**IJCTA**, 10(9), 2017, pp. 593-602 ISSN: 0974-5572


# A Hybrid Prediction Based Data Dissemination Scheme for Vehicular Ad hoc Networks

**Ashima Sood*, Rasmeet Singh** and Prabhsharan Kaur*****

**ABSTRACT**

Vehicular Ad hoc Network (VANET) is a novel approach where vehicles communicate with each other under challenging situations characterized by recurrent disconnections and long delays. They work on the principle of ad hoc networks. In the case of disconnections in the network, the messages do not reach their destination on time. Such disconnections result in data loss or delay. In order to avoid such data delay, we proposed a hybrid prediction based data dissemination scheme which is based on V2V communication paradigm. The vehicles periodically predict their future position and on the basis of the relative distance between the intermediate vehicles and destination, the next hop neighbor selection is performed. The vehicles relay messages hop-by-hop between the intermediate vehicles to finally reach their destination, thereby, reducing delay and enhancing network efficiency. The proposed scheme has been analyzed through extensive simulation and the results indicate the effectiveness of the proposed scheme with respect to existing scheme.

***Index Terms:*** data dissemination, future position prediction, store-carry-forward, VANETs

## 1. INTRODUCTION

In recent years, population explosion has led to tremendous growth in usage of Internet and related technologies by different communities all over the globe. This enormous population growth has also contributed to exponential increase in vehicle density that results in number of accidents and traffic jams. Thus, there is a need for an intelligent vehicular system which can detect and regulate vehicular movement. Such a system is referred to as Intelligent Transportation System (ITS) [1]. In this system, every vehicle broadcasts varied information collected through installed sensors about the traffic to every other vehicle in the vehicular environment. A vehicular environment known as Vehicular Ad hoc Network (VANETs) [2] is a special type of mobile ad hoc network in which the vehicles communicate through wireless networks. In VANETs, vehicles possess the ability to communicate directly with other vehicles by vehicle-to-vehicle (V2V) communication, or, they can transmit information with the help of existing roadside infrastructure called roadside units (RSUs) using vehicle-to-infrastructure (V2I) or vehicle-to-roadside (V2R) communications. The Dedicated Short Range Communications [3] standard has been developed for inter-vehicle communication (IVC).

A major issue for data dissemination in VANETs is the frequent network disconnection due to relatively high mobility of vehicles. This may hamper timely data delivery during disconnections. Also, due to highly dynamic topology of vehicles, periodic disconnections result in lack of end-to-end connectivity between the source and destination vehicles [4]. Thus, most of the existing data delivery mechanisms exhibit performance degradation. To address the problem of data delay, the idea of store-carry-forward has been integrated in VANETs. In this approach, the intermediate vehicle between source and destination stores the

* Research Scholar, *Email: soodashima01@gmail.com*
** Associate Professor, *Email: rasmeetsbali@gmail.com*
*** Assistant Professor, *Email: prabhsharan.kaur13@gmail.com*

message and carries it till it finds another vehicle in its transmission range and forwards it when another vehicle comes in its contact. The process is repeated until the message reaches its destination [5]. The movement of vehicles on the road can assist in timely and successful message delivery when the messages are relayed to next vehicle in the vehicular environment [6]. The packets are relayed in hop-by-hop manner until the destination node receives the packet. Figure 1 depicts a VANET scenario in which a vehicle stores packets, carries and passes it to the next vehicle that comes into its vicinity. The vehicles transmit information using V2V and V2R communication.

The data dissemination techniques in VANETs are classified into two generic categories called push-based and pull-based techniques [7]. The push based mechanism is generally employed in most of the data dissemination techniques. The dissemination of data in VANETs is done using several routing protocols [8] that intend to deliver data to the destination even in disconnected or intermittent networks. The Vehicle-Assisted Data Delivery (VADD) [9] protocol works on the concept of store-carry-forward scheme for data dissemination to cope with frequent disconnections in the vehicular network. In order to get an optimal path from source to destination, an optimal link selection can be used. In this scheme, an extra storage known as dropboxes are introduced that store the messages until it finds next suitable vehicle [10]. An epidemic routing algorithm [11] assures reliable message delivery when there exists a network partition while going from source to destination based on periodically pair-wise connection. In this scheme, messages are replicated and many copies of same message are distributed among different nodes so as to increase probability of message delivery.

Most of the existing data dissemination protocols exhibit performance degradation especially when packet transfer is not scheduled in sparsely populated areas, thus, causes high packet delay and low data-delivery rate. Most of the existing data dissemination protocols exhibit performance degradation especially when packet transfer is not scheduled in sparsely populated areas, thus, causes high packet delay and low data-delivery rate. An efficient energy-aware predictive clustering approach [12] has been implemented on VANETs that performs prediction of vehicle mobility. Based on the prediction process, the average variation of the vehicle movement is analyzed.

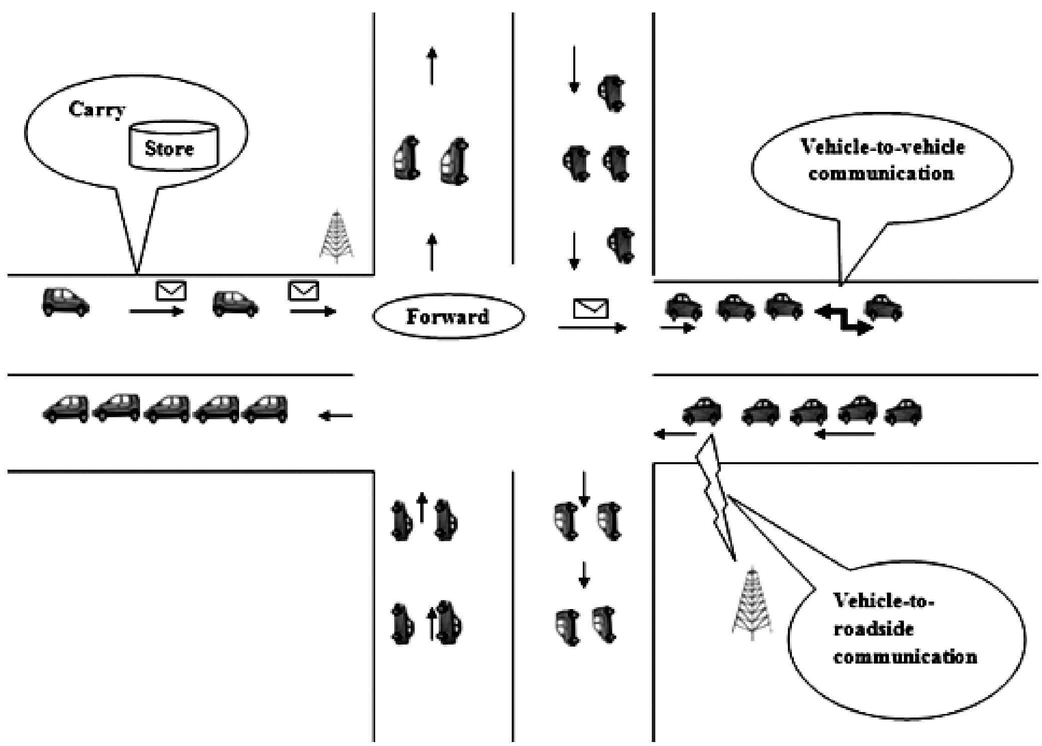



**Figure 1: General scenario of Vehicular Ad hoc Networks (VANETs)**

Also, prediction can be done in clusters using prediction based clustering algorithm which predicts the future position of upcoming vehicles and transmit the information to the neighboring vehicles. A cluster head is selected from each cluster which is responsible for handling network responsibilities so as to reduce delay, overhead and improves communication [13]. In order to store the information about transferring of packets, a file sharing scheme based on Distributed Hash Table can be used [14]. With the help of this scheme, packets are transferred to various nodes by using hash tables that store the information about sender and receiver nodes identities. It helps in reducing the delay and improves performance. The beaconing scheme in [15] helps in reducing the congestion and enhancing the utilization of limited resource effectively. The beaconing scheme depends upon the prediction done by taking into account the current and historical traffic parameters such as traffic density and vehicle speed.

Although, numerous data dissemination schemes have been proposed for VANETs, but only a few prediction based data dissemination schemes have been proposed. The proposed data dissemination scheme called Predictive- hybrid data dissemination or P-HDD involves prediction based on which the vehicles can locate their nearby vehicles and can carry forward the message to them even in the case of disconnection in the network. The remaining paper is organized as follows. Section 2 describes the problem formulation. Section 3 describes our proposed scheme and section 4 includes the simulation, results and comparative analysis with the existing scheme. Ultimately, section 5 concludes the paper.

## 2. PROBLEM FORMULATION

Vehicles in the modern era are equipped with devices like sensors and GPS systems which help them to recognize the vehicle movement and distance travelled. The future position of vehicle is predicted using the current position of that particular vehicle and the distance between its previous and current position. The vehicles can easily communicate with other vehicles as long as they are in their communication range. Increase in distance between the vehicles results in connection fading that result in delay or loss of packets. So, the prediction technique helps in predicting the future position of vehicle to which the packet would be transferred even in the case of network disruption. The predicted vehicle will carry forward the packet to the destination until it comes in contact to another vehicle, thus, reducing data-delivery delay and overhead.

## 3. PROPOSED SCHEME

In order to determine the future position of vehicles, the proposed scheme uses the predictive approach for future mobility of vehicles described in [12]. The positions and velocities of vehicles are computed in the network at discrete time periods ($\tau$) that are moving on pre-defined paths. The assumed position of prior vehicle $V_{i-1}$ helps to predict the future position of intermediate vehicle that lies on its path within its transmission range R. Vehicle $V_{i-1}$ forwards the message $M_i$ to next relay vehicle $V_i$ which then carries $M_i$ and looks for another vehicle to relay message to finally reach the destination vehicle $V_{dest}$ at '$\tau$' time. The fundamental objective of the proposed scheme is to minimize the data-delivery delay between the vehicles by predicting their future positions so as to reduce data loss during frequent disconnections in the network. This scheme ultimately reduces packet drop and improves the overall efficiency of data dissemination in VANETs.

### 3.1. Prediction based algorithm

The proposed prediction based scheme helps in retaining data by predicting future position of vehicles to which the data would be transferred even in the case of network disruption. The predicted vehicle will carry forward the packet to the destination until it comes in contact to another vehicle.

In algorithm 1, the initial position and velocity of vehicles are initially assumed in the network at discrete time period ($\tau$) moving on pre-defined paths. Initially, for 'N' number of vehicles, the actual position of vehicle $V_i$ is assumed. The pre-computed velocity '$s_0$' and existing velocity '$s_1$' is used to evaluate the average velocity of the upcoming vehicle for 'x' time instance. The future mobility prediction is then carried out taking into consideration the real vehicle position $realpos_\tau$ and the computed velocity of $V_i$. The predicted position of vehicles is evaluated as in (1):

$$predpos_\tau = realpos_\tau + \tau * \left(s_{\tau-1} + \left(s_\tau - s_{\tau-1}\right)/2\right) \tag{1}$$

This algorithm helps in generating different values by evaluating future position estimation ã for different vehicles on the lane at $\tau$ intervals.

### 3.2. Predictive Hybrid Scheme

The hybrid predictive data dissemination scheme is the combination of scheme used in [12] and [13]. The proposed predictive hybrid data dissemination scheme, P-HDD, is a position-based scheme which uses aforementioned prediction based algorithm for data dissemination in densely and sparsely populated areas. In algorithm 2, real positions of vehicles at source and destination and, predicted positions of intermediate relay vehicles are taken as input. For each vehicle on the path, future prediction is done initially by calculating $\gamma_i$ as described in algorithm 1. When any vehicle reaches at intersection, it selects the route on which the destination vehicle ($V_{dest}$ ) exists.

**Algorithm 1: Future Position Estimation**

Inputs : Prior and current position of vehicle, Real position of every vehicle during prior predication ($pos_{real}$), Velocities of vehicles in prior time intrvals $\tau$.

Output : Future position estimation ($\gamma_i$)

Assumption : Vehicles are assumed to be moving on pre-defined path.

for (vehicle $V_i = 1$; $V_i \leqslant N$) do
$\gamma_{i,o} = 0$;
$flag_i = 0$;
$realpos_{(\tau)}$ = prior known position of $V_i$;
$s_0$ = prior calculated velocity of $V_i$;
$s_1$ = existing velocity of $V_i$;
for ($\tau = 1$; $s \leqslant x$) do
    $realpos_{(\tau)}$ = last computed position of $V_i$;
    $S_{\tau-1} = S_\tau$;
    Determine existing velocity of $V_i$, $s_\tau$;
    $predpos_\tau = realpos_\tau + \tau * (s_{\tau-1} + (s_\tau - s_{\tau-1})/2)$;
    if ($\tau \geqslant$), then
    $flag_i = 1$;
    end if
    if ($flag_i \neq 0$), then
    $\gamma_\tau = \left(\sum_{i=1}^{\tau=1} \gamma_i + \left(predpos_\tau - realpos_\tau\right)\right)/2$;
    end if
  end for
end for
END

**Algorithm 2: Predictive Data Dissemination**

Inputs : Real positions of vehicles at source and destination
Predicted position of intermediate vehicles.
Output : Predictive Data Dissemination
Assumption : Vehicles are assumed known about future positions of next vehicles.

for every $V_i$, do
predpos at every $\tau$ time using $\gamma_i$;
*if* ($V_i$ is in transmission range $\mathbb{R}$ of $V_{i-1}$), then
    Forwards message $M_i$ to $V_i$;
else
    Stores $M_i$ and lok for other intermediate $V_i$ in its $\mathbb{R}$;
end if
    if (multiple vehicels are in $\mathbb{R}$ of $V_i$), then
        Select $V_i$ with distance $\mathbb{D}$ = minimum;
    end if
    if ($V_i$ is at intersection), then
        Choose the direction of destination vehicle $V_{dest}$.
    end if
end for
END

## 4. PERFORMANCE EVALUATION

In this section, we evaluate the performance of the proposed hybrid prediction based data dissemination scheme and comparative analysis is further done.

### 4.1. Simulation Settings

To study the performance of proposed scheme, Opportunistic Networking Environment (ONE) simulator [16] is employed. The simulation is done using map-based mobility model of Helsinki city which provides

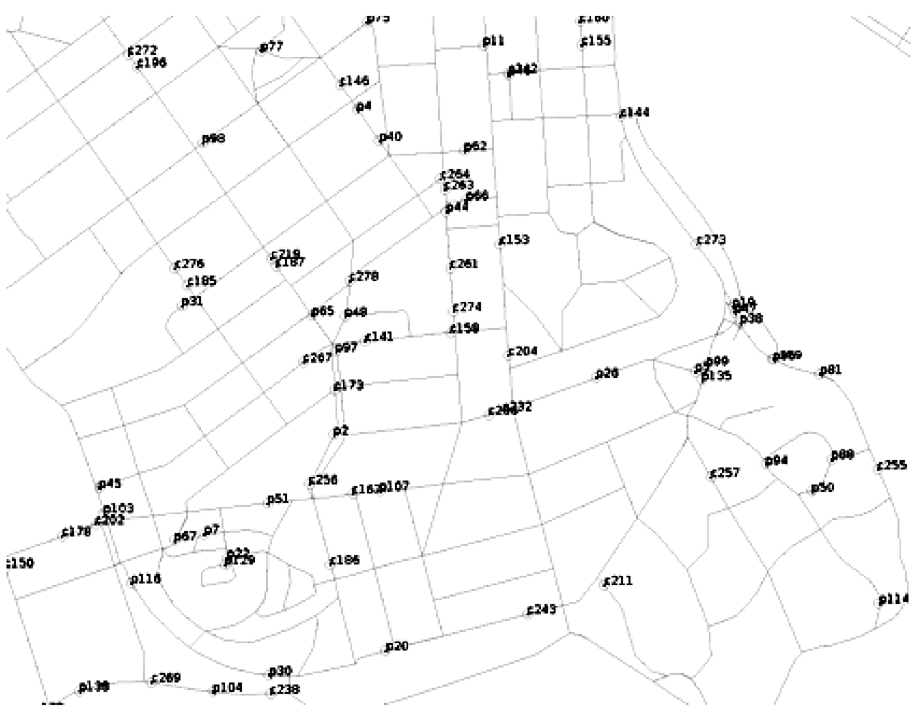


**Figure 2: Map-based simulation with vehicles on different paths**

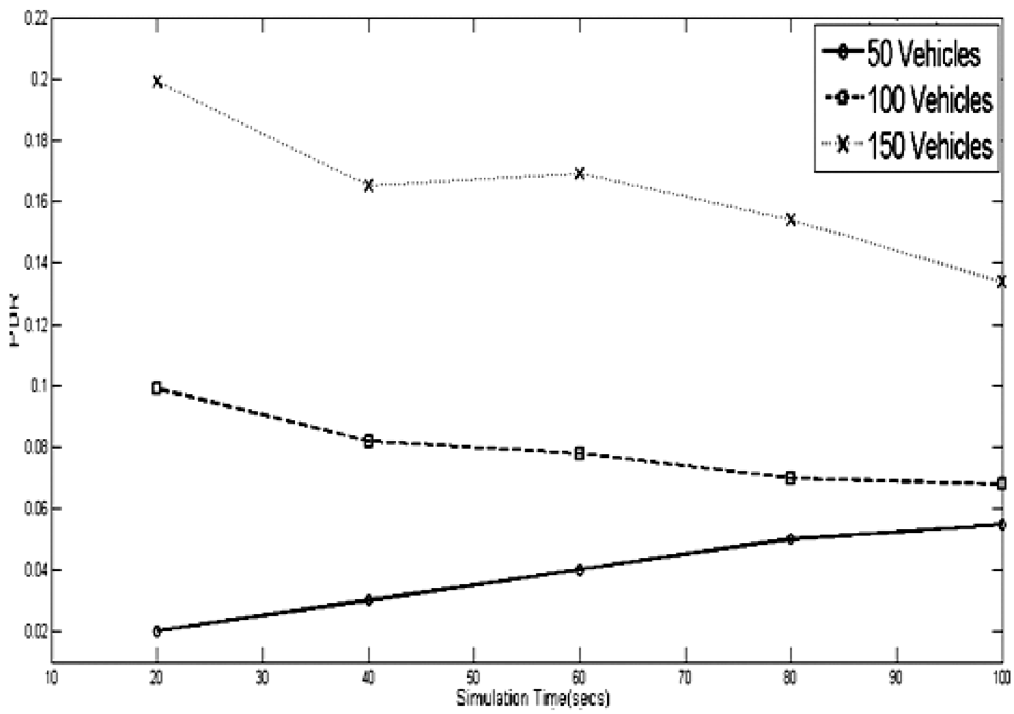
pre-defined routes and path that are derived from real map as in Figure 2. The vehicles run on different lanes with speed ranging from 10 km/h to 50 km/hr. Figure 2 shows the map-based model of Helsinki city which has a number of vehicles on different lanes.

Following parameters have been used for performance evaluation:

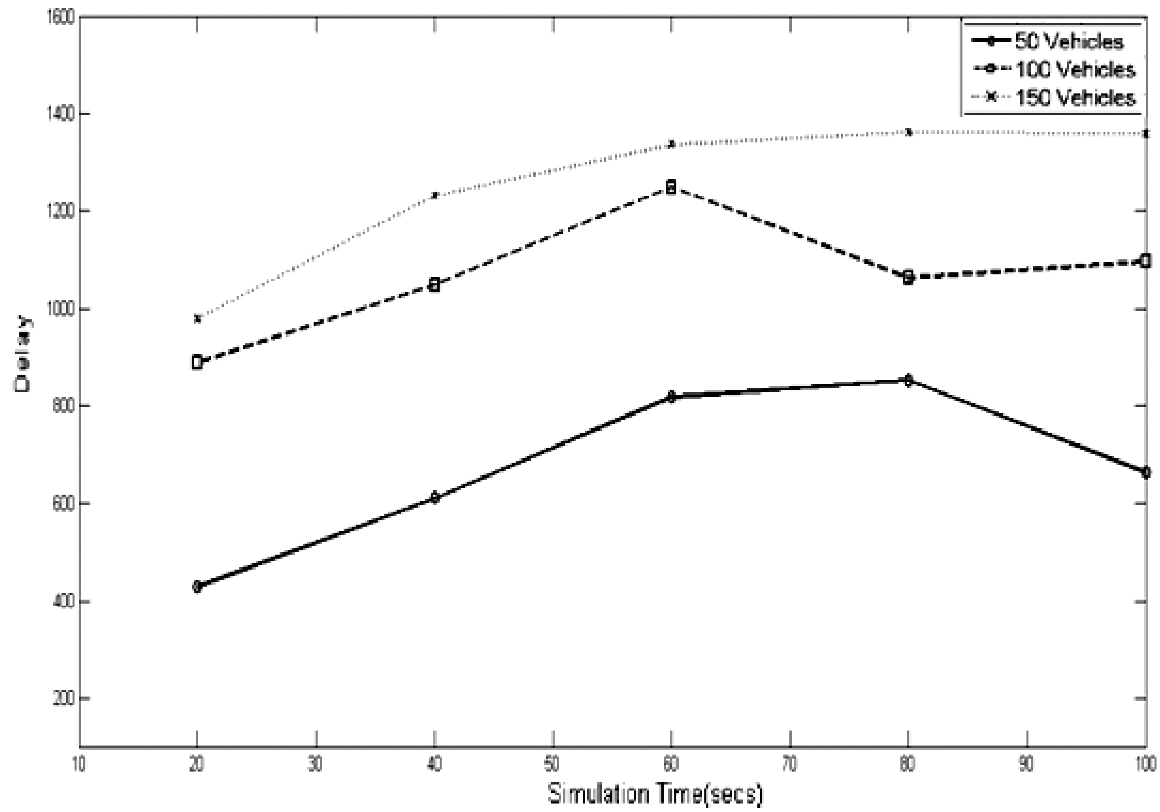
- Packet Delivery Ratio (PDR): It is defined as the ratio of total number of packets delivered successfully and the total number of packets sent from source to destination. Higher PDR signifies more efficiency in the network.
- Data-Delivery Delay: It is described as the total delay that has cropped up after data dissemination from source to destination.
- Overhead: It is defined as the wasted network resources like bandwidth etc. during data transmission.
- Throughput: It is a measure of average number of successful delivered packets per unit time.

### 4.2. Predictive HDD

The evaluation of P-HDD is done by focusing on the aforementioned parameters. The change in PDR for varied number of vehicles at different simulation time is shown in Figure 3(a). All the results in this segment are based on 150-vehicle deployment and the simulation time varies from 20s to 100s. The value of PDR is initially low when the vehicles density is less on the roads due to unavailability of neighboring vehicles and gradually increases with increasing vehicle density. The data-delivery delay depends on the delivery ratio. In Figure 3(b), the delivery delay decreases due to increase in percentage of successfully delivered data at the destination side. In Figure 4(a), overhead increases with increasing simulation time (ranging from 5 to 10) since the vehicle density is more. This dynamically varying vehicular environment leads to bandwidth wastage and degrades the efficiency of network. Also, in Figure 4(b), throughput increases with increasing number of vehicles due to increased probability of vehicles to forward packets to the next hop. The value of throughput rises from 4300 Mbps to 5500 Mbps due to timely data delivery which ultimately improves the system performance.

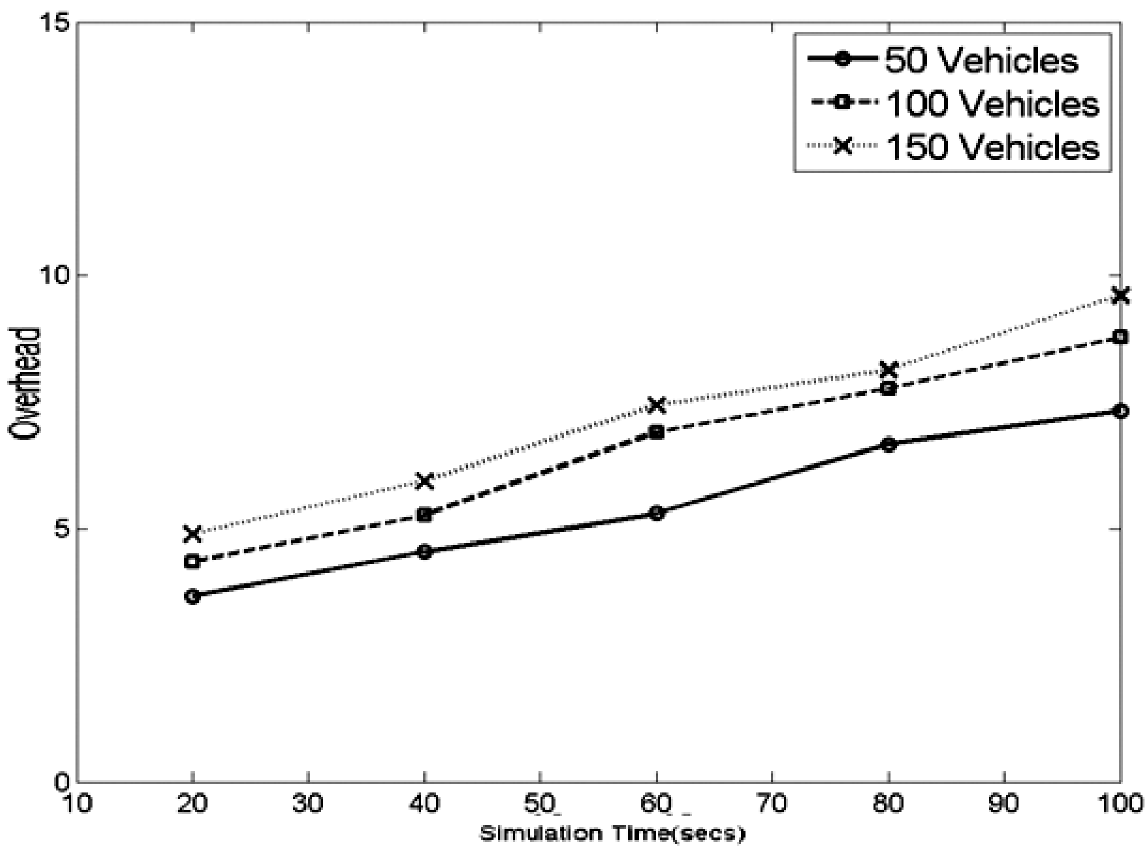



**(a)**

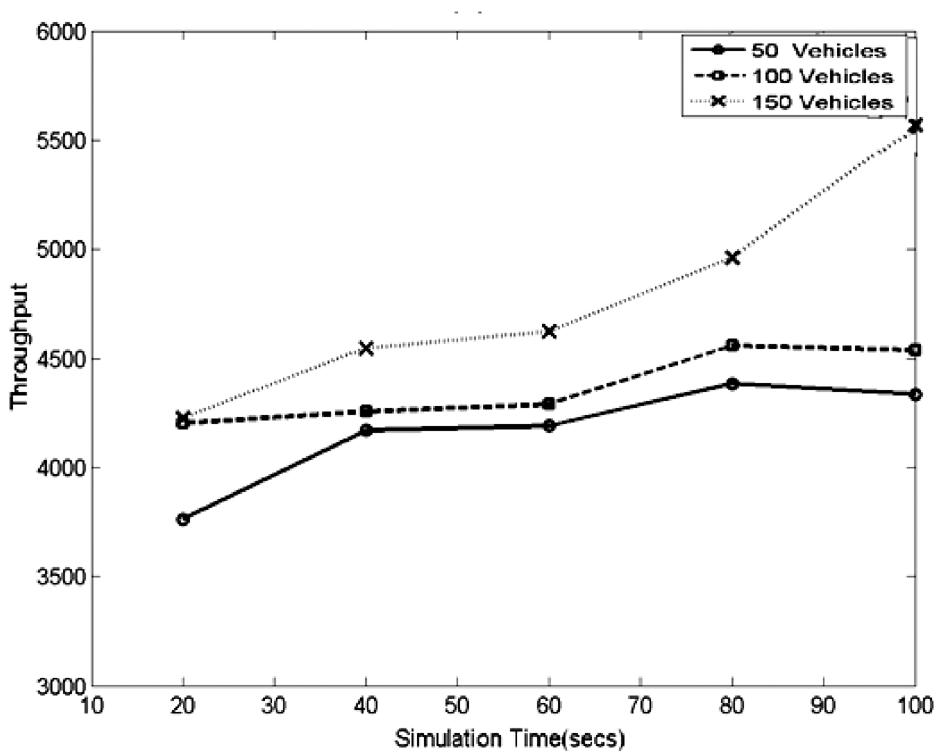



**(b)**

**Figure 3: Variation in (a) Packet Delivery Ratio (b) Delay with reference to Simulation Time**




**(a)**

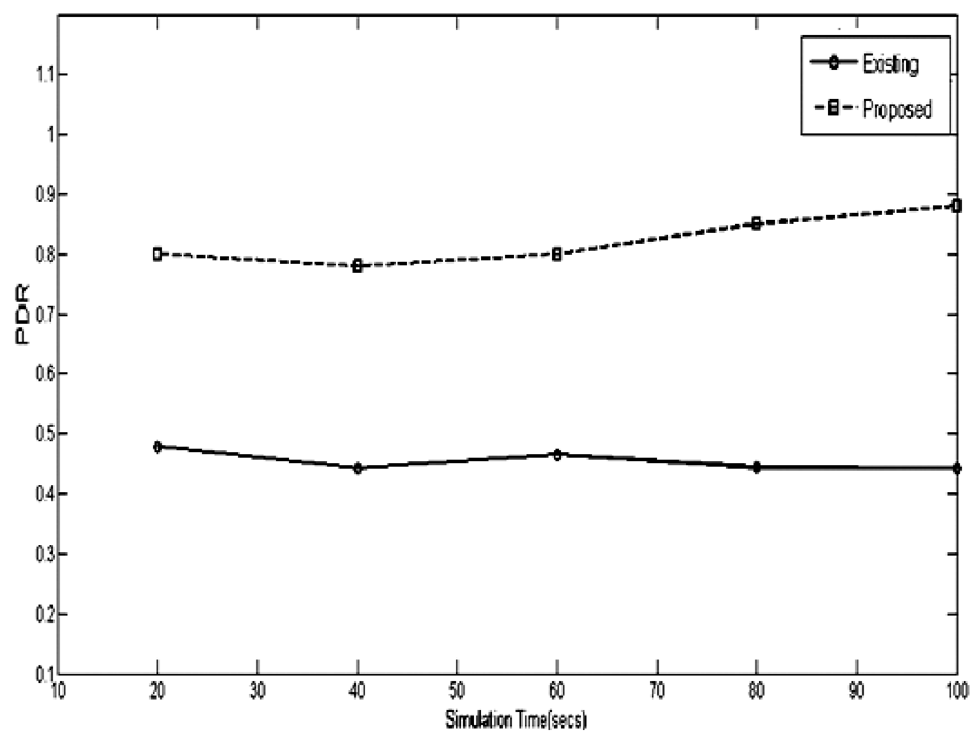



**(b)**

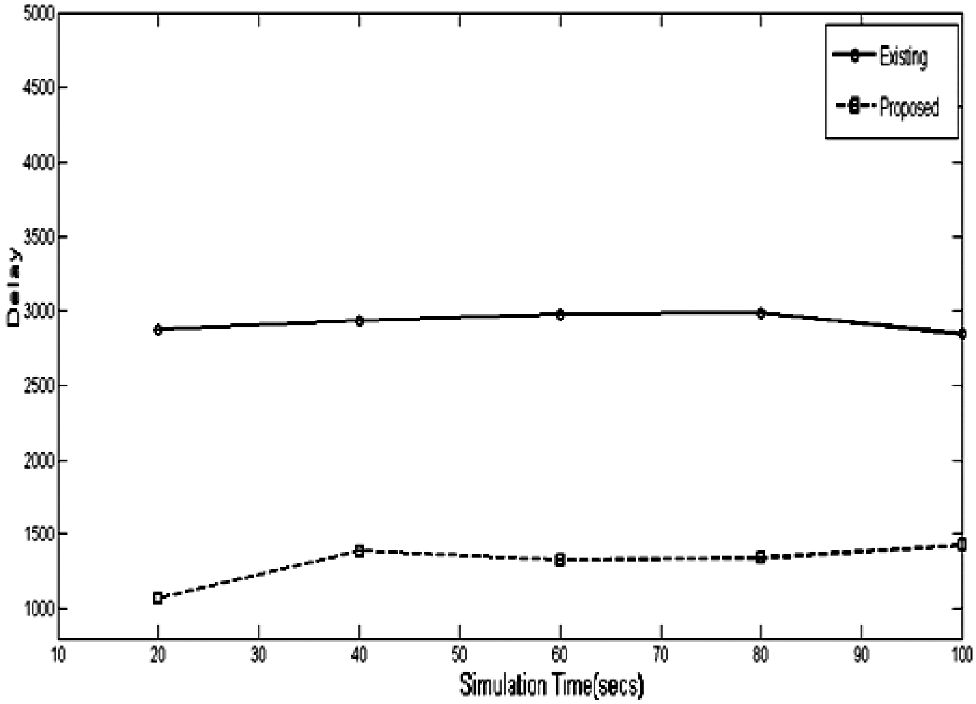
**Figure 4: Variation in (a) Overhead (b) Throughput with reference to Simulation Time**

### 4.3. Comparative Analysis

In this segment, a comparative analysis of the proposed scheme with the current existing scheme [13] has been performed. The variation in PDR of our proposed scheme in comparison to existing scheme is shown in Figure 5(a). The percentage of delivered packets for P-HDD is higher than the other existing ones. This




**(a)**




**(b)**

**Figure 5: Comparison of (a) Packet Delivery Ratio (b) Data Delay for P-HDD with existing scheme with respect to Simulation Time**

is due to the reason that P-HDD has the ability to predict future positions of vehicles and the use of store-carry-forward approach. Hence, PDR of the proposed scheme for a number of vehicles increases with increasing data sending rate due to the future prediction done for path election and data dissemination. Also, data-delivery delay is less for our scheme as compared to existing scheme due to prior position prediction of vehicles that helps in timely data delivery at the destinations as shown in Figure 5(b). Initially, the delivery delay increases and then becomes constant. This is because, the vehicles gradually improve the process of future positions of the upcoming vehicles and thus, they can effectively deliver data to the destined vehicles which ultimately reduce data-delivery delay. Hence, there is an improvement in performance in our scheme as compared to [13].

Thus, from the above results, we can deduce that P-HDD scheme has high PDR value and low delay due to future predictable movement of vehicles. Thus, it proves helpful in making our scheme more efficient. Due to high data delivery rate and less delivery delay, the overall throughput of the proposed scheme is high which makes our scheme more efficient. Also, due to its efficient implementation, the proposed scheme can be used in variety of future applications for VANETs.

## 5. CONCLUSION

In this paper, a predictive hybrid data dissemination scheme is proposed. The proposed scheme utilizes prediction mobility scheme in order to identify the neighboring relay vehicles to carry-forward the message to destination. Our scheme proves efficient in addressing the issues such as frequent disconnections in the network and minimizing data delivery delay with high throughput in VANETs. The proposed scheme was evaluated for different simulation time and varied number of vehicles on road. As observed from derived simulation results, the proposed P-HDD scheme helps in achieving high throughput with minimum delivery delay.

As future work, several other data dissemination schemes may be designed that work efficiently for disconnected networks which will work on predictable vehicle mobility.

## REFERENCES

[1] Miller, Jeffrey. “Vehicle-to-vehicle-to-infrastructure (V2V2I) intelligent transportation system architecture.” In *Intelligent Vehicles Symposium, 2008 IEEE*, pp. 715-720. IEEE, 2008.

[2] Al-Sultan, Saif, Moath M. Al-Doori, Ali H. Al-Bayatti, and HussienZedan. “A comprehensive survey on vehicular Ad Hoc network.”*Journal of network and computer applications* 37 (2014): 380-392.

[3] Yin, Jijun, Tamer ElBatt, Gavin Yeung, Bo Ryu, Stephen Habermas, Hariharan Krishnan, and Timothy Talty. “Performance evaluation of safety applications over DSRC vehicular ad hoc networks.” In *Proceedings of the 1st ACM international workshop on Vehicular ad hoc networks*, pp. 1-9. ACM, 2004.

[4] Kumar, S., S. H. Ahmed, U. Qasim, Z. A. Khan, N. Amjad, M. Q. Azeem, A. Ali, M. J. Ashraf, and N. Javaid. “Analyzing link and path availability of routing protocols in vehicular ad-hoc networks.”*Journal of Basic and Applied Scientific Research* 4, no. 2 (2014): 189-206.

[5] Ng, Seh Chun, Wuxiong Zhang, Yu Zhang, Yang Yang, and Guoqiang Mao. “Analysis of access and connectivity probabilities in vehicular relay networks.”*IEEE Journal on Selected Areas in Communications* 29, no. 1 (2011): 140-150.

[6] Chen, Zong Da, H. T. Kung, and Dario Vlah. “Ad hoc relay wireless networks over moving vehicles on highways.” In *Proceedings of the 2nd ACM international symposium on Mobile ad hoc networking & computing*, pp. 247-250.ACM, 2001.

[7] Tomar, Pratibha, Brijesh Kumar Chaurasia, and G. S. Tomar. “State of the art of data dissemination in vanets.”*International Journal of Computer Theory and Engineering* 2, no. 6 (2010): 957.

[8] Chen, Wai, Ratul K. Guha, Taek Jin Kwon, John Lee, and YuanYing Hsu. “A survey and challenges in routing and data dissemination in vehicular ad hoc networks.”*Wireless Communications and Mobile Computing* 11, no. 7 (2011): 787-795.

[9] Zhao, Jing, and Guohong Cao. “VADD: Vehicle-assisted data delivery in vehicular ad hoc networks.”*IEEE transactions on vehicular technology* 57, no. 3 (2008): 1910-1922.

[10] He, Jianping, Lin Cai, Peng Cheng, and Jianping Pan. “Delay minimization for data dissemination in large-scale VANETs with buses and taxis.” (2015).

[11] Vahdat, Amin, and David Becker. “Epidemic routing for partially connected ad hoc networks.” (2000).

[12] Bali, Rasmeet S., Neeraj Kumar, and J. J. P. C. Rodrigues. “An efficient energy-aware predictive clustering approach for vehicular ad hoc networks.”*Int J Commun Syst. doi* 10 (2015): 1002.

[13] Kaur, Prabhsharan, and Rasmeet Singh Bali. “Vehicular clustering based on future position estimation for highway scenario.” In *2015 Annual IEEE India Conference (INDICON)*, pp. 1-6.IEEE, 2015.

[14] Kaur, Prabhsharan, Rasmeet S. Bali, and Arvinder Kaur. “M-DART based Asynchronous File Sharing Scheme in VANET.” Procedia Computer Science 57 (2015): 288-295.

[15] Qian, Jin, Tao Jing, Yan Huo, Hui Li, Liran Ma, and Yanfei Lu. “An Adaptive Beaconing Scheme Based on Traffic Environment Parameters Prediction in VANETs.” In International Conference on Wireless Algorithms, Systems, and Applications, pp. 524-535. Springer International Publishing, 2016.

[16] Keränen, Ari, JörgOtt, and TeemuKärkkäinen. “The ONE simulator for DTN protocol evaluation.”In *Proceedings of the 2nd international conference on simulation tools and techniques*, p. 55.ICST (Institute for Computer Sciences, Social-Informatics and Telecommunications Engineering), 2009.