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OLBR: Optimization of Location-Based Routing protocols in Vehicular Ad Hoc Networks

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***Abstract*—The proposed work employs ns-3, SUMO, and NetAnim to create geographical routing in vehicular ad hoc networks (VANETs). The research attempts to assess the performance of three well-known protocols AODV, DSDV, and OLSR in VANET settings. Utilizing SUMO's realistic mobility models and NS3's simulation capabilities, the project simulates node communication, protocol behaviour, and vehicle movement. The main purpose is to know how well various routing techniques work in dynamic vehicular situations.**

***Keywords*—Geographical Routing, VANET, node, AODV, DSDV, OLSR.**

I. INTRODUCTION

A system that improves communication between vehicles and roadside equipment is called a Vehicular Adhoc Network (VANET). It benefits like vehicle-to-vehicle (V2V) and Inter-vehicle communication (IVC). It uses a distributed ad hoc technique to enhance traffic conditions and driving safety. VANET is a component of the broader Intelligent Transportation System (ITS), which try to improve the system's overall performance. Through active communication, VANETs enable cars to recognise and react to traffic jams and accidents, ensuring driver safety. And also, high dynamics, frequent network changes are the present difficulties for VANETs. Vehicular Adhoc Networks (VANETs) have gained a lot of attention due to their unique characteristics, including distributed management, multi-hop routing, and self-configuration. Traditional protocols, such as network topology-based AODV and DSR, have no way to adapt to the dynamic changes happening in VANETs. Geographic routing, that relies on geographical information instead of topology, is as a scalable and effective solution to this issue. Geographic routing, as compared to path-based techniques, makes advantage of nodes geographic locations, doing away with the requirement for complex routing tables. There are certain issues with the common greedy forwarding method, that forwards packets to nodes nearby which are closer to the target. These issues include communication voids. To improve communication between node in VANETs our proposed work involves different geographic routing algorithms like Greedy forwarding, GPSR (Geographical Position based Routing) and in this algorithm many parameters can influence the GPSR performance such as obstacles, the link quality, the network size, and so on. The technique of fuzzy logic is used to apply these two criteria in order to determine the optimal next-hop selection, which will improve performance. In the context of a vehicular Adhoc network (VANET), packets can be safely passed from one node to another via Optimised Link State Routing (OLSR) and without any data loss by using these mentioned algorithms we can safely pass the packets from one node to another in the network without any data loss in Vehicular Adhoc Network (VANET).

II. LITERATURE REVIEW

[1] Dynamic Trust Tokens (DTT), a recent VANET security system, use hybrid cryptography for real-time dependability assessment, which may cause data packet loss. Geographic Position-Based Routing (PBR) uses cryptographic techniques to guarantee network integrity, whereas Geographic Secure Path Routing (GSPR) uses position and path authentication to secure location-based services. [2] VANET protocols were developed by researchers to guarantee lossless data transport. By utilising greedy forwarding and perimeter modes, GPSR maximises package transit while removing obstacles. By highlighting junctions, GPCR increases the efficiency of urban routing. Through beacon messages at intersections, GPSRJ+ improves GPSR in urban VANETs. [3] Research which was presented at the IScV conference, assessed

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Geographic and Topology-Based Routing Protocols in VANETs with a focus on performance and QoS analysis in vehicular ad hoc networks. [4] Geographic Routing Protocols in VANETs are examined in a Vehicular Communications survey, which also probably discusses their usefulness, difficulties, and future developments for effective routing and communication techniques in vehicular networks.

[5] Vehicular Ad-Hoc Networks (VANETs) have recently seen the introduction of innovative protocols such as V-GEDIR, which employ Voronoi Diagrams for loop-free routing (VD-GREEDY & CH-MFR). Junction-based Geographic Distance Routing (JGEDIR) uses a strategic, greedy distance method that takes into account the positioning of vehicles at intersections to optimize latency. [6] Examining Void Handling Techniques for Geographic Routing in VANET networks, this research delves into strategies aimed at bridging communication gaps. [7] Furthermore, QAGR, an adaptive geographic routing method based on Q-learning, was presented. QAGR separates routing into two parts: ground and aerial. For context-specific information, fuzzy logic is used, and for global routing, a depth-first search technique is applied. [8] Additionally, trust management for security in geographic routing has been studied by researchers. An ideal Road-Side Unit setup was shown, combining triangulation-based location verification with trust-oriented secure multi-hop routing. [9] A QoS-aware service selection architecture designed for pervasive contexts is presented in this research. In order to improve overall quality and performance, it focuses on streamlining the processes used for service selection in these kinds of situations. [10] The comparative analysis of the AODV and EDAODV routing protocols in VANETs under congestion conditions is explored in this paper. It evaluates their performance through thorough analysis, offering important information for vehicle network congestion control solutions. [11] Utilizing an optimized trust computation model within a chimp-AODV enabled WSN, this investigation explores the identification of dishonest nodes, addressing their selfish behaviors.. [12] A delay-based routing protocol designed for collision avoidance on VANETs, with the goal of optimising routing algorithms. Its main objective is to increase vehicular networks' efficiency, especially in situations where collisions are a concern. [13] The fault-tolerant peer-to-peer multicasting overlay strategy designed for emergency data transmission in VANETs. The goal of the project is to improve the dependability of data distribution in vehicle networks in emergency conditions.

III. METHDOLOGY

A. Geographic Routing Framework Establishment: -

Proposed work is Implemented by a hierarchical network structure specific to VANETs. This defines core, distribution, and access layers to manage data flow efficiently, considering vehicular movement, communication ranges, and routing functionalities inspired by the different algorithms.

B. VANET Model:

Vehicular Ad Hoc Networks, or VANETs, are networks that function like automobiles, akin to the social networking paradigm. VANETs, which are acknowledged for improving wireless systems in the automobile industry, allow cars to communicate while they are in motion, so strengthening their dependability. The basic VANET concept, which enables communication between neighbouring roadside devices and surrounding automobiles.

C. Architecture:

Figure 1. Working of VANET in real time scenario

VANET's real-time functioning is shown in Figure 1 against the background of a route map. Figure 2 shows the Architecture of our Project . Parking and traffic information services improve operations. Road details facilitate vehicle adaption, and cooperative duties are supported by WiFi and V2V communication.

Figure 2. Architecture of Location based routing protocols

D. Algorithm:

Vehicle Ad Hoc Networks (VANETs) use a variety of routing techniques, including:

Topology-Based which Balances overhead and scalability by relying on reasonably accurate network structure information. Position-Based for position-aware routing, this method uses GPS or location data that is efficient and from moderate to very accurate. Cluster-Based assists in scalability, minimizes control overhead, groups nodes into clusters with a modest degree of accuracy. Traffic-Aware routing optimizes routes based on dynamic traffic statuses by taking into account moderate to extremely accurate traffic circumstances.

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Algorithms	Accuracy
Positional Based	Moderate - High
Topology Based	Moderate
Cluster Based	Moderate
Traffic aware	Moderate - High
Opportunistic	Low - Moderate

Figure 3. Accuracies of Routing algorithms in VANET

Each has unique benefits and trade-offs that affect the precision and effectiveness of routing in dynamic vehicle situations. Figure 3 shows the accuracies of different routing algorithms in VANET.

In Vehicular Ad Hoc Networks (VANETs), position-based routing determines forwarding by using location information, usually GPS. It is effective for mobile networks, allowing location-aware communication and cutting down on the burden of keeping network topology data updated. Figure 4 shows different types of algorithms in position based routing. Position-based routing in VANETs directs packets based on node positions for effective communication by using GPS data for forwarding. GPS data is used in position-based routing in VANETs to direct data transfer by node positions for effective forwarding and communication.

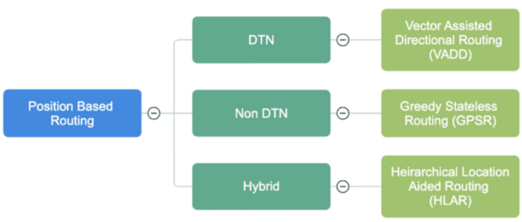


Figure 4. Types of Algorithms in Position Based Routing

Vehicular Ad Hoc Networks (VANETs) employ topology-based routing, which determines packet forwarding based on network structural information. Figure 5 shows the different types of algorithms in topology based routing. This method helps with effective data transmission inside the network's architecture by striking a balance between overhead and scalability.

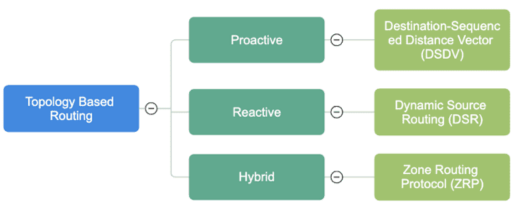


Figure 5. Types of Algorithms in Topology Based routing

Vehicular Ad Hoc Networks (VANETs) group nodes into clusters to reduce control overhead and maximise efficiency through cluster-based routing. Localised decision-making is given priority in this method, which is seen in Figure 6. It also reduces global traffic and improves routing efficiency inside clusters. In addition, it provides resilience in dynamic contexts by strengthening the network against unforeseen changes. This architecture is a scalable and extremely effective approach for communication between vehicles.

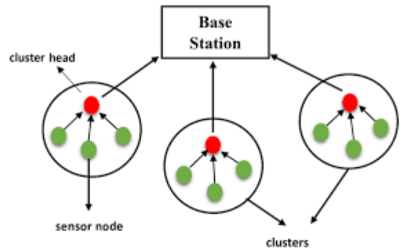


Figure 6. Working of Cluster Based Routing

The Ad-hoc On-Demand Distance Vector (AODV) protocol functions as a reactive routing algorithm in vehicular ad hoc networks (VANETs), with a focus on dynamic vehicular contexts. As one of the distance-vector algorithms, AODV uses sequence numbers to keep routing data current, which improves route establishment efficiency. AODV starts a route discovery process when a car tries to communicate with an unidentified location. Because of its adaptive character, which makes it suitable for fluctuating connection and changing topologies, AODV is a useful tool for improving the efficiency and reliability of communication in VANETs.

The Destination-Sequenced Distance Vector (DSDV) protocol ensures current and consistent data by routinely broadcasting routing tables, which is well-suited for proactive routing on VANETs. It preserves route stability by using sequence numbers, which helps nodes quickly determine the most recent paths. A workable approach for drastically altering VANET topologies, DSDV prioritises route consistency above rapid adaptation and provides straightforward routing decisions and loop-free paths in stable networks.

Topology-based routing techniques include the Optimised Link State Routing (OLSR) protocol, which we use for geographical routing in our VANET project. By routinely sharing details about the whole network topology with nearby nodes, OLSR adopts a proactive approach to maintaining and updating routing tables. The topology-based structure of OLSR is ideally suited to VANET requirements, particularly in situations where vehicle mobility causes quick topology changes. The proactive nature of OLSR guarantees faster adaptation to dynamic network conditions, providing more robust and dependable communication channels, in contrast to the reactive approach of AODV or the periodic updates of DSDV. Within the dynamic and rapidly evolving VANET environment, OLSR is the best option for meeting the geographical routing requirements of our project because of its capacity to store up-to-date topology information and create effective routes based on this data.

E. Testing and Validation:

Comprehensive Testing will be done by Conducting rigorous testing, simulating various VANET scenarios using the hybrid optimization algorithms such as Optimised Link State Routing (OLSR). Testing the efficiency, security, and performance of the proposed geographic routing protocols under different vehicular densities, mobility patterns, and communication ranges. This validation aims to ensure that the routing protocols function optimally in diverse VANET conditions.

IV. IMPLEMENTATION

NS3, SUMO, and NetAnim were among the technologies used in the simulation setup. NS3 and SUMO were connected in order to provide connection, which allowed the SUMO simulation to create the initial configuration file, osm.sumocfg. Figure 7 shows how to simulate vehicles using SUMO.

Figure 7. Simulation of Vehicles using SUMO.

After the simulation, The emphasis turned to getting an output mobility file namely vanettrace.xml with important vehicle information. we can see osm.sumocfg which looks same what it look like in Figure 2. The Figure 8 shows the vanettrace.xml file which we have received.

Figure 8. Vanettrace.xml file from SUMO

By running a Python Trace Exporter command, the osm.sumocfg file was changed to the appropriate vanetmobility.tcl format that is compatible with NS3. Figure 9 shows the file which we have received by converting Vanettrace.xml file to NS3 format which is vanetmobility.tcl.

Figure 9. Vanettrace.xml file converted to NS3 format

The next stage required extensive changes to the NS3 code, which was necessary to incorporate visualisation features and facilitate data understanding.

The edited code was executed in the terminal environment using the NS3 Scratch Tool. Currently we are executing the code using protocol 1 and scenario 2 which is OLSR. Figure 11 shows the flow statistics which we got after executing the code. Using our mobility.tcl file this code generated some important output files such as VanetAnim.xml file, which was made especially for Net Animation visualisation. Figure 11 and 12 shows final simulation which we get in NetAnimation Tool. Figure 14 shows the IP and Mac address of nodes. Furthermore, a thorough log file was created, vigorously crafted to assist in debugging and troubleshooting any possible inconsistencies in the simulation. Flow statistics were obtained in scenario 2 by using protocol 1 (OLS) with the NS3 Scratch Tool Figure 10. Node addresses were shown in Figure 13 by the mobility.tcl output, VanetAnim.xml for Net Animation Figure 11 and Figure 12. The log file helps with anomaly debugging.

Figure 10. Flow statistics on execution.

From the above statistics obtained as CSV files with the necessary tabular data were created, providing a thorough and organised depiction of important metrics and statistics that were acquired throughout the simulation procedure.

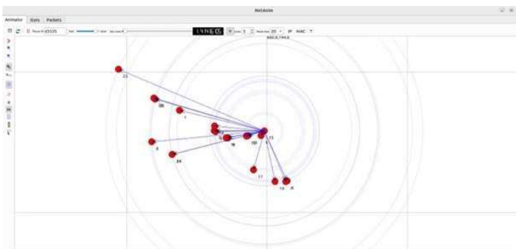


Figure 11. NetAnimation Tool Final Simulation.

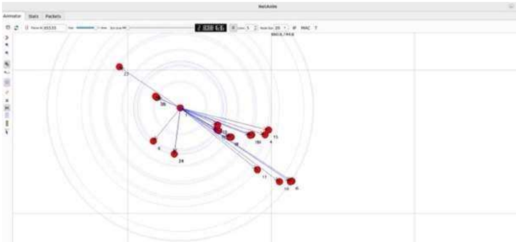
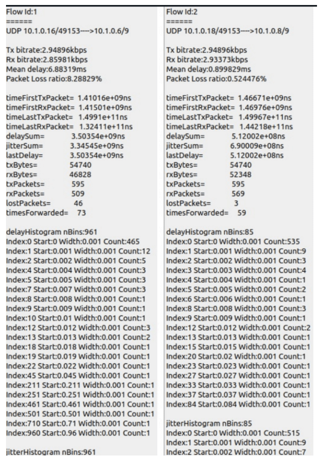


Figure 12. NetAnimation Tool Final Simulation.

Figure 13. IP and Mac Address of nodes

The NetAnimation Tool in NS3 provided strong visualisation capabilities that were essential for interpreting the intricate dynamics of the simulated vehicular network. Important network properties like the IP and MAC addresses of specific nodes were graphically shown with the dynamic movement of the cars. A fine-grained comprehension of the network's architecture and the particular interactions taking place between various entities was made possible by this degree of information. Figure 14 shows the flow level statistics of AODV.



Flow Id:1
======
UDP 10.1.0.16/49153---->10.1.0.6/9

Tx bitrate:2.94896kbps
Rx bitrate:2.85981kbps
Mean delay:6.88319ms
Packet Loss ratio:8.28829%

timeFirstTxPacket= 1.41016e+09ns
timeFirstRxPacket= 1.41501e+09ns
timeLastTxPacket= 1.4991e+11ns
timeLastRxPacket= 1.32411e+11ns
delaySum= 3.50354e+09ns
jitterSum= 3.34545e+09ns
lastDelay= 3.50354e+09ns
txBytes= 54740
rxBytes= 46828
txPackets= 595
rxPackets= 509
lostPackets= 46
timesForwarded= 73

delayHistogram nBins:961
Index:0 Start:0 Width:0.001 Count:465
Index:1 Start:0.001 Width:0.001 Count:12
Index:2 Start:0.002 Width:0.001 Count:5
Index:4 Start:0.004 Width:0.001 Count:3
Index:5 Start:0.005 Width:0.001 Count:3
Index:7 Start:0.007 Width:0.001 Count:3
Index:8 Start:0.008 Width:0.001 Count:1
Index:9 Start:0.009 Width:0.001 Count:1
Index:10 Start:0.01 Width:0.001 Count:1
Index:12 Start:0.012 Width:0.001 Count:3
Index:13 Start:0.013 Width:0.001 Count:2
Index:18 Start:0.018 Width:0.001 Count:1
Index:19 Start:0.019 Width:0.001 Count:1
Index:22 Start:0.022 Width:0.001 Count:1
Index:45 Start:0.045 Width:0.001 Count:1
Index:211 Start:0.211 Width:0.001 Count:1
Index:251 Start:0.251 Width:0.001 Count:1
Index:461 Start:0.461 Width:0.001 Count:1
Index:501 Start:0.501 Width:0.001 Count:1
Index:710 Start:0.71 Width:0.001 Count:1
Index:960 Start:0.96 Width:0.001 Count:1

jitterHistogram nBins:961

Flow Id:2
======
UDP 10.1.0.18/49153---->10.1.0.8/9

Tx bitrate:2.94896kbps
Rx bitrate:2.93373kbps
Mean delay:0.899829ms
Packet Loss ratio:0.524476%

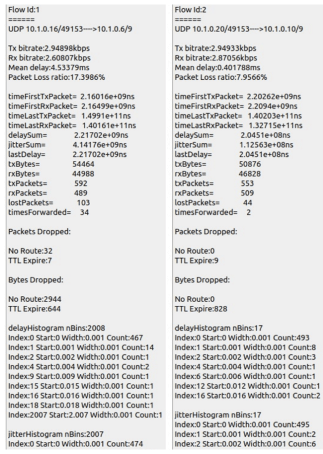
timeFirstTxPacket= 1.46671e+09ns
timeFirstRxPacket= 1.46976e+09ns
timeLastTxPacket= 1.49967e+11ns
timeLastRxPacket= 1.44218e+11ns
delaySum= 5.12002e+08ns
jitterSum= 6.90009e+08ns
lastDelay= 5.12002e+08ns
txBytes= 54740
rxBytes= 52348
txPackets= 595
rxPackets= 569
lostPackets= 3
timesForwarded= 59

delayHistogram nBins:85
Index:0 Start:0 Width:0.001 Count:535
Index:1 Start:0.001 Width:0.001 Count:9
Index:2 Start:0.002 Width:0.001 Count:3
Index:3 Start:0.003 Width:0.001 Count:4
Index:4 Start:0.004 Width:0.001 Count:1
Index:5 Start:0.005 Width:0.001 Count:2
Index:6 Start:0.006 Width:0.001 Count:1
Index:8 Start:0.008 Width:0.001 Count:3
Index:9 Start:0.009 Width:0.001 Count:1
Index:12 Start:0.012 Width:0.001 Count:2
Index:13 Start:0.013 Width:0.001 Count:1
Index:15 Start:0.015 Width:0.001 Count:1
Index:20 Start:0.02 Width:0.001 Count:1
Index:23 Start:0.023 Width:0.001 Count:1
Index:27 Start:0.027 Width:0.001 Count:1
Index:33 Start:0.033 Width:0.001 Count:1
Index:37 Start:0.037 Width:0.001 Count:1
Index:84 Start:0.084 Width:0.001 Count:1

jitterHistogram nBins:85
Index:0 Start:0 Width:0.001 Count:515
Index:1 Start:0.001 Width:0.001 Count:9
Index:2 Start:0.002 Width:0.001 Count:7

Figure 14. Flow level statistics for AODV

Figure 15 shows the flow level statistics of DSDV. Figure 16 shows the flow level statistics of OSLR. The combination of immediate visualisation and comprehensive statistical analysis enabled a comprehensive understanding of the behaviour of the simulated network.



Flow Id:1
======
UDP 10.1.0.16/49153---->10.1.0.6/9

Tx bitrate:2.94898kbps
Rx bitrate:2.60807kbps
Mean delay:4.53379ms
Packet Loss ratio:17.3986%

timeFirstTxPacket= 2.16016e+09ns
timeFirstRxPacket= 2.16499e+09ns
timeLastTxPacket= 1.4991e+11ns
timeLastRxPacket= 1.40161e+11ns
delaySum= 2.21702e+09ns
jitterSum= 4.14176e+09ns
lastDelay= 2.21702e+09ns
txBytes= 54464
rxBytes= 44988
txPackets= 592
rxPackets= 489
lostPackets= 103
timesForwarded= 34

Packets Dropped:

No Route:32
TTL Expire:7

Bytes Dropped:

No Route:2944
TTL Expire:644

delayHistogram nBins:2008
Index:0 Start:0 Width:0.001 Count:467
Index:1 Start:0.001 Width:0.001 Count:14
Index:2 Start:0.002 Width:0.001 Count:1
Index:4 Start:0.004 Width:0.001 Count:2
Index:9 Start:0.009 Width:0.001 Count:1
Index:15 Start:0.015 Width:0.001 Count:1
Index:16 Start:0.016 Width:0.001 Count:1
Index:18 Start:0.018 Width:0.001 Count:1
Index:2007 Start:2.007 Width:0.001 Count:1

jitterHistogram nBins:2007
Index:0 Start:0 Width:0.001 Count:474

Flow Id:2
======
UDP 10.1.0.20/49153---->10.1.0.10/9

Tx bitrate:2.94933kbps
Rx bitrate:2.87056kbps
Mean delay:0.401788ms
Packet Loss ratio:7.9566%

timeFirstTxPacket= 2.20262e+09ns
timeFirstRxPacket= 2.2094e+09ns
timeLastTxPacket= 1.40203e+11ns
timeLastRxPacket= 1.32715e+11ns
delaySum= 2.0451e+08ns
jitterSum= 1.12563e+08ns
lastDelay= 2.0451e+08ns
txBytes= 50876
rxBytes= 46828
txPackets= 553
rxPackets= 509
lostPackets= 44
timesForwarded= 2

Packets Dropped:

No Route:0
TTL Expire:9

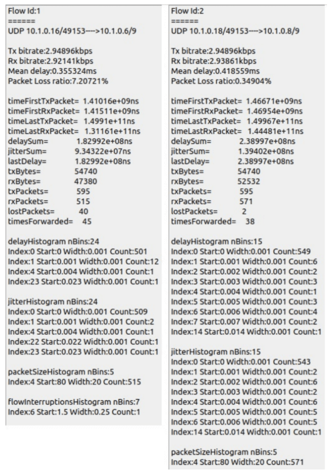
Bytes Dropped:

No Route:0
TTL Expire:828

delayHistogram nBins:17
Index:0 Start:0 Width:0.001 Count:493
Index:1 Start:0.001 Width:0.001 Count:8
Index:2 Start:0.002 Width:0.001 Count:3
Index:4 Start:0.004 Width:0.001 Count:1
Index:6 Start:0.006 Width:0.001 Count:1
Index:12 Start:0.012 Width:0.001 Count:1
Index:16 Start:0.016 Width:0.001 Count:2

jitterHistogram nBins:17
Index:0 Start:0 Width:0.001 Count:495
Index:1 Start:0.001 Width:0.001 Count:2
Index:2 Start:0.002 Width:0.001 Count:6

Figure 15. Flow level statistics for DSDV



Flow Id:1
======
UDP 10.1.0.16/49153---->10.1.0.6/9

Tx bitrate:2.94896kbps
Rx bitrate:2.92141kbps
Mean delay:0.355324ms
Packet Loss ratio:7.20721%

timeFirstTxPacket= 1.41016e+09ns
timeFirstRxPacket= 1.41511e+09ns
timeLastTxPacket= 1.4991e+11ns
timeLastRxPacket= 1.31161e+11ns
delaySum= 1.82992e+08ns
jitterSum= 9.34322e+07ns
lastDelay= 1.82992e+08ns
txBytes= 54740
rxBytes= 47380
txPackets= 595
rxPackets= 515
lostPackets= 40
timesForwarded= 45

delayHistogram nBins:24
Index:0 Start:0 Width:0.001 Count:501
Index:1 Start:0.001 Width:0.001 Count:12
Index:4 Start:0.004 Width:0.001 Count:1
Index:23 Start:0.023 Width:0.001 Count:1

jitterHistogram nBins:24
Index:0 Start:0 Width:0.001 Count:509
Index:1 Start:0.001 Width:0.001 Count:2
Index:4 Start:0.004 Width:0.001 Count:1
Index:22 Start:0.022 Width:0.001 Count:1
Index:23 Start:0.023 Width:0.001 Count:1

packetSizeHistogram nBins:5
Index:4 Start:80 Width:20 Count:515

flowInterruptionsHistogram nBins:7
Index:6 Start:1.5 Width:0.25 Count:1

Flow Id:2
======
UDP 10.1.0.18/49153---->10.1.0.8/9

Tx bitrate:2.94896kbps
Rx bitrate:2.93861kbps
Mean delay:0.418559ms
Packet Loss ratio:0.34904%

timeFirstTxPacket= 1.46671e+09ns
timeFirstRxPacket= 1.46954e+09ns
timeLastTxPacket= 1.49967e+11ns
timeLastRxPacket= 1.44481e+11ns
delaySum= 2.38997e+08ns
jitterSum= 1.39402e+08ns
lastDelay= 2.38997e+08ns
txBytes= 54740
rxBytes= 52532
txPackets= 595
rxPackets= 571
lostPackets= 2
timesForwarded= 38

delayHistogram nBins:15
Index:0 Start:0 Width:0.001 Count:549
Index:1 Start:0.001 Width:0.001 Count:6
Index:2 Start:0.002 Width:0.001 Count:3
Index:3 Start:0.003 Width:0.001 Count:3
Index:4 Start:0.004 Width:0.001 Count:1
Index:5 Start:0.005 Width:0.001 Count:3
Index:6 Start:0.006 Width:0.001 Count:4
Index:7 Start:0.007 Width:0.001 Count:2
Index:14 Start:0.014 Width:0.001 Count:1

jitterHistogram nBins:15
Index:0 Start:0 Width:0.001 Count:543
Index:1 Start:0.001 Width:0.001 Count:2
Index:2 Start:0.002 Width:0.001 Count:6
Index:3 Start:0.003 Width:0.001 Count:2
Index:4 Start:0.004 Width:0.001 Count:6
Index:5 Start:0.005 Width:0.001 Count:5
Index:6 Start:0.006 Width:0.001 Count:5
Index:14 Start:0.014 Width:0.001 Count:1

packetSizeHistogram nBins:5
Index:4 Start:80 Width:20 Count:571

Figure 16. Flow level statistics for OSLR

Flow Id	1
Tx Bitrate	2.94896 kbps
Rx Bitrate	2.85981 kbps
Mean Delay	6.88319 ms
Packet Loss Ratio	8.28829%
Time First Tx Packet	1.41016e+09 ns
Time First Rx Packet	1.41501e+09 ns
Time Last Tx Packet	1.4991e+11 ns
Time Last Rx Packet	1.3241e+11 ns
Delay Sum	3.50354e+09 ns
Bitrate Sum	3.34545e+09 ns
Last Delay	3.50354e+09 ns

Table 1. AODV flow statistics

Flow Id	1
Tx Bitrate	2.94898 kbps
Rx Bitrate	2.60807 kbps
Mean Delay	4.53379 ms
Packet Loss Ratio	17.3986%
Time First Tx Packet	2.16016e+09 ns
Time First Rx Packet	2.16499e+09 ns

Time Last Tx Packet	1.4991e+11 ns
Time Last Rx Packet	1.40161e+11 ns
Delay Sum	2.21702e+09 ns
Bitrate Sum	4.14176e+09 ns
Last Delay	2.21702e+09 ns

Table 2. DSDV flow statistics.

Flow Id	1
Tx Bitrate	2.94896 kbps
Rx Bitrate	2.92141 kbps
Mean Delay	0.355324 ms
Packet Loss Ratio	7.20721%
Time First Tx Packet	1.41016e+09 ns
Time First Rx Packet	1.41511e+09 ns
Time Last Tx Packet	1.4991e+11 ns
Time Last Rx Packet	1.31161e+11 ns
Delay Sum	1.82992e+08 ns
Bitrate Sum	9.34322e+07 ns
Last Delay	1.82992e+08 ns

Table 3. OLSR flow statistics

Table 1 shows the AODV flow statistics and Table 2 show the flow statistics of DSDV and Table 3 shows the flow statistics of OLSR protocol. The capacity to visualise data comprehensively was essential in gaining practical insights and guiding well-informed judgements that improved the dependability and effectiveness of vehicular communication systems.

V. CONCLUSION

The thorough implementation and assessment of geographic routing protocols in VANETs demonstrated significant findings. By simulating vehicles with SUMO and then converting the data into NS3 format, three well-known protocols OLSR, DSDV, and AODV were executed one by one. By means of comprehensive simulations and Net Animation visualisation, comparision of statistics demonstrated differing protocol performances.

We inferred that OLSR turned out to be the most optimised protocol, demonstrating improved performance in terms of important metrics including packet loss ratio, mean delay, transmitted bytes (txbytes), jitter sum, and final delay. since of its strong performance, OLSR is the best option since it provides efficient and dependable communication, which is essential in dynamic road settings.

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