Zone Routing Protocol Using Anycast Addressing For Ad-Hoc Network

Tapaswini Dash
Computer Science and Engineering
International Institute of Information Technology
Bhubaneswar, India
tapaswini.iiit@gmail.com

Bharati Mishra
Computer Science and Engineering
International Institute of Information Technology
Bhubaneswar, India
bharati@iiit-bh.ac.in

***Abstract*— Zone Routing Protocol (ZRP) is a hybrid protocol that combines the advantages of both the proactive and reactive protocols. It is classified as: Intra Zone Routing, which uses hop count of the N-neighbors using proactive techniques and Inter Zone Routing, which includes the rest of the network excluding the N-neighbors using reactive techniques. In anycast routing, the packets are routed to the most nearest anycast group member. In this paper, the concept of anycast is used in Zone Routing Protocol assuming the destination as a member of anycast address, hence the packet can be sent to any of the other member of the anycast group which is located nearer to the the source node. In this paper a comparative study is also done among hybrid protocol (Zone Routing Protocol), and the proposed idea of using anycast addressing with Zone Routing Protocol where the proposed idea performs more efficiently.**

Keywords- ***Ad-hoc network; Zone Routing Protocol; Anycast routing***.

I. INTRODUCTION

An ad-hoc network is a collection of mobile nodes which can communicate among themselves without depending on any predefined infrastructure. Here, each node participates in the reliable operation associated with the network and some of them behave as routers to establish an end-to-end connection. Since, it is an infrastructure less network with limited resources, therefore an efficient routing in ad-hoc network is very crucial. There have been many proposals for an efficient routing protocol in an ad-hoc network [1]. They are classified as: proactive such as OSLR [2], reactive such as AODV [3] and hybrid such as ZRP [4]. ZRP is the most simple self-organizing and self-configuring protocol without a heavy load in the network

Anycasting is a new networking paradigm where identical address is assigned to multiple nodes providing a specific service. An anycast packet can be delivered to any of the anycast group member. In this paper anycast addressing is used with Zone Routing Protocol where multiple nodes which are assigned the same anycast address reduces the control packet overhead as the destination address can be the most nearest anycast group address.

This paper is divided VI sections. In Section II, the entire description for Zone Routing Protocol is presented. In Section III, the address conversion for Anycast addressing is described. In Section VI, algorithm of using Anycast addressing inn Zone Routing Protocol is proposed. In Section V, the performance evaluation for Zone Routing Protocol and the Proposed Algorithm is done. Finally, in Section VI, the conclusion and future work is stated.

II. ZONE ROUTING PROTOCOL

This protocol uses both the proactive and reactive schemes. The proactive scheme is used for all the nodes within the zone radius which is the Hop Count (HC) and the reactive scheme is used for all the other nodes in the network excluding the nodes in zone radius. The Zone Routing Protocol can be used in various network environments by setting proper zone radius [5].

A. *Intra Zone Routing Protocol*

The nodes within the zone use proactive routing. Here, each node within the zone records the routing information to the destination node DN in the routing table. When there is a routing request the path to the DN is determined by referring to the routing table. This is called IntrA zone Routing Protocol (IARP). This protocol is illustrated using an example described below:

- Node S generates the IARP packet periodically with a Hop Count (HC) and sends it to A, B, and C, which are its neighboring nodes (in Fig. 1 referred by the black solid arrow).
- Nodes which receive the IARP packet record the route information (HC=1, DN=S) in the own routing table by referring to the IARP packet information. The HC is incremented and the relay node (RN) is added. For example, the SN=S, HC=2, the RN=C. The Relay Node sends the IARP packet to its neighbor nodes.
- Until the HC is equal to zone radius, the second step is repeated.
- Nodes inside the zone carry out all the operation mentioned above and maintain their own routing tables. When there is a data packet sending request to the nodes within the zone radius, the packet is sent using the information in the routing table. Thus, the IARP maintains the route for each node inside the zone. In the routing table each record has a Time-To-Live (TTL) parameter. If an IARP packet for a record does not come during the TTL, the record in the routing table is deleted assuming the node movement.

B. *Inter Zone Routing Protocol*

In ZRP, when the data sending is outside the zone radius of the source, it is a reactive routing and is called IntEr Routing Protocol (IERP).

- In Fig. 2, we assume that the destination node DN is node D, which is located beyond the HC (assuming HC=1) and the source node S has no routing information about node D, so an IERP request packet is generated and sent to all the border nodes of the source with source node SN=S, DN=D and number of border-cast NB=1.
- We see that the IERP request packet is sent to all the border nodes of the source called ‘border-cast’. Here, the border nodes are node A, B and C.
- After the border nodes receive the IERP request packet they add one to the NB and add their own name to the relay node RN field in the IERP request packet. The information of the IERP request packet for node A is SN=S, DN=D, RN=A and NB=2. The route to the DN node is searched by referring to their own routing tables. If the DN is not found in the routing table then the border-cast is repeated as in Fig 3. But when the IERP request packets are sent to the SN or the RN, these packets are discarded by these nodes. If the DN is found in the routing table, then an IERP reply packet is sent to the SN. In Fig. 4, as the IERP request packet has the routing information from S to D, so the node I sends the IERP reply packet to the source node S by using this information.
- In fig. 5 the SN now knows the route to the DN=D and hence, it sends the data packet to D via the route S-C-I-D.

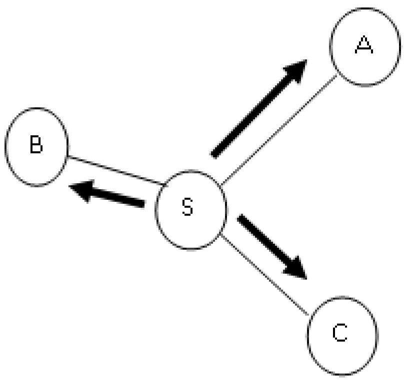

Figure 1. Transmission of IARP packets from S

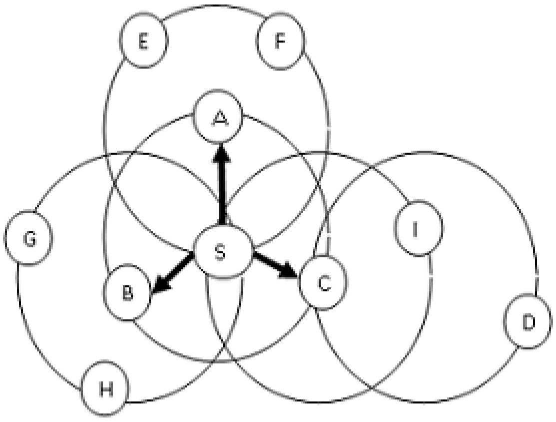

Figure 2. Border-cast of IERP packets.

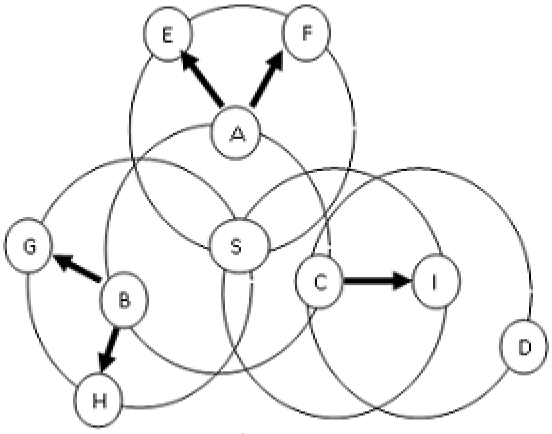

Figure 3. IERP Request packets.

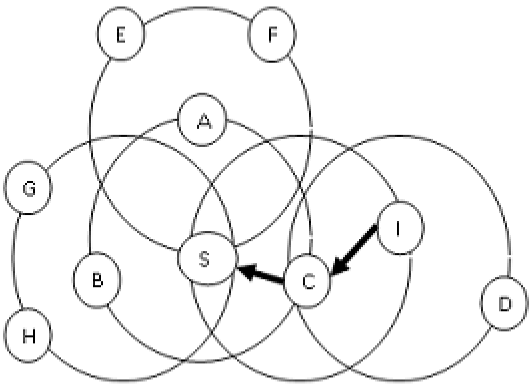

Figure 4. IERP reply packets.

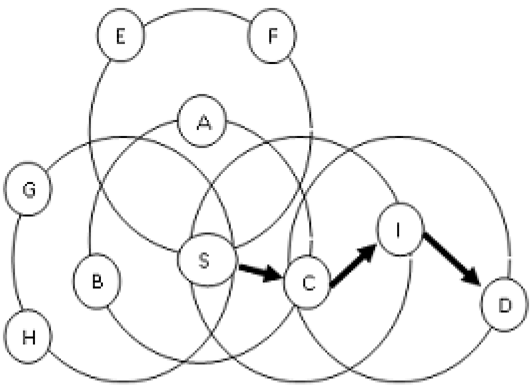

Figure 5. Path from S to D.

III. ANYCAST ADDRESSING

A single anycast address is assigned to multiple nodes and only one member of the assigned anycast address communicates with the originator at a time. Anycast has a stateless nature where it cannot ensure that all the packets belonging to the same anycast address will go to the same destination node. This leads to serious problem in that stateful protocol like TCP cannot be supported. When a host initiates TCP connection to an anycast address, the receiving host cannot set its own anycast address as the source address for the acknowledgement packet. The IPv6 specification [6] prohibits the anycast address from being set into the source address field of the packet header. This is because an IPv6 anycast address does not identify a single source node. If the protocol allowed the anycast address to be set to the source address of the packet , the receiving host could not be sure that all packet sent during the communication had come from the same host. Weber and Cheng [7] recently discussed the anycast address mapper proposed by Oe and Yamaguchi [8]. It translates the anycast address to its corresponding unicast address at the host receiving anycast packet; this is done prior to the anycast communication [9].

A. Anycast Address Resolution Protocol(AARP)

AARP resolves the anycast address specified by the application into their corresponding unicast address. In figure 6, when host C wants to establish anycast communication with a host whose anycast address is AA , the protocol follows the following steps:

- Host C calls the socket API (example connect() in TCP) with the anycast address AA within its parameter. The AARP Library's API is called instead of the socket layer's API.
- The AARP library converts the anycast address AA into the respective unicast address UA in the callee function.
- After conversion, the AARP Library calls the original socket API through the UA.
- After communication has been established, all packets from the host C are given the UA in their destination address and transferred to host S.

B. The Address Conversion Method

For address conversion the host connecting to the anycast address should receive atleast one packet from the destination host. There are two approaches to convert this address.

- THE PROBE PACKET METHOD (CLIENT-INITIATED) - The host sends a probe packet to the anycast address before the start of the communication, and it can obtain the destination's unicast address from the source address to the reply packet.
- THE PIGGYBACK METHOD (SERVER-INITIATED) - The anycast host appends its anycast address to the packet when sending it back to the connecting peer. It can recognize that the packet has been sent from the host associated with the anycast address by checking the information that has been added to the packet.

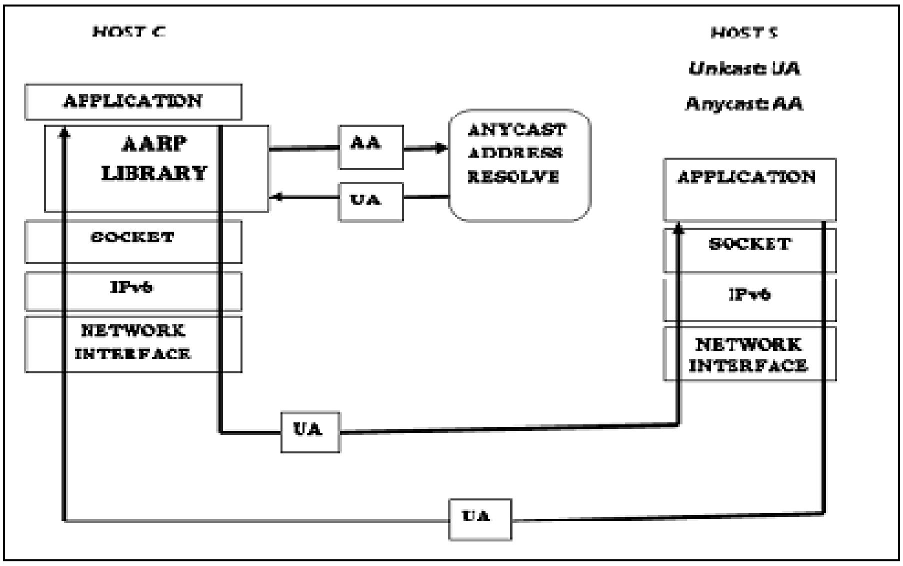

Figure 6. The protocol stack for AARP.

IV. PROPOSED ALGORITHM

The proposed algorithm assumes that the network has already implemented anycast addressing and the Zone Routing Protocol (ZRP) uses anycast addressing . The zone radius,i.e. the Hop Count (HC) is assumed to be one for the network.

A. Algorithm for the proposed idea

1) The source S wants to send data packet to the destination D.
2) The destination node is a member of the anycast address. So, the packet can be sent to any of the member of the anycast group which is more nearer to the source S. Hence, the destination node along with the other anycast group members belongs to the anycast address AA.
3) The source S checks its IARP packets which are sent periodically to all the nodes within its zone. If the routing information for any of the anycast address AA is found using IARP packets then the search is stopped and Step 7 and Step 8 is followed.
4) If the anycast address AA is not found within its zone, then IERP packets is border-cast to all the border nodes of S. If the routing information of the anycast address AA is found using IERP packets then the search is stopped and Step 7 and Step 8 is followed.
5) If the anycast address AA is also not found within the previously border-cast nodes, then IERP packets are again border-cast to all the border nodes of that previously border-cast nodes.
6) Step 5 is repeated until the anycast address AA is found.
7) If anycast address AA is found, then the IERP RouteReply packet is sent from the anycast address AA to the source.
8) The data packets are sent from the source S to the anycast address AA via the information received from the RouteReply packet.

B. Flowchart of the algorithm

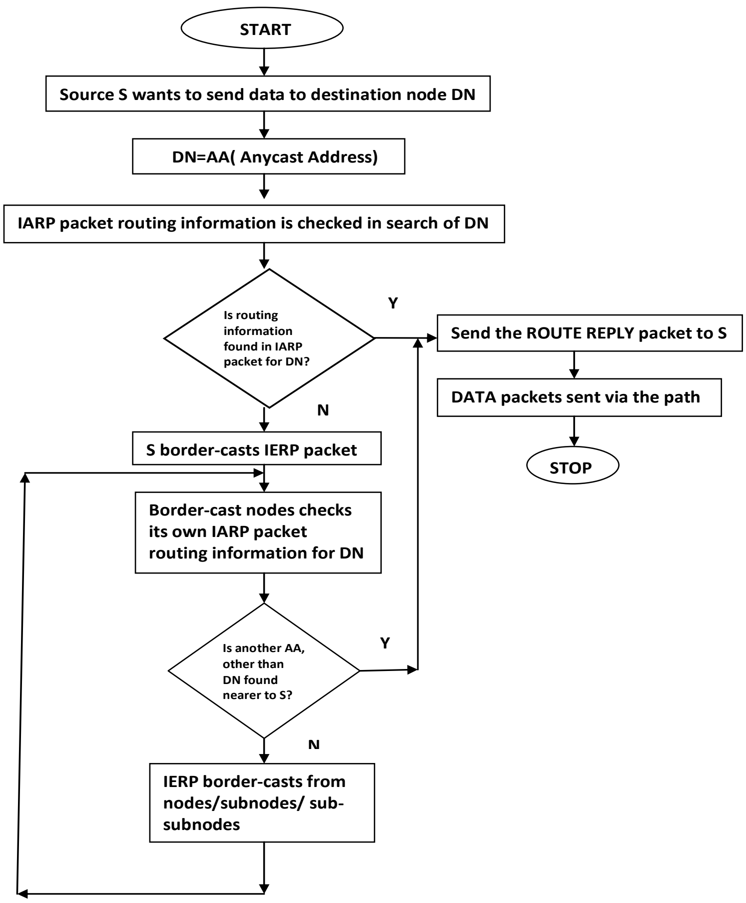

Figure 7. Flowchart of the algorithm

V. PERFORMANCE EVALUATION

The proposed idea is simulated using MATLAB 2009b and a comparative study of the proposed idea of using anycast in Zone Routing Protocol (ZRP) is done with the hybrid protocol (Zone Routing Protocol (ZRP)). The proposed idea has lower control packet overhead, lower power loss, lower normalized routing load, and higher packet delivery ratio.

A. Simulation Parameters

In this simulation we have the following parameters:

- Number of nodes- Ranges from 1000 to 4000.
- Type of topology- User-specific.
- Number of data packets- Ranges from 100 to 500.
- Zone radius (Hop Count) for ZRP- 1.
- Anycast addressing – Assumed to be already implemented in the network.

B. Simulation Results and Consideration

In Fig.8, we show the simulation results for the control packet for Zone Routing Protocol and Zone Routing Protocol using anycast. From this figure, we conclude that the control packet overhead for ZRP is more than the ZRP using anycast as the destination node is the member of the anycast group and hence, the search takes place for any of the anycast address member which is nearer to the source.

In Fig.9, we show the simulation results for the power loss against the number of message packets sent for ZRP and ZRP using anycast. From this figure, we conclude that the power loss for ZRP is more than the power loss for ZRP using anycast because in ZRP, the search is for an unicast address which can be located far from the source, but in ZRP using anycast, the destination node is a member of anycast group. Hence, the most nearer anycast member can also be the destination.

In Fig.10, we show the simulation result of the comparison of packet delivery ratio against number of message packets sent, between ZRP and ZRP using anycast. Packet delivery ratio is the ratio between the received packets by the destination node (anycast address AA) and the sent packets by the source node. From this figure, we conclude that the packet delivery ratio for ZRP is lesser than ZRP using anycast because of the reason stated above.

In Fig.11, we show the simulation result of the comparison of the normalized routing load against the number of message packets sent, between ZRP and ZRP using anycast. Normalized routing load is the ratio between the routing control packets and the received packets by the destination (anycast address). From this figure, we conclude that the normalized routing load for ZRP is higher than ZRP using anycast because of the reason stated above.

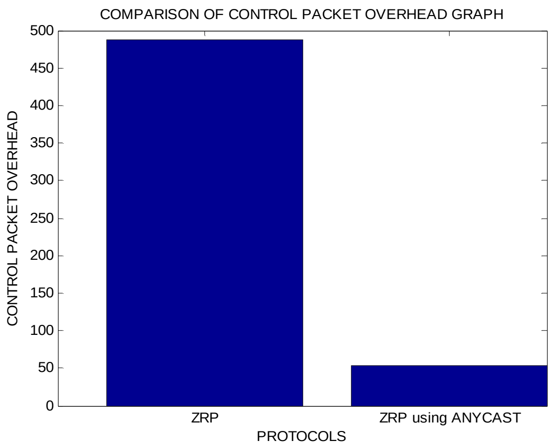

Figure 8. Characteristic of control packet overhead

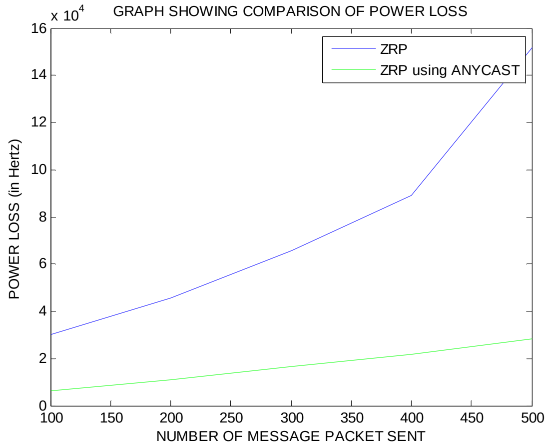

Figure 9. Characteristic of power loss

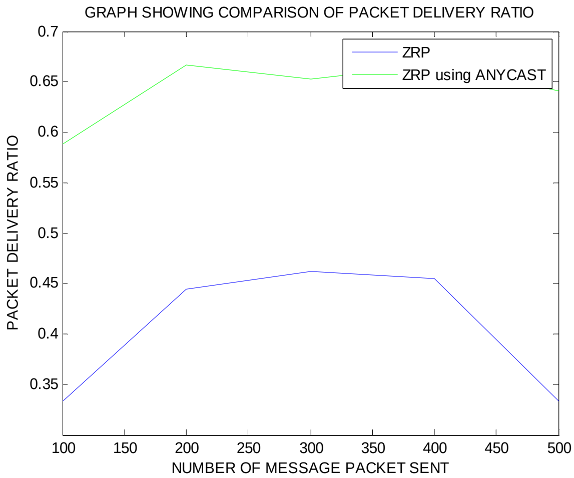

Figure 10. Characteristic of packet delivery ratio

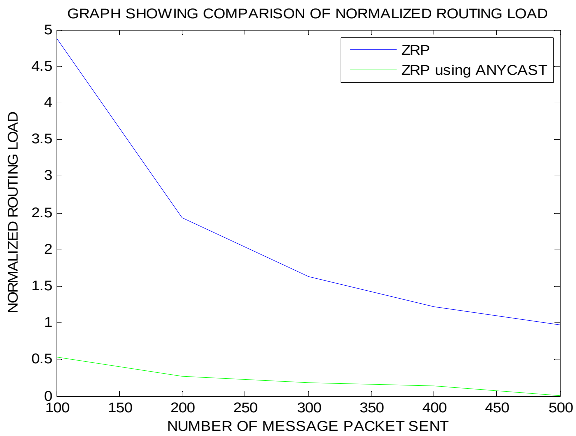

Figure 11. Characteristic of normalized routing load

VI. CONCLUSION AND FUTURE WORK

In this paper, we have proposed an idea of using anycast addressing in Zone Routing Protocol (ZRP). From the simulation results we have concluded the following:

- The control packet overhead for ZRP using anycast is less than ZRP.
- The power loss for ZRP using anycast is less than ZRP.
- The packet delivery ratio for ZRP using anycast is more than ZRP.
- The normalized routing load for ZRP using anycast is less than ZRP.

As a future work, we plan to implement anycast addressing in the network so that the results obtained can be more accurate as the overhead for implementing anycast addressing can be estimated. We also plan to design an algorithm to decide the zone radius based on the network environment change and verify its effectiveness using anycast addressing in ZRP.

ACKNOWLEDGMENT

The authors wish to thank the Department of Computer Science and Engineering of International Institute of Information technology, Bhubaneswar, for their guidance and encouragement towards the completion of the work and also Veer Surendra Sai University of Technology, Burla for their valuable support.

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AUTHORS PROFILE

Ms. Tapaswini Dash is currently continuing her M-Tech in the Department of Computer Science and Engineering at International Institute of Information Technology, Bhubaneswar. She has obtained her Bachelor's degree in Information technology from Veer Surendra Sai University of Technology, Burla. Her research interest is Wireless Networking, and Mobile Computing.
Email id – tapaswini.iiit@gmail.com

Mrs. Bharati Mishra is currently working as an Assistant Professor in the Department of Computer Science and Engineering. She has obtained her Bachelor's degree in Computer Science and Engineering from Veer Surendra Sai University of Technology, Burla. She has obtained her Master's degree in Computer Science and Engineering from International Institute of Information Technology, Bhubaneswar. Her research interest is Network Security.
Email id - bharati@iiit-bh.ac.in