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Interpretation and Investigations of Topology based Routing Protocols applied in Dynamic System of VANET

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Abstract

The intelligent transportation system is necessary for smart connection among vehicles and roadways equipment. VANET is an emerging research area and gaining attention for this smart connection where each vehicle is a node in the ad-hoc network consists of groups of stationary or moving vehicles. These dynamic system of vehicles are linked together through a wireless link i.e., VANET. It provides an infrastructure that builds new solution for safety, comfort of drivers and passengers but the implementation of the VANET presents a hurdle in the selection and designing of a routing mechanism for dynamic vehicle system which is capable of providing reliable and efficient transportation of packets. To improve performance of dynamic system of VANET there are several routing protocols which may enable packet transport from the source node to the destination node. The prior objective of this research is to select and suggest reliable routing protocol for VANET's implementation in vehicle system dynamics. This research presents the overall investigation and interpretation of routing protocol based on topology i.e., AODV, OLSR, DSR, and DSDV on the grounds of simulation parameters (packet delivery ratio, overhead, throughput). The performance is evaluated using network simulator (NS-3) and mobility simulator (SUMO). The result shows that in case of throughput and overhead, protocol DSR outperforms but in case of PDR, protocol AODV outperforms. From the above, conclusion is that this research will assist the researchers in selecting the better routing protocol in the implementation of dynamic system of VANET infrastructure.

1. Introduction

Vehicles can interact freely with one another through DSRC in an integrated fashion. For this interaction [1] V-2-V, V-2-I, or hybrid communication modes are available. The vehicle communication configurations rely heavily on the local environment due to the usage of location systems and sophisticated wireless technology. V-2-V is ssential for developing countries due to lack of infrastructure, insufficient internet and infrastructure costs, wide inhabited areas, and the rise of crime of city property, which has resulted in the failure to install RSU on main highway. Some KPIs, such as delay, number of hops, retransmission attempts, traffic received, and throughput, are required to analyze the V-2-V network or indeed any VANET network.

It is not required that the network achieve the best outcomes across all KPIs. A collection of wireless sensors and an OBU are installed in vehicles that participate in a VANET. These gadgets allow vehicles and their surroundings to communicate wirelessly. Each vehicle becomes a packet transmitter, collector, and router which allows vehicles to communicate with people via wireless media [2] to other automobiles or RSUs inside their range. The RSU, which is usually mounted across the wayside, is equipped with one network device that employs IEEE 802.11p radio technology [3] to connect inside the network architecture and can be expanded with additional network devices. As shown in Figure 1, all vehicles are free to move throughout the road network and primarily interact with one another or RSUs.

Vehicular movement and signal transmission between vehicles require an accurate development of a realistic simulation environment within a realistic simulation duration. Actual-world Road layout, real-time information network requirements, as well as micro-mobility modelling are all required for a realistic presentation of vehicle mobility. But routing is a key concern due to frequent mobility of nodes when trying for VANET implementation. To meet this demand, there are number of routing protocols based on topology, position, cluster, geo-cast, broadcast etc. This study examines topology-based routing protocols i.e., proactive and reactive ad-hoc routing techniques and protocols are (AODV, OLSR, DSDV, DSR). The performance of protocols is evaluated using traffic and network simulators. The two forms of topology based VANET routing protocols are compared: The first is proactive, whereas the second is reactive. As a result, first routing methods are not supported by a bigger network since tables are maintained by each node to hold the most up-to-date information from the network's nodes. Furthermore, the routing table is becoming increasingly overburdened and consuming more bandwidth. While second routing are triggered by a request are known as on-request routing protocols., there is no need to keep the packet data of the device If a network connection is lost, the data will be lost in the network. If a vehicle wishes to deliver a warning on a given recipient's network, this protocol checks the proper path and forms an affiliation to receive and transmit packets by getting an additional compliance.

The major idea of this research is to be to select the most effective routing algorithms for dynamic systems of vehicles. This paper gives a performance assessment of the topology based VANET properties in terms of high-density dynamic systems of vehicles. This assessment includes the process of designing a road layout. To simulate the models of microscopic mobility automobiles and produce trace files, simulation of urban mobility is used. These trace files are also utilized as a TCL file source to the NS3 simulator to offer mobility. This research aims to boost the VANET network's overall performance by enhancing PDR, expanding throughput, and lowering overhead.

To meet the research objectives, a complete analysis of the DSDV, AODV, DSR, and OLSR protocols is carried out in five distinct set of node density tracks (20, 30, 40, 50, and 60), as well as the speed of nodes, to assess investigations and interpretations for various matrices. The suggested protocol is being implemented using simulation methods mainly as a move for urban mobility simulation generator (SUMO). The authors are employing SUMO because SUMO includes features such as limitations on load condition, how many lanes, crossovers, and traffic signals there are, as well as autos with unique characteristics like length of vehicle and idling qualities. SUMO also lets you allocate vehicles to specific users or randomly generated routes. Because each vehicle comes and departs on time, and the XML format is used for all user inputs. SUMO's GUI mode can also be used to visualize the route topology that has been developed. One of the paper's main contributions is to make a comparison abilities outcomes using mobility simulator under the traffic simulator based on parameters Throughput, OH, and PDR, and the protocols AODV, OLSR, DSR, and DSDV are used.

The below are some of the work's key contributors:

a. Investigate the impact of node density on dynamic system of VANET’s performance and investigations of the routing protocols using both productive and participatory routing approaches. This research will use VANET to recommend a safe and secure routing protocol for the vehicle system dynamic community.

b. Research main purpose is to emphasize the performance analysis of dynamic system of vehicle and how to use the tools at hand in NS-3 to work with VANET.

c. The work's findings will be investigated, interpret, argued, compared, and analyzed before the optimum routing protocol is determined for dynamic system of vehicle.

The NS-3 simulation tool was employed in this study. The research challenge entails not only comparing four protocols, but also showing how the NS-3 tools are used to simulate the experimental setup and how VANET works for dynamic system of vehicles..

The following is how the paper is organized: The second section provides high-level summary of the topic. VANET protocols that will be compared, including AODV, OLSR, DSR, and DSDV. Section 3, deals with the existing work using different routing protocols. Section 4 deals with methodology to demonstrate the various stages of the paper. Section 5 describes the performance modelling and simulation models (mobility and network simulator) and performance matrices used for this work. SUMO and NS-3 are used to investigate the efficacy of AODV, OLSR, DSR, and DSDV. The outcome and explanation of the setup for five highway network scenarios are presented in section 6. Finally, in section 7, it is determined that the data matched the projected results based on theoretical analysis. The DSR efficiency was found to be the best of the four protocols in relation to OH, Throughput ratio, and protocol AODV is best in terms of PDR.

2. Routing Protocol Basics

issue in VANET that involves routing mechanism is operation of networks [2, 4] and QoS, rapid exchange of data, latency as well as flexibility etc. Because of the high node versatility, routing is a major key concern to solve in VANET. In an Ad-Hoc network, several routing techniques are employed in vehicular environment to create connection between V-2-I and V-2-V.

On the basis of VANET architecture, V-2-V is further divided [5, 6] into topology, position, cluster, geo-cast, multicast-based routing. V-2-I is further divided into static and mobile infrastructure and further categorized are shown in Figure 2.

The VANET routing protocols and associated explanations are listed below:

Topology-based routing protocols [7-9]: Topology information is used to forward data packets from the source to the target node in this manner. In many terms, the techniques in routing process require node topological knowledge. This routing method may be divided into three categories: Routing might be proactive, reactive, or hybrid.

Position-based (geographic-based) routing protocols [10]: Nodes are frequently equipped with GPS sensors in these methods to get the node's geographical information. The routing process is then carried out using this geographical data.

Broadcast-based routing protocols: The flooding approach is used to carry out the routing operation [11-12] in these algorithms. Duplicate packet suppression algorithms are used by broadcast-based routing protocols to deal with routing traffic.

Cluster-based routing protocols: Therefore, in category [13-14] one-hop or two-hop connections distances form a cluster, with one serving as the head of a cluster and the rest serving as cluster members. Cluster heads communicate with nodes within the same cluster, while cluster-headers connect with nodes outside the cluster.

Geo-cast-based routing protocols: This method of routing is a type of controlled flooding in which the geographical zone nearest to the destination is chosen [15-16]. To decrease communication delays and communication overhead, the packet forwarding procedure is then completed in various zones by multicasting packets.

In Table 1, the different types of routing protocols with their advantages and disadvantages are presented.

Table 1. Routing Protocols.

	Routing Protocol Name	Definition	Types	Advantages	Disadvantages
1.	Topology Based	It transmits data packets between nodes over the VANET using connections information.	i) Proactive ii)Reactive iii) Hybrid		
	i) Proactive [7]	Depends on table-driven methodology's routing algorithms.		i) Low latency ii) Pre-defined tables	Bandwidth wastage by unused routes.
	ii) Reactive [8]	It is dependent on the routing algorithms used in the on-demand process.		i) Network traffic reduction. ii) Band width control.	i) High latency in path searching. ii) Node's communication disturbance Occurrence.
	iii) Hybrid [9]	It is combination of proactive and reactive protocols		i) Low delay ii) More reliable	
2.	Geographic/Location Based [10]	These are built on methods for employing location-based apps as a positioning mechanism.	i) DTN ii) Non-DTN iii)Hybrid	i) Path selection is easy. ii) It is not necessary to locate and manage routes. iii) Scalability is an important consideration. iv) Suitable for patterns with a lot of nodes moving.	i)It necessitates the use of position-determining services. ii) A GPS device will not work in a tunnel since there is no satellite signal.
3.	Broadcast Based [11,12]	It utilized the road network's functional organizational approach.		i) Very Simple ii) Low delay	i) It consumes significant network bandwidth. ii) Due to flooding cause longer data transmission delays.

4.	Cluster Based [13, 14]	It forms cluster as a unit, with a party leader for every group who is responsible for coordinating the bridge execution between the various groups.	i) Low cost ii) High latency	Dependency on group leader.
5.	Geo-Cast Based [15, 16]	These nodes include information about themselves and other nodes. It sends data packets to a certain geographic area.	i) Use for Multicast routing ii) Simple Method	Not available for random region

In this research only four topology-based routing protocols are utilized, two protocols from proactive (DSDV, OLSR) and two protocols from reactive (AODV, DSR) type of routing protocol. Not much work is reported utilizing DSDV, AODV, OLSR, DSR protocols in literature. As a result, the authors used the techniques described above in this study.

The following is a full overview of the procedures listed above:

2.1. Topology Based Routing Protocol

To conduct packet forwarding, these routing techniques make use of network connectivity information. They are further separated into two categories: Proactive and Reactive Routing Protocols.

2.1.1. Proactive based routing protocols

It means that, regardless of career advancement, routing information such as [7] the next relaying hop is kept in the process. The benefit of proactive protocols is that no network connection is needed because the journey to the destination is kept in the meantime; however, it delivers minimal delay for actual applications. A table is built and maintained within a node. As a consequence, each table entry signifies the next hop address on the way to a certain destination. It also results in the preservation of unused data pathways, resulting in a reduction in channel capacity. OLSR and DSDV are examples of proactive protocols.

i) OLSR: It is a proactive system that is built on a link state algorithm. It uses a periodic message exchange to keep network topology knowledge up to date at each node. It's a step forward from a pure link state protocol and compresses the amount of data delivered in messages and minimizes the chances of data transfer required to flood the network with these signals. To accomplish this, the protocol uses a multipoint relaying mechanism to efficiently and cost-effectively flood its data packets. It offers the most efficient routes in terms of hop count, which are promptly obtainable. This protocol performs best in big, congested MANET.

The following are some of the benefits of using the OLSR optimization protocol:

Rather than announcing all links, the OLSR optimization protocol declares only a subset of them with its multicast relay pickers, which reduces the number of control packets.

It reduces control traffic flooding by disseminating messages around the network through only a few selected nodes known as multipoint relays.

The node's broadcast messages are only retransmitted by this multipoint relay. In a flooding or broadcast method, this strategy dramatically reducing the chance of data transfer.

ii) DSDV: Routing is a modified Bellman-Ford algorithm table-driven routing system based for MANET and C. Perkins and P. Bhagwat designed it. The essential contribution of the method is that it is necessary to solve the cycle problem. Each entry in the routing table has a destination address, which is set even if there is no link; otherwise, an odd system is available. The emitter must send the next update using the destination number provided by the generator. Full dumps are sent seldom and smaller incremental updates are sent more frequently to disseminate routing information among nodes.

2.1.2. Reactive based routing protocols

Whenever a node needs to communicate with some other, it creates the route. It keeps track of the currently active connections, which reduces the burden on the networks. Reactive routing's route discovery phase involves flooding the network with path-finding inquiry packets[8], which ends when the route is found and AODV and DSR are part of it.

i) AODV: It is an on-demand protocol that only starts route discovery whenever a sender wants to send a packet to another node. To complete the route discovery operation, the Route Request packet (RREQ) is delivered to its neighbors.

The following are the protocol's main goals:

1. Only send out discovery packets when absolutely necessary.
2. To differentiate between local connectivity management (neighborhoods identification) and topology maintenance in general.
3. Changes in local connectivity should be communicated to neighboring nodes.

The following are some of the features of AODV:

1. Nodes only store the routes that are needed.
2. The necessity for broadcast is decreased.
3. Reduces memory requirements and duplications that aren't necessary.
4. Rapid response to active route link failures.
5. Scalable to huge populations of nodes, with loop-free pathways maintained using destination sequence number.

ii) DSR: It is a routing protocol that runs on demand (Perkins, 2007). It's a low-power, high-speed routing protocol for multi-hop VANET. It allows the network to self-organize and customize itself without requiring any additional surveillance equipment or management. It consists of two fundamental techniques that work together to allow an ad hoc network to find and retain source routes.

3. Related Work

Lot of work related to routing protocols is present in literature. In this study the most important work's performance of routing protocols on the basis of topology are discussed. NS-2, NS-3, and NET-Sim were used to evaluate the performance of routing protocols in the VANET environment, and Veins simulation tools, there is a huge demand for qualitative comparison in addition to performance assessment studies.

The purpose of using NS-3 in this study is to look at routing protocol performance analysis. Furthermore, VANETs and MANETs share many similarities, particularly in recent years, with the exception of the shortage in the case of MANET infrastructure. As a result, the focus of this study will be on a survey of VANET routing protocols such as (CBR, OLSR, AOMDV, DIR, CAR, TROUVE, GyTAR, GPSR, GPCR, ACR, AODV, DSDV, and DSR protocols) [17-26]. Then there's the traffic control interface module, which connects to network and traffic simulators. Because VANET is made up of mobile nodes with a dynamic structure, identifying, managing, and employing communication techniques is difficult for fast-moving vehicles.

Liu etal. In [17] proposed in urban situations, and it is recommended to increase the GPCR routing protocol's performance. To compare the result of VanetMobisim in the constrained of the GPCR routing protocol, the NS-3 simulator is used to find the best next hop node. In respect of PDR and time delay, the CA-GPCR approach outperforms conventional protocols.

Malik etal. In[18] analyzed Greedy Perimeter Stateless Routing, correlation queue length and time in position-based routing (GPSR). Network Simulator (NS3) and Mobility Simulator are used in the simulation (SUMO). The scenarios improved the GPSR's PDR, throughput, and packet loss performance. GPSR has the lowest performance for EED results.

Liu etal. In[19] indicated that a Delay-aware and Backbone-based Geographic Routing (DBGR) protocol is presented for urban VANETs. According to simulation results, the proposed protocol outperforms existing protocols in terms of PDR and EED.

But in [20] Ardakani etal. Proposed a VANET cluster-based routing protocol that employs a new addressing system that assigns an address to each node depending on its mobility pattern. The network is subsequently partitioned in an address-centric way using the Hamming distance algorithm. When compared to two benchmarks, AODV and DSDV, this protocol enhances routing reachability while lowering routing EED and traffic received, according to simulation findings.

S. Daud etal. In[21] showed an adaptive geographical routing for urban vehicular networks based on quality of transmission (AGQOT) is suggested. The proposed protocol can increase the network's performance in terms of PDR and EED.

P. K. Singhal etal. In [22] presented in a VANET-based IoT context, a comparison of the performance of two possibly the best routing systems: (a) DSDV and (b) AODV. Delay, jitter, packet loss ratio, throughput transferred, and produced throughput are all factors to consider, and these two routing methods were compared.

M. K. Hasan etal. In[23] suggested an upgraded AODV (EAODV) routing protocol using a selective route cache technique, during the route discovery phase, based on a source/destination pair. In terms of PDR, average EED, and normalized routing OH, simulation findings suggest that EAODV beats standard AODV.

Malik etal. In[24] reported for VANETs, two existing routing method's total performance i.e., AODV and DSR in this research. For a constant network size, simulation findings show that combining a good channel model with an efficient routing approach improves VANET link throughput.

Mahdi etal. In[25] presented comparative analysis of five different node densities, and choose between the AODV, DSDV, and DSR protocols. For each protocol, various parameters such as (throughput, PDR, and EED). The DSR has a significantly better throughput than the AODV and DSDV, according to the findings. Because of the low average EED, DSDV is the best option.

Waseem etal. In[26] presented a practical evaluation of the VANET topology in terms of time for high-traffic scenarios to achieve their goal, the researchers looked into three different routing systems: DSDV, AODV, and AOMDV. The simulation results suggest that AOMDV outperforms the DSDV and AODV protocols in high-traffic locations. The AOMDV protocol improves overall network performance by achieving maximum throughput with minimal EED.

From the literature it is concluded that each technique has its own set of drawbacks and advantages that make it perfect for a specific situation. Most of the work in this field are utilizing NS-2 simulation tool and also not emphasizing the importance of SUMO. Very less work has been found on NS-3. As a result, the authors are using the NS-3 and SUMO tools for this work, comparing four routing protocols and recommending the optimum routing based on performance analysis. This research is using four routing protocols (DSDV, AODV, OLSR, DSR) for providing VANET infrastructure because these protocols are well suited to the given network and providing better result in the given situation.

Table 2, shows the comparison of related work with this research and concluded that in maximum work NS2 simulator is used as network simulator and different mobility simulators with different simulation parameters. In this research using three parameters (TR, OH, and PDR) and simulators (NS-3, SUMO) the results discussed in the next section with graphs.

Table 2. Comparison with Related Work.

Sr. No.	Year	Article	Protocol	Network Simulator	Mobility Simulator	PDR	OH	TR
1.	2017	[17]	CA-GPCR, GPCR, DSDV	NS3	VanetMobiSim	CA-GPCR is more Suitable with higher PDR	Not Applicable	Not Applicable
2.	2017	[18]	GPSR	NS3	SUMO	GPSR perform better in case of PDR	Not Applicable	GPSR perform better.
3.	2018	[19]	DBGR, iCAR, GyTAR, GPSR	NS2	VanetMobiSim	DBGR perform better (High PDR)	Not Applicable	Not Applicable
4.	Apr 2018	[20]	ACR, AODV, DSDV	VEiNS	SUMO	ACR perform better (High PDR)	Not Applicable	Not Applicable
5.	2018	[21]	AGQOT, GPSR, GyTAR	NS2	VanetMobiSim	AGQOT improve PDR	Not Applicable	Not Applicable
6.	2019	[22]	AODV, DSDV	NS2	NSG2.1	AODV perform better shows high PDR	Not Applicable	AODV was better
7.	2019	[23]	AODV, EAODV	NS2	-	Enhanced AODV was better	Not Applicable	Enhanced AODV was better
8.	2020	[24]	AODV, DSR	Net-SIM	SUMO	DSR perform better shows high PDR	Not Applicable	DSR perform better
9.	Jan 2021	[25]	DSDV, AODV, DSR	NS2	MOVE, SUMO	AODV is much better than DSDV, DSR	Not Applicable	DSR perform better than AODV, DSDV
10.	Feb 2021	[26]	AOMDV, AODV, DSDV	NS2	SUMO	AODV outperform than AOMDV, DSDV	Not Applicable	AOMDV perform better

11.	This paper	This paper	AODV, DSR, DSDV, OLSR, None	NS3	SUMO	AODV	DSR	DSR

4. Methodology

The diagrammatic flow of the different stages of the paper is shown in Figure 3. The goal of this work is to determine the efficacy of dynamic system of VANET highway routing protocols scenarios as well as selecting the greatest VANET routing protocols for dynamic system of vehicles. DSDV, OLSR (proactive), AODV, and DSR are the routing protocols that are being tested (reactive). The initial stage in our methodology is to use network simulation with the NS-3 simulator under SUMO to investigate what is a dedicated network and how it varies from a conventional network. The second stage involves learning about MANET, a dedicated wireless network, and conducting research on its features and routing protocols. A TCL file is created using SUMO. The reason for selecting SUMO is that it's a road trip model that's accessible, small, and light. Users can also create custom road topologies and import fully prepared map formats from a wide range of towns and cities all over the globe.

It also allows for the use of speed limits, as well as lane identification, intersections, and lighting. SUMO also gives cars the option of allocating identified customers or random routes. After finishing sets, SUMO's GUI mode is used to depict all of the preceding steps. After understanding MANET, dealing with VANET becomes simple in the third step. In the fourth and last stage of our method, we use a network simulator called NS-3 to find the results of the proposed routing protocols. The experiments are analyzed using two routing strategies for different scenarios, and then the optimum routing protocol for that situation is chosen. DSDV, AODV, and DSR, OLSR are the four protocols that will be studied in this research. To verify the VANET simulation, the NS-3 network simulators were employed for the highway scenario. Throughput, packet delivery rate, and EED Delay are all used to evaluate performance. The output is saved in a trace file and shown with the help of a C++ script. Finally, the results are calculated using an excel file, and gnu charting is performed using NS-3 csv files.

5. Performance Simulation And Modeling

5.1. Performance Modeling

In this work the most commonly used performance matrices are:

1) PDR: It takes into account the ratio of properly signal received to total packets sent. To achieve better connection speeds, PDR should have a higher value. This is how it looks [27]:

PDR= Total successful packets received/ Total transmitted packets (1)

2) Throughput Ratio: The expected amount at which data packets are sent via an essential component is referred to throughput ratio [28]. It is the proportion of information that is efficiently received via a communication medium. Bits per second is the most used unit of measurement (kbps) and calculated by:

TR= Number of packet sent/ Time period (2)

3) Overhead: This figure indicates the network's saturation level. It's the ratio of additional routing packets to target vehicle packets received. The lower the OH, the better the networks performance. It is calculated by [29]:

OH = Number of overhead messages in total / Total transmitted data packets. (3)

After discussion of different performance matrices now different simulators used for VANET are described.

5.2. Simulation

5.2.1. Simulation tools and methods

To simulate and test the application's performance, the TCL simulation framework employs two methods: Mobility Simulator and Network Simulator. The expense of deploying and testing VANETs is considerable, and it takes a lot of time. Simulation can be a beneficial and less expensive substitute for actual implementation as an alternative option. To acquire good results from VANET simulation, it's necessary to construct realistic models, given the VANET system's intricacy, this is a difficult task (e.g., simulators need to model both mobility patterns and communication protocols). The mobility and network components, which are the core building elements of modern VANET simulators, are discussed in this section.

5.2.1.1. Mobility/Traffic Simulators

In a simulation study of dynamic system of VANETs, a mobility model that accurately replicates the real behaviors of autos in traffic is critical. The primary purpose of a mobility simulator is to generate vehicle movement patterns in response to a set of instructions. When it comes to vehicle mobility modelling, there are two types of descriptions: micro mobility and macro mobility. Simulators for macro-mobility must take into account all of the macroscopic factors that road geometry, lane count, safe regulations, and traffic signals defining intersection crossing laws all have an impact on vehicular traffic. Micro mobility, but at the other hand, describes a vehicle's unique behaviors when it can interact with several other drivers or the transport networks: travel speed under varied traffic situations, speed, braking, and passing criteria, conduct in the presence of signalized intersection and traffic signals, and overall driving mood related to the driver's age, gender, or mood are all factors to consider. A VANET simulation must account for both macro- and micro-mobility descriptions in order to be reliable. SUMO is an example of a mobility simulator [30], Sim- Mobility [31]. The brief description of both the simulators is given below:

1) SUMO: There are several tools for modelling road traffic microscopes, including as FARSI and VISSIM, however the simulator tool employed in this study is SUMO. SUMO [30] is a micro- and small-scale travel road simulator that is free and open-source. It allows users to construct custom road topologies and acquire ready-to-use map files from a variety of urban centers around the world. It may also allocate vehicles to individual users or generate routes at random with SUMO. Modelling the public transportation system is also an option because each vehicle comes and departs on a schedule and all user inputs are in XML format. SUMO's GUI mode can also be used to visualize the route topology that has been developed. Figure 4, representing the total running and simulation end time for total number of vehicles in Delhi.

2) Simulation configuration: VANET output is examined across five set of situations to train a network. The output is then copied to an excel file to calculate performance metrics (parameters). Average Throughput, PDR, OH are used to evaluate the performance of OLSR, AODV, DSDV, and DSR. The simulation parameters and their specification are given in Table 3.

Table 3. Matrices for Performance.

Sr. No.	Parameters	Specification
1	Packet size	1000
2	Sending Rate	64 Kbps
3	Propagation	Two-Ray Ground loss model
4	Transmission	2 Ray Ground
5	Bandwidth	6 Mbps
6	Dimensions (X, Y)	753 *683 sq.m
7	Time end for simulation	300 seconds
8	Queue Length	40 packets
9	Transmission protocol	TCP
10	Speed	20 m/s
11	No. of nodes	20,30,40,50,60
12	Routing Protocol	AODV, DSR, OLSR, DSDV
13	Type of channel	Wireless
14	Antenna model	Omni
15	MAC Type	Mac/802.11

5.2.1.2. Network Simulators

The exchange of messages between connected nodes is simulated using a network simulator. Vehicles and RSUs are frequently implicated in the case of a VANET, and wireless communications are the most common mode of communication. Other essential metrics should eventually be included in the simulation [32] as well as all elements of the data transmission (for example, the whole protocol stack, signal to noise ratio, packet error rates). Both the network components and events are described in the network model. Components include nodes, routers, switches, and connections. Data transmissions and packet failures are two examples of events.

A network simulator's output typically contains network level data, link metrics, and device metrics for a specified simulation scenario. Each event in the simulation is recorded in a trace file. Discrete-event simulation is used by the majority of network simulators. There is a list of "pending events." maintained in this method, which is then handled at each step. Some events can lead to the emergence of new ones. The arrival of a packet at a node, for example, may cause a new packet to be sent. OPNET [33], NS3 [34], and NS2 [35] are some of the most extensively used VANET simulators.

1) Network simulator by NS-3: It is used to implement routing and evaluate the performance of different set of nodes. It is an open-source network simulation tool. This is written in C++ and can also write scripts in C++ and python. User can simulate simple and complex networking scenario. The minimum requirements of NS-3 are to have C++ and python is installed in the system.

sudo apt-get install g++ python3

It uses a python tool called bake to download and install NS-3 and after installation user could run an example using

. /waf –run examples/tutorial/first

NS-3 simulator’s total computation is less than NS-2 and memory allocation is also good. It can prevent from unnecessary parameters to be stored. For gnu plotting .csv files are more suitable and for network animation .XML files are more suitable.

Network Animation visualization: Figure 5, shows the network animation in net-anim and is showing number of nodes and vehicles with their IP address.

6. Result And Analysis

6.1. Simulator Setup

TR, PDR, and OH are three typical performance measures used to compare the above-mentioned protocols' performance. So, in this section, researchers will look at five different scenarios to see how node density and mobility affect dynamic system of VANET routing protocol performance.

6.2. Simulation results and analysis

This part discusses simulation and result analysis utilizing three performance metrics (throughput, PDR, and OH) and five various set of densities (20,30,40,50,60) with the use of network simulator (NS-3) and mobility simulator (SUMO).

6.2.1. Throughput Ratio

As the number of nodes between the source and the destination grows, so does the complexity of the system and throughput also decrease or drops. It's measured in kbps. As a consequence, whenever a packet from the second node arrives at the third node, the first node is unable to send the next packet until more packets from the second node arrive, and so on. As shown in Figure 6, the DSR has a greater performance than the AODV, OLSR, and DSDV protocols when compared to all routing protocols. Between the two reactive routing protocols, DSDV and AODV, it has been discovered that AODV outperforms DSDV. DSDV uses typical on-demand routing and destination sequence numbers, whereas AODV leverages source routing, which allows AODV packets to arrive at their destination faster and with higher throughput. As a result, AODV can achieve higher throughput than DSDV. However, as the nodes grow, DSR is predicted to outperform OLSR, DSDV, and AODV. In fig. 6, it is shown that the number of nodes increases as the packet drop reduces, resulting in higher throughput. The throughput value will be zero if no protocol is selected.

6.2.2. BSM_PDR

This experiment's network performance is assessed using five distinct types of simulations, shown in Figure 7. It shows the packet transmission ratio for five different nodes using the OLSR, AODV, DSR, and DSDV protocols. The higher the PDR, the more exact and appropriate the routing protocol will be. When all protocols were compared, it was discovered that AODV performed better than the rest, while DSR had a zero percent PDR since DSR does not handle BSM packets.

6.2.3. Overhead

The lower the OH, the better the networks performance. From results it is indicated that DSR is having high OH in 20,30,40,50 set of nodes but gradually it is decreasing from 20 set of nodes to 60 set of nodes. Conclusion is that when nodes will increase then overhead value would be decreasing. If the nodes are high then DSR would perform better. In case of DSDV it is shown that as the nodes are increasing so the value of overhead would also increase. But in case of OLSR and AODV if the nodes are increasing the value of overhead once increases but later it starts decreasing. When no protocol is selected in that case value of overhead would be same in all the cases. So, finally it is concluded that for lower value of nodes DSDV would work better whereas for higher value of nodes DSR will serve as a better option as shown in Figure 8.

6.3. Discussion

In few research works different mobility simulator (VanetMobiSim, SUMO, NSG2.1) and network simulator (VEiNS, NS2, NS3) are used and compared on the basis of different routing protocols (AODV, DSDV, CBR, OLSR, AOMDV, DIR, CAR, TROUVE, GyTAR, GPSR, GPCR, ACR and DSR protocols) utilizing PDR, Average EED, Throughput Ratio as performance metrices. The scenarios are used to base the research findings in this paper. OLSR, AODV, DSDV, and DSR were examined in terms of (throughput ratio, PDR, and overhead) utilizing four protocols (AODV, DSDV, OLSR, and DSR) and there are five different set of nodes (20, 30, 40, 50, and 60), using simulation on NS3 and SUMO.

This study looked into the effect of the vehicle's node density factor on routing protocol performance and the dominance was utilized to draw graphs and set performance criterion tests. As a result of the findings, it was discovered that DSR performs significantly better than the protocols AODV, OLSR, and DSDV in terms of throughput. So, when there are 60 nodes, in terms of overhead, the DSR protocol is the most efficient. While AODV is better than other protocols, when case of PDR especially at the set of node level (30). This implies that any approach or protocol used will be evaluated in different scenarios, depending on the nature of the task.

7. Conclusion And Future Scope

The goal of this study is to determine the most appropriate and efficient routing methods in a high-traffic density area of vehicle dynamic system. This paper gives a practical assessment of the VANET topology's properties in terms of time for high-density traffic conditions of vehicle dynamic system. Extensive simulations on a highway traffic scenario are used to test the dynamic system of VANET routing algorithms. Investigations and interpretation of performance of AODV, OLSR, DSDV, and DSR is analyzed on various performance metrics (Overhead, PDR, and Throughput). Simulation outcomes concluded that overall DSR perform better among AODV, OLSR, DSDV, DSR in case of Overhead when number of nodes are high but if nodes are low then DSDV perform better and in case of throughput DSR perform better among all. But in case of percentage of BSM_PDR AODV will perform better among all. As a result, the reactive routing protocol (DSR, AODV) outperforms all of the performance metrics examined in this study. Based on the results of this study, other routing protocols with more performance metrics should be explored for further performance analysis in the future. The work's flaw is that it's feasible that the identical routing protocols might produce poor outcomes in other urban traffic areas. Routing protocols for dynamic system of VANETs must have been examined on a regular basis for vehicle communication and vehicle, passenger, and driver safety. As a result, different routing protocols must be studied as well. More routing protocols with different performance metrics can be simulated and tested in the future using varying densities of nodes or cars. Through analysing the dynamic performance of a vehicle system for various nodes it is concluded that DSR, AODV performed among all the routing protocol discussed for comparison. It will provide safe and reliable routing protocol for the vehicle system dynamic community for further research.

Abbreviations

V-2-V Vehicle-to-Vehicle

V-2-I Vehicle-to-Infrastructure

OBU On-Board Unit

KPI Key performance indicators

RSU Road Side Units

DSRC Dedicated Short Range Communication

QoS Quality of Service

LIDAR Light Detection and Ranging

CR Collision Ratio

MAC Media Access Control

PDR Packet Delivery Ratio

EED End-to-End Delay

OH Overhead

SUMO Simulation of Urban Mobility

NS-2 Network Simulator-2

NS-3 Network Simulator-3

TCL Tool Command Language

TSC Traffic Signal control

GUI Graphic User Interface

OLSR Optimized Link State Routing Protocol

DSDV Destination-Sequenced Distance-Vector

AODV Ad Hoc on-Demand Distance Vector

DSR Dynamic Source Routing

VANET Vehicle Ad-Hoc Network

ITS Intelligent Transportation Systems

DTN Delay Tolerant Network

GPS Global Positioning System

MANET Mobile Ad-Hoc Network

XML Extensible markup language

Declarations

Data Availability

Data sharing not applicable to this article as no datasets were generated or analysed during the current study.

Ethical Rule:

Authors are following all the ethical rules of this journal which will maintain the high integrity of journal and article.

1. This article is original.
2. Article is not submitted to other journal.

Disclosure statement

The authors declare that they have no conflict of interest.

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Figures

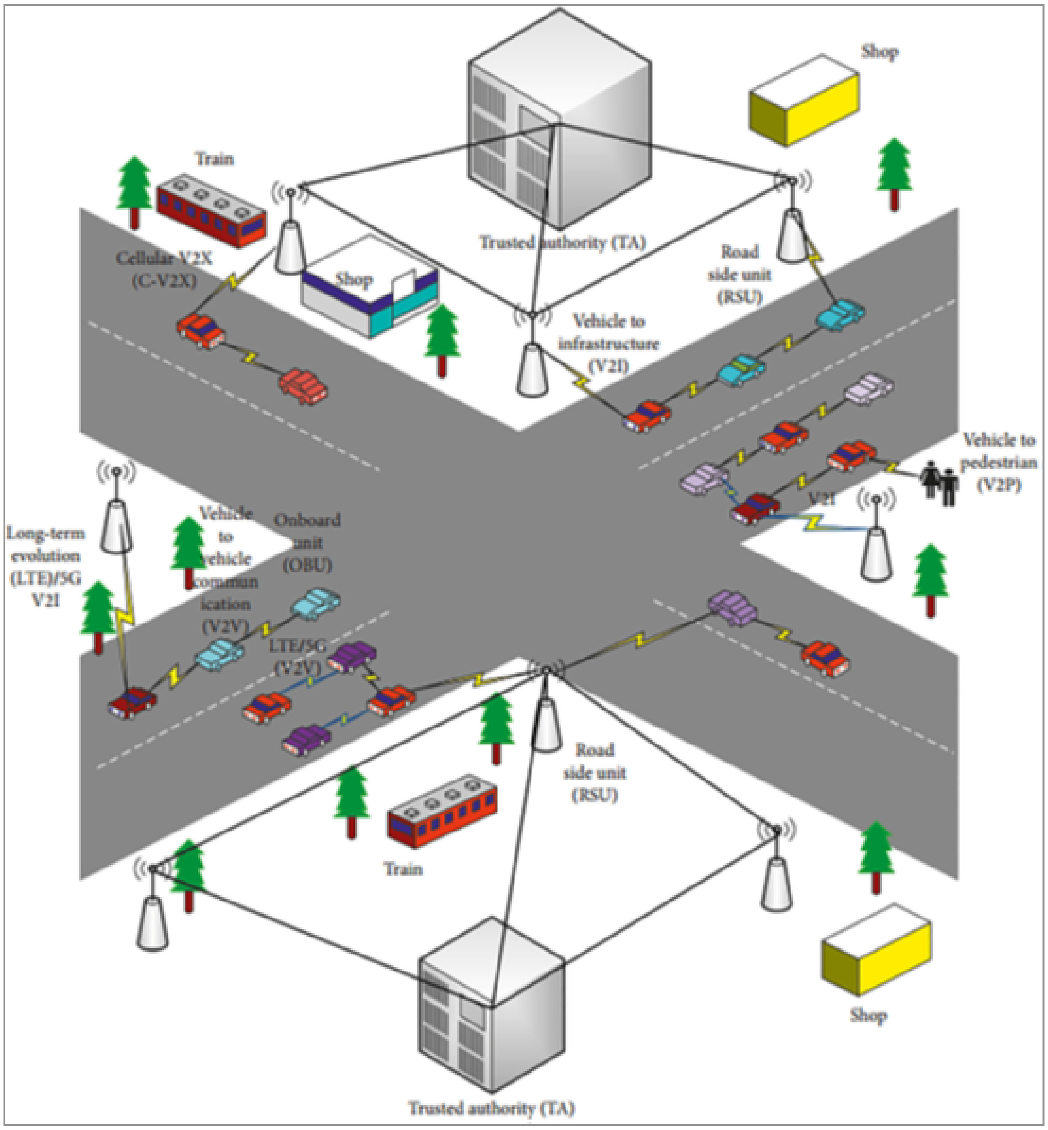

Figure 1

Typical VANET Architecture [1].

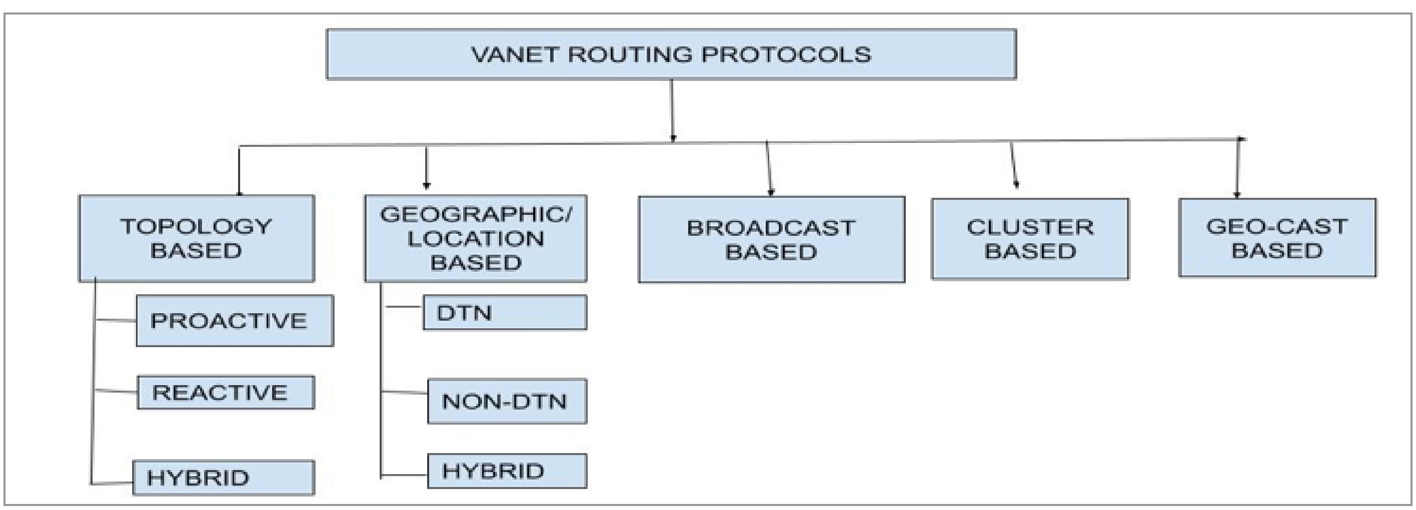

Figure 2

Taxonomy of VANET routing protocols.

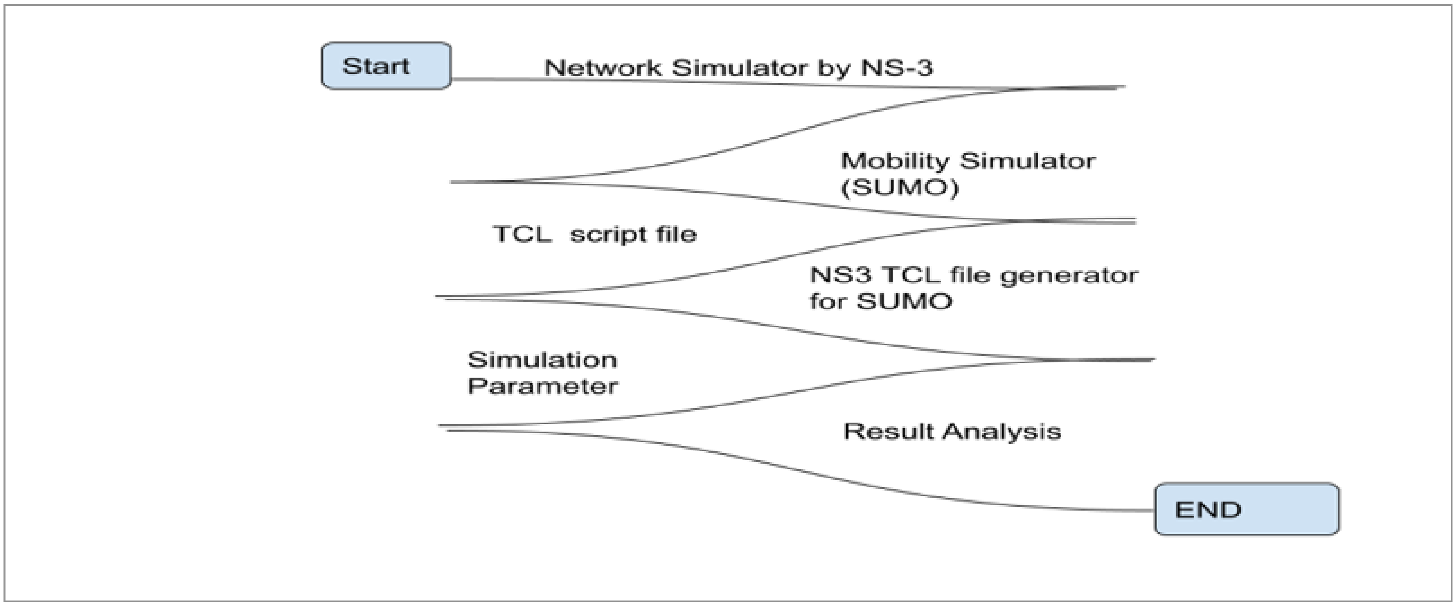

Figure 3

Methodology Stages.

Figure 4

(a). SUMO GUI Configuration.

(b). Traffic congestion creation in SUMO of Delhi city area (courtesy of Openstreetmap.com).

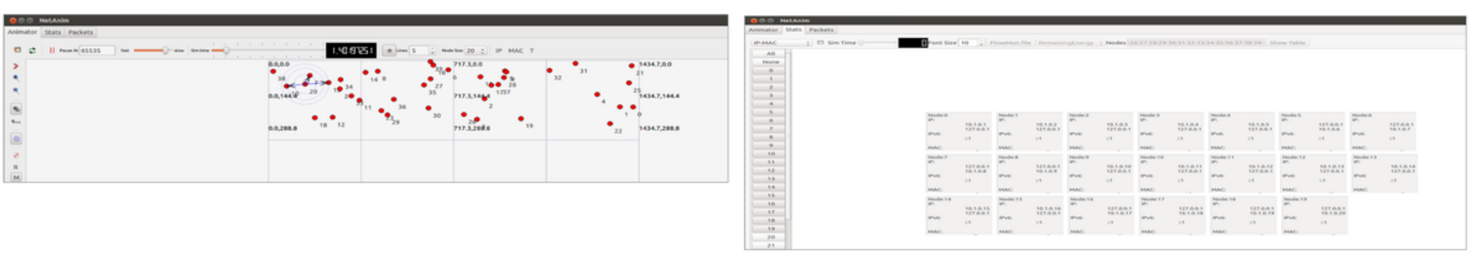

Figure 5

(a). Animation with Nodes.

(b). Animation with IP Address.

Figure 6

(a). Throughput variation with 20 Set of Nodes.

(b). TR variation with 30 set of Nodes.

(c). TR variation with 40 set of Nodes.

(d). TR variation with 50 set of Nodes.

(e). TR variation with 60 set of Nodes.

Figure 7

(a). PDR percentage at 20 set of Nodes.

(b). PDR percentage at 30 set of Nodes.

(c). PDR percentage at 40 set of Nodes.

(d). PDR percentage at 50 set of Nodes.

(e). PDR percentage at 60 set of Nodes.

Figure 8

(a). Overhead variation with 20 Set of Nodes.

(b). Overhead variation with 30 set of Nodes.

(c). Overhead variation with 40 set of Nodes.

(d). Overhead variation with 50 Set of Nodes.

(e). Overhead variation with 60 Set of Nodes.