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VEHICLE TO VEHICLE COMMUNICATION PROTOCOL

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Abstract

Vehicle-to-Vehicle (V2V) communication protocol is an emerging technology in the field of Intelligent Transportation Systems (ITS) that enables vehicles to exchange real-time information such as speed, location, direction, and traffic conditions. By establishing a wireless communication link, usually based on Dedicated Short-Range Communication (DSRC), 5G, or Cellular-V2X (C-V2X), vehicles can share critical safety and mobility data with one another to reduce accidents, improve traffic efficiency, and enhance driver awareness. The protocol defines standardized communication rules that ensure interoperability among different manufacturers and vehicles, thereby creating a reliable vehicular network. V2V communication supports applications such as collision avoidance, lane-change assistance, traffic congestion management, and emergency vehicle prioritization. With growing advancements in IoT and AI, V2V is expected to play a crucial role in enabling autonomous driving and the development of fully connected smart transportation systems.

I. INTRODUCTION

The rapid increase in the number of vehicles on roads has led to rising challenges such as traffic congestion, accidents, and inefficient transportation systems. Traditional traffic management techniques have proven inadequate in ensuring real-time safety and efficiency. To address these issues, **Vehicle-to-Vehicle (V2V) communication** has emerged as a transformative solution that allows vehicles to communicate directly with one another without relying on centralized infrastructure.

V2V communication enables vehicles to exchange data such as position, velocity, and acceleration, allowing them to anticipate potential hazards and take preventive actions. Unlike conventional warning systems, V2V operates in **real-time** and covers situations that might not be visible to drivers or vehicle sensors alone, such as blind-spot detection or hidden vehicle movement.

The adoption of V2V communication, along with Vehicle-to-Infrastructure (V2I) and Vehicle-to-Everything (V2X), is paving the way for a **connected and autonomous**

transportation ecosystem, improving road safety, reducing accidents, and supporting the growth of smart cities.

II.LITERATURE SURVEY

In recent years, significant research has been carried out on Vehicle-to-Vehicle (V2V) communication protocols as part of Intelligent Transportation Systems (ITS) to improve road safety and traffic management. Early studies primarily focused on Dedicated Short-Range Communication (DSRC), a standard based on IEEE 802.11p, which allows low-latency communication between vehicles within a short range. Researchers highlighted its effectiveness in applications such as collision avoidance, lane departure warnings, and cooperative adaptive cruise control. However, scalability issues and high congestion in dense traffic environments limited its performance.

To overcome these challenges, subsequent works explored Cellular-V2X (C-V2X) and 5G-enabled vehicular communication, which offer broader coverage, higher data rates, and better reliability. Studies have shown that C-V2X enhances communication for highway platooning, emergency braking alerts, and real-time traffic monitoring, making it a strong candidate for future smart transportation systems. Moreover, integration of edge computing and cloud-based solutions has been examined to process large amounts of vehicular data efficiently, reducing latency while supporting predictive analysis of traffic flow.

Recent literature also emphasizes the role of artificial intelligence (AI) and machine learning in V2V protocols. These approaches enable vehicles to make intelligent decisions such as predicting potential collisions, optimizing routes, and prioritizing emergency signals. Furthermore, blockchain-based frameworks have been proposed to ensure secure and tamper-proof communication between vehicles, addressing issues of trust, privacy, and cybersecurity.

Overall, the survey of existing literature highlights that while V2V communication protocols have evolved from simple DSRC-based systems to advanced 5G, AI-driven, and blockchain-enabled frameworks, challenges such as network reliability, interoperability, scalability, and security remain open areas of research. These studies provide a foundation for the development of more robust, scalable, and intelligent V2V communication protocols in the future.

III. EXISTING SYSTEM

Currently, most modern vehicles are equipped with onboard sensors such as radar, ultrasonic sensors, cameras, and LiDAR to assist in navigation, adaptive cruise control, blind spot detection, and collision avoidance. While these technologies provide localized situational awareness, they operate within a limited range and are heavily influenced by environmental conditions such as fog, rain, snow, or obstructions like large vehicles or infrastructure. This dependency often leads to reduced reliability in complex driving scenarios, particularly in urban environments with high traffic density.

Several pilot projects and research initiatives have explored Dedicated Short-Range Communication (DSRC)-based V2V systems, which enable direct wireless communication between vehicles to exchange safety-critical information such as speed, location, and braking status. However, DSRC adoption has faced significant barriers including spectrum allocation disputes, high infrastructure investment requirements, and limited scalability in high-traffic networks. Furthermore, due to the absence of global interoperability standards, vehicles from different manufacturers often struggle to communicate seamlessly, reducing the system's overall effectiveness. Existing commercial implementations are also fragmented, as most are manufacturer-specific driver assistance systems rather than universal V2V communication protocols. While some high-end vehicles support basic cooperative awareness messages or emergency alerts, these systems remain isolated and do not form part of a larger connected ecosystem. This lack of integration prevents real-time, predictive safety applications such as cooperative collision avoidance, intersection management, and coordinated platooning.

Thus, the current systems can be described as sensor-dependent, fragmented, and limited in predictive capabilities, focusing primarily on reactive measures rather than proactive accident prevention. Without a standardized, reliable, and scalable V2V communication framework, the promise of truly intelligent transportation systems remains unrealized.

IV.PROPOSED SYSTEM

The proposed system introduces a standardized Vehicle-to-Vehicle (V2V) communication protocol designed to overcome the limitations of existing sensor-dependent and fragmented systems. Instead of relying solely on local perception through onboard sensors, this protocol enables vehicles to continuously exchange real-time data such as speed, acceleration, braking intensity, GPS location, lane changes, and hazard warnings with surrounding vehicles. By establishing a direct communication link, vehicles can extend their situational awareness beyond line-of-sight and environmental barriers, thereby enhancing decision-making in critical scenarios. The proposed system leverages a combination of Dedicated Short-Range Communication (DSRC) or 5G Cellular Vehicle-to-Everything (C-V2X) technology to ensure low-latency, high-reliability data transmission, making it suitable for safety-critical applications like cooperative collision avoidance and intersection management. To ensure interoperability and scalability, the protocol is designed as a universal framework, enabling vehicles from different manufacturers to communicate seamlessly, regardless of brand or model. It incorporates standardized message formats such as Basic Safety Messages (BSM) and Cooperative Awareness Messages (CAM), ensuring consistency across heterogeneous networks. In addition, the system integrates security and privacy mechanisms like message authentication, encryption, and anonymization to protect against cyberattacks and unauthorized tracking. A layered architecture is proposed where the application layer handles safety alerts, the network layer manages routing and data dissemination, and the physical layer ensures efficient transmission using wireless spectrum resources.

Unlike existing reactive systems, the proposed protocol focuses on proactive and predictive safety measures. For instance, a vehicle approaching an intersection can receive advance alerts about another vehicle's hidden trajectory, or a car in a high-speed platoon can coordinate braking with all vehicles simultaneously to avoid chain collisions. The system can also integrate with Vehicle-to-Infrastructure (V2I) networks to support traffic signal optimization, congestion management, and emergency vehicle prioritization. Furthermore, the modular design of the protocol allows future integration with autonomous driving systems, creating a foundation for fully intelligent and cooperative transportation networks.

Overall, the proposed system aims to build a reliable, scalable, secure, and interoperable V2V communication framework that shifts transportation safety from individual sensor-based awareness to cooperative intelligence, paving the way for smarter, safer, and more efficient road networks.

V.SYSTEM ARCHITECTURE

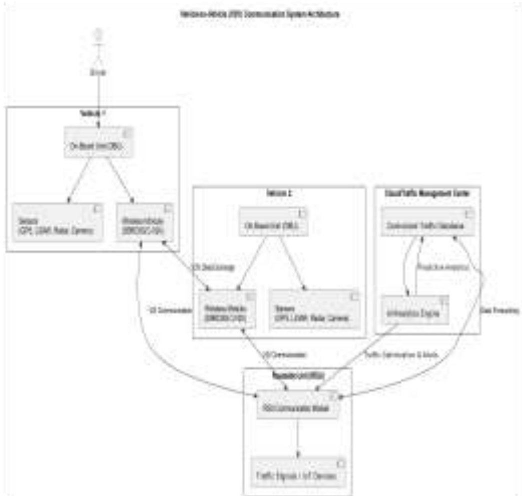

Fig 5.1 System Architecture

The system architecture of the proposed Vehicle-to-Vehicle (V2V) communication protocol is designed as a multi-layered framework that integrates vehicles, roadside infrastructure, and a communication backbone into a seamless ecosystem. At the core of the architecture are equipped vehicles that function as intelligent nodes, each embedded with an On-Board Unit (OBU), sensors (GPS, accelerometer, LiDAR, cameras), and wireless communication modules (DSRC or 5G C-V2X). These OBUs act as both data producers and consumers, continuously broadcasting critical information such as vehicle speed, position, acceleration, braking status, and lane changes. Neighboring vehicles receive this data and process it in real time to assess potential risks and trigger safety actions such as collision warnings or adaptive braking.

The communication layer ensures efficient exchange of data using short-range wireless technologies with low latency and high reliability, enabling real-time coordination between vehicles even in dense traffic conditions. Above this lies the network layer, which handles data routing, message dissemination, and prioritization, ensuring that high-priority safety alerts (e.g., emergency braking or accident warnings) are transmitted instantly while non-critical information (e.g., traffic updates) is handled with lower prior

VI.IMPLEMENTATION

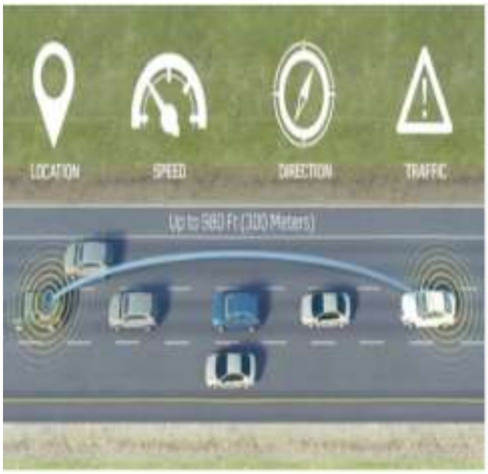

Fig 6.1 V2V Communication

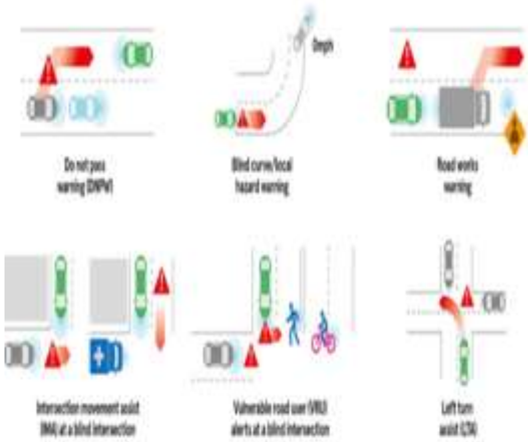

Fig 6.2 Vehicle Platooning

VII.CONCLUSION

The development and deployment of Vehicle-to-Vehicle (V2V) communication protocols mark a transformative step toward achieving safer, smarter, and more efficient transportation systems. Unlike traditional onboard sensors such as cameras, radar, and LiDAR, which only provide limited and localized awareness, V2V communication offers a holistic, predictive framework by enabling vehicles to share critical real-time information about speed, position, direction, and road conditions. This extended situational awareness allows drivers and autonomous systems to anticipate potential hazards well in advance, significantly reducing the likelihood of accidents caused by human error, poor visibility, or unexpected maneuvers.

The proposed V2V protocol, built on advanced wireless technologies such as Dedicated Short-Range Communication (DSRC) and 5G Cellular-V2X (C-V2X), overcomes the limitations of existing systems by ensuring low-latency, high-reliability communication. Furthermore, integration with roadside units (RSUs) and cloud-based traffic management centers provides a collaborative environment where vehicles can interact not only with each other but also with infrastructure, creating a

Vehicle-to-Everything (V2X) ecosystem. This improves overall road efficiency by optimizing traffic flow, reducing congestion, and enabling real-time rerouting during emergencies or roadblocks.

Another critical advantage of the V2V protocol lies in its scalability and adaptability. As more vehicles and smart infrastructure adopt this technology, the effectiveness of the system grows exponentially, ensuring that the entire network benefits from increased participation. Moreover, with the incorporation of AI-driven analytics at the cloud level, predictive modeling and traffic forecasting can further enhance safety and efficiency by identifying accident-prone zones, recommending alternative routes, and improving emergency response times.

Despite challenges such as interoperability across manufacturers, spectrum allocation, cybersecurity threats, and high deployment costs, the benefits of V2V far outweigh these obstacles. With continuous advancements in wireless communication, data security, and standardization efforts, these issues are steadily being addressed. In the long run, the implementation of V2V protocols is expected to serve as a foundation for fully autonomous driving, enabling cooperative decision-making among vehicles and paving the way for accident-free transportation.

In conclusion, the V2V communication protocol represents a paradigm shift in intelligent transportation systems by bridging the gap between localized vehicle sensors and large-scale, cooperative road safety frameworks. Its ability to enhance driver awareness, improve traffic efficiency, and support autonomous driving makes it a cornerstone technology for the future of smart mobility. The successful adoption of V2V will not only save countless lives but also transform urban mobility, reduce environmental impact, and contribute to the creation of safer, sustainable, and intelligent cities.

VIII.FUTURE SCOPE

The future of Vehicle-to-Vehicle (V2V) communication is highly promising, with its applications extending far beyond basic safety alerts and collision prevention. As advancements in wireless communication, artificial intelligence, and smart infrastructure continue to evolve, V2V is expected to become the backbone of next-generation intelligent transportation systems.

One of the most significant future applications of V2V lies in the development of fully autonomous vehicles. By allowing cars to share precise real-time information about their movements, road conditions, and surrounding environments, V2V will enhance the decision-making capabilities of autonomous driving systems. This cooperative communication will enable vehicles to negotiate lane changes, intersections, and merging scenarios without human intervention, significantly reducing accidents caused by human error.

Additionally, integration with Vehicle-to-Everything (V2X) frameworks will expand the scope of V2V beyond car-to-car communication. Vehicles will interact with roadside infrastructure, traffic signals, pedestrians, and smart city networks, resulting in a seamless transportation ecosystem. This will improve urban traffic management, minimize congestion, and enhance emergency response efficiency by providing priority signals for ambulances, fire trucks, and police vehicles.

Cybersecurity and data privacy will also play a central role in the future of V2V systems. Research is already underway to incorporate blockchain-based security mechanisms and end-to-end encryption to safeguard data against hacking and malicious attacks. With these advancements, V2V protocols will achieve higher reliability and trust, ensuring that communication is both accurate and tamper-proof.

Another important area of future growth is the integration of Artificial Intelligence (AI) and Machine Learning (ML). By analyzing massive amounts of vehicular data, AI-driven V2V systems will be able to predict traffic patterns, identify high-risk zones, and suggest optimal routes. These predictive capabilities will not only enhance safety but also reduce fuel consumption and carbon emissions, contributing to sustainable mobility.

Moreover, V2V communication is expected to become a key enabler for Intelligent Transport Systems (ITS) within smart cities. By integrating with IoT sensors, cloud computing, and big data analytics, future transportation systems will provide personalized travel recommendations, real-time public transport updates, and improved logistics for goods delivery. This will transform cities into more efficient, eco-friendly, and user-centric environments.

In the long term, the evolution of 6G wireless communication will further enhance the speed, reliability, and scalability of V2V protocols. Combined with edge computing, this will ensure ultra-low latency and real-time processing, which are critical for mission-critical applications like automated emergency braking, platooning of vehicles, and high-speed autonomous driving.

Overall, the future scope of V2V communication is vast and transformative. From enabling accident-free roads and sustainable urban transport to powering fully autonomous mobility, V2V is poised to redefine the way vehicles and cities interact. With ongoing global standardization efforts, rapid advancements in wireless technology, and growing adoption in smart transportation initiatives, V2V will emerge as a cornerstone technology for the next generation of intelligent and connected mobility systems.

IX. REFERENCES

[1] K. Abboud, H. A. Omar, and W. Zhuang, “Interworking of DSRC and cellular network technologies for V2X communications: A survey,” IEEE Transactions on Vehicular Technology, vol. 65, no. 12, pp. 9457–9470, Dec. 2016.

[2] H. Hartenstein and K. P. Laberteaux, “A tutorial survey on vehicular ad hoc networks,” IEEE Communications Magazine, vol. 46, no. 6, pp. 164–171, Jun. 2008.

[3] C. Campolo, A. Molinaro, R. Scopigno, “Vehicular ad hoc Networks: Standards, Solutions, and Research,” Springer, 2015.

[4] M. Amoozadeh, A. Raghuramu, C. Chuah, D. Ghosal, H. Zhang, J. Rowe, and K. Levitt, “Security vulnerabilities of connected vehicle streams and their impact on cooperative driving,” IEEE Communications Magazine, vol. 53, no. 6, pp. 126–132, Jun. 2015.

[5] J. B. Kenney, “Dedicated Short-Range Communications (DSRC) standards in the United States,” Proceedings of the IEEE, vol. 99, no. 7, pp. 1162–1182, Jul. 2011.
[6] A. Bazzi, B. M. Masini, A. Zanella, and G. Pasolini, “IEEE 802.11p for vehicular networking: A survey,” IEEE Communications Surveys & Tutorials, vol. 23, no. 1, pp. 68–92, 2021.
[7] M. Gerla and L. Kleinrock, “Vehicular networks and the future of the mobile internet,” Computer Networks, vol. 55, no. 2, pp. 457–469, Feb. 2011.
[8] S. Rezaei, R. Sengupta, and H. Krishnan, “Reducing the communication required by DSRC-based vehicle safety systems,” IEEE Transactions on Vehicular Technology, vol. 59, no. 2, pp. 4062–4068, Oct. 2010.
[9] M. Segata and R. Lo Cigno, “Simulation of cooperative driving: A survey,” IEEE Communications Surveys & Tutorials, vol. 17, no. 2, pp. 760–778, 2015.
[10] A. Al-Saadi, A. H. Abdullah, O. Kaiwartya, M. T. Al-Doori, “Systematic review of security vulnerabilities in vehicular ad hoc networks,” Security and Communication Networks, vol. 2018, Article ID 8746457, 2018.