# Impact of Delayed Control Message in AODV Protocol

Haoran Miao, Ye-Eun Lee and Ki-Il Kim*
Dept. of Computer Science and Engineering, Chungnam National University
miaohaor@naver.com, yeyettt@naver.com,kikim@cnu.ac.kr*

**Abstract**

Ad-hoc On-demand Distance Vector (AODV), is one of well-designed routing protocols in mobile ad hoc networks. It supports the functionality of node mobility modules through multiple control messages to create and maintain paths for data transfer. Even though a number of studies have been conducted to achieve rapid discovery of paths across the network, but few have focused on impact of control messages. This paper proposes a method to adjust the transmission time of messages used in path recovery according to their individual characteristics. Simulation results show the improved performance of the proposed algorithm rather than traditional AODV routing protocol.

## 1. Introduction

To maintain network topology and ensure the mobility of nodes in mobile ad hoc networks, a new routing protocol is required in a way that differs from existing network protocols. AODV [1] is a well-known routing protocol that establishes and maintains network routes through several control messages. But, most studies [2-4] are focused on methods to reduce message overhead caused by the broadcasting of control messages. However, if we observe the features and operation method of control messages, we can see that the order in which these control messages are transmitted has a significant impact on the overall performance.

In [5], the authors present a noticable example by proposing a method to forward messages to more distant destination nodes first by adjusting the transmission time of RREQ messages with route settings proportional to the distance to the destination. With this approach, it is confirmed that in the case where the RREQ messages are destined for the same destination node, the route discovery process is not repeated at intermediate nodes rather than transmitted to the entire network. Since these previous studies only focused on route discovery messages, there is no performance analysis in the field of route management messages.

In this paper, the transmission time of the RERR messages, which occurs in the state of link broken is reduced to solve this problem. It suggests a way to adjust the transmission time and presents an evaluation of performance results. Depending on the route distance between nodes that detected link failure and the source node, the proposed method transmits the RERR message first to a more distant node so that the route can be restored quickly through RREQ. On the other hand, in the case of a node with a short route, the transmission of the RERR message is delayed. If the route communication is restored by the existing RREQ, then proceed to use the new route.

The performance of the proposed method was evaluated through simulations and confirms that, the proposed method maintains a higher transmission rate and a shorter delay time than the conventional AODV mechanism. Chapter 2 of this paper shows the proposed algorithm, and Chapter 3 describes in detail the obtained simulation results. We present the conclusion of this study in Section 4.

## 2. Proposal Algorithm

In the proposed method, when a node detects a link failure, it will check the distance between itself and the source node. The calculation of distance can utilize each node's location information if it is available or check the hop counts from the source node through an additional field added. Based on the distance between itself and the source node, each node determines its own RERR message transmission time as shown in Equation (1) below.

$$T_i^{RERR} = Timeout(i, j) \times \frac{1}{Dist(i,S)} \quad (1)$$

As it can be seen from Equation (1), the time for transmitting RERR in the current node ***i*** is affected by the expired time of intermediate nodes` links, and **Dist(i, S)** which is the distance to the source node ***S***. That means, if the distance between two nodes is longer, the expired time is shorter, hence shorter transmission delay time will be given. After this time, node ***i*** forwards the RERR message, and each node proceeds with route recovery accordingly. When a path is recovered by the RERR of a distant node, the nodes close to the distance do not need to transmit additional messages by utilizing the recovered path.

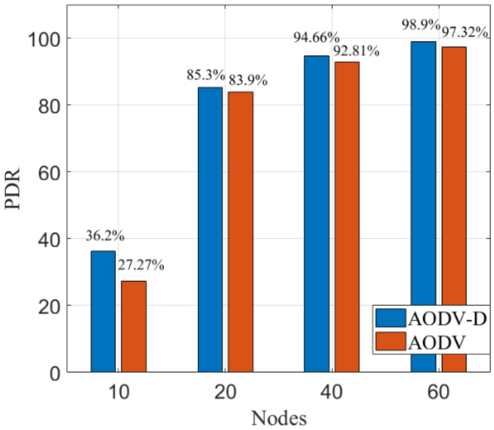
## 3. Performance Evaluation

For the performance evaluation of the proposed scheme, the simulation environment using NS3-3.29 was configured as shown in <Table 1>.

In Figure 1 and Figure 2, AODV-D (AODV-Delay) represents the proposed method, and AODV stands for the conventional AODV. Performance evaluation was compared in terms of packet delivery ratio and end-to-end delay. Firstly, looking at the result of the Packet delivery ratio according to the different number of nodes in Fig.1, it can be seen that the overall proposed method shows a higher packet reception rate than the existing method.

<Table 1> Simulation Environment Settings

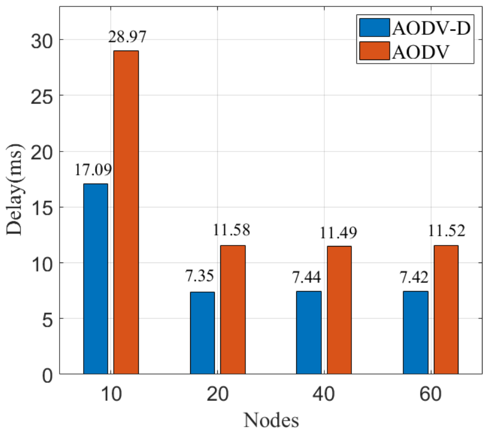
| Parameters | Values |
|---|---|
| Simulation duration | 100s |
| Simulation area | 500*500m |
| Number of nodes | 10,20,40 and 60 |
| Transmission range | 250 m |
| Traffic type | CBR |
| Packet rate | 4 packets/sec |
| Data payload | 512 bytes/packet |




(Figure 1) Packet delivery ratio as a function of number of nodes

Furthermore, when the quantity of packets is small, a difference occurs in the reception rate between the two protocols, but it can be seen that the performance is similar as the number of nodes increases. When the number of nodes becomes large, which means there are many neighbor nodes, the validity of the proposed method is low because RERR neighbor nodes can quickly execute the process of repairing and replacing the route link.

On the other hand, when the node density is low, it can be seen that the overhead of the control message is reduced, thereby increasing the packet delivery ratio.




(Figure 2) End-to-end delay as a function of number of nodes

In addition, as shown in Figure 2, it can be confirmed that the proposed method has a lower transmission delay than the conventional AODV, which is caused by the same reason as explained before in regards to the packet delivery ratio results. It can be seen that in the proposed method the end-to-end delay decreases dramatically when the number of nodes is small. Meanwhile, the ratio decrease as the number of nodes increases.

## 4. Conclusion

In this paper, a method for improving the performance of the AODV routing protocol was presented by adjusting the transmission time of the RERR message. It was proved through simulation results that the performance of the routing protocol can be improved by adjusting the link expired time and the dynamic time according to the distance.

Following this study, we are considering an extension to a method that considers other control messages including the RERR, and it is in our plan to conduct and present some detailed performance analysis and evaluation.

## Acknowledgement

This study was supported by the Institute for Information & Communications Technology Planning & Evaluation (IITP) grant funded by the Korean government (MSIT) (No. 2019-0-01343, Training Key Talents in Industrial Convergence Security).

## Reference

[1] C.E. Perkins and E.M. Royer, "Ad hoc On-Demand Distance Vector (AODV) Routing," in Proc. of IEEE Workshop on Mobile Computing Systems and Applications, New Orleans, LA, USA ,1999.

[2] Venetis Kanakaris, David L Ndzi, Kyriakos Ovaliadis and Yanyan Yang, "A New RREQ Message Forwarding Technique Based on Bayesian Probability Theory," EURASIP Journal on Wireless Communications and Networking, Oct. 2012.

[3] S. Gupta and A. Mathur, "Enhanced Flooding Scheme for AODV Routing Protocol in Mobile Ad Hoc Networks," in Proc. of International Conference on Electronic Systems, Signal Processing and Computing Technologies, Jan. 2014.

[4] Bhagyalakshmi and A. K. Dogra, "Q-AODV: A Flood Control Ad-Hoc on Demand Distance Vector Routing Protocol," In Proc. of International Conference on Secure Cyber Computing and Communication, Dec. 2018.

[5] Ye-Eun Lee, Ki-Il Kim, "RREQ Transmission Order Control Techniques for AODV Performance Improvement," in Proc. of KIPS ACK 2021.