ENHANCING THE QUALITY OF SERVICE (QoS) FOR RELIABLE AD HOC NETWORK USING LINK PREDICTION ALGORITHM

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Abstract

The mobile or the wireless adhoc network is a framework utilizing the nodes or the devices that are mobile to develop a potent network that does not rely on any infrastructure.The nodes are never stationary, they roam freely and extend communication with the nearby device over the wireless medium, without a need for a central body to control their actions. Frequent changes in network topology due to mobility and limited battery power of the mobile devices are the key challenges in the adhoc networks that affect the performance of the network. One of the greatest problems is the issue of a link failure and availability of future route causing packets drop and requires retransmission, thus affecting performance and quality of service.

In this paper, an analytical approach is proposed in finding the availability of future routes. Availability of a route in future mainly depends on the availability of links between the nodes forming the route.

Paper Identification

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1. INTRODUCTION

The progressive developments and Advances in wireless technology and hand-held computing devices have brought revolution in the area of mobile communication. The increasing mobility of humans across the globe generated demand for infrastructure-less and quickly deployable mobile networks. Such networks are called Mobile Adhoc Networks (MANET).

A wireless network is normally a decentralized network. The network is adhoc because each node is willing to forward data for other nodes, and so the determination of which nodes forward data is made dynamically. This is in contrast to wired networks in which routers perform the task of routing. It is also in contrast to managed (infrastructure) wireless networks, in which a special node known as an Access point manages communication among other nodes. Since the adhoc network is a decentralized network, it should detect any new nodes automatically and induct them seamlessly. Conversely, if any node moves out of the network, the remaining nodes should automatically reconfigure themselves to adjust to the new scenario. If nodes are mobile, the network is termed as a MANET (Mobile AdhocNETwork). The Internet Engineering

Task force (IETF) has setup a working group named MANET for developing standards for these networks.

Mobile Ad-Hoc Network (MANET) is a powerfully improved able of remote network with no static framework. Every host stands for as router and proceeds in a discretionary way. For a live connection, the end host and the transitional nodes can be mobile [1, 2]. Thus, routes are inclined to break much of the time, which prompts as often as possible rerouting to discover another connection to repair or a recently accessible way to recouping correspondence [3, 4].

The wireless ad hoc networks have benefits. They are quickly deployable and proper for the condition were setting up or keeping up a conveying framework is troublesome or infeasible. For instance, calamity recuperation (quake, fire), a war zone, law implementation, and vehicle-to-vehicle networking in savvy transportation frameworks. Also, the mobile nodes convey the capacity to travel openly with no pressure [5]. MANETs also have drawbacks. The battery life is aptly limited, and the radio recurrence brings about impedance. Above all, the network topology may adjust continually as a result of node activity [6, 7].

Routing Protocol Strategies: Due to the dynamic nature of MANETs, designing communications and networking protocols for these networks is a challenging process. One of the most important aspects of the communication process is design of the routing protocols which are used to establish and maintain multi-hop routes to allow the data communication between nodes.

There are three basic Adhoc routing strategies.

i) Proactive routing strategy or Table-driven.

ii) Reactive strategy or Source-initiated and is called as demand driven

iii) Hybrid strategy

i) Proactive strategy: In this strategy, every node continuously maintains the complete routing information of the network. When a node needs to forward a packet, the route will be readily available, thus there is no delay in searching for a route. However, for a highly dynamic topology, the Proactive protocol routing is not an efficient MANET routing solution. Destination Sequenced Distance Vector (DSDV) Routing and Optimized Link State Routing[8], Wireless Routing Protocol(WRP)are the protocols based on this strategy.

ii) Reactive strategy: In this strategy, nodes only maintain routes to active destinations. A route search is needed for every new destination. Therefore, the communication overhead is reduced at the expense of route setup delay due to route search. These schemes are preferred for the adhoc environment since battery power is conserved both by not sending the advertisements as well as not to receiving them[9]. Dynamic Source Routing (DSR), AODV, ACOR and ABR are the examples of demand driven strategy.

iii)Hybrid strategy: In hybrid strategies, the protocol divide the network into zones (clusters) and run a proactive protocol within the zone and a reactive approach to perform routing between the different zones. This approach is better suited for large networks where clustering and partitioning of the network is very common [10]. TORA, ZRP, CEDAR and HSR are theprotocols follow this strategy.

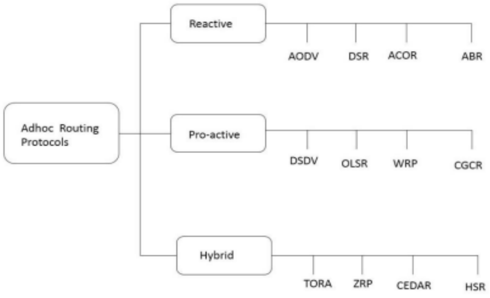


Fig: 1 Categorization of Ad hoc routing Protocols

2. LITERATURE REVIEW

Ad-Hoc On-Demand Distance Vector Routing Protocol (AODV): AODV is a reactive routing protocol developed by Perkins and Royer [11] and its multi-hop routing and discovery protocol are effective upon request. The AODV protocol includes the benefits of the DSDV and DSR protocols [11]. In the route discovery process, the source node broadcasts a route request (RREQ) packet across the MANET nodes and sets the time to wait. The RREQ packet contains routing information including the IP address of the originator, the broadcast ID, and the target sequence number. To preserve the reverse route to a source node, any intermediate node receiving the RREQ packet conducts two operations. The intermediate node first checks whether the RREQ packet was sent before with the same IP and broadcast ID source address and then decides whether the RREQ packet should be refused or accepted. The intermediate node must also test the destination sequence number stored in its routing table if the RREQ packet is accepted. The intermediate node uni-casts the Path Reply (RREP) packet in the source node if the sequence number reaches or matches the sequence number registered in the RREQ packet. If no intermediate node has a fresh enough path to the destination node, the RREQ packet may begin to traverse until the destination node is reached. Fig.2 indicates the source node (S) that sends RREQ packets to its adjacent nodes over the network until the RREQ packet reaches the destination node (D). The destination (D), which replies to the source node using an RREP, is shown in Fig. 3.

Often in AODV, each network node sent a “Hello” packet regularly to maintain its one-hop neighbor routing table. A “Hello” packet is used to evaluate whether the adjacent link is still active. The node sends “Hello” packet with a time interval called “Hello”-interval to its neighbor node to mark broken links between the nodes. Each node sends “Hello” packets to its surroundings and receives its acknowledgment. If a node sends “Hello” packets to a neighbor twice and has not received a message of acknowledgment for it, then the node initiates the broken connection process. If the connection node is near the destination node (i.e., the hop number to the destination node is less than that of the hops to the source node), a new route, known as Local Repair, is necessary to reach the destination node

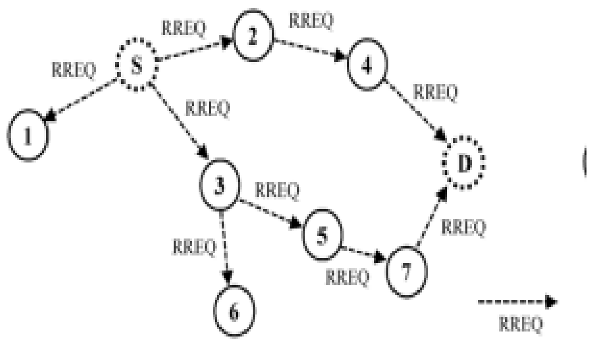


Fig 2: AODV broadcasts RREQ packet

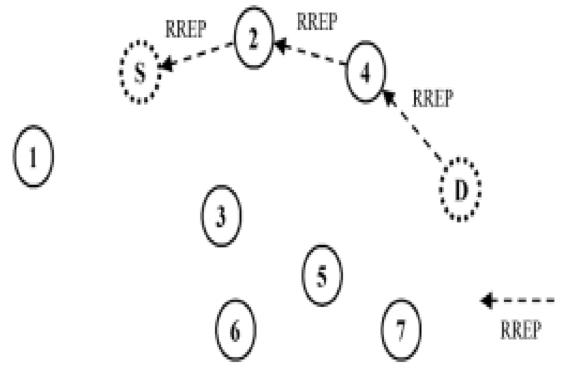


Fig 3: AODV replies RREP packet

Fig. 4 shows, for example, the local repair process when the connection between node 4 and node D has been disrupted. In this case, node 4 propagates a Route Error Packet (RERR), which contains addresses of the unreachable destination, to the source node. The routes which have an unattainable destination node that is the RERR propagation node, are no longer visible and propagate the RERR once again. When the source nodes collect the RERR and the route rediscovered, the path to the destination node is equally invalid. [12].

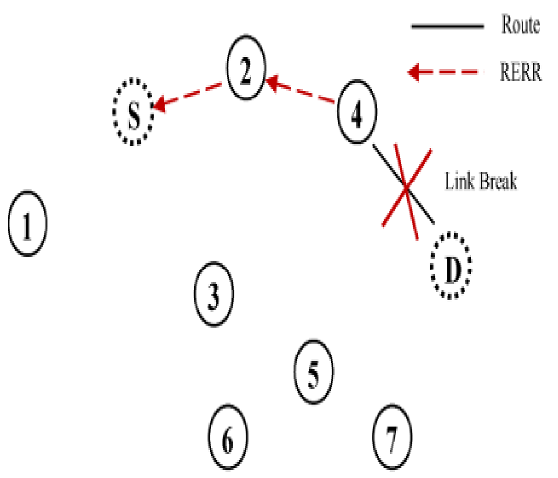


Fig. 4: AODV RERR packet

S. R. Malwe et.al. [13] proposed two predictive link efficiency techniques that are used during control packet routing. These techniques are known as regionally based approximation.and segment-based estimates. The results show that familiarity with the link status during routing allows identifying more trusted routes with less overhead control, thereby increasing the overall network efficiency.

S. Rani and T. C. Aser[14] suggested an enhanced AODV-based Randomized Link Repair(RLRAODV) routing protocol that uses multiple route response packets for data transmission across alternative paths during link loss. The suggested protocol reduced the overhead incurred by network congestion.The simulation show that RLRAODV performs better than AODV performance.

R. Suraj et. al. [15] examined a new mobility prediction approach using existing genetic algorithms to enhance MANET routing algorithms. The suggested lightweight genetic algorithm uses the weighted roulette wheel algorithm to execute outlier elimination, based on heuristics and parent selection [16].

A. Yadav [17] suggested a signal strength-based connection quality prediction approach that should be used in AODV routing. The method is called AODV Link Prediction. This reduces losses and delays in end-to-end data packets. The results show a substantial decrease in packet drops and typical end-to-end delays. The data packet delivery ratio of AODV and the link estimation are also being improved.

R. Alsaqour et. al. [18]present the impacts of location information on the efficiency of greedy stateless routing protocols, resulting from network parameters like beacon packet interval time and node movement speed, on the impact of the location inaccuracy. The authors introduced a fuzzy logic-dynamic beaconing strategy to improve the efficiencies of a nearby node list by increasing the period between beacon packets to deal with inaccuracies in the location information of a neighborhood node list.

A. Sundarrajan and S. Ramasubramanian[19] developed a failure recovery approach for multicast network routing. The approach built an independent route path to overcome a single link or single node breaks down. This proposed approach has the advantages which enable it to build a tree of multicast protection that provides immediate recovery of failure for any individual node failures.

Z. Zhang, Z. Li, and J. Chen [20] proposed an enhanced Local Preventative Repair Mechanism (PLRM) for the Wireless Ad-hoc Sensor Network (WASN) AODV routing protocol. By monitoring the quality of the links and other performance metrics such as traffic load and remaining energy, PLRM prevents link breakage. The proposed mechanism PLRM shows better efficiency in terms of packet delay, overhead control and packet delivery ratio in WASN compared with other improved AODV route repairing schemes.

Saeed et al [21] presented the classification of the routing protocols of the mobile adhoc network based on their characteristics and the design doctrine of the routing methods or the network frame work.

Bai et al [22] presented the performance evaluation of the two flat routing protocol proactive and the reactive routing protocols along with the simulation result justifying their performance

Nayak et. Al. [23] proposed the routing considering the mobility of the nodes, and evaluates the reactive routing under different mobility to improve the applications of the protocol.

Er-Rouidi, et. al. [24] elaborated the energy consumption of the routing protocols, by comparing the performance of the four routing protocols DSR, OLSR, DSDV and the AODV further evaluates the parameters of the network that influence's the energy consumption in the various routing protocols under variety of traffic and the mobility models.

Darabkh, et al [25] presented the dual phase AODV that is also mobility aware to establish more stable routes, diminishing the route failures,

Majd, et. al. [26] evaluated the network performance of the MANET in the terms of the energy usage, routing overhead, throughput and delay comparing the performance of the various routing protocols that come under the table driven and on demand.

Ghouti et. al. [27] utilized the extreme machine learning to design a mobile ad hoc network that is enriched with the prediction of its mobility, but does pay heed to the prediction accuracy limitations while calculating the distance between the neighbouring nodes.

Forster et. al. [28]presented the survey on the machine learning techniques for the adhoc networks classifying the available methods and evaluating them and presenting the most applicable algorithms suited for the adhoc networks.

Darwish et. al. [29] developed the firefly algorithm in finding the shortest optimal path for the routing in the wireless adhoc network.

Li, et. al. [30] utilized the reinforcement learning in the VANET to deliver the information with the limited amount of delay and hops.

3. Proposed Model

Routing presents a challenge in MANET because mobility of nodes will cause frequent link breaks and hence frequent changes in topology due to mobility, leading to frequent route change. Thus quality of service provisioning for application becomes a challenge .

An interpolation based approach has been proposed to predict the duration of availability of the current route. This approach aims to improve the Quality of Service (QoS) by predicting a link failure before its occurrence and routing the data packets through an alternate path, while nodes are moving around dynamically in the Mobile Ad hoc Network. Availability of route is determined by availability of links between the nodes forming the route. Therefore, to estimate future availability of route, it is important to predict the availability of these links. Newton divided difference interpolation is used for link prediction to estimate the availability of active link to the neighbouring nodes. Based on this information, when link failure is expected between two nodes, proactively an alternate path is build up even before the link breaks. This reduces the data packet drops and hence the recovery time.

In this approach, three consecutive measurements of signal strength of packets received from the previous node are used to predict the link failure using the Newton divided difference method. The Newton interpolation polynomial has the following generalized expression.

$$f(x) = f(x_0) + (x - x_0) f(x_0, x_1) + \cdots + \left(\prod_{i=0}^{n-1}(x - x_i)\right) f(x_0, x_1, \ldots, x_n).$$

The received signal strengths of the three latest data packets and their time of occurrence are maintained by each receiver for each transmitter from which it is receiving. Using three received data packets' signal power strengths as P_1, P_2, P_3 and the time when packets arrived as t_1,t_2, t_3, instants respectively and P_r as the threshold signal strength to be operative at the time t_p, one can predict t_p. We assume that at the predicted time t_p, when received power level reduces to threshold power, the link will break. The threshold signal strength P_r, is the minimum power receivable by the device.

$$P_r = P_1 + (t_p - t_1)\Delta + (t_p - t_1)(t_p - t_2)\Delta^2. \quad (3.1)$$

$$P_r = P_1 + \frac{(t_p-t_1)(P_2-P_1)}{(t_2-t_1)} + (t_p - t_1)(t_p - t_2)\left(\frac{(P_3-P_2)}{(t_3-t_2)} - \frac{(P_2-P_1)}{(t_2-t_1)}\right)/(t_3 - t_1). \quad (3.2)$$

$$\text{Let } A = ((P_2 - P_1)/(t_2 - t_1)), \quad (3.3)$$

$$B = \left(\frac{(P_3-P_2)}{(t_3-t_2)} - \frac{(P_2-P_1)}{(t_2-t_1)}\right)/(t_3 - t_1). \quad (3.4)$$

The equation (3.2) becomes

$$P_r = P_1 + (t_p - t_1)A + (t_p - t_1)(t_p - t_2)B. \quad (3.5)$$

Rearranging equation (3.5),

$$Bt_p^2 + (A - Bt_1 - Bt_2)t_p + (P_1 - P_r - At_1 + t_1t_2B) = 0. \quad (3.6)$$

This is of the form

$$at_p^2 + bt_p + c = 0, \quad (3.7)$$

where $a = B$,

$b = (A - Bt_1 - Bt_2)$ and

$c = (P_1 - P_r - At_1 + t_1t_2B)$.

Therefore, the predicted time t_p at which link will fail is

$$t_p = \frac{-b+\sqrt{b^2-4ac}}{2a}.$$

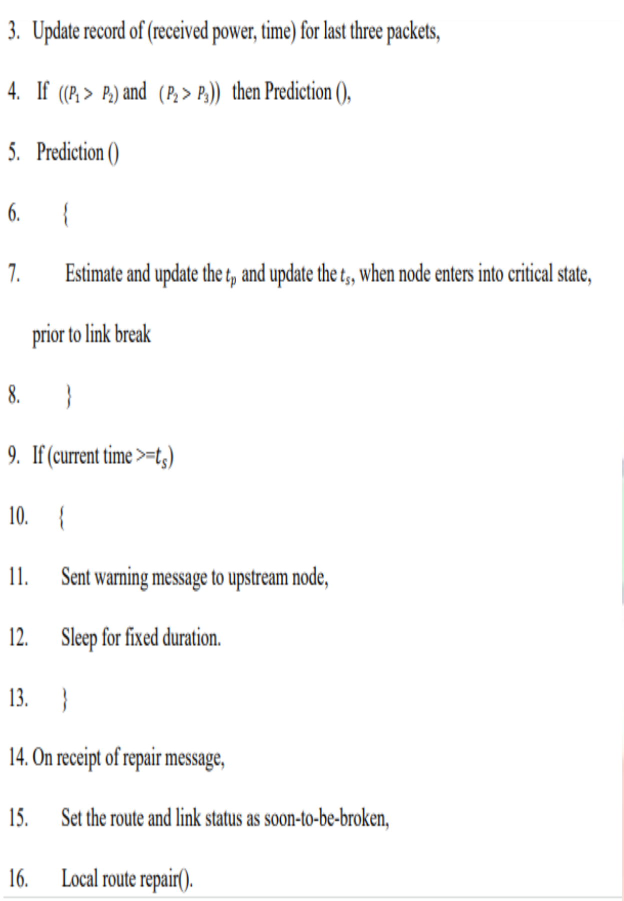
Routing protocol needs time to setup a new or alternate path, thus a time parameter, critical time, is introduced. The critical time, should be sufficient enough to send error message to upstream node to source of the packet and for source to find a new route. It should be just smaller than link break time. After time, the node enters into critical state and node should find an alternate route. When a link is expected to fail between nodes, the upstream node first attempts to find a route to the destination. If such route is not found within a fixed time called discovery period, a link failure warning is sent towards the sources whose flows are using this link. Source nodes can invoke the route discovery mechanism to setup restoration paths. At time, the received power is sufficient for sending warning message to the upstream node and discovering an alternate path either by local route repair around the link which is going to break or by setting up new paths from sources. As two nodes move outwards, signal power of the nodes drops. Thus we define link break when nodes are first crossing the radio transmission range and broken links are repaired locally in k hops. The value of k is two, i. e. broken links can be repaired in two hops. The proposed local route repair procedure attempts to repair broken route locally with minimum control overheads for faster recovery

3.1 Link Prediction Algorithm(AODVLP)

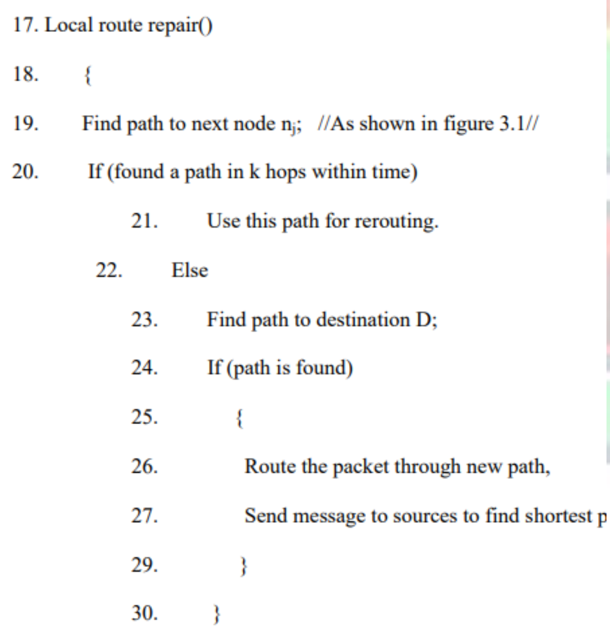
Each time a data packet is received, the receiving node monitors the link with the following algorithm:

Algorithm 1: Link prediction algorithm

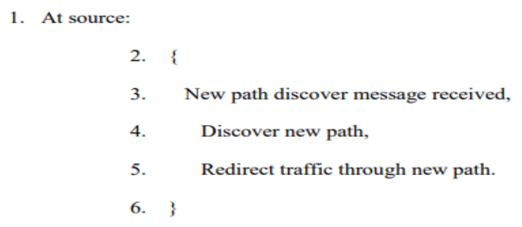
1. For each neighbour,
2. On receipt of a packet,



```
Update record of (received power, time) for last three packets,
If $((P_1 > P_2)$ and $(P_2 > P_3))$ then Prediction (),
Prediction ()
    {
    Estimate and update the $t_p$ and update the $t_s$, when node enters into critical state,
    prior to link break
    }
If (current time >=$t_s$)
    {
    Sent warning message to upstream node,
    Sleep for fixed duration.
    }
On receipt of repair message,
    Set the route and link status as soon-to-be-broken,
    Local route repair().
```



```
Local route repair()
    {
    Find path to next node $n_j$;   //As shown in figure 3.1//
     If (found a path in k hops within time)
            Use this path for rerouting.
         Else
            Find path to destination D;
            If (path is found)
                {
                 Route the packet through new path,
                 Send message to sources to find shortest p
                }
            }
```

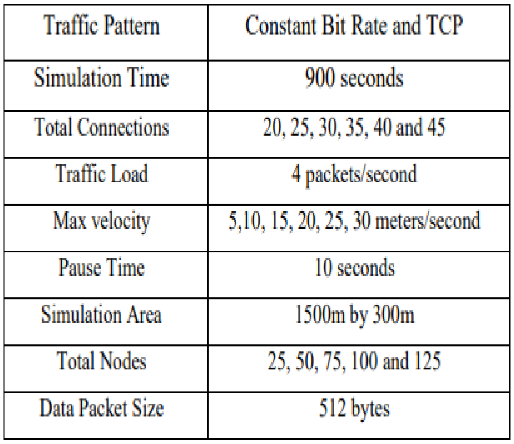


```
At source:
    {
    New path discover message received,
      Discover new path,
      Redirect traffic through new path.
    }
```

3.2 Simulation and Results

3.2.1 Simulation Parameters: NS-2 simulator is used to simulate AODV routing algorithm without (AODV) and with (AODVLP) link prediction to determine performance gain if any.The detailed simulation parameters are mentioned in table 3.1

Table 3.1 Simulation parameters for AODVLP



Traffic Pattern	Constant Bit Rate and TCP
Simulation Time	900 seconds
Total Connections	20, 25, 30, 35, 40 and 45
Traffic Load	4 packets/second
Max velocity	5,10, 15, 20, 25, 30 meters/second
Pause Time	10 seconds
Simulation Area	1500m by 300m
Total Nodes	25, 50, 75, 100 and 125
Data Packet Size	512 bytes

3.2.2 Performance Metrics

The performance of the model is evaluated in terms of number of route failures, packet delivery ratio and average end-to-end delay as a function of number of nodes and node mobility.

Packet delivery ratio is the ratio of the data packets delivered to the destination to those generated by either CBR or TCP sources. The higher the value better is the performance. The IP packets generated due to retransmissions in TCP are counted as separate data packets for the purpose of packet delivery ratio. For example, A data packets are sent from TCP source resulting in A+A' packets, where A' packets are due to retransmissions. B packets are received then packet delivery ratio will be.

Average end-to-end delay of data packets includes all possible delays caused by buffering during route discovery, queuing at interface queue, retransmission delays at MAC layer, propagation and transfer time.

Number of route failures is the number of routes which failed during the simulation time.

3.2.3 Simulation Results and Analysis

The number of nodes was varied from 25 to 125 and node velocity from 5 to 30 meters/second. At a time, one variable was changed and other was kept constant. When the parameters are kept fixed, they are assumed to take the following values — network size = 50 nodes and node velocity = 5 meters/second.

The simulation results are obtained for AODV and AODVLP for CBR sources.

1. **The network size is varied and other simulation variables are kept constant** with pause time as 10 seconds and velocity as 5 meters/second, to get the results shown in figures 3.2, 3.3, 3.4 and 3.5.

Figure 3.2 shows variation of route failures with increasing network size. Results show that route failures are much less in AODVLP as compared to AODV.

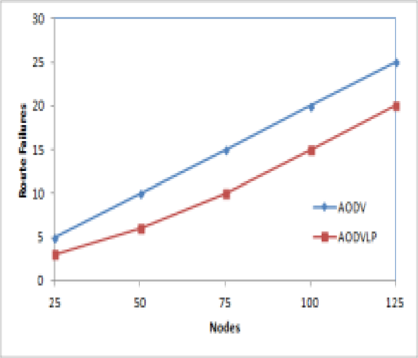


Figure 3.2: Route failures vs nodes

Figure 3.3 shows variation of packet delivery ratio with increasing network size. Results show that packet delivery ratio is better in AODVLP as compared to AODV.

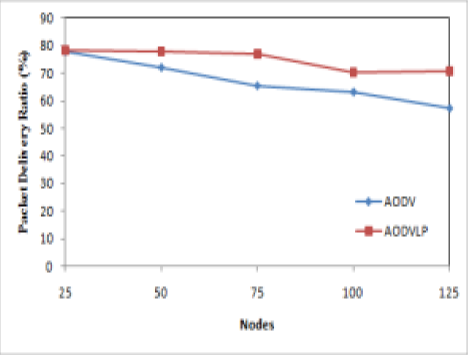


Figure 3.3: Packet delivery ratio vs nodes

Fig 3.4 shows an increase in average RTS collisions per node are observed. Due to more collisions, the delivery ratio decreases by retransmitting the packets more than once.

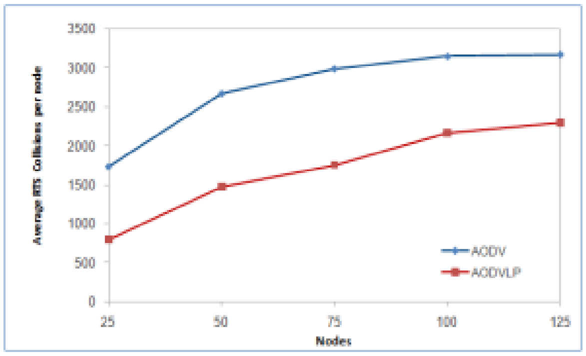


Figure 3.4: Average RTS collisions per node vs nodes

The **end-to-end delay** is an average of difference between the time a data packet is generated by an application and the time the data packet is received at its destination.

Figure 3.5 shows decrease in end-to-end delay in AODVLP as compared to AODV due to advance route discovery in case of route failures. However, end-to-end delay increases with increase in the network size in AODVLP and AODV because high node density increases collisions, which results in retransmission of packets.

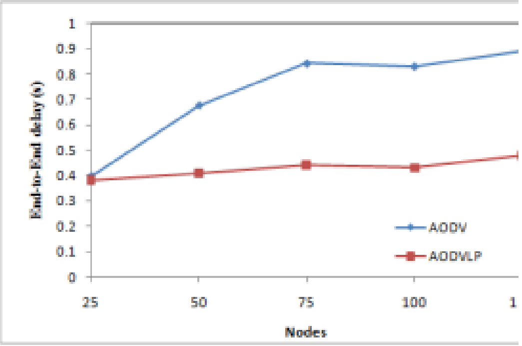


Figure 3.5: End-to-end delay vs nodes

2. The velocity is varied in discrete steps as 5, 10, 15, 20, 25 and 30 meters/second for a fixed network size of 50 nodes and pause time of 10 seconds in figures 3.6, 3.7, 3.8 and 3.9.

Figure 3.6 shows variation of route failures with increasing node velocity. From these results, it is quite evident that AODVLP gives fewer route failures than AODV because link prediction model helps in discovering the alternative routes in advance before a link failure, and messages are delivered through the alternative routes. However, for AODVLP and AODV, route failures increase with increase in node velocity. With fast mobility, more links and thus more routes break.

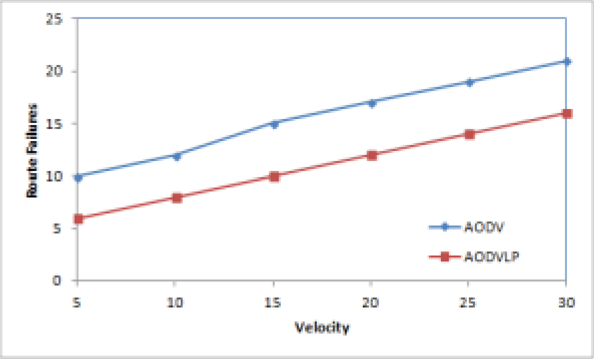


Figure 3.6: Route failures vs node velocity

Figure 3.7 shows variation of packet delivery ratio with increasing node velocity. Results show that packet delivery ratio is better in AODVLP as compared to AODV.

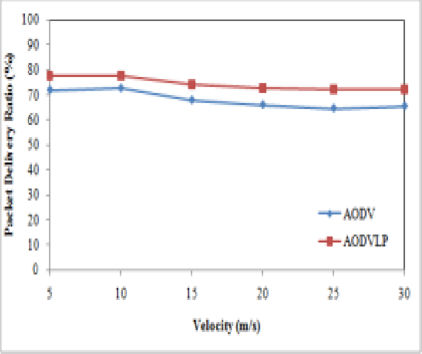


Figure 3.7 Packet delivery ratio vs node velocity

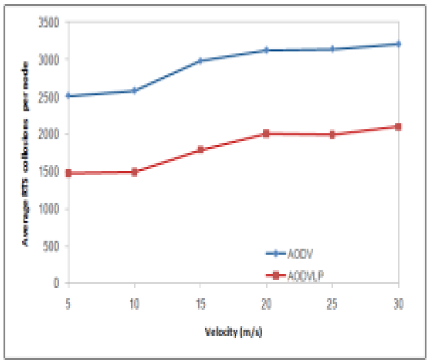


Figure 3.8 Average RTS collisions per node vs node velocity

Figure 3.9 shows increase in end-to-end delay with increase in node velocity. The results show that AODVLP outperforms AODV significantly with increase in node velocity. It is observed that the end-to-end delay increases when node velocity increases.

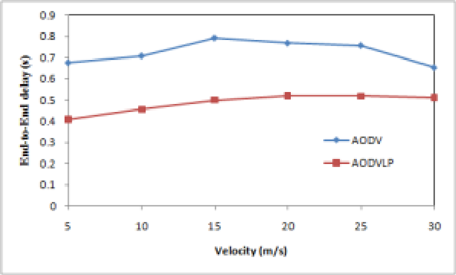


Figure 3.9 End-to-end delay vs node velocity

3.2.2 Energy Simulations: The simulation results for the study of energy consumption of AODV and AODVLP schemes. We have compared throughput, energy consumption per successful transmission of AODVLP and AODV schemes. It is observed that their performance behaviour by varying network load and the node density within a given area. Network load is the rate of generation of packets in the network and throughput is calculated as number of kilobytes data received by the destination node per second.

i) The packet generation rate is varied for a fixed network size of 50 nodes, velocity of 5 meters/second and pause time of 10 seconds in figures 3.10 and 3.11. The simulation results are obtained for AODV and AODVLP. Fig. 3.10 shows that AODVLP achieves higher throughput compared to AODV. It happens because in AODVLP, alternative routes are discovered in advance before a link failure and delivers a message through alternative route.

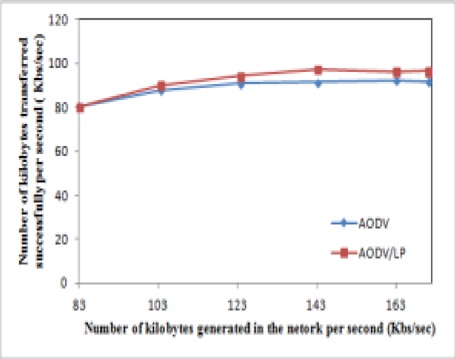


Figure 3.10: Successfully data transmission rate vs traffic generated rate

Figure 3.11 shows variation of energy consumed per successful communication of 1 kilobyte of data with increasing packet generation rate. Results show that power consumption per successful communication of 1 kilobyte of data is lesser in AODVLP as compared to AODV. It happens because in AODVLP link successes are observed to avoid packet drops and thus, avoiding retransmissions of packets.

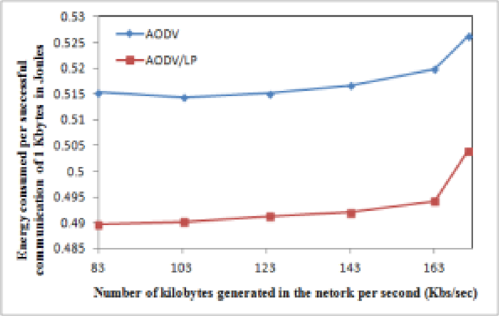


Figure 3.11: Average energy consumption (in Joules) per communication of 1Kbyte of data vs traffic generated rate

ii) The density of the nodes is varied and other simulation variables are kept constant with pause time as 10 seconds and velocity as 5 meters/second in figures 3.12 and 3.13.

Figure 3.12 shows that in AODV and AODVLP, the throughput per node is decreasing with increase in number of nodes because increase in node density increases collisions and contention.

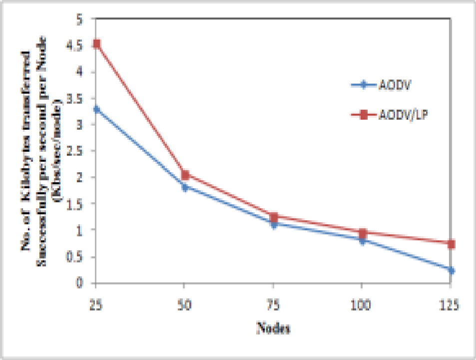


Figure 3.12: Throughput per node vs nodes

Figure 3.13 shows AODVLP consumes lesser energy as compared to AODV and therefore more packets can be transmitted in lesser energy. The energy consumption increases in case of both the schemes as the node density increases. Increased node density causes more contentions and collisions. But the energy consumption of the AODVLP is lower throughout the density variation thereby making it the scheme, which consumes lesser energy.

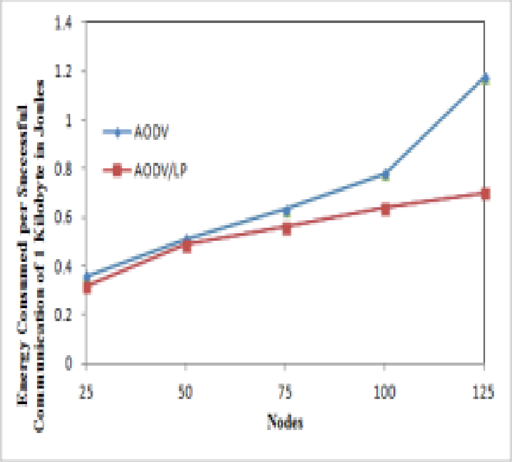


Figure 3.13: Energy consumption per communication of 1 kilobyte data vs nodes

3.2.3 TCP Simulations

The simulation results are obtained for AODV and AODVLP with TCP sources. The performance metrics are packet delivery ratio and end-to-end delay. As seen from figures 3.14 and 3.17, AODVLP offers better end-to-end delay performance than AODV and comparable packet delivery ratio in both AODVLP and AODV.

i)The network size is varied with fixed pause time as 10 seconds and velocity as 5 meters/second in figures 3.14 and 3.15. From figures 3.14 and 3.15, it can be seen that AODVLP offers slightly better end to-end delay performance than AODV and both have nearly identical packet delivery ratio with increased node density. The packet delivery ratio in AODV and AODVLP are comparable and remains low, as shown in figure 3.14 because of feedback property of TCP, which deceases the rate of packet generation with increasing estimated round-trip time and vice versa (rate limiting property of TCP).

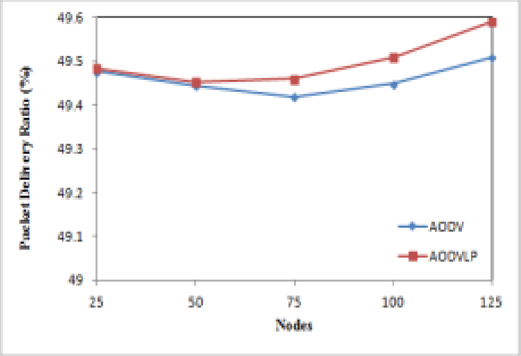


Figure 3.14: Packet delivery ratio vs nodes

Figure 3.15 shows decrease in end-to-end delay in AODVLP as compared to AODV due to advance route discovery in case of route failures. However, end-to-end delay increases with increase in the network size in AODVLP and AODV because high node density increases contention and collisions, which results in retransmission of packets.

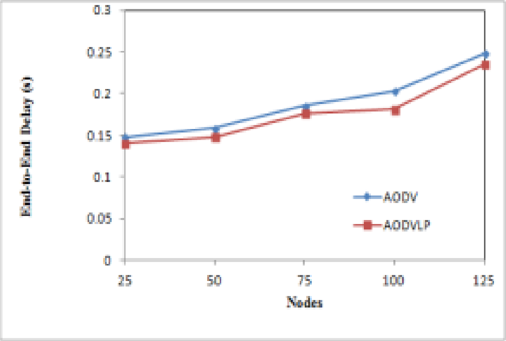


Figure 3.15: End-to-end delay vs nodes

ii)The velocity is varied as 5, 10, 15, 20, 25 and 30 meters/second for a fixed network size of 50 nodes and pause time of 10 seconds in figures 3.16 and 3.17.

Figure 3.16 shows that packet delivery ratio is better and comparable in AODVLP as compared to AODV. It happens because in AODVLP, alternative routes are discovered before the route failures and more data is successfully delivered to the destination and packet delivery ratio remains low in AODVLP and AODV both due to feedback property in TCP.

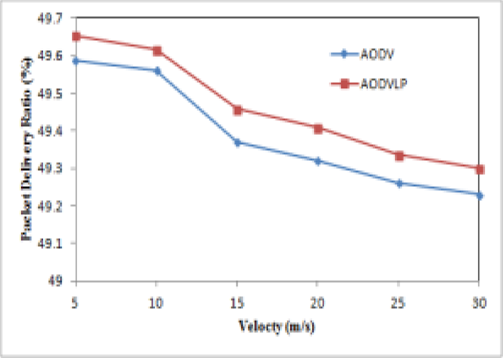


Figure 3.16: Packet delivery ratio vs node velocity

Figure 3.17 shows increase in end-to-end delay with increase in node velocity. The results show that AODVLP outperforms AODV significantly with increase in node velocity. We observe that the end-to-end delay increases when node velocity increases.

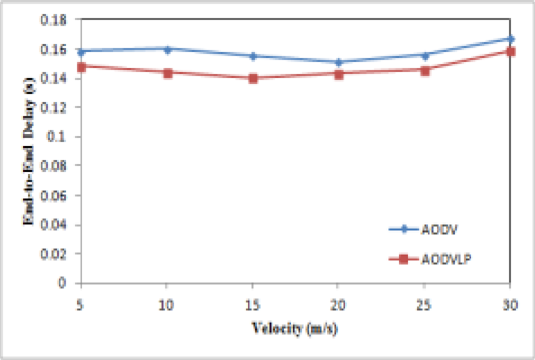


Figure 3.17: End-to-end delay vs node velocity

4. CONCLUSION

A new routing protocol AODVLP is proposed with link prediction for adhoc networks. A prediction function that predicts link breaks based on signal strength of the three consecutive received packets and a threshold signal strength, has been presented. The AODV can thus proactively initiate repair process even before the occurrence of failure. The performance of the proposed AODV with link prediction has been evaluated and compared with AODV using simulations. The simulation results show that the proposed algorithm performs well and results in lower end-to-end delay and higher packet delivery ratio due to local and proactive repair processes, and therefore leading to improvement of the Quality-of-Service. AODVLP can be further improved by limiting overhead of unnecessary control messages. The suitability of AODVLP for real-time traffic needs to be further studied by testing it with smaller sized CBR packets at a higher packet generation rates.

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