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# A COMPARISON OF IMPROVED AODV ROUTING PROTOCOL BASED ON IEEE 802.11 AND IEEE 802.15.4

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**Abstract**

Recently, wireless network industry for the ubiquitous generation is growing quickly. Especially, IEEE 802.15.4 is one of special issues of the networking technology for sensor network. Then, many researchers are studying it for enhanced performance. But many researchers are not focusing on developing routing protocol. So we had proposed improved AODV routing protocol in previous research. But it had studied about performance analysis based on IEEE 802.11. In this paper, we proposed improved routing protocol using AODV (Ad hoc On-demand Distance Vector) for sensor network. The simulation result is analyzed and compared based on IEEE 802.11 and IEEE 802.15.4.

Keywords: AODV, Routing Protocol, IEEE 802.11, IEEE 802.15.4, ZigBee

## 1. Introduction

The recent networks are trending toward ubiquitous environment that makes possible anywhere, anytime service. So we are using various wireless network technology such as 3G, 4G of cellular network, Ad-Hoc, and IEEE 802.11 based WLAN (Wireless Local Area Network), and Bluetooth. Especially, IEEE 802.15.4 is a very important technology of ubiquitous sensor network, because it needs supporting of frequent movement.

If it finds a new shortest routing path than already created path during expire time, it does not changing routing path because AODV routing protocol must maintain routing path during expire time. Therefore, we proposed improved AODV routing protocol for reset a new shortest routing path during sending a packet.

**Nomenclatures**

| | |
|---|---|
| *D* | Destination code |
| *S* | Source code |
| | |
| *Abbreviations* | |
| AODV | Ad hoc On-demand Distance Vector |
| DMP | Disjoint Multi-path |
| DSDV | Destination Sequenced Distance Vector Routing |
| DSR | Dynamic Source Routing |
| IETF | Internet Engineering Task Force |
| MANET | Mobile Ad hoc Network |
| PERR | Packet Error |
| QoS | Quality of Service |
| RERR | Route Error |
| RFC | Request for Comments |
| RREP | Route Response |
| RREQ | Route Request |
| TCP | Transmission Control Protocol |
| WLAN | Wireless Local Area Network |

This paper contains five sections. At first, we present an introduction to this paper, and then study routing protocol for wireless network. Next, we explain the improved AODV routing protocol. And then, we analyze result of simulation. At last, we conclude this paper.

## 2. Routing Protocols for Wireless Network

There are two types routing protocol for wireless network. First, proactive type is operating routing path before sending data. If it changes topology of nodes, this information sends neighbor nodes. And neighbor nodes updated it. The well-known proactive routing protocol is DSDV.

Second, reactive type is setting routing table on demand, and it maintains active routes only. The well-known reactive routing protocols are DSR and AODV.

Wireless Network makes frequent movement. So it needs supporting movement of reactive routing protocol. In this section, we study well-known reactive routing protocol.

### 2.1. DSR (Dynamic Source Routing)

DSR is being standardized in the IETF MANET (Mobile Ad-hoc Network) working group [1]. DSR is a well-known, reactive routing protocol. It computes a route only if one is needed. The route discovery consists of route request and route reply. The route request is broadcast into the wireless network. However, instead of setting the reverse paths in the routing tables of the nodes, the route request collects the addresses of the traversed nodes on its way to the destination. Route reply sends this path back to the source where all paths are stored in a route cache. The path, that is, the list of addresses from the source to the destination, is included in the header of each packet by the source node. Each node forwards a received packet to the next hop based on the list of addresses in the header (source routing). DSR uses PERR (Packet Error) messages for the notification of route breaks [2].

### 2.2. DMP DSR (Disjoint Multi-path DSR)

DMR DSR is routing protocol that enhances DSR. It sends message of information of moved or disconnected nodes to neighbor nodes. Next, this information removed in routing table [3]. So DMR DSR routing protocol ensures QoS (Quality of Service).

### 2.3. AODV(Ad-hoc On-demand Distance Vector)

AODV is a very popular routing protocol for sensor network. AODV has been standardized in the IETF as experimental RFC 3561 [4, 5]. There are several implementations available, for instance, AODV-UU of Uppsala University [6]. AODV uses a simple request-reply mechanism for the discovery of routes (Fig. 1). It can use hello messages for connectivity information and signals link breaks on active routes with error messages. Routing information has a timeout associated with it as well as a sequence number. The use of sequence numbers allows to detect outdated data, so that only the most current, available routing information is used. This ensures freedom of routing loops and avoids problems known from classical distance vector protocols. When a source node *S* wants to send data packets to a destination node *D* but does not have a route to *D* in its routing table, then a route discovery has to be done by *S*. The data packets are buffered during the route discovery.

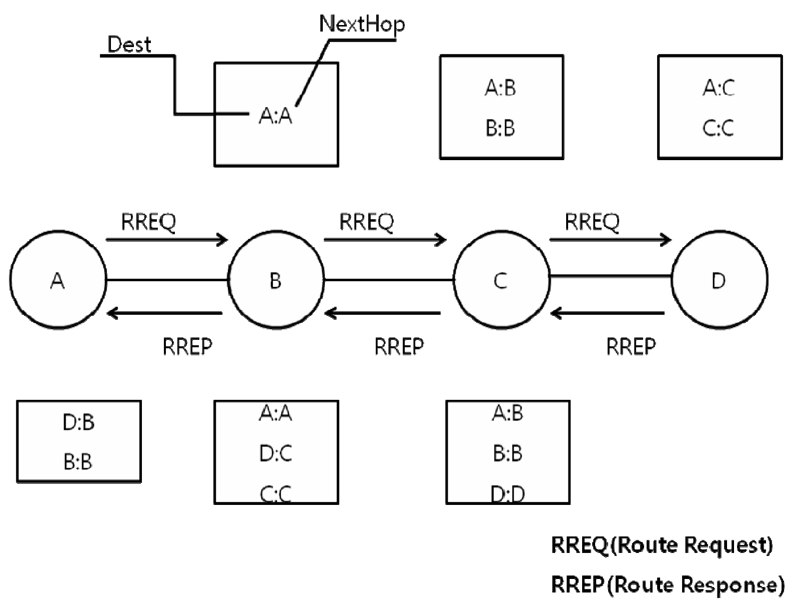


**Fig. 1. AODV Routing Discovery.**

The source node *S* broadcasts a RREQ (Route Request) throughout the network. In addition to several flags, a RREQ packet contains the hop count, a RREQ identifier, the destination address and destination sequence number, and the originator address and originator sequence number. The hop count field contains the distance to the originator of the RREQ, the source node *S*. It is the number of hops that the RREQ has travelled so far. The RREQ ID combined with the originator address uniquely identifies a route request. This is used to ensure that a node rebroadcasts a route request only once in order to avoid broadcast storms, even if a node receives the RREQ several times from its neighbors.

On receipt of a RREP (Route Response) message, a node will create or update its route to the destination *D*. the hop count is increment by one and the updated RREP will be forwarded to the originator of the corresponding RREQ. Eventually, the source node S will receive a RREP if there are paths to the destination. The buffered data packets can now be sent to the destination D on the newly discovered path.

If it has happened a link failure, the node generates a RERR (Route Error) message. It contains the addresses and corresponding destination sequence number of all active destinations that have become unreachable because of the link failure. The RERR message is sent to all neighbors that are precursors of the unreachable destinations on this node. A node receiving a RERR invalidates the corresponding entries in its routing table. It removes all destinations that do not have the transmitter of the RERR as next hop from the list of unreachable destinations. If there are precursors to the destinations in this pruned list, the updated RERR message is forwarded to them.

## 3. Improved AODV Routing Protocol

Original AODV routing protocol is not resetting a new shortest routing path during expire time, because it must maintain it until disconnecting nodes. So, we proposed improved AODV routing protocol for reset a new shortest routing path during sending packet.

Improved AODV routing protocol maintains expire time that created first. So expire time in routing table is not updating until expire time. Therefore, routing table updated in a cycle.

Figure 2 is virtual network topology for example. The source node is 0 and destination node is 4. If it starts routing on fixed nodes, the routing table makes like Tables 1 and 2.

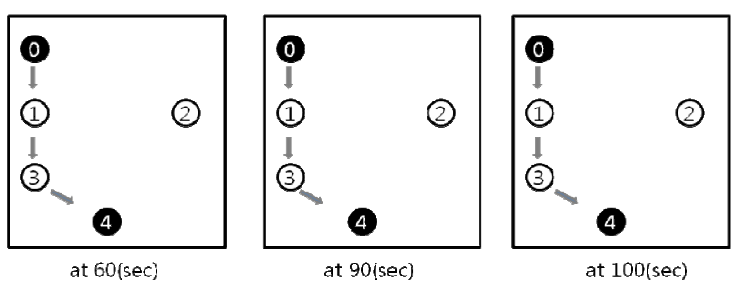


**Fig. 2. Network Topology for Example.**

Tables 1 and 2 show the same values. Like this, improved and original AODV routing protocol created same routing path when fixed nodes

**Table 1. Original AODV Routing Table when Fixed Nodes.**

| Time | Source | DES. | Next hop | Hops |
|---|---|---|---|---|
| 60 | | 4 | 1 | 3 |
| 90 | 0 | 0 | 0 | 1 |
| | | 4 | 1 | 3 |
| 100 | | 4 | 1 | 3 |

**Table 2. Improved AODV Routing Table when Fixed Nodes.**

| Time | Source | DES. | Next hop | Hops |
|---|---|---|---|---|
| 60 | | 4 | 1 | 3 |
| 90 | 0 | 0 | 0 | 1 |
| | | 4 | 1 | 3 |
| 100 | | 4 | 1 | 3 |

Figure 3 shows routing path on moving nodes. At first, the node 2 moved near node 1. Next, the node 2 moved existing location. Finally, the node 4 moved near node 1.

The original AODV maintains one's path during moving nodes. So, the routing table and routing path are shown in Fig. 3 and Table 3.

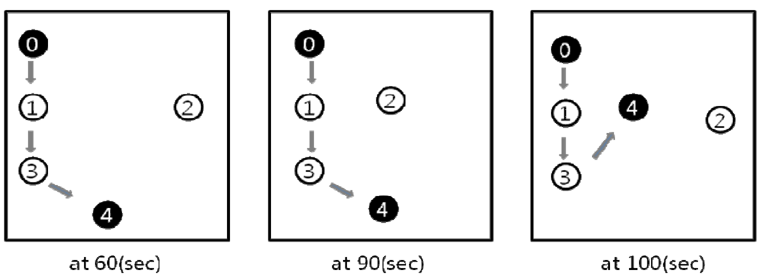


**Fig. 3. Routing Path of Original AODV during Moving Nodes.**

**Table 3. Original AODV Routing Table when Moved Nodes.**

| Time | Source | DES. | Next hop | Hops |
|---|---|---|---|---|
| 60 | | 4 | 1 | 3 |
| 90 | 0 | 0 | 0 | 1 |
| | | 4 | 1 | 3 |
| 100 | | 4 | 1 | 3 |

The improved AODV resets the shortest routing path during moving nodes. So, Fig. 4 and Table 4 show the routing table and routing path

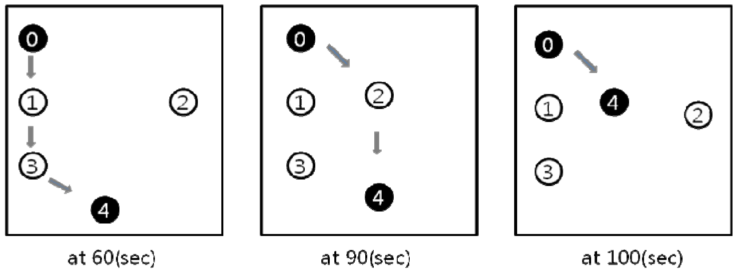


**Fig. 4. Routing Path of Improved AODV during Moving Nodes.**

**Table 4. Improved AODV Routing Table when Moved Nodes.**

| Time | Source | DES | Next hop | Hops |
|---|---|---|---|---|
| 60 | 0 | 4 | 1 | 3 |
| 90 | | 0 | 0 | 1 |
| | | 4 | 2 | 2 |
| 100 | | 4 | 4 | 1 |

Improved routing protocol ensures shortest routing path through fixed expire time. So the source packet sends to destination quickly than original AODV routing protocol.

## 4. Result of Simulation

The QualNet 4.5 is used to certify the performance of improved AODV routing protocol. QualNet 4.5 made by Scalable Networks Technology and it is a discrete event simulator targeted at networking research [7]. It provides substantial support for simulation of TCP, routing, and multicast protocols over wired and wireless networks.

### 4.1. Simulation environment

In this paper, the IEEE 802.11 Radio, MAC, and IEEE 802.15.4 Radio, MAC of QualNet 4.5 along with the AODV routing algorithm are used. The throughputs of original and improved AODV routing protocol during 130 or 200 seconds are tested as indicated in Table 5.

Figure 5 shows the network topology for the simulation. The source node is 0 and destination node is 4. At first, the node 2 moved near node 1. Next, the node 2 moved existing location. Finally, the node 4 moved near node 1.

**Table 5. Simulation Environment.**

| Method | Value |
|---|---|
| Simulation Time | 130, 200 seconds |
| Packet | CBR |
| Item Size | 32 byte |
| Interval | 1 second |
| Packet Sending time | During end of simulation |
| routing protocol | AODV |

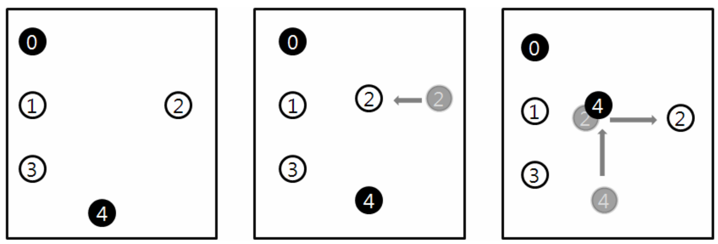


**Fig. 5. Network Topology for Simulation**.

## 4.2. Simulation result based on IEEE 802.11

Figure 6 is the result of throughput of improved and original AODV routing protocol when fixed node based on IEEE 802.11. The throughputs of improved and original AODV routing protocol seem same result, because these are not changing routing path when fixed nodes. Improved AODV presents bad throughput at resetting routing path (25seconds), but it is no problem for an overall performance.

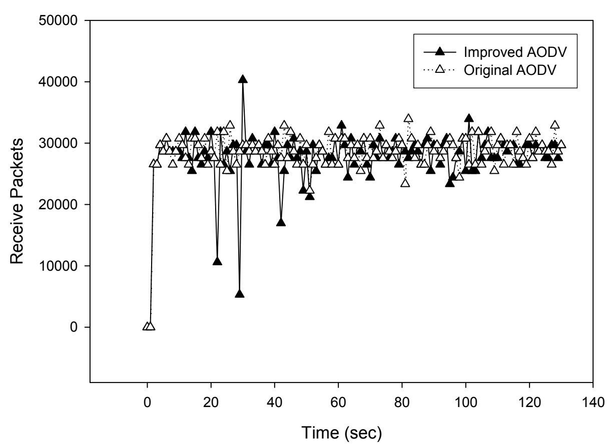


**Fig. 6. Comparison of Throughput when Fixed Nodes Based on IEEE 802.11.**

Figure 7 is the result of throughput of improved and original AODV routing protocol during moving node based on IEEE 802.11. The throughput of improved and original AODV routing protocol seems different result, because improved AODV routing protocol is changing routing path in a cycle. Especially, improved AODV routing protocol presents good result at 40~60 and 90~130, because it resets shortest routing path than original AODV routing protocol.

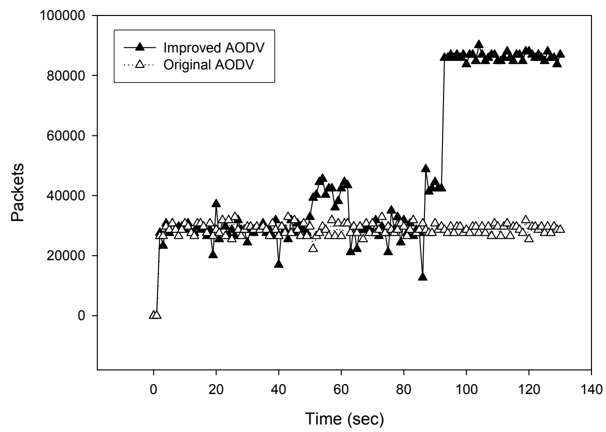


**Fig. 7. Comparison of Throughput when Moved nodes Based on IEEE 802.11.**

## 4.3. Simulation result based on IEEE 802.15.4.

Figure 8 is the result of throughput of improved and original AODV routing protocol when fixed node based on IEEE 802.15.4. The throughput of improved and original AODV routing protocol seems different result, because improved AODV routing protocol is changing routing path in a cycle. Especially, IEEE 802.15.4 needs frequency resetting routing path. So, Improved AODV routing protocol present good result.

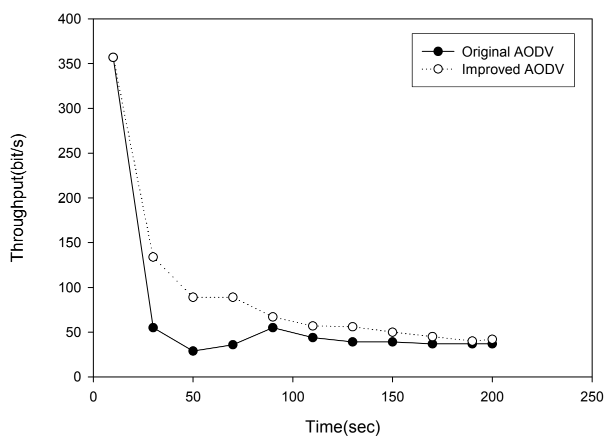


**Fig. 8. Comparison of Throughput when Fixed Nodes Based on IEEE 802.15.4.**

Figure 9 is the result of throughput of improved and original AODV routing protocol during moving node based on IEEE 802.15.4. The throughput of improved and original AODV routing protocol seems different result, too. Especially, improved AODV routing protocol presents good result than fixed node. This is because it finds shortest routing path frequency than fixed node.

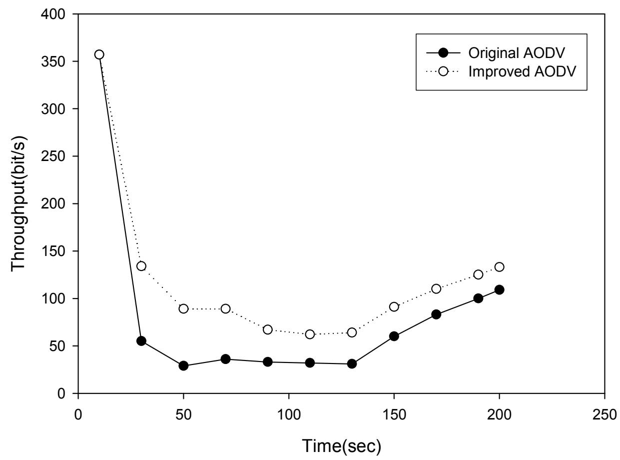


**Fig. 9. Comparison of Throughput when Moved Nodes Based on IEEE 802.15.4.**

## 5. Conclusions

In this paper, we proposed improved AODV routing protocol through fixed expire time and we simulated it for analyzed performance by QualNet 4.5.

The improved routing protocol is to certify that it ensures shortest routing path, because this simulation results show good performance based on IEEE 802.11 and IEEE 802.15.4 both.

If you used improved AODV routing protocol for frequent movement state, you experience improvement of performance. Especially, wireless sensor network happens frequent movement, so it is a good routing protocol for wireless sensor network.

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