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Review on Minimum Headway Distance for Connectivity in VANETs

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ABSTRACT: The knowledge of vehicle headway distribution is essential for estimating the probability of connectivity in vehicle ad hoc networks. The distribution of vehicles in a single lane has been taken into account that consecutive vehicles have to maintain a minimum safe distance between them. The account of safe distance improves the agreement between vehicles theoretical spacing distribution and empirical data in single lane traffic. The overall objective of this paper is to discuss the various features, architecture, applications of VANETS and algorithm that can be applied on vehicles for routing process.

KEYWORDS: VANETS, Features, Applications, Genetics Algorithm

I. Introduction

Vehicular Ad Hoc Networks (VANETs) are created by applying the principles of mobile ad hoc networks (MANETs) - the spontaneous creation of a wireless network for data exchange - to the domain of vehicles. They are a key component of intelligent transportation systems (ITS).

While, in the early 2000s, VANETs were seen as a mere one-to-one application of MANET principles, they have since then developed into a field of research in their own right. By 2015, the term VANET became mostly synonymous with the more generic term inter-vehicle communication (IVC), although the focus remains on the aspect of spontaneous networking, much less on the use of infrastructure like Road Side Units (RSUs) or cellular networks.

VANET simulation is fundamentally different from MANETs (mobile ad hoc networks) simulation because in VANETs, vehicular environment imposes new issues and requirements, such as constrained road topology, multi-path fading and roadside obstacles, traffic flow models, trip models, varying vehicular speed and mobility, traffic lights, traffic congestion, drivers' behavior, etc. Currently, there are VANET mobility generators, network simulators, and VANET simulators. VANETs support a wide range of applications - from simple one hop information dissemination of, e.g., cooperative awareness messages (CAMs) to multi-hop dissemination of messages over vast distances. Most of the concerns of interest to mobile ad hoc networks (MANETs) are of interest in VANETs, but the details differ. Rather than moving at random, vehicles tend to move in an organized fashion. The interactions with roadside equipment can likewise be characterized fairly accurately. And finally, most vehicles are restricted in their range of motion, for example by being constrained to follow a paved highway.

1.2 VANET MobiSim

Vanet MobiSim is an extension to CanuMobiSim, a generic user mobility simulator. CanuMobiSim provides an efficient, easily extensible mobility architecture, but due to its general purpose nature, suffers from a reduced level of detail in specific scenarios. Vanet MobiSim is therefore aimed at extending the vehicular mobility support of CanuMobiSim to a higher degree of realism. In the following, for reasons of space, we are only listing the original additions introduced by Vanet MobiSim, but it is to note that the complete tool integrates all of the CanuMobiSim features, providing a very wide set of possibilities in simulating vehicular mobility.

1.2.1 Macromobility Features: In Vanet MobiSim, macro-mobility takes into account the road topology, the road structure (unidirectional or bidirectional, single or multi-lane), the road characteristics (speed limits, vehicle classes restrictions) and the presence of traffic signs (stop signs, traffic lights, etc.). Moreover, the concept of macro-mobility also includes the effects of the presence of points of interests, which influence movement patterns of vehicles on the road topology. Vanet MobiSim enhances CanuMobiSim allowing defining the road topology in the following novel ways:

- **TIGER map:** The road topology is extracted from a map of the TIGER database.
- **Clustered Voronoigraph:** the road topology is randomly generated by creating a Voronoi tessellation on a set of non uniformly distributed points. This creates fast and configurable random graphs, yet reflecting the non-uniform distribution of obstacles in an urban area.

The concept of vehicular macro-mobility is not limited to motion constraints obtained from graph-based mobility, but also includes all aspects related to the road structure characterization. VanetMobiSim therefore also contains:

• Physical separation of opposite traffic flows on each road.

• Introduction of roads with multiple lanes in each direction.

• Speed constraints on each road segment.

• Implementation of traffic signs at each road intersection.

1.2.2 MicroMobility Features: The concept of vehicular micro-mobility includes all aspects related to an individual car's speed and acceleration modeling. Vanet MobiSim adds two original microscopic mobility models in order to include the management of intersections regulated by traffic signs and of roads with multiple lanes.

• Intelligent Driver Model with Intersection Management (IDMIM) adds intersection handling capabilities to the behavior of vehicles driven by the IDM. In particular, IDM-IM models two different intersection scenarios: a crossroad regulated by stop signs, or a road junction ruled by traffic lights.

• Intelligent Driver Model with Lane Changes (IDM-LC) extends the IDM-IM model with the possibility for vehicles to change lane and overtake each others.

1.3 Architecture of VANET

The basic idea is that if a user wants to participate in a VANET (the user's vehicle is not required to have a manufacturer's issued certificate), he purchases a payment-processing-device (similar to automatic toll payment devices - sold for tens of dollars). Each device will have an identification and an associated certificate [17]. During initialization the device will be linked/registered with the user's account; user's information will be maintained with the provider and will not be stored in the device. The basic procedure is illustrated in Fig 1. When a user enters a service area and wants to use the service, he makes the payment for the service using onboard payment device. The payment-authorization/service request message will be encrypted using provider's public key, thus hiding the device ID/certificate and services requested from eavesdroppers. The user is issued a pseudonym and other IDs necessary for the service by the provider. The concerned server is also informed of the service purchased and temporary credentials.

The temporary credentials can also be used to provide desired security attributes for VANET applications including vehicle to vehicle -V2V communications. As a baseline service, the user can obtain just the temporary credentials, in this case the temporary credentials will not be sent to servers. Certificate, IP address, MAC address etc can all be issued on temporary basis and refreshed several times during a service period. They are encrypted to ensure security and privacy. Initially, they can be encrypted using a random session key sent along the request. Later, they can be encrypted

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using current public key. The certificate of CA is hard coded in the device, enables other users to check validity of a certificate. Methods can be employed to safeguard against replay, spoofing, man-in-the-middle etc.

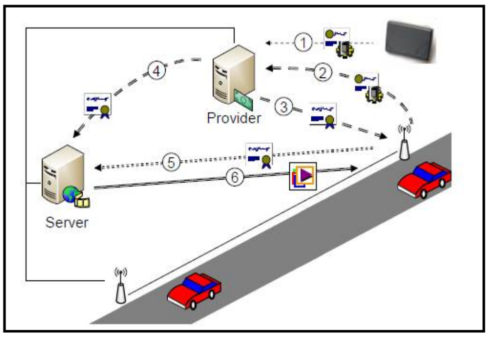

Figure1: Architecture of VANET

1.4 Applications of VANETS

The RSU can be treated as an access point or router or even a buffer point which can store data and provide data when needed [19]. All data on the RSUs are uploaded or downloaded by vehicles. A classification of applications is also done by [20] as Car to Car Traffic applications, Car to Infrastructure applications, Car to Home applications and Routing based applications. The authors in [19] discusses about the various attacks based on their classification. Based on the type of communication either V2I or V2V, we are arranging the applications of VANETs into following classes:

1) Safety oriented,

2) Commercial oriented

3) Convenience oriented

4) Productive Applications

1.4.1 Safety Applications

Safety applications include monitoring of the surrounding road, approaching vehicles, surface of the road, road curves etc. The Road safety applications can be classified as:

1) Real-time traffic: The real time traffic data can be stored at the RSU and can be available to the vehicles whenever and wherever needed. This can play an important role in solving the problems such as traffic jams, avoid congestions and in emergency alerts such as accidents etc.

2) Co-operative Message Transfer: Slow/Stopped Vehicle will exchange messages and co-operate to help other vehicles. Though reliability and latency would be of major concern, it may automate things like emergency braking to avoid potential accidents. Similarly, emergency electronic brake-light may be another application.

3) Post Crash Notification: A vehicle involved in an accident would broadcast warning messages about its position to trailing vehicles so that it can take decision with time in hand as well as to the highway patrol for tow away support.

4) Road Hazard Control Notification: Cars notifying other cars about road having landslide or information regarding road feature notification due to road curve, sudden downhill etc.

5) Cooperative Collision Warning: Alerts two drivers potentially under crash route so that they can mend their ways.

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6) Traffic Vigilance: The cameras can be installed at the RSU that can work as input and act as the latest tool in low or zero tolerance campaign against driving offenses.

1.4.2 Commercial Applications: Commercial applications will provide the driver with the entertainment and services as web access, streaming audio and video. The Commercial applications can be classified as:

1) Remote Vehicle Personalization/ Diagnostics: It helps in downloading of personalized vehicle settings or uploading of vehicle diagnostics from/to infrastructure.

2) Internet Access: Vehicles can access internet through RSU if RSU is working as a router.

3) Digital map downloading: Map of regions can be downloaded by the drivers as per the requirement before travelling to a new area for travel guidance. Also, Content Map Database Download acts as a portal for getting valuable information from mobile hot spots or home stations.

4) Real Time Video Relay: On-demand movie experience will not be confined to the constraints of the home and the driver can ask for real time video relay of his favourite movies.

5) Value-added advertisement: This is especially for the service providers, who want to attract customers to their stores. Announcements like petrol pumps, highways restaurants to announce their services to the drivers within communication range. This application can be available even in the absence of the Internet.

1.4.3. Convenience Applications: Convenience application mainly deals in traffic management with a goal to enhance traffic efficiency by boosting the degree of convenience for drivers. The Convenience applications can be classified as:

1) Route Diversions: Route and trip planning can be made in case of road congestions.

2) Electronic Toll Collection: Payment of the toll can be done electronically through a Toll Collection Point. A Toll collection Point shall be able to read the OBU of the vehicle. OBUs work via GPS and the on-board odometer or techograph as a back-up to determine how far the Lorries have travelled by reference to a digital map and GSM to authorize the payment of the toll via a wireless link. TOLL application is beneficial not only to drivers but also to toll operators.

3) Parking Availability: Notifications regarding the availability of parking in the metropolitan cities helps to find the availability of slots in parking lots in a certain geographical area.

4) Active Prediction: It anticipates the upcoming topography of the road, which is expected to optimize fuel usage by adjusting the cruising speed before starting a descent or an ascent. Secondly, the driver is also assisted.

1.4.4. Productive Applications

We are intentionally calling it productive as this application is additional with the above mentioned applications. The Productive applications can be classified as:

1) Environmental Benefits: AERIS research program is to generate and acquire environmentally relevant real-time transportation data, and use these data to create actionable information that support and facilitate “green” transportation choices by transportation system users and operators. Employing a multi-modal approach, the AE-RIS program will work in partnership with the vehicle-to-vehicle (V2V) communications research effort to better define how connected vehicle data and applications might contribute to mitigating some of the negative environmental impacts of surface transportation.

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2) Time Utilization: If a traveler downloads his email, he can transform jam traffic into a productive task and read on-board system and read it himself if traffic stuck. One can browse the Internet when someone is waiting in car for a relative or friend.

3) Fuel Saving: When the TOLL system application for vehicle collects toll at the toll booths without stop-ping the vehicles, the fuel around 3% is saved, which is consumed when a vehicles as an average waits normally for 2-5 minutes.

1.5 Genetic Algorithm

Genetic algorithms have now been applied almost exclusively to single-attribute1 problems. But a cautious look at many real-world GA applications reveals that the objective functions are actually multi attribute. Typically, the GA user some ad-hoc function of the multiple attributes to yield a scalar function. Often-seen tools for combining multiple attributes are constraints, with associated thresholds and penalty functions, and weights for linear combinations of attribute values. But penalties and weights have demonstrated to be problematic. The GA solution is generally very sensitive to small changes in the penalty function coefficients and weighting factors.

II. LITERATURE SURVEY

Sherif M. Abuelenin [1] describe the knowledge of vehicle headway distribution is essential for estimating the probability of connectivity in vehicle ad hoc networks. The distribution of vehicles in a single lane has considered taking into account that consecutive vehicles have to maintain a minimum safe distance between them. It is shown that the account of safe distance improves the agreement between vehicles theoretical spacing distribution and empirical data in single lane traffic. Minimum distance affects the connectivity probability in light traffic conditions also be studied. the headway distribution of single lane traffic is also shown in the free flow conditions is better modeled using a shifted exponential model which takes into account the safe distance between vehicles.

Martinez, et al. [2] has discussed that wireless communication technologies have greatly impact on daily lives. From indoor wireless LANs to outdoor cellular mobile networks, wireless technologies have benefited billions of users around the globe. The era of vehicular ad hoc networks (VANETs) is now evolving, gaining attention and momentum. VANET simulation is fundamentally different from MANETs (mobile ad hoc networks) simulation because in VANETs, vehicular environment imposes new issues and requirements. Currently, there are VANET mobility generators, network simulators, and VANET simulators. Finally, while each of the studied simulators provides a good simulation environment for VANETs, refinements and further contributions are needed before they can be widely used by the research community.

Lu, Rongxing et al. [3] has discussed about prime target of the quality of privacy in vehicular ad hoc networks (VANETs), location privacy is imperative for VANETs to fully flourish. Although frequent pseudonym changing provides a promising solution for location privacy in VANETs, if the pseudonyms are changed in an improper time or location, such a solution may become invalid. To cope with the issue an effective pseudonym changing at social spots (PCS) strategy has presented to achieve the provable location privacy. In particular first introduce the social spots where several vehicles may gather. By taking the anonymity set size as the location privacy metric, two anonymity set analytic models has developed to quantitatively investigate the location privacy that is achieved by the PCS strategy.

Saleet et al. [4] has presented presents a class of routing protocols for vehicular ad hoc networks (VANETs) called the Intersection-based Geographical Routing Protocol (IGRP), which outperforms existing routing schemes in city environments. IGRP is based on an effective selection of road intersections through which a packet must pass to reach the gateway to the Internet. The selection is made in a way that guarantees, with high probability, network connectivity among the road intersections while satisfying quality-of-service (QoS) constraints on tolerable delay, bandwidth usage, and error rate. Geographical forwarding is used to transfer packets between any two intersections on the path, reducing the path's sensitivity to individual node movements. To achieve this mathematically formulate the QoS routing problem as a constrained optimization problem. Specifically, analytical expressions for the connectivity probability, end-to-end

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delay, hop count, and bit error rate (BER) of a route in a two-way road scenario are derived. A genetic algorithm is proposed to solve the optimization problem.

Toutouh et al. [5] has discussed that recent advances in wireless technologies have given rise to the emergence of vehicular ad hoc networks (VANETs). In such networks, the limited coverage of WiFi and the high mobility of the nodes generate frequent topology changes and network fragmentations. This paper deals with the optimal parameter setting of the optimized link state routing (OLSR), which is a well-known mobile ad hoc network routing protocol, by defining an optimization problem. This way, a series of representative metaheuristic algorithms are studied in this paper to find automatically optimal configurations of this routing protocol. In addition, a set of realistic VANET scenarios have been defined to accurately evaluate the performance of the network under our automatic OLSR. In the experiments, OLSR configurations result in better quality of service (QoS) than the standard request for comments as well as several human experts, making it amenable for utilization in VANET configurations.

Al-Rabayah et al. [6] Vehicular ad hoc networks (VANETs) are highly mobile wireless networks that are designed to support vehicular safety, traffic monitoring, and other commercial applications. Within VANETs, vehicle mobility will cause the communication links between vehicles to frequently be broken. Such link failures require a direct response from the routing protocols, leading to a potentially excessive increase in the routing overhead and degradation in network scalability. A new hybrid location-based routing protocol has been proposed that is particularly designed to address this issue. New protocol combines features of reactive routing with location-based geographic routing in a manner that efficiently uses all the location information available. The protocol is designed to gracefully exit to reactive routing as the location information degrades.

H. Yong et al. [7] has proposed a distributed key management framework based on group signature to provision privacy in vehicular ad hoc networks (VANETs). Distributed key management is expected to facilitate the revocation of malicious vehicles, maintenance of the system, and heterogeneous security policies, compared with the centralized key management assumed by the existing group signature schemes. In this framework, each road side unit (RSU) acts as the key distributor for the group, where a new issue incurred is that the semi-trust RSUs may be compromised. Thus, security protocols have developed for the scheme which is able to detect compromised RSUs and their colluding malicious vehicles. A practical cooperative message authentication protocol is thus proposed to alleviate the verification burden, where each vehicle just needs to verify a small amount of messages.

L. Rongxing et al. [8] has achieved a vehicle user's privacy preservation while improving the key update efficiency of location-based services (LBSs) in vehicular ad hoc networks (VANETs), a dynamic privacy-preserving key management scheme called DIKE has proposed. Specifically, in the proposed DIKE scheme, first introduce a privacy-preserving authentication technique that not only provides the vehicle user's anonymous authentication but enables double-registration detection as well then present efficient LBS session key update procedures has presented. Performance evaluations via extensive simulations demonstrate the efficiency and effectiveness of the proposed DIKE scheme in terms of low key update delay and fast key update ratio.

Cenerario et al. [9] has focused on intelligent transportation systems and, more precisely, on inter vehicle ad hoc networks. A vehicular ad hoc network (VANET) is a highly dynamic network as the vehicles communicate using short-range wireless communications and can move very quickly. In this paper, dissemination protocol has described that vehicles can use to share information by using vehicle-to-vehicle communications. The dissemination approach considers the relevance of the data, represented by what we call encounter probability, to decide when rediffusion is needed. The protocol is able to disseminate data about any type of event in the network by setting appropriate weights for the different factors that affect the computation of the encounter probability.

Dang et al. [10] Vehicular Ad hoc Network (VANET) is developed to enhance the safety, comfort and efficiency of driving. The IEEE 802.11p/WAVE and IEEE 1609.4 family are standards intended to support wireless access in VANETs. In this paper, an Efficient and Reliable MAC protocol has proposed for VANETs (VER-MAC) which allows nodes to broadcast safety packets twice during both the control channel interval and service channel interval to increase the safety broadcast reliability. By using the additional data structures, nodes can transmit service packets during the control channel interval to improve the service throughput.

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Shen et al. [11] has discussed that data dissemination is a promising application for the vehicular network. Existing data dissemination schemes are generally built upon some random-access protocol, which results in the unavoidable collision problem. To address this problem, in this paper a novel data dissemination strategy has designed from the scheduling perspective. A data dissemination scheduling framework is then proposed. In the proposed framework, the main challenge is how best to assign the transmission opportunity to nodes with maximum dissemination utility and to avoid the collision problem. A novel and practical relay selection strategy has also proposed and adopt the space-time network coding (STNC) with low detection complexity and space-time diversity gain to improve the dissemination efficiency.

Feng et al. [12] has discussed that data aggregation is a useful technology that can decrease the communication bandwidth cost in the process of data gathering in VANETs. However, data aggregation may lose some data accuracy. Current data aggregation schemes in VANETs only consider saving bandwidth cost while ignoring the application requirement, which may result in the inaccuracy of aggregated data for dynamic routing application. Therefore, a framework in which application demands are considered in the process of data aggregation has proposed to ensure the accuracy of aggregated data for dynamic routing application. The framework consists of three parts: extracting QoI constraints of aggregated data, distributing the QoI-based data gathering queries, routing and aggregating data with QoI constraints.

COMPARISON TABLE:

Name of author	Title of the paper	Technique	Benefits	Limitations
Sherif M. Abuelenin	"Effect of minimum headway distance on connectivity of VANETs."	Shifted Exponential Model	safe distance improves the agreement between vehicles	safe distance between vehicles on the congested traffic phase is ignored
Martinez, et al.	"A survey and comparative study of simulators for vehicular ad hoc networks (VANETs)."	Network simulators and VANET simulators.	Simulators gives good simulation environment for VANETS	Extensions for more refinement is required that is ignored
Lu, Rongxing et al.	"Pseudonym changing at social spots: An effective strategy for location privacy in vanets."	Pseudonym changing at social spots (PCS) Strategy	Analytic models has developed to quantitatively investigate the location privacy	Effectiveness of PCS strategy has not been discussed
Saleet et al.	"Intersection-based geographical routing protocol for VANETs: a proposal and analysis"	Genetic algorithm is proposed	satisfying quality-of-service (QoS) constraints on tolerable delay, bandwidth usage, and error rate	Performance of routing process should be more improved
Toutouh et al.	"Intelligent OLSR routing protocol optimization for VANETS."	metaheuristic algorithms	find automatically optimal configurations of routing protocol	time consuming issues deriving from large simulations

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Al-Rabayah et al.	"A new scalable hybrid routing protocol for VANETS"	new hybrid location-based routing protocol	To gracefully exit to reactive routing as the location information degrades.	scalability performance is required more improvement
H. Yong et al.	"A distributed key management framework with cooperative message authentication in VANETS."	distributed key management framework	To facilitate the revocation of malicious vehicles	Security on vehicles required more improvement
L. Rongxing et al.	"A dynamic privacy-preserving key management scheme for location-based services in vanets."	Dynamic privacy-preserving key management scheme	Low key update delay and fast key update ratio	Both keys are updated simultaneously are ignored
Cenerario et al.	"A content-based dissemination protocol for VANETs: Exploiting the encounter probability."	Dissemination protocol	Vehicles can use to share information by using vehicle-to-vehicle communications.	Dissemination protocol security for sharing data is ignored
Feng et al.	"Data Aggregation and Routing Guidance with QoS Guarantee in VANETs."	Data aggregation	To ensure accuracy of aggregated data for dynamic routing	Failure of nodes during data routing is ignored

III. CONCLUSION

Vehicular Ad Hoc Networks (VANET) have been envisioned to play an important role in the future wireless communication service market for safety communications as well as for information and entertainment applications. Examples of safety-oriented applications for VANET are the notifications of emergency situations, such as car accidents or bad weather conditions. The distribution of vehicles in a single lane has been taken into account that consecutive vehicles have to maintain a minimum safe distance between them. The account of safe distance improves the agreement between vehicles theoretical spacing distribution and empirical data in single lane traffic. Although minimum headway distance based VANETs has shown better results than other techniques but still suffers from abnormal environmental conditions. To improve results we will evaluate the dynamic communication and dynamic path selection using artificial bee colony algorithm to enhance the results of VANETs further in future.

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