

Performance Evaluation of AODV and DSDV Routing Protocol in wireless sensor network Environment

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Abstract. One of the most important issues in Wireless sensor networks (WSNs) is collecting and processing data perceived from the environment and sending that data to be processed and evaluated. So routing data towards the destination node is a fundamental task in WSNs. However, due to the resource constraints, different routing protocols have been proposed considering specific application and scenario characteristics [1]. In this paper two protocols AODV and DSDV have been simulated using NS-2 package and compared in terms of packet delivery fraction, end to end delay and throughput in different environment; varying period of pause time and the number of expired nodes. Simulation results show that AODV routing protocol has better performance in terms of packet delivery fraction and throughput but, AODV suffers from delay.

Keywords: Wireless Sensor Network, AODV and DSDV.

1. Introduction

Routing protocols are a key feature of any network. They enable each node to learn about the other nodes in order to find a link to their destination. Because some nodes could be mobile in wireless sensor networks (WSNs), routes between nodes change very often. Therefore, it is not possible to establish fixed paths and infrastructure between nodes.

The traditional routing protocols have several shortcomings when applied to WSNs, which are mainly due to the energy, the frequency changes in the topology and density of deployment. However, many Ad hoc routing protocols are proposed for WSNs due to their quick and economically less demanding deployment. Destination-Sequenced Distance Vector (DSDV) and Ad Hoc On-Demand Distance Vector Routing (AODV) are good examples of Ad hoc protocols that are proposed and implemented in WSNs [5].

Even though AODV and DSDV have long been implemented within the WSN environment, but not enough researches are done on comparing these protocols under different environments and their full potential has not been understood clearly and still needs a huge number of research activities in order to discover and overcome their issues.

By analysing how a protocol performs under a certain environment, the shortcomings of the protocol could be discovered and more research could be done on removing those shortcomings. However, this paper proposes to undertake comparison of these two protocols in specific scenarios with WSNs in order to help in choosing the best protocol suited to particular conditions by highlighted the pros and cons of these two tested protocols.

2. Routing Protocols

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The focus in this paper has been given to DSDV and AODV routing protocols:

2.1 DSDV

DSDV protocol is based on the Bellman-Ford routing algorithm [14]. It is a proactive protocol and belongs to the table-driven family. Routes between the nodes in the network are always being maintained and updated. Each node in the network maintains a routing table which contains information about how old the route is, the shortest distance as well as the first node on the shortest path to every other node in the WSNs [6].

In order to prevent loops and counter the count to infinity problem, a sequence number which is originated by the destination node tags each entry in the network. The sequence number for each node is chosen randomly and it is usually an even number. Each node has to update its sequence number periodically and in the normal update, the sequence number is increased by two. If a node discovers an expired path and wants to send an update about it to its neighbours, only then does it increase the sequence number for a disconnected node by one.

There are two classified categories for routing updates: full dump update and incremental update. In the former, the complete routing table is transmitted by the node. In order to reduce the potential traffic, this type of update should be used only in the situation where complete or huge amounts of topology are changed. Whereas, in the case of incremental updates, the node sends only the entries that have been changed since the last update. In a fast changing network, incremental messages could grow and get bigger which affect the performance of the network. So full dumps are preferred in a fast changing network [2].

2.2 AODV

AODV is an improvement on the DSDV algorithm. It is a reactive routing protocol that uses an on-demand approach to find and establish routes. AODV maintains routes as long as they are needed by the source nodes and it is considered one of the best routing protocols in terms of power consumption and establishing the shortest path. However, it is principally used for ad-hoc networks, but nowadays it is widely used in WSNs as well [4][6].

In AODV, each node periodically broadcasts HELLO messages to its neighbouring nodes and then uses these neighbours to establish routing and send messages. In case there is a message wanting to be sent to some nodes which are not neighbours to the source node, the source node finds a path to the destination by sending a Route Request Message (RREQ) to its neighbours [4].

Although the control traffic messages are dramatically reduced in AODV protocols because of the fact that nodes initiate a route discovery process just when it is required, multiple RREP messages in replay to one RREQ message lead to heavy control overhead periodic. Also, the hello message leads to unnecessary bandwidth consumption.

3. Simulation Tool

All simulations have been carried out using the NS simulator programme version 2.34 under Linux platform.

NS2 is an open source simulator software and used by a lot of institutes and researchers. The main goal of the NS2 simulator is to provide support to education and research in networking. It is one of the best programmes in terms of comparing different routing protocols and designing new ones. NS2 has been written in two languages: Object oriented variant of Tool Command Language (OTCL) and object oriented language C++ [3].

4. Experimentation

Initially, each node is placed at a certain location and then starts moving to new locations with a specific speed. The data packet size and time simulation are fixed with 50 bytes and 150 sec

respectively for all the simulation scenarios. Also, the same Media Access Control (MAC) layer is used in all experiments (IEEE802.11).

The same topology has been implemented for all experiments (500m x500m). All nodes have energy of 5 joules and the node decreases its battery level by 0.5W each time it sends a message, while it decreases by just 0.25 W when it receives a message.

The simulation is divided into two different experiments:

4.1 Experiment One

For varying pause time and keeping the number of nodes (100), area size of the simulation 500mx500m, speed (2 m/s) and simulation time (150 sec).

When the chosen pause time is 0 sec, it means that the nodes are in continuous motion and do not stop. On the contrary, if the pause time is 150 sec, this indicates there is no node mobility since the total simulation time is also 150 sec. So these varying pause times affect the average speed of the mobile nodes

However, the simulation has been run with for four different pause times: 0, 40, 80, and 110 sec.

Table1: simulation parameters for both experiments

SIMULATION PARAMETERS		
Experiment	One	Two
Examined Protocols	DSDV& AODV	DSDV& AODV
Channel Type	Wireless Channel	Wireless Channel
Simulation Area (m x m)	500x500	500x500
Simulation time	150 sec	150 sec
Number of nodes	100	100
(number of nodes/ number of connections)	10	10
Mobility (m/s)	2	2
Node movement mode	Random waypoint	Random waypoint
Initial energy	5 J	5 J
Transmitting Power	0.5 mw	0.5 mw
Receiving Power	0.25 mw	0.25 mw
Node pause time	0,40, 80,110 (sec)	2 (sec)
Traffic Type	CBR	CBR
Packet size (bytes)	50	50
Performance Parameters	Throughput, PDF, E-E delay	Throughput

4.2 Experiment Two

For a better understanding of how expired nodes in WSNs affect routing protocol performance, the expired nodes in this experiment are controlled by turning off specific nodes at a certain time of simulation.

Four scenarios have been used to investigate the relationship between sensor network performance, particularly its throughput, and the number of expired nodes. However, each scenario has a different number of expired nodes:

Scenario one: turn off six nodes at time 90 (nodes 10, 11, 12, 13, 14 and 15).

Scenario two: turn off twelve nodes. Nodes from 10 to 15 are turned off at time 40 of the simulation time and nodes from 20 to 25 turned off at time 90.

Scenario three: turn off 45 nodes. Nodes from 10 to 15 and from 80 to 90 are turned off at time 40, nodes from 30 to 35 are turned off at time 70, nodes from 20 to 25 turned off at time 90 and nodes from 5 to 9 are turned off at time 100 and nodes from 50 to 60 are turned off at time 110.

Scenario four: turn off 50 nodes. Additionally to the nodes which were turned off in scenario three, nodes from 15 to 19 are turned off at time 80 in this scenario.

The number of nodes in experiment two is kept constant (100 nodes), pause time for each node is two seconds, area size of the simulation 500mx500m and whole simulation time is 150 sec.

Table 2: Number of expired nodes over the time of simulation

Time simulation (sec)	Number of expired node			
	Scenario One	Scenario Two	Scenario Three	Scenario Four
At time 40	0	6	17	17
At time 70	0	0	6	6
At time 80	0	0	0	5
At time 90	6	6	6	6
At time 100	0	0	5	5
At time 110	0	0	11	11
Total expired nodes	6	12	45	50

5. Results And Analysis

5.1 Results and analysis for Experiment one

The simulation results for experiment one are shown in this section in the form of line graphs. The X-Axis presents the nodes' pause time in seconds, while the Y-Axis presents the performance metric considered.

5.1.1. Average throughput

According to the simulation results presented in figure 1, better performance is shown by AODV. Throughput increases in both protocols with increasing pause time, even though it is increased more dramatically in AODV protocol.

In AODV, throughput shows a big growth from 40kbits/sec at pause time 0 sec to 61kbits/sec at pause time 110 sec. In contrast, throughput in DSDV is 6.15 Kbit/sec at pause time 0 sec and increases by approximately 13 Kbit/sec at pause time 110 sec.

At low pause time (high mobility) the network topology will change frequently, more broken links will occur and the discovery process will be needed more. As a consequence, there will be a greater routing overhead and packets will be dropped resulting in more delay and less throughput.

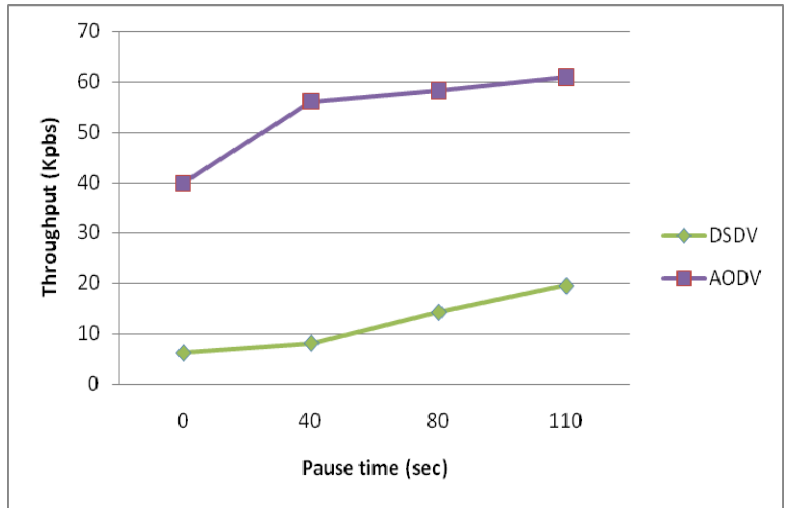


Figure1: The throughput in DSDV and AODV protocols in experiment onewith the pause time 0, 40, 80 and 110 sec

5.1.2. End to end delay

From figure 2 it can be estimated that DSDV perform much better that AODV in terms of time delay. This attribute can be explained by the fact that DSDV is a proactive routing protocol and in these types of protocols the path to a destination is immediately available. In other words, there is no delay caused by routing discovery. Furthermore, DSDV routing protocol tries to drop the packets, if it is not possible to deliver them which means less delay. On the other hand, in AODV packets stay in the send buffer till the route is discovered in order to be sent to the destination on that route [3].

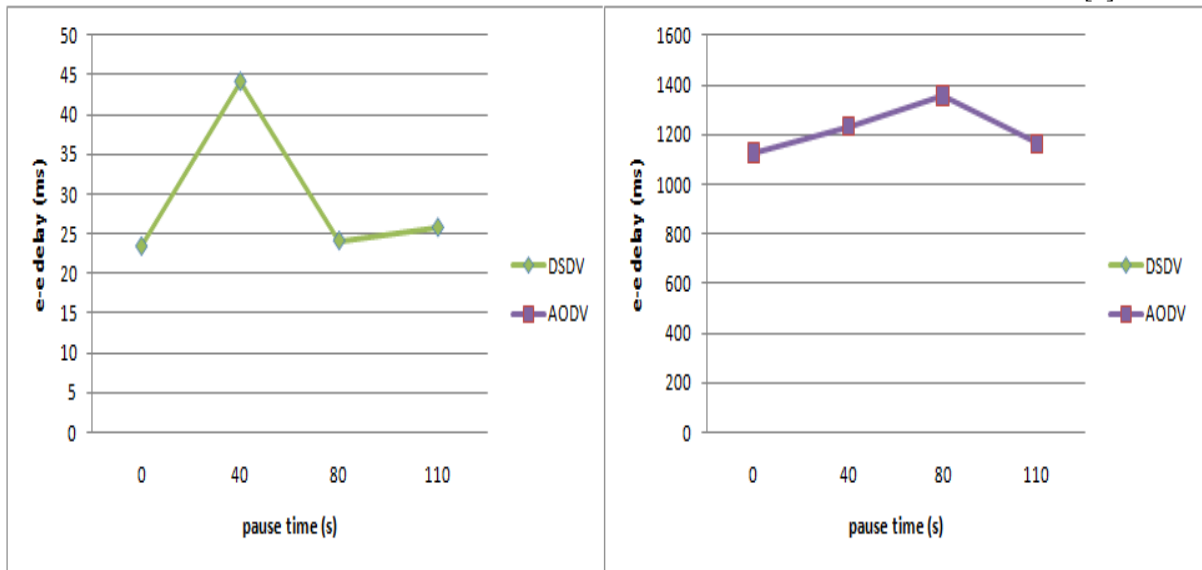


Figure2: Average E-E delay in for both DSDV and AODV in experiment three with the pause time 0, 40, 80and 110 sec

However, in DSDV protocol, the time delay increases with an increasing pause time up to 40ms then starts declining till pause time 80ms. From this point on, it becomes almost constant. In contrast, AODV shows an increasing time delay when the duration of waiting time for the nodes ranges between 0 and 80 sec. But when the pause time is more than 80 sec, the delay time starts declining.

5.1.3. Packet Delivery Fraction (PDF)

As can be clearly seen in figure 3, the packet delivery fraction in AODV is very much better when compared with DSDV in all scenarios. The reason for the better packet delivery fraction in AODV over DSDV is that AODV protocol tries to guarantee that the packets will be delivered to the destination by delay compromising. Whereas in DSDV, if it is not possible for the packets to be delivered, DSDV tries to drop them which means a lesser PDF as well as less delay Furthermore,

DSDV is a table-driven protocol and updates its table periodically which leads to an increase in the routing load in the network and less PDF. On the other hand, AODV is an on-demand routing protocol and adapts faster than DSDV to the change of the routing caused by mobile nodes in WSNs.

However, PDF increases in both routing protocols in respect of pause time. This is because when the nodes are not moving too much the routing status becomes relatively stable and as a result a path finding process is not required.

At pause time 0, PDF in AODV is six times more than DSDV. It is 21.8 for AODV and just 3.36 for DSDV. At pause time 110 sec, PDF for AODV is 33.24 which is 22.5 greater than the PDF in DSDV.

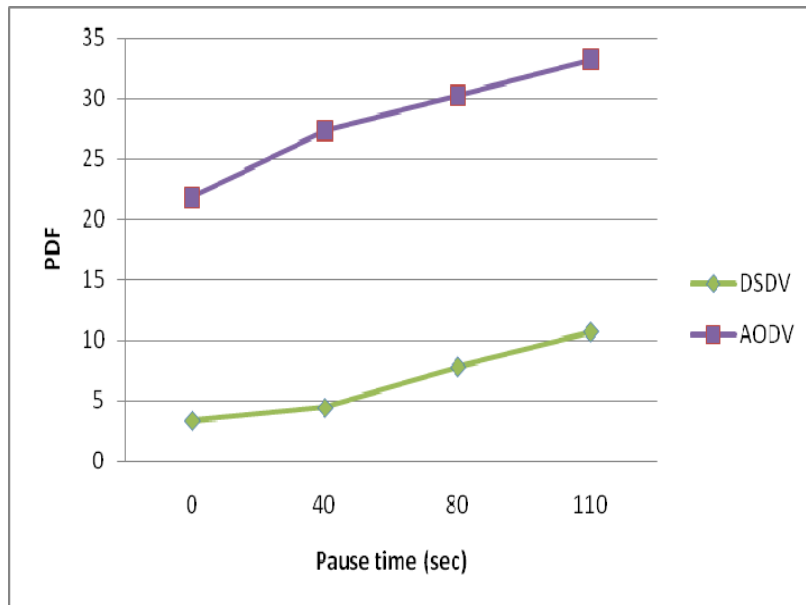


Figure3: PDF for both DSDV and AODV in experiment one with the pause time 0, 40, 80 and 110 sec.

5.2. Results and analysis for Experiment Two

In this section the X-Axis illustrates the number of expired nodes in the first graph and the simulation time in the second one, whereas the Y-Axis illustrates the average throughput in kilo bit per second in the two following line graphs.

As an overview from the figure 4, the most significant features is that the average throughput in both routing protocols goes down steeply as the number of expired nodes rises.

With six expired nodes, both protocols show the best performance in average throughput. It is 16.9 kbps for DSDV and 51.29 kbps greater for AODV. The lowest amount of throughput is at 50 invalid nodes; 42.45 kbps in AODV and 2.86 kbps in DSDV.

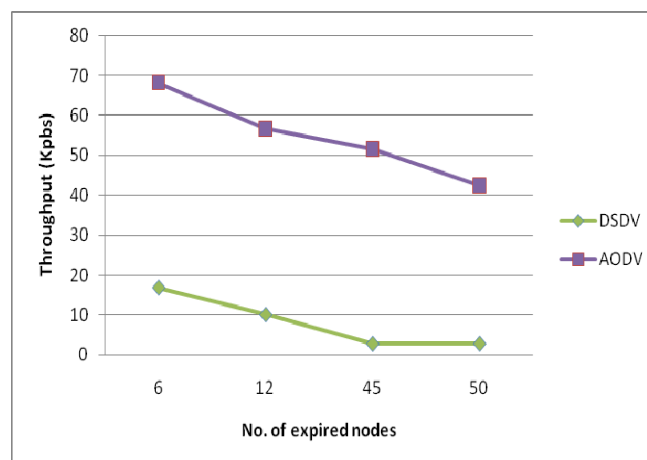


Figure4: Average throughput in both DSDV and AODV protocols in experiment two with the scenarios 1, 2, 3 and 4.

It would be useful to look at the instant throughput presented in figure 5 to clarify the poor performances in DSDV and AODV as the number of expired nodes increases.

Based on figure 5, DSDV exhibits more stability than AODV in terms of throughput, even though the maximum average throughput reached in DSDV is 16.89 kbps which is very low compared with the throughput for AODV (68.19Kbps). The six expired nodes at the time simulation 90 sec has by far a bigger effect on AODV than DSDV.

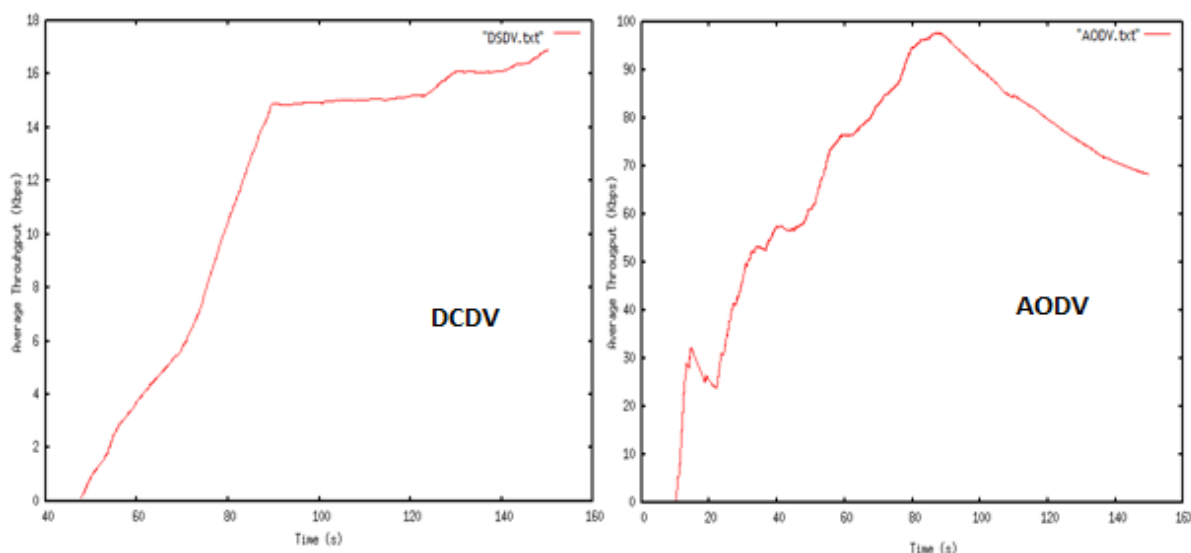


Figure5: The instant throughput in both DSDV and AODV protocols in experiment two scenario one.

In AODV, however, the average throughput declines steadily at the simulation time 90 sec and does not recover during the simulation time.

In contrast, in DSDV these expired nodes have an effect just for a small period of time (approximately 40 sec). The throughput increases rapidly between the simulation time 20 and 90 sec. But, it remains static for 40 seconds between the simulation time 90 and 130 sec as a result of the six expired nodes at simulation time 90 sec. From then onwards it starts growing again but at a slower pace, ending the simulation time with 16.89 kbps.

This attribute can be explained by the fact that AODV is an on-demand protocol and when many nodes are expired, the average end-to-end delay increases as a consequence of decreasing the intermediate nodes. On the other hand, DSDV is a proactive protocol and keeps more than one path to send the packets and when some nodes are expired in the network, table updates for the valid nodes and routes are required.

6. Discussion

The simulation results shown in previous sections reveal that there no one protocol which is better than the other in all scenarios.

In applications where the data packets need to be sent over some unfeasible areas, for example, when some sensor nodes run out of battery at the same time in a particular area in the network, where there is serious network congestion, or where a sudden disaster leads to the destruction of some nodes in the network. However, in this kind of situation, even though AODV does not show such high stability as DSDV, AODV still performs much better.

In applications where delay time is not important and the message needs to be guaranteed to arrive at its destination, AODV would be the right choice since it delivers more packets to their destination. Whereas in applications where time delay is a critical issue, DSDV would be preferred to AODV, even though it has less PDF.

7. Conclusion

In this paper, two routing protocols named DSDV and AODV are simulated and compared under specific scenarios with WSNs environment. With the help of the NS2 simulator programme, DSDV and AODV are evaluated in respect of packet delivery fraction, end to end delay and average throughput.

However, the simulation results reveal that there is no one protocol which is better than the other. Each protocol has its own advantages as well as its disadvantages making it suitable for some applications and not for others. Hence, an efficient routing protocol should be selected that suits the desired sensing task.

Under packet delivery fraction, AODV has better performance than DSDV in the considered scenarios. PDF increases with an increase in the pause time for both protocols.

As far as throughput is concerned, AODV performs by far better compared to DSDV. Average throughput in both protocols decreases steadily with an increase in the number of expired nodes and in case of pause time, the average throughput increases with increasing pause time.

AODV suffers from delay. Regardless of the period of pause time, it shows longer average end-to-end delay in comparison with DSDV in the considered scenarios. However, the time delay fluctuates in DSDV protocol with an increase in pause time. On the other hand, end-to-end delay increases in AODV with increasing pause time.

8. Acknowledgements

This work would not have been possible without the help of Allah and the efforts, encouragements and constant support of my family. I am heartily thankful to my family. Without their prayers, support, trust, and understanding I would not have been able to seek a single word.

9. References

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