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A Comprehensive Survey on Challenges and Issues in V2X and V2V Communication in 6G Future Generation Communication Models

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ABSTRACT

The latest generation of technologies for Information and Communication Technologies (ICT) with V2V that links multiple vehicle to each other and Vehicle to Everything (V2X) links vehicles to every other object in the world. In addition to making travel more pleasant and secure, it also has far-reaching implications for enhancing traffic efficiency, decreasing pollution, and lowering accident rates with better resource utilization levels. V2X applications raise concerns regarding traffic safety and data security that have not yet been thoroughly assessed, as the technology is still in its infancy. There needs to be extensive testing and verification of the technology before it can be released to the public. As the quantity of vehicles on the highway continues to rise, vehicular networks must contend with new difficulties, including volatility, diversity, and scale. Collective Perception (CP) refers to the sharing of sensor data in V2X communication. V2X-capable stations, such as autos, vulnerable road users, and Roadside Units (RSUs), can enhance traffic safety and efficiency in VANETs by exchanging lists of detected items inside the designated frequency band. This process also helps optimize resource consumption. Position, direction, and speed are just few of the qualities that describe an object for the sake of traffic safety. Additional stringent requirements for cellular-based vehicular networks include low latency, high reliability, and excellent spectrum efficiency with high life time. When the life time of connected autonomous vehicles finally arrives, there will be a plethora of innovative uses in a wide range of transportation settings and scenarios. A V2X and V2V communication networks that are both to make this great idea come true, we need computers that are very smart and can handle the very fast, very reliable, low-latency transfer of huge amounts of data. 6G communication technologies are poised to meet the requirements of next-gen V2X. In this research, a variety of enabling technologies, such as novel data sources, algorithms, and system architectures for V2V, V2X data transmissions, securing the data and communicating with other vehicles and RSUs are discussed. This research is helpful for numerous research scholars, academicians and industry experts for getting complete information of the working of available models and their limitations, so that innovative models can be designed with better efficiency.

1. INTRODUCTION

The inception of 6G necessitates a top-down approach in its design and development, ensuring the fulfillment of the requirements of numerous services that are presently awaiting a network with the capacity to accommodate them. 6G's broad purpose is to serve many different vertical markets, but the standard's architecture must become increasingly vertically oriented to fulfill the needs of those businesses [1]. This line of thinking is applicable to the situation of vehicle services, which place demanding QoS requirements on the underlying network infrastructure due to their basic mobility and crucial bandwidth, latency, and reliability needs [2]. Frequency, personal information rate, peak transmission rate, core network, mobility, and latency are the six essential aspects where 6G is expected to outperform 5G, as summarized in Table 1. This highlights the significance of the 6G network's potential for enhancing latency, frequency, data throughput, mobility, and service coverage [3].

The importance of the V2X industry segment is reflected in the 3GPP standards, which are being developed as part of the 6G ecosystem [4]. The Network Exposure Function (NEF) is the foundation for service parameter provisioning in this Technical Specification for V2X communications as it provides access to the core network [5]. This capability enables the 6G app to do actions such as querying the User Equipment (UE) for information on the condition of the network, implementing policies, receiving notifications about changes in location, and requesting that traffic routing be altered [6]. The fulfillment of Quality of Service (QoS) and security requirements in this specific industry depends significantly on this factor. Although the exact methods and consequences of its design are not completely established, they are still extremely important.

Connecting V2X is an important strategy for enhancing the effectiveness of the current transportation system. Since V2X is a cyber-physical system, it is susceptible to the effects of things like traffic and the network's overall state. In addition, latency, dependability, throughput, accessibility, and cyber security requirements to V2X performance are heterogeneous in the design of applications [7]. Some safety applications for connected automobiles, including autonomous pilots, necessitate minimal latency and great dependability. In a congested area, it should be possible for multiple vehicles to access a node within a small radius [8]. Serious incidents involving several vehicles and pedestrians could occur if the V2X requirements for performance of applications are not met. Before widespread deployment and practical use of vehicles, the V2X network of communication should be tested and reviewed thoroughly and methodically [9].

The principal means of communication between vehicles in a short-range direct V2V connection is broadcast transmission. This is so that all vehicles in the area can be informed about the current road conditions and take appropriate action based on safety information sent by a specific vehicle. One example is when a car alerts its neighbors to hazardous traffic conditions so that they can fix it. On top of that, most safety apps need to handle mobility data from nearby vehicles. Therefore, supporting the immediate transmission of broadcast messages among vehicles that are close to each other, the interface is used. A number of V2V safety applications rely on the periodic or event-triggered broadcasting of messages by each vehicle. When it comes to the communication layer, V2V safety applications are the most demanding. Some use cases call for very dependable communication networks with a latency of 100 ms or less from end to end.

The testing strategies are extensively researched in accordance with the actual requirements of the application. It could be broken down into two types of testing: performance testing and functionality testing [10]. End-to-end latency, transmission range, and packet drop rate are just few of the performance metrics that may be tested with performance testing. Functionality testing is typically used to determine how well an application does its intended tasks, such as the proper execution of predetermined scenes [11], the app's security prowess, and so on. Two-way connections between cars, and cars and infrastructure and pedestrians and the internet, are made possible by cutting-edge information and communication technology with the V2X concept. This technology might allow pedestrians, cars, roads, and even the cloud to talk to one another. V2X can contribute in the growth of novel techniques and novel forms of cars and facilities for transportation, as well as the building of an intelligent transport system, in addition to helping vehicles collect more data [12]. Major advantages include better traffic management, less pollution, reduced accident rates, and reduced resource consumption.

The V2V and V2X communication model was shown in Figure 1.

The present V2X communication technologies comprise of DSRC and Long-Term Evolution for V2X (LTE-V2X). The DSRC system has been standardized by the Institute of Electrical and Electronics Engineers (IEEE) and the Society of Automotive Engineers (SAE). DSRC allows vehicles to transmit pertinent security information directly to nearby cars and pedestrians by utilizing the 802.11p protocol at the physical layer and the medium access control (MAC) layer [13]. This reduces the burden on all parties involved in the verification, connected procedures, and data broadcast that occurs before sending. The network's structure and security protocols are established by IEEE 1609 WAVE. The application-level message format is defined by SAE J2735, whereas the performance criteria for different V2X communication scenarios are defined by the J2945/x family of standards [14]. LTE-V2X, derived from 3GPP's advancements in LTE mobile communication technology, provides a substantial data transfer speed and efficient Quality of Service (QoS) management for Vehicle-to-Everything (V2X) connectivity. It can function in either a cellular (Uu) or direct (PC5) method of communication [15].

Intelligent mobility, intelligently connected vehicles, and autonomous driving are just a few examples of how V2X can be put to use. The latency, dependability, throughput, user density, and security needs of the V2X environment are very application-specific [16]. Extremely low latency and a trustworthy network are necessary for safety applications and automated driving. For instance, since most of the time spent in a car is spent in motion at high speeds, bad actors may easily cause catastrophic traffic accidents by transmitting misleading information. By intercepting data packets, malicious actors can also learn the owner's name, the location of the car, the driver's path, and more [17]. Users' confidentiality is being compromised. The route and geographical information contained in the V2X data has implications for national security [18].

Unique to V2X systems are the peculiarities that, when combined with higher degrees of connection and driver autonomy, bring up previously unexplored security challenges and problems. Services and applications used by the automotive industry are frequently mission-critical, which means that security standards are projected to become increasingly demanding over time. New applications of CAM, like dynamic map sharing, enhanced vehicle platooning, and cooperative collision avoidance, have peculiarities in their features and deployment circumstances, and therefore pose a number of security risks.

The attack surface is sufficiently big with extended threat vectors due to the complicated V2X networking landscape, which an attacker may exploit intentionally to invade the system. For instance, without changing the messages, a vehicle platoon disruption attack can be executed by quickly replaying specific important information. There are a number of security risks that might disrupt system operation and reduce network performance, even though V2X can accommodate numerous important entities in a cooperative ITS environment spanning more than one domain. Security breaches could endanger drivers and passengers in V2X vehicles because of how closely linked safety and security are. To tackle vulnerabilities in safety-critical vehicle scenarios and mitigate their negative impacts, new privacy-aware and security-aware procedures are necessary.

5G V2X builds upon the fundamental principles and system architectures of LTE-based V2X, but achieves superior performance by allocating additional resources to both the spectrum and hardware components. The future proliferation of autonomous vehicles is anticipated to be driven by urbanization, increasing incomes, and technological advancements. Consequently, there will be an important rise in the demand for communication tools and digital programs to support AI-driven autonomous cars [19]. The growing need for advanced features in autonomous vehicles, such as 3D displays, holographic control systems, immersive entertainment, and enhanced in-car information, is causing new communication difficulties for the V2X network. The developments in wireless technology will lead to new challenges in data throughput, the factors that will increase demands on current wireless networks include latency, coverage, spectral/energy/cost efficiency, intelligence level, networking, and security. Keeping this in mind, it's possible that 5G V2X networks won't be able to serve a wide variety of needs and applications. While research into ITS concepts has been ongoing for some time now, current-generation V2X communication infrastructure can only offer rudimentary levels of intelligence [20]. Therefore, a drastic paradigm shift toward more flexible and diversified network ways is required for effective communication.

The 6G wireless communication network, which has just been suggested, aims to connect various networks both on and off the ground [21]. Many consider this integration to be the first step toward this revolution. What this means is that V2X systems will be able to become more intelligent and ubiquitous, with improved reliability and safety, faster and more comprehensive wireless connectivity, and communication coverage that is noticeably smarter, longer-lasting, and more environmentally friendly. Future V2X networks will require innovative approaches to intelligent decision-making and flexible learning. This is essential because these networks have high service demands, varied communication conditions, and a wide variety of network components [22-26]. With the help of machine learning (ML), 6G is set to improve radio signal performance by creating autonomous and intelligent radio systems. Many state-of-the-art features, such as enhanced context awareness, automated data grouping, flexible coordination, and automatic configuration, will be easier to implement thanks to this innovation. In this research, a variety of enabling technologies, such as novel data sources, algorithms, and system architectures for V2V, V2X data transmissions, securing the data and communicating with other vehicles and RSUs are discussed.

Table 1. Comparison of 6G Vs 5G [21]

Major Factors	6G	5G
Peak data rate	>100Gb/s	10[20] Gb/s
User experience data rate	>10Gb/s	1Gb/s
Traffic density	>100Tb/s/km^2	10Tb/s/km2
Connection density	>10million/km^2	1million/km^2
Delay	<1ms	ms level
Mobility	>1000km/h	350km/h
Spectrum efficiency	>3x relative to 5G	3~5x relative to 4G
Energy efficiency	>10x relative to 5G	1000x relative to 4G
Coverage percent	>99%	About 70%
Reliability	>99.999%	About 99.9%
Positioning precision	Centimetre level	Meter level
Receiver sensitivity	< -130dBm	About -120dBm

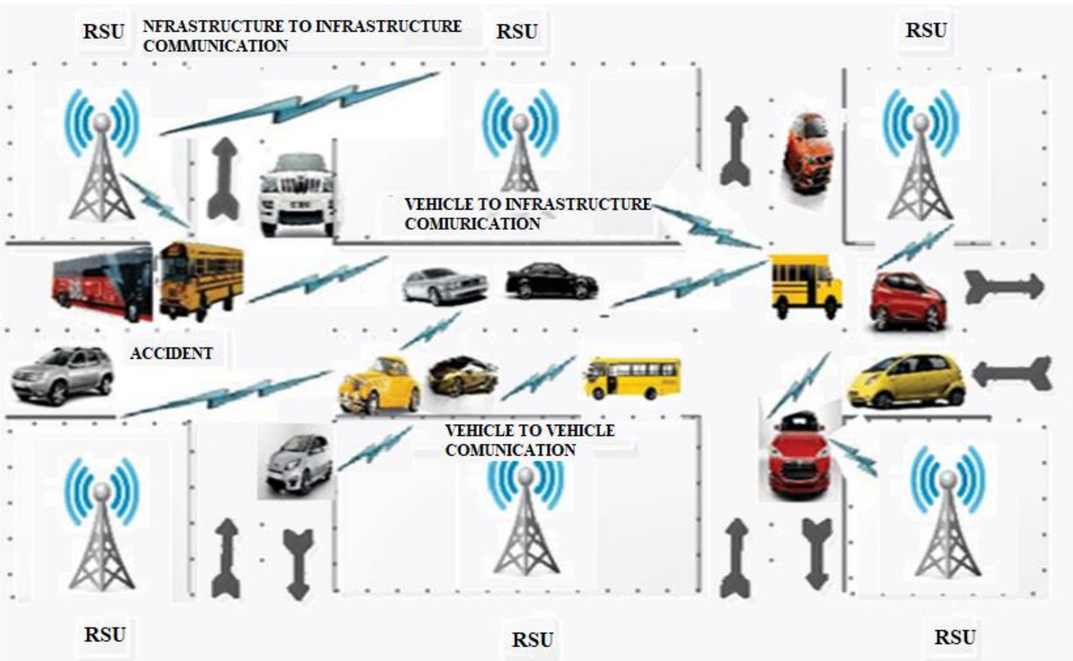

Figure 1. V2V and V2X communication model [27]

2. LITERATURE SURVEY

Having ultra-reliable low-latency communication is critical for future vehicle-to-vehicle networks to improve traffic safety and the driving experience. It is very difficult to guarantee the latency and reliability performance of V2V networks due to the fast channel fluctuations caused by high mobility. By lowering latency and guaranteeing dependable transmission, the novel resource allocation approach proposed by Ding et al. [1] enhances the effectiveness of V2V connections. The suggested method maximizes efficiency on a micro and macro level. If several V2V links are allowed to share the same RB, then only one RB would be plenty for them all. The RB allocation problem was modelled using a factor graph by Hou et al. [2], who used a function mapping. That's why the RB allocation problem is analogous to the factor graph model's message update and belief inference challenges. Belief Propagation with Real-time Update of Messages (BPRUM) is a new approach that the author introduced. It updates all nodes' messages continuously instead of periodically.

Table 2. Traditional model working and limitations (a)

Ref. No.	Year of Publication	Manuscript Title	Proposed Model	Limitations
[1]	2022	Resource management on two timescales for ultra-reliable and low-latency vehicle communications.	The author introduced a novel resource allocation mechanism to facilitate V2V communications with low latency and good reliability. The proposed approach optimizes resources on both a global and micro scale. The central base station periodically acquires channel information from cars on a large scale.	The resource management scheduling model used in this model experiences more delay that considers two-time scale resource listing detecting the allocated and released time metrics. The communication latency is reduced but the scheduling delay also need to be reduced.
[3]	2023	Allocating Cellular Network Resources Geographically for Combined Vehicle-to-Infrastructure and Vehicle-to-Vehicle Communications.	The author assumed cluster-based routing for V2I interactions and geo-based RA for V2V communications; we looked into numerous scenarios where routing-awareness may be employed for RA to boost performance and proposed a new method based on this realization.	The task of geo based resource allocation is a time consuming process in resource allocation and re allocation. The clustered model can be further enhanced using the threshold range based model for better accuracy.
[4]	2022	Offloading Internet of Vehicle Tasks from Hybrid Networks with Time Delays Using Deep Reinforcement Learning.	The author offered a deep reinforcement learning (DRL)-based hybrid task offloading system (HyTOS) to optimize resource consumption and management. To accomplish vehicle-to-edge (V2E) and vehicle-to-vehicle (V2V) offloading, this method takes into account both delay constraints and resource demand.	The delay constrained offloading model is computationally complex that is used for data offloading to other vehicles. The Overload from excessive reinforcement may diminish results. The cost of maintaining is exorbitant.
[5]	2023	C-V2X-based spectrum sharing with a focus on longitudinal control for vehicle platoons	The author pinpointed the maximum and minimum times for sending and receiving messages. To perform wireless resource management, including optimal power allocation.	The spectrum sharing model proposed is better; however, the sharing model considered results in collisions that may be avoided with a deep learning model that performs the task better.

Table 3. Traditional model working and limitations (b)

Ref. No.	Year of Publication	Manuscript Title	Proposed Model	Limitations
[6]	2022	Spectrum-Shared Resource Allocation for UAV-Assistant Road Networks.	The author focuses on a scenario where a UAV exchanges cached content files with vehicular users utilizing UAV-to-vehicle (U2V) links, while V2V links reuse the UAV spectrum to relay safety-critical information.	The spectrum sharing model delay levels and ratio is not in satisfactory range. The energy efficient model can be enhanced using the vehicle performance enhancement and delay level reduction.
[7]	2021	Meta-Reinforcement Learning Based ResourceAllocation for Dynamic V2X Communications.	The author developed two strategies to overcome these obstacles. To begin improving the effectiveness of V2I and V2V connections, the author presented a resource allocation strategy predicated on deep reinforcement learning (DRL).	The meta reinforcement model in resource allocationexperiences long time usage so that other jobs will be delayed. The delay levels need to be reduced as it impacts the accuracy.
[8]	2022	Utilizing Graph Matching and Actor-Critical Learning for C-V2X Radio Resource Management.	For cellular vehicle-to-everything (C-V2X), the author proposes a centralized-distributed radio resource management (RRM) strategy to balance out the risk of collisions between vehicles.	The proposed model resource management process is energy consuming process that degrades the model performance. The energy efficiency models can be integrated for better performance.
[9]	2023	DRL-based V2V computation offloading for vehicle networks that use block chain.	The author proposed a VEC architecture that utilizes block chain technology to ensure the security and efficiency of V2V work offloading. The author devised a computationoffloading technique for block chain smart contracts using deep reinforcement learning (DRL). This strategy enables mobile agents to delegate computationally demanding tasks to adjacent agents.	The block chain enabled model is secured. However, the maintenance and time for offloading process and recoding in the blockneed to be reduced.
[10]	2022	Content Distribution Based on Joint V2I and V2V Scheduling in mmWave Vehicular Network.	The author investigated scheduling concerns for mmWave vehicle networks, with a particular emphasis on content delivery. The limited communication resources of RSUs and the rapid movement of cars have posed challenges for all vehicles in the same network to complete material downloading.	The process of content distribution and scheduling is effective in this model. However the resource request handling time need to be reduced for quick distribution that impacts the performance.

Table 4. Traditional model working and limitations (c)

Ref. No.	Year of Publication	Manuscript Title	Proposed Model	Limitations
[11]	2022	Socially Aware V2X Networks With RIS: Joint Resource Optimization.	The author presented a three-stage approach for joint resource JRARO stands for distribution and RIS optimization. The simulation results show that the proposed algorithm works and that the RIS has the ability to make vehicle communications much better in terms of overall V2I capacity.	The joint resource optimization model performance is effective. However, the V2X network resource handling process and optimization model can be enhanced using the hybrid methods with minimum delay levels.
[12]	2023	A multi-agent deep reinforcement learning approach is used for joint secure offloading and resource allocation for a vehicular edge computing network.	A deep reinforcement learning-based method for joint secure offloading and resource allocation (SORA) was put forward by the author. This goal is met by the physical layer security (PLS) method and the spectrum-sharing system.	The proposed model resource allocation is accurate and efficient. The resource misuse need to be avoided and time constraint based resource scheduling need to be preferred for improving the performance levels.
[13]	2022	Based on Consortium Blockchain, sharing data between vehicles is safe and quick.	The author implemented a consortium blockchain system for transparent and anonymous V2V data transfer in this study. Data may be exchanged without having to swap restricted stock units thanks to 5G and blockchain technology.	Because of a consortium's centralized network architecture, malicious users are more likely to break the rules of network. Due to the rising number of users, it is difficult to upgrade such a platform because doing so requires the approval of all users in the network.
[14]	2021	Spectrum sharing based on quality of service for reconfigurable intelligent surfaces (RISs) helped vehicle networks.	The author investigated the problem of spectrum sharing in RIS-enhanced vehicular networks. For V2I and V2V communications, the author relied on global CSI because of the challenges of obtaining real-time CSI due to the fast-changing nature of some V2X channels.	The resource detection time and allocation time of the model degrades the network performance. The spectrum sharing model for intelligent surfaces consumes more energy also that need to be reduced.
[15]	2022	Full-Duplex Vehicle-to-Infrastructure (V2I) Communications Require Joint Resource Allocation and Power Control in High-Density Networks.	The author introduced a Dual Graph Colouring-based Interference Management (DGCIM) technique to tackle this intricate problem.	The proposed joint resource allocation model identifies collisions in the network that increases loss rate.

The goal of optimizing resource allocation (RA) efficiency has been made more difficult by rising mobility and the sheer volume of cars on the road. Several RA mechanisms have been created to facilitate the equitable distribution of C-V2X assets. However, routing-aware RA hasn't been talked about much in the research world. In this study, Alrubaye and Ghahfarokhi [3] used cluster-based routing for V2I communications and geo-based RA for V2V communications. They looked at a number of situations where routing-awareness could be used for RA to improve performance, and they came up with a method that uses routing-awareness for RA. In the IoVs, a V2V or V2I connection allows a connected vehicle to exchange data with other vehicles or RSUs. Vehicles, according to users, should be able to pool their resources by coordinating with other fully-loaded and idle vehicles. To better manage and employ resources, Wu et al. [4] suggested HyTOS, a hybrid task offloading system based on deep reinforcement learning. The time and resources needed to complete vehicle-to-edge (V2E) and vehicle-to-vehicle (V2V) offloading are both considered by this method. The author employed deep Q networks (DQNs), a mechanism for dynamic decision-making, to make optimal offloading decisions. Here, we talk about spectrum sharing within the framework of a vehicle platoon that needs longitudinal control. Specifically, the optimum and optimum periods for message transmission and reception were identified by Han et al. [5]. Wireless resource management, which includes determining the optimal method of spectrum sharing and power distribution among the participating vehicles, requires taking intracell interference and other communication requirements into account after obtaining the delay constraint. The Table 2 represents the traditional model working and limitations.

There is significant opportunity for UAVs to support service delivery via vehicle networks. Sharing frequencies among multiple users in a dense UAV-assisted vehicular network reduces the impact of a lack of available spectrum. The increasing need for data has renewed concerns about the UAVs' energy usage. Qi et al. [6] focused on a scenario where a UAV shares cached content files with vehicular users using UAV-to-vehicle (U2V) links, while V2V links reuse the UAV spectrum to relay safety-critical information. V2I and V2V communications in V2X use the same network architecture. In this study, Yuan et al. [7] developed two strategies to overcome these obstacles. The author has presented a deep reinforcement learning (DRL)-based resource allocation technique to begin enhancing the efficiency of V2I and V2V connections. A deep Q-network (DQN) is employed to address the sub-band assignment problem, while a deep deterministic policy-gradient (DDPG) handles the continuous power allocation issue. Cellular vehicle-to-everything (C-V2X) radio spectrum utilization increases the risk of vehicular crashes; to mitigate this, Zhou et al. [8] presented a centralized-distributed radio resource management (RRM) system for C-V2X. Power management is done by edge nodes, whereas channel allocation is managed centrally.

Connecting cars together to share processing power is an example of vehicular edge computing (VEC). How to encourage automobiles to pool their computing resources while ensuring the dependability of resource distribution in task offloading is a prevalent problem when cars engage in computation offloading with one another they have never met before. To ensure the security and efficiency of V2V job offloading, Shi et al. [9] presented a VEC architecture that employs block chain technology. To help mobile agents delegate some of their computationally intensive activities to adjacent agents, the author developed a deep reinforcement learning (DRL) based computation offloading approach for use in block chain smart contracts. The author presented a method for choosing consensus nodes and an improved consensus algorithm based on practical Byzantine fault tolerance (PBFT) to reinforce the dependability of job allocation and improve the efficiency of consensus.

The widespread use of automotive applications has led to a significant interest in mmWave-based vehicular networks among both academic and industrial communities. mmWave communications, due to their extensive bandwidth, can achieve transfer speeds between vehicles in the range of several gigabits per second (Gbps). The study conducted by Su et al. [10] focused on examining scheduling issues in mmWave vehicle networks, specifically in relation to content delivery. All vehicles in the same network have struggled to finish content downloading due to the restricted communication resources of RSUs and the frequent mobility of vehicles. The Table 3 represents the traditional model working and limitations.

This study explores the application of RIS in a socially trusted V2X communication system, where several V2I and V2V links compete for spectrum, motivated by the promise of RIS-based transmission. Maximizing the overall capacity of V2I links within the V2V dependability limitation is achieved through joint optimization of power distribution, RIS reflection coefficients, and spectrum allocation. A three-stage method for joint resource allocation and RIS optimization (JRARO) was proposed by Gu et al. [11] to effectively address the mix-integer and non-convex problem that was stated. The results of the simulation prove that the suggested algorithm works as intended and show that the RIS can potentially increase the total capacity of vehicle-to-infrastructure connections.

The VU offloading links in multi-user VEC networks share the frequency spectrum with the V2V communication links; nevertheless, Ju et al. [12] devised a method to enhance privacy and resource efficiency in these networks. They used deep reinforcement learning to create SORA, which stands for safe offloading and resource allocation. A spectrum-sharing strategy and the physical layer security (PLS) approach accomplish this. In the case of unlawful data transmission, it becomes even more challenging to determine where the breach originated. In this study, Cui et al. [13] used a consortium blockchain system to send V2V data in a transparent and anonymous manner, preventing secondary data sharing. Thanks to 5G and blockchain technologies, data can be traded without the need to shift restricted stock units. A new delegated proof-of-stake consensus method was developed by the author to enhance the distributed IoV's practical applications.

The adaptability of a reconfigurable intelligent surface (RIS) to its wireless environment significantly improves its performance as a communication medium. Therefore, RISs may prove to be an invaluable asset in the quest to perfect V2X services. Chen et al. [14] looked into the issue of spectrum sharing in RIS-enhanced vehicular networks because many V2V links use spectrum that is already owned by V2I lines. Due to the fast-changing nature of some V2X channels, the author relied on global CSI for V2I and V2V communications instead of real-time CSI. The wireless full-duplex (FD) method can enhance spectrum efficiency and throughput simultaneously. Guo et al. [15] detailed their findings on how to include V2V connections into an FD mobile network in their study. When the uplink and downlink of the V2I share the same RB, it becomes problems for resource allocation and power control at the FD base station due to interference. The author devised a DGCIM (Dual Graph Coloring-based Interference Management) technique to address this challenging problem. The Table 4 represents the traditional model working and limitations.

The complexity of material delivery is exacerbated by user expectations of fast downloads, low latency, and quick gratification. A content dissemination technique that takes users' demographics and geography into account was proposed by Bute et al. [16] to tackle the aforementioned challenge of V2V peer identification and resource allocation. Both the uplink and downlink phases take the quality of service (QoS) of vehicle-to-network (V2N) users into account, and V2V users are matched to exchange content depending on shared interests and connection stability. In order to improve the efficiency of data distribution, Zhang et al. [17] developed a model that uses UAVs to support a novel scheduling method for file sharing and proactive caching in V2X networks. Using unmanned aerial vehicles (UAVs) as caching-capable flying base stations (BSs), the author proposed a dynamic trajectory scheduling (DTS) method to optimize caching time during proactive caching.

Wang et al. [18] explored the domain of conflict analysis by means of a case study involving a fleet of cars with varying degrees of automation. V2X communication primarily enables status-sharing and intent-sharing as forms of cooperation. Both status sharing and intent sharing enable vehicles to communicate about their present and planned movements, respectively. Intent sharing allows for the communication of planned future movements, such as maximum speeds and acceleration limits, while status sharing allows for the communication of current conditions, such as location and speed. Studying how conflict analysis might be used to improve the decision-making of autonomous and semi-autonomous vehicles, Wang et al. [19] laid the groundwork for this field of study. The author focused on scenarios in which cars can exchange data about their locations, speeds, and intentions with one another via V2X communication technology. The Table 5 represents the traditional model working and limitations.

With this study, Zhao et al. [20] provided a method for resource allocation in V2X networks that fully takes advantage of the SCMA-oriented RMA used by these systems. In this study, the author investigated an SCMA based on random multiple access (RMA), wherein users of both V2I and V2V choose codebooks from a shared pool for transmission. The full bandwidth is divided in half for V2I transmission and half for V2V transmission to prevent user interference. To maximize throughput for all V2I users while satisfying the reliability needs of V2V users, we devised a problem that involves maximizing both the selection of users to receive codebooks and the allocation of available bandwidth. There is no easy answer to this problem since it is a mixed-integer programming (MIP) problem with a probabilistic constraint.

Table 5. Traditional model working and limitations (d)

Ref. No.	Year of Publication	Manuscript Title	Proposed Model	Limitations
[16]	2023	Distributing Cellular and V2V Content with QoS Consciousness Using a Fusion of Social and Physical Attributes.	The author suggested a content dissemination approach that considers users' demographics and geography. Vehicle-to-vehicle (V2V) users are paired to share content based on their similar interests and the reliability of their connections, while the quality of service (QoS) of V2N users is taken into account during both the uplink and downlink phases.	The list of attributes considered are less that can be extended by considering the internal and external factors to improve the quality of service levels.
[17]	2021	A Protocol for Distributing Data Utilizing Unmanned Aerial Vehicles, Featuring Anticipatory File Sharing and Caching in V2X Networks.	The author designed a model to increase the efficacy of data distribution by introducing a unique scheduling system for file sharing and proactive caching in V2X networks that is facilitated by UAVs.	The file sharing model consumes more time and the delay levels are also high. The delay levels results in performance degradation that need to be improved.
[18]	2023	Multi-vehicle conflict resolution with delayed status and intent updates.	The author investigated the field of conflict analysis. The two main types of cooperation made possible by V2X communication are status-sharing and intent-sharing.	The vehicle location detection and the parameters for the detection need to be updated for reducing the conflicts and also information sharing need to be updated to perform in less time.
[19]	2023	Analysis of Potential Conflicts in Cooperative Maneuvers That Use V2X Communication to Disclose Status and Goals.	The author provided a foundation for conflict analysis and demonstrated how it may be utilized to enhance the decision-making of vehicles operating with varied degrees of automation and collaboration.	The security levels of the intent sharing is less as the number of attacks is high and there need to be a better attack management model to improve the security levels.
[20]	2023	Allocating Resources Efficiently in SCMA-V2X Networks with Random Multiple Access.	The author provided a method for resource allocation in V2X networks that fully takes advantage of the SCMA-oriented RMA used by these systems. In this study the author investigated an SCMA based on random multiple access (RMA), wherein users of both V2I and V2V choose codebooks from a shared pool for transmission.	The proposed model is suggested to use hybrid deep learning and optimization models for better resource allocation. The cluster generation process helps in detection.

3. DISCUSSIONS

There may be a lot of uses for the 6G network, but there are no hard requirements or standards in place just yet. There are many who think 6G networks should be more than just a capacity upgrade for 5G networks [26]. Coverage shouldn't be limited to just the ground, even though the 5G network has its restrictions. Additionally, the 6G network will feature significantly improved AI. The development of the 6G network is considered by many professionals in the field as being driven and enabled by AI [27]. Until 5G networks can provide truly immersive, totally autonomous services, there is still a long way to go. Despite being an improvement over existing systems, the 5G communication infrastructure will fall short of enabling fully automated and intelligent concepts within the next ten years. The 5G network will bring many new capabilities and greatly increase the reliability of communications. Coexistence of licensed and unlicensed channels, improved spectrum management, and increased frequency ranges are some of the new features of 5G technology [28].

Research into V2X cyber security is currently receiving a lot of attention because of the booming industry of vehicular communication. The ever-changing threat landscape in the burgeoning IoV paradigm and the expected increasing importance of cyber security in V2X technologies are the driving forces behind this study. Constant threat assessment and a wide range of innovative security solutions are required to address risks brought about by recent developments in V2X communication and the advent of hitherto unseen vehicular use cases. A great deal of work has gone into trying to address the additional security requirements of V2X and provide practical solutions that will make the V2X ecosystem smarter and safer in recent years. Nevertheless, there is still a long way to go until V2X security concerns are fully addressed. With more and more vehicles connected and autonomous driving becoming the norm, there is a growing threat to the security of IoV systems from assaults that are more precise, covert, and scalable. Furthermore, the increasing use of AI/ML technologies in several areas of V2X communication could potentially have a negative impact on how vehicular systems are operated. Within this framework, this paper aims to acquaint the reader with important V2X security aspects by providing a thorough and organized review of previous research in the subject. The viability of proposed strategies in protecting V2X security and privacy against different threats can be assessed by analyzing their strengths and shortcomings.

In the European Union, one such platform that is focusing on V2X is ERTICO. Another is C-ITS (Cooperative Intelligent Transport Systems). Automated driving, which incorporates communication technologies into transportation systems, will play a crucial role in achieving the ambitious aim of halving the number of fatalities on European roads by 2020, as stated in the European Commission's white paper on transport. Presently, the V2X standard for Europe is being developed by ETSI (the European Telecommunications Standards Institute).

A number of Asian nations are utilizing vehicle-to-electro-X technology to create smart transportation systems. These nations include Japan and Singapore. An ITS ecosystem dedicated to excellence in Vehicle to Everything (V2X) research, innovation, and teaching is being developed by the Singaporean Land Transport Authority (LTA). In order to encourage the widespread use of linked cars in Japan and around the world, KDDI Corp. and Toyota Motor Corp. of Japan will create a worldwide communications platform. at China, the first 25 autonomous vehicles outfitted with a variety of sensors, communication modules, and electronic control units are undergoing testing at the National Intelligent Connected Vehicle (Shanghai) Pilot Zone, which is situated at Shanghai Auto Expo Park and Tongji University.

Due to the fact that vehicular networking technology has transformed automobiles into constantly connected "computing objects," there are now far more entry points for cybercriminals than in the past. It goes without saying that security is of the utmost importance when it comes to V2X communication. Consequently, there are a lot of initiatives focusing on V2X security within the broader framework of security for vehicular networks.

Improved air interfaces, resource allocation [29], decision making, and computation are just some of the cutting-edge technologies that 6G will need to implement to reach its lofty promises. Support from UAVs and low earth orbit satellites [30] may help V2X systems improve communication quality in areas where traditional terrestrial communication systems may have blind spots. Air interfaces, resource allocation, decision making, and computing will all need to be made more reliable and efficient for 6G. As shown in Figure 2, a typical 6G-V2X system integrates multiple types of vehicle communication to pave the way for a wide range of promising future applications.

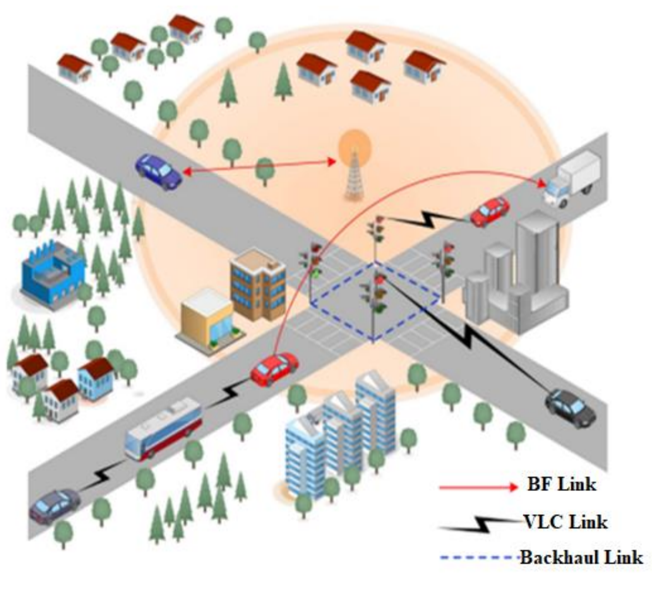

Figure 2. 6G V2X system [29]

V2X has garnered a lot of attention as a key enabler of ITS. Improved road safety, more efficient traffic flow, and the ability to meet infotainment needs are all made possible via V2X connections. V2V, Vehicle-to-Pedestrian (V2P), V2I, and Vehicle-to-Network (V2N) communications are all part of V2X. One possible feature of these interactions is their proximity-based nature, which necessitates coordination between neighbouring cars and other equipment. Ad hoc communications using the 802.11p standard are the first established option for V2X communications. The lack of centralized management is a weakness of this standard, which makes it difficult to ensure requirements for security applications. There will be a wide variety of transportation scenarios and practical uses in the future of networked self-driving vehicles, which will incorporate several modern technology. The establishment of a V2X communication network with superior intelligence and the capability to deliver very fast, very reliable, and low-delay transfer of large amounts of data is crucial for the realization of this lofty goal. It is probable that 6G communication technology will meet the upcoming needs of the next-generation V2X. Intelligent routing models and efficient resource sharing models are essential for improving network service quality and resolving survey-identified limitations.

4. CONCLUSION

With the imminent completion of 5G network research and deployment, many researchers have prioritized 6G networks. 6G networks will provide better network services than previous generations. There are always exciting new features available in the next iteration of communication technology. Research and development into V2X connections have risen as self-driving, internet-connected cars become the norm in smart cities. Through investigating their prospective features and advantages, which go much beyond those of 5G, this survey has identified a number of essential enabling technologies and novel aspects of next-generation 6G-V2X networks. The most recent findings in the application of machine learning in 6G car networks are reviewed as a step toward the realization of truly intelligent transportation systems. Recent successes, critical challenges, and promising future directions are covered for each enabling technology. Recent estimates put the quantity of traffic data generated by future V2X vehicles at more than 1 terabyte per round. Any breach in the security and privacy of the real-time data exchanged via V2X would be a major issue. Opportunities to enhance and expand V2X networks abound in the future. For V2X vehicles to become more efficient, secure, and dependable, new communication protocols are required. In addition, there may be new difficulties for V2X interactions due to privacy and security concerns with the wireless sensors in linked vehicles. One drawback and one nuisance of wireless channels is that they are broadcast in the environment. Hence, improvements to the wireless network are essential for future V2X networks to ensure broadband coverage and ubiquitous connectivity. The data transmitted via V2X must be secure and reliable. This is crucial for establishing trustworthy transportation networks in smart cities, as data privacy and security infractions are becoming increasingly commonplace in everyday life. This research provides a brief analysis on the challenges and issues on V2X and V2V models that helps researchers to design new models for providing better routing and data security models in VANETs.

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