이동 LISP망에서 네트워크 기반 이동성 제어 기법

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요 약

기존 LISP(Locator-Idenifier Separation Protocol) 기반 이동성 제어 기법에서는 각 이동 단말이 Tunnel Router (TR)에 연결될 수 있다. 하지만 이와 같은 단말이 이동성 제어에 대해서는 랜드로의 지원이 필요하다. 본 논문에서는 네트워크 기반 이동성 제어 방식을 제안한다. 기존의 단말 장치 이동성 방식과 달리 제안하는 네트워크 기반 방식은 두 가지 특성을 가진다. 1) 각 TR은 이동 단말이 접속한 Access Router (AR)에 구축된다. 2) 랜드로브를 지원하기 위해 Routing Locator (RLOC) 갱신 동작은 Ingress TR (ITR)과 Egress TR (ETR) 사이에서 수행된다. 따라서 분석 및 비교를 통해 기존의 방식에 비해 제안하는 방식이 랜드로브 지원을 크게 증가 시킬 수 있음을 확인하였다.

키워드: LISP, 이동성, 네트워크 기반, 랜드로브, 성능분석

Network-based Mobility Control in Mobile LISP Networks

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ABSTRACT

This paper proposes a network-based mobility control scheme in wireless/mobile networks, which is based on the Locator-Identifier Separation Protocol (LISP). Compared to the existing LISP mobility scheme, the proposed scheme is featured by the following two points: 1) each LISP Tunnel Router (TR) is implemented at the first-hop access router (AR) that mobile nodes are attached to, and 2) for handover support, the LISP Routing Locator (RLOC) update operation is performed between Ingress TR and Egress TR. By numerical analysis, it is shown that the proposed scheme can reduce the handover latency much more than the other candidate schemes.

Keywords: LISP, Mobility, Network-based, Handover, Performance Analysis

1. Introduction

The Locator-Identifier Separation Protocol (LISP) [1] was proposed for routing scalability by separating IP addresses into Endpoint Identifiers (EIDs) and Routing Locators (RLOCs). For mobility support, a host-based scheme for mobile LISP [2] is being discussed, in which the Tunnel Router (TR) is located at a mobile node (MN). However, such a host-based mobile LISP scheme tends to give large signaling overhead and handover latency, as seen in the comparison of Mobile IP (MIP) [3] and Proxy MIP (PMIP) [4].

In this paper, we propose a network-based mobility scheme to support seamless handover in mobile LISP networks. Compared to the existing LISP mobility scheme, the proposed scheme is featured by 1) each TR is implemented at the access router (AR) that mobile nodes are attached to; and 2) for handover support, the RLOC update operation is performed between Ingress TR (ITR) and Egress TR (ETR).

This paper is organized as follows. Section 2 describes the proposed LISP-based mobility control. In Section 3 and 4, we analyze and compare the proposed scheme with the other candidate schemes in terms of handover latency. Section 5 concludes this paper.

2. Proposed LISP-based Mobility Control

2.1 Network Model

(Fig. 1) shows a network model for LISP-based mobility control, in which Correspondent Node (CN) and
MN are located in the same domain. For EID-RLOC mapping services, the Map Server (MS) is employed to manage the EID-RLOC mapping for all MNs in the domain [5].

In addition, the proposed mobility scheme assumes that each TR is co-located with the first-hop access router (AR) that MNs are attached to. Each TR also has its local mapping cache, which contains the EID-RLOC mapping that has been obtained by the Map Query operation with MS. This mapping cache will be referred to by TR in the data forwarding to a remote node.

2.2 Map Registration and Map Query

When a MN enters a new TR area, it will establish the network connection with the concerned AR/TR. In this process, MN shall bind its EID to its TR, by which a TR can identify the list of EIDs of its attached MNs. Then, TR performs Map Registration (for EID-RLOC binding) by sending a Map Register message to MS.

The Map Query operation for data transport can be illustrated in (Fig. 2), in which CN (EID1) sends data packets to MN (EID2).

In the figure, CN sends an initial data packet to MN via its attached ITR (RLOC1). ITR will first look up its Map Cache to find the RLOC of MN; if yes, it can deliver the data packet to the identified RLOC2, which is not shown in the figure; otherwise, ITR shall perform the Map Query operation by sending a Map Request to MS. On reception of the Map Request, MS responds with a Map Reply to ITR after DB lookup. Based on the received Map Reply message, ITR will update its Map Cache by creating the entry with EID2 and RLOC2.

Now, ITR sends the data packet to ETR (RLOC2). On reception of the data packet from ITR, ETR will update its Map Cache by creating an entry with EID1RLOC1. This is done to deliver the data packets from MN to CN. Then, ETR forwards the original data packet to MN. Since then, MN and CN can exchange data packets based on the established Map Caches of ITR and ETR.

2.3 RLOC Update for Handover Support

For handover support, the two messages are defined: 1) RLOC Update Request from ETR of MN to ITR of CN, and 2) RLOC Update Reply as a response to RLOC Update Request. Then, the RLOC Update operations for handover control are performed as shown in (Fig. 3).

With an L2 trigger such as Link-Up, MN is attached to ETRnew. We assume that the L2 trigger contains the information of ETRold, which is delivered from MN to ETRnew. For context transfer, ETRnew asks ETRold about the information of MN (e.g., EID and RLOC of CN). Then, ETRnew sends an RLOC Update Request to ITR of CN. ITR of CN updates its Map Cache from EID2RLOC2 to EID2RLOC3, and send an RLOC Update Reply to ETRnew. ETRnew updates its Map Cache with EID1RLOC1. The data path between MN and CN is changed to MN ⊘ RLOC1 ⊘ RLOC3 ⊘ CN.

3. Analysis of Handover Latency

Let us consider the following handover schemes.

- **LISP-MN-MIPv6**: This scheme is based on the work in [2], in which TRs are integrated into MNs. Mobile IPv6 [3] is employed to support mobility. For handover support, MN shall perform the MIPv6 Route Optimization with CN.

- **LISP-AR-PMIPv6**: This scheme employs Proxy MIPv6 [4], in which TRs are implemented at PMIPv6 Mobile
Access Gateways (MAGs). It is assumed that HA is co-located with PMIP Local Mobility Anchor (LMA). To support the handover of MN, MAG (acting as TR) shall perform the Proxy Binding Update operation with LMA/HA.

- LISP-AR-RU: This is a purely proposed scheme, in which TRs are implemented as ARs. For handover of MN, its new ETR shall perform the RLOC Update (RU) operation with ITR of CN. To do this, a handover context transfer is required between old ETR and new ETR.

In the analysis, we assume that CN and MN are located within a single mobile network domain. In the mobility control operations, we will ignore the security issues.

Let us denote $T_{MD}$ by the movement detection delay in the link layer, and $T_{AC}$ by IP address (RLOC) configuration delay such as DHCP or IPv6 address auto-configuration. In addition, we define $T_{a-b}$ as the transmission delay of a packet between two nodes, $a$ and $b$. It is assumed that all the node processing delays are relatively small and thus negligible.

In the LISP-MN-MIP scheme, the handover latency (HOLSP-MN-MIP) consists of the following components: 1) movement detection of MN in the new AR region, which is $T_{MD}$; 2) RLOC (i.e., IP address) configuration of MN, which is equal to $T_{AC}$; 3) MIPv6 Route Optimization between MN and CN, which is $2(T_{MN-AR}+T_{AR-MN})$; 4) data transmission from CN to MN after handover, which is $T_{CN-AR}$+T_{AR-MN}. Accordingly, HOLSP-MN-MIP can be represented as

$$T_{MD}+T_{AC}+2(T_{MN-AR}+T_{AR-MN}).$$

In the LISP-AR-PMIP scheme, the handover control will be performed between MAG of MN and LMA. Thus, its handover latency (HOLSP-AR-PMIP) consists of the following components: 1) movement detection of MN, $T_{MD}$; 2) MN-HoA acquisition of MAG from Policy Server (PS), which is $2T_{MAG-PS}$; 3) Proxy BU operation between MAG and LMA/HA, which is $2T_{MAG-MAG}$; 4) data transmission from CN to MN via LMA/HA, which is equal to $T_{CN-MAG}+T_{MAG-MAG}+T_{MAG-MN}$. Therefore, HOLSP-AR-PMIP can be represented as

$$T_{MD}+2T_{MAG-PS}+T_{CN-MAG}+T_{MAG-MAG}+T_{MAG-MN}.$$
From the figure, we can see that the two network-based schemes give better performance than the host-based scheme and that the LISP-AR-PMIP gives lower handover latency than LISP-AR-RU for a larger $T_{AR-AR}$ value.

(Fig. 7) shows compares the performance for different $T_{UE-AR}$, in order to see the impact of wireless network condition. From the figure, we can see that the proposed LISP-AR-PMIP scheme gives the best performance among all of the candidate schemes.

5. Conclusions

This paper proposed a network-based mobility control scheme in mobile LISP networks. From the performance analysis for three candidate schemes, it is suggested: 1) each LISP Tunnel Router should be located with the first-hop 'access router' of mobile nodes, rather than the mobile node, and 2) for handover support, the RLOC update operation should be performed between Ingress TR and Egress TR to provide the route optimization.

References