MANET: Evaluation of Optimum Routing Protocol

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***Abstract*-** A mobile Ad hoc network is a dynamic, infrastructure-less, self-configuring and self-healing network of mobile. A MANET is a multi-hop peer-to-peer wireless network. In Ad hoc network there is no central control or Administration. Each node is free to move arbitrarily as the network topology changes regularly. As per need of new applications new research aspects related to energy consumption, mobility management of node, minimize packet loss ratio, increase throughput has been appeared. In MANET one major task is a link failure due to movement of a nodes. So, there is always need of better utilization of network with different routing protocol. This paper most discuss Table-driven (Proactive) e.g. DSDV and On-demand (Reactive) routing protocol e.g. AODV, DSR protocol. These three protocols performance is analyzed and compared on performance measuring metrics Packet Delivery Ratio, Average Throughput, Residual Energy, Mobility of node using NS-2.

Index Terms- AODV, DSR, DSDV Protocol, MANET, Residual Energy.

I. INTRODUCTION

Ad hoc network is a short-range temporary network. This network without the support of any recognized structure or centralized control. The ad hoc network contains of set of mobile nodes connected wirelessly in a self-configured, self-healing network without fixed infrastructure. In this each node free to move randomly as the network topology alteration frequently [1]. The node behaves as a route as they packet forward traffic to another specified node in a network. Basically Ad hoc network design some specific purpose or task. In MANET forwarding a message has to be taken care by mobile node, alive in the network. Therefore, each node behaves like host as well as a router in this network. To providing the dynamic topology special routing protocol or algorithm are needed. For small network the flat routing protocol are sufficient. But in larger network either hierarchical or geographical routing protocol are used [2] [3]. All the nodes are also located different location like airplanes, cars, industries, offices or with people having small electronic devices etc. These nodes can connect randomly each other and forms topologies. And also, these nodes communicate each other and send message neighbor nodes as a router. So, these nodes make them more suitable for instant network connection [4]. Today one of the main areas of researcher is routing technology. Which will route message from source to sink. In this research we have evaluated performance of AODV, DSR, and DSDV routing protocols based on average throughput, packet delivery ratio, residual energy, by using NS-2 simulator. The rest of paper is organized as follows: Section 2 presents brief overview of MANET routing protocols that we evaluate. Section 3 present overview of working protocols. Section 4 describes simulation environment. Simulation results are shown in Section 5 Result analysis is done in Section 6 and finally, conclusions are drawn in section 7.

II. MANET ROUTING PROTOCOLS

Routing is a process of finding a path from source to destination among randomly distributed routes. The broadcasting is indispensable and a common operation in ad hoc network. It consists of spread a packet from a source node to all the nodes in the network. It is also used for route discovery protocols in MANET. Routing Protocol in Mobile Ad hoc Network (MANET) are categorized such as Proactive protocol, Reactive protocol and Hybrid protocol. In this paper, the table-driven and the on-demand protocols are explained and then compared with different parameters [1][5].

A. Proactive Routing Protocol or Table-Driven

Proactive protocol also called a table-driven routing protocol. Proactive routing protocol try to preserve reliable, update routing information from each node to the network. This protocol requires each node to preserve one or more routing tables to store routing information and they respond to change in network topology by spread route updates throughout the network to maintain a consistent network view. These are Proactive routing protocols: DSDV, WRP etc. [1] [2] [4] [6].

B. Reactive Routing Protocol or On Demand

Reactive protocol also called a on demand routing protocol. Reactive protocol is kind of query-reply dialog. This type routing protocol creates route only when desired by the source node. When a source wants to send a message to destination, it asks the route discovery mechanisms to find the path to the destination. This procedure is finished once a route is determined after all possible measures have been examined. Once a route has been recognized, it is preserved by a route maintenance procedure until either the sink becomes inaccessible along each path from the source or until the route is no longer want. In on demand schemes, nodes keep the routes to active sink. So, route search is significant for every unknown sink. These are Reactive protocols: AODV, DSR, TORA etc. [4] [6].

C. Hybrid Protocol

Hybrid protocol is using best features of both the proactive and reactive routing protocols. This routing protocol is originally established with some proactively inspected routes and then serves the demand in addition activated nodes through reactive flooding. The choice of one or the other method requires an antecedent for different cases. Hybrid Protocol: Zone Routing Protocol (ZRP) [4] [7].
So, these category of routing protocols are described but choosing best one is very difficult. Because, one protocol best for one scenario and other one is best for another scenario. In this paper we observed with simulation of AODV, DSR and DSDV routing protocols. These three protocols briefly described below. figure 1 represents categorization of Mobile Ad hoc Network Routing Protocols.

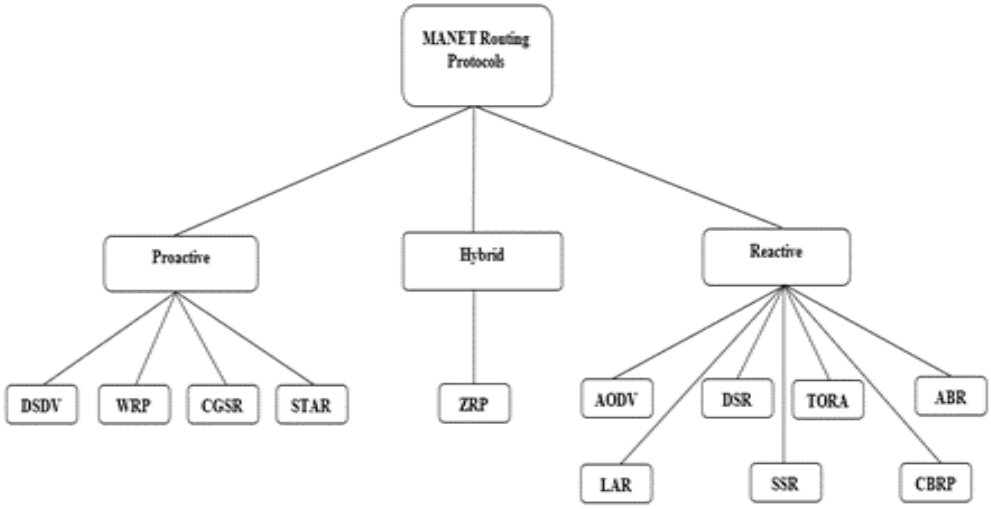

Fig 1. Categorization of a MANET Routing Protocols

III. OVERVIEW OF AODV, DSR AND DSDV PROTOCOL

A. Ad hoc On-Demand Distance Vector (AODV)

AODV is a distance vector on-demand MANET routing protocol, i.e. there is no periodical route information exchange. AODV is responsive routing protocol which does not find or establish a route until or unless requested by nodes. AODV use destination sequence number to make sure that all route is loop free and also contains the information of most recent route is used. AODV give fast revision to active topology situations, fewer processing and memory overhead, improved network utilization, and offer unicast route to sink with in the mobile ad-hoc network [2] [3] [8].
This protocol consists two major phases:
3.1.1 Route Discovery.
3.1.2 Route Maintenance.

3.1.1 Route Discovery

In this phase when a source node wants to transfer data with sink node and does not have a predefined or legal route to that sink it starts route discovery method to find the other node of the sink. In this source node sends a route request message (RREQ), which is broadcasted. If all those nearest nodes do have any information about the destination node then they will further send the message to its nearest nodes and so on until the destination node is found. If any node has a valid route to the destination, it responds to the route - request with a route-reply (RREP) message. After RREP message is received by nodes then intermediate nodes recorded the path in the routing table and this path identified the route from source to destination then nodes start sending packets [9].

3.1.2 Route Maintenance

The second phase of AODV is route maintenance it is perform by source node. Basically, it divided in two parts:

1. Source node moves.
2 Destination or Intermediate node move.

A node sends route error message (RERR) its source. When the link is break down with the next hop. Intermediate nodes receiving a Route error message and after they update their routing table by decide the distance of the destination to infinity. When the message (RERR) is reached to source, then it starts new route discovery process.[9][10].

B. Dynamic Source Routing (DSR)

DSR also on-demand routing protocol, which uses essentially a source routing concept. In source routing the inventor knows complete hop-by-hop route to the destination. The routes information is stored in the route cache. When a node needs to transfer a data packet to a sink node for which it does not already know the route. Then DSR protocol is used. DSR each hop or node preserves a route cache with route entries which are continually updated. So, this way node recognizes new routes. The sender of the packets selections and controls the route used for its own packets, which also supports features such as load balancing. All routes used are definite to be free of loops as the sender can avoid matching hops in the designated routes. DSR has the capacity to handled unidirectional links. Like other protocols DSR not requires periodic packets of within the network [10][11][12].

It composed of two parts:

3.2.1 Route Discovery
3.2.2 Route Maintenance.

3.2.1 Route Discovery

In this phase when a node in the network attempts to send a data packet to a sink node for which route is not recognized, it uses a route discovery procedure to discovery a route. Route discovery uses simple flooding technique in the network by RREQ packets. Each node getting an RREQ rebroadcasts it further, without knowing the destination or when it has a route to the sink node then store route in its route cache. Such a node reply to the RREQ with RREP message to its original source [13][14].

3.2.2 Route Maintenance [15]

The periodic routing updates are sent to all the nodes. Uncertainty any connection on a source node is cracked, the source node is notified using a RERR packet. The source removes any route using this link. A new route discovery method must be announced by the source if this route is still wanted. Also, any forwarding node caches the source route in a packet it forwards for possible future use.

Some of the techniques that are advanced to improve it are:

a). **Salvaging:** A central node can use a different route from its own cache, once a data packet encounters unsuccessful link on its source route.

b) **Gratuitous route reparation:** A source node receiving a RERR packet loofahs the RERR in the succeeding RREQ. This supports cleaning up the caches of other nodes in the network.

C. Destination Sequenced Distance Vector (DSDV)

DSDV is a proactive routing protocol based on the distance vector algorithm. In proactive or table-driven routing protocols, each node endlessly preserves update routes to every other node in the network. Routing information is repeatedly transmitted all over the network in order to uphold routing table steadiness. The routing table is updated at each node by discovery the change in routing data about all the accessible destinations with the number of nodes to that specific sink.

IV. PREVIOUS WORK DONE

Several works have been done in past few years to find which protocol is efficient and good for MANET in different parameters.

Charles E. Perkins et al. [2] have studied AODV Vector Routing. This paper described how AODV protocol work how RREQ send how RREP reply source request, how route table or path mange. In this paper simulation can be described different parameters like Hello Interval, Route Discovery Timeout, Route Expiration, Reverse Route Life Maximum of Retransmissions and also varying the no. of node.

David B. Johnson et al. [11] presented the DSR Protocol for Multi-Hop Wireless Ad Hoc Networks. This paper classifies the process of DSR through simulation on a variety of measure and communication designs. In this described the principle mechanisms of Route Discovery and Route Maintenance used by DSR, and have shown they enable wireless mobile nodes to automatically form a completely self-organizing and self-configuring network among themselves.

Guoyou He et al. [13] reviews the DSDV protocol, and analyses the properties of DSDV when it is used for ad hoc networks routing. In this DSDV arises route variation because of its principles of route informs.

Ammar Odeh et al. [15] described the evaluation of AODV and DSR routing protocol in MANET. The performance metrics is Sending time, accessing time, Transmission time, Propagation time, Reception time, receive time, Aggregate throughput, Drop packet, Efficiency

of routing protocol. In this paper different performance metrics were investigated with respect to packets' size. In this experiment, DSR has shown better performance in terms of efficiency for a packet size less than 700 bytes.

Abdul Hadi Abd Rahman et al. [19] described the evaluation of AODV, DSDV and I-DSDV Routing Protocols in MANET. In this paper, all the three-routing protocol are evaluated based on the three-performance metric which are Packet Delivery ratio, End-to-End Delay and the Routing Overhead. The results indicate that the performance of I-DSDV is superior to regular DSDV. It is also observed that I-DSDV is even better than AODV protocol in PDR but lower than AODV in E2E delay and Routing Overhead.

V. SIMULATION ENVIRONMENT

NS2.35 Network Simulator is used for the simulation of routing protocol in MANET.NS2 is an open source distinct event network simulator is performed under Linux (Ubuntu18.04) environment. It is used for the simulation of network protocols with different network topologies. Network animator (NAM) is used for the graphical view of the network. Other Tools don't have all the modules that ns-2 has [20]. NS use two language: Object oriented Tool Command Language (OTcl) and Object-oriented language C++.

Table1: Simulation Parameters

Parameters	Values
Protocol Studied	AODV, DSR, DSDV
Channel Type	Wireless
Mobility Model	Random waypoint mobility model
Propagation Model	Two Ray Ground
Antenna Type	Omni Directional Antenna
Simulation Area (meters)	900m * 900m
Simulation Time (second)	30,60,90,120,150 sec
Traffic Type	FTP
No. of Nodes	50
No. of Packet	50
Energy (joules)	50 unit
Packet size (bytes) for 1st Simulation	750
Packet size (bytes) for 2nd Simulation	1500
Packet size (bytes) for 3rd Simulation	3000
Packet size (bytes) for 4th Simulation	4500
Packet size (bytes) for 5th Simulation	6000

A. *Performance Evaluation Parameters*

AODV, DSR and DSDV routing protocol are compared on the basis of three performance metrics. For simulating these protocol awk script are written for all these performance metrics.

1. Average Throughput.

Average Throughput of a network is the average rate of positively message transported over a communication channel. The system throughput or average throughput is the sum of the data rates that are delivered to all terminals in a network[17][18][24].

Average Throughput = (No. of received packets / (Finish time – Start time)) * (8/1000) kbps

2. Packet Delivery Ratio

Packet delivery ratio is defined as the ratio of the entire number of packets received by sink node to the entire number of packets sent by the starting node [24]. It is calculated as:

PDR = (Received packets / Sent packets) * 100

3. Residual Energy

Residual Energy = Total Energy-Used Energy. It is observed that with every simulation whether a node takes part in communication process or not, if it is in active state some amount of energy is being dissipated [21][25].

B. Scenario of Different Protocols

The scenario represents figures showing running simulation for Random waypoint mobility model with AODV, DSR and DSDV routing protocol

1. Random Waypoint mobility model with AODV, DSR, DSDV

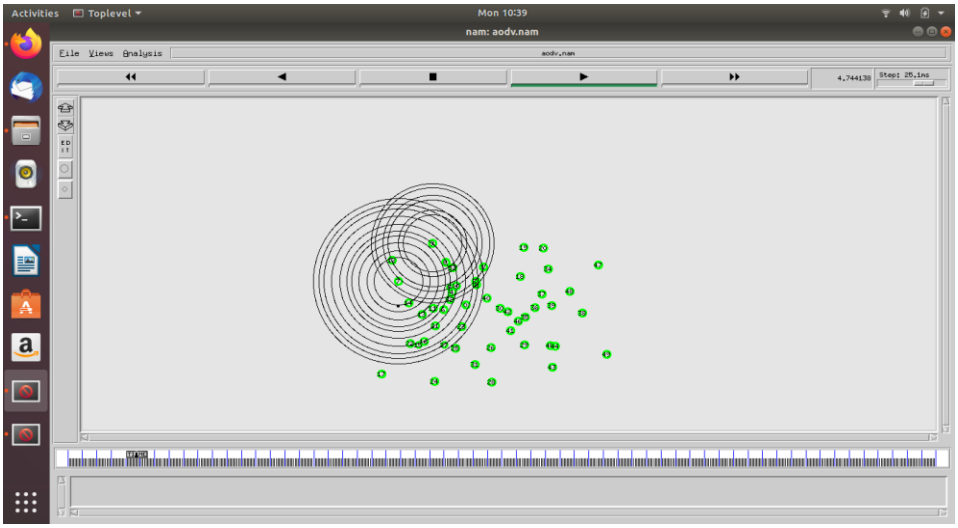

Figure 2: AODV

With figure 2 AODV and figure 3 DSR random waypoint mobility model was implemented for 50 nodes.

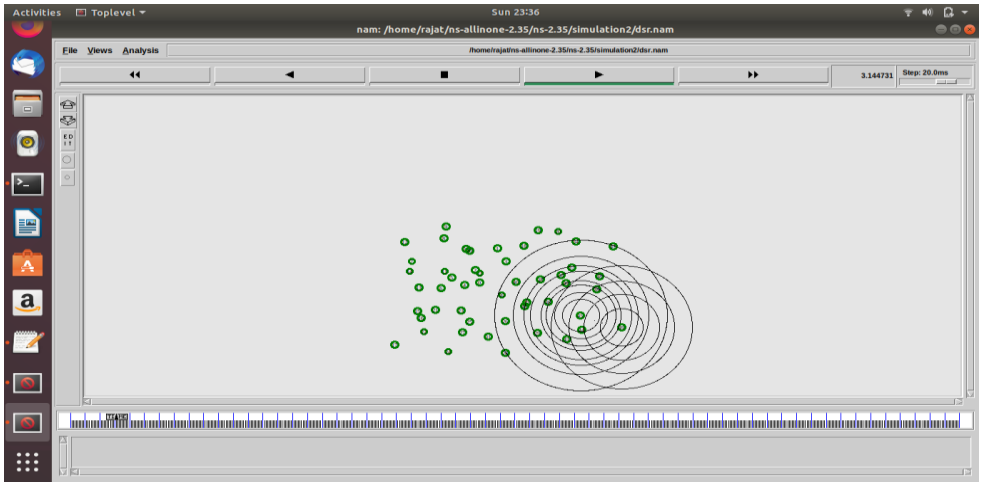

Figure 3: DSR

Netanim is the tool showing running simulation. Green dots defined node is active or fully energy in AODV and DSR. In this Figure black circle defined the communication done one node to other in a particular range.

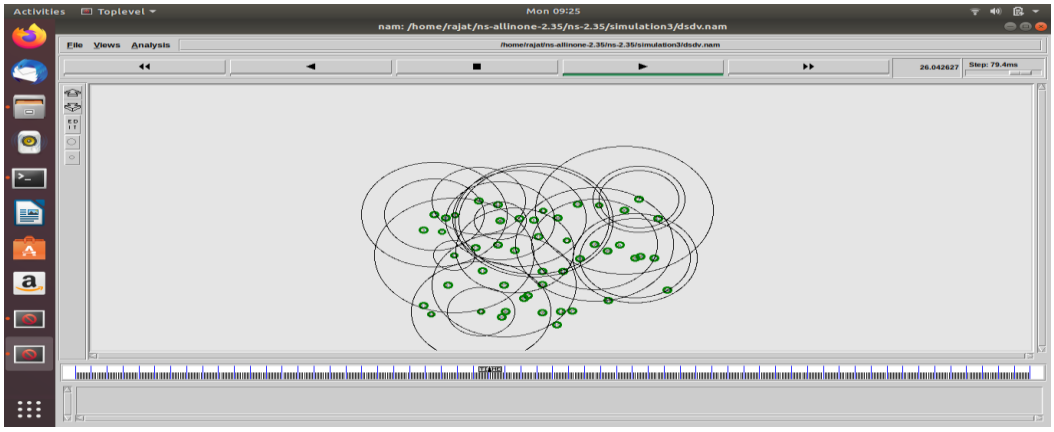

Figure 4: DSDV

With figure 4 random waypoint mobility model was implemented for 50 nodes. Netanim is the tool showing running simulation. Green dots defined node is active or fully energy in DSDV. In this Figure black circle defined the communication done one node to other in a particular range.

2. Energy Loss in DSR and DSDV:

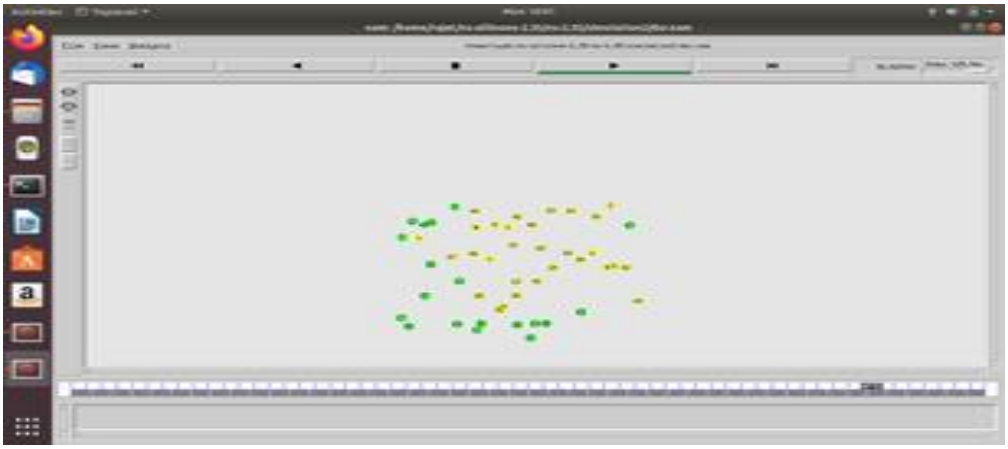

Figure 5: Energy Loss in DSR

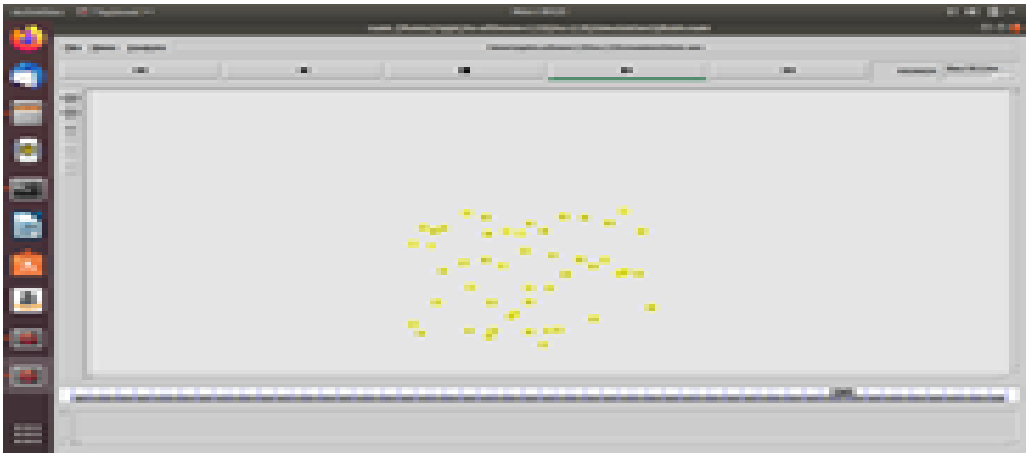

Figure 6: Energy Loss in DSDV

In figure 5 and Figure 6 yellow color(dots) defined the less energy in the node and communication may be affected any time.

VI. RESULTS AND ANALYSIS

To obtained the mobility model Random waypoint mobility model are implemented with AODV, DSR and DSDV for simulation time 30,60,90,120,150sec with 50 nodes. To obtained the reading in operating system Ubuntu 18.04 the tool and trace metric and gnuplot are used for graph.

A. Average Throughput

Figure 7 represent Average Throughput With AODV, DSR and DSDV in simulator NS-2.

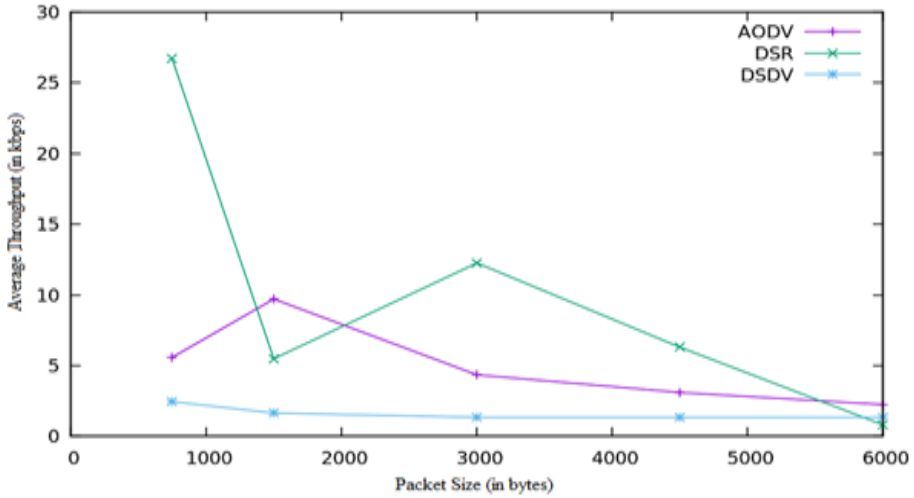

Figure 7: Average Throughput in AODV, DSR and DSDV

Figure 7 Average Throughput of AODV, DSR and DSDV routing protocol for MANET environment is measured for the varying packet size. It is obvious from the graph that average throughput is 5.5%, 27% and 2.4% packet size 750 bytes for AODV, DSR and DSDV respectively. It is clearly observed in the graph that average throughput decreases as the packet size increases. If packet size is large then fever packet is sent source to destination. It is clearly shown in graph DSR routing protocol better then AODV and DSDV routing protocol in MANET.

B. *Packet Delivery Ratio (PDR)*

Figure 8 represent Packet Delivery Ratio with AODV, DSR and DSDV in simulator NS-2.

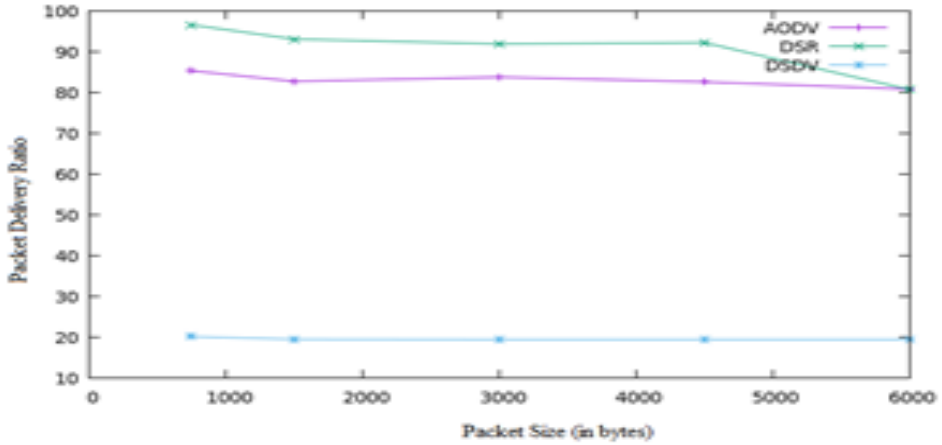

Figure 8: Packet Delivery Ratio in AODV, DSR and DSDV

Packet delivery ratio in AODV, DSR and DSDV are shown in figure 8 PDR measured the varying packet size. When packet size is 750 bytes, PDR of DSR is nearly 100% and PDR of AODV is 87% and PDR of DSDV is 20%. It is shown in graph that on increasing the packet size, PDR of AODV, DSR and DSDV routing protocol deceasing. It is clearly shown in graph DSR routing protocol better then AODV and DSDV routing protocol in term of PDR.

C. Residual Energy

Figure 9 represent Residual Energy with AODV, DSR and DSDV in simulator NS-2.

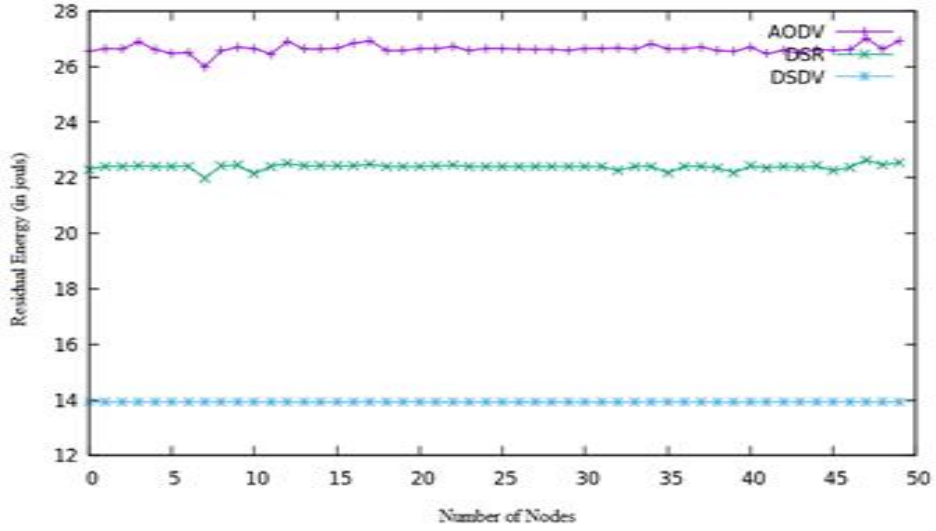

Figure 9: Residual Energy in AODV, DSR and DSDV

Residual Energy in AODV, DSR and DSDV (50 joules) are shown in figure 9 measured the fixed packet size 1500 bytes. It is obvious from the graph that Residual Energy is 26.3 joules for AODV 22.1 joules for DSR and 14 joules energy remaining for DSDV routing protocol. In this graph shown clearly AODV routing protocol better then DSR and DSDV routing protocol in term of Residual Energy.

VII. CONCLUSIONS AND FUTURE WORK

A detail study of routing protocols is done in this paper which focused on the energy conserving schemes used by protocols and their real time support towards application like scrutiny, monitoring etc. It is concluded that DSR performs better than AODV and DSDV in Average Throughput, Packet delivery ratio. But AODV performs better in case of energy. AODV is more energy efficient as compared to the DSR and DSDV.

Extensive research work is going on in field of routing in MANET to provide efficient data transfer from source node to destination node. It has been found that the research regarding multicasting in MANET is still to go a long way. This work can be further enhanced to support routing protocol in Grid Environment. Possible topics of the future research directions on multicast routing protocols include the following: Multiple paths and load balancing, Security, Designed new Hybrid Protocol.

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