

# Identification of key components for 6LoWPAN network performance analysis

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**ABSTRACT** – As the number of interconnected devices grows significantly in Internet of Things' era, efficient communication between devices is a mandatory. 6LoWPAN is an emerging communication technology that supports IoT network. However, there are uncertainties in finding suitable components for 6LoWPAN network performance analysis. Thus, this study aims to identify significant details in investigating network performance. By applying the SLR approach, relevant details of routing protocol, performance metrics, and simulation tools were identified. The results from this study guide and facilitate future evaluation process in 6LoWPAN network performance analysis.

## 1. INTRODUCTION

Internet of Things (IoT) acts as a model for connecting objects, peoples, and things to the Internet. Integration of IoT with other technologies enhances device to device communication in sensing and communicating with their external or internal environments. In this decade, the number of interconnected devices is significantly increased and this phenomenon is expected to continue and eventually surpass the number of people [1]. Most of these devices are low-cost embedded devices with low power, limited memory, and small size [2]. With various device specifications, interoperability becomes one of the challenging issues in the IoT environment. Thus, the Internet Engineering Task Force (IETF) introduced the next-generation Internet Protocol version 6 (IPv6) over Low-Power Wireless Personal Area Networks (6LoWPAN) to support a huge number of interconnected IP-based embedded devices.

The 6LoWPAN adopts the IPv6 stack for seamless connectivity between IEEE 802.15.4 multi-hop based sensor networks and IPv6 based infrastructure. 6LoWPAN comprise of edge router and sensor nodes. An edge router is the core of the 6LoWPAN network that links 6LoWPAN network to the other IP internet. It routes the 6LoWPAN packets to the IPv6 packets and assigning IPv6 prefixes in the 6LoWPAN network.

This paper aims to identify key components such as type of routing protocols, simulation tool, and performance metrics that relevant in evaluating the

network performance of 6LoWPAN. The rest of this paper is structured as follows: Section 2 describes the methodology used for literature review process whereas Section 3 provides the results and discussion of the study. Section 4 presents the conclusion of the paper.

## 2. METHODOLOGY

The Systematic Literature Review (SLR) [3] method was used to identify relevant routing protocols, simulation tools and performance metrics through previous researches. The collected data were critically analysed to extract the significant details. SLR framework is consists of three stages namely planning, conducting, and reporting.

Initially, the coding scheme or called keyword was determined. These keywords were used in the search process of articles and journals: "Performance Analysis" OR "Performance Evaluation" AND "6LOWPAN" "routing protocol". Then, various online databases were selected for the search process. IEEE Xplore, ScienceDirect Scopus, Web of Science, Emerald Insight and ACM Digital Library databases were used in this stage. In these reliable databases, conference publications and journal articles published in the period from 2016 to 2020 were searched to ensure the inclusion of relevant and recent studies. Lastly, the results of the SLR process were reported and illustrated to guide the research.

## 3. RESULTS AND DISCUSSION

After searched all the selected databases, we found a total of 1,263 articles, of which 325 were from ScienceDirect, 131 from IEEE Xplore, 21 from Scopus, 77 from Web of Science, 16 from Emerald Insight, and 693 from ACM. Three iterations were conducted to refine the findings, so that the final set only comprised of sound-related works for the study. This procedure is illustrated in Figure 1.

### 3.1 Routing Protocols

Based on the analysis, three (3) routing protocols named Routing Protocol for Low-Power and Lossy Networks (RPL), Ad-hoc On-Demand Distance

(AODV) and 6LoWPAN Ad-Hoc On-Demand Distance Vector Routing Protocol (LOAD) were involved in most of the related works which measures the performance of 6LoWPAN network. The performance analysis of these protocols is commonly carried out through simulation.

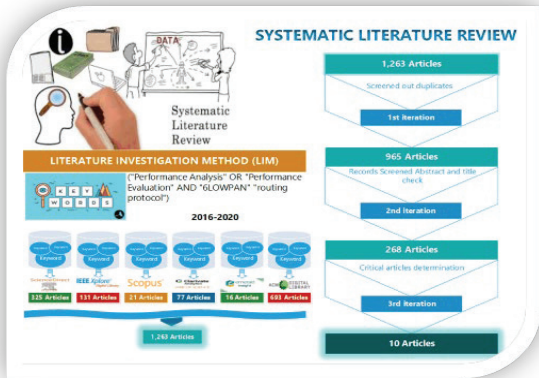


Figure 1 Result from SLR process

### 3.2 Simulation tools

The outputs of the review showed that a number of simulators are available to simulate the routing protocols such as NS-3, NS-2, J-sim, OMNeT ++, MATLAB, Castalia, QualNet, TOSSIM, and COOJA. These simulators are well known because of their high popularity in the research community for network theories validation.

Characteristics and features of these simulators were analyzed and among them, COOJA simulator with Contiki operating system becomes the best candidate for the study as it is highly portable and able to perform multitasking. As COOJA focuses on low power IoT devices, the user interface is simple and flexible. COOJA simulator supports fully standardized IPv4 and IPv6 as it supports low power standards like 6LoWPAN and Constrained Application Protocol (CoAP). Figure 2 depicts the example of COOJA simulator interface.

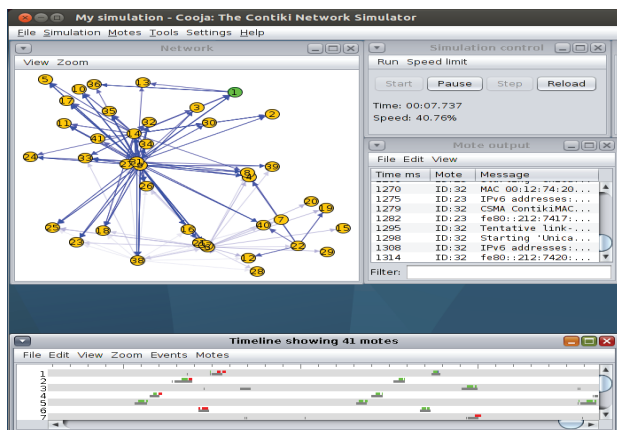


Figure 3 COOJA Simulator Interface [4]

### 3.3 Network Performance Metrics

For efficiency, the routing protocol must be tested against certain networking parameters. Findings from the SLR process indicated that the most frequent parameters used in previous researches are end-to-end

delay, throughput, packet delivery ratio, and power consumption. According to [5], the end-to-end delay of each packet is the total number of delays calculated from the source to the destination. Whereas, throughput is number of successfully transmitted packets from source to destination per second. A good designed network has a high value of throughput. Packet delivery ratio (PDR) [6] is the ratio of total packets delivered to total packets sent from source node to destination node. Maximum number of data packets reaches the destination is recommended. Moreover, [7] states that the energy consumption is the total energy consumed by the network to perform all processes such as transmission, reception and data aggregation.

## 4. CONCLUSION

Due to the existence of some uncertainties in 6LoWPAN network performance analysis, this paper suggests three (3) routing protocols named RPL, AODV and LOAD, four (4) network parameters and a COOJA simulator as key components that commonly used in 6LoWPAN network analysis.

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