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# Block-VN: A Distributed Blockchain Based Vehicular Network Architecture in Smart City

Pradip Kumar Sharma\*, Seo Yeon Moon\*, and Jong Hyuk Park\*

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## Abstract

In recent decades, the ad hoc network for vehicles has been a core network technology to provide comfort and security to drivers in vehicle environments. However, emerging applications and services require major changes in underlying network models and computing that require new road network planning. Meanwhile, blockchain widely known as one of the disruptive technologies has emerged in recent years, is experiencing rapid development and has the potential to revolutionize intelligent transport systems. Blockchain can be used to build an intelligent, secure, distributed and autonomous transport system. It allows better utilization of the infrastructure and resources of intelligent transport systems, particularly effective for crowdsourcing technology. In this paper, we propose a vehicle network architecture based on blockchain in the smart city (Block-VN). Block-VN is a reliable and secure architecture that operates in a distributed way to build the new distributed transport management system. We are considering a new network system of vehicles, Block-VN, above them. In addition, we examine how the network of vehicles evolves with paradigms focused on networking and vehicular information. Finally, we discuss service scenarios and design principles for Block-VN.

## Keywords

Blockchain, Internet of Things, Security, Vehicular Network

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## 1. Introduction

Internet of Things (IoT) involves “Things” (IoT devices) which have remote detecting as well as actuating abilities and can exchange information with other associated devices and applications. IoT devices can gather information and process the information either locally or send the information to bring together servers or cloud-based application back-ends for processing [1]. IoT advancements are promising for modern and assembling frameworks. Specialists have to gauge a trillion dollar effect of IoT on the manufacturing and industrial divisions [2]. A recent on-request model of assembling that is utilizing IoT innovations called cloud-based manufacturing (CBM) [3]. CBM empowers universal, advantageous, on-request arrangements access to a common pool of configurable assembling assets that can be quickly provisioned and discharged with negligible administration exertion or specialist organization collaboration [4,5].

Today, urban communities face complex challenges in improving the personal satisfaction of their

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residents. As the 2014 report on the global outlook for urbanization in the United Nations indicates, the bulk of the world's population currently lives in urban areas, and an additional 2.5 billion people are expected to move in urban areas by 2050 [6]. Urban fixing, people's living conditions have been affected by extended parked roads, carbon dioxide, nursery oil exits, and waste transfer. The idea of "smart city" is a reaction to these questions; it has regained prevalence in recent years. Many urban communities are characterized as "smart" when they distinguish some of their qualities such as broadband, advanced incorporation, and information workforce. A typical basic certainty is that these astute urban areas take advantage of the creative use of new kinds of data and correspondence innovations (ICTs) to strengthen mutual sharing [7]. A city cannot be described as "smart" by using particular sectoral or constrained changes. A smart city includes, on a level plan, combined components, for example, smart administration, intelligent versatility, intelligent life, intelligent use of characteristic assets, smart subjects and intelligent economics [8]. Nevertheless, due to the space requirements and the thickness of the urban population, urban communities are typically meant to pass on savings to use, including access to shared assets in relation to the possession of resources [9]. There are different methods to use the current advances to make competent economies and social orders, but sharing is one of the main assets of smart cities.

Over the past few years, smarter vehicles, more secure and less tiring driving encounters have been understood. Currently, conventional vehicles have devices, for example, GPS, radio handset, small-scale impact radars, cameras, on-board computers and various kinds of detection devices to warn the driver of a wide range of good conditions—being of the street and mechanical breakdowns. The vehicles are more refined due to their on-board storage capacity, on-board computing capabilities, significant matching capabilities and fewer power hindrances, which are supported by sensors, actuators, radar hosts and GPS [10,11]. Most types of vehicles can be equipped with event data recorder (EDR) and GPS gadgets embedded soon [12]. The EDR is responsible for recording the fundamental traits of portability, for example by increasing speed, deceleration, sensor and radar readings, lane changes and comparative information. Recorded information is archived appropriately and connected to a GPS. In addition to interim weather, the EDR collects data, such as the slowest and most remarkable speed, the time and position of the best speed/deceleration, as well as the zone and target trajectories for the various path. In addition, most vehicles will have various sensors, such as fuel tank level, tire weight, engine and outdoor temperature sensors that report to the EDR. As a result, these accumulations of processing and detection capabilities, Internet access, and power supplies will require smart applications for vehicles suitable for use on PCs with large storage devices that can be called fixed on wheels, for example in in-vehicle computing devices. Currently, the obstruction on highways is one day a day occasion, and most often we are not warned by notification blocking caution. For a long time, the ITS discussion arranged separate responses to mitigate the hoof. Among the provisions envisaged, the number of lanes on roads and roads should be extended. A late review has shown that this arrangement is ineffective over the long term and may even increase levels of clogging and contamination. By providing adequate notifications, drivers could be satisfied with choices taught that would alleviate sabotage, improve road safety, and save fuel and time [13].

Blockchains have recently been drawn in light of a legitimate concern for partners on a wide range of businesses: finance, medical services, utilities and the government division [14-19]. The goal behind this explosion of enthusiasm: with a blockchain configuration, applications that might already function just by a delegate put the stock, can now work in a decentralized manner, without the requirement of a focal specialist, and to accomplish a similar utility with a similar measure of assurance. It was practically

impracticable for some time recently. We say that the blockchain allows systems without trust since the gatherings can run despite the fact that they do not believe. The absence of a trusted delegate implies a faster compromise between the performing parties. The overwhelming use of cryptography, a normal key for block chain systems, brings legitimacy behind each of the connections in the system. Intelligent contracts, self-executing scripts that insist on the block chain, integrate these ideas and take into account legitimately, scattered and vigorously automated workflows. This should make blocking chains to specialists and engineers working in IoT space.

This paper examined the emerging ad hoc network for vehicles in the application of the smart city and introduced a distributed architecture based on blockchain for the vehicle network to meet current challenges as well as future and require services. We examine its architecture and operations and discuss its service scenarios and design principles.

The rest of the paper is structured as follows: in Section 2, we examine the benefits of blockchain technique, and research issues and challenges related to the vehicular network. Distributed architecture for the vehicular network is proposed in Section 3. Section 4 discuss the require design principles in a vehicular network. Lastly, the conclusion of the paper is discussed in Section 5.

## 2. Related Works

### 2.1 Benefits of the Blockchain Technique

As a digital payment framework, blockchain has some advantages over existing electronic frameworks. These benefits largely approximate the beneficiary of a blockchain exchange, but some benefits could be recognized by the exchange senders as well.

- **Transparency:** All blockchain network exchanges are cleared in the blockchain, which means a total, verifiable and unchanging record of any action exists.
- **No risk of fraud:** When sent and deleted, a blockchain exchange cannot be canceled by the sender.
- **Low or no exchange costs:** The organization of the blockchain network is sponsored by the procedure of creation of the treasury. Thus, exchanges on the blockchain network can be sent for a small or no exchange fee. Also, there is no cost to get to the blockchain network.
- **Transactions almost instantaneous:** Exchanges of blockchain networks immediately register. Affirmation and compensation for these exchanges can occur in minutes to more than 60 minutes. In traditional payment systems, compensation takes much longer.
- **Network security:** The blockchain network itself is exceptionally secure thanks to the use of cryptographic and decentralized blockchain conventions. Individuals in general of the private key sets used to provide adequate security against the danger of a wild constraint hack or the inadvertent appearance of two clients producing a similar private key. Moreover, there is no single goal, combined with disappointment, which limits the vulnerability of the blockchain network to downtime and piracy.
- **Financial data assurance:** Blockchain transactions can be performed without revealing to the beneficiary sensitive individual and financial data, limiting the potential presentation of such data to database piracy.

- Financial access: Despite the fact that it cannot give most of the administrations of account management and its specialized multifaceted nature may be too high for some clients; blockchain can offer incentive storage and payment services for clients who need access traditional financial services.

## 2.2 Research Issues and Challenges in Vehicular Network

Because of the dynamic environment of registering, detecting, conveying, and sorting out structures empower self-governance and specialist to adapt to the nearby surroundings that have a large influence. The vehicular network is intricate substances that must be built and intended to work with the working environment and the innate burdens. A vehicular network's physical resource, control, synchronization, and aggregation of a vehicular network are research challenges, described below.

### 2.2.1 Architectural formation of vehicular network

Challenges incorporate issues in regards to the arrangement of the sensible structure of the vehicular network and associations with physical assets. Subsequently, the intense need of dealing with the versatility of the host and heterogeneity ought to be considered for figuring, correspondence and storerooms, and vehicle affiliations, for example, changes in intrigue or area, asset disappointment, and disavowal. In this manner, we need to consider the accompanying angles:

- Adaptable mobile architecture: One of the fundamental qualities of the vehicular network is the portability of the nodes which specifically influences on the accessible computational capacities and capacity assets, for illustration, the quantity of stopped vehicles in the stopping is not consistent. Subsequently, to give fluctuating application prerequisites and asset availability progressing, the important related convention engineering and vehicular network organizing must be created [20].
- Robust architecture: The crucial building squares and structures that form vehicular network ought to be built and intended to confront the basic worry of the temperamental working circumstance. Olariu et al. [21] were the first to propose a strong element architecture for the vehicular network in view of Eucalyptus cloud framework and virtualization way to deal with total the computational and capacity assets. More prominent accentuation and more looks into are important for the movement of virtual machines among autos and efficient vehicle representation.

### 2.2.2 Privacy and security of vehicular network

Privacy and security are critical aspects of the setting up and keeping up the trust of clients in the vehicular network. Security measures are required to guarantee the vehicular network correspondence and data in the confined and dependable environment, while security techniques are expected to ensure against system threats. Setting up trust connections between a few members is a fundamental piece of reliable correspondence and calculation. As a portion of the vehicles identified with the vehicular network may have met beforehand, the proactive errand of propelling an essential trust relationship among vehicles is alluring and conceivable. Olariu et al. [22] portrayed vehicular network as an

arrangement of vehicles which share the capacity of registering force, the Internet get to and capacity to frame ordinarily distributed computing. In this way, it is foreseen that vehicular network endures an indistinguishable security issue from cloud computing. The primary security difficulties of the vehicular network include [23-29]:

- Checking the verification of clients and the respectability of messages because of the high mobility of nodes.
- Guaranteeing the confidentiality of the delicate message by utilizing the cryptographic calculation.
- Guaranteeing the safe area and restriction because most applications in vehicular frameworks depend on area data.
- Giving information disengagement to ensure the security of put away information on the cloud.
- Secure information access to ensure put away information on the cloud against unapproved gets to. The security and protection issue of the vehicular network has not yet been tended to in writing and need more thought.

### 3. Block-VN Distributed Architecture

To summarize, our observation of the current vehicular network is that vehicular network applications advance from basic information purchasers to ones that empower neighborhood coordinated efforts with adequate substance for wealthier client experience. Though the basic systems administration does not appear to bolster the center capacities, the developing applications request effectively. This chapter presents recent research endeavors that address the issues under two classes of networking and computing.

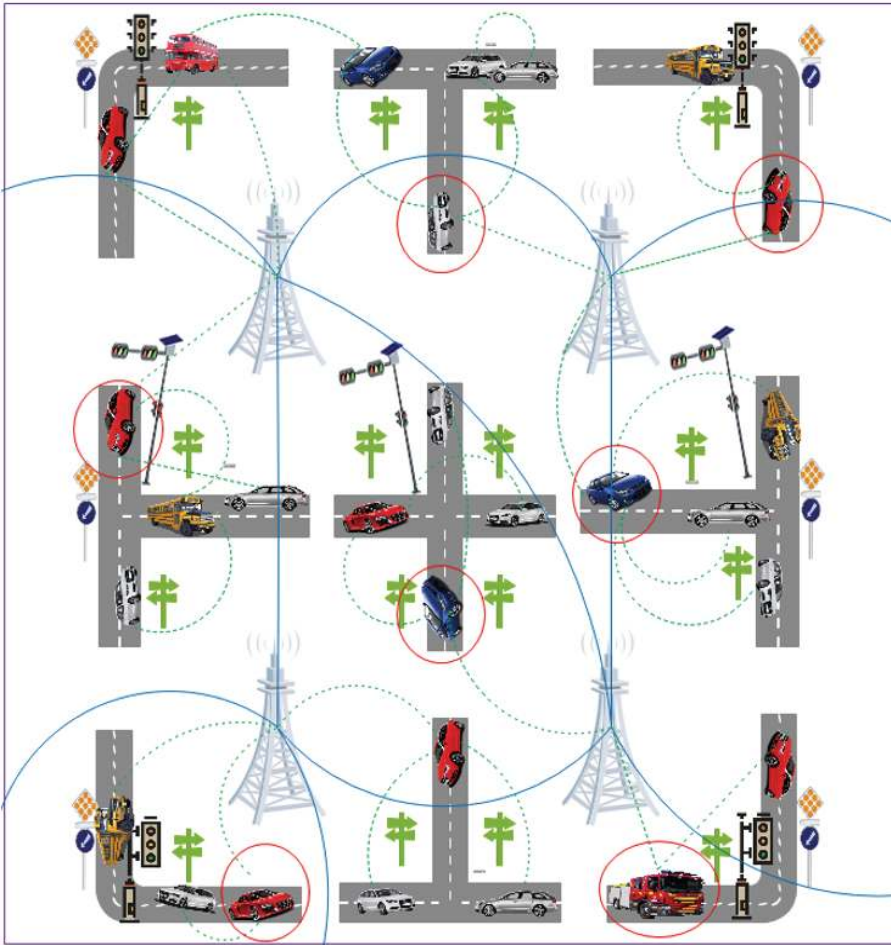
#### 3.1 Architecture Overview

We propose a Block-VN model, an architecture based on blockchain in the smart city for the vehicle network, which allows the development of the distributed network of large-scale vehicles in a more efficient and effective way. Fig. 1 illustrates the Block-VN architecture of the blockchain vehicle network to meet future challenges and requirements. In the Block-VN model, the controller nodes are connected in a distributed manner to provide the necessary services on a large scale. The vehicle node with the red circle represents the miner node, which handles request/response requests. Rest all vehicle nodes are just ordinary nodes. An ordinary node may send a service request message either to minor nodes (vehicle) or controller nodes. By using the minor and controller nodes in a distributed way, we can easily achieve the scalability and high availability of the vehicle network. Block-VN also improves vehicle network architecture by enabling consumer-to-machine and machine-to-machine trusted intermediary free services and by providing distributed, secure, and shared records of all services, assets, and inventories.

#### 3.2 Block-VN Model Architecture

Fig. 2 shows the structure of the Block-VN model. Each time the registration of a new vehicle issued, the department of motor vehicles (manufacturers) provides full details to the revocation authority. The

revocation authority has the power to decide which vehicle considers to be the minor node outside the nodes of the controller. The revocation authority provides all information of the ordinary and miner vehicles nodes to the distributed blockchain vehicle network. Each controller node primarily includes a hash, a timestamp, a nonce, and a Merkle root to hold all the information required to provide the necessary services. Each controller works at the individual level to process and compute the data and share it to other nodes in a distributed manner. Each communication will be made using the public-private key encryption technique to secure the privacy of the client's data.



**Fig. 1.** Overview architecture of Block-VN.

### 3.3 Miner Node's Structural Design

The elements of the miner node are distinguished from those of the controller nodes. Each miner node vehicle has three asset classifications: computing, sensors, and data storage, as shown in Fig. 3. The data storage stores the substance of the vehicle created from applications and sensors and in addition to records visuals and multimedia. It supports the sharing of information between members of the blockchain network by accepting an external pursuit request and responding with a coordinated



substance. The sensor can auto-activate and further distinguish the opportunities in the physical world. With technological progress, each sensor is specifically associated so that the outer frames can read the sensor information as well as control the sensor. The computing asset is similar to that of the blockchain controller node regardless of whether its capacity is limited in view of the fact that it is an accumulation of portable assets.

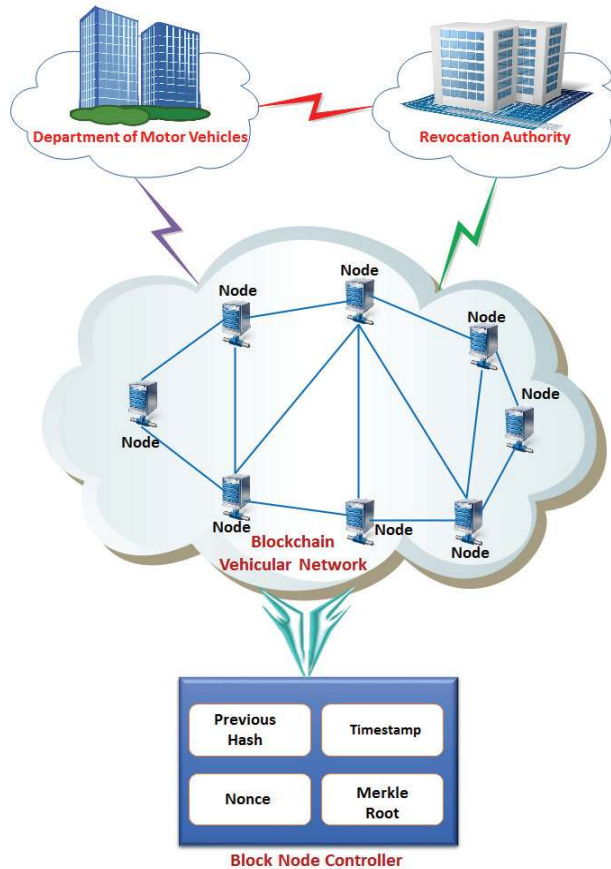


Fig. 2. Block-VN model architecture.

### 3.4 Service Scenario

**SmartPay:** Shanu gets into her car to drive to work; she is an active mother and senior director for a large corporate. The car consequently synchronizes with Shanu’s smart mobile phone’s SmartPay benefit, a framework that gives security and trust by “epitomizing” Shanu through smart contracts on its blockchain interface. That permits it to work as an autonomous payment device. SmartPay starts a few elements on Shanu’s in-car show; it connections to journey planner, and Shanu goes into SmartPay travel organizer her office as her goal. SmartPay travel organizer decides, by questioning vehicle information, that the auto is low on fuel, so it consequently plots a course using an advantageous petrol station that is promoting aggressive fuel costs. In the wake of topping off with fuel consequently paid for by SmartPay’s smart contact include, Shanu gets a message over the SmartPay interface that her

work car stop is full and that SmartPay travel organizer has started a shrewd contract trade and paid for another car stop, a short separation from her office.

While at work, Shanu gets a message that SmartShop has offered her everyday shopping rundown to neighborhood retailers, decided the one with the best costs, paid for it all, and has composed conveyance, which arrives not long after Shanu's returns home from work. Later that same night, Shanu's daughter, Zimpy, makes a request to get the car. Zimpy's smart contract with Shanu's car gives her get to. However, it does not empower the vehicle to make self-ruling installments for everything; shrewd contracts are correctly that-keen; they are adaptable for every relative. In this way, Zimpy can refuel. However, she cannot treat her companions to a drive through KFC utilizing her mom's SmartPay benefit. In addition, regardless of the possibility that Zimpy could pay for things she ought not, Shanu would rapidly discover because she would have the capacity to check the changeless exchange history on SmartPay's interface to the car's blockchain record.

**SmartShare:** A standout among the best application situations is real-time ride-sharing that can be easily accomplished by Block-VN model. Our project to build an open-source system, around the world, circulated ride-sharing, in order to challenge and modify the private transport frameworks built with large quantities of wasted waste seats and payload space. Block-VN model of constant travel sharing allows private car owners to give their empty seats to others venturing to each part of a similar course. It also offers a multi-rebound response for riders to switch between a few vehicles on their approach to goals, focusing on expanding the number of coordination rides and additionally making a more vigorous scope on customer needs transport. Contrast and such gathering stages as Lyft and Uber, Block-VN can take ride-sharing to the next level of decentralized, the group owned-and-supervise transportation arranges without unacceptable embedded decision-making or risks such as privacy leaks and surges pricing.

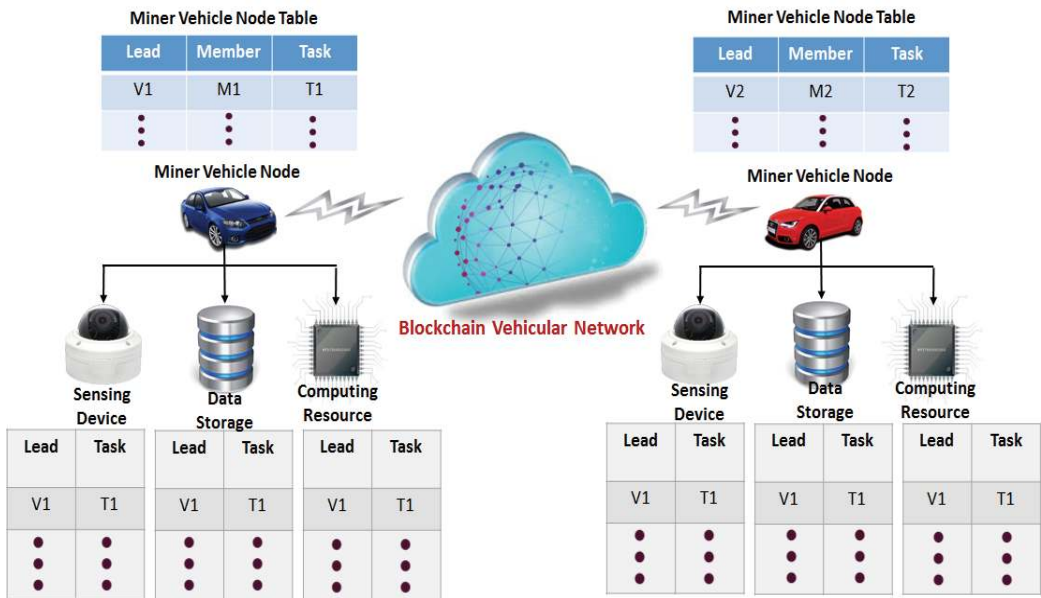


Fig. 3. Miner node's structural design.



## 4. Proposed Design Principles for Vehicular Network

Exploring on the vehicle network is at an extremely preparatory stage. This chapter discusses the require design principles for future improvement.

- **Distributed operations:** A vehicle network platform operates in a decentralized manner, and the vehicle to organize the assets are no longer reliable. Verify that in the Internet cloud, an administrative arrangement is a client-server communication between an organization specializing in clouds having an unlimited asset limit and a thin client device. For example, a client device in CloneCloud [30] has a cloned duplicate in the cloud that flexibly provides enough processing assets to satisfy customer demand. In Block-VC, in any case, there is no cooperative specialized in the clouds, and each vehicle plays at the same time the parts supplier and buyer. In addition, vehicle assets are constrained. That is, a buyer step must look for assets on demand and adapt to the circumstances in which the assets accessible in the blockchain network are not as much as what it requires.
- **Management of service content:** Most vehicle substances have neighborhood meaning and time extension, and eventually will likely quickly become noticeably obsolete. In this way, the cloud platform must treat the substance through whole life cycles. Block-VN substance can be created by a coordinated effort between different vehicles and miner with their sensory information and assets. At the moment when their legitimacy lapses, they should be placed on the system of blockchains to save the assets of the system. A distributor can predict the spatial and fleeting degree of the substance in their production, which helps the buyer to evaluate their persistent values. Be that as it may, an accurate forecast is not unimportant. As an option, shared detection and taking after the implementation of attention applications can decide the substance is an excellent opportunity to live.
- **Privacy and security:** Since Block-VN allows the sharing of assets, the most basic security issue would be a risk concentrating on the cloud itself. An attacker can send a DoS attack like jamming. Again, it might attempt to infuse malicious software into the scene to go through the assets of the scene or choose the scene in a botnet. An interruption frame or an honesty check of the frame can help minimize damage. Privacy is also vital in Block-VN because the substance each vehicle creates tends to reveal individual data. An anonymization plan can help solve the problem. Future research should also address the concerns of protecting buyers in the administration. They effectively search for assets and substance on the network. Verification of these exercises may reveal examples of client use of particular applications. A secure search conspiracy must make these exercises undetectable by using appropriate cryptosystems.
- **Fault tolerance:** Block-VN services depend heavily on sensory information collected from vehicles. This reduces at the time of administration various forms of basic leadership spending collection of sensors. In any case, sensors can be physically broken, glitch, or be traded for the purpose that they can transmit inaccurate information to procedures or even neglect to convey information. In addition, a vehicle that connects with a restricted asset limit may not provide enough assets and substance to meet the needs of the Block-VN administrations. The advantage of Block-VN must have the capacity to withstand such unpredictable failures.

## 5. Conclusion

The vehicular communication develops with the rising new ideal models, and this paper studies the details of the evolution. We have examined the applications of the ad hoc vehicle network and observed the remarkable features that cannot be effectively supported by the existing system. To address these features, we proposed a Block-VN model, a new distributed blockchain architecture based on the vehicle network. The Block-VN model allows vehicles to discover and share their resources to create a network of vehicles on which they work together to produce value-added services. Block-VN is a future vehicle network system, is built on top of them. To help comprehend Block-VN, we covered its operations, illustrated service scenario and discussed the principles of requirement.

In future work, we will continue to deepen our research interests in the financing of mobile vehicles in a sharing economy, and we seek to integrate the blockchain and wearable technology. Indeed, we believe that it is the impeccable public storage of the blockchain, coupled with a distributed file system model provided to manage scaling, transparency and security.

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