Infrastructure Independent Mobility Support for Multiple Mobile Routers Multihomed NEMO Networks

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Abstract
The performances of the handover through the heterogeneous networks play a crucial role for OoS-sensitive applications and real-time services. Although, NEMO BS protocol has the merit to allow today the deployment and the experimentation of non-temporal constraints services, without having to function in a degraded mode, its performances (high latency, high packet loss and the important signaling cost) are clearly non-optimal and consequently it is considered non-suitable for time constraints applications. Several architectures and mechanisms were proposed to optimize the performances of NEMO handover. However, these optimizations remain insufficient to meet the needs for the applications to critical performance. This paper proposes a mobility support for multihomed NEMO networks when several mobile routers are deployed. A proactive approach consisting in carrying out soft handover (Make Before Brake) is adopted, leading to the availability of several tunnels simultaneously which will be used according to the management of mobility. A performance evaluation under NS2 making it possible to validate the model suggested is envisaged.

Keywords: *Network mobility, NEMO, Multihoming, Mobile Router, seamless handoff, IEEE 802.21, MIH triggers, NS2, NMG, MoM*

1. Introduction

Multihoming [1] is a promising solution to provide an omnipresent Internet service and other advantages as load-sharing [2]-[4], fault-Tolerance/redundancy [5], Policy-based Routing [6]-[8] and so on. Today, multihoming in NEMO networks constitutes a solution for important research which objective is to provide solutions for mobility management that ensure a permanent internet connectivity, at anytime, anywhere. Thus, NEMO support combined with multihoming constitutes the missing part which will enable us to be permanently connected to Internet without service interruption.

To reduce the impact of NEMO handover on OoS-sensitive applications and real-time services, several proposals for NEMO performance optimization were made [15]-[19]. The solutions suggested in this context suffer from several limitations. On one hand, they are dependant either on the infrastructure network or of deployed NEMO application. On the other hand, the performances carried out are subjugated with certain parameters of the environment.

The objective of this paper is to suggest a new mobility support (NEMO BS protocol extension) for the context of multiple mobile routers multihomed NEMO network. Such context means that NEMO network has several mobile routers (MR) of which each one presents a single external interface and admits a Home Agent (HA), but only one MNP prefix is used.

Our aim is to develop an infrastructure independent solution. For that, we move towards an intelligence located in the centre of NEMO network itself. To take the totality of mobility decisions, we introduce a central entity (intelligent router) within the NEMO network, which will play the role of a Gateway between embarked MNNs and MRs. We called this entity NMG (NeMo Gateway), it is responsible of handovers management and traffic distribution between the MRs, in a transparent way for the MNNs inside the NEMO network. All the traffics (sent and received) of MNNs pass through the NMG, all the mobile routers of NEMO network are connected to NMG either wired or wireless. So, NMG has multiple interfaces, we will use the standard IEEE 802.21 [9] especially remote MIH services to manage the MRs.
In the proposed solution, we will adopt a proactive approach which consists at executing soft handovers (Make Before Brake) conducting to the availability of several tunnels simultaneously. Thus, the breakdown of an active link for a given MR causes only a swing in the traffic via another MR having a previously established tunnel.

The paper is organized as follows. Section 2 gives a brief description of our proposed mobility support. Protocol

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details are presented in Section 3. Simulation results are presented in Section 4. Section 5 concludes the paper.

2. Description of the Proposed Mobility Support

To overcome the lack in multihoming support within the MEMO BS protocol [14], we introduce a new approach for the network mobility by suggesting a central gateway inside the mobile network to ensure the management of the mobility.

2.1 NMG gateway

In our proposition**,** the NMG (NeMo Gateway) will be the unique default gateway for all the MNNS. All the MNNs outbound traffic like the inbound traffic intended to MNNs must pass through the NMG (Figure 1).
Mobile NEMO network accepts a primary MR mobile router and one or several secondary MRs. The Home Agent (HA) of the Primary MR is called the Primary HA.
The MNP prefix delegated to the primary MR is also transmitted to NMG, which announces it to MNNs nodes. Inside the NEMO network, MRs can only communicate with NMG router (they must not communicate neither with each other nor with the MNNs). Once a failure within the actual used path to internet is detected, one of the registered MRs and possessing a tunnel to the primary Home Agent should replace the MR which link with the access network is broken down (the MR for the replacement is called substituent).
The NMG gateway has the responsibility to choose and to set out the MR router substituent on the base of the data it keeps concerning all the MRs. For this purpose, we plan a module to be implemented at NMG level which we call MoM (Mobility Management).

The main idea behind our proposal is, if possible, to save and to establish tunnels in advance between each secondary MR and the HA of the primary MR to use them when the primary MR (or a secondary MR) with an operational open tunnel becomes out of service or loses connectivity to the access network (Figure 1).

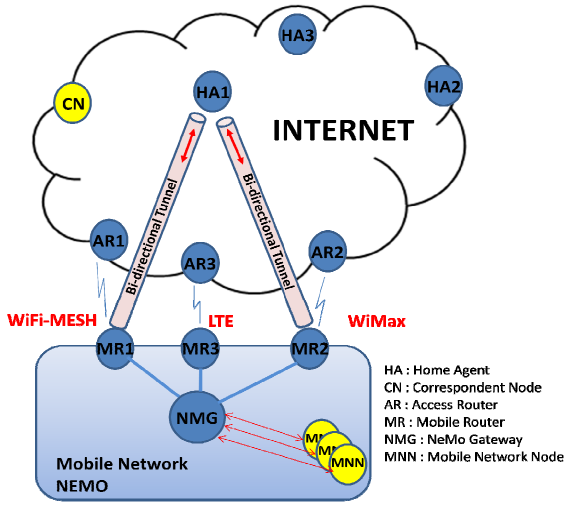

Fig. 1 – Diagram architecture for the proposed mobility support

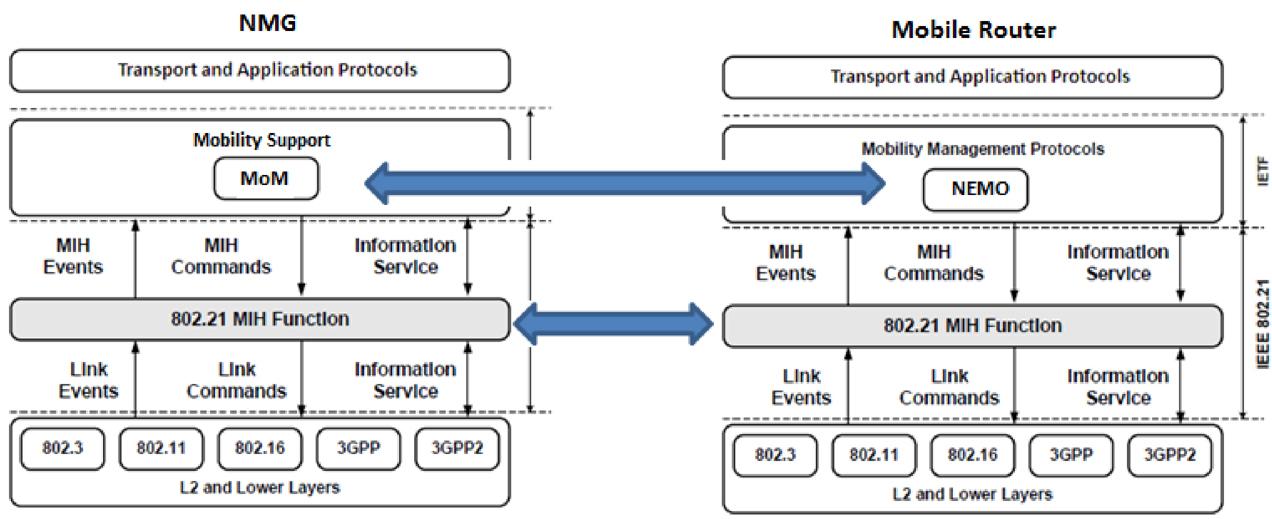

Fig. 2 – Architecture of the mobility stack for MRs and NMG

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2.2 MIH IEEE 802.21 services

In this work, we take as a base the defined and specified mechanism in the IEEE standard 802.21 [9] to develop our proposition. The MIH services of this standard allow us to assist the NEMO in its tasks such as environment detection. We will use the local and remote MIES and MICS services at the level of each MR and at the level of NMG.

The local services allow detecting the changes in MRs links' states, to activate the triggers associated. The remote MIES services allow MRs the notification of NMG gateway of the events associated to links occurring at their level; in the other hand the NMG may use the remote MICS services to obtain the needed information on the MRs links' states and their quality and characteristics.
The following MICS and MIES services are used in this approach:

- MIH_Link_Down service: locally, this service is used by the MRs and the NMG to notify the local MIHF from in internal link breakdown. The NMG will use the local service to detect the inaccessible or out of service MRs. In remote, the MRs use this service to inform the MIHF of NMG about the external link breakdown.

- MIH_Link_Going_Down service: used only in remote by the MRs to notify the MIHF of NMG when an external link is about to break down.

- MIH_Get_Status service: used only in remote by the NMG to request MIHF of MRs about the state of its external link.

- MIH_Get_Information service: is employed in remote by the NMG to request MIHF of a MR for information in relation to a specific interface. The type of information requested is specified by the IE (Information Element) parameter.

We note here that all MRs belonging to the NEMO network are registered at the NMG level (e.g., by physical addresses) and their internal interfaces (ingress interfaces) are configured with IP addresses from the delegate MNP prefix, so that they are easily authenticated.
We have defined at the NMG level a cache named NMGcache (Table 1) to maintain the necessary information concerning all MRs in NEMO network. Each cache entry contains the following fields:

MR	Type	HoA	CoA	Tunnel Status	Active
MR1	1	HoA1	MR1 CoA	1	1
MR2	0	HoA2	MR2 CoA	1	0
MR3	0	HoA3	MR3 CoA	0	0

Table 1 – NMGcache at NMG level

MR MAC field: the ID of the MR (for example, the physical address of the ingress interface)

- MRType Field: Primary MR (value 1) or secondary MR (value 0)
- HoA Field : MR Home Address
- CoA Field : the CoA obtained address by MR (defining its present location)
- Tunnel Status field: value 1 for an established tunnel or value 0 for a tunnel non yet established
- Active field : shows if the tunnel is actually active (value 1) or not (value 0)

3. Proposed mobility support operations

3.1 Procedure for the registration of a new MR substituent

Let's consider the example in Figure 3, where the parent network (Home network) is the WiFi-Mesh network and MR1 is the primary router. Assuming the secondary mobile router MR2 got a temporary CoA address on the WiMax access network and established a tunnel with its HA2 Home Agent. The mobile router MR2 then notifies the NMG of this tunnel establishment by using an authenticated message including the following information:

- The address of the MR2 in its parent network (being HoA2)
- The obtained CoA address
- a Nonce (random integer number) used as a return routability control.

For this notification, we use the New_tunnel_Notification message, which is sent by the management module of the NEMO mobility at MR2-level to the MoM module at the NMG level.

The New_tunnel_Notification message is processed differently by NMG depending on whether the source is a primary or secondary MR. We immediately explain the treatment to the cases where the sender is a secondary MR, and the case where the sender is the primary MR will be explained later.

New_tunnel_Notification message sent by MR2, NMG updates MR2 entry of its NMGcache. Then, it transmits to MR1 the obtained information from MR2 requesting it to communicate the information to its Home Agent to carry out the registration of MR2 as a substituent of MR1. This request is done by sending a New_Sub_Reg message by the MoM (NMG) to the NEMO module of MR1.

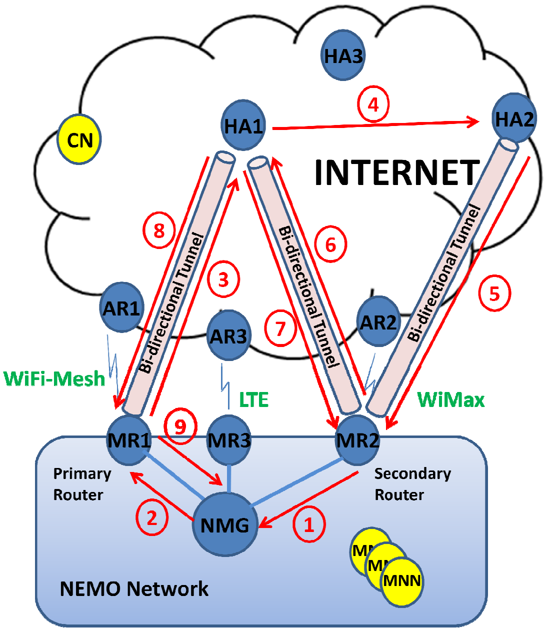

Fig. 3 – Mobility support principles based on NMG

1	New_tunnel_Notification
2	New_Sub_Reg
3	Sub_Reg_Request
4	Sub_Reg_Invite
5	Sub_Reg_Invite
6	Substitute_ BU
7	Substitute_BACK
8	Substitute_Reg_Notification
9	Substitute_Reg_Confirmation

The MR1 Router in its turn sends to its Home Agent HA1 a Sub_Reg_Request message containing information sent by NMG. Upon receiving this message, the HA1 sends to MR2 a message of invitation to registration (Sub_Reg_Invite).

This message includes the following information:

- prefix MNP delegated to MR1
- the Nonce generated by MR2
- a Nonce generated this time by HA1

This message arrives at MR2 via its Home Agent HA2. MR2 checks the validity of the message. If the message is valid, it answers HA1 with a Substitute_ BU message (substitute Binding Update) including:

- Its temporary address CoA
- MNP prefix
- the Nonce generated by HA1

After checking the validity of this message, HA1 registers MR2 as a substituent for MR1 in its binding cache and sends to MR2 a message Substitute_BACK (substitute Binding Acknowledgement). In parallel, HA1 sends a Substitute_Reg_Notification message to MR1 to inform it that MR2 was registered as a substituent. This information is immediately forwarded by means of a Substitute_Reg_Confirmation message to NMG which updates its NMGcache. This process is illustrated in Figure 4.

The tunnels established with HA1 are either on open state or a closed state according to whether the tunnel is currently used to convey the traffic or not. The new tunnel established between MR2 and HA1 is initially put on the closed state, expecting an order of switching to make it swing to the open state. A possible scenario is the case where primary router MR1 has no link with the access networks, and that NEMO network is being served by one of its secondary mobile routers. In this case, when MR1 establishes a new tunnel with HA1, this latter is put automatically at the opened state by HA1. The New_tunnel_Notification message sent by MR1 to NMG simply induces a shunting by NMG of the outgoing traffic (outbound) on MR1.

Unless a policy of routing is being implemented at the level of the HA1, this latter should always use by priority HA1-MR1 tunnel (primary tunnel).
The tunnel already open with secondary MR can either be used simultaneously with the primary tunnel or simply closed.

3.2 Changes at the level of the Binding Cache

In NEMO BS [14], a mobile router can register only one CoA address at its HA. Consequently, the registration of multiple CoAs with only one HoA address is not possible. In order to settle this problem and to allow the secondary mobile routers to be registered at HA1 of the primary mobile router, we have modified the structure of the binding cache of HA1 to take into account the information on the possible mobile substituent routers.

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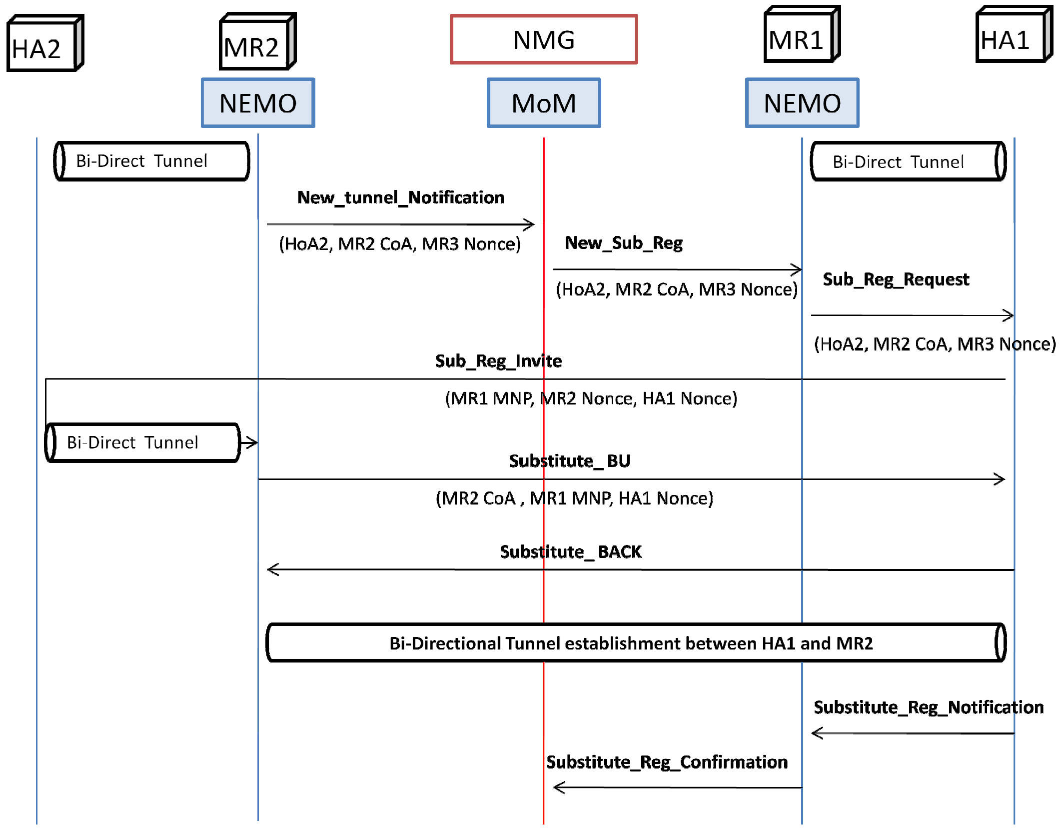

Fig. 4 – Procedure of MR substituent registration

We have added three fields (Table 2):

- Type: This indicates if the registered MR is primary (value 1) or secondary (value 0).
- Tunnel: This indicates if this tunnel is open (value 1) or closed (value 0) to the data traffic. Once established, the tunnel is by default open to the signalization traffic and closed to the data traffic.

Prefix	CoA	Type	Tunnel
MNP	MR1 CoA	1	1
MNP	MR2 CoA	0	0
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Table 2 – New Binding Cache
for the CoAs multiple registration support

3.3 Link break down detection

We use the approach based on MIH_Link_Going_Down service for the breakdown detection of MR links presenting open tunnels with the primary HA. In this approach, in order to activate the tunnel of a MR substituent before the activation of LD trigger, we use the Link_Going_Down (trigger LGD) event allowing the prediction of the links break down. The LGD trigger will be used with a preset threshold:

$$P_{rx} < \alpha_{LGD} P_{th}$$

where P_{rx} is the received signal strength (RSS)
P_{th} is the threshold strength below which the link is considered broken down
α_{LGD} is the LGD coefficient slightly superior to 1 (typical values: 1.05, 1.10, …)

So, in the same manner, if a LGD event is generated by the external interface of a MR, the MIHF of the MR sends this event (remote MIH_LinkGoing_Down) to the MIHF of NMG, this latter notifies immediately the MoM module.

4. Handover soft procedure (tunnel switching)

Let's consider again the example in Figure 3. Assuming that the moving of NEMO network makes its primary MR

(MR1) at the point of losing the connectivity with its actual access network (MIH_Link_Going_Down Event). When the NMG detects this event by means of MoM module, it looks immediately in its cache NMGcache the available MRs substituent (Tunnel Status = 1, Active = 0), it selects one following a predefined policy (for example following the pass-band or the earliest one,...) and it sends it a message Tunnel_Activation_request asking it to request the HA1 (the primary HA) the opening of the associated tunnel (Figure 5).

Assuming that NMG choses MR2 to replace MR1. The NMG sends, therefore, the message Tunnel_Activation_Request to MR, this latter sends in its turn a message Tunnel_Opening_Request to HA1 indicating the parameters and the reason of this request (tunnel MR1_HA1 inaccessible). At the reception and the validation of this message :

- HA1 opens the tunnel HA-MR2 in both direction by which the traffic coming from or going to NEMO network is immediately transmitted.
- HA1 sends to MR2 a Tunnel_Opening_Replay

Once MR2 received a message Tunnel_Opening_Replay (Successful Operation), it replys the NMG with a message Tunnel_Activation_Replay.

The HA1 will use simultaneously the tunnels HA1-MR1 and HA1-MR2 until the confirmation of the HA1-MR1 tunnel breakdown. HA1 will employ a special process: the tunnel survivability test; it sends to MR1 a message Tunnel_Alive_Request. If the MR1 has not lost its link with the access network, it replies by the message Tunnel_Alive_Replay.

The HA1 will repeat this test during a definite delay that we called AliveTestDelay (30 s by default). The repletion period is fixed at 3s. If at the expiration of this delay, the MR1 still replies, so the HA1 maintains the HA1-MR1 tunnel and could close or not the HA1-MR2 tunnel following the routing strategies implemented at the HA1 level (bicasting, load share, applications preferences, ...). If in the contrary, before the expiration of the AliveTestDelay the HA1 router doesn't receive successively three messages Tunnel_Alive_Replay, it concludes that MR1 has lost its link with the access network; HA1, thus, deletes the corresponding entry to MR1 of its binding cache. Figures 6, 7 and 8 give in notation Abstract Protocol Notation [13], the executed algorithms respectively by a MR (NEMO module), the primary HA (NEMO module) and the NMG (MoM module) at the present extension framework.

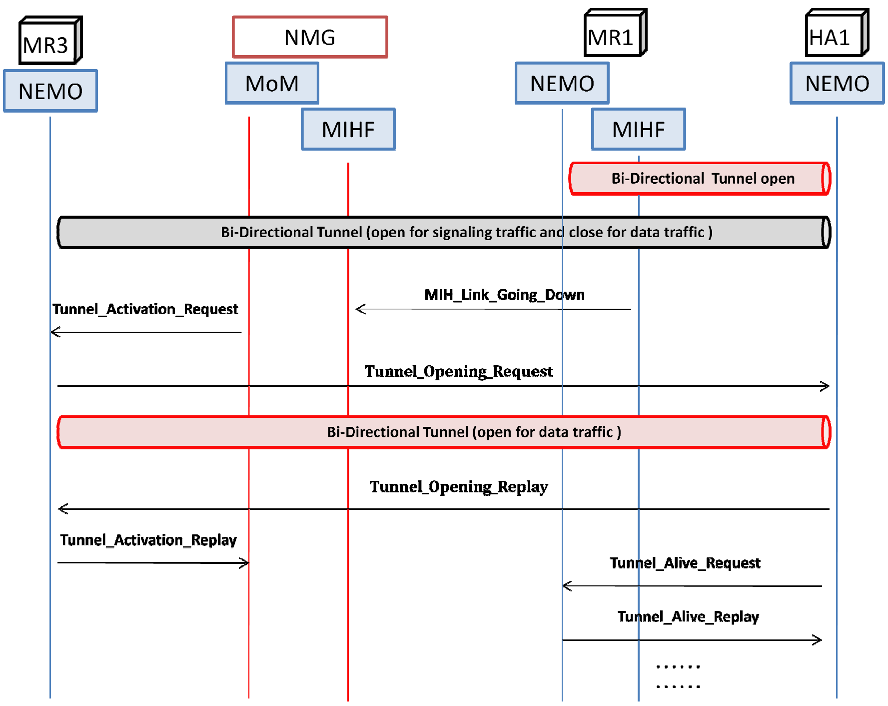

Fig. 5 – Tunnel opening procedure for data traffic

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```
bool newTunnel;
integer MRType; (Primary : 1, Secondary: 0)

newTunnel →
send New_Tunnel_Notification to NMG

receive Sub_Reg_Invite from primary HA→
  if (MRType==1) then
    discard message;
  else
    if (message valide) then
      send Substitute_BU to primary HA ;
    else
      discard message;
    fi
  fi

receive Substitute_BACK from primary HA→
  if (MRType==1) then
    discard message;
  else
    establish bi-directional tunnel with primary HA;
  fi

receive New_Sub_Reg from NMG →
  send Sub_Reg_Request to primary HA ;

receive Substitute_Reg_Notification from primary HA→
  send Substitute_Reg_Confirmation to NMG ;

receive Tunnel_Activation_Request from NMG →
  if (MRType==1) then
    discard message;
  else
    send Tunnel_Opening_Request to primary HA ;
  fi

receive Tunnel_Opening_Replay from primary HA →
  if (MRType==1) then
    discard message;
  else
    send Tunnel_Activation_Replay to NMG ;
  fi

receive Tunnel_Alive_Request from primary HA →
  send Tunnel_Alive_Replayt to primary HA ;
```

Fig. 6 – Executed Algorithm by a MR (NEMO module)

```
receive Sub_Reg_Request from MRi→
  generate HA's Nonce;
  send Sub_Reg_Invite to MRj (using HoAj);

receive Substitute_BU from MRj→
  if (message valide) then
    update binding cache;
    send Substitute_BAck to MRj (using CoAj);
    send Substitute_Reg_Notification to MRi ;
  else
    discard message;
  fi

receive Tunnel_Opening_Request from MRj→
  open MRj for data traffic;
  send Tunnel_Opening_Replay to MRj ;
  start survivability test;
```

Fig. 7 – Executed algorithm by the primary HA (NEMO module)

```
bool primaryMR; (true, false)

receive New_Tunnel_Notification from MRi→
  if (PrimaryMR) then
    switch traffic to primary MR;
  else
    lookup in NMGcache for Active Tunnel (say MRj);
    send New_Sub_Reg to MRj ;
  fi

receive Substitute_Reg_Confirmation from MRj→
  update NMGcache;

receive remote MIH_Link_Going_Down from MRi →
  lookup in NMGcache for available tunnels (Tunnel
status=1);
  select the most recent tunnel (say MRi);
  send Tunnel_Activation_Request to MRi;

receive Tunnel_Activation_Replay from MRi→
  update NMGcache;
  forward outbound traffic via MRi;
```

Fig. 8 – Executed algorithm by the NMG (MoM module)

5. Implementation and Performance Evaluation

5.1 Implementation under NS2

The implementation is done under NS-2.29 version [10] including the MIH package of NIST [11]. In one hand, we created a C++ MoMAgent inheriting from the Agent class of NS-2 [12], to assume the mobility management at the NMG entity level. The implemented messages are: New_Sub_Reg, Tunnel_Activation_request, and Tunnel_Activation_Replay.

In addition, we have brought modification on the NEMO agent implemented at the MR and HA levels to assume the registration mechanism of multiple CoAs of secondary routers and tunnel switching, we have modified the HA cache and added the following messages:

New_tunnel_Notification, sub_Reg_Request,
Substitute_BU, Substitute_BACK,
Substitute_Reg_Notification, and
Substitute_Reg_Confirmation.

5.2 Simulations

The simulations are conducted under NS2 to evaluate the performances and to validate the introduced mobility support.
The topology of the simulated network is presented in Figure 9, where a hierarchical addressing [12] is adopted:

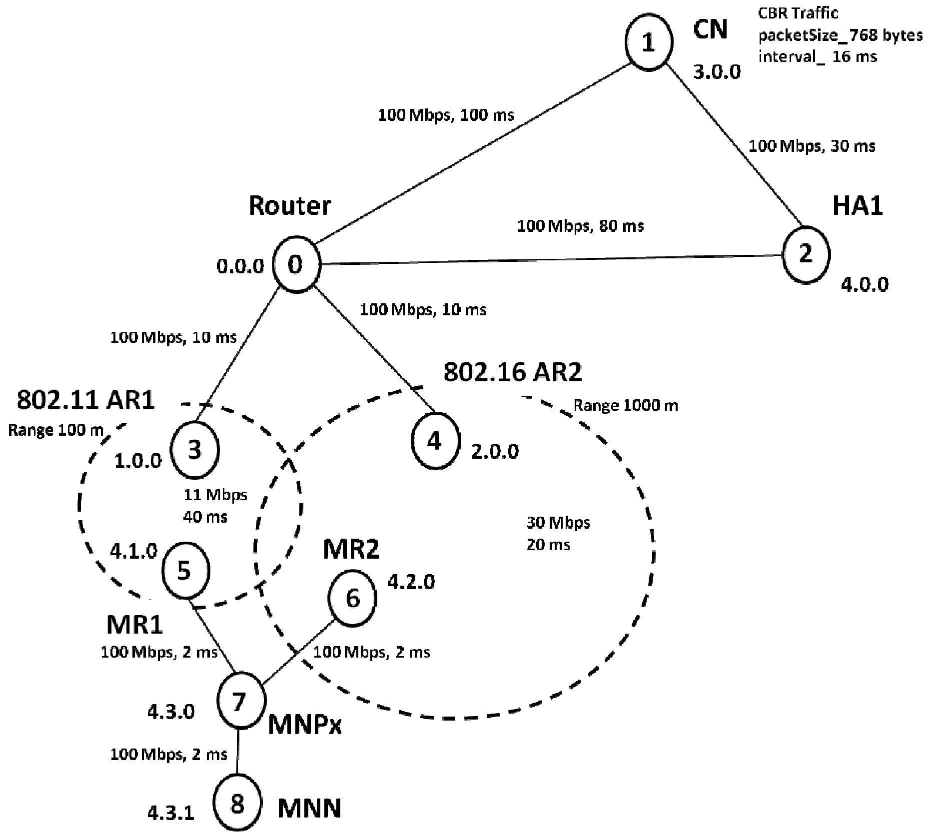

Fig. 9 – Topology of simulated NEMO network

- Node 0: a router (0.0.0) presenting four wired interfaces
- Node 1: a corresponding node CN (3.0.0).
- Node 2: the HA1 Home Agent (4.0.0) of the primary router MR1.
- Node 3: a base station IEEE 802.11 (access router AR1 (1.0.0)) with a coverage of 100m.
- Node 4: a base station IEEE 802.16 (access router AR2 (2.0.0)) with a coverage of 1000m.
- Node 5: the primary mobile router MR1 (4.1.0) presenting two interfaces: an external interface (802.11) and an internal interface (802.3) linked to NMG.
- Node 6: a secondary mobile router MR2 (4.2.0) presenting two interfaces: an external interface (802.16) and an internal interface (802.3) linked to NMG.
- Node 7: the NMG router (4.3.0) presenting three wired interfaces (802.3).
- Node 8: an MNN (4.3.1) linked directly to NMG.

The characteristics of the links and those of the bandwidth as well and the delay are referred in Figure 9. A streaming traffic CBR is sent by the CN towards a node MNN of the NEMO network (PacketSize = 768 bytes, Interval = 16 ms). The simulation time is fixed at 20s.

The NS-2 simulator doesn't withstand the mobility of a full network, for this reason we have emulated the movement of NEMO network by reducing the emission power of the base station IEEE 802.11 (access router AR1 (1.0.0)). Following the importance of the caused power, we activate either trigger LGD or trigger LD.
We consider the following simulation plan:
At the beginning of the simulation (from t=0 to t=5s), NEMO network has a single link with the internet network, the link with the base station 802.11 (AR1), the base station 802.16 being deactivated. Consequently, a single tunnel is available, the one established between MR1 (the primary router) and its HA.
At t= 5s, the base station 802.16 is active, a second tunnel is established between the secondary router MR2 and the HA, MR2 is registered in HA as a substituent of MR1.

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At t=10s, we activate the trigger Link_Going_Down at MR1 level, and this by reducing suitably the emission power of the base station IEEE 802.11.

Then, at t=10 s, t= 10.05 s, t= 10.1 s, t = 10.15 s, t = 10.2 s, …., t = 10.5 s, in the same way with the previous, we activate the trigger Link_Down to scan the rang [0,500 ms] of the possible values for the TimeInterval parameter associated to LGD trigger. This manipulation will allow us to determine the threshold for which it is possible to ensure a seamless connectivity.

5.3 Results

We have presented in Figure 10, the services interruption time according to TimeInterval parameter. It is determined by the past time between the reception of the last data packet (traffic CBR) via MR1 and the reception of the first data packet via MR2.
It is obvious that the connexion delay is inversely proportional to TimeInterval, more this latter increases, more is the chance to finish the tunnels switching operation before the current link breaks down.

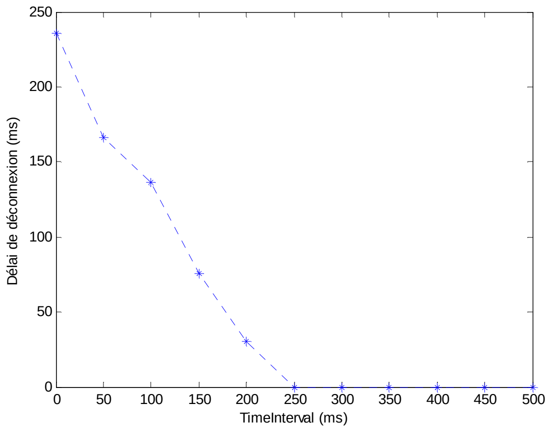

Fig. 10 – Services interruption delay vs TimeInterval parameter (LGD trigger)

Value 0 for TimeInterval means that the used trigger for the activation of the tunnel commutation is the Link_Down, i.e. we are dealing with a hard handover.
We note the threshold value of 250 ms for the TimeInterval, for which the disconnection delay is null. For applications such as the vision conference and the voice on IP (VoIP), a delay of 50 ms is tolerable [20], thus a threshold of 200 ms for TimeInterval can be kept. Notice that we have used a RTT maximal value between AR2 and HA given by the reference [21], that is 200 ms.

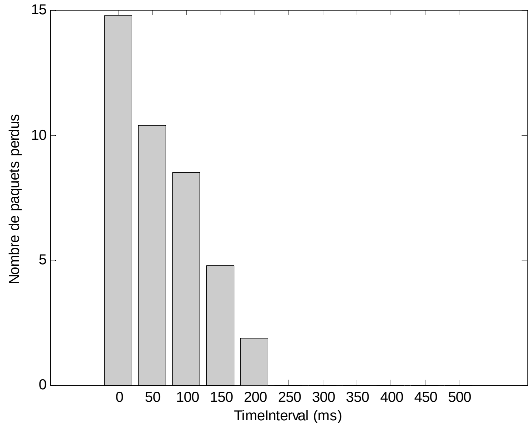

Fig. 11 – Packets loss vs TimeInterval parameter (LGD trigger)

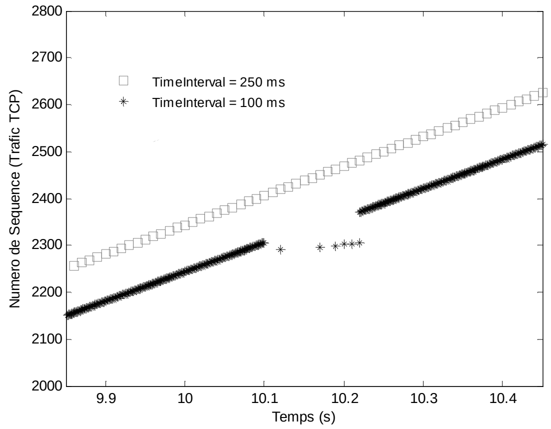

Fig. 12 – Highlighting the interruption by sequences number

Figure 11 represents the number of the lost packet according to TimeInterval. We can determine this by making the difference between the sequence number (TCP packet) and the first packet of the received data after re-establishing the connection and the sequence number of the last data packet received before disconnecting. An example is illustrated on Figure 12.

We notice a maximal loss of 15 packets for the case TimeInterval = 0. If we make a comparison with the NEMO BS protocol [14], with the same application CBR (PacketSize = 768 bytes, Interval = 16 ms), handover of this latter for an average time of 1250 ms will generate a loss of about 78 packets.

The representation of the received traffic flow (Throughput) measured at the MNN level is given at the figure 13 for the TimeInterval values: 0 ms , 100 ms and 250 ms. The curves form of this figure confirms the results obtained previously.

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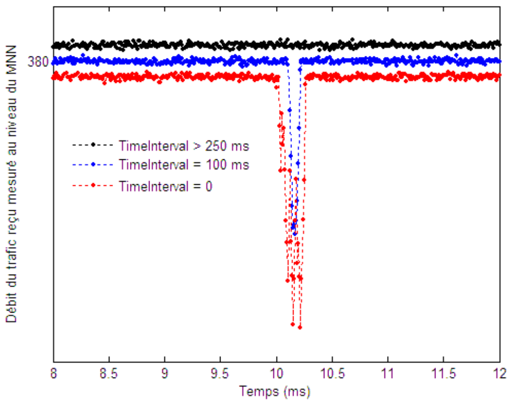

Fig. 13 – Throughput vs TimeInterval (LGD trigger)

6. Conclusion

In this paper, we have described a new approach for mobility management in multiple mobile routers multihomed NEMO context. The proposed solution is infrastructure independent; it doesn't require any change in Internet architecture, while ensuring a seamless connectivity to meet real time applications needs and demands in QoS. We considered a multihomed NEMO network with several MRs domiciled in different HAs. This architecture is based on the introduction of the notions of primary router and secondary router, and the integration of a new entity called NMG (NeMo Gateway) inside the mobile network, playing the role of a gateway between the embarked MNNs and the MRs, and which the principle task is the management of handovers using local and remote MIH IEEE 802.21 services. We extended the NEMO BS protocol by the registration support of the secondary routers (substituent MRs), and of the tunnel switching support.

References

[1] C. Ng, E. Paik, T. Ernst, M. Bagnulo, “Analysis of Multihoming in Network Mobility Support,” IETF, RFC 4980, October 2007.
[2] E. K. Paik, H. S. Cho, T. Ernst and Y. H. Choi, "Load sharing and session preservation with multiple mobile routers for large scale network mobility," The proceedings of AINA 2004: Page(s):393 - 398 Vol.1.2004.
[3] F. Guo, J. Chen, W. Li, and T. Chiueh, ”Experiences in Building A Multihoming Load Balancing System,” Proc. of IEEE INFOCOM 2004, Mar 2004.
[4] S. H. Cho, J. K. Na and C. K. Kim, "A dynamic load sharing mechanism in multihomed mobile networks," ICC 2005 16-20 May 2005 Page(s):1459 - 1463 Vol. 3. 2005.
[5] R. Kuntz and J. Lorchat. Building Fault Tolerant Networks using a multihomed Mobile Router: a Case Study. In Asian Internet Engineering Conference (AINTEC) 2006, Bangkok,Thailand, November 2006.
[6] K. Mitsuya, K. Tasaka, and R. Wakikawa. A Policy Data Set for Flow Distribution. Internet Draft draft-mitsuya-monami6- flow-distribution-policy-02.txt, October 2006.
[7] C. Park, N. Choi, E. Paik, T. Kwon and Y. Choi, “Multiple Interface/Prefix Selection for Virtual Mobile Networks”, ICACT, February 2008.
[8] IETF, Internet Draft, Feb. 2004.Q. Wang, R. Atkinson, and J.Dunlop, “Towards Always Best Connected Multi-Access: the MULTINET Approach”, IWCMC '08. August 2008.
[9] IEEE 802.21-2008, Media Independent Handover Services. 2008.
[10] NS-2 Network Simulator, http://www.isi.edu/nsnam/ns
[11] The Network Simulator NS-2 NIST add-on—IEEE 802.21 model (based on IEEE P802.21/D03.00), National Institute of Standards and Technology (NIST), January 2007.
[12] The VINT Project. The ns Manual. http://www.isi.edu/nsnam/ns/ns-documentation.html.
[13] M. G. Gouda, “Elements of Network Protocol Design,” John Wiley and Sons, 1998.
[14] V. Devarapalli, R. Wakikawa, A. Petrescu, and P. Thubert, "Network Mobility (NEMO) Basic Support Protocol," IETF, RFC 3963, January 2005..
[15] Dinakaran M, P. Balasubramanie, ” Performance Tuning of Data Transfer in Vehicular Networks”, IJCSI -Volume 9, Issue 1, pp.350-356, January 2012.
[16] Q.B Mussabbir, W. Yao. Optimized FMIPv6 using IEEE 802.21 MIH Services in Vehicular Networks. IEEE Transactions on Vehicular Technology. Special Issue on Vehicular Communications Networks, 2007.
[17] H. Lin, H. Labiod. Hybrid handover optimization for multiple mobile routers-based multihomed NEMO networks, in: Proceedings of IEEE International Conference on Pervasive Service, Istanbul. 2007.
[18] Z. Huang, Y. Yang, H. Hu and K. Lin. A fast handover scheme based on multiple mobile router cooperation for a train-based mobile network Int. J. Modelling, Identification and Control, Vol. 10, No. 3/4, pp 202-212. 2010.
[19] G. Jeney, L. Bokor and Z. Mihaly. GPS aided predictive handover management for multihomed NEMO configurations. 9th International Conference on Intelligent Transport Systems Telecommunications, pp 69-73. 2009.
[20] Neal seitz, ITU-T QoS Standards for IP-based Networks. Standards Report, IEEE Communications magazine, June 2003.
[21] Details for North Americ Internet Traffic Report. 2012 http://www.internettrafficreport.com/namerica.htm

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