A Systematic Review on Routing Protocols for VANETs

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Abstract - *Vehicle Ad-hoc Networks (VANET) have grown to be a fascinating area of study for those working to create Intelligent Transport Systems. Vehicles move continuously and at various speeds in metropolitan areas, which frequently cause changes in the architecture of the network. The performance of routing procedures when sending data from one vehicle to another is the fundamental problem encountered in an urban environment. As a result, the effect of density in an urban context on the routing process in VANET has been the subject of research, as in the case with this work. This research focuses on routing protocols for VANETs.*

***Key Words*:** VANET, Routing Protocol, V2V Communication, ProMRP, QoS

1. INTRODUCTION

Vehicular Ad-hoc Networks have attracted the attention of scientists and engineers all over the world in recent years. This consideration arises from the significance of VANET in resolving traffic and safety issues as well as improving entertainment facilities in Intelligent Transportation Systems (ITS). Vehicular Ad hoc Networks (VANETs) are a subset of mobile ad hoc networks that allow communication between vehicles as well as vehicles and roadside units (RSUs). VANET seeks to transform vehicles into intelligent modes of transportation capable of collecting, transferring, and presenting data via vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communication.

Vehicle-to-vehicle communications (V2V) allow vehicles to share messages by establishing temporary connections between them. We're thinking about having vehicles send traffic reports to the nearest RSU via multi-hop communications. That is, messages are forwarded hop by hop until they reach the nearest RSU.

In general, urban roads are divided into two categories: intersections and road segments. A position-based routing protocol looks for the most efficient road segment—or routing path—between two communication nodes. Two crucial factors need to be taken into account: how to forward data packets along the chosen road segments and how to choose which road segments to use as the routing path. In VANETs, message transmission must contend with challenging issues like heterogeneous vehicle densities, frequent topology changes, and intermittent connectivity. The experience of VANET-based applications with a variety of quality of service (QoS) requirements, such as low latency and high accessibility, may be significantly impacted by these new challenges.

Another feature of VANET technology is its integration with a full ITS, for a variety of purposes. Routing, reliability analysis, message scheduling, and medium access are all aspects of VANET technology. For several decades, VANET routing has been regarded as a research problem. Road safety and operation are intended to be improved in urban, rural, and highway settings through the use of ITS. These days, sensors, cameras, and on-board units are examples of computational devices that have the capacity to gather vast amounts of data. When handled appropriately using machine learning techniques, this enormous amount of data can be leveraged to produce practical tools that enhance the previously mentioned ITS.

2. LITERATURE SURVEY

By gathering and referring to several studies, a literature review was undertaken. On routing protocols for VANETs, L. L. Cárdenas et.al [1] Describe a novel routing system for VANETs created specifically for urban settings, the probabilistic multi-metric routing protocol (ProMRP). ProMRP uses three metrics—vehicle density, travel time, and bandwidth—to make decisions about how to transfer data using a probabilistic approach. The protocol chooses the optimal forwarding node to use as the next one based on maintaining the lowest average packet delay and guaranteeing the highest probability of packet delivery. The

EProMRP version also included an algorithm that allows one to accurately estimate the node's current position in the forwarding moment. The EProMRP proposal chooses the best forwarding technique to guarantee packet delivery in addition to adjusting the node's present position during packet delivery.

L. Liu et al [2] suggested a trustworthy geographic routing scheme for urban VANETs that is based on forwarding quality. To determine the optimal routing path, two factors were taken into consideration: QoF and link reliability. While the QoF is intended to reflect the channel quality by taking into account transmission cost, packet delivery ratio, and the impact of relative link positions on the network performance, link reliability is represented by the link lifespan, which characterizes the mobility of the nodes. Road segments can be assessed using the road weight evaluation (RWE) architecture, in which the backbone link is built to transport data. The smaller grid zones on the city map are intended to fit the network scale of an urban city. Various transmission strategies for packet forwarding are presented according to the destination's location. The suggested protocol outperforms current schemes in terms of packet delivery ratio and transmission delay, according to simulation results.

J. Wu et al. [3] suggested a novel Traffic-Aware Routing (QTAR) protocol that uses RSU assistance to support Q-learning. QGGF, or efficient Q-greedy geographical forwarding, is based on V2V Q-learning within road segments, and R2R Q-learning is used to support intersection forwarding. This protocol enhances the overall

routing performance of urban VANETs. Based on simulation evaluation results, QTAR performs better than other related routing protocols with respect to higher packet delivery ratio in sparse and dense traffic cases and lower packet delivery delay with minimal communication overhead in moderate traffic cases.

K. Kandali et al [4] suggested a new clustering-based routing protocol to enhance data transmission in VANET in a high density and high mobility environment. The protocol is based on a modified K-Means algorithm combined with Continuous Hopfield Network and Maximum Stable Set Problem. The Continuous Hopfield Network solves the Maximum Stable Set Problem by choosing the suitable CHs.

The link reliability model is then used as the basis for clustering, and cluster maintenance chooses a new cluster head based on factors like node degree, vehicle speed, and free buffer. If a vehicle satisfies the requirements of having a maximum node degree, a suitable velocity, and a maximum free space, it will be deemed a cluster head in each cluster. To evaluate the efficacy of the suggested method, a simulation in a highway vehicular environment was run, and a comparison with ICA-RBF and RMRPTS was made. According to the simulation results, KMRP significantly increases throughput by reducing collisions and traffic congestion.

L. L. Cárdenas et al [5] Contributing to the creation of a clever machine learning-based routing protocol for VANETs that will be utilized to report traffic-related messages in urban settings is the aim. The current vehicle holding a given packet will use a new machine learning (ML)-based forwarding algorithm to determine which vehicle is the best next-hop to send that packet to its destination within its transmission range. A neural network constructed from a dataset of data records gathered during simulated urban scenarios serves as the foundation for this algorithm. The simulation results demonstrate how our multi-metric routing protocol for VANETs in urban settings has a higher packet delivery probability thanks to this ML-based proposal.

M. A. Jubair et al [6] Introduced QoS-aware CH selection and hybrid cryptography. The QoS+ routing protocol uses hybrid security and clustering to preserve security and energy efficiency. The generation of ECC keys and QoS-based CH selection are the two primary steps in the proposed protocol. To run the simulation, NS2 is utilized. Parameters like network throughput, normalized routing load, message success rate, end-to-end delay, energy efficiency, and energy consumption are calculated to assess the network's performance. Based on the speed and transmission range, the following parameters are calculated: average cluster number, CH efficiency, and cluster member efficiency. The outcomes are calculated and contrasted with earlier KMSUNET and ECHS techniques. The suggested QoS+ superior results with variable vehicle speed and transmission range are achieved in the dynamically changing topology.

G. D. Singh et.al [7] Using the firefly algorithm and the GA technique, an efficient routing protocol was proposed. The suggested methodology took advantage of the characteristics of fireflies to finish the task and communicate with other nodes. The suggested HGFA was evaluated and contrasted with the PSO and Firefly routing algorithms. When applied to sparse and dense traffic networks, the data obtained from the simulation results confirms that transmission was greatly decreased. The other two performance metrics, PDR and average throughput, were even more successfully met. Because of this, the suggested algorithm is better and can be applied to Swarm Intelligence-based routing

S. A. Rashid et al [8] proposed a novel framework Reliability Aware Multi-Objective Optimization Based VANETs Routing (RAMO). The three levels of the framework are the routing algorithm, the reliability and geometrics-based routing criteria, and the simulation of the VANET system. The real network is the next step. An optimization block that controls the reliability, geometrical, and routing block parameters is also a part of the framework. The optimization is based on the development of a novel variant of multi-objective harmony searching and is presented from a multi-objective perspective. This is a combination of Gaussian mutation, objective decomposition, and a harmony memory extraction algorithm that is referred to as Enhanced Gaussian Mutation Harmony Searching (EGMHS). Two levels of the evaluation were completed. The EGMHS evaluation was the first, and it made use of nine benchmarking

R. Han et al[9] A speed and position aware dynamic routing (SPDR) scheme is proposed for disseminating Emergency Messages(EMs) on a multi-lane highway scenario. traffic. It is designed with a cooperative forwarding approach and dynamic, greedy routing based on speed metrics. Greedy routing is used with a speed metric to identify the optimal next-hop for retransmission in order to guarantee dependable forwarding. The collaborative forwarding strategy is used to increase delivery success when forwarding fails. According to the simulation results, the suggested SPDR performs better in terms of message delivery ratio, average dissemination delay, and network throughput than GPSR and role-based multicast protocols.

K. Kandali et al [10] suggests an effective clustering routing system for VANETs based on PSO (Particle Swarm Optimization) and DPC (Density Peaks Clustering). The clustering algorithm used in this approach combines the advantages of the DPC and PSO algorithms. This scheme adds the DPC algorithm to the PSO algorithm to select CH (Cluster Heads). It builds clusters based on link quality rather than distance. The effectiveness of the suggested new routing approach (ECRDP) in an urban setting is evaluated by contrasting it with the GAPC and NMDP-APC algorithms using various densities. The results show how well the suggested strategy works to maintain routing efficiency and cluster stability.

3. COMPARATIVE ANALYSIS

Table -1: Comparative Study of Routing Protocols for VANETs

S.No.	Authors	Methods used	Benefits
1	L. L. Cárdenas et al[1]	ProMRP	ProMRP calculates the likelihood that every node's neighbor who is presently transporting a packet will deliver it to its destination.
2	L. Liu et.al[2]	QFRG	Ensuring QoF and meeting the link reliability requirement determine the optimal route in QFRG.
3	J. Wu et al[3]	RSU assisted QTAR	In both sparse and dense traffic scenarios, QTAR achieves a higher packet delivery ratio than other related routing protocols currently in use.
4	K. Kandali et al. [4]	KMRP	By guaranteeing the stability of the clusters in high density and mobility and reducing transmission delay, KMRP improves the packet delivery ratio.
5	L. L. Cárdenas et al[5]	MPANN	In most situations, MPANN performs better than 3MRP in terms of packet losses and packet delays.
6	M. A. Jubair et al[6]	QoS+	superior QoS+ results in the dynamically changing topology with variable vehicle speed and transmission range.
7	G. D. Singh et.al[7]	HGFA	It works well in networks that are dense or sparse.
8	S. A. Rashid et al[8]	RAMO	It performs better than the others in terms of networking and MOO metrics.
9	R. Han et.al[9]	SPDR	Regarding the mean dissemination delay, network throughput, and message delivery ratio, SPDR performs better than the current protocols.
10	K. Kandali et.al[10]	ECRDP	The ECRDP method demonstrates a remarkable capacity to uphold cluster stability when dealing with a substantial quantity of automobiles.

4. CONCLUSIONS

With adequate discussion regarding routing protocols for VANETs, an efficient routing protocol that meets the needs and characteristics of VANETs is essential for achieving good results in terms of average packet loss percentage and average packet latency from beginning to end. VANETs have unique requirements and characteristics that make designing suitable routing protocols difficult. Vehicles go continuously and at varying speeds in urban environments, causing frequent changes in network topology. The effectiveness of routing protocols in transporting data between vehicles is the major problem in urban scenario.

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