Development of 6LoWPAN smart home system: a performance evaluation of network control traffic overhead

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ABSTRACT – The development of IoT embedded devices growing rapidly especially in Smart Home Automation System (SHAS). To sum up, the devices imposes overhead on the IoT network. Therefore, 6LoWPAN was developed to accommodate these constraints. 6LoWPAN is IP based communication where as it allows each device connect to the internet directly. For this reason, the power consumption was reduced. However, the limitation of data transmission frame size become RPL (6LoWPAN protocol) overhead. Meanwhile HRPL was develop to enhanced the RPL to reduce the control traffic overhead (CTO) that causes the routing overhead. This paper presents the performance analysis of HRPL based on SHAS testbed. Our result show HRPL significantly reduced the CTO. The observed CTO packets reduced about 30% than RPL. For further research is required to study using various metric such as latency, Packet Delivery Ration (PDR) and Convergent time.

1. INTRODUCTION

The IoT (Internet of Things) concept is everything that can communicate with each other via a network anywhere. This technology brings a major revolution in creating a smart environment to improve the quality of life [1]. Due to this matter, IoT deployment grows rapidly year by year in multiple platforms like smart home, healthcare, manufacturing, smart farming, etc[2]. However, most IoT devices are categories as low power, low cost, low memory, and low bandwidth [3] which create a necessity for low power networks to save energy consumption. Therefore, IPv6 Low Power Wireless Personal Area Network (6LoWPAN) was introduced by Internet Engineering Task Force (IETF) that allows the smallest devices to transmit information using an Internet Protocol (IP). The 6LoWPAN technology enables the system to use IPv6 formats by IEEE 802.15.4. However, IEEE 802.15.4's standard packet size is limited to 127 octets and the adaption layer use to encapsulate and compress the User Datagram Protocol (UDP) header to keep transmission short in order to reduce the power consumption [4]. Nevertheless, this condition causes the routing overhead is high. Based on a previous study [5]–[7], IPv6 Routing Protocol for LLNs (RPL) is effective as a 6LoWPAN routing protocol however needs improvement to overcome the routing overhead. Thus, HRPL was introduced in [8] to enhance RPL by adding H field to Destination-Oriented Directed Acyclic Graphs (DODAG) Information Object (DIO) based object format. H field responds to the three conditions: i) rebroadcast DIO message, ii) discard the DIO message and iii) no change that expected can minimize the routing overhead and provides an efficient way of communicating devices. To evaluate the performance of HRPL in the real world, the 6LoWPAN smart home system was developed [9]. This paper presents the performance analysis of HRPL in terms of Control Traffic Overhead (CTO) metrics. We compare the result of the experiment performed with the RPL protocol. The reminders of this paper are organized as follows. Section 2 shows the methodology then Section 3 describes the evaluation result and final, we emphasize the contribution of this paper and future works.

2. METHODOLOGY

This study focuses on evaluating the performance of HRPL and RPL protocol in real scenarios based on the 6LoWPAN environment. Figure 1, presents the testing design in this analysis.

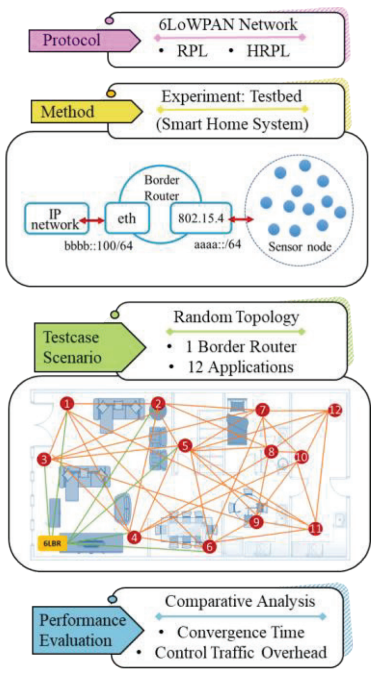

Figure 1 Methodology Design for HRPL Testing [10].

3. RESULT AND DISSCUSION

Control Traffic Overhead (CTO) are define the total number of DODAG Information Solicitation (DIS), Destination Advertisement Object (DAO) and DIO. The DIS, DIO and DAO message transmitted by nodes for the formation of DADOG in the network. Figure 2(a) and 2(b) presents the overall packet traffic (send and received) for HRPL and RPL during experiment setup. Based on our observation, HRPL generates 1074 packets/sec (30% lower) less than RPL. Figure 3-6 shows the comparison of DIS, DIO, DAO and CTO between HRPL and RPL for each node. In our scenario HRPL reduced 28% of DIO message (Figure 3), 36% of DAO Message (Figure 4), 26% of DIS message (Figure 5) and 30% of CTO (Figure 6). The result shows the H condition that added to the RPL DIO based object format has reduced control message overhead significantly.

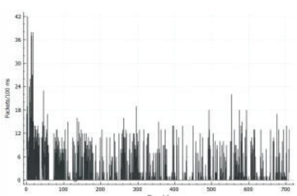

Figure 2(a) RPL Packets Traffic

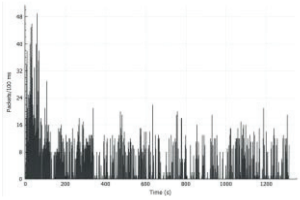

Figure 2(b) HRPL Packets Traffic

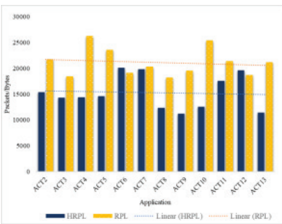

Figure 3 The Comparison DIO Message for Each Node

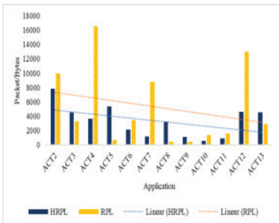

Figure 4 The Comparison DAO Message for Each Node

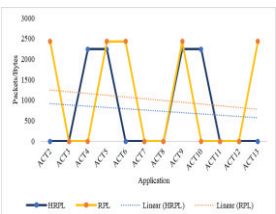

Figure 5 The Comparison DIs Message for Each Node

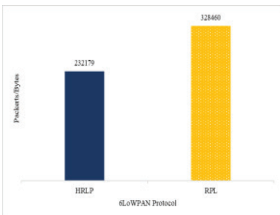

Figure 6 The Comparison CTO

4. CONCLUSIONS

IoT devices face many limitations and 6LoWPAN system offers many advantages for embedded devices to communicate via internet with low power consumption. HRPL was proposed to overcome the RPL routing overhead. This paper proved that the HRPL is significantly reduced the routing overhead when it implements in SHAS. So that, we plan to investigate our HRPL in various metrics like Packet Delivery Ratio, latency and convergent time Also we plan to implement HRPL in real world scenario with different topology like star, chain.

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