can draw figure 4 below that shows the signaling cost when τ is changed for existing P-FMIPv6 and proposed FMIPv6.

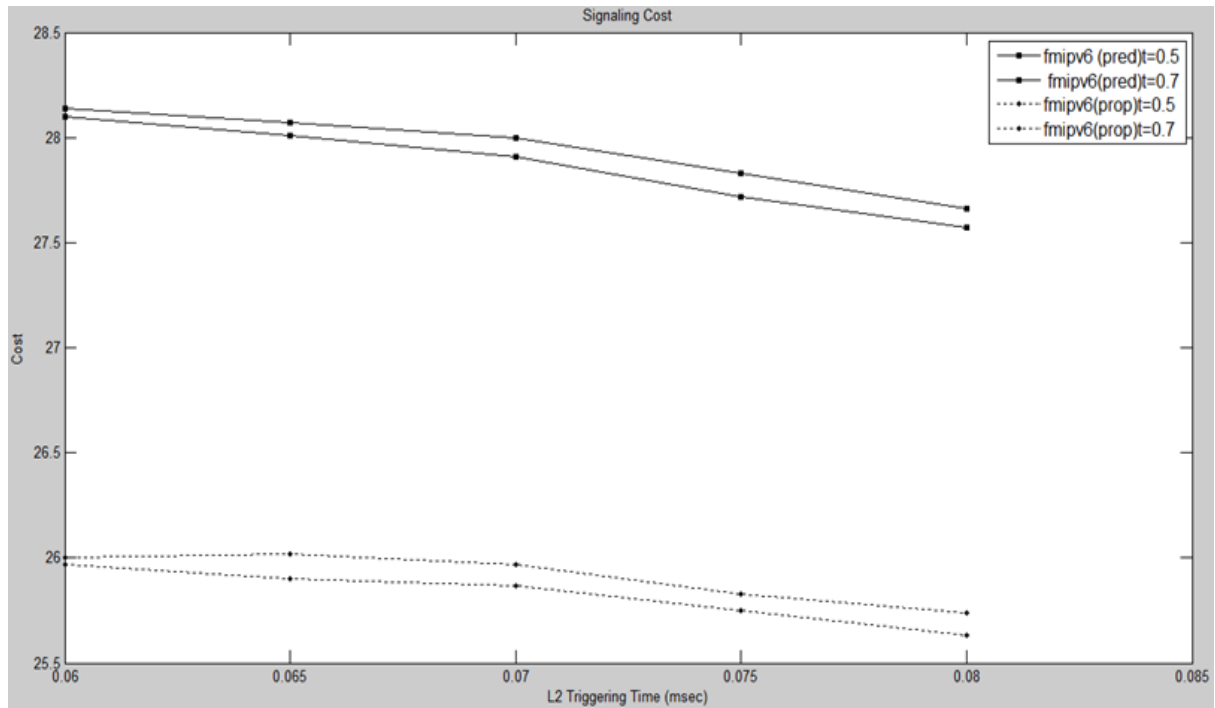


Figure 4. Signaling cost for existing predictive fast mobile IPV6 and proposed fast mobile IPV6 as function to L2 when τ is change.

From figure 4 above it shows that proposed Fast Mobile IPv6 (predictive) exhausts less signals than existing Fast Mobile IPv6 (predictive) because there is a signal reduced between PAR and NAR in the initiated of handover to get NCoA from NAR instead of MN . So, Proposed FMIPv6 is less than existing predictive fast mobile IPV6 by 2 approximately. Because PAR form the new care of address without waiting for an MN to send FBU.

Conclusion

This study proposes an enhanced Fast Mobile IPv6 scheme for Mobile IPv6. A mobile node selects an address in the scheme using modified FMIPv6 Internet Control Message Protocol (ICMP) header format and transfer the address configuration functionality from the mobile node to the previous access router. Also, the binding updates to home agent and correspondent node are performed from the time point when the Previous Access Router (PAR) sends Fast Binding acknowledgement to mobile node and new access router simultaneously. Using numerical analysis and MATLAB R2007b shows that proposed scheme generated less signaling cost compared with the existing FMIPv6.



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