Vehicular Ad hoc Network for Intelligent Transport System: A review

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Abstract

the numbers of accidents are increasing in an exponential manner with the growing of vehicles numbers on roads in recent years. This huge number of vehicles increases the traffic congestion rates. Therefore, new technologies are so important to reduce the victims in the roads and improve the traffic safety. The Intelligent Transportation Systems (ITS) represents an emerging technology to improve the road's safety and traffic efficiency. ITS have various safety and not safety applications. Numerous methods are intended to develop the smart transport systems. The crucial form is the Vehicular Ad hoc Networks (VANET). VANET is becoming the most common network in ITS. It confirms human's safety on streets by dissemination protection messages among vehicles. Optimizing the traffic management operations represent an urgent issue in this era a according to the massive growing in number of circulating vehicles, traffic congestions and road accidents. Street congestions can have significant negative impact on the life quality, passenger's safety, daily activities, economic and environmental for citizens and organizations. Current progresses in communication and computing paradigms fetched the improvement of inclusive intelligent devices equipped with wireless communication capability and high efficiency processors.

Keywords— *V2V, V2I, VANET, ITS*

1. Introduction

Vehicular ad hoc networks (VANETs) represent a vital part of Intelligent Transportation System (ITS). VANET is a developed style of a mobile ad hoc network (MANET). VANET aims to recover road safety and exchanging information among vehicles in an effectiveness manner. Vehicles are prepared with wireless units to communicate with neighboring vehicles directly through single or multi hops in a Vehicle-to-Vehicle (V2V) style. Vehicles can communicate with Road Side Units (RSUs) in a Vehicle-to-Infrastructure (V2I) or Infrastructure-to-Vehicle (I2V) style [1]. Many researchers' conducts their researches on VANETs features. VANETs encompass of many embedded sensors in vehicles and on roadside. V2V and V2I are the main two communication methods in VANET [2] . These networks are characterized by its predictable changes which are limited to roads and traffic rules. Furthermore, VANETs have influential processing units and big storage capabilities. VANET has not constrained with any energy problem. Vehicles are feeding all the installed communication units from their batteries. But, the communication links between the moving vehicles are disconnected and failed due to the massive speed and low density in roads [3]. Messages in VANET may be broadcasted among vehicles, but many difficulties are affecting this process. Broadcasting resulted in a flooding problem. Flooding created due to the fact that each vehicle receives a message will re-forward it to all its neighboring vehicles. So, broadcasting storm problem will be happened due to the redundant rebroadcasting. Such problem affects the bandwidth, processing resources and multiple same messages will reached to each vehicle. The network delay and collisions are also increases [4].

Clustering procedures are efficient in reducing the flooding problem. Clustering is a grouping method to collect the vehicles that having similar criteria. Each clustering approach has many precise principles to form a stable cluster. Creating stable cluster is one of the most challenges in VANETs. In a stable cluster, cluster head (CH) must stay for long time although the network topology changes [4]. The good clustering procedure are [5] benefits in reducing the transmission overhead, keeping bandwidth, network Efficiency, Stability [5]. Resources re-allocating and topology information aggregation. The most noteworthy highlights of VANET incorporate self-association, circulated organizing, and exceptionally unique topology. The VANET highlights and its applications to street security have pulled in a considerable measure of enthusiasm for industry and the scholarly community all the more so into the examination on change of transportation frameworks for sparing a large number of lives. Numerous individuals get truly harmed or lose their lives in street mishaps either because of driver carelessness, movement clog, infringement of activity rules, inadequate data of streets, expanded populace, and an absence of security foundation. Consequently, decrease of movement blockage and improvement of street security is of most extreme worry for the prosperity of mankind. Figure 1 demonstrates the primary VANET design. The fundamental VANET are formed from vehicles On Board Unit (OBU), RSUs, Application Units (AUs), a Passage System (A), correspondence fields (intra vehicle area, specially appointed and foundation spaces), and Web [6].

An OBU is implanted in every vehicle which gives a promotion The RSU is stationary; it is normally for all time mounted along the roadside. The AU is a graphical interface among client and OBU. The A containing cell get to arrange (Door and RSUs), and remote access organize (hotspot). This encourages the V2I correspondence subsequently framing framework space. The intra vehicle space encourages correspondence inside a vehicle (among OBU and AU). A specially appointed area is utilized to impart between vehicles utilizing single/multi jump correspondence. The correspondence somewhere in the range of V2V and V2I are accomplished through a Devoted Short Range Correspondence (DSRC) framework [7]. Current advancements in data and correspondence advances (ICT) have bolstered new methodologies, for example, the commonness of ITS for intersections association.

Figure 1: Vehicular Specially appointed System Engineering.

To empower participation and association among streets clients progressively, settled frameworks and control focuses must be shaped to steady ITS (C-ITS) [8].

The VANET gives expansive range of utilizations which are gathered into wellbeing and solace applications [27,28]. Figure 2, demonstrates a far reaching portrayal of the urgent VANET applications [7].

Figure 2: Vehicular Specially appointed System Applications

VANET empowers V2V correspondence where vehicles trade information while moving at various rates. Since Specially appointed system does not depend on any settled foundation, vehicles are sorted out in an all around characterized dynamic topology. Notwithstanding, the range distributed to V2V experienced absence of limit because of increment in number of vehicles [9].

2. Vanet's Architecture, Domain And Wireless Access Technology

VANET's Architecture, Domain and Wireless Access Technology used in VANET will describes in this section [10].

A. *Architecture Of VANET*
The architecture of a VANET involves different specific apparatuses working in three dissimilar domains. These apparatuses are OBU, AU and RSU.

Application Unit
AU is an in vehicle tool to utilize the travelling proficiencies of the OBU. AU can be either a devoted device for precise application such as security or as an internet communication element. Each OBU can have several AUs inserted in it to share the processing and the resources of OBUs. AU can be inserted inside the OBU as a single component or it may be fixed separately and assist the OBU to compose a required wireless connection. OBU and AU are having certain logical differences [11].

On Board Unit
An OBU is an instrument that exists in a vehicle to assist in exchanging information with neighbors OBUs or with RSUs. It composed of a specific boundary to join other OBUs, a resource command processor (RCP), network equipment for short range wireless communication based on IEEE 802.11p radio technology and a user interface. OBU has wireless abilities in sending, forwarding and receiving information.it can performs the process of data routing, improve the quality of service, security and IP mobility.

Road-side Unit
RSU is a fixed structure created along the roads sides to achieve the required networking abilities for short range wireless communications using IEEE 802.11p.

B. *Domains In VANET*
• **In-vehicle**: it is responsible for the process of exchanging information between vehicles. Each vehicle is already prepared by OBU and at least one AU.
• **Ad hoc**: it encompass on the process of V2V and V2I. Each vehicle including OBU has an ability to play the role of mobile ad hoc node that permits communications between nodes and with RSU and establishing a VANET.
• **Infrastructure domain**: it keeps safety and non-safety messages that vehicles exchange with RSU and wireless hotspots (HT).

C. *Wireless Access Technology In VANET*
VANET can be implemented in several technologies according to the wanted application such as traffic optimization or road safety. Advanced technology is supporting vehicles in the process of exchanging information with RSUs and with other adjacent vehicles. VANET usually utilize short range wireless communication based on IEEE 802.11p standard or Wi-Max IEEE 802.16 to exchange information between vehicles.
• **IEEE 802.11p** is a modification type of IEEE 802.11 standards. This type is compatible and suitable to be used in vehicular environment through its wireless access in vehicular environments (WAVE). Vehicles can communicate with each other or with RSU according to the ITS license band of (5.85-5.925 GHz).
• **IEEE 802.16** represents a sequence of wireless standards generated by IEEE (the "Institute of Electrical and Electronics Engineers").

3. Vanet's characteristics

VANETs have a few interesting attributes contrasted with standard MANETs. Following are the unequaled qualities of VANETs [3, 12]
•Development forecast: The developments of vehicles are con-stressed by the urban format, for example, avenues, convergences and streets, with the goal that the future developments of the vehicles could be unsurprising .
•Inconsequential power constraints: VANETs have no power restrictions, as every vehicle is furnished with a long life battery .
•Expansive scale organize: The tremendous number of vehicles taking an interest in the systems prompts a wide scale arrange, particularly in swarmed urban zones, for example, city entrance, downtown area, and roadways .
• Impermanent system thickness: The variety of movement stream causes alterable system thickness in VANETs, i.e. the system thickness could be low, for example, the instance of provincial zones, or gigantic, for example, the instance of surge hours or road turned parking lot [13].

4. Challenges of Vanet

Different applications are tried in ITS, ranges from movement security to infotainment applications. Such assortment of uses includes numerous necessities on the vehicular correspondence conventions. These diverse necessities speak to new difficulties [14][15]

•Transmission capacity impediments: Because of the nonattendance of unified controller that accomplishes the organization of deficient data transmission and substance process, VANETs require to beat the channel blockage issue, particularly in a swarmed region .

•Postpone requirements: VANETs having a consistent strict time rules. Thusly, recommending a postpone time level is vital in anticipating a viable convention .

•Security and responsibility rights: The change of protection and responsibility must be controlled in vehicular correspondence. Every vehicle needs to conviction the got messages sources and to ensure the driver's security .

• Cross-layering conventions: Managing media and constant applications has serious cutoff points in area and time. Because of the dynamic topology, the ways are over and again changed. Hence, creating honest association through the vehicle layer is one of the arrangements. Along these lines, making cross-layer conventions might be useful to enhance VANETs.

• **Small effective diameter:** VANETs having limited transmission range which result in small effective network diameter and low connectivity between moving vehicles.

• **Security attacks:** VANETs is an open nature wireless environment. So, it can be attacked by massive number of threats. Avoiding new threats and secure the vehicular communication is a significant topic.

• **High dynamic and frequently disconnected topology:** due to vehicles high speed, VANET's topology is changing repeatedly. VANETs are suffered from several challenging circumstances. Most of these challenges are the irregular connectivity, repeated link break and disconnection. To solve some of these challenges, a new study field known as Vehicular Delay Tolerant Networks (VDTNs) is presented to handle such circumstances [13].

5. Data Dissemination

The diffusion of collected information by a vehicle about its environment provides an assistance for well street traffic safety [16]. VANET's specific characteristics add several challenges in the field of data dissemination. Some of these are due to the vehicles highly speed which leads to raped changes in topology. Various researches are organized (although they are being hard to setup and maintain) to create effective data dissemination, such as clustering, trees, and grids. Some VANET's clustering approaches have been suggested in [17][18][19]. The vital challenge in such methods is how to set up and keep the cluster efficiently. The vehicles density is always variable. Any intended protocol must have ability to scale this problem. A geo-cast style is proposed in to exceed these issues[20][21][22].

In order to resolve the difficult of disseminating the messages from the source vehicle to the wanted destination, many clustering approaches have been presented. The essential procedure of clustering is to collect vehicles in groups based on certain vehicular features such as direction, velocity and location [23]. Vehicles in VANETs are highly movable which leads to a high chance of network partitions. In VANET the end-to-end message cannot be assured [17]. Irregular joining may lead to the packet loss problem. Therefore, keeping a universal network topology is crucial for a vehicle. Due to these reasons, a flat network topology is no longer efficient for data dissemination in VANETs. To solve this problem, a hierarchical network topology, called cluster, has been proposed for VANETs. A cluster represents a virtual collection of vehicles having related characteristics. Clustering structure is the technique to separate vehicles into various groups according to certain techniques [24].

6. Clustering

A cluster is a virtual group of nodes having similar characteristics. Clustering scheme is the method to divide vehicles into different groups according to some rules [1].

Clustering in VANETs is the method of forming vehicles into sets based on specific features. Figure 3, show the vehicles clustering issues in vehicular ad hoc networks [1].

Figure 3: Vehicles clustering isses.

A usual cluster organization is shown in Figure 4, present that the vehicles are separated into a four virtual groups (surrounded by circles). Vehicles can be assigned altered roles, such as cluster head (CH), member or gateway.

Figure 4: Clustering in VANETs.

A CH is a vehicle which responsible to lead the cluster communication by conveying bandwidth and controlling its cluster members. In each formed cluster, one CH must be elected. Special features are always help in electing a cluster head. Other vehicles in a cluster will be assigned as cluster members. In highway, vehicles can move with high speed and any adjacent clusters can share an overlapping vehicle for a certain time. When one vehicle belong to two clusters it can behaves as cluster gate [16].

7. Conclusions

This paper delivers an extensive review in dealing with the most VANET issues. Focusing is made on VANETS architecture, wireless access technologies, communication fields, characteristics, requirements, challenges and applications. An in depth analysis may support interests to focus on the critical factors to develop VANET and hold its Challenging issues. This paper revealed many challenges covering trust management, routing, security, and most of the active investigation to link the VANET difficulties with ITS.

Streets traffic congestions represent an exciting challenging in the urbanized technologies, VANETs era. Improving the global environment automation and building reliable ITS can add a positive significant effect toward minimizing the waiting times in street congestions. Many developed emerging technologies can contribute in facilitating the traffic congestion problems. Upcoming ITS based VANETs can offer real-time required responses to vehicles drivers. The enhancement of clustering Issues in vehicular ad hoc networks will optimize the street's traffic management and making the ITS more efficient environment. The future aim is to get more attention on the clustering issues with real application of the roads to get an optimal decision with a negligible delay in data dissemination.

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