UtilitasMathematica

ISSN 0315-3681 Volume 122, 2025

Reliable Path Selection in AODV: A QoS-Based Strategy for MANET

Dr. D. Sudha
Assistant Professor, Department of Computer Applications, Chikkanna Government Arts College, Tiruppur-641602, Tamil Nadu, India
Dr.A. Kathirvel
Professor, Department of CSE, Saveetha Engineering College, Chennai, Tamil Nadu, India

ABSTRACT

This paper presents an enhancement to the Ad-hoc On-Demand Distance Vector (AODV) routing protocol by introducing a QoS Parameter-Based Reliable Path Selection (QRP-AODV) mechanism. The study focuses on optimizing packet transmission with minimal delay and assured delivery, achieved through link routine examination. The simulation is conducted using the Qualnet Simulator, demonstrating the improvements in Packet Delivery Ratio (PDR), end-to-end delay, average jitter, and routing overhead. The proposed model is compared with existing routing protocols such as NATCAD, EDAODV, LBT, and DRP, demonstrating superior performance in MANETs.

1. Introduction

Mobile Ad Hoc Networks (MANETs) are characterized by their dynamic topology and lack of centralized infrastructure, posing challenges in ensuring reliable data transmission. AODV is a widely used routing protocol, but its performance can be affected by high traffic, congestion, and node mobility. The proposed QRP-AODV addresses these challenges by selecting the most reliable path using key QoS parameters.

2. QoS PARAMETER BASED ON RELIABLE PATH SELECTION MECHANISM

Packet transmission in a MANETs is handled by a collection of intermediary nodes located between the transmitter and recipient nodes. Higher bandwidth, fewer latency, and high - availability are all benefits of optimized data packets, which can be obtained by assessing signal strength. A route is constructed between transmitter and the receiver in the QRP-AODV (QoS Reliable Path -Ad hoc On Demand Distance Vector) protocols.

A minimum transmission time and reliable delivery are done by route discovery and forwarding data packets. Calculating and decreasing the waiting time results in the shortest data transmission. Reliable delivery is achieved without packet loss. It increases the throughput.

The shortest path decision in the Routing algorithm, which is used in MANET, provides the basis for this suggested system QoS parameter. The delay_constant_factor is used to calculate queue delay. It is occupied in the inter queue space and each path cumulative values of the path_delay_estimation are calculated. The minimum value is chosen as best path. The chosen optimum method meets QoS requirements such as enhanced throughput without transmission errors and decreased latency.

Sufficient neighbor nodes chosen by additional parameters have an average energy level and average inter_queue_space as discussed in Algorithm1. Congestion Avoidance Depends on Dynamic Queu e Spaces. The active route is broken or congested due to the heavy traffic. The incoming arrival rate and the service rate depend on dynamic changes in the queue size. It reduces the traffic. The sufficient numbers of node detection and congestion avoidance are determined by the best path selection as given in Algorithm2.

2.1 Algorithm1 for Sufficient Node Detection

Initially all nodes are used for checking the average_energy_level and average_queue_size. If this condition is satisfied that nodes are assigned as a Non_critical_node, otherwise they will become a critical_node. A selection of these Non_critical_nodes acts as a neighbor node which travels from S to D.

```
AEL-Average Energy Level AQS-Average_Queue_Space
N- Available number of nodes in MANET.
Array Node [ ] <- {[0],[1],....[n-1]};
//LIST OF NODES IN MANET
Array    Critical_Node[M],Non_Critical_Node[N]; M<-Maximum number of critical node
<= n
N<-Maximum number of Non critical node <= n Initialize i=>0,j=>0,k=>0
While (i<n) Start
If ((node[i]>=AEL)&&(node[inter_queue_space[i]]>=AQS)) Non_Critical_Node[j]
=node[i];
else
Critical_Node[k] =node[i]; k++;
i++;
End
```

2.2 Sufficient Number of Node Detection and Congestion Avoidance

Initial Non critical Nodes are chosen by additional parameter having an average_energy _level and average _queue _space in Eq. (2.3). Based on the inbound arrival time given in Eq.(2.1) and the utilization rate in Eq.(2.2) allocating the queue length, the node states that the current path is damaged or overloaded. If the incoming data rate is greater than service rate, the traffic is high and it takes more delay.

When the traffic is high, then queue shrinks from its fixed size. If the service rate is high, the queue attains growth. It takes low traffic. The queue is infinite in size. In this QUEUE size is dynamic based on heavy and low traffic.

$$\text{Arrival Rate} = \frac{incoming\ data\ rate\ a\ number\ of\ packets\ arrived}{Total\ Number\ of\ packets} \quad 2.1$$

$$\text{Service Rate} = \frac{outgoing\ data\ rate\ a\ number\ of\ packets\ serviced}{Total\ Number\ of\ packets} \quad 2.2$$

$$\text{Inter\_queue\_space} = \frac{outgoing\ data\ rate\ a\ number\ of\ packets\ serviced}{Total\ Number\ of\ packets} \quad 2.3$$

Algorithm 2: Route Discovery and Forwarding Data Packets

Non_ Critical_ Node has been selected, which involves route discovery until all the neighbor nodes are visited exactly once to reach the destination. Then RREP message is sent back to S node.

Start of Source (S)

Do

{

(Neighbor Node=Next_hop_Node(S))

If((neighbornode==Non_Critical_Node)&&(next_hop_node!=destinatio n_node))

Send AODV RREQ Packet to Neighbor node Repeat Step by assigning S=Neighbor Node
Else if (Next_hop_node==Destination_node)

Reversed back RREP to the Source node and establish a multiple path in

path [0], path[1]………..path[n-1] between from source to destination. Call
Best_path[path[n]] routine

Else

Reject the current Neighbor node and move to next neighbor node

} until (all neighbor nodes are visited).

2.3 Path Delay Estimation

Step1: In this node are assigned delay constant factor based on packet occupied in the inter_queue_space. The probability value 1 indicates that the queue is full and all the incoming packets are dropped.

Step2: The probability value 0.25 indicates the packets are filled quarter size of the queue and probability value 0.5 indicates half the queue is filled by the incoming packet.

Step3: Depends on this probability value, delay_constant_factor is 1, 2 and 3 assigned to the node.

If(inter_queue_space(n[j]<=0.25) than assign as Waiting_time_factor(n[j])=1

Elseif(inter_queue_space(n[j]<=0.50) than assign as Waiting_time_factor(n[j])=2

Otherwise Waiting_time_factor(n[j])=3.

Step 4: Each path Cumulative value of the Delay_constant_factor is calculated. The minimum value is chosen as best_path and it is used for transmission in an algorithm

Function Best_path(path[n])

```
{
Declare array path_delay_estimation[] For I = 0 to n-1
Path[i], let n [0], n [1].......n[k] be Non_critical_node nodes in the
available path.
Path_delay_estimation[j] <- 0 For j = 0 to k
If  (inter_queue_space (n[j]<=0.25)
Waiting_time_factor(n[j]) = 1
else if (inter_queue_space(n[j] <= 0.50)
Waiting_time_factor (n[j]) = 2
else
Waiting_time_factor (n[j]) = 3 end if
Path_delay_estimation[i]+=Waiting_time_factor (n[j])
End for
End for
Best _path <- minimum (path_delay_estimate[i]) Return (Best_path)
}
```

3. FLOWCHART FOR QRP PROCESS:

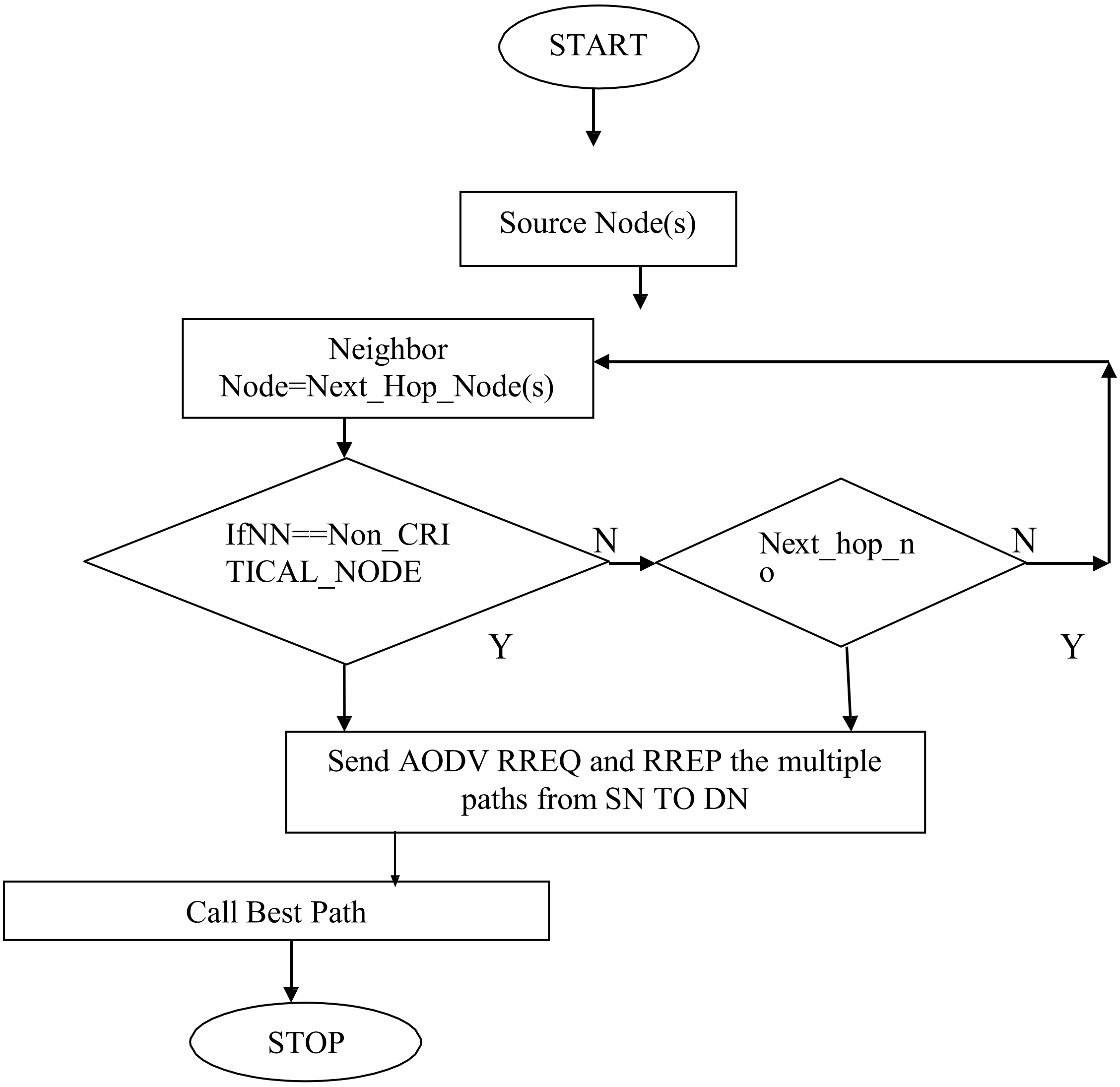
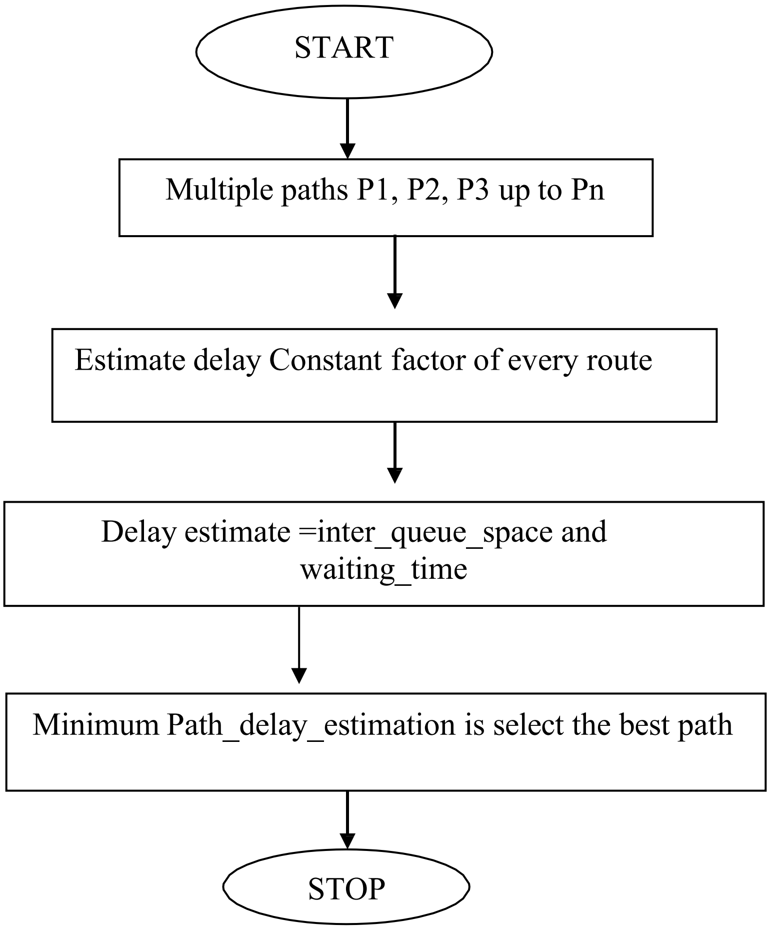


Figure 1.1 flowchart diagram for QRP process

3.1 FLOWCHART FOR BEST PATH SELECTION:



4. SIMULATION RESULTS

Qualnet Simulator used to simulate the QoS factor based on reliable route collection mechanism using AODV mechanism. In this model 500 nodes are traditional nodes are placed in the area size 1200 X 1000. In this model a wireless channel with IEEE 802.11 has been used by the MAC layer protocol. The parameter is used to create this scenario in table 1.1. A certain constraint range from 0% to 40 % of stable neighbor node is arbitrarily selected. For these three main reasons alone the Sufficient Node Detection, Congestion Avoidance Depends on Dynamic

Queue Spaces and Route Discovery and Forwarding Data Packets in QRP are considered.

Various arrangements of studies utilizing AODV convention and altered AODV, known as QRP-AODV have been performed. In the first processes noncritical nodes are chosen by a parameter which has an average energy level and signal strength. The second processes dynamically designed by the queue space shrink and grow depending on incoming arrival rate and the service rate to forward the data packets.

Last process is to select the best from the available path, which results of reduced overhead, delay and time taken for delivery of the data packets in each node.

4.1 Input Parmeter Models

Traffic flow pattern is about CBR. The transmission device's energy is 0.258938W, and the node scope is 250m. The network setup antenna height should be 2.0m and packet bit rate 512 bits. The rapid node movements to the RWP of data transmission are 2 m/s.

Table 1.1 Simulation parameters for QRP

Parameters	Metrics
Execution Time	900 S
Total number of nodes	500 nos
Area Size	1200 X 1000
Layer 2 protocol	802.11
Signal strength	250 m
Traffic	CBR
Load	512 bytes
Deployment	Random
Mobility Model	RWP
Velocity	2 m/s
Flows	20

4.2 Performance Metrics

The four evaluation metrics utilized in the research work are as follows:

PDR: It's characterized as proportion between effectively received packets and generated packets to those produced by CBR traffic source as seen in Equation (4.1).

Packet Delivery Ratio=PDN/PSN (4.1)

Here PDN is the profitably received data's from destination and PSN generates data's by source.

Average Delay: it is the time taken by information packet to reach target.

Average Jitter: it's characterized as variety in the delay of received packets. The latency is increased due to network congestion, incorrect queuing, or setup issues. The latency in between transmission in this steady flow of messages can change rather than remaining constant.

Routing Overhead- A number of times Route Discovery (RD) happens again and again due to the node failure to Deliver Packets. (DP) Equation (4.2) is given blown.

$$\text{Routing Overhead}=\sum^{n} Nod(RDi)+\text{DP} \quad (4.2)$$

4.3 RESULTS AND DISCUSSIONS OF QOS FOR RELIABLE PATH (QRP)

4.3.1 Effect of Varying Nodes with Fixed Network Area in Mobile AD HOC Network

The effect of varying numbers of node is 100,200,300,400 and 500 in which identical outcomes of the PDR, Delay, Average Jitter and Overhead are produced. A comparative evaluation factor is NCTCAD, EDAODV and LBT as compared to the QRP Routing algorithm in Table 1.2. Various factors convey analysis of representation effect of varying nodes in the fixed network area, effect of variation in simulation time with fixed nodes and effect of variation in unreliable node % with fixed area and mobile nodes.

EXPERIMENTS: INVESTIGATION – I

Experiment result has been produced by improving the network performance in QRP-AODV. Varying parameters are discussed using the following steps.

Network area fixed -1200m X 1000m

Varying number of nodes -100 to 500 nodes

Route discovery and forwarding the data packets a comparative evaluation factor is NCTCAD, EDAODV, LBT and DRP as compared to the QRP Routing Protocol.

Various parameters investigation as PDR, delay, average jitter and communication overhead.

4.3.2 PDR

PDR vs. Number of nodes is discussed here. The effect varying number of nodes is 100, 200, 300, 400, and 500 with the successful delivery of the data packet ratio varying from 0% to 100%. If a reliable neighbor node increases, then the established link is provided by the stability in QRP concepts. Average energy level and Average received signal strength based on selection of non critical neighbor nodes will increase the packet delivery ratio.

Figure 1.2 shows the Number of Nodes vs. Packet Delivery Ratio (%). The effects of variation in the number of nodes are 100,200,300,400 and 500. When the amount of non critical node is increased, the PDR (%) also increases. The QRP results compared with previous concept of DRP Algorithm. QRP PDR is shows slight improvement of roughly 2.87% compared to DRP. The QRP result analysis is better when compared to other algorithm in 20.67% of

NATCAD, 15.82% of EDAODV and 11.74% of LBT as shown in the graph.

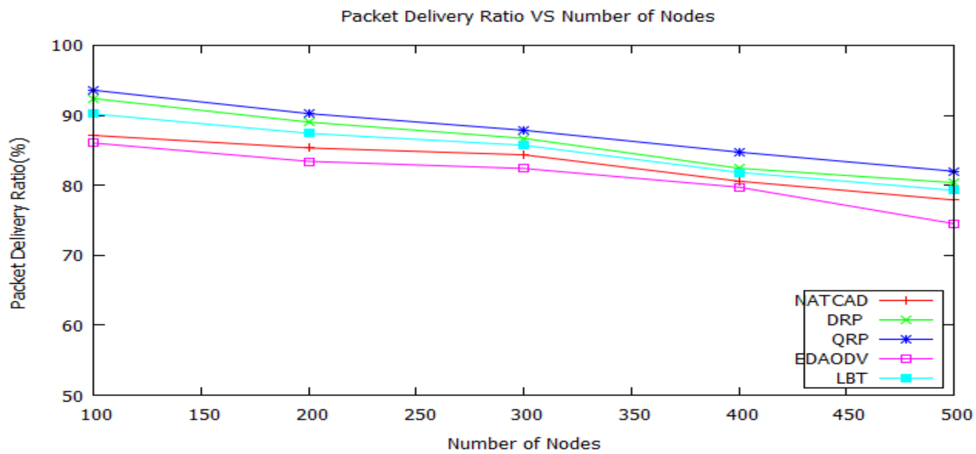


Figure 1.2 Number of Node vs. Packet Delivery Ratio (%)

4.3.3 Delay

Figure 1.3 displays the Number of Nodes vs. Delay (Sec). The effects of variation in the number of nodes are (100, 200, 300, 400 and 500). The number of stable node increases and end to end delay decreases

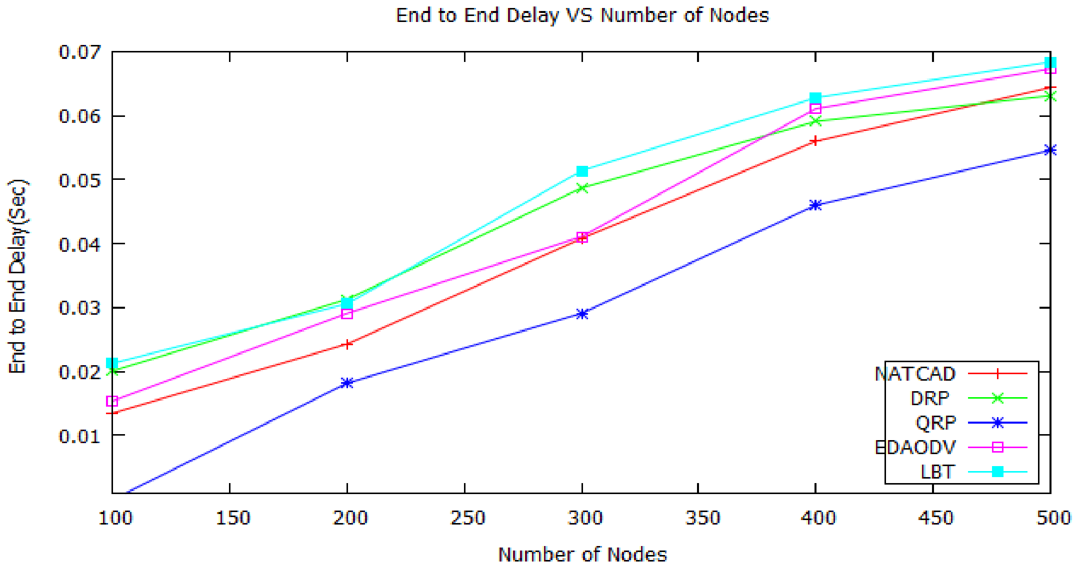


Figure 1.3 Number of Node Vs End to End Delay (Sec)

In the proposed system QRP algorithm selects a path that involves less traffic, i.e. the nodes in the path should have minimum queue size. The packet travelling from source to destination on this selected best path has minimum queue delay and reduces delay. Total number of nodes increases from 300 to 500 as a consequence, QRP decreases roughly to 7.225% compared to DRP. An existing algorithm in NATCAD, EDAODV and LBT is compared to the QDR. The resulting analysis EDAODV and LBT roughly increases delay by 9.951% as well as 16.18% compared to the QDR.

4.3.4 Average jitter

Figure 1.4 shows the Number of Nodes vs. Average Jitter (ms).The effect of variation in the number of nodes are (100, 200, 300, 400 and 500). The consequence of nodes increases from 400 to 500, when QRP decreases roughly average jitter to 1.290% compared to DRP. NATCAD is roughly average Jitter 2.814% which is greater compared to QRP. Likewise QRP average Jitter is lesser compared to 3.955% of EDAODV and 4.291% of LBT.

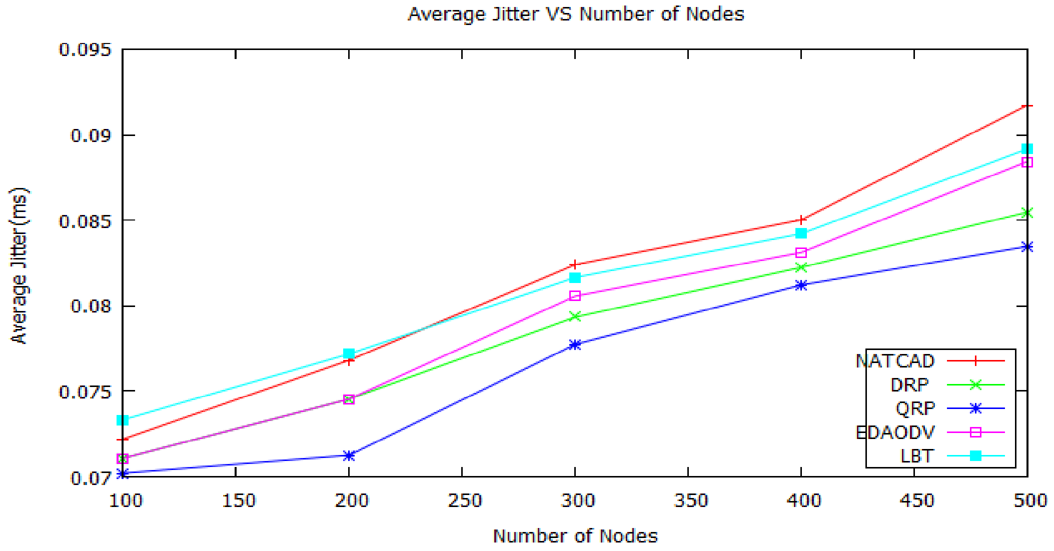


Figure 1.4 Number of Node Vs Average Jitter (ms)

4.3.5 Communication overhead

Figure 1.5 expressions the Nodes vs. Overhead. The effect of variation in the number of nodes are (100, 200, 300, 400 and 500).A number of reliable node increases and the routing overhead decreases. The number of nodes increases from 400 to 500 as a consequence, QRP routing overhead decreases roughly to 1.40% compared to DRP. Likewise QRP Routing overhead is lesser compared to 23`61% of EDAODV and 26.41% of LBT.

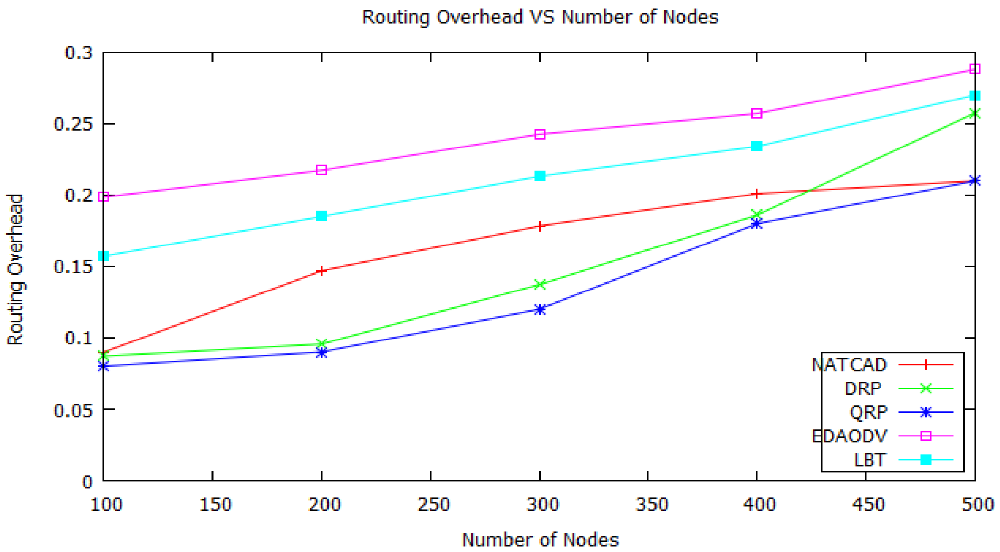


Figure 1.5 Number of Node Vs Routing Overhead

Table 1.2 QRP Results for Normal Nodes

Specification	Method Name	Mobility Node				
		100	200	300	400	500
Packet Delivery Ratio (%)	QRP	93.57	90.23	87.85	84.73	81.99
	DRP	92.38	89.01	86.70	82.43	80.36
	NATCAD	87.11	85.33	84.35	80.58	77.89
	EDAODV	86.02	83.41	82.39	79.72	74.51
	LBT	90.19	87.41	85.71	81.84	79.27
End to End Delay (Sec)	QRP	0.O107	0.0182	0.0391	0.0460	0.0546
	DRP	0.0173	0.0313	0.0487	0.0591	0.0631
	NATCAD	0.0120	0.0343	0.0508	0.0560	0.0644
	EDAODV	0.0144	0.0291	0.0411	0.0611	0.0673
	LBT	0.0187	0.0306	0.0514	0.0628	0.0684
Average Jitter(ms)	QRP	0.08347	0.08121	0.07774	0.07125	0.07021
	DRP	0.08547	0.08224	0.07933	0.07454	0.07107
	NATCAD	0.09173	0.08502	0.08240	0.07681	0.07220
	EDAODV	0.08844	0.08312	0.08056	0.07454	0.07107
	LBT	0.08917	0.08421	0.08165	0.07718	0.07333
Routing Overhead	QRP	0.0801	0.0900	0.1200	0.1800	0.2100
	DRP	0.0870	0.1000	0.1573	0.1960	0.2575
	NATCAD	0.1676	0.2283	0.2477	0.2561	0.2870
	EDAODV	0.1769	0.1954	0.2244	0.2363	0.2665
	LBT	0.0899	0.1583	0.1869	0.2040	0.2121

5. CONCLUSION

The QRP-AODV protocol effectively enhances MANET performance by optimizing path selection based on energy levels and queue space. The QRP Parameters Based on Best Path Selection for minimum transmission time and maximum throughput provided. this mechanism is to select a path that involves less traffic i.e. the nodes in the path should have minimum queue size. The packet routed in this selected best path may have minimum queue delay and hence it reduces the end to end delay in arrived packets. Simulations have evaluated the QRP-AODV and compared with NATCAD, EDAODV, LBT and DRP Algorithm. In the First process only noncritical nodes are involved in route discovery. The Second process designed dynamically by the queue space shrink and grow depending on the incoming arrival rate and the service rate to forward the data packets produced by reducing the congestion and increasing packet delivery ratio. Last process is to select the best from the available path, which results in the reduction of the overhead, end to end delay and time taken for delivery of the data packets in each node.

The simulation results validate the efficiency of QRP-AODV in terms of higher PDR, reduced end-to-end delay, and minimized routing overhead. Future work will explore further enhancements in dynamic environments with varying mobility patterns.

REFERENCES

1. Zonghua, M. and Xiaojing, M., (2011). "A modified AODV routing protocol based on route stability in MANET".

2. Rajakumari, K., Punitha, P., Lakshmana Kumar, R. and Suresh, C., (2020). " Improvising packet delivery and reducing delay ratio in mobile ad hoc network using neighbor coverage-based topology control algorithm". International Journal of Communication Systems, p.e4260.

3. Kumaran, T.S. and Sankaranarayanan, V., (2011). "Early congestion detection and adaptive routing in MANET". Egyptian Informatics Journal, 12(3), pp.165-175.

4. Gnanasekaran, P. and Vibeeth, B., (2015), March. "Link breakage time based QoS improvement in mobile ad hoc network". In 2015 International Conference on Circuits, Power and Computing Technologies [ICCPCT-2015] (pp. 1-4). IEEE.

5. Maamar, S. and Abderezzak, B., (2016). "Predict link failure in AODV protocol to provide quality of service in MANET". International Journal of Computer Network and Information Security (IJCNIS), 8(3), pp.1-9.

6. Zadin, A. and Fevens, T., (2013). "Maintaining path stability with node failure in mobile ad hoc networks". Procedia Computer Science, 19, pp.1068-1073.

7. Huang, J., Fan, X., Xiang, X., Wan, M., Zhuo, Z. and Yang, Y., (2016). "A clustering routing protocol for mobile ad hoc networks." Mathematical Problems in Engineering, 2016.

8. Denko, M.K. and Lu, H., (2006). " An aodv-based clustering and routing scheme for mobile ad hoc networks." In Ad-Hoc Networking (pp. 83-97). Springer, Boston, MA.

9. Tamizarasu, K. and Rajaram, M., (2012). "An AODV-based Clustering Approach for Efficient Routing in MANET". International Journal of Computer Applications, 51(15).

10. SandeepMonga, J.L Rana, JitendraAgarwal (2019)."An Enhanced-Node Feature Based Clustering Algorithm for MANET". (Mobile Ad-hoc Network) International Journal of Recent Technology and Engineering (IJRTE) ISSN: 2277-3878, Volume- 8 Issue-4, November 2019

11. Aissa, M., Belghith, A. and Drira, K., (2013). "New strategies and extensions in weighted clustering algorithms for mobile ad hoc networks". Procedia Computer Science, 19, pp.297-304.

12. Sikdar, A.R. and Xaxa, D.K., (2015) An "Enhanced-NQCA Combined Metrics Based Clustering Algorithm for MANETs. " International Journal of Computer Science and Information Technologies, Vol. 6 (4) , 3799-3805.