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A Simulated analysis of AODV, DSR, AOMDV and DSDV routing Protocols on Different Parameters

[1]Abhishek Thakur, [2]A. J. Singh

[1]Research Scholar, [2]Professor
[1 2] Department of Computer Science
Himachal Pradesh University, Shimla

Abstract

Wireless sensor networks (WSN) have evolved as an important field in wireless technology. WSN comprises of tiny, cheap sensor nodes that are connected to form a network. Sensor nodes accumulate data from the surroundings and transfers sensed data to the sink node for further processing. Routing is one of the main challenging tasks in WSN because there is no central authority that manages the information exchange among the nodes. The goal of routing in WSN is to discover appropriate path in a network so that network lifetime increases. In WSNs, routing protocols vary depending on the application and the structure of network. This paper's primary goal is to simulate four routing protocols, i.e., AODV, AOMDV, DSR, and DSDV and analyze their performance based on various performance metrics on network simulator NS 2.35.

KEYWORDS: *WSN, routing protocol, AODV, DSDV, DSR, AOMDV, Throughput, Packet delivery ratio, Loss packet ratio, end-to-end delay, Routing load, and average residual energy.*

I. INTRODUCTION

A wireless sensor network comprises many small, low-powered, and low-cost sensor nodes deployed across a large geographic area. for specific application fields such as disaster emergency response, healthcare applications, power system applications, roadside and transportation applications, and so on [1]. Sensor nodes accumulate data from their environment [23] and sends it to the sink node via multihop routing algorithms. The sensor nodes have limited memory, processing speed, and power source [2]. Nodes have limited battery life as they are battery powered, and batteries can't be replaced or charged easily after their deployment. So, a well-planned routing strategy is required to increase the network lifetime. There are various design issues in routing protocol because of nodes' high mobility. Various protocols have been designed by to minimize the energy consumed so that the lifetime of network is increased [3].

The following are the remaining sections of the paper: Section II will cover WSN routing protocols, routing challenges and design issues. Section III will provide an overview of the discussed routing protocols. Section IV discusses the Simulation parameters and simulation outcomes of the comparison of AODV,DSR, DSDV and DSDV. Section V presents the paper's conclusion.

II. ROUTING IN WIRELESS SENSOR NETWORK

The method of choosing a route in a network to transfer packets from one node to another is known as routing. Sensor nodes in multihop communication not only produce data but also act as a path for other nodes to send data back to the sink node. In a WSN, routing methods are application-specific and data-centric[4]. The routing protocols can aggregate data while optimizing energy consumption [5]. The routing protocols should be designed efficiently to use the limited resources of sensor nodes optimally to enhance the network lifetime [6]. Various routing challenges and design issues in WSN are [7] [18] :

- **Node deployment:** There are two ways to deploy the nodes. First is manual, where nodes are manually placed and routing is done through pre-established routes; the other is random, where nodes are spread arbitrarily in an application-specific area.

- **Energy consumption:** The process of establishing the routes is vital to conserve the energy of nodes. Nodes are primarily deployed in a random manner as less energy is used in multi-hop communication compared to direct communication.
- **Fault Tolerance**: Routing protocols should be able to create new links so that if any sensor node fails, the overall efficiency of the network is not affected.
- **Environment**: Nodes are usually operated in regions that are unreachable due to the adverse environment.
- **Hardware Constraint**: The sensor node should be tiny in size, and the different units of sensor nodes like sensing, positioning system, power and mobilizer should take minimal power to become energy efficient.
- **Transmission Media:** Transmission media is wireless and is not impacted by high error and fading.
- **Node capabilities**: Sensor nodes can execute three main functions at the same time: relaying, sensing, and aggregation. However, if a node is required to execute all activities at the same time, the node's energy may quickly deplete.

III. CLASSIFICATION OF ROUTING PROTOCOLS IN WSN

There are three kinds of routing protocols [8]: flat-based routing, hierarchical routing, and location-based routing. Distance vector and state link methods are used to find routes in routing protocols.

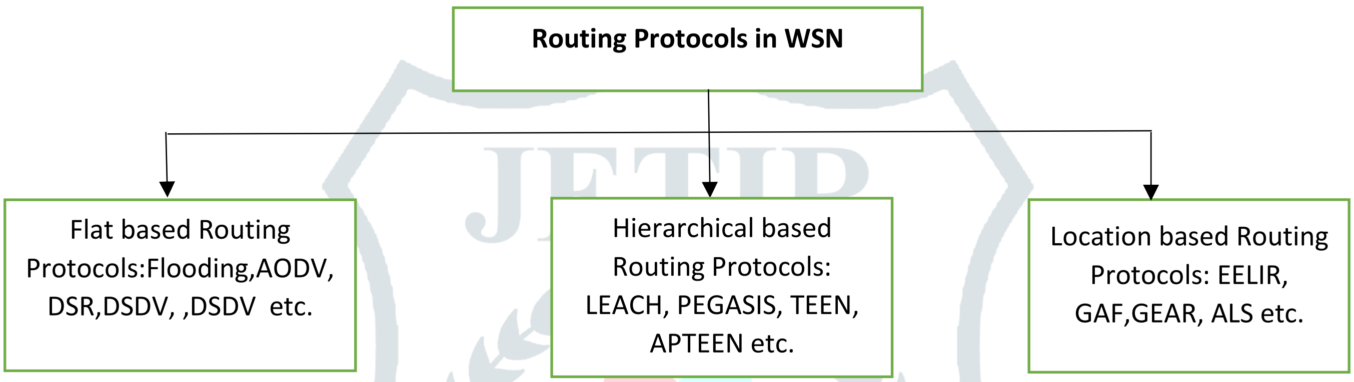

Figure 1: Routing Protocols Classification in WSN

When the sender node transfers its data to the sink node in flat routing protocols, the intermediate sensor node performs some form of aggregation on the data derived from multiple source nodes. Then it transmits the aggregated information to the sink. Flat-based routing protocols [20] [24] can be divided into two categories: proactive and reactive routing protocols. In proactive routing protocols every node broadcasts its routing table to all neighboring nodes. Every node maintains its routing table [19], which comprises of a sequence of nodes to each destination node. There are changes in the routing table after some specific time or when something changes in the network. The control information exchange between nodes is done in intervals, keeping routes updated for each node. Examples of these routing protocols are: DSDV, OLSR etc. Reactive routing protocols create routes on demand, i.e., route is formed only when there is data to be sent along that route. When you need a route, these protocols start a route discovery procedure and discover the optimal route. There is no periodic overhead, but the disadvantage is the latency due to the route discovery procedure. The route discovery procedure takes place through flooding. When the destination gets data, it forwards a route reply through the path it came. Reactive routing protocols include AODV, AOMDV, DSR etc. Routing protocol's main task is to efficiently send data packets and establish communication. To deliver data efficiently and have higher throughput, a well-planned routing strategy is required. This paper discusses and compares four flat-based routing algorithms based on different performance metrics.

A) AODV (Ad-hoc On Demand Distance Vector) Routing Protocol: -

AODV is a on-demand routing protocol used in WSN. AODV [9] finds the path only when needed and is maintained only till they are in use which reduces overhead in the network. The node has information only about the next hop when transferring the packet. AODV uses destination sequence number [10] which is an increasing number to prevent loops in the network. Routes are found by route discovery cycle, when a route to the receiving node is found, the path knowledge is forwarded to the source node. A node [14] [9] increments its sequence number when it starts a new route request. When the node gets a route request for itself, it increments the sequence number to maximum before sending route reply to that node. There are two processes of AODV- route discovery and route maintenance. AODV uses three types of control messages:

- RREQ- This message is created by source node. The packet has [9] destination's IP address, sequence number of source node, hop count which has an initial value of zero, and the destination's last known sequence number .This packet is transmitted to all the other nodes to create a path from source to destination.
- RREP- The route reply (RREP) message is transmitted to the origin node in response to RREQ message by the destination node to set up a route path for data transmission.

- RERR- A route error message is transmitted when there is a link failure in the network. This error message is unicast to the previous hop or if there were many nodes using this link it broadcasts this message to all those previous nodes. Route error message contains a list of all the lost destinations.

B) DSR (Dynamic Source Routing) protocol: -

DSR [11] is a source-based reactive routing protocol. The initiator node has knowledge of the route to the destination or the sequence of intermediate nodes to the destination. DSR can keep multiple paths in its route cache. The protocol contains two main processes that are Route Discovery and Route Maintenance. These processes are employed to find and preserve paths between nodes. Before starting route discovery, the source node examines its route cache for a valid route, and if one is discovered, the route discovery process is not initiated. DSR uses three control messages: RREQ, RREP, RERR.

RREQ and RREP control messages are used to discover a route in the course of the route discovery process. RERR control message is employed by the Route maintenance process to broadcast link failure in the network.

C) AOMDV (Ad-hoc On Demand Multipath Distance Vector) Routing Protocol: -

It is a multipath reactive routing protocol [12] that provides numerous routes that are disjoint and loop-free. The algorithm contains two processes, Route Discovery, and Route maintenance, for finding and maintaining the routes from source to destination. AOMDV discovers numerous routes in a single route discovery. It uses backup routes to transmit information when the initial route fails. AOMDV minimizes the chance of congestion, thus increasing reliability. On the other hand, network overhead is increased in the process of finding routes. The protocol includes additional RREP and RERR control messages and additional fields in routing control packets for multipath discovery and maintenance. It maintains connectivity and provides a quick and effective method for recovering faults. However, message overheads are high when finding a new path.

D) DSDV (Destination-Sequenced Distance Vector) Routing Protocol: -

DSDV is a proactive routing protocol [13] based on table-driven routing. Every node [15] has a routing table ,which holds destination and the hops needed to reach that node. Each node shares its routing table periodically or when something changes in the network. Node upgrades its routing table when it finds a path that has less hops than the original path. It prevents loops in the network by assigning each entry with a unique sequence number which is incremented after each update in the node. The routing updates are of two types:

- Fully dump: The Node sends its entire routing table to the network's other nodes.
- Incremental updates: The node only broadcasts the entries that have changed since the last time they were sent.

IV. SIMULATION PARAMETERS AND RESULTS

A) About Simulator:

NS2.35 Network simulator is used for the simulation of wired and wireless networks. NS2 is an open-source simulator used for networking research. Simulation is performed under Linux (Ubuntu 16.0.4) environment. It uses two languages:

- C++ - It is used for detailed implementation of network protocol.
- Object Oriented Tool Command Language (OTCL)- It is used to create network scenarios that can be simulated.

B) Performance Parameters Used:

The six parameters [21] used for comparing the AODV, DSR, AOMDV, and DSDV routing protocols are:

- **Throughput:** It is measured as the average number of bits transmitted in the network per unit of time. It is computed as:
  Throughput= (Finish time – Start time) * (8/1000) kbps

- **Packet Delivery Ratio (PDR):** It is calculated as the proportion of total packets that arrived at the receiving node to total packets transmitted by the sending node. It is calculated as:
  PDR= (Received packets / Sent packets) * 100

- **Loss Packet Ratio (LPR)**: It is calculated as the no. of packets dropped by the receiving node divided by the total no. of packets transmitted by the sender node. It is calculated as:
  LPR = (no. of packets transmitted by source - no of packets received by destination)/ node of packets sent) *100

- **Average Residual Energy:** Some energy is squandered when nodes execute network tasks like as sensing, processing, and data transmission. As time passes, the residual energy of nodes decreases. It is the mean value of energy remaining in each node. It is calculated as:

energy avail[i] = energy_avail[i]-(energy_avail[i] – energy_value)

Average Residual Energy= energy_avail[i] / number of nodes

- **Average end to end delay:** It is calculated as the time a packet takes to get to the destination node after the source node sends it. It also includes processing and queuing time. It is computed as:

Average end to end delay= (Arrival time of packet at the destination - Time when the packet was created)

C) Simulation parameters:

The NS2.35 Network Simulator [16] was used to run the simulations. The simulation scenario has a rectangular area of 500m x 500m. Table 1 summarizes [22] the various simulation parameters used [17].

Table 1: Simulation Parameters

PARAMETERS	VALUE
Protocols studied	AODV, DSR, AOMDV and DSDV
Channel type	Wireless
Propagation Model	Two Ray Ground
Antenna Type	Omni Directional Antenna
Simulation Time	50 sec
Simulation Area	500m x 500m
Traffic Type	UDP
Packet Size	256 bytes
Max number of connections	50
Number of nodes	100,125,150,175,200
Initial energy of nodes	100 Joules

D) Simulation Results

Network simulator version NS2.35 has been used to perform simulations. A varying number of nodes, like 100,125,150,175,200 with a fixed simulation time of 50 seconds is used to evaluate the performance metrics throughput, PDR, PLR, average end-to-end delay and average residual energy.

- **Throughput**- Fig 2 illustrates that the throughput of the selected protocols decreases when no. of nodes increases. When the nodes are incremented, AODV outperforms the rest of the protocols. Throughput of AOMDV and DSR is sharply reduced as the no. of nodes increases.

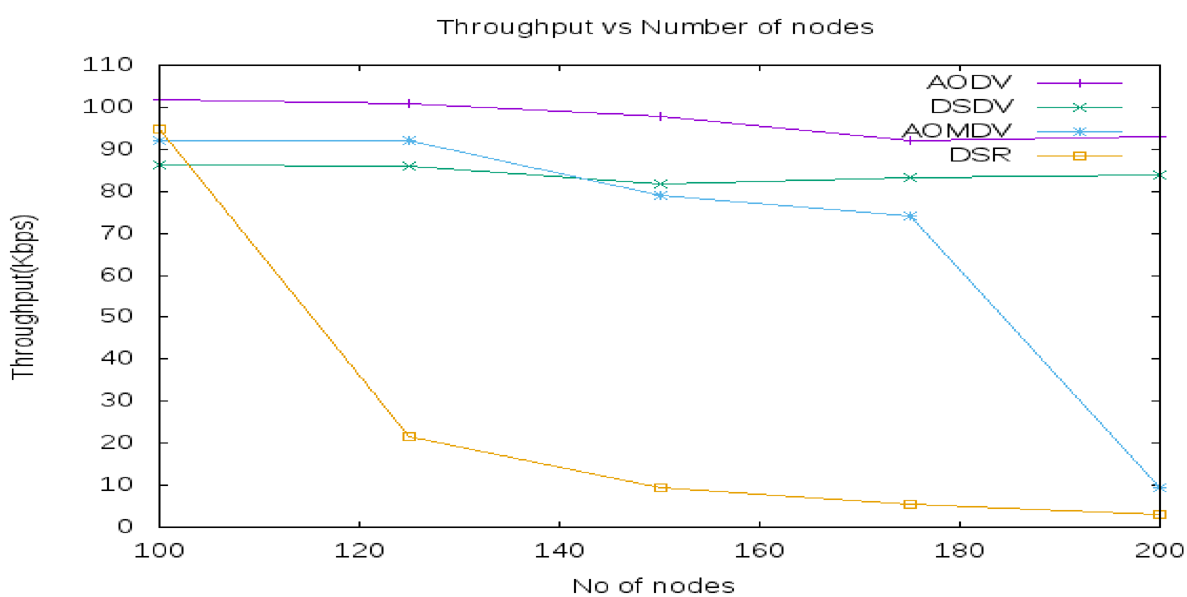

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Figure 2: Throughput vs Number of nodes

- **Packet delivery ratio-** Fig. 3 illustrates that with an increment in the number of nodes PDR declines as the number of the received packets decreases. AODV and DSDV perform fairly well but AOMDV and DSR show poor performance with increase in the number of nodes.

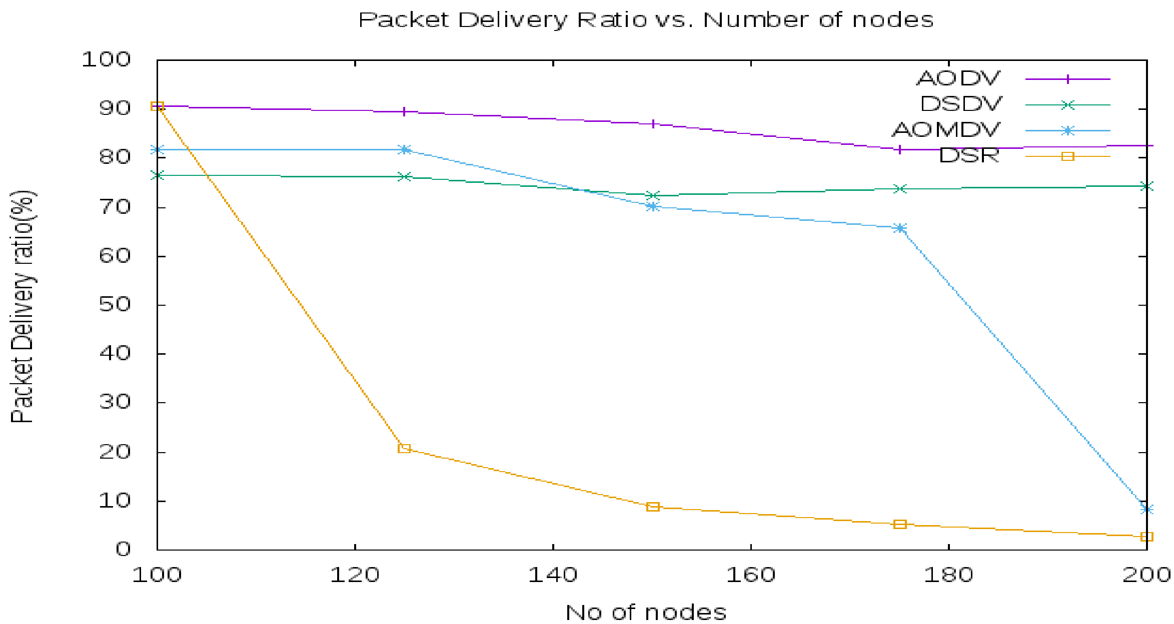

Figure 3: Packet delivery ratio vs Number of nodes

- **Loss packet Ratio-** Fig. 4 illustrates that as the nodes are incremented, networks become incapable of handling such a massive number of nodes, and packets cannot reach the destination node. Among the four, AODV handles packets the best**.**

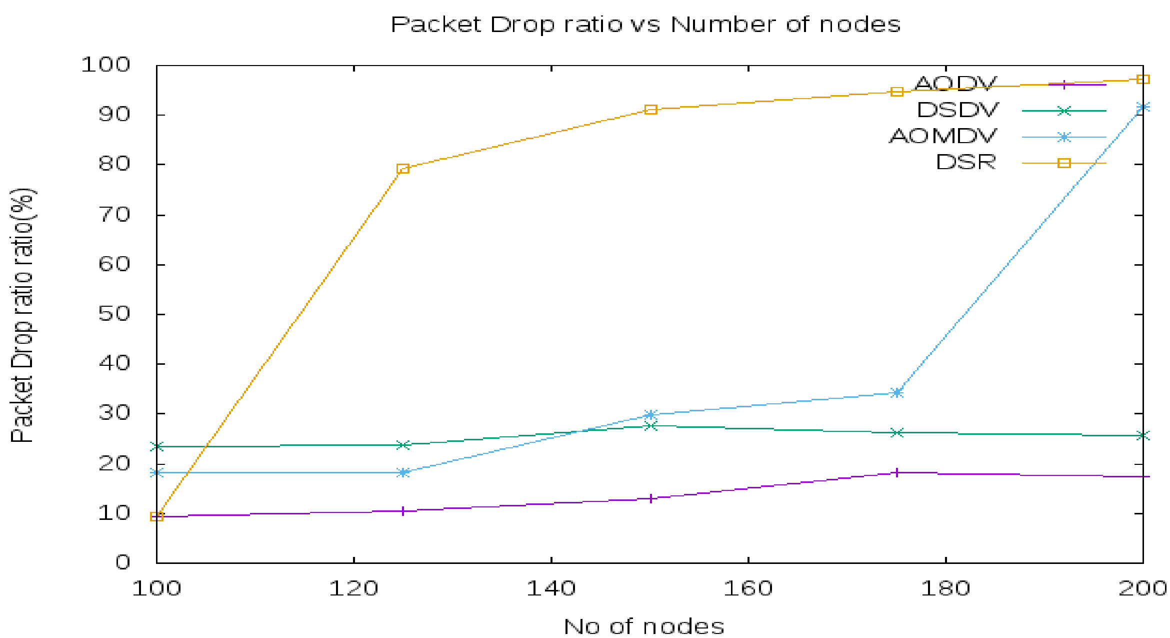

Figure 4: Packet drop ratio vs Number of nodes

- **Average residual energy-** It has been observed that each active node dissipates some energy whether or not it engages in the communication process. The initial energy of nodes is 100 joules. Fig. 5 shows that DSDV had higher average residual energy than others because it received fewer packets than other protocols.

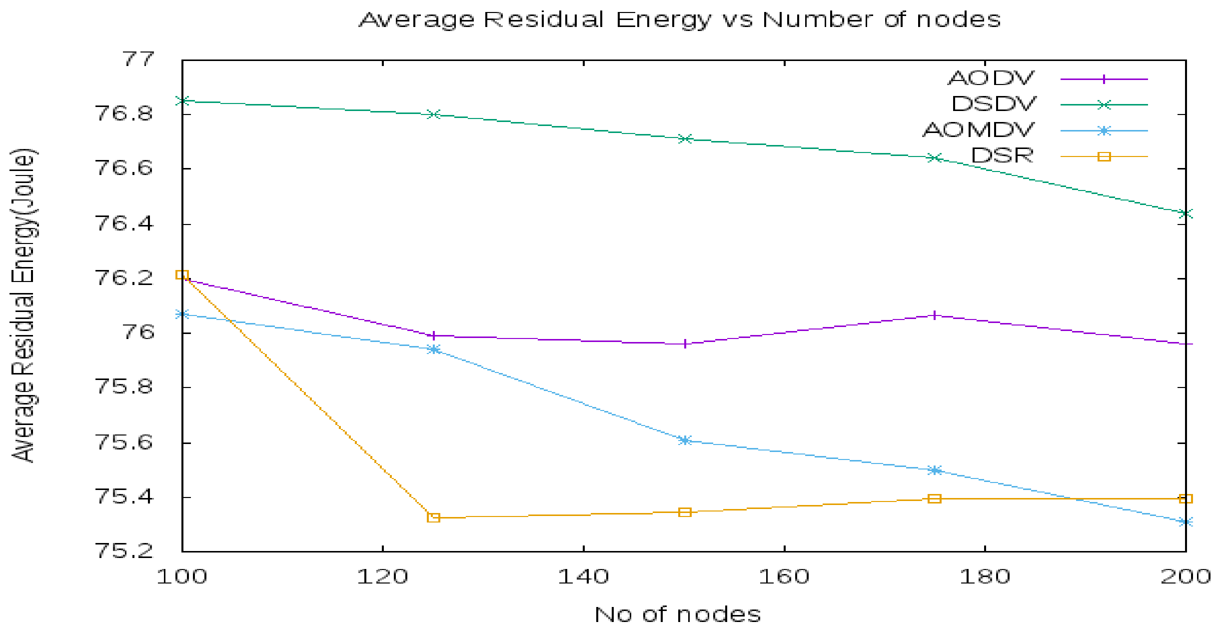

Figure 5: Average Residual energy vs Number of nodes

- **Average end to end delay**- Figure 5 illustrates that packets take longer to reach the destination node as the nodes are incremented. It is demonstrated that as nodes are incremented, AODV and DSDV route packets in less time when compared to DSR and AOMDV.

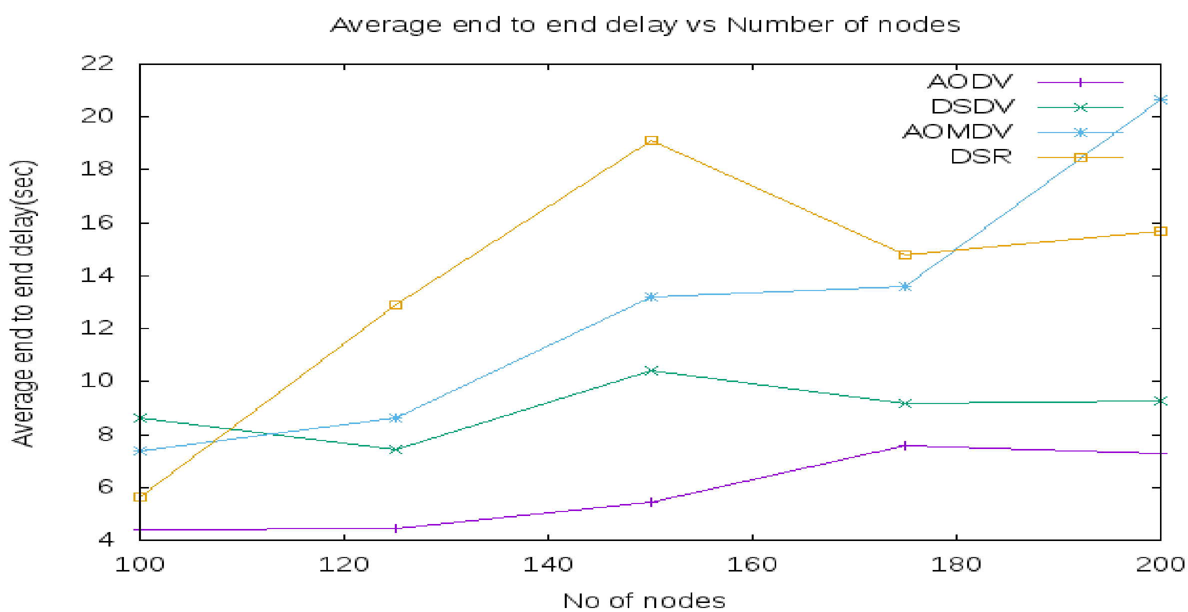

Figure 6: Average end to end delay vs Number of nodes

V. CONCLUSION

WSNs are essential in various real-world applications. Routing mechanisms play an important role in effectively delivering packets in the network. This paper examines the impact of various simulation parameters on the four flat-based routing protocols to get precise results. To measure the performance, five different performance parameters were used. The results conclude that AODV and DSDV perform better than DSR and AOMDV in throughput, PDR, packet drop ratio, average remaining energy and average end to end delay. DSDV had the highest residual energy as it uses pre-established routes. AODV is much more suitable than the rest three protocols for a large number of nodes. DSDV can be used in the future for applications that require energy-efficient protocols. The analysis results can be used in the future to decide which protocol is suitable for different scenarios.

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