Proposal of Collective Handover Processing Method Utilizing Network Mobility (NEMO) in SDN environment

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Abstract

NEMO is a mobility management theory for processing large scale handovers. It was proposed on the basis of Mobile IP but various research was done to make it possible to utilize in various environments. SDN is a network in which the program with the control plane and data plane separated is possible, and it is a network structure that conducts centralized management. OMM, a variation of the PMIPv6 to suit the SDN environment, was made to operate over the controller after regarding management functions as one application. This paper proposes a large scale handover processing theory that applies the NEMO technique in an OMM environment. The theory has the NEMO concept applied to OMM. Through this, we propose processing collective handovers by processing MN's collective handovers as network topology changes in SDN environments. Furthermore, the proposed theory reduced overheads. Also, the fundamental SDN structure was kept and more efficient data forwarding was made possible by utilizing the technique used in OMM.

***Keywords**: Network Mobility, OpenFlow-based mobility management, Proxy Mobile IPv6, OpenFlow, Software Defined Networking*

1. Introduction

Mobility management is one of the most important internet research fields. Among this Network mobility(NEMO)[1] was proposed as research about collective handovers. It is a concept that processes collective mobility management. NEMO was joined with diverse mobility management theories and MIP based handover support protocol[2][3] and a classic case is Network Mobility Support Scheme on PMIPv6 networks[4].

Proxy MIPv6(PMIPv6)[5] is a local mobility management protocol, and it is proposed by the IETF NetLMM working group. It's main characteristic is that the mobility related processes which used to be done by MN is now done by the network entity.

Software Defined Networking(SDN) is a network structure in which a program with the data plane and control plane separated is possible. The data plane is only in charge of functions related to the transfer of data packets and the OpenFlow-enable switch performs this function. The control plane is the aggregation of the remaining distributed network management functions such as topology management, QOS, path setup, etc. and is performed by the centralized controller. Additionally, OpenFlow[6] was proposed as the standard interface for the interaction of the two separated planes. OpenFlow consists of OpenFlow protocol, the security channel which connects the controller and switch, and the switch which satisfies OpenFlow spec.

OMM[7], a variation of PMIPv6, is a form adjusted to fit the SDN environment. Under the SDN environment, the central controller is the most suitable to perform the functions previously done by the network entities of PMIPv6(LMA, MAG), so a method that runs over the central controller after uniting LMA and MAG into one application was proposed. Furthermore a more efficient data path will

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be set up by network topology information between each GW and AS that is based on network topology information in the MME.

The proposed scheme is large scale handover of MN using NEMO. The proposed scheme supports network based mobility management in the SDN environment. It is based on the modified data structure in the MME based of the OMM. The proposed theory has one MME and has no need for an additional mobility management control message between mobility management components. Additionally, tunneling overhead is removed by removing the tunneling method between network components. The proposed theory uses the flow matrix that was previously used in OMM but was modified to fit the mobile router.

2. Related Works

PMIPv6 is a representative mobility management protocol based on Local based on the network. It consists of 2 network components(LMA and MAG). LMA acts as the Home Agent in MIPV6. It allocates MN's NHP and takes charge of one end of the IP tunnel for the transfer of data about MN. MAG checks MN's movement and attachment and is in charge of the other end of the tunnel. The basic concept of PMIPV6 is to conceal MN's mobility from MN itself and replacing MN by the network entity when mobility related signaling.

Network Mobility(NEMO) Basic Support Protocol is one of the standard protocols for supporting collective handovers. NEMO divide whole network into the network, which is the basis, the MR, that is able to move, and the sub-domain, which consists of MNs that are connected to the router. MR sets itself as the default gateway and forms a domain that includes sub-network entities and MNs. In the occurrence of handover, it is processed so that each MN's handover is substituted by the mobility of MR. Early NEMO was based on MIP, but as theories adapt to other protocols were presented, it is able to support diverse protocols. Classic examples would be FMIP-NEMO, PMIPv6-NEMO, etc.

Network Mobility Support Scheme on PMIPv6 Networks is a theory with the NEMO technique applied in the pmipv6 environment. Therefore MNs do not take charge of processes related to handover and, like in PMIPv6, the network entity deals with the functions related to handover. However, depending on the network segments, each HA(LMA-MN) handling MN and HA(LMA-MR) managing MR must exist separately, and overhead occurs repeatedly since the tunneling technique needs to be used between each LMA-MN and LMA-MR, and LMA-MR and MR. This is occurred in order to implement both the handover on MR and the handover on MN. OMM is a type of PMIPV6 modified for the SDN environment. It is made to operate on the centralized controller with the convergence of the functions of LMA and MAG, which do not need to be divided in the centralized network structure into one application. Also it was made to actively utilize network topology information provided by the basic SDN controller, and through this calculate beforehand the passes between each GWs and ASs and store this information. Due to this, signaling overheads occurred by existing LMA-MAG communications were removed, and computer power consumed in unnecessary repeated PATH calculations when MNs are in access were saved. Also by enabling effective handovers with preliminary simulations on handover, the handover signaling costs were reduced.

3. OMM-based NEMO protocol

OMM-based NEMO protocol(OMMNEMO) is the mobility management theory with the addition of NENO function on the basis of OMM. In this paper, we suppose three things. First, we suppose that the MN attachment and handover are the same as OMM. Secondly, we suppose that the SDN controller must have the path setup function and topology management function, and MME is supported by the particular functions. Thirdly, we suppose that MR is the direct access of MN.

A. Architecture

The presented theory consists of the MME located above the controller and open-flow enabled switches. SDN controller is the basement of the control application, and provides OMMNEMO through the internal function and other functions. Open-flow enabled switches handle packet forwarding in the SDN domain. MR, as a movable router, is able to move within the SDN domain.

1) OpenFlow enabled switch

Open-flow enabled switch refers to a switch satisfying the open-flow qualification. It can be categorized by each switch's roles into GW, IS, AS, MR, and CS. AS provides the network access service to MN, and a movable switch among these becomes MR. IS are the switches located between the AS and GW. CS, as one of the IS, is the intersecting point of the previous path and the new path. When a handover occurs, this CS gives information on the IS that doesn't need to update the flow table, and reduces the number of unnecessary updates on the flow table.

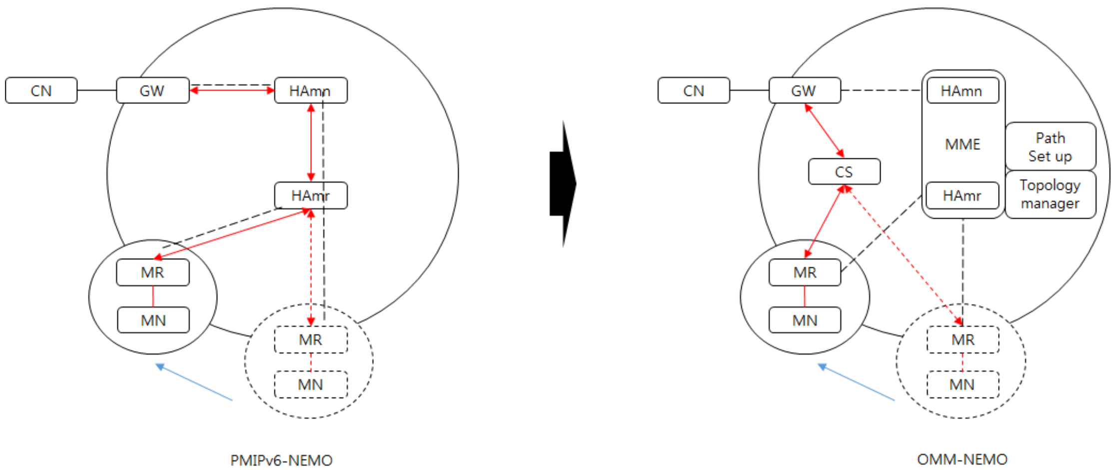

Figure 1. Comparison of PMIPv6-NEMO and OMMNEMO

2) Mobility Management Entity.

MME, as a control application for mobility management, operates on the SDN controller. MME receives the access status from the AS or MR. It also performs the existing HAmn(Home agent of MN) and HAmr(Home agent of MR) functions of PMIPv6-NEMO, and when a change in the MR location occurs, it modifies the path-related information of the surrounding switches of the moved MR with the support of the topology manager.

B. Data Structure in MME.

MME borrows the data structure of OMM, but there are parts in need of modification. First, among the MN-related information, the AS information field where MN is in access should be modified to the MR information field. Secondly, the MNs list is required that are connected to the MR. Lastly, when a MR handover occurs, the information list of the MR and the surrounding switches in need of modifications is required depending on the location.

1) Binding Cache

MME BCE	MN info	Mobile Node Identifier
		Link-Layer Identifier of the MN
		List of IPv6 MN-Home Network Prefix
		Access Technology Type
	Flow Matrix info	Access Switch $_j$ (AS_j)
		Interface Identifier to the MN
		Gateway Switch $_i$ (GW_i)

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Mobile Node Identifier	MN info	MME BCE
Link-Layer Identifier of the MN		
List of IPv6 MN-Home Network Prefix		
Access Technology Type		
Mobile Router $_j$ (MR_j)	Flow Matrix info	
Interface Identifier to the MN		
Gateway Switch $_i$ (GW_i)		

(a) Binding Cache Entry

Figure 2. BCE of 2OMM and BCE of OMMNEMO.

Binding Cache is a set of binding cache entries on each MN. Each BCE is created when MN accesses the OMM domain, and it is updated when the access point or network status is changed. The data structure of each BCE used in the OMM and OMMNEMO are presented in figure 2. They have the same basic form, the AS field of the existing OMM data structure should be written with the modification to the MR field.

2) Flow Matrix

Flow Matrix is a matrix recording the passes between the MR and GW. The switch-ID and interface-ID of IS to reach the MR and AS connected to each GW should be recorded. Lastly, the list of current accessing MNs should be stored in each MR and AS.

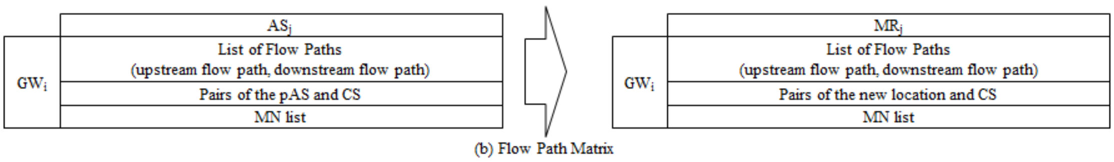

Figure 2. Flow Matrix of the OMM and OMMNEMO.

In the case of the Flow Matrix of the existing OMM, the information of MNs accessed in MR is recorded in the field that was used to record the existing MN list. Also when a handover occurs in the existing OMM, the information that the MR itself needs to modify and the interface-information that the surrounding switches need to modify in cases of MR movement, need to be recorded in the field that was used to record the previous existing AS and the related CS.

4. Conclusion

We have proposed OMMNEMO, in other words, the application of the NEMO protocol concept based on OMM. We have introduced the idea of MR of NEMO in order to support collective handovers under the SDN environment, and modified the existing OMM data structure to support MR and the related contents. Also, we have removed additional burdens by only using the basic SDN structure and OpenFlow signal messages in implementation, and eliminated the chance of tunneling overhead occurring in Packet forwarding by not utilizing the tunneling technique.

5. References

[1] IETF, ”Network Mobility (NEMO) Basic Support Protocol,” RFC 3963,Jan. 2005.
[2] I. Soto, C.J. Bernardos, M. Calderson and A. Banchs, ”NEMO-Enabled Localized Mobility Support for Internet Access in Automotive Scenarios,” IEEE Communications Magazine, pp 152-159, May 2009.
[3] H. Lee, Y. Han and S. MIN, ”Node Mobility Support Scheme between the mobile network and PMIPv6 Network,” NetCoM 2009, pp.93-97, 2009.
[4] Hyo-Beom Lee, Youn-Hee Han and Sung-Gi Min, “Network Mobility Support Scheme on PMIPv6 Networks”, International Journal of Computer Networks & Communications (IJCNC) Vol.2, No.5, September 2010.
[5] IETF, “Proxy Mobile IPv6,” RFC 5213, Aug. 2008.
[6] Open Networking Foundation, ”OpenFlow Switch Specification Version 1.5.0,” December 2014.
[7] Pill-Won Park, Seong-Mun Kim, and Sung-Gi Min, “OpenFlow-Based Mobility Management Scheme and Data Structure for the Mobility Service at Software Defined Networking,” Received 18 November 2015; Revised 5 February 2016; Accepted 10 February 2016.