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Region Based AODV Geographic Routing Protocol for Quasi MANET

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Abstract: In a disaster recovery scenario, there may be some static wireless nodes at special service providing locations such as a medical camps or helipads and the other mobile nodes such as mobile equipment carried by a rescue personal or any transport vehicle. This forms a Quasi MANET in which the mobile nodes periodically communicate to the static nodes with some critical priority. In Quasi MANET under consideration, there are some percentage of node which are not at all mobile throughout whole time of operation. This research work main scope is to design and implement a location based AODV routing model for Quasi MANET scenario and evaluate its performance with normal AODV routing protocol and other MANET routing protocols. Hence implemented a Region based Route Request Processing in AODV (RRRP_AODV) and compared its performance with normal AODV. The arrived result verifies the noteworthy progress in performance of RRRP_AODV.

Key words: MANET, quasi-static, AODV, DSDV, DSR, Geo-AODV, disaster, NS2, region, geographic, routing

INTRODUCTION

Mobile Ad Hoc Network (MANET): A MANET atmospheres has certain issues of constraint and inadequacy (Perkins, 2001).

- Naturally the wireless link individualities are time-varying. There are transmission barriers like interference, fading, blockage and path loss that leads to the prone behavior of wireless channels (Tonguz and Ferrari, 2009)
- Inadequate range of wireless transmission When comparing to wired networks in wireless reduced data rates due to the limited radio band. Therefore, in order to keep low overhead the bandwidth should be used optimal (Buchegger and Boudec, 2002)
- Packet loss; In MANETs due to hidden terminal problem, frequent link breakage results in higher packet loss and collision (Papadimitratos and Haas, 2002)
- Routing; Due to mobility regular route changes and path breaks. The dynamic topology leads to frequent path breaks (Lochert *et al*., 2003)
- Frequent network barriers; Intermediate nodes are affected due to the node mobility leads to partition of the network (Bose *et al*., 2001)

Reactive routing protocols (Das *et al*., 2000; Kim *et al*., 2005) such as Ad Hoc On Demand Distance Vector (AODV), (Bai and Singhal, 2006) Dynamic Source Routing (DSR), (Johnson and Maltz, 1996) reduces routing overhead but adding latency. Proactive routing protocol mechanism maintains table driven up to date routing information. One of the popular routing is Destination Sequenced Distance Vector (DSDV) (Tuteja *et al*., 2010).

The two Transport Layer protocols (Blum *et al*., 2004) namely one is Transmission Control Protocol (TCP) (Chandran *et al*., 2001) and other is User Datagram Protocol (UDP). In TCP once the connection is initiated data sent in bidirectional. UDP is termed as connectionless Internet protocol. In UDP as packet chunks in multiple chunks multiple messages are sent (Rango *et al*., 2003a, b).

Quasi MANET: Ad Hoc networks can be generally of two kinds. Mobile and quasi-static.quasi-static networks has nodes having fixed or moveable.

In this study evaluated some of the popular reactive and proactive MANET routing algorithms under this Quasi mobile ad hoc network scenario.The increase in node density and mobility will reduce the performance of any routing protocol under normal MANET scenario. But, in Quasi MANET under consideration, there are some percentage of node which are not at all mobile throughout whole time of operation. Hence by considering this as a research problem and present a model for location based

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routing that can be implemented in AODV. The scope of this paper is to present a simple model for location based routing that can be applied for any Quasi MANET Communication scenario.

Literature review: Topological routingaccomplish packet forwarding by usingrouting table information. Geographic routing decides to forward packets with the help of neighboring location information and self location awareness (Ko and Vaidya, 2000) In geographic routing using GPS (Global Position System) provides location information which enhancing the performance of message delivery.

For the LAR protocol RREQ packets forwarding zone recomputed using mobile nodes geographical location. The shape of the zone effects the performance based on the packet delay , packet loss and control overhead. The multi-step resizing of the request zone is compared with other routing protocols. Simulation results shows the betterment of the reducing control overhead (Rango *et al*., 2003a, b).

In this research, designed and implemented a region based route request message processing in AODV, exclusively designed for Quasi MANET communication scenario. The main difference of this proposed algorithm with other geo routing algorithms such as LAR (Ko and Vaidya, 2000; Deb *et al*., 2009) and Geo-AODV (Rao *et al*., 2009; Pathak *et al*., 2008) is that in this model the mobile nodes will not share their location information with one another and hence increase the message overhead.

MATERIALS AND METHODS

A proposed model under Quasi MANET

A sample Quasi MANET scenario: As shown in Fig. 1 by considering a MANET disaster recovery scenario with 40 nodes and assume that there are 4 static nodes N0, N2, N4 and N6, at some special service providing locations such as a medical camps or helipads shown as black circled filled with red color. The black circles filled with yellow are mobile nodes-they may be a mobile equipment carried by a rescue personal or an ambulance or any transport vehicle.

Assuming that the mobile nodes may try to communicate with one another and most importantly, they try to communicate with the static nodes at service providing locations very often. Hence, in this evaluation, measuring the performance of the network during the communication among mobile nodes and the static nodes.

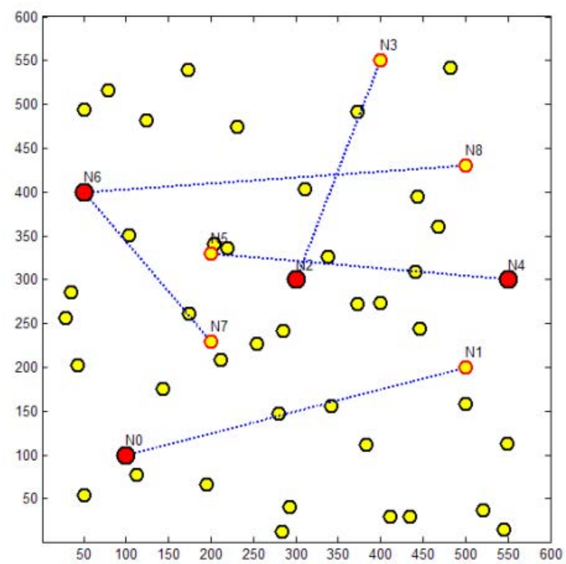

Fig. 1: Quasi MANET sample topology

Hence, at an instant of this scenario, the nodes N1, N3, N5, N7 and N8 are trying to communicate with that 4 static nodes at the service providing locations. The blue dotted lines connecting the mobile node and the static nodes is the line of sight.

According to this proposed model, the mobile nodes will communicate with one another in normal ways and communicate with the static nodes at the service locations using the proposed Quasi MANET geo routing approach. Hence as per the basic nature of this design, the communication among the mobile hosts and the service locations were prioritized and will get best quality of service. RRRP_AODV Routing Protocol Geo Routing in Quasi MANET.

In region based route request processing AODV model the rectangular region is chosen as a sample shown in the Fig. 2. By using basic geometric rules calculating the coordinates of that rectangular region among two nodes N0 and N1.

By considering the virtual, right angle triangle $N_0N_1P_3$ that is constructed over the line N_0N_1 that connects the two nodes.

The problem here is to find the location of the points P1, P2, P3 and P4 or in general, necessity to find the location of the point above and below the right angle of the line N_0N_1. Hence, the point:

$$P_n = (x_n, y_n) \tag{1}$$

$$\text{The slope of A} = mA = \frac{y2 - y1}{x2 - y1} \tag{2}$$

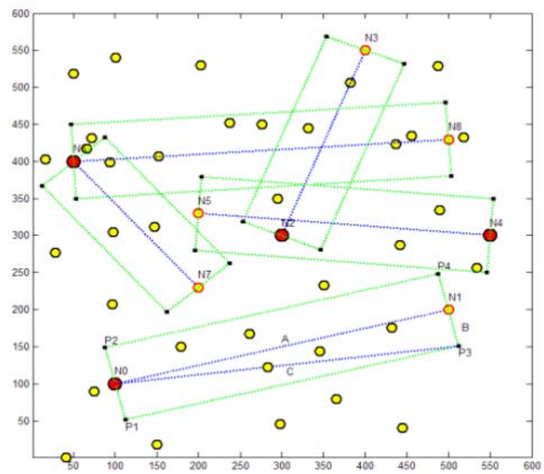

Fig. 2: Rectangular region sample quasi MANET scenario

$$\text{The slope of } B = mB = \frac{x2 - x1}{y2 - y1} = \frac{1}{mA} \quad (3)$$

The length of line N_1P_3 is B, able to find the coordinates x,y and the points P1, P2, P3 and P4 are as follows

$$P1_x = N_{0x} + B\times\left(\frac{1}{\sqrt{1+mB^2}}\right) \quad (4)$$

$$P1_y = N_{0y} + B\times\left(\frac{mB}{\sqrt{1+mB^2}}\right) \quad (5)$$

$$P2_x = N_{0x} - B\times\left(\frac{1}{\sqrt{1+mB^2}}\right) \quad (6)$$

$$P2_y = N_{0y} - B\times\left(\frac{mB}{\sqrt{1+mB^2}}\right) \quad (7)$$

$$P3_x = N_{1x} + B\times\left(\frac{1}{\sqrt{1+mB^2}}\right) \quad (8)$$

$$P3_y = N_{1y} + B\times\left(\frac{mB}{\sqrt{1+mB^2}}\right) \quad (9)$$

$$P4_x = N_{1x} - B\times\left(\frac{1}{\sqrt{1+mB^2}}\right) \quad (10)$$

$$P4_y = N_{1y} - B\times\left(\frac{mB}{\sqrt{1+mB^2}}\right) \quad (11)$$

The points P_1, P_2, P_3 and P_4 forms a rectangular region $\Re$. According to the above illustration, the width of the rectangle is 2B. Hence, the area of the rectangular region $\Re$ = A×2B. Able to increase the area of the region $\Re$ by increasing B.

By controlling the routing rules with in this region $\Re$, able to control the behaviour of a routing algorithm and design a geo routing algorithm. Generally as per the basic design, each generated RREQ messages will try to send to all the nodes. But, it is not necessary for resolving a shortest path among sender and receiver. Because, only the nodes within region $\Re$ will be allowed to forward the RREQ message from the source and destination, then the overhead in establishment of a stable, shortest path will get reduced very much.

Even though the earlier Location-Aided Routing (LAR) (Rango *et al*., 2003a, b) is working based on similar principle, it takes the hypothesis that all node in the network identifies the speed and location of the concern receiver node. For that it assumes a location resolution mechanism using a location server. Hence, each node in the network should periodically send its location to a central node and other nodes will raise query for the location of any nodes in the network.

The previous implementation of Geo_AODV does not mark the undertaking that each node recognizes the speed and locality of the receiver node but it will try to find and issue position information to other nodes in the network- Hence it will cause additional message overhead.

But in Quasi MANET scenario, the mobile nodes need not know the location of all other mobile nodes and only need to know the location of the static nodes which are situated at service providing locations. Hence, this proposed Geo routing algorithm conceptually will perform better than the previous LAR (Defrawy and Tsudik, 2011) as well as Geo-AODV (Xue *et al*., 2008; Braga and Martin, 2011).

RESULTS AND DISCUSSION

This study presents the performance of different routing algorithm on a Quasi MANET scenario.The evaluation is made using NS2.35 under Ubuntu Linux Operating System (Xiang *et al*., 2013; Chen *et al*., 2013). In this simulation, using the following common parameters while setting up the Quasi MANET. In the

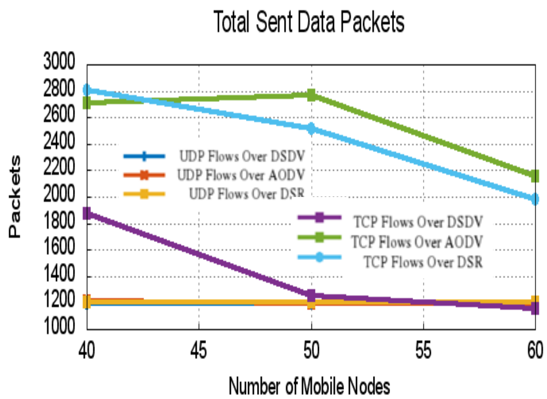

Fig. 3: No. of mobile nodes vs sent data

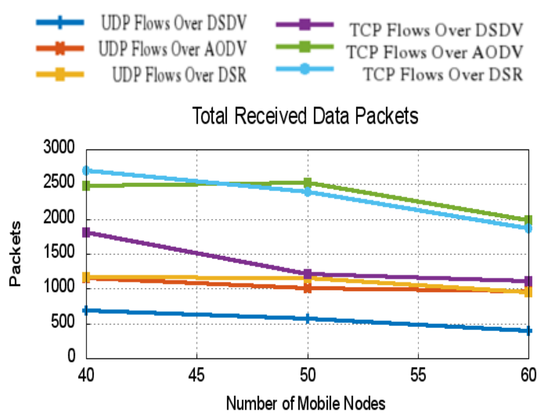

Fig. 4: No. of mobile nodes vs. received data

Quasi MANET scenario the mobile nodes speed is 20 m sec^{-1} with the communication pattern of Constant Bit Rate (CBR) between nodes along the transport agent is TCP , the nodes moves based on Random Way Point model in the topographical area of 800×800 with the total simulation time is 100 sec with the packet size 2048 bytes having pause time of 10 sec and the interval is 0.05 sec. This work uses the IEEE 802.11 function at the MAC Layer. In the proposed RRRP_AODV region width is 150 m. For checking the performance the used metrics arethroughput, totalsent data packets, total received data packets, packet delivery fraction, routing load, MAC load, routing overhead, total droppedpackets andconsumed battery energy.

Figure 3 shows the comparison of AODV, DSDVand DSR over TCP and UDP in terms of sent data packets. TCP over DSR and AODV is able to send much data packets when less number of mobile nodes.The performance is decreasing when increase of mobile nodes in the network. Figure 4 shows the comparison of AODV, DSDV and DSR with respect to received data packets. TCP over DSR and AODV is able to receivemore data packets.

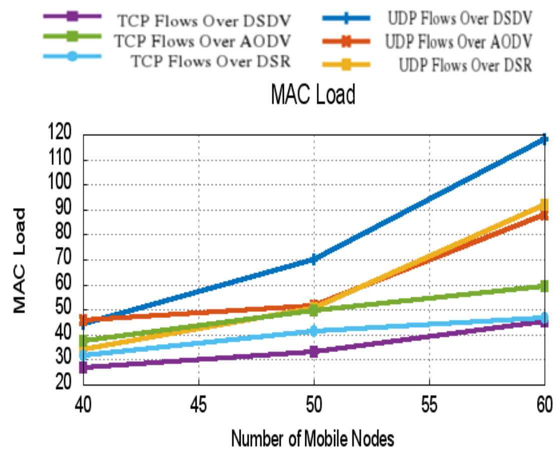

Fig. 5: No. of mobile nodes vs. MAC load

Figure 5 TCP over all the routing methods provided some what lesser MAC load. UDP over DSDV provided poor performance among all the compared methods. Figure 6 exhibits the performance in terms of Routing load. As shown in this graph, TCP over all the routing methods provided some what lesser routing load at high node density. TCP over DSDV provided good performance among all the compared methods.

Figure 7 the performance of AODV, DSDVand DSR over TCP and UDPin terms of routing overhead is compared. TCP over AODV and DSR resulted high routing overhead. UDP over DSDV provided less overhead among all the compared methods. Figure 8, the number of dropped packets at all the layers is more for TCP over AODV since sending more packets and provided highest throughput than all other mehods. Figure 9 the performance of AODV, DSDVand DSR is compared. Let the number of mobile nodes be x-axis and throughput be y-axis. TCP over DSR and AODV is sending more packets when compared to DSDV.

Observations made on Quasi MANET:

- In general, AODV and DSR performed good but the overhead and routing load were high. This makes the possibility of applying Geographic Routing techniques in AODV and DSR to reduce such overhead
- Even TCP over AODV and DSR provided best load performance
- Even UDP over some routing algorithm provided good PDF under this Quasi MANET
- The total dropped packets at all layers, AODV is dropping much packets at all layers irrespective of its high througput. Hence, there is much scope for improving AODV using geo routing concept

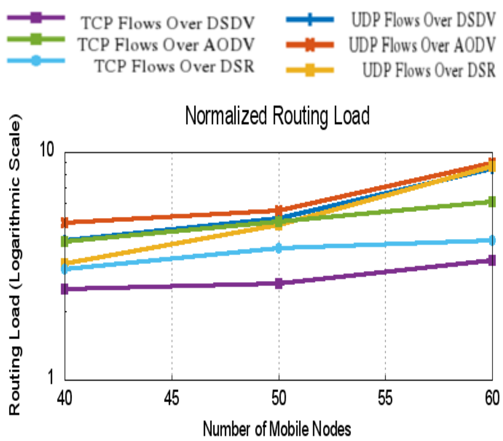

Fig. 6: No. of mobile nodes vs. routing

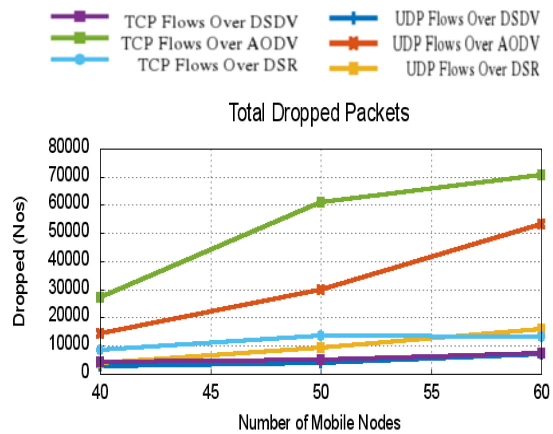

Fig. 8: No. of mobile nodes vs total dropped packet

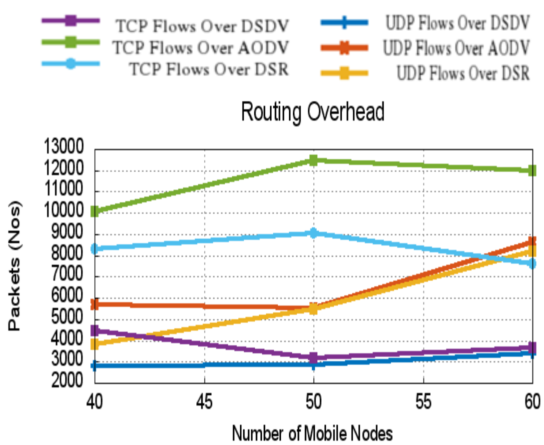

Fig. 7: No. of mobile nodes vs. routing overhead

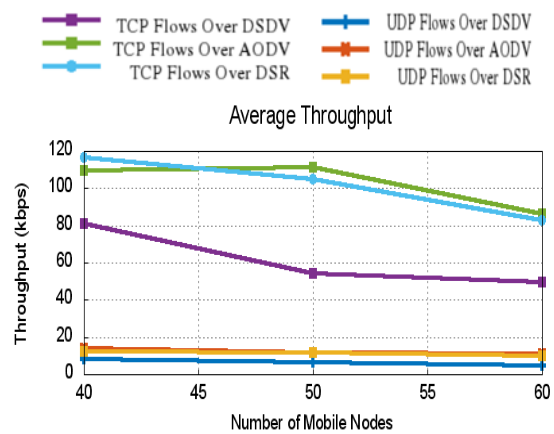

Fig. 9: No. of mobile nodes vs throughput

- The overhead measured in term of routing overhead, normalized routing load and MAC load, AODV unecessarily spending much effort for achieving that level of throughput and delivery ratio. All these overhead can be reduced by incorporating suitable geo routing based mechanism in AODV
- It is obvious that the increase in mobility reduced the performance in terms of throughput. But, with respect to other metrics, the performance was almost constant or little bit low with respect to the increase in mobility. It may be due to the communication with the static nodes. This should be explored further to understand this strange behaviour
- Hence by altering the routing mechanism of AODV using source and destination location based packets decisions, then can achieve even better throughput at much reduced overhead

'Proposed RRRP_AODV' over TCP results: In this section the comparison of proposed RRRP_AODV is compared with the AODV over TCP in a Quasi MANET scenario

Figure 10 the performance of proposed RRRP_AODV and normal AODV is compared based on sent data packets. Theproposed RRRP_AODV is able to forward more packets than the normal AODV. Figure 11 the proposed RRRP_AODV routing algorithm is receiveing more number of packets than normal AODV routing algorithm due to less overhead.

Figure 12 illustratesthe effect of MAC load on the proposed RRRP_AODV, provided lesser MAC load than the normal AODV since limited region hence less MAC request. Figure 13, it is observed thatthe proposed RRRP_AODV routing algorithm delivered lesser routing load than the normal AODV since route request is reduced. The routing overhead of Fig. 14 implies that the

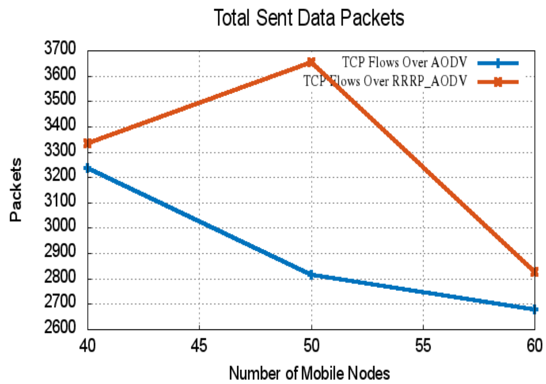

Fig. 10: No. of mobile nodes vs sent data (total)

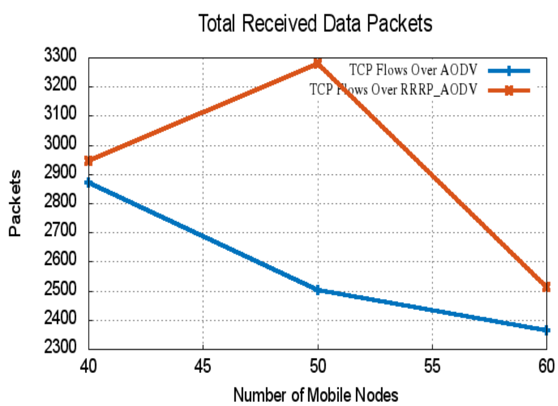

Fig. 11: No. of mobile nodes vs received data (total)

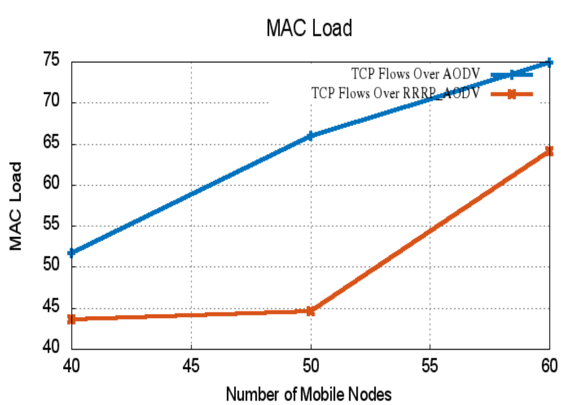

Fig. 12: No. of mobile nodes vs MAC load

proposed RRRP_AODV provided lesser overhead than normal AODV since the routing request packets generated is less.

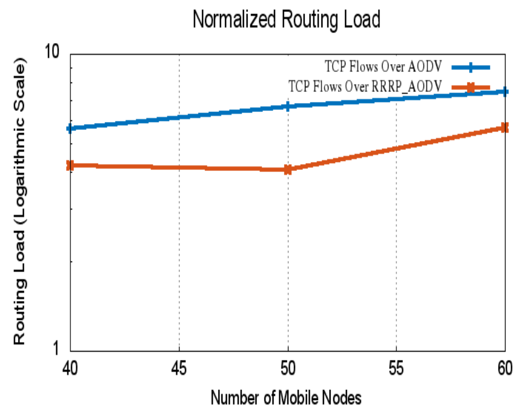

Fig. 13: No. of mobile nodes vs. routing load

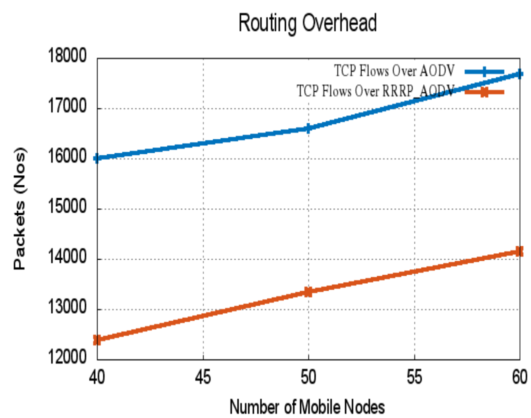

Fig. 14: No. of mobile nodes vs routing overhead

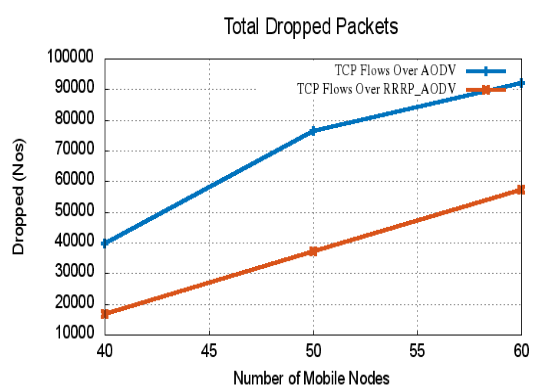

Fig. 15: No. of mobile nodes vs total dropped packets

Figure 15 shows the comparison of proposed RRRP_AODV and normal AODV with respect to total dropped packets. The proposed RRRP_AODVdropped

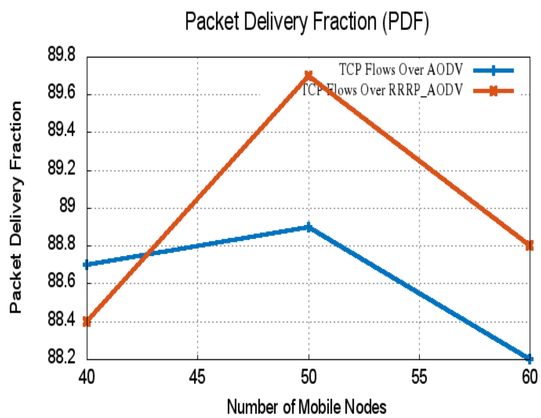

Fig. 16: No. of mobile nodes vs. PDF

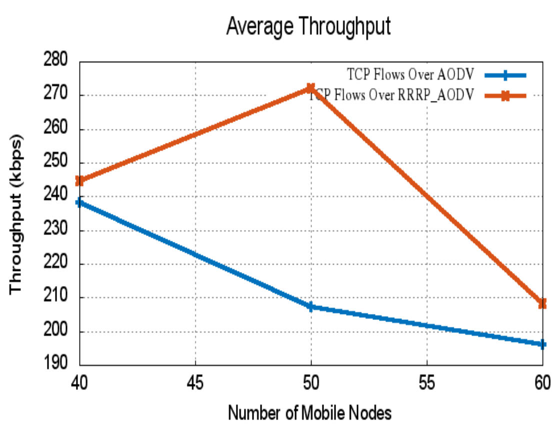

Fig. 17: No. of mobile nodes vs. throughput

negligible packets than the normal AODV. Figure 16 shows the comparison of the packet delivery fraction of the proposed RRRP_AODV and normal AODV. Proposed RRRP_AODV routing algorithm showing better than that of normal AODV routing algorithm due to limited region based route request.

Figure 17 comparing the results ofproposed RRRP_AODV and normal AODV in terms of throughput.The proposed RRRP_AODV provided better througput than the normal AODV. Figure 18 shows the consumed battery energy by the proposed RRRP_AODV and the normal AODV. This graph shows thatthe proposed RRRP_AODV is sending and receiving more packets hence consumed much energy.

Improving quasi MANET geo routing: There are many possibilities to do further enhancements in controlling routing messages on the proposed RRRP_AODV routing

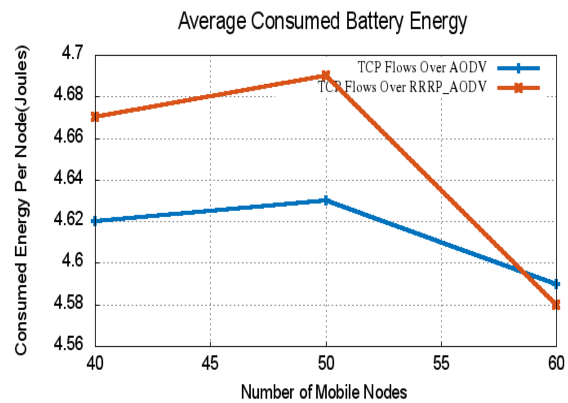

Fig. 18: No. of mobile nodes vs. consumed battery energy

protocol. This research work proposing the following enhancements in improving the performance by controlling the mechanism of RREQ and RREP messages.

Node selection criteria: By considering the following highly mobile and high density network condition. Here high probability for finding many nodes with in the rectangular region is an instant of communication.

There are much scope for improving the performance of the previously presented Quasi MANET geo routing algorithm under this highly mobile and high density network condition. Assuming there are M number of nodes with in the bounded region $\Re$.

If by filtering some nodes with some rule, then will end up with some stable nodes and achieve comparitively stable end to end connection among source and destination. For example, able to avoid some nodes within the region to become a hop in the path among source and destination:

- Able to avoid all the nodes with velocity greater than a threshold velocity
- Able to avoid any node at any velocity which were at the edges of the region which are on the way of moving out from the rectangle hence that they will be out of the rectangle after some time t
- Able to avoid all the nodes which are having lesser power than a threshold power hence it may preserve the battery power of the mobile hosts and will increase the life of the entire network

Different region selection criteria proposal: Instead of using rectangular regions as shown in Fig. 2, able to consider changing the geometry of the region and explore

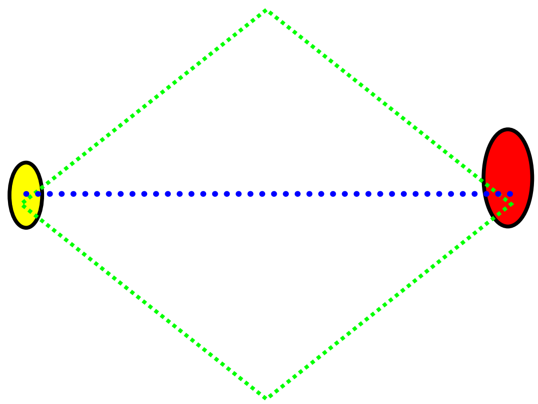

Fig. 19: Diamond or rectangular region

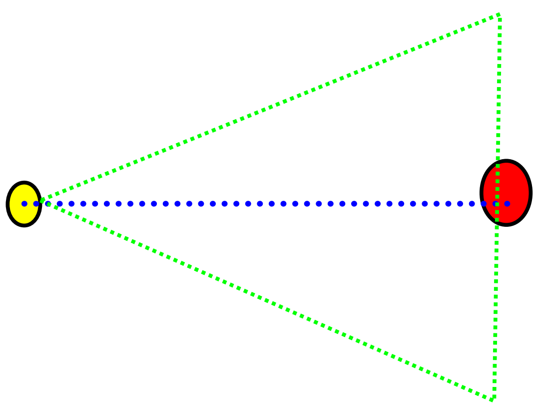

Fig. 20: Triangular region

the difference in performance. This research addresses to use some of the elementary shapes that will not involve much overhead in calculations.

Diamond or rectangular region: Selecting nodes in a diamond or rectangular region with the source and destination nodes at the two opposite corners. Able to resolve the co-ordinates of two diagonal points at the vertical center of this diamond/rectangle using the modified version of Eq. 4-7 shown in Fig. 19-21.

Triangular region: Selecting nodes in a triangular region with the source at one corners and the destination at the opposite base. Able to resolve the co-ordinates four points of the Trapezium using the modified version of Eq. 4-11.

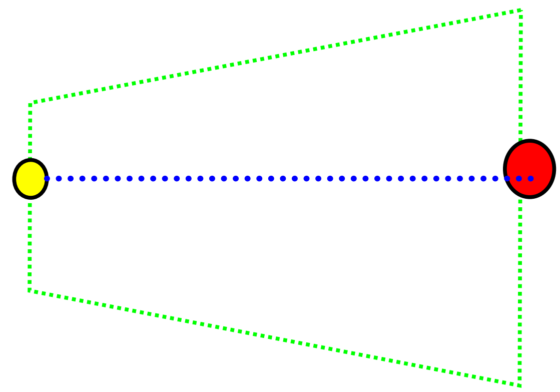

Fig. 21: Trapezium region

CONCLUSION

This research work addresses the three routing protocols performance and two transport protocols in a Quasi MANET and proposed a simple model of incorporating geo routing concepts in AODV. This work addressed different ways to find a region and within that region, able to control the behavior of a routing algorithm and design a Geo routing algorithm and implemented a rectangular region based route request processing in AODV routing. In this proposed model RRRP_AODV, only the nodes within the rectangular region were allowed to forward the RREQ message from the source and destination, hence, that the overhead in establishment of a stable, shortest path will get reduced very much. This reduced the overall overhead to a considerable level and significantly improved the overall performance.The evaluation is made on the proposed RRRP_AODV under ns2 simulator and shown the better performance.

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