International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Revolutionizing Urban Mobility: Smart Transportation & Vehicle-to-Infrastructure Communication: A Review

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Abstract

The burgeoning popularity of IoT technology has significantly altered transportation, with an extensive variety of repercussions. Intelligent Transportation Systems (ITS) are at the vanguard of this change, which has the potential to fundamentally change urban transportation for both individuals and businesses. ITS has expanded considerably in recent years, owing to global urbanization and industrialization advancements. It is regarded as a game-changing technology that improves road safety, improves traffic flow, and improves the entire driving experience. Despite many research efforts on ITS applications and simulation platforms, formal semantic descriptions for intelligent transportation systems have been noticeably lacking. Rising rates of accidents suggest the necessity for a robust Smart Transport System (STS) that prioritizes improving mobility, and reliability, as well as reducing carbon dioxide and methane emissions from automobiles beyond dispersing gains throughout everywhere. Multiple traffic signal management approaches have been designed to enhance real-time traffic movement at intersections, but none have achieved seamless, congestion-free traffic movements. The creation of an interconnected unified framework that integrates and links vehicles with VANET, IoT, and AI technologies will significantly affect the establishment of an innovative reliable mobility network. Internet of Vehicles (IoV) systems will connect several automobiles to share vital information through an IoT-enabled network. Vehicle-to-infrastructure (V2I) communication is essential in developing intelligent transportation and rail traffic management systems, significantly improving road traffic safety and efficiency. A V2I system integrates transmission and analysis capabilities into vehicles and corresponding infrastructure. Wireless sensors are strategically positioned along highways or driving zones in this system. The significance of safe and effective V2X communication between automobiles and facilities expands substantially as intelligent modes of transport progress.

Keywords: IoT, IoV ,Vehicle, Infrastructure, V2V, Communication, Transportation, STS, V2I

1. Introduction

Despite multiple investigations on managing traffic, there is currently a research absence in completely addressing all aspects of urban transportation management system [1]. The rapid advancement of Internet of Things (IoT) technology has had a tremendous impact on the transportation industry, with far-reaching consequences. Intelligent Transportation Systems (ITS) are an important IoT deployment [2]. In recent years, significant focus has been laid on the establishment of congestion mitigation algorithms to ensure the effective distribution of safety signals in vehicle-to-vehicle (V2V) communication [3]. IoT technology rapidly developed a viable traffic management system, especially in road transportation, by leveraging its wide capabilities in coordinating, tracking, detecting, and communicating, among other things [4]. The growing popularity of ITS presents novel challenges, such as the necessity for effectively transferring high data rates, providing accelerated response systems for users, integrating fresh technology, and streamlining their remote installation [5]. Securing Vehicular Sensor Networks (VSNs) is a critical challenge in the growing ITS. Users communicate sensitive information that risky entities may assault. Malware and spam are common threats as are black holes and wormholes, as well as physical and electrical disruptions [6]. The IoT-driven Traffic Management System is vital for traffic management, secure data sharing, and accident detection. It equips self-driving cars and intelligent devices with sensors for effective data acquisition and transferring [7]. Vehicle networks are indispensable for ITS safety and reliability. The next 6G breakthroughs will bring substantial network density and heterogeneity, bringing new challenges to sustaining robust authentication approaches. The issues include flexibility, compatibility, assurances, and anonymity [8]. ITS encompasses multiple methods and technologies that boost transport effectiveness and security, while also offering a platform for frictionless interaction and communication among all parties involved [9]. IoT-enabled communication between vehiclesbrings in a new era of connectivity, giving progress to ITS. As more cars connect to the Internet, enormous amounts of data are generated, requiring efficient data management and interpretation into vital data for successful systems [10]. Data analytics combined with sensor data handling to improve traffic management in the world of IoT-based vehicle communication. IoT-ITS optimizes customer perceptions of productiveness and accuracy by automating multiple forms of transportation [11]. The vehicle-to-vehicle (V2V) network is an entirely novel concept that utilizes diverse communication technologies, including Wi-Fi and Bluetooth. Due to the substantial number of nodes in these networks and their distant locations, there is an ongoing examination of the feasibility of routing protocols. Fig. 1 depicts the progressive 6G vehicular applications in the smart transportation system, showcasing the advancements and developments in the integration of sixth-generation technologies for enhanced mobility and connectivity [12].

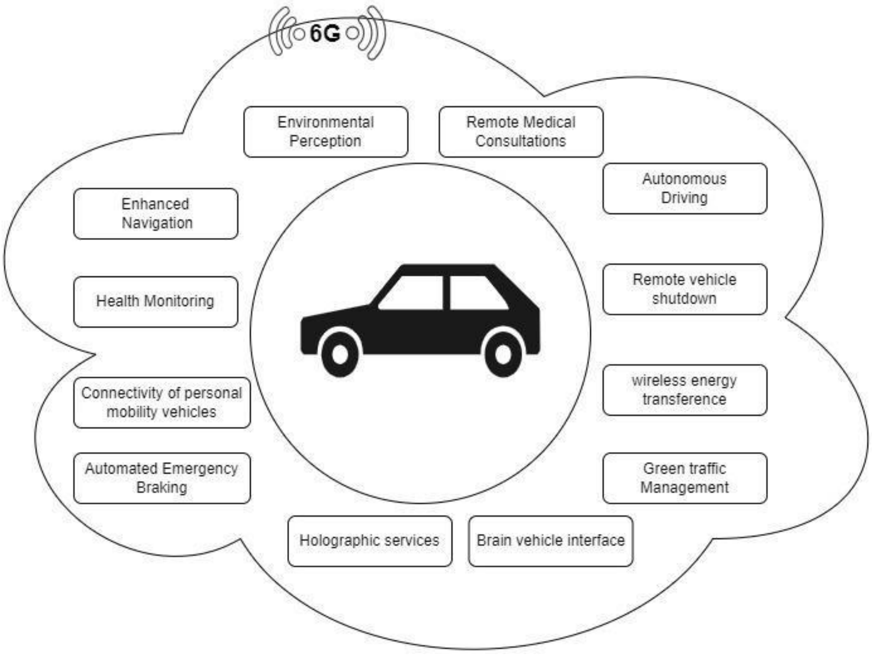

Figure 1: Evolutionary 6G vehicular applications

1.1 Internet of Things & Vehicle-to-Vehicle Transportation

Creating a customized module for the automotive industry would boost customer satisfactionin vehicles. This module might help automobiles maximize passenger comfort, strengthen security, intervene in crises, provide dependable parking, and reduce traffic infractions [13]. Based on the latest resource utilization research, adaptive vehicular networks necessitate efficient utilization of an extensive variety of components. As a result, it is imperative to reiterate the vitality of approaching challenges related to rapidly spreading networks with high connectivity requirements [14]. Future vehicular networks anticipate relying heavily on Vehicle-to-Infrastructure (V2I) connectivity as collaborative ITS services accumulate momentum. These links, while typically functional, may have intermittent connectivity disruptions. By employing cloud-provided vehicle data to improve decision-making, V2I interactions facilitate centralized network management [15]. Smart mobility powered by the Internet of Vehicles (IoV) improves V2V connectivity and yet introduces it to an open- channel setting with motorists, pedestrians, roadside facilities, and vehicle management systems, making it vulnerable to adversary surveillance, modification, elimination, or fraudulent data insertion [16]. The emergence of IoT is viewed as a boon for the vehicle industry, with several opportunities to build, evolve, and boost seamless customer satisfactioncontributions. Over time, IoT has developed and evolved substantially in an array of automotive applications [17]. The primary traffic concern stems from elevated commuter numbers. IoT technology is critical for improving municipal infrastructure, including areas such as public parking lot surveillance, sound detection in various locations, and traffic level management [18]. IoT can revolutionize and offer numerous possibilities in a broad spectrum of domains, including smart cities and intelligent transportation. Autonomous vehicles are intelligent vehicles that can navigate and function autonomously on carefully developed road infrastructure [19]. A connected vehicle is an essential component of the IoV, showcasing a novel IoT application. It enables information interchange via sensors and smart deviceswithin the vehicle as well as smart systems outside the vehicle, which is a vital part of ITS [20]. Vehicles communicate simultaneously with surrounding IoT-enabled intelligent devices through V2X communication, possibly changing our driving habits. The swift growth of IoT in transportation has transformed conventional applications into adaptive ones [21]. IoT- powered vehicles promise to improve services and stimulate cutting-edge innovations. However, this integration involves the creation of new communication infrastructures and platforms in order to fulfil an array of networking and architectural needs [22]. Vehicles leverage open communication channels to communicate wirelessly with one another, cloud servers, and roadside equipment. To strengthen data privacy and security, a lightweight authenticated, privacy-preserving framework is being implemented within the context of IoV deployment [23]. IoV and linked vehicles have the potential to drastically strengthen autonomous driving. Big data technology, with its immense networked data storage, can be utilized in autonomous vehicle research and IoV development. IoV delivers two-way communication between vehicles and their environment. Below, Fig. 2 illustrates the Vehicle-to-Infrastructure system of systems, providing an explanation of the integrated connectivity and communication framework between vehicles and various infrastructure components within the system [24].

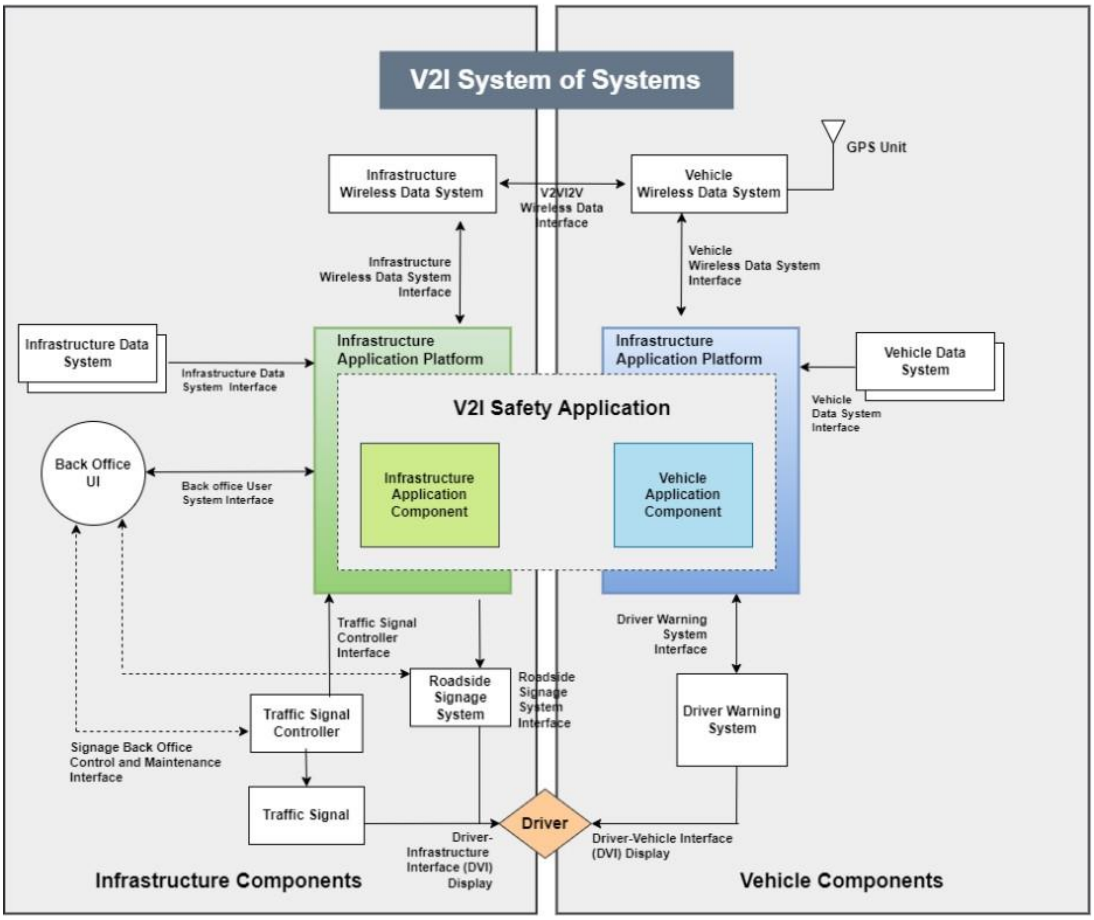

Figure 2: V2I Architecture

1.2 Vehicular Ad-hoc Network (VANET)

Excellent communication is essential for efficient and secure smart transportation systems. V2X communication has emerged as a critical component in the development of intelligent transportation networks in smart cities [25]. The Vehicular Ad-hoc Network (VANET) broadens on Mobile Ad-hoc Networks (MANETs) in modern transportation, presenting opportunities for enhanced security, reliability, and privacy. Nonetheless, direct communication has obstacles, particularly in terms of overhead [26]. VANET is separated into two major components: vehicle-to-infrastructure (V2I) and vehicle-to-vehicle (V2V) communication systems. This technology is still in its infancy and is not widely employed. Dedicated Short Range Communication (DSRC) is currently an essential component in this system [27]. In wireless technology, V2I connectivity is frequently maintained by a combination of software, components, and programming. It is compatible with a variety of systems, including traffic signs, road signs, and lighting systems [28]. The implementation of an intelligent and trustworthy transportation system will be significantly impacted by the establishment of a globally connected system that incorporates and connects automobiles utilizing VANET, IoT, and AI technologies [29]. Nevertheless, VANETs acknowledge resource management challenges in evolving, resource-constrained vehicle environments. Coupling cloud-fog computing and Software-Defined Networking (SDN) with VANETs optimally leverages computing capacity across multiple layers for managing vehicular data [30]. VANETs have substantially enhanced traffic management and are the foundation of effective traffic regulation in major towns. However, it is critical to recognize that they may have limitations that limit their ability to tackle particular problems in specific situations [31]. Increasing confidence in message processing nodes can assist in addressing VANET security challenges holistically. On the other hand, dishonest vehicles such as Man in the Middle (MiTM) and attackers disseminating destructive content pose a severe VANET threat [32]. Extensive study has recently been carried out on blockchain-based VANETs for their potential to provide decentralized administration, information authenticity, and accountability. We may establish a VANET-specific handover authentication scheme using blockchain technology [33]. To effectively operate VANETs, persistent data transfer among automobiles, Road Side Units (RSUs), and architecture necessitates an expansion beyond the current host-centric IP-based network. Information-centric networking (ICN) topologies deliver a comprehensive solution for fixing the drawbacks of IoT-based VANETs, commonlyknown as VANET-IoT [34]. Key research concerns involve sustaining a phenomenal vehicular experience, strengthening network operator services, and determining optimal RSUs for reliability. It is critical to consider these issues to improve the functionality of RSU functions during network encapsulation [35]. Three stages constitute an exclusive RSU placement framework for V2I communication that employs multicriteria decision-making (MCDM). A real-time V2I hardware system for gathering data is being developed, involving node mobility-like vehicles with transmitting and communicating devices, as well as physical RSUs. Below, Fig. 3 elucidates the VNET architecture within the system, detailing the framework designed for vehicle-to-vehicle communication, showcasing the infrastructure and mechanisms facilitating seamless interaction among vehicles [36].

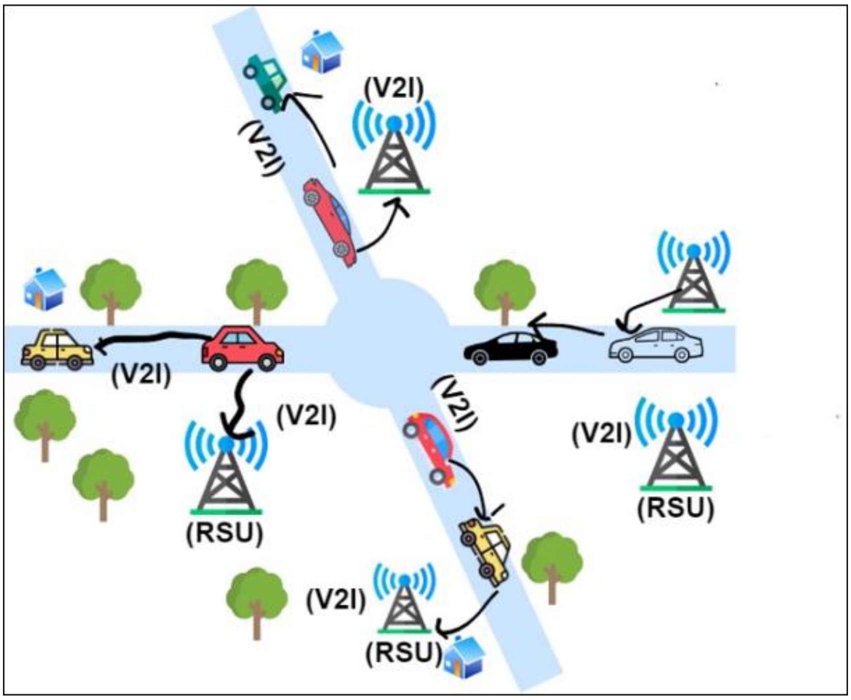

Figure 3: VNET Architecture

1.3 Intelligent Traffic Management

Experts are fascinated by intelligent transportation's capability to transform mobility. In smartcities, IoT provides motorists with advantages such as efficient coordination of traffic, streamlined administration, facilitated parking, and greater security [37]. As smart cities flourish, novel requirements for controlling carbon emissions (CEs) in the transportation system become apparent. ITS provides a solution to both traffic congestion and CEs caused by a sharp rise in vehicle numbers [38]. An IoT-based evaluation of performance methods anticipates improving vehicle communication, traffic management, driver security, and cloud-based applications. A GPS-based route selection model proves essential for addressing urban transportation challenges congestion mitigation, and remote vehicle connectivity [39]. Modernization and technological innovations have culminated in a significant rise in the number of automobiles, generating severe traffic congestion, more accidents, and greater pollution. Consequently, IoV is critical to adequately control and manage traffic [40]. On highways, lane switches aimed at passing slower vehicles yet maintaining momentum could harm oncoming drivers who are unprepared. The idea is to provide a warning system to help drivers make educated judgments before changing lanes on unidirectional roadways [41]. Intelligent traffic lights dynamically supervise transport and pedestrian movement. Implementing a top-tier system necessitates precise recognition of independent traffic patterns. These technologies efficiently regulate traffic by recording visuals and making real- time assessments that reflect their current situation [42]. Robust tracking of traffic events and congestion gives vital insights into strengthening traffic security and provides information on the type of traffic incidents, violations, driving patterns, and more [43]. A vehicle's capability to determine optimal routes through communication with its sensors and infrastructure is critical in autonomous driving. Following that, the vehicle will automatically follow established routes [44]. Conventional approaches often ignore traffic guidance, adjusting patterns, collisions, emergencies, and crosswalks when synchronizing signal timing at surrounding intersections. Real-time Traffic Signal Control (TSC) technology innovation is vital for effectively regulating congestion in smart city crossings [45]. Soaring accident rates draw attention to the necessity of a robust Smart Transportation System (STS). Modifications should prioritize optimizing traffic flow, sustaining system reliability, and minimizing vehicle carbon dioxide and methane emissions [46]. A thorough examination of V2X connection channel statistics in the mmWave frequency occurs in a range of traffic environments and deployment circumstances. The study employs a constructed ray-tracing (RT) simulator with verified electromagnetic (EM) parameters to create three-dimensional (3D) ecological models employing Open Street Map (OSM) data [47]. Millimeter-wave (mmWave) transmits adequate bandwidth for traffic management and vehicular passenger entertainment. To mitigate the substantial route loss and offer an appropriate optimum coupling loss, effective mmWave transmission utilizes directional antennas at the transmitter or receiver. Fig. 4 illustrates the general architecture for vehicle-to-infrastructure communication within the system, providingan explanation of the overall framework designed to facilitate effective interaction between vehicles and infrastructure components [48].

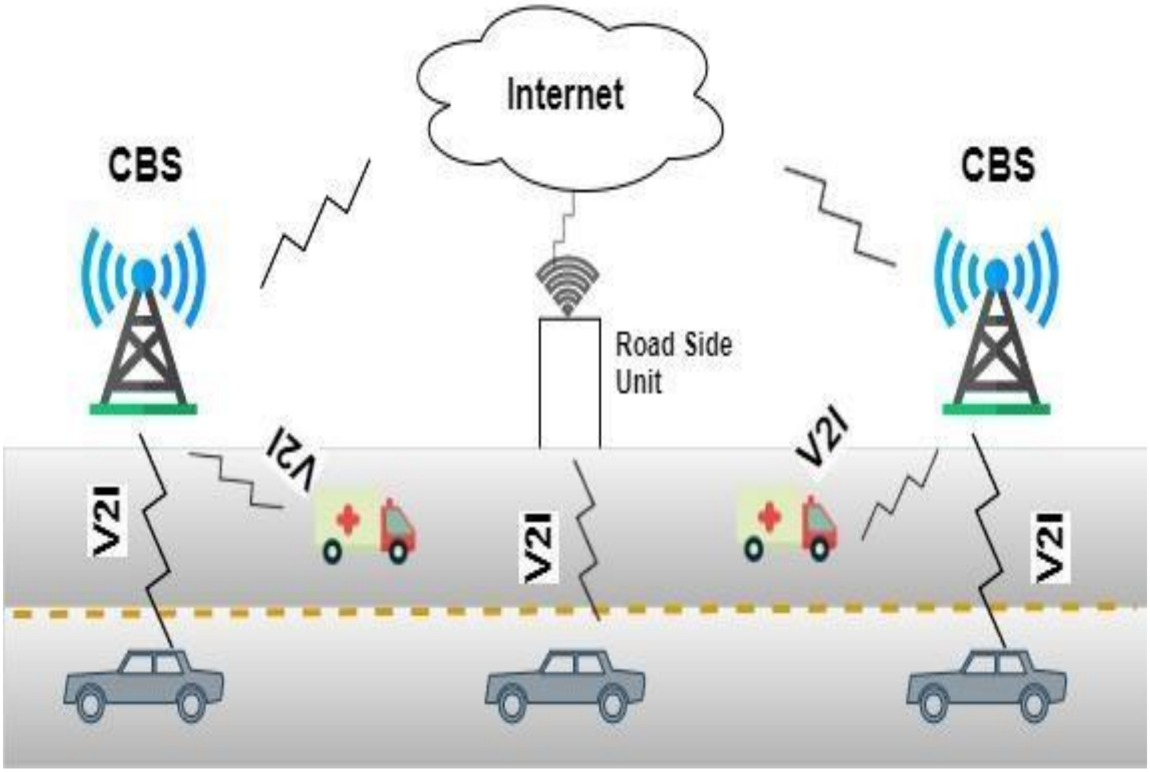

Figure 4: General architecture for vehicle-to-infrastructure communication

1.4 Edge Cloud

Current approaches encounter difficulties in adequately validating an enormous quantity of communications generated by multiple vehicles within their interaction range. The situation is triggered by the substantial computing load engaged with sequential authentication [49]. The integration of high-speed, resilient, low-latency connections with AI and IoT technologies will pave the way for fully intelligent Autonomous Vehicles (AVs), showcasing the synergy between real-world and digital information in the context of Industry 4.0 [50]. An eco-driving algorithm that leverages connected vehicle technology and incorporates fundamental kinematic wave and car-following model initiatives to accomplish two key goals. These objectives attempt to increase signal intersection throughput and minimize fuel usage [51]. Vehicles communicate with one another and relate items in IoV. Autonomy, speed, and fragmentation are critical for facilitating the smooth exchange of data. Blockchain technology has emerged as a secure vehicle communication option [52]. Sensor-based perception is essential for Connected Autonomous Vehicles (CAVs), which use technology such as vision cameras, LiDARs, and radars. Cooperative awareness provides a lot of possibilities for enhancing road safety [53]. Conventional traffic signal systems transmit halt instructions but cannot detect law offenders, ultimately triggering misconduct. An automated traffic signal system based on the Dijkstra algorithm should be implemented to improve security, eliminate human mistakes, and avoid malpractice [54]. IoT empowers smart vehicles with real-time obligations, but resource limits, such as sophisticated DAG operations, cause challenges. Constrained cars can shift work to neighbouring underused vehicles for optimum resource management [55]. For superior passenger and vehicle safety, acountry must prioritize efficient transportation management, stimulating interactions in an intelligent transportation network such as V2V, Vehicle-to-Human (V2H), Vehicle-to-Mobile (V2M), and Vehicle-to-Other (V2R) connections to parties such as theatres, residences, and food establishments along highways [56]. The

IoV's existing network access technologies and communication protocols are unpredictable. IoV infrastructure components lack an identified communication protocol layer and data interface, resulting in complexity in network connections and cooperative communication throughout the system [57]. IoV is emerging as a competitive data authentication technique. Some of them employ complex certificate management and are susceptible to quantum Diffie-Hellman attacks. To strengthen IoV's wireless security, a new certificate-less data authentication mechanism was proposed [58]. Sensor-based systems like accelerometers, acoustic sensors, and LIDAR could be employed in three ways prevention, pre-detection, and post-detection. These approaches are typically included in frameworks like ITS, which make use of V2X and IOV communication protocols [59]. Traffic jams, interruptions, and accidents plague existing transportation options. This study describes an Adaptive Traffic Management (ATM) system designed and implemented utilizing Machine Learning and IoT [60]. Although cloud computing is fantastic for managing enormous quantities of information, it may not be appropriate for time-sensitive applications like Smart Traffic Monitoring. As a consequence, integrating fog computing into intelligent platforms is necessary for leveraging cloud computing fundamentals [61]. The Edge Information System (EIS), which employs wireless network edge resources such as radio access points, is critical for the creation of IoV. Edge computing, edge storing, and edge AI all play essential roles in delivering low-latency knowledge, processing, and data administration [62]. Conventional methods for detecting intrusions might not prove appropriate in situations involving huge volumes of vehicle data and multiple cybersecurity risks. Therefore, sophisticated intrusion detection systems are necessary to effectively prevent attackers in these networks [63]. A fuzzy algorithm monitors traffic density and driving speeds employing optics to foresee congestion levels. Using this data, the algorithm chooses routes while maintaining integrity in order for improved traffic flow [64]. Accidents that cause injuries to numerous people are frequently triggered by driver distractions and disrespect for traffic regulations and signals. Thus, developing an IoT-enabled intelligent transportation system is imperative [65]. ITS improves transportation security, ecological sustainability, and accessibility while minimizing environmental impact. Despite substantial research on ITS applications and training platforms, delivering formal conceptual descriptions for these systems remains untapped [66]. Future smart cities will have seamless communication and entirely autonomous mobility on established routes. This needs a robust, flexible system architecture and continuous connectivity, a difficulty that may be reduced by using Fog-Cloud Networks [67]. As personal communications and transportation technology advances at an exponential rate, the interesting prospect of assessing whole new business possibilities through concepts now beyond our scope occurs [68]. Smart transportation and smart cities depend on Software-Defined Vehicular Networks (SDVNs). However, safety concerns persist due to increased transit, a greater attack surface, with the possibility of alternate attack routes in the future. Below, Fig.5 explains the Architecture of the Internet of Vehicles (IOV) based on vehicular clouds which is a dynamic network infrastructure connecting vehicles, users, and other smart devices to the Internet [69].

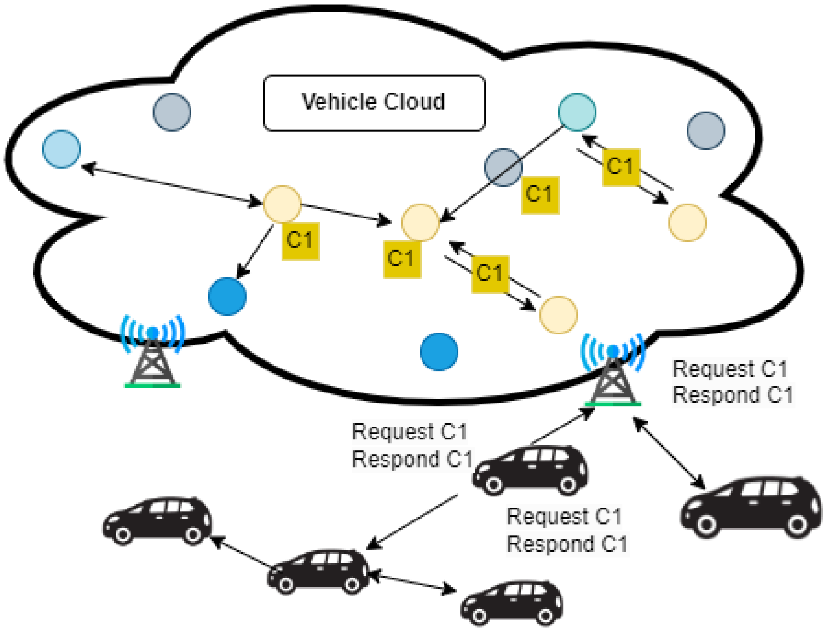

Figure 5: Architecture of IOV based on vehicular clouds

Figure 6 elucidates the reliability advantages stemming from the integration of blockchain technologies in the Internet of Vehicles (IoV) within IoT-enabled traffic management and vehicle-to-infrastructure communication. By leveraging blockchain, a decentralized and secure system is established, enhancing data integrity, transparency, and trust. This technology ensures a robust and tamper-resistant framework for managing traffic data and facilitating seamless communication between vehicles and infrastructure. The figure demonstrates how blockchain contributes to the overall reliability and efficiency of IoV applications, addressing key concerns in the context of traffic management and vehicle- infrastructure connectivity [69].

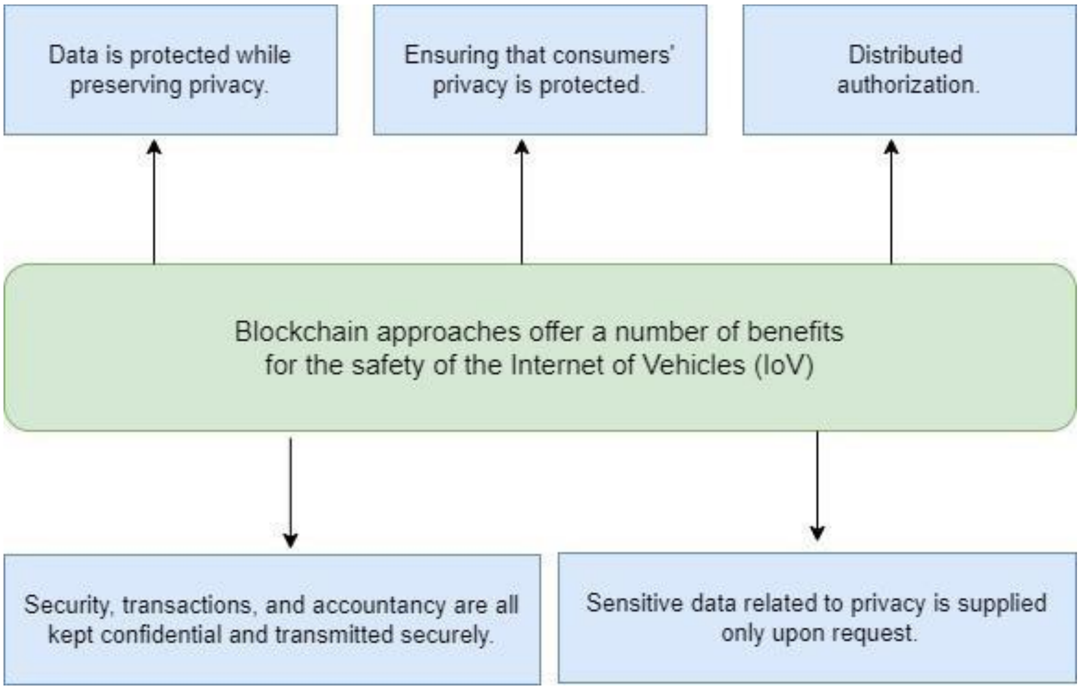

Figure 6: Reliability benefits of blockchain technologies for the Internet of Vehicle

2. Literature Review

Various papers had been surveyed on the Revolutionizing Urban Mobility: Smart Transportation & Vehicle-to-Infrastructure Communication – A Review. Mainly, the list of the surveyed papers is described below.

Smith, J., & Johnson, R. (2019) [70]**.** "A Comprehensive Review of IoT-Enabled Traffic Management in Smart Transportation Systems." In this paper, the authors provide an extensive analysis of the current state of IoT applications in traffic management, emphasizing the importance of addressing key issues such as data security and system scalability.

Patel, A., & Sharma, S. (2020) [71]**.** "Vehicle-to-Infrastructure Communication: A Critical Survey of Emerging Technologies." This study offers insights into the various communication technologies facilitating vehicle-to-infrastructure communication, highlighting their strengths and weaknesses. The authors also discuss potential avenues for improving communication efficiency.

Lee, M., & Kim, Y. (2017) [72]**.** "Challenges and Opportunities in the Integration of IoT in Traffic Signal Control Systems." The paper reviews challenges faced in integrating IoT into traffic signal control and explores opportunities for optimizing traffic flow. It addresses issues like system interoperability and proposes solutions for a more efficient traffic management system.

Wang, H., & Chen, L. (2018) [73]**.** "Security Concerns in IoT-Enabled Smart Transportation: A Literature Review." Focusing on security aspects, this paper delves into the potential vulnerabilities and threats in IoT-enabled smart transportation systems. The authors suggest strategies for enhancing security measures to protect against cyber-attacks.

Gupta, R., & Singh, A. (2021) [74]. "Scalability Challenges in Large-Scale IoT-Based Traffic Management Systems." This paper discusses the scalability challenges associated with the implementation of IoT in traffic management on a large scale. It explores scalable architecture designs and proposes solutions for accommodating the growing number of connected devices.

Chen, X., & Li, W. (2019) [75]. "An Overview of Communication Protocols for Vehicle-to-Infrastructure Communication in Smart Transportation." The authors survey various communication protocols employed in vehicle-to-infrastructure communication systems. The paper evaluates the strengths and weaknesses of these protocols and suggests improvements for better performance.

Kumar, S., & Gupta, M. (2022) [76]. "Towards Sustainable Smart Transportation: An Integrated Approach to IoT and Green Technologies." This paper explores the integration of IoT with green technologies for achieving sustainability in smart transportation. It discusses how environmentally friendly solutions can be incorporated into traffic management systems.

Yang, Q., & Zhang, Y. (2018) [77]. "Machine Learning Approaches in IoT-Based Traffic Prediction for Smart Transportation." Focusing on traffic prediction, this paper reviews machine learning techniques applied to IoT data for accurate traffic forecasting. The authors discuss the potential of machine learning in improving the efficiency of smart transportation systems.

Li, J., & Wang, P. (2020) [78]. "Real-time Data Analytics for Traffic Management in IoT- Enabled Smart Cities." This paper emphasizes the importance of real-time data analytics in traffic management within IoT-enabled smart cities. It explores the use of big data analytics to extract meaningful insights for optimizing traffic flow.

Park, C., & Kim, H. (2016) [79]. "A Survey on Smart Transportation Systems: Challenges and Opportunities." The authors provide a comprehensive survey of smart transportation systems,

highlighting both challenges and opportunities. The paper discusses key aspects such as data privacy, system integration, and the role of government policies in shaping the future of smart transportation.
In table 1, surveyed various papers and comparison analysis is done by measuring different methods, advantages, issues, and parameters.

Table 1: Comparative analysis of various techniques, advantages, issues, and parameter metrics

Author and Year	**Techniques**	**Advantages**	**Issues**	**Parameters**
Smith, J., & Johnson, R. (2019)	Extensive analysis of current IoT applications in traffic management.	- Identification of key issues such as data security and system scalability.	- Security concerns. - Scalability challenges.	- Data security measures. - System scalability.
Patel, A., & Sharma, S. (2020)	Survey of communication technologies for vehicle-to- infrastructure communication.	- Insights into communication technologies. - Discussion on potential avenues for improving efficiency.	- Strengths and weaknesses of communication technologies.	- Communication efficiency. - Technology strengths and weaknesses.
Lee, M., & Kim, Y. (2017)	Review of challenges and opportunities in integrating IoT into traffic signal control.	- Exploration of opportunities for optimizing traffic flow. - Proposal of solutions for a more efficient traffic management system.	- System interoperability challenges.	- Traffic flow optimization. - Solutions for efficient traffic management.
Wang, H., & Chen, L. (2018)	Focus on security concerns in IoT- enabled smart transportation.	- Identification of potential vulnerabilities and threats. - Strategies for enhancing security measures.	- Cybersecurity threats.	- Security enhancement strategies.
Gupta, R., & Singh, A. (2021)	Discussion on scalability challenges in large-scale IoT- based traffic management.	- Exploration of scalable architecture designs. - Proposal of solutions for accommodating the growing number of connected devices.	- Scalability challenges.	- Scalable architecture designs. - Solutions for accommodating connected devices.
Chen, X., & Li, W.	Survey of communication	- Evaluation of strengths and	- Protocol weaknesses.	- Protocol performance

(2019)	protocols in vehicle-to-infrastructure communication.	weaknesses of communication protocols. - Suggestions for improvements.		improvements.
Kumar, S., & Gupta, M. (2022)	Exploration of IoT integration with green technologies for sustainable smart transportation.	- Discussion on environmentally friendly solutions.	- Integration challenges of IoT and green technologies.	- Environmental sustainability measures. - Integration challenges.
Yang, Q., & Zhang, Y. (2018)	Review of machine-learning approaches in IoT- based traffic prediction.	- Exploration of machine learning potential in traffic forecasting.	- Machine learning efficiency challenges.	- Traffic prediction accuracy. - Machine learning efficiency.
Li, J., & Wang, P. (2020)	Emphasis on real- time data analytics for traffic management in IoT-enabled smart cities.	- Importance of real-time data analytics discussed. - Exploration of big data analytics for optimizing traffic flow.	- Data analytics challenges.	- Real-time data analytics importance. - Big data analytics for traffic optimization.
Park, C., & Kim, H. (2016)	Comprehensive survey of smart transportation systems, highlighting challenges and opportunities.	- Broad overview of challenges and opportunities.	- Privacy concerns. - System integration challenges.	- Data privacy measures. - System integration strategies. - Government policy impact.

3. Objectives of the Study

Define Formal Semantic Descriptions for ITS: Develop formal semantic descriptions for Intelligent Transportation Systems (ITS) to address the existing gap in the literature, providing a foundation for standardized communication and understanding within the field.

Explore Smart Transport System (STS) Development: Investigate and propose the development of a robust Smart Transport System (STS) that prioritizes improving mobility, reliability, and safety while simultaneously aiming to reduce carbon dioxide and methane emissions from automobiles.

Integrate VANET, IoT, and AI Technologies: Develop an interconnected unified framework that integrates and links vehicles with Vehicular Ad-Hoc Networks (VANET), Internet of Things (IoT), and Artificial Intelligence (AI) technologies to establish an innovative and reliable mobility network.

Implement Internet of Vehicles (IoV) Systems: Implement and evaluate Internet of Vehicles (IoV) systems to connect multiple automobiles, enabling the sharing of vital information through an IoT-enabled network to enhance overall transportation efficiency and safety.

Promote Vehicle-to-Infrastructure (V2I) Communication: Investigate and emphasize the significance of Vehicle-to-Infrastructure (V2I) communication in developing intelligent transportation and rail traffic management systems, aiming toimprove road traffic safety and efficiency.
Address Urbanization and Industrialization Challenges: Consider the challenges posed by global urbanization and industrialization advancements, aiming to develop solutions that not only improve transportation systems but also align with broader societal and environmental goals.

4. Future Recommendations

This review article describes future recommendations that can be incorporated into the development of Smart Transportation Systems.

Dynamic Networking Requirements:
In-vehicle network algorithms and protocols must adapt to constant movement and distinct distances between automobiles, necessitating dynamic networking capabilities.

Blockchain-based ITS Challenges:
Blockchain-based Intelligent Transportation Systems (BITS) encounter obstacles such as inadequate scalability, which causes network connection concerns and single-point failures. Security and privacy concerns remain unresolved research issues for BITS.

Machine Learning for BITS:
In Blockchain-based ITS, using multiple Machine Learning algorithms improves anomalous activity detection and system performance.

Big Data Analysis:
Big data analysis is vital for deriving value from enormous volumes of data in Blockchain-based ITS systems, which propels innovation.

5G Technology Adoption:
Adoption of 5G technology in BITS improves total system performance, transforming enterprises and communities.

Collaboration and Partnerships:
Implementing a worldwide blockchain-based transportation system involves substantial engagement and coordination among numerous parties.

Enhanced Security Measures:
Future safety features include the use of magnetic ID cards to monitor travelers and notify law enforcement if appropriate.

Privacy and Authentication:
Proper procedures for authentication need to be implemented to address security issues, especially for vehicular-to-vehicular (V2X) and vehicular-to-pedestrian interactions.

Blockchain for Smart Vehicular Networks:
Leveraging blockchain technology may boost the security of smart automobile networks, particularly where sensors play a significant part in decision-making.

ATM System for Vehicular Tracking:
ATM systems support the effective tracking and redirection of transportation during traffic congestion, hence increasing the efficiency of traffic and minimizing accidents.

Automatic Accident Detection:
Autonomous accident detection systems participate in accident investigation, eliminating reprise incide-

nts and accelerating road restoration.

Autonomous Cars for Traffic Relief:

Autonomous vehicles can mitigate traffic congestion while boosting driving security, consequently addressing transportation issues.

Promoting Environmentally Friendly Modes:

To minimize emissions and improve air quality in cities, smart transportation systems may prioritize and promote sustainable methods of mobility such as public transportation, cycling, and electric automobiles.

5. Conclusion and Future Scope

Conclusions

This study provides a concise response to the vital social issue and recommendations of intelligent transportation system design. Using thresholding and edge detection approaches, the suggested identification system swiftly and accurately detects road signage. The systematic literature assessment indicates that extensive research on the Internet of Vehicles (IoV) was conducted between 2014 and 2023. We present a thorough review of traffic signal synchronization for intelligent automobiles, an innovative technology with tremendous potential in intelligent transportation systems (ITS). ITS employ information and communication technology to improve transportation services while reducing congestion, accidents, and air pollution. We can create a more productive, transparent, secure mode of transportation by combining blockchain's anonymity and decentralization with smart contract automation. The incorporation of IoT sensors improves system intelligence and connectivity. Sensors are installed at key control points in this infrastructure, and their location is recorded by end sink nodes deployed along a road or within a driving area. Employing any one technology to achieve all the potential of the Intelligent Transportation System is inadequate. To fully realize its potential, it is vital to integrate several IoT technologies such as GPS, GIS, and RFID for sophisticated traffic control, allowing tremendous advancement. This article examines network attributes for V2I communication in the millimeter-wave (mmWave) frequency area in great depth. The research looks at various road situations and deployment scenarios. V2I vehicles use software, hardware, and programming to communicate both ways with infrastructure. Wireless communication is formed through items such as traffic lights, road signs, and path signs, and vice versa.

Future Scope

The future scope of Smart Transportation Systems, particularly focusing on traffic management and vehicle-to-infrastructure communication, holds immense promise for revolutionizing urban mobility. With the integration of Internet of Things (IoT) technologies, these systems can optimize traffic flow, reduce congestion, and enhance overall transportation efficiency. Real-time data collection and analysis enable dynamic traffic management, allowing authorities to respond promptly to changing conditions. Vehicle-to- infrastructure communication facilitates seamless interaction between vehicles and traffic infrastructure, promoting safer and more coordinated transportation. Furthermore, the implementation of smart transportation systems can contribute to environmental sustainability by reducing emissions and fuel consumption. As technology continues to advance, the future may see the widespread adoption of autonomous vehicles, further enhancing the capabilities of these systems. Overall, the integration of

IoT in traffic management and vehicle-to- infrastructure communication holds the potential to create more sustainable, efficient, and safer urban transportation ecosystems.

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