An Improved Route Optimization Algorithm for RMTP Support in the NEMO Environment

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Abstract. There are lots of researches for mobility of MS (Mobile Station) in All IP-based networks. In particular, NEMO (NEtwork MObility) does not support mobility of each MS, but mobility of networks that include a group of MS. Some researches attempt to overcome limitations of wireless networks with the protocol in the wired state and it maintains the performance for the wired environment. There are no researches about multicast with reliability in NEMO. Therefore, this paper proposes an efficient algorithm to solve these problems, when RMTP (Reliable Multicast Transport Protocol) applies to the NEMO environment, in order to support high reliability with multicast. Also, this paper shows the better performance for the proposed algorithm in terms of the delay and transmission rate between AR and TLMR, as compared with RMTP in NEMO.

Keywords: NEMO, RMTP, delay, transmission rate

1. Introduction

Of the ultimate goal of 4G network a step closer to the All IP network has gone to find out. In addition to through several WG IP-based mobility of the mobile terminal is going to continue to study. In particular Mobile IP [1,2] and Hierarchical Mobile IP v6 [3], Fast Handoff for Mobile IP v6 [4], Proxy Mobile IP [5] is a typical technology. These technologies provide individual mobility of the mobile terminals, but they are not appropriate for group mobility of the mobile terminals. IETF Mobility EXTensions for IPv6 (MEXT) WG [6] proposed a technique called NEMO, the mobility of mobile devices was to manage. In NEMO through NBS (NEMO Basic Support) protocol, the highest MR (Mobile Router) is responsible to manage mobility, but the lower mobile terminals do not perform any work on the management for mobility. However, studies on multicast in the NEMO environment are not active, and especially, studies on multicast with high reliability are none. RMTP [7] for multicast with high reliability is one of technologies to add reliability to multicast.

In this paper, in NEMO environment an efficient algorithm to support RMTP is proposed. The algorithm proposed in order to efficiently support the RMTP, path of data through Light-NEMO+ to optimize, Mobile devices add a field of separate TLMR, MR case of placed in his of the home network case and of not placed case moving to another network was to the action. In addition the data receiving for terminal of sub without encapsulation process to a parent the MR is passed. Through this, by reducing encapsulation overhead has been minimized. Thus, the MR for sends the data to mobile devices is action as state not encapsulated like Light-NEMO+. In Section 2, we investigate the problems when RMTP is applied in the NEMO environment, and propose an algorithm to solve the problems. In Section 3, we evaluate the performance of the proposed algorithm in terms of the delay and transmission rate. Finally, we conclude in Section 4.

2. Route Optimization Algorithm for Efficient RMTP and Network Mobility

In this section, we propose our algorithm for RMTP support in the NEMO environment. The procedure for our algorithm can be seen through Figure 1. In addition, with this algorithm the route of RMTP data carried out can be seen in Figure 2. Through this process, the transport sector can be divided into four kinds.

First, RTMP network service RMTP, has shape of tree structure. Home Agent networks to support and to ensure mobility of device of interior NEMO. A wireless network communicates directly NEMO's TLMR, and it can be divided into NEMO networks. Through the separation process, NEMO environment occurring error of data is eliminate in path RMTP. So the number of re-transmissions for errors is reduced. In addition, TLMR perform to function of DR of RMTP.

So route according to re-transmissions is reduced. Delay according to this was designed to reduce.

If message joined to RMTP groups be delivered is to sub-mobile device, MR announces wishing RMTP their child to top of TLMR. Data is transmitted. TLMR received this analyzes join message of RMTP. So the sender's address and port, recipient's address and port are separated. And it is stored in mapping table. After, TLMR create new message as joining to RMTP group. So it is sent to sender RMTP. If mobile device want to RTMP, TLMR are joined to RMTP on behalf of mobile device. And HA of TLMR will be used to Bi-directional Tunnel method to join to RMTP.

In addition, TLMR register near DR and sender of RMTP HA of TLMR, RMTP join process will finish.
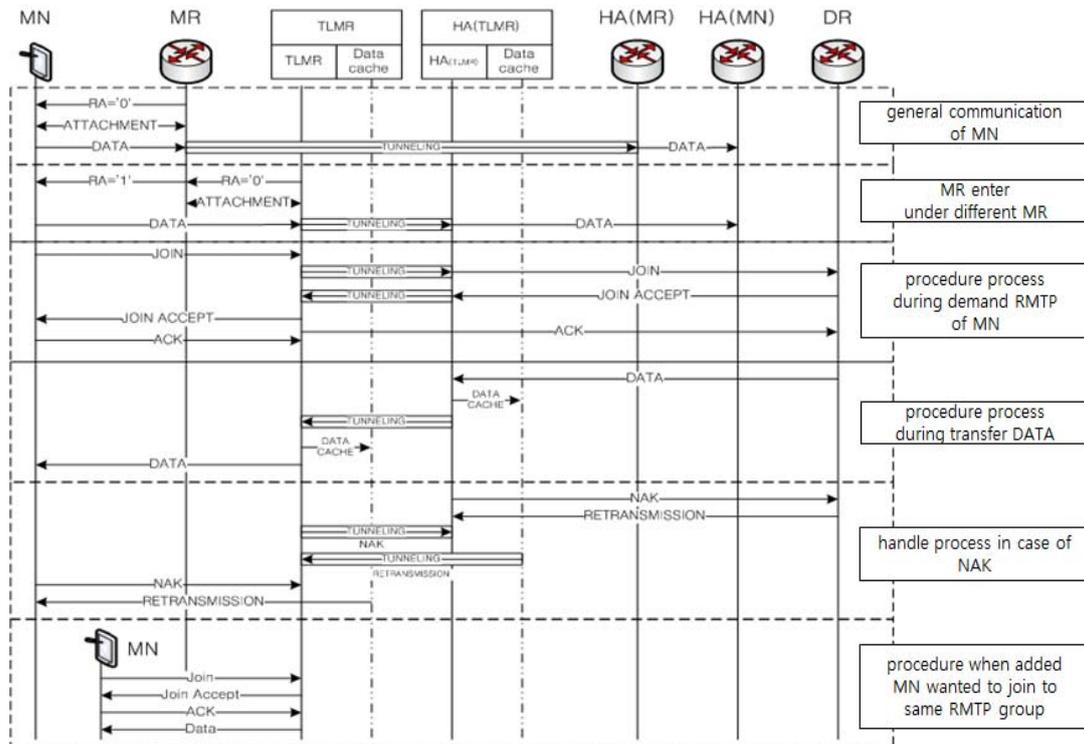

Fig. 1: Procedure for the proposed algorithm

TLMR, Message receives from RMTP sender, RMTP message is stored in his buffer. And address and port of mobile device wanted to join to RMTP through a mapping table. So after creating new message format, message is forwarding to original mobile device.

In addition, TLMR NAK come from mobile device is prepared. So RMTP data is temporarily stored in buffer of TLMR. And if NAK is received, it is re-transmitted. In other words, TLMR acts as a temporary DR. NEMO is temporarily consists of small RMTP area. This process is determined by mapping table, it is consists. In the case of internal NEMO, it is solved as a temporary RMTP group. But TLMR and communication with wireless medium is case of different. Error of data from outside NEMO will be occurrence. And if it of interior NEMO is forward, it can cause serious problem. Therefore these process need of checking errors in TLMR. Thus, TLMR is assumed as L4 router. And error of received RMTP

message is determined. If through these process, there are errors in RMTP data received in TLMR, TLMR requests re-transmission to DR belongs to own. And it is forwarding to sub-mobile device.
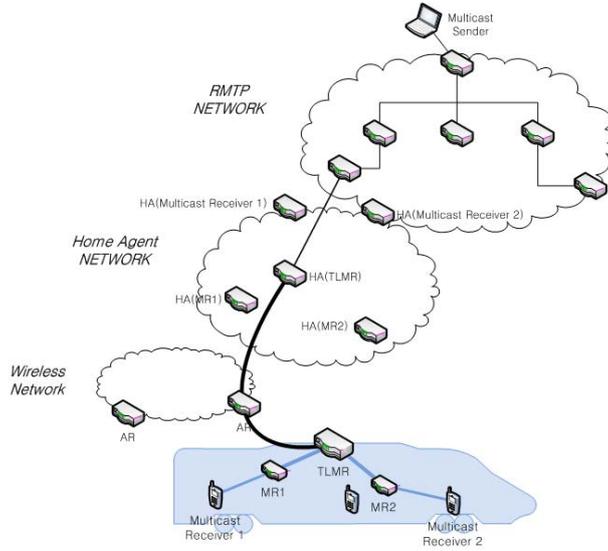

Fig. 2: Data path embodied through path optimization algorithm of RMTP

As mentioned earlier, if device of same RMTP group of interior NEMO is present, repetition data is transmitted over HA network. So network overload is caused, bottleneck in TLMR be noted causing. However, when using proposed protocol, these problems can be solved. First, if any mobile device joins to RMTP group A, TLMR already has mapping table for group A. If at these situation, different mobile device want to join in group A, address and port of latter move device in mapping table is stored. Then if you receive data, you use RMTP or unicast. And if you deliver to latter mobile device, network overload by repetition data can reduced.

3. Performance Evaluation

In this section, when the mobile device wants to use RMTP presence in the existing NEMO environment, the performance evaluation for the proposed algorithm is conducted. In the case of network of RMTP, if mobile device of interior network created by RTMP tree attempts to communicate using RMTP, it is joined by DR located on edge of RMTP. And data by DR are transferred and re-transmitted.

First wireless communication method of interior NEMO is assumed to be 10^5 for BER as WLAN. Also interior NEMO, transmission medium of between TLMR and AR (Access Router) is determined depending on each of performance evaluation. In the case of existing NEMO environment, delay depending on transfer of data is as follow.

$$D_{Delivery} = D_{DR-HA(MN)} + d \times D_{HA-HA} + D_{HA-AR} + D_{AR-TLMR} + d \times D_{NEMO}$$

(1)

Entire Delay to transfer data transmission Delay and transmission Delay through each of HA of MR level of internal NEMO between DR and MN (Mobile Node), transmission Delay between HA and wireless AR, transmission Delay between AR and TLMR, and Delay depending on MR level of interior NEMO is assumed. Equation (1) indicates the delay in overall. d in Equation (1) means the level of NEMO. If it is bigger, pinball routing by tunneling occurs.

Therefore Delay is increased in HA network. In addition, Delay for transmission even within NEMO can be increased. This can be applied as proposed algorithm. Through Equation (1), existing environment and proposed algorithm is represent in applied environment Delay caused by each of equation.

Depending on above equation, average value of Delay of existing NEMO environment is following.

$$D_{total} = D_{Delivery} + 2\sum_{rt=1}^{\infty} \{1 - P_{AR} \times (P_{WLAN})^d\}^{rt} \times D_{Delivery}$$

(2)

When MN of interior NEMO transmission data, Equation (2) represent raised total Delay. If after sending data, error occurs, subsequent re-transmission Delay occurs, again to CN, signal needs re-transmit and re-transmission data occurs. Re-transmissions can reduce error probability. And it is expressed as above.

In the case of the proposed algorithm, unlike existing NEMO environment, transmission of RMTP data can be divided into two parts. One is transmission between DR-TLMR, while another is transmission between TLMR-MN.

Therefore each part is represented as following equation.

$$D_{DR-TLMR} = D_{DR-HA(MN)} + d \times D_{HA-HA} + D_{HA-AR} + D_{AR-TLMR} \tag{3}$$

$$D_{TLMR-MN} = d \times D_{NEMO} \tag{4}$$

If this equation represents totally, average Delay of proposed protocol is as follow.

$$D_{total} = D_{Delivery} + 2\sum_{rt_1=1}^{\infty}(1-P_{AR})^{rt_1} \times D_{DR-TLMR} + 2\sum_{rt_2=1}^{\infty}\{1-(P_{WLAN})^d\}^{rt_2} \times D_{TLMR-MN} \tag{5}$$

In case of the proposed protocol, re-transmission exists on two sides between DR-TLMR and TLMR-MN. Therefore, rt1, rt2 is calculated by dividing. The probability of success of WLAN in the internal NEMO is assumed as 10-5 BER. Also, MTU is 1500 bytes. Therefore, the MTU transmission success probability is calculated based on the binomial distribution. Such equation is expressed as follow.

$$P(x) = \binom{12000}{0}(0.00001)^0(1-0.00001)^{12000} \tag{6}$$

Equation (6) in MTU transmission indicates the probability without error of entire bits. 1500bytes is 12000bits and BER is 10-5, so it can be expressed as above. According to above equation, success probability of WLAN is 89%.

For performance evaluation, the AR-TLMR delay according to the transmission success probability is compared in Figure 3. The delay changes depending on the transmission success probability of AR can be seen in the graph. When the probability is quite low, re-transmission happens a lot. Therefore, the delay is greatly high. As the probability becomes larger, the number of retransmissions is reduced. As a result, the delay can also be decreased. In particular, when our algorithm is applied to RMPT in the NEMO environment, the delay can be reduced significantly.

In Figure 4, the transmission delay according to the level of NEMO is graphically represented. As the NEMO's level increases, the increase of delay is shown in this graph. The existing algorithm exhibits the exponential increase with the increasing level of NEMO in terms of the total delay. On the other hand, the proposed algorithm shows the significant improvement in that the delay curve does not increase much according to the level of NEMO.
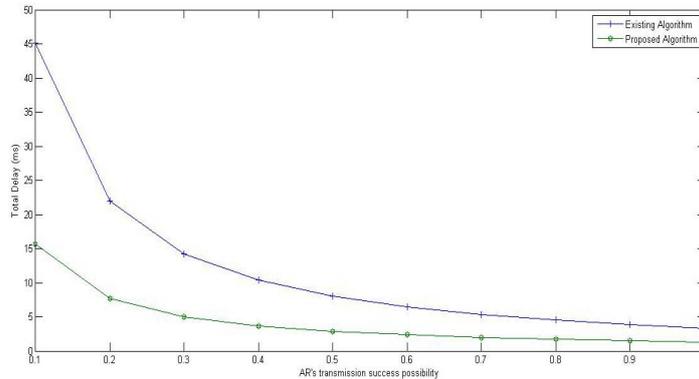

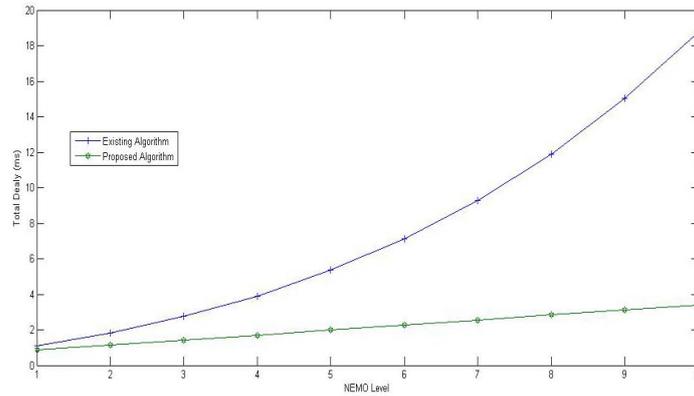Fig. 3: Transport Delay according to the transmission success probability of AR

Fig. 4: Transport Delay according to the level of NEMO

4. Conclusions

When RMTP is applied directly to the NEMO environment, it causes some problems. With the Light-NEMO+ protocol in NEMO, the pinball routing problem can be prevented. Our algorithm can improve route optimization to efficiently support RMTP, and also reduce the packet overhead between MR and TLMR using their location add identifiable field. Therefore, the creation of unnecessary tunnels is prevented. Through this, in the deep environment in terms of the level our algorithm can improve the delay compared to the existing methods. The delay according to the transmission probability is reduced, and it was proved by the results of performance evaluation.

5. Acknowledgements

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