Route Rating and Centrality in Zone Routing Protocol for MANET

Shwetanshu Maan, Sunita Tiwari

Abstract*— Routing is an important challenge in wireless adhoc networks. Mobile Adhoc networks are infrastructure less and are characterized by multi-hop wireless connectivity and changing network topology. They are self organized networks. Role of routing protocols becomes even more significant because of the dynamically changing topology of MANET. A routing protocol is required whenever a packet needs to be transfer to a destination via number of nodes. Since the mid 90s MANETs are popular research topic due to growth of laptops and wifi wireless networking. Various protocols are evaluated to make MANETs reliable. Most prominent categories are proactive, reactive and hybrid. Proactive and Reactive both have some disadvantages therefore we use hybrid routing protocols to enhance performance of adhoc networks. In this work we aim to compare the performance of proactive (DSDV), reactive (DSR) and hybrid (ZRP and modified ZRP) routing protocols and also aim to propose an enhanced form of ZRP to uplift its performance.

***Index Terms*— Mobile Adhoc Networks (MANETs), Routing Protocols: Reactive, Proactive, Hybrid, Route Rating.**

I. INTRODUCTION

MANET is an autonomous collection of mobile devices over relatively bandwidth constraint network or wireless link. A mobile adhoc network (MANET) is infrastructure less and self configuring network. Wireless adhoc or on-the-fly networks are those in which nodes are free to move and organize themselves in an arbitrary fashion. Wireless ad hoc networks are very easy to implement and cost effective networks as they do not require any pre-existing infrastructure and base stations. The network topology changes rapidly and unpredictably over time since nodes are mobile. In MANETs all network activities including topology discovery and delivering messages must be executed by nodes themselves. Hence it is said that an adhoc network is decentralized. MANETs are able to operate in a stand-alone fashion or could possibly to a larger network such as internet. Due to lack of fixed infrastructure various issues like interferences, unreliable wireless medium, asymmetric propagation properties of wireless channel, hidden and exposed terminal phenomena, transmission rate limitation and blindly invoking congestion control of transport layer etc are inherent in MANET.

Application area of MANET is diverse, ranging from small, static networks to large scale mobile, highly dynamic networks. One of many possible uses of MANETs is in business environment where collaborative computing is more important outside the office environment than inside, such as Business Meetings outside office on a given assignment. Also mobile adhoc network can be used to provide crisis management service applications such as disaster recovery, where the communication infrastructure is entirely destroyed and restoring quickly is crucial [1]. By using a mobile adhoc network, any infrastructure could be setup in hours. Another application is Bluetooth designed to support a personal area network. Famous IEEE 802.11 or Wi-Fi protocol also supports an adhoc network system. A role of adhoc networks also exists in various military applications [10], construction sites, convention centers, etc.

Routing in adhoc networks has been a challenging task due to constant changing topology. Number of routing protocols has been developed to accomplish this task. Important classifications of MANETs Routing Protocols [4] includes-

Proactive Routing Protocols: Also known as Table-Driven Protocols. Maintain consistent overview of the network. In this each node uses routing tables to store information of other nodes in the network. This information is used to transfer data among various nodes. Presence of large routing tables, low scalability and high mobility results in consumption of bandwidth which is very sparse in adhoc networks. Also continuous updates create unnecessary network overhead.

Reactive routing protocols: also known as On-Demand protocols. Determine route to destination only when data is to be send. In case of route unknown, the source initiates a search to find one. High latency time in route finding and excessive flooding occurs.

Hybrid Routing Protocols: Combines advantages of proactive and reactive routing. Initially routing is established with some proactively prospected routes and then the demand is served through reactive flooding from additionally activated nodes.

In this work we aim to analyze the performance of MANET routing protocols DSDV, DSR and ZRP over parameters such as throughput, end-to-end delay and packet delivery fraction. Also, in this work we aim to propose a modified ZRP to uplift the performance of and compare its performance with the DSDV, DSR and ZRP.

Rest of the paper is organized as follows. Overview of routing protocol is provided in section 2 and related works has been discussed in section 3. Section 4 provides the proposed modification in ZRP. In section 5 we discuss about simulation environment, performance parameters used and results. Section 6 present conclusion and future directions.

II. OVERVIEW OF ADHOC ROUTING PROTOCOLS

In this section we are presenting a brief overview of the three routing protocols DSDV (Proactive), DSR (Reactive) and ZRP (Hybrid).

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In wireless ad hoc networks there must be some way of finding a route between two nodes. This is done with an ad hoc routing protocol. Often the routing protocol operates below the network layer, but still has knowledge about it. In literature various routing protocols for MANET exists each with their own strength and weaknesses.

A. Destination Sequenced Distance Vector Routing (DSDV)

DSDV is a table driven routing protocol. DSDV is known as proactive routing protocol. DSDV requires each node to maintain a routing table (Destination-address, Metric, and Sequence-number) for the next hop to reach a destination node and number of hops to reach destination. It periodically broadcast updates to the network and if a node does not receive a periodic update from its neighbor for a while link is assumed to be broken. Each route in DSDV is tagged by a sequence number to avoid formation of routing loops. It chooses the route for forwarding which have highest sequence number and when two routes have same sequence number than one with lower metric is chosen.

B. Destination Sequence Routing (DSR)

DSR is also distance vector routing and uses sequence number to avoid route looping. It belongs to the class of reactive protocol and allows nodes to dynamically discover route. It does not maintain routes to all possible destinations but establish them dynamically as and when the need arise. The overhead of route table maintenance is therefore low as each node does not need to contain up to date information for a complete path to a destination because the complete route a packet must follow to reach its destination is included in its header by the source [1]. Source routing ensures the loop freedom. To discover the route to destination from source network is flooded with route request packets (RREQ). A RREQ packet is rebroadcast by all intermediate nodes. The destination node replies to the earliest request to the source node. Route discovery mechanism of DSR is shown in Fig. 1 a) and b).

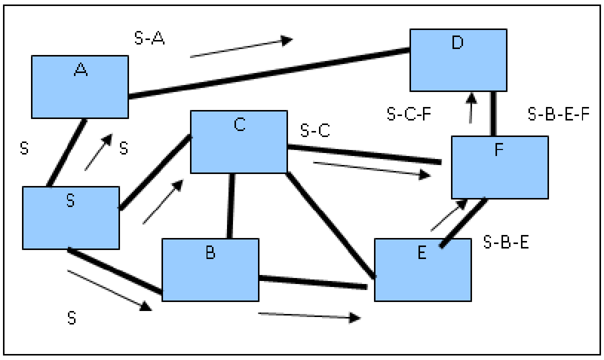

Fig. 1 a): Sending procedure of a request packet in DSR

C. Zone Routing Protocol (ZRP)

It falls under the category of hybrid routing protocols with both a proactive and reactive routing component. ZRP reduces the control overhead caused by proactive protocols and decreases the latency in reactive protocols. Each node individually creates its own neighborhood which it calls a routing zone. The zone is defined as a collection of nodes whose minimum distance from the node in question is not greater than a value known as “zone radius”. A proactive routing protocol, Intra-zone routing protocol (IARP), is used within routing zones and a reactive protocol, Inter-zone routing protocol (IERP) is used between routing zones. IERP is invoked if the IARP cannot find the destination, i.e. the destination is beyond a node’s zone. Instead of doing a flood search, it exploits the structure of the routing zone to do more intelligent query execution [7]. This is achieved through ‘border casting’. In border casting node direct the message out only to its peripheral nodes.

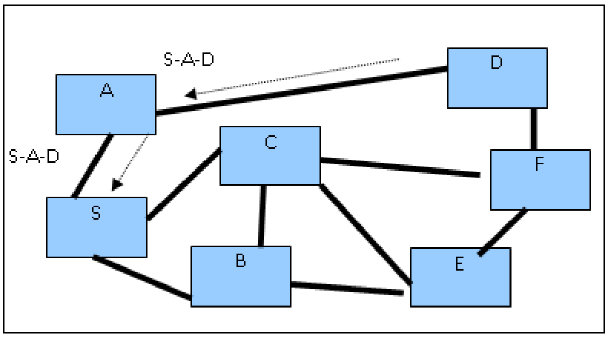

Fig. 1 b): Replying procedure of route request in DSR.

III. RELATED WORK

Various researches have done a comparative study on proactive, reactive and hybrid protocols [2]. The table 1 below briefly describes some of the work done to comparatively analyze all three categories of MANETs routing protocol.

Table 1. Summary of related work

Study	Protocols	Simulator Used	Performance Metrics
Performance Evaluation of DSDV and DSR Routing Protocols for Wireless Adhoc Networks [6]	DSR and DSDV	Ns-2.29	Packet Delivery Fraction and Throughput
Performance Analysis of Proactive and Reactive Routing Protocols for Adhoc Networks [12]	DSR, AODV and DSDV	Ns-2	Packet Delivery Ratio, Average End-to-End Delay, Packet Loss and Routing Overhead
Performance of Mobile Adhoc Networks Routing Protocols in Realistic Scenarios [11]	AODV, OLSR, DSR and ZRP	QualNet	Packet Delivery Ratio, Latency and Jitter
Performance Evaluation and Simulation of Mobile Adhoc Network Routing Protocols [13]	AODV, DSDV, DSR and OLSR	Two different Scenarios	Average Routing Overhead, Packet Delivery Ratio and End-to-End Delay

Performance Evaluation of Adhoc Routing Protocols using NS2 Simulation [8]	AODV, DSR and DSDV	Ns2	Packet Delivery Fraction, Average End-to-End Delay and Normalized Routing Load

There hasn't been any related work and simulation results presentation regarding how ZRP can be modified for its performance enhancement from average to something extra.

IV. PROPOSED MODIFICATION IN ZRP

While comparing original ZRP with DSDV and DSR we notice that ZRP gives an average performance [4]. For ZRP there are some concerns. Our main idea is to modify ZRP in such a way so that instead of simple hop count a new routing metric decide a route. This new routing metric depends on assigning a rating to a node so that whole path can be rated. In case of multiple paths from source to destination, a route with highest path metric and lowest centrality is chosen.

Proposed Pseudo Code: To determine less loaded routes we make use of two concepts namely Path Rating and Centrality

A. Path Rating

1. Each node maintains rating of every other node in the Ad-hoc network, depending upon the packet dropping and packet sending to the nodes successfully.
2. Path metric is calculated by taking average of the ratings of each node in the path as this allows choosing shortest path algorithm if no metric is given to nodes.
3. In case of multiple paths a route with highest metric is chosen.

Algorithm for assigning rating to a node

1. For a neutral node, that is a new node, is given a rating of 0.5.
2. Rating of each node is done with top rating of 1.0 to ensure if all are neutral nodes then shortest path first is chosen.
3. For every 200ms the rating of nodes on active path is incremented by 0.01.
4. Maximum value of neutral node is 0.8.
5. Packet is dropped on a link and if a node becomes un-reachable will lead to deduction of 0.05 of node's rating.
6. Lower limit of a neutral node is 0.0.
7. Changes on the ratings of other nodes than one mentioned above are not performed.
8. Any misbehaving node given a rating of -100.
9. If the simulation is run for long period of time then the negative ratings can be reset after a long timeout period.
10. If no node is found that can be given packet to forward, Send Route Request is given.

B. Computation of Centrality

1. Source node S sends a RREQ message including the size of its routing table as its centrality:

$$E_1 = size(rtable(s)) \qquad \text{..........(1)}$$

2. Upon receipt of this message, neighbor node V_1, not knowing a route to the solicited destination, acquires $p(n) = p(1)$ and $n = 1$ from the received RREQ message and diffuses a modified replica with the novel average centrality:

$$E_2 = \frac{1}{2}E_1 + \frac{1}{2}size(rtable(X_1)) \qquad \text{...(2)}$$

3. Iteratively, for an n^{th} intermediate node V_n, the novel average eccentricity:

$$E_{n+1} = \frac{n}{n+1}E_n + \frac{1}{n+1}size(rtable(X_n)) \qquad \text{...(3)}$$

4. Finally, when destination node 'D' receives messages from various possible paths to S, it simply chooses the route having smallest average centrality.

Therefore, we will choose the path which is having highest path metric and lowest centrality [3].

V. SIMULATION

Simulation is the imitation of the operation of a real-world process over time. Various simulators are available like QualNet, OPNET, and NS2 etc. Here, simulation work is done on NS2. NS2 is an object oriented simulator and is extensively used by research community. It is event-driven and works in non-realtime fashion. NS2 uses Tcl and object Tcl shell as interface and consist of C++ core methods. This section will do analysis on DSDV, DSR, ZRP and Modified ZRP. Also performance evaluation is done on the basis of different parameters.

A. Simulation Parameters

Table 2. Setup parameters for simulation

Parameter	Value
Platform	Linux CentOS 5
NS Version	Ns-2.33
Traffic Type	CBR
Radio Propagation	TwoRayGround
Protocols	DSDV, DSR, ZRP, Modified ZRP
Antenna Type	OmniAntenna
Packet Size	512 bytes
Pause Time	5, 10, 20, 40, 100
Number of nodes	10, 20, 30, 40, 50

B. Performance Parameters

The following metrics are used for different protocols evaluation:

- **Throughput:** Average rate of packets successfully transferred to their final destination per unit time.
- **End to End Delay:** It signifies the amount of time taken by packet from source to destination.
- **Packet Delivery Fraction:** Ratio of total data packets received to total ones sent by CBR source.

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C. Results Analysis

Results are analyzed on the basis of different performance metrics. Graphs shown below shows simulation results are according to network and pause time model i.e. varying number of nodes and changing pause time respectively.

Fig. 2 shows changes in value of Throughput of different protocols with respect to number of nodes. Modified ZRP (ZRP_New) performance enhances from original one.

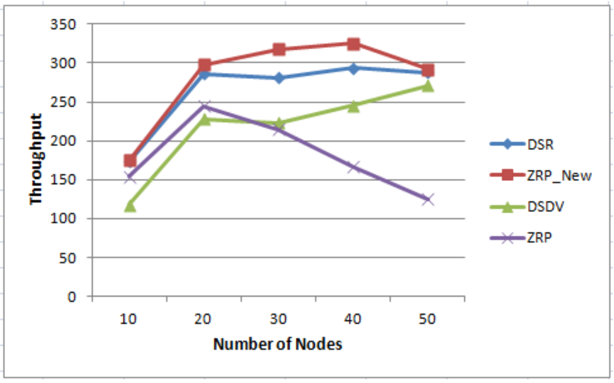

Fig. 2 Throughput Vs # of Nodes

Fig. 3 depicts End to End delay with network model only. In this original ZRP delay is highest while delay in modified ZRP minimizes. DSDV has lowest value for End to End delay.

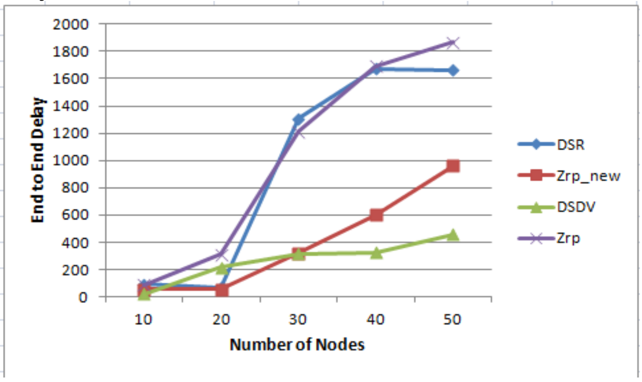

Fig. 3 End-to-End Delay Vs # of Nodes

Fig. 4 compare different routing protocols for Packet Delivery Fraction (%) and again we conclude with uplift in performance of New ZRP as compared to others.

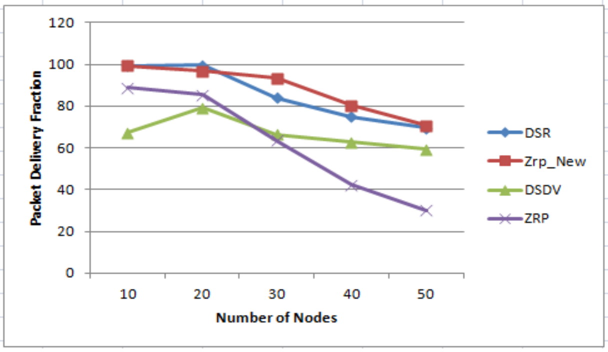

Fig. 4 Packet Delivery Fraction Vs # of Nodes

Fig. 5 shows Throughput with varying value of Pause Time. DSR and ZRP_New have approximately same values.

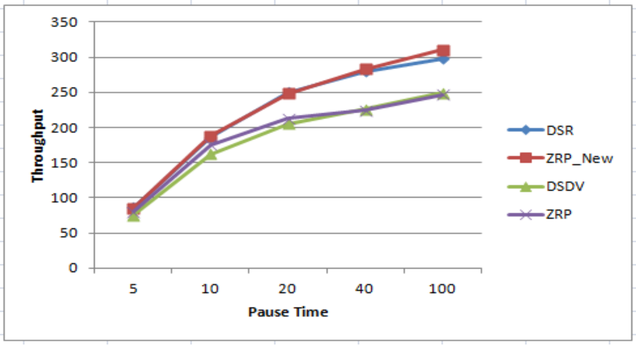

Fig. 5 Throughput Vs Pause Time

Fig. 6 evaluates End to End Delay with respect to Pause Time. ZRP has the maximum value while ZRP_New shows decrement in value when compared with DSDV, DSR and ZRP_New.

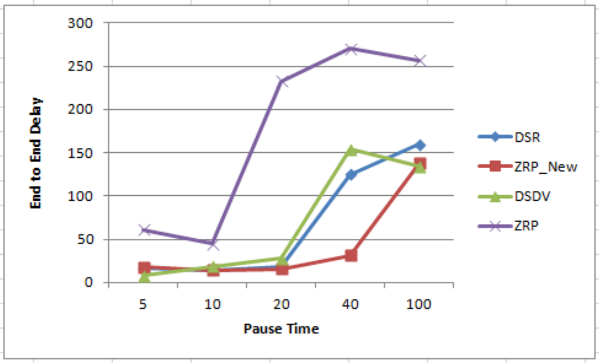

Fig. 6 End-to-End Delay Vs Pause Time

Fig. 7 depicts Packet Delivery Fraction for DSDV, DSR, ZRP and ZRP_New. We conclude that PDF for DSR and ZRP_New vary similarly with changing Pause Time.

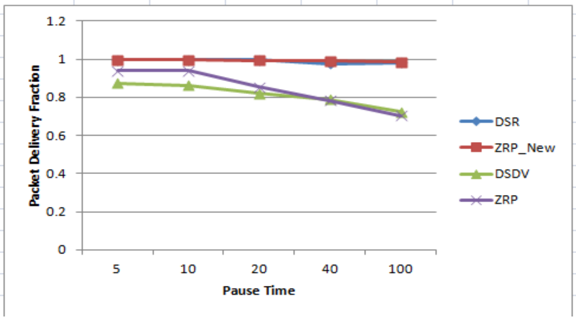

Fig. 7 Packet Delivery Fraction Vs Pause Time

VI. CONCLUSION

In this work we have analyzed the performance of different routing protocol over number of nodes and pause time in the network. In this study we have concluded that each protocol performs well in some cases while have drawbacks in other cases. We have also incorporates the concept of path metric and centricity in ZRP and shown that it has very good effect on the performance of existing ZRP. Therefore we conclude that by considering concept of path metric and centrality in ZRP gives better performance as compared to DSDV, DSR and ZRP in almost every the cases. In our future work we aim to further enhance the performance of modified ZRP and study its behavior.

REFERENCES

1. Sree Ranga Raju and Dr. Jitendrnath Mungara, "ZRP versus AODV and DSR : A Comprehensive Study on ZRP Performance" 2010 International Journal of Computer Applications (0975-8887) Volume 1, No. 12.
2. Amandeep Verma, "A Study of Performance Comparisons of Simulated Ad hoc Network Routing Protocols" Int.J. Comp.Tech.Appl. , Vol 2 (3), 565-569.
3. Oussama Souihli, Mounir Frikha and Mahmoud Ben Hamouda, " Load-Balancing in MANET shortest-path routing protocols" www.elsevier.com/locate/adhoc.
4. Kavita Pandey and Abhishek Swaroop, " A Comprehensive Performance Analysis of Proactive, Reactive and Hybrid MANETs Routing Protocols" IJCSI International Journal of Computer Science Issues, Vol. 8, Issue 6, No. 3, November 2011.
5. Manijeh Keshtgary and Vahide BaBaiyan, "Performance Evaluation of Reactive, Proactive and Hybrid Protocols in MANET" International Journal on Computer Science and Engineering(IJCSE).
6. Singh Rajeshwar, Singh Dharmendra K. and Kumar Lalan (2011), "Performance Evaluation of DSR and DSDV Routing Protocols for Wireless Adhoc Networks" International Journal Advanced Networking and Applications, Volume: 02, Issue 04, pp: 732-737.
7. G.Vijaya Kumar, Y.Vasudeva and Dr. M.Nagendra, " Current Research Work on Routing Protocols for MANET: A Literature Survey" International Journal on Computer Science and Engineering Vol. 02, No. 03, 2010, 706-713.
8. Shah Samyak, Khandre Amit, Shirole Mahesh and Bhole Girish, "Performance Evaluation of Adhoc Routing Protocols using NS2 Simulation" Proceedings of International Conference on Mobile and Pervasive Computing" pp: 167-171.
9. Kapang Lego, Pranav Kumar Singh, Dipankar Sutradhar. "Comparative Study of Adhoc Routing Protocols AODV, DSR and DSDV in Mobile Adhoc Networks", International Journal of Computer Science and Engineering, Vol.1, No. 4 364-371 2011.
10. S. A. Ade, P.A.Tijare , "Performance Comparison of AODV, DSDV, OLSR and DSR Routing Protocols in Mobile Ad Hoc Networks", International Journal of Information Technology and Knowledge Management July-December 2010, Volume 2, No. 2, pp. 545-548.
11. Hsu J., Bhatia S., Takai M., Bagrodia R. and Acriche M.J. "Performance of Mobile Adhoc Networking Routing Protocols in Realistic Scenarios" , Proceedings of IEEE Conference on Military Communications, Vol. 2, pp. 1268-1273.
12. Tyagi S S and Chauhan R K (2010). "Performance Analysis of Proactive and Reactive Routing Protocols for Adhoc Networks", International Journal of Computer Applications, Vol. 1, No. 14, pp. 27-30.
13. Singla Vikas, Singla Rakesh and Kumar Ajay (2001). "Performance Evaluation and Simulation of Mobile Adhoc Network Routing Protocols", International Journal of Engineering and Information Technology, Vol. 1, No.1.

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