Volume 8, No. 5, May-June 2017
ISSN No. 0976-5697
International Journal of Advanced Research in Computer Science
REVIEW PAPER
Available Online at www.ijarcs.info

A Comprehensive Survey of VANET Architectures and Design

Navpreet Panjrath
Department of Computer Science & Applications,
Kurukshetra University, Kurukshetra India

Monika Poriye
Department of Computer Science & Applications,
Kurukshetra University, Kurukshetra, India

Abstract: Vehicular ad hoc networks (VANETs) are suitable networks that can be used in smart transportation system. VANET is based on short-range wireless communication between vehicles. VANETs do not need any outlay, apart from the wireless network interface. Vehicular Ad-Hoc Networks (VANET) are particular type of Mobile ad Hoc Networks (MANET) where wireless set vehicles form a network automatically while traveling along the road. Messages can be delivered openly among vehicles without permanent infrastructure. This paper presents various kinds of communication system and components in VANET.

Keywords : VANET, MANET, RSU, VWCA, V2I, V2V.

I. INTRODUCTION

Vehicular Ad-hoc Networks (VANETs) are self-organized networks built up from moving vehicles. Vehicular Ad-hoc Networks (VANETs) represent a quickly rising challenging class of Mobile Ad Hoc Networks (MANETs). VANETs are self-organized communication networks build up from roaming vehicles in addition to characterized [1] by very high velocity and restricted degree of choice in nodes movement patterns. VANETs require the definition of precise networking techniques whose achievability and performance are tested by means of simulation.

Vehicular ad hoc networks (VANETs) are key module for the development of Intelligent Transportation System. VANET improves the safety of our transportation systems by providing sensible and proficient data dissemination about actions like accidents, road environment and traffic jams outside the driver's information. Due to the features of VANET, data distribution is a central matter that has to be addressed. The protocol is used to approximation the concentration of vehicles on a given road. As in any clustering algorithm, the creation of the cluster and make use of the bandwidth are main tasks.

There are three algorithms:-

1. Vehicular clustering based on the weighted clustering algorithm (VWCA) that consider the number of neighbors based on dynamic transmission range, the route of vehicles, the entropy, and the suspect value parameters. These parameters can raise steadiness, connectivity and can decrease transparency in network. On the additional hand, transmission range of a vehicle is essential for forwarding and receiving messages. When a permanent transmission range device is used in VANET, it is expected that vehicles are not positioned in the range of their neighbors. This is since of the high-rate topology changes and high inconsistency in vehicles density.
2. Hello messages and concentration of traffic in the area of vehicles are used to adaptively alter the transmission range between them.
3. Resolve a disbelieve rate for all vehicles used in the VWCA.

II. VANET ARCHITECTURE

A straightforward VANET architecture consists of moving vehicles communicating with further vehicle in the range as well as the vehicle communicating with a number of nearby Road Side Units (RSU). A VANET[2] is vary from MANET in the aspect that the vehicles do not travel arbitrarily as in MANETs, rather in VANET the moving vehicles pursue some rules and pathway such as roads or freeway.

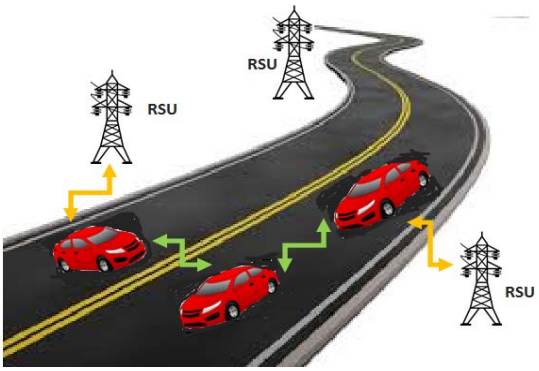

Fig.1. Simple VANET Architecture

The architecture can be split down into three modules namely Mobile unit domain, Infrastructure domain and Management domain

2.1 Mobile unit domain

The Mobile unit domain consist of the mobile unit like the vehicle with intelligent system, mobile users etc. In this domain the contact happens by two ways first by using V2C communication model i.e. communication among vehicle to vehicle, second through V2I communication model i.e. communication involving vehicles to infrastructure.

2.2 Infrastructure domain

The Infrastructure domain primarily contains the Road side units (RSU) and [3] additional transceivers which are implemented to bear the vehicle communication. Communication is done by V2I model.

2.3 Management domain

This domain includes management systems like the servers and supervision applications. Whenever a message comes to

the server regarding any accident or traffic slow down difficulty, the server send aware message reverse to further incoming vehicle in the range. This knowledge is extremely helpful for the vehicle to deal with the situation.

III. VANET COMPONENTS

3.1 **Application Unit (AU):**- The AU is the gadget equipped within the vehicle that uses the applications provided by the provider using the communication capabilities of the OBU. The AU can be a devoted device for security application or a usual device such as a Personal Digital Assistant [4] (PDA) to run the Internet, the AU can be linked to the OBU with a wired or wireless association and might be located with the OBU in a single physical component; the distinction between the AU and the OBU is logical. The AU communicates with the network exclusively via the OBU which takes the task of all mobility and networking actions.

3.2 On Board Unit (OBU):- An OBU is a wave apparatus usually mounted with on-board, a vehicle used for exchanging in sequence with RSUs or with other OBUs. It consists of a Resource Command Processor (RCP), and resources comprise a read/write memory used to pile up and retrieve information, a user interface, a specific interface to tie to other OBUs and a network device for minute range wireless communication based on IEEE 802.11p[4] radio technology. This moreover includes an additional network device for non-safety application based on additional radio technologies such as IEEE 802.11a/b/g/n. The OBU connects to the RSU or to other OBUs during a wireless link based on the IEEE 802.11p radio frequency channel, and is trustworthy for the communications with other OBUs or with RSUs; it also provides a communication services to the AU and ahead data on behalf of other OBUs on the network. The major function of the OBU is wireless radio access, ad hoc and geographical routing, network blocking control, consistent message convey, data safety and IP mobility.

3.3 Roadside Unit (RSU):- The RSU is a wave device commonly set along the road side or in dedicated locations, such as at junctions or near parking places. The RSU is equipped with one network gadget for a dedicated short range communication based on IEEE 802.11p radio technology, and can also be ready with other network devices so as to be used for the purpose of communication inside the infrastructural network. The foremost functions associated with the RSU are:-

3.3.1 RSU extend the communication range of the ad hoc network by information re-distribution to further OBUs and by transfer the information to other RSUs in order to ahead it to further OBUs.

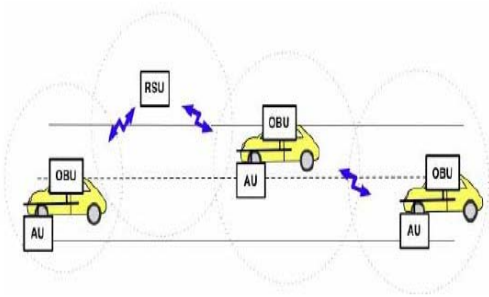

Fig.2. Forwarding of data of OBUs with RSU [11]

3.3.2 Operating safety utility such as a low bridge warning, accident caution or work zone, using infrastructure to vehicle communication (I2V) and performing as an information foundation

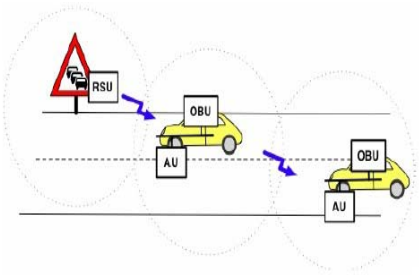

Fig.3. RSU as an information source [11] (organizing security applications)

3.3.3 Internet connectivity to OBUs.

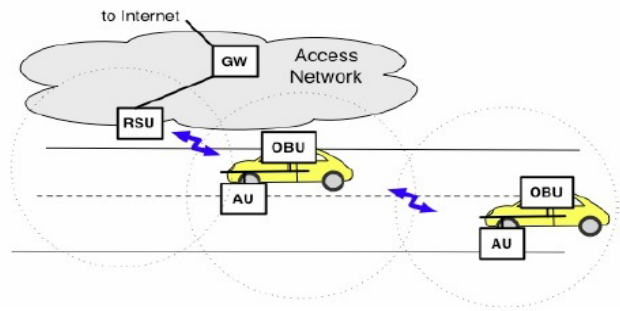

Fig.4. Internet connectivity to the OBUs by RSU[11]

IV. ROUTING PROTOCOL

4.1 Topology-based protocol: - In topology-based protocol, a connection have to be established from source node to destination node sooner than data transmission. Ad-hoc On-demand Distance Vector routing (AODV) is a topological based protocol. It will send a huge amount of redundant data packets and add to routing overhead by blind Flood.

4.2 Position-based protocol: - Position-based protocol needs no preset link before data transmission, each hop among source and destination can be preferred instantaneously and autonomously. Greedy Perimeter Stateless Routing (GPSR) [5] takes no measure to update the neighbor table and the destination location however it has two shortcomings. Firstly, the neighbor table might not equivalent the actual position without bearing in mind the node mobility. Secondly, the position of destination have not at all updated subsequent to encapsulating in the data packets.

4.3 Map-based protocol: - This protocol is applied rarely at the present. It uses the GPS arrangement and digital map to choose the best path.

V. RELATED WORK

In [2], author states a variety of existing routing protocols with their merits and demerits. In VANET, communication can be done in two ways to provide a record of applications like emergency motor vehicle warning, safety etc. These are between various vehicles well-known as vehicle to vehicle and among vehicles and roadside units known as vehicle to roadside communication. Performance of this type of communication between vehicles depends on dissimilar

routing protocols. Continuous progresses in wireless communications have opened novel research fields in computer networking focused at extending data networks connectivity to environments where wired answers are impossible. Presented VanetMobiSim, an add up to the Canu MobiSim user mobility framework proficient of producing practical vehicular mobility traces for a number of network simulators and macroscopic, microscopic levels of VANET.

A novel clustering algorithm for Vehicular Ad-Hoc Networks has been suggested. The foremost aim was to raise the stability of a cluster structure as the objective environment has very high degree of mobility [3]. The dilemma of clustering is an significant topic amongst researchers operating with ad-hoc networks.

Vehicular ad hoc networks (VANETs) are suitable networks that can be used in smart transportation systems. VANET is based on restricted wireless communication between vehicles. VANETs [4] are built on-the-fly and there is no need of investment, apart from the wireless network interface that takes numeral of neighbors based on transmission range, the direction of vehicles, and the entropy and value parameters. These parameters can increase stability and connectivity and can reduce overhead in networks.

A new concept Vehicle-to-vehicle communication in the field of road traffic protection, an increasing number of global studies and research being performed on the subject matter. Traffic safety has become a main concern and, with the development of communication technologies and wireless networks, VANET networks have emerged. VANET, or Vehicular Ad-hoc Network, ensures a communication protocol among close vehicles or between a vehicle and infrastructure (indicator, traffic light, road junction). The key purpose of these networks leftovers resident safety [5] and comfort in traffic. Author reviewed VANET networks nowadays benefit from high visibility among researchers due to their traffic optimization profit in urban environments, fuel savings and pollution effect decrease in most cities.

VANET has been emerged as a famous field for research and it receives significant interest. VANET [6] uses different specifications of the WLAN 802.11 family. It takes the fundamentals of ad hoc network and the VANET creates a network with a set of independent entities with the facility to communicate between them. The Adaption to the variety of 802.11 families causes a notable increase in the number of wireless network. The VANET has various benefits along with many challenges together with security, privacy, Quality of communication, effective bandwidth utilization etc. Author reviewed a broadcast based messaging system it require more efficient methods for broadcasting message. Reliable broadcasts in a VANET environment is still an open problem of research. Time plays an important factor because if the alert message reaches the receiver after the planned time then there is no use of having such system. So the routing mechanisms are choosing in such a way to decrease the time delay in the message communication.

A new clustering technique fit for the VANET environment on highways with the plan of enhancing the firmness of the network topology is proposed. This technique [7] takes the speed variation as a parameter to form relatively stable cluster structure. A simulation was conducted to calculate our method

and compare it with the most frequently used clustering methods. A new VANET cluster formation algorithm is proposed that tends to cluster vehicles showing similar mobility patterns in one cluster. The speed dissimilarity among vehicles in addition to the position and the direction during the cluster configuration process is measured. This technique groups fast moving vehicles on the fast speed lanes in one cluster, while slow moving vehicles in an additional cluster. The simulation outcome demonstrates that this algorithm increases the cluster lifetime and decreases vehicle transitions among clusters. This procedure considerably increases the stability of the global network topology by reducing the rate of cluster creation.

Researchers and developers understand and differentiate the core features surrounding VANET in one solid document; there is no need to go through other related papers and articles preliminary from VANET architecture and concluded up with the most suitable simulation tools to simulate VANET protocols. Author reviewed a complete survey dealing with all the issues in front of VANET, VANET architectures, components, VANET [8] communication domains, wireless access technologies, VANET characteristics, VANET Applications, challenges and simulation tools. This survey helps researchers to spotlight on the issues surrounding VANET and its applications, showing great deal of understanding of how to tackle all issues associated with VANET.

In VANET, two types of communication can be done to give a list of applications like emergency vehicle warning; safety etc. Performance of such type of communication among vehicles depends on a variety of routing protocols.

VI. VANET COMMUNICATION DOMAINS

The communication among vehicles, RSU and the infrastructure form three kind of domains:-

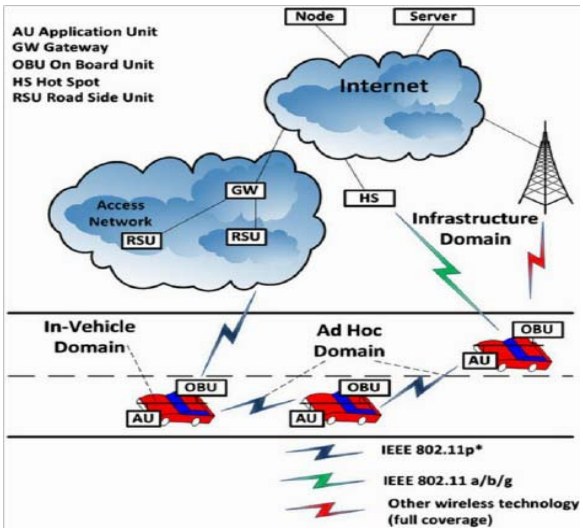

Fig.5. VANET Communication domains [10]

6.1 In-vehicle domain: This includes Vehicle to Vehicle communication (V2V) and Vehicle [8] to Roadside Infrastructure communication (V2I) which we classify them as the Ad hoc domain and the final type of communications

is the Vehicle to Broadband Cloud communication in which the vehicle communicate with a monitoring data hub, this type incorporate the Infrastructural domain .

6.2 Ad hoc domain: The ad hoc domain in VANET is collection of vehicles prepared with OBUs and a station along the road side, the RSU. Two kinds of communications are in the ad hoc domain:

As a part and real application of an ITS inter vehicle communication gain consideration from researchers, academics and industry leaders, especially in US and Japan. The ability to advance road traffic safety, driving effectiveness and to expand on board device horizons, vehicles communicate with other vehicles through OUBs forming a MANET, which helps communication between vehicles in a complete distributed manner with non centralized coordination. With direct wireless connection vehicle communicate with another vehicle, forming a single hop vehicle to vehicle communication (V2V); a committed routing protocol is used when there is no direct communication to forward data from one vehicle to another until it reaches the destination point, forming multi-hop [9] vehicle to vehicle communication.

Vehicles communicate with RSU to boost the range of communication by sending, receiving and forwarding data from one node to another.

6.3 Infrastructural domain: The RSU can join to the infrastructural networks or to the Internet, allowing the OBU to way in the infrastructure network; there is a possibility that the AUs are registered with the OBU to join to any internet based host.

TABLE 1: Comparison of Different Methods

No.	Author	Year	Methods Used	Advantages	Limitations	Parameter Used
1	A. Kharrat et al.	2016	Survey of VANET study various specifications of the WLAN 802.11 family	Minimum number of features reduces the cost of classifier.	Nodes are more dynamic in VANET because most of the vehicles travel at high speed	Headway distribution , safe distance between vehicles
2	Surmukh Singh et al	2014	Routing protocols in VANET for intelligent transportation (ITS).	Surely provide a route hop. Can send unicast, m messages	More investigation is needed to satisfy the several characteristics of a routing protocols	End-to-end delivery , throughput
3	Maria Claudia Surugiu	2013	Develop novel active and passive vehicle safety systems. Vehicle-to-vehicle communication is a comparatively novel concept in the field of road traffic safety, rising number of studies and research being performed on the subject.	The purpose of these networks remains occupant security and relieve in traffic.	Completeness result better in global threshold method..	Traffic density on roads ,preparing traffic information for vehicles
4	Zaydoun Y Rawashdeh et al.	2012	A novel clustering technique appropriate for The VANET environment on highways with the objective of enhancing the firmness of the network topology. Speed difference is considered as a parameter to produce relatively steady cluster structure.	On the locale scale it provides more stable cluster.	Computational cost complexity is high	Routing tables of individual node
5	Ahmad Khademzadeh et al.	2011	Vehicular clustering based on the weighted clustering algorithm (VWCA) that takes into thought the number of neighbors based on dynamic transmission range, the direction of vehicles, the entropy, and the suspect value parameters	Stability and connectivity is increased and overhead is reduced in the network.	High-rate topology changes and high inconsistency in vehicles density.	Content Distributions in Vanets.
6	Lianfeng Shen et al.	2010	A cluster-based directional routing protocol (CBDRP) for highway, in which cluster head selects one more header according to the moving	Link stability problem in VANET, reliable and	Results presented are preliminary and requires clinical evaluation.	Vehicles speed , Data dissemination

			direction of vehicle to frontward packets.	fast data transmission , high delivery ratio at a nominal latency		
7	Nitin Maslekar	2009	A direction based clustering algorithm for data distribution. This protocol is used to approximate the density of vehicles on a certain road. The development of the cluster and the use of the bandwidth are main tasks	If vehicles are moving along the same direction packet is forwarded to them.	Threshold selection using histogram will be inefficient WAVE stack is superior than TCP/IP stack, in terms of performance, in vehicular surroundings.	Data traffic load and network parameters
8	Grzegorz Wolny et al.	2008	Changes in the Basagni's Distributed and Mobility-Adaptive Clustering (DMAC) algorithm. Some extra conditions that have to be satisfied before the cluster head change, are introduced to better go with the road traffic.	The stability of cluster is appreciably increased.	Applicative where the parameters must be updated.	Robustness , neighborhood follow
9	Beham and Gurulakshmi	2007	Three techniques are proposed that depends on the local positions of the receiver and transmitter nodes. The algorithms are totally distributed and computationally better.	Less error sensitive and can be applied to minimal amount of data with reliable results compared to supervised segmentatio n methods.	Limited set of directions as opposed to arbitrarily moving in random directions within an enclosed Area.	Periodic Connection

VII. CONCLUSION

VANET networks because of their traffic optimization benefits in urban environments, fuel savings and pollution effect reduction in most cities enjoy high visibility among researchers. VANET Networks (Vehicular Ad-Hoc Networks) are a special case of ad-hoc wireless networks. This paper presents various kinds of communication system and components in VANET. Authentication helps in achieving secure communication among vehicles and RSUs. The relative analysis shows the merits and demerits of different methods with specific to different parameters.

REFERENCES

[1] Marco Fiore Jerome Harri, FethiFilali, Christian Bonnet "Vehicular Mobility Simulation for VANETs" IEEE 2007.

[2] B.Ayyappan,Dr.P.Mohankumar "Vehicular Ad Hoc Networks (VANET): Architectures, Methodologies And Design Issue" IEEE 2016.

[3] LianfengShen "Cluster-Based Directional Routing Protocol in VANET" IEEE 2010.

[4] NitinMaslekar "Direction Based Clustering Algorithm for Data Dissemination in Vehicular Networks" IEEE 2009.

[5] Maria Claudia Surugiu , Radu Virgiliu Alexandrescu "Analysis of the Development and Implementation of VANET Network Intervehiculary Communication Systems'' IEEE 2013.

[6] Ahmad Khademzadeh "An efficient clustering algorithm in vehicular ad hoc networks" IEEE 2011.

[7] Zaydoun Y Rawashdeh and Syed Masud Mahmud "A novel algorithm to form stable clusters in vehicular ad hoc networks on highways" IEEE 2012.

[8] Saif Al Sultan, Moath M. Al Doori, Ali H. Al Bayatti, Hussien Zedan "A comprehensive survey on Vehicular Ad Hoc Network'' IEEE 2013.

[9] Surmukh Singh Sunil Agrawal "VANET Routing Protocols: Issues and Challenges''IEEE 2014.

[10] Olariu S, Weigle MC,"Vehicular networks practice",1st ed. Chapman & Hall/CRC;2009.

[11] Saif Al-Sultan, Moath M.Al-Doori, Ali H. Al-Bayatti, Hussien Zedan " A Comprehensive survey on vehicular Ad Hoc network"2013.