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A Systematic Review of Routing Protocols for Vehicular AD Hoc Networks and Recent Developments

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Abstract

The development of Vehicular Ad Hoc Networks (VANETs), new strong technology that aims to keep passengers secure, has developed. Cars may be linked to the Internet using IEEE 802.11p, which is a technology that can be used with or without existing infrastructure. To solve these issues and get packets to their ultimate destinations on VANETs, there are several current and proposed technologies that may be used. Following the preceding, this study presents a full explanation of several current routing strategies in literature, so that a specific approach may be selected based on its suitability for a given application. Many routing strategies are categorised in the article, with critical examination of each categorization's merits, weaknesses, limits, and uses.

Keywords: Routing Protocols, Intelligent Transportation Systems, Vehicle Routing

1. INTRODUCTION

Ad hoc NETworks for vehicles, often termed VANETs, are kind of mobile NETworks (MANETs). They serve as the backbone of an Intelligent Transportation System (ITS), which aims to enhance road safety by streamlining vehicle operation. Due to the widespread availability and low cost of wireless technology, they have the primary benefit of not requiring a costly infrastructure. Cargo-side or vehicle-side devices mounted in cars or on the roadside provide early warning of possible risks and circumstances

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for drivers. Drivers benefit from real-time traffic and weather information (including ice) and Internet access as well as enhanced road safety as a result of this technology.

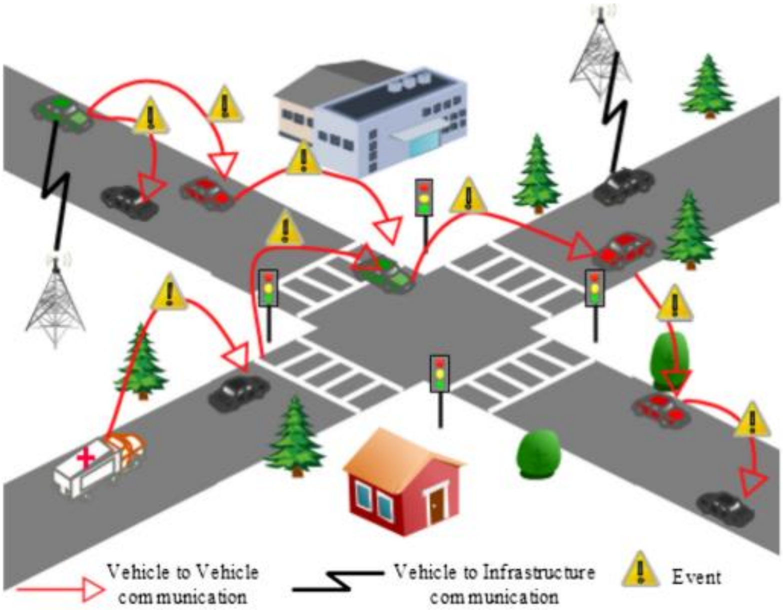

Figure 24 VANET-scenario.

The frequent topology changes and high vehicle speeds that distinguish a VANET. Because of this, it is difficult to route and forward packets in VANETs. Topology-based routing (such as AODV and DSR) and position-based routing techniques have been compared in urban and highway traffic situations and reveal that typical ad-hoc protocols have trouble coping with high mobility peculiar to vehicle ad-hoc networks. They have somewhat different needs than other sorts of mobile ad hoc network systems. There is no limit to how much memory and energy can be stored in today's automobiles, and every vehicle may obtain its own physical location since current vehicles can be fitted with a positioning system (GPS). When compared to traditional ad hoc networks, this one is much more dynamic due to the great mobility of the automobiles, which do not move at random but rather follow a defined pattern of movement.

2. LITERATURE REVIEW

(Elaryh Makki Dafalla et al., 2022) Voice over Internet Protocol (VoIP) makes use of the VANET infrastructure to provide high-quality services to mobile users. In order to maintain an adequate level of Quality of Service (QoS) for voice conversations, these networks must overcome several obstacles. VoIP applications on the VANET network are tested using the Optimized Link State Routing Protocol. Quality of Service (QoS) characteristics such as end-to-end latency, delay variation (jitter), and chance of packet loss between two moving hops across multi-hop Ad-hoc networks were assessed before and after executing the OLSR algorithm. End-to-end latency, jitter and packet loss probability were reduced by 18.72 percent, 20.42 percent and 128.6 percent, respectively, when the technique was applied to two nodes. When additional hops were added, the latency increased to about 400 ms, which is not allowed by ITU-T standards. The OLSR initially performed well for four hops. Instead of utilising a simulation, we developed a testbed to get the findings we wanted.

(Ye et al., 2021) Advanced Intelligent Transportation Systems (ITS) now rely on V2X communication in the form of the vehicular ad hoc network (VANET) to send and receive data. The development and implementation of innovative network routing protocols that provide V2X communication with reliable end-to-end connection and efficient packet transfer is a critical research topic in VANET. VANET's packet delivery accuracy and reliability are threatened by the dynamic nature of road traffic vehicles. In VANET, position-based routing protocols are the technique of choice because of their ability to deal with the frequent changes in vehicle movements. (I) inaccuracy in high-dynamic network topologies, (II) improper link-state estimation, and (III) poor movement prediction in diverse route layouts are some of the disadvantages of current routing protocols. A novel target-driven and mobility prediction (TDMP) based routing protocol for high-speed mobility, dynamic topology of vehicles, fluctuating traffic flow, and diverse road layouts in VANETs is suggested in this paper. For inter-vehicle connection status estimation, The Received Signal Strength Indicator (RSSI) and a driver's destination target are the foundations on which TDMP builds an effective routing system. TDMP's dynamic position prediction and evaluation of inter-vehicle connection status, as well as global road layout, may help enhance packet transmission over current geographic routing protocols, according to the authors. When compared to other common position-based routing protocols, such as GPSR, GyTAR, and PGRP, simulations on operational road environments show better performance in terms of getting better packet delivery ratio by 21-57 %, reducing end-to-end delay by 13 % -47 %, and average hops count by 17 % -48 %.

(Hu et al., 2021) A range of new uses in civilian wireless communications (such as 5G and 6G) and the military sector might be enabled by the flying ad hoc network (FANET), specific sort of mobile ad hoc network (MANET). In FANET, routing protocol is critical. Aerial nodes are supposed to move at random while constructing routing protocols for FANET. A mission-oriented FANET (MO-FANET), where aerial nodes normally travel toward specified form of destination provided parting points, maybe with fairly deterministic flight route during retaining an established formation, is plainly incompatible with this approach. An new cyber-physical routing protocol is presented in this study that takes full use of mission-determined trajectory dynamics to construct a temporal sequence of joining and splitting, as well as an adjacency matrix for each node. According to thorough simulations in a MO-FANET based on realistic setups, our protocol has a superior packet-delivery ratio (PDR) than the current representative routing methods used in FANETs at expense of even lower overhead and lower average end-to-end latency.

(Jaiswal, 2020) In position-based routing systems, the Location ID is derived from the GPS location of a vehicle. Vehicle ad hoc networks (VANETs) are concerned about the GPS accuracy since it is impacted by environmental and technological variables. Because of this, the GPS position of a car may deviate from its real location by margin error of 5–100 m. This research evaluated position-based routing protocol utilising Kalman filter (KF) and extended Kalman filter (EKF) to minimise the impact of the margin of error on routing (EKF). As a prediction module, each of these was used in order to reduce location error and improve the average latency, packet delivery ratio, and throughput. C++ programming and the Eigen library were used to create KF and EKF prediction modules, which were then integrated into an NS-3.23 simulator. When it came to PDR, AD, and throughput, the proposed routing protocol was pitted against the CLWPR (cross-layer, weighted, and position-based) standard.

(Saleh, 2019) Providing drivers with secure and reliable warning messages necessitates securing data transmission in VANETs. A secure routing mechanism for VANETs has been presented in this work. It combines a security unit that uses a modified Diffie-Helhman key agreement protocol with an efficient location-aided routing protocol (LAR) which uses a tilted rectangular shape (TRS) request zone. Communication between cars on VANETs is protected against a man in the middle attack by the Secure Tilted Rectangular-Shaped Request Zone Locating-Aided Routing Protocol (STRS-RZLAR) (MITMA). The suggested routing protocol surpasses the unsecure TRS-L AR and the conventional L AR in terms of safe data delivery by performing extensive simulation results utilising 2 primary network parameters: vehicular node density and the number of malicious nodes.

(Bhoi et al., 2018) Media sharing, internet access, file transfer, and gaming are just a few of the many non-safety applications available on the UVANET. Routing is critical to UVANET's ability to provide better service to its customers. For non-safety applications, a new routing protocol for UVANET is presented in this work. Drivers and passengers in separate parking lots may play multi-player games with each other in a non-safety application. As a result, it's important that the game's data reaches its final destination quickly. The simulation results demonstrate that the suggested protocol fulfils the end-to-end delay tolerance of 100 ms when the city area's vehicle density is large. Final tests of proposed routing protocol are carried out by running a simple puzzle game on a UVANET prototype suited for indoor and outdoor use.

(Boussoufa-Lahlah et al., 2018) There have been several routing protocols developed for Vehicular Ad hoc NETworks (VANETs) throughout the last decade. Because of the constant changes in the environment and the great mobility of the vehicles, the geographic routing protocols (GR) and position-based routing protocols (PBR), which are based on the locations of the vehicles, have shown to be the most suitable for VANETs. Routing protocols based on location rather than IP addresses, as in the case of Mobile Ah hoc NETworks (MANETs), are used to pick the optimal route for forwarding data. In addition, unlike MANET routing protocols, they do not share link status information or preserve previously defined routes. As a result, the protocols are more resistant to topology changes and vehicle movement. A state-of-the-art on routing techniques based on vehicle location is presented in this work. It is important to understand the objectives for designing these protocols, as well as the prospective future research areas, in order to make an informed decision about whether or not these protocols are appropriate for your application.

(Tyagi & Dembla, 2017) Mobile nodes based on mobile ad-hoc networks (MANET), as well as vehicular nodes based on ad-hoc networks for vehicles, have become more common in next-generation communication networks (VANET). The goal of VANET is to keep drivers safe by allowing them to communicate with other cars autonomously. The ad hoc network's vehicles operate as intelligent mobile nodes, capable of forming dynamic networks and moving around rapidly. Due to the constant movement of the vehicles, the ad-hoc networks demand a high level of efficiency and security in their communication. Warm-hole attacks, denial-of-service attacks, and Black-hole attacks are all more likely on these networks. For the first time, an unique approach is used to analyse the security aspects of routing protocols in VANET and the applicability of the AODV (Ad hoc On Demand) protocol to identify and counter a specific kind of network attack known as the Black Hole Attacks. As part of a new technique to improve AODV's security mechanisms, the source node saves all route answers in a look-up table, which may be used to identify and avoid Black Hole Attacks. The PUSH and POP operations used to sort all route responses are stored in this table, which keeps the sequences in ascending order. It is assumed that the RREP has a very high destination sequence number, thus the priority is determined based on that. ITS security is improved, as is VANET security as a consequence of using the suggested technique to identify and prevent a Black Hole Attack on ITS nodes. To carry out this study, researchers turned to NCTUNs simulator.

(Dua et al., 2014) For Vehicular Ad-hoc Networks, this study presents a Reliable Routing Protocol (R2P) that breaks up the network into zones that overlap. The Master Node (MN) is designated for each zone and is responsible for keeping the zone's routing boards up to current for inter- and intra-zone communication. The Internal Routing Board (IRB) and the External Routing Board (ERB) are the two kinds of boards that R2P relies on (ERB). Each network node maintains its own IRB, which is called a Zone Routing Board (ZRB) or a Private Routing Board (PRB). Zone node routes are registered by both ZRB and PRB, whereas ERB is maintained by MN and records gateways to adjacent zones. Finding the best path to the destination is done by R2P using a particular route-discovery method. Routing protocols from the recent VANET have been compared to this new system. R2P has been found to outperform the competition in tests.

(Boussoufa-Lahlah et al., 2015) An intelligent transportation system (ITS) may benefit from the use of Vehicular Ad Hoc Networks (VANETs), a kind of Mobile Ad Hoc Networks (MANETs) (ITS). Routing data is the most difficult part of VANET systems. This is because of the frequent topological changes caused by the vehicles' great mobility. VANET routing protocols have proven that position-based routing is ideally suited for dynamic situations, such as inter-vehicle communication on highways. It's challenging for position-based routing to handle two-dimensional situations containing barriers (buildings, trees, etc.), such as in metropolitan areas, where radio broadcasts are often obstructed by these obstructions. To cope with obstructions and voids in a metropolitan context, this study proposes a position-based routing technique for Vehicular Ad Hoc Networks.

(Bitam et al., 2013) Over the last decade, there has been a dramatic rise in interest in Vehicular Ad hoc NETworks (VANETs), which are networks of vehicles that provide real-time and accurate information to drivers and authorities. Routing protocols for VANETs have recently been suggested to ensure timely transmission of messages. Hybrid Bee Swarm Routing (HyBR), a protocol for VANETs, is presented here for the first time. To account for the dynamic environmental changes that occur in real-time in VANETs, HyBR utilises the continuous learning paradigm. Topology routing and spatial routing are combined in the protocol. Road safety services are guaranteed by transmitting packets with minimal delays and high packet delivery via the use of HyBR, a unicast and multipath routing protocol. The end-to-end latency, the packet delivery ratio, and the normalised overhead load were all used in our performance test to show how well HyBR works. While standard routing algorithms such as Ad hoc On-Demand Distance Vector (AODV) and Greedy Perimeter Stateless Routing (GPSR) performed well, HyBR outperformed them in terms of performance.

(Wang & Lin, 2013) In the transportation industry, vehicle-to-vehicle communications might benefit from the use of vehicle ad hoc networks (VANETs). Because vehicle velocity fluctuates over time, VANET data transmission is complicated by the network's frequent topological changes. As a result, it is critical to devise a routing system that is both efficient and trustworthy. Clustering is an effective method for routing in a mobile context, according to previous research. It has been shown that the PC clustering (PC) method is more efficient than conventional clustering methods. Since vehicle behaviour and connection quality aren't taken into consideration in the PC process, it may be inappropriate for use in VANET cluster structure construction. For the one-way multi-lane highway situation, we provide PassCAR, a passive clustering assisted route planning technique. PassCAR's major goal during route discovery is to find persons capable of forming an effective cluster structure. Multi-metric voting entails nodes competing for a participant based on metrics such as node degree, expected transmission count, and connection duration. Results from a series of simulations demonstrate that PassCAR not only improves route discovery but picks more appropriate nodes as well to join new cluster structure. Because of its preference for dependable, robust, and long-lasting routing pathways, this well-designed cluster structure enhances packet delivery ratios and boosts network performance.

(Bernsen & Manivannan, 2012) Emerging technologies such as Vehicle Ad Hoc Networking (VANETs) enable cars to build self-organizing networks on the road without the help of fixed infrastructure. The construction of an effective route and the adaptation of the routing protocol to the quickly changing topology of moving vehicles are prerequisites for communication in VANETs, however. VANET routing protocols are designed to achieve this purpose. In this research, we describe the Reliable Inter-VEhicular Routing (RIVER) protocol, an efficient routing system for VANETs. Streets are represented in River by an undirected graph with vertices at places where they meet and edges at sites where they don't. The edges indicate street segments between these points. For the first time, RIVER employs real-time, active traffic monitoring and assigns a dependability grade to each street edge using this and other data collected passively. The protocol then selects the most reliable route based on these dependability ratings. Using control messages, a node's neighbours may be identified, and the dependability of street edges can be determined. This information can be shared with other nodes.

(Bhaumik et al., 2012) High mobility wireless ad hoc networks, such as the Vehicular Ad hoc Network (VAN), allow moving cars to exchange data without the need of infrastructure. Vehicles may travel at a variety of speeds, and the network topology is constantly changing, making the development of multi-hop communication in VANE T a challenge. Communication between cars might be disrupted at any moment if network nodes fail to communicate with each other. Having a solid routing protocol is essential for ensuring reliable communication between automobiles. Affinity-based clustering routing protocols for VANETs have been given in this research, which divides the overall network into a number of different clusters depending on infrastructure type, traffic, and node speed and affinity propagation. Routing overhead and time it takes to discover a suitable route are the primary goals of this new suggested routing system.

(Van Minh et al., 2012) When a node travels at high speed, it creates temporary communication connections that impair the performance of protocols that have been created. As a result, previously established paths are often rendered invalid, causing delays and extra expense to be incurred. When it comes to route discovery time, this research focuses on measuring end-to-end latency in VANETs and applying these data to develop route metrics. It is our goal to decrease routing overhead, speed up convergence, and improve the quality of the routing table in each node by using a hybrid routing protocol (mixed proactive/reactive routing protocol). Our suggested paradigm is well shown by the simulation results.

(Bernsen & Manivannan, 2009) VANETs enable cars to build a self-organizing network without the need for a permanent infrastructure, such as the Internet. Establishing an effective route between network nodes and having it adapt to frequently changing topology of moving vehicles is a precondition for communication. The goal of VANET routing protocols is to do this. Unicast routing protocols for VANETs are discussed in this study, with a chronology of the evolution of current unicast routes provided. In addition, we categorise and describe the current VANET unicast routing protocols and compare their quality. Existing procedures in this field may now be clearly classified and characterised, revealing their strengths and limitations as well as any unresolved concerns.

3. APPLICATIONS OF ROUTING

There are three primary areas of routing applications: safety, transportation efficiency, and entertainment [6]. Safety applications, such as rapid message distribution and collision prevention, fall within this category. Dynamic route planning and real-time traffic monitoring are two of the most important applications in transportation efficiency. Infotainment applications include, but are not limited to, those that provide convenience, such as finding the local gas station, restaurant seating availability, or movie showtimes. Routing in VANET has many more essential applications such as:

I. Alert generations

- Information about vehicles approaching a junction is gathered, processed, and analysed by RSU. RSU will generate an alarm and tell oncoming cars if there is a risk of collision or accident, and they will take proactive actions to prevent such a circumstance.
- Everyone on the road is alerted in case of an emergency, allowing emergency vehicles to pass safely.
- Even in the event of an accident, cars approaching the area are alerted so that they may use other routes.
- Alerts to slow down and refrain from using horns are sent out by RSUs in certain places such as hospitals, schools, and animal crossing zones.

II. Vehicle maintenance

- It is common for RSU to be put in places where people are confined to their homes or where animals are moving through to inform drivers that they must slow down or refrain from honking while approaching the area.

III. Community services

- It is feasible to distribute a huge file to others by letting them to download individual chunks at a time. The car choose which peer to download from based on what it thinks is the best. This cooperative file assembly is highly suggested due to the limited quantity and capacity of accessible access points. For this collaborative downloading, BitTorrent or CarTorrent may be employed.

IV. Security services

- On any roadway or in any city, dangerous events like heavy traffic, inclement weather, man-made or natural disasters, or hostile attacks might occur. Multimedia material like video may be sent from one or more automobiles to the vehicles trailing behind so that they are visually alerted about the situation. Rather of just receiving an alert text message, these cars have the ability to make a more educated choice.

4. CONSTRAINTS AND CHALLENGES

In VANETs, routing might face a variety of issues and limits when it comes to managing Quality of Service (QoS) for diverse services:

- Because of the great mobility of nodes, topology is always changing. In certain locations, vehicle density is low.
- Poor network connection and performance degradation due to varying vehicle density and speed on the road.
- Based on preset criteria, efficient clustering and the selection of the Cluster Head (CH).

- Security and intrusion detection

Numerous VANET-related research suggestions have been published in the literature in response to the above-described limits and obstacles.

5. TAXONOMY OFROUTING IN VANETs

Routing protocols for dependable, high-quality service, like minimal End-to-End Delay and low collision and interference are available in a variety of ways to achieve these goals. These are analysed in terms of both their successes and their shortcomings. Topology, geography, hybridity, clustering, opportunistic and data fusion are some of the categories used to categorise routing systems, as illustrated in Figure 2.

- **Topology Based Routing**

Topology-based routing is concerned with how information is sent from source to destination, and how it is picked. It is thus possible to classify it as routing protocols that are proactive and reactive in nature.

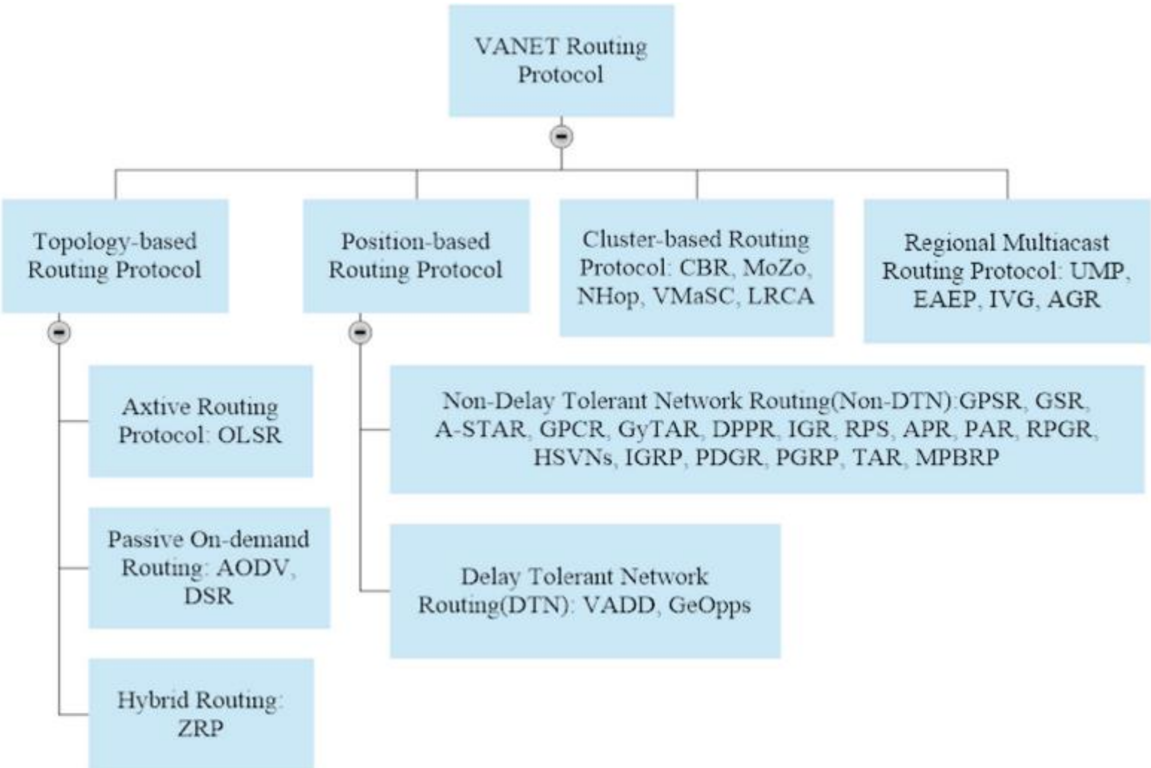

Figure 25 Taxonomy of VANET routing protocols.

Routing tables are frequently sent across the network in order to keep the list of destinations and their routes up to date. Reactive schemes protocol uses a flood of Route Request packets to discover a route on demand. There is a solution to the issue of large bandwidth use, but it’s slower than proactive routing when connection is accessible immediately. When it comes to restructuring and failures, these protocols have a slower response time.

- **Geographic routing**

These protocols use location data obtained either from a GPS system or via periodic beacon messages to help in route planning. The messages may be routed directly without having to know the network topology or previous route discovery if they know their own location and the target location.

It is better at PDR and latency than DSR, but the loss of connection in the route picked by the algorithm causes GSR to fail. Packet delivery may be 40 percent faster if A-STAR, with its traffic awareness, chose routes with better connection. Bypassing lost nodes using recovery techniques minimises packet loss in GSR, whereas DSR, which is more aggressive, relies on the node that has made the most progress and causes more packet losses. DSR accomplishes just 86% of packet delivery with GPSR, which is why GPSR has a better data packet delivery rate of 97%. In the absence of planarization, GPSR has good results on connection graphs. Because it eliminates all of the cross-links seen during planarization, CLDP is more efficient than GPSR, but it has a greater stretch cost.

- **Hybrid routing**

In order to combine the best aspects of both Topology-based and Geographic-based systems, these protocols have been developed. IntrAzone Routing Protocol (IARP), a proactive routing component, keeps zone's routing database current. An interzone routing protocol (IERP) is used to find routes outside of the zone. In fact, IARP and IERP are members of a larger proactive family and reactive routing protocols known as IARP/IERP. It is necessary to employ Bordercast Routing Protocol (BRP) for global route finding. Zone boundaries may be accessed directly by BRP nodes. New nodes and broken links are detected by ZRP using the MAC Layer's Neighbour Discovery Protocol (NDP). The NDP uses beacon signals to keep track of its neighbours. A node gets deleted from the database after a certain amount of time if it has not sent a beacon message. The protocol's performance may be improved by altering the transmission power of nodes to regulate the number of nodes in a zone.

- **Clustering based routing**

Among the numerous cars in a cluster, a single node is designated as the CH, in charge of overseeing the other nodes, collectively referred to as "cluster members." A border node is node that is within communication range of two or more clusters. They vary in how the CH is picked and how the routing is handled.

Due to Roadside Router failures, the LocVSDP performance is adversely degraded. This is due to the fact that service requests were interrupted during the propagation phase of a location-based request. During the reply propagation phase, service messages are interrupted. FTLocVSDP, on the other hand, has a success rate of 70% up to 100 nodes, which is 50% greater than LocVSDP's. As a result, both the amount of data sent and the time it takes to respond have increased. In low-density scenarios, alternative routing methods suffer from significant collisions, resulting in a poor PDR. The VWCA protocol has been devised to enhance network security.

6. OTHER TYPES OF ROUTINGS

Greedy Perimeter Stateless Routing: As an ad-hoc network protocol, (GPSR) uses the greedy algorithm as its core mechanism to ensure that messages reach their final destinations as quickly as feasible in congested networks. It is possible that GPSR packets may be sent along highways with low vehicular density or significant network disconnections, resulting in a high rate of packet loss and transmission delay, since GPSR only sends packets greedily based on a vehicle's location.

Greedy Perimeter Coordinator Routing: In VANET, the (GPCR) technique enhances the GPSR's dependability. However, unlike the GPSR, the GPCR selects a relay node based on road data rather than GPS coordinates. Instead of picking only one, GPCR takes junction-based routing into account along with the location of the router. When using GPCR, traffic density on the nearby node and connection to the destination are taken into account when forwarding packets. Latency and trans-mission delay may grow if traffic density is low and connection between nodes is clear to be poor. GPCR assigns a specific vehicle, known as the coordinator, to relay packets and address obstacle difficulties at intersections. And packets in GPCR are transported straight between intersections without need of road maps, which can be fail to determine the optimum way.

Greedy Traffic-Aware Routing: The geographic routing protocol (GyTAR) may be used in urban areas since it is based on intersections. With GyTAR's consideration of the specific qualities such as high dynamic vehicular traffic, high road traffic density, and road topolgy, both car-to-car and value added infrastructure-based ITS services may benefit. The inter-section is used to transport the data packets to their final destinations. It also depends on curved distance to target node and traffic density between present junction and potential intersection for dynamic selection of intersection. Global information would cause incorrect intersection selection, increasing the transmission latency and packet loss, which would be a problem because of the absence of global information in this case..

Predictive Directional Greedy Routing: A directional greedy mechanism is used to pick the next-hop neighbour in (PDGR) based on each neighbor's location, direction, and velocity. The weight computation for each next-hop node in PDGR is shown as a weight calculation based on their location and direction information. PDGR has been tested and evaluated using the NS2 simulator. To put the PDGR to the test, certain parameters like as packet delivery ratio, end-to-end latency, average hops, send rates, and node count were chosen. It is, however, a simulation of an open environment, not one that takes into account the metropolitan region.

Predictive Geographic Routing: Precisely because it takes into account vehicle mobility issues and predictability, (PGRP) is a newer routing protocol that emphasises vehicle connection. Tests of the PGRP have been carried out using the MOVE plat-form, which incorporates Sumosuda and Ns-2. PGRP may be employed in grid-based and highway-based environments. PGRP, on the other hand, does not take into account the accelerating speed of each vehicle and the aim of the driver in order to make a better judgement in genuine urban environment.

On addition, several researchers have recently proposed the FoG-oriented framework for PBR in VANET. Urban connectivity-aware PBR systems make use of a variety of modelling techniques, including genetic algorithms and regression-based models. Road intersections and parked automobiles near junctions are used for route selection and packet transmission in their research. In order to improve packet delivery ratio, end-to-end latency, transmission time, and cost, this sort of structure should be implemented.

7. CONCLUSION

VANETs have evolved in recent decades as a powerful new technology that may be utilised in broad range of applications, including search-and-rescue, surveillance, and entertainment. All of these scenarios need effective routing methods that can cope with the vehicles' rapid mobility and frequent topological changes. Various current routing systems and their respective benefits and drawbacks are discussed in this study. Each kind of routing is examined in depth in the book. As a conclusion, a comparison of several routing strategies with regard to various criteria is also included. One of the above-described schemes would be implemented in the future and compared to other schemes in its category to see how well it performed.

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