SZRP - Hybrid approach of determining the optimal path in Mobile ad hoc network

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Abstract – A mobile ad hoc network has a dynamic nature that leads to constant changes in its network topology. As a end result, the routing problem becomes more complex and challengeable in large scale networks. In this paper, we proposed the hybrid approach of routing (SZRP) an enhancement of Independent Zone Routing which allows distributed configuration for the optimal size of each node's routing zone, on per-node basis. Here in this SZRP, control messages and data packets are sent along with efficient tree like structure in order to reduce the network load and also here zone formation is based on the real time traffic of the network. We demonstrate the performance of SZRP with various performance metrics. Results indicate that SZRP is highly scalable for large networks compared to IZRP by considering performance metrics Packet Delivery ratio, End-to-End Delay and Normalized Routing overhead.

Index Terms – MANET, packet delivery ratio, End-to-End Delay, Self Zone Routing, IZRP.

1 INTRODUCTION

A mobile ad hoc network (MANET) is comprised of mobile hosts that can communicate with each other using wireless links. In this environment a route between two hosts may consist of hops through one or more nodes in the MANET. An important problem in a mobile ad hoc network is finding and maintaining routes since host mobility can cause topology changes. [1]
Mobile Ad hoc networks routing protocols are classified into Proactive, Reactive and Hybrid Routing Protocols. The Zone Routing Protocol (ZRP) is one of the hybrid routing protocols in which every network node proactively maintaining routing information about its routing zone, while reactively acquiring routes to destinations beyond the routing zone. It is considered to be one of the most scalable routing protocol due to its multi-scoping and hybridization features. Hence, to implement the Algorithms for a MANET must be self-configure to adjust a environment and traffic where they run, and goal changes must be posed from the user and application.

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Ideally, a routing algorithm for an Ad hoc network should not only have the general characteristics of any routing protocol but also consider the specific characteristics of a mobile environment. Based on the routing information update mechanism, Ad hoc wireless network routing protocols are basically divided into 3 categories pro-active routing, re-active protocols, Hybrid routing protocols. The Proactive routing algorithms maintains up-to date routing information and also consistent between every pair of nodes in the network by proactively propagating route updates at fixed time intervals. Proactive routing algorithms maintain routing tables for all nodes in the network, a route is found as soon as it is requested. The advantage of these protocols is low latency in discovering new routes and minimizes the end-to-end delay. Example of proactive protocols are Destination-Sequenced Distance Vector (DSDV) [2], Cluster-Head Gateway Switch Routing Protocol(CGSR) [3], Optimized Link-State Routing (OLSR) [4], and Topology-Based Reverse Path Forwarding (TBRPF) [5] Protocols.

Reactive on-demand routing algorithms establish a route only on demand by the node to the destinations. It maintains routes only when the route expires or destination node may not accessible. Here comparatively between the pro-active and reactive protocols, reactive protocols are more efficient than proactive protocols in terms of control overhead and power consumption because routes are only established only when required. Examples of the reactive routing protocols are Dynamic Source

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Routing Protocol (DSR) [6], Ad Hoc On-Demand Distance-Vector Routing Protocol (AODV) [7] [8], Temporally Ordered Routing Algorithm (TORA) [9].

Rest of the paper is organized in the following manner: Section II describes the related work that includes optimization and comparisons already done with ZRP. In Section III we propose our own modification to ZRP where we used reactive component of ZRP architecture inside the zone and outside the zone we have used the proactive component. In Section IV we summarize the results of extensive simulation scenarios and comparison of traditional ZRP with modified ZRP, AODV and OLSR. Section V concludes the paper.

2. Survey on Related Work

In mobile ad hoc network, all transmitting data are delivered to destination in hop by hop and there can be multiple paths. Ad hoc network are classified into three categories proactive (table-driven), reactive (on-demand), hybrid. DSDV is the famous proactive routing protocols. AODV is reactive protocols. Here, we concentrate on hybrid routing protocols one among them is ZRP. ZRP has been compared with AODV, OLSR and DSR. In [10] ZRP, DSR and AODV have been compared in which delay, throughput, received packet time, packets byte received and other perimeters have been chosen. Simulations result is obtained for different number of nodes. Here AODV has better performance while ZRP has worst performance in terms of bytes received. But it has better performance for delay. A mechanism of back-off time is introduced to avoid same query packet are sent to the peripheral nodes. So, all the peripheral nodes are assigned different back-off times. Instead of using all the peripheral nodes only selective nodes that are in the same direction in the destination are used to send the query messages reactively.

In [11] ZRP, OLSR and DSR are compared considering for delay, throughput, jitter. It is shown that OLSR has best performance in terms of delay but ZRP has moderate performance for any number of nodes for maximum number of connections taken in terms of delay, throughput and packet delivery ratio.

In [12] mobile ID's are used in the same zone. If any node finds a different ID then it drops the proactively routed packet as it is out of zone. For out of zone communication is achieved by not using mobile ID's via unsetting the flag that mandates to use such ID's.

In [13] Route query packets are reduced by only selecting few peripheral nodes to find a new route. Only IERP is modified by selecting limited peripheral or border nodes and the route is cached for a while to reuse it for the same destination node. But when the destination node moves to a new node's zone, the IERP search query is restricted to only the next peripheral node as the time that the node has moved is not sufficient and it is possible that node might be in next node's zone. However, if the node is not found, the last node that obtained the route query initiates the route request. Results obtained that SZRP had better results in terms of delay, throughput, and arrival rate and link usability.

ZRP uses both proactive and reactive approach, the key parameter by which it can establish a balance between both strategies is zone radius. [4] has proposed zone radius estimation techniques which minimizes the total ZRP overhead. Other protocols named IZRP [1],FZRP[6] are proposed in literature as the extensions to the basic ZRP version. IZRP (Independent Zone Routing) protocol has proposed mechanisms for calculating the optimal zone radius of the node. These mechanisms are known as min searching and adaptive traffic estimation. FZRP (Fish-eye Zone Routing) protocol has proposed an architecture where the proactive part of ZRP is designed with Fish-eye routing. A detailed attempt for performance analysis of ZRP overhead against numerous different parameters via simulation in OPNET can be found in [7]. In literature, [8] and [9] have attempted to model the routing overhead for different routing protocols. [8] has performed routing overhead analysis for only AODV, DSR and OLSR. [9] only considered the asymptotic analysis of the routing overhead.

3. Zone Routing Protocol.

Zone Routing Protocol (ZRP) [12] is a well-known hybrid routing protocol that is most suitable for large-scale networks. The ZRP framework is designed to provide a balance between the proactive and reactive routing approaches. Here the zone is formed that defines the transmission radius for every participating node. It uses a proactive mechanism of node discovery within zone and reactive mechanism is used outside the zone.

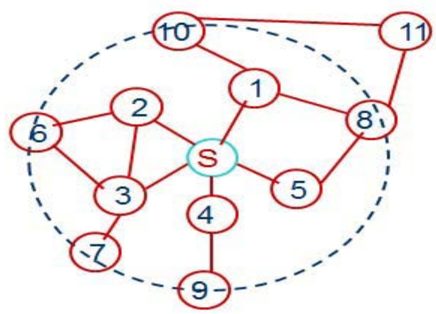


Fig. 1 a. Routing zone with radius ρ=2

ZRP utilizes the fact that node communication in ad hoc networks is mostly localized, thus the changes in the node topology within the vicinity of a node are of primary importance. ZRP makes use of this characteristic to define a framework for node communication with other existing protocols. Local neighborhoods, called zones, are defined for nodes. The routing zone of a given node is a subset of the network, within which all nodes are reachable within less than or equal to zone radius hops. The size of a zone is based on ρ factor, which is defined as the number of hops to the perimeter of the zone. There may be various overlapping zones, which helps in route optimization.

An example of a routing zone for node S of radius 2 is shown in figure 1[14]. The nodes from 1 to 10 belong to the routing zone of S, but not node 11. The nodes 6 to 10 are called peripheral nodes because hop distance from S is equal to radius of the routing zone. The information about neighbors is required to construct a routing zone of a given node. A neighbor is defined as a node with which direct communication can be established. Neighbor discovery is accomplished by simple "Hello" packets (periodic transmission of beacon packets (active discovery) or with promiscuous snooping on the channel to detect the communication activity (passive discovery)) [15] . ZRP uses three components for the optimal routing is IARP, IERP, and BRP. In IARP [16] is proactive approach and always maintains upto-date routing tables. Route queries outside the zone are propagated by the route requests based on the perimeter of the zone (i.e., those with hop counts equal to ρ), instead of flooding the network. The Interzone Routing Protocol (IERP) [17] uses a reactive approach for communicating with nodes in different zones. Route queries are sent to peripheral nodes using the Border cast Resolution Protocol (BRP) [18]. Since a node does not resend the query to the node in which it received the query originally, the control overhead is significantly reduced and redundant queries are also minimized.

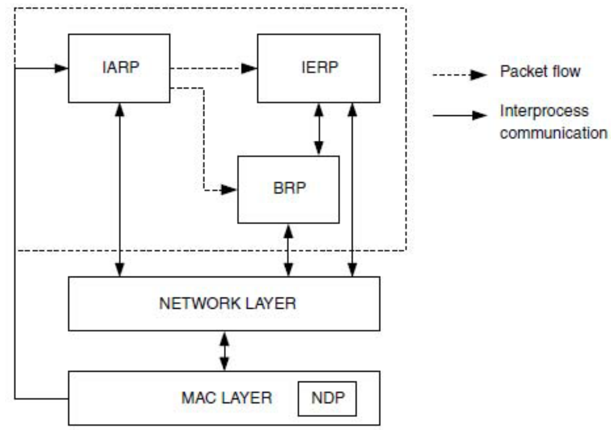


Fig : 2 ZRP Architecture.

ZRP provides a hybrid framework of protocols, which enables the use of any routing strategy according to various situations. It can be optimized to take full advantage of the strengths of any current protocols [12]. Neighbor discovery information is used as a basis for proactive monitoring of routing zones through the IntrAzone Routing Protocol (IARP) [16]. Since ZRP assumes that local neighbor discovery is implemented on the link-layer and is provided by the Neighbor Discovery Protocol (NDP) [15] , the first protocol to be part of ZRP is the IntrAzone Routing Protocol, or IARP [16]. Hence the larger the routing zone, the higher the update control traffic. The paths to the nodes which are outside the routing zone can be achieved by IERP [17]. If the destination belongs to its own zone, then it delivers the packet directly. Otherwise, source node bordercasts the Route Request to its peripheral nodes. If any peripheral node finds destination node within its routing zone, it sends a Route Reply back to source node indicating the path; otherwise, the node reborder casts the Route Request packet to the peripheral nodes and this procedure continues until the destination is identified [12].

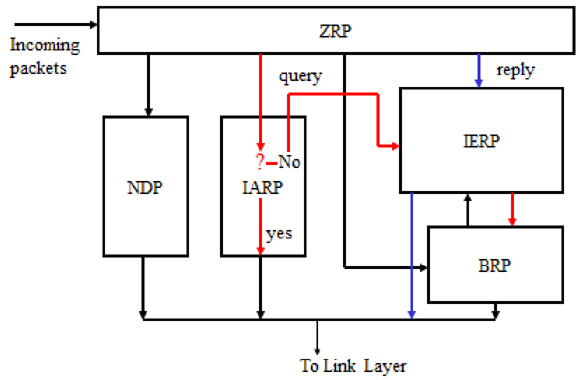


Fig: 3

4 Proposed Algorithm:-Self Zone Routing Protocol.

4.1 Motivation

To realize an efficient routing in mobile ad-hoc networks various routing protocols based on proactive and reactive schemes have been introduced. And, they respectively have pros and cons in terms of various perspectives required. To combine the pros of two schemes, hybrid routing is designed and most protocols of this approach are based on ZRP.

In the ZRP, nodes maintain routing table to use proactive routing protocol for destinations available within zone. It means the ZRP uses the proactive routing protocol within the zone and use the reactive routing protocol outside the zone. Where data transmission and mobility of node occurs frequent, the proactive routing has more advantages, and the reactive routing is applicable in contrary case. Under this, the purpose of proactive and reactive approaches is very significant in hybrid scheme. However, ZRP uses just hop number to form the zone. Almost, in large scale environment, the border of frequent data transmission is not corresponding to the hop based zone, because the direction of delivery path tends to lean into the certain destination in a brief time. This emerged from the question: Is the number of hops the best criterion to define proactive routing zone? If a protocol defines zones efficiently taking into consideration the real traffic load and mobility, it could be great. Hence, we contribute to find the solution of this new requirement.

Algorithm: SZRP

Step 1: Create the dynamic topology with the mobility of the node.

Step 2: Every node has to maintain the neighbor and routing table.

Step 3: Nodes has to send route request to find the destination.

Step 4: Zone is formed based on the traffic load in the network.

Step 5: Traffic is calculated using the formula (3)

Step 6: If the traffic is high, then proactive component is used to deliver the packets

Step 7: If the traffic is low, then reactive component is used to deliver the packets.

4.2 The concepts of SZRP

The main role of SZRP is determination of the zone. ZRP defines proactive routing zone based on number of hops as shown in Fig. 1(a). But the efficiency of the zone is not guaranteed because the zone is defined regardless real traffic load. Contrarily, SZRP can form customized zone using traffic load between nodes as show in Fig. 1(b). In this scheme, every node records traffic load of destination for defining proactive routing zone. If the frequency of traffic to a certain destination becomes high, the zone would be created and the source proactively manages the zone. At any given destination, which approach is favorable between proactive and reactive one is very significant in hybrid protocols, and we focus on traffic load that means the amount of actual data transmissions. Where T is traffic load, and data transmission (df). T is calculated for both the approaches. In this equation and ld are the lengths of control data frames. Average hop count of overall nodes (hc) and hop count of destination (n). Finally, number of nodes in overall network is denoted as P

$$T_{proactive} = P^2 l^2 + \lambda_d w_d l_{dst} \longrightarrow \qquad (1)$$

$$T_{reactive} = \lambda_d w_d l_{dst} \longrightarrow \qquad (2)$$

4.3 Protocol explanations

SZRP uses proactive routing within the zone and reactive routing with outside the zone. This SZRP define zone and it manages the node with the network. In traditional ZRP the zone is defined with the number of hops using the Time-to-Live (TTL) value so it is managed easily. It is insufficient to manage zone with only TTL value. So, new way to define zone and mange using traffic is SZRP and zone is defined by ZID(zone id). Every zone has unique ZID

There are two stage in SZRP: In first stage zone is formed by the number of hops due to the absence of information about the traffic. In second stage, every node defines new zone considering traffic load. After selecting destinations source send crzonemsg(create zone message) to the destinations. If the destination available in the initial zone the message is delivered to the destination by proactive approach. If it is not in the initial zone, the message is delivered to the destination by reactive approach.

4.4 Traffic Decision:

To make a decision whether it is heavy traffic or not for that current traffic is required. To define traffic , traffic indication and threshold value θ.

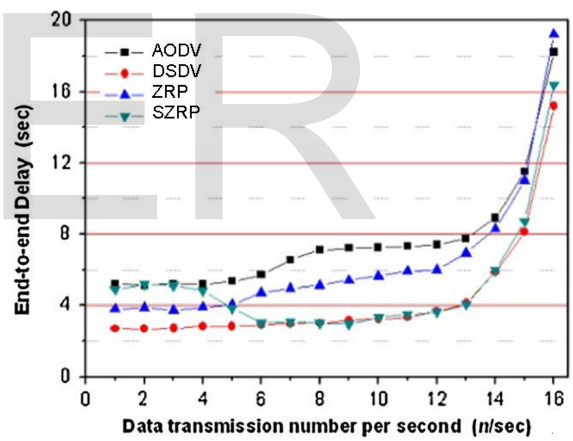
$$TI(n,t)=\alpha.TI(n,t-1)+(1-\alpha)(F(n,t))+H(n,t)) \rightarrow \quad (3)$$

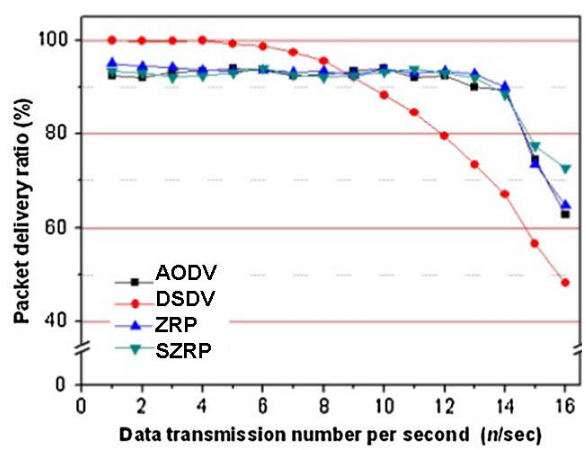
Where ($0< \alpha<1$)

TI represents the traffic load from source itself and destination. High value of TI means heavy traffic, so it could TI represents the traffic load from the source itself to the destination. F(n,t), H(n,t), and TI(n,t) also have a value between 0 and 1. High value of TI means there are heavy traffic loads, so it favorable for proactive routing. Each node has the number of TI for many destinations. In a source, when TI of a destination is greater than α, this destination is selected for proactive routing. The TI is calculated considering the number of transmitted data in the near past and the number of hops to the destination. In this case, moving average is used with the appropriate weighted value of α. For considering the current traffic load, we present it to F(n,t) function to represent the scaled value between 0 and1. And, we also consider the number of hops as H(n,t) function which is also represented for the scaled value between 0 and 1, because the number of hops is generally influenced from the distance. We get the half value of the sum of F(n,t) and H(n,t) to limit the current TCI value between 0 and 1.

Simulation parameters

Parameter	value
Routing protocol	AODV,DSDV,ZRP
Data rate	100kbs
MAC type	SMAC
Baseband frequency	2.4GHz
Initial Zone TTL	2
Network size	100 nodes
Traffic Agent	CBR
Traffic Pattern	128bytes
Power in mode	50.7/49.2(mW)
Communication range	200m
Variables for SZRP	t:2,k:7,l:3, α:o.7





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5 Conclusion

In this paper, new protocol is designed to consider the real traffic. By calculating the traffic, zone is formed and for heavy traffic zone , proactive is favorable. For Low traffic zone, reactive is favorable.

In simulating the protocols for packet delivery ratio and end to end delay comparing the other protocols like AODV, DSDV and conventional ZRP, SZRP shows the moderate result.

REFERENCES

1. Azzedine Boukerche "Performance Evaluation of Routing Protocols forAd Hoc Wireless Networks" Mobile Networks and Applications 9, 333– 342, 2004 ONT K1N- 6N5, Canada
2. Mahdipour, E.Rahmani, A.M.Aminian.E; "Performance Evaluation of Destination-Sequenced Distance-Vector(DSDV) Routing Protocol" IEEE International Conference on Future Networks, Mar 2009, Page(s):186-190
3. Arora, V.,Rama Krishna, C.; Performance evaluation of routing protocols for MANETs under different traffic conditions" 2010 2nd IEEE International Conference on Computer Engineering and Technology(ICCET), Issue April 2010 Volume: 6 page(s): V6-79 - V6-84
4. Clausen, T., Jacquet, P, "Optimized Link State Routing Protocol", IETF Internet Draft, Jan2003, http://menetou.inria.fr/draft-ietf-manet-olsr-11.txt
5. R. Ogier, F. Templin, and M. Lewis. "Topology Dissemination Based on Reverse- Path Forwarding(TBRPF)." February 2004. http://www.ietf.org/rfc/rfc3684.txt.
6. D. Johnson, Y. Hu, and D. Maltz. "The DynamicSource Routing Protocol(DSR) for Mobile Ad Hoc Networksfor IPv4", February 2007.http://www.ietf.org/rfc/rfc4728.txt.
7. C. Perkins, E. Belding-Royer, and S. Das. "Ad hoc On Demand Distance Vector RoutingProtocol",Feb2007. http://www.ietf.org/rfc/rfc3561.txt.
8. Luo Yu-hong, Wang Jian-xin, Chen Song-qiao. An Energy-efficient AODV routing protocol based on link stability[J]. Journal of Circuits and Systems, 2008, 13(6): 141-147.
9. Kuppusamy, P.Thirunavukkarasu, K. Kalavathi B.; "A study and comparison of OLSR, AODV and TORA routing protocols in ad hoc networks" 2011 3rd IEEE international Conference on Electronics Computer Technology (ICECT), Issue Date: 8-10 April 2011 On page(s): 143 – 147
10. Raju, S.R.; Runkana, K.; Mungara, J.; , "ZRP versus AODV and DSR: A Comprehensive Study on ZRP Performance on MANETs," Computational Intelligence and Communication Networks (CICN), 2010 International Conference on , vol., no., pp.194 199, 26-28 Nov. 2010.
11. Gandhi, S.; Chaubey, N.; Shah, P.; Sadhwani, M.; , "Performance evaluation of DSR, OLSR and ZRP protocols in MANETs," Computer Communication and Informatics (ICCCI), 2012 International Conference on , vol., no., pp.1-5, 10-12 Jan. 2012.
12. Hun-Jung Lim; Soo-Jin Jung; Jong-Hyouk Lee; Young-Ju Han; Tai- Myoung Chung; , "MANET ID : Improvement on Group Communications and ZRP," Systems and Networks Communications, 2007. ICSNC 2007. Second International Conference on , vol., no., pp.9,25-31 Aug. 2007
13. Barolli, L.; Honma, Y.; Koyama, A.; Durresi, A.; Arai, J.; , "A selective border-casting zone routing protocol for ad-hoc networks," Database an Expert Systems Applications, 2004. Proceedings. 15th International Workshop on , vol., no., pp. 326- 330, 30 Aug.-3 Sept. 2004
14. Prasun, Sinha, Srikanth, Krishnamurthy, Son, Dao: "Scalable Unidirectional Routing with Zone Routing Protocol (ZRP) Extensions for Mobile Ad Hoc Networks." IEEE TRANSACTIONS ON NETWORKING, VOL. 4 2006.
15. Joo-Chul Lee,Youn-Hee Han; Myung-Ki Shin; Hee-Jin Jang; Hyoung-Jun Kim "Considerations of Neighbor Discovery Protocol (NDP) over IEEE 802.16 Networks" The 8th IEEE International Conference on Advanced Communication Technology (ICACT)Volume: 2, 2006, Page(s): 951 – 955
16. Haas, Zygmunt J., Pearlman, Marc R., Samar, P.:Intrazone Routing Protocol (IARP), June 2001, IETF Internet Draft, draft-ietf-manet-iarp-01.txt.
17. Haas, Zygmunt J., Pearlman, Marc R., Samar, P.:Interzone Routing Protocol (IERP), June 2001, IETF Internet Draft, draft-ietf-manet-ierp- 01.txt.
18. Haas, Zygmunt J., Pearlman, M R., Samar, P.:" The Bordercast Resolution Protocol (BRP) for AdHoc Networks, June 2001, IETF Internet Draft, draft-ietf-manet-brp-1.txt.