Vehicular Ad-hoc Network Security and Data Transmission: Survey and Discussions

Ankit Temurnikar[1], Dr. Pushpneel Verma[2], Dr. Jay Trilok Choudhary[3]

[1]Research Scholar, Department of CSE, Bhagwant University Ajmer, Rajasthan, India

[2]Department of CSE, Bhagwant University Ajmer, Rajasthan, India

[3]Department of CSE, MANIT, Bhopal Madhya Pradesh., India.

ABSTRACT

In the recent years, Vehicular Ad-Hoc Networks (VANETs) have taken a lot of researchers' attention because it is used in many safety and commercial applications such as safety message dissemination, collision detection, providing comfortable passengers services and traffic control. A vehicular network consists of vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communications supported by wireless access technologies such as IEEE 802.11p. This innovation in wireless communication has been envisaged to improve road safety and motor traffic efficiency in near future through the development of intelligent transportation system (ITS). At the network layer, the main issue is to invent the energy efficient and reliable routing, to transmit data from source to destination, for maximization of lifetime of the network. In this paper we presents the review in the vehicular ad-hoc network for quality of services such as, communication, delay, packet delivery ration, transmission error etc., also focus on the challenges and issues in the recent trends in vehicular ad-hoc network and discuss the above to resolve in future.

Keywords: Vehicular ad-hoc network, Quality of services, Clustering, Transmission error, communication.

INTRODUCTION

The continuous development of wireless communication technology and embedded system, intelligent transportation system has become a hot research field in recent years. As a special MANET (Mobile Ad hoc Networks), the Vehicular Ad hoc Networks (VANET) is an important part for the ITS (Intelligent Transportation System). VANET architecture [1]
is divided into two communication architectures, including vehicle to vehicle (V2V) and vehicle to infrastructure (V2I). With the flexibility of self-organization of vehicles, V2V architecture can easily implement information sharing and data communication between vehicles; V2I architecture enables the vehicle to access the Internet, achieves long-distance communications and meets the needs of traffic and vehicular entertainment etc. As the main application field of VANET, ITS requires VANET to provide real-time and effective information to the driver, such as road condition information and traffic jam, to ensure efficient and safe travel.

In VANET, interaction between gathered independent nodes is carried out through radio waves. There is a direct interaction among nodes, if it is in radio range otherwise intermediate node needed for routing packets. In VANET, each of the independent mobile node has a wireless interface to share information with other nodes. These networks are completely distributed. It works at any place. It does not require any static infrastructure as a base station. Also, it does not require static infrastructure as an access point. The VANET is a form of the mobile nodes which are used for various applications related to the environment [8].

In the recent years, car manufacturing industries, academia and government agencies have started putting much joint efforts together towards realizing the concept of vehicular communications in a wide scale. Some frameworks are already worked out with the first landmark of standardization processes made by US Federal Communications Communication (FCC) through the allocation of 75MHz of dedicated short range communication (DSRC) spectrum[3] basically to accommodate vehicle-to vehicle (V2V) and vehicle-to-infrastructure (V2I) communications for safety-related applications [11].

Data transmission in such environment is critical and has to be distributed in multiple paths to improve the end to end delay. The frequent topology changes in the vehicular ad hoc network (VANET) environment make the generated stale routes in routing table leads to unnecessary routing overhead. Subsequently, the frequent route repairs increase the link notification failures and route discoveries drastically. Therefore the discovered route between couple of vehicles should be as stable as possible to satisfy QoS requirements [2].

Data dissemination generally refers to the process of spreading data or information over distributed wireless networks. This dissemination uses one of the two available communication modes. The message will be disseminated in a multi-hop fashion when V2V communication is enabled and will be broadcasted by all the roadside units (RSU) when V2I communications are used instead. A hybrid version is also possible, RSUs broadcast the messages and, as they do not cover the whole network, some vehicles are selected to forward the message to complete the dissemination. These messages can be flooded at a certain number of hops or in a given area depending on the application purposes [19].

Clustering is a technique to group nodes into several clusters. Each node in the cluster structure plays one of three roles: Cluster Head (CH), Cluster Gateway (CG), and Cluster Member (CM). The CH in a cluster plays the roles as coordinator and backbone. It is in charge of all the communications inside a cluster, managing medium access and allocating the resource to cluster members. A CG is a border node of a cluster that can communicate nodes belonging to different clusters. The clustering scheme has been well investigated in wireless ad-hoc networks in recent years. However, considering the characteristic of VANETs, such as high speed, sufficient energy and etc., the clustering schemes proposed for conventional wireless ad-hoc networks are not suitable for VANETs. Therefore, clustering schemes for VANETs should be designed specifically [6].

Most of existing clustering algorithms in VANETs are based on one-hop communication where cluster head (CH) and cluster members (CM) can communicate directly. Small coverage of one-hop clusters leads to an increase in the number of CHs. This can decrease routing efficiency and raise communication cost when communication beyond the cluster small range is necessary. Multi-hop clustering algorithms extend the communication coverage in the same cluster and reduce the number of CHs and subsequently the number of clusters [7].

The rest of this paper is organized as follows. In Sect. II, we discuss the overview of VANET. In section III we present related work, with the tabular form also. Section IV gives a detailed description of problem statement after the literature survey. Conclusion and perspectives are presented in Sect. V.

II OVERVIEW OF VANETS

In 1999, the Federal Communication Commission allocated a frequency spectrum for vehicle-vehicle and vehicle-roadside wireless communications. The Commission then established the service and license rules for Dedicated Short Range Communications (DSRC) service in 2003. DSRC is a communication service that uses for public safety and private applications. The allocated frequency and developed services enable vehicles and roadside beacons to form V ANET in which the nodes can communicate wirelessly with each other without central access point. In contrary, nodes in V ANET are rechargeable and can be constrained by the road and traffic patterns [15].

In VANETs, participating vehicles are equipped with a set of wireless sensors and on board units (OBUs) to allow for possibility of wireless communication between the vehicles and their environs. These devices make each vehicle function as packet sender, receiver and router which enable the vehicles send and receive messages to other vehicles or road side units (RSUs) within their reach via wireless medium. These sets of wireless sensors, OBUs or some typical radio interfaces enable vehicles form short-range wireless ad-hoc networks to broadcast kinematic data to vehicular networks or transportation authorities/agencies which process and use the data to foster traffic efficiency and safety on the motorways. Vehicles can directly establish communication wirelessly with one another forming V2V communications or with fixed RSUs forming V2I communications. These vehicular communication configurations rely heavily on acquisition of accurate and up-to-date kinematic data of both the vehicles and the surrounding environment with the aid of positioning systems and intelligent wireless communication protocols and access technologies for reliable, efficient and timely information exchange. Considering the network environment of VANETs with unreliable, shared communication medium and limited bandwidth [18], smart cross-layer communication protocols are required to guarantee reliable and efficient delivery of data packets to all vehicles and infrastructures (RSUs) within the vehicles radio signal transmission coverage.

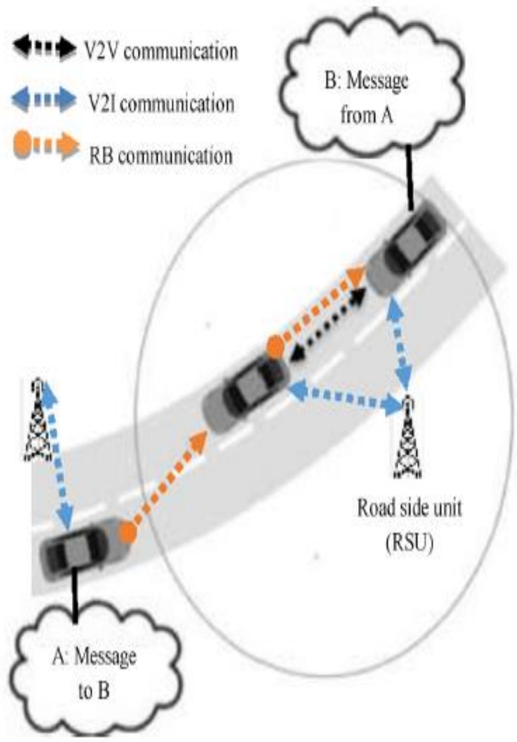

Fig. 2 Possible vehicular communication configurations in intelligent transport systems (ITS) [11].

III RELATED WORK

In recent years, many studies have been done concerning how to manage communications between the vehicles and also ensure to provide best quality of services among the vehicles in the vehicular ad-hoc network. [1] In this paper, author proposed a novel passive multi-hop clustering algorithm (PMC) is proposed to solve the problems. The PMC algorithm is based on the idea of a multi hop clustering algorithm that ensures the coverage and stability of cluster. In the cluster head selection phase, a priority-based neighbour following strategy is proposed to select the optimal neighbour nodes to join the same cluster. This strategy makes the inter-cluster nodes have high reliability and stability. By ensuring the stability of the cluster members and selecting the most stable node as the cluster head in the N-hop range, the stability of the clustering is greatly improved. In the cluster maintenance phase, by introducing the cluster merging mechanism, the reliability and robustness of the cluster are further improved. In order to validate the performance of the PMC algorithm, they do many detailed comparison experiments with the algorithms of N-HOP, VMaSC, and DMCNF in the NS2 environment. [2] In this paper, author proposed a new algorithm for multi-constrained QoS routing in vehicular network by adopting clustering approach. In the algorithm design, some QoS metrics are used in addition to the stability metrics for finding and establishing a stable route to destination. This is achieved by calculating the corresponding QoS provision values before selecting an optimal, reliable and stable route. NCTUns 6.0 network simulator was used for the experiment of the proposed scheme. Results show a significant improvement of the proposed approach in terms of broken links, routing overhead and end-to-end delay. The main focus of author is to provide stability for routing safety traffic information and to explore the difficulties of providing packet level QoS for real-time traffics in vehicular network. They determined to overcome these challenges by setting the priority queues over separate channels Control Channel and Service Channel DSRC's seven-channel band plan, their routing path deals with the dynamic nature of high mobile vehicles by reducing the delay and connection duration in QoS due to retransmission of packets. [4] In this paper, author aimed to provide an efficient voting method to improve the reliability of decision making for message voting. It also reduces the voting delay and network information overhead. The proposed method is simulated in NS2. The experimental results in this paper indicated that the proposed methods decision making precision is improved between 6% and 30% compared to similar methods in the literature, under conditions such as traffic amount, number of nodes and operation period time. It also reduces the number of transferred packets between 1% and 9% in different environmental conditions. They tried to handle the clustering based on multi-channel communications with the aim of message safety, instant nodes communications and quick data delivery. Clustering parameters are based on nodes' average speed, average life expectancy for the cluster head selection, nodes' direction, and suitable size for clustering. They lead to clusters adapted to large-scale environments. [6] In this paper, authors have proposed a new clustering algorithm that considers both node position and node mobility in vehicular ad hoc environments. The proposed algorithm intends to create stable clusters by reducing re-clustering overhead, prolonging cluster lifetime, and shortening the average distance between CHs and their cluster members. Most important, this algorithm supports single and multiple CHs. Simulation results show the superiority of the clustering algorithm over the other three well-known algorithms. Shortening average distance between CHs and their cluster members could generate collisions. Their contribution is to constraint this average distance. They presented a beacon-based clustering algorithm aimed at prolonging the cluster lifetime in VANETs. They used a new aggregate local mobility criterion to decide upon cluster re-organisation. The scheme incorporates a contention method to avoid triggering frequent re-organisations when two CHs encounter each other for a short period of time. However, nodes that have lost their cluster-head due to merging or mobility and cannot find nearby clusters to join, they will all become CHs almost at the same time. [7] In this paper, author proposed a D-hop clustering algorithm, called DHCV, which organizes vehicles into non overlapping clusters which have adaptive sizes according to their respective mobility. The D-hop clustering algorithm creates clusters in such a way that each vehicle is at most D hops away from a cluster head. To construct multi-hop clusters, each vehicle chooses its cluster head based on relative mobility calculations within its D-hop neighbors. The algorithm can run at regular intervals or whenever the network formation changes. One of the features of this algorithm is tendency to re-elect the surviving cluster heads whenever the network structure changes. Extensive simulation results have been done under different scenarios to show the performance of our clustering algorithm. [8] In this work, authors provide a method for the dynamically changing VANET, that elects the cluster head of the clusters and uses different parameters for the same. The QoS parameters are taken care while selecting the cluster head. The parameters involved for the same are direction of the vehicle, Speed of the vehicle, Duration for which it has been cluster head in past, Density of the Cluster, Packet Delivery ratio, Network Lifetime, Degree of the node, Transmission Range. The method proposed is the agglomerate method which involves all the parameters majorly affecting the VANET. Thus, this method will select the cluster head effectively and improves the QoS parameters of the VANET. [10] In this paper, authors simulate the Black Hole attack in a VANET environment with a generated real world mobility model using MOVE Tool and SUMO and analyze the performance of this communication under this attack. And then they propose a clustering algorithm to detect and react against the black hole attacker node. Their work is about designing a mobility model to simulate continuous road traffic with SUMO and MOVE Tool to generate a real world simulation. Then, they implemented a Black Hole attack inside this model to give a real aspect to the attack, and then they analyzed the results to see the impact of this attack on the network communications. Thereafter, they proposed a cluster-based algorithm to detect and isolate the malicious node from the network with an algorithm complexity analysis. [13] In this paper, author presents a modified version of the original Safe Clustering Algorithm (M-SCA) whereby safety distance is applied in the cluster maintenance stage to extend the cluster phase. NS2 simulation is conducted to measure the performance of the proposed scheme under QoS parameters, emergency message inter-arrival time, and overhead. The proposed clustering scheme by them is intended to leverage the benefits of network clustering and attain prompt delivery of emergency safety messages to avoid chain collisions. Furthermore, an evaluation is also performed to observe the performance of the proposed clustering scheme under several metrics such as throughput, packet delivery ratio, end-to-end delay and overhead. The clustering algorithm is compared against two clustering algorithms. [15] In this paper, author proposed a cluster-based routing algorithm which is scalable, efficient and distributed. In the proposed algorithm when selecting the cluster head the speed deviation of vehicles as well as the remaining time to destination is taken into account. Simulation results show that the proposed algorithm has lower End-to End delay compared with CBLR algorithm. The proposed algorithm is a cluster-based routing algorithm which is based on CBRP. The algorithm divides the nodes into a number of overlapping or disjoint 2- hop diameter clusters in a distributed manner. They proposed a cluster-based routing algorithm. In their algorithm, a cluster head is selected for each cluster to maintain cluster membership information. To address high mobility and speed variation of nodes, they give the node with high estimated travel time and low speed deviation a high chance to become a cluster head. [18] In this work, authors propose a model that calculates the value of stable nodes, they use YATES algorithm. This mechanism is designed to overcome the stability of cluster. They propose a model which seeks to determine the value of stability of nodes from the distance, probability, and the difference in speed parameters using the Yates algorithm. The proposed model possesses a better cluster stability where stability is defined by long CH duration, long cluster member duration, and low rate of CH change. Their study justifies the possibility of applying the YATES algorithm as a promising solution for the development of the routing system. They proposed a clustering algorithm that calculates the stability of each node by using distance, difference in speed and probability parameters. The algorithm can meet the needs of existing clustering routing protocols in terms of creating stable canals between different nodes. The work proposed in their paper is part of a broader approach in which their clustering algorithm is based on their model. [19] In this paper, author focuses on the routing protocol for VANETs and briefly describes some of those protocols. They present a thorough evaluation of routing protocols. All the protocols have been examined with varying mobility and offered load using the NS-2. The comparison focuses on the following performance metrics average end-to-end delay and bandwidth. They demonstrate the advantages and limitations of different routing protocols in VANET environment. The main aim of their study was to identify which routing method has better performance in highly mobile environment of VANET. This paper reveals the performance analysis of reactive, proactive and position routing protocols in comparison with cluster-based routing protocols AMACAD and MOBIC. Cluster-based routing protocols represent some similarities in terms of average end-to-end delay, packet delivery ratio and bandwidth. Reactive routing protocols represent also some similarities in terms of packet delivery ratio. However difference among reactive routing protocols due to the different approach of routing storage and maintenance. [21] In this paper, author presents a novel Simplified Node decomposition and Platoon (SNAP) head selection cluster based routing algorithm for Vehicular Ad hoc Networks (VANET) communication. The major novelty of their paper is the two proposed algorithms through which the number of platoons and platoon heads (PH) are decided upon for increasing the network lifetime. Algorithm-1 analyzes the distribution of nodes and forms a set of possible minimum number of platoons (clusters) having equal number nodes, based on Hierarchical clustering technique. The algorithm-2 partitions the given network into platoons and selects the platoon head (PH) based on coverage range of wireless node. It uses SPSS statistical software tool for platoon decomposition and also to determine the platoon head (PH). The number of iterations required for selection of PH is found to be minimum, irrespective of the number of network nodes. The platoon is controlled by its platoon head (PH) and the data transfer happens locally between the platoon nodes and its head. [25] In this paper, authors propose a clustering algorithm aiming at providing a more stable backbone for future information dissemination in VANETs. To improve the information dissemination efficiency on the road, the proposed clustering algorithm should present a good cluster stability and low overhead. They evaluate cluster stability from the following aspects: average cluster head lifetime and average number of clusters. Mobility metrics, considered in their proposed algorithm includes vehicle’s position, moving direction and velocity information. In addition, they also propose an estimated connection time parameter, called Link Lifetime Estimation (LLT), to choose the gateway node in a cluster. Their simulation studies the influence of different cluster parameters on their cluster stability. They try to generate as much of real vehicle traffic scenarios as possible by using SUMO (Simulation of Urban Mobility). [26] In this paper, authors propose a unified framework of clustering approach (UFC), composed of three important parts like neighbor sampling, back off-based cluster head selection and backup cluster head based cluster maintenance. Three mobility-based clustering metrics, including vehicle relative position, relative velocity, and link lifetime, are considered in their approach under different traffic scenarios. Furthermore, a detailed analysis of UFC with parameters optimization is presented. Extensive comparison results among UFC, lowest-ID, and

VMaSC algorithms demonstrate that their clustering approach performs high cluster stability, especially under high dynamic traffic scenarios. efficiency, cluster changing rate, and cluster stability.

Ref. No.	Author's name	Publication detail	Advantages	Tools
[1]	Degan Zhang , Hui Ge, Ting Zhang,Yu-Ya Cui, Xiaohuan Liunand Guoqiang Mao	IEEE transactions on intelligent transportation systems, 2018	A new multi-hop clustering algorithm PMC is generated in which the stability and reliability of VANET is improved as well as the stability of Clusters are also improved and the cost of clustering is reduced effectively.	NS2 (release 2.35) network simulator And Vanet MobiSim
[5]	A.H. Abbas, L. Audah, N.A.M. Alduais	IEEE, 2018	ICH is used to solve the problem of uplink connection at the base station and also solves the problem of packet dropping between the two base stations because of the weak Receive Signal Strength (RSS) due to the interference frequency's from the base stations.	MATLAB, ARDUINO and GPS with antenna
[14]	Jaejeong Lee and Byoungchul Ahn	International Journal of Applied Engineering Research, 2017	It improves the problem of the message transmission on WAVE communication standard. It also reduces average message delay time and improves the reception ratio compared with EMDOR.	Network simulator, NS3
[19]	Bouchra Marzak, Hicham Toumi, Elhabib Benlahmar and Mohamed Talea	Springer, 2017	Cluster-based routing protocols can be applied in increasing the speed and density of vehicles, hence the performance increases, which makes use of routing protocol suitable for VANET.	NS2 and MOVE
[31]	Yue Zhang, Kai Liu, Shanzhi Liu, Jiaqi Zhang,Tao Zhang, Zhen Xu, and Feng Liu	IEEE, 2018	It solves intra-cluster and inter-cluster transmission collision problems in vehicular ad-hoc networks. It also improves average throughput and successful transmission probability as well as it minimizes average end-to-end delay.	MATLAB
[37]	Navpreet Panjrath, Monika Poriye , Vinod Kumar	International Research Journal of Engineering and Technology, 2017	A novel forwarding approach is used to improve performance of vehicles in VANETs as well as Fitness value is minimized which results an increase in packet reception, increase in throughput and reduces the time complexity.	Differential Evolution (DE) optimization algorithm and PSO optimization algorithm

Table 1: Shows the comparative study of vehicular ad-hoc network.

IV PROBLEM IDENTIFICATION

The most relevant issue to provide QoS in VANETs is the intermittent connectivity of vehicles caused by high dynamic mobility. The high mobility of vehicles joining and leaving the network all the time makes the connectivity among them very unstable, so even the best effort service cannot be guaranteed [2]. One of the main issues in vehicular ad-hoc networks is how to communicate between vehicles. For communication in this platform, observer vehicles or available nodes at closer distances to the event, send warning messages to inform nodes away in further distance, so that, they can make the appropriate decision. There may be some unreliable nodes in vehicular ad-hoc networks that attempt to send false information [4]. The problem of constructing a theoretical framework for dynamically organizing vehicular mobile nodes in VANETs into clusters where it is necessary to provide robustness in the face of topological changes caused by node motion, node failure and node insertion/removal [6]. Packet losses due to transmission errors, in ad-hoc wireless network experience a largest packet loss. Packet loss occurs because of increased collision. This collision is done in the presence of hidden terminal. There is uni-directional links and usual path breaks because of mobility of node [8]. Security threats and the battery constraints, speed of vehicle, transmission range, packet delivery ratio and throughput are also part of the recent vehicular ad-hoc network challenges and issues for the researchers.

V CONCLUSIONS AND FUTURE SCOPE

Vehicular ad hoc network (VANET) is a challenging network environment that pursues the concept of ubiquitous computing for future. Vehicles equipped with wireless communication technologies and acting like computers will be on our roads soon, and this will revolutionize our concept of traveling. Vehicular ad hoc networks (VANETs), as a special kind of mobile ad-hoc network, will have a promising prospect in the future intelligent transportation system (ITS); The typical set of VANET application areas, such as vehicle collision warning and traffic information dissemination have made VANET an interesting field of mobile wireless communication. This paper provides an overview on current research state, challenges, potentials of VANETs as well as the ways forward to achieving the long awaited ITS. In the future we need to find out the solution for the above issues and challenges mentioned in the problem statement and design error free and accident free vehicular ad-hoc network for the intelligent transportation system.

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