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Impact of Variable Transmission Range and Scalability With Respect To Mobility and Zone Size On Zone Routing Protocol Over Manets

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ABSTRACT
A variety of protocols are used in ad hoc network but the most popular protocol one is Zone Routing Protocol (ZRP). ZRP is a hybrid routing protocol. Transmission power affects the design and performance of all the protocols in Mobile Ad hoc Networks (MANETs). Mobility of nodes and selection of Zone Size in ZRP are also the major issues. In this paper, the impact of Transmission Ranges and Scalability by varying Mobility rate along with Zone Radius on QoS based performance metrics has been analyzed. The environment has been simulated using NS2.33 Simulator. The objective of our work is to analyze that at what speed and by taking how much zone radius ZRP will be able to perform efficiently and effectively for Mobile Ad hoc Networks.
***Keywords* -** MANETs, ZRP, QoS, Transmission Range.

I. INTRODUCTION

Mobile Adhoc Network (MANET) is a self created and self organised network. MANET refers to a multi-hop packet-based wireless network composed of a set of mobile nodes that can communicate and move at the same time without using any kind of fixed wired infrastructure [1]. MANETs are actually adaptive networks that can be formed and deformed on the fly without the need of any centralized administration. In adhoc networks each and every node works as router [2]. This exclusive characteristic allows the use of MANETs in many particular civilian and military situations as well as in the emerging sensor networks technology. As other packet data networks, one-to-one communication in MANET is achieved by unicast routing for each single packet. Routing in MANETs is challenging due to the constraints existing on the transmission bandwidth, battery power, CPU time and the requirement to cope with frequent topological changes resulting from the mobility of nodes. We argue that variable range transmission control should underpin the design of future wireless ad hoc networks, and not, common-range transmission control. Power control affects the performance of the network layer. A high transmission power increases the connectivity of the network by increasing the number of direct links seen by each node but this is at the expense of reducing network capacity. The type of power control used can also impact the connectivity and performance of the network layer. Choosing a higher transmission power increases the connectivity of the network. In addition, power control impacts the signalling overhead of routing protocols used in mobile wireless ad hoc networks. Higher transmission power decreases the number of forwarding hops between source-destination pairs, therefore reducing the signalling load necessary to maintain routes when nodes are mobile. The signalling overhead of routing protocols can consume a significant percentage of the available resources at the network layer, reducing the end user's bandwidth and power availability. The goal of QoS provisioning is to achieve more deterministic network behaviours, so that information carried by the network can be better delivered and network resources can be better utilized. The QoS parameters differ from application to application for example in case of multimedia application bandwidth, delay jitter and average delay are the key QoS parameters [3]. In this paper, we have analyzed the impact of an alternative approach and make a case for variable-range transmission control and scalability with Mobility speed and zone radius. Scalability is a very important issue in routing protocol. Because this is direct relate with routing overhead.[4] The performance of routing protocol is depend upon size of network, mobility speed, transmission range and zone radius. In MANET routing protocols are divided into three types:

Proactive Routing Protocol:

This approach is known as a table driven routing, to guarantee that routing tables are up-to-date and reflect the actual network topology, nodes running a proactive protocol continuously exchange route updates and recalculate paths to all possible destinations. The main advantage of proactive protocols is that a route is immediately available when it is needed for data transmissions. However, if user traffic is not generated, then resources are wasted due to the proactive route update mechanism. Also, proactive protocols do not scale well to large networks and do not converge if the mobility rate is high, although differential route updates and variable update rates may mitigate such limitations [5].

Reactive Routing Protocols:

A different approach in the design of a routing protocol is to calculate a path only when it is necessary for data transmissions. Protocols of this family are dubbed reactive protocols or on ÿ demand routing protocols. A reactive protocol is characterized by a path discovery procedure and a maintenance procedure. Path discovery is based upon a query-reply cycle that adopts flooding of queries. The destination is eventually reached by the query and at least one reply is generated. Path discovery is triggered asynchronously on-demand when there is a need for the transmission of a data packet and no path to the destination is known by the source node. Discovered paths are maintained by the route maintenance procedure until they are no longer used. The main advantage of reactive protocols is that if data traffic is not generated by nodes, then the routing activity is totally absent. The main drawback is the network-wide path discovery required to obtain routing information. Since discovery must be based on flooding, such a procedure is very costly.

Hybrid Routing Protocol:

It combines the best features of proactive and reactive protocols. The rest of the paper is organized as follows: section II gives a brief description of related works which help in improvement of the ZRP performance. Section III explains overview of ZRP for MANETs. Section IV presents simulation based results, evaluation and performance comparison graphs of our work. Finally, conclusion and future work are presented in section V.

II. RELATED WORK

Savita Gandhi et al in [6] compared the performance of DSR, OLSR and ZRP in different mobile scenario by random waypoint model and result have conclude that average e2e delay, average jitter, NRL is highest on ZRP than other protocol. Dinesh Singh, Ashish K. Maurya et al in [7] examined the performance differences of LANMAR, LAR1, DYMO and ZRP routing protocol. A. Loutfi et al [8] Impact the network size, traffic load & zone radius and result show that radius zone of 3 is preferred & optimal value compare to radius 2 when traffic load is important & also experiment on IARP & IERP traffic with different zone radius and different node density. Yuki Sato et al [9] Introduction a EZRP in this less control packets are send and nodes send control packet when nodes are moving, and conclude that the control packet is decrease so the waiting time is also decrease .The delay is decreased and data transmission rate and throughput are increased when the number of nodes is increased.[10] Compare AODV, DYMO, ZRP, OLSR on Qualnet 4.5 Developer and conclude that ZRP demonstrates the best performance than the remaining three routing protocols. Brijesh Patel et al. in [11] proposed an analytical model that allows us to determine the routing overhead incurred by the scalable routing framework on ZRP. In order to make ZRP adaptive, the mechanisms must be devised for detecting the non-optimality of zone radius setting. In addition to that, the cost-benefit analysis must be done to understand the tradeoff involved between the optimality detection cost and additional overhead cost incurred due to non-optimality. S. Ramachandram [12] Genetic Zone Routing Protocol(GZRP) was proposed Modified Timer based caching technique to GZRP. Its performance analysis is done using GloMoSim (Version 2.03). improvement for GZRP with caching over normal GZRP. Application of caching scheme removes the stale routes and makes the search faster. The delivery of packets is seen to a maximum of 40% improvement for cached GZRP over GZRP with the help of load balancing, fault tolerance and caching. Rajneesh Kumar Gujral et al [13] Analyze that at what speed and by taking how much zone radius ZRP will be able to perform efficiently and effectively for MANETs. Give a results that if the radius zone is small then the nodes act as reactive protocol so if the zone is less than the average delay is more. When the mobility rate is less then throughput , packet delivery ratio is maximum and if the mobility rate and zone size is increase the control overhead is also increased. Arivubrakan P. et al In [14] the performance of AODV and DSDV routing protocols by varying transmission range and simulation time has been analyzed. It is observed that the transmission range as a system parameter affects the overall energy consumption of wireless ad hoc networks. Karthiga G et al[15] the performance of transport layer protocols TCP and UDP on AODV, DSDV, TORA and DSR routing protocols in multicast environment by varying pause time with 50 nodes scenario has been simulated. The result indicates that TCP is not appropriate transport protocol for highly mobile multi hop networks and UDP is preferred. Nicles Beijar in [16] discussed the problem of routing in Ad hoc network and analyzed that ZRP reduces traffic amount compared to pure proactive or reactive routing. Yuanzhu Peter Chen et al. [17] presented zone routing algorithm for finding weakly connected dominating set and suggested clustering to simplify routing. Sree Ranga Raju et al. [18] considered protocols of AODV and DSR as a reference for analyzing ZRP with QUALNET simulator. They observed ZRP uses additional time as it uses IARP, IERP by studying ZRP operation of route discovery. They took different parameters for performance analysis like end to end delay, packets received etc. From the above analyzed survey, their result have concluded that lot of work has been done on ZRP, but no research work suggested us how well ZRP will adapt in MANET with respect to nodes mobility, zone size and scalability. So in this paper, we have analyzed impact of scalability with respect to mobility and zone size on ZRP over MANETs.

III. OVERVIEW OF ZONE ROUTING PROTOCOL

ZRP is a hybrid routing protocol based on parameter called routing zone [19]. ZRP is proposed to reduce the control overhead of proactive routing protocols and decrease the latency caused by routing discover in reactive routing protocols [20]. A node routing zone is defined as a collection of nodes whose minimum distance from the node in question is no longer greater than a parameter called zone radius [21]. In ZRP there are further two sub-protocols,: Intra-zone routing protocol (IARP) [22] is used inside routing zones where a particular node employs proactive routing and a reactive routing protocol: Inter-zone routing protocol (IERP) is used between routing zones, respectively. A route to a destination within the local zone can be established from the proactively cached routing table of the source by IARP; therefore, if the source and destination is in the same zone, the packet can be delivered immediately. Most of the existing proactive routing algorithms can be used as the IARP for ZRP. IERP route discovery operates as follows. The source node first checks whether the destination node is within its zone if so path to the destination is known and no further route discovery is required if the destination is not within the source routing zone the source border casts a route request to its peripheral nodes. Peripheral nodes are the nodes whose minimum distance to the nodes is equal to zone radius. Peripheral nodes executes the same algorithm-checks whether destination is within zone if so route reply is sent back to the source otherwise peripheral nodes forward route request to their peripheral nodes which follows same procedure. Figure 1 illustrates the routing zone of radius 2, 3 and 4 w.r.t. node T.

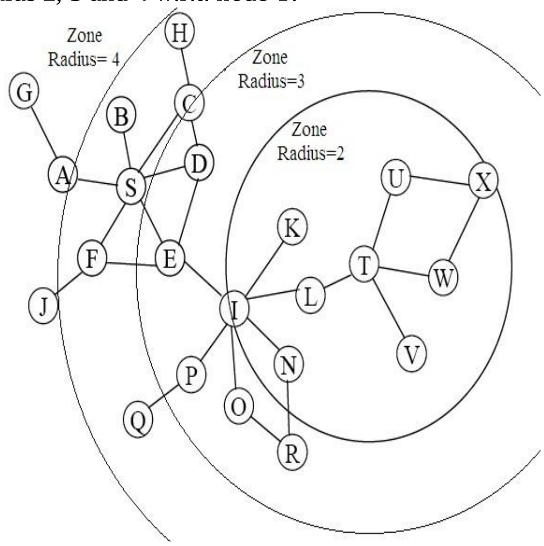

Fig 1: Zone Routing with Radius 2, 3 and 4

IV. QOS BASED PERFORMANCE METRICS

The performance of ZRP with Constant Bit Rate (CBR) Traffic has been analyzed using NS2.33 simulator. The performance metrics includes the following QoS parameters such as Packet Delivery Ratio (PDR), Throughput, End to End Delay and Routing Overhead. The parameters taken for simulation are summarized in Table 1.

Packet Delivery Ratio (PDR): PDR also known as the ratio of the data packets delivered to the destinations to those generated by the CBR sources. This metric characterizes both the completeness and correctness of the routing protocol.

$$PDR = \frac{\sum_{1}^{n} CBRrece}{\sum_{1}^{n} CBRsent} * 100$$

Average End to End Delay: Average End to End delay is the average time taken by a data packet to reach from source node to destination node. It is ratio of total delay to the number of packets received.

$$Avg\_End\_to\_End\_Delay = \frac{\sum_{1}^{n}(CBRrecetime - CBRsenttime)}{\sum_{1}^{n} CBRrece} * 100$$

Throughput: Throughput is the ratio of total number of delivered or received data packets to the total duration of simulation time.

$$Throughput = \frac{\sum_{1}^{n} CBRrece}{simulationtime}$$

Normalized Protocol Overhead/ Routing Load: Routing Load is the ratio of total number of the routing packets to the total number of received data packets at destination.

$$Routing\_Load = \frac{\sum RTRPacket}{\sum CBRrece}$$

V. SIMULATION RESULTS AND DISCUSSION

The performance of ZRP has been analyzed with varying Transmission Range, Mobility, Zone Size and Number of Nodes. The parameters used for simulation are summarized in Table 1 and positioning of 25 and 50 nodes is illustrated in Figure 2 and Figure 3. The performance metrics comprises of QoS parameters such as packet delivery ratio, end to end delay, routing overhead and throughput.

TABLE I. Simulation Parameters

Parameters	**Values**
No of Node	25, 50
Simulation Time	100 sec
Environment Size	1200x1200
Traffic Size	CBR (Constant Bit Rate)
Queue Length	50
Source Node	Node 0
Destination Node	Node 2
Mobility Model	Random Waypoint
Antenna Type	Omni Directional
Connection Type	UDP
Simulator	NS-2.33
Mobility Speed	100,200,300 m/s
Transmission Range (in meters)	200,300,400,500 and 600
Operating System	Linux Enterprise Edition-5

Fig 2 Initial Positioning of 25 Nodes

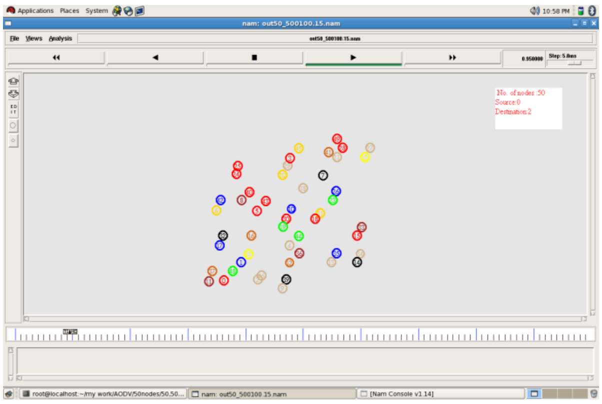

Fig 3 Initial Positioning of 50 Nodes.

A Packet Delivery Ratio

Packet Delivery Ratio (PDR) of ZRP is shown in Figure 4-6 for 25 nodes and in Figure 7-9 for 50 nodes. It has been observed that the packet delivery ratio is at higher side when Zone Radius is maximum i.e. 5R with all transmission ranges. PDR increases with the increase in Transmission Range for 25 nodes scenario but decrease with the increase in Transmission range in 50 nodes scenario. It is also observed that packet delivery rate start decreasing at highly mobility environment and no effect of zone radius is there.

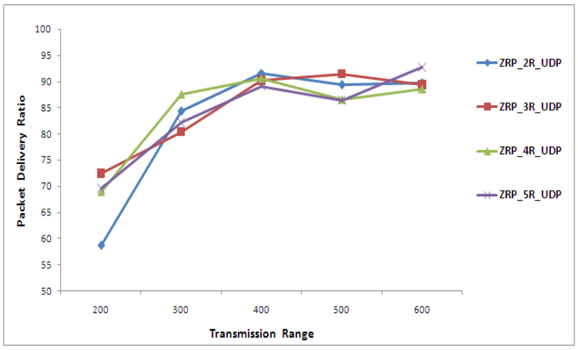

Fig 4 Impact of varying Transmission Range & Zone radius on Packet Delivery Ratio is with 100 mobility speed for 25 nodes.

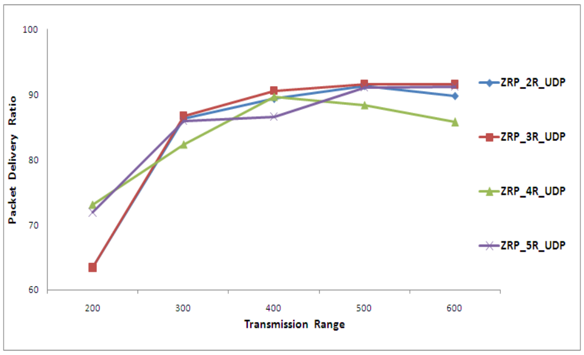

Fig 5 Impact of varying Transmission Range & Zone radius on Packet Delivery Ratio is with 200 mobility speed for 25 nodes

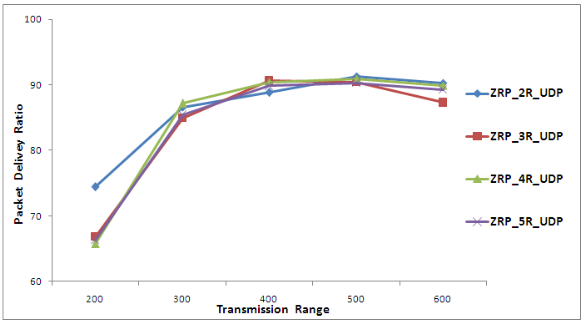

Fig 6 Impact of varying Transmission Range & Zone radius on Packet Delivery Ratio is with 300 mobility speed for 25 nodes

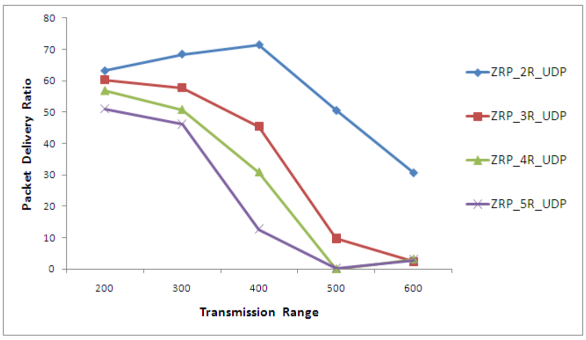

Fig 7 Impact of varying Transmission Range & Zone radius on Packet Delivery Ratio is with 100 mobility speed for 50 nodes.

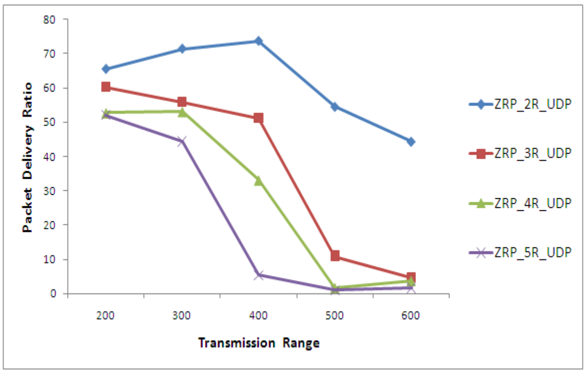

Fig 8 Impact of varying Transmission Range & Zone radius on Packet Delivery Ratio is with 200 mobility speed for 50 nodes.

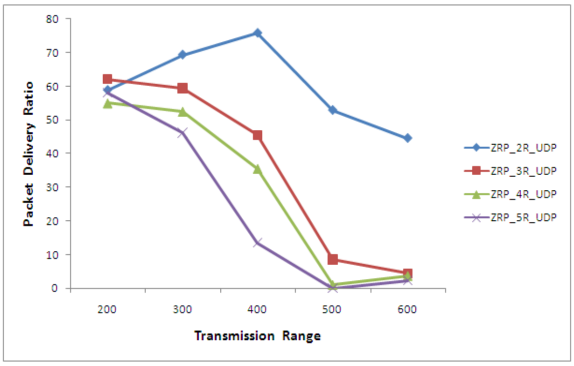

Fig 9 Impact of varying Transmission Range & Zone radius on Packet Delivery Ratio is with 300 mobility speed for 50 nodes.

B End to End delay

Average End to End Delay of ZRP is shown in Figure 10-12 for 25 nodes and in Figure 13-15 for 50 nodes. It has been observed that the Average End to End Delay is decreasing with the increase in Transmission Range. Delay is minimum when Zone Size is smaller in almost all cases. It is also observed that the delay is constantly decreasing with increase in mobility speed. ZRP is hybrid routing protocol in which within zone proactive routing is done, so as we increase the zone radius then nodes get more nodes information within their routing table that decrease the average delay.

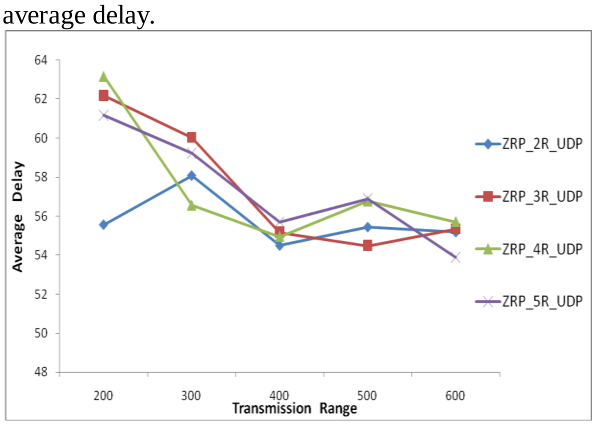

Fig 10 Impact of varying Transmission Range & Zone radius on Average End to End Delay is with 100 mobility speed for 25 nodes.

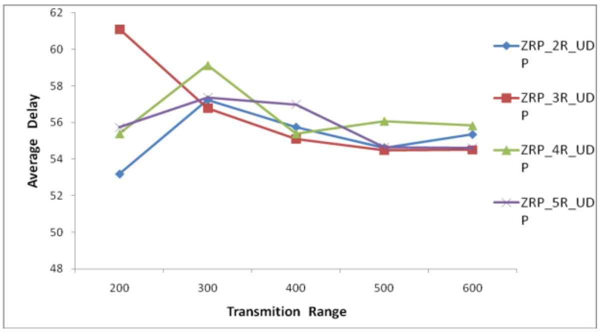

Fig 11 Impact of varying Transmission Range & Zone radius on Average End to End Delay is with 200 mobility speed for 25 nodes.

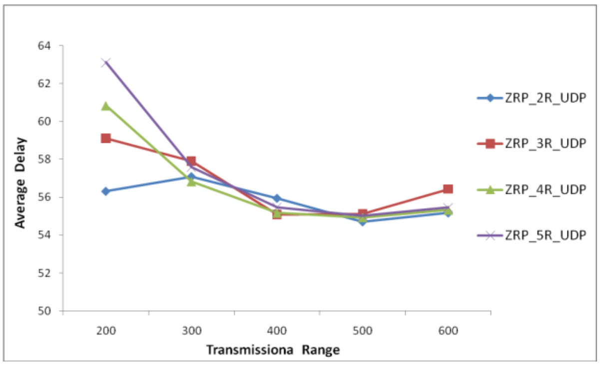

Fig 12 Impact of varying Transmission Range & Zone radius on Average End to End Delay is with 300 mobility speed for 25 nodes.

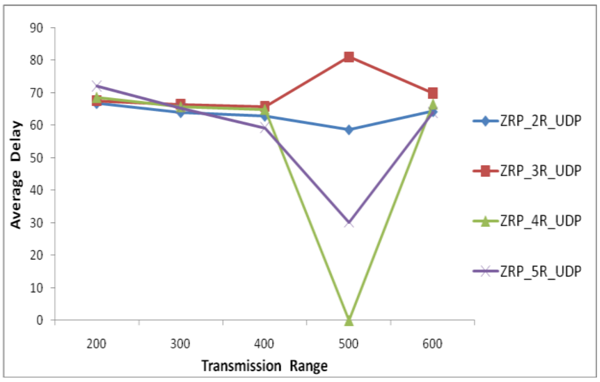

Fig 13 Impact of varying Transmission Range & Zone radius on Average End to End Delay is with 100 mobility speed for 50 nodes.

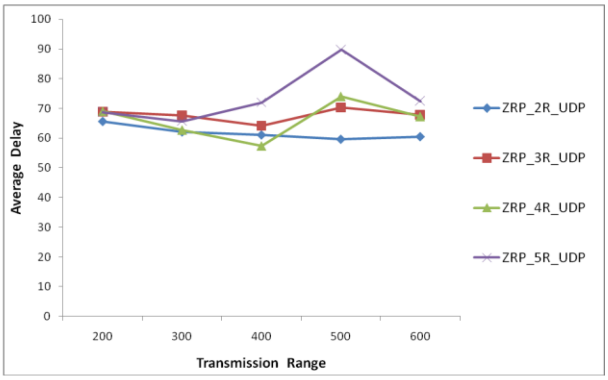

Fig 14 Impact of varying Transmission Range & Zone radius on Average End to End Delay is with 200 mobility speed for 50 nodes.

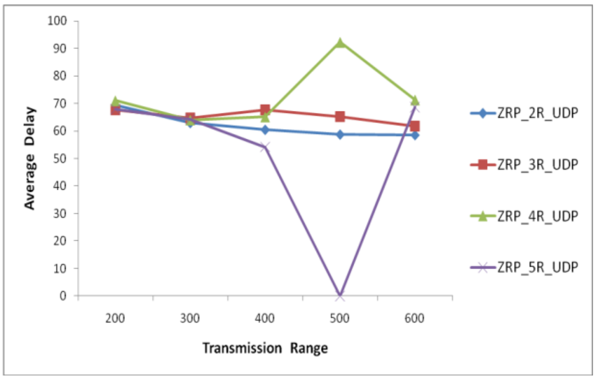

Fig 15 Impact of varying Transmission Range & Zone radius on Average End to End Delay is with 300 mobility speed for 50 nodes.

C Throughput

Average Throughput of ZRP is shown in Figure 16-18 for 25 nodes and in Figure 19-21 for 50 nodes. It has been observed that the Average Throughput is highest when the mobility rate and zone radius is minimum. It has also been observed that Average Throughput increases with the increase in Transmission Range for 25 nodes scenario but decrease with the increase in Transmission range in 50 nodes scenario. It is also analysed that with the increase in mobility rate lot of routes break that causes large numbers of packets dropped. It is also observed that throughput is directly proportional to number of packets received by the receiver node.

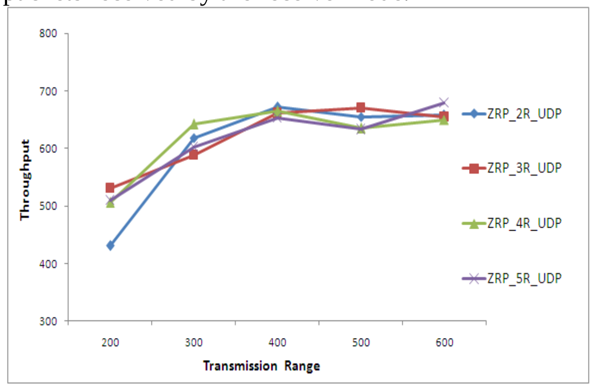

Fig 16 Impact of varying Transmission Range & Zone radius on Throughput with 100 mobility speed for 25 nodes.

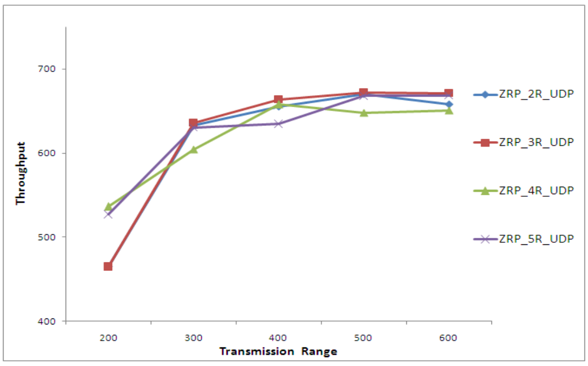

Fig 17 Impact of varying Transmission Range & Zone radius on Throughput with 200 mobility speed for 25 nodes.

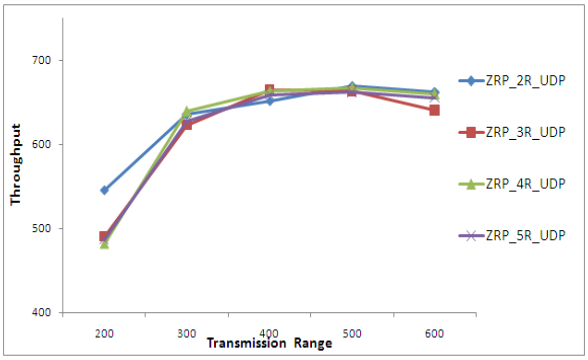

Fig 18 Impact of varying Transmission Range & Zone radius on Throughput with 300 mobility speed for 25 nodes.

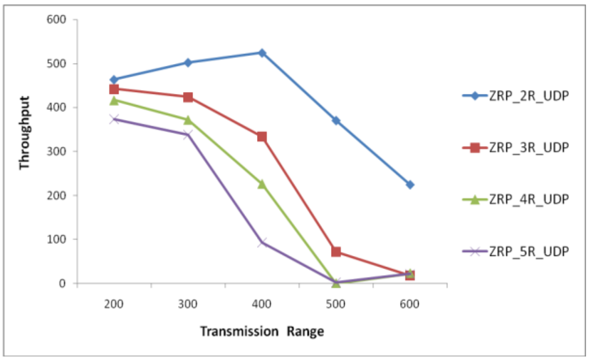

Fig 19 Impact of varying Transmission Range & Zone radius on Throughput with 100 mobility speed for 50 nodes.

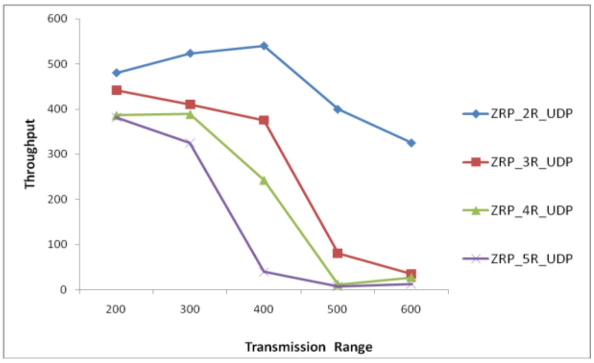

Fig 20 Impact of varying Transmission Range & Zone radius on Throughput with 200 mobility speed for 50 nodes.

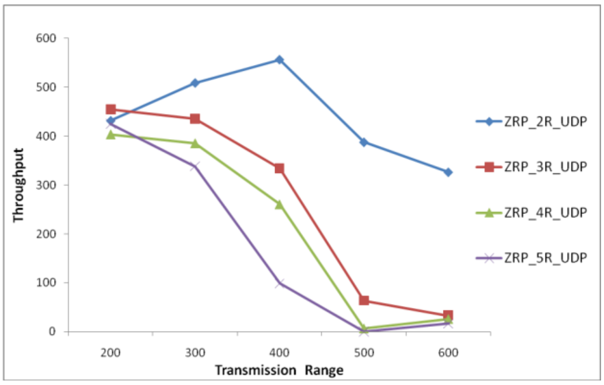

Fig 21 Impact of varying Transmission Range & Zone radius on Throughput with 300 mobility speed for 50 nodes.

D Routing Overhead

Routing Overhead of ZRP is shown in Figure 22-24 for 25 nodes and in Figure 25-27 for 50 nodes. It has been observed that the Routing Overhead is decreasing with increase in Transmission Range for 25 nodes and increasing with increase in Transmission Range for 50 nodes scenario. It is observer that with higher mobility speed and bigger Zone Size, Routing Overhead is maximum for 50 nodes scenario. Analysis shows that Routing Overhead is more in high mobility rate that are due to frequent route break occurs and lots of route reconfiguration requests are generated and it start increasing when the zone size is getting bigger.

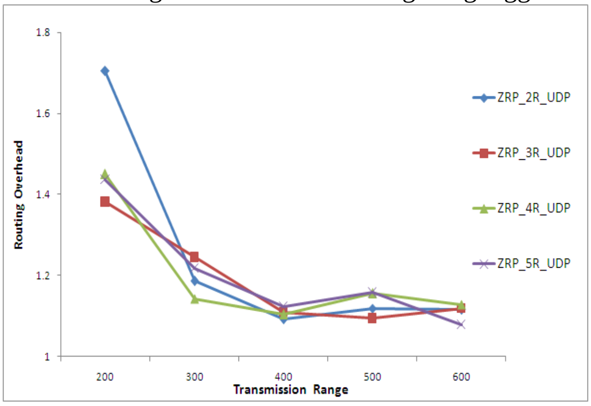

Fig 22 Impact of varying Transmission Range & Zone radius on Routing Overhead with 100 mobility speed for 25 nodes.

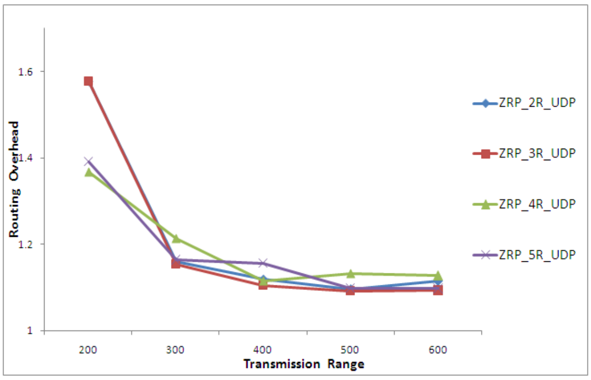

Fig 23 Impact of varying Transmission Range & Zone radius on Routing Overhead with 200 mobility speed for 25 nodes.

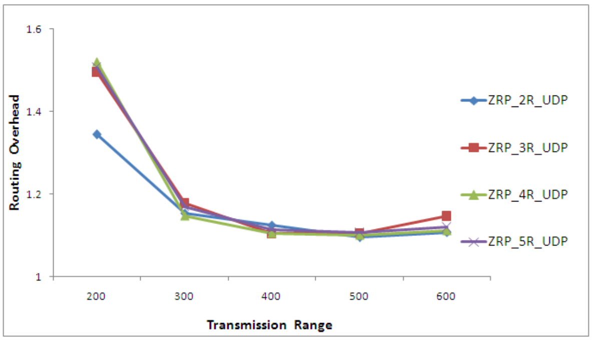

Fig 24 Impact of varying Transmission Range & Zone radius on Routing Overhead with 300 mobility speed for 25 nodes.

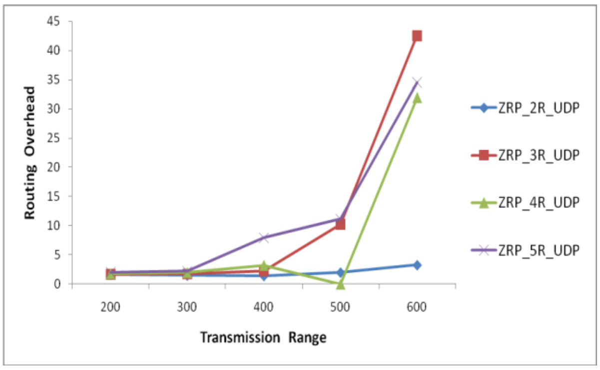

Fig 25 Impact of varying Transmission Range & Zone radius on Routing Overhead with 100 mobility speed for 50 nodes.

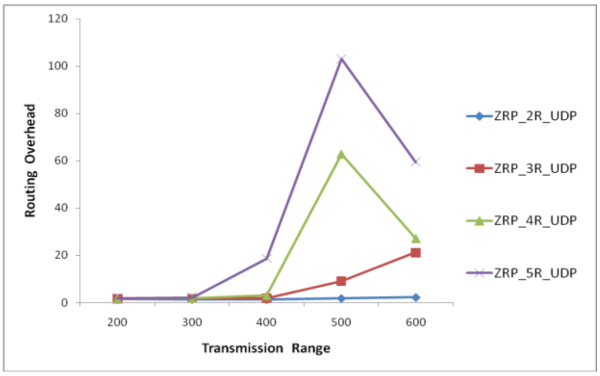

Fig 26 Impact of varying Transmission Range & Zone radius on Routing Overhead with 200 mobility speed for 50 nodes.

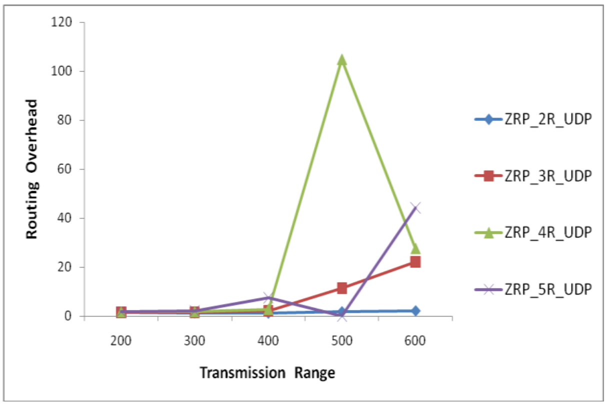

Fig 27 Impact of varying Transmission Range & Zone radius on Routing Overhead with 300 mobility speed for 50 nodes.

VI. CONCLUSION

The Transmission Range, Zone Size, Mobility and different number of nodes as a system parameter affects the overall wireless ad-hoc networks. The performance of ZRP shows some differences by varying Transmission Range, Zone Size, Mobility and different number of nodes. From our experimental analysis we conclude that transmission range has inverse effect with scalability. When number of nodes are less then with the increase in transmission range performance is getting better every time but when we scale up the network with the increase in transmission range performance of ZRP is getting poorer. It is also conclude that when zone size is very small it act as reactive routing protocol because the probability of destination node with in routing zone is less, so average delay is more. ZRP uses proactive routing within the zone as zone size gets increased then delay keeps on reducing destination nodes can come under the routing zone. We also concluded that when nodes mobility rate is less then throughput, packet delivery ratio is maximum as packets drop is less and as mobility rate and zone size is increased the control overhead also increased. In future work, simulations can be performed by increasing number of mobile nodes and varying transmission range is also great concern.

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