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NUMERICAL ANALYSIS OF MANEMO ROUTING SCHEME IN MULTIHOMING ENVIRONMENT

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Abstract
NEMO-BSP is the result of MIPV6 development that lacks mobility support in NEMO. Therefore, in this letter we discuss MANEMO routing and multihoming (MROM) providing detailed analysis with a numerical model. MROM, by maximizing the handoff performance, has been justified to have better mobility support than the ordinary NEMO-BSP and P-NEMO.

Keywords--handoff, routing, multihoming, NEMO-BSP and P-NEMO

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INTRODUCTION

Mobile IPv6 protocol supports host mobility, such as laptops, mobile phones and PDAs. MIPv6 upholds session continuity in between Mobile router Nodes (MN) and their Correspondent Node (CN) with no regards to the MN existing point of attachment (PoA) to the global Internet [1].

Mobile IPv6 exploits Home Agent (HA) to transmit/receive packets in between exact geographical position of mobile node and the CN. The base specifications of Mobile IPv6 include a Route Optimization (RO) scheme called the Return Rout ability (RR) Procedure. It allows an MN to transmit Binding Update (BU) packet to its CNs. Then, packets are directly routed between MNs and their CNs.

While this optimization reduces latency of the communication and improves performances, which is similar to what has been shown in [2], [3] and [4], it also introduces several problems such as modifications of end-nodes, complexity, and server overload.

Later, there was a claim arisen about the lack of supporting mobility of full network, the Network Mobility support (NEMO). Therefore, the IETF established "NEMO Work Group" to proffer mobility alternative based on the perception of MIPv6 protocol [5]. That is to enhance the IP network, which is Mobile Router (MR) instead of a single host.

The major goal of Network Mobility (NEMO) is to specify a solution that allows Mobile Networks Nodes (MNNs) to remain connected to the Internet and to be continuously reachable while an MR serving the mobile network changes its position [4].

However, the solution must be dynamic to handle numerous forms of mobile networks configurations. Networks having several subnets and nested mobile networks can also be managed. To manage and maintain the mobility of a complete network, an MR is regarded as the main mobile access in the NEMO Basic Support (NEMO BS) scheme. MANEMO then introduced to use the infrastructure-less ability of the MANET [6] with global insistent availability feature of the NEMO [7].

MANEMO protocol is a layer three alternative to enhance Route Optimization (RO) plus multihoming [8] [7]. MANEMO offers a mechanism to choose a suitable routing path to an Exit Router Interface normally in the MANEMO Fringe Stub (MFS). IETF classified MANEMO alternative to two classes [8] which are, the NEMO-based MANEMO (NCM), and the MANET-based MANEMO (MCM).

Solutions for MANEMO have already been proposed within the IETF that is possibly related to ongoing work in IETF such as current routing protocols (i.e., OSPF), network mobility support (i.e., NEMO), MANET Auto Configuration (i.e., AUTOCONF), Mobile Ad-hoc Sensor Network (i.e., 6LOWPAN), and MNs and multiple interfaces in IPv6 (i.e., Monami6). This paper is arranged as follows: In Section II, we present an overview on our MROM scheme followed in section III by numerical modelling and analysis. In section IV we conclude our paper.

MANEMO ROUTING AND MULTIHOMING OVERVIEW

Recent literatures projected several concepts for new architectures that support mobile router handoff as the move between multiple wireless communications technologies [9] [10] [11]. A good example of the concept is the named data networking [33] [34]. Mobile routers with multiple interfaces can be multihomed to enhance network availability and balanced traffic load (load balancing)using flow distribution via concurrent connectivity during inter technology handoff.

While exploiting the importance of multiple router interfaces, this section gives a brief overview of the proposed Multihoming-based framework to enhance Mobility in a P network mobility (proposed MROM). [12]. Based on the framework, the Flow-centered Local Mobility Anchor Point), and itsServing mobile router function as an LMA and mobile router in PNEMO.

Also, in the framework, the existing Flow-enabled mobile router and its newly attached Flow-enabled mobile router functions as a auxiliary of MAG1 and MAG 2. Both CFMR with NFMR are responsiblefor locating the serving mobile router's handoff between multiple networks Type [13].

They also operate to distinguish and reach Mobile Network Prefix and its Home Network Prefix from a recognized message that is sent from the local HA (i.e. FLMA). Moreover, CFMR with NFMR exchange the framework of the serving mobile router via layer two activating mechanism. A framework with the network components and entities is presented in Figure 1.

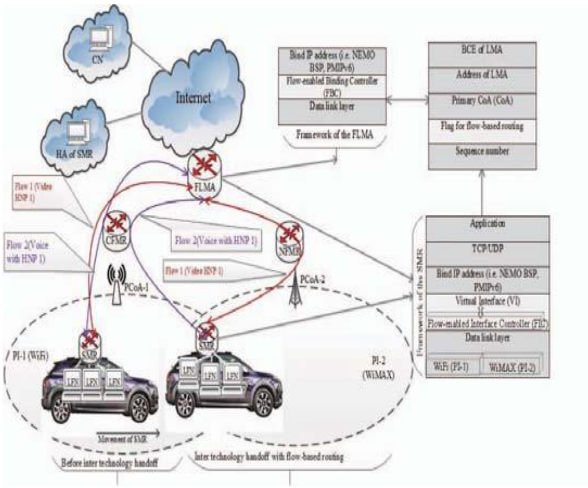

Figure 1. Reference Framework of PROPOSED MROM Scheme

The proposed scheme is better enhanced to help support the network-based mobility protocol in a NEMO BSP. The successive assessment is a summary of significant improvements for the proposed scheme. In the proposed scheme, CFMR with NFMR exchange messages of Handover Initiations along with Handover Acknowledgement (HAck) messages prior to layer two mobile handoff. This is to help assist the serving mobile introduced flow-based routing efficiently in a P network mobility environment. The handover initiation message accompanied accumulated packet of the serving mobile router like identification of the serving mobile router, Home Network Prefix, Mobile Network Prefix, flow address, Flow identification, precedence, application form flowand etc. This whole set of messages assist enabling the new flow mobile router to retransmit mandatory registration packets (message) with other options of MNP of serving mobile router for achieving location update procedure. For fast mobile registration, a prior substitute mandatory Update and prior substitute mandatory Acknowledgement messages are condensed inside a HI and HAck messages. Also, a novel mobility alternative known as Flow-centred Mobile Network Prefix is added in EPBU and EPBA information. This is simply to inform the routing links current status and to demand for operating the flow-centred routing at handoff in P network mobility environment.

ANALYSIS OF THE PROPOSED MROM

This section presents a mathematical scheme that is established to estimate network performance of the proposed MROM framework. The scheme is later benchmarked with standard network mobility BSP and P network mobility scheme [14], [15] and [16]. P-NEMO is compared with the proposed MROM because both schemes incorporates firmly engrained P mobile IPv6, that is a network centered mobility protocol in network mobility to solve mobility open issues. However, to differentiate and contrast, network mobility BSP is the benchmarked protocol for allmobility management support targeting network mobility. It is also the enhanced variety of the Mobile IPv6. The benchmarked metrics to compute performance of this frameworkare average mobile handoff latency and its influence on packet loss, signaling cost, and packet delivery cost.

Table 1. Notations Used for Analytical Evaluation

Symbols	Explanation
NSMR	Number of the SMR
NVR	Number of vertical road
NHR	Number of horizontal road
m	Number of APs in each row
n	Number of APs row
Yv	Vertical length of dissection area
xh	Horizontal length of dissection area
shd	Distance of horizontal road
Svd	Distance of vertical road
μh	SMR mobility rate
TSMR	Cell residence time
TLs	Link switching delay
Pwlr	ProbabiJjty of wireless link failure
Bw1	Bandwidth of the wireless link
Bwd	Bandwidth of the wired link
twl	Wireless link delay
td	Wired link delay
Hx-y	Hop distances between x and y
Lz	Length of the Z message
λs	Average Session Length
r	Radius of a cell
V	Average speed of vehicle
τ	weight factors of tunneling
ε	weight factor for the packet loss cost

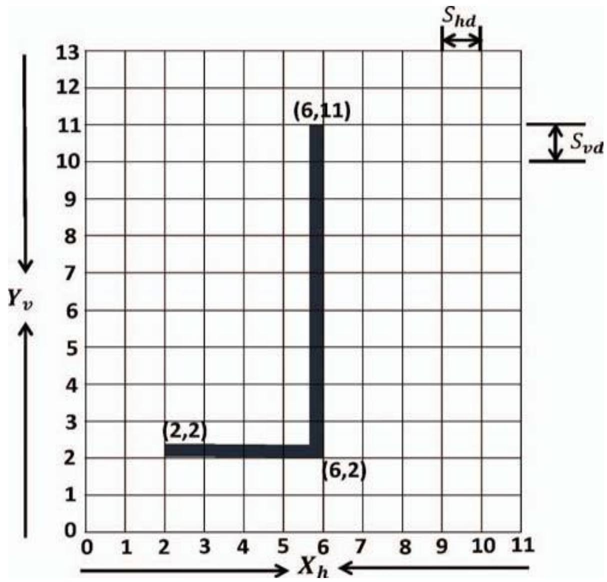

Figure 2. An example of Road using CSM Model

For the scheme's cell residence time in seconds, and mobility proportion of serving mobile router of a cell in CSM model shown in figure 2. The evaluation is expressed as:

$$T_{SMR} = \frac{E(t) + E(p)}{E(c)} \quad (1)$$

Where, E(t) and E(p) are the computed amount of serving mobile router's epoch time as well as pause time. The computed amount of SMR's cell intersecting epoch is represented as E(c). Then, It is projected that the mobile speed of the serving mobile is v. Hence, E(t) is computed as:

$$E(t) = \left(\frac{X_h \times (N_{vR}+1)}{3N_{vR}} + \frac{Y_v(N_{hR}+1)}{3N_{hR}}\right) \quad (2)$$

Based on equation two, the amount of horizontal with vertical mobile path road is denoted as N_{HR} and N_{VR}. whereas the horizontal and vertical dimention of separationpart is denoted as X_h and Y_v respectively. Thus, N_{HR} and N_{VR} are:

$$N_{hR} = \frac{X_h}{S_{hd}} + 1 \quad (3)$$

$$N_{vR} = \frac{y_v}{S_{vd}} + 1 \qquad (4)$$

From Equation three and four, the space between horizontal with vertical path (road) is denoted as S_{hd} and S_{vd}. becuase the unsystematic pause time of simulation is inbetween 0 to U_{max}. this is to eliminate collisions in both intersecting path, and hence E(p) calculated as:

$$E(p) = 0.5\, U_{Max} \qquad (5)$$

It is delibrated that, allfixed Access Points (AP) coverage distance is sphericalhaving radius r, and r > S_{hd} and r > S_{vd}. It is also presumed that, $2r = K1 . s_{hd} = k2 . v_{sd}$. For all the mobility activities around horizontal with vertical direction (i.e. Kl S_{hd} to 2Kl . S_{hd}), there must be maximum of multiple APs intersecting. Therefore, E(c) calculated as:

$$E(c) = \left[\frac{1}{6N_{vR}^2}\{(m^2 + m)K1(6N_{vR} - 4mK1 + 3)\}\right] + \left[\frac{1}{6N_{hR}^2}\{(n^2 + nK26NhR{-}4nK2{+}3\right. \qquad (6)$$

It is identified that predictableamount of APs intersecting limits with maximum numbers of Kl, K2 (i.e., $2r/S_{hd}$ and $2r/S_{vd}$). Higher amount of kl, k2 present larger distance area for APs, noting in minut amount of AP intersecting. however, predictable amount of APs intersecting incrises with the greater values of N_{HR} and N_{VR}. Greater values of N_{HR} and N_{VR} present limited coverage area for APs, leading to higher amount of AP intersecting. Also, it is also predicted that the access gateway node distance equate AP area. Therefore, the serving mobile router handoff rate (μ_h) is computd as:

$$U_h = \frac{1}{T_{SMR}} \qquad (7)$$

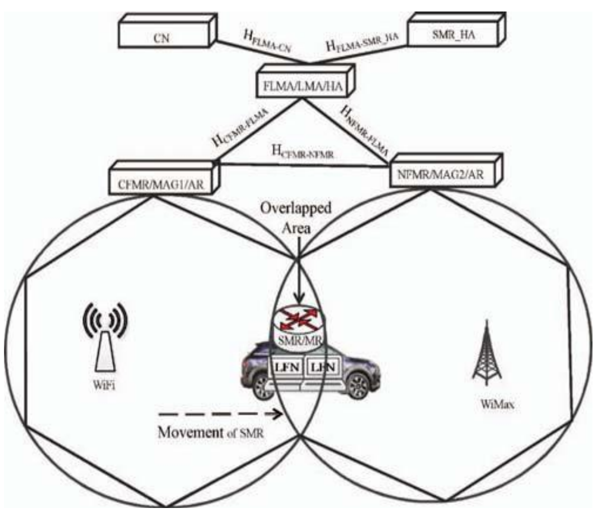

Figure 3. Analytical Framework of PROPOSED MROM Scheme

From figure 4, the total improvement of P-NEMO is reduced as τ increases, in which the proposed MROM maintains its value even when τ increases. This is as a result of tunneling issues in P-NEMO that has effect and can affect session continuity. Accordingly, the P-NEMO scheme and our proposed MROM presents better than other approach.

Therefore, it can be aded that from charatcer 4, the proposed MROM scheme can highl enhance handoff performance as compared to network mobility BSP and P network mobilityeven when T_{LS} and τ are increasing. This is also because, SMR can dividedthe request flow issues between several access experience when acheiving handoff.

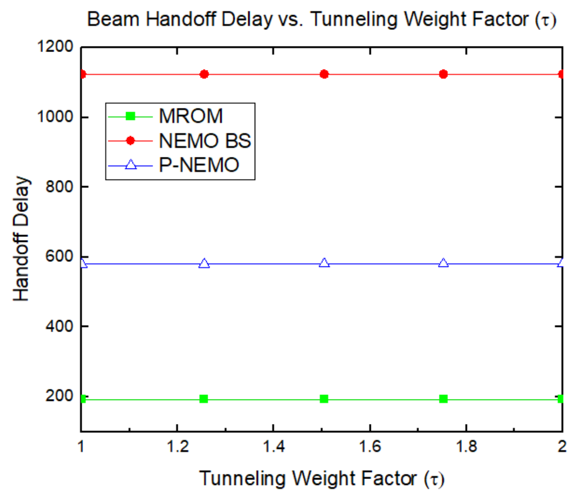

Figure 4. Handoff Delay Gain vs. Tunneling Weight Factor

In Figure 5, the quantity of lost packets during inter-technology handoff for all the schemes as shown in figure for different amount of serving mobile router and various cell residence time (T_{SMR}) as well. It can be deduced from Figure 5, the overall lost packets for all the schemes has increased as the SMRs change, and assign in less residence times (i.e. T_{SMR}=20 sec.). when the T_{SMR} value change between 20 to 100 sec, the serving mobile router surely stagnant in cell and cannot move to additional position. Thus, the lost packets at handoff is negligible as shown in Figure 5. Hence, lost packet is directly proportional to the mobile handoff interference time in seconds as defined in [12]. Therefore, handoff mode for the proposed MROM scheme present less packet loss when associated to P network mobility and network mobility BSP.

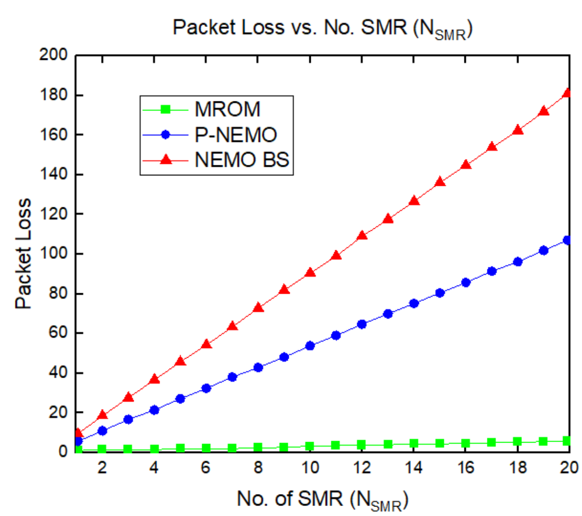

Figure 5. Packet Loss vs. Number of SMR (T_{SMR}=80sec.)

In figure 6, lost packets has risen at a proportionate rate in all the three outlines. Network schemes (i.e., the proposed MROM and P network mobility) presents better associated to the standard network mobility BSP. This is as a result of no mobile signaling through the wireless path (when λ_S rises). However, the proposed MROM utilizes limited amount of packets when associated to network mobility BSP and P network mobility. This is as a result of their support of multiple handoff in P network mobility. This explains that the proposed MROM is can function enhanced in real time network applications where interrupted packets are transmitted at sophisticated data rates.

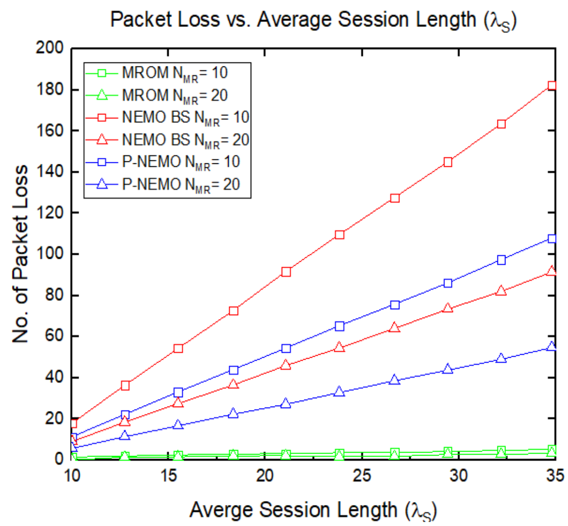

Figure 6. Packet Loss vs. Average Session Length (packets/flow)

CONCLUSION

Network Mobility has been an active research area recently [21] [22] [23] [24] and [25] including mobility management in named data networking [32] [33]. In this research, NEMO-BSP successor is presented and supported with a detailed numerical model analysis, where the presented MROM by maximizing the handoff performance,and has been justified to have better mobility support than benchmarked network mobility BSP and P network mobility.

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