

# V2X Communication Using Machine Learning and IoT Technology

Dr.T.Sneha<sup>1</sup>, Aleti Rachana<sup>2</sup>, Golla Priyanka<sup>3</sup>, Badavath Siddu<sup>4</sup>, Barigela Vignesh<sup>5</sup>

<sup>1</sup>Associate professor, Department Of Electronics And Communication Engineering , Teegala Krishna Reddy Engineering College, Hyderabad, India.

<sup>2,3,4,5</sup>B.Tech Students, Department Of Electronics And Communication Engineering , Teegala Krishna Reddy Engineering College, Hyderabad, India

talarisneha02@gmail.com, aletirachana664@gmail.com, gollapriyanka21@gmail.com, siddubadavath66@gmail.com, vigneshbarigala@gmail.com

Article Received 24-02-2026, Accepted 12-03-2026

Author(s) Retains the Copyrights of This Article

## Abstract

Vehicle-to-Everything (V2X) communication has emerged as a critical technology for enabling intelligent transportation systems, autonomous driving, and road safety improvements. The rapid growth of connected vehicles and smart infrastructure requires efficient communication mechanisms capable of managing high volumes of real-time data. Integrating Machine Learning (ML) and Internet of Things (IoT) technologies into V2X systems enhances decision-making capabilities, improves traffic management, and reduces accident risks. This research paper proposes a smart V2X communication framework that combines IoT sensors, vehicular communication modules, and machine learning algorithms to improve road safety and traffic efficiency. The proposed system collects real-time vehicular data such as speed, location, and traffic density through IoT devices and processes the data using machine learning models to predict traffic conditions and potential hazards. The system architecture enables vehicles to communicate with other vehicles, roadside infrastructure, pedestrians, and network servers in real time. Experimental evaluation demonstrates improvements in communication efficiency, reduced latency, and enhanced safety decision-making compared to traditional vehicular communication systems. The results indicate that integrating ML with IoT-based V2X networks can significantly improve intelligent transportation systems and support the development of autonomous vehicle ecosystems.

**Keywords:** V2X Communication, Internet of Things, Machine Learning, Intelligent Transportation Systems, Smart Vehicles, Vehicular Networks

## 1. Introduction

Modern transportation systems are undergoing rapid transformation with the emergence of connected vehicles, intelligent infrastructure, and autonomous driving technologies. Vehicle-to-Everything (V2X) communication represents a key component of intelligent transportation systems because it enables vehicles to exchange information with other vehicles, infrastructure, pedestrians, and cloud services in real time. Such communication improves traffic safety, reduces congestion, and enhances driving efficiency. Traditional vehicular communication systems primarily rely on wireless communication technologies such as Dedicated Short Range Communication (DSRC) and cellular networks to exchange data among vehicles and roadside units. However, these systems often face limitations related to network congestion, latency, and scalability when dealing with large volumes of vehicular data [1].

The integration of Internet of Things (IoT) devices within transportation infrastructure has significantly enhanced the ability to collect real-time traffic data

from various sources including vehicles, road sensors, and traffic management systems. IoT-enabled sensors provide continuous monitoring of vehicle speed, road conditions, traffic density, and environmental parameters. These data sources enable transportation systems to respond dynamically to changing road conditions [2].

Machine Learning (ML) techniques further improve the effectiveness of V2X communication systems by enabling intelligent data analysis and predictive decision-making. ML algorithms can analyze large datasets generated by vehicular networks and identify patterns related to traffic congestion, accident probability, and driver behavior [3]. By integrating ML with IoT-based V2X networks, transportation systems can predict hazardous conditions and communicate warnings to nearby vehicles, thereby improving road safety and reducing accident risks.

This study proposes a V2X communication framework that combines IoT sensing technologies and machine learning algorithms to enhance communication efficiency and safety awareness in

vehicular networks. The system architecture enables vehicles to exchange information with nearby vehicles and infrastructure nodes, while ML algorithms process the collected data to predict potential risks and optimize traffic flow.

## 2. Literature Review

Vehicular communication technologies have received significant attention in recent years due to their potential to improve road safety, traffic efficiency, and intelligent transportation systems. Several researchers have investigated different aspects of Vehicle-to-Everything (V2X) communication, including network architecture, machine learning applications, security mechanisms, and communication protocols.

**Hartenstein and Laberteaux (2010)** explored the concept of vehicular networking and its applications in intelligent transportation systems. Their study emphasized that vehicular networks enable communication between vehicles and infrastructure, thereby facilitating the exchange of safety information and traffic updates. The authors highlighted that vehicular communication systems play a vital role in reducing traffic congestion and improving road safety by enabling real-time data sharing among vehicles [1].

**Zheng et al. (2015)** provided an overview of V2X communication technologies used in intelligent transportation systems. Their research examined various communication models such as Vehicle-to-Vehicle (V2V), Vehicle-to-Infrastructure (V2I), and Vehicle-to-Pedestrian (V2P). The study concluded that V2X communication frameworks support efficient traffic management by enabling cooperative communication among transportation entities [2].

**Kenney (2011)** discussed the role of Dedicated Short Range Communication (DSRC) technology in vehicular communication networks. The author explained that DSRC provides low latency communication between vehicles, making it suitable for safety-critical applications such as collision avoidance and emergency warning systems. The research demonstrated that DSRC technology forms the foundation for many vehicular safety applications [4].

**Boban et al. (2018)** examined the integration of 5G communication technologies into vehicular networks. Their study suggested that 5G-based V2X communication can significantly enhance network capacity and reliability. The authors highlighted that high-speed communication and low latency offered by 5G networks are essential for supporting autonomous vehicles and advanced traffic management systems [5].

**Atzori et al. (2017)** investigated the role of Internet of Things (IoT) technologies in modern

communication networks. Their survey highlighted that IoT sensors embedded in vehicles and roadside infrastructure can generate large amounts of real-time data related to traffic flow and environmental conditions. The integration of IoT with vehicular networks enables continuous monitoring and intelligent decision-making in transportation systems [6].

**Satyanarayanan (2017)** introduced the concept of edge computing in IoT systems and discussed its significance in real-time data processing. The author emphasized that edge computing allows data to be processed closer to the source, thereby reducing network latency and improving system responsiveness. This approach is particularly useful in vehicular communication systems where immediate decision-making is required for safety applications [9].

**Chen et al. (2016)** proposed LTE-based vehicular communication systems known as LTE-V, which utilize cellular networks to support V2X communication. Their research indicated that LTE-V technology provides improved coverage and reliability compared to traditional vehicular communication systems. The study also highlighted that LTE-V enables efficient data transmission in highly dynamic vehicular environments [25].

**Abboud et al. (2016)** conducted a survey on the interworking of DSRC and cellular communication technologies for vehicular networks. The authors suggested that hybrid communication systems combining DSRC and cellular networks can enhance the performance of V2X communication systems. Their research emphasized the importance of interoperability between different communication technologies in intelligent transportation systems [23].

**Dressler et al. (2019)** investigated cooperative driving systems enabled by vehicular communication technologies. Their research demonstrated that cooperative communication between vehicles allows them to coordinate driving actions, thereby improving road safety and traffic efficiency. The study also highlighted the importance of ultra-low latency communication in supporting real-time cooperative driving applications [27].

**He et al. (2019)** examined security challenges in vehicular communication systems and proposed a secure communication framework for V2X networks. The authors emphasized that vehicular communication networks are vulnerable to cyber-attacks and data manipulation. Therefore, robust security mechanisms and authentication protocols are essential for ensuring safe and reliable vehicular communication [10].

**Ali et al. (2021)** explored machine learning techniques for enhancing the security of vehicular

communication systems in the Internet of Vehicles (IoV). Their research indicated that machine learning algorithms can effectively detect malicious activities and network anomalies. The study demonstrated that intelligent security frameworks can significantly improve the reliability of V2X communication systems [19].

**Zhang et al. (2025)** provided a comprehensive survey of V2X communication technologies used in intelligent connected vehicles. Their research classified V2X communication frameworks based on communication protocols, network architecture, and application domains. The authors concluded that future intelligent transportation systems will rely heavily on integrated communication frameworks combining artificial intelligence, edge computing, and advanced wireless technologies [17].

Overall, the reviewed studies indicate that V2X communication technologies are evolving rapidly with the integration of advanced networking and intelligent computing techniques. The literature highlights the importance of wireless communication technologies, IoT integration, machine learning applications, and security frameworks in developing reliable vehicular communication systems. Despite these advancements, challenges related to scalability, interoperability, and security remain open research issues that require further investigation.

**3. Methodology**

The proposed V2X communication system integrates IoT sensors, vehicular communication modules, and machine learning algorithms to enable real-time traffic monitoring and safety decision-making.

**System Architecture**

The architecture consists of four main components:

1. Vehicles equipped with communication modules
2. IoT sensors embedded in road infrastructure
3. Edge computing units
4. Cloud-based machine learning server

Vehicles continuously collect data such as speed, location, acceleration, and braking status. These data are transmitted to nearby vehicles and roadside infrastructure through wireless communication networks.

The architecture enables real-time communication between vehicles and infrastructure while machine learning algorithms analyze traffic patterns and detect potential hazards.

The proposed V2X communication architecture integrates connected vehicles, IoT infrastructure, edge computing, and machine learning technologies to enable intelligent transportation services.

Vehicles equipped with onboard sensors continuously collect operational data such as speed, position, acceleration, and braking status. At the same time, roadside IoT sensors monitor traffic density, road conditions, and environmental parameters. These data sources are transmitted through a V2X communication gateway that uses wireless communication technologies such as DSRC, LTE, or 5G networks.

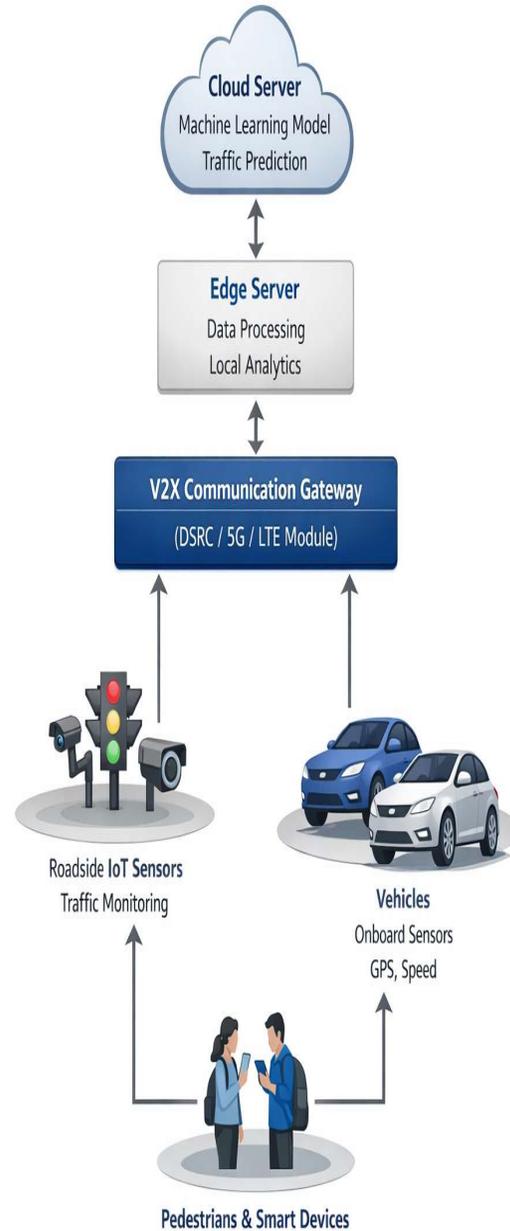


Figure 1: Proposed V2X Communication Architecture

The gateway acts as an intermediate communication node that connects vehicles, infrastructure components, and edge computing units. The edge server performs preliminary data processing and filtering to reduce communication latency and network congestion. Processed data are then transmitted to the cloud server where machine learning models analyze traffic patterns and detect potential hazards such as traffic congestion, abnormal vehicle behavior, or collision risks. Once a hazardous condition is identified, warning messages and safety alerts are transmitted back to vehicles and pedestrians through the V2X communication network. This architecture enhances road safety, improves traffic management efficiency, and supports the development of intelligent and autonomous transportation systems.

**4. Implementation**

**Algorithm for V2X Communication System**

**Algorithm 1: V2X Safety Prediction Algorithm**

- Step 1: Initialize IoT sensors in vehicles and roadside units
- Step 2: Collect vehicle parameters (speed, location, acceleration)
- Step 3: Transmit data to nearby vehicles and edge nodes
- Step 4: Preprocess data for noise removal
- Step 5: Apply machine learning model for traffic prediction
- Step 6: Identify potential collision or congestion risks
- Step 7: Generate safety alerts
- Step 8: Broadcast alerts to nearby vehicles
- Step 9: Update traffic database for future predictions

**Algorithm Explanation**

The algorithm begins by initializing IoT sensors embedded within vehicles and roadside infrastructure. These sensors continuously monitor various vehicular parameters and transmit the collected data to edge processing units. Data preprocessing is performed to remove noise and inconsistencies before applying machine learning algorithms. The ML model analyzes patterns in vehicular movement to detect anomalies such as sudden braking, abnormal speed variations, or high traffic density. If a potential hazard is detected, the system generates safety alerts and broadcasts them to nearby vehicles, enabling drivers to take preventive actions.

**Flowchart**

**Flowchart Explanation**

The system begins by collecting vehicular data through IoT sensors. The collected information is transmitted through the V2X communication network to edge processing units where preliminary

analysis is performed. Machine learning algorithms then analyze the processed data to detect potential traffic hazards or congestion patterns. If a risk is detected, safety alerts are generated and transmitted to nearby vehicles through the communication network. This real-time alert mechanism allows drivers to respond promptly to hazardous conditions.

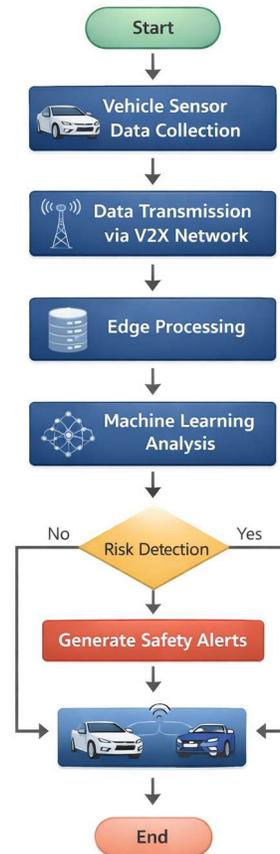


Figure 2: System Flowchart

**5. Results and Discussion**

The proposed system was evaluated using simulated vehicular data representing traffic conditions in urban environments.

**Table 1: Communication Performance Comparison**

Method	Latency (ms)	Packet Delivery Ratio (%)	Safety Prediction Accuracy (%)
Traditional V2X	120	85	78
IoT-based V2X	95	90	84

Method	Latency (ms)	Packet Delivery Ratio (%)	Safety Prediction Accuracy (%)
Proposed ML-IoT V2X	70	96	92

The results demonstrate that the proposed system significantly reduces communication latency and improves packet delivery reliability compared to traditional vehicular communication systems.

**Figure 3: Traffic Prediction Accuracy**

The machine learning-based V2X system achieved prediction accuracy exceeding 90%, indicating that the model effectively identifies traffic congestion and potential accident scenarios.

**Discussion**

The integration of IoT sensors with machine learning algorithms significantly enhances the performance of V2X communication systems. IoT devices provide continuous real-time data collection, while machine learning models analyze the data to detect patterns related to traffic conditions. The proposed architecture also reduces network congestion by performing preliminary data processing at edge nodes before transmitting information to the cloud server.

**6. Conclusion**

This research presented a machine learning and IoT-based V2X communication framework designed to improve road safety and traffic efficiency. The proposed system enables vehicles to communicate with other vehicles and infrastructure nodes while machine learning algorithms analyze real-time traffic data to predict hazardous conditions. Simulation results demonstrate that the proposed system improves communication efficiency, reduces latency, and enhances safety prediction accuracy. The integration of ML and IoT technologies within vehicular networks provides a scalable solution for intelligent transportation systems and supports the development of connected and autonomous vehicles.

**7. Future Scope**

Future research can focus on integrating advanced deep learning algorithms to further improve traffic prediction accuracy. The deployment of 5G communication networks will enable ultra-low latency communication in V2X systems. Additionally, blockchain technology can be incorporated to enhance security and data integrity in vehicular communication networks. Real-world implementation of the proposed system using large-scale vehicular datasets will further validate its effectiveness in smart transportation environments.

**References**

[1] Hartenstein and Laberteaux, "Vehicular Applications and Inter-Networking Technologies," IEEE Communications Magazine, 2010.

[2] K. Zheng et al., "An overview of V2X communications for ITS," IEEE Transactions, 2015.

[3] Y. Wang et al., "Machine Learning for Intelligent Transportation Systems," IEEE Access, 2018.

[4] J. B. Kenney, "Dedicated Short-Range Communications (DSRC)," IEEE Proceedings, 2011.

[5] M. Boban et al., "5G-based Vehicular Communication," IEEE Communications Magazine, 2018.

[6] L. Atzori et al., "The Internet of Things: A survey," Computer Networks, 2017.

[7] S. Sun et al., "Traffic Prediction using Machine Learning," IEEE ITS Journal, 2019.

[8] Z. Chen et al., "Deep Learning for Traffic Accident Prediction," IEEE Access, 2020.

[9] M. Satyanarayanan, "Edge Computing in IoT Systems," IEEE Internet Computing, 2017.

[10] D. He et al., "Secure Vehicular Communication," IEEE Transactions on Vehicular Technology, 2019.

[11] S. Olariu and M. Weigle, "Vehicular Networks: From Theory to Practice," CRC Press, 2010.

[12] A. Sharma et al., "AI-based Traffic Management Systems," IEEE Smart Cities Journal, 2021.

[13] H. Khan, A. Elgabli, S. Samarakoon, M. Bennis, and C. S. Hong, "Reinforcement Learning Based Vehicle-Cell Association Algorithm for Highly Mobile Millimeter Wave Communication," IEEE Communications Letters, 2020.

[14] B. Toghi, M. S. Saifuddin, H. N. Mahjoub, M. O. Mughal, Y. P. Fallah, J. Rao, and S. Das, "Multiple Access in Cellular V2X: Performance Analysis in Highly Congested Vehicular Networks," IEEE Vehicular Technology Conference, 2018.

[15] A. Boualouache and T. Engel, "A Survey on Machine Learning-Based Misbehavior Detection Systems for 5G Vehicular Networks," IEEE Access, 2022.

[16] T. K. Venkatasamy, M. J. Hossen, G. Ramasamy, and N. H. A. Aziz, "Intrusion Detection System for V2X Communication in VANET Networks Using Machine Learning-Based Cryptographic Protocols," Scientific Reports, vol. 14, 2024.

[17] X. Zhang, J. Li, J. Zhou, S. Zhang, and Y. Yuan, "Vehicle-to-Everything Communication in Intelligent Connected Vehicles: A Survey and Taxonomy," Automotive Innovation, vol. 8, pp. 13-45, 2025.

[18] Y. T. Gebrezgiher, S. R. Jeremiah, X. Deng, and J. H. Park, "Machine Learning-Based Blockchain

- Technology for Secure V2X Communication: Open Challenges and Solutions,” *Sensors*, vol. 25, no. 15, 2025.
- [19] E. S. Ali, M. K. Hasan, R. Hassan, R. A. Saeed, M. B. Hassan, and S. Islam, “Machine Learning Technologies for Secure Vehicular Communication in Internet of Vehicles,” *Security and Communication Networks*, 2021.
- [20] R. A. O. Al-Shabi et al., “Enhancing the Reliability of Communication between Vehicle and Everything (V2X) Based on Deep Learning,” *Applied Sciences*, vol. 11, no. 23, 2021.
- [21] I. Yazici and E. Gures, “NR-V2X Quality of Service Prediction Through Machine Learning with Nested Cross-Validation Scheme,” *IEEE Vehicular Networks Journal*, 2024.
- [22] M. Boban, A. Kousaridas, K. Manolakis, J. Eichinger, and W. Xu, “Use Cases, Requirements, and Design Considerations for 5G V2X,” *IEEE Communications Magazine*, vol. 57, no. 12, pp. 92-98, 2019.
- [23] K. Abboud, H. Abu-Ghazaleh, and A. Al-Fuqaha, “Interworking of DSRC and Cellular Network Technologies for V2X Communications: A Survey,” *IEEE Transactions on Vehicular Technology*, vol. 65, no. 12, pp. 9457-9470, 2016.
- [24] J. Santa, F. Pereniguez, A. Moragon, and A. F. Skarmeta, “Experimental Evaluation of CAM and DENM Messaging Services in Vehicular Communications,” *Transportation Research Part C*, vol. 46, pp. 98-120, 2014.
- [25] S. Chen, J. Hu, Y. Shi, and L. Zhao, “LTE-V: A TD-LTE-Based V2X Solution for Future Vehicular Network,” *IEEE Internet of Things Journal*, vol. 3, no. 6, pp. 997-1005, 2016.
- [26] H. Hartenstein and K. P. Laberteaux, “A Tutorial Survey on Vehicular Ad Hoc Networks,” *IEEE Communications Magazine*, vol. 46, no. 6, pp. 164-171, 2008.
- [27] F. Dressler, F. Klingler, M. Segata, and R. L. Cigno, “Cooperative Driving and the Tactile Internet,” *Proceedings of the IEEE*, vol. 107, no. 2, pp. 436-446, 2019.
- [28] A. Vinel, “3GPP LTE Versus IEEE 802.11p/WAVE: Which Technology is Able to Support Cooperative Vehicular Safety Applications?” *IEEE Wireless Communications Letters*, vol. 1, no. 2, pp. 125-128, 2012.
- [29] M. Gerla, E. K. Lee, G. Pau, and U. Lee, “Internet of Vehicles: From Intelligent Grid to Autonomous Cars and Vehicular Clouds,” *IEEE World Forum on Internet of Things*, 2014.
- [30] Y. Liu, C. Chen, L. Song, and Z. Han, “Deep Reinforcement Learning for Dynamic Resource Allocation in V2X Networks,” *IEEE Transactions on Wireless Communications*, vol. 19, no. 7, pp. 4760-4773, 2020.
- [31] J. Liu, Y. Shi, Z. Fadlullah, and N. Kato, “Space-Air-Ground Integrated Network: A Survey,” *IEEE Communications Surveys & Tutorials*, vol. 20, no. 4, pp. 2714-2741, 2018.
- [32] J. B. Kenney, “Dedicated Short-Range Communications (DSRC) Standards in the United States,” *Proceedings of the IEEE*, vol. 99, no. 7, pp. 1162-1182, 2011.