Research Article

Simulation of IoT-based Vehicular Ad Hoc Networks (VANETs) for Smart Traffic Management Systems

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Nowadays, traffic congestion and increasing road accidents have become a major concern for both developed and developing countries. To overcome this challenge, an internet of things (IoT)-based Vehicular Ad Hoc Network (VANET) system is proposed in which vehicles interact with other vehicles and infrastructure. These self-organized ad hoc vehicle networks not only boost traffic safety but also enhances the efficiency of traffic management systems. The VANET systems are beneficial in busy locations, where improved data dissemination protocols are used to categorize a vehicle’s transmission. However, the performance of these VANETs is also hampered by network splits and insufficient connections. Under these situations, the proposed simulation model reduces broadcast storms by minimizing redundancies, which is equally beneficial for both rural and urban settings. The suggested Next Forwarder Vehicle (NFV) protocol is based on three factors: position, distance, and orientation. Moreover, the DDP4V technique is used to analyse each of these features. Results indicate that DDP4V is compatible with 96% of all traffic scenarios and simulation durations. It can transport data packets 60% faster due to its broadcast suppression capabilities. Also, it compared to AID and DBRS, DDP4V has fewer dispersed packets, which results into reduced retransmissions. Similarly, DDP4V delivers 90% coverage for 400 vehicles/km², which is 30% greater than prior techniques. It is observed that the proposed protocol reduces broadcast storms by employing a waggon wheel to choose the next forwarding vehicle. In high-traffic areas, it outperforms standard techniques. Similarly, it employs a patchwork of vehicles outside of the impacted region to convey data. The industrial IoT-based VANETs provide an effective tool to monitor and control traffic besides reducing the number of traffic accidents.

1. Introduction

A smart gadget can gather and transmit data faster than a human. The Internet of Things (IoT) links devices such as phones, vehicles, and home appliances. Technologies based on electronic industry 4.0 were the first IoT technology to be applied in manufacturing [1, 2]. It links autos and roadside devices [3], a self-organizing network of connected vehicles. Increasing vehicle usage has led to increased traffic congestion and car pileups, both of which are hazardous. According to the WHO, automobile accidents kill or injure 1.25 million people each year [4]. Therefore, VANETs place a premium on security, and these networks should offer entertainment as well as environmental protection in addition to security [5].
VANETs have already piqued the attention of academic and industrial researchers. VANETs are decentralised networks in which each vehicle node broadcasts its position and speed to its neighbours on a regular basis. This information is used to alert distant cars in the network about accidents or traffic congestion. VANETs provide a diverse set of applications that may be characterised as either safe or dangerous [6]. A broad variety of signals must be given at high data rates in nonsafety applications. Each vehicle in a VANET sends a message (a data packet), and the overwhelming majority of VANETs transmit data through broadcast. They do not need to know where you are or how you got there. This eliminates the need for time-consuming tasks like address creation, routing, and topology maintenance, and VANET data transport is hampered by broadcast storms, network splits, and capacity limits. With all these constraints, efficient and effective data distribution becomes a challenging and impressive task [7, 8]. Most automakers are working on effective data delivery through VANETs. Several data distribution strategies have been developed for various VANET settings and traffic conditions [9, 10].

Our important contributions to the article are listed as follows:

(i) Creation of a dependable and efficient data transmission system for highway and urban VANET applications

(ii) The transmission zone of the source vehicle is separated into three different sections. As a result, the best thing to do would be to use a lot of cars to spread information and avoid broadcast storms

(iii) The number of repeated transmissions is also monitored and reduced using an NFV mechanism

2. Background

Many ways of data distribution inside VANETs have been suggested in the literature. A highway VANET protocol is one that is often used on the road, such as a highway or a city street. Highway data dissemination protocols are discussed below:

Both Simple and Robust Dissemination (SRD) tinkers to combat fragmented networks are successful in sparse networks. This approach is used to determine the frequency of the highway beacon, DRIFT [11]. It is quicker and broader than DRIFT, plus it is more stable and storm-proof. This research included three Speed Adaptive Broadcasts (SABs). Slotted-1 persistence ratios should be reduced using redundancy ratios. Broadcom is provided via a VANET [12]. Cars interact on two different levels; the next level chooses vehicles in the cell’s geographic centre to interact with other automobiles both within and outside the cell. It can handle broadcast storms and other network issues; LTE is an ideal for long-distance connections with minimal latency. VMaSC clusters vehicles before selecting CH, and it is chosen to serve as VANET/LTE nodes with dual interfaces.

In VANETs, probabilistic data transmission is common, and the Immortal Forwarding (IF) algorithm [13] selects an NFV based on two criteria: vehicle density and distance from the source vehicle. Because each car recognises the cars of its neighbours, the IF protocol has a high forwarding probability. To prevent “carelessly” transferring data packets, it should wait for the latter to retransmit. As a result, the broadcast storm has been mitigated. Three distributed and probabilistic data distribution algorithms were developed to improve reach, reduce MAC layer collisions, and reduce duplication in high traffic. Using previously communicated global positioning system data, the retransmission chance is computed. Added limitations result in Vehicular Ad Hoc Networks (VANETs). Due to vehicle and infrastructure mobility, VANETs do not need preexisting networks. Too few cars? This is where roadside infrastructure may help. Drivers cannot access safety and nonsafety programmes without VANETs. But VANET cannot communicate between two moving cars. Many VANET programmes, both good and bad, have message routing difficulties. Building a solid and dependable message broadcast system for VANET safety applications is difficult.

MobiCast is a VANET technology that allows for time-based network architecture adjustments [14]. Zone of relevance (ZoR) enables vehicle communication in real-time. It also makes use of zone of forwarding (ZoF) inside the ZoR. Data packets are retransmitted within a network after they have been received. The basic goal is to choose the ZoR, ZoF, and vehicles to use within the ZoF. This protocol was created for VANET comfort applications that are geographically oriented (ZoR). The key distinction is that MobiCast-Carry-Forward (MCF) employs the carry-forward technique, which leads to increased end-to-end latency.

Networked autos get precise vehicle data propagation of Urban Multihop Broadcast (UMB) [15], which uses multihop V2V and V2I networks to handle broadcast storms. It chooses the vehicle that is the farthest away from the sender to transfer data packets. It routes data packets in all directions through a junction. Repeaters cannot be used at every crossing all the time. When there are obstructions that create differentiation between distinct road segments and make crossings difficult, then AMB does not need infrastructure [16]. However, while comparing with other protocols, the Ad hoc Multihop Broadcast (AMB) protocol has a high success rate and makes economical use of bandwidth.

The Distance-Based Relay Selection (DBRS) protocol [17] achieves the same results every time, and DBRS vehicle sends out a data packet. The amount of time spent varies according to the distance between automobiles. As a result, the automobiles that were the farthest had to wait the shortest time. DBRS organises retransmissions of the same data packet to avoid broadcast storms. Long waits may occur due to scarcity of vehicles within the transmission range restrictions. The quantity of identical data packets is used by AID to choose NFV. It lowers the broadcast storm by intercepting data packets destined for other cars. AID is not in charge of network segmentation. Both are addressed by the U-Hydi protocol [18]. In densely populated areas, there are two techniques to reduce the effect of the broadcast storm. It employs store-carry-forward to transport data packets over a network.
Geocast data transport is decentralised, and it divides a map and major event places define an important ZoR. Partitioning the map is necessary, both rely on the network backbone and network forwarding. Hybrid-Based Election Backbone (HBEB) makes microbackbones (backbone nodes) with a single manufacturer. The contention is used to choose backbone nodes, and V2V and V2I interfaces are used to offer data services, helping to increase data exchange and service delivery.

3. Protocol for Data Dissemination

It handles challenges like broadcast storms, network partitioning, erratic connections, and NFV selection. As a result, overhead has decreased, as it has the risk of accidents and delays. It has the potential to be used both in rural and urban VANETs. The proposed technique reduces broadcast storms by reducing redundancy. Impacted vehicles situated outside of the affected region may be used to distribute data through network partitions, DDP4V NFV isolation (also known as waggon wheels).

The transmission zone is then divided by forwarders shown in Figure 1. The most important portion is ideal, followed by normal, and ultimately ahead. The transmission zone is then divided by forwarders as shown in Figure 1: A: Transmission Range B: Normal Segmentation C: Ahead Segmentation A: Transmission Range B: Normal Segmentation C: Ahead Segmentation D: Vehicle Transmission Range of the Transmitting Vehicle and E: The Area in Front of You is shown with angle. The most important portion is ideal, followed by normal, and ultimately ahead.

Members of a network may become separated from one another as a consequence of network partitioning, resulting in the establishment of several groups. There are random neighbouring autos inside the three waggon wheel segments. A vehicle’s transmission zone is a 200–300 meter circle. Aside from the circles, the provided method is amazing. The waggon wheel concept prevents vehicles stationed in different segments from delivering the same data packet, therefore solving the broadcast storm problem. Vehicles in the optimal range have fewer gears, meaning lower network load.

The proposed data dissemination strategy is shown in Figure 2 and discussed below. The procedure is broken down into five steps.

3.1. Stages of Emergency Detection. A car comes to an abrupt halt on the side of the road, signalling an accident. Assume you have a simple 1-hop neighbour car ID, position, trip direction, and distance. GPS-like devices are used to gather vehicle data. They help with network topology. This data is required to compute VFP and NFV.

3.2. Messages of Emergence. The first vehicle to provide an emergency alert is the source vehicle, and the data packet is sent backwards to warn oncoming cars. The proposed solution entails using multihop connections to send data packets to as many cars as possible. This technique avoids the need to manually update the neighbour information database, which may be problematic in congested areas.

3.3. Vehicle Positioning. In VANETs, vehicle categorisation is critical for future retransmissions and data delivery. The transmission zone of the source vehicle is separated into portions in Figure 1. Oncoming vehicles are classified into three categories depending on their placement inside each sector: ideal, normal, and ahead. The data packet should be transmitted by the vehicle that is the farthest away in this case. The vehicle at the far end of the ideal segment should be used to decrease delays and repeat retransmissions. If no vehicles are discovered within the optimum sector due to a lack of vehicles in the optimal and ordinary sectors, vehicles outside of those segments provide the data packet. Carriers are required to provide data packets to all inaccessible vehicles on their route. The technique for each waggon wheel component is shown in Algorithm 1.

3.4. Next Forwarder Vehicle Selection. The received data packets are subsequently retransmitted to other network nodes by a forwarder vehicle. The protocol performance is determined by the NFV utilised. A data distribution system must meet certain NFV selection criteria to be a success.

3.5. Emergency Message Rebroadcaster. Choosing the correct NFV vehicle among a network’s vehicles is crucial. The suggested protocol chooses an NFV based on three factors: position, distance, and orientation. These three components allow for efficient data packet routing. The distance, on the other hand, is defined as the greatest distance between two automobiles. The most distant Ri vehicle will be the NFV. This element also depicts the direction of a vehicle in relation to a source, and Ri vehicles approach the source vehicle to transmit data in the proposed system.

When you cancel a scheduled message, it is resent. Canceling the scheduled message, Ri vehicles take longer to send data packets because of network disruption and/
VLAN and examine the configuration, filtering of untagged packets using the VLAN Protocol. VLAN membership is determined at layer-3. It has a number of protocols. IP-based networks are not affected. When a vehicle detects a problem, an M (emergency data packet) is sent to the affected region. NFVs are wonderful for vehicles in the correct business context. Each vehicle (Ri) changes its position. Otherwise, the information should be disseminated as Ri case shown in Figure 3. The data delivery method for DDP4V scheme is given in Figure 3, and it determines whether Ri is in the impacted zone. If not, Ri discards it. It also searches for the initial data packet; Ri inspects each data packet for defects and get rid of the preceding data packet. If not, it will be discarded. A waggon wheel is used to assemble a data packet. Alternatively, in the waiting time of Algorithm 1, Ri sends the data packet to the specified destination.

Our VANET data distribution technique effectively handles sparsely connected networks, broadcast storms, network splits, and optimum NFV choice (DDP4V). When transferring data over the network, emergency protocols propose minimizing overhead, collisions, and latency. It can handle both urban and highway VANET traffic. Rules may halt a broadcast storm. Moving cars out in the way of network partitions and bad network connections may help. Because the “waggon wheel” is split, it may choose the best NFVM. A car can quickly communicate with other cars. This location has two sides. Back segment subsegments are lovely. The transmission zone is divided into zones based on the following forwarder’s vehicles. It is followed by the optimal segment for packet forwarding. Waggon wheel cars may park in any of the waggon wheel’s three parts. Assume a 200-300 meter radius circle around the gearbox, the proposed method may be utilised on forms other than circles. So surrounding cars cannot split a single data packet into parts covering the same or a less vital area. Keeping autos in the right sector saves time and money (network load).

All network vehicles transmit data packets during dispersion. With quicker data transfer, broadcast storms may occur. Important information must be provided as soon as possible. Source cars that identify network splits send data packets to affected vehicles. Vehicles that are network-connected may now exchange data. After receiving packet M, each Ri vehicle searches for network partitions. If not, Ri discards it. It also has an effect. No way, no how a data packet that should have been transmitted is discarded. Data packets are evenly distributed across roads and cities. A data packet is cancelled when Ri is not in the automobile (M), to save time, and Tj-Ri data packets are ignored.

1. There are five distinct inputs from which to choose: Each car in the affected region has been damaged.
2. If this is your first time receiving the message, output: NFVs, Tj = Ri Direction. There are two parameters to the angle atan2 method (arctangent function).
3. To calculate the distance, divide the distance between Ri and Tj by two. The default delay for new connections is 0.01 (distance to/communication radius).
4. R’s appointment has been postponed. A delay is the sum of the present delay and the waiting time.
5. In this instance, terminate the programme and set the priority to (0.02). (0.04).
6. If the amount of time spent waiting is longer than the amount of time that was chosen at random (0.05, 0.07).
7. Establish the RiMessage schedule (delayed).

**Algorithm 1: A methodology for selecting the next forwarder vehicle.**

![Figure 2: Depiction of data dissemination strategy.](image-url)
4. Results

The DDP4V technique is used to analyse each of these features, and comparing DDP4V to different data delivery methods using the following criteria, how many vehicles get data packets? In the total number of automobiles vs the number of data packets received because each vehicle in the network sends out the same amount of data packets, the reliability of VANET data transmission is increased. Broadcast storms may occur because of high data rates. Data packets need time to transfer between vehicles. Latency must be maintained to a minimum in an emergency. For neighbouring vehicles, the average MAC layer crashes. A significant number of automobile accidents might generate broadcast storms. For reliable transmission, compact package size is required.

4.1. A Highway-Based VANET. This protocol is suitable for application in a variety of VANET setups. The construction of a 10-kilometer, three-lane road with opposing traffic began (east-west and west-east). Every hour, 800 cars go on the other side of each freeway. The network now supports three vehicle types: high-speed, moderate-speed, and slow-speed. These vehicles have top speeds of 33, 26, and 20 meters per second, respectively. In other words, a dynamic vehicular network is made up of three distinct vehicle kinds.

The number of automobiles in the experiment varies. Each simulation is made up of 50% fast automobiles, 25% medium-sized cars, and 25% slow cars.

After a little respite, a passing automobile on the highway suggests a collision. Create a 2048-byte data packet to begin data dispersion. The data packet contains fresh information. A warning has been sprayed in the other direction. We want to reach as many folks travelling east on I-95 as possible. The transmission range is about 250 yards per car with an 18 Mbit/sec MAC layer [19]. There were about 50 different iterations. For traffic analysis, DDP4V and other approaches are used. Figure 4 shows a route with varying traffic. The whole zone is covered by just DDP4V and floods. DDP4V is compatible with 96% of all traffic scenarios and simulation durations. A broadcast storm arises when there are too many broadcasts during the flooding process.

In highly populated areas, data distribution technologies reduce the effects of broadcast storms. When there are fewer transmissions, broadcast storms are lessened. Flooding allows for the best feasible transmission rate while avoiding the need for broadcast suppression. They transmit at a slower rate than DDP4V but cover a smaller area (Figures 4(a) and 4(b)). DDP4V provides comprehensive coverage. DBRS has the lowest overhead since it sends fewer data packets to other automobiles.
DDP4V has the lowest overhead of any full-coverage protocol, and the average latency of AID is the longest (Figure 5(a)). AID says that it analyzes data from other cars before giving it to the user. Delivery time is affected by the density of DDP4V trucks. When autos are in their optimal sector, data packets are transferred more swiftly. DDP4V beats DV-CAST and DBRS in terms of coverage and distance. Keeping delays to a minimum increases the likelihood of a broadcast storm. When cars are present in the optimal section, DDP4V provides lower overall latency than other protocols. On average, data packet collisions occur at a rate of two per second.

This setting influences the speed with which data is transmitted in high-traffic areas. All collisions are shown in Figure 5(b). When traffic congestion worsens, flooding is the leading cause of accidents. Due to a lack of vehicle cooperation, several cars are attempting to share the little available bandwidth [20–22]. There is just one accident per automobile in these procedures. People who drive cars with the DDP4V protocol do not have to deal with as many broadcast storms on the road at the same time.

4.2. An Example of a VANET in a Congested Area. The method has previously been tested in a city; our study was carried out on a km² Manhattan grid with ten-by-ten two-lane roads. This was shown using the Veins framework [23], and each vehicle has a range of 200 yards and a MAC data rate of 18 Mbit/sec [19]. The Internet of Things (IoT)
links devices such as phones, vehicles, and home appliances. Technologies based on electronics Industry 4.0 were the first IoT technology to be applied in manufacturing [24–26], and it links autos and roadside devices. To complete an epoch simulation, a vehicle (source) delivers a 2048-byte data packet to its neighbours. There are 50 iterations for each result, and we do not test DV-CAST since it is just for highways. DDP4V and other highway procedures are also being investigated on an equal footing in cities, summarizing the most significant urban simulation parameters. High-rise signal attenuation is sometimes overlooked in urban settings.

Figure 6 depicts an urban network that is not segregated, the coverage percentage Figure 6(a) for varied traffic densities. In densely populated areas, we may be able to achieve a high delivery rate by broadcasting data packets to virtually every automobile nearby [27, 28]. Flooding causes all data packets from targeted automobiles to be retransmitted. Floods cannot express their entire information since there are only 250 autos per km$^2$, and the others cover the same territory. All options approach 80% when considering a vehicle density of 200–250 per km$^2$.

These solutions are beneficial in high-traffic areas (400 cars per km$^2$), and DDP4V data packets are received by autos in the ideal sector block from other automobiles. In low-traffic areas, the covering is visible. Figure 6 depicts data packets transmitted during dissemination. Figure 6(b). The flooding protocol has the highest road overhead since all cars submit the same data packet.
It can transport data packets 60% faster than floods due to its broadcast suppression capabilities. Compared to AID and DBRS, DDP4V has fewer dispersed packets, reducing retransmissions while increasing bandwidth. Figure 6 depicts the data packet delivery time to target vehicles. Flooding, unlike other protocols, maintains low latency over a broad spectrum of traffic. DDP4V develops more slowly at low dosages (200–300/km²). Due to increased traffic density, the DDP4V time was shortened. AID and DBRS are outperformed by DDP4V. The DDP4V is a great solution for VANET applications that need high data throughput without causing network congestion. DDP4V delivery times decrease as traffic density increases. As the traffic density of a network grows, more cars will reach the optimal portion. Therefore, automobiles in the optimal sector rapidly distribute data packets [29, 30]. Collisions in MAC layer packet transmission. Crash rates spike after floods and continue to rise as road
congestion intensifies. Flooding systems in populated regions are insufficient to deal with widespread storms.

Collisions occur in almost every protocol; this reduces the likelihood of packet collisions. It sends data while reducing broadcast storms, and unified messaging is used in urban VANETs. The approach is then tested in a city setting. As a result, we created a Manhattan grid with 24 two-lane roadways evenly spaced across 4 miles. To divide the network, we built a 200 m × 1000 m barrier along with the source vehicle. Automobiles, therefore, are unable to speak with one another. Each grid investigates the attenuation of signals in buildings, and as a result, each car transmits across a 200-meter range. The source vehicle on the grid transmits a 2048-byte data packet to its neighbours. New network segmentation has been deployed. Cars from different zones must transport data packets from one zone to the next [31].

Figure 7: Simulation results for urban scenario. (a) Traffic flow vs coverage. (b) Traffic flow vs number of data packets.
Figure 7 summarises the findings of a partitioned urban network. Figure 7 shows full protocol coverage at different traffic volumes (Figure 7(a)). At 200 automobiles per km², all these techniques accomplish 35–40% of the needed cars. Coverage is restricted since data packets only reach vehicles on the same side as the originating vehicle. Vehicles are capable of transporting data packets from a source to a partitioned region. DDP4V delivers 90% coverage at 400 vehicles/km², which is 30% greater than prior techniques. In Figure 7, congestion raises overhead, especially when using DDP4V. Because messages must be sent across network partitions, DDP4V overhead increases. On the other hand, DDP4V is unable to resolve the network’s broadcast storm issue.

In the anticipated delivery date for all cars, DDP4V’s network delivery is the slowest when utilised through network partitions outside of the afflicted zone, and DDP4V causes packet loss. Depending on traffic demand, delivery times vary from 300 to 400 ms. Transmission delays decrease as traffic volume increases. As a result, as network traffic density rises, more cars may be able to reach the best sector. As a result, vehicles in the best category transmit data packets quickly. The average MAC layer collision rate during data transmission is depicted in Figure 7. DDP4V has fewer packet collisions but no floods than AID and DBRS, and it has a reduced delivery latency due to fewer redundant retransmissions. DDP4V may or may not use network partitions to transmit emergency messages.

5. Conclusion

It oversees broadcast storms, network segmentation, and the adoption of NFV, and the suggested protocol might be used in any VANET environment. In highway, city, and network segmentation in crowded places, autos retransmit data packets. Traffic density reduces the time it takes for data packets to be delivered because cars in the right place send data packets quickly. The DDP4V protocol reduces broadcast storms by employing a waggon wheel to choose the next forwarding vehicle. DDP4V use NFV to eliminate unnecessary transfers, and it provided the most in-depth treatment of any of the tests. In high-traffic areas, it outperforms standard techniques. In a divided city, it outperforms alternative protocols by 30%. It employs a patchwork of autos outside of the impacted region to convey data. A timer is used to do this, and as a result, the protocol’s robustness increases.

We created a simulation model and put the DDP4V protocol through its paces in urban VANETs. In simulations, this strategy swiftly distributes data packets to all targeted automobiles. Duplicate packets, propagation delays, and hop counts have all been reduced. DDP4V is a stable and low-cost solution that does not need network partitioning. Several academics worked on VANET to improve a greater emphasis on protocol design and implementation. Model checking has the potential to enhance research. To enhance our study abilities, we must address the issue. The mobile RSU will aid in the removal of UAVs in an emergency.

Data Availability

Data will be available on request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

References

[1] M. Wolf and D. Serpanos, “Safety and security in cyber-physical systems and Internet-of-Things systems,” Proceedings of the IEEE, vol. 106, no. 1, pp. 9–20, 2018.
[2] J. Espada, R. Yager, and B. Guo, “Internet of Things: smart things network and communication,” Journal of Network and Computer Applications, vol. 42, pp. 118-119, 2014.
[3] J. Contreras-Castillo, S. Zeadally, and J. Guerrero-Ibanez, “Internet of vehicles: architecture, protocols, and security,” IEEE Internet of Things Journal, vol. 5, no. 5, pp. 3701–3709, 2017.
[4] T. Toroyan, M. Peden, and K. Iaych, “WHO launches second global status report on road safety,” Injury Prevention, vol. 19, no. 2, pp. 150–150, 2013.
[5] F. Belamri, S. Boulfekhar, and D. Aissani, “A survey on QoS routing protocols in vehicular ad hoc network (VANET),” Telecommunication Systems, vol. 78, no. 1, pp. 117–153, 2021.
[6] B. Cui and X. Yan, “A review of data management and protocols for vehicular networks,” International Journal of Web and Grid Services, vol. 13, no. 2, pp. 186–206, 2017.
[7] R. Kashyap, “Applications of wireless sensor networks in healthcare,” in IoT and WSN applications for modern agricultural advancements: Emerging research and opportunities, IGI Global, Pennsylvania, United States, 2020.
[8] R. Nair, P. Nair, and V. Dwivedi, “FPGA on cyber-physical Systems for the Implementation of Internet of Things,” in FPGA Algorithms and Applications for the Internet of Things, IGI Global, Pennsylvania, United States, 2020.
[9] R. Kashyap, “Miracles of healthcare with Internet of Things,” in Smart Devices, Applications, and Protocols for the IoT, pp. 120–164, IGI Global, Pennsylvania, United States, 2019.
[10] R. Kumar and R. Nair, “Multi-cryptosystem based privacy-preserving public auditing for regenerating code based cloud storage,” International Journal of Computer Applications, vol. 155, no. 10, pp. 16–21, 2016.
[11] L. Villas, A. Boukerche, G. Maia, R. Pazzi, and A. Loureiro, “DRIVE: an efficient and robust data dissemination protocol for highway and urban vehicular ad hoc networks,” Computer Networks, vol. 75, pp. 381–394, 2014.
[12] A. Durresi, M. Durresi, and L. Barolli, “Network trust management in emergency situations,” Journal of Computer and Systems Sciences, vol. 77, no. 4, pp. 677–686, 2011.
[13] S. Panichpipatnoi and L. Cheng, “Irresponsible forwarding under real intervehicle spacing distributions,” IEEE Transactions on Vehicular Technology, vol. 62, no. 5, pp. 2264–2272, 2013.
[14] Y. Chen and Y. Lin, “A mobicast routing protocol with carry-and-forward in vehicular ad hoc networks,” International Journal of Communication Systems, vol. 27, no. 10, pp. 1416–1440, 2012.
[15] Z. Pei, X. Wang, Z. Lei, H. Zheng, L. Du, and W. Chen, “Joint optimization of multi-hop broadcast protocol and MAC protocol in vehicular Ad Hoc Networks,” Sensors, vol. 21, no. 18, article 6092, 2021.
[16] G. Korkmaz, E. Ekici, and F. Ozguner, “A cross-layer multihop data delivery protocol with fairness guarantees for vehicular networks,” *IEEE Transactions on Vehicular Technology*, vol. 55, no. 3, pp. 865–875, 2006.

[17] M. Kuai, X. Hong, and Q. Yu, “Delay-tolerant forwarding strategy for named data networking in vehicular environment,” *International Journal of Ad Hoc and Ubiquitous Computing*, vol. 31, no. 1, pp. 1–12, 2019.

[18] R. de Sousa, A. Boukerche, and A. Loureiro, “A distributed and low-overhead traffic congestion control protocol for vehicular ad hoc networks,” *Computer Communications*, vol. 159, pp. 258–270, 2020.

[19] C. Sommer, S. Joerer, M. Segata, O. Tonguz, R. Cigno, and F. Dressler, “How shadowing hurts vehicular communications and how dynamic beaconing can help,” *IEEE Transactions on Mobile Computing*, vol. 14, no. 7, pp. 1411–1421, 2015.

[20] R. Kashyap, “Machine Learning and Internet of Things for Smart Processing,” in *Artificial Intelligence to Solve Pervasive Internet of Things Issues*, Academic Press, United States, 2021.

[21] R. Kashyap, “Machine learning for internet of Things,” in *Research Anthology on Artificial Intelligence Applications in Security*, pp. 976–1002, IGI Global, Pennsylvania, United States, 2021.

[22] R. Kashyap, “Machine learning, data mining for IoT-based systems,” in *Handbook of Research on Big Data and the IoT*, pp. 314–338, IGI Global, Pennsylvania, United States, 2019.

[23] Y. Zhou and S. Sun, “Performance analysis of opportunistic beam splitting NOMA in millimeter wave networks,” *IEEE Transactions on Vehicular Technology*, vol. 71, no. 3, pp. 3030–3043, 2022.

[24] R. Nair and A. Bhagat, “Healthcare information exchange through blockchain-based approaches,” in *Transforming Businesses with Bitcoin Mining and Blockchain Applications*, pp. 234–246, IGI Global, Pennsylvania, United States, 2020.

[25] R. Nair, P. Sharma, A. Bhagat, and V. Dwivedi, “A survey on IoT (Internet of Things) emerging technologies and its application,” *International Journal of End-User Computing and Development*, vol. 7, no. 2, pp. 1–20, 2018.

[26] M. Gourari, H. Wu, M. Palaniswami, and R. Buyya, “An application placement technique for concurrent IoT applications in edge and fog computing environments,” *IEEE Transactions on Mobile Computing*, vol. 20, no. 4, pp. 1298–1311, 2020.

[27] G. Naqvi, S. Masood, S. Khushnood, A. Rizwan, and M. Jahanzaib, "The rollover prediction and prevention of bullet proof vehicles for improved stability," *Life Science Journal*, vol. 10, no. 4s, pp. 209–214, 2013.

[28] H. Alsulami, S. Serbaya, E. Abualsaud, A. Othman, A. Rizwan, and A. Jalali, "A federated deep learning empowered resource management method to optimize 5G and 6G quality of services (QoS)," *Wireless Communications and Mobile Computing*, vol. 2022, Article ID 1352985, 9 pages, 2022.

[29] M. Saleem and A. Rizwan, “Development of application specific intelligent framework for the optimized selection of industrial grade magnetic material,” *Polymers*, vol. 13, no. 24, article 4328, 2021.

[30] R. Krishnamoorthi, S. Joshi, H. Z. Almarzouki et al., “A novel diabetes healthcare disease prediction framework using machine learning techniques,” *Journal of Healthcare Engineering*, vol. 2022, Article ID 1684017, 10 pages, 2022.

[31] W. Xia, R. Neware, S. D. Kumar, D. A. Karras, and A. Rizwan, “An optimization technique for intrusion detection of industrial control network vulnerabilities based on BP neural network,” *International Journal of Systems Assurance Engineering and Management*, vol. 13, no. S1, pp. 576–582, 2022.