



<http://www.icact.org/>

- MAIN
- MESSAGE
- OBJECTIVES
- COMMITTEE
- SESSION OVERVIEW
- TUTORIAL SESSION
- PLENARY SESSION
- TECHNICAL SESSIONS
- POSTER SESSIONS
- AUTHOR INDEX
- REVIEWER LIST
- TABLE OF CONTENTS
- VENUE

THE 12th INTERNATIONAL CONFERENCE on ADVANCED COMMUNICATION TECHNOLOGY

ICT for Green Growth and Sustainable Development



Phoenix Park, Korea
Feb. 7-10, 2010

IEEE Catalog Number CFP10561-CDR
ISSN 1738-9445
ISBN 978-89-5519-146-2



COPYRIGHT (C) 2010
BY GIRI.
ALL RIGHTS RESERVED
PRODUCED BY GIRISIM

Organizers



Sponsors



- 16. *Mathematical Analysis of Primary Users Characteristics Effects on Cognitive Radios***
 S. M. Hosseini(Islamic Azad University of Aliabad Katoul, Iran), M. Teimouri(Faculty member of
 Gonbad Higher Education Center, Iran) **1252**
- 17. *QMIP: Query-based Mobile IP for Performance Enhancement***
 Soon Hong Kwon, Jae Wan Park, Seok Joo Koh, Hee Young Jung(Kyoung-buk National University,
 Korea) **1256**
- 18. *The Impact of IMT System on ATSC System***
 Heon-Jin Hong, Dong-Chul Park(Chungnam National University, Korea) **1261**
- 19. *An Intelligent Destination Initiated Reservation Protocol for Wavelength Management in
 WDM Optical Networks***
 Debashis Saha(Indian Institute of Management IIMCalcutta, India) **1266**
- 20. *Mobile IPTV Performance Enhancement based on WiBro MMR Technology***
 Young-il Kim, Gonchigsumlaa Khishigjargal, Soon Young Song, Yong Su Lee, Park Dae Geun, Chun Sun
 Sim, Park Young Soo, Cheol-Hye Cho, Won Ryu(ETRI, Korea), Seong Young Seo, Suk Chan Kim(Pusan
 University, Korea) **1272**

Session 9A: Wireless Communication Technology (IX)

- 1. *A CMOS Baseband Receiver for Wireless Broadband Communications***
 Seunghyun Jang, Seung-Sik Lee, Sang-Sung Choi, Kwang-Chun Lee(ETRI, Korea) **1279**
- 2. *Performances Comparison among Smart Antenna RAKE Receiver and the other Applicable
 RAKE Receivers***
 Haiyang Fu, Xiong Liu, Wenfei Ruan, Xiangdong Jia(Nanjing University of Posts and
 Telecommunications, China) **1283**
- 3. *A Novel BEM- Based Channel Estimation Algorithm for Time Variant Uplink OFDMA System***
 Fatemeh Ganji, Farid Samsami Khodadad(Malek Ashtar University, Iran), Vahid Tabatabavakili(Iran
 Science and Technology University, Iran), Makan Hosseinezhad(Azad University (South Tehran Branch ,
 Iran), Amin Safaei(International Campus of Sharif University of Technology, Iran) **1289**
- 4. *The Adaptive Seamless Service Mechanism Design for Scalable Video Coding Extension of
 H.264/AVC Video Stream over IEEE 802.16e Network***
 Jiun-Yu Tu, Jung-Shyr Wu, Chih-Sheng Wang(National Central University, Taiwan), Chiung-Fang
 Hsu(Industrial Technology Research Institute, Taiwan) **1294**
- 5. *Analysis of ASTC in a Correlated Rayleigh Fading Channel with Imperfect Channel estimation***
 Ahmed BANNOUR, Mohamed Lassaad AMMARI, Ridha BOUALLEGUE(ENIT, Tunisia) **1300**

Session 9B: Ad Hoc Networks (II)

- 1. *A Reliable and Adaptive AODV Protocol based on Cognitive Routing for Ad Hoc Networks***
 Zhenhui Zhai, Yong Zhang, Mei Song, Guangquan Chen(Beijing University of Posts and
 Telecommunications, China) **1037**

QMIP: Query-based Mobile IP for Performance Enhancement

Soon Hong Kwon*, Jae Wan Park*, Seok Joo Koh*, Hee Young Jung**

*School of Electrical Engineering and Computer Science, Kyungpook National University, San-Kyeok-Dong 1370, Buk Ku, Daegu, Korea

**Electronics and Telecommunications Research Institute, Ga-Jung-Ro 138, Yu-sung Ku, Daejeon, Korea

Abstract—Mobile IP (MIP) suffers from the so-called triangular routing problem. Moreover, MIP Home Agent (HA) tends to undergo server data traffic load, since it should deliver all the data packets toward mobile nodes. This Paper proposes a simple extension of MIP, called Query-based MIP (QMIP), in which the binding query to HA will be used to get the care-of address of a mobile node and to deliver the subsequent data packets over the optimized data path. The proposed QMIP scheme can be applied to MIPv4 and Proxy MIPv6 as well. By analysis, we show that the QMIP can reduce the overall transmission delays of data packets to mobile nodes, compared to the MIP.

Keywords— Mobile IP, Binding Query, QMIP, Mobility

I. INTRODUCTION

The Mobile IP (MIP) was designed to support IP mobility [1]. However, it suffers from the well-known ‘triangular routing’ problem, in which Correspondent Node (CN) should transmit data packets to Mobile Node (MN) via Home Agent (HA) over a non-optimized data path, until the route optimization is additionally performed between CN and MN. Another crucial concern of MIP is the excessive data traffic load at HA, since all the data packets from CNs toward MNs should be delivered by way of HA. Such overhead at HA will become much severe, as the number of MNs increases in the network.

This paper proposes a simple extension of MIPv4, called Query-based MIPv4 (QMIPv4), in which AR will perform the binding query to HA, so as to get the Care-of Address (CoA) of MN and to deliver all the subsequent data packets over the optimized data path. For this purpose, we define the two new messages: Binding Query Request and Binding Query Reply.

The proposed QMIP scheme can also be applied to the Proxy MIPv6 (PMIPv6) [2], rather than MIPv6 [3], since PMIPv6 has the similar structure with MIPv4. We will first present QMIPv4, and then discuss Query-based PMIPv6.

II. QUERY-BASED MIPv4

A. Data Transmission with Binding Query

We consider a simple network model for QMIPv4, as depicted in Figure. 1. In the figure, MN performs the MIPv4 registration (or binding update), and then CN tries to communicate with MN. The AR has own Query Cache (QC) table. This QC table will be referred to by AR to identify the CoA of MN.

Now, CN transmits data packets to MN over Home Address (HoA) of MN. On reception of the first data packet destined to MN, the AR will first look for CoA of MN in its QC table. If the corresponding CoA is found in the table (we call it Cache Hit), AR will deliver the data packet directly to MN by using the IP-in-IP tunneling. Otherwise, if the CoA is not found (we call it Cache Miss), the AR will send a Binding Query Request message to HA so as to get the CoA. Then, HA responds with a Binding Query Reply message (containing CoA of MN) to AR. The resulting information of mapping between HoA and CoA of MN will be recorded into the QC table of AR, which will be referred to by AR in the subsequent data transmissions to MN.

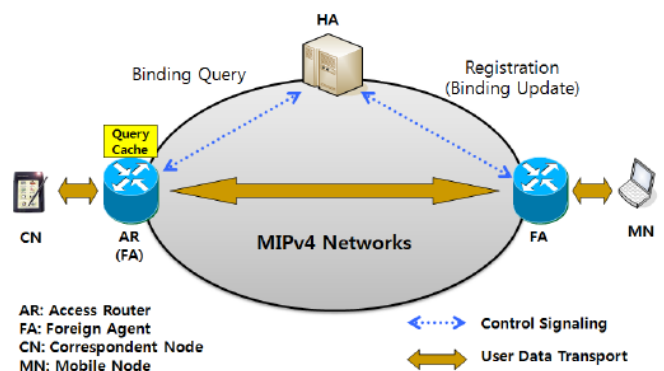


Figure 1. Network model for QMIPv4

B. Comparison with MIPv4

Figure.2 compares the information flows of MIPv4 and QMIPv4. In MIPv4, MN will perform the registration with HA. All the data packets transmitted by CN will be forwarded to HA and delivered by HA to MN using the IP-in-IP tunneling, whereas MN will transmit its data packets directly to CN, and hence the triangular routing occurs. Just after the route optimization, CN can use the optimized path for data delivery to MN.

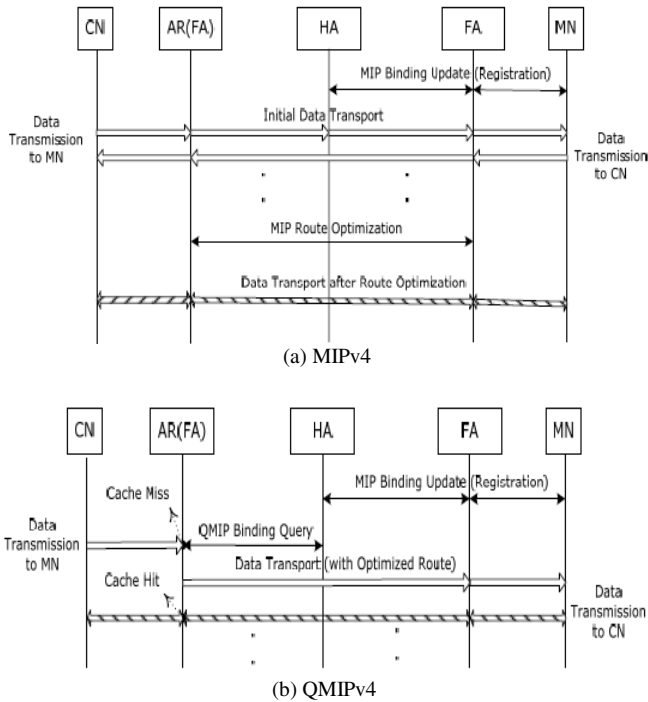


Figure 2. Network model for QMIPv4

The proposed QMIPv4 is the same with MIPv4, other than the binding query operation with HA. When the first data packet from CN, AR will search for the corresponding CoA of MN in its QC table. In case of Cache Hit that the CoA is found in the table, AR can transmit the data packet directly to MN over the optimized path. However, in case of Cache Miss, AR should perform the binding query to HA. After this, all the subsequent data packets will be delivered to MN over the optimized route, without further binding query operations.

Note that in MIPv4 the data transport between MN and CN will be done over the optimized route, just after the route optimization is completed, whereas the proposed QMIPv4 can intrinsically realize the route optimization with a single binding query operation. Moreover, in QMIPv4, Cache Hit may occur even for the first data packet of CN (i.e., the binding query operation can be omitted), if another CN in the same AR region is already communicating with the identical MN at that time.

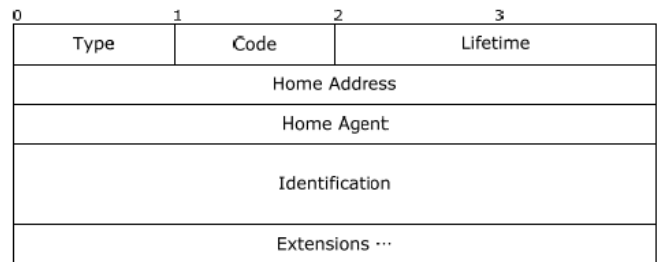
With the data transport over the optimized path, QMIPv4 can reduce the transmission delays of data packets, compared

to MIPv4. In addition, QMIPv4 can avoid the problem of the excessive data traffic load at HA, since the data transmission to MN will be performed by the concerned AR, instead of HA, in the distributed manner.

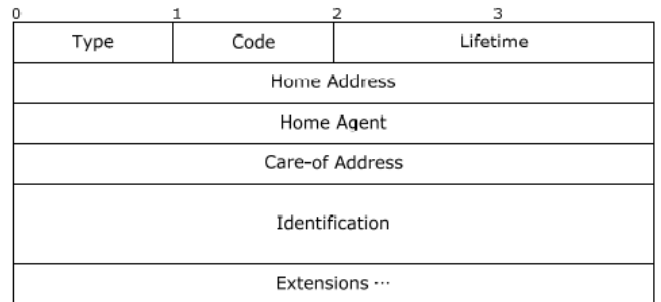
C. New Messages for QMIPv4

To support the QMIPv4, the two messages need to be newly defined: Binding Query Request (from AR to HA) and Binding Query Reply (from HA to AR). These messages can be defined in the similar format with the MIP registration request/reply messages, as shown in Figure. 3.

As shown in the figure, the Binding Query Request message contains the information on HA and HoA of MN, whereas the Binding Query Reply message additionally includes CoA of MN. The specific types of messages are for further study.



(a) Binding Query Request



(a) Binding Query Reply

Figure 3. Binding Query messages for QMIPv4

D. Considerations of Query-based Proxy MIPv6

The Query-based MIP scheme can also be applied to the Proxy MIPv6. In this case, the PMIPv6 Mobile Access Gateway will function as the QMIPv4 AR and/or FA, and the PMIPv6 Localized Mobility Agent acts as the QMIPv4 HA. In addition, the PMIPv6 Proxy Binding Update messages may need to be extended to support the binding query operation. Details of the Query-based PMIPv6 are for further study.

III. PERFORMANCE ANALYSIS

A. Analysis

As the performance metrics, we can consider the transmission delay of data packets and the message overhead by the binding query. However, the message overhead seems to be negligible in the viewpoint of performance, since only a single binding query operation will be required for each MN. Thus, we focus on the analysis of data transmission delays of data packets flowing from CN to MN for both MIPv4 and QMIPv4.

For analysis, let us denote TD_{MIP} and TD_{QMIP} by the overall transmission delays of data packets from CN to MN for MIPv4 and QMIPv4, respectively. In addition, we define the packet transmission times between two nodes as follows (it is assumed that the transmission times are symmetric):

- T_{AR-HA} : packet transmission time between AR and HA
- T_{HA-FA} : packet transmission time between HA and FA
- T_{AR-FA} : packet transmission time between AR and FA

On the other hand, we may consider the node processing time at HA and AR to handle the lookup of table/cache entries and the IP-in-IP tunneling in MIPv4 and QMIPv4. However, we assume that those node processing delays are almost identical at HA and AR, even though the node processing delay at HA will be larger than that at AR, since HA has much more table entries than AR.

Now, we consider a general case that MN moves into an FA region, other than AR or HA. In MIPv4, the overall data transmission delay (TD_{MIP}) for each of data packets can be expressed as:

$$TD_{MIP} = T_{AR-HA} + T_{HA-FA} \quad (1)$$

In QMIPv4, for the first data packet, the data transmission delay with Cache Miss ($TD_{QMIP-CM}$) includes the time required for binding query between CN and HA ($2 T_{CN-HA}$) and the data transmission from CN to FA (T_{CN-FA}). Thus, we get

$$TD_{QMIP-CM} = 2 T_{AR-HA} + T_{AR-FA} \quad (2)$$

For the second and further data packets, the binding query operation is not required, and thus the overall data transmission delay with Cache Hit ($TD_{QMIP-CH}$) can be obtained as

$$TD_{QMIP-CH} = T_{AR-FA} \quad (3)$$

From the equations (1)-(3), we can get a generalized result on overall transmission delays of data packets, as shown in Figure.4. In the figure it is assumed that T_{AR-FA} is smaller than $T_{AR-HA} + T_{HA-FA}$.

With the above results, we now consider the following two extreme cases:

- Case 1: MN stays in the HA region;
- Case 2: MN is in the same AR region with CN.

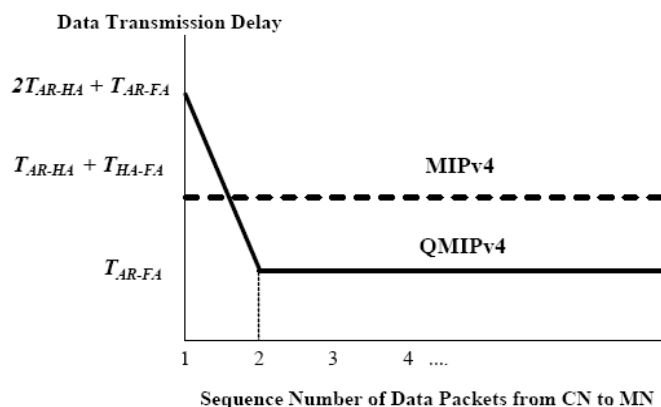


Figure 4. Data transmission delays of MIPv4 and QMIPv4

In Case (1) that MN is in the home network, we get $T_{HA-FA} = 0$ and $T_{AR-HA} = T_{AR-FA}$. Thus, the overall transmission delays can be expressed as

$$TD_{MIP} = T_{AR-HA} \quad (1-1)$$

$$TD_{QMIP-CM} = 3 T_{AR-HA} \quad (2-1)$$

$$TD_{QMIP-CH} = T_{AR-HA} \quad (3-1)$$

From these results, we see that QMIPv4 gives the same transmission delay with MIPv4 in the Cache Hit case. However, QMIPv4 may provide larger transmission delay than MIPv4 in the Cache Miss case (for the first data packet).

In Case (2) that MN is in the same AR region with CN, we get $T_{AR-FA} = 0$ and $T_{AR-HA} = T_{HA-FA}$. The overall transmission delays for MIPv4 and QMIPv4 will be

$$TD_{MIP} = 2 T_{AR-HA} \quad (1-2)$$

$$TD_{QMIP-CM} = 2 T_{AR-HA} \quad (2-2)$$

$$TD_{QMIP-CH} = 0 \quad (3-2)$$

From the above equations, we see that QMIPv4 gives the same transmission delay with MIPv4 even in the Cache Miss case. Moreover, QMIPv4 can provide zero transmission delay in the Cache Miss case.

In summary, we see that QMIPv4 can provide much smaller data transmission delays than MIPv4 for all the data packets other than the first data packet. In particular, when MN is in the same AR region with CN, the data transmission delay will become nearly zero, as shown in equation (3-2). This benefit comes from the optimized data path that is configured by using the binding query operation and the resulting Query Cache.

B. NS-2 Simulation Results

We now compare the existing MIPv4 scheme and the proposed QMIPv4 scheme in the performance perspective. To compare the performance, we employ the network simulator-2 [4] for the test network, as shown in Figure 5.

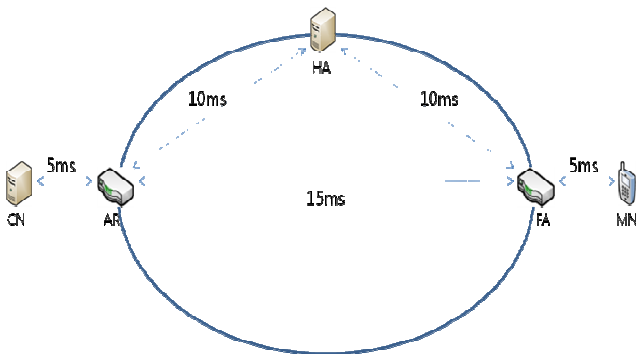


Figure 5. Simulation topology

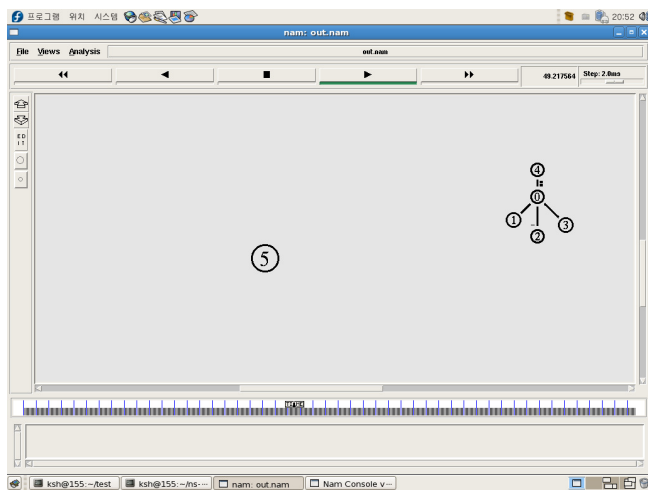


Figure 6. Example of simulations

Figure 6 shows a topology performed in our simulation. We will show the packet delivery times of the candidate schemes for the simulation topology by using NS/NAM, in which Node 4 represents CN, and Node 0 does AR, Node 1 is HA, Node 2 and 3 are FA, Node 5 is MN.

The proposed QMIPv4 performs the route optimization by sending a query message to the Home Agent, before data packet delivery. It is expected that the QMIPv4 gives a short packet delivery time, since it uses an optimized path, whereas the existing MIPv4 will not perform the route optimization in the initial phase.

Figure 7 shows the packet delivery time for the QMIPv4 and MIPv4 schemes. From the figure, we can see that QMIPv4 shows a higher performance more than the MIPv4

scheme, and also that the gap of performance gets larger as the number of packets increases.

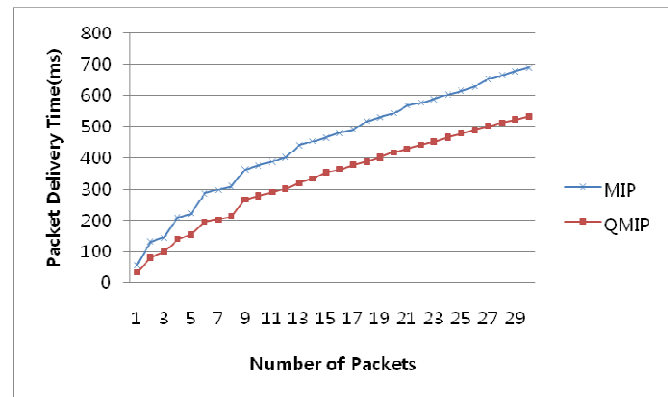


Figure 7. Packet delivery time of MIPv4 and QMIPv4

We now investigate the performance of packet delivery time for different packet transmission delays. It is noted that the MIPv4 scheme tends to use a larger AR-HA or FA-HA path, compared to the proposed QMIPv4 scheme. Figure 8 shows the packet delivery times of the candidate schemes for different AR-HA delivery time.

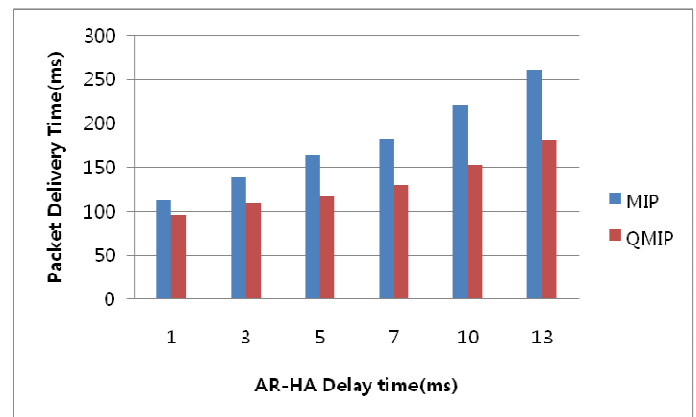


Figure 8. Packet delivery time with AR-HA delay time

From the figure 8, it is shown that the proposed QMIP scheme smaller packet delivery times than the existing MIPv4 scheme for all cases. Moreover, the gap of packet delivery time gets larger, as the AR-HA delay increases. This is because the existing MIPv4 is quite influenced by the AR-HA path delay, since all data packets are delivered over the concerned path.

In addition, we evaluate the performances of the candidate schemes by packet loss rates in the wireless networks. For this purpose, we measured the packet sequence number of the packets delivered over simulation period, for different packet loss rates, as shown in Figure 9.

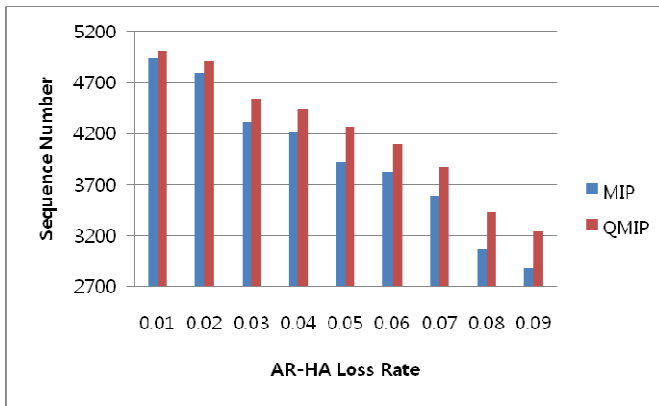


Figure 9. Packet sequence number with packet loss rate over AR-HA

From the figure, we can see that the proposed QMIP scheme much more packets than the existing MIP scheme for a given packet loss rate between AR and HA. This implies that the throughput of the proposed scheme is better than the existing scheme. It is also noted that the gap of throughputs gets larger, as the packet loss rate increases.

In summary, Figure 10 shows the packet sequence number for each of the candidate schemes to compare the throughput performances over simulation period.

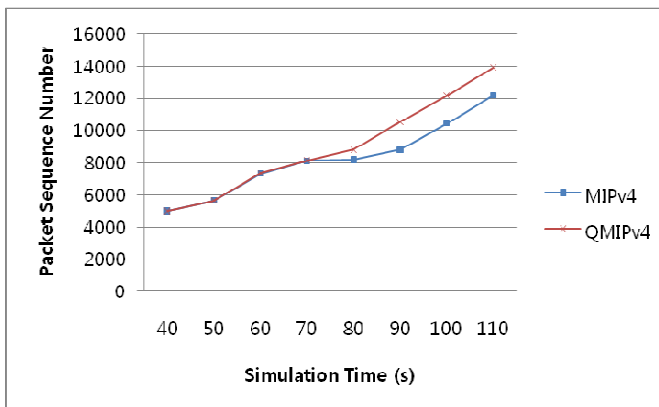


Figure 10. Comparison of throughput over simulation time

From the figure, we can see that the proposed QMIP scheme provides better throughput performance than the existing MIP scheme, and as the simulation time goes further the performance gain of the proposed scheme gets larger.

IV. CONCLUSIONS

This paper presents the Query-based MIP scheme that uses the binding query to HA so as to get the optimized data path. The proposed QMIP scheme can be applied to both MIPv4 and PMIPv6. In QMIP, we can achieve much smaller transmission delay of data packets than MIP in the usual case.

Moreover, the QMIP is helpful to avoid the excessive data traffic load at HA, since the data transmission to MN will be performed by AR in the network, instead of HA.

For future works, we need to evaluate the performance of QMIP by numerical simulations and experimentations for a variety of test environments. In addition, we need to study how to support or extend the MIP fast handover [5] in the QMIP scheme.

ACKNOWLEDGMENT

This research was supported by the MKE (The Ministry of Knowledge Economy), Korea, under the ITRC (Information Technology Research Center) support program supervised by the NIPA (National IT Industry Promotion Agency): (NIPA-2009- C1090-0902-0009).

REFERENCES

- [1] IETF RFC 3344, IP Mobility Support for IPv4, August 2002.
- [2] IETF RFC 5213, Proxy Mobile IPv6, August 2008.
- [3] IETF RFC 3775, Mobility Support in IPv6, June 2004.
- [4] Network Simulator NS-2, <http://www.isi.edu/nsnam/ns>.
- [5] IETF RFC 4988, Mobile IPv4 Fast Handovers, October 2007.