Direct Routing for Mobile Multicasting in Distributed Mobility Management Domain

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Abstract— **Distributed mobility management is the newly emerging research trend replacing the current centralized ones. So far, no complete solution has been found for integrating IP multicast into the DMM domain. In one recent research, some use cases for multicast support in the DMM environment showed some problems such as traffic duplication and non-optimal routing. In this paper, we propose a new scheme to support the multicast listener in the DMM domain, which overcomes the above mentioned problems. Our scheme uses a direct routing concept that makes use of the current multicast infrastructure. Each access router in our scheme has both mobility management and MLD proxy functions. Numerical analysis shows that our proposal improves the other schemes in terms of packet loss rate.**

Keywords-Mobile Multicast; Multicast Listener Support; Distributed Mobility Management; multimedia; handover.

I. INTRODUCTION

Current centralized mobility management schemes suffer major issues such as single point of failure and sub-optimal routing. To solve these issues, several Distributed Mobility Management (DMM) approaches are discussed in [1]. The popularity of live multimedia services makes IP multicast [o] a very important technique in reducing redundant traffic in the Internet network. The integration of IP multicast and mobility management brings new user experiences for delay-sensitive applications and optimizes network bandwidth. A base deployment for supporting mobile multicast listener in a PMIPv6 domain is standardized [2]. Additionally, some use cases for supporting multicast in DMM presented issues, such as duplicated traffic and non-optimal routing [3].

In our previous work [4], we discussed the concept of direct routing which utilizes the existing multicast infrastructure and separates multicast function from Local Mobility Anchor (LMA). This concept helps us avoid problems, such as duplicated traffic and tunnel convergence when combining multicast with mobility management. However, our work did not show the details of protocol operation. It only supported multicast in the centralized domain.

In this paper, we apply this concept into a new environment, i.e., DMM environment. In our scheme, each access router has functions of mobility management and MLD proxy. Moreover, the central database is extended to store multicast context information with mobility session information. By numerical analysis, our proposal's packet loss rate will be improved over the other schemes [2] [3].

The paper is organized as follows: Section II presents our scheme for multicast support in the DMM domain. Section III analyzes our scheme performance. Section IV shows a result of numerical analysis. The paper ends with conclusion and future researches.

II. MULTICAST LISTENER SUPPORT IN DISTRIBUTED MOBILITY MANAGEMENT DOMAIN

Figure 1 shows network architecture for multicast support in the DMM domain. Both mobility management functions of LMA (e.g., prefix allocation, location management) and Mobile Access Gateways (location update) are embedded in each distributed access router (DAR). Additionally, these DARs have MLD proxy function and are connected to the multicast infrastructure.

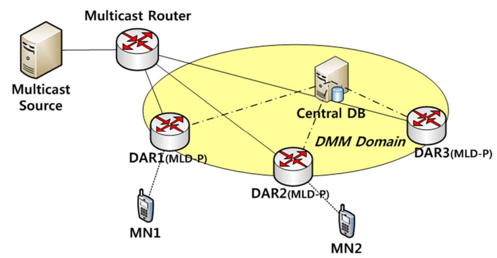

Figure 1. Architecture for multicast support in the DMM domain

Our scheme also introduces a new extension for the central database (CDB). Thus, the CDB will contain the multicast context information (e.g., multicast source, group address) beside the mobility session information of MN. The content of CDB is shown in Table I.

TABLE I. BINGDIND TABLE IN CDB

MN-ID	Prefix	Anchor	MC?	S	G
MN1	MN1-HNP1	pDAR	No	-	-
MN2	MN2-HNP1 MN2-HNP2	pDAR nDAR	Yes	S1	G1

Figure 2 shows the handover procedure of the MN. In this case, we consider that the MLD proxy function is installed in each DAR. When the MN attaches to the previous DAR (pDAR), it will send a MLD report to the pDAR to join the multicast channel.

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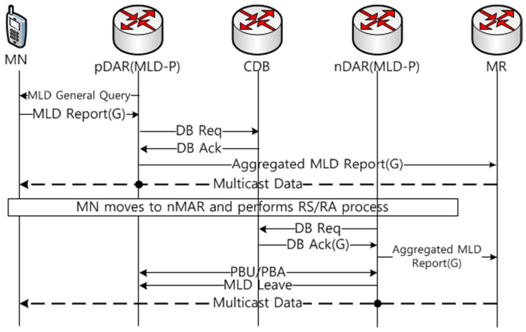

Figure 2. Initiated Attach and Handover Procedure

This multicast context information of the MN will be registered in the central database through the DB Req/DB Ack process. Then, the pDAR sends the aggregated MLD report to join the multicast tree, so the multicast data will be routed to the pDAR, finally to the MN. When the MN performs handover to new DAR (nDAR), the MN performs an attachment procedure using RS/RA messages. The nDAR immediately queries to the CDB to get the mobility session information of the MN (previous anchor points) and the multicast context information of the MN (content source and multicast group address). Then, the MN performs a location update procedure to the pDAR via PBU/PBA messages and sends an aggregated MLD report to the multicast tree. From that point on, the multicast data can flow from the multicast tree to nDAR, finally to the MN.

III. Performance Analysis

In this section, our scheme and three others: 1) Base deployment for multicast listener support in PMIPv6 domain scheme; 2) Tunnel-Based Reactive Scheme; and 3) Tunnel-Based Proactive Scheme will be evaluated and compared in terms of packet loss rate. The analytical model is referred from [3], [5], [6].

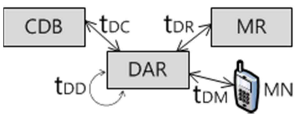

Figure 3. Reference Topology

Figure 3 shows the network topology used for performance evaluation. D_{scheme} is defined as the total latency for completing all signaling procedures plus the time for sending the first multicast data packet to the MN. In our analysis, we only take into account the signaling procedures used for receiving the multicast data. The formula for calculating each component delay $t_{entities}$ is referred from [5].

- *Base deployment for multicast listener support in PMIPv6 domain (BDMP)*
$$D_{BDMP} = 4t_{DC} + 3t_{DM} \quad (1)$$
- *Tunnel-Based Reactive Scheme (TBRS) [3]*
$$D_{TBRS} = 4t_{DC} + 2t_{DD} + 3t_{DM} \quad (2)$$
- *Tunnel-Based Proactive Scheme (TBPS) [3]*
$$D_{TBPS} = 4t_{DC} + 2t_{DD} + t_{DM} \quad (3)$$
- *Our scheme without tunnel when deploying MLD-Proxy (MPWT)*
$$D_{MPWT} = 2t_{DC} + 2t_{DR} + t_{DM} \quad (4)$$

We assume the coverage area of each DAR has the diameter *l*, the velocity of the MN is *v*, and the density of the MN in one coverage area α. The subnet crossing rate is given as follows:

$$r_c = \alpha v l / \pi \quad (5)$$

We suppose the packet arrival rate follows the Poisson distribution and has the average value λ. Thus, the packet loss rate is calculated as:

$$L_{scheme} = \lambda \times r_c \times D_{Scheme} \quad (6)$$

IV. Numerical Results

The numerical values for performance analysis are referred from [5] [6]. Figure 4 shows the multicast packet loss rate variation with the mobility rate of the MN. The multicast packet loss rate of our scheme increases at a much lower rate than two other tunnel-based schemes. Additionally, our scheme has a bit lower packet loss rate than the BDMP. This low packet loss rate is resulted from the low handover latency of our scheme. This low latency of our scheme is due to optimized signaling operation (one CDB query/response for getting both the mobility session and the multicast context information). By separating multicast and unicast routing, we can receive the multicast data without waiting for signaling procedures of unicast traffic to finish.

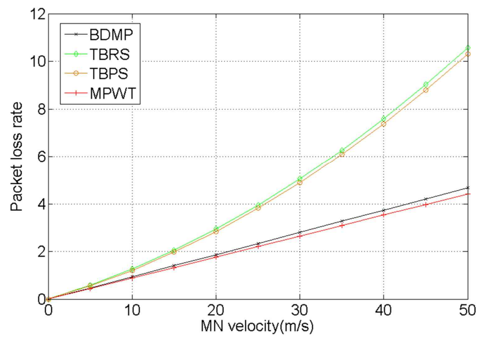

Figure 4. Packet Loss rate

V. Conclusion and Future Work

In this paper, we proposed a scheme to support multicast listener in the DMM domain. Our scheme uses a direct routing concept which utilizes the existing multicast infrastructure and separates multicast function from LMA, so existing problems, such as traffic duplication and non-

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optimal routing, have been solved. By numerical analysis, our scheme achieves the lowest packet loss rate, when the handoff rate increases. Therefore, our scheme will provide a better user of experience. Our future work will include the simulation of our scheme to get the exact packet loss rate. In addition, we will extend to support multicast sender in DMM domain, in other words, the mobility of multicast content source.

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