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PERFORMANCE EVALUATION OF OLSR ROUTING PROTOCOL IN A TESTBED ENVIRONMENT

Wardi, Adnan, Zulkifli Tahir, Adriannus Bonny, Astriana
Electrical Engineering Department
Engineering Faculty, Universitas Hasanuddin
Makassar, South Sulawesi, Indonesia
wardi@unhas.ac.id

***Abstract*—This paper presents an OLSR routing protocol for ad hoc network in a real world experiment. The scenarios of the testbed are established on a static and dynamic node to evaluate the protocol in terms of self-configuration, multi-hop communications, and the ability in mobile nodes. The evaluation based on throughput, delay, and packet loss. The results show that the OLSR protocol provides a reliable routing protocol for ad hoc networks.**

I. INTRODUCTION

A mobile ad hoc network (MANET) is a dynamic collection of mobile nodes which interconnected via wireless links. Mobile nodes can freely and dynamically move and organize themselves into arbitrary and temporary network topologies. Thus, the network topologies may change rapidly and unpredictably. Due to the absence of any fixed communication infrastructure, each node in MANETs must be capable of functioning not only as a host but also as a router.

A large number of routing protocols have been proposed for MANETs. Such protocols can be categorized as proactive, reactive, and hybrid protocols [1]. The proactive routing protocols, such as OLSR and DSDV, periodically exchange information on each node to maintain up to date routing table for all nodes throughout a network. In contrast, the reactive routing protocols, such as AODV and DSR, do not need periodic transmission of topological information. The hybrid routing protocols such as TORA and ZRP, integrate some characteristics of both reactive and proactive routing protocols.

Several techniques have been done to evaluate the performance of the routing protocol. The well-known methods are network simulation and real world testbed. The simulation models have been widely presented in some applications, e.g. NS2/NS3, OPNET, QualNet, NetSim. However, simulation techniques are sometimes criticized for imprecision in capturing the characteristics of realistic the condition of the nodes. On the other hand, the real world experiment can present actual environmental conditions [2]-[6].

This paper conducts an experiment in a real world for OLSR. It presents the performance of the protocol in terms of throughput, delay, and packet loss. The rest of this paper is organized as follows. Section 2 describes the concept of OLSR. In Section 3, we explain the design and implementation of the research. Section 4 discusses the performance of OLSR with results of simulation. We conclude the paper in Section 5.

II. OPTIMIZED LINK STATE ROUTING (OLSR) PROTOCOL

OLSR is a proactive routing protocol, developed specially for MANETs [7]. In OLSR, each mobile node performs flooding of broadcast packets which contain Traffic Control (TC) messages. TC messages have topological information collected by exchange of HELLO messages between each pair of adjacent nodes. In order to reduce the number of broadcast packets, OLSR uses the idea of MPR [8], in which each mobile node selects some of one-hop neighbor nodes as an MPR set. The MRP set of a mobile node covers all its two-hop neighbor nodes. Only MPR nodes forward the flooding packets. Although the one-hop neighbor nodes which are not a member of the MPR set receive and process TC messages, they do not retransmit them to further nodes. Therefore, the number of flooding packets is reduced.

A. HELLO Message

In order to detect links and neighbors, HELLO messages are periodically sent by each node to its one-hop neighbor nodes according to the hello-interval time. HELLO messages are not forwarded to further nodes. A HELLO message of a mobile node contains information on its one-hop neighbor nodes and links status. Thus, this mechanism enables each node to detect not only their one-hop neighbor nodes but also their two-hop neighbor nodes. This information is used by each node to independently select its own MPR nodes among its symmetric one-hop neighbor nodes.

B. TC Messages

TC messages perform a task of topology declaration. TC messages are broadcasted by each node for advertising its own topological information collected by exchange of HELLO messages. Each mobile node generates the TC messages periodically at every refreshing period called TC-interval except that there are changes detected in the mobile node before the TC-interval. A TC message contains information on its MPR selector set and includes the sequence number associated to the TC message. Only the nodes which are selected as MPR nodes can disseminate TC messages. Based on the information diffused by TC messages, each mobile node creates its own routing table.

C. MPR Selection

Each node has an N_willingness parameter which indicates the intention of the node to forward packets. The N_willingness is set to be 0 (WILL_NEVER), 1 (WILL_LOW), 3 (WILL_ DEFAULT), 6 (WILL_HIGH), or 7 (WILL_ALWAYS). WILL_NEVER indicates that a mobile node does not wish to forward messages, and thus it is not selected as an MPR node. WILL_ALWAYS indicates that a mobile node is always selected as an MPR node.

III. DESIGN AND IMPLEMENTATION

This research is composed of five laptops. The characteristics of the laptops can be seen in Table 1. The laptops are mounted with linux Ubuntu with kernel 2.6.38, OLSRD 0.5.6-r7, Wireshark 1.4.6-1, Giver, and VLC Media Player 2.01 [9]-[12]. The experimental is done at the third floor of electrical engineering department of Universitas Hasanuddin.

The testbed is set up for video streaming and transferring data text. The video streaming is transmitted by using UDP protocol to stream 40.2 MB file running at 30 frames per second at 1300 kbps while the text data with 2.2 MB are sent over TCP protocol.

TABLE I. SPECIFICATION OF THE LAPTOP

Node	Brand	Processor	RAM
A	Acer 4736	Intel Centrino	1 GB
B	Acer 4935	Intel Centrino	1 GB
C	Asus A43E	Intel Core i3	2 GB
D	Toshiba L510	Intel Core i3	2 GB
E	BenQ C42E	Intel Celeron M	512 MB

A. OLSR Protocol Configuration

All devices are installed with OLSRd 0.5.6-r7 protocol provided by Tonnesen [10]. The configuration of the routing protocol is shown in Table 2.

TABLE II. CONFIGURATION OF OLSR

No.	Parameter	Level
1.	Hello Interval	5.0 s
2.	TC Interval	2.0 s
3.	Willingness	7
4.	MPR Coverage	5
5.	IP Version	4

B. Scenario of Testbed

Testbed scenarios are established based on a static and dynamic node. The scenario of the fixed node evaluates the self-configuration of the OLSR and multi-hop communications. The scenario of the movable node is to show the ability of OLSR to implement on mobile nodes.

1) Self-configuration scenario

This scenario is to show the ability of the OLSR protocol in finding a new route to keep communicating when a router node cannot be reached. The scenario can be seen in Fig. 1.

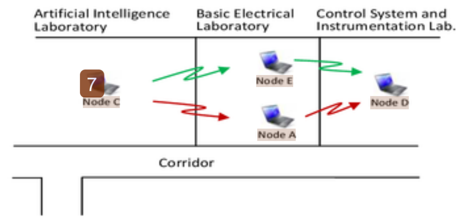

Figure 1 Self-configuration Scenario

Node C streams a video to Node D via a router whether node A or node E. During communication, the router node is turned off to see the self-configuration of OLSR protocol.

2) Multihop scenario

This scenario evaluates a multi hop communication of OLSR protocol. The scenario is shown in Fig. 2.

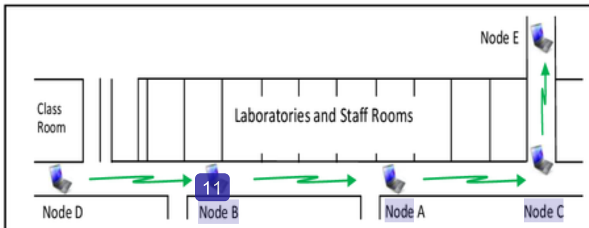

Figure 2 Multihop Scenario

In the scenario, to test 1-hop communication, node D sends text data and video streaming to Node B. The next, node D sends text data and video streaming to Node A via node B for 2-hop. Experiment of 3-hop is conducted by sending text data and video streaming from node D to node C via node B and node A. Network for 4-hops is set by transmitting text data and video streaming between node D and node E via node B, node A, and node C.

3) Mobile scenario

In Fig. 3, all nodes are mobile and can communicate each other. Each node moves according to the tract with the average speed of 0.467 m/s.

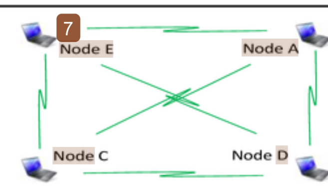

Figure 3 Mobile Scenario

The procedure of the scenario is node A transmits a video streaming to only node C. Then, repeats the procedure to both node C and node D. The next, node A streams to node C, node D, and node E.

IV. EXPERIMENTAL RESULT

This section summarizes the results obtained for the OLSR Protocol. The results are capture by Wireshark 1.4.6-1a to record all data during communication among the nodes in the ad hoc network [11].

A. *Results of Self-configuration Scenario*

Data are collected to see the change of routing table when node C is transmitting a packet data to node D. Then, node A as a router is turned off. The traceroute shows the change of the router from node A to be node E. In the process, before hello message and TC message reach their interval time update, there are packets drop for 8.73%. As a result, the number of throughput decreases by 8.75%. Moreover, the length of the time delay increase from 8.30 ms to 9.18 ms. The results of the route change can be seen in Fig. 4.

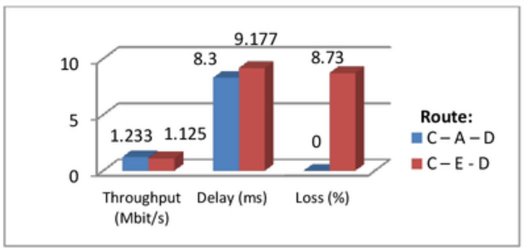

Figure 4 Self-configuration Scenario

B. *Result of Multihop Scenario*

The experiments of multi hop communication are set for 1-hop, 2-hops, 3-hops, and 4-hops. The results can be observed from Fig. 5 to Fig. 7.

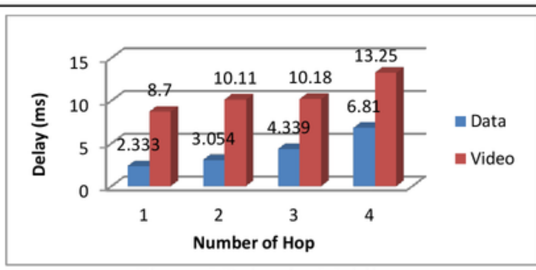

Figure 5 Delay for Multihop

Fig. 5 shows the average delay of OLSR for 1-hop, 2-hops, 3-hops, and 4-hops. The end to end delay when sending data text for 1-hop is about 2.333 ms, for 2-hops is 3.054 ms, for 3-hops is 4.339 ms, and for 4-hops is 6.81 ms. The streaming video also shows an increase in the length of delay from 8.7 ms for 1-hop to 13.25 ms for 4-hops.

Fig. 6 presents the number of hop versus the number of loss of data packet. In the figure, there is no packet drop when sending data text. Compare to the streaming video, the packet loss rise when increasing the number of hop. The number of packet loss change at 4.04 %, 7.64%, 10.48%, and 17.77% for 1-hop, 2-hops, 3-hops, and 4-hops respectively.

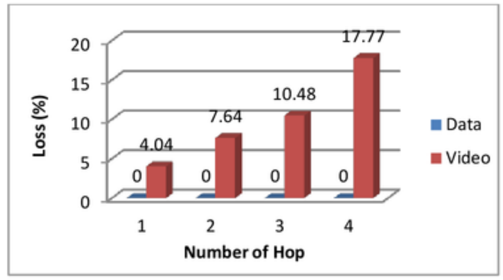

Figure 6 Loss for Multihop

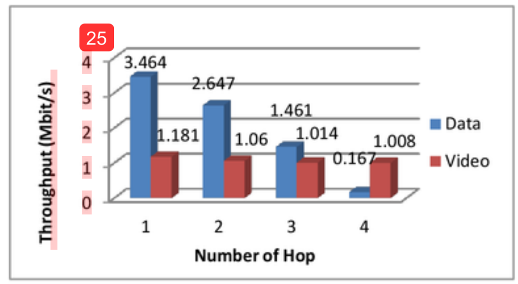

Figure 7 Throughput for Multihop

Fig. 7 shows the performance of OLSR in multihop network for total throughput. It can be seen that the more the number of hop the smaller throughput for both data text and streaming video. The average throughput for video streaming remains stable between 1.181 Mbit/s and 1.008 Mbit/s. Moreover, for data text, the average throughput decreases proportional to the length of delay.

C. *Result of Mobile Scenario*

This experiment evaluates the protocol OLSR when nodes moving during communicating. Each node travels about 120m in the determined area with the average speed of approximately 0.467 m/s. The experiments are conducted in 3 scenarios. The first, node A transfers a video streaming to only node C. The second, node A sends to both node C and node D. The last node A streams to node C, node D, and node E. The results are shown in Fig. 8, Fig. 9, and Fig. 10.

Fig. 8 shows the packet loss for 1, 2, and 3 clients. The protocol OLSR has the highest number of packet drop when simultaneously sending to 3 nodes compared to 1 node and 2 nodes. The figure presents the difference of the number of packet loss for all destination nodes because each node has different characteristics.

Fig. 9 describes an increase in the number of delay time with increasing the destination nodes. This is due to the limited capabilities of the sender node and the capacity of the network. The highest delay is shown on node D with duration of 9.278 ms when node A simultaneously transfers a video streaming to 3 destination nodes.

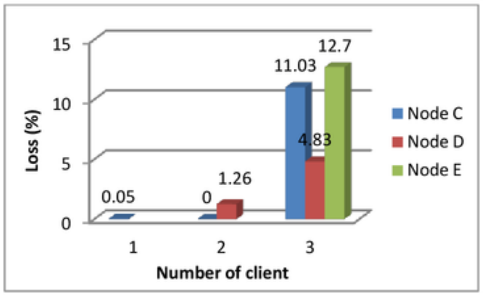

Figure 8 Loss for Mobile Node

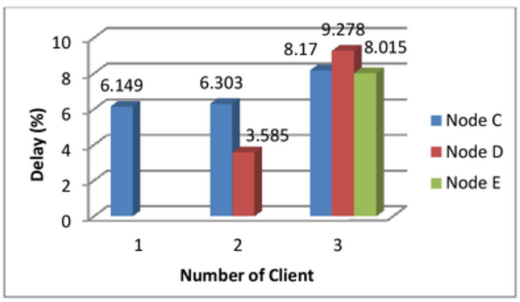

Figure 9 Delay for Mobile Node

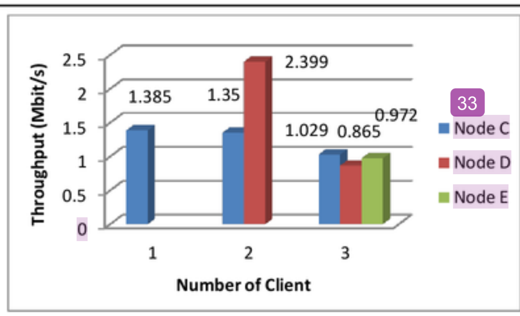

Figure 10 Throughput for Mobile Node

Fig. 10 shows the throughput versus the number of client. The average throughput decreases when the sender node transmits packet data to more nodes. The values are also influenced by the length of delay time and the number of packet drop. Even though node D has the smallest packet loss, it has the highest length of delay. As a result, node D experienced lowest throughput with the average of 0.865 Mbit/s compared to node C and node E.

V. Conclusion

This paper implements an OLSR protocol that runs on a real ad hoc network.

- In a self-configuration scenario, the amount of throughput, delay, and packet drop decrease about 8.75%, 8.73 %, and 0.11% respectively.
- In multihop scenario, the lowest performances are presented when transferring data until 4-hop i.e.:
  - The delay is 6.81ms for data text and 13.25 ms for video streaming.
  - The packet loss about 17.77 % for video streaming and there is no packet loss when sending data text.
  - The throughput around 167 Kbit/s for data text and 1.008 Mbit/s for video streaming.
- In mobile scenario, the more clients receive data the lower performance of OLSR. The average delay, packet loss, and throughput when a node sending packets simultaneously to 3 destination nodes are 8.49 ms, 9.52 %, and 955 Kbit/s respectively.

All parameters, i.e. throughput, delay, and packet drop show a good performance in both static and dynamic condition. Therefore, the OLSR protocol provides a reliable routing protocol for ad hoc networks.

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