Survey on Proactive and Reactive Protocols in MANETs

Arpitha C N, Dr. Arun Biradar

Abstract —A Mobile Ad-hoc Network (MANET) is infrastructure less network formed by mobile nodes sharing wireless channel without any centralized administration. As nodes are mobile they can move arbitrarily, the network topology, which is typically multi-hop, can change frequently and unpredictably resulting in route changes, frequent links break and possibly packet losses. One of the main challenges of MANET is the design of robust routing algorithms that adopt to the frequent and randomly changing network topology. There are several routing protocols which have already been proposed for providing communication among all the nodes in the network and are classified into proactive and reactive protocols. In this paper , we compare and evaluate the performance of widely used both table-driven such as DSDV and on-demand unipath and multipath routing protocols such as AODV and AOMDV by passing various parameter metrics like Throughput, End-to-End delay, Packet delivery ratio, Packet drop and Average energy consumption by using simulation.

Index Terms— AODV, AOMDV, DSDV, Throughput, End-to-End Delay, Packet delivery ratio, Packet drop, Routing overhead and Normalized routing load.

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1. INTRODUCTION

A mobile ad-hoc network or MANET is a collection of mobile nodes sharing a wireless channel without any centralized control or established communication backbone. They have no fixed routers with all nodes capable of movement and arbitrarily dynamic. These nodes can act as both end systems and routers at the same time. When acting as routers, they discover and maintain routes to other nodes in the network. The topology of the ad hoc network depends on the transmission power of the nodes and the location of the mobile nodes, which may change from time to time [1].

The routing protocols for Ad hoc wireless network are classified as follows:

- **Table driven or proactive routing protocol**: Routing table holds and maintains the topological information of the nodes. Routing Information is obtained by exchanging routing tables within the network. Whenever a node requires a path to destination it runs an appropriate path finding algorithm on the topology information it maintains.

  Example: Destination–Sequenced Distance vector (DSDV), Wireless Routing Protocol (WRP), Source – Tree Adaptive Routing Protocol (STAR) , Cluster-Head Gateway Switch Routing Protocol (CGSR).

- **On demand or reactive routing protocols**: The protocols do not maintain the network topology information. These protocols execute the path-finding process and exchange routing information only when a path is required by a node to communicate with destination. Hence periodical exchange of routing information among the nodes is not seen.

  Example: Dynamic Source Routing Protocol (DSR), Ad hoc On-Demand Distance Vector Routing Protocol

(AODV), Temporally Ordered Routing algorithm (TORA).

- **Hybrid Routing Protocols**: The protocols form the routing with a specified zone using proactive routing scheme and reactive routing scheme is used for nodes which are beyond the zone.

  Example: Zone Routing Protocol (ZRP) , Zone-Based Hierarchical Link State Routing protocol (ZHLS).

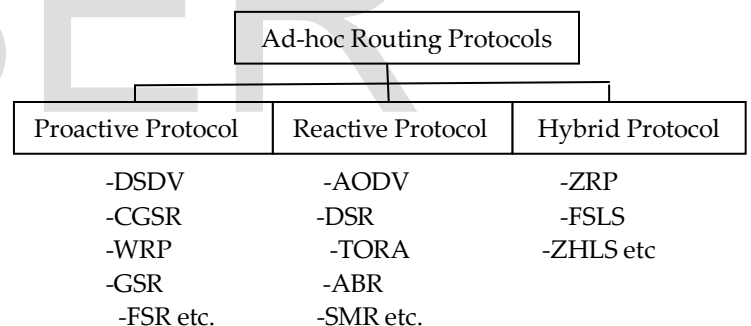| Ad-hoc Routing Protocols		
Proactive Protocol	Reactive Protocol	Hybrid Protocol
-DSDV	-AODV	-ZRP
-CGSR	-DSR	-FSLS
-WRP	-TORA	-ZHLS etc
-GSR	-ABR	
-FSR etc.	-SMR etc.	

Fig 1: Classification of Routing Protocols

2. Related work

Numerous routing protocols are already implemented and also perform the comparison between those protocols. In [2] they compare the performance of AODV, AOMDV, DSR,DSDV under MANET concerning Power aware routing and the results show that AOMDV consumes minimum energy compared to AODV, DSR and DSDV protocols. AOMDV is analyzed as the best protocol compared to AODV, DSR and DSDV when energy efficiency is taken into consideration.

DSDV is a modification of the conventional Bellman-Ford routing algorithm [3]. It addresses the drawbacks related to the poor looping properties of RIP in the face of broken links. The main drawbacks of both link-state and distance-vector

protocol are that they take too long to converge and have a high message complexity. Because of the limited bandwidth of wireless links in an ad hoc network, message complexity must be kept low. In addition, the rapidly changing topology requires that the routing protocols can find routes quickly. So new routing protocols have to be developed to fulfill this basic philosophy.

The destination sequenced distance vector (DSDV) protocol [4] is an adaptation of the classical Bellman-Ford [5] routing protocols. It is specifically targeted for the adhoc networks. It addresses the long-lived loops and counting to infinity problems of the conventional distance-vector routing protocols. In DSDV, the time complexity is O(d = network diameter) [6], and the communication complexity (link addition/failure) is O(N = number of nodes in the network) .In DSDV it is difficult to determine the maximum setting time and it does not support multi-path routing. The destination central synchronization suffers from latency problem. It has excessive communication overhead due to periodic and triggered updates.

The widespread use of mobile and handheld devices is likely to popularize ad hoc networks, which do not re-quire any wired infrastructure for intercommunication, in which each node can move in any direction & acts as a router. To assist communication in such network, a routing protocol is vital whose primary aspiration is to set up proficient route among pair of nodes, due to this lot of reactive, proactive & hybrid routing protocols have been proposed. Out of which one of most popular one is Adhoc on-demand distance vector routing (AODV) due to its high performance gain compared to other protocols in MANET, therefore its performance needs to be evaluated by making use of various metrics such as end to end delay, packet delivery ratio (PDR) & Packet loss[7]. They conclude that there is non-linear change in the values of these metrics also realized working & control massages involved in AODV protocol

AOMDV was designed primarily for highly dynamic ad hoc networks where link failures and route breaks occur frequently. It maintains routes for destinations in active communication and uses sequence numbers to determine the freshness of routing information to prevent routing loops. It is a timer-based protocol and provides a way for mobile nodes to respond to link breaks and topology changes [8] they compare the performance of AODV,DSR and proved AOMDV gives better performance as compared to AODV and DSR in terms of packet delivery fraction and throughput but worst in terms of end-to end delay.

Ad-hoc On-demand Multipath Distance Vector Routing (AOMDV) [9] protocol is an extension to the AODV protocol for computing multiple loop-free and link disjoint paths. The routing entries for each destination contain a list of the next-hops along with the corresponding hop counts. All the next

hops have the same sequence number. This helps in keeping track of a route.

In [10] under MANET the routing protocols like DSR, AODV, FSR, ZRP are compared by passing parameter metrics like Jitter, Throughput, Average end-to-end delay, Packet delivery ratio, Pause time and showed that DSR shows best performance than AODV, FSR and ZRP in terms of packet delivery ratio and throughput as a function of pause time. FSR show lowest end-to-end delay and ZRP has less average jittering than DSR, AODV and FSR. DSR and AODV performed the worst in case of average jitter and ZRP performed the worst in case of throughput.

D.D.Chaudhary, Pranav Pawar[11] perform comparison of following routing protocols AODV, AOMDV, DSDV by passing parameter metrics like End-to-End Delay, Energy Consumption in Wireless Sensor Networks and finally DSDV, AODV and AOMDV are compared with 802.11 and 802.15.4 IEEE standards. From the all the graphical results, which are explored using NS2 simulator, it is observed that, for delay-sensitive applications, it obligatory to adopt the 802.15.4 IEEE standard with DSDV routing protocol. The energy consumption is also low in this combination.

3. Existing system

Three protocols discussed here are DSDV, AODV and AOMDV

Working of DSDV

Destination-Sequenced Distance-Vector Routing (DSDV) is a proactive and table driven routing protocol [14], based on classical Bellman-ford routing mechanism basic improvement made includes freedom from loops in routing tables , more dynamic and takes less convergence time. It maintains the topological information in the form of tables at every node. Routing table contains list of all known destination nodes within the network along with number of hops required to reach particular node, next node and sequence number assigned by destination node. At regular intervals these tables are exchanged between the neighbors, this helps to maintain up to date view of the network topology. Table is maintained at the every node, contains the shortest distance and the first node on the shortest path to every other node in the network. The table is updated with increasing sequence number tags which prevent loops, to counter count-to-infinity problem and for faster convergence. Destination initiates table updates with a new sequence number which is greater than the previous one. As and when the table updates are received, updating of tables at the nodes is based on the received information or holds it for some time to select the best metric received from multiple versions of the same update table from different neighboring nodes. Depending on the sequence number of the table update, it may forward or reject the table. The time involved in route setup process is less due to the availability of

routes to all destinations at all times. Table update is of two types- incremental update and full dump. Incremental update takes a single network data packet unit (NDPU) , these type of updates are used when a node does not observe significant changes in local topology. Full dumps may take multiple NDPUs, a full dump is done either when the local topology changes significantly or when an incremental update requires more than a single NDPU.
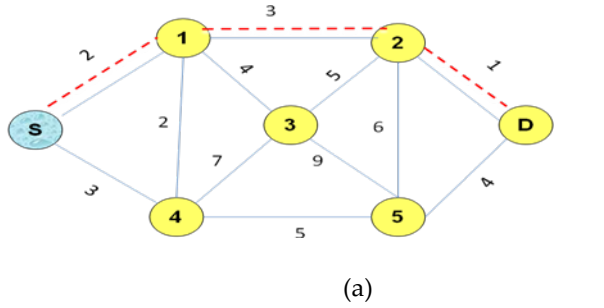

(a)

Dest	NextHop	Dist	Seqno	Cost
1	1	1	12	2
2	1	2	16	5
3	1	2	18	6
4	4	1	20	3
5	4	2	22	8
D	1	3	24	6

(b)

Using DSDV we are finding shortest path from source S to the destination D, the topology of the network is shown in fig 2(a). Each node maintains the routing table, fig 2(b) shows the routing table maintained by source node S. To reach from S to D the DSDV protocol finds that the hop count is 3 and cost is 6. Fig 2(c) shows the routing table updated when the link break between nodes 1 and 2 occurs. When a node finds that a route is broken it increments the sequence number of the route and advertises it with infinite metric. Destination advertises new sequence number.   In this scenario the new sequence number for node 2 is 26 as shown in routing table.
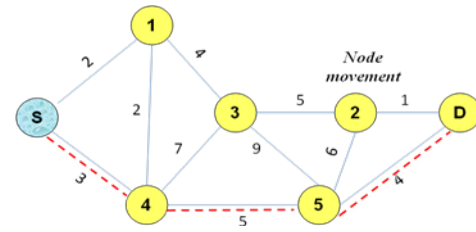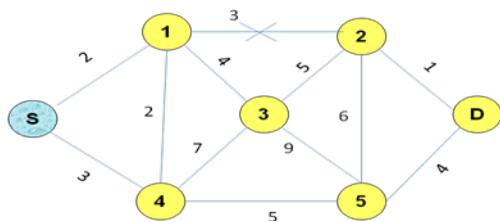
Dest	NextHop	Dist	Seqno	Cost
1	1	1	12	2
2	1	3	26	11
3	1	2	18	6
4	4	1	20	3
5	4	2	22	8
D	4	3	24	12

(c)

Fig 2: (a): Topology graph of the network (b): Routing table for node S (c): Route maintenance in DSDV.

Working of AODV

Ad hoc On-Demand Distance Vector (AODV) routing protocol used to find routes by on demand scheme[12]. Route is found only when the source is in need to transmit data packets.It is a unipath routing protocol. Routes Requests (RREQs), Route Replies (RREPs),Route Errors (RERRs) and Route Reply Acknowledgment (RREP-ACK) are the message types defined by AODV. If the route is not available for the desired destination then the source node floods the Route Request packet in the network and then it obtains many different routes to different destinations from a single Route Request. An AODV Route Request packet holds the source identifier, the destination identifier, the source sequence number, the destination sequence number, the broadcast identifier, and time to live field. In order to determine an up-to-date path and freshness of the route to the destination, AODV uses a destination sequence number. As the Route Request packet is received by the intermediate node, it forwards the packet or Route Reply is prepared if it has a valid route to destination, for which validity of route is indicated by the destination sequence number. Route Reply packets are sent to the source by all of the intermediate nodes which are having the valid routes to destination or the destination node itself are allowed to send Route Reply packets to source. As the node receives the Route Reply packet, it forwards the data packet with the help of the previous node Information from which the Route Reply packet was received. If a path break is detected at an intermediate node, the node informs the end nodes by sending an Route Error message with the hop count set as infinity. The end nodes delete the corresponding entries from their tables. The source node reinitiates the path-finding process with the new broad-

cast identifier and the previous destination sequence number. Each time RREQ broadcasted to its neighbor a reverse path is created because of this reverse path a unique ID is assigned when a RREQ message is generated, each node will check this ID and the address of the initiator and discards the message if it had already processed that request. During route maintenance adjacent nodes exchange periodic HELLO messages.

(a)

(b)

(c)

(d)

Fig 3: (a) Propagation of RREQ, (b) Route request in reverse direction, (c) RREP path to the source (d) Route Maintenance

in AODV

Fig 3(a) shows that when the route is required source node forwarded the RREQ packets to its neighbor nodes 1 and 2. The nodes 1 and 2 in turn send RREQ to its neighbor, fig 3(b) shows that RREQ packets also forwarded to source node 1 in reverse direction. Fig 3(c) shows that propagation of RREP towards source node through node 2 and 1. Finally the link between nodes 1 and 2 gets broken then nodes 1 and 2 invalidates route to D in route table and sends Route Error message to its neighbors.

Working of AOMDV

Ad-hoc On-demand Multi path Distance Vector Routing protocol is an extension to the AODV protocol for computing multiple loop-free and link disjoint paths [13]. The routing entries for each destination contain a list of the next-hops along with the corresponding hop counts. All the next hops have the same sequence number. This helps in keeping track of a route. For each destination, a node maintains the advertised hop count, which is defined as the maximum hop count for all the paths, which is used for sending route advertisements of the destination. Each duplicate route advertisement received by a node defines an alternate path to the destination. Loop freedom is assured for a node by accepting alternate paths to destination if it has a less hop count than the advertised hop count for that destination. Because the maximum hop count is used, the advertised hop count therefore does not change for the same sequence number. When a route advertisement is received for a destination with a greater sequence number, the next-hop list and the advertised hop count are reinitialized. AOMDV can be used to find node-disjoint or link-disjoint routes. To find node-disjoint routes, each node does not immediately reject duplicate RREQs. Each RREQs arriving via a different neighbor of the source defines a node-disjoint path. This is because nodes cannot be broadcast duplicate RREQs, so any two RREQs arriving at an intermediate node via a different neighbor of the source could not have traversed the same node. In an attempt to get multiple link-disjoint routes, the destination replies to duplicate RREQs, the destination only replies to RREQs arriving via unique neighbors. After the first hop, the RREPs follow the reverse paths, which are node disjoint and thus link-disjoint. The trajectories of each RREP may intersect at an intermediate node, but each takes a different reverse path to the source to ensure link disjoint ness.
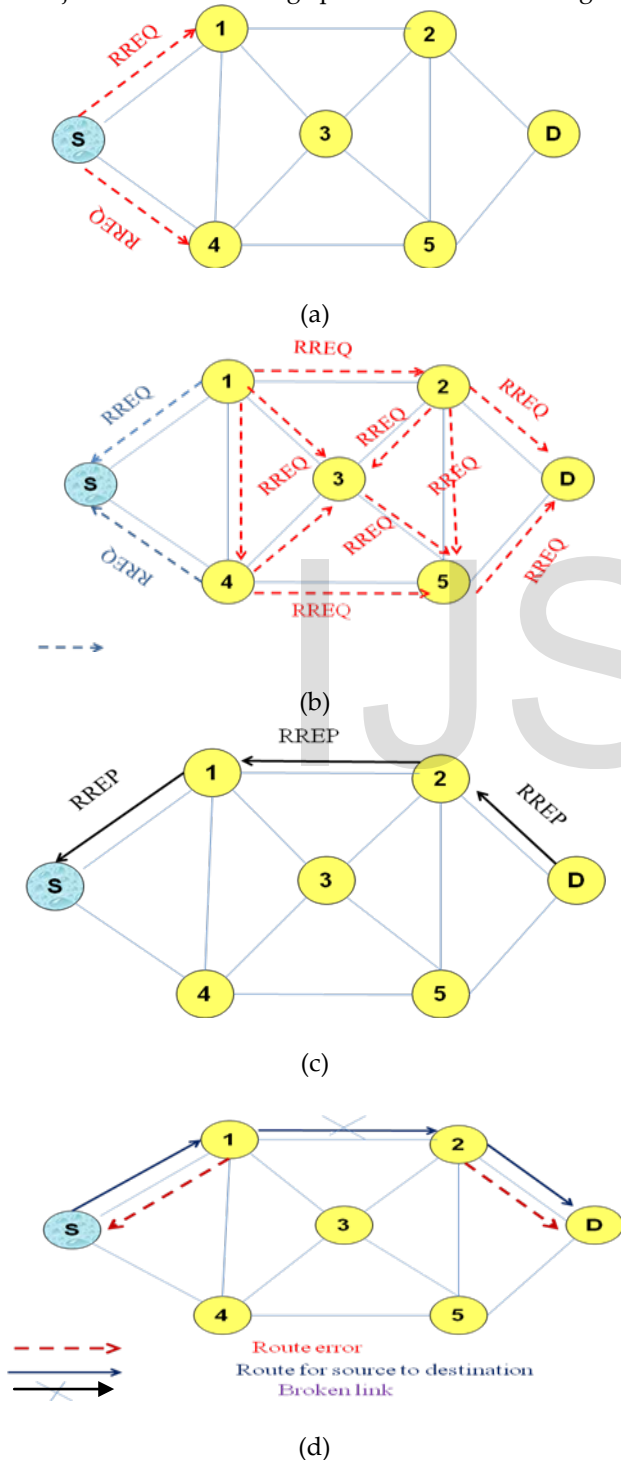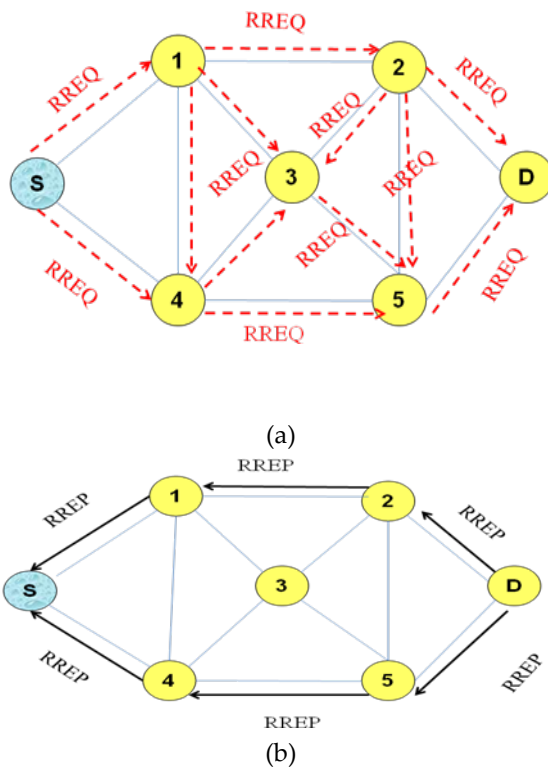
(a)

(b)

Fig 4: (a) Propagation of RREQs in AOMDV, (b) RREP multi path in AOMDV

AOMDV provides multipath from source to destination which are node disjoint and link disjoint. Fig 4(a) shows the broadcast of RREQ from source node S and fig4(b) shows multiple route from destination node D to S which are node-disjoint and link-disjoint through neighbor nodes.

4. Proposed system

In proposed system we are taking three routing protocols namely DSDV[14], AODV[15] and AOMDV[16] to compare and analyze how proactive and reactive protocols react to changing network environment by passing some of the parameter metrics using simulation. And also examine and validate the advantages and limitations of these protocols.

The main contribution of this present paper is as follows

i)   Here we are comparing both unipath and multipath routing protocols .we show in the comparison that DSDV performs best in static network than AODV and AOMDV; AODV performs well in low mobility scenario. AOMDV outperforms the other protocols in highly mobile networks and offers best load balancing and fault tolerance.

ii)   we demonstrate that multi-path routing is only advantageous in networks of high node density or high network load compare to unipath routing protocol; and

iii)   AODV used as a benchmark to reveal the strengths and limitations of multipath versus unipath. we confirm that

multi-path routing protocols create less overhead compared to single path routing protocols.

The following are the parameter metrics taken into consideration to compare the routing protocols

- *Throughput:* Refers to amount of data that can be transferred from sender to receiver in a given amount of time or Number of packets arriving at the sink or it is the ratio of the total amount of data that reaches a receiver form a sender to the time it takes for the receiver to get the last packet.

- *End-to-End Delay*: The 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.

$\sum$ (Receive time – send time) / $\sum$ Number of connections

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

- *Packet Delivery Fraction* : It is the ratio of data packets delivered to the destination to those generated by the source.

PDF = No. of packets received/No. of packet sent.

- *Routing overhead*: It is the total number of control packets or routing packets generated by routing protocol during simulation.

- *Normalized routing load*: It is defined as the number of control packets transmitted per data packet arrived at the destination.

NRL = No. of routing packets / No. of packets received.

5. Conclusion

The objective of this paper is to provide a quantitative comparison of both unipath and multi-path routing protocols for mobile ad-hoc networks, examine some of the advantages and also to find out one common limitation in all three protocols and to find solution for that problem. Our study shows that the AOMDV protocol is more robust and performs better in most of the simulated scenarios .The AODV protocol achieves best performance in scenarios with low mobility and higher node density. DSDV performs best in static networks, heavy routing overhead if the size of the network increases in presence of mobility.

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- *Arpitha C N is currently pursuing masters degree program in Computer Science and Engineering in Visvesvaraya Technological University, India, PH-8495844451. E-mail: arpitha.aa89@gmail.com*
- *Dr.Arun Biradar is Professor and Head of the Department in Computer Science and Engineering Department, EWIT, Bangalore,India, E-mail: hod-csea@gmail.com*

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