Parametric Analysis of Zone Routing Protocol on the basis of Mobility

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Abstract-In this paper, the Zone Routing Protocol (ZRP) is surveyed for the nature of its parametric performance under various mobility conditions. ZRP is well known as hybrid routing protocol works on various routing phenomenon like Intra-Zone Routing Protocol (IARP) which routes within its routing zone, Inter-Zone Routing Protocol (IERP) which routes outside the routing zone, Bordercast Resolution Protocol (BRP), Query Control Mechanisms (Query Detection (QD1/QD2), Early Termination (ET), Random Query Processing Delay (RQPD)). The analyzed performance of the variety of parameters such as PDR (Packet Delivery Ratio), Packet Loss, Average Throughput, Average End-to-End Delay of Zone Routing Protocol in different simulating environment with and without mobility is compared.

Keywords –Hybrid Routing, Proactive Routing, Reactive Routing, Routing zone, Mobility Criteria, Performance Parameters.

I. INTRODUCTION

ZRP is among most popular hybrid routing protocols. Zone Routing Protocol is a prominent protocol combining both proactive and reactive nature of routing. It is the ad hoc protocol in which proactive technique is performed within a scope of local neighborhood or routing zone only. ZRP composed of Intra-Zone Routing Protocol (IARP), Inter-Zone Routing Protocol (IERP), Bordercast Resolution Protocol (BRP) along with various Query Control mechanisms. IARP has limited scope which is defined/set by zone radius. Within this routing zone radius, IARP very well maintains the topology information of its local zone. IERP works as a global routing component for ZRP. Whenever a node needs a route not available in local neighborhood, IERP is used to send the data. As the traditional predefined nature of reactive routing protocols, route discovery and route maintenance is also performed by IERP. For the reduction of routing overhead Bordercast Resolution Protocol is used. By using the information provided by IARP, it directs the route requests outward. The outward request sent is multicast in nature sent to certain set of peripheral nodes (surrounded). If in case there is no reply after BRP, the set of peripheral nodes again perform bordercasting to their peripheral nodes. Two main approaches may be followed for bordercasting, root directed bordercast and distributed bordercast. The query control mechanism in ZRP includes: Query Detection (QD1/QD2), Early Termination (ET), and Random Query Processing Delay (RQPD). In bordercast tree all nodes can detect the QD1 and can avoid the redundancy of queries in node's routing zone. Overhearing in transmission range by any node is possible, extending the QD2. During relaying of query, it can prune covered nodes or already relayed nodes resulting ET. With RQPD a relaying node can have another chance to prune downstream nodes.

II.ZRP ARCHITECTURE

ZRP acts as a framework for other protocols. The local and global neighborhood in ZRP are divided in a way so as to gain advantages of each routing technique. Local neighborhood, named as 'Zone', have number of nodes which may be overlapped within different zones which may have different sizes. Size of the zone in ZRP is defined as the count of number of hops it takes to reach to its peripheral nodes called 'Zone Radius' [4]. It may or may not be predefined. This hybrid behavior helps to suggest and decide to follow the technique among both. This initiates route-determination procedure on demand but at limit search cost [1]. The proactive nature of this protocol minimizes the waste count associated to this technique at the expense of routing overhead. The Zone Routing Protocol consists of several components, which only together provide the full routing benefit to ZRP [6].

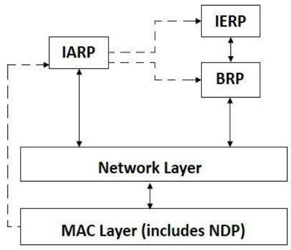

Figure 1. ZRP ArchitectureModel

Each component basically works independently of the other and they may use different technologies in order to maximize efficiency in their particular area. Components of ZRP are IARP, IERP and BRP. The relationship between components is illustrated in Figure 1. IARP is responsible for proactive nature maintenance while IERP for the reactive nature one. Bordercasting leverages (completely uses) IARP's up-to-date view of local topology to efficiently guide route queries away from the query source [2].

A. Intra-Zone Routing Protocol (IARP)–

This protocol communicates with only interior nodes of the routing zone. Zone radius limits the zone size. In Intra-Zone Routing Protocol, the change in topology results in change in local neighborhood. It always desires/curious to update the routing information [8]. IARP helps in node redundancy removal along with provision of tacking to number of link-failures. Figure 2. Shows the routing zone concept with radius 2 hops. Here S is considered as a source node having zone radius of 2 hops. So in this case, the node E, D are considered as interior nodes having hop count less than zone radius. The nodes A, B and C are considered to be peripheral nodes having hop count less than or equal to the zone radius. While Nodes F have the hop count greater than the zone radius, i.e. Outwards the specified zone.

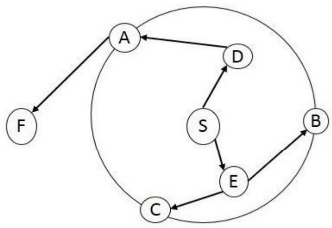

Figure 2. ZRP with zone radius 2 Hops

However, it should be kept in mind that zone is not a description of physical distance [2]. Neighbor Identification can be usually performed by Media Access Control (MAC) protocol and Neighbor Discovery Protocol (NDP). Operation of IARP is done by broadcasting "hello" beacons to all of its neighbor nodes. The reception and acknowledgement of these beacons indicates the connection establishment.

B. Inter-Zone Routing Protocol (IERP) –

IERP is the global reactive routing component of ZRP. Inter-Zone Routing Protocol is responsible for acquiring route to destination that are located beyond/outside the routing zone. With the help of knowledge gained about local topology from Intra-zone routing protocol, IERP perform the on-demand routing mechanism [5]. In presence of route, it issues route queries. Bordercasting helps to minimize the delay caused by route discovery in this. Redundancy of nodes (already covered) is avoided. An example is illustrated in Figure 3.

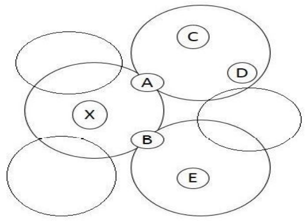

Figure 3. IERP Operation

X prepares to send data to destination D. X checks if D exists in its local neighborhood. If so, route is already known by X. Otherwise, a query is sent to its peripheral nodes by X i.e. (A, B). These peripheral nodes further checks for D in their routing zone. Like in here, when A send query to C, C recognized D as the node in its routing zone and respond back to query. The path then established is X-A-C-D [2].

C. Bordercast Resolution Protocol (BRP)–

Whenever route is requested with the global reactive routing technique, BRP is used to command it and maximizes its effectiveness. Routing information provided by IARP is used by BRP. This information is constructed by IARP from its map provided by local proactive technique. It maintains the redundancy removal phenomenon by pruning the nodes it has already covered (received the query) i.e. When a node receives a query packet for a node that does not lie within its local routing zone, a bordercast tree is formed/constructed so that the packet can be forwarded its neighbors. Upon reception of the packet, bordercast tree is reconstructed by these nodes to determine whether or not it belongs to the tree of the sending node. If it does not belongs to the bordercast tree of the source node, it continues to process the request and determines if the destination lies within it's routing zone and takes the appropriate action, so that the nodes within the zone are marked as covered nodes [4]. The two approaches used by BRP are :

- *Root Directed Bordercast*

In this, source and peripheral nodes construct their multicast trees to which the forwarding instructions to routing query packet are appended, as results in additional route overhead which keep on increasing with increase in zone radius.

- *Distributed Bordercast*

In this, an extended routing zone is established and maintained by each node which increases the local routing information exchanges, resulting in reduction of route discovery requirement.

D. Query Control Mechanisms

As per strategy of ZRP, querying performing is more efficient way than directly flooding the route requests but due to heavy overlapping, multiple forwarded route requests can result into more control traffic than flooding. This happens because whenever a query is bordercasted, it covers the node's complete routing zone and excess route query traffic is the result of redundant query messages. Thus a collection of query control mechanism is introduced by ZRP.

- *QD1/QD2*

With the help of Bordercast Resolution Protocol, the relaying nodes in the tree becomes able to detect the redundant query (QD1). For this process, BRP use bordercast tree hop by hop. It is possible for queries to be detected within the transmission range of relaying node, extending query detection capability (QD2).

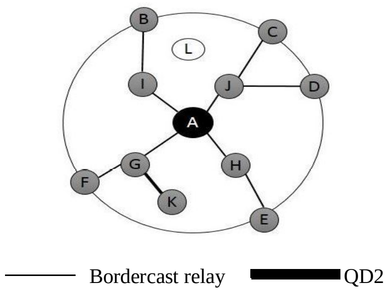

Figure 4. Query Detection (QD1/QD2)

In example, as when node A bordercast to its peripheral nodes (B-F), The intermediate nodes (relaying) (G, H, I, J) are able to detect query by QD1. Using QD2, node K able to detect node G's transmission even if node K does not belong to node A's bordercast tree. Even with the high level query detection, QD2 does not guarantee of the whole routing zone being informed. Like in here, node L does not overhear and is thus unaware that L's routing is covered by query or not. The relationship between components is illustrated in Figure 1. IARP is responsible for proactive maintenance while IERP for the reactive one. Bordercasting leverages IARP's up-to-date view of local topology to efficiently guide route queries away from the query source [2].

- *Early Termination (ET)*

In general, it may not be possible to understand that whether query has been perfectly outward to the uncovered zones or not but the information obtained from QD1 and QD2 can very well support Early Termination.

- *Random Query Processing Delay (RQPD)*

During bordercast, node's routing zone is covered instantly but even the query may take some infinite amount of time to make a way along the bordercast tree, it can be detected by Query Detection mechanism. Within this time, it is possible that any neighboring node may re-bordercast the same message simultaneously. This problem can be addressed by bordercasting RQPD. During scheduling of random delay by waiting node, it can benefit to detect the previous bordercast tree for already covered areas. This is how RQPD can significally improve performance up to a certain point [2].

In Multicast Zone Routing Protocol, a multicast tree membership information is usually maintained proactively. Multicast ZRP makes on-demand route requests by Multicast Inter zone routing protocol with an efficient query mechanism [3]. For MANETs, there exist an extension of ZRP named as Two-Zone Routing Protocol (TZRP). In this two zones may having different topologies and route updation mechanisms are used to attain the decoupling of protocol's ability to adapt to traffic characteristics which are gained from the ability to adapt the mobility. TZRP provides a framework to balance tradeoff between pure proactive and reactive routing techniques more effectively than ZRP [3].As per simulation in [9], the proactive protocol shows the slightly constant number of flooded packets with increase in the transmission radius while ZRP as compare to this protocol, shows a drastic increase in the number of flooded packets. The simulations performed in [10], shows that the proactive part is able to communicate a large amount of routing information at very low overhead. In real-time scenarios, ZRP (mobile nodes) may attain good performance as done on real-time network and traffic configuration as per experimentation performed in [11][12].Further Performance of ZRP protocol can be enhanced as per done in [13], where various parameters are taken into consideration and observed. The security of any protocol is also a big issue. Security of ZRP mainly aims to tackle the problem of excess bandwidth and long route requests delay etc. There may be certain mechanisms for security such as identity based key management. In this mechanism, identifier with the strong cryptographic binding is chosen. Another can be mechanism which may provide a secure neighbor discovery. A mechanism for certain alarm messages in presence of any malicious node (s) can also be adapted [7].

III. SIMULATION

The simulation will be performed using Network Simulator (NS-2). The traffic source will be Continuous Bit Rate (CBR). The model will be in a rectangular area of 3000m x 3000m with 30 nodes.

During simulation, nodes will start the transmission and in case of mobility, within transmission mobile nodes will change their positions resulting change in configuration and topology of the network which will further effect the traffic and transmission. Different number of source nodes and mobile nodes will be generated. The model parameters will be used are as follows:

Table -1 Model Parameters

Parameters	**Value**
Simulator	**NS2**

Protocol	ZRP
Channel	Channel / Wireless Channel
Propagation Model	Propagation / Two way Ground
Network Interface	Phy / WirelessPhy
MAC Type	Mac/802_11
Interface Queue type	Queue / Droptail / Priqueue
Link Layer Type	LL
Simulation Time	30sec
Simulation Area	3000 x 3000
Transmission Range	250m
Traffic Type	CBR (TCP)
No. of source nodes	5, 10, 15, 20, 25
No. of mobile nodes	5, 10, 15, 20, 25
Speed of Mobile nodes	50m/s
Packet Size	100

A. Packet Loss

It is the number of packets not been received by the destination nodes.

Packet Loss = Packet send – Packet received

The Loss of packets is observed to be more in ZRP without mobile nodes as compare to the packet loss in ZRP with mobile nodes.

Without Mobility: With increase in nodes, the loss of packets keep on increasing.

With Mobility: With increase in nodes, the loss of packets decrease after a while and increase again.

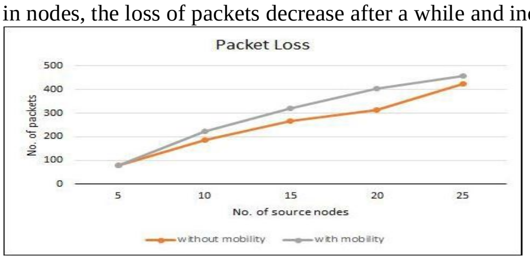

Figure 5. Packet Loss

B. Packet Delivery Ratio

It can be defined as the ratio that is used to calculate the number of packets transmitted by source node to the number of packets received by destination node.

PDR = Σ Number of packets received / Σ Number of packets sent

The packet delivery ratio of ZRP without mobility shows better performance than the ZRP with mobility.

Without Mobility: With increase in number of nodes, the packet delivery ratio first increase and then decreases.

With Mobility: With increase in number of nodes, the packet delivery ratio keeps on decreasing.

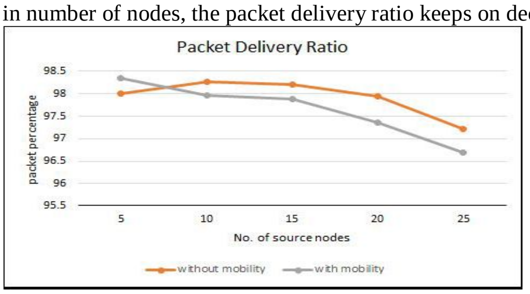

Figure 6. Packet Delivery Ratio

C. Average Throughput

It is the calculation of number of packets received by receiver in data transmission time. It is represented in bits/bytes per second.The average throughput of ZRP without mobility is slightly better than in the ZRP having mobility.

Without Mobility: With increase in number of nodes, the average throughput keep on increasing.

With Mobility: With increase in number of nodes, the average throughput first increase and then decrease.

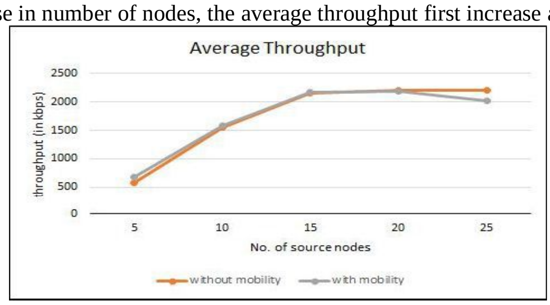

Figure 7. Average throughput

D. Average End-to-End Delay

It is the total time taken by packet from source node to the destination node.

Av. End-to-End Delay = (Start-time$_{ij}$- End-time$_{ij}$) / N

Where ij is the time when sending/receiving of packet j at node i starts/stops and N is the total number of nodes.The average delay in ZRP without mobility attains bad performance than delay in ZRP with parameters.

Without Mobility: With increase in number of nodes, the average end-to-end delay keep on increasing.

With Mobility: With increase in number of nodes, the average end-to-end delay first increase, then decrease and again increase.

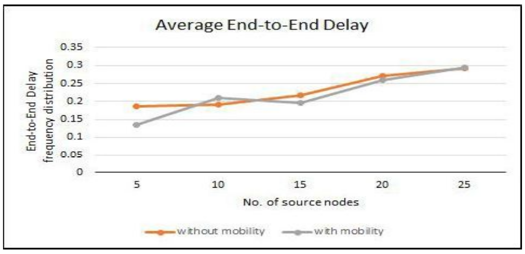

Figure 8. Average End-to-End Delay

IV.CONCLUSION

In this survey of Zone Routing Protocol, this hybrid routing protocol is more efficient in absence of mobile nodes as compare to the one having mobile nodes. The parameters Packet Loss, Packet Delivery Ratio, Average Throughput and Average End-to-End Delay has been considered, among which Packet Loss, Packet Delivery Ratio, Average Throughput of the Zone Routing Protocol not having mobile nodes showed good performance while Average End-to-End Delay in this criteria proved worse as compare to the Zone routing Protocol having mobile nodes. It has concluded that with increase in number of nodes and number of mobile nodes, the performance of the Zone Routing Protocol falls after a while. Further this state of ZRP can be analyzed with more parameters under different situations.

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