Proxy Mobile IPv6 에 대한 라우트 최적화에서 불규칙 패킷을 다루기 위한 기법

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A Scheme to Handle Out-of-Order Packets in Route Optimization for Proxy Mobile IPv6

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Abstract

Out-of-Order Packet (O^3P) problem is an issue that significantly impacts to the QoS of service and network. Route optimization (RO) in PMIPv6 is proposed by P.Loureiro and M. Liebsch to reduce the load of LMAs and transmission delay. In RO scheme, at the time the optimal path is established, there exist two paths: optimal path and old path as non-optimal path for transmitting data between MN1 and MN2 that is the cause of O^3P occurring. This paper proposes a scheme to prevent O^3P problem by using packet buffering technique and a new mobility message, named End Traffic Marker (ETM) to mark the end of packet delivery through the old path.

1. Introduction

Proxy Mobile IPv6 (PMIPv6) [1] is a network-based mobility management protocol that does not require a mobile node (MN) to be involved in any mobility signaling, which makes PMIPv6 more practical and efficient. The basic PMIPv6 does not support the Route Optimization (RO). All packets delivered between two MNs in two different PMIPv6 domains are always transmitted via LMAs that increases the load of the LMAs and transmission delay. In order to optimize the path transmission, there are several schemes are proposed [2-3], in which, P.Loureiro and M. Liebsch [3] proposed a RO scheme for PMIPv6, where a pair of MAGs creates an optimal routing path for communication between mobile nodes (MNs) to reduce the load of the LMA and transmission delay. The Fig.1 shows the RO path as an optimal routing path MN2-MAG3-MAG1-MN1 and the basic path as a non-optimal routing path MN2-MAG3-LMA2-LMA1-MAG1-MN1 for packet transmission from the MN2 to the MN1.

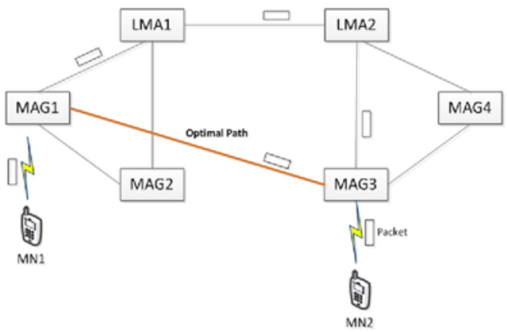

Fig. 1. The Optimal Path in PMIPv6

However RO scheme in PMIPv6 does not consider about the Out-of-Order Packet (O^3P) problem that occurs because RO scheme maintains two paths: the new path as optimal path and the old path as non-optimal path for data delivery from MN2 to MN1 at the time when the optimal path has just established. Since O^3P problem may cause losing the data at applications using the UDP protocol or the increase retransmission of the TCP protocol, we propose a new scheme to prevent O^3P by using packet buffering technique to buffer the packets delivered through the optimal path, and defining a new mobility message, named End Traffic Marker (ETM), to mark the end of packet delivery through the non-optimal path.

The remaining paper is organized as follows. The section 2 introduces RO scheme as a related work. The O^3P problem in RO scheme is presented in the section 3. The section 4 explains the proposed scheme. Finally we conclude our work in the last section.

2. Route Optimization in PMIPv6

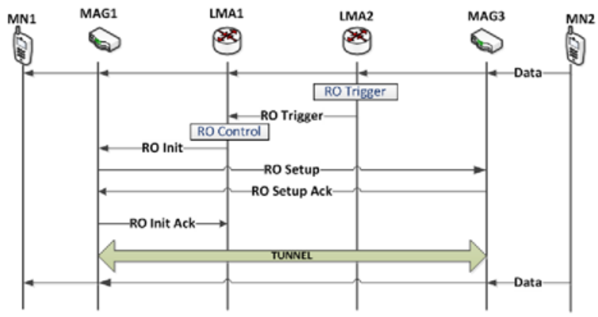

Fig. 2. The RO scheme in PMIPv6

P.Loureiro & M.Libebsch propose RO procedure to create an optimal path as a new path in PMIPv6 to reduce the load of LMAs and transmission delay between the MN1 and the MN2. The Fig. 2 shows the data transmission from the MN2 to the MN1 and messages signaling in RO procedure. At the first time, the packets are delivered from the MN2 to the MN1 via the non-optimal path MN2-MAG3-LMA2-LMA1-MAG1-MN1. LMA2 detects the possibility of optimal route then triggers to the LMA1 by sending RO Trigger message. Then, LMA1 sends RO Init message to the MAG1 to initialize establishing the optimal path. Upon receiving the RO Init message, the MAG1 exchanges RO Setup and RO Setup Ack messages with MAG3 for establishing the tunnel as the optimal path.

3. Out-of-Order Packets in Route Optimization

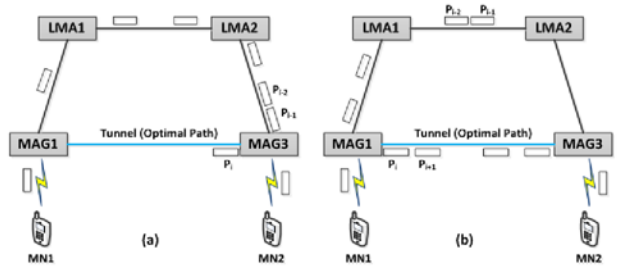

Fig. 3. Out-of-Order Packet in RO scheme

RO scheme creates an optimal path for data transmission between MN1 and MN2, but RO has O^3P problem. Fig. 3 shows the data transmission from the MN2 to MN1. At time the optimal path is ready, the packets are delivered from the MN2 to the MN1 using the optimal path shown as Fig. 3(a). Suppose that a sequence of packets S = $\{P_1, P_2, \ldots, P_{i-1}\}$ is delivered via the non-optimal path, and a sequence of packets S' = $\{P_i, P_{i+1}, \ldots, P_n\}$ is delivered via the optimal path, as shown in Fig. 3 (b). It is obvious that the first portion of packets $\{P_i, P_{i+1}, \ldots, P_n\}$ have higher sequence numbers but they are delivered to the MAG1 before the last portion of packets $\{P_1, P_2, \ldots, P_{i-1}\}$. Therefore, the O^3P problem occurs when all the packets arrive at the MN.

4. Proposed Scheme

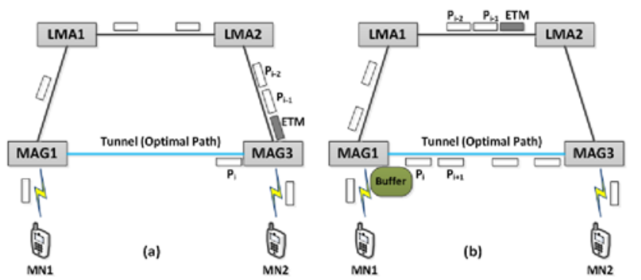

Fig. 4. Using packet buffering and ETM message to avoid O^3P problem

The paper proposes a scheme to prevent O^3P problem. In the proposed scheme, the MAG1 has to be aware of the time when the last packet, termed P_{i-1} comes through the non-optimal path and uses packet buffering to prevent O^3P. Fig. 4 shows the scenario preventing O^3P issue by using packet buffering and ETM message. At the time when the optimal path is ready and the MAG3 changes the data delivery from the non-optimal path to the optimal path, the MAG3 generates ETM message and sends it to the MAG1 through the non-optimal path right after the last packet P_{i-1}, as shown in Fig. 4 (a). This means that the sequence of packets S = $\{P_1, P_2, \ldots, P_{i-1}, \text{ETM}\}$ is delivered to the MAG1 via the non-optimal path, while the sequence packet S' = $\{P_i, P_{i+1}, \ldots, P_n\}$ is delivered to the MAG1 via the optimal path. Instead of delivering directly to the MN, the sequence of packets S' is held in the buffer and the MAG1 waits the message ETM arriving, as shown in Fig. 4 (b). The packets held in the second buffer are flushed to the MN at the time the MAG1 receives the ETM message that ensure all the packets from the MN2 will be delivered to the MN1 in sequential order.

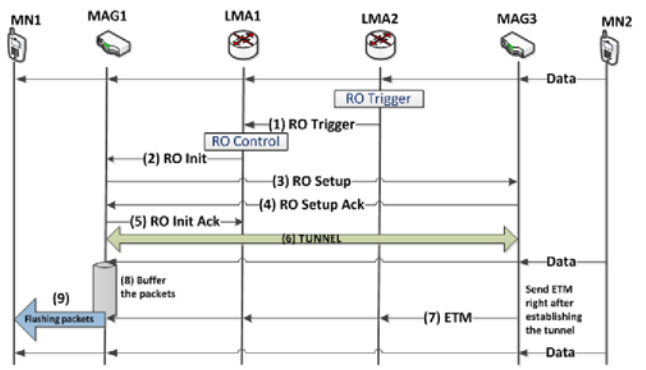

Fig. 5. The proposed scheme

The Fig.5 shows the message signaling in the proposed scheme. The steps 1 to 6 are described in RO scheme. Right after the data transmission changes to the optimal path, the MAG3 generates and sends ETM message to the MAG1 through the non-optimal path to mark the end of data delivery via the path at step 7. The MAG1 holds the packets transmitted through the new path in the buffer at step (8) to avoid the O^3P problem. When the MAG1 receives ETM message, it flushes buffered packets to the MN1. With this, all packets transmit to the MN1 from the MN2 in order.

5. Conclusion

P.Loureiro and M. Liebsch proposed the RO scheme to create an optimal path for data transmission between MNs. Since O^3P issue occurs in RO scheme and efficiently impact to QoS of network. The paper proposed a scheme to prevent O^3P in RO by using packet buffering and ETM message. Future works will be intended to implement the proposed scheme in the real testbed to evaluate the performance.

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