INTERNATIONAL RESEARCH JOURNAL ON ADVANCED SCIENCE HUB
e-ISSN : 2582 - 4376
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Special Issue of First International Conference on Management, Science and Technology (ICMST 2021)

Relative study of Routing Protocols in Diverse Topologies of Wireless Sensor Network

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Abstract

Without the network model, node can't communicate with each other. When a node sends data to any another node in that network either data flows directly or indirectly through number of different hops. Different layers are associated with the model having their objective and responsibility. In wireless sensor network (WSN), the nodes are communicated with their goals from time to time following the structure of the network, number of protocols working on different layers of the model. Here, our focus on the topology and routing protocols behaviour in WSN. Analysis on the act of routing protocol like DSDV, AOMDV, AODV and DSR over the different topologies like chain, grid and parking lot. And also considering the performance of responsive and unresponsive flow of the network. The results are analyzed depending upon the simulation metrics like throughput, delay, jitter, PDR (packet delivery ratio), packet drop. Simulations are done using NS2 and the graphs are plotted by using gnuplot.

Keywords: Chain, Grid, Parking- lot, AODV, AOMDV, DSDV, DSR, NS2, gnuplot

1. Introduction

The term computer network elaborates the communication or shares the resource between the nodes either in wired or wireless medium. For communication, all the nodes follow the rules and regulation of the network model. The performance of the network depends upon the topology and protocols which are used in different layers of the model [1]. Normally, the network follows either OSI/ISO or TCP/IP model. Communication occurred within the network after establishing the path. Establish, transmit and receive are the measure steps for the node communication. For communication, network needs the hardware device like computer, server, router, switch, repeater etc as well as the software for different protocols. In wireless sensor network, the nodes are communicated either in a static or dynamic environment. Static topology means the nodes are fixed according to their co-ordinates in the terrain area. But, in case of dynamic, the nodes are changed their coordinates from time to time. Here, for our analysis, we take the static topology like chain, grid, and parking-lot. Routing protocol of the network layer also takes another measure role for the performance of the network. The objective of routing protocol is storing the packets and forwards the packets to the destination. But behind that lot of algorithm works for optimization, easy to find route, less energy consumption etc. Similarly, the application layer of network model takes another important role i.e. provides the service. Service is categorized into 2 types. One is responsive and another is unresponsive. In case of responsive, the acknowledgement came from receiver to sender after successful transmission. It is normally used important messages like

hospitality, body area network, military application etc. There is no acknowledgement concept in case of unresponsive; it is used for short message like mobile message. Routing protocol, service and the topology decides the performance of the network in terms of throughput, PDR, packet drop etc. [2]. ISO/OSI and TCP/IP network model is used for communication in the network. Network models are divided into layers according to their responsibility. Here, we consider the routing protocols (network layer) and flows (transport layer). Numbers of routing protocols are designed to optimize the route and flows are important for providing the message properly. For simulation, the network layer protocols like AODV, DSDV, DSR and AOMDV are considered; similarly, TCP and UDP protocol of transport layer. This paper aim is to study on the act of routing protocols in the different topologies like chain, grid and parking-lot.

2. Related Work

Author look over the concert of Ad-hoc On-Demand Multi-Path Distance Vector (AOMDV) routing protocol over reliable and unreliable traffic. As a result, when the data packet creation increases, unresponsive flow of AOMDV decreases [1]. The author in [2] comprises between the 2 on-demand routing protocols like AODV and AOMDV with respect to the transport layer protocols (TCP and UDP). The outcome says that AOMDV performs well than AODV in case of throughput and energy consumption. Here, the author discussed the network topologies in WSN and found the performance of different topologies [3]. There is a need of reduction in energy consumption in order to enhance the performance of the network. In [4-6], the author focused or discussed about different topologies in wireless sensor network. Conclusion says that chain topology performs better among all. According to different opinion or suggestion, here, we comprise and analyze the QoS of routing protocols like AODV, DSR, AOMDV and DSDV over the topologies like chain, grid and parking-lot.

3. Routing Protocol

Routing protocols are present in the network layer. Main responsibility is store and forwards the packet to the destination. Besides that, each routing protocol has the algorithm to discover the route, priority knowledge about the packet, response time etc. This way, routers gain knowledge of the topology of the network [7-10]. All the routing protocol classified on the basis of table driven or on-demand concept. In case of table driven, each node keeps the records of routing table where, source, destination, total hops to forward to destination, and sequence number are present. At the time of communication, new sequence is generated for each route.Each routing protocol maintains their route either in table driven way or an On-demand way. In case of table driven way, size and type of packet, address of source and destination, numbers of hops are maintained in the route table. Before sending the packets, sender is easily found out their path from the source to destination. Whereas, the routes maintained on the basis of demand. It is also called as reactive protocol. For on demand routing route request (RREQ) packets are used by route discovery process throughput the network.

3.1 DSDV (Destination Sequenced Distance Vector)

The DSDV protocol is designed with the idea of the classical Bellman-Ford algorithm. The routing table is maintained at every mobile station including all information for routing. The sequence number is generated after creation the route which is maintained in route table from source to destination [9]. Communication starts from sender node and finally reaches at destination. In case of node failure during communication, a different route is selected to assign the next hop immediately.

3.2 DSR (Dynamic Source Routing)

DSR Routing protocols have three steps i.e Route Selection mechanism, Route Discovery and Route Maintenance. Route Selection mechanism includes source selection and destination selection mechanism. Here, the necessity to find routes to other nodes is eliminated as route is created only when required.

3.3 Adhoc On Demand Distance Vector (AODV)

Like DSDV, AODV does not broadcast any changes in the network. Other routing protocols has the route table for communication, maintenance etc.; but in this case, the route table is updated according to the demand basis. It reduces the route maintenance and also minimizes the active routes than other protocol.

3.4 Ad-hoc On-demand Multipath Distance Vector (AOMDV)

This protocol is an extension of AODV protocol. Like, AODV it also focus on computation of multiple loop-free and link disjoint routes. It finds node-disjoint or link-disjoint routes. There is more overhead and latency caused by route discovery. This shortcoming can be avoided by having multiple redundant paths to the destination. For multiple path computation some overhead is required [10-13].

4. Topology

Network Topology is the schematic description of a network arrangement, connecting various nodes (sender and receiver) through lines of connection. Ex Bus, Chain, Grid and Parking Lot, star topology. Here, in our analysis, we are focusing on three topologies (Chain, Grid and parking-lot).

4.1 Chain Topology

In this topology, each computer connects with other in series. If a message is to be intended to a destination through the line, each system forwards it in sequence towards the destination.

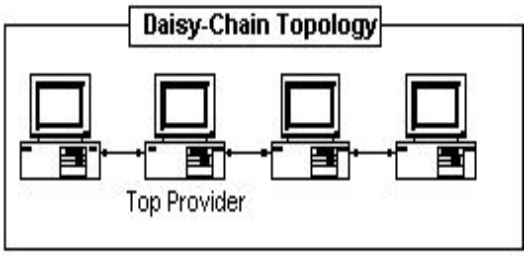

Fig.1: Chain Topology

Chain topology sometimes called as a Daisy-Chain topology. Figure 1 shows the chain topology.

4.2 Grid Topology

Figure 2 look like as a grid topology**.** Here, each node is attached with two exactly neighbour nodes to form a one or more dimension. In this topology, the nodes are communicated according to the chain concept and loop.

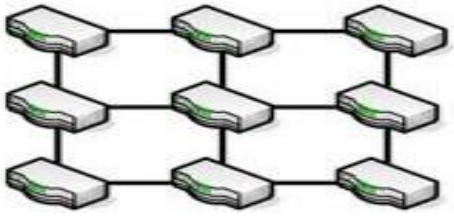

Fig. 2: Grid Topology

For high reliability and network performance FDDI based network systems uses two counter-rotating token-passing rings. When an *n*-dimensional grid network is connected in more than one-dimension circularly, the resulting network topology is a torus, and the network is called "toroidal".

4.3 Parking Lot Topology

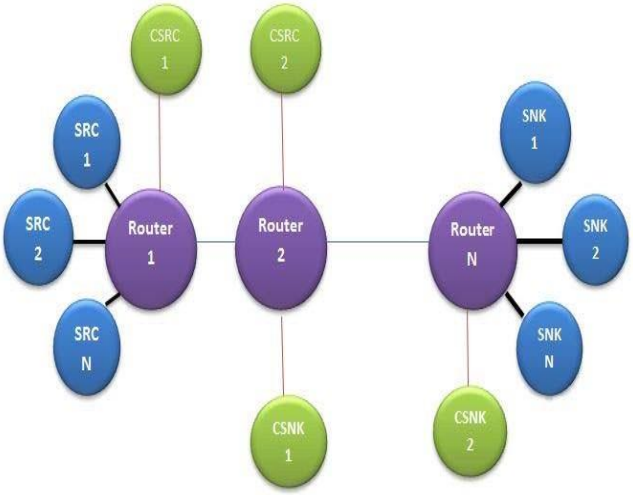

Fig.3: Parking Lot Topology

Parking lot topology is also called as multiple bottleneck topologies. Here source nodes and sink nodes are connected to routers. The parking-lot topology in figure 3 resembles dumb-bell topology except the presence of cross traffic traversing through the intermediate routers. For introduction of cross traffic, cross sink and cross source nodes are added to the network.

5. Simulation and Result Analysis

5.1 Simulation Environment

All the results are examined through the simulator ns2 [12] and the graphs are plotted through gnuplot. The following tables are taking as an assumption for evaluating the performance of different routing protocols over the responsive and unresponsive environment under different topologies like chain, grid and parking lot. Table 1 describes about the simulation set up environment for chain, grid and parking lot topology.

5.2 Performance Metrics

Network performance depends on different metrics like throughput, PDR, packet drop, end to end delay, jitter etc. The description of parameters as follows:

- **Throughput:** Number of successful packet is received by the sink.

  Throughput = Number of received packet * packet size/ Simulation Period.

- **Packet Delivery Ratio:** It is calculated with the results of packets send and receive.
  PDR = Number of received packets / Number of Sent packets

- **Packet Drop:** Packet drop = Total number of packets sent – Total number of packet received.

- **End to End Delay:** It calculates the send and receives time of each packet. Delays due to route discovery, queuing, propagation and transfer time are included in the delay metric.

- **Jitter:** It is latency in the sending packets over the network.

TABLE 1: SIMULATION ENVIRONMENT

Parameters	Chain /Grid / Parking Lot Topology
Simulator	Ns-2(Version 2.35)
Channel Type	Channel/Wireless
Radio- propagation model	Two ray Ground
Network Interface Type	Phy/wirelessPhy
MAC Type	MAC/802.11
Interface Queue Type	Queue/DropTail/Priqueue CMUPriqueue
Link Layer Type	LL
Antenna	Antenna/OmniAntenna
Maximum packet in ifq	50
Area(M*M)	2000*2000
No. Of mobile node	7 / 36 /23
Source Type	UDP,TCP
Simulation Time	150sec
Routing Protocols	AODV,DSDV,DSR,AOMDV

5.3 Result Analysis

5.3.1 Chain Topology

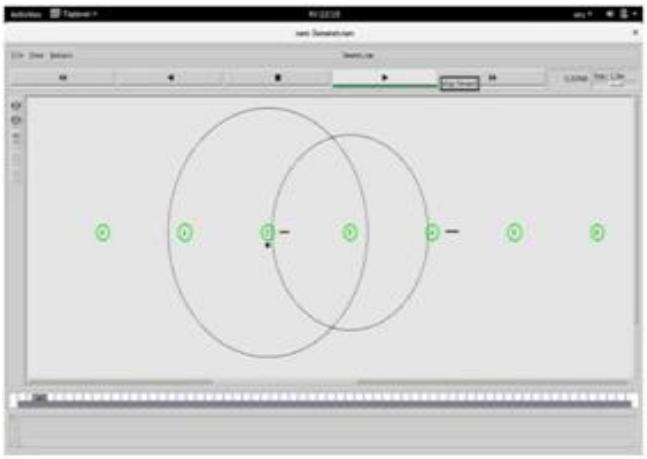

Fig.4: Chain Topology

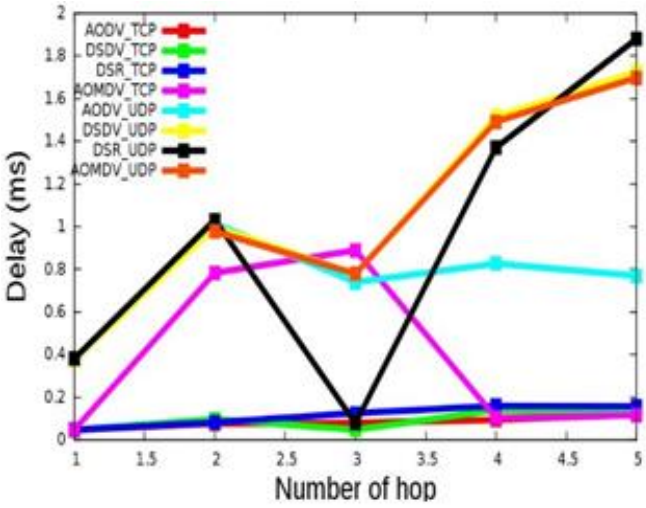

Fig.5: Number of hop vs Delay

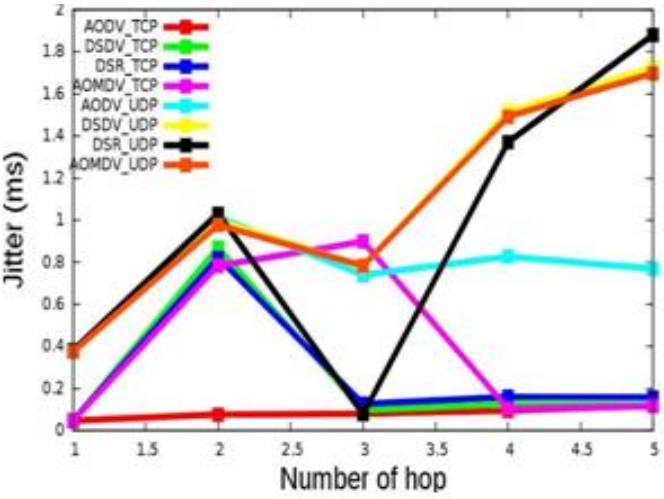

Fig.6: Number of hop vs Jitter

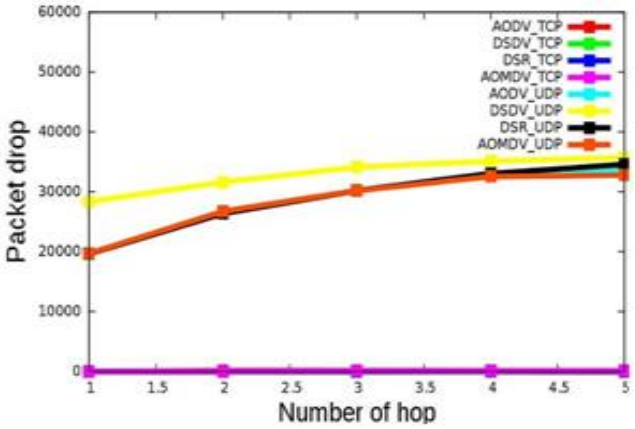

Fig.7: Number of hop vs Packet drop

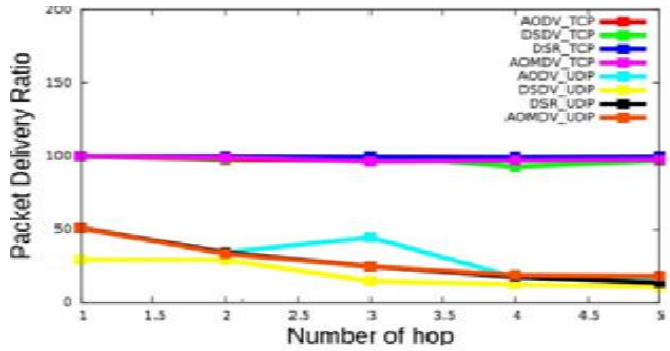

Fig.8: Number of hop vs Packet delivery ratio

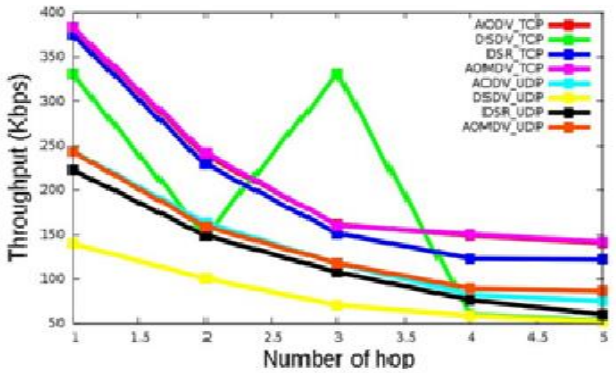

Fig. 9: Number of hop vs Throughput

From the above figure 4 shows the chain topology, whereas, figure 5 to 9 states about the performance. In this topology, we conclude that AODV protocol performs better in case of delay and jitter; whereas DSR performs better in case of packet drop and PDR. But AOMDV outfit than other in case of throughput.

5.3.2 Grid Topology

The following figures are shown the snapshot and results regarding grid topology.

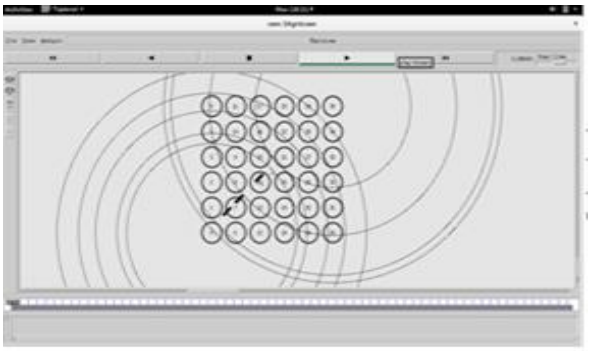

Fig.10: Grid Topology

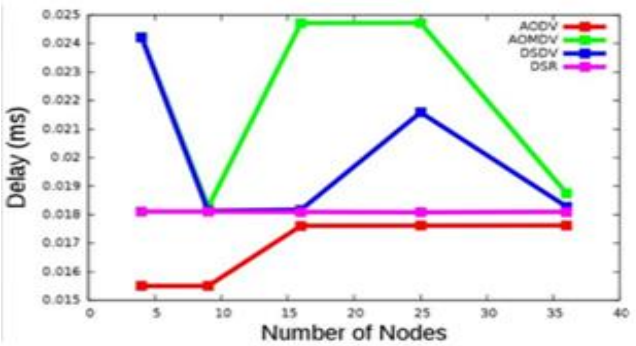

Fig. 11: Number of nodes vs Delay

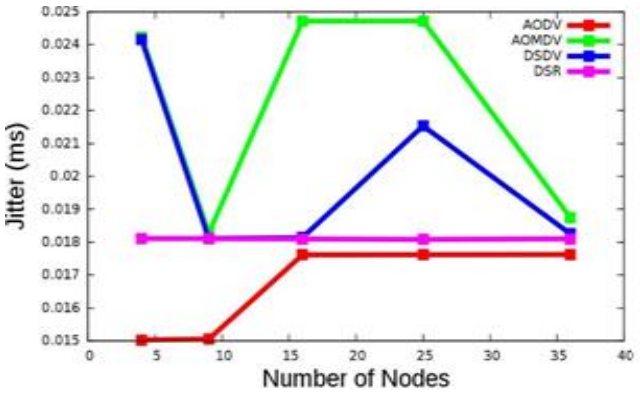

Fig.12: Number of nodes vs Jitter

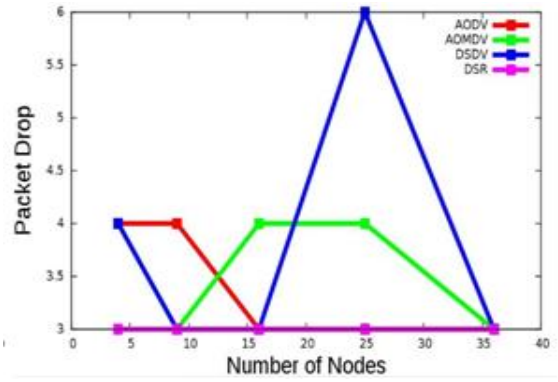

Fig.13: Number of nodes vs Packet drop

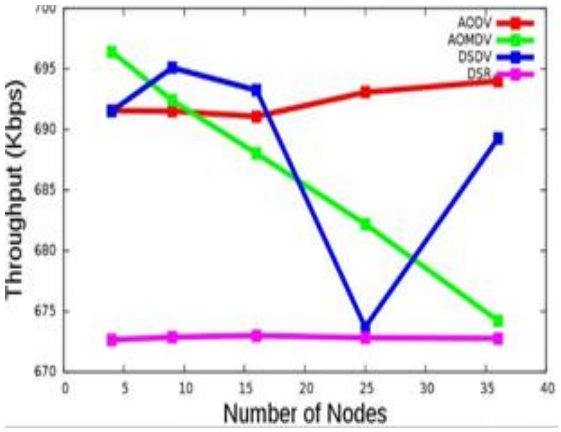

Fig.14: Number of nodes vs Throughput

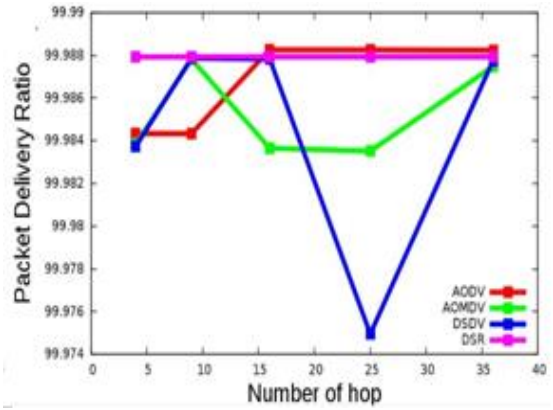

Fig.15: Number of hops vs Packet delivery ratio

Figure 11, 12 and 14 shows protocol AODV performs better in metrics like delay, jitter and throughput respectively. Similarly, DSR performs well in terms of packet drop and PDR in figure 13 and 15 respectively.

5.3.3 Parking Lot Topology

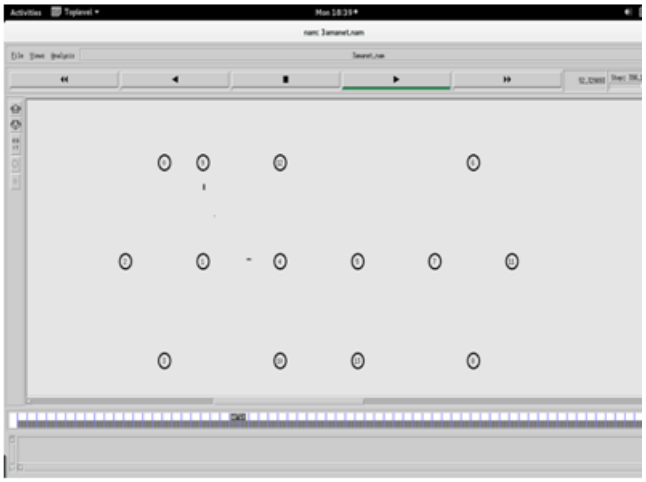

Fig. 16: Parking Lot Topology

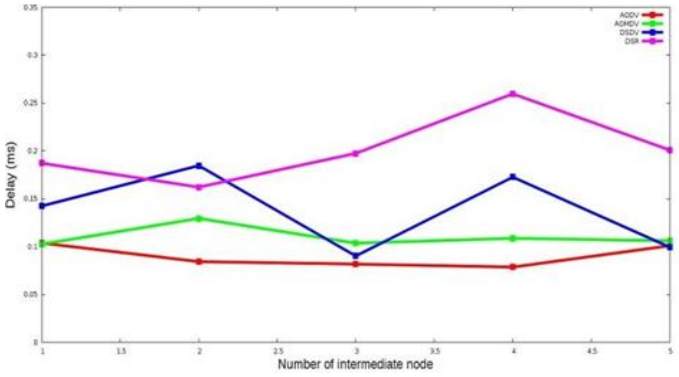

Fig. 17: Number of intermediate node vs Delay

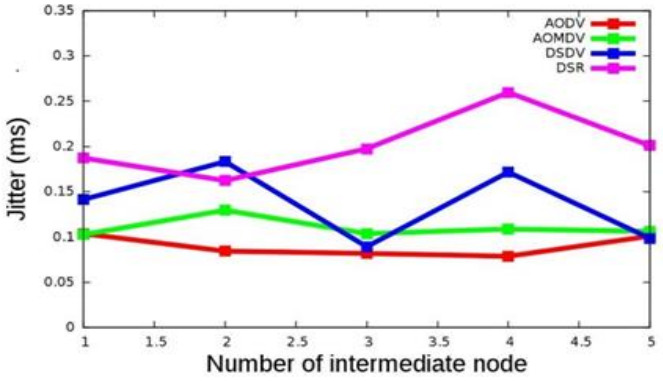

Fig.18: Number of intermediate node vs Jitter

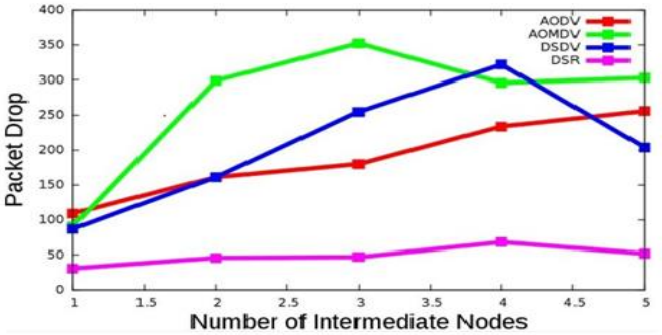

Fig. 19: Number of intermediate node vs Packet Drop

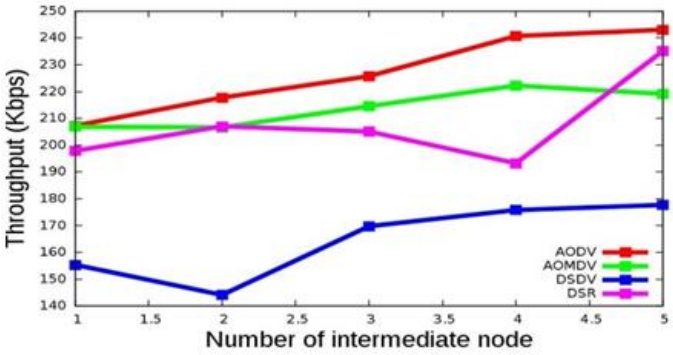

Fig.20: Number of intermediate node vs Throughput

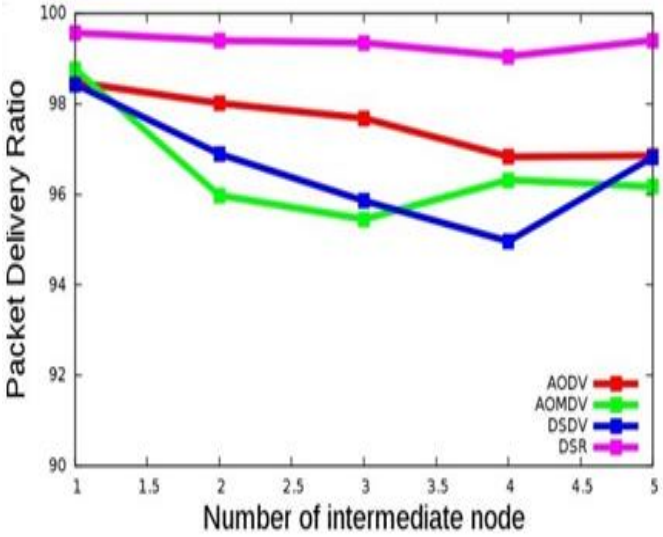

Fig.21: Number of intermediate node vs Packet Delivery Ratio

In parking lot topology, we conclude that protocol AODV performs fine result than other in term of delay, jitter and throughput shown in figure 17, 18 and 20 respectively. Whereas, DSR outperforms than other in PDR and packet drop shown in figure 21 and 19 respectively.

Conclusion and Future Work

This paper compares four protocols of network layer such as AODV, AOMDV, DSDV, and DSR in different topologies such as chain, grid and parking lot. We have concluded that in chain topology, responsive flow is better than unresponsive flow. Under responsive flow, AOMDV produce better throughput whereas in packet drop and PDR, DSR is sound. AODV is better in case of jitter and delay. For grid and parking lot topology, AODV is better in delay, throughput and jitter. In case of packet delivery ratio and packet drop DSR is better. In throughput AODV is better among other protocols. Further we are going to implement using ZRP protocol and MAC protocol IEEE 802.15.4.

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