Optimization of Control Parameter of Differential Evolution Algorithm for Efficient Design of FIR Filter
S.Chattopadhyay, S.K.Sanyal and A.Chandra

Performance Evaluation of MLPC and MFCC for HMM based Noisy Speech Recognition
Mizanur Rahman, Md. Babul Islam

E-Commerce, E-governance & Others

Cognitive Change in Women’s Empowerment in Rural Bangladesh
Zebunnessa Laizu, Jocelyn Armarego, Fay Sudweeks

Employee Characteristics and Their Value Perceptions about Web-based B2E Systems Use in Bangladesh
Md Mahbubur Rahim, Mohammed Quaddus and Shahin Akhter

How experience affects technology acceptance: A quest for ICT development strategies in Bangladesh
Md. Shah Azam, Mohammed Quaddus, Mahbubur Rahim

Sensor Proxy Mobile IPv6 (SPMIPv6) - A Framework of mobility supported IP-WSN
Md. Motaharul Islam, Mohammad Mehedi Hassan, Eui-Nam Huh

Towards mobile based e-learning in Bangladesh: A framework
Ahsan Habib, A. S. M. Latiful Hoque

Graphics, Multimedia & Others

Comparative Performance Analysis of MPEG4, FLV and 3GP Multimedia File Formats using Wireless Network Parameters
Mohammad A. R. Mustafa, Mohammad Mamun Elahi, M. Alamgir Hossain, Mohammad Mahfuzul Islam

Data Exchange: Query Answering for Positive Query with at Most One Inequality
Md. Shirajum Munir, Md. Ahsanul Alam, S. M. Masud Karim

Developing an Efficient Search Suggestion Generator, Ignoring Spelling Error for High Speed Data Retrieval Using Double Metaphone Algorithm
Ashis Kumar Mandal, Md. Delower Hossain, Md. Nadim

Facial Expression Recognition Based on a Weighted Local Binary Pattern
Mohammad Shoyaib, M. Abdullah-Al-Wadud, Jo Moo Youl, Muhammad Mahbub Alam, Oksam Chae

Kinetisation of View of 3D Point Set
M. A. Wahid, M. Kaykobad, Masud Hasan

Session Management Protocol for Virtual Classroom in Teleteaching
Pallab Biswas, Vivek Nair, Soumen Nandi, Soumendra Nath Biswas, Amitava Biswas, Animesh Dutta

Information System & Digital System Design

A Composition Technique of Multiple Switching Functions Based on BDD
Md. Sayem Chowdury, G. M. Rokibul Hasan, Kamrul Hasan Talukder

A Multivalued Storage System Using Memristor
Faisal Mohsin

A Safe System with Safe Logistics Support for Chittagong Port
Md. Kafil Uddin, Muhammad Kamal Hossen
Sensor Proxy Mobile IPv6 (SPMIPv6) - A Framework of mobility supported IP-WSN

1st Md. Motaharul Islam, 2nd Mohammad Mehedi Hassan, 3rd Eui-Nam Huh
Department of Computer Engineering, College of Electronics and Information
Kyung Hee University, 1 Seocheon-dong, Giheung-gu, Yongin-si,
Gyeonggi-do, 446-701, Republic of Korea.
motahar@khu.ac.kr, hassan@khu.ac.kr, johnhuh@khu.ac.kr

Abstract

IP based Wireless Sensor Networks (IP-WSN) are gaining importance for its broad range of applications in health-care, home automation, environmental monitoring, security & safety and industrial automation. In all of these applications mobility in sensor network with special attention to energy efficiency is a major issue to be addressed. Host based mobility management protocol is inherently unsuitable for energy inefficient IP-WSN. So network-based mobility management protocol can be an alternative to the mobility supported IP-WSN. In this paper we propose a mobility supported IP-WSN protocol based on PMIPv6 called Sensor Proxy Mobile IPv6 (SPMIPv6). We present its architecture, message formats and also analyze its performance considering signaling cost and mobility cost. Our analyses show that the proposed scheme reduces the signaling cost by 67% and 60% as well as reduces mobility cost by 55% and 60% with comparison to MIPv6 and PMIPv6 respectively.

Keywords: wireless sensor network, IP-WSN, IETF, 6LoWPAN, IEEE 802.15.4.

I. INTRODUCTION

Recent advancement in micro-electro-mechanical systems and wireless communication systems have enabled the development of low cost, low power, multifunctional sensor nodes that are small in size and communicate in short distances [1]. A sensor network is a special type of communication network that is composed of a large number of sensor nodes that are densely deployed either inside the phenomena or very close to it [4]. The tiny sensor nodes consisting of sensing, data processing and communicating components are capable of holding IP stack [3]. IP-WSN concept is being implemented in many sophisticated application from building and home automation to industrial manufacturing. With the implementation of adaptation layer over IEEE 802.15.4, it becomes feasible to transmit IPv6 packet in IP-WSN [2]. Adaptation layer makes usage of stateless compression technique to elide adaptation, network and transport layer header fields- compressing all the three layers down to a few bytes [3]. IP enabled sensor node has opened the door for further research to the advanced and distributed applications in sensor network.

Mobility in sensor network is a challenging issue. This issue is not addressed in WSN for its resource and energy constraints. Moreover, sensor nodes in WSN introduce excessive signaling overhead due to its numerous tunneling over the air. Excessive signaling cost becomes a barrier for introducing mobility in low power IP-WSN. But due to the availability of 6LoWPAN, we propose mobility supported IP-WSN protocol called Sensor Proxy Mobile IPv6 (SPMIPv6) based on PMIPv6. Since SPMIPv6 is a network based localized mobility management protocol, it meets up the demand of energy efficiency in terms of reducing signaling costs and mobility costs. We also present its architecture, message formats and also analyze its performance by measuring signaling cost and mobility cost. We have compared SPMIPv6 with MIPv6 and PMIPv6 and evaluated performances of our proposed scheme. The evaluation shows that SPMIPv6 shows better performances in terms of signaling costs and mobility costs than that of MIPv6 and PMIPv6.

The rest of the paper is organized as follows. Section 2 reviews the background related to PMIPv6 and 6LoWPAN. Proposed Sensor PMIPv6 Protocol architecture, its mobility scenario, message formats and operational architecture are depicted in section 3. Section 4 illustrates performance evaluation and finally, section 5 concludes this paper.

II. BACKGROUND

2.1 Overview of PMIPv6

PMIPv6 is designed to provide network-based mobility management support to a Mobile Node (MN) in a topologically localized domain. Foundation of PMIPv6 is based on MIPv6 in the sense that it extends MIPv6 signalling and reuses many concepts. An MN is exempted from participation in any mobility-related signalling, and the proxy mobility agent in the serving network performs mobility-related signalling on behalf of the MN. Once an MN enters its PMIPv6 domain and performs access authentication, the serving network ensures that the MN is always on its home network and can obtain its home address on any access network. That is, the serving network assigns a unique home network prefix to each MN, and conceptually this prefix always follows the MN wherever it moves within a PMIPv6 domain. From the perspective of the MN, the entire PMIPv6 domain appears as its home network. The new principal functional entities of PMIPv6 are the mobile access gateway (MAG) and local mobility anchor.
Based Localized Mobility Anchor (SLMA), Sensor network based Mobile Access Gateway (SMAG), numerical fully functioned IPv6 header stack enabled sensor node. In this model SLMA will also incorporate the functionality of Authentication, Authorization, and Accounting (AAA); we call it Sensor Authentication, Authorization, and Accounting (SAAA) service. The main role of SLMA is to maintain the reachability to the sensor node’s address while it moves around within the SPMIPv6 domain, and the SLMA includes a binding cache entry for each recently registered sensor node. The binding cache entry maintained at the SLMA is more specific than LMA in PMIPv6 with some additional fields such as sensor node identifier, the sensor node’s home network prefix, and a flag bit indicating a sensor proxy registration. SMAG acts as an Edge Router. The main function of SMAG is to detect sensor nodes movement and initiate mobility related signaling with the sensor node’s SLMA on behalf of the sensor node.

III. PROPOSED SPMIPv6 MOBILITY SCHEME

3.1 Overview of SPMIPv6 Mobility Protocol

We propose SPMIPv6 protocol for network based localized mobility management protocol for IP-WSN. The SPMIPv6 architecture will consists of Sensor network based Localized Mobility Anchor (SLMA), Sensor network based Mobile Access Gateway (SMAG), numerous fully functioned IPv6 header stack enabled sensor node. In this model SLMA will also incorporate the functionality of Authentication, Authorization, and Accounting (AAA); we call it Sensor Authentication, Authorization, and Accounting (SAAA) service. The main role of SLMA is to maintain the reachability to the sensor node’s address while it moves around within the SPMIPv6 domain, and the SLMA includes a binding cache entry for each recently registered sensor node. The binding cache entry maintained at the SLMA is more specific than LMA in PMIPv6 with some additional fields such as sensor node identifier, the sensor node’s home network prefix, and a flag bit indicating a sensor proxy registration. SMAG acts as an Edge Router. The main function of SMAG is to detect sensor nodes movement and initiate mobility related signaling with the sensor node’s SLMA on behalf of the sensor node.

3.2 SPMIPv6 Mobility Scenario

We consider different mobility scenarios of a patient in a specialized hospital in figure 2. This figure indicates different floor as a Personal Area Network (PAN) in which there are SMAG and IP sensor in the body area of the patient. The doctors can monitor patients continuously through the IP-WSN. All the floors are considered in a single SPMIPv6 domain. Inside the SPMIPv6 domain there are six floors considered as individual SMAG domain. The mobility issue considered in this scenario are: Case-I: Movement of nodes within the same SMAG domain of the SPMIPv6 domain, Case-II: Movement of nodes between different SMAGs of the same SPMIPv6 domain, Case-III: Movement of nodes between different SMAGs of different SPMIPv6 domains, Case-IV: Movement of a SMAG-based PAN within the same SPMIPv6 domain, Case-V: Movement of a SMAG-based PAN between different SPMIPv6 domains. These scenarios are explained below:

Case-I: In this case, mobility of the nodes will be handled by the appropriate SMAG, without the involvement of the SLMA. This, the simplest mobility scenario, arises frequently in hospital management: a patient can move within the PAN of a single branch of the hospital for purposes such as exercise and fresh air.
Case-II: In this case, mobility will be handled by the appropriate SMAG with minimal initiative from the SLMA. The initial coordination will be performed by the SLMA alone; then the SMAG will oversee the remaining procedures. In our hospital management model, a patient can move from one PAN to another PAN in the same branch of the hospital.

Case-III: In this case, mobility is inter-domain, using the public PMIPv6 domain. The LMA, AAA, and SLMA will coordinate with one another. In our hospital management model, a patient can move on an emergency basis from one PAN of a hospital branch to a PAN of another branch of the same hospital.

Case-IV: In this case, mobility is based on the network mobility protocol, confined to the same domain. Only the SLMA and corresponding SMAGs will be involved. In our hospital management model, a patient with the whole set up can move from one PAN to another PAN.

Case-V: This case also affords Network mobility based mobility, but is much different from Case-IV. In our hospital management model, a patient can move on an emergency basis with its whole setup from one branch of a hospital to the more specialized branch of the same hospital.

3.3 Message Format for SPMIPv6
Proxy binding update (PBU) and proxy binding acknowledgement (PBA) message format for SPMIPv6 are depicted in Figure 3 and Figure 4 respectively. In the proposed PBU and PBA messages a flag bit S added. If S flag is set it indicates the SMIPv6 based operations. If S bit is not set then it will indicate non SPMIPv6 operations. The meaning of other flags bit are explained in details in different request for comments (RFC) [6][7][8][9]. Different mobility scenario discussed in section 3.2 can be adopted in mobility options field of the proposed PBU and PBA messages.

3.4 Architecture of the SPMIPv6
Figure 5 represents the operational architecture of SPMIPv6 which includes the functionality of SLMA, SMAG and Sensor node. It also depicts the interaction between the three entities. IP based sensor nodes consist of all the layers including adaptation layer which acts bridging layer between upper and lower layers. SMAG contains both sensor interface and ethernet interface since it acts as a gateway. Moreover, SMAG contains information of the sensor nodes belongs to it. SLMA contains the binding cache entry and SAAA which performs sensor information caching and authentication respectively.

IV. PERFORMANCE EVALUATION
To evaluate the total signaling costs and mobility related cost, we compare our analytical model with respect to MIPv6, PMIPv6 and SPMIPv6. For analyzing signaling costs, we use a two-dimensional random walk model [11][12][16] based on the properties of regular, absorbing Markov chains. Random walk mobility models are designed for dynamic location areas and are suitable for...
inter-PAN and intra-PAN movement when mobility is generally confined to a limited geographical area. Such scenarios include homes, vehicles, hospitals, and departmental stores [17]. For setting up different parameter values we have followed the approach as mentioned in [18] [19].

Figure 6. Analytical model for the performances analysis of SPMIPv6

Table I: System Parameter

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BU</td>
<td>Binding Update Message</td>
</tr>
<tr>
<td>BA</td>
<td>Binding Acknowledgement Message</td>
</tr>
<tr>
<td>PBU</td>
<td>Proxy Binding Update Message</td>
</tr>
<tr>
<td>PBA</td>
<td>Proxy Binding Acknowledge Message</td>
</tr>
<tr>
<td>Dsmag-slma</td>
<td>Distance between SMAG and SLMA</td>
</tr>
<tr>
<td>Dsn-smag</td>
<td>Distance between SN and SMAG</td>
</tr>
<tr>
<td>Mintra-pan</td>
<td>Intra PAN Mobility</td>
</tr>
<tr>
<td>Minter-pan</td>
<td>Inter PAN Mobility</td>
</tr>
<tr>
<td>α</td>
<td>Unit transmission cost in wireless link</td>
</tr>
<tr>
<td>β</td>
<td>Unit transmission cost in wired link</td>
</tr>
<tr>
<td>RS</td>
<td>Router Solicitation Message</td>
</tr>
<tr>
<td>RA</td>
<td>Router Advertisement Message</td>
</tr>
<tr>
<td>C_{id}</td>
<td>Sensor Mobility Cost</td>
</tr>
<tr>
<td>C_{bu}</td>
<td>Binding Update Cost</td>
</tr>
</tbody>
</table>

The total signaling cost of the scheme based on MIPv6:

\[ SC_{mipv6} = M_{intra-pan} \cdot C_{id} + M_{inter-pan} \cdot (C_{id} + C_{bu}) \]

Where \( C_{id} \) and \( C_{bu} \) are calculated in term of MIPv6 as follows:

\[ C_{id} = \alpha \cdot (R_{mipv6} + R_{mipv6}) \cdot D_{sn-smag} \]
\[ C_{bu} = \alpha \cdot (BU_{mipv6} + BA_{mipv6}) \cdot D_{sn-smag} + \beta \cdot (BU_{mipv6} + BA_{mipv6}) \cdot D_{mag-slma} \]

The total signaling cost of the scheme based on PMIPv6:

\[ SC_{pmipv6} = M_{intra-pan} \cdot C_{id} + M_{inter-pan} \cdot (C_{id} + C_{bu}) \]

Where \( C_{id} \) and \( C_{bu} \) are calculated in term of PMIPv6 as follows:

\[ C_{id} = \alpha \cdot (R_{pmipv6} + R_{pmipv6}) \cdot D_{sn-smag} \]
\[ C_{bu} = \beta \cdot (PBU_{pmipv6} + PBA_{pmipv6}) \cdot D_{mag-slma} \]

The total signaling cost of the scheme based on SPMIPv6:

\[ SC_{spmipv6} = M_{intra-pan} \cdot C_{id} + M_{inter-pan} \cdot (C_{id} + C_{bu}) \]

Where \( C_{id} \) and \( C_{bu} \) are calculated in term of SPMIPv6 as follows:

\[ C_{id} = \alpha \cdot (R_{spmipv6} + R_{spmipv6}) \cdot D_{sn-smag} \]
\[ C_{bu} = \beta \cdot (PBU_{spmipv6} + PBA_{spmipv6}) \cdot D_{mag-slma} \]

The figure 7 depicts the signaling cost with respect to the number of IP-WSN node in term of the MIPv6, PMIPv6 and SPMIPv6. Signaling cost increases as the number of IP-WSN node increase. Our proposed scheme (SPMIPv6) increases the performance linearly with the comparison to MIPv6 and PMIPv6. And the signaling cost increases more rapidly as the no of IP-WSN node increases. Proposed SPMIPv6 scheme reduces 67% and 60% signaling cost with respect to MIPv6 and PMIPv6.

Figure 7. Number of Node versus Signaling Cost

Figure 8 shows the mobility cost with respect to number of hops used by the mobile sensor nodes in MIPv6, PMIPv6 and SPMIPv6. Mobility cost increases exponentially as the number of hops increases. In this scenario also our proposed scheme (SPMIPv6) enjoys less mobility cost with respect to MIPv6 and PMIPv6. Proposed SPMIPv6 scheme reduces 60% and 55% mobility cost with respect to MIPv6 and PMIPv6.
V. CONCLUSION

In this paper we present a sensor proxy mobile IPv6 (SPMIPv6) protocol which enhances the mobility issue in IP-WSN. As mobility in sensor network is a challenging issue, it must be addressed with special attention to energy efficiency. Since SPMIPv6 is a sensor network based localized mobility management protocol, it meets up the demand of energy efficiency in terms of reducing signaling costs and mobility costs. Here we also present its architecture, message formats and evaluates its performance by analyzing signaling costs and mobility costs. Our experiments show that SPMIPv6 reduces both signaling cost and mobility cost with comparison to MIPv6 and PMIPv6. In this paper, we focus 6LoWPAN based IP-WSN of the same vendor and protocol stack. In future we will focus on the sensor networks consisting of multi vendor and heterogeneous protocol stack.

ACKNOWLEDGEMENT

This work was supported by the Korea Science and Engineering Foundation (KOSEF) grant funded by the Korea government (MEST) (No. 2010-0016959) and by the MKE(Ministry of Knowledge Economy), under ITRC(Information Technology Research Center) program supervised by the IITA(Institute of Information Technology Advancement)(NIPA-2010-(C1090-1021-0003)). The corresponding author is Eui-Nam Huh.

REFERENCES