CROSS LAYER BASED CONGESTION FREE ROUTE SELECTION IN VEHICULAR AD HOC NETWORKS

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ABSTRACT

For creating a mobile network, the moving cars consider as nodes in the Vehicular Ad-Hoc Networks (VANETs). Each participating car is turned into a wireless router in the VANETs that allows the connecting and creating a network. To improve the comfort and safety of driving of automotive users, the vehicular environment system develops in the vehicular environment systems using the wireless access. The channel congestion causes the degradation of quality of service in such cases with higher vehicle density. The real-time and reliable communication is required for various safety applications of VANETs. The dense traffic network has included one of the major challenges as avoiding the communication channels' degradation. To provide the network with efficient operation, most of the studies are recommended to use the appropriate congestion control methods. It's important to note that many congestion control mechanisms are not implemented for event-driven real-time safety messages. Based on the congestion probability approach estimation, CFRS-CP-Congestion free route selection is introduced for minimizing the total number of data flow packets that passing through the congested nodes. At each node, the congestion probability is estimated using the proposed technique of CFRS-CP based on link quality, MAC overhead, neighbour density & vehicle velocity. Then, the estimated congestion probability is used for route assessment. The estimated probability value is appended to the control packets for comparison. All the available routes are assessed based on the estimated congestion probability which results in congestion free routing path for every round of data communication. The simulation results prove that the proposed method decreases end to end delay by 32% and improves PDR up to 30% and throughput up to 45% compared to the existing protocols.

KEYWORDS

Congestion, Link quality, MAC, Neighbor density, VANET, Vehicle velocity.

1. INTRODUCTION

The communication of vehicles on roads is allowed using the emerging technology of the vehicular ad-hoc network (VANET) to enhance the comfort and driving safety for automotive users [1]. In VANETs, the communication can be established among vehicles and vehicular infrastructures, like vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communications. With one OBU, each vehicle is equipped in the V2V communications among On-Board Units (OBUs), and the communications of V2I is occurred between OBUs and Road-Side Units (RSUs) [2]. VANETs can be implemented in different non-safety and safety applications, such as infotainment, optimization of traffic, toll payment, and parking management.

The characterization of VANETs has been performed based on the changes of high topology rate, high variability, and high mobility in node density. Some challenges like data dissemination, routing, scalability, security, and total performance degradation are resulted due to these characteristics in VANETs [3]. For enhancing the VANET's performance, the policies of Qualities of Service (QoS) have been utilized. The congestion control is one of the major operations of a network to improve the parameters of QoS, including delay and reliability. For ensuring the reliable and safe communication without any delay, the congestion control is exploited. By using the self-organized and decentralized techniques, the congestion should be controlled owing to the frequently route break and dynamic changing topology. In VANETs, some of the existing strategies for congestion control are controlled the network congestion efficiently in VANETs, but in most cases they increase number of computations needed and time complexity for controlling congestion which results in high overhead in the network [4]. Figure 1 shows the architecture view of VANET.

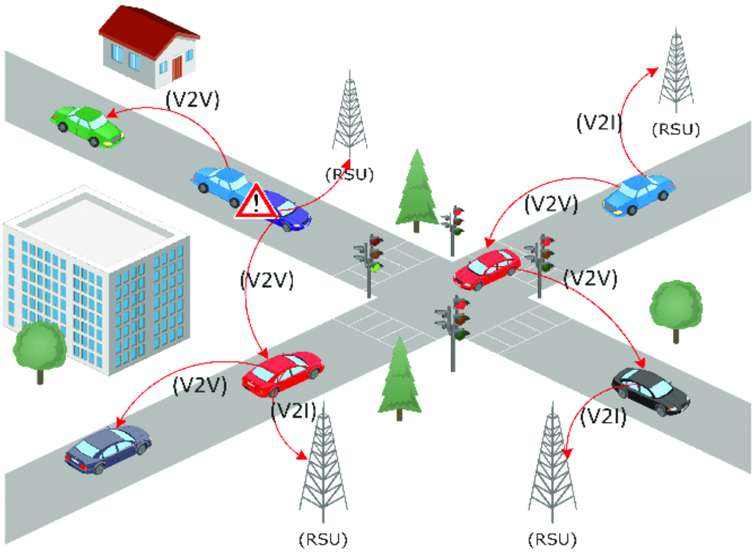

Figure 1. A VANET architecture

The unpredictable, highly-mobile, and dynamic vehicle nodes is resulted that degrades the performance of an application due to the frequent changes of traffic situation between dense and sparse alternative conditions in VANETs [5]. The issues of channel congestion have been impacted by many safety applications, specifically in the dense traffic cases, where safety messages disseminate by various vehicle nodes to other vehicles. Different schemes of congestion control have proposed for addressing the issues of channel congestion [6]. For identifying and controlling the congestion, different techniques have been adopted in these schemes. Due to the frequently-changing and dynamic topologies and vehicular nodes' high-mobility, various challenges have been faced when developing the optimal congestion control scheme. Because of the stringent requirements in relevant to the data reliability, most of the earlier methods can't be adapted directly to the safety or event-driven applications. One type of event-driven messages, like the emergency brake light application while forwarding is focused by some schemes. Different safety applications' requirements are differentiated from each other, including lane-changing warning messages, violation of traffic signals, and pre-crash sensing. But they are difficult to meet in real-time environment. Author [7] introduced a smart pathway that can be bridge the gap between IoT services with its real data traffic. This routing process for computing two or more paths to pass the more than one high priority real traffic data a these paths to improve the gloomy picture of this protocol in the context of IoT.

For addressing crucial problems like traffic congestion and passenger safety, the Intelligent Transportation Systems (ITS), i.e. the telecommunication integrates with the information technologies into transportation systems were improved. The modern ITS is formed by the vehicular ad hoc network (VANET) that contains mobile vehicles connecting through the wireless communication in an ad-hoc manner with no control when moving on the roads. For supporting the vehicle-to-infrastructure (V2I) and vehicle-to-vehicle (V2V) information exchange, the most promising wireless technology is considered as Dedicated Short Range Communication (DSRC). In general, two types of data relevant to the beacons and event-driven messages disseminate by the vehicles. Here, beacons known as BSM or Basic Safety Messages in the CAM or US cooperative awareness messages in Europe. The data about neighbours, including speed, direction, and position is informed that broadcast periodically by using beacons. In the emergency cases like road surface collapse, accidents, and car collisions, the event-driven messages distribute in a multi-hop manner over a geographic area. Beyond the line of sight, these messages help the vehicles to expand their awareness and restrict the potential dangers.

Various safety applications like slow vehicle indication and car collision avoidance were designed based on the timely and reliable exchanging of beacons through V2I or V2V communication for VANETs that provide the experience quality for passengers and drivers. The 60% of car collisions can be avoided based on the existing literature that suggests using the safety applications that warn the drivers on time in prior to the collisions. The timely and reliable dissemination of beacons between vehicles is considered in the safety applications. However, it’s crucial to maintain the beacons’ dissemination in a reliable manner for safety applications with proper operation.

For addressing the above-mentioned problems, the CFRS-CP - Congestion free route selection is considered to implement through the approach of congestion probability. It aims to reduce the passing number of data packets at the congested nodes. The congestion probability is estimated at each node based on the proposed technique of CFRS-CP using the neighbor density, link quality, MAC overhead & vehicle velocity. Then, the estimated congestion probability is used for route assessment and least congested path is selected for data transmission.

Our contributions

- The total number of packets that passing at the congested nodes are reduced in every communication which reduces communication overhead.
- The cross-layer parameters such as MAC overhead, link quality, neighbour density & vehicle velocity improves the relay selection accuracy.
- Every route is assessed based on the estimated congestion probability which results in congestion free routing path for every data communication.

2. LITERATURE SURVEY

Luo et al., [8] has developed a schema of cluster-based file transfer (CFT) for enabling the efficient file transmission among vehicles. Based on the direct communication of V2V, the requested file was transmitted in the network. The high-intensity file transfer could be attained using the method of CFTAs without any roadside units and access points. Based on the free mobility model, the vehicles’ mobility was represented. To specify the minimum and maximum speeds for safety, the measure of safety distance (SD) was used. For computing the moving direction, velocity, and position of vehicles, the connection time prediction model was utilized to predict the connection time among the vehicles. To determine the network’s transmission capability and cluster size, the extensive simulations have been performed. However, due to the unpredicted movement of the vehicle makes the cluster unstable that leads to frequent re-clustering of the network and increase in network overhead.

Abuashour et al., [9] has proposed the intelligent transportation system (ITS) for improving the QoS. The network throughput is increased using the IDVR-intersection dynamic routing of VANET that reduces different parameters that restrict the QoS. Two different categories like macroscopic and microscopic were classified using the vehicular mobility model. The network communication was established with reduced overhead using the wireless routing protocol, known as CBLTR. In three different scenarios, the HELLO messages propagate in the protocol, such as: when new CH is announced itself; when CM is entering into the cluster zone; and when CM is left from the cluster zone. However, it failed to provide efficient data aggregation among the CM and CH nodes which impacted the network performance.

Gupta et al., (2018) [10] has discussed that it’s desirable to achieve the seamless, secure, and highly dynamic environment for passengers in the wireless ad-hoc network. The non-traceability and key agreement are considered for wireless ad-hoc network to meet the requirements of seamless and secure network based on the strong privacy of two unidentified party verification model. These protocols are based on a two-party authentication protocol and group signature scheme, but no optimal mechanism for efficient routing exists.

The loop-free operations are ensured by using the mechanism of greedy forwarding for messages’ forwarding in the location-based routing. The nodes’ current physical coordinate values are used in this mechanism that has obtained via the nodes’ mounting GPS (Agarwal et al., 2018) [11]. However, the overhead incurred during data transmission was not considered hence it increases the overall network overhead.

Shelly and Babu et al., (2017) [12] has used the location-based routing protocols for VANETs to limit the issue of vanished link among nodes due to the seldom changes and mobility. The proposed method uses for establishing the optimal path from sender to the destination node by using the coordinate values of current vehicle nodes based on the location-based routing techniques for data transmission towards the intended destination. However, this method used GPSR that includes some disadvantages that make not suitable for VANETs with higher mobility scenario.

Rana et al., (2017) [13] has proposed an improved directional-location aided routing (ID-LAR) protocol to enhancing the routing overhead. A small sub-request zone area is partitioned from the large requested zone area using the ID-LAR protocol with the location coordinate values of nodes. The request zone’s reduced size is limited the process of neighbor searching those results in the reduced routing overhead. The protocol of ID-LAR is a position-based routing method that assists in computing the forward area for choosing the next forwarder node and the coordinates may not be accurate due to real-time complications.

Kamlesh Kumar Rana et al., (2020) [14] has proposed a novel routing algorithm known as LAMR for a VANET to overcome the problem of link vanishing. It has chosen a remarkable next-hop towards the destination or desired location for establishing a stable path from sending to destination nodes. The vehicles’ link stability is decided by vehicles’ localization through the mechanism of geometry-based localization. The performance of proposed algorithm is better than the other algorithms like D-LAR and LAR in terms of throughput and vehicle velocity. Throughput increases with the increment of number of vehicles. However, this method relied on location-aware multi-hop routing that makes the proposed method inaccurate.

B. Suganthi and R. Ramamoorthy et al., (2020) [15] have proposed an advanced and efficient routing protocol, called as FBAODV for VANETs to enhance the network QoS. By sending the RREP and RREQ messages, the link is established between nodes. To evaluate the proposed protocol, the simulation results are analyzed based on different parameters like end-to-end delay, overhead, packet rate, and PDR. The proposed protocol's efficiency has achieving than the other traditional protocols. Thus, the network's energy consumption is reduced and the packet delivery ratio is increased with the average throughput. However, this protocol need further improvement to enhance the QoS of the overall network.

PROBLEM STATEMENT

Different protocols for routing have been used to achieve the optimal and efficient routing under various traditional works of VANETs. The routes would be discovered over the communication network using the existing methods through the maintenance of an optimal path between source and destination nodes. Many protocols are proactive routing methods that don't need any route discovery and stores the destination in the backup. The network latency and bandwidth will be reduced if it doesn't able to maintain the unused data paths. It is also lacking in improving the network QoS that results in the minimized network performance. However, the protocols have various issues, such as communication overhead, inefficient bandwidth usage, not optimum usage of resources, and higher transmission delay. A new approach is required to design for solving the issues, specifically in emergency cases of VANET.

3. PROPOSED METHOD

The Less time and cost are used to design the efficient strategies of congestion control for satisfying the reliability needs of VANETs. The transmission reduces for a total number of data packets based on the congested nodes. The congestion occurs and the subsequent data is required to be dropped when a limited buffer space is full. To establish a routing protocol, the strategy of proposed congestion control was developed to increase the system performance based on the multi-rate network's reliability and minimum resources of a network. To enhance the system performance and linkage among nodes, the proposed CFRS-CP method calculates the congestion probability of each route using MAC overhead, link quality, neighbour density & vehicle velocity parameters, and utilize the parameters for establishing the routing parameter. Each routing metric is detailed as follows:

3.1. MAC overhead:

The standard packet sequence is acknowledged (ACK), data, request-to-send (RTS), and clear-to-send (CTS) in the network of 802.11. The definition of a short inter-frame space (SIFS) is described as the amount of time between the receipt of data packets and the next transmission. As mentioned in Equation (1), the channel occupation will be described owing to the contention of MAC:

$$C_{oc} = RTS_{time} + CTS_{time} + SIFS_{time} \tag{1}$$

Where, RTS_{time} and CTS_{time} represent the consumed time on Request To Send and Clear To Send, respectively while $SIFS_{time}$ refers to the Short Inter Frame Space period. The equation (2) is used to determine the MAC overhead:

$$MAC_{oh} = C_{oc} + T_{acc} \tag{2}$$

Where, T_{acc} refers to the time taken because of the access contention.

3.2. Link Quality:

From the physical layer, the received signal strength can be utilized for predicting the quality of a link and abandon the links, which have lower signal strength by using a route selection. The transmission power P_{trans} is contained in the broadcasted RTS packets if broadcasting the RTS packets from the sender nodes. The below-mentioned relationship uses for free-space propagation model by the received signal strength that measures using the intended node upon receiving the RTS packet. The equation (3) is used to estimate the link quality from the above observations:

$$LIQ = P_{trans}\left({}^{\omega}/_{4\pi d^2}\right) * G_{trans} * G_{recv} \tag{3}$$

Where, G_{trans} and G_{recv} refer the transmitting and receiving gains of omni directional antennas, respectively, d is the distance between sender and receiver, and ω indicates the carrier's wavelength.

3.3. Neighbour density:

The nodes' selection with enhanced connectivity is allowed in the density approach. The continuous connectivity is provided with the improved lifetime. Based on the nodes' distance, the node density is determined and is indicated as follows equation (4):

$$D = \frac{1}{M} * \sum_{i=1}^{1-M} DIST(i,j) \tag{4}$$

Where, M represents the total number of nodes and $DIST$ is the distance between a node and its neighbour node. Therefore, the node density for the entire node in the network is summarised as follows equation (5):

$$ND = \frac{1}{M} * \sum_{i=1}^{N} D\,(N) \tag{5}$$

3.4. Vehicle velocity:

In VANETs, the nodes are moving with higher speeds usually. The efficient path selection is required for stable communication among all vehicles. The relative velocity between two nodes is to be zero and the continuous communication connection can be maintained when all vehicle nodes are moving with the same speeds and direction changes are not occurred. The lifetime of a link would be shorter if the relative velocity is larger between two moving nodes. The control message is sent by the nodes periodically in VANETs and it is used for connecting the links directly. Based on the broadcasted control messages, the neighbourhoods of nodes can keep on tracking. From the routing table, the node deleted if it's not able to get the message from the neighbourhood for a particular period. Equation (6) is mentioned the velocity function:

$$V_{velocity} = \frac{(1+r)^w + (V_{pre} * (N-1))}{N} \tag{6}$$

Where, N represents the received control messages that exchanged during the interval time, V_{pre} indicates the previously recorded velocity, r is the relative value between velocities and current vehicle velocity that coveyed on the control messages and w is the weight value.

3.5. Estimation of Congestion probability of routing path

The congestion probability is computed within each node through the parameters of $MAC_{oh}, LIQ, ND, V_{velocity}$ at time t. The congestion probability estimation function is defined as follows equation (7):

$$\boldsymbol{CP_t} = \frac{1}{MAC_{oh} * LIQ * ND * V_{velocity}} \quad (7)$$

Where $\boldsymbol{CP_t}$ represents the congestion probability at time t, MAC_{oh} is the MAC overhead, LIQ is link quality, ND is neighbour density & $V_{velocity}$ is the vehicle velocity at time t. In the proposed routing technique, each node's CP value was chosen at time t.

3.6. Routing strategy:

For each node of a network, the CP value is used as the routing parameter at time t and a set is termed as the 'relative neighbour'. Node b becomes the relative node behaviour of a and node b is the node a's neighbour if only if

$$CP_b \leq CP_{a\_avr}$$

Where, CP_{a_avr} refers to the node a's average CP values and CP_b indicates the node b's CP at time t.

The equation (8) is used to define the set of relative neighbours for node a:

$$RN_a = \{node\ b \mid (node\ b\ is\ the\ neighbor\ of\ node\ a\ ) \ \&\ (CP_b \leq CP_{a\_avr})\} \quad (8)$$

In the route discovery, two phases are involved. The searching process for a destination node includes in the neighbour table during the first phase. Here, a routing path builds between source and destination nodes if a destination node is found out in a neighbour table while sending the control packets to the destination. Once the link establishes between source and destination nodes, a route discovery process has been completed. It is changed to the second phase if a destination node is not in the neighbour table. A source node broadcasts the address of a destination node to the relative neighbours RN in the second phase of a route discovery. This discovery process continues until finding the destination node based on the addressing for a next node. The process completes when a route establishes by determining a destination node.

In order to compute the congestion free paths between source-destination pairs, the control packet structures are modified with an additional field called $CP - value$ which represents congestion probability.

Through the control packets' broadcasting to the neighbours, the route discovery process is initiated whenever a source node is required to communication with other nodes for which the routes are not active for its routing table. The contained information is recorded by the relative neighbours upon receiving the control packets when a new path is provided to the source rather than the duplicate packets' discarding. Although the relative neighbours can be provided an available route for the destination, they are excluded from the reply message broadcasting to the source directly for achieving the accuracy. Alternatively, the destination is only considered for sending a reply message to the source. The reverse routes are updated by the destination upon packet reception in case of relative neighbours. A response packet is prepared to generate for the source by the destination. The response packet will send back to the source after receiving it by the relative neighbour. The path with least CP-value is chosen for transmission of data packets after receiving the response packets through the source node. Figure 2 represent the updated control packet structure.

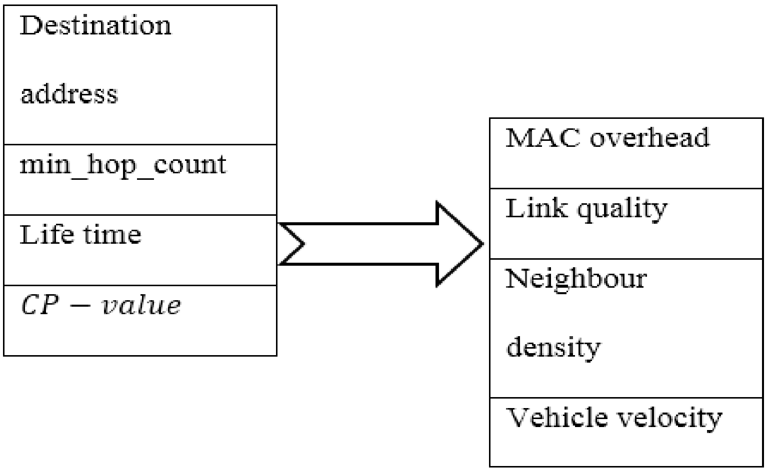

Figure 2. updated control packet structure

Effectiveness of the proposed method

The proposed protocol ensures the congestion-free relay selection by estimating the CP-value of the available routing paths. The estimated congestion probability is used to choose the relay nodes at each node based on the MAC overhead, link quality, neighbour density & vehicle velocity. The MAC overhead parameter calculates the short inter-frame space measurement that describes the amount of time taken between transmission and receiving of one packet to the next. This helps to identify the channel occupancy rate and to schedule the data transmission accordingly. The parameters neighbour density and vehicle velocity improve the connectivity and stable relay selection. The relative neighbours are defined for every node using CP-value parameter. The proposed protocol makes relay selection by considering all aspects such as channel availability, occupancy, stability, overhead and the quality of the links. The proposed technique reduces the overhead by 50% based on the evaluation results when compared to the existing protocols.

Algorithm

$MAC_{OH(n)}$ = MAC overhead of node 'n'; $LIQ(n)$ = link quality of node 'n'; $ND(n)$ = neighbour density of node 'n'; $V_{velocity(n)}$ = velocity of node 'n';
CP = congestion probability;
###
For all nodes 'n' at time 't'
    Estimate $MAC_{OH(n)}, LIQ(n), ND(n), V_{velocity(n)}$
    Estimate $CP_{(n)t}$
End for
For all nodes $'n'$
Identifying relative neighbours RN_n
    If $CP_k \leq CP_{n\_avr}$

$RN_n = k$
End for
Route discovery
If $node_a$ wants to communicate with $node_b$
For all the neighbours
If $neighbor_{address} == node_b$
Send request
Else
Send request to RN_a
End if
End for
End

In the above algorithm, for every node n in the network, the parameters $MAC_{OH(n)}, LIQ(n), ND(n), V_{velocity(n)}$ are estimated to evaluate $CP_{(n)}$ at time t. Identify the relative neighbours RN_n for the nodes based on the estimated CP value. After estimating the relative neighbours, during route formation, the data sending node that seeking out for a destination node in the neighbour table. The routing path establishes using a node when a destination is found out in the neighbour table. Else, the node broadcasts the address of destination node to relative neighbours RN. The discovery process is continued to find out the destination node that address the next node. In a set of RN, each node continues to carry out the discovery process for a route from the first phase in the next step of a route discovery. If a route is setup to the destination, the process stops.

4. RESULTS DISCUSSION

4.1. Experimental Setup

Based on different performance metrics, the existing and proposed routing protocols have been validated through the simulation results using NS2 simulator. Here, the performance measures are end-to-end delay, overhead, throughput, and PDR. For evaluating the results, the package of NS2.35 was utilized through the setting of suitable simulation for a proposed system, which is shown in below Table 1.

Table 1. Simulation table

PARAMETER	VALUE
Traffic type	CBR
Packet rate	512 bytes/ 0.8ms
Radio range	250m
Packet length	512 bytes
CBR interval	0.1
MAC type	MAC/802_11
Routing Protocol	AODV
Simulation time	200s
Number of vehicles	50
Area	1000 x1000
Routing methods	LAMHR, FB-AODV, CFRS-CP
Transmission Protocol	UDP
Initial Energy	100j

The simulation work has been performed for the network area of 1000 m*1000 m with 50 to 500 vehicles for validating the proposed model's performance CFRS-CP. For unrestricted space dissemination model, the simulation work is used for representing the nodes' transmission range R around the vehicle.

4.2. Simulation Result and Analysis

In this section, the obtained simulation results are discussed in different scenarios. The proposed technique is evaluated for the network of 50 nodes and the area of 1000*1000 m2.

End-end delay evaluation

It analyzes based on the Euclidean displacement from source to destination. The definition of end-to-end delay is described as the time taken for transmitting the data packets from source to destination node. It can be determined as follows:

$$End - End\ Delay = \frac{Overall\ delay}{Total\ counts\ of\ packets\ sent}$$

The delay can be computed based on the difference between sent time of a message and received time of a message. Table 2 shows the compared values and Figure 3 illustrates the plotted values.

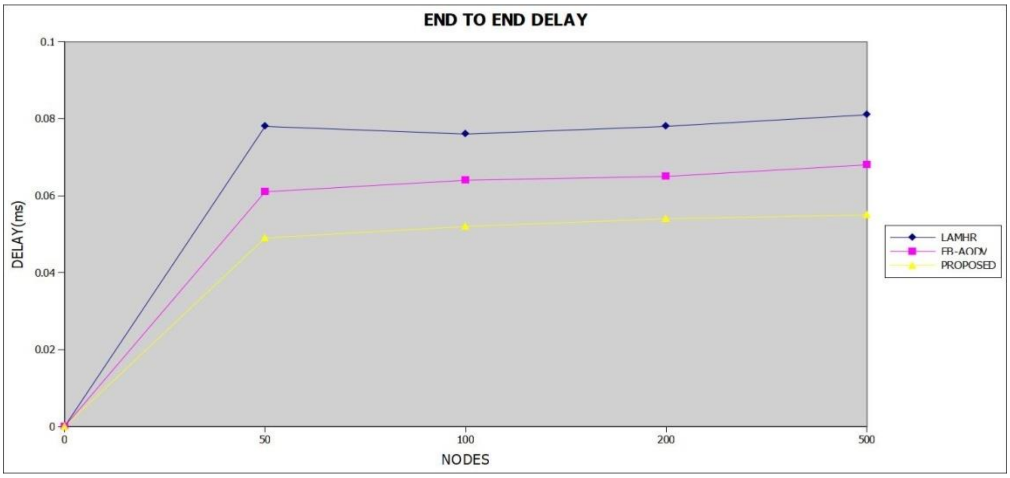

Figure 3. End to End Delay

Table 2. End to End Delay proposed technique compared to the other existing methods

NODES	LAMHR	FB-AODV	PROPOSED
50	0.078	0.061	0.049
100	0.076	0.064	0.052
200	0.078	0.065	0.054
500	0.081	0.068	0.055

In the proposed technique, the average end-to-end delay was 0.042 ms and the average end-to-end delay of FB-AODV and LAMHR were 0.062 and 0.078 ms respectively. The estimation of congestion probability of each and every route and the selection of congestion free routing paths ensured the uninterrupted transmission of data between destination and source nodes. So that the data packets could reach the destination within estimated time hence lower end to end delay was experienced in proposed network.

Overhead evaluation

The definition of overhead can be described as the fraction of all sent routing protocol packets over a number of data packets, which are received at the destination node. It can be described as the ratio between total number of routing packets that have been sent over a network and a total number of received data packets. Table 3 shows the compared values and Figure 4 illustrates the plotted values.

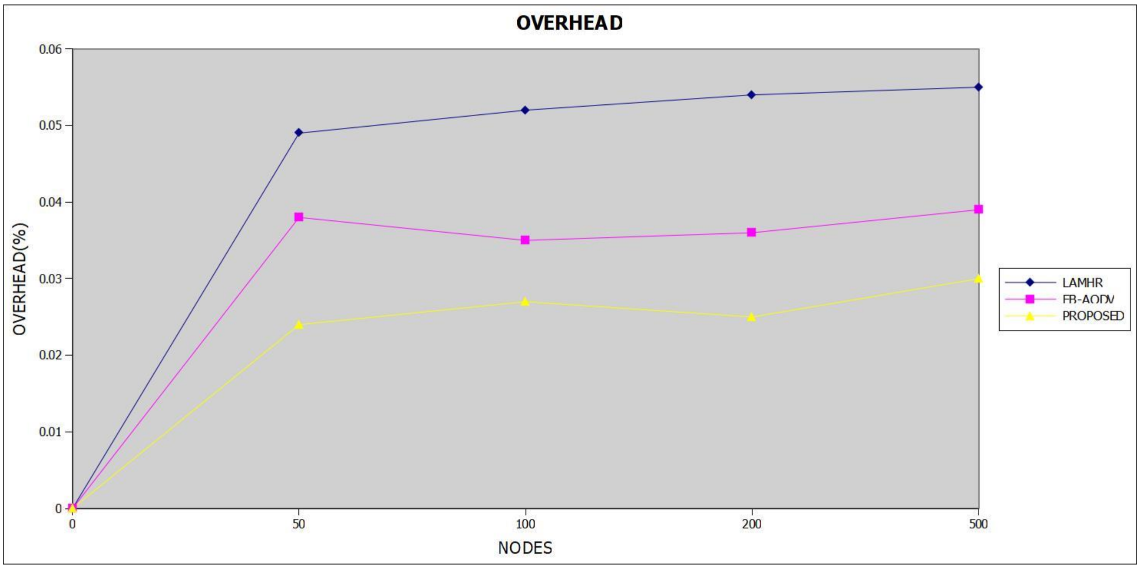

Figure 4. Routing overhead

Table 3. Routing overhead proposed technique compared to the other existing methods

NODES	LAMHR	FB-AODV	PROPOSED
50	0.050	0.038	0.024
100	0.053	0.035	0.027
200	0.055	0.036	0.025
500	0.056	0.039	0.030

The frequent path breakage between the nodes due to excess amount of the congestion and other reasons are the major cause of path reconstruction. In the proposed network, the probability of frequent path reconstruction was reduced due to congestion probability based path selection strategy. So the number of control packets transmitted across the network in the proposed network was comparatively lesser than the existing methods.

Packet delivery ratio evaluation

PDR describes as the relation between received data packets and generated data packets by the desired and sender locations respectively.

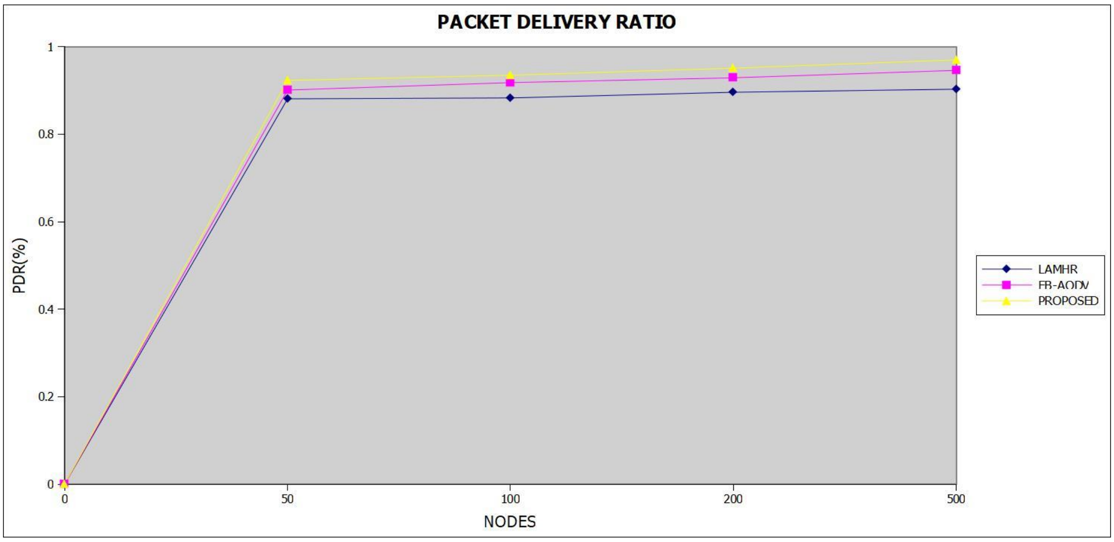

Figure 5. Packet delivery ratio

The proposed method is evaluated to determine the PDR, which calculates based on the data transmission packets' efficiency from any node to the remaining nodes. It is estimated as follows:

$$PDR = \frac{Number\ of\ packets\ recevied}{number\ of\ packets\ transmitted} * 100$$

The selection of routing path between the communicating nodes impacts the PDR of a network. In the proposed network, the routing path selection was made based on the congestion probability of the links which resulted in the selection of non-interference or less-interference paths between the nodes. So that the data packets can reach their destination without much interruption in the routing path. The average PDR experienced in the proposed was 0.96% whereas the existing methods experienced bit lower PDR rate than the proposed network. Table 4 shows the compared values and Figure 5 illustrates the plotted values.

Table 4. The PDR of a network proposed method compared to the other existing methods

NODES	LAMHR	FB-AODV	PROPOSED
50	0.881	0.901	0.923
100	0.883	0.918	0.935
200	0.896	0.929	0.951
500	0.903	0.946	0.970

Throughput evaluation

At the destination, the total number of received packet measures as the end-to-end network throughput. It has been considered as the external parameter for determining the proposed protocol's effectiveness. The successful number of total packets to the desired nodes is counted for measuring the throughput for a link between two nodes. For increased performance, the throughput values increment is a great indicator and the measurement is in bits per second (bit/s or bps). The below equation represents the throughput:

$$\text{throughput} = \frac{\text{packets}_{\text{delivered}} * \text{packet}_{\text{size}} * 8}{\text{time}}$$

The throughputs are shown in the Figure 6 and the results indicate that the increased throughput is observed for growing number of nodes.

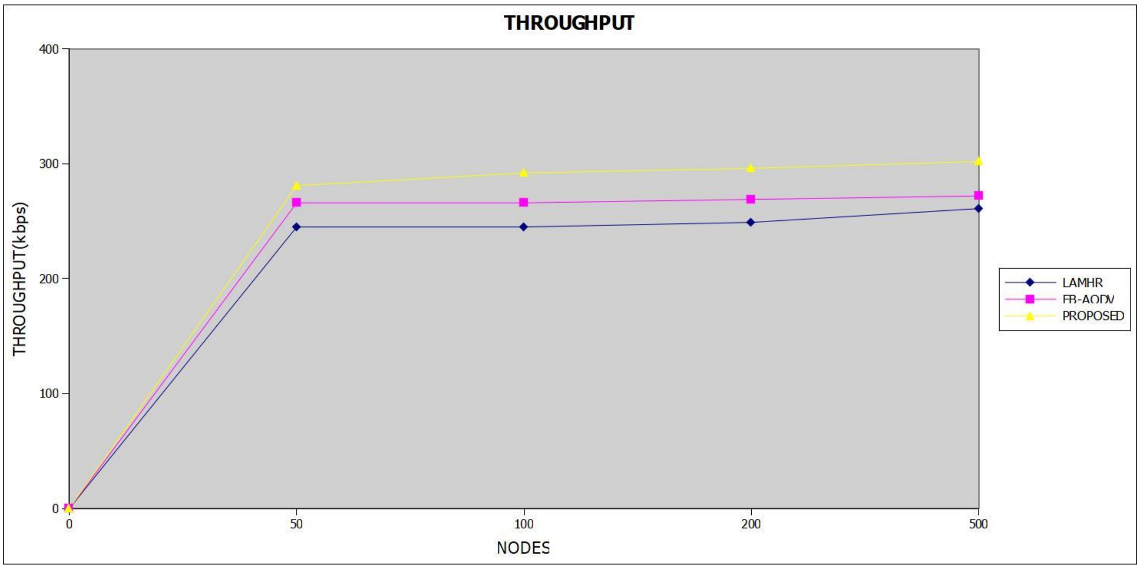

Figure 6. Throughput

The below listed table 5 shows the successful data delivery rate per second was higher for a proposed technique compared to the other existing methods. The reason for the high throughput rate was the effective routing path selection by evaluating the congestion probability between the communicating nodes, which selects interference free paths between nodes. The simulation graph proves the proposed technique's effectiveness over the existing protocols.

Table 5. Throughput proposed technique compared to the other existing methods

NODES	LAMHR	FB-AODV	PROPOSED
50	245	266	281
100	246	266	292
200	249	269	296
500	261	272	302

4.3. Comparison of performance metrics with Vehicle Speed

The figures 7-10 shows comparison between proposed and existing protocols while compare with speed and performance metrics, as a result validated and shows more performance on proposed method.

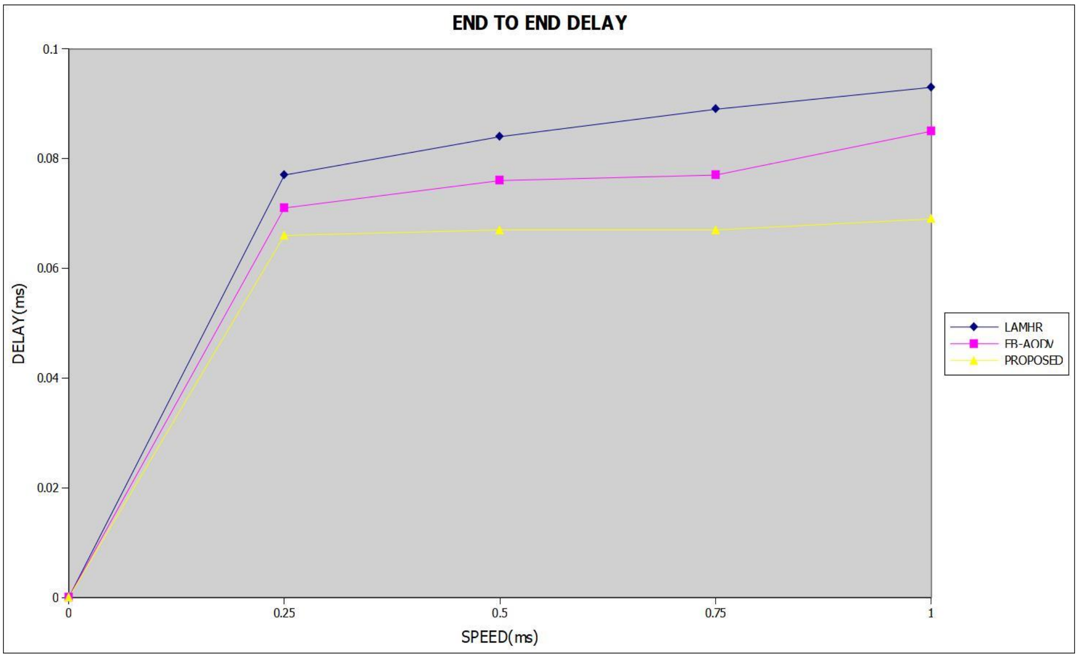

Figure 7. Performance comparison of obtained End to End Delay (ms) using existing and proposed congestion routing protocol

Vehicle speed	LAMHR	FB-AODV	PROPOSED
0.25	0.077	0.071	0.066
0.50	0.084	0.076	0.067
0.75	0.089	0.077	0.067
1	0.093	0.085	0.069

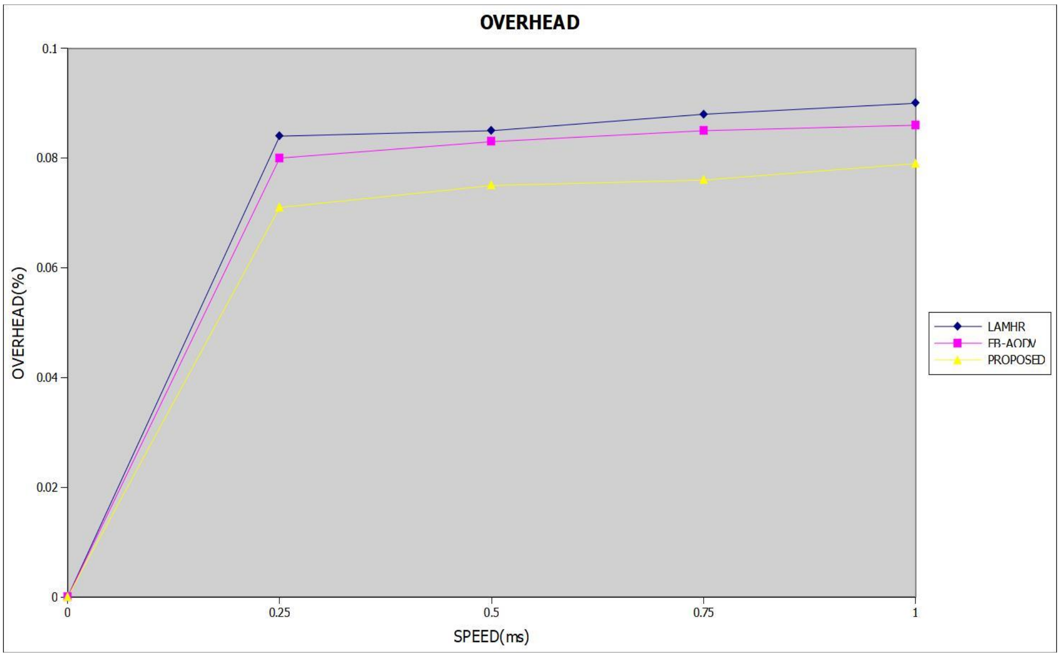

Figure 8. Performance comparison of obtained Routing overhead (%) using existing and proposed congestion routing protocol

Vehicle speed	LAMHR	FB-AODV	PROPOSED
0.25	0.084	0.080	0.071
0.50	0.085	0.083	0.075
0.75	0.088	0.085	0.076
1	0.090	0.086	0.079

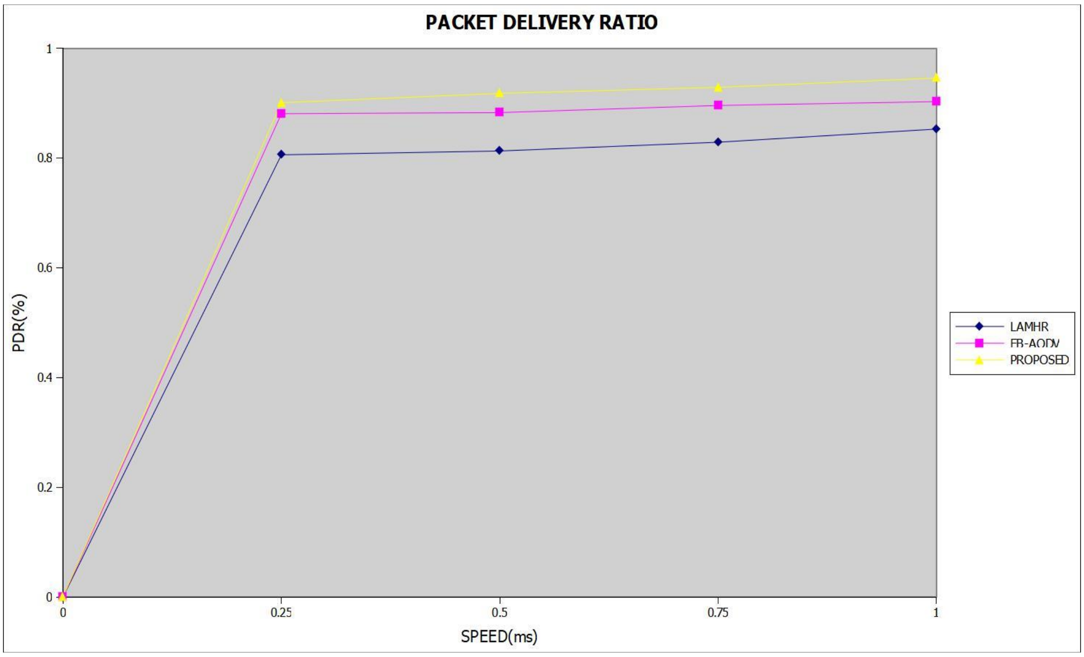

Figure 9. Performance comparison of obtained Packet delivery ratio (%) using existing and proposed congestion routing protocol

Vehicle speed	LAMHR	FB-AODV	PROPOSED
0.25	0.806	0.881	0.901
0.50	0.813	0.883	0.918
0.75	0.829	0.896	0.929
1	0.853	0.903	0.946

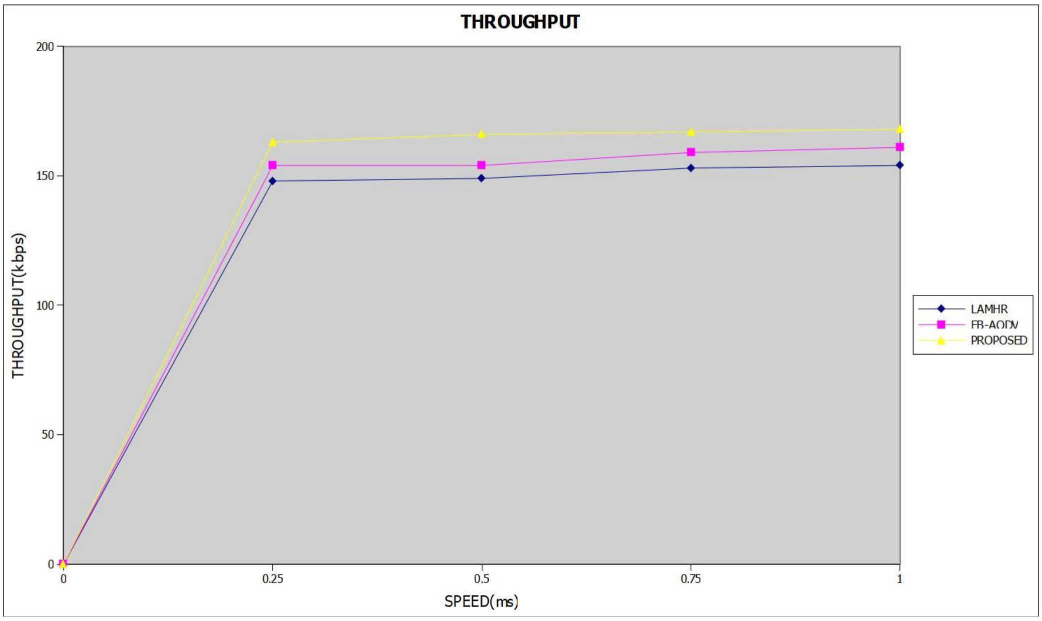

Figure 10. Performance comparison of obtained Throughput (Kb/s) using existing and proposed congestion routing protocol

Vehicle speed	LAMHR	FB-AODV	PROPOSED
0.25	148	154	163
0.50	149	154	166
0.75	153	159	167
1	154	161	168

5. CONCLUSION

VANETs have been improved to improve the comfort and safety of driving for automotive users. CFRS-CP-Congestion free route selection has been implemented for reduced the total number of data packets using the congestion probability method at the congested nodes. It estimates the congestion probability using the vehicle velocity, neighbour density, link quality, and MAC overhead at each node. Then, the estimated congestion probability is used for route assessment. The simulation results prove the proposed routing method's benefits.

FUTURE SCOPE & LIMITATIONS

In future, this work can be further extended to provide priority-based dissemination of safety messages in emergency environments with utmost security. Also, data integrity is limited in high-speed networks which should be further enhanced.

CONFLICTS OF INTEREST:

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