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Modified Distance Aware Zone Routing Protocol for Less Delay Transmission in MANET

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Abstract

Mobile Adhoc Network (MANET) is a promising area of research under wireless networking. On the basis of routing update mechanism MANET protocols are mainly classified into proactive routing protocols and reactive routing protocols. Zone routing protocol (ZRP) comes under the category of hybrid MANET Routing Protocol which combines the best feature of both proactive and reactive approaches.. An enhancement to ZRP named Distance Aware Zone Routing Protocol(DZRP) is proposed to deal with an issue of the basic ZRP i.e in determining the zone radius the actual physical distance is not considered .The paper identifies the issues with DZRP and proposes a cost effective modification to to solve the identified issue. The paper also provides a detailed look into the implementation of the modified distance aware zone routing protocol.

Keywords: *ZRP, DZRP, Ad-hoc network, Routing, MANET, Wireless Networking*

1. Introduction

A mobile ad hoc network (MANET) is a self-configuring network of mobile devices connected by wireless links. The word Ad Hoc means informal. These types of networks are usually informally set up for meeting a particular purpose. Each device in a MANET is free to move independently in any desired direction. This mobility is the main attraction of MANET. The principle behind Ad Hoc networking is multi-hop relaying. In a MANETs, all nodes can act as source as well as forwarders of packets. They provide robust communication in a variety of environments such as military communication, disaster recovery situation etc when all other infrastructures are down.

Due to high mobility nodes , interference and less infrastructure compared to any other network, this network are highly error prone and can go down frequently Therefore, routing in MANET is a critical job. In ad hoc networks, nodes are not familiar with the current topology, they have to discover it. The basic idea is that a new node may announce its presence and others should listen to this announcements broadcast by its neighbors. Each node learns about nodes nearby and how to reach them and they also will do the same announcement i.e. way to reach them.

2. Zone routing Protocol

Zone routing protocol as its name implies is based on the concept of zones. Zone routing protocol comes under the category of hybrid MANET Routing Protocol. Based on the current network traffic an optimal zone radius is determined. The zone radius r expressed in hops. The zone thus includes the nodes, whose distance from the node is at most r hops. The zones of the neighbouring nodes overlap.

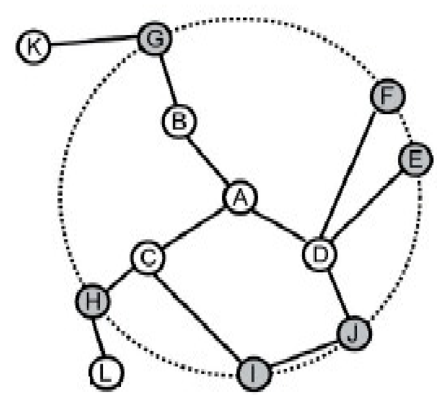

Fig. 1 Example routing zone with r=2

If for a node inside the zone, routes are immediately available, i.e it uses a proactive approach. For the nodes whose destination is outside the zone, an on demand approach is used[1].

2.1 Routing Framework

The ZRP protocol suit is comprised of the following protocols

- IARP (Intra Zone routing protocol)[2]
- IERP (Inter Zone Routing Protocol)[3]
- BRP (Border cast Routing Protocol) [4]
- NDP (Neighborhood Discovery Protocol)[4].

If the destination node is within the zone, the packets are routed directly to destination since routing information is available immediately. The IARP maintains routes for the nodes within the routing zone. The IERP is responsible for finding routes to destinations located beyond a node's routing zone. The IERP operation is initiated by checking whether the destination is within its zone. If so, no further route discovery processing is needed. If the destination is not within the source node's routing Zone, the source sends a route request to all its border nodes (nodes whose distance is equal to the zone radius).Now all the border nodes checks whether the destination is in its zone, if so route reply is sent back to source, else it will repeat the border casting process. The BRP is used in the ZRP to direct the route requests to the peripheral nodes(border nodes).ZRP relies on NDP provided by the Media Access Control (MAC) layer to check whether the neighbor nodes are alive or not. NDP transmits "HELLO" beacons at regular intervals say Tbeacon=0.25s.This short beacons contain only the source address. Upon receiving a beacon, the neighbor table is updated. If a new beacon fails to arrive within 2.Tbeacon of the most recent beacon, a link failure is reported. Neighbors, for which no beacon has been received within this specified time, are removed from the table.

3. A Survey on various improvements of ZRP

A survey has been conducted through various modifications done on the basic Zone routing Protocol. Adaptive ZRP (AZRP) modifies the base ZRP by allowing different zone radius for each node depending on its mobility instead of fixing it to be same for all nodes. Independent Zone Routing Protocol (IZRP) allows independently sized routing zones which allow nodes to dynamically and automatically configure their optimal zone radii in a distributed fashion, thus making the framework truly flexible. In Enhanced Zone Routing Protocol (EZRP) reliability of the route is calculated by each node. Fisheye Zone Routing Protocol (FZRP) adopts the concept of Fisheye state Routing (FSR) in which distance and path quality of the immediate neighborhood of a nodes are maintained and progressively less detail as the distance increases. A- Zone routing protocol tries to enhance the cache mechanism used in basic ZRP by associating a routing information priority with the latest access time and thus improving information store format of cache in the routing table. Power aware ZRP tries to reduce the power consumption by creating zones with respect to different power levels. Scalable unidirectional routing with zone routing protocol deals with the issue of unidirectional links by using a query enhancement mechanism that recursively builds partial routes to the destination. Genetic Zone routing protocol (GZRP) is based on the genetic algorithm (GA) which tries to discover multiple paths to the destination.

The conclusion drawn from this survey is that none of these methods considered the actual physical distance in determining the zone radius.

4. Distance Aware Zone Routing Protocol

The main issue in ZRP is determining the optimal Zone radius for which hybrid min search/traffic adaptive zone radius estimator gives the optimal measurement.. But the ZRP protocol determines the zone size only based on the number of hops, the actual physical distance between the nodes is not taken into consideration. Since MANET uses radio waves for communication, the bandwidth of radio waves is limited. So if the radius of the zone gets increased the radio coverage of the sender node will not reach the border nodes in its zone, so the number of broadcasts needed to find the border nodes in the zone, which will obviously increase which result in the increased utilization of bandwidth [11]. Effective utilization of bandwidth is one of the major issues faced by MANET routing which motivates the proposal of distance aware ZRP.Speed of packet delivery also gets increased. The proposed enhancement to ZRP for the effective utilization of bandwidth is to assign weight to edge where the edge weight is the actual physical distance between the nodes having links to each other. Other than number of hops, weight is also considered while checking whether a node can be included within the zone. A threshold value for distance is set according to the available bandwidth. So the nodes which exceed the threshold are not included within the zone[8].

4.1 Physical Distance Measurement in DZRP

Physical distance between nodes is measured by equipping each device with its own GPS receivers; we equip 3 fixed nodes with GPS receivers, and a one-time computation. Once computed, it is stored in the node permanently. Instead of direct communication, we go for hops. When a node wants to know its position, it locates 3 one-hop neighbors and sends a *PReq* (Position Request) to all of them. If they have precomputed positions, they simply return it via a *Prep*. Else, they themselves perform the same procedure and get their positions [8].

Then, we can calculate the coordinates (x,y) as:

$$x = \frac{c1(y1-y2)+c2(y1-y0)}{2[x0(y1-y2)+x1(y2-y0)+x2(y0-y1)]}$$

$$y = \frac{c1(x1-x2)+c2(x1-x0)}{2[y0(x1-x2)+y1(x2-x0)+y2(x0-x1)]}$$

where

$$c1 = x0^2+y0^2-x1^2-y1^2-d0^2+d1^2$$

$$c2 = x1^2+y1^2-x2^2-y2^2-d1^2+d2^2$$

5. Issues identified in DZRP

The first issue identified with DZRP is that it generates excess traffic. For this physical distance measurement itself additional traffic of is 20% generated. So it is not at all suitable for highly mobile environment. More over communication overhead is high. Actually for getting the above mentioned advantages of DZRP actual physical position of nodes is not required, only the physical distance between the nodes is needed. So the paper suggests an easy cost effective way to find the physical distance between the nodes.

6. Modification Proposed

The concept behind DZRP and its enhanced version remains the same, but the method of finding the physical distance between the nodes is different. The result obtained proved that the transmission delay is much reduced and throughput is considerable increased in the modified DZRP compared to the basic DZRP.

6.1 Physical Distance Measurement

Distance between the nodes is calculated based on the round trip time (RTT) which is the time required for a signal pulse or packet to travel from a specific source to a specific destination and back again. This round trip time is calculated from the hello packet sent by the neighbor discovery Protocol (NDP).

Figure. 2 Distance measurement using RTT

The time at which the hello packet is sent from the source to the destination and the time at which the destination's acknowledgement reaches the source is recorded. From this the distance between the nodes is calculated using the formula:

Distance = (t2-t1)/2 * V

Where,

t1=Time at which Hello beacon is sent from n1 to n2
t2=Time at which ACK beacon is sent back from n2 to n1
V=Transmission speed

6.2 Modifications Identified

Add a new field, distance which is computed based on the RTT, to the routing table of each node.

- Hello packet needs modification, i.e., a new field to store the time is to be added.
- IARP module needs modification. Here comes the checking of zone radius. It has to be modified i.e., the distance also has to be checked before deciding whether a node has to be placed inside the zone or outside the zone.

7. Advantages

Other than all the advantages of DZRP the modified one gives the following advantages:

- Additional traffic is not generated
- Less overhead
- Not a very complex algorithm
- Very less processing is needed at the nodes themselves.

8. Implementation

8.1. System Architecture

The tool which is planned to use is network simulator version 2.33.Network simulator 2 (ns2) is a popular open source discrete event simulator for computer networks. It is often used by researches to help evaluate the performance of new protocols or validate analytical models. ns2 allows you to setup a computer network, consisting of nodes/routers and links.

8.2. Module level Design

To evaluate the performance of DZRP, it has to be compared with basic ZRP. The implementation tool ns2 has to be installed initially. After that ZRP, which is not currently available with ns2 has to be patched. The simulation has to be generated using network animator. The graph which shows the transmission delay has to be plotted using xgraph. A copy of ZRP named DZRP should be patched next. The simulation and the graph which shows the transmission delay has to be plotted. Both graphs have to be compared to evaluate the performance.

9. Results Obtained

9.1 Simulation Parameters

Table 1: Simulation parameters

Parameter	Value
Number of Packet(Traffic) Sources	5
Topology Size	800x800 m
Transmission(radio) range	250 m
Traffic Type	Constant Bit Rate (CBR)
Packet size	512 Bytes
Standard packet sending rate	5 packets/sec [20Kbps]
Standard ad hoc host speed	20 m/s (Max)
Mobility Model	Random waypoint
Pause Time	5 sec
Simulation Time	900 sec
Wireless channel bandwidth	2 Mbps
ZRP periodic route update interval	10 sec
Zone radius	2 Hops

9.2 . Graph showing the throughput comparison

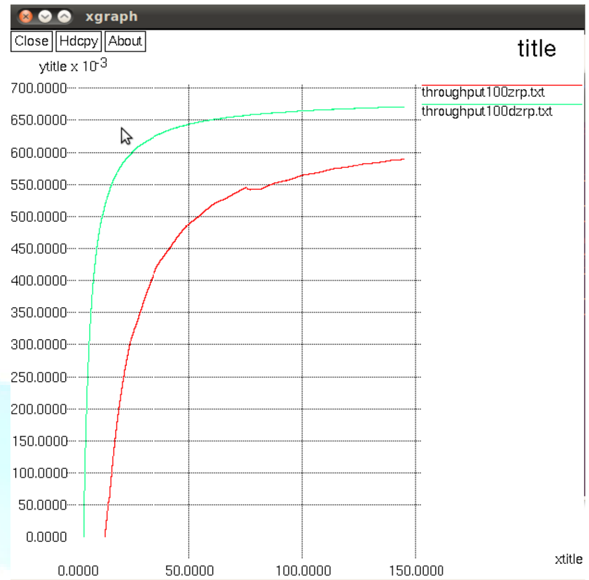

Figure. 5 Throughput comparison graph of ZRP and enhanced DZRP when number of nodes=100

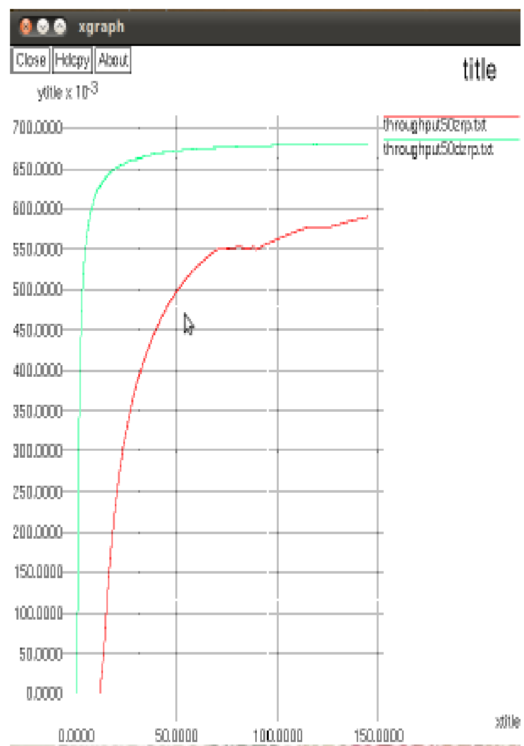

Figure. 6 Throughput comparison graph of ZRP and enhanced DZRP when number of nodes=50

Table 2:Comparison of result obtained for ZRP and EDZRP

Number of Nodes=30	ZRP	EDZRP
ReceivedPackets	21278	23277
Packet Delivery Ratio	97.9199%	99.9227%
Total Dropped Packets	9	1
Average End-to-End Delay	132.857 ms	131.918 ms

10. Results Analysis

From the output file obtained DZRP proved to have decreased delay and packet drop compared to ZRP. From the graph obtained DZRP proved to have increased throughput compared to ZRP. When the number of nodes is 5, the packet drop shown in the basic Zone routing protocol due to the loss of packets sent to the border nodes which is outside the zone radius is rectified in the improved Distance Aware Zone Routing Protocol. When the number of nodes increases, there is a considerable difference in average end to end delay, throughput, number of received packets and packet drop rate between the ZRP and DZRP. From the overall result analysis conducted it is clear that as the no: of nodes increases DZRP is having a considerable decrease in average end to end delay and packet drop and provides an increased throughput.

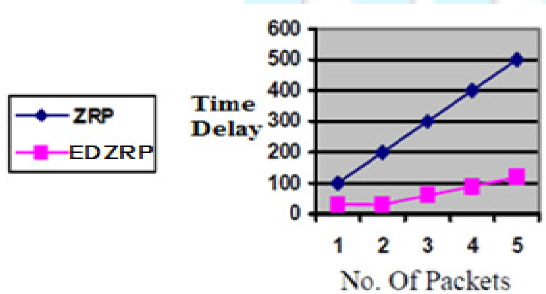

Figure. 7 Graph showing the comparison in time delay of ZRP and enhanced DZRP

11. Applications

Other than all the applications of basic protocol Enhanced distance aware zone routing protocol is most suited for applications like military, commando operations where communication delay is highly intolerable. In such a situation network has to be set up immediately without an infrastructure. Since there are not more than 50 nodes, the issue of network congestion due to traffic doesn't occur. So the time calculated from the sending and receiving of hello packets is accurate and the information communicated reaches the destination nodes without delay.

12. Future Work

The proposal of considering the distance as a factor for determining the zone radius can be also used for efficient utilization of power since according to Inverse Square Law, the power received by the receiving node is inversely proportional to square of the distance between the nodes [11].

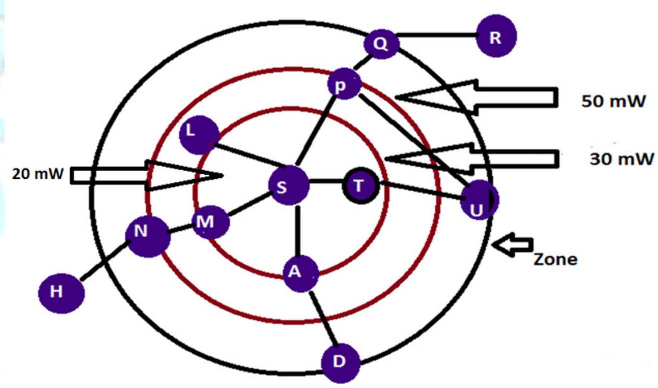

Figure. 8 Effective power utilization, Zone radius 2 hops

So the power required for delivery varies according to the nodes distance. For effective utilization of transmission power, multiple circles with increasing radius are considered from the source node. Different transmission power is assigned to the nodes within each circle which prevents the wastage of transmission power.

13. Conclusion

The enhanced distance aware ZRP reduces the total time required by the packet to reach the intended destination and provides efficient power and bandwidth utilization, in addition to all the advantages due to hybridization. Enhanced DZRP provides an increased throughput too. More over distance calculation using round trip time provides a simple and cost effective way of computing physical distance without generating additional traffic.

Acknowledgments

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