

Performance Analysis of DSDV, AODV and ZRP Routing Protocol of MANET and Enhancement in ZRP to Improve its Throughput

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Abstract- Mobile Ad-hoc network (MANET) is a non-infrastructure, self-configurable and decentralized network of autonomous mobile nodes which are capable for communication over wireless links. Routing is the main part for any wireless network and same is for MANET. There are two approaches for routing in MANET one is Proactive and another is Reactive. Zone routing protocol is a hybrid protocol means that it uses Proactive approach in its inter-zone whereas Reactive approach in its intra-zone. This work revolves around enhancement in Zone routing protocol in the area of fast route reconfiguration and route acquisition delay.

Index Terms- MANET, DSDV, AODV, ZRP, SBZRP, MDVZRP

I. INTRODUCTION

In Mobile ad-hoc network the topology is dynamic as nodes moves to and fro from a network very quickly and unpredictably. The key factor that determines how efficiently a multi-hop wireless network reacts to topology changes and node mobility is the routing algorithm. Many routing algorithms have been proposed for proactive and reactive approach and as well as for hybrid approach [1]. In proactive routing approach it continuously evaluates the path of the network, so whenever it needs to send the packets in the network the routes is already known and can send immediately. Reactive routing protocol invokes the route only when it is required. So route determination required more time as compared to proactive protocol. Because of larger delay and control traffic it is not applicable to the real-time system. Hybrid routing is the combination of proactive and reactive approach and it make use of proactive to determine the early routes in its internal zone whereas uses the reactive approach in its intra-zone, that is communicating between inter-zone of the network. ZRP uses the hybrid routing approach.

The performance comparison for all the approaches is presented in this paper. Routing protocol DSDV [2] is for proactive, AODV [3] is for reactive and ZRP [4] for Hybrid are well-known approaches in their respective domains. The parameter end-to-end delay and number of packets successfully routed are examined for each of the approaches and some enhancement is proposed for hybrid protocol ZRP so as to improve its performance. Finally the simulation results of protocols implemented on Network Simulator NS-2 are concluded here.

II. ROUTING PROTOCOLS IN MANET

Mobile Ad-hoc networks topology of the nodes in the network is dynamic so such networks do not assume all the nodes to be in the direct transmission range of each other. Hence these networks require specialized routing protocols that provide self-starting behavior. These protocols are classified as proactive and reactive.

A. Proactive Routing Protocols

In proactive routing, each node has the latest information of the routes to any node in the network. Here each node periodically transmits the routing information to its neighbor so as to build a global view of the network topology. Examples of this class of Ad Hoc routing protocols are the Destination Sequenced Distance Vector (DSDV) and the Optimized Link State Routing (OLSR) protocols. The Matter of concern is Bandwidth and power utilization is more as it need to broadcast the routing tables. As the number of nodes in the MANET increases, the size of the table will increase.

Destination-Sequence-Distance-Vector (DSDV) [1]:- DSDV is proactive routing protocol. Each mobile node maintains a routing table that stores for all reachable destinations, the next-hop and number of hops to reach that destination and the sequence number assigned by the destination. This transmission takes place also in topology change cases. DSDV applies two types of routing updates: full dump or incremental update. Full dump carries the full table with all available routing information and this is suitable for fast changing networks. Incremental dump carries only the updated entries since last dump, which must fit in a packet and is suitable when network is stable. DSDV possesses routes availability to all destinations at all times, which involves much less delay in the route setup process. The use of sequence number distinguishes stale routes from new ones, where routes with higher sequence numbers are favorable. However, the updates due to broken links lead to a heavy control overhead during high mobility, proportional to the number of nodes in the network and therefore affecting scalability

B. Reactive Routing Protocols

In reactive routing protocols it constantly updates their route information with the latest route topology. Instead, when a source node wants to transmit a packet, it floods a query into the network to obtain the path to destination. Examples of Reactive routing protocols are the Ad Hoc on-demand Distance Vector Routing (AODV) and Dynamic Source Routing (DSR). The

matter of concern is the route to destination will have to be acquired just before communication begins due to which the latency period for most applications is likely to increase drastically.

Ad Hoc on Demand Distance Vector Routing (AODV) [2].- Ad Hoc On-Demand Distance Vector routing protocol is a reactive protocol so it discovers routes when needed and are maintained only as long as they are necessary. Each node maintains sequence numbers and this number increases as it learns about the changes in the topology. This sequence number ensures that most recent route is selected whenever route discovery is initiated.

Routing in AODV is done in two steps i.e. the Route Discovery and Route Maintenance. When a node wants to send a packet to some destination node, it checks its table to find whether it has a route to the destination node or not. If it does, it forwards the packet to the next hop towards the destination and if the node doesn't have valid route to the destination, it must initiate a route discovery process. The source node initiates a route request (RREQ) packet that contains the source node's IP address, current sequence number, destination's IP address and last known sequence number. The RREQ also contains a broadcast ID and this is incremented every time the source node initiates a RREQ. Thus, the broadcast ID and the source IP address uniquely identify a route request. Once the RREQ is created, the node broadcasts this packet and sets a timer to wait for a reply. When a node receives a RREQ, it first checks whether it has seen it before noting the source IP address and broadcast ID pair. If it has already seen a RREQ with the same source IP address and broadcast ID, it silently discards the packet. Else, it records this information and processes the packet.

The node sets up a reverse route entry for the source node in its route table. This reverse route entry contains the source node's IP address and the IP address of the neighbor from which the RREQ was received. The destination node responds with a unicast route reply (RREP) packet to the source. If the node is not the destination node, it increments the RREQ's hop count by one and re-broadcasts this packet to its neighbors. If the RREQ is lost, the source node is allowed to re-broadcast a route discovery again. Once a route has been discovered for a given source/destination pair, it is maintained as long as needed by the source node. When a link breaks, a route error (RERR) message is sent to the affected source nodes whenever a packet tries to use the link.

III. THE ZONE ROUTING PROTOCOL- SHORT OVERVIEW

The behavior of purely proactive and reactive schemes suggests that what is needed is a protocol that initiates the route determination procedure on-demand, but at limited search cost. The *Zone Routing Protocol ZRP* [3] is an example of such a hybrid reactive/proactive scheme. On one hand, it limits the scope of the proactive procedure only to the node's local neighborhood. As we shall see, the local routing information is referred to quite often in the operation of the ZRP, minimizing the waste associated with the purely proactive schemes. On the other hand, the search throughout the network, although it is

global, can be performed efficiently by querying selected nodes in the network, as opposed to querying all the network nodes.

ZRP defines a routing zone for each node separately and the zones of neighboring nodes overlap with each other. Each zone has a radius R expressed in hops. Thus the nodes which are exactly at the distance R from the source node are peripheral node and the node which are at a distance less than R from source node are known as interior node. In below figure the source node S includes the nodes $A, B, C, D, E, G, H, I, J$ and K in its routing zone and node L is the exterior node for node S . the node A, B, C, D and E are interior nodes whereas G, H, I, J and K are the peripheral node or border node.

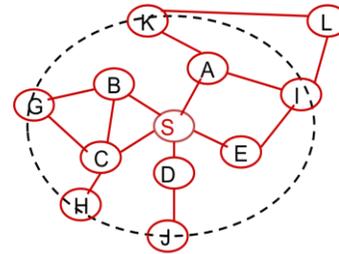


Fig.1:- A routing zone of radius 2 hops

The formation of a routing zone requires a node to know about its *neighbors*. A neighbor is defined as nodes that are directly connected to another node. Identification of a node's neighbors is done with the help of MAC-level *Neighbor Discovery Protocol (NDP)*. Such a protocol typically operates through the periodic broadcasting of "hello" beacons. The reception (or quality of reception) of a "hello" beacon can be used to indicate the status of a connection to the beaconing neighbor.

The ZRP maintains routing zones through a proactive component called the Intra Zone Routing Protocol (IARP) [5]. IARP maintains routes within the routing zone of source node and Reactive routing protocol Inter-Zone routing (IERP) [6] is responsible for acquiring routes to destinations that are located beyond the routing zone. The routes within the zone will always be available by using IARP and the routes outside the zone take the help of IERP. IERP uses IARP for the complete route between source node and destination node.

Border-cast resolution protocol (BRP) [7] is used by ZRP to direct the route request to peripheral nodes whenever the destination node is outside the zone of source node. Here it utilizes the IARP to construct the border-cast tree so that pruning can be easily done. Whenever the node receives the query packet for a node which is not available in its zone it forwards the query to all of its border node and they construct the border tree so that availability of destination node can be checked and if available routes is pruned back and if doesn't find it in its zone it forwards the query to all of its border node.

The inter-relationship of the ZRP component protocols is illustrated in Figure 2. The proactive maintenance of the routing zone topology is performed by the IARP, through exchange of route update packets. Route updates are triggered by the MAC level NDP, which notifies the IARP when a link to a neighbor is established or broken. The IERP reactively acquires routes to nodes beyond the routing zone using a query-reply mechanism.

IERP forwards queries to its peripheral nodes through a border-cast delivery service provided by the BRP. The BRP keeps track of the peripheral nodes through up-to-date routing zone topology information provided by the IARP. The IERP also makes use of the IARP routing zone information to determine whether a queried for destination belongs to its routing zone.

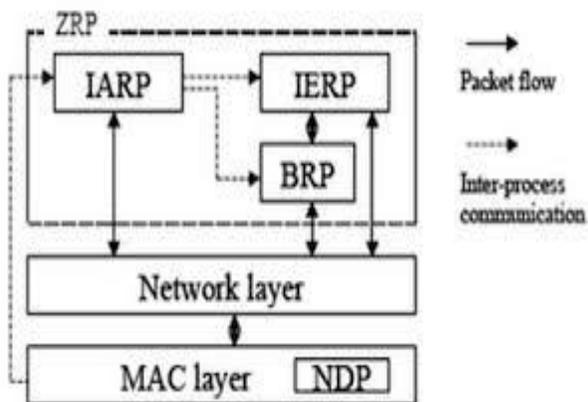


Fig.2:- Architecture of ZRP

IV. COMPARISON BETWEEN VARIOUS APPROACHES

An analytical performance comparison of some of the most important algorithm is presented, like Destination Sequenced distance Vector (DSDV), Ad-hoc on Demand Vector (AODV) and Zone Routing Protocol (ZRP). The performance regarding end-to-end delay and the number of packet successfully routed to their destination are examined. The other performance measuring criteria are as follows:-

- i. **Throughput:-** It is defined as the total amount of data a receiver receive from the sender divided by the time it takes for the receiver to get the last packet. The throughput is measured in bits per second [8].
- ii. **Average jitter:** - Jitter is the variation in the time between packets arriving, caused by network congestion, timing drifts, or route changes. It should be less for a routing protocol to perform better.
- iii. **Average End-to-End Delay:** - End to end delay includes how long it a packet takes to travel from the source to the destination [9]. This includes all possible delays caused by buffering during caused by buffering during route discovery, queuing, retransmission delays and transfer time.
- iv. **Packet Delivery Ratio:** - It is defined as the ratio of number packets received by the destination to the number of packets originated by the source. For better performance of a routing protocol, it should be better [10].

	DSDV	AODV	ZRP
Throughput	Highest	more than ZRP	Lowest
Average Jitter	Lowest	High	Better than AODV
End to end delay	Lowest	More than DSR	Low
Packet Delivery Ratio	High	Medium	Low

Fig.3:- Comparison of various protocols

The ZRP approach has lowest throughput and we will try to improve it with proposed work.

V. PROPOSED WORK

Selective Border-casting and Multi destination zone routing are the two approaches which have been used so as two reduce the number of packets flow in the network.

A. MDVZRP Approach:-

Multi destination zone routing (MDVZRP) reduces the route discovery to more than 3 times than a reactive protocol. If link is broken during route an alternative path will be used instead of using the local route repair as in some reactive protocol. It uses the full dump technique, in which the new node will receive the routing table from its nearest neighbors once they are joined with each other. Thus it will provide the entire network view than its zone only.

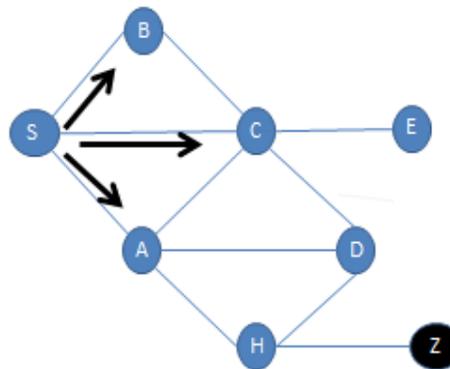


Fig.4:- Multiple routes to destination

In above example, the source node S has three alternative paths for the destination node Z and they are A, B and C respectively. All the available routes are mentioned in a table below:-

Sequence No.	Route Request	No. of Hops	Note
1	S-A-H-Z	3	CORRECT
2	S-A-D-H-Z	4	Same as 1 st and long route

3	S-A-C-D-H-Z	5	Same as 2 nd and long route
4	S-C-D-H-Z	4	CORRECT
5	S-C-A-D-H-Z	5	Same as 4 th and long route
6	S-C-A-H-Z	4	Possible but A-node joint
7	S-B-C-D-H-Z	5	C-Node joint
8	S-B-C-A-H-Z	6	C-Node joint
9	S-B-C-A-D-H-Z	6	C-Node joint and long route

Fig.5:- Various possible to destination

As shown in table, initially the node A will be used to send the packets via the path S-A-H-Z and if link is broken due to the mobility of node A, it will use the node C to send the packet via the path S-C-D-H-Z. Here if link C-D is broken than also it has an alternate path S-C-A-H-Z, so that local repair can be avoided.

B. SBZRP approach:-

Selective Border-casting zone routing (SBZRP) [11] reduces the load by limiting the number of control messages during the search of new route. When simple ZRP searches for a new route, the number of IERP packets will be increased due to which node buffer will be congested and will result in delay. When the mobility of node increases, route search failure becomes high so in the standard protocol the search will begin from the initial point whereas in SBZRP the route will be search from the point of failure of node. Thus the time is shorter due to which the delay will be less as compared to ZRP.

In our example, source node S generates the IARP packet and broadcasts in its local routing zone, by using neighbor's information, the central node updates its routing table. When the destination is outside the routing zone IERP will be initialize. Here, the source node S will send the request packet to its all border node G, H, I and J respectively. Here each node will check that whether the destination is available in its routing zone but will not find it so it will use border-cast tree and forward the packets to its border node.

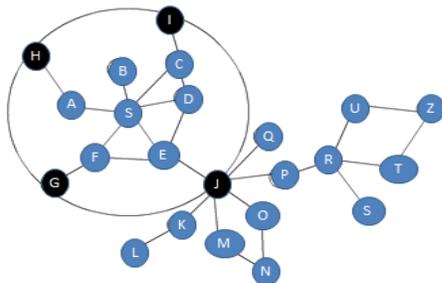


Fig 6: - IERP packet transmission by node S

Destination Node	Source Node	Intermediate node	Packet Type	No. of Hops
Z	S	Null	REQ	2

Fig.7:- IERP Request packet format of node S

Now, J will broadcast the packet to its border node N, L, F, S, D and R respectively. Here each node will check that whether the destination is available in its routing zone or not and find it there, it will forward the packets and if it not then will forward the packets to its border node.

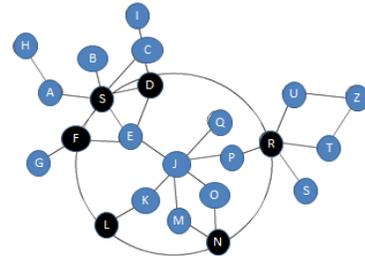


Fig.8:- IERP packet transmission by node J

Destination Node	Source Node	Intermediate node	Packet Type	No. of Hops
Z	J	Null	REQ	2

Fig.9:- IERP Request packet format of node J.

Now, R will forward the packets to J and Z respectively and finds the border node as destination node Z.

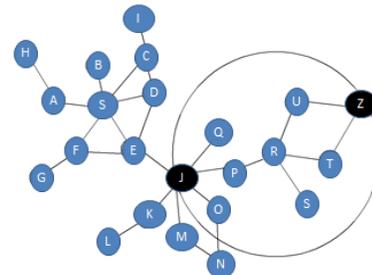


Fig.10:- IERP packet transmission by node R

Destination Node	Source Node	Intermediate node	Packet Type	No. of Hops
Z	R	Null	REQ	2

Fig.11:- IERP Request packet format of node S.

In this Selective border-casting approach the IERP Request packet's must save discovered routing information in a buffer for a while and if there are requests for the same destination which the IERP REQ's are sent by nodes in the previous search. For example, when a destination Z moves

inside the routing zone of J, as shown in the Figure, the previous recorded route information stored in the node J and R, the node J will generate the Reply packet to source S.

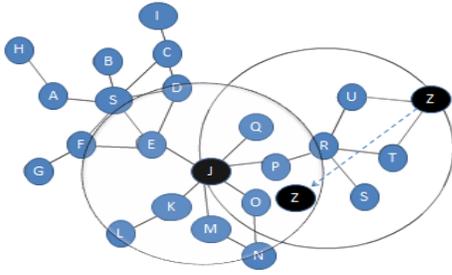


Fig.12:- a case when destination moves inside the zone.

Destination Node	Source Node	Intermediate node	Packet Type	No. of Hops
Z	S	R,J	REP	2

Fig.13:- IERP Reply packet format of node S.

In the case of destination which moves outside the zone of L as shown in the Figure, it has no route to destination which is required for the query source, and then a new search is started from the node R.

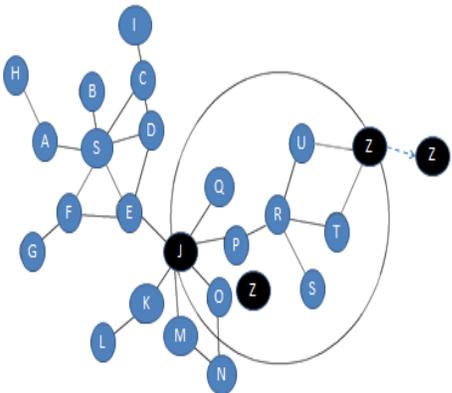


Fig.14:- a case when destination moves outside the zone.

Thus the numbers of route request packets are reduced, as the query begins from the node reporting the failure instead of beginning from source.

VI. WORK FLOW AND RESULT

Algorithm 1: Main program

Begin

- Initialize the nodes in network layer
- Call ZRPInit
- Call ZRP Router function
- Call ZRP Finalize

End.

Algorithm 2: ZRP Init

Begin

- Initialize the nodes with ZRP initialization
- If (IARP/IERP/MDVZRP/SBZRP) are running
- Display error message –
- Disable the initialization
- Else
- If (MDVZRP is enabled)
- Register ZRP with MDVZRP
- Call MDVZRP
- Init – else
- Register ZRP with IARP
- Call standard IARP Init
- Register ZRP with IERP
- Call standard IERP Init
- Register ZRP callback Functions
- Initialize statistics variables
- Stop

End.

Algorithm 3: MDVZRP Init

Begin

- Node enters MDVZRP Initialization
- Initialize private data structure
- Read zone radius
- Initialize the routing table
- Read user statistics
- Schedule timer
- Stop

End.

Algorithm 4:ZRP Router function

Begin

- If MDVZRP is initialized already then Call MDVZRP Router function
- Else initialize standard IARP Router function
- If packet is not routed then Call standard IERP router function
- Stop;

End.

Algorithm 5: MDVZRP Router function

Begin

- Enter Router function
- Check for route in the table
- If route available

Send packets to next layer

If error occurs display error message –

Ask for retransmission

- else

Initialize the broadcast with destination address

Find the routing information
Update the routing table
Stop
End.

Algorithm 6: ZRP Finalize

Begin

- If node enters MDVZRP Initialization then call
 - MDVZRP Final standard
- If node enters SBZRP Initialization then call
 - IARP/IERP/BRP Final standard
- If node enters QCS Initialization then call
 - IARP/IERP/QCS Final standard
- Stop;

End.

After implementing the modified ZRP it can be said that the performance of the network has been improved. Parameters like throughput, low overhead transmission and efficiency are measured below. Here, as shown in the figure below it can be said that with the enhancement in ZRP, throughput up to 25-30 nodes increases and then it slows down. But the most important thing is that though it slows down, it remains better than that of standard ZRP protocol.

VII. CONCLUSION

Initially the comparison between various routing protocols was done and it was concluded that Zone routing protocol is weak in the area of throughput. So few approaches were proposed and they solve the problem to some extent. The proposed structure provides us the view better than that of standard ZRP protocol. Here, we have tried to reduce the extra packet flow in the network by using the query detection method. This scheme allows us less control traffic than purely reactive route discovery, and with less delay than conventional AODV searching.

The approach MDVZRP and SBZRP reduces the no. of packets overhead in the network due to which the no. of packets received will be increased and so the performance will be

improved. By considering the other parameters we can do further modification in the currently updated protocol.

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