ZMRP: A Performance Analysis of Zone Multicast Routing Protocol in MANETs

Anup Kumar Sahu[1], Jajati Mallick[2], Chinmayee Behera[3]
[1, 2]Purushottam Institute of Engg. &Tech.Rourkela, India
[3]K.E.C, Bhubaneswar, Odisha, India

ABSTRACT
ZRP is one of the well-known Hybrid routing protocols in MANET. But still it has lots of limitations due to network load by many useless control packets. When the protocol searches for a new route, it sends many worthless control packets. To enhance the ZRP in this paper, we propose ZMRP (Zone Multicast Routing Protocol). ZMRP reduces the network load by limiting the number of control packets, when the protocol searches for a new route.

Keywords: Mobile Ad-hoc Network, OLSR, AODV, ZRP.

1. INTRODUCTION
A mobile Ad hoc network (MANET) is a mobile wireless network that does not have fixed infrastructure or centralized administration or an access point in wireless local area network. There are no fixed routers instead each node acts as a router and forwards traffic from other nodes. The nodes are open to move haphazardly thus, the network's routing topology may change quickly and unexpectedly. Mobile Ad hoc networks can be classified into three groups table-driven or proactive, on-demand or reactive and hybrid routing protocols. Proactive routing protocols try to maintain up-to-date routing information between every pair of nodes in the network by Propagating, proactively, route updates at fixed intervals. As the resulting information is generally maintained in tables, the protocols are sometimes referred to as table-driven protocols. Proactive routing protocols are Destination-Sequenced Distance Vector (DSDV) routing, Clustered Gateway Switch Routing (CGSR), Wireless Routing Protocol (WRP) and Optimized Link State Routing (OLSR).

Reactive routing does not try to determine the network connectivity. Instead, a route determination procedure is invoked on demand when a packet needs to be forwarded. A route is established to a destination when there is a demand for it. So it is also known as on-demand routing protocol. Reactive routing protocols are Dynamic Source Routing (DSR), Ad hoc n Demand Distance Vector (AODV) routing, temporally Ordered Routing Algorithm (TORA) and Associativity Based Routing (ABR). [1]Hybrid routing protocol is combining the best properties of both the proactive and the reactive approaches. ZRP can be classed as a hybrid reactive/proactive routing protocol. Hybrid routing protocols are Zone Routing Protocol (ZRP) and Zone-based Hierarchal Link state routing protocol (ZHLS).

2. RELATED WORK
Proactive routing uses surplus bandwidth to maintain routing information, while reactive routing involves long route request delays. Reactive routing also inefficiently floods the entire network for route determination. The Zone Routing Protocol (ZRP) aims to address the problems by combining the best properties of both approaches. ZRP can be classed as a hybrid reactive/proactive routing protocol. [2] In ZRP, a node proactively maintains routes destinations within a local neighborhood, which is considered as a routing zone. A node routing zone is defined as a collection of nodes whose minimum distance hop from the node is no greater than a parameter referred to as the zone radius. Each node maintains its own routing zone, but the routing zones of neighborhood nodes overlap. For construction of a routing zone the information of neighbor nodes is needed. A neighbor node is defined another node that a direct communication can be established and is one hop away. In ZRP, the IntrAzone Routing Protocol (IARP) is used for routing within a zone and IntErzone Routing Protocol (IERP) for routing beyond the routing zone. So generally proactive routing protocol is used as an IARP and reactive routing protocol is used as an IERP. Generally OLSR is used as a proactive routing protocol and AODV is used as a reactive routing protocol. [3] [7]

The Optimized Link State Routing (OLSR) protocol is a proactive routing protocol, but which is a variation of traditional link state routing, modified for improved operation in ad hoc networks. The key feature of OLSR is its use of multipoint relays (MPRs) to reduce the overhead of network floods and the size of link state updates. Each node computes its MPRs from its set of neighbors. The MPR set is selected such that when a node broadcasts a message, the retransmission of that message by the MPR set will ensure that the message is received by each of its two-hop neighbors. Hence, whenever a node broadcasts a message, only those neighbors in its MPR set rebroadcast the message. Other neighbors that are not in the MPR set process the message but not rebroadcast it. [4] [6]

AODV minimizes the number of required broadcasts by creating routes on a demand basis. The nodes that are not on a selected path do not maintain routing information or participate in routing table exchanges. When a source node needs to send a message to some destination node and does not already have a valid route to that destination, it initiates a path discovery process to locate the other node. It broadcasts a route request (RREQ) packet to its neighbors, which then forward the request to their neighbors, and so on, until either the destination or an intermediate node is located. [5] [8] [9]

3. ZONE MULTICAST ROUTING PROTOCOL (ZMRP)

The proposed ZMRP is a shared tree multicast routing protocol. Center node or the mother node sends or broadcast message to the other node. This shows its existence or presence of group and its leader. ZMRP is a source initiated multicast protocol that combines reactive as well as proactive routing approaches. Every source node has a routing zone. A proactive approach is used inside this zone and reactive approach is used across zones. If the source node has a valid route to any node on the tree and its wants to join that group its sends unicast multicast request along the route to the multicast tree and waits for a multicast route reply.

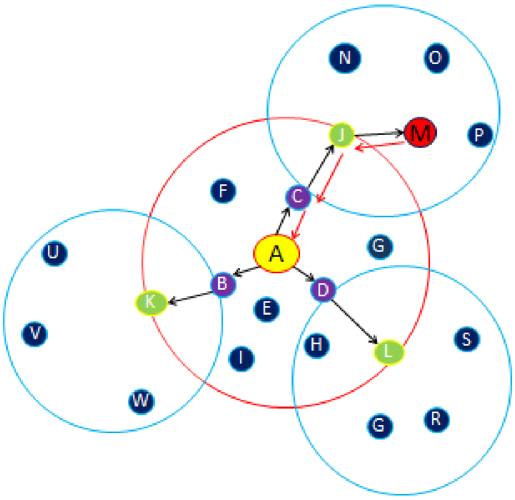

Figure 1. Route Search of ZMRP

Let explain ZMRP by using the above figure; consider that source node A has a data packet to send to the node M. As it is a hybrid routing protocol, so it is combination of proactive as well as reactive routing. The source node A uses the proactive technique to check whether the destination is within the zone or not. If the destination node is within the zone then source simply sends a unicast message to that node or if it has the route to that destination too. If it is not found the destination node M or it does not have a valid route to that destination then simply it initiates multicast request to the peripheral node instead of broadcast request to save bandwidth, energy and reduce network load. So the source node A wants to send the request to the peripheral nodes K,J,L respectively through forwarding node B, C, D. Now node A will send a multicast message to node B, C, D and then B, C, D will forward that message to the peripheral node. Then the entire peripheral node will check their proactive zone. In this process the node J has the information about node M. It will send the route ACK as well as M wants to be a member of a multicast group of source. So it will send a member request with the route reply.

4. PERFORMANCE EVALUATION

We consider the following scenarios for simulations. In Scenario I, the number of nodes is 7, the field size is 1000 m x 1000 m, the transmission distance is 100 m, and the nodes are not moving (network topology is not changed).In Scenario II, the numbers of nodes are 10, 20, 30 but the field size is 1000 m x 1000 m, the nodes are moving. And the moving speed is 5 m/s. We compare the performance of the proposed ZMRP with ZRP. Figure 2 shows packet delivery ratio with number of nodes for ZMRP and ZRP routing protocol. The red line shows graph for ZMRP and the blue line shows the graph for ZRP protocol. The basic difference between the two protocols is less. When the number of nodes is more (the network load is high), the ZMRP has better performance than ZRP. This is because when the network load is high many packets collide and the network performance degrades.

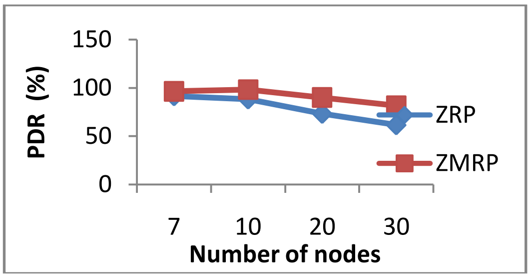

Figure 2. Packet Delivery Ratio vs. Number of nodes

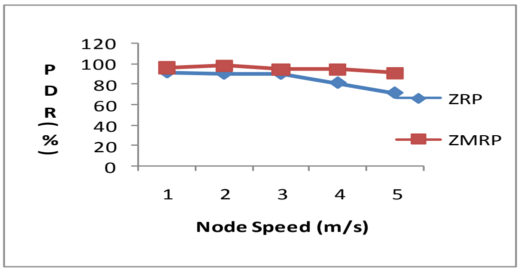

Figure 3. Packet Delivery Ratio vs. Node speed

Figure 3 shows packet delivery ratio with node speed for ZMRP and ZRP routing protocol. The red line shows graph for ZMRP and the blue line shows the graph for ZRP protocol. When the node speed is more, that means the moving degree is high, the ZMRP has higher link usability than ZRP. Thus, the new route search time is shorter than ZRP and the number of data sent to the DN becomes high. The ZMRP has better performance than ZRP.

Figure 4 shows throughput with number of nodes for ZMRP and ZRP routing protocol. The red line shows graph for ZMRP and the blue line shows the graph for ZRP protocol. When the network load is high, the ZMRP has better behavior than ZRP. When the network load is high, the throughput is decreased for both protocols. The reason is that the number of collided packets is increased, which results in decrease of network throughput.

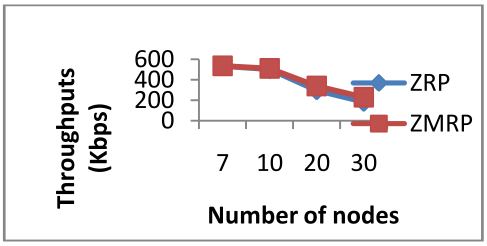

Figure 4. Throughput vs. Number of nodes

Figure 5 shows latency with node speed for ZMRP and ZRP routing protocol. The red line shows graph for ZMRP and the blue line shows the graph for ZRP protocol. When the node speed is more, that means the moving degree is high, the latency of ZRP is higher than ZMRP. This is because when the ZRP searches for a new route, the number of IERP RQP is increased, thus the node buffer is congested, which results in the increase of latency.

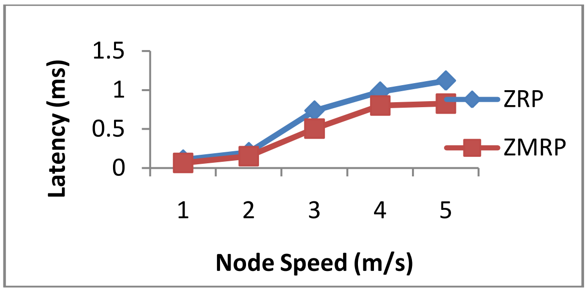

Figure 5. Latency vs. Node speed

5. CONCLUSION

In this paper, we have proposed a new zone routing protocol for ad-hoc networks called Zone multicast Routing Protocol (ZMRP). In a ZMRP, when the network load is high, the number of arrived packets to DN without loss in ZMRP is higher than ZRP, resulting in better throughput of ZMRP. Also, the latency of ZMRP is lower than ZRP.

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