International Journal of Academic Research and Development
ISSN: 2455-4197
Impact Factor: RJIF 5.22
www.academicsjournal.com
Volume 3; Issue 1; January 2018; Page No. 730-733

A review on various approaches of data communications in ITS

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Abstract
VANET is an intelligent transportation system that has been developed for automatic driven vehicles. In the process of VANET vehicles have been communicated with road side unit, and other vehicles that are available on the roads. In this paper various approaches that are responsible for communication in VANET has been discussed. In VANET various approaches that are used for communication are location based, ID based or MAC based. On the basis of these approaches V2V (vehicle to vehicle), V2R (vehicle to Road Side Unit) and R2R (Road Side Unit to Road Side Unit) is possible. Vehicles have been used for sharing of different locations and vehicles density on road.

Keywords: ITS, VANET, DSRC, MAC and V2R

1. Introduction

1.1 VANET

A vehicular ad hoc network (VANET) uses cars as mobile nodes in a MANET to create a mobile network. A VANET turns every participating car into a wireless router or node, allowing cars approximately 100 to 300 meters of each other to connect and, in turn, create a network with a wide range. As cars fall out of the signal range and drop out of the network, other cars can join in, connecting vehicles to one another so that a mobile Internet is created. It is estimated that the first systems that will integrate this technology are police and fire vehicles to communicate with each other for safety purposes.

1.2 Types of VANET

Intelligent transportation system

Vehicular ad-hoc network is also called as intelligent transportation system (ITS). In this the vehicles communicate with each other called vehicle to vehicle communication (V2V) or inter vehicular communication and vehicles communicate with the road side equipments called as vehicle to road communication (V2R). In intelligent transportation systems, each vehicle takes on the role of sender, receiver, and router to broadcast information to the vehicular network or transportation agency, which then uses the information to ensure safe, free-flow of traffic. Each vehicle broadcast the message to other ones.

1.3 Inter vehicular communication

It is the communication between vehicles. In inter vehicular communication there are two types of message forwarding: Naïve broadcasting and intelligent broadcasting. In naïve broadcasting, vehicles send broadcast messages periodically and at regular intervals. If the message comes from a vehicle in front, the receiving vehicle sends its own broadcast message to vehicles behind it. The dis-advantage of this method is that the large number of message broadcasting are generated due to which the message collision occurs and the message delivery rate become slow.

1.3.1 In intelligent broadcasting: If the vehicle detecting that they receives the same message from behind, it assumes that at least one vehicle in the back has received it and ceases broadcasting. The assumption is that the vehicle in the back will be responsible for moving the message along to the rest of the vehicles

1.4 Vehicle to roadside communication

Thevehicle-to-roadside communication configuration represents a single hop broadcast where the roadside equipment sends a broadcast message to all equipped vehicles in the surrounding area. Vehicle-to-roadside communication configuration provides a high bandwidth link between vehicles and roadside equipments. The roadside units may be placed every kilometer or less, enabling high data rates to be maintained in heavy traffic. For instance, when broadcasting dynamic speed limits, the roadside equipment will determine the appropriate speed limit according to its internal timetable and traffic rules. The roadside unit will periodically broadcast a message containing the speed limit and will compare any geographic or directional limits with vehicle data to determine if a speed limit warning applies to any of the vehicles in the surrounded area.

1.6 Routing in VANET

1.6.1 Protective routing protocol

Proactive routing protocols employ standard distance-vector routing strategies (e.g., Destination-Sequenced Distance-Vector (DSDV) routing) or link-state routing strategies (OLSR) and Topology Broadcast-based on Reverse-Path Forwarding (TBRPF)). They maintain and update information on routing to all nodes even then also when the path is not used. Route updates are periodically performed regardless of network load, bandwidth constraints, and network size. The main limitation of such approaches is that the maintenance of unused paths may occupy a significant part of the available bandwidth if the topology of the network changes frequently.

1.6.2 Reactive routing protocol

Reactive routing protocols such as Dynamic Source Routing (DSR), and Ad hoc On-demand Distance Vector (AODV) routing implement route determination on a demand or need basis and maintain only the routes that are currently in use, thereby reducing the burden on the network when only a subset of available routes is in use and this limit the bandwidth wastage. Communication among vehicles will only use a very limited number of routes, and therefore reactive routing is particularly suitable for this application scenario.

1.6.3 Position-based routing

Position-based routing protocols require that information about the physical position of the participating nodes be available. This position is made available to the direct neighbors in the form of periodically transmitted beacons. A sender can request the position of a receiver with the help of a location service. The routing decision at each node is then based on the destination's position contained in the packet and the position of the neighbor of the forwarding node. Consequently, position-based routing does not require the establishment or maintenance of routes.

1.6.4 Forwarding

A geographic unicast transports packets between two nodes via multiple wireless hops. When the requesting node wants to send a unicast packet, it finds the position of the destination node by looking at the location table.

1.6.5 Protocols for dedicated short-range communication (DSRC)

Protocols, namely Coordinated External Peer Communication (CEPEC) and Communications Architecture for Reliable Adaptive Vehicular Ad Hoc Networks. (CARAVAN) use mapping and timeslot allocation to minimize the occurrence of denial of service attacks or attacks that burden the limited bandwidth present in vehicular networks. Communications in a vehicular network are susceptible to denial of service attacks by jamming the communication medium or taxing the limited wireless bandwidth that is available. These attacks are occurs due to the DSRC standard specification that a vehicle only send data when it senses that the channel is ideal, allowing a malicious vehicle to constantly transmit noise to prevent transmission from within sensing range of the attacker vehicles.

2. Review of Literature

Sharanappa (2014) [1] *et al*. in the paper "Performance Analysis of CSMA, MACA and MACAW Protocols for VANETs" analyse the Carrier sense multiple access (CSMA), Multiple Access with Collision Avoidance (MACA) and Multiple Access with Collision Avoidance for Wireless (MACAW) for VANET environment. Vehicular Ad Hoc Networks (VANETs) are a special type of Mobile Ad Hoc Networks (MANETs). Recent advances in various wireless communication technologies and the emergence of computationally rich vehicles are pushing VANET research to the forefront in academia and industry. A lot of research results have been published in various areas (such as routing, broadcasting, security and others) of VANET in the last decade covering both vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) scenarios.

Khalid (2013) [2] *et al*. in the paper "Performance Analysis and Enhancement of the DSRC for VANET's Safety Applications" An analytical model for the reliability of a dedicated short-range communication (DSRC) control channel (CCH) to handle safety applications in vehicular ad hoc networks (VANETs) is proposed. Moreover, the model takes into consideration 1) the impact of mobility on the density of vehicles around the transmitter, 2) the impact of the transmitter's and receiver's speeds on the system reliability, 3) the impact of channel fading by modeling the communication range as a random variable, and 4) the hidden terminal problem and transmission collisions from neighboring vehicles. It is shown that the current specifications of the DSRC may lead to severe performance degradation in dense and high-mobility conditions. Therefore, an adaptive algorithm is introduced to increase system reliability in terms of the probability of successful reception of the packet and the delay of emergency messages in a harsh vehicular environment. The proposed model and the enhancement algorithm are validated by simulation using realistic vehicular traces.

Mahalle (2012) [3] *et al*. in the Paper "A DSRC Based Smart VANET Architecture" defines the DSRC technology and its defects in order to achieve reliable content distribution. The Smart VANET architecture abides by the DSRC channel plan. The architecture divides road into segments and assigns a service channel to each segment. The Smart VANET combines a segment based clustering technique with a hybrid Medium Access Control (MAC) mechanism (known as the Smart MAC protocol). Using cross-layer integration, Smart VAN*Et al*so provides a solution for broadcast storm problems and offers scalability. The paper presents the Smart VANET architecture and states its advantages.

Chan-Ki (2012) [4] *et al*. in the paper "Survey of MAC Protocols for Vehicular Ad Hoc Networks" provide a survey of Media Access Control protocols for vehicular ad hoc networks and classify the existing Media Access Control protocols into the three major categories of time-based, dedicated short-range communication-based, and directional antenna-based. Moreover, they discuss the characteristics of these Media Access Control protocols and show their advantages and disadvantages. In addition we define some open issues and future work related to Media Access Control protocols for vehicular ad hoc networks.

Saurabh (2012) [5] *et al*. in the paper" DEMO: Simulation of Realistic Mobility Model and Implementation of 802.11p (DSRC) for Vehicular Networks (VANET)" demonstration and description of generating realistic mobility model using various tools such as e World, Open Street Map, SUMO and TraNS. Generated mobility scenario is added to NS-2.34

(Network Simulator) for analysis of DSR and AODV routing protocol under 802.11p (DSRC/WAVE) and 802.11a. Results after analysis shows 802.11p is more suitable than 802.11a for VANET.

3. Approaches Used

DSRC: The primary motivation for deploying DSRC is to enable collision prevention applications. These applications depend on frequent data exchanges among vehicles, and between vehicles and roadside infrastructure DSRC, which is a candidate for use in a VANET, is a short to medium range communication service that supports both public safety and private communication. The communication environment of DSRC is both vehicle-to-vehicle and vehicle-to/from-roadside. The VANET aims to provide a high data rate and at the same time minimize latency within a relatively small communication zone Dedicated Short-Range Communication (DSRC) is a standard that aims to bring vehicular networks to North America. Traffic fatalities have been a long standing problem in the United States, as in the rest of the world. As an indication of the severity of the problem, in 1999 there were 6,279,000 motor vehicle accidents that accounted for 41,611 deaths in the United States [12]. In 1991, the US Congress passed the Intermodal Surface Transportation Efficiency Act of 1991 that resulted in the creation the first generation of Intelligent Transportation System (ITS). The goal of the ITS program is to incorporate technology into the transportation infrastructure to improve safety.

MAC: Media Access Control protocols such as TDMA, FDMA, or CDMA are difficult to implement for VANET. For any of these protocols to be used either time-slot, channels, or codes need to be dynamically allocated, which requires synchronization that is difficult to achieve in a network where the nodes have a high degree of mobility. The objective of the media access control layer is to arbitrate the access to the shared medium, which in this case is the wireless channel. If no method is used to coordinate the transmission of data, then a large number of collisions would occur and the data that is transmitted would be lost. The ideal scenario is a MAC that prevents nodes within transmission range of each other from transmitting at the same time, thus preventing collisions from occurring. Equally important, the media access control must be fair, efficient, and provide the ability to prioritize traffic. Another obstacle restricting the wide-spread adoption of vehicular ad hoc networks is that is based on the wireless protocol IEEE 802.11, that was designed for networks with different characteristics than a VANET. A large focus of the 802.11 standards has been on wireless LANs. The majority of the 802.11 protocols are designed around the fact that a centralized controller is present in the network, the access point (AP). In vehicular ad hoc networks the use of an AP is limited to situation where a RSU is present.

IEEE 802.11p standard: The IEEE 802.11p standard is designed to enable the deployment of VANETs in high-speed environments. It is an amendment to the IEEE 802.11-2007 standard, and combines the physical layer supplement IEEE 802.11a with the Quality of Service (QoS) amendment IEEE 802.11e. The PHY layer of the standard uses the same signal processing and specification as the OFDM PHY used in the IEEE 802.11a standard. To achieve a robust connection under high velocities, small modifications are proposed. Instead of using the full clocked mode of 20 MHz, the usage of the half clocked mode with 10 MHz bandwidth is foreseen in vehicular environments. Consequently, parameters in the time domain are doubled and data rates are halved. This approach makes the signal more robust: effects of Doppler spread are reduced because of the reduced bandwidth and the larger guard interval reduces inter-symbol interference caused by multi-path propagation.

Ad Hoc on-Demand Distance Vector Routing (AODV): Ad Hoc On-Demand Distance Vector Routing using distance-vector concept, AODV protocol does not maintain a routing table, but when a node needs to communicate with another node on demand node only to the approach to building routing table. In mobile ad-hoc network when a node wants to send data to another node in the network, the first broadcast a Route Request (RREQ) packet. RREQ in the network is a kind of flooding of the transfer mode, destination until they were received a RREQ. The node can only be processed once on the same RREQ and to avoid routing loop generation. The all the nodes between the source and the destination of the RREQ will be passing a temporary record will be on the last hop. when the destination of the RREQ received from different places, choose a shortest path, and to the source sent the direction of Route Reply (RREP).

Dynamic Source Routing (DSR)

DSR is the use of the concept of source routing, the routing information that is directly recorded in the inside of each packet, DSR is needed only when the path to find out the path that is on demand. Route Discovery of DSR and AODV is similar, but also broadcast from the source client to send a Route Request, and difference is that Route Request after one hop to another. This hop of the ID will be recorded in the Route Request a Route Record. When the Route Request reaches at the destination, they will have all the nodes in the path of information, and destination receive a Request from different places and choose where the best path, according to Route Record to send a Route Reply back to source, source will be recorded in the route reply stored inside the route record in the routing table. The path from source to destination is established.

4. Conclusion

VANET is field of networking that deals with automatic driven system based on intelligent transportation system. In this field all the vehicles are enabled with OBU (On Board Unit) that contain GPS system, Transmitter and receiver. In VANET various approaches have been used for communication over the network so that information can be easily sharing on the network. In this process V2V communication has been done based on DSRC approaches. MAC address has been used for communication between the nodes so that information can be easily transmitted and vehicles can be easily communicated. In this paper various routing strategies have been discussed so that one can understand communication process of the VANET.

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