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An Enhanced Macro Mobility Management Scheme in NEMO Environment to Achieve Seamless Handoff

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Abstract: In NEMO network, handoff is the process in which the Serving MR (SMR) needs to change its point of attachment to the network when it moves from one network to another new network. Usually during handover, firstly the SMR needs to be disconnected from the old network and then it gets connected to a new network. Thus there is a possibility to lose the connectivity from the Internet as well as its Home Agent (HA) and Correspondent Nodes (CNs). During this time, it becomes difficult to send or receive any data packets which results in packet loss and delay. Accordingly for real time applications that depend on timely packet delivery within certain acceptable thresholds will be sensitive to the length of time a SMR loses connectivity while performing handover. In case of this type of applications seamless handoff is generally expected which includes both features i.e. smooth (no or very little packet loss) as well as fast (low delay) handoff. But in accordance with NEMO Basic Support Protocol (NEMO BSP), only one primary Care of Address (CoA) of SMR can be registered with home agent, which affects the handoff performance resulting packet loss and delay. This paper presents an enhanced macro mobility management scheme for NEMO network which integrates improved FHMIPv6 with mobile networks. The main idea of the proposed macro mobility scheme is to apply the improved fast handoff mechanism for the SMR handoff with its Local Fixed Node (LFN) in NEMO network in order to achieve seamless handoff in terms of packet loss and delay. The performance of the proposed scheme is evaluated using simulation approach. The simulation is done using Network Simulator (NS-2). The simulation result shows that the proposed scheme outperforms the standard NEMO BSP in terms of packet loss (packet loss less than 6%).

Key words: NEMO BSP · Seamless handoff · Macro Mobility · SMR · FHMIPv6 · NEMO

INTRODUCTION

There are two well known mechanisms in Internet Mobility to reduce the handoff delay are classified into host mobility (MIPV6 with its enhancements are mainly HMIPV6, FMIPV6, HMIPV6) as well as the Network Mobility (NEMO BSP) [1-3]. According to host mobility, the main purpose of HMIPv6 is [4] to decrease the frequency and latency of location updates caused by MN's mobility where as the FMIPv6 [5] can reduce the handover latency and packet loss during handover of MN through providing all the necessary information of next AR for Layer 3 handover before going to the part of its subnet. Due to further reduce signaling overhead and packet loss, it is possible to use HMIPv6 and FMIPv6 jointly known as FHMIPv6 [6]. However, if these mechanisms are combined in NEMO environment then Mobile.

Node (MN) and Mobile Routers (MR) performs different IP layer handoff. Hence, it is needed to apply some mechanisms which are able to adapt improved FHMIPv6 [7] in order to achieve uninterrupted Internet connection during handoff for mobile routers with its nodes in NEMO network [8]. As an extension of NEMO

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BSP, in this paper some NEMO based handoff schemes have been analyzed in terms of packet loss and handoff delay. This paper is structured as follows: firstly, evaluates some mobility management schemes to achieve seamless handoff in NEMO network. Then the detailed operation of the proposed scheme is discussed. After that, the performance of the proposed scheme is evaluated via Network Simulator (NS-2) with result analysis which is presented followed by the conclusion.

Relared Works: There are several extensions of NEMO Basic Support Protocol (NEMO BSP) in order to allow multihoming, nested mobile networking and the route optimization.

The authors in paper [9], presents a new architecture and mechanism in order to optimize the routing mechanisms in nested mobile networks for NEMO basic support and the performance analysis of this new architecture is properly done for reducing the handoff latency. In accordance with the proposed mechanism, two types of Mobile Router (MR) are distinguished primarily. MRs which have direct access to the infrastructure via their egress interfaces, are denoted as TLMRs for Top Level MRs. All others mobile routers in the nested mobile network are denoted as IMRs for Intermediate Mobile Routers. The proposed solution is achieved by adding functionality to the Mobile Nodes/ Mobile Routers (MN/MR) and Home Agents (HA). A new one-bit field "R" is added to the Router Advertisement (RA) messages. This field is set to 1 by MR and inform other nodes that they are connected to a mobile/moving network. As soon as a MR connects to a new point of attachment and receives a new CoA, it starts advertising a RA message in its mobile network after setting the field R to 1. When a new MR visits this mobile network and receives a RA with the field R set to 1, it behaves as an IMR as shown in Figure 1. With the intention of providing information about the CoA of Mobile Nodes, a new “CoA option” is added to binding ppdate messages. Indeed except the new CoA option field, there is no additional message or overhead in this scheme. By applying this mechanism it is possible to avoid any ingress filtering mechanism. Additionally the home address of the BU message is added to the security policy, so that packets originated from this address can be forwarded. This solution minimizes the registration delay component of the overall handoff latency to some extent. However it is still an open issue for current researchers.

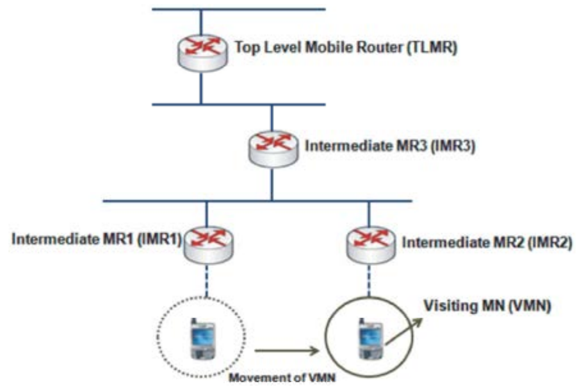

Fig. 1: Mobility management in nested mobile network [9]

In [10], explains an adaptive NEMO support protocol which formulates the use of the HMIPv6 and NEMO basic support protocols. Depending on the SMR in the adaptive NEMO support protocol, utilizes the adaptive BU strategy. This is the main feature differentiating a mobile network. When the SMR is low it is essential to decrease the number of BUs which is the main reason to use the adaptive BU whereas when the SMR is high then the number of tunneling is reduced. By using the adaptive mechanism, it is shown that the adaptive NEMO support protocol is scalable and works sound for different mobile environments as well as improves the performance because of low SMR as well. Hence, this technique is most significant for the NEMO networks. However, further research need to reduce implementation overhead in order to SMR measurement with security concern.

In [11], explains the measurement of the performance of NEMO in a NEMO tested with explored the handoff performance and routing overheads in NEMO network. In addition, this paper also explained the non- optimized handoff performance of NEMO is not appropriate for the sensitive applications, like voice-over-IP since handoff delays. The handoff delay in NEMO BSP is up to 2.75 s. Moreover, it is also shown that routing overheads in NEMO BSP makes the use of scarce wireless network resources inefficiently. Therefore, to overcome the shortcomings of NEMO BSP, they propose a new handover scheme Make-Before-Break (MBB) handoffs to use multiple interfaces simultaneously as well as expanded OptiNets RO scheme. The advantages of the MBB handoffs is that it makes possible to take the advantage of high-speed of mobile router but has short range radio technologies except cooperating the service that it proposes to mobile network nodes (MNN). However, the possible limitation to use multiple interfaces in mobile devices, like an increase in power consumption, interference originated by the usage of multiple interfaces with increasing size and cost. But these limitations are only applicable for the mobile host. It does not give the restriction of using multiple interfaces on MRs for the do not limit the use of multiple interfaces on MRs to the similar level. Extended OptiNets RO scheme has increase performance to remove the packet overhead in NEMO BSP. Therefore it can be said that MBB handoff scheme with the extended OptiNets RO scheme improve the performance with highly sensitive application in terms of packet loss and delay.

Moreover in [12], presents a modified fast-Integrated light-NEMO handoff scheme which combines the Modified Fast Integrated-Handover scheme and the Light- NEMO network model due to achieve a seamless handoff in nested mobile networks with analytical results. The advantages of this scheme are that it decrease the handoff delay as well as improve the service disruption time during the handoff. However, further improvement is needed to achieve seamless handoff completely by applying appropriate route optimization mechanism.

In [13], presents a solution of route optimization based on multihoming mechanism in local mobility management framework named as multihoming-LRO. The proposed scheme gives the solution for optimized route as well as supports fast handover. Here, Multiple local mobility anchors(LMAs) requests for mobile node(MN) connecting to it with replacing information to each other within same local mobility Domain (LMD). In multihoming-LRO, it is possible for mobile router (MR) to connect to outside with having multiple mobile routers. When central link is not good in quality then MR can attach to secondary LMA earlier than primary link is stopped through identifying the main LMA and secondary LMA as well as setting two threshold of link performance. If MR require then two links are able to provide concurrently to MR. when one link is not work well, then it is possible for MR to communicate with other node by the help of another link. Therefore, it is possible to improve robustness with providing self-recovery as well as smaller binding cache. Fast handover intra-LMD and inter-LMD can be performed easily through establishing new link before disconnecting old one. This scheme generates only one tunnel between the closest MR and it's HA. Hence it can decrease the forward and reverse date path without registration with it's HA again when MR moves inside LMD. As a result, signaling cost is reduced. Moreover, the control of nested-NEMO's topology that is actively altered will be improved through moving the mobility management function to fix node from mobile node. In this scheme, no need to add signal cost when topology of the total nested-NEMO is modified with remaining MR in bone-network. However, how to measuring link's performance is still an active research area.

Enhanced Macro Mobility Scheme: In order to minimize handoff delay as much as possible in NEMO network, this paper presents an enhanced Macro Mobility management scheme in NEMO environment which can be identified as MM-NEMO scheme for further reduction of handoff delay. It is assumed that each MAP has MAP Information Table (MIT) that stores information of all neighboring MRs and it is possible to share the information with the neighboring MAP in order to choose the New MR (NMR). Additionally, after receiving Router Advertisement (RA) message, each MAP (CMAP, NMAP) will update the MIT as well [14]. The new LCoA and RCoA are created by CMAP in the place of the Serving MR (SMR) that shows that FBU message is not entailed for CMAP. Therefore, the FBU option is attached within the RtSolPr message as a replacement of the FBU message to perform handoff of the Serving MR with its Local Fixed Node (LFN) in order to accomplish the FBU in advance in NEMO environment. As a result, the CMAP can start fast handoff while it receives RtSolPr from the SMR after L2 triggering. In the proposed scheme no new messages are required to be defined as the improved FHMIPv6 [7] is assumed to be integrated with mobile networks. Figure 2 illustrates the handoff operation of the proposed scheme and accordingly explained in details [15]:

- In the beginning, the SMR sends IRtSolPr message (with the I bit set as shown in Figure 3) to the CMAP through the CMR to allow the support of MM-NEMO. Since the I bit is set, then the CMAP will create a new LCoA and RCOA on behalf of the SMR. However, the SMR will follow NEMO BSP if I bit is not set.
- Once creating new LCoA, the CMAP sends the IPrRtAdv message to the SMR and also the handover Initiation (HI) message to the NMR which contains New LCOA (NLCOA). It can be seen that the SMR does not require to send the FBU to the CMAP. Rather it just needs to wait for the FLBAck message. The message format for IRtSolPr with FBU option is shown in Figure 3.

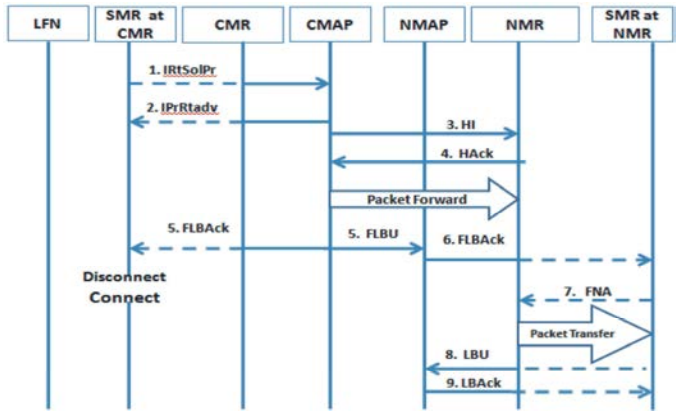

Fig. 2: Handoff procedure of Proposed Macro Mobility scheme [15]

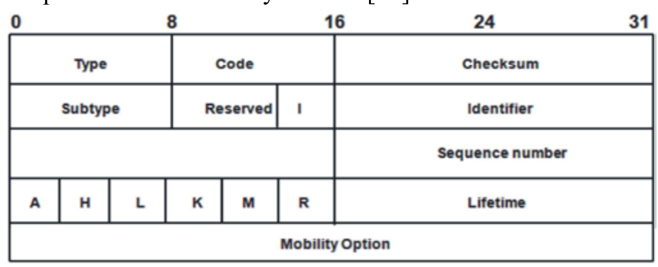

Fig. 3: FBU Option in Router Solicitation Proxy message

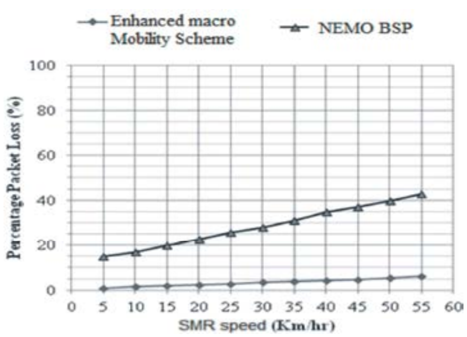

Fig. 4: Packet loss of the enhanced macro mobility scheme

- Once the Handover Initiation (HI) message is sent to the NMR, the NMR executes Duplicate Address Detection (DAD) mechanism to confirm whether the new NLCoA is unique or not.
- If the address is not duplicated, the NMR sends the HAck message to the CMAP.
- After receiving the HAck message, the CMAP sends FLBAck message to the Serving MR to acknowledge the availability of the address. At the same time, Fast Local Binding Update (FLBU) is sent to NMAP that contains NRCoA for DAD operation to verify the SMR's new RCOA. Concurrently, bi-directional tunnel is established between CMAP and NMR (which starts to buffer the packets sent to the SMR).
- After verifying the NRCoA, NMAP sends the FLBAck message to the SMR and BU message to it's HA and CN consequently. Then layer 2 launchs handoff procedure and layer 3 connections will be cut.
- SMR sends FNA message to NMR when it arrives at NMAP domain. Subsequently, NMR transmits the buffered packet to the SMR. The

SMR sends the Local Binding Update (LBU) message to NMAP after getting buffered packets from NMR.

Simulation Approach: The simulation is carried out by the Network Simulator (NS2) [16] in order to determine the percentage of packet loss in the real scenarios. Packet loss has been used as performance metrics for proposed scheme. The parameters set in case of the simulated part of proposed scheme are:

- It is assumed, there are 4 SMRs and only 1 fixed Corresponding Node (CN), two Access Routers (e.g. NMR and CMR) which individually represent old connection (before handoff) and new connection (after handoff). The Serving MR's moving speed is set to 5~60 Km/hr.
- The coverage area of the ARs (CMR, NMR) has been set to 200 × 200 m^2.

RESULTS AND PERFORMANCE ANALYSIS

During the handoff, some packets never arrive at the destined receiver because of packet lost or distortion. The cost due to packet loss combining with the cost for packet tunnelling gives the total packet delivery cost. The comparative performance results between the NEMO BSP and proposed MM-NEMO scheme is shown in this section. In proposed scheme, the performance criterion is packet loss.

Packet Loss: The packet loss for the proposed scheme is less than 6%, whereas the packet loss of NEMO-BSP is much higher from the total packet delivered which is sent from SMR to the CN as demonstrated by Figure 4. This is because the SMR does not need to frequent handoff in to the proposed scheme because the local mobility agent (i.e, MAP) manages all the local mobility.

CONCLUSION AND FURTHER STUDIES

The Proposed enhanced macro mobility scheme is supported fast handover between the MAP domains by adopting the FHMIPv6 (host based mobility protocol) to achieve the seamless handoff in between MAP domains. Therefore, the proposed scheme outperforms the standard NEMO BSP in terms of packet loss. In addition, the simulation result shows that the proposed scheme is improved (packet loss less than 6% in compare with NEMO-BSP). In order to get the more precise evaluation, visiting and local mobile node can be considered which will be future research work.

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REFERENCES

1. Devarapalli, V., R. Wakikawa, A. Petrescu and P. Thubert, 2005. Network Mobility (NEMO) basic support protocol", RFC 3963.
2. Johnson, D.B., C.E. Parkins and J. Arkko, 2004. Mobility support in IPv6, RFC 3775.
3. Perera, E., V. Sivaraman and A. Seneviratne, 2004. Survey on network mobility support, Mobile Computing and Communications Review.
4. Soliman, H., C. Castelluccia, K. El Malki and L. Bellier, 2005. Hierarchical Mobile IPV6 Mobility Management (HMIPV6), RFC 4140, IETF.
5. Koodli, R., *et al*., 2005. Fast Handover for Mobile IPV6, RFC 4068, IETF.
6. Jung, H., *et al*., 2005. Fast Handover Support in Hierarchical Mobile IPV6, International Conference on Advanced Communication Technology.
7. Chen-wen, W. and W. Ping, 2009. Improved Fast Handover scheme for Hierarchical Mobile IPv6, Proceedings of 4th International Conference on Computer Science and Education.
8. Yoo, S., S. Choi and D. Su, 2009. Analysis of Fast Handover Mechanisms for Hierarchical Mobile IPv6 Network Mobility, Wireless Pers Commun, 48: 215-238.
9. Sabeur, M., B. Jouaber and D. Zeghlache, 2005. MR-proxy based solution for Nested Mobile Network Problems, WPMC, Aalborg, Denmark.
10. Pack, S., T. Kwon, Y. Choi and E. Park, 2009. An adaptive Network mobility support protocol in hierarchical mobile Ipv6 networks, IEEE Transactions on Vehicular Technology, at 1-1, 2009.
11. Petander, H., E. Perera, KC. Lan and A. Seneviratne, 2006. Measuring and improving the performance of network mobility management in ipv6 networks, IEEE Journal on Selected Areas in Communications, 24(9): 1671-1681.
12. Mohammed, B.A. and T. Wan, 2010. Modified Fast-Integrated Light-NEMOv6 Handoff in IEEE 802.16e BWA Networks In 2nd International Conference on Network Applications, Protocols and Services.
13. Hua, L., L. Yuan-an and W. Qiu-tian, 2008. Fast handover and route optimization of multihoming based nested mobile networks, IEEE.
14. Sheng, L., Y. Li Tsai, *et al*., 2010. An Efficient Fast Handoff Scheme in Hierarchical MIPv6 for NEMO, International Symposium on Computer, Communication, Control and Automation.
15. Shayla Islam, A.H. Aisha-Hassan, M.K. Hasan, A.S. Rashid, O.O. Khalifa and O. Mahmoud, 2012. Macro Mobility Scheme in NEMO to support Seamless Handoff, International Conference on Computer and Communication Engineering 2012 (ICCCE2012), doi: 10.1109/ICCCE.2012.6271186.
16. Kong, R., 2008. The Simulation for Network Mobility based on NS2, In International Conference on Computer Science and Software Engineering.