Journal of Applied Sciences

ISSN 1812-5654

Journal of Applied Sciences 14 (16): 1877-1882, 2014
ISSN 1812-5654 / DOI: 10.3923/jas.2014.1877.1882

An Improved Fast Handover Program of Mobile IPv6

[1]Wang Jin-Bao and [2]Yi Yun-Yun
[1]School of Mathematics and Computer Science, Anhui Normal University, Anhui Wuhu, 241000, China
[2]Computer Science, Anhui Polytechnic University, Anhui Wuhu, 241000, China

Abstract: Based on elaborate analysis of the FMIPv6 technology, an improved fast handover program is proposed. The NCoA of mobile node will be configured according to the user list of the NAR, thus avoiding duplicate address detection of NCoA, thereby increasing FMIPv6 overall handover performance. Finally, we use OPNET to do simulation experiments, showing that the program can shorten the handover delay and packet loss rate and it is an effective and viable program.

Key words: FMIPv6, handover delay, NCoA, simulation experiment

INTRODUCTION

In order to keep the mobile users connected to the Internet during movement, IETF studied Mobile IPv6 protocol and provides good support for the movement of the mobile user, but the existing Mobile IPv6 protocol can not meet the practical demand of ensuring the security of handover, i.e., Qos. The most important thing is to study of mobile IPv6 is the mobile switch, which directly affects the performance of communication and thus it becomes a hot research topic of network technology (Han *et al*., 2006; Wang and Qian, 2013; Kim *et al*., 2013). The following are currently mobile IPv6 handover algorithms: Mobile IPv6 standard handover mechanism (MIPv6), FMIPv6, HMIPv6, EFWD, FHMIPv6, FFHMIPv6 and W-MPLS.

MIPv6: The standard Mobile IPv6 handover mechanism of high-latency, high packet loss and network performance bottlenecks could not meet the demands from a variety of real-time traffic (Kusin and Zakaria, 2011; Alrashdan *et al*., 2011). FMIPv6 is provided in order to improve the mobile IPv6 protocol, so it can speed up the handover process of IPv6 mobile hosts to reduce the existing time for communication connection interruption to guarantee the correctness of the real-time transmission of traffic flow. It does this by registering in advance and when a new alien network handover is not completed, by maintaining a network of communication with the former network, to realize fast handover, in order to provide real-time business support. FMIPv6 focuses on the rapid implementation of handover, predicting the mobile handover events and responding quickly, by router discovery in advance before the actual handover, configuring a new care-of address and establishing two-way tunnel access operations between the old router and the new router and to provide data transmission services before the establishing of the MN and the new router, the CN and the Home Agent and updating registration.

HMIPv6: HMIPv6 introduces a new entity called the mobility anchor point (MAP, Mobility Anchor Point), it can be used as hierarchical MIPv6 network routers at any level (including subnet access router) and it does not require every subnet to have a MAP. The using of MAP can restrict the mobile node signaling interaction with the outside of this area, it can support fast mobile IP handover and can help mobile host to realize seamlessly moving and it can also support specific mobile network conditions. The address obtained from MAP is the Regional Care-of Address (RCoA, Regional Care-of Address), depending on the usage of the mobile host RCoA, the MAP has 2 modes: The basic mode and extended mode. When roaming the MAP domain, the mobile host can use RCoA as an alternate care-of address (extended mode), or form their own RcoA in MAP subnet (basic model). HMIPv6 can reduce Mobile IPv6 Binding Update delay; reduce the binding update message transmitted over the network, to improve the overall handover performance. But the two handover algorithms can not solve handover delay and packet loss caused by duplicate address detection. He Improved the duplicate detection algorithm based on FMIPv6, thus reducing the handover delay and improving the handover speed.

EFWD (Enhanced forwarding from the previous care-of address) (Gwon and Yegin, 2004): The algorithm design ideas is by introducing link layer trigger mechanism and

Corresponding Author: Wang Jin-Bao, School of Mathematics and Computer Science, Anhui Normal University, Anhui Wuhu, 241000, China

the establishment of a network tunnel between the original and new networks to reduce the handover latency and data loss. In terms of handover latency, EFWD eliminates the basic mobile IPv6 protocol mobile detection delay by the link layer trigger mechanism. In terms of packet loss, EFWD eliminates data loss of movement detection and binding registration.

FHMIPv6 (Fast handover support in hierarchical mobile IPv6) (Jung and Koh, 2004): The algorithm design idea is to use both FMIPv6 and HMIPv6 programs in basic Mobile IPv6 protocol, but not a simple combination of both. F-HMIPv6 utilization of the advantages of FMIPv6 and HMIPv6 and achieve good results in reducing the handover delay and loss of data, F-HMIPv6 avoids the problem of triangle routing domain, but increases MAP agents load.

FF-HMIPv6 (Flow based fast handover for MIPv6) (Yao and Chen, 2004): This algorithm mainly proposes portfolio optimization program for the mobile node switching among the MAP domains, the mobile node uses the simple combination of FMIPv6 and HMIPv6 when switching the domains, the mobile node uses the MAP agency instead of the front access router functions of FMIPv6 when the mobile node switches between domains, thereby speeding up the switching speed.

W-MPLS (a layer 2.5 mobility scheme for fast handover based n MPLS forwarding mechanism and a virtual interface architecture) (Sethom *et al*., 2004): The algorithm uses the MPLS label forwarding data, rather than finding the IP address, not forwarding data by IP tunneling again, thereby speeding up the forwarding rate.

These algorithms do not optimized for duplicate address detection algorithm, the duplicate address detection algorithm has been further improved by the author based on the FMIPv6 algorithm and improved switching performance of the mobile node.

FMIPV6 HANDOVER TECHNOLOGY

FMIPv6 algorithm: FMIPv6 fast handover algorithm is divided into 2 modes: Predictive quick switch and reactive quick switch (Zheng and Wang, 2010), both of which require technical support by link layer handover. Here discussed is only the former one.

Predictive fast handover (Oh *et al*., 2007) refers to a mobile node receiving a confirmation message of binding in the original link before moving. It is an ideal handover mode that means the third layer handover began when MN and PAR still maintains connection to the second link. That is, a neighbor notice can be sent immediately after the mobile node is switched to the NAR, so that the cached data packets can be forwarded immediately to the MN.

Predictive fast handover procedure is as follows:

- When the MN predictes that it would be entering a new network according to the underlying signal changes, it will send a route request message proxy PrSolPr to the PAR
- When the PAR receives PrSolPr sent by MN, it will send MN a proxy router advertisement PrRtAdv. PrRtAdv will give the new network-related information of mobile node
- After receiving PrRtAdv, MN will configure a new care-of address used on the new network according to NAR given in PrRtAdv and send PAR a quick binding update message FBU. FBU will authorize the establishment of bidirectional tunnel between PAR and NAR
- When PAR receives FBU from MN, it will immediately send NAR a handover message HI, which contains the original MN care-of address, the original link-layer address, the new care-of address and information of tunnel that is going to create. HI message indicates that MN is performing switch and it requires NAR to respond and give the information required for handover
- According to the received information HI, NAR will perfom a duplication test for the new care-of address. If the new care-of address is valid and there is no duplication, neighbor cache entries are established for MN so as to prevent new care-of address to be used by other nodes and a handover confirmation message HACK will be sent to PAR. If the new care-of address is unavailable, NAR will re-assign a care-of address available to MN
- When PAR receives HACK, it means the tunnel has been successfully established. But if NAR detects a new care-of address is not available, it will return an NCoA available in the HACK to PAR. If the care-of address is available, PAR sends FBACK message to MN and NAR and forwards the packet to MN. If HACK has NCoA, the PAR will re-bind updates and carry NCoA information in the FBACK message sent to the MN
- When the MN is connected to the same network, it will send NAR a neighbor advertisement FNA message informing NRA that it is already connected to the NAR's link. When the NAR receives FNA, it will forward the cache packet to MN and delete agents neighbor cache entry, reestablish the neighbor cache entry for the MN. Then, the binding

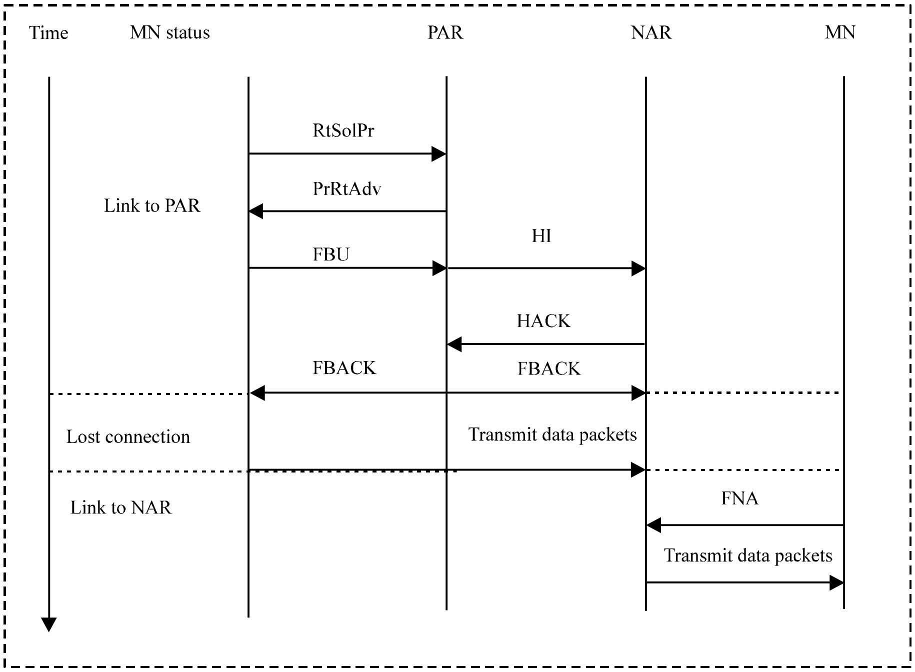

Fig. 1: FMIPv6 switching process

update message can be sent to the home agent and the communication peer and before the end of the operation, MN can send packets by the tunnel between PAR and NAR. Its handover process is shown in Fig. 1

FMIPv6 handover performance analysis: According to the algorithm, the handoff delay has 4 main parts: (1) L2 handover delay (DL2), (2) motion detection delay (DRA), (3) duplicate address detection delay (DAD) and (4) registration delay (DBU). L2 handover delay is associated with the network access technology and different access technology has different handover delay. The mobile node is generally judged whether they moved by receiving the router advertisement, so that the mobile detection time is typically related to router notification interval. The time interval is as short as the movement detection delay, but more time is also consumed by the router delay, which can be set between 0.5 and 1.5 sec. And the mobile node detects whether there are duplicate subnet address by transmitting a neighbor solicitation. According to the above analysis, IP addresses in the NAR user list can be used to configure care-of address for a mobile node, avoiding duplicate address detection process, thereby reducing the handover delay.

IMPROVEMENT SCHEME

Improved algorithm procedure is as follows:

- When the mobile node moves to a new link layer and establish a layer link, the layer of the mobile node will trigger L2 signal
- When the mobile node receives the L2 signal, it will immediately send a route request message RS+ to the router, where RS+ will add a request flag R in the header ICMPv6, saying mobile node requests a new care-of address from the router and also adds a new IP address option in the ICMPv6 header to transmit PAR's IP address
- When the router receives RS+ message, it first detects whether it contains flag R. If not, it will be carried out in accordance with a common RS message; otherwise it means the mobile node has a link-layer switch. Then, NAR will detect whether there has been sub-gateway switch in the mobile node and its detecting method is as follows: The IP address in the IP address option of RS+ message is first drawn out and compared with the NAR's own IP address. And if same, then there is no the switch among subnets and NAR just need to return to a normal response message RA; if different, then the switch occurs and NAR should be performed according to the following steps:

  - **Configure care-of address:** In the IPv6 implementation process, a list of user information is generally established in order to control user and data forwarding. The list holds all the second line host's IP addresses (Al-Surmi *et al*., 2013; Pandey *et al*., 2013) and you can choose one IP address, which is not in the list, as a new care-of address so that you can avoid duplicate address detection process

- **Sends a route response message RA+ to the mobile node:** The message is added a care-of address option based on RA and its content is a new care-of address NAR configures for the mobile node

- After the mobile node receives RA+ message, it will judge whether subnet switch occurs according to the network prefix in the RA+ message. If not, then the switch will stop, otherwise it will configure a new care-of address, which is the IP address transmitting Address option in RA+ message. The address has been carried out the duplicate address detection on NAR, so duplicate address detection process is not needed
- Then, send a binding update message (FBU) to PAR
- Upon receiving FBU message, PAR encapsulates the packet whose destination address is PcoA and then send it to the mobile node; meanwhile it builds a binding table entry, whose home address is PcoA and care-of address is NcoA and establish communication tunnel between PcoA and NcoA. The survival of the tunnel can be specified by liftetime option; the tunnel will be automatically deleted when the survival is expired. When the tunnel is established, PAR sends a rapid-binding confirmation message (FBACK) to the mobile node
- After the mobile node receives FBACK, a reverse tunnel from the mobile node to the PAR will be established, thus building a bi-directional tunnel between the PAR and making communication between the mobile node and the communication terminal recovered successfully
- Afterwards, the mobile node will take the source address as NcoA to send binding update message to HA and CN. When the binding update operation of the HA and the CN is completed, the mobile node can transmit data communication with a new NcoA address and a bidirectional tunnel is automatically deleted at this time. If the mobile node does not complete the binding update operation to the HA and CN within the survival of the tunnel, FBU must be re-issued to PAR to prolong its lifetime, keeping data communication proceeding smoothly

SIMULATIONS

Network topology: OPNET tools (Hassan and Hoong, 2013; Magagula *et al*., 2012; Shang *et al*., 2012; Hussain *et al*., 2012; Tao *et al*., 2012; Kim *et al*., 2012) will be used for the simulation of FMIPv6 handover and improved algorithms and the simulation results be compared. The network topology is shown in Fig. 2.

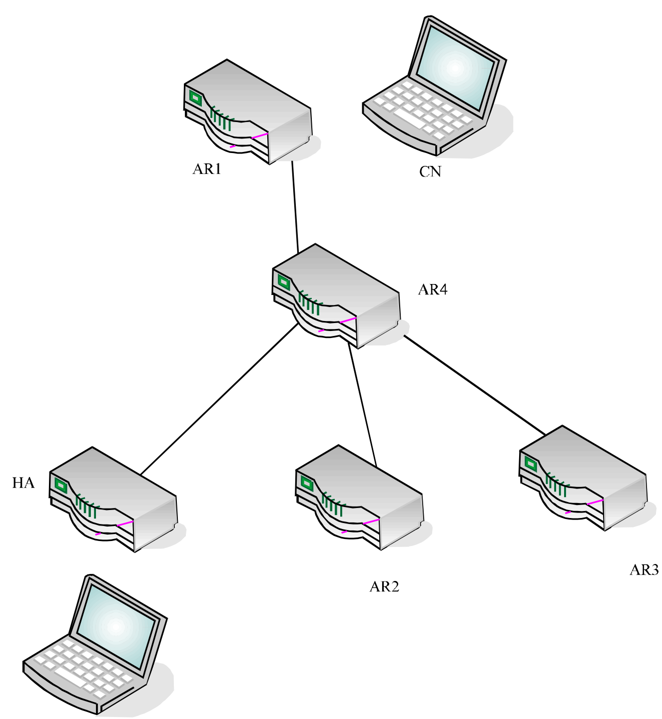

Fig. 2: Network topology

Table 1: Experimental results

Handover scheme	Overall transmission data rate (kb sec^{-1})	Overall data receiving speed in handover	Overall data loss rate (%)	MN receiving data rate		CN receiving data rate	
				Normal	Toggle	Normal	Toggle
FMIPv6	1000	780	22	500	405	500	375
		740	26	500	400	500	340
		760	24	500	390	500	370
Improvement program	1000	840	16	500	430	500	410
		870	13	500	450	500	420
		860	14	500	444	500	416

The network topology used by the simulation consists of the following parts: A stationary communication node CN, a mobile node MN, 5 routers (wherein, AR1 is CN's access router, HA is the MN's home agent, AR2 and AR3 are the MN's access router in the field, AR4 are connected to the AR1, HA, AR2, AR3 so that they can communicate with each other. In the beginning of the experiment MN moves through AR2 by 10 km h^{-1} and finally to AR3 and primary observation goes to MN's and CN's data transmission speed. MN and CN use the wlan_workstn_adv model and the router wlan_ethernet_slip4_adv node model and improve both of them so as to make them applicable to the experiment. Both of MN and CN are transmitting data to each other by 500 kb sec^{-1} in the experiment and conducted three tests.

Experimental results and analysis: Experimental results are shown in Table 1. In the first test, when using FMIPv6 algorithm, the overall data receiving speed is 780 kb sec^{-1} and the overall data loss rate is 22. In the second test, when using FMIPv6 algorithm, the overall data receiving speed is 740 kb sec^{-1} and the overall data loss rate is 26%. In the third test, when using FMIPv6 algorithm, the overall data receiving speed is 760 kb sec^{-1} and the overall data loss rate is 24%. The average of overall data receiving speed of three times is 760 kb sec^{-1}, the average of overall data loss rate of three times is 24%. The overall data receiving speed is 840 kb sec^{-1} and the overall data loss rate is 16% in the first test when using the improved algorithm. The overall data receiving speed is 870 kb sec^{-1} and the overall data loss rate is 13% in the second test when using the improved algorithm. The overall data receiving speed is 860 kb sec^{-1} and the overall data loss rate is 14% in the third test when using the improved algorithm. The average of overall data receiving speed of three times is 856.7 kb sec^{-1} and the average of overall data loss rate of three times is 14.3% when using the improved algorithm. It can be seen that the overall data receiving speed of the improved program is faster than the overall data receiving speed of the FMIPv6 program in the switching process. Therefore, the improved program has a smaller data loss rate, which provides further evidence of improved one having shorter handover delay and better handover performance.

CONCLUSION

An improved fast handover scheme is proposed on the basis of FMIPv6 handover scheme. The scheme uses flag R to request a new care-of address, accelerating judgment of subnet handover. It also takes advantage of IP addresses of all second line hosts to configure a new care-of address and of the bi-directional tunnel to reduce the communication interruption time. Based upon simulation experiments, the handover scheme improves the handover performance by reducing the handover delay and packet loss rate, which also proves that the program is feasible and effective.

The algorithm also has some disadvantages, though improved handover speed of mobile nodes, but not able to solve the problem caused by the mobile node "ping-pong movement", this problem can be alleviated by add the MAP, in subsequent studies we will modify. this algorithm for further.

ACKNOWLEDGMENT

This study is supported by Youth Fund of Anhui Polytechnic University (2007YQ031).

REFERENCES

Al-Surmi, I., M. Othman, N.A.W. Abdul Hamid and B.M. Ali, 2013. Latency low handover mechanism considering data traffic lost preventing for proxy mobile IPv6 Over WLAN. Wireless Personal Commun., 70: 459-499.

Alrashdan, M., M. Ismail, K. Jumari, G.A. Abed and S. Hassan, 2011. Performance comparison analysis of SSHMIPv6 and HMIPv6 lost packets using network simulator NS-2. Inform. Technol. J., 10: 1989-1993.

Gwon, Y. and A. Yegin, 2004. Enhanced forwarding from the previous care-of address (EFWD) for fast handovers in mobile IPv6. Proceedings of the IEEE Wireless Communications and Networking Conference, Volume, 2, March 21-25, 2004, Atlanta, GA., USA., pp: 861-866.

Han, Y.H., H. Choi and S.H. Hwang, 2006. Reactive handover optimization in IPv6-based mobile networks. IEEE J. Selected Areas Commun., 24: 1758-1772.

Hassan, M.M. and P.K. Hoong, 2013. Seamless handover integrated solution for video transmission over proxy mobile IPv6 in a micro mobility domain. J. Network Comput. Appl., 36: 66-76.

Hussain, R., S.A. Malik, S.A. Khan and S. Abrar, 2012. Design, implementation and experimental evaluation of an end-to-end vertical handover scheme on NCTUns simulator. Simul. Modell. Pract. Theor., 26: 151-167.

Jung, H. and S. Koh, 2004. Fast handover support in hierarchical mobile IPv6. Proceedings of the 6th International Conference on Advanced Communication Technology, February 9-11, 2004, Phoenix Park, Korea, pp: 551-554.

Kim, M.S., S.K. Lee and N. Golmie, 2012. Enhanced fast handover for proxy mobile IPv6 in vehicular networks. Wireless Networks, 18: 401-411.

Kim, C., H. Hwang, J.W. Baik and K.G. Lee, 2013. Multicast based proxy mobile IPv6 for inter-domain handover. Math. Comput. Model., 5: 2863-2872.

Kusin, Z. and M.S. Zakaria, 2011. Distance based mobility anchor point selection scheme with dynamic load control in hierarchical mobile IPV6. Inform. Technol. J., 10: 1817-1823.

Magagula, L.A., H.A. Chan and O.E. Falowo, 2012. Handover approaches for seamless mobility management in next generation wireless networks. Wireless Commun. and Mobile Comput., 12: 1414-1428.

Oh, H., K. Yoo, C.K. Kim, W.J. Yang, T.I. Kim and H.W. Jung, 2007. An enhanced fast handover scheme with temporal reuse of CoAs and PBP in IPv6-based mobile networks. Proceedings of the International Conference on Multimedia and Ubiquitous Engineering, April 26-28, 2007, Seoul, Korea, pp: 183-189.

Pandey, D., F. Bashir, G.Y. Kee and J.Y. Pyun, 2013. Performance evaluation of vertical handover for IEEE 802.21 enabled proxy mobile IPv6. Proceedings of the Interational Confererence on Computing, Management and Telecommunictions, January 21-24, 2013, Ho Chi Minh, Vietnam, pp: 21-31.

Sethom, K., H. Afifi and G. Pujolle, 2004. Wireless MPLS: A new layer 2.5 micro-mobility scheme. Proceedings of the 2nd International Workshop on Mobility Management and Wireless Access Protocols, October 1, 2004, Philadelphia, PA., USA., pp: 64-71.

Shang, T., Y. Zhang and J. Liu, 2012. An escrow-free access authentication mechanism for mobile IPv6 network. Sensor Lett., 10: 1715-1723.

Tao, M., H. Yuan, S. Dong and H. Yu, 2012. Initiative movement prediction assisted adaptive handover trigger scheme in fast MIPv6. Comput. Commun., 35: 1272-1282.

Wang, X. and H. Qian, 2013. A mobility handover scheme for Ipv6-based vehicular *ad hoc* networks. Wireless Personal Commun., 70: 1841-1857.

Yao, W.M. and Y.C. Chen, 2004. An enhanced buffer management scheme for fast handover protocol. Proceedings of the 24th International Conference on Distributed Computing Systems Workshops, March 23-24, 2004, Tokyo, Japan, pp: 896-901.

Zheng, G. and H. Wang, 2010. Optimization of fast handover in hierarchical mobileIPv6 networks. Proceedings of the 2nd International Conference on Computer Modeling and Simulation, Volume 4, January 22-24, 2010, Sanya, Hainan, pp: 285-288.