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A Comparative Study of Routing Protocols vs Energy Consumption in MANETs

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ABSTRACT—A Mobile Ad-hoc Network(MANET) is a dynamic self configuring network that can be formed without the presence of an trusted, pre configured infrastructure or platform. Various protocols have been developed for the purpose of communication between the nodes in MANET. Since the nodes are in constant motion it is challenging to achieve communication among the nodes reliably. Energy is spent while transmission and reception of information. The intermediate nodes act as router and forward the data and lose energy. Hence energy consumption is one of the main quality of service considered in this paper along with Packet Delivery Fraction(PDF), Throughput and end to end delay. Simulation is performed considering the four main routing protocols in MANET i.e AODV, AOMDV, DSDV and DSR. The simulation results show that the PDF of DSR is high while the energy consumption of DSDV is less. Hence a new protocol E-DSR(Energy – Dynamic Source Routing) is being implemented to achieve high packet delivery fraction along with low energy consumption.

KEYWORDS—AODV, AOMDV, DSDV, DSR, MANET, PDF, throughput, Energy, Delay

I. INTRODUCTION

A Mobile Ad-hoc Network or MANET is a collection of mobile nodes in constant motion sharing a wireless channel without any pre determined infrastructure or centralized controlled communication backbone. They lack fixed routers and all nodes are capable of movement in arbitrary direction and speed dynamically. All nodes in the network act as routers if they are part of the communication path and forward the data to neighbouring nodes. The topology of the network depends on the node position and the transmission power of each node, the position of the nodes are subject to change with respect to time and hence a change in topology.

One of the main challenges in ad-hoc networking is reliable delivery of packets to mobile nodes. The communication is a challenging task as the topology changes with respect to time and there could be packets dropped due to the same. Neither the network has a centralized control nor is the topology known. Various protocols have been developed in order to achieve a high packet delivery fraction. These protocols are classified into three categories as shown in Fig 1.

1. Table- driven / Proactive Routing Protocols
2. On-demand / Reactive Routing Protocols
3. Hybrid Protocols

Proactive routing protocol is a table driven in which every node in the network maintains a routing table in which all the possible destinations within the network as well as the number of hops to reach each destination are recorded. Each route entry is marked with a sequence number. Nodes periodically transmit routing table updates throughout the network

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in order to maintain table consistency. Route updates contains the address of some node, the number of hops to reach the destination, the destination sequence number as well as a sequence number that uniquely identifies the update.There are many Proactive routing protocols out of which we considered Destination-Sequenced Distance-Vector (DSDV) protocol for comparison.

Reactive routing techniques, also called *on-demand* routing, take a very different approach to routing than proactive protocols. A large percentage of the overhead from proactive protocols stems from the need for every node to maintain a route to every other node at all times. In a wired network, where connectivity patterns change relatively infrequently and resources are abundant, maintaining full connectivity graphs is a worthwhile expense. The benefit is that when a route is needed, it is immediately available. In an ad hoc network, however, link connectivity can change frequently and control overhead is costly. Because of these reasons, reactive routing approaches take a departure from traditional Internet routing approaches by not continuously maintaining a route between all pairs of network nodes. Instead, routes are only discovered when they are actually needed.

When a source node needs to send data packets to some destination, it checks its route table to determine whether it has a route. If no route exists, it performs a *route discovery* procedure to find a path to the destination. Hence, route discovery becomes on-demand. There are many reactive protocols out of which we considered aodv, dsr and aomdv.

Hybrid protocol combines the advantages of proactive and reactive routing. The routing is initially established with some proactively prospected routes and then serves the demand from additionally activated nodes through reactive flooding. The choice of one or the other method requires predetermination for typical cases. Advantage depends on number of other nodes activated. Reaction to traffic demand depends on gradient of traffic volume. Since hybrid protocols are combination of both proactive and reactive, only the basic two classifications are considered for the purpose of comparative analysis.

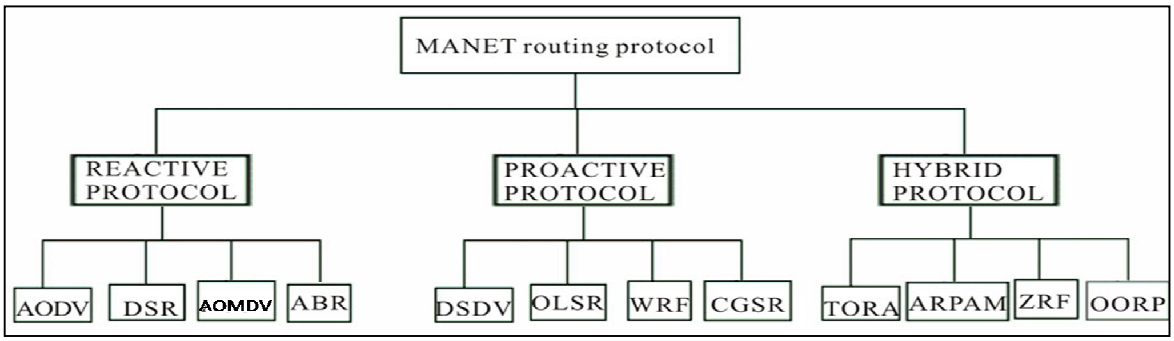

Fig 1 : Various Routing Protocols in MANET

II. ROUTING PROTOCOLS

A. Adhoc On Demand Distance Vector (AODV) Protocol

AODV is the on-demand (reactive) topology-based routing protocol in which backward learning procedure is utilized in order to record the previous hop in the routing table. In the backward learning procedure, upon receipt of a broadcast query (RREQ) which contains source and destination address, sequence numbers of source and destination address, request ID and message lifespan, the address of the node sending the query will be recorded in the routing table. Recording the specifications of previous sender node into the table enables the destination to send the reply packet (RREP) to the source through the path obtained from backward learning. Fig 2 illustrates the working of an

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AODV protocol with use of RREQ and RREP mechanism. In case of any link failure RERR is used to intimate the sender of the failure.

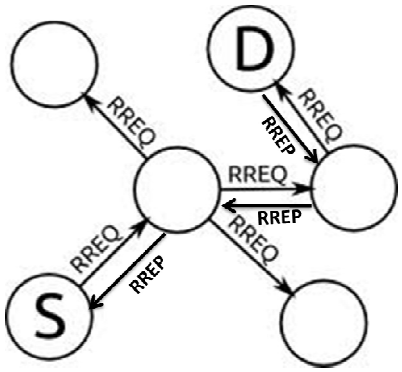

Fig 2 : Working of AODV Protocol

Multiple RREP messages may be delivered to the source via different routes but updating the routing entries will occur under one condition which is if the RREP has the greater sequence number. A message with higher sequence number represents the more accurate and fresh information.

In this protocol energy is consumed while sending and transmitting the Route Request and Route Reply packets as well. Hence energy is depleted more as every node spends energy in forwarding and receiving the control packets. Energy is spent for transmission of control packets along with data packets every time.

B. Adhoc On Demand Multipath Distance Vector(AOMDV) Protocol

AOMDV is designed to calculate multiple paths during the route discovery in highly dynamic ad hoc networks where the link breakage occurs frequently due to high velocity of vehicles. In AODV routing protocol, a route discovery procedure is needed after each link failure. Performing such procedure results in high overhead and latency. Thus, this defect is overcome by having multiple paths available. In AOMDV, performing the route discovery procedure will be done after all paths to either source or destination fail. In AOMDV routing protocol, it is endeavored to utilize the routing information already available in the underlying AODV protocol. However, little additional modification is required in order to calculate the multiple paths. Multiple RREP packets are received by the source node and based on the sequence numbers, data is transmitted to destination through various paths without overloading any individual path. The working of AOMDV protocol is as shown in Fig 3.

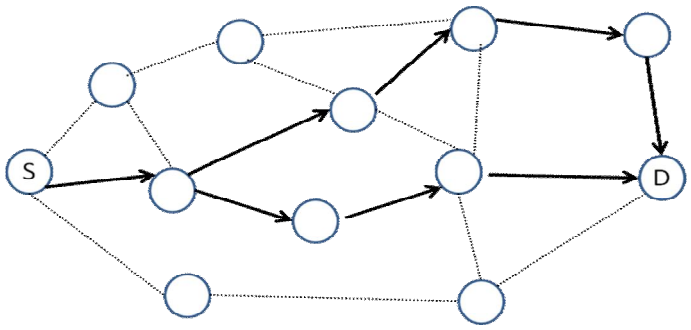

Fig 3. Working of AOMDV Protocol

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Since data is transmitted through multiple paths, the packet delivery fraction is high when compared to AODV. Any individual path is not overloaded with data. Hence there is less packet drops comparatively with respect to AODV protocol

The energy consumption with respect to this protocol remains moderate with respect to individual nodes as multiple paths are considered . The average energy of the complete network implementing AOMDV protocol is high as multiple nodes are involved in multiple paths.

C. Destination Sequenced Distance Vector (DSDV) protocol

This is proactive / table driven protocol. In DSDV, each mobile node of an ad hoc network maintains a routing table, which lists all available destinations and next hop to each destination and a sequence number generated by the destination node. Using such routing table stored in each mobile node, the packets are transmitted between the nodes of an ad hoc network.

Each node of the ad hoc network updates the routing table with advertisement periodically or when significant new information is available to maintain the consistency of the routing table with the dynamically changing topology of the ad hoc network. Periodically or immediately when network topology changes are detected, each mobile node advertises routing information using broadcasting or multicasting a routing table update packet. The elements in the routing table of each mobile node change dynamically to keep consistency with dynamically changing topology of an ad hoc network. To reach this consistency, the routing information advertisement must be frequent or quick enough to ensure that each mobile node can almost always locate all the other mobile nodes in the dynamic ad hoc network.

Fig 4 represents the implementation of DSDV protocol. Bi-directional links represent the flow of information between the nodes. Table 1 depicts the routing information stored in node 4 of Fig 4. The Destination column represents the destination nodes in the network. Next hop field represents the neighbour node which can forward data to destination node. Metric represents the number of hops the destination is away from node. Sequence number represents the destination sequence number.

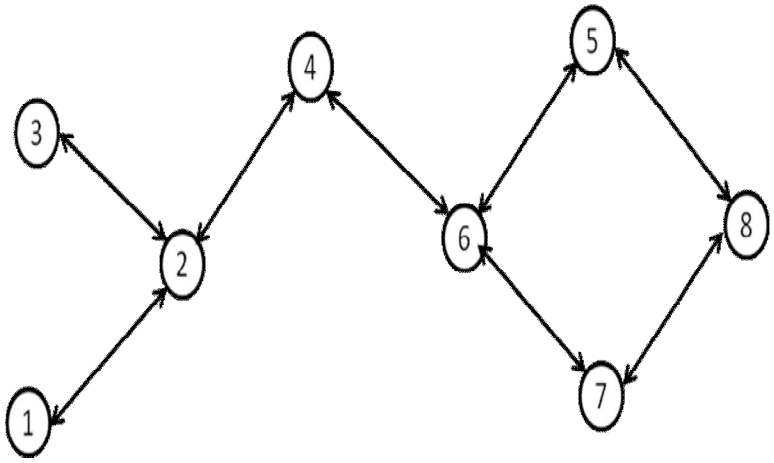

Fig 4 : Adhoc network implementing DSDV protocol

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TABLE 1 : ROUTING TABLE OF NODE 4

Destination	Next Hop	Metric	Sequence Number
1	2	2	S406_1
2	2	1	S128_2
3	2	2	S564_3
4	4	0	S710_4
5	6	2	S392_5
6	6	1	S076_6
7	6	2	S128_7
8	6	3	S050_8

D. Dynamic Source Routing (DSR) protocol

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DSR is a reactive routing protocol i.e. determines the proper route only when packet needs to be forwarded. For restricting the bandwidth, the process to find a path is only executed when a path is required by a node (On-Demand Routing). In DSR the sender (source, initiator) determines the whole path from the source to the destination node (Source-Routing) and deposits the addresses of the intermediate nodes of the route in the packets.

The protocol is composed of the two main mechanisms of "route discovery" and "route maintenance", which work together to allow nodes to discover and maintain routes to arbitrary destinations in the ad hoc network. Route discovery is used whenever a source node desires a route to a destination node. First, the source node looks up its route cache to determine if it already contains a route to the destination. If the source finds a valid route to the destination, it uses this route to send its data packets. If the node does not have a valid route to the destination, it initiates the route discovery process by broadcasting a route request message. The route request message contains the address of the source and the destination, and a unique identification number. Route maintenance is used to handle route breaks. When a node encounters a fatal transmission problem at its data link layer, it removes the route from its route cache and generates a route error message. The route error message is sent to each node that has sent a packet routed over the broken link. When a node receives a route error message, it removes the hop in error from its route cache. Fig 5 depicts the creation of route and transmission of data using DSR protocol.

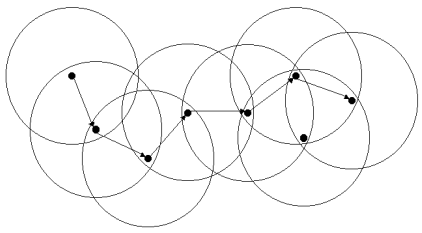

Fig 5 : Dynamic Source Routing Protocol in MANET

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III. SIMULATION METHODOLGY

A Discrete Event Simulator is used to create events in timely manner. NS2(Network Simulator) is used to create Ad-hoc network environment for the execution and working of the various routing protocols. The simulation is repeated with varying the routing protocols i.e AODV, AOMDV, DSDV and DSR. The performance of the protocols is observed with respect to the PDF(Packet Delivery Fraction), Throughput, End to End Delay and Energy. Fig 6 depicts the network setup with "0" being Source and "1" being Destination, the intermediate nodes are provided with mobility to implement a Mobile Ad Hoc Network.

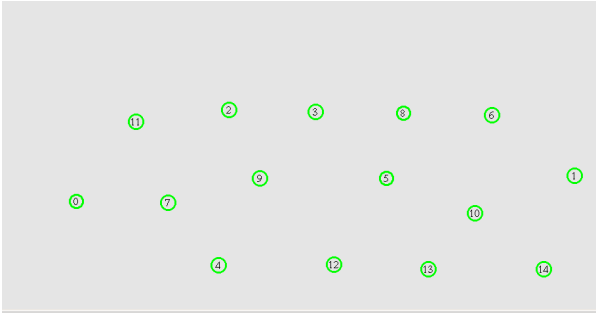

Fig 6 : Network Topology

TABLE 2 : SIMULATION SETUP

Simulator	NS 2.34
Deployment Area	500 X 400
No. of Nodes	16
Simulation Time	150 Sec
Traffic Type	FTP
Routing Protocols	AODV, AOMDV, DSDV, DSR
Packet Size	512
Initial Energy per node	1000
Transmission Energy	0.9%
Reception Energy	0.8%
Sensing Energy	0.2%
Queuing Model	DropTail
Parameters	Throughput, Packet Delivery Fraction, Delay and Energy

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The simulation results obtained are as shown in Table 3.

TABLE 3 : SIMULATION RESULTS

Protocol / Parameter	AODV	AOMDV	DSDV	DSR
Packet Delivery Ratio	90.46 %	97.97 %	93.906 %	99.50 %
Throughput (kbps)	122.61	118.08	130.61	99.92
End to End Delay (ms)	88.61	311.45	97.84.61	58.51
Energy Consumption	92.50 %	94.41 %	63.50 %	83.26 %

Packet Delivery Fraction refers to the ratio of number of packets successfully received by the destination to the number of packets transmitted by the source. It is observed that the Packet Delivery Fraction of Dynamic Source Routing is more when compared with the rest of the protocols.

The throughput is more in case of DSDV as the protocol is Table Driven and has route configured before the transmission of the data, whereas in other protocols the route is configured only when there is data to send and hence less packets are transmitted as initial time is spent in route setup.

End to End Delay is the parameter considered to take into the time taken by the network to deliver the data to the destination. In the analysis made it is observed that DSR protocol takes the least amount of time to deliver data to the destination.

Energy is the main parameter considered in this paper as it is crucial for communication and could be the main cause for failure of nodes in MANET. The results show that DSDV protocol consumes the least amount of energy as the energy is not spent in transmission of control packets to establish the route as the route is established prior to any demand from the sender.

IV. CONCLUSION

This paper evaluated the performance of the well known routing protocols in Mobile Ad hoc Networks with respect to parameters such as Packet Delivery Fraction, Throughput, End to End Delay and the energy consumption with respect to the protocol. It has been noted that the use of the protocol depends on the parameter the user is interested in. If the user wants reliably delivery of data with energy and other parameters not being a constraint then DSR protocol is best chosen to do the same. In case the user wants high data rate irrespective of number of packets delivered successfully or dropped then DSDV protocol is a better option. The choice of the protocol varies with the interested parameter. To make DSR protocol more energy efficient , a new protocol E-DSR (Energy efficient DSR) protocol can be implemented which delivers high packet delivery fraction along with low energy consumption. E-DSR protocol is the future of MANETs as it has high packet delivery success rate and consumes less energy, giving nodes more life time and making the nodes available for transmission over a longer period and reducing the packet drop due to node failures.

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BIOGRAPHY

Sherikar Krishna Reddy is a M.Tech Scholar in the Computer Network Engineering , The Oxford College of Engineering, Bangalore. He received Bachelor of Engineering degree from SDMIT, Ujjre, in the stream of Computer Science Engineering. His research interests are in Mobile Ad hoc Networks and Design of energy efficient solutions for security concerns regarding communication in MANETs.

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Sunil Rathod is a M.Tech Scholar in the Computer Network Engineering, The Oxford College of Engineering, Bangalore. He received Bachelor of Engineering degree from BLDEA'S College of Engineering and Technology, Bijapur, in the stream of Electronics and Communication. His research interests are Mobile Ad hoc Networks and Design of energy efficient solutions for routing failure in IP networks.

Mrs Vinodha K received her Bachelor of Engineering in Electronics and Communication in 1998. She received her ME in Computer Science and Engineering from Anna University in 2008.She is pursuing PhD in Computer Science and Engineering at VTU, Belgaum. Currently she also holds a faculty position as Assistant Professor, Department of ISE, The Oxford College of Engineering. Her main research interests are Computer Networks and Distributed Networks.