International Journal of Engineering Research and Applications (IJERA) ISSN: 2248-9622
National Conference on Advances in Engineering and Technology
(AET- 29th March 2014)

RESEARCH ARTICLE OPEN ACCESS

Performance based Reliable Data Communication Analysis on TCP, UDP by varying nodes, mobility speed and zone radius over ZRP

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ABSTRACT
ZRP is a hybrid routing protocol for ad hoc networks. ZRP combines the best features of proactive and reactive routing protocols to balance the control overhead on Ad Hoc Networks. This paper presents performance based reliable data communication analysis on TCP, UDP by varying nodes, zone radius and mobility speed Over ZRP. The environment has been simulated by 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 provide reliable data communication support for Mobile Ad hoc Networks.
Keywords – Ad Hoc Network, ZRP, TCP, UDP etc.

I. Introduction

Mobile Ad hoc Network (MANET) is a self created and self organized 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 ad hoc networks each and every node works as router [2]. 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. For reliable data communication on routing protocols TCP (Transmission Control Protocol) provides connection-oriented, end-to-end, error free data delivery supports [3] [4] [5]. A TCP connection is a virtual circuit between two nodes, conceptually very much like a telephone connection but with reliable data transmission between them. A sending node divides the data stream into segments. Each segment is labeled with an explicit sequence number to guarantee ordering and reliability. When a host receives in sequence the segments, it sends a cumulative acknowledgment (ACK) in return, notifying the sender that all of the data preceding that segment's sequence number has been received. If an out-of -sequence segment is received, the receiver sends an acknowledgement indicating the sequence number of the segment that was expected. If outstanding data is not acknowledged for a period of time, the sender will timeout and retransmit the unacknowledged segments.

Similarly UDP (User Datagram Protocol) is one of the protocols that are widely used in traditional networks (wired network). The services provided by UDP are unordered delivery of packets, connectionless service, full duplex connection and message boundaries preserving, no congestion control and packet delivery [6]. In contrast to wired network, wireless packet networks are characterized as low-bandwidth and unreliable, in which a considerable amount of packet losses are induced by both channel failure and network congestion. Depending on the environment, moving speed, and network loading, packet loss can be random or burst. Since UDP does not perform any error recovery, streaming multimedia over wireless networks can yield unpredictable degradation and poor video/audio quality. One of the in efficiency of UDP is that it fails to incorporate the properties of the wireless network, where a channel error only partially corrupts a packet. UDP discards a packet containing only a small part of corrupted data.

The routing in ad hoc network is based on multihop relay of control/data packets. Due to multihop relaying, there are lots of design issues at the transport layer that are induced traffic, induced throughput unfairness, power and bandwidth constraints, misinterpretation of congestion, dynamic topology and completely de coupled transport layer [7]. Hence it is necessary to know the performance of UDP and TCP under ad hoc networks on different routing protocols. In this paper, the performance based reliable data communication analysis on TCP, UDP by varying mobility speed and zone radius over ZRP has been done. The rest of the paper is organized as follows: section 2 gives a brief description of related works which help in improvement of the ZRP performance. Section 3 explains overview of ZRP for MANETs. Section 4 presents simulation based results, evaluation and performance comparison graphs of our work. Finally, conclusion and future work are presented in section 5.

II. RELATED WORK

Extensive literature survey has been done on ZRP. In [8], author compared the performance of AODV and OLSR using TCP and UDP over ns- 2. Their simulation results show that AODV performs better in static networks. In [9], authors compared the performance of proactive and reactive routing protocols using TCP, and shows that reactive routing protocol produces a lesser routing overhead over low network speeds. The performance of AODV over OPNET, to determine the effect of TCP and UDP applications over AODV is evaluated [10].

In [11], authors considered protocols of AODV and DSR as a reference for analyzing ZRP with QUALNET simulator. Authors 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.

In [12], authors analyzed the performance of ZRP. 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.

An analytical model that allows us to determine the routing overhead incurred by the scalable routing framework on ZRP is proposed [13]. 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. In [14], authors compared the performance of DSR, AODV and ZRP, especially focusing on ZRP and the effect of some of its most important attributes to the network performance. It has been observed from their work that the performance of ZRP was not up to the task and it performed poorly throughout all the simulation sequences. So in this paper, we have analyzed ZRP with varying nodes, mobility speed and zone size on TCP, UDP traffic over MANETs.

III. OVERVIEW OF ZONE BASED ROUTING PROTOCOL

ZRP is a hybrid routing protocol based on parameter called routing zone [15]. ZRP is proposed to reduce the control overhead of proactive routing protocols and decrease the latency caused by routing discover in reactive routing protocols [16]. 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 [17]. In ZRP there are further two sub-protocols,: Intra-zone routing protocol (IARP) [18] 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 [11]. 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.

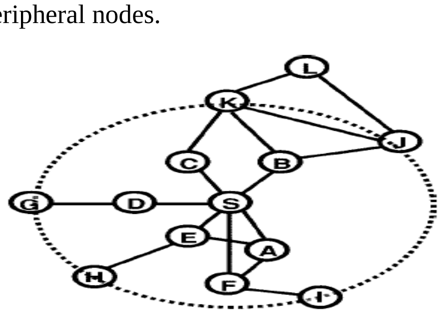

Figure 1 illustrate the Zone Routing with Radius 2

S – Central Node
L – outside zone
A-F – Neighbors
G-K – Peripheral

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 with respect to node S.

IV. Simulation Parameters And Environment

The performance based reliable data communication analysis on TCP, UDP by varying nodes, mobility speed and zone radius over ZRP has been analyzed by taking following 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.

Table 1 Simulation Parameters

Parameters	Value
No of Node	50, 75,100
Simulation Time	10 sec
Environment Size	1200 x 1200
Traffic Size	CBR (Constant Bit Rate)
Queue Length	50
Source Node	0
Destination Node	2
Mobility Model	Random Waypoint
Antenna Type	Omni directional
Simulator	NS-2.33
Mobility speed	100,200,300 m/s
Protocols	ZRP,TCP,UDP
Zone Radius	2,3,4,5
Operating System	Linux Enterprises version -5

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

5.1 Packet Delivery Ratio

ZRP has better packet delivery ratio in all scenarios of TCP. As observed from Fig 2, Fig 3 and Fig 4, in low mobility speed ZRP has more packet delivery ratio as compare to the higher mobility speed. As zone size increases packet delivery ratio decreases almost in all cases of TCP and UDP. It is also analyzed as the UDP is connectionless, lots of location contention, it further increases the unreliable support as mobility and zone size increases. So we have concluded that packet delivery ratio is inversely propositional to mobility speed and zone size in both TCP and UDP.

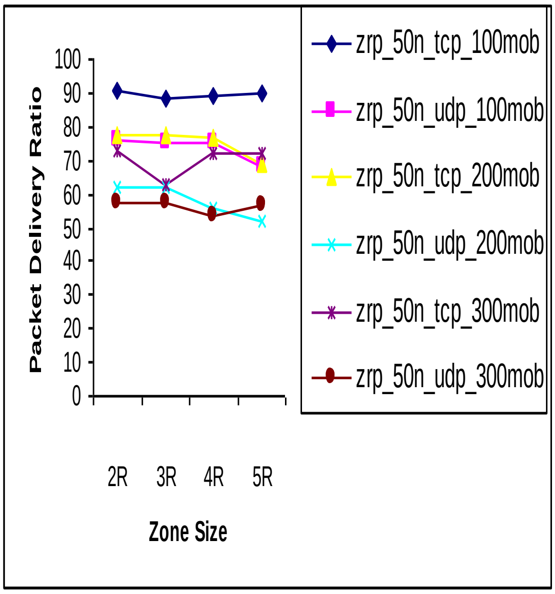

Fig 2: Effect of Varying Zone Radius and Mobility Rate on the Packet Delivery Ratio for 50 nodes over TCP and UDP

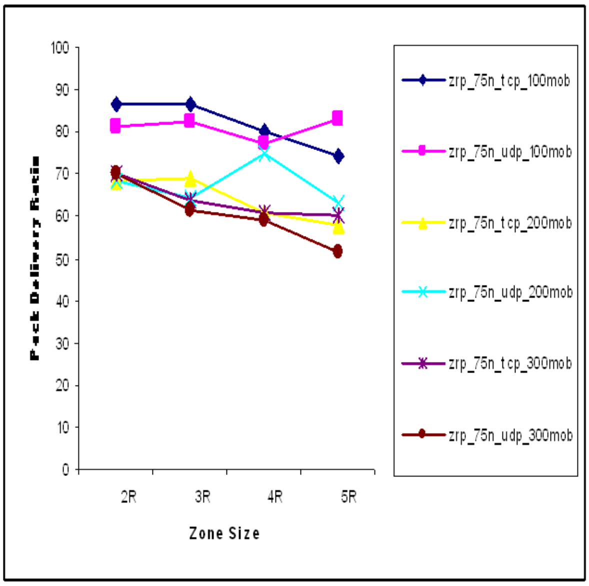

Fig 3: Effect of Varying Zone Radius and Mobility Rate on the Packet Delivery Ratio for 75 nodes over TCP and UDP

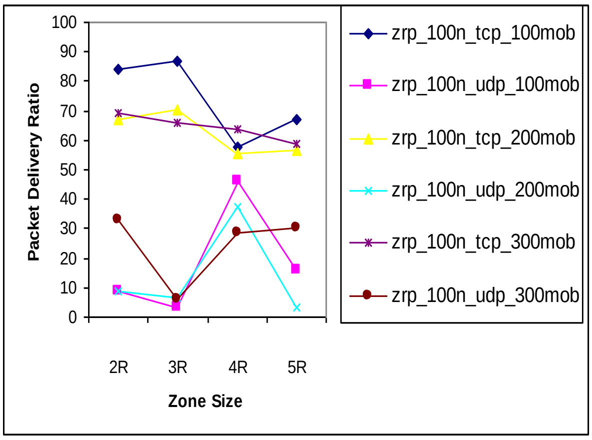

Fig 4: Effect of Varying Zone Radius and Mobility Rate on the Packet Delivery Ratio for 100 nodes over TCP and UDP

5.2 Average Throughput

Similarly to packet delivery ratio of ZRP average throughput is better in all the cases of TCP. As observed from Fig 5, Fig 6 and Fig 7, at lower mobility speed ZRP shows more average throughput as compare to the higher mobility speed and zone size. As zone size increases average throughput decreases down in almost all cases. So we have analyzed that average throughput is inversely proportional to mobility speed and zone size. Similarly to packet delivery ratio the average throughput of UDP is less than TCP.

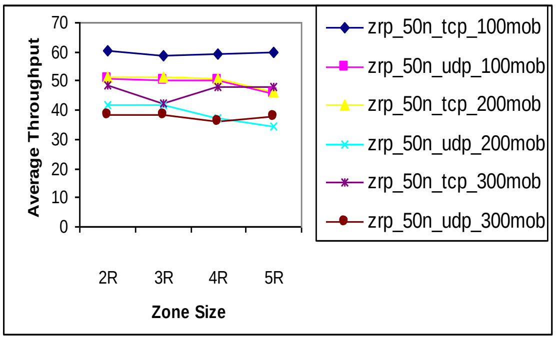

Fig 5: Effect of Varying Zone Radius and Mobility Rate on the Average Throughput for 50 nodes over UDP and TCP

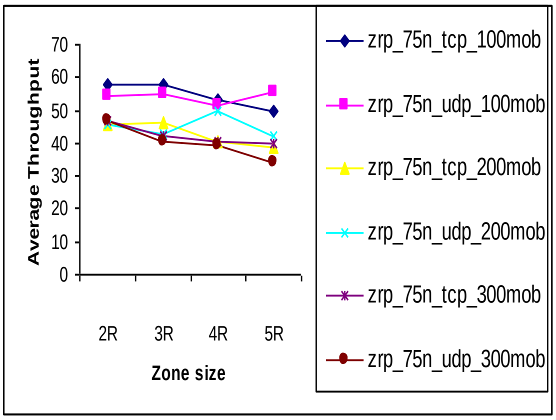

Fig 6: Effect of Varying Zone Radius and Mobility Rate on the Average Throughput for 75 nodes over TCP and UDP

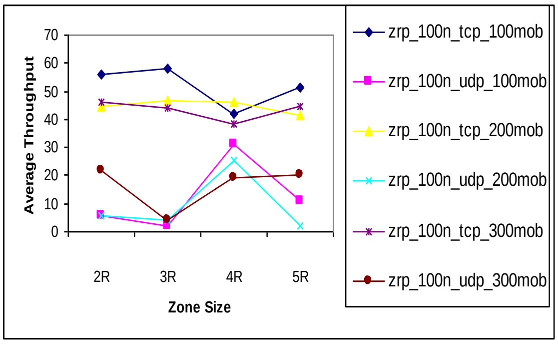

Fig 7: Effect of Varying Zone Radius and Mobility Rate on the Average Throughput for 100 nodes over TCP and UDP.

5.3 Average Delay

As TCP is connection oriented, so it makes end to end connection, end to end delivery of data, flow control, congestion control and error control. As observed form Fig 8, Fig 9 and Fig 10, the average delay in ZRP is minimum in all cases of TCP. As zone size increases average delay decreases except in some cases. In case of UDP average delay is minimum when mobility is low and with the increase in mobility average delay increases as shown in Fig 10.

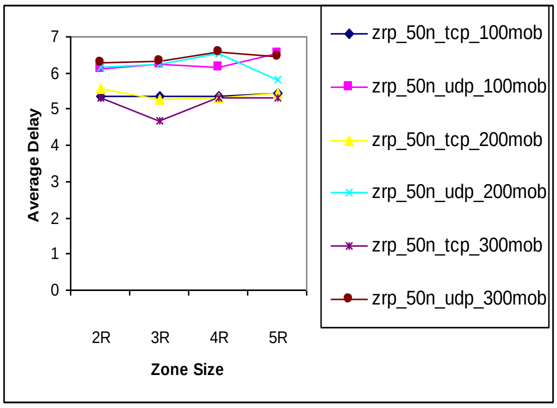

Fig 8: Effect of Varying Zone Radius and Mobility Rate on the Average Delay for 50 nodes over TCP and UDP.

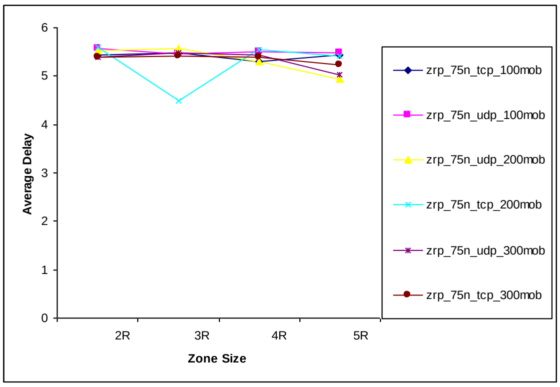

Fig 9: Effect of Varying Zone Radius and Mobility Rate on the Average Delay for 75 nodes over TCP and UDP.

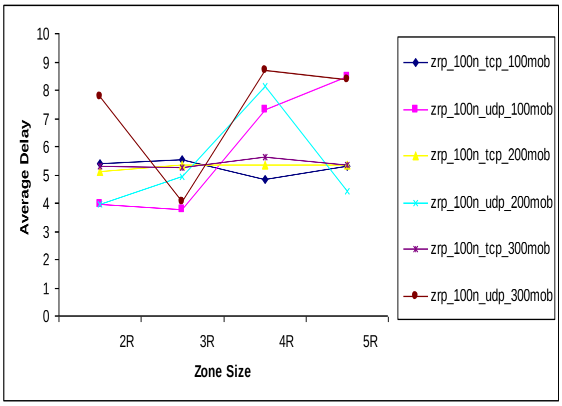

Fig 10: Effect of Varying Zone Radius and Mobility Rate on the Average Delay for 100 nodes over TCF and UDP.

5.4 Routing Overhead

Routing overhead is less in case of TCP. It increases with the increase in mobility. From Fig 11, Fig 12, and Fig 13, we have observed that routing overhead is directly proportional to mobility, as mobility increases routing overhead increases. With the increase in zone size routing overhead increase in many cases. From Fig 13, in case of 100 nodes and UDP, we observe that routing overhead is minimum in case of 300 mobility. In case of 100 mobility till 3R routing overhead is maximum, after 3R with the increase in zone size routing overhead here decreases down.

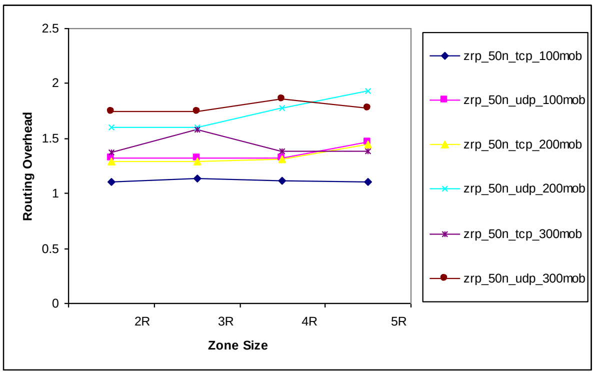

Fig 11: Effect of Varying Zone Radius and Mobility Rate on the Routing Overhead for 50 nodes over TCP and UDP.

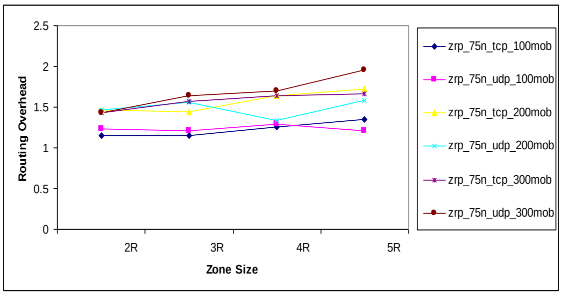

Fig 12: Effect of Varying Zone Radius and Mobility Rate on the Routing Overhead for 75 nodes over TCP and UDP.

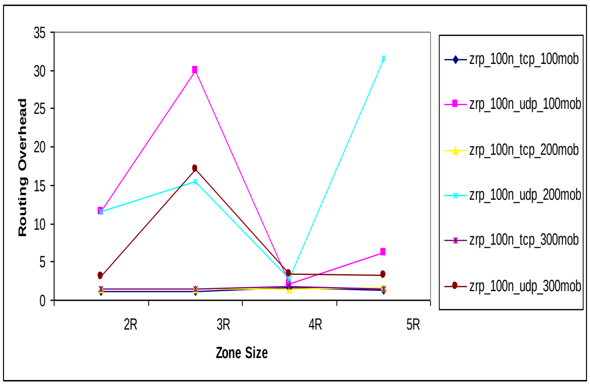

Fig 13: Effect of Varying Zone Radius and Mobility Rate on the Routing Overhead for 100 nodes over TCP and UDP.

VI. Conclusion And Future Scope

Simulation based analysis of ZRP has concluded 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. As TCP is reliable protocol and when its performance is analyzed on ZRP, its results shows maximum packet delivery ratio with lower mobility speed and lowest packet delivery ratio with highest mobility speed. Throughput is also inversely proportionate to mobility speed and zone size. Similarly, when we analyzed UDP due to its unreliable nature its performance is poor in all the scenarios. So after analysis and result discussion this paper concludes that UDP flows perform better in the case of dense networks with little or no mobility. TCP flows perform better for high mobility scenarios

After overall analysis of performance comparison of these transport layer protocols, it is also observed that the transport layer is completely decoupled from lower layers. So there is a need to develop a more cross layer protocols over ad hoc networks for reliable data communication.

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