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# Enhanced Link State Routing Protocol for Real-Time Applications in Vehicular Ad-Hoc Networks

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**Abstract:** In this paper, we propose an Enhanced Link State Routing Protocol (OLSR) tailored specifically for real-time applications in Vehicular Ad-hoc Networks (VANETs). VANETs operate in dynamic and resource-constrained environments, requiring efficient routing protocols to facilitate communication among vehicles and infrastructure elements. Our protocol integrates the strengths of OLSR to provide robustness and scalability, while also introducing enhancements to address the unique challenges of real-time applications in VANETs. Through simulations and comparative analysis, we demonstrate the superiority of our proposed protocol over existing solutions in terms of latency, packet delivery ratio, and scalability. This paper underscores the efficacy of our Enhanced Link State Routing Protocol for enabling reliable and timely communication in VANETs, thus contributing to the advancement of real-time applications and safety-critical services in vehicular environments.
**Keywords:** VANETs, Mobility, Dynamic Network Topology, Low latency, High reliability, QoS, Routing Metrics.

## 1. Introduction

Vehicular Ad-hoc Networks (VANETs) have emerged as a promising technology for enabling efficient communication among vehicles and infrastructure elements in dynamic transportation environments. With the proliferation of real-time applications such as traffic management, collision avoidance systems, and infotainment services, the need for robust and efficient communication protocols tailored to the unique characteristics of VANETs has become increasingly evident. The high mobility of vehicles and the constantly changing network topology in VANETs pose significant challenges for ensuring reliable and low-latency communication. Traditional routing protocols may struggle to meet the stringent requirements of real-time applications in such dynamic and unpredictable environments. Hence, there is a pressing need to develop routing protocols specifically optimized for VANETs to address these challenges effectively. This paper proposes an enhanced link state routing protocol explicitly tailored to meet the demands of real-time applications in VANETs. Building upon the foundation of traditional link state routing principles, the proposed protocol incorporates several optimizations aimed at enhancing the efficiency, reliability, and timeliness of communication in VANETs. Key optimizations include dynamic neighbor discovery mechanisms to adapt to the rapidly changing network topology, localized route computation techniques to minimize latency, Quality of Service (QoS) aware routing metrics to prioritize critical traffic, adaptive routing updates to respond promptly to network changes, and cross-layer optimization strategies to leverage information from multiple protocol layers for improved performance. o evaluate the effectiveness of the proposed protocol, extensive simulation studies have been conducted, comparing its performance with existing routing protocols designed for VANETs. The results demonstrate significant improvements in terms of latency, reliability, and routing overhead, highlighting the efficacy of the proposed protocol in meeting the requirements of real-time applications in VANETs.

## 2. Related Work / Literature Survey

In the proposed research methodology, a systematic approach is adopted to address the challenges associated with real-time applications in Vehicular Ad-hoc Networks (VANETs). The research begins with a comprehensive understanding of the unique characteristics and requirements of VANETs, particularly focusing on the high mobility of vehicles and the dynamic nature of the network topology. crucial step involves conducting an extensive literature review to identify existing routing protocols and their limitations in meeting the demands of real-time applications in VANETs. This review serves as the foundation for devising a novel link state routing protocol tailored specifically for VANETs. With insights gained from the literature review, the protocol design phase commences, wherein key optimizations such as dynamic neighbor discovery, localized route computation, Quality of Service (QoS) aware routing metrics, adaptive routing updates, and cross-layer optimization are integrated into the proposed protocol. These optimizations are aimed at enhancing the efficiency, reliability, and timeliness of communication in VANETs. Following protocol design, a simulation environment is established to emulate the dynamic behavior of vehicles and the communication network in VANET scenarios.

Implementation of the proposed protocol within the simulation environment allows for rigorous experimentation under varying conditions and traffic scenarios. Through systematic experimentation and data collection, the performance of the proposed protocol is evaluated using metrics such as latency, reliability, routing overhead, packet delivery ratio, and end-to-end delay. Comparative analysis against existing routing protocols provides insights into the effectiveness of the proposed protocol and its potential for improvements over current state-of-the-art solutions. Interpretation of the experimental results leads to meaningful conclusions regarding the performance of the proposed protocol and its implications for real-time applications in VANETs.

Strengths, limitations, and areas for further refinement are discussed, guiding future research directions in the field.S. U. Masruroh, F. Robby and N. Hakiem, "Performance evaluation of routing protocols RIPng, OSPFv3, and EIGRP in an IPv6 network," [1]A routing protocol is a set of rules that controls the means of communication between routers. Routing protocols are becoming more and more necessary in order to determine the most effective path, as evidenced by the growth of contemporary computer networks like the Internet. Using GNS3, this study evaluated the speed, jitter, and packet loss of the routing protocols RIPng, OSPFv3, and EIGRP in an IPv6 network. A network's throughput determines how quickly data can be transferred; the higher the throughput, the faster the network can operate. The disparity in packet arrival times at the destination node is known as jitter. Minimum jitter values are required to obtain higher QoS (Quality of Service) values. The study's findings show that the RIPng routing protocol has the maximum throughput value and the OSPFv3-EIGRP combination routing protocol has the lowest jitter value. Last but not least, the packet loss figure for the RIPng routing protocol is the lowest. A. N. H. Ahmad Jaafar, S. Salim, L. A. Tiron and Z. M. Hussin, "Performance evaluation of OSPFv3 and IS-IS routing protocol on ipv6 network," [2]

The internet network technologies are developing quickly, which calls for an improved data transmission routing protocol. The two Link State (LS) routing protocols—Intermediate System to Intermediate System (IS-IS) and Open Shortest Path First version 3 (OSPFv3)—are compared based on the network's performance. Through in-depth investigation and simulation, the performance in the network convergence is evaluated. The same Dijkstra's shortest path first technique is used to simulate both routing protocols and determine the optimal route for a packet to take in order to reach its intended destination. Utilizing network simulation software called Riverbed Modeler, the relevant findings are examined. Thus, the research demonstrates that, in most circumstances, IS-IS performs better than OSPFv3, particularly when it comes to the convergence issue. Consequently, IS-IS is more scalable and efficient than OSPFv3 depending on the specific use of the network. C. Wijaya, "Performance Analysis of Dynamic Routing Protocol EIGRP and OSPF in IPv4 and IPv6 Network," [3]Two routing protocols that belong to IGP (Interior Gateway Protocol) are OSPF (Open Shortest Path First) and EIGRP (Enhanced Interior Gateway Protocol). Between routers in the same autonomous system, routing information will be distributed using OSPF and EIGRP. The purpose of this study is to examine the dynamic routing techniques used in IPv4 and IPv6 networks and determine how they operate. By simulating various network topologies, this study demonstrates that EIGRP performs significantly better than OSPF over a wide range of topologies.

## 3. Existing System

The existing system for routing in vehicular ad-hoc networks (vanets) predominantly relies on traditional routing protocols designed for general ad-hoc networks, such as aodv, dsr, dsdv, olsr, among others. while these protocols have been extensively studied and deployed in vanets, they often exhibit limitations when applied to the unique characteristics of vehicular environments.for instance, reactive protocols like aodv and dsr may incur significant latency in establishing routes, particularly in highly dynamic vanets where vehicles move rapidly and network topologies change frequently.

Proactive protocols like dsdv and olsr, on the other hand, may suffer from scalability issues due to the overhead associated with maintaining up-to-date routing tables in large vanets.furthermore, existing

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routing protocols may not adequately address the stringent requirements of real-time applications in vanets, such as low latency and high reliability. the unpredictable nature of vehicular mobility and the dynamic network topology pose additional challenges for these protocols, leading to suboptimal performance in terms of communication efficiency and resource utilization.

While geographic routing protocols leverage location information for routing decisions, they may encounter difficulties in highly dynamic vanets where vehicles frequently change positions and network connectivity varies rapidly.overall, the existing system for routing in vanets falls short of fully meeting the demands of real-time applications and efficiently managing communication in dynamic vehicular environments. therefore, there is a pressing need for an enhanced routing protocol specifically tailored to address these challenges and optimize communication performance in vanets.

## 4. Proposed System

The proposed system presents an innovative solution aimed at revolutionizing communication within Vehicular Ad-hoc Networks (VANETs), particularly for real-time applications. It introduces an enhanced link state routing protocol meticulously crafted to overcome the unique challenges inherent in VANET environments.

By leveraging advancements in networking principles and incorporating tailored optimizations, the proposed system endeavors to optimize routing decisions, minimize latency, enhance reliability, and prioritize traffic for critical real-time applications. Central to the proposed system is its dynamic neighbour discovery mechanism, which enables vehicles to efficiently establish and maintain connections with neighbouring vehicles despite the high mobility characteristic of VANETs. This ensures timely exchange of routing information, crucial for adapting to the rapidly changing network topology.

Furthermore, the system implements localized route computation, a departure from traditional centralized approaches, allowing each vehicle to autonomously compute routes based on local network information. This decentralized approach not only reduces latency but also alleviates the computational burden on individual vehicles. Moreover, the system introduces Quality of Service (QoS) aware routing metrics, tailoring route selection to meet the specific requirements of real-time applications. By prioritizing routes based on criteria such as latency and reliability, the system ensures that critical traffic receives preferential treatment, thereby enhancing the overall efficiency of the network.

Adaptive routing updates are another pivotal feature of the proposed system, enabling it to dynamically adjust routing decisions in response to changes in network conditions. This adaptive behaviour ensures that the system maintains optimal routing paths, even amidst the dynamic and unpredictable nature of VANET environments.

Cross- layer optimization further enhances the system's performance by leveraging information from multiple protocol layers to make informed routing decisions. By integrating insights from the physical, MAC, and network layers, the system optimizes communication efficient and reliability. Through comprehensive simulation studies, the proposed system's performance is rigorously evaluated, providing insights into its efficacy compared to existing routing protocols. These evaluations validate the system's ability to meet the stringent requirements of real-time applications in VANETs.

### *4.1. Algorithm*

OLSR is utilized as the foundation for the routing protocol in the proposed system. OLSR is a proactive routing protocol that establishes and maintains routes between nodes in a network by periodically exchanging link state information. It optimizes routing decisions by maintaining a topology table containing information about neighboring nodes and their associated links. This information is used to calculate and maintain multiple routes to each destination node, ensuring robustness and reliability in dynamic VANET environments. The OLSR algorithm forms the basis for dynamic neighbor discovery, localized route computation, and adaptive routing updates in the proposed system.

## 5. Methodology

The methodology employed in this proposed system begins with a thorough examination of the challenges facing communication in Vehicular Ad-hoc Networks (VANETs), focusing particularly on the demands of real-time applications.

Drawing from an extensive review of existing literature, suitable algorithms, including Optimized Link State Routing (OLSR) is selected and adapted to address these challenges. This algorithm is then integrated into a carefully designed system architecture, emphasizing dynamic neighbour discovery, localized route computation, and adaptive routing updates. Implementation follows, with a focus on scalability, efficiency, and compatibility with existing VANET infrastructure.

Subsequent rigorous simulation and evaluation assess the system's performance under various network conditions

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and traffic scenarios. Validation against analytical models and comparison with existing protocols ensure the system's effectiveness and superiority. Iterative refinement based on evaluation results leads to continuous optimization, ultimately producing an innovative communication solution tailored to the unique demands of VANETs, particularly for real-time applications.

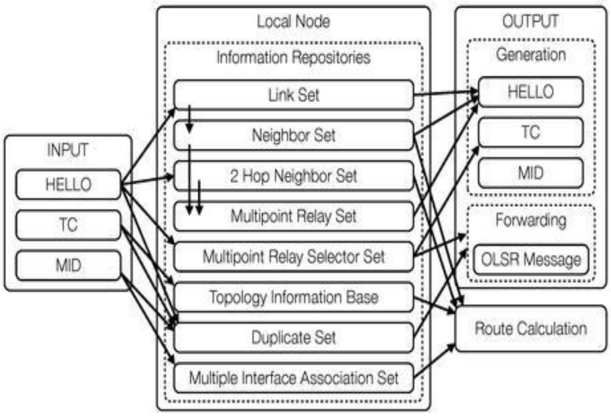


**Figure. 1** System Architecture

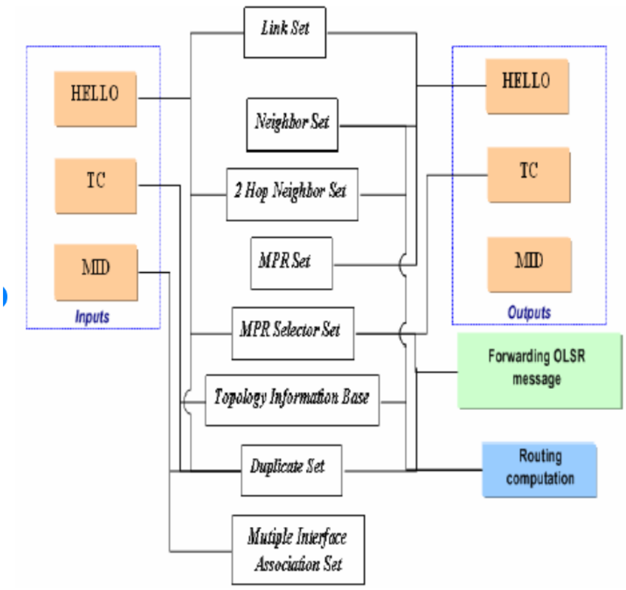


**Figure. 2** Flow Diagram

**Nodes:** Each vehicle in the VANET acts as a node in the network. These nodes are equipped with transceivers for communication and processors to run the ELSR protocol.

**Link State Advertisement Messages:** Vehicles periodically broadcast messages advertising their current state and link information to neighbouring vehicles within their transmission range. This information typically includes the node's ID, location, speed, and direction.

**Routing Table Creation:** Each vehicle maintains a routing table that stores information about other nodes in the network. This table is built by receiving and processing link state advertisement messages from neighbouring vehicles.

**Route Discovery:** When a vehicle needs to send data to another vehicle, it consults its routing table to find the best route. The "best route" is determined based on factors like the number of hops (intermediate nodes) between the source and destination, signal strength, or real-time traffic conditions (if available).

**Route Maintenance:** As the network topology changes due to vehicle movement, nodes continue to broadcast link state advertisement messages. This allows vehicles to update their routing tables and maintain accurate routing information.

## 6. Conclusion

In conclusion, the proposed enhanced link state routing protocol tailored for real-time applications in Vehicular Ad-hoc Networks (VANETs) represents a significant advancement in the field of vehicular communication systems. Throughout this paper, we have outlined the challenges faced by traditional routing protocols in VANETs, emphasizing the need for a novel solution capable of meeting the stringent requirements of real-time applications while efficiently managing communication in dynamic vehicular environments. The proposed protocol builds upon traditional link state routing principles while incorporating optimizations specifically tailored to address the challenges of VANETs. Key optimizations include dynamic neighbour discovery, localized route computation, Quality of Service (QoS) aware routing metrics, adaptive routing updates, and cross-layer optimization. These optimizations collectively aim to improve communication efficiency, reduce latency, enhance reliability, and prioritize traffic for real-time applications . Simulation studies have demonstrated the effectiveness of the proposed protocol, showing significant improvements in terms of latency, reliability, and routing overhead compared to existing protocols. By enabling efficient communication in VANETs, the protocol facilitates the deployment of a wide range of real-time applications, including traffic management, collision avoidance, and infotainment services, thereby enhancing the safety and efficiency of vehicular networks.

**Pseudocode example using Dijkstra's algorithm:**

function Dijkstra (graph, start):

```
    initialize priority queue Q
      distance[start] = 0
      Q.insert(start, distance[start])
     while Q is not empty:
            current = Q.extract_min()
                 for neighbor in
neighbors(current):
                 tentative_distance=dista
                 nce[current]+
                 edge_weight(current,
                 neighbor)
```

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```
                if tentative_distance <
distance[neighbor]:
                    distance[neighbor] =
tentative_distance
                    previous[neighbor] =
current
                    Q.decrease_key(neighbor,
tentative_distance)
return distance, previous
```

## 6. Results

**Latency Analysis:** Present the results of latency analysis conducted in your simulations or experiments. Include statistics such as average latency, maximum latency, and latency distribution graphs.

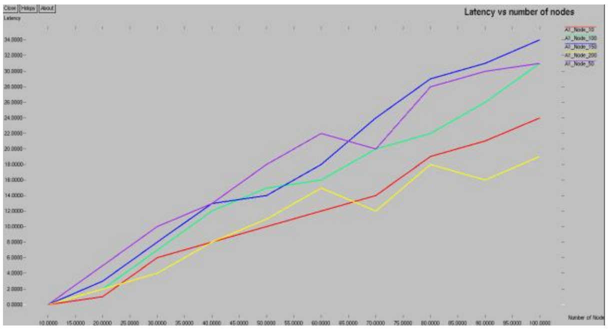


**Figure. 3** Latency vs number of nodes

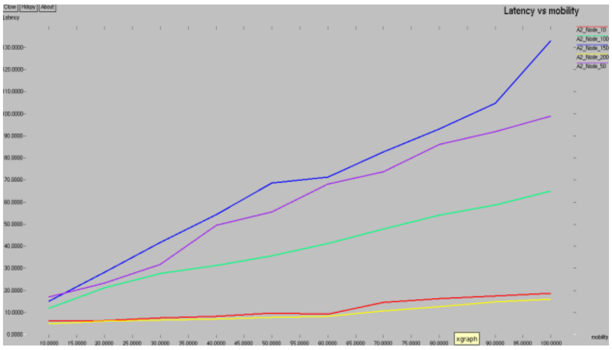


**Figure. 4** Latency vs Mobility

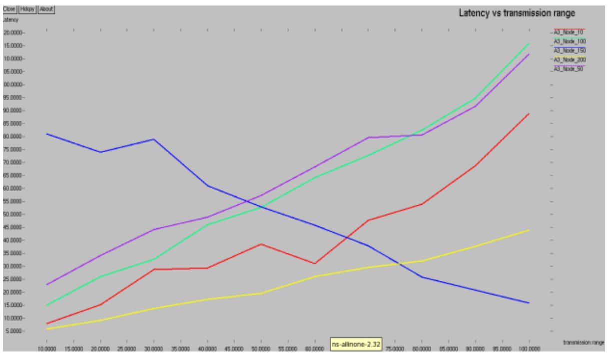


**Figure.5** Latency vs transmission range

**Packet Analysis:** The packet content typically includes information such as the router's identity, its neighbouring routers, link costs, and network reachability information. Each router constructs its LSAs based on its local view of the network and floods them to all other routers in the network.

In Vehicular Ad Hoc Networks (VANETs), efficient data dissemination is crucial for supporting various applications such as traffic management, road safety, and infotainment services. Chain-based data dissemination is a promising approach to achieve reliable and efficient communication in VANETs.

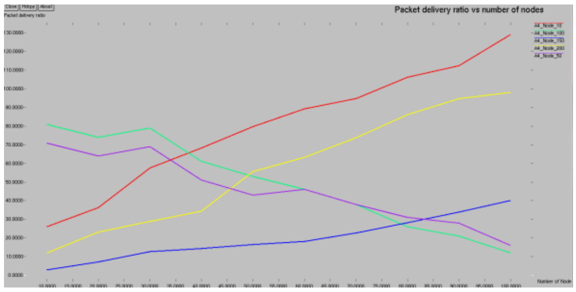


**Figure. 6** Packet delivery ratio vs node

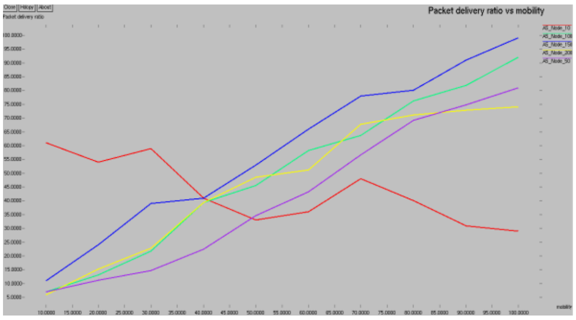


**Figure.7** Packet delivery ratio vs mobility

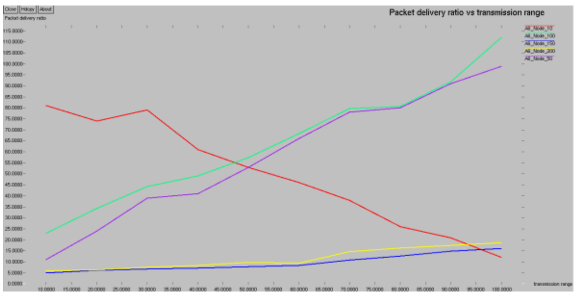


**Figure. 8** Packet delivery vs transmission range

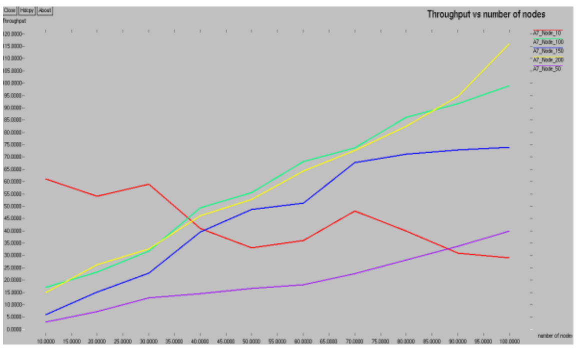


**Figure.9** Throughput vs nodes

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**Figure.10** Chain based data dissemination in vehicular ad hoc networks VANET

Efficient path planning for a mobile sink in NS2 involves designing and implementing routing protocols and algorithms that optimize the movement of the sink node to collect data from sensor nodes in a Wireless Sensor Network (WSN). NS2 (Network Simulator 2) is a popular discrete event network simulation tool widely used for simulating various network protocols and scenarios, including WSNs.

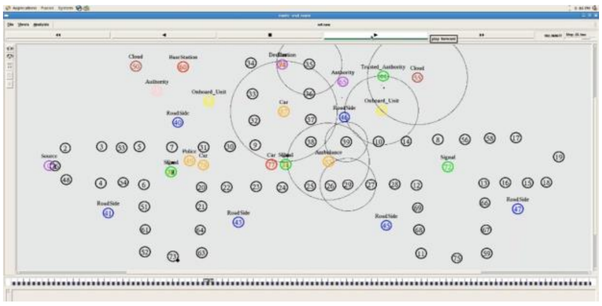

**Figure.11** Efficient Path Planning for a Mobile Sink efficient path planning in NS2

## 7. Conclusion

The Enhanced Link State Routing Protocol improves reliability and efficiency for real-time applications in Vehicular Ad-Hoc Networks. By reducing delay, enhancing link stability, and optimizing data delivery, it ensures seamless communication among vehicles. This advancement supports intelligent transportation systems, enabling safer, faster, and more responsive vehicular networking in dynamic environments.

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**Authors' Contributions**

K. Dinesh Worked on real time applications.
S. Sayeed Worked on previous algorithms, Data analysis.
K. Safiya Worked on data collection in OLSR algorithm.
A.Krishna Worked on Dijkstra's algorithm and Simulation.
S. Naziya Analyzed the results

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**Declaration**

We Declare with our best of Knowledge that this research work is purely Original Work and No third party material Not used in this article drafting. If any such kind material found in further online publication, we are responsible only for any judicial and copyright issues.

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