A Hybrid Approach of Using Anycast Addressing With Zone Routing Protocol

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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, a literature review about Zone Routing Protocol and Anycast addressing is presented along with the concept where we propose to use Anycast addressing in Zone Routing Protocol assuming that the destination as a member of anycast address, is proposed. This idea is proposed for the consistent improvement of performance of Zone Routing Protocol.

Keywords: *Ad Hoc Network, Anycast Addressing, Zone Routing Protocol.*

1. 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 we propose a new concept of using Anycast addressing 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 into 6 sections. In section 2, we provide a brief literature review about Anycast addressing and Zone Routing Protocol. In section 3, we describe the Zone Routing Protocol in details. In section 4, we describe the address conversion protocol for Anycast addressing. In section 5, we propose the algorithm of combining Anycast addressing with Zone Routing Protocol which is also described along with the flowchart. Finally in section 6, the conclusion and future work is stated.

2. Literature Review

In this section, we discuss all the work that has been done for Anycast addressing and Zone Routing Protocol. We have discussed the various protocols that has been proposed for it and implemented till now. We have even discussed the drawbacks for few. So, a new protocol is proposed which can improve the performance parameters of these two concepts. Hence, by combining the advantages of both Anycast ddressing and Zone Routing Protocol, we can obtain a better protocol which prove to be more efficient.

2.1 Anycast Addressing

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. We present a short literature review about Anycast addressing.

In [5], Dong Xuan et al., addressed routing problems for anycast messages in packet switching networks. They have addressed the issues related to routing anycast packets. The anycast protocol is consisted of two sub protocols: the routing table establishment sub protocol and the packet forwarding sub protocol. For the former, they propose four methods (SSP(shortest-shortest path method), MIN-D(minimum distance method), SBT(source based tree method), and CBT(core-based tree) methods) in which the performance evaluation shows that the systems that use the SBT or CBT method perform much better than the one using the SSP or MIN-D method. But they also note that some combination of the methods introduced in this paper results in delay performance very close to the dynamic optimal routing protocol (DOR).

A shared-tree has advantages of scalability as it is a one tree per group approach, however, the traffic may concentrate on somenodes of the singletree trunk when many sources sendtheir multicast packets to the tree center (core)simultaneously. Anycast routing may lead the traffic from different sources through different paths to the members in a group. Furthermore, the traffic from the same source can be transmitted along different paths to the members inthe group by using dynamic anycast path selection. Thus, the performance and reliability of multicast routing using anycast routing techniques was improved. In [6], Weijia Jia et al., proposed a protocol consisting of two parts: router configurations and packet transmission. The algorithm uses an improved version of the original CBT protocol. While maintaining the same level of scalability, there improved CBT protocol has much better performance relative to CBT based algorithms because we have used anycast routing technology, but the disadvantage was that The key issue was to model thetraffic on the shared multicast tree so that a delay bound can be derived.

The typical source-tree routing algorithm applies the shortest path tree (SPT) algorithm and one source tree is required to construct for each source. Routers implementing a link state algorithm periodically collect reachable information from their neighbors, and the flood this throughout the routing domain in so-called linkstate update packets. One of the overheads in the source tree approach is the processing cost of Dijkstra calculation which computes the shortest-path tree for each active source. Another problem associated with source-tree routing is that a router has to keep the pair information (source, group) and consequently may overwhelm the routers in a subnet or area. In reality the Internet is a complex, heterogeneous environment and potentially has to support many thousands of activegroups which may sparsely distribute. Obviously, the source tree approach is not scalable. Therefore, in [7], they made a comparative study between the well-known source tree and shared-tree routing and discovered that the main drawback of using a shared-tree in a network is the“traffic concentration”. If every sender uses the same shared-tree, traffic may congest along certain links of the shared-tree, especially near the core of the shared-tree.Another drawback of the shared-tree is that the sender and receiver may not connect through the shortest path, hence the end-to-end delay could be higher than using the source tree approach.in order to overcome the the shortcomings of shared-tree aand shared tree they used anycast.

In [8], a dynamic routing algorithms, which are suitable for IP anycast packet forwarding is proposed by Dong Xuan et al. The objective of the dynamic routing algorithm is to minimize the computational complexity to update the tree and maintain the routing stability bymaking minimal changes to the current routing tree of the network. After the tree formations, the packet forwarding protocol will decide the transmission of the packets based on the cost factor. The two main protocols involve in thepacket transmission are the Routing Tree Formation Protocol (RTFT) and the Packet Forwarding Protocol (PFP).The major outcome of this paper is new dynamic RTFP and PFP.They worked on Anycast Group Based Shortest Path First algorithm (AGBSPF), Load-Balanced AGBSPF algorithm Core-based Tree (CBT) and Load Propagation algorithm which are the proposed new protocols for anycast packet forwarding. They developed AGBSPF and evaluated it. It guarantees the shortest path from the source to the receiver of the anycast group as it will identify the nearest node with the same anycast address from the source. Thus, it results in lesser total distance compared with the Core Based Tree (CBT) either for random topology or the group based. Hence, with lesser distances, AGBSPF reduces the end to end delay for the packets transmission and gives the fastest packet transmission speed rate compared to CBT. Besides, CBT-Random gives the worst case from the simulation results whereas the CBT Topology and CBT-Group gives similar results. It is because the CBT-T is choosing the center node based on the maximum number of passes-by other node, so most probably the core node of theCBT-T is same as the CBT-G. However CBT-G produces slightly lesser end to end delay than the CBT-T as for different group, CBT-G selects different core that is nearer to the destination group compare to static core node selected by the CBT-T. But, the disadvantage was group membership and security issues were not considered.

In [9], the support of service-oriented addresses anycast communication as discussed. Since there are no protocol standards or even consensus on routing control, inter-segment anycast commnnications are not yet available. Anycast Address Resolution Protocol (AARP) to establish TCP connections with a specific anycast address is presented and a routing protocol for intersegment anycast which changes the anycast address into a corresponding unicast address, and actual communication uses the unicast address after conversion is proposed.

In [10], Akiko Nakaniwa et al., propose a server and route selection method with application-level QoS-based anycast protocol. The protocol has the following advantages. 1) The latest server and route information can be constantly acquired through distributed resource management by E-BB. 2) The server and route selection algorithm enables to consider both the server load and network load simultaneously. 3) High reliability can be guaranteed by decentralized control. They have proposed a QoS-based anycast protocol to select the best server and the best route in Diffserv networks. In this protocol, the server and route selection algorithm that enables us to consider both the server load and network load simultaneously is introduced. The resource management is distributed to improve the system reliability. Also, the broadcasting of search messages to candidate servers to make the discovery of the best server and the best route more effectively is applied. The proposed protocol here is able to effectively discover the best server and the best route that satisfy the user's QoS requirements.

In [11], Jianxin Wang, and Yuan zheiig , proposed anycast protocol for IP flow in mobile ad hoc networks, which is based on the AODV protocol. AODV protocol may transmit the unbalanced traffic load in the network. Using anycast protocol A-AODV, the traffic load can be balanced thus, reducing the transmission delay and increase the route utilization. That all the members in one anycast group share one anycast address enables them to take the same priority in the routing searching process.Therefore, this approach can provide the transmission path with shortest length. With scattering of anycast server in the geographical area, the traffic load is obviously distributed inthe network. All these properties can help to improve the performance of the network.

In [12], an anycast protocol for Ipv6 flow in mobile ad hoc networks, which is based on the DSR protocol is proposed by Jianxin Wang et al.. DSR performs poorly when the traffic load is unbalanced in the network. In contrast to DSR, A-DSR achieves good load balance . Since the members in the anycast group sharing one anycast group address makes all members equally share of thetraffic load. This provides the transmission path with multiple shortest lengths. With scattering of anycast server in the geographical area, the traffic load is obviously distributed in the network and consequently, A-DSR enhances the performanceof message routing. Therefore, anycast protocol can effectively improve the performance and enhance the service availability of mobile wireless ad hoc network through the distributed the traffic load, especially for the replicated services of a group of peer nodes.

Another anycast routing protocol called Anycast Routing protocol based on Multi-Metrics (ARMM) is proposed by Zhang Li et al. [13]. ARMM protocol sets up the routing by taking hop number, data transmission delay, residual bandwidth, and server load as the server and path selection criteria. ARMM differs from other approaches as it uses values of bandwidth and delay on the direction from servers (anycast members) to clients, rather than the normal direction from clients to servers. So ARMM can select the best server/path with sufficient network resource (say bandwidth etc) for server data transmission to clients. ARMM can achieve better resource utilization for the service data for QoS routing and also show that independent anycast routing protocol has low probability to cause the routing oscillation as normal unicast routing protocols does when dynamic metrics are introduced.

In [14], ARDSR(An Anycast Routing Protocol for Mobile Ad hoc Network) is proposed by Gegang Peng et al. This protocol has a lot of advantages such as balancing traffc load, conserving network bandwidth and saving host energy. It accomplishes an effective anycast routing in dynamic ad hoc networks. The simulation results show that the protocol can get good performance in dynamic network environment. This protocol can balance traffic loads better in ad hoc network. Because it always selects a nearest destination node from an anycast group node as the destination of data transmission, ARDSR can conserves node power and further reduces the routing overhead involved.

Another two routing protocols for inter–segment anycast to support anycast–oriented communication is proposed in [15]. The proposed architecture (1) achieves the advantages of anycast communications, (2) takes the deployment scenario into the existing unicast network into consideration, and (3) maintains scalability. RIPng and AOSPF were modified to ARIP and AOSPF, which support both unicasting and anycasting.

In [16], a new anycast routing protocol called PIA-SM (Protocol Independent Anycast - Sparse Mode) is designed and implemented. They focused on PIM-SM (Protocol Independent Multicast - Sparse Mode), which is one of multicast routing protocols available now, to develop an anycast routing protocol because anycast and multicast have many similar properties. PIA–SM which realize IPv6 anycast communications. In addition, the PIA-SM router was implemented on an existing system and that the router can forward anycast packets to most appropriate anycast receiver is verified. PIA–SM selects an anycast receiver but that selection does not depend on any client but the RP (Rendevous Point), gathers traffic of anycast packets on the RP. In addition, PIA router adds the entry of anycast addresses as host entries into its unicast routing table. These problems generate the serious scalability problem when we use PIA–SM as the anycast routing protocol in the global network.

In [17], they propose a novel anycast-based mobile P2P (Peer-to-Peer) routing protocol for MANETs, called AMPP, which integrates Chord and anycast routing protocol at the network layer in highly dynamic MANETs. They propose a network layer routing protocol AMPP, which can reduce overhead and optimize query lookup service. AMPP combines advantages of IP anycast and DHT-based P2P protocol.

A new scope for anycast is presented in [18] is an Application-Layer Distributed Home Agent Discovery on Mobile IPv6 forming anycast Mobile IPv6 framework to offer distributed home agents discovery protocols, enabling the mobile node (MN) to find the best suitable Home Agent (HA) and correspondent node (CN) to forward datagram. Mobile IPv6 owns the advantages including service reliability, less latency and shorter route path with the help of anycast. This paper proposes a scalable anycast mobile IPv6 network to try gaining exposure for anycast and improving its efficiency. The proposed method can save bandwidth and reduce delay even with mobile node hand-off.

In [19], an anycast scheme is designed to support both the media streaming service and TCP based applications. It consists of two parts, an anycast address mapper and a clustering scheme. The anycast address mapper is used to resolve the anycast address. The clustering scheme is used to manage the overhead of the anycast requests. In order to make the clustering scheme be able to support IPv6, the message formats and schemes must be modified to support the features of the IPv6. The scheme can be used to establish a stable route for anycast supported connection oriented applications. But the packet data structures and data flows was needed to be improved. The DL scheme can be used to control the query message of on demand routing protocols such as AODV and DSR.

In [20], they have developed a new Anycast routing protocol by modifying the existing multicast routing protocol because anycast and multicast have many similar properties. Protocol Independent Multicast-Sparse Mode (PIM-SM) is chosen as a basis to design a new anycast routing protocol. they have improve the design by considering the status (free or busy) of the anycast receivers as an important factor in our design. Besides the metric value of the receiver,they have also proposed a new variable in the routing table called BMF (Best Metric Factor). In this paper we proposed a new IPv6 anycast mechanism depending on the PIM-SM, which improved the performance by reducing the delay and keeping the jitter stable most of the time. The effect of the proposed design is observed clearly when we increase the number of the anycast senders because the proposed mechanism depends on the load traffic.

In [21], the authors introduced density-based anycast routing, a new anycast routing paradigm particularly suitable for wireless ad hoc networks. Instead of routing packets merely on proximity information to the closest member, density-based anycast routing considers the number of available anycast group members for its routing decision.They presented a unified model based on potential fields that allows for instantiation of pure proximity-based, pure density-based, as well as hybrid routing strategies. there results show that the best performance lies in a tradeoff between proximity and density. In this combined routing strategy, the packet delivery ratio is considerably higher and the path length remains almost as low than with traditional shortest-path anycast routing.

In [22], a distributed k-Anycast routing protocol based on mobile agents is proposed. The protocol forms multiple components and each component has at least k members. Each component can be treated as a virtual server, so k-Anycast service is distributed to each component. In this protocol, mobile agents are applied to initiate or manage components and routing table, so each routing node needn't global network information, only needs to exchange routing information with its neighbors, so the protocol saves much communication cost and adapts to high dynamic networks. Performances of the new designed protocol in both high network load and large network scale is better than performance of those former k-Anycast communication approaches.

In [23], performance of two anycast based reactive routing protocols for mobile Ad hoc networks-Anycast Routing based Dynamic Source Routing (ARDSR) and Anycast routing protocol based on AODV (A-AODV) is evaluated.

Performance is evaluated with respect to fraction of packets delivered, end-to-end delay, routing load and energy consumption for given traffic and mobility model. Relative strength, weakness and applicability of each anycast based reactive routing protocol to diverse situations are studied and evaluated. These on demand anycast routing protocol improve the performance and enhance the service availability of mobile wireless Ad hoc network.

In [24], the protocols based on a theory of potential fields have been proposed to improve packet delivery ratio in large mesh networks by routing to area with higher density of nodes instead of the shortest path routing. Here, they consider the density of nodes through count of routes. They proposed a simple anycast protocol which utilizes count of routes to the anycast group member as a routing metric and evaluate its performance. They demonstrated that the protocol can effectively work under dynamic conditions in wireless ad hoc networks. Especially is scalable for networks with few group members out of many nodes and for ad hoc networks applied in pedestrian speed scenarios. Due to the dynamic nature of these networks, pure proximity routing has difficulties to find alternative routes when intermediate link or node to group member fails. they presented the anycast protocol which has advantage of shortest path routing as well as considers density of hosts in the network.

2.2 Zone Routing Protocol

A lot of research is going on Zone Routing Protocol(ZRP). A short survey about all the work that has been done till now is presented in this sections. In [25], Marc R. Pearlman,and Zygmunt J. Haas, address the issue of configuring the ZRP to provide the best performance for a particular network at any time. Previous work has demonstrated that an optimally configured ZRP operates at least as efficiently as traditional reactive flood-search or proactive distance vector/link state routing protocols (and in many cases, much more efficiently). In the first half of this paper, they demonstrate the effects of relative node velocity, node density, network span, and user data activity on the performance of the ZRP. They introduce two different schemes (“min searching” and “traffic adaptive”) that allow individual nodes to identify and appropriately react to changes in network configuration, based only on information derived from the amount of received ZRP traffic. The amount of intrazone control traffic required to maintain a routing zone increases with the size of the routing zone. However, through a combination of bordercasting and query detection/termination, they were able to exploit the knowledge of the routing zone topology to reduce the amount of interzone route query traffic. In summary, dense networks consisting of a few relatively fast moving nodes favor reactive (small zone radius) configurations. On the other hand, a sparse network consisting of many slowly moving nodes would favor a more proactive (large zone radius) configuration.

In [26], Prasun Sinha et al., proposed the extensions to ZRP to support its deployment when unidirectional links are present. In particular, a query enhancement mechanism that recursively builds partial routes to a destination is proposed. This work extends the Zone Routing Protocol for functioning in networks with unidirectional links. The most common reason for the presence of unidirectional links is the difference in transmission capabilities of the mobile nodes. The intra zone and inter zone routing protocols have been modified to work for unidirectional links. For unidirectional links with large (larger than ZONE_RADIUS) inclusive cycles, a mechanism for recursive enhancement of the query has been proposed. The nodes that do not know of the destination but know of alternate nodes that have paths to the destination are reported back to the source. If the query is unresolved the source then issues an enhanced query that computes route for one of the alternate destinations. A heuristic has also been proposed to solicit enhancement messages from nodes when all the previous mechanisms fail to compute routes due to unidirectional links with large inclusive cycles.

In [27], Spilios Giannoulis et al. focus in the routing layer while closely observing the developments in MAC layer. They examine analytical simulation results for the routing protocols DSR, TORA and ZRP especially focusing in ZRP and the impact of some of its most important attributes to network performance. Zone Radius and IARP Update Interval against DSR and TORA. Regretfully TORA was not up to the task and it performed poorly throughout all the simulation sequences, hence putting itself out of competition. DSR on the other hand performed admirably and it would be the clear winner if not for its bad behavior in high traffic cases. There is where ZRP takes over the task of maintaining the network stable and does it well with little end-to-end delay increase. Zone radius attribute is clearly having a great impact in ZRP performance. They concluded that the zone radius should be configured to as low as 2 hops in case of low traffic and mobility scenarios, but as the traffic increases so must the zone radius.

In [28], the authors propose a Selective Border-casting Zone Routing Protocol (SBZRP) to reduce the network load by limiting the number of control packets when the protocol searches for a new route. The performance of the proposed protocol was evaluated by computer simulations using two Scenarios: Scenario I (nodes were not moving) and Scenario II (nodes were moving). They concluded that. 1) When the network load is high, the number of arrived packets to DN without loss of SBZRP is higher than ZRP, resulting in better throughput of SBZRP. Also, the mean delay of SBZRP is lower than ZRP, 2) When the node moving degree is high, the SBZRP has high link usability than ZRP.

By adopting the idea of Fisheye State Routing in ZRP, a more efficient protocol called Fisheye Zone Routing Protocol (FZRP) was proposed in the paper. FZRP provides the advantage of a larger zone with only a little increase of the maintenance overhead. Two levels of routing zone are defined in FZRP: the basic zone and the extended zone. Different updating frequencies of changes of link connectivity are associated with the basic zone and extended zone. In [29], Chun-Chuan Yang and Li-Pin Tseng, an efficient clustering and routing protocol that combining Zone Routing Protocol with the idea of Fisheye State Routing was proposed. The protocol was called Fisheye Zone Routing Protocol (FZRP), in which two levels of routing zone, the basic zone and the extended zone, are defined. Each mobile node in FZRP maintains timely routing/topological information in its basic zone. In order to reduce the maintenance overhead introduced by the extended zone, updating frequency for the extended zone is properly reduced. Reduction of the updating frequency for the extended. Zone results in inaccuracy of the routing table, so the mechanism of bordercasting has been modified as presented in the paper. Simulation study has shown that FZRP is more efficient than ZRP in route finding with only a little increase of the maintenance overhead.

In [30], Akio Koyama et al. proposed an Enhanced Zone Routing Protocol (EZRP). In EZRP, each node calculates the reliability of the route. In the case of reliable route, the Source Node (SN) sends the data packet directly to the Destination Node (DN) using that route without route searching. While, in the case of unreliable route, the SN searches for a new route again. They have showed that the network performance can be improved by using EZRP. Hence, it can be concluded that when the network load is high, the number of arrived packets to DN without loss for EZRP is higher than ZRP, resulting in better throughput of EZRP. Also, the average delay of EZRP is lower than ZRP.

The new concept of genetic algorithms provides a set of available paths to the destination in order to load balance the network. This gives us the reduction in overhead and better delivery of packets. A new routing protocol as Genetic Zone Routing Protocol (GZRP) is proposed inn [31], which applies the genetic algorithmic approach for finding the multiple shortest paths (near optimal) to the existing Zone Routing Protocol in order to load balance the network in the case of congestion occurrence and provides robustness in the case of route failures. This gives the better delivery of packets to the destination and reduces overhead and delays on the network. In [32] also the results of the effect of load balancing on GZRP is presented. The results show that GZRP outperforms ZRP while balancing the load. we have presented the performance evaluation of Genetic Zone Routing Protocol (GZRP) which is an extension to the Zone Routing Protocol (ZRP) with the use of genetic algorithm (GA). GZRP is more efficient compared to ZRP as it reduces considerably the average end-to-end delay and control overhead. The results indicate that GZRP is well balanced protocol compared to ZRP due to mobility of the nodes and number of the nodes in a network is concerned.

Another perspective is the fact of implementing service discovery at the routing layer instead of the application layer, in order to reduce Service Discovery (SD) overhead and to limit resources consumption. In [33] the authors develop an integrated service discovery protocol, called BF-SD-ZRP, utilizing a combination of different optimization techniques: piggibacking of SD information on the routing messages, compact description of SD using Bloom filter (BF) and service caching. They have presented a method for discovering services using a combination of Bloom filters and the extensibility feature of ZRP. In addition, the protocol uses local caching to reduce discovery latency. It is expected that BF-SD-ZRP is better than other cross-layer proposals [34, 35]. The service cache is used to conserve network bandwidth.

In [36], Yuki Sato et al. propose a new zone based routing protocol, which reduces the number of control packets. In the conventional routing protocols, the control packets are transmitted periodically. However, in the proposed protocol, the control packets are only transmitted when nodes are moving. The proposed method has low delay characteristics than EZRP,and reduced control packet overhead.

In [37], A. Loutfi and M. Elkoutbi, studied the impact of the network size, the traffic load and the zone radius on ZRP performances. The obtained results show that a radius zone of 3 is a preferred and optimal value compared to radius 2 when the traffic load is important. They studied the impact of three parameters: density, load and mobility on the optimal radius value for ZRP. The obtained results show that a value of 2 can be considered as optimal for small and medium loads. The value of 3 is suitable in case of an important load and high density.

In [38], Brijesh Patel and Sanjay Srivastava proposed a general, parameterized model for analyzing control overhead of ZRP. A generic probabilistic model for data traffic is also proposed which can be replaced by different traffic models. Further, as the mobility increases the optimal zone radius value decreases, and as the traffic increases the value of optimal zone radius increases. If a node operates away from the optimal zone radius setting then it has to bear additional routing overhead. They observed that as the mobility increases the optimal zone radius value decreases. And as the traffic increases the value of optimal zone radius increases. If the nodes operate away from the optimal zone radius setting, it has to bear additional overhead. The optimal zone radius setting varies according to network conditions. ZRP framework must behave adaptively against these conditions to give efficient and scalable performance. In order to make ZRP adaptive, the mechanisms must be devised for detecting the non-optimality of zone radius setting.

In [39], AZRP is discussed, which combines two completely different routing methods into one protocol. Within the routing zone, the proactive component AIARP maintains up-to-date routing tables. Routes outside the routing zone are discovered with the reactive component AIERP using route requests and replies. By combining border casting, query detection and early termination, it is possible to reduce the amount of route query traffic. AZRP makes an extension for ZRP protocol that can adapt well to the complicated network with nodes moving non-uniformly. AZRP utilizes the excellent performance of the hybrid-driven manner of ZRP and simultaneously overcomes the bad adaptability of ZRP which assumes each node move uniformly and presets the same zone radius.

In [40], SreeRangaRaju and Jitendranath Mungara, proposed an algorithm to provide improved quality of service via hybrid routing protocol- Zone Routing Protocol (ZRP). They considered two reactive routing protocols Dynamic Source Routing (DSR) and Ad hoc On Demand Distance Vector (AODV) as reference for analyzing ZRP by considering route acquisition delay and quick route reconfiguration during link failure. These parameters viz., route acquisition delay and quick route reconfiguration have their impact on increase in end to end delay, this automatically decreases the number of packets received thus the throughput. To improve the efficiency of ZRP we have proposed an algorithm. The proposed work provides quick route reconfiguration by multicast routing and selective border casting mechanisms during link failure conditions and acquisition delay is been reduced by controlling query message packets, which in turn reduces the control overhead. Thus by the implementation of their proposed algorithm the average end-to-end delay will be minimized, which results in better throughput. So the number of bytes and total packets received at the destination will be increased.

The problem of routing by considering link stability (link expiry time) and node mobility is also a major concern. Link instability and node mobility causes frequent topology changes that result in routing complexity. The proposed Zone and Link Expiry based Routing Protocol (ZLERP) for MANETs is an enhancement to existing ZRP that offers better routing services [41]. An attempt is made to limit control overheads in the network by selecting the path with stable links between two nodes. This paper presented a model for unicast, source initiated routing for mobile ad hoc networks using hybrid protocol which ensures link stability and limits the control overheads of the network to some extent. In this proposed method, pattern of node movements is studied using received signal strengths between neighboring nodes at periodic time intervals and link stability is determined. It does not introduce any extra overheads into the network for getting necessary information which is required for discovering stable links, as it is done by NDP while finding neighbors. As links are stable, breakage will occur less frequently, hence less number of control packets are propagated in the network for route maintenance. However the limitation of the protocol is, path found may not be a shortest path because links contributing in a shortest path may not be stable links. We need to address the connectivity improvement with the proposed scheme.

The performance evaluation comparison of ZRP with other protocol is also an important parameter that should be considered. In [42, 43, 44], the performance evaluation of three different routing protocols i.e. Dynamic Source Routing Protocol (DSR), Ad hoc On-demand Distance Vector (AODV), Fisheye State Routing (FSR) and Zone Routing Protocol (ZRP) with respect to variable pause times is done. Performance of DSR, FSR and ZRP is evaluated based on Average end-to-end delay, Packet delivery ratio, Throughput and Average Jitter. According to the simulation results, DSR shows best performance than AODV, FSR and ZRP in terms of packet delivery ratio and throughput as a function of pause time. FSR show lowest end-to-end delay and ZRP has less average jittering than DSR, AODV and FSR. DSR and AODV performed the worst in case of average jitter and ZRP performed the worst in case of throughput.

In [45], implemention of the zone-based routing protocol called ZRP and EZRP to real machines was done and it was evaluated by real environment. In the evaluation results, we showed that EZRP which is our proposed protocol has better performance than ZRP. By using EZRP, the number of IERP packets could be decreased than ZRP. The transmission success rate and the network throughput of EZRP could be improved than ZRP.

3. Zone Routing Protocol

3.1 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("Transmission of IARP packets from S") 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 (referred by white arrow in Fig. 1).
- 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.

3.2 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 ("Border-cast of IERP packets") 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 ("IERP Request packets"). 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 ("IERP Reply packets"), 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 ("Path from S to D") 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.

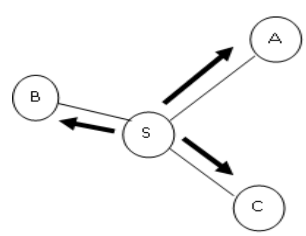

Figure 1. Transmission of IARP packets from S.

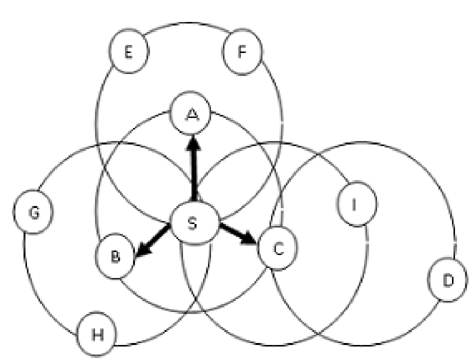

Figure 2. Border-cast of IERP packets.

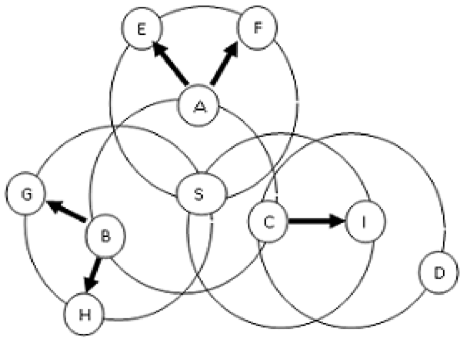

Figure 3. IERP Request packets.

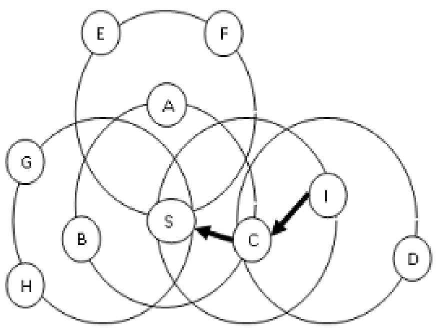

Figure 4. IERP reply packets.

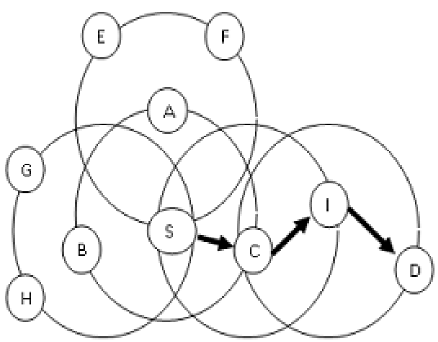

Figure 5. Path from S to D.

4. 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 [11] 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 [12] recently discussed the anycast address mapper proposed by Oe and Yamaguchi [13]. It translates the anycast address to its corresponding unicast address at the host receiving anycast packet; this is done prior to the anycast communication [14].

4.1 Anycast Address Resolution Protocol (AARP)

AARP resolves the anycast address specified by the application into their corresponding unicast address. In figure 6 ("The Protocol Stack for AARP"), 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.

4.2 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.

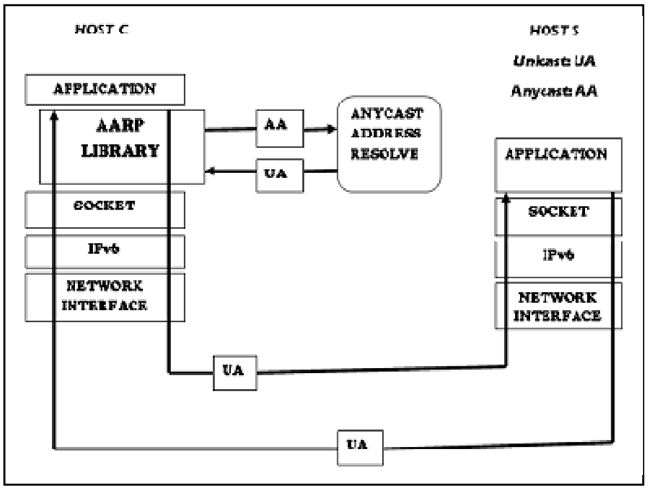

Figure 6. The Protocol Stack for AARP.

5. 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.

5.1 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 member 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-casted zone, then IERP packets are again border-casted to all the border nodes of that previously border-casted node.
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.

5.2 Flowchart for the Proposed Idea

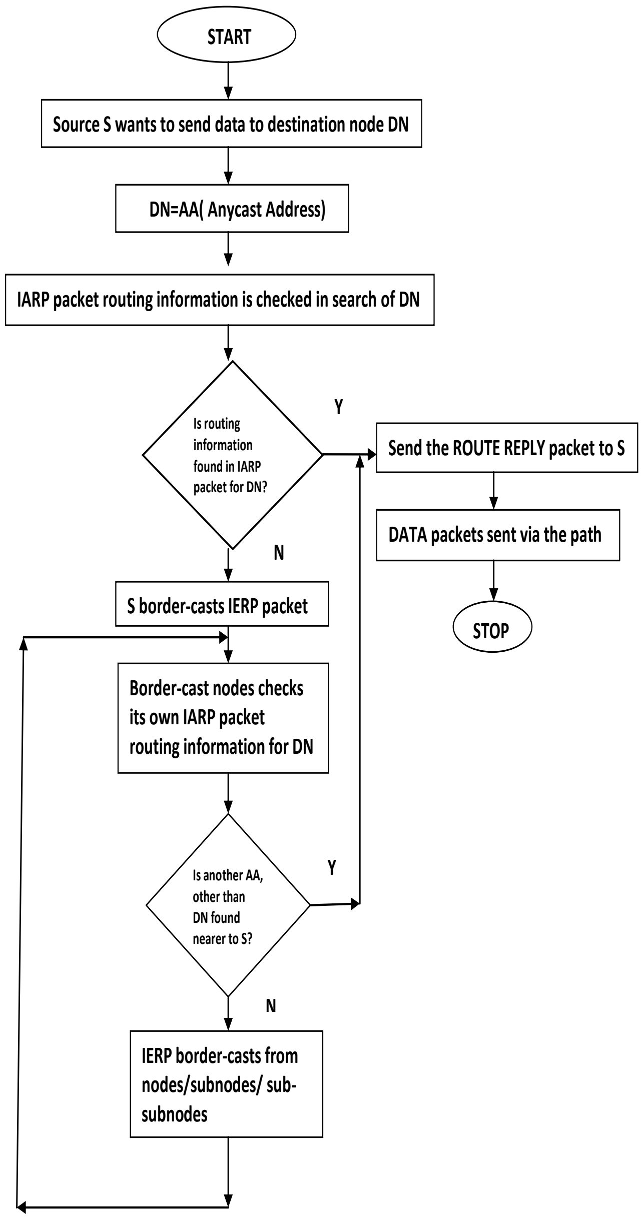

Figure 7. Flowchart of the algorithm

6. Conclusion and Future Work

In this paper, we have presented a brief literature review on the past work that has been done for Zone Routing Protocol and Anycast addressing. We have also proposed an idea of using Anycast addressing in Zone Routing Protocol (ZRP). Using this combined approach , the performance parameters can be improved as the destination node can be a member of the anycast group which can be located nearer to the source.

As a future work, we plan to implement the proposed algorithm of combining Anycast addressing in Zone Routing Protocol in a real-time network so that we can improve the performance parameters.

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