Proxy Mobile IPv6 Route Optimization

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***Abstract*— Proxy Mobile IPV6 (PMIPV6) is a network-based mobility management protocol that supports network mobility, regardless of whether or not a Mobile Node (MN) supports mobility protocol. Route Optimization (RO) is a function to minimize packet transmission delay through the optimal path between routers communicating with each other. Basic PMIPV6 does not support the RO. Thus, many schemes have proposed to support the RO. The out-of-sequence will occur in which packets arrive out of order, which may happen between the existing path (i.e) basic PMIPV6 path and the newly established RO path. The out-of-sequence problem is solved by using the packet sequence number and the time when the packet occur and it reduce the packet transmission delay. This particular feature enables resource optimization in their networks and reduces energy consumption of an MN and handover signaling cost. It allows a mobile node (MN) to move around within the same PMIPV6 domain by keeping the same IP address.**

Keywords*— *Proxy Mobile IPv6, Route Optimization, Out-of-sequence, Out-of-order.

I. INTRODUCTION

Mobility based management protocol enables particular feature resource optimization in their networks and reduces energy consumption of an MN. A Mobile Access Gateway (MAG) and a Local Mobility Anchor (LMA) are in charge of the mobility of an MN in the PMIPv6 domain. However, basic PMIPv6 does not support Route Optimization (RO). If so, all packets are always transmitted via an LMA, and this increases the load of an LMA and increases packet transmission delay. Many schemes are proposed to support the RO to resolve this problem in PMIPv6. When the RO occurs in PMIPv6, the MN communicates with the Correspondent Node (CN) via the RO path between MAGs.

Proxy Mobile IPv6, a network-based localized mobility protocol that allows a mobile node (MN) to move around within the same PMIPv6 domain by keeping the same IP address. However, PMIPv6 does not support the global handover since it supports only an intra-domain handover. To support the global handover, MNs need to load the protocol stack for the global mobility.

The RO path is defined as a new path, and the basic PMIPv6 path as an old path. When the new path is established, the out-of-sequence problem occurs due to the difference the transmission time between the old path and the new path. This problem causes packet loss in User Datagram Protocol (UDP) and packet retransmission request messages in Transmission Control Protocol (TCP). The Out-of-sequence Time Period (OTP) scheme is proposed to resolve the problem. The OTP scheme is the solution to restrain the tunnel establishment when the new path is established. However, the scheme cannot provide reliable service to an MN, because it is hard to predict the restraint time of the tunnel establishment in the OTP scheme.

II. PREVIOUS WORK

The RO schemes for PMIPv6 have been proposed. The packets generated between an MN and a CN are transmitted via an LMA before the new path is created. After the RO, a tunnel is established between the MAGs that the MN and the CN are connected. However, tunnels exist in the old path and the new path. Some packets are transmitted using the old path and some packets are transmitted using the new path. Therefore, the out-of-sequence problem occurs. The OTP scheme was proposed to prevent this problem.

The OTP scheme prevents the problem by the tunnel restraint during the RO in PMIPv6, but it stores the packets at both MAG and LMA. In addition, it does not forward the packet during the RO. Therefore, the packet reception delay is longer than the PMIPv6 supported by RO. It predicts the tunnel restraint time to resolve the problem, but the approach to the prediction does not guarantee prevention of out-of-sequence packets precisely.

To provide reliable service for MN more accurately to prevent the out-of-sequence problem. By using the sequence number resolves the problem effectively, using the packet sequence number, and reducing the forwarding delay time using the value of Time To Live (TTL).

III . METHODOLOGY

A.Motivation And Basic Assumptions

The basic PMIPV6 path established after the Mobile Node (MN) registered in binding cache entry of the Mobile Node LMA. The PMIPV6 path exists between the MAG and LMA of the Mobile Node (MN) and this path is considered as old path. During RO occurs in PMIPV6, the MN communicates with Correspondent Node (CN) via the RO path between MAG's.

They use IP header's information to prevent the problem more effectively. The identification field, which is the number assigned from a router of the IP header, is a unique number used by devising or recombining a packet following the Maximum Transfer Unit (MTU). Accordingly, it is possible to know the packet sequence using the identification number in the communication between routers. MAGs and LMAs know the packet sequence via the identification number in the IP header.

Therefore, this determines the out-of-sequence packets that arrive at the MAG by the identification number in the IP header. TTL value in the IP header is used to calculate the transmission time of the old path and the new path. These scheme count the number of routers through the old path and the new path from the TTL value. THE TTL value in the tunnel header decreases when the packet passes through the tunnel, since the packet is encapsulated, but the TTL value in the IP header does not. The packet is decapsulated after passing through the tunnel. Then, the TTL value in IP header decreases just one.

It is impossible to count the accurate number of routers in each path due to this situation. This scheme uses the minimal encapsulation to resolve the problem. Minimal encapsulation is proposed to reduce the header's overhead. The TTL value usually decreases after a packet passes through the tunnel, because the minimum information is kept at the inner IP header, and the remaining information moves to the tunnel header.

B .Models

The MAG's buffer the packets and it is received from the RO path, until all the packets pass from the old path. Enabling the sequence number to understand the order of all the packets passing though the old and new path resolves the problem more precisely than other schemes do. In addition, the packets transfers via the shortest path due to performing the buffering in MAGCN, Thus, the problem is resolved, and the packet reception delay is reduced.

C. Basic Operation

The packets between an MN and a CN pass through the old path before the new path is established. If the new path is established, the packets pass through the new path. MAGCN receiving the packets via the new path, buffers the packets to prevent the problem. From the beginning of the buffering in MAGCN, MAGCN compares the sequence number of the first packet in the buffer and the sequence number of the packet that passed via the old path. MAGCN performs the buffering until the last packet from the old path arrives at MAGCN. When the last packet from the old path arrives at MAGCN, MAGCN forwards the packet and then forwards the all packets in its buffer.

The out-of-sequence problem is prevented by storing the packets from the new path in the MAG's buffer, until all the packets pass from the old path. Enabling the sequence number to understand the order of all the packets passing though the old and new path resolves the problem more precisely than other schemes do. In addition, this scheme transfers via the shortest path due to performing the buffering in MAGCN, Thus, the problem is resolved, and the packet reception delay is reduced. MAGCN forwards the packets in the buffer to CN after the last packet from the old path passes through MAGCN. However, if the last packet from the old path is lost, MAGCN performs the buffering infinitely.

The maximum forwarding delay time (*Twait*) is calculated to prevent infinite buffering in this scheme scheme. If the last packet from the old path does not arrive at MAGCN within the *Twait*, the packets in the buffer are forwarded to CN. The problem is prevented using the maximum forwarding delay time, even though the packets from the old path are lost.

$$\text{Twait} = \text{TOP} - \text{TNP} \quad \ldots\ldots.(1)$$

$$\text{TOP} = (\text{TTLMax} - \text{TTLOP}).\ \text{TOne-Hop} \quad \ldots.(2)$$

$$\text{TNP} = (\text{TTLMax} - \text{TTLNP}).\ \text{TOne-Hop} \quad \ldots.(3)$$

Twait is calculated by the time difference between the times that the packets coming from the old path and the new path, arrive at MAGCN. Twait is calculated by equation (1). TOP and TNP define the time that the packet passes via the old path and the new path, respectively. From equation (1), they calculate the different arrival times between TOP and TNP. Equation (2) and (3) are the formulas to calculate TOP and *TNP*. TTLMax is the maximum value of TTL. TTLOP and TTLNP are the TTL values of the packets from the olpath and the new path, respectively.

IV. EXISTING SYSTEM

A. Signal Flowing Between Mobile And Correspondent Node

The signaling flow from the last packet from the old path is lost in MN's interdomain handover. When MAG2 receives the RO Init message from LMA2, MAG2 performs the flow to calculate the *Twait*. MAG2 saves the TTL value of the RO Setup message and inter-arrival time of the RO Setup message between MAG1and MAG2.

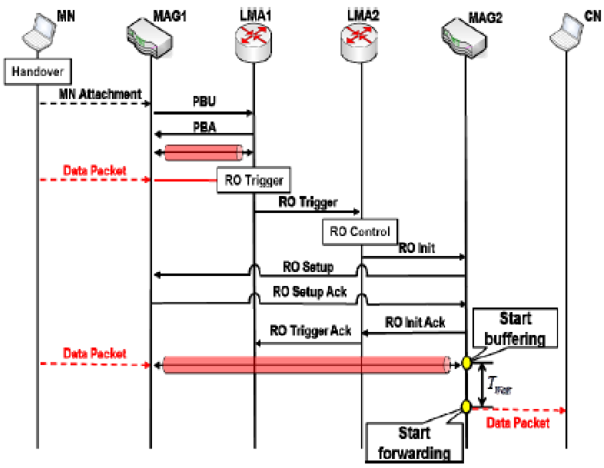

Fig.1. Signal Flowing Between Mobile And Correspondent Node

When the RO is completed, MAG2 starts to store the packets from the new path and checks the packet sequence number from the old path. If the last packet from the old path

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arrives at MAG2, MAG2 forwards the packet to CN. Next, MAG2 forwards all the buffered packets in MAG2 to CN. However, if the last packet from the old path does not arrive at MAG2 during *Twait*, MAG2 determines the last packet from the old path is lost. Therefore, MAG2 forwards all buffered packets in its buffer to CN.

This scheme provides reliable service to resolve the out-of-sequence problem more precisely than the OTP scheme. The problem is prevented using *Twait*, even though the packets from the old path are lost. In addition, the scheme minimizes the packet reception delay, using the old path during the establishment of the new path. Moreover, this scheme reduces the buffering cost, because the buffering is performed only by MAGCN.

B. Experimental Evolution

They run the simulator implemented in C++ to measure the number of the out-of-sequence packets. They conduct their experiment in the UDP environment to determine the packet loss and out-of-sequence packets. The experiment uses the CBR traffic generator, and data packets are generated in 0.02 seconds interval. If the traffic is generated by CBR, they verify the incidence of packet reception delay and the number of out-of-sequence packets accurately. Packet size is fixed at 500 bytes.

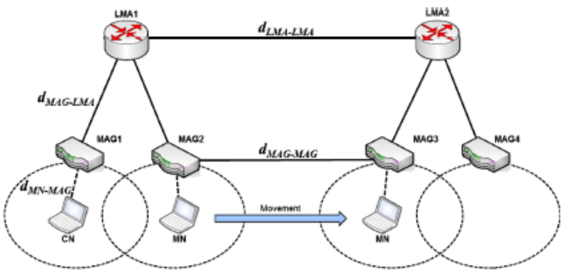

Fig.2. Network topology of simulation.

They configure *dLMA-LMA* as 15hops, *dMAG-LMA* and *dMAG-MAG* as 7hops, *dMN-MAG* as 1hop. In this experiment, the number of the out-of-sequence packets and the packet reception delay are verified during the RO setup in the inter-domain handover.

C.Simulation Results

Fig. 3 shows the simulation results of PMIPv6 supported by RO. This scheme cannot prevent occurrence of out-of–sequence packets. Fig. 4 is the simulation results based on sequence number.

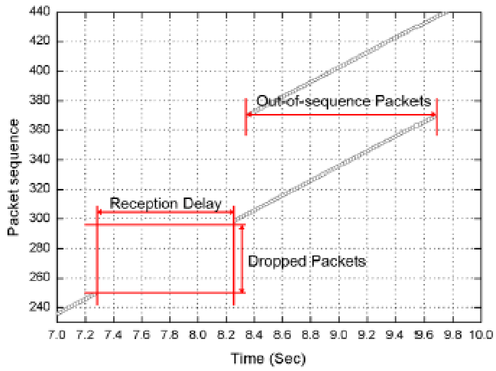

Fig.3. PMIPv6 support by RO.

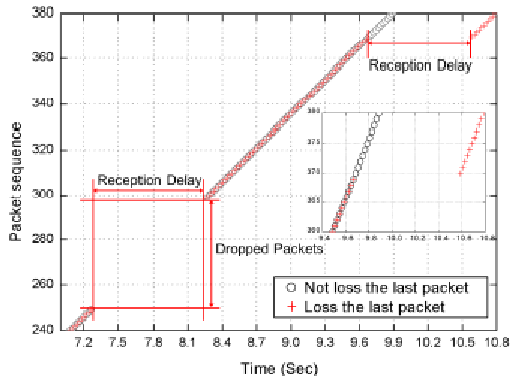

Fig. 4. Simulation results based on sequence number

V. CONCLUSION

Route Optimization (RO) is a function to minimize packet transmission delay through the optimal path between routers communicating with each other. The difference of the transmission delay between the old path and the new path generates the out-of-sequence problem in PMIPv6. Some schemes are proposed to resolve the out-of-sequence problem, but they do not solve the problem effectively. This scheme provides reliable service for MN more accurately to prevent the problem occurring from the RO. The scheme resolves the problem effectively, using the packet sequence number, and reduces the forwarding delay time using Twait.

In this scheme, they compare PMIPv6 supported by RO and the scheme based on sequence number via simulation. This scheme resolved the out-of-sequence problem and reduced the packet reception delay after the new path is established. They provide a reliable service in PMIPv6 RO by adapting the sequence number scheme. To evaluate the performance of this scheme in the future using a test bed and mathematical modeling.

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