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**Research Article**

# MPDM Scheme for QoS Aware Routing Protocol Using Fuzzy Based Link Monitoring System

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**ABSTRACT**

In Mobile Ad Hoc Network (MANET) the applications of a multimedia system like video, audio broadcasting needs the path at which the data transmit might be reliable, delay-sensitive, and energy-efficient one. In addition, the delivery of information in vehicular networks (VANETs) is regarded as a demanding one because of high mobility and invariable topological difference. An existing routing protocol of ad hoc network fail to function better in terms of QoS metrics like packet delivery ratio (PDR), delay and so on., where there are heavy traffic and high mobility. So as to overcome the existing drawbacks, the proposed technique is implemented. In the proposed mechanism, the system model is initialized, and the route discovery process is carried by sending a route request. The multipath decision making (MPDM) scheme is employed to ensure the best route availability and the probability of link failure. Once the multipath decision-making condition is satisfied, the route path is established, and the communication takes place based on QoS constraint. Fuzzy based link monitoring scheme is employed to check the probability of link failure. Finally, the performance analysis is carried, and the comparison is made for proposed and existing mechanisms to prove the efficiency of the proposed scheme.

**Keywords:** MANET, VANET, Packet delivery ratio, QoS, Fuzzy based link monitoring system, Multi path decision making process.

## INTRODUCTION

A mobile ad hoc network (MANET) is a set of autonomous mobile devices connected by wireless links in a distributed manner and without a fixed infrastructure. Real-time multimedia services, such as video-streaming over MANETs, offers very promising applications, e.g., two members of a group of tourists who want to share a video transmitted through the MANET they form, a video-streaming service deployed over a MANET where users watch a film, among other examples [1]. As a significant factor of Intelligent Transportation Systems (ITS) and smart cities, VANETs become a rising and attracting attention from both industry and research communities, which are regarded as a particular kind of MANETs [2]. In the VANETs environments, every vehicle can function as a router for communicating with each other devoid of relying on the rigid supports of infrastructure. There were two ways of wireless communication with Vehicle-to-Infrastructure (V2I) and Vehicle-to-Vehicle (V2V) [3] on behalf of several applications that were categorized as infotainment and the safety applications [4], as the assistance of driver, collision warning, internet access, etc. On comparing other MANETs, VANETs consist of some special features that involve road pattern restrictions, large scale network sizes, self-organization, high mobility, no constraints of energy, etc. [4]. The vehicular networks [2 3] is considered as a challenging technology which provides smart vehicles for exchanging wireless information's between them, so as to attain excess safer and convenient system of transportation. This information might comprise data regarding the conditions of traffic, adaptive assistance of trip, alarms and warnings, and availability of parking gas station, with infotainment applications.

In the environment of VANET, QoS signifies a valid dispute for researchers. Consequently, several related QoS surveys are present in literature. In a vehicular context, main QoS related issues were presented while authors compared and surveyed various techniques and approaches for offering QoS support in the vehicular networks.

Two constraints are needed for offering quality assurance on behalf of real-time applications; delay-sensitive in the MANET framework. The multipath routing has increased their notice in the community of researchers in the past few years [5]. The residual portion of the paper is structured, as shown. Section II provides the related work. Section III is the depiction of the proposed mechanism. The Simulation background and parameters are detailed in section IV. Section V portrays conclusions.

## RELATED WORKS

This section is the depiction of various existing approaches employed so far related to the VANET environment.

[6] depicted the QoS-aware resource reallocation in the SDN networks depending on the prediction of traffic. For solving the optimization issues, two schemes were proposed, like a fast optimal one and an exact solution. The presented techniques were related to the perspective of accuracy. Furthermore, the influence of prediction on the reallocation of resources was presented. By this way, it is revealed that comparing the traditional system, the presented the loss of packet and enhanced the throughput considerably.

[7] considered various unusual protocols and approaches, depicting in what way this is probable for considering reservations of bandwidth in-advance for attaining continuity of service, thereby eradicating call dropping at the time of dynamic sessions. Initially, the importance of reserving in-advance in wireless cellular networks was presented, and then the existing protocols and approaches were discussed for the determination of most appropriate future cells.

[8] described a wide-ranging review of QoS-aware routing protocols in the literature of VANETs. The protocols were examined depending on the capabilities of supporting services of ITS infotainment, functionality, and weakness of protocol, the problem of the multi-constraint path, design, and objective challenges. In this manner, future directions were outlined for QoS-aware protocol research in VANET.

[9] implemented a novel method, which is the prediction dependent competent approach of multi-hop clustering with the adaptive selection of the relay node for VANET. The model comprises four layers. They were multi-hop clustering processes, prediction depending on the approach of clustering, method of adaptive selection of the link, and the enhanced protocol of routing.

[10] projected two protocols, which in turn uses the density of vehicles for the prediction of data packet delivery time before sending the data and uses the movement of vehicles information for the determination of the highest route lifetime, considering the vehicle's velocity variation for the ease of highway applications. These schemes were estimated in the vehicle density function on the estimation of the control overhead, the percentage of packets delivery, average route lifetime, the throughput, the average end-to-end delay, and the generation of the average route number failures at the of data packets transmission.

[11] highlighted the application challenges faced by WSNs for environment monitoring and those faced by a technique suggested, as well as the possibility that might be revealed on the applications of WSNs with SDN. Moreover, a performance consideration was considered on assuming an essential aspect which might be unobserved while improving the functionalities of the network. A Software Defined Wireless Sensor Network (SDWSN) approach was offered as an endeavor for the enhancement of monitored frameworks application.

[12] presented a view on WSN, which has been engaged previously in many areas like industry, health, and military. With a number of intrinsic restrictions in WSN, a critical concern is a security. The stated functions of wireless devices security must be well established. In this, a method of security testing that depends on levels of security was suggested for WSN. The experimental outcomes reveal that the platform was the most feasible one for the assessment of security level device in WSN.

[13] extend the existing reactive and proactive routing protocols, that is to say, AODV and OLSR. In AODV, a strategy was presented on behalf of the route request modification and mechanism of route reply for the generation of the stable path with the use of MCDM. Conversely, a modification strategy of selection algorithm MPR in OLSR, was suggested for maintaining stable topology with the use of MCDM.

[14] implemented a hybrid design method, where reactive routing AODV syndicate features with proactive routing and geographic routing protocol. Adaptive Hybrid Routing Protocol (AHR), vehicles employ proactive routing protocol on behalf of reactive routing protocol and V2I communication with geographic routing protocol intended for V2V communication. The system, in turn, incorporates both reactive and geographic routing protocols features together with schemes of proactive routing. It then integrates these routing protocols in a way that competently employs the entire available locations information and departs to reactive routing since the information location degrades.

[15] suggested an approach in which routing logic based on fuzzy optimization was presented. Link and Energy recognition were the factors that were taken to manipulate vehicular communication. A fuzzy based decision-making system was employed for deciding factors related to fluctuating energy and acceptance of data rate for ensuring proper neighbor selection and reliable routing. It offers less energy consumption and high throughput on comparing traditional routing logic.

[16] highlighted the major intention of introducing an optimal route path process for minimizing the link failure chances and energy consumption reduction of nodes in the network. In this article, an algorithm of the modified route optimal path at which the nodes were in cluster form was projected in the direction of achieving this objective. In this, the scheme of mobility prediction was employed for the stability of the network, and the two-tier method was employed in the minimization of energy consumed in the course of a Location Aided Routing (LAR) protocol.

[17] focus simply on multicast, which was denoting a process of information sending from one node to a group of nodes that was established in diverse locations. This paper purpose was to learn the traditional multicast routing protocols in VANET and create a superior survey regarding them and establish the disadvantages and advantages of everyone with categorize them into a different category depending on some parameters affected like vehicle trajectory, quality of service and so on. Subsequent to the analyses of these routing protocols it was accomplished that there was a persistent requirement for creating competent multicast routing protocol in this network for reducing the consumption of resource and enhancing overall performance.

[18] projected an Ant Colony Optimization (ACO) dependent algorithm for resolving this issue. Additionally, a concept of the terminal intersection was offered for decreasing routing exploration time and easing congestion of the network. Furthermore, so as to reduce network overhead, Local QoS Models (LQM) was presented for evaluating complete and real-time QoS of urban road segments. The results of the simulation authenticate the derived models of LQM and show the AQRV effectiveness.

[19] anticipated a set of routing protocols intended for VANET to take into account their specific uniqueness. The protocols based on the vehicles' positions, termed geographic routing (GR) or PBR (position-based routing protocols, were exposed to be the mainly sufficient one to the VANETs due to their strength for handling changes in the active atmosphere and high mobility of vehicles. On behalf of using IP addresses, the similar one in the case of MANET protocol, routing protocols depending on the position based on the position of environmental vehicles on selecting the best pathway for transmitting data.

[20] presented the prediction-dependent reliable and efficient opportunistic probability of the PRO routing algorithm for VANETs. The PRO routing algorithm might calculate the variation of signal-to-interference-plus-noise ratio SINR and PQL packet queue length receiver. The predicted consequences were utilized for relaying utility vehicle determination in the candidate set. The vehicle’s utility computation is a weight-dependent algorithm, and the weights are of PQL and SINR variances.

## PROPOSED WORK

This section offers the explicit narration of the proposed mechanism. The overall flow of the proposed system is shown below:

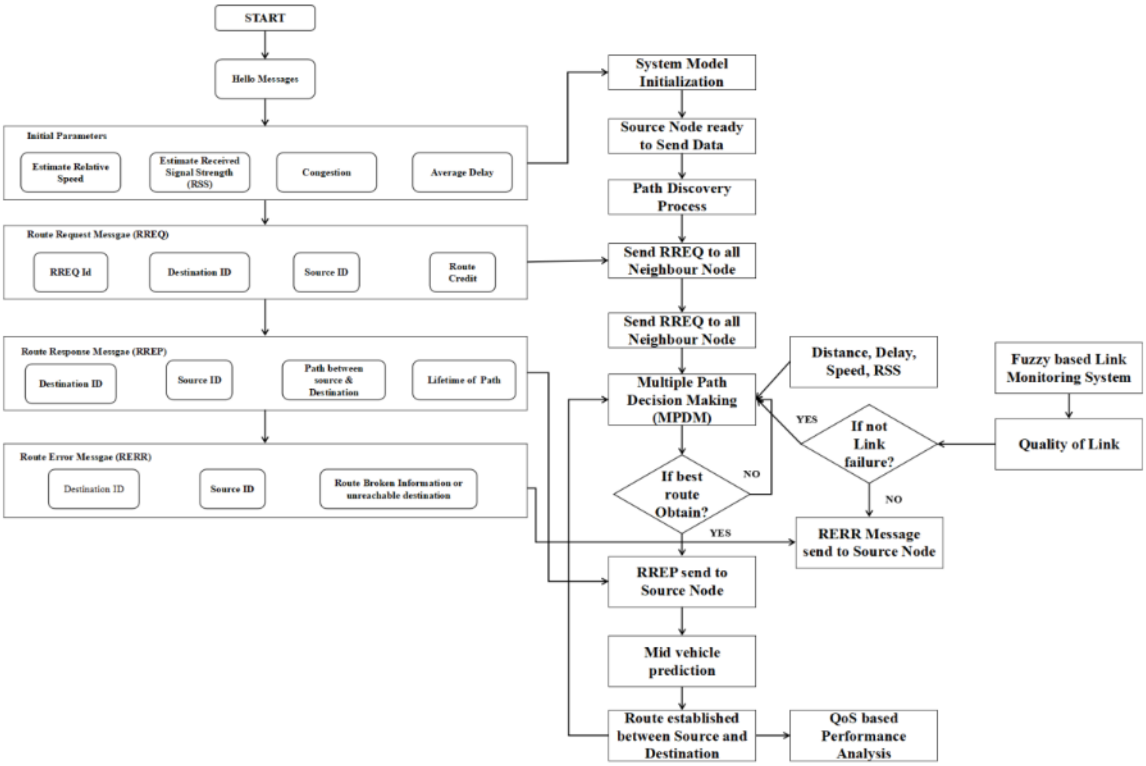


**Figure 1: Flow of the proposed mechanism**

### A. *System Model:*

Initially, two general models were presented to suggest the transformation of information among mobile nodes in the MANET. It was assumed that there was an N number of mobile nodes that were moving at some distance as per the reference region model of group mobility. The entire nodes in the model have an equivalent range of transmission. Each node is capable of transferring information to the neighboring nodes. The coordinates are regarded as the location information sent by nodes at two consecutive time's t1 and t2, correspondingly. To examine simplicity, it was presupposed that one node is fixed, and another node is moving, however, actually, they are all moving at the entire time period. At this time, it is understood that nodes maintain their direction and velocity at the duration $\Delta t = t2 - t1$ and reach the destination at the moment t2.

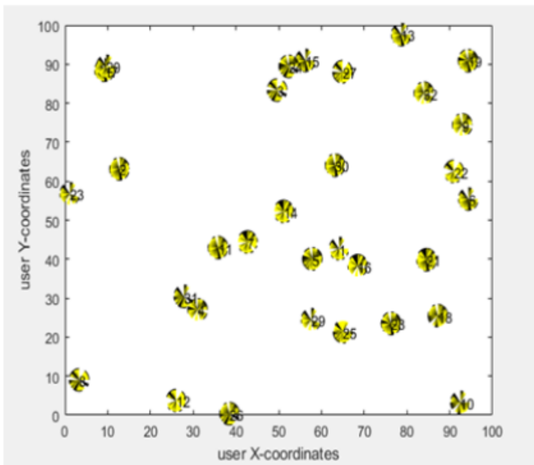


**Figure 2: System model**

### B. *RREQ discovery process:*

The process of route discovery in MRP starts once the node wants to communicate to other another which has no different path. The routing request is sent and is termed as the RREQ discovery process. In the routing protocol, each node that receives the RREQ rebroadcasts the RREQ, thereby incrementing the hop count by one. Once the node gets quite a lot of same RREQ copies, it utilizes only the initial copy so as to create a reverse path; the entire duplicates that arrive afterward are discarded. However, as the intention is to identify several paths, these route broadcasting duplicates might be employed for the establishment of multiple paths; conversely, only those route broadcasting which in turn assure node disjointness and loop freedom might be employed for the establishment of reverse paths.

So as to update the routing table of nodes, an admission is only updated or added in the condition that route broadcasting satisfies one of these following criteria.

a:

(i) The route broadcasting packet's sequence number is better than the existing route entry's sequence number.

(ii) The Sequence numbers are identical, and the route broadcasting EPD (expected path delay) is less than of the existing route entry EPD, and the number of valid RREQs is less than three.

(iii) There is no existence of route entry for the route broadcasting originator.

### *C. Multi-path decision making (MPDM):*

Once the route request is sent, then the multi path decision making takes place as per the following criteria like: distance, delay, speed, and RSS. In the decision is taken once there is an availability of the best path. If there is an availability of the best path, then the route reply is sent so as to ensure the mid-vehicle prediction. Also, the probability of link breakage or failure is detected, which in turn sends an error message to ensure the failure of link between the source and destination. Thus, the decision is taken as per the presence of the best route, link failure probability.

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**Multipath Decision-Making algorithm:**

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**Input:** *Node initialization* $N_n$

**Output:** *decision matrix* $dest_{nmat}$

---

Step1: *initialize the nodes,*

*Congestion* $Co_c$

*nodes* $n_e$

*source_id* $s_{id}$

*speed* $s_p$

*maximum_length* $max_{len}$

*destination_id* $d_{id}$

*movement_speed=randi([1 50],length(*$u_n$*))*

*no_packets=rand([10 20],length(*$u_n$*))*

*Step2: calculate Euclidean distance estimation*

*for i=1:length(*$N_n$

*for j=length(*$N_n$*)*

$dist_e = \sqrt{N_n(1,i) - N_n(1,j))^2 + N_n(2,i) - N_n(2,j))^2}$

*end*

*end*

*Step3: Fuzzy Logic Prediction*

*Decision matrix* $dm_{mat}$*=[];*

```
for xi=1:size((s_id, 1)
if mean(s_id, 1)>size(s_id, 2)
 Ans=1  ///positive response
end
Else
Ans=1 // negative response
end
dm_mat=[dm_mat; s_id, 1]/2
end
   for yi=1:length((u_n)
        spatial_radius s_rad=min(r_c(i), r_c(j))
if  dist_e < s_rad
 normalized_node nor_node =1-(dist_e)/ s_rad
else
 s_node = 0
   end
      end
         end
step 4: relative closeness estimation
  for xi=1:size(s_p, 1
      neighbor_list n_node=sqrt(Σ(s_p(ii,:) − nor_node(ii,:))^2)
    end

step 5: quality of link
    for ii=1:length(idelchannel)
          qulaity_idle=randi([1 30 ],noidelchennal(ii))
  end
for cc=1: n_node
 if temp_node==1
     dest_node con_node=[dest_node  dest_idel_node]
end
end

step 6: normalized relative  speed
 residula_energy re_e=d_e/i_e
dest_nmat=no_packs*   re_e
decision_mat  dest_nmat=mean(dest_node)
for cc=1:length(u_n)
 multi_path=p_node(xi)*temp(xi)+ re_e
end
```

### D. Route reply and route maintenance process

As the node receives RREQ, which is the RREQ destination, the node then updates/adds the entry in their respective routing table, which in turn creates a reply RREP. The reply RREP is then broadcasted to the source node; also, EPD field is being set back to zero. Successive nodes which accept RREP keep up their routing table as per specified conditions, the RREP's EPD field incremented along with their estimated delay up to and with the node, and then forwarding RREP to next hop in the direction of source node which was recognized in the course of the reverse-path in the process of route discovery depending on lowest EPD; as a result, the node check their RREQ table which then forwards RREP to the next hop by lowest EPD. Once the target receives successive RREQs from various last hops, it then produces a RREP for all individual last hop and for each distinctive neighbor hop. In addition, every intermediate node can forward simply one copy of RREP for each destination and for each source sequence number. This is done for guarantying disjointness of the node paths. If there is no availability of reverse path, the RREP will be discarded, which is moreover due to the condition that the node is in participation at the active path for a similar pair of source destination. Once the source attains the entire RREPs from the destination, the maximum of three paths employs the path with the lowest value of EPD and keep others as backup routes in the condition that the significant path is unsuccessful for some cause.

*Route Error message (RERR)*

Route maintenance is an extension and was acquired through packet Route Error (RERR). If the intermediate node recognizes the failure of link or node because of their undetected hello message, mobility, and so on, which in turn produces RERR packet. The RERR packet, in turn, broadcasts through the entire nodes which have a path in the course of the failed link and, in turn, invalidate the entire accessible paths in all nodes alongside the way that consists of the path over the unsuccessful link. If the packet RERR reach the source and still the source is in necessitate for a path to the destination, it thus switches over to the second path available at the source node. When all paths are not valid, and still the source needs the path to a similar destination, the source begins a new process of route discovery.

The anticipatory handoff takes place as the value of EPD path increases, and there is lower EPD in routing table for another path which then switches to a path having lower EPD; thus for maintaining QoS for a connection lifetime and use the best path available always in terms of EPD to be the primary path on behalf of transmission of data Also, it employs a mechanism of salvaging at which the transmitted packets over unsuccessful path were being re-transmitted through back up paths.

### E. Fuzzy based link Monitoring system and QoS based performance estimation

The source node's primary process of path selection might select the majority stable path with another path for the transmission of data. So as to attain Path Stability Probability (PSP), the source node ought to achieve the possibility of stability of each link, thereby creating the path initially. The intermediate node, in turn, estimate link stability probability (LBP) over the received RREP's signal strength, and the PSP field of RREP is updated, which in turn finally transfers it to the source node.

*The Link Break Probability (LBP)*

In MANET, it is hard for predicting once the link in turn breaks. However, the virtual stability of the link is being estimated on relating the current and recent signal strengths. The signal strength varies distance; thus, a distance is a superior metric for assessing the link dependability.

The breakage probability of the link belongs to the path established is being monitored through the established signal strength from the next hop node in real-time. Once the possibilities of link interruption go beyond the threshold, the source node is switched and notified to the alternate path so as to maintain communication. To keep away from the increment of network traffic load, the system employs packets HELLO periodically to sense the stability of the link.

In the probability of a link interruption monitoring process, the relative distance among nodes is employed for the estimation of whether the link will be intermittent. The relative distance among nodes is considered from the received signal strength of the HELLO packet. The node does not need to estimate the relative distance of entire neighboring nodes for reducing computational overhead, however simply the distance from the next-hop node.

$$u_{n+1} \approx u_n \quad (1)$$

$$s_{n+1} = u_{n+1} \cdot t + s_n \approx u_n \cdot t + sn \quad (2)$$

If the value of $s_{n+1}$ is better than the range of communication, the node sends the packet to the source node immediately.

In this, link failure probability and monitoring are done with the use of fuzzy based link monitoring system. It is a type of logic which signifies the proportions with the falsehood and truthfulness degrees.

is a type of

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and falsehood. As shown in Fig. 1, a fuzzy logic system mainly

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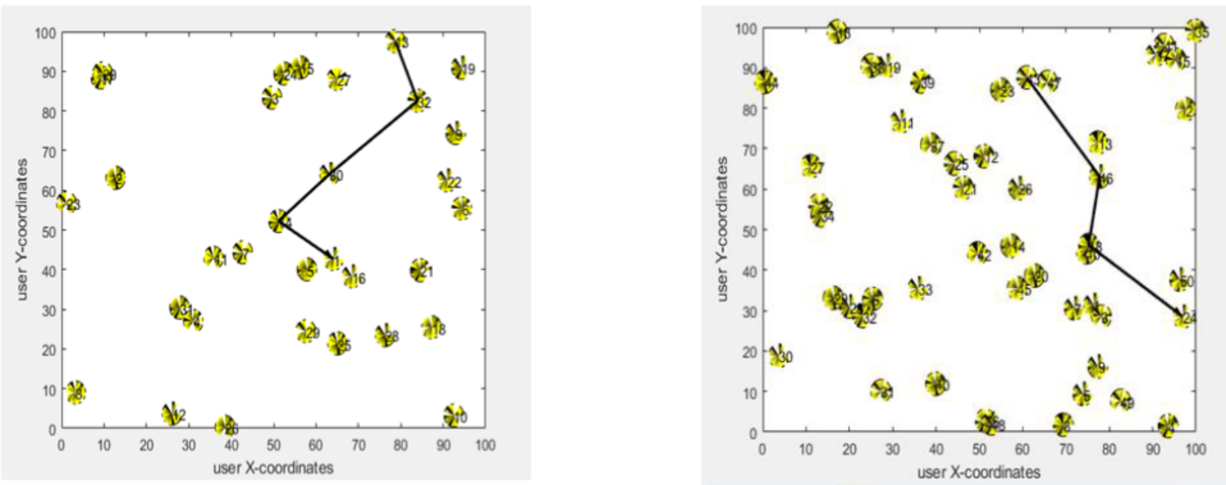
*QoS based performance analysis:*

As the multi path decision making and link failure monitoring conditions are satisfied, then the process of route establishment takes place, which in turn maintains the better path for communication. The QoS based performance analysis is carried out to ensure better transmission of data among the nodes without any link failure. Quality of Service (QoS) is the administration ensure rendered by a network to the users to meet a lot of pre-characterized administration necessities while transmitting packets from a source node to a destination node.




(a) (b)

**Figure 3 (a), (b): QoS based routing in VANET framework**

## PERFORMANCE ANALYSIS

The performance analysis of the proposed system is shown below:

The performance analysis with the use of the NS-2 simulator is employed to evaluate the projected performance in various scenarios. The existing approach investigation is assessed in terms of PDR and Delay [20].

**A. Packet Delivery Ratio (PDR):**

PDR is referred to be the traffic amount gets effectively at the destination the same as the fraction of generated traffic through the source node.

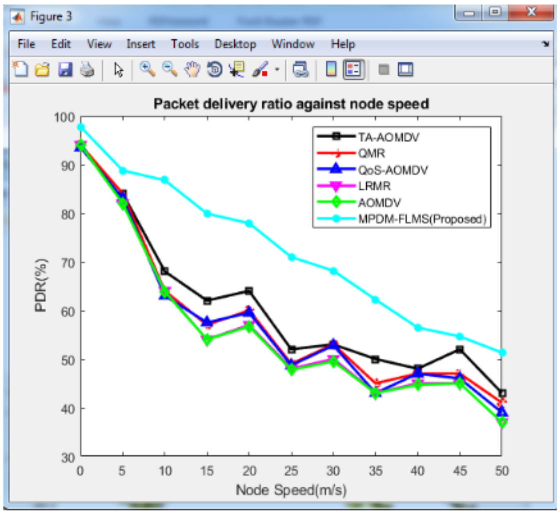



**Figure 4: PDR vs node speed**

Figure 4 depicts that the packet delivery ratios of existing approaches go down obviously as the node speed reduces quietly whereas on comparing the PDR of the proposed methodology. The difference turns out to be more evident at higher speeds. The projected method has high delivery ratios than existing methods as the previous obtain the prediction of node's trust that promotes the successful delivery possibility.

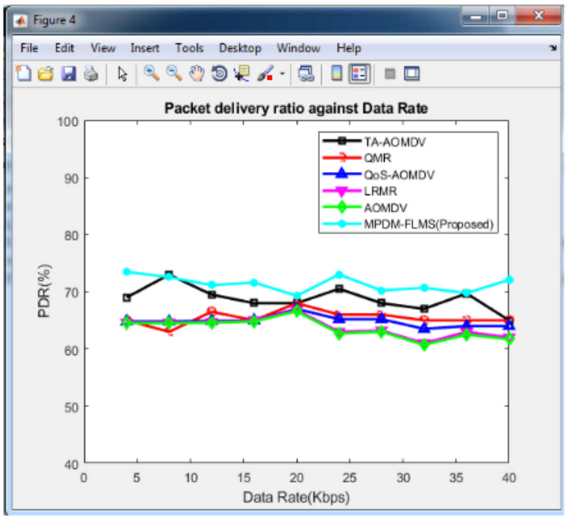



**Figure 5: PDR vs data rate (kbps)**

Figure 5 signifies that the packet delivery ratios of existing approaches enhance obviously as data rate increase quietly on relating the PDR of the projected method. The variation turns out to be more noticeable at the higher data rate. The projected process has high delivery ratios than existing methodology as the previous one that promotes the successful delivery possibility.

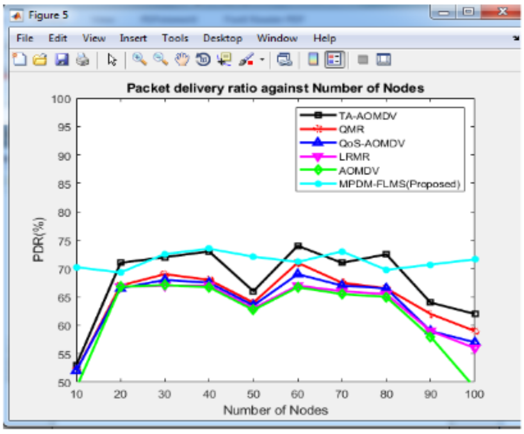



**Figure 6: PDR vs number of nodes**

Figure 6 denotes that PDR of existing approaches varies obviously as several nodes differ quietly on relating PDR of the presented scheme. The projected method has high delivery ratios than existing methodology as the previous one that promotes the successful delivery prospect.

**B. End-to-End delay:**

Average E2E delay signifies the time difference among the packet reception through the target and the instant the source created it; this covers all delays possible encountered through a packet.

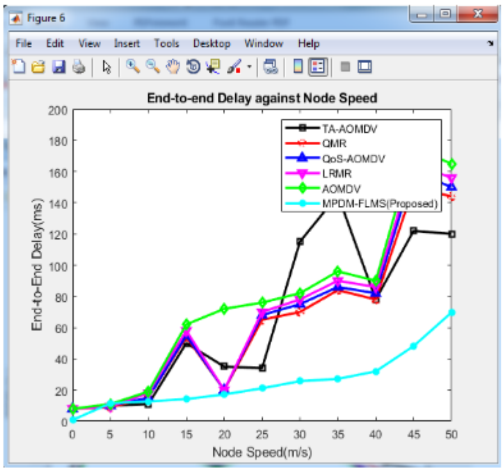



**Figure 7: Delay vs node speed**

Figure 7 portrays to facilitate that E2E delay in this protocol increases by an enhancement in node speed. The route entries turn out to be not valid rapidly at high speeds, and therefore the source nodes begin more route rediscoveries by the conveyance of information. At maximum speed, the average latency decreases correspondingly.

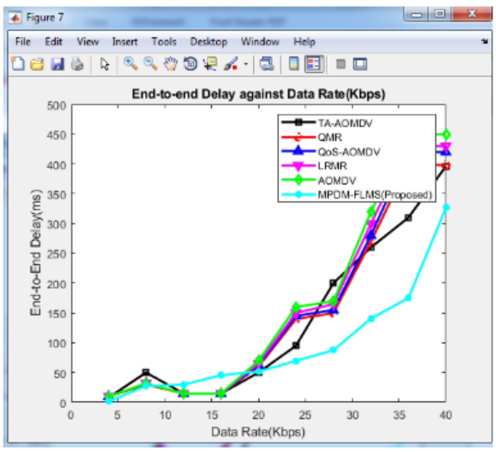



**Figure 8: Delay vs data rate (kbps)**

Figure 8 represents that E2E delay of existing approaches enhances obviously as data rate increase quietly while comparing the delay of the proposed methodology. The variation turns out to be more noticeable at the higher data rate. The projected method has less delay than existing methodology as the previous one, which elevates the probability of delay.

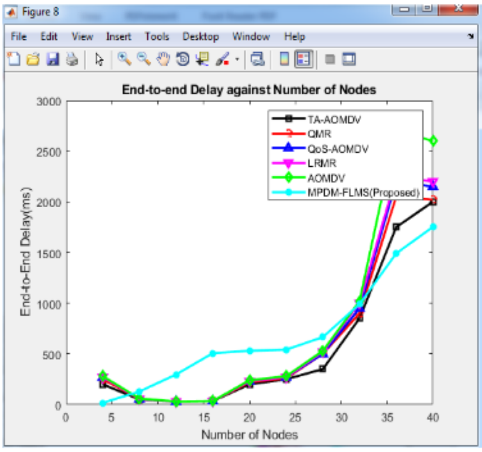



**Figure 9: Delay vs number of nodes**

Figure 9 specifies that the packet delivery ratios of existing approaches increase obviously as a number of nodes differ quietly on relating the ratio of proposed methodology delivery. The projected method has less delay than the existing methodology as the previous one that promotes the possibility of successful delivery.

## CONCLUSION

The performance of the proposed mechanism is made by altering the densities of the node, data rate, and the speed is examined with the use of NS2. The QoS metrics PDR and Delay are almost the same for this situation. In the proposed mechanism, the system model is initialized, and the route discovery process is carried by sending route requests. The multi path decision making (MPDM) scheme is employed to ensure the best route availability and the probability of link failure. Once the multi path decision making condition is satisfied, the route path is established, and the communication takes place based on QoS constraint. Fuzzy based link monitoring scheme is employed to check the probability of link failure. In our future work, include new algorithms and aspects like scalability, fault tolerance, Network Dynamicity, and data fusion to the model, it ensures high trustworthiness of the network.

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