PERFORMANCE ANALYSIS OF AODV AND DSR ROUTING PROTOCOLS FOR WIRELESS SENSOR NETWORKS

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Abstract

Wireless sensor networks have wide variety of applications. This paper compares the two protocols in a group of Reactive Protocols is ad hoc on demand distance vector protocol (AODV) and dynamic source routing protocol (DSR) for wireless sensor networks. By comparing and analyzing the performance of various aspects as follows: Packet sent, Packet received, Packet loss, Packet delivery ratio, Average of Throughput, and Average of Energy consumption using the Network Simulator ns-2.

Keywords: Wireless Sensor Network, Reactive Protocols, AODV, DSR, ns-2

Introduction

A wireless sensor network is a distributed sensing technology that can be used to monitor physical phenomenon and can be easily deployed and it's useful for many applications. A sensor network is made of the distribution of lots of sensor nodes which require a hop routing paradigm. Sensor networks application ranges from important issues such as environmental and habitat monitoring, traffic control, emergency scenarios, and health care [1]. Wireless sensor nodes are composed of three main parts: the detection, the processing and wireless data transmission. Node that sends data is called the source node and the data collection nodes in the network are called the Sink Node. Sensor nodes are battery-operated. Most of sensor network applications need a lot of sensor nodes which are distributed over the sensor areas. A requirement of lot of sensor nodes leads to a difficulty in battery change.

Research to analyze the performance of AODV and DSR protocols for IEEE 802.15.4/ZigBee [2] by the ns-2 simulation program simulates a network node corresponding to 41, 101 and 201. Traffic density is 6, 12 and 18. The simulation results of AODV has better performance than DSR.

A. Reactive Protocols

Reactive protocols create routes only when needed.

1. AODV

AODV protocol is used to send the information to perform a route discovery by sending a Route Request broadcast out to the side until it reaches the destination node. When the destination receives a Route Request, it replies with a unicast Route Reply back along the Route Request to the source [3]. AODV protocol holding a routing table in each node, the routing table is updated faster.

2. DSR

DSR protocol work efficiently with 2 main mechanisms: Route discovery and Route maintenance. Route Discovery mechanism searches for the route connected to the destination. On the other hand, Route Maintenance is for reconstructing the route. To send data to it before routing it to the search path if not which acts as an energy-saving. The route discovery is performed by the Route Request sent to a neighbor. When the destination receives a Route Request, it replies by sending a Route Reply back to the original route. DSR protocol is not stored in the routing tables in the nodes except the source node [4].

B. Simulation Parameters

1. Packet sent

Amount of packet sent by the source node.

2. Packet received

Amount of packet received by the Sink Node.

3. Packet Delivery Ratio

Packet Delivery Ratio = Number of Received Packets / Number of Transmitted Packets x 100 [2]

4. Packet Loss

Packet that is not able to reach the destination [2]. Packet Loss = Number of Transmitted Packets – Number of Received Packets

5. Average of Throughput (T_a)

The amount of work done in one unit of time [5].

T_a = (No. of information packages received by the destination node x 8 / time of the simulation)

6. Energy Consumption

E_a is calculated from the sum of difference between starting energy (E_i) and final energy (E_f), divided by the number of nodes losing their energy in the connection. This is mentioned in [5]. The energy consumption is computed using the ns-2 Energy Model [6].

$$E_a = \frac{\sum_{k=1}^{k=n} (E_{ik} - E_{fk})}{N} \quad (1)$$

C. The Network Simulator ns-2

ns-2 Open-Source program was developed by the Information Sciences Institute (ISI). ns-2 is used to simulate the performance of the network which support wireless sensor network simulation. The simulation of alternative routes used to send data packets, the simulation-based Multicast protocol and the protocol of IP [7].

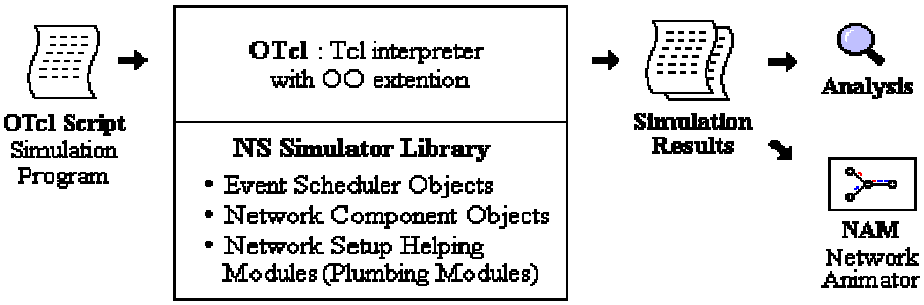

Figure 1 Operation overall structure of ns-2.

Users will need to write OTcl Script which determined the default simulation environment. OTcl Script and OTcl Interpreter will be set by the script environment parameters received. The results of the model will have two parts: NS Trace File is a file detailing the model all simulation the second is the Network Animator (NAM), a graphics file.
This paper analyzes the performance of AODV and DSR focused on a protocol-based Reactive, which will be analyzed in the Packet sent, Packet received, packet loss, packet delivery ratio, average of throughput and average of energy consumption. Experiment with different sizes of networks, using network simulator ns-2.
Section Methodology discusses the simulation model. The simulation results are in Section Results and finally a conclusion is in Section Discussion and Conclusion.

Methodology

Simulation to determine the performance of these two protocols by using the network simulators NS-2 included 3 traffics where as Traffic 1 node was set closely to the Sink Node. Traffic 2 was set half way to the Sink Node and Traffic 3 was set remotely to the Sink Node, respectively. The numbers of Nodes were 49, 100, 225, 400 and, 841 in the square area. The range of each node was 18 meters long. The information transmitted in the form the Constant Bit Rate (CBR) in every 0.2 second.

Table 1 Simulation Environment

List	Description
Simulation Program	ns2.35
Number of nodes	49, 100, 225, 400, 841
Radio-propagation model	TwoRayGround
Interface queue type	DropTail/PriQueue
Antenna model	OmniAntenna
Max packet in interface queue	50 Byte
Routing protocol	AODV, DSR
Traffic type	Constant Bit Rate (CBR)/UDP
CBR Interval Time	0.2 Second
MAC Layer/PHY Layer	Mac/802.15.4
Node Movement	Fix
Surface	140mx140m, 200mx200m, 300mx300m, 400mx400m, 600mx600m
Initial Energy	3 Joule
Packet Size	500 Byte
Amount of Traffic	3
Sink Node	Node number 0
Node Distance	18 Meter
Radio Range	40 Meter
Simulation Time	100 Second

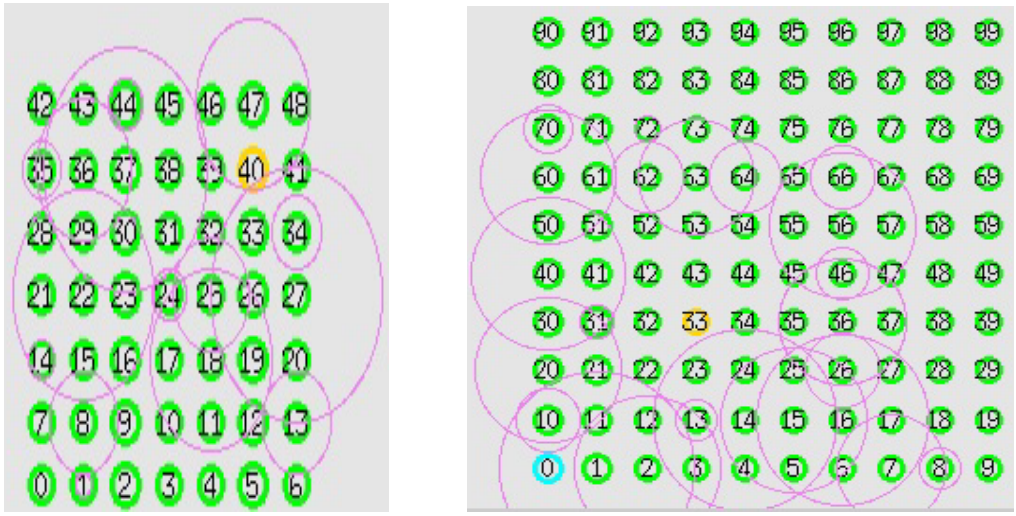

Figure 2a Topology of wireless sensor network for 49 and 100 nodes.

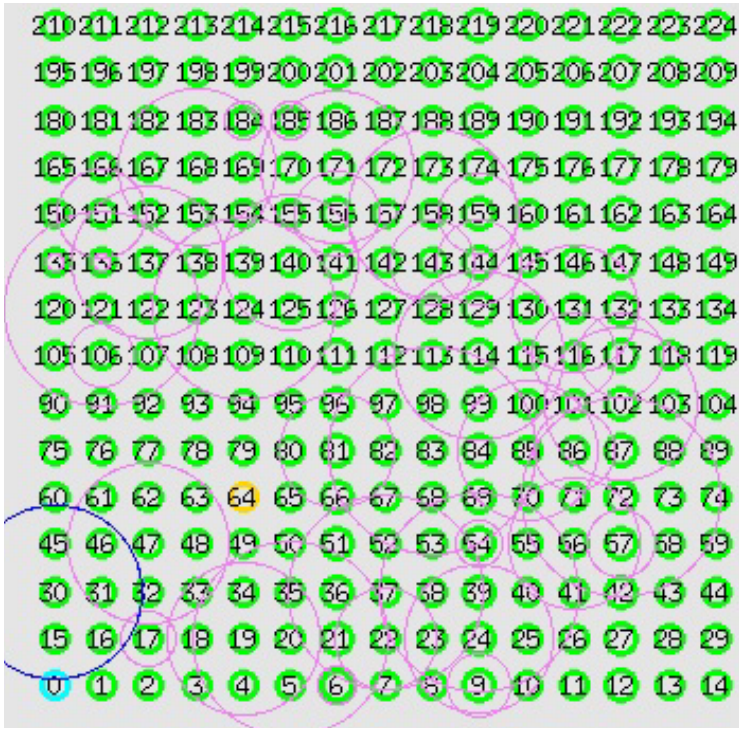

Figure 2b Topology of wireless sensor network for 225 nodes.

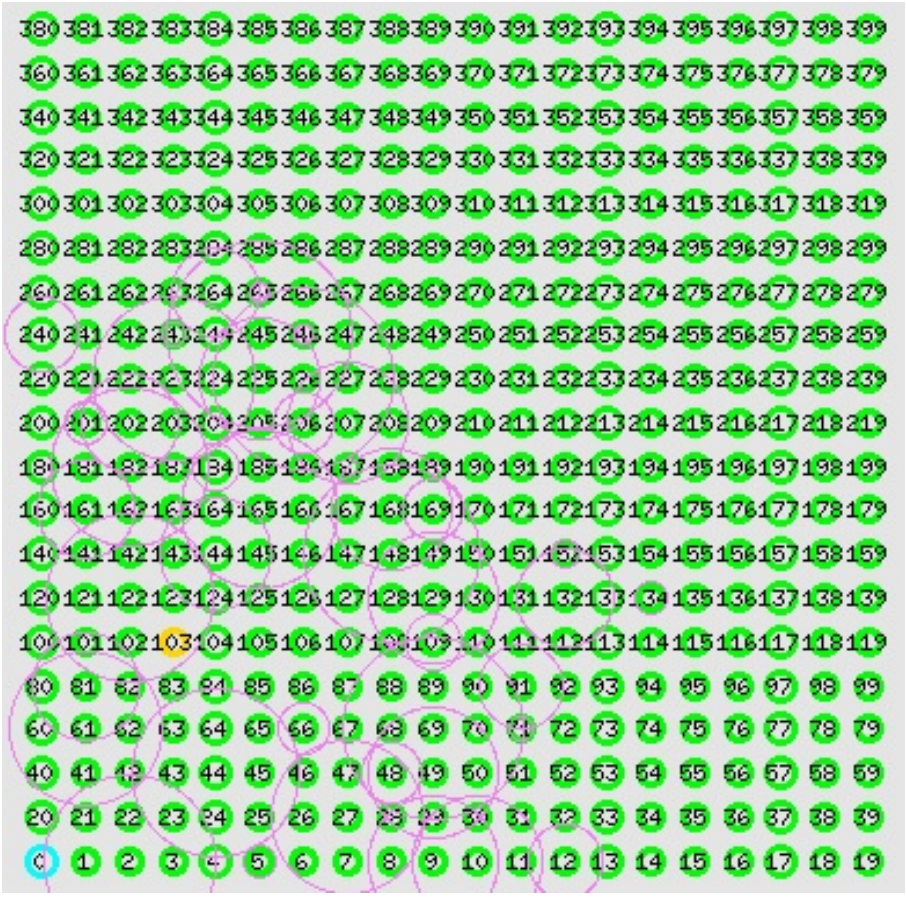

Figure 2c Topology of wireless sensor network for 400 nodes.

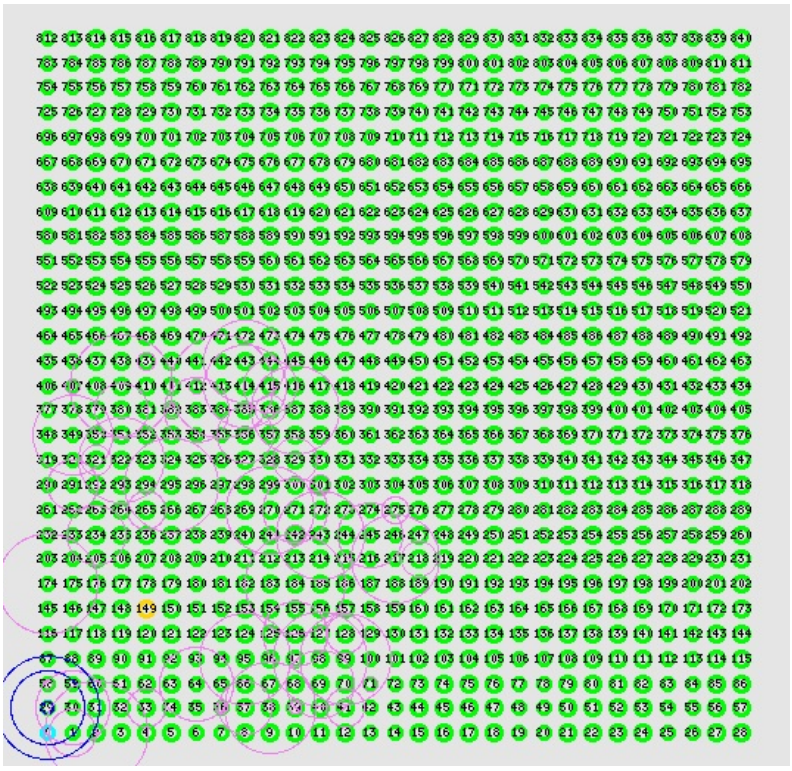

Figure 2d Topology of wireless sensor network for 841 nodes.

Results

Analyzing the capacity of the two main protocols can be divided into 6 parts as follows: Packet Sent, Packet Received, Packet Loss, Packet Delivery Ratio, Average of throughput, Energy Consumption.

Table 2 Packet sent, Packet received, Packet Loss, Packet Delivery Ratio, Average of Throughput, Average of Energy Consumption

Node	Packet sent		Packet received		Packet Loss	
	AODV	DSR	AODV	AODV	AODV	DSR
49	158400	159594	112410	84154	45990	75440
100	127260	45742	110430	45616	16830	126
225	122850	45616	113130	45498	9720	118
400	133920	122	120600	0	13320	122
841	128880	122	127980	0	900	122
Node	Packet Delivery Ratio		Average of Throughput		Average of Energy Consumption	
	AODV	DSR	AODV	DSR	AODV	DSR
49	0.70	0.52	8992	6732	1.76	0.70
100	0.86	0.99	8834	3649	0.96	0.25
225	0.92	0.99	9050	3639	0.80	0.13
400	0.90	0	9648	0	0.68	0.09
841	0.99	0	10238	0	0.36	0.02

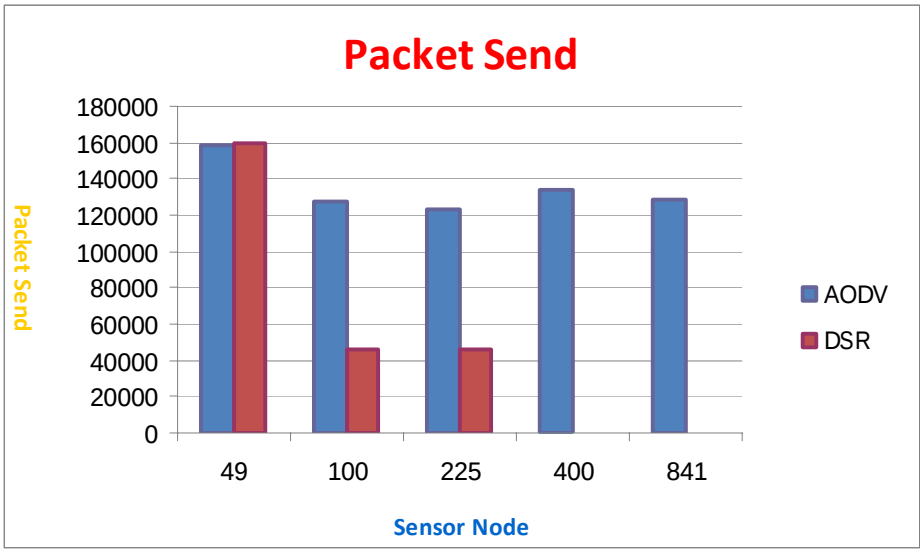

Figure 6 Packet sent

A. Packet sent

The graph shows the sensor network which has 49 nodes. Packet sent of DSR was a bit more. The two protocols included 3 Traffics could be able to search for route to the Sink Node. The ability of Packet Sent was noticeably the same. At the 100 and 225 node sensor networks, the amount of Packet Sent that transferred AODV protocol was greater than DSR protocol since it completely found all the three traffics meanwhile DSR protocol could only find one route close to the Sink Node. At 400 and 841 nodes, AODV protocol had more amounts of Packet

Sent than DSR protocol due to the fact that AODV protocol could find all the three traffics where as DSR protocol could find some of them.

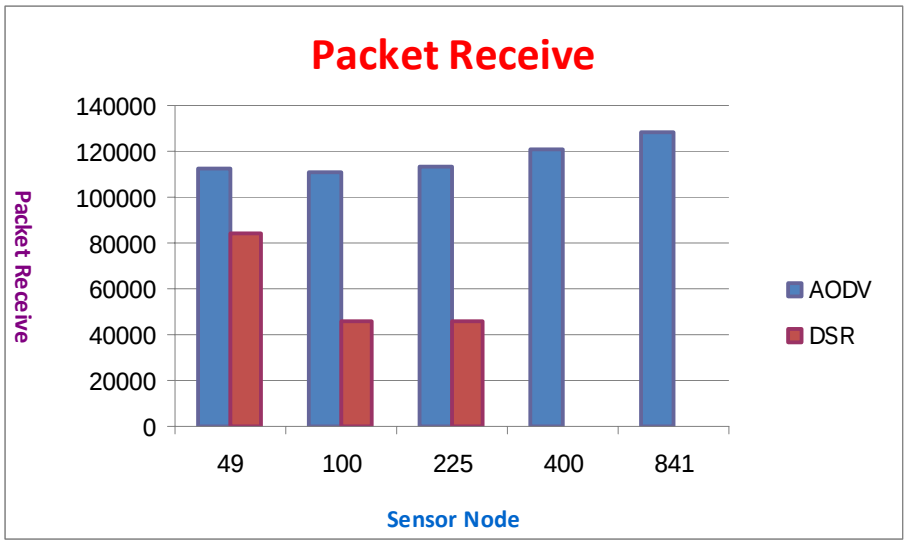

Figure 7 Packet received

B. Packet received

The amount of the Packet Received of AODV protocol was much more than DSR protocol since it successfully searched for the three traffics in all networks as mentioned earlier. However, 49 nodes of sensor network had a high Packet Sent but low Packet Received due to the great distance of the Sink Node caused a high Packet Loss.

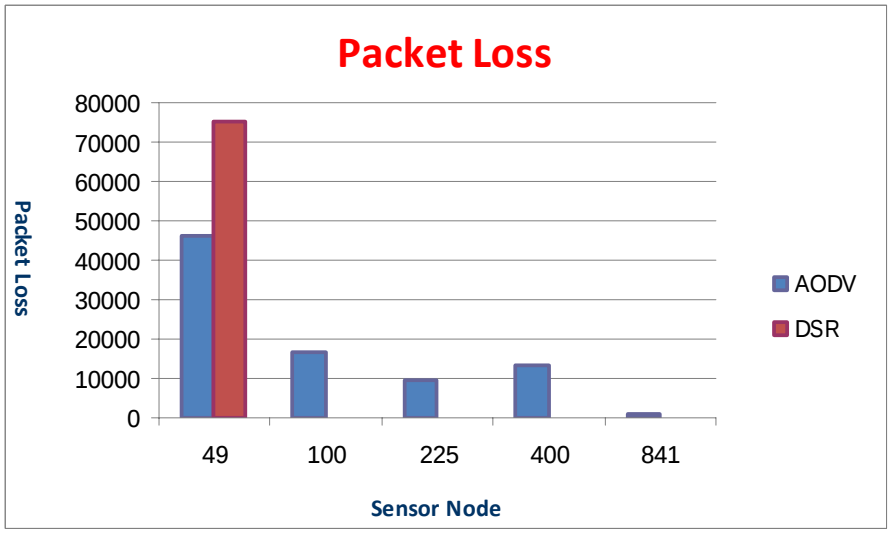

Figure 8 Packet Loss

C. Packet Loss

The graph shows network sensor 49 nodes Packet Loss of DSR protocol which was greater than AODV protocol existing in the great distant traffic to the Sink Node. The Packet Loss was also greater than the other two in the half way and closed distance where as 100 and 225 networks; the DSR protocol had lesser Packet Loss than AODV protocol since it could find one route closest to the Sink Node. At the network sized 400 and 841, the DSR protocol had

lesser Packet Loss than AODV protocol as well due to the fact that DSR protocol could not find any routes.

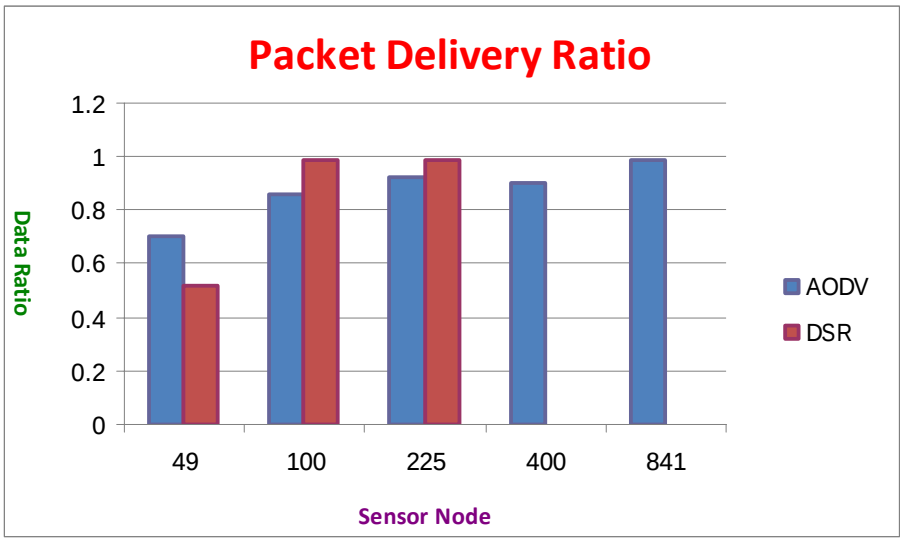

Figure 9 Packet Delivery Ratio

D. Packet Delivery Ratio

At the network sized 49 nodes, the Packet Deliver Ratio of the AODV protocol was greater than DSR protocol since it had more Packet Loss in the traffic which was farer to the Sink Node where as the network sized 100 and 225, DSR protocol had more packet Delivery Ratio than AODV protocol due to the traffic which was nearest to the Sink Node enabled it to find only one route. For 400 and 841 network size, AODV protocol had more Packet Delivering Ratio than DSR protocol but could not find any routes.

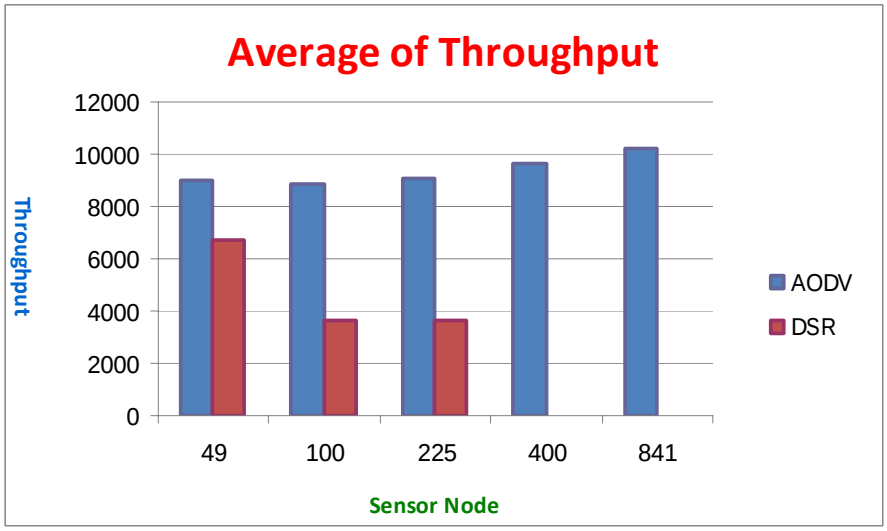

Figure 10 Average of Throughput

E. Average of Throughput

Every network size of AODV protocol had greater average of throughput than DSR protocol since DSR protocol was unable to find all of the three traffics as stated earlier.

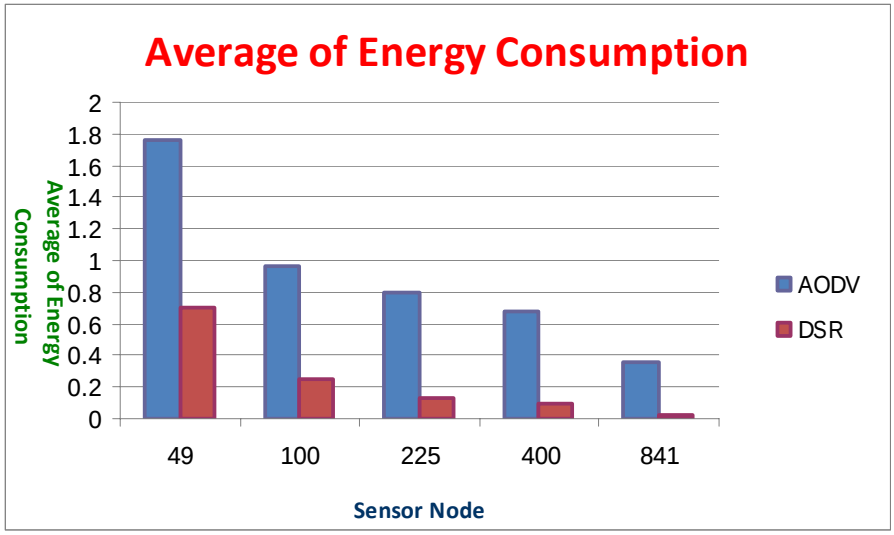

Figure 11 Average of Energy Consumption

F. Average of Energy Consumption

The graph shows the average of energy consumption of AODV protocol was greater than DSR protocol due to the ability of searching the three traffics successfully done by AODV protocol in every network size where as DSR protocol failed.

AODV has a greater demand of Packet Sent, Packet Delivery Ratio and Average of Throughput than DSR protocol as the reason mentioned above. The small network will have more volume of Average Energy Consumption than the large one. The reason is that in every small network node shares the greater opportunity to the information transmitting than the large network.

The larger the network is, but the amount of the node remain stable, the less the network can share the data transmitting, that is to say, the more spacious area, the more expansion of the node appears.

In concludes, DSR protocol is more suitable for small size network the large one accompany with the consideration on the ability of searching for the traffics. This study reveals that the strength of DSR protocol is the act of finding the traffic existing in the node first, if not available then it starts to find others. This will act as energy-saving. Meanwhile, AODV protocol is suitable for multi-sized sensor networks which are more strengthen than DSR protocol and be able to find Traffics in multi-sized network.

Discussion and Conclusion

The result of this designed experiment revealed that DSR protocol was more suitable for small sensor network than the large one. It depended on the ability of searching for the traffics and also acted as energy-saving. In the mean time it could find traffics of its own before searching elsewhere. AODV protocol was suitable for multi-sized sensor network and had more power to find Traffics, Packet Delivering Ratio and Average of Throughput than DSR protocol.

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