Simulation and Comparison of Energy Efficient Routing Protocols in MANET's using NS2

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Abstract— **Mobile ad hoc network (MANET) consists of a collection of wireless mobile nodes that are capable of communicating with each other without the use of infrastructure network. This paper describes the simulation result of wireless network in order to choose best routing protocol that consumes less energy while distributing packets to node in network topology. The simulation and comparison of routing protocols such as Ad-hoc On-demand Distance Vector (AODV), Dynamic Source Routing (DSR), Destination Sequenced Distance Vector (DSDV) and Ad hoc On-demand Multipath Distance Vector (AOMDV) routing protocol are performed. By using the performance metric such as total number of packet sent, Total number of packet received, packet delivery ratio, Throughput and total number of energy remained in nodes. From this we can predict the best routing protocol in MANETs using Network Simulator (NS) 2.**

Keywords— AODV, DSR, DSDV, AOMDV, MANET, NS2

I. INTRODUCTION

Mobile Ad Hoc Networks are a wireless network which does not require any infrastructure support for transferring data from one node to another node [1].In these infrastructure networks, each node works as source, receiver and intermediate router. From this we can say that node can acts as host or router at different time period depending upon simulation time. If node wants to send the data it can act as a source and if node wants to receive the data it acts as receiver, if node has to transfer the data packets to other node, then it will act as a router. Nodes are free to move over network topology. Topology of MANET network keeps on hanging dynamically which makes to work good in uniform networks because the requirements differ in the two cases. In wireless networks, routing protocols quickly respond to change in network topology which occurs frequently in these networks [2].

II. ROUTING IN MANET

Most quality of services routing algorithms represent an expansion of present classic best-effort algorithms. Many routing protocols have been generated which support developing and carrying on multi-hop routes between nodes in MANETs. These algorithms can be classified into two different cases: reactive routing protocol such as DSR, AODV, and TORA (Temporally-Ordered Routing Algorithm), and proactive routing protocol such as DSDV [6].

In the reactive routing protocols, routes are uncovered between a source and a destination only when the need arises to send data. This provides a decreased operating of communication and the quality of the scalable. In the proactive protocols, routing tables which include routing data between all nodes are generated and retained endlessly irrespective of the need of any given node to convey at that time. With this approach, the response time for route knowledge is relatively small, which may be essential for certain applications, but the operating cost of communications increased in the continued update of information for routes which might not be used for a more time if at all is too high. Additionally, this address needs more memory due to definitive increase in the area of the routing table. These necessities put limits on the size and compactness of the network. A third hybrid address, the Zone Routing Protocol (ZRP), has also been aimed and attempts to acquire the uses of both methods. In ZRP, the network is disunited into regions. A proactive table driven aim is used for assignment and maintenance of routes between nodes of the same region, and a reactive on-demand aim is used for communication between nodes of different region. This concept can be impressive in larger networks with applications that expose a relatively high degree of sector of communication, where communication between nodes with closeness to one another is much more often than that between nodes which are additionally apart [3].

Before convincing the current appeals for design and implementation of quality of service routing protocols, it is important to briefly debate the present excellent-effort routing protocols which live for MANETs. Many routing protocols have been created to determine and support routes between source and destination nodes [4].

A figure showing the different types of routing protocols is shown as:

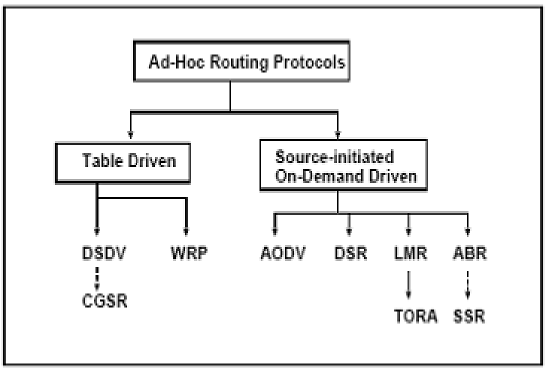

Fig 1: Types of Routing Protocols [3]

Among the most important and superior routing algorithms for MANETs that have evolved are three fundamental types. Each of these three fundamental types has its own merits, demerits, and fitness of use in some types of ad hoc networks depending on the action, number of nodes included, 'node density, underlying link layer technology, and general difference of the environment and applications are supported. These three routing algorithms are: (a) on demand such as DSR, AODV, and TORA routing protocol, and (b) table-driven such as DSDV protocol. There are also other cases of routing protocols considered for more quality of being scalable such as (c) the ZRP (Zone Routing Protocol), which is a hybrid representation for routing in ad hoc networks, in extra to others [5].

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

In order to transfer the data packet to destination AODV routing protocol uses on-demand technique, it makes use of destination sequence number. But in AODV routing protocol the intermediate and source node keeps the next-hop information. Initially while finding the route in on-demand routing protocol, source node broadcast *RouteRequest* packet in the wireless ad-hoc network. Source node may obtain many numbers of routes to different destinations by means of *RouteRequest* packet. AODV routing protocol uses destination sequence number (DestSeqNum) to determine latest path to destination which is main advantage of AODV when compare to other on-demand routing protocols. If the DestSeqNum of the present packet is higher than the last DestSeqNum which is stored at the node then only the node updates its information in the routing table. Destination identifier (DestID) and source identifier (SrcID) are carried by *RouteRequest* Packet. Along with it, it also carries time to live (TTL), broadcast identifier (BcastID) and destination sequence number (DestSeqNum) field which helps to identify the shortest path between source and destination node. DestSeqNum checks the latest route that is received by the source node. When a *RouteRequest* received by the intermediate nodes it either send it further or builds a *RouteReply* if it is correct route to the destination. The correct route is determined by intermediate node only by comparing sequence number of intermediate node and the sequence number of destination in the RouteRequest packet. If duplicate RouteRequest are received multiple times then they are discarded, this process is indicated by SrcID-BcastID pair. The intermediate node that are present between source and destination node have valid routes or the route reply packets from the destination itself allowed to send to the source. While forwarding the *RouteRequest* the intermediate node enters into the last node address and its BcastID. In case if a *RouteReply* is not received a timer is used in order to delete this entry. This plays an important role while finding active path at the intermediate node that are present between source and destination as AODV protocol does not all data packets of source routing. The node stories information about previous node only when it receives the *RouteReply* packet which helps to forward the packets further to next node as a next hope towards the destination.

B. Dynamic Source Routing (DSR)

The main advantage of DSR is that it uses of source routing. That is, the source will know the complete information about hop-by-hop route to the destination. This will be helps to routes information between source and destination which is stored in a route cache. The packet header that contains source route is carried by data packets. Whenever the node in the network wants to send data packets to destination, initially it will be not having any information about the route. Instead it uses route discovery process to determine the route. Route discovery is based on distributing of Route Reply Packets (RREQ) in the network. Each node in a network receives the RREQ packets and re-distributes it until it reaches to destination in its route cache. Destination node in turn sends Route Reply Packet (RREP) to source node. An RREP and RREQ packet helps to discover the route path and the route carried back by the RREP packet is cached at the source. If any link between source and destination fails then intermediate nodes will send Route Reply Error packets to destination node. The source deletes any route using this link from its route cache. The source will discover route for data packets with the help of route cache.

C. Destination Sequenced Distance Vector (DSDV)

The routing protocol DSDV depends upon Bellman-Ford algorithm. The packets that are transmitted between source and destination depend on routing table which will be present at each node. Routing table will decide the flow of packets and it contains all the possible destinations from a node to any other node in the network and also the number of hops to each destination. The main attributes of DSDV protocol are: avoiding routing loops, to avoid the "number of count to infinity" problem, and to lower the high routing overhead. Each node issues a sequence number that is attached to every new routing-table update message and uses two different types of routing-table updates, named "full" and "incremental dumps", respectively, to reduce the total number of control messages disseminated. Each node keeps statistical data concerning the average setting time of a message that the node receives from any neighbouring node. The data that is present at routing table used to lower the number of rebroadcasts of possible routing entries that may arrive at a node from different paths but with the same sequence number. DSDV works only with bidirectional links between nodes. When we consider any table driven protocols in which each intermediate node maintains a routing table that stores all the information about next hop that reach to all destinations. At every instant of time each routing tables of nodes will get updates of routing and even at change of topology are observed.

D. Ad hoc On-demand Multipath Distance Vector (AOMDV)

AOMDV protocol is an extended version of AODV this is due to generating multiple free loop and link disjoint paths. The routing information is stored at routing table in which it contains hop counts and list of next-hops. Same sequence number will be having to all the next hops. In order to transfer the data packets between source and destination, each node maintains the number of hop counts for all the routing paths which will be helpful for announcing route to destination from source. Alternate paths that have less number of hop counts than the advertised hop count for destination such paths are allowed to accept by the nodes. This is because the maximum hop count is used when compare to advertise hop count hence it does not vary for the same sequence number. Whenever a destination receives the route announcement by a greater sequence number, the advertised hop count and next-hop list is reinitialized. With the help of AOMDV protocol we can easily identify duplicate routes. In order to find node disjoint routes, each RREQ that are received from neighbour source nodes defines a disjoint path. This is due to the same RREQs packet is not communicated by intermediate nodes and different source of neighbour. The main advantages of using AOMDV protocol is that it allows nodes that are present between source and destination to reply to RREQs packets, while finding disjoint paths.

III. PERFORMANCE METRICS

When we analysed the performance of AODV and AOMDV routing protocol, we concentrated on three performance metrics which are Average Jitter, Average End-to-End Delay, and Throughput.

- ***Average Jitter***

It is defined as average of the variation in latency (response time) over time from point to point. It is measured in milliseconds [8].

- ***Average end-to-end delay***

It is defined as average time taken by a data packet to arrive in the destination. It also includes the delay caused by route discovery process and the queue in data packet transmission. Only the data packets that successfully delivered to destinations that counted.

∑ (arrive time – send time) / ∑ Number of connections

The lower value of end to end delay means the better performance of the protocol.

- ***Throughput***

Throughput is defined as the average number of packets successfully delivered per unit time i.e. average number of bits delivered per second.

Throughput=ΣTotal number of received packets at destination/time taken

IV. SIMULATION PARAMETERS

The performance analysis of energy efficiency of AODV, DSR, DSDV and AOMDV routing protocol in MANETs is performed in a simulated environment. NS 2.34 [7] simulator is used under Linux (ubuntu 11.10) or windows platform for simulation. The link breakage analyses are performed by following simulation parameters for both protocols.

Simulator	Ns-2.34
Protocol	AODV, DSR ,DSDV AOMDV
Simulation duration	0-5.6 seconds
Simulation area	1500m x 1000m
Number of nodes	5
Movement model	Random Waypoint
MAC Layer Protocol	IEEE 802.11
Link Type	Duplex-link
Queue size	50
Transmission range	250
Interference range	550
Packet Size	1500 bytes/packet
Application Type	FTP
Agent Type	TCP
Initial Energy	100 Joules
rxPower	1.0 W
txPower	5.0 W
SleepPower	0.0001 W
IdlePower	0.005 W

Tab1: simulation parameters used in this evaluation

V. SIMULATION RESULTS AND ANALYSIS

The simulation results are shown in the following section in the form of varying graphs. The performance of AODV, DSR, DSDV and AOMDV are based on number of packet received, sent and energy consumed by nodes is done on parameters like packet delivery ratio, total energy remained in node and throughput.

"Fig 2" shows the creation of network topology with 5 mobile nodes as it is shown in the Network Animator (NAM) console which is a built-in program in NS-2-allinone package after the end of the simulation process.

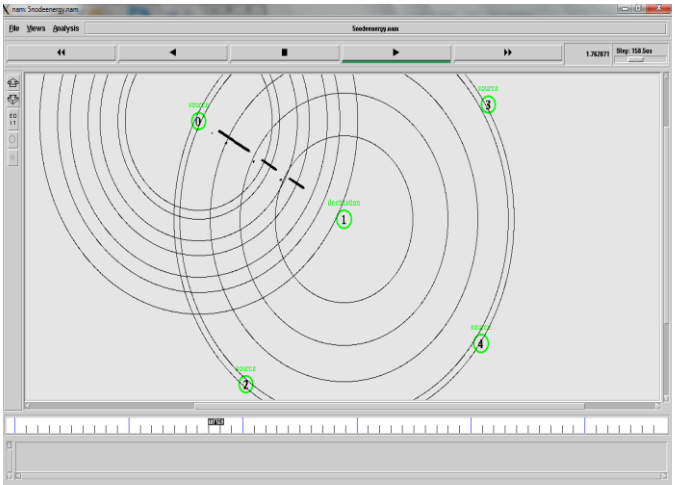

Fig 2. 5 nodes network topology

In fig 2, it consists of totally 5 nodes, in which 4 nodes (0, 2, 3, 4) act as source, where as node 1 act as destination node.

Each source node sends packet to destination node 1 for about 2 seconds.

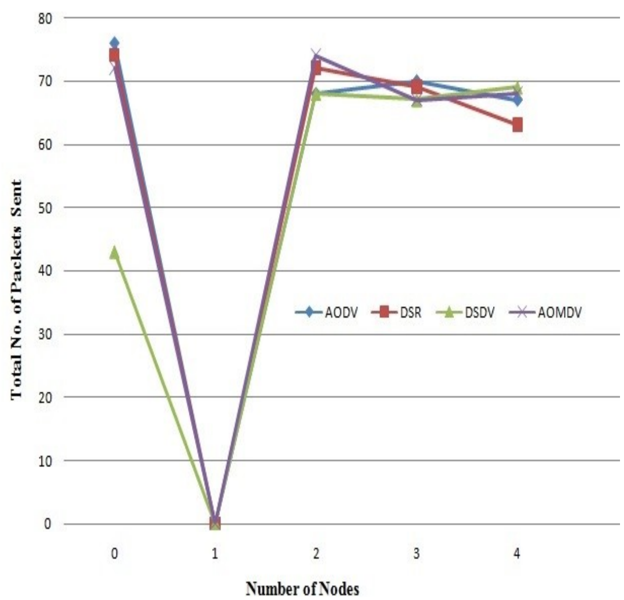

Fig 3. Total number of packet sent by each node.

In fig 3, It shows the total number of packets transmitted by each node (0, 2, 3 and 4), as node 1 acts as a destination the packet sent by it is zero.

Packet Sent / Routing Protocols	Node 0	Node 2	Node 3	Node 4
AODV	76	68	70	67
DSR	74	72	69	63
DSDV	43	68	67	69
AOMDV	72	74	67	68

Tab2. Describes routing protocols and packet sent by each node after simulation.

From table 2, we can predict that the total number of packets sent by all nodes during AODV and AOMDV protocol is high, that is 281 packets when compare to other routing protocols.

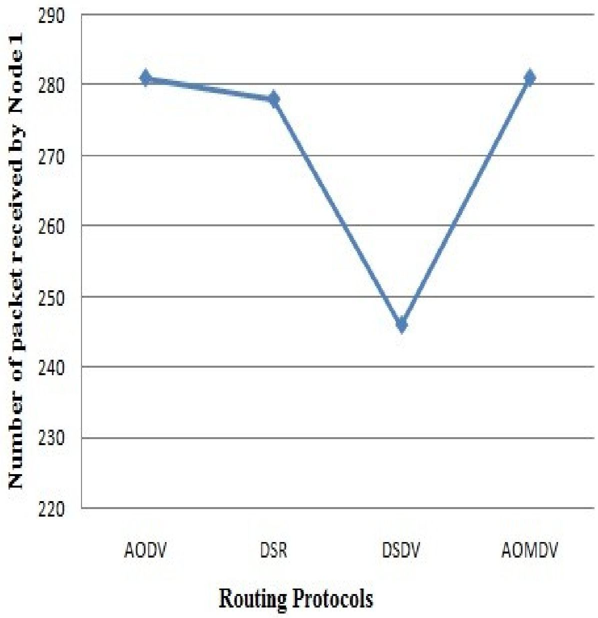

Fig 4. Total number of packet received by node 1 at each routing protocol.

In fig 4, it shows the total number of packets received by node 1 during each routing protocol simulation. The total numbers of packets received during DSDV protocol are less, which are about 246 packets when compare to other routing protocols.

Packet Received / Routing Protocols	Node 1
AODV	**281**
DSR	278
DSDV	246
AOMDV	**281**

Tab3. Describes routing protocols and packet received by node 1 after simulation.

From table 3, we can predict that the numbers of packets received by node 1 during AODV and AOMDV protocol are same.

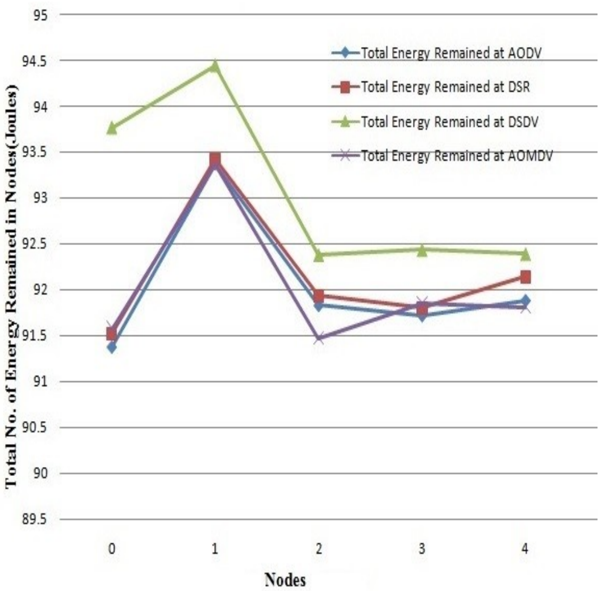

Fig 5. Total amount of energy remained in each node after simulation.

Total Energy Remained in Nodes / Routing Protocols	Node 0	Node 1	Node 2	Node 3	Node 4
AODV	91.3721	93.3673	91.8255	91.7142	91.8797
DSR	91.5215	93.4202	91.6348	91.7961	92.1354
DSDV	**93.7632**	**94.4290**	**92.3734**	**92.4290**	**92.3849**
AOMDV	91.5788	93.3607	91.4702	91.8582	91.8086

Tab4. Describes routing protocols and total energy remained in each node after simulation.

From fig5 and its respective table 4, we can see that the total energy remained in each node after the end of the simulation is more during DSDV protocol when compare to other protocols. From fig6 and its respective table 5, we can predict that the average throughput is more in AODV and AOMDV protocol when compare to other.

Fig 6 shows, the average throughput is less in DSDV protocol.

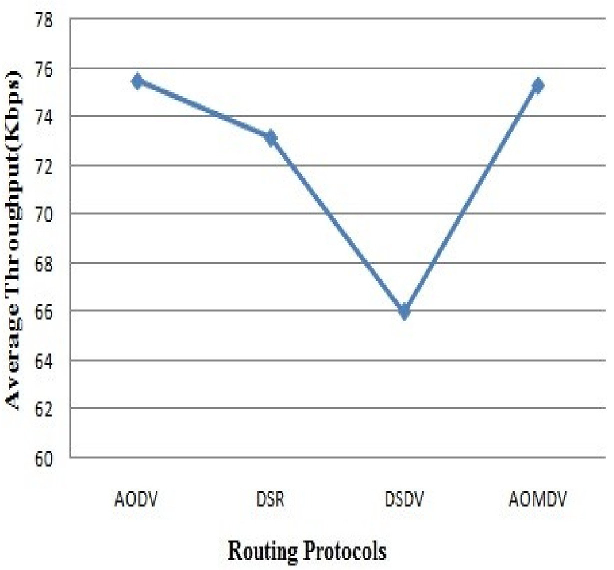

Fig 6. Average throughput at each routing protocol.

Routing Protocols	Throughput (Kbps)
AODV	**75**
DSR	73
DSDV	66
AOMDV	**75**

Tab5. Describes routing protocols and average throughput after simulation.

Each routing protocol will be provided around 5.6 Sec. to transmit the packet to destination node. Here there will be four sources which will be sending packets to one destination node.

The simulation result shows, the performance of AODV and AOMDV protocol are almost same in the case of total packet sent, total packet received and total energy remained in nodes after simulation process.

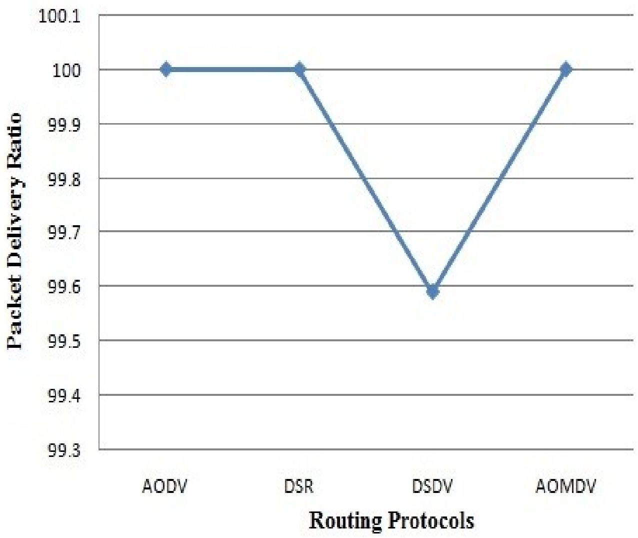

Fig 7. Packet delivery ratio at each routing protocol.

Routing Protocols	Packet Delivery Ratio(PDF)
AODV	**100 %**
DSR	100 %
DSDV	99.59 %
AOMDV	**100 %**

Tab6. Describes routing protocols and average packet delivery ratio after simulation.

From fig 7 and table 6, the packet delivery ratio is less in DSDV protocol. When compare to other routing protocols.
As a result AODV, DSR and AOMDV protocol has 100% packet delivery ratio.

CONCLUSION

From overall simulation results of MANET's network, we can predict as AODV, DSR and AOMDV protocol consumes more energy to transmit the packets when compare to DSDV protocol. The throughput and packet delivery ratio of AODV and AOMDV protocol are same when compare to DSR and DSDV protocol. Even though the DSDV protocol consumes less energy in transmitting the packets but its throughput and packet delivery ratio is less when compare to other protocol. As a result AODV and AOMDV protocol performances better in all grounds than DSR and DSDV protocol.

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