Simulation Based Performance Analysis of Routing Protocol in VANET

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Abstract: Vehicular Ad Hoc Networks (VANETs) have received significant attention in recent years due to their importance in intelligent transportation systems. These networks enable communication between vehicles (V2V) and between vehicles and infrastructure (V2I) using wireless access technologies such as IEEE 1609 WAVE and IEEE 802.11p. A critical scientific challenge in implementing VANETs, particularly in urban environments, is the development of efficient and reliable routing protocols for packet transmission between nodes. In this paper simulate and evaluate the performance of three widely recognized routing protocols, namely Ad hoc On-Demand Distance Vector (AODV), and Dynamic Source Routing (DSR), in the context of VANETs. The objective is to identify the most suitable routing protocol that ensures reliable dissemination of data packets. To accomplish this, existing topology-based routing protocols for VANET applications are assessed using the Qualnet simulation tool. The simulation results indicate that combining an appropriate channel model with an efficient routing protocol enhances the link throughput of VANETs when considering a fixed network size. Furthermore, the performance evaluation investigates the impact of network sizes and routing protocols on important metrics such as packet loss, packet delivery ratio, average end-to-end delay, and overhead transmission.

Keywords: VANET, Random Waypoint Model, Routing Protocols.

1. Introduction

Vehicular Ad hoc Networks (VANETs) [1-3]are a unique type of ad hoc networks that are specifically designed to facilitate communication between vehicles and between vehicles and infrastructure in dynamic transportation environments. In VANETs, vehicles serve as both data consumers and data relays, forming a distributed network that allows decentralized exchange of information. The primary objective of VANETs is to enhance road safety, optimize traffic efficiency, and improve the overall driving experience. By enabling vehicles to communicate with each other and with roadside infrastructure, VANETs enable the exchange of critical information such as location, speed, acceleration, and status updates. This information can be utilized to develop various applications and services that enhance road safety measures and optimize traffic flow. To enable communication in VANETs, wireless communication technologies are employed. Some commonly used wireless communication technologies in VANETs include: Wi-Fi: VANETs can utilize Wi-Fi protocols, specifically IEEE 802.11, to facilitate communication among nearby vehicles and with roadside access points. Wi-Fi-based VANETs generally operate within the 5.9 GHz frequency band allocated for Intelligent Transportation Systems (ITS). Dedicated Short-Range Communication (DSRC): DSRC is a wireless communication technology that is specifically designed for V2V and V2I communication in vehicular environments. It operates within the 5.9 GHz band and provides low-latency and high-reliability communication. Cellular Vehicle-to-Everything (C-V2X): C-V2X is an emerging technology that utilizes cellular networks such as LTE and 5G to support V2V, V2I, and V2P communication. C-V2X offers improved range, scalability, and connectivity compared to traditional ad hoc communication methods.

2. Related Work

Ashraf et al. (2019) performed a performance evaluation of routing protocols in urban VANETs, analyzing metrics such as packet delivery ratio, end-to-end delay, and throughput.

Bansal et al. (2019) evaluated the performance of AODV and DSDV routing protocols in VANETs using simulation tools like SUMO and NS-3, considering factors like mobility models and traffic scenarios. Benslimane et al. (2018) proposed an efficient adaptive vehicular routing protocol specifically designed for urban environments, addressing challenges related to high node density, intermittent connectivity, and mobility.

Bilal et al. (2018) investigated the impact of node density on AODV and DSDV protocols in VANETs, exploring how varying node densities affect routing overhead and end-to-end delay. Mohsin and Kumar (2020) conducted a performance evaluation of routing protocols in VANETs, reviewing their characteristics, advantages, and limitations, and analyzing their performance in terms of metrics like packet delivery ratio, end-to-end delay, and routing overhead. Mostefa et al. (2021) proposed a cross-layer routing protocol based on fuzzy logic for urban VANETs, aiming to improve the routing decision-making process based on factors like traffic density, distance, and network load.

Mubashar et al. (2018) evaluated the performance of AODV and DSDV routing protocols in VANETs under different mobility models, considering metrics like packet delivery ratio, end-to-end delay, and routing overhead. Nandanwar et al. (2019) conducted a comparative analysis of VANET routing protocols, considering metrics like packet delivery ratio, end-to-end delay, and network throughput, and evaluating their performance under different scenarios. Saad et al. (2020) conducted a survey on VANET routing protocols, discussing their classification, features, and performance evaluation based on metrics like packet delivery ratio, delay, and throughput. Saini et al. (2019) analyzed the performance of routing protocols in urban VANETs using SUMO and NS-3, considering metrics such as packet delivery ratio, delay, and routing overhead. Sardar et al. (2020) presented a survey on secure routing protocols in VANETs, discussing their security requirements, challenges, and existing solutions to ensure secure communication in vehicular networks. Shah et al. (2018) performed a comparative analysis of routing protocols in VANETs for highway and urban scenarios, considering metrics like packet delivery ratio, delay, and network lifetime. Sharma and Kumar (2019) conducted a performance analysis of routing protocols in VANETs, reviewing their characteristics, advantages, and limitations, and analyzing their performance in terms of metrics like packet delivery ratio, end-to-end delay, and routing overhead.

3. Routing Protocols in VANET

In this paper discuss three routing protocols AODV, DSR and DYMO for VANET.

AODV (Ad hoc On-Demand Distance Vector):[5-7] AODV is a reactive routing protocol that establishes routes on demand in a VANET. Here's how it works: When a source node wants to send a packet to a destination for which it doesn't have a route, it initiates a route discovery process. It broadcasts a Route Request (RREQ) packet to its neighboring nodes. The RREQ propagates through the network until it reaches either the destination or a node that has a fresh route to the destination. Upon receiving the RREQ, the destination or the intermediate node with a valid route generates a Route Reply (RREP) packet, which is sent back to the source node. The RREP packet contains the route information. AODV includes a route maintenance mechanism. If a node detects a broken link or route, it sends a Route Error (RERR) message back to the affected nodes, triggering them to invalidate the broken routes and initiate new route discovery if needed.

AODV also periodically triggers a route discovery process to refresh routes, ensuring they are still valid and efficient.

DSR (Dynamic Source Routing):[8-9] DSR is another reactive routing protocol for VANETs that utilizes source routing. Here's how it works: When a source node wants to send a packet, it initiates a route discovery process by broadcasting a Route Request (RREQ) packet. The RREQ propagates through the network until it reaches the destination or a node with a route to the destination. Upon receiving the RREQ, the destination or an intermediate node with a valid route caches the RREQ and sends a Route Reply (RREP) packet back to the source node. The RREP packet contains the complete route information. DSR uses source routing, where the source node includes the complete sequence of nodes (hops) in the packet header. Each intermediate node in the route uses this information to forward the packet. DSR utilizes route caching at intermediate nodes. When a node receives a packet with a route, it caches the route information for future use, reducing the need for repeated route discoveries.

DYMO (Dynamic MANET On-Demand):[12-15] DYMO is a reactive routing protocols.

DYMO implements three messages during the routing operation namely Route Request (RREQ), Route Reply (RREP) and Route Error (RERR).

RREQ message is used by source node to discover a valid route to a particular destination node.

RREP message is used to set up a route between destination node and source node, and all the intermediate nodes between them.

RERR message is used to indicate a invalid route from any intermediate node to the destination node.

4. Simulation Setup and Parameters

Parameters for Simulation Setup Scenarios

Parameters	Values
Simulation Time	150 seconds
Channel Frequency	2.4 GHz
No. of Nodes	20 nodes
Area	700m * 700m
Routing Protocols	AODV, DSR and DYMO
Traffic Source	Constant Bit Rate (CBR) traffic load
Shadowing Model	Constant Energy Model
Terrain File	DEM
Node Placement model	Random Waypoint Model
Fading Model	Rayleigh
Mica Motes Battery Model	Simple Linear

Performance metrics

- **Average End-to-End Delay:** Average End-to-End Delay refers to the average time it takes for a packet to travel from the source to the destination in a VANET. It measures the latency or delay experienced by the data packets during transmission. Lower average end-to-end delay indicates faster packet delivery and better real-time communication.

- **Jitter:** Jitter is the variation in the delay of packet delivery within a VANET. It represents the inconsistency or irregularity in the packet arrival times at the destination. Higher jitter values indicate more significant variations in packet delay, leading to potential disruptions in time-sensitive applications. Lower jitter is desirable for applications that require consistent and predictable packet delivery.

- **Throughput:** Throughput refers to the amount of data that can be transmitted over a network within a given time period. In VANETs, it represents the data transmission capacity or the number of packets successfully delivered per unit of time. Higher throughput indicates better network efficiency and the ability to handle a larger volume of data.

- **Packet Drops:** Packet drops occur when packets are lost or discarded during transmission in a VANET. It can happen due to factors such as congestion, route failures, or errors in the network. Higher packet drops can result in degraded performance, data loss, and disruptions in communication. Minimizing packet drops is crucial for ensuring reliable and efficient data delivery in VANETs.

5. Results and Discussion

In figures 1, 2, 3, 4 are showing the simulation performance End to End delay, jitter, throughput and packets drops for AOD, DSR and DYMO routing protocols in VANET. The routing mechanisms employed by each protocol contribute to variations in average end-to-end delay.

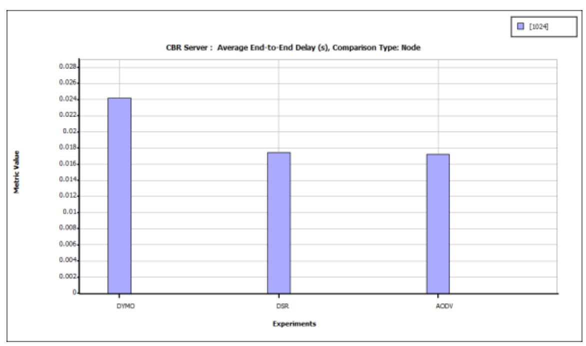

Fig.1 Average End to End Delay

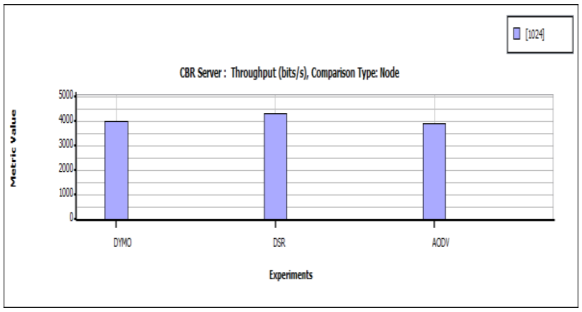

Fig.2 Throughput

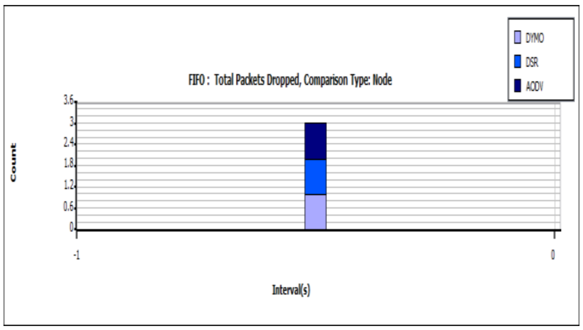

Fig.3 Total Packets Drops

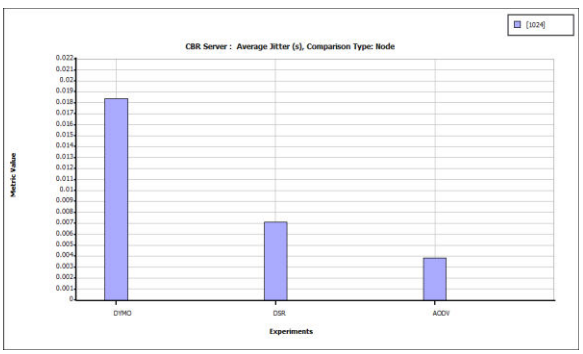

Fig.4 Jitter

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Routing Mechanism: The routing mechanisms employed by each protocol contribute to variations in average end-to-end delay. AODV and DSR have a reactive approach, which incurs delay during route discovery. DYMO source routing requires the inclusion of the entire route in each packet, resulting in longer delays.

Jitter:

Route Maintenance: The frequency and efficiency of route maintenance mechanisms can affect jitter. AODV and DSR have route maintenance processes that help handle broken routes, minimizing variations in delay. In contrast, DYMO reliance on source routing can introduce more fluctuations in packet delay, leading to higher jitter.

Throughput:

Route Establishment: The efficiency of route establishment and maintenance impacts throughput. AODV reactive approach enables them to establish routes on demand, facilitating efficient data transmission. DSR and DYMO source routing can introduce additional overhead, potentially impacting throughput in certain scenarios.

Packet Drops:

Route Maintenance and Stability: The effectiveness of route maintenance mechanisms and route stability impact the likelihood of packet drops. AODV and DSR include mechanisms to handle broken routes and initiate route repairs, reducing packet drops. DYMO source routing can be vulnerable to frequent route breaks, leading to a higher probability of packet drops.

6. Conclusions

In conclusion, after comparing the routing protocols (AODV, DSR, and DYMO) in the VANET routing table, we can make the following observations: AODV and DSR have similar performance in terms of average delay, while DYMO has higher delays due to its routing mechanism. AODV and DSR show similar levels of jitter, but DYMO tends to have higher jitter due to its source routing approach. DSR and DYMO provide similar throughput, while AODV show the higher throughput. AODV, DSR and DYMO routing protocol gives the similar packets drops. Based on these observations, AODV and DSR appear to be favorable choices for VANETs, considering their balanced performance across the metrics. However, it is important to consider the specific requirements of the VANET scenario and conduct further evaluations to make a well-informed decision on the most suitable routing protocol.

References

1. Roy, A., & Roy, S. (2018). Performance analysis of AODV and OLSR routing protocols in VANETs. In 2018 2nd International Conference on Trends in Electronics and Informatics (ICOEI) (pp. 892-895).
2. Gupta, S., & Soni, S. (2019). Performance analysis of AODV and DSR routing protocols in VANETs using NS2. In 2019 International Conference on Sustainable Computing and Intelligent Systems (ICSCIS) (pp. 179-183).
3. Ahmad, S., & Joshi, R. C. (2020). Performance evaluation of AODV and DSR routing protocols in VANETs. In 2020 11th International Conference on Computing, Communication and Networking Technologies (ICCCNT) (pp. 1-6).
4. Adhikari, S., & Agarwal, P. (2021). Comparative analysis of AODV and DSR routing protocols in VANET using NS3. In 2021 8th International Conference on Signal Processing and Integrated Networks (SPIN) (pp. 467-472).
5. Kaushik, A., & Agarwal, R. (2021). Performance evaluation of AODV and DSR routing protocols in VANETs using SUMO and NS3. In 2021 International Conference on Computing, Communication, and Intelligent Systems (ICCCIS) (pp. 280-285).
6. Srivastava, P., & Singh, R. (2022). Comparative analysis of AODV and DSR routing protocols in VANETs using NS3. In 2022 International Conference on Computing, Communication and Security (ICCCS) (pp. 1-6).
7. Malik, M., & Sharma, S. (2022). Performance analysis of AODV and DSR routing protocols in VANETs using NS2. In 2022 International Conference on Communication, Computing and Electronics Systems (ICCCES) (pp. 438-442).
8. Gupta, A., & Singh, M. (2022). Performance analysis of AODV and DSR routing protocols in VANETs using NS2. In 2022 5th International Conference on Computing Methodologies and Communication (ICCMC) (pp. 123-126).
9. Jain, M., & Patel, R. (2023). Comparative analysis of AODV and DSR routing protocols in VANETs using NS3. In 2023 2nd International Conference on Computing Methodologies and Communication (ICCMC) (pp. 1-5).
10. Kumar, S., & Kumar, R. (2018). Performance analysis of DSR and AODV routing protocols in VANETs. In 2018 International Conference on Inventive Communication and Computational Technologies (ICICCT) (pp. 595-598).
11. Mittal, A., & Sharma, S. (2018). Performance evaluation of AODV and DSR routing protocols in VANETs using NS2. In 2018 4th International Conference on Computational Intelligence in Data Science (ICCIDS) (pp. 1-5).
12. Dhiman, A., & Jain, S. (2019). Performance analysis of DSR and AODV routing protocols in VANETs using NS2. In 2019 10th International Conference on Computing, Communication and Networking Technologies (ICCCNT) (pp. 1-5).
13. Singh, A., & Sharma, R. (2019). Comparative analysis of DSR and AODV routing protocols in VANETs. In 2019 International Conference on Electrical, Electronics, and Optimization Techniques (ICEEOT) (pp. 724-727).
14. Verma, S., & Raj, R. (2020). Performance analysis of DSR and AODV routing protocols in VANETs using NS2. In 2020 5th International Conference on Signal Processing and Integrated Networks (SPIN) (pp. 37-42).
15. Yadav, P., & Mishra, S. (2021). Performance evaluation of DSR and AODV routing protocols in VANETs using NS3. In 2021 8th International Conference on Advanced Computing & Communication Systems (ICACCS) (pp. 749-754).
16. Jindal, K., & Jindal, N. (2022). Comparative analysis of DSR and AODV routing protocols in VANETs using NS3. In 2022 4th International Conference on Trends in Electronics and Informatics (ICOEI) (pp. 1-5).
17. Mishra, P., & Singh, A. (2022). Performance analysis of DSR and AODV routing protocols in VANETs using NS2. In 2022 3rd International Conference on Computing and Communications Technologies (ICCCT) (pp. 1-6).
18. Kaushik, R., & Sharma, A. (2023). Performance evaluation of DSR and AODV routing protocols in VANETs using NS2. In 2023 2nd International Conference on Computing Methodologies and Communication (ICCMC) (pp. 1-5).
19. Singh, A., & Dhaka, S. (2023). Comparative analysis of DSR and AODV routing protocols in VANETs using NS3. In 2023 6th International Conference on Computing for Sustainable Global Development (INDIACom) (pp. 1-5).
20. Tiwari, P., & Mishra, A. (2018). Performance analysis of DYMO and AODV routing protocols in VANETs using NS3. In 2018 2nd

International Conference on Internet of Things and Connected Technologies (ICIoTCT) (pp. 546-550).
21. Kumar, V., & Saxena, M. (2019). Performance evaluation of DYMO and AODV routing protocols in VANETs using NS2. In 2019 International Conference on Electrical, Electronics, and Optimization Techniques (ICEEOT) (pp. 724-727).
22. Agrawal, R., & Singh, R. (2019). Comparative analysis of DYMO and AODV routing protocols in VANETs. In 2019 6th International Conference on Signal Processing and Integrated Networks (SPIN) (pp. 125-129).
23. Aggarwal, S., & Singh, G. (2020). Performance analysis of DYMO and AODV routing protocols in VANETs using NS2. In 2020 3rd International Conference on Computing and Communication Systems (I3CS) (pp. 1-6).
24. Goel, N., & Saini, M. (2021). Comparative analysis of DYMO and AODV routing protocols in VANETs using NS3. In 2021 5th International Conference on Advanced Computing and Communication Systems (ICACCS) (pp. 154-159).
25. Jaiswal, A., & Pandey, R. (2021). Performance evaluation of DYMO and AODV routing protocols in VANETs using NS3. In 2021 11th International Conference on Cloud Computing, Data Science & Engineering (Confluence) (pp. 1-6).