

# **Performance Evaluation and Comparison of AODV, DSR and Hybrid Routing Protocols in Mobile Ad hoc Networks**

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**ABSTRACT:** Mobile Ad-Hoc networks are highly dynamic networks characterized by the absence of physical infrastructure. Nodes of these networks functions as a routers which discovers and maintains the routes to other nodes in the network. Due to mobility, connections in the network can change dynamically and nodes can be added and removed at any time. In this paper, we have compared the performance of AODV, DSR and Hybrid routing protocols on the basis of Packet Delivery Ratio, Throughput, End to End Delay, Routing overhead and energy consumption in Mobile Ad-Hoc network using Matlab. Simulation results show that Hybrid Routing Protocol gives better performance than AODV and DSR in all situations.

**KEYWORDS:** AODV, DSR, Hybrid, PDR, throughput, end to end Delay, routing overhead, mobility, Mat lab

## **I. INTRODUCTION**

The mobile ad-hoc networks is considered a group of wireless mobile nodes that are capable of communicating with each other without the use of network infrastructure or any centralized administration. The transmission range of each low power node is limited to each other proximity. The out-of-range nodes are routed through intermediate nodes in network [1]. Routing protocol plays an important role to send data from source to the destination that discovers the optimal path between the two communication nodes. Every protocol has its own rules to finds the route. There are various routing protocols proposed by researchers. Routing protocols in MANETs are broadly divided into three categories: Proactive (table-driven), Reactive (source-initiated on-demand-driven) and Hybrid [2].

Reactive routing protocols such as AODV and DSR, consume less energy than proactive routing protocols because they use route discovery only when the route is needed [3]. The dynamic nature of MANET is a challenging problem. The routing mechanisms in MANET are made complicated due to the interaction of three fundamental issues with regard to network such as contention, congestion and node connectivity. Every ad hoc routing protocol has their own advantages based on their individual performances in the network [4].

It is argued that the routing protocols can be analyzed and evaluated, in respect of qualitative and quantitative metrics. A Distributed operation, Loop-freedom, Demand-based operation, Security constitute are qualitative metrics. On the other hand, End-to-End Delay, Throughput, Packet Delivery Fraction (PDF), and Normalized Routing Load (NRL) are the quantitative metrics [2], [6]. Despite the similarity of the two protocols regarding their on-demand behavior, it is concluded that for metrics, such as delay and throughput, DSR performs better than AODV in a less stressful network with lower load or less mobility, whereas AODV outperforms DSR in a more stressful network [5]. Security is very difficult due to lack of pre existing infrastructure, wireless nature of communication link and frequently changing network topology. There are various attacks on wireless channels like black hole attack, wormhole attack etc [6]. Due to bandwidth constraints, it is readily understandable that an on demand approach is often used in wireless ad-hoc network scenarios. The most famous routing approach in ad-hoc networks is that of reactive protocols and the most popular on-demand routing algorithms are Ad-hoc On-Demand Distance Vector routing (AODV) and Dynamic Source

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Routing (DSR) [8]. As a network grows, routes between sources and destinations become longer. When a route breaks due to node mobility or node failure, flat routing protocols like DSR and AODV typically discard the whole original route and initiate another round of route discovery to establish a new route from the source to the destination. Thus, this approach wastes the knowledge of the original route and may cause significant overhead in global route discoveries. An optimization to AODV is local repair [10]. A combination of the two routing protocols called DOA (DSR over AODV) is used to overcome these issues. DOA is usually implemented using a model called Way Point Routing model in which the problem of position estimation errors occurs. This work enhances DOA with a new algorithm called Exponential Weighted Moving Average (EWMA) for on-line updating of nodal contact probability to minimize the possibilities of position estimation errors [13].

## II. ROUTING PROTOCOL

### Dynamic Source Routing Protocol (DSR):

Dynamic Source Routing Protocol (DSR) protocol was proposed for routing in MANET in which each mobile node is required to maintain a route cache that contains the source routes of which the mobile node is aware. The node updates entries in the route cache as and when it learns about new routes. The protocol consists of two phase:

#### Route Discovery:

The route discovery process initiates whenever the source node wants to send a packet to some destination. Firstly, the node consults its route cache to determine whether it already has a route to the destination or not. If it finds that an unexpired route to the destination exists, it makes use of this route to send the packet. On the other hand, if the node does not have such a route, it initiates route discovery by broadcasting a Route Request (RREQ) packet. The Route Request (RREQ) packet contains the address of the source and the destination, and a unique identification number as well. Each intermediate node that receives the packet checks whether it knows of a route to the destination. If it does not, it appends its own address to the route record of the packet and forwards the packet along to its neighbors. The DSR protocol selects one of these routes, which constitutes the shortest one and caches the others in case of a link failure [5]. The Route Cache is designed to be loop free and stored in any format in represented by a data structure [7]. However, in case it finds a route, a Route Reply (RREP) packet containing the optimal path is transmitted back to the source node through the shortest route. A Route Reply (RREP) is generated when either the destination or an intermediate node with current information about the destination receives the Route Request (RREQ) packet. As the Route Request (RREQ) packet propagates through the network, the route record is formed. If the Route Reply (RREP) is generated by the destination then it places the route record from Route Request (RREQ) packet into the Route Reply (RREP) packet. The Route Reply (RREP) packet is sent by the destination itself.

#### Route Maintenance Phase:

When a node encounters a fatal transmission problem at its data link layer, it generates a Route Error (RERR) packet. When a node receives a route error packet, it re-moves the hop in error from its route cache. All routes that contain the hop in error are truncated at that point. Acknowledgement (ACK) packets are used to verify the correct operation of the route links. This also includes passive acknowledgements in which a node hears the next hop forwarding the packet along the route [2].

By using the cache, the route discovery overhead is reduced. DSR Supports multipath routing and does not require any periodic beaconing or hello message exchanges. DSR is not effective in large networks because Packet size keeps on increasing with route length because of source routing [9].

### Ad Hoc On-Demand Vector Routing Protocol (AODV):

Ad Hoc On-demand Vector routing protocol (AODV) [4], [5] is a reactive routing protocol for ad hoc mobile networks that creates routes only between nodes which wishes to communicate. It has three phases:

#### The Route Request Phase:

Firstly, the source node broadcasts a Route Request (RREQ) packet to its neighbors. The neighbors in turn broadcast the packet to their neighbors until it reaches to an intermediate node that has recent route information about the

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destination or it reaches the destination itself. A node discards a Route Request (RREQ) packet that it has already seen. The Route Request (RREQ) packet uses sequence number to ensure that the routes are loop free and to make sure that if the intermediate nodes reply to route request, they reply with the latest information only. During the process of forwarding the Route Request (RREQ) packet, intermediate nodes record in their route tables the address of the neighbor from which the first copy of the Route Request (RREQ) is received. This information is used in the next phase.

**The Route Reply Phase:**

To inform the source node about the destination a route reply (RREP) packet is used. As the Route Reply (RREP) packet traverses back to the source, the nodes along the path enter the forward route into their tables.

**The Route Maintenance Phase:**

Once the route from source to destination is set each node in the network starts its maintenance phase. In this phase if the source moves, it can easily reinitiate route discovery process to the destination but if one of the intermediate nodes moves, then moved nodes neighbor realizes the link failure and sends a link failure notification (Route Error) to their upstream neighbors and so on until the source node is notified. The source node may then choose to re-initiate route discovery for that destination [2]. Multiple RREP packets in response to a single RREQ could lead to overloading and periodic updates of the network topology to unnecessary consumption of bandwidth [5]. AODV is □ Very effective in highly dynamic networks. □ Since the information of stale routes expires after a specific time, AODV requires less space as compared to other reactive routing protocols. AODV lacks an efficient route maintenance technique since routing information is always obtained on demand Like DSR, AODV suffers from high route discovery Latency [9]. AODV resolves the problem of large headers found in DSR [12].

**Hybrid Routing Protocol:**

The environment is created for transferring the data from one place to another with 1000\* 1000 dimensions. 100 nodes have been given as an input. Xlocs and ylocs are being found out with- in a network. Randomly, source and destination nodes have been chosen from the nodes. Initiate the coverage area i.e., 20 % of the width of the network to find to coverage set for each node. On the basis of DSR, the path is being found based on the nearest neighbor node. In DSR Routing approach, source node send packet to destination node to get the route from source to destination. It contains request\_id which is unique and record listing of the address for each intermediate node. This message has forwarded. Destination node of the route discovery returns the RREP message to the source node. When the source node received RREP it records this route in the route cache. Before sending packets, node saves the copy of original packet in a local buffer. In route maintenance, source node detects another route towards the destination if the network topology change or existing link breaks as a network grows.

When a route breaks due to node mobility or node failure, flat routing protocols like DSR and AODV typically discard the whole original route and initiate another round of route discovery to establish a new route from the source to the destination. When a route breaks, usually only a few hops are broken, but other hops are still intact. Thus, traditional approach wastes the knowledge of the original route and may cause significant overhead in global route discoveries. An optimization of Protocol is based on shortest and reliable path to destination and local repair of path during link break due to mobility of nodes. For this initialize data transfer with further specifications: = Delay with nodes;  $\Delta\epsilon_n$  = Energy consumption in general;  $P_n$  = Packets in network.

After that, initialize AODV routing algorithm. The area of DSR is given to area of AODV and the xlocs and ylocs of DSR is transferred to xlocs and ylocs of AODV. The speed parameters are configured further 10m/s or 50 m/s. AODV is combined with DSR routing protocol i.e. named as Hybrid Routing Protocol which can be created by modifying the path of DSR routing protocol on the basis of energy consumption parameter. Except source and destination nodes, all the energy parameters of nodes would be selected of the path. A node is finding out which has the less energy consumption as compare to path node within the coverage area of its previous and next node of path. Now, this node would be replaced by the path node and this process will be applied to rest of the nodes of path. With this, a path is generated with less energy consumption. With the new path, data transferred is performed and the QOS parameters evaluated. [14]

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## III. METHODOLOGY

The simulation experiments are performed using MATLAB. The traffic sources are CBR (continuous bit – rate). The source-destination pairs are spread randomly over the network. The data packet size is 512 bytes. The mobility model selected is random waypoint model in a rectangular field of 1000m x 1000m with 100 nodes. In this mobility model, each node starts its journey from a random chosen location and to a randomly chosen destination.

PARAMETERS	USED IN SIMULATION
Simulator software	MATLAB(2010)
Channel type	wireless channel
Antenna type	Omni Antenna
Radio-propagation model	two ray ground
Mac type	Mac/802.11
Protocols studied	DSR,AODV,HYBRID
Simulation area	1000×1000 m <sup>2</sup>
Transmission range	250 m
Node movement model	Random waypoint
Traffic type	CBR(UDP)
Packet size	512 Bytes
Number of nodes	30,40,50,60,70,80,90,100
Speed	10 m/sec and 50 m/sec

TABLE 1

In order to evaluate the performances of three MANET protocols, several metrics need to be considered. These metrics Reflect how efficiently the data is delivered to destination. Some of these metrics are suggested by the MANET working group for routing protocol evaluation.

### *i Packet Delivery Ratio*

The ratio between the number of packets originated by the application layer CBR sources and the number of packets Received by the CBR sink at the final destination.

### *ii .Average End-to-end Delay*

This includes all the possible delays caused by buffering during route discovery latency, queuing at the interface Queue, retransmission delays at the MAC, and propagation and transfer times.

### *iii. Routing overhead*

The total number of routing packets transmitted during the simulation. For packets sent over multiple hops, each Transmission of the packet or each hop counts as one transmission.

### *iv. Throughput*

Throughput – Throughput or network throughput is the average rate of successful message Delivery over a communication channel.

## IV. SIMULATION RESULTS AND ANALYSIS

Simulation study shows that performance of routing protocol in terms of throughput, packet delivery ratio, and routing overhead strongly depends upon network conditions such as mobility and node density .The set of experiments uses varying no. of nodes and varying speed.

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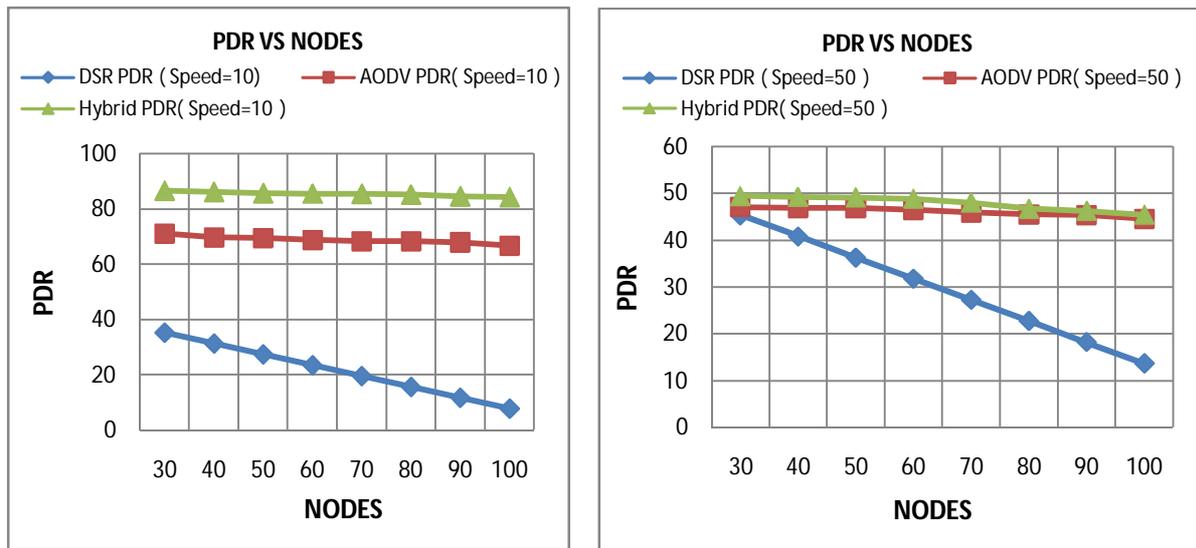
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## Performance analysis with varying node density and varying node speed

### 1) Packet delivery ratio vs. nodes

Figure 1(a, b) indicates the plot between packet delivery ratio and number of nodes. Packet Delivery Ratio is higher for hybrid protocol and remains constant up to 100 nodes. It is due to optimum path finding and local repair in case of link break. At high node density, more collision occurs due to traffic and more link break. Due to this packet delivery is less in DSR as compared to AODV and HYBRID protocol. In AODV, PDR is slightly less than HYBRID protocol for low and high mobility. At high mobility, nodes moves out of network and packet does not reach the desired destination node. Due to this, at high mobility packet delivery is slightly less in HYBRID as compared to low node mobility. In DSR, PDR greatly reduced at high mobility due to more link break.



(a)

(b)

Fig .1. Packet delivery ratio vs. nodes (a) Packet delivery ratio vs. nodes for 10m/s (b) Packet delivery ratio vs. nodes for 50m/s

### 2) Throughput vs. no. of nodes

Figure 2(a, b) indicates the graph between throughputs vs. no. of nodes. Throughput is higher for hybrid protocol and remains constant up to higher nodes density. It is due to optimum path finding and local repair in case of link break. As the no. of nodes increase, the throughput decreases for DSR and AODV protocol. This is due to the fact that packet delivered to the destination are lost during transmission and Routing takes more time to deliver packets to destination due to retransmission attempts. Throughput of hybrid protocol slightly decreases at higher node speed.

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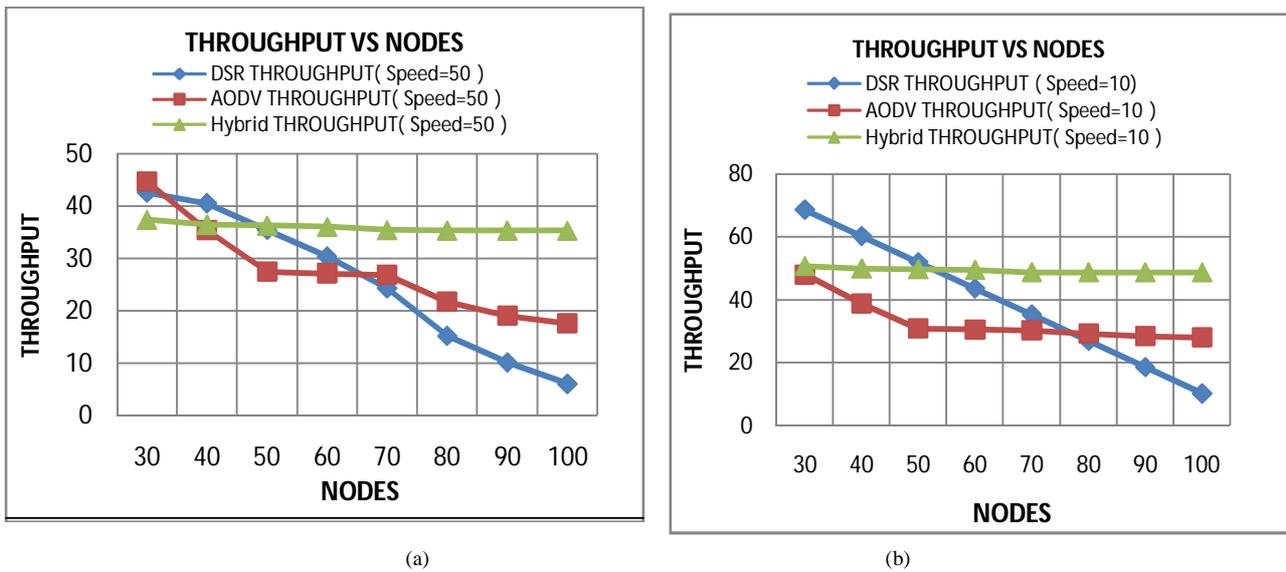


Fig.2. Throughput vs. no. of nodes (a)Throughput vs. nodes for 10m/s (b) Throughput vs. nodes for 50m/s

### 3) End to end delay vs. no. of nodes

Figure 3(a, b) indicates the graph between end to end delay vs. no. of nodes. As the no. of nodes increased, end to end delay for DSR protocol increases sharply at low speed. Routing takes more time to deliver packets to destination due to retransmission attempts. End to end delay for hybrid protocol is very less for low and high node density at low speed. End to end delay for AODV protocol is slightly more than hybrid protocol. It is also observed that at higher speed delay in Hybrid protocol is more as compared to low node speed for three protocols.

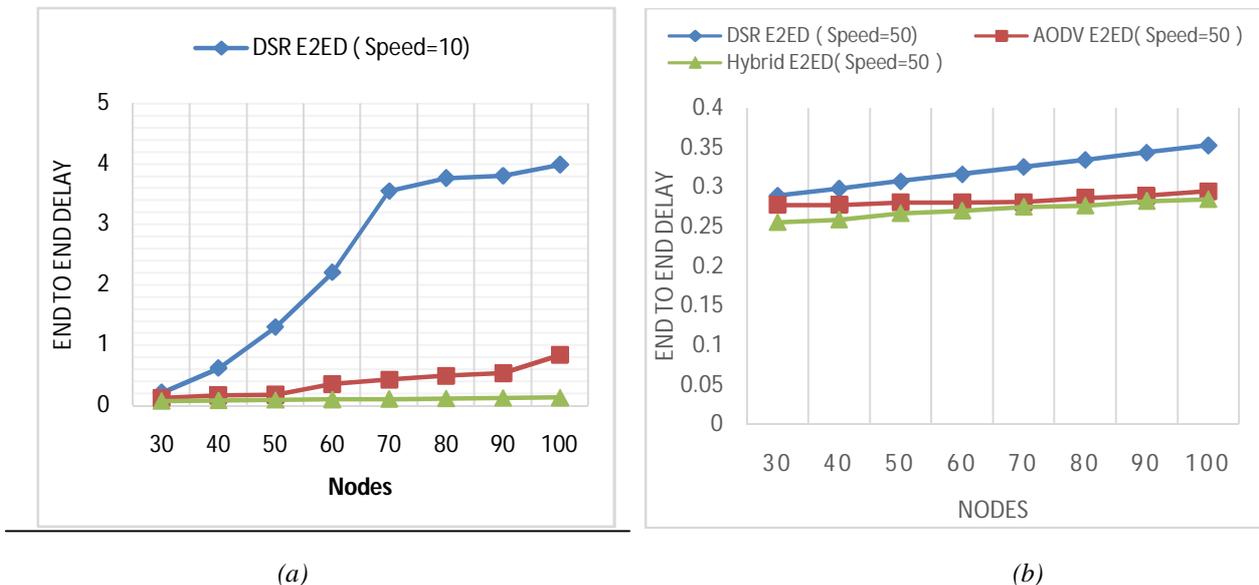


Fig.3. End to end delay vs. no. of nodes (a) End to end delay vs. no. of nodes for 10m/s (b) End to end delay vs. no. of nodes for 50m/s

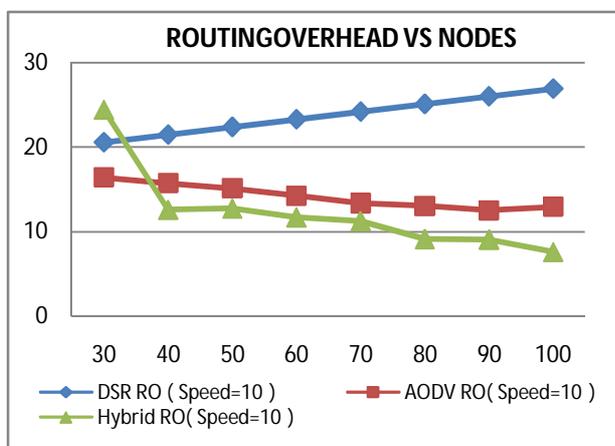
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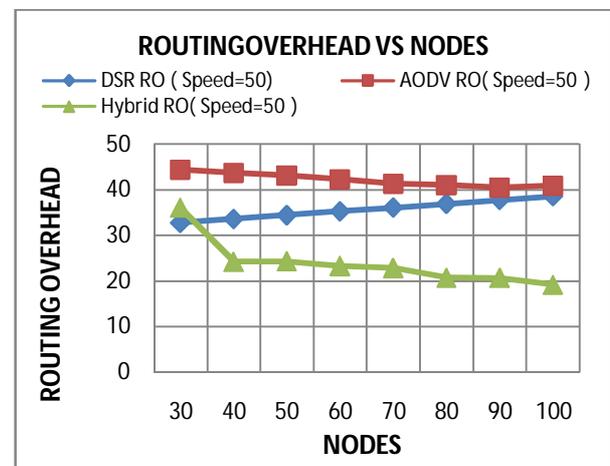
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### 4) Routing Over head vs. no. of nodes

Figure 4(a, b) indicates the graph between routing Over head vs. no. of nodes. In case of hybrid protocol, Routing over head is very less as compared to other two protocols. The most distinct advantage of Hybrid is that when a node on the route moves or fails, instead of discarding the whole route and discovering a new route only the particular broken segment replaced with a new one. This is done to save time in discovering a new route .Routing overhead is more at more speed but remain constant over the entire node density.



(a)

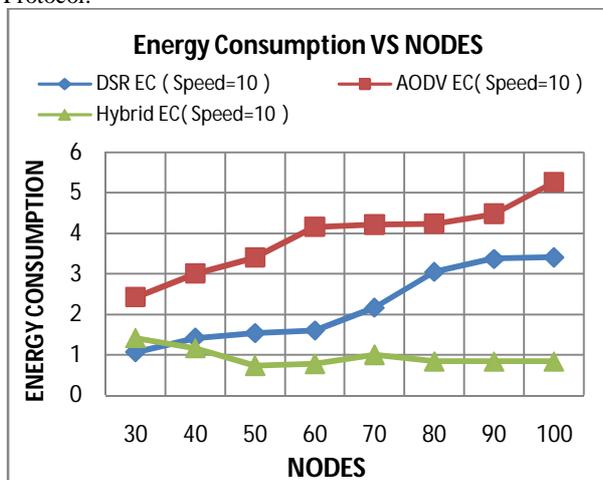


(b)

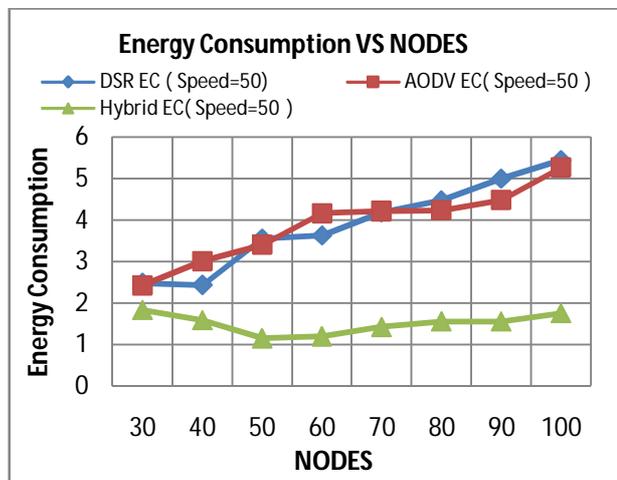
Fig.4. Routing Over head vs. no. of nodes (a) Routing overhead vs. no. of nodes for 10m/s (b) Routing overhead vs. no. of nodes for 50m/s

### 5) Energy consumption vs. no. of nodes

Figure 5(a, b) indicates that when the number of nodes increases, the energy consumption increases for AODV and DSR at low and high node speed to maintains the routing information of all nodes but energy consumption for hybrid protocol is very less for low and high speed. There is not much difference observed between energy consumption at low and high node speed for Hybrid Protocol.



(a)



(b)

Fig.5. Energy consumption vs. no. of nodes (a) Energy consumption vs. no. of nodes for 10m/s (b) Energy consumption vs. no. of nodes for 50m/s

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## V. CONCLUSION

In this work, performance of DSR, AODV and Hybrid routing protocol in mobile ad hoc networks has been studied and compared by using MATLAB. Hybrid protocol is implemented using DSR and AODV Routing Protocols. Performance carried out in terms of packet delivery ratio, Throughput, end to end delay, routing overhead and energy consumption. From the analysis, it is observed that packet delivery Ratio, throughput is higher in case of Hybrid protocol in comparison to AODV and DSR protocol at low and high node speed. Also it is observed that end to end delay, Routing overhead and energy consumption is very less in case of Hybrid protocol in comparison to AODV and DSR protocol at low and high node speed. Simulation results show that the performance of Hybrid protocol is better than AODV and DSR in the case of different networks topology and stressed environment conditions.

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