

Link Quality Indicator for Performance Evaluation in 6LoWPAN Routing Protocol

Nin Hayati Mohd Yusoff^{1,*}, Nurul Azma Zakaria², Norharyati Harum²

¹ Centre for Graduate Studies (PPS)

Faculty of Information and Communication Technology

Universiti Teknikal Malaysia Melaka, Hang Tuah Jaya, 76100 Durian Tunggal, Melaka, Malaysia

² Center for Advanced Computing Technology

Faculty of Information and Communication Technology

Universiti Teknikal Malaysia Melaka, Hang Tuah Jaya, 76100 Durian Tunggal, Melaka, Malaysia

*Corresponding e-mail: nin6699@gmail.com

Keywords: 6LoWPAN, Routing Protocol, Network Performance

ABSTRACT – 6LoWPAN is a link network that allows each node connect to other nodes directly. However, the limitation of 6LoWPAN frame length is 127 bytes over IEEE802.15.4, the performance issue especially in link quality as seen by end nodes become more challenging in designing routing protocol. Therefore, this paper emphasizes on the link quality indicator (LQI) which has a significant effect to ensure the 6LoWPAN routing protocol is able to achieve efficiency network performance Quality of Services (QoS). It was found that the three important of LQI: overhead, throughput and latency in order to achieve efficient QoS in 6LoWPAN routing protocol.

1. INTRODUCTION

“Internet of Thing” (IoT), a term that proposed by Kevin Ashton is going to be the new rule for the future, “Anything that can be connected will be connected”[1]. By moving to IoT, the embedded devices that define low power, small, low cost, limited memory capacity is growing in rapid pace[2]. These devices are universally becoming Internet Protocol (IP) enabled to be connected to the Internet by using Wireless Sensor Network (WSN). Thus, Internet Protocol version 6 (IPv6) over Low Power Wireless Personal Area Network (6LoWPAN) is a standard link network for IEEE 802.15.4 in frequency range 2.5 GHz band were introduced by Internet Engineering Task Force (IETF).

However, the 6LoWPAN standard is limited to 250 kbps, and the frame length is limited to 127 bytes compared to packet size over IEEE 802.15.4 is 1280 bytes. In this condition, the packet size enables to be encapsulated the IEEE 802.15.4 frames in more than 16 fragment [3]. Due to this matter, routing becomes the main issues in 6LoWPAN network capability. On the other hand, the routing algorithm has to optimize the formation of the path to ensure the network achieves the efficiency performance. However, the challenging issues in the design of such protocol is the performance of link quality that measures the network Quality of Service (QoS). The Link Quality Indicator (LQI) that has an impact on network performance and also affects the QoS. Therefore, in this work, we have studied

previous research in order to identify the LQI that can be considered as the critical area of QoS in designing 6LoWPAN routing protocol. The objective of this paper is to explore the LQI that contributes in achieving efficient quality service of network based on 6LoWPAN routing requirement. The rest of this paper is structured as follows: The methodology section describes a method used to identify the indicator. Next, Section 3 provides the result and discussion and finally Section 4 presents the conclusion.

2. METHODOLOGY

The document analysis approach was used to identify the LQI through previous research and prior theories. Based on this analysis, three indicators that have a significant effect in measuring the QoS of 6LoWPAN routing protocol was identified. The collected data were analyzed by using meta-analysis method to get the most significant indicators.

3. RESULT

3.1 Routing Overhead

Routing overhead is the number of routing packets required to transfer bit per packet frame from source to destination [4]. Routing algorithm generates small size routing packet such as HELLO, RREQ, RREP and RERR packets that are used for checking whether the neighbour node is active or not. Routing packet is considering to be overhead in the network or it call routing overhead when both routing and data packet have to share same network bandwidth most of the time. The fragmentation of the frames should minimize the routing overhead in order to save network lifetime that is a critical parameter to 6LoWPAN nodes. On the other hand, to provide a reduction in the power consumption transmission of packet frame that will effect network lifetime, the size of the control packet frame should not be crossed with 6LoWPAN standard frame size. The standard frame size for 6LoWPAN is compressed to 22/33 octets with packet size 127 byte [3]. However, the routing protocol overhead will change according to the changes in the network topology. As mentioned in [9], when the nodes are moving, there is a corresponding

increase of routing overhead and this affect by the speed of the movement. Therefore, to optimize the network performance, the routing overhead must be reduced but the nodes speed must be increased. Due to this matter routing overhead indicator is a significant effect on the performance of 6LoWPAN routing protocol that can improve the QoS.

3.2 Throughput

The design of routing protocol must consider about the probability rate of successfully delivering of packet frames [5] or it calls network throughput that is used to measure how fast the data have been sending through the network. Based on the prior study, we conclude that in 6LoWPAN network, the throughput indicator is significant with Packet Delivery Rate (PDR) [5-9]. The higher PDR give the higher throughput. PDR is the number of successfully received packet frames that sent by the sender (end-to-end) including re-transmissions and it showed in percentage. The reliability of data rates that are used to evaluate the performance of throughput indicator in 6LoWPAN is shown in Table 1 [10].

Table 1. The data rates in ideal 2.4 GHz Channel that adopted in 6LoWPAN

MAC address	Data Rate	Reliable/Unreliable
16-bit	151.6 kbit/s	Unreliable
16-bit	139.0 kbit/s	Reliable
64-bit	135.6 kbit/s	Unreliable

However the rate can change significantly overtime and the requirement of a successful end-to-end packet delivery ratio may be varied according to different application and distance [6]. So that, it is necessary to study the behavior of routing protocol on a huge scale (thousands of nodes) network and distance.

3.3 Latency

Various types of latency are possible to give the delay cause such as buffering during routing discovery latency, queuing at the interface queue, and retransmission delays at the mesh layer, propagation and transfer times [8]. These latencies must be considered to achieve the best performance of QoS for 6LoWPAN routing algorithm. Therefore, the design of routing algorithm requires simple and optimal control packets of each node, so the time of establishment path also decreases[6]. However, it is found that the average end-to-end delay will reduce especially when the speed increase with more data packets are delivered to destinations without waiting for route discovery latency [11]. Therefore, latency is one of the indicators that significant to be measured for 6LoWPAN routing algorithm that will optimize the 6LoWPAN QoS. The range of latency that reliable in 6LoWPAN shown in Table 2 [10].

Table 2. The range of Latency in Ideal 2.4 GHz that adopted in 6LoWPAN

MAC address	Data Rate	Reliable/Unreliable
16-bit	[1.92ms, 6.02ms]	Unreliable
16-bit	[2.46ms, 6.56ms]	Reliable
64-bit	[2.75ms, 6.02ms]	Unreliable
64-bit	[3.30ms, 6.56ms]	Reliable

4. Conclusion

The limitations of 6LoWPAN such as small frame sizes, limited data rates, limited memory, sleeping node cycles have increased the complexity and challenges in designing routing algorithm. This paper has present the most important LQI that significant to optimize the 6LoWPAN network QoS that is being used to understand the indicators issue that needs to be a tackle to measure the performance of the 6LoWPAN algorithm. We discussed and analyzed three (3) essential indicators that influence the performance of QoS in designing the 6LoWPAN routing protocol must to achieve the minimal routing overhead, maximum throughput and reduce latency.

5. References

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