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Efficient and Reliable Data Dissemination Approaches for VANET

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***Abstract*—** VANET Technology is the tremendously increasing day to day and a prominent research technology in the area of vehicular nodes which provides with concrete and real applications. Prominent development of applications and inherent characteristics such as frequent disconnection of network, rapid dynamic topology, and predictable mobility have made data dissemination technique inside VANET system as a crucial challenging task in the significant area of wireless sensor networks. Many of VANET applications require real-time communication with high reliability. Data dissemination is the base for whole network and it is a mechanism of spreading the data or information over dispersed networks. Data dissemination is intended to use the resources of a network in an optimal way to provide the needs to end users in dedicated network environment. To initiate efficient data dissemination technique in VANET system we have to consider both data forwarding node and not participated nodes in that data dissemination. So, data dissemination protocol should be designed exclusively so that achieves dissemination of data to end point without affecting data in dense and sparse network of VANET system. In this paper, we discuss the data dissemination protocols history thoroughly. The main objective of this paper is to provide fundamental concepts of data dissemination in VANET system environment.

***Keywords*—** Data Dissemination Prortocol, VANET, Store and Forwarding, Geocast, Beacon, MAC, BPSK.

I. INTRODUCTION

Now-a-days vehicles are providing excellent comfort facilities to human life. All type of communication among vehicular nodes is considered as VANET system environment. VANET is a special kind of wireless ad hoc network and unique class of MANETS (Mobile Ad hoc Networks) which uses moving vehicles as portable nodes (exponentially highly dynamic in nature). They are highly mobile and tremendous amount of embedded computing power. VANETs harness the potential of information and communication technologies to create a smarter, safer and efficient transportation network [1]. VANET applications are developed based upon data dissemination model so that extensive and variety of data to be disseminated to set of vehicular nodes. Data dissemination meant for receiving and sending of data from source vehicular node to destination vehicular node. GPS (Global Positioning System) and GSM (Global System for Mobile communication) based tracking systems are used to track the vehicular node around the globe. It is interesting field of research in scientific environment. Data delivered after stipulated time not only useless but also causes severe consequences for the traffic safety system. In order to avoid vehicle collisions data should be disseminate from source node to destination node in VANET [2]. In VANET system the dynamic nature of topology is exacerbated by the unpredictable nature of driver response to various events.

A. Fundamental Concepts of Data Communication

A Data communication in a network is the exchange of data between two nodes transmitter and receiver through some form of transmission medium. Fundamental characteristics of data communication system depend on three concepts:

- Delivery
- Accuracy
- Timeliness

A data communication system is made up of five components.

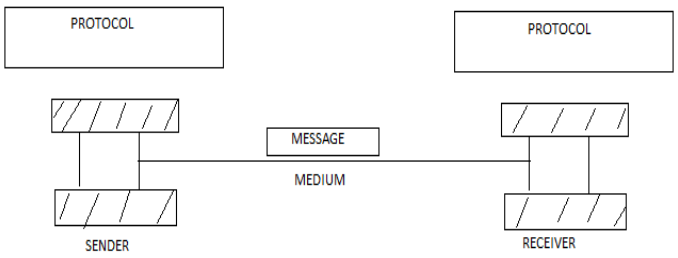

Figure 1. Data communication system

- **Sender:** who sends the data.
- **Message:** to be transmitted data or information.

- **Medium:** the physical path by which a message transmitted from sender to receiver.
- **Protocol:** group of rules that controls the data communication.
- **Receiver:** who receives the data.

Data transmitted over a communication path either in two ways: broadcast, and point-to-point. In broadcast method, communication channel is shared by all machines and a packet to all destinations at once. In point-to-point, communication channel is share by some point. If there is only one sender and one receiver in P2P communication then it is termed as unicasting. Moreover, data is sent either parallel or serial ways. Parallel means data at once to all destination nodes and serial means one after one in serial way.

A transmission mode is the direction of signal flow among source and destination nodes in VANET. There are three types of data transmission modes available. These are:

- **Simplex:** one way communication. Ex:-commercial radio broadcasting
- **Half-duplex:** two way communication, but not same time. Ex:- CB radio
- **Full-duplex:** two way communication at same time simultaneously. Ex:-mobile phone call

A transmission channel is characterized by two basic parameters: bandwidth and signal-to-noise-ratio.

Niquist's theorem states that if B is the bandwidth of a transmission channel having L levels, then the maximum data rate R is given by (on Bandwidth)

$$R = 2B.\log_2 L$$

Shannon extended this work using S/N (SNR) ratio as:

$$R = B.\log_2 [1 + S/N]$$

Two key parameters that are directly affected by the channel conditions are one is SNR (Signal-to-Noise Ratio) and second is SINR (Signal-to-Interference-to-Noise Ratio) defined as:

$$SNR\ [db] = power\ received[db] - 10 * log10(noise)$$

And

$$SINR[db] = powerreceived[db] - 10 * log10(\sum(powerInt+noise)$$

Information includes either safety-related information non-safety information is broadcast among vehicular nodes. To do information dissemination [3], VANET system uses both radio and infrared waves. The electromagnetic waves ranging in frequency between 3 KHz to 1 GHz are called radio waves whereas waves from 300 GHz frequency to 400 THz (wavelength from 1 mm to 770 mm) are termed as infrared waves. Infrared waves have capacity to penetrate into the wall. Radio waves cover VHF (very high frequency) waves, micro and millimeter waves. Infrared and millimeter waves use line-of sight technology whereas VHF and microwaves use broadcast communication technology. Generally, data communication is controlled by standards within their network. Because of restrictions in previous standards, these standards have not been utilized total strength of wireless waves. So, a new standard IEEE 802.11p has been developed to utilize ultimate strength of wireless waves. In order to improve the QoS (Quality of Service) feature and better comfort facilities to users, VANET allows dividing the spectrum into cannels. QoS depends on numerous parameters such as data latency, data variance, and bandwidth [4]. PHY and MAC layers used for communication in VANET system. The MAC extensions are used to get better QoS services. In 1999, the FCC (Federal communications commission) which is belongs to USA has allocated 75 MHz frequency band in the range of 5.850-5.925 MHz and nature of administration enhancements of IEEE 802.11e as DSRC (Dedicated Short Range Communication) , so that to enable infotainment and safety services to be used only in VANET system for ITS (Intelligent Transport System) to enable communication based safety, and infotainment services [5]. DSRC defined in 802.11p standard and utilizing 802.11a physical layer. There are two types of channels in DSRC, control channel and service channels. Every channel contains 10MHz width. Control channel is particularly meant for safety communications and service channels for both safety and non-safety communications. In 2008, the ETSI (European Telecommunications Standards Institute) has allocated a radio spectrum of 30 MHz at 5.9 GHz for Intelligence Transport System. ETSI defined two types of messages: CAMs (Central Access Messages) and DENMs (Decentralized Environment Notification Messages). CAMs are broadcast packets sent periodically. A CAM packet contains the information about vehicle speed, direction, and vehicle position. DENMs are event driven and application specific messages which are used in emergency situations. They are triggered from the hazard start time and they send data periodically until the hazard disappears. All type of data is stored in a database called LDM (Local Dynamic Map)[6]. In data dissemination a vehicular node involved with using 70-100 embedded sensors with corresponding microprocessors. Using communication among vehicular nodes, better comfort can be provided and dangerous situations can be alleviated in human life while transporting goods as well as human beings. In data dissemination, vehicular nodes communicate by using IEEE 802.11a/b/g/n.

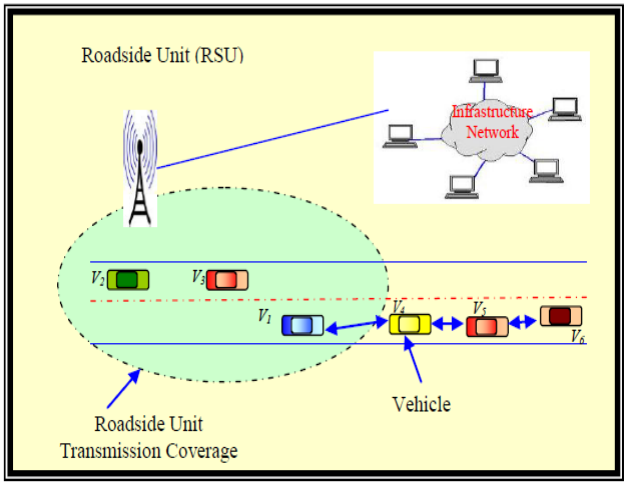

Figure 2. Vehicular Ad Hoc Networks

Furthermore, VANET data dissemination protocols can be categorized as [7]:

- Infrastructure-based
- Broadcast-based
- Geocast-based

Infrastructure-based protocols mostly use RSU (Road Side Units) in order to send and receive data in VANET system. They can achieve better results in data dissemination mechanism, but they involve with cost infrastructure. So, infrastructure less protocol has introduced in VANET system to dissemination of data with decreasing the cost. Dissemination of data is usually confronted with two problems, in dense traffic conditions and frequent disconnection of network. Moreover, all data dissemination techniques sorted into two classes.

- Infotainment services
- Emergency services

Among all data dissemination protocols, Geocast data dissemination protocols are functioned very well based on ZoR (Zone of Relevance) [8] i.e. in particular geographical [9] area. We can create ZoR area in many forms such as triangle, quadrilateral or circle. It sends data only to vehicles inside a particular area. Moreover, Geocast is the appropriate method for achieving better results in VANET system. After, determining the area broadcast mechanisms use to disseminate the data to vehicular nodes in VANET system. Traffic related information can be exchanged in the form of beacons. A beacon is periodic hello message. Data can be delivered by internet backbone which provided by RSU.

This research paper organized into four sections. First section describes about introduction, second section discusses some related work, third section explains about methods which are available in data dissemination. And in fourth section, we give conclusion. At last, we provide references which are used to prepare this research paper.

II. RELATED WORK

In VANET system environment communicating vehicular nodes exchange information messages usually consist of a message header and message body. A message header data includes message ID, the time of creation, the time to live, source, destination along with a vehicle ID. The message body consists of different types of data whether it is raw data or processed data. Most commonly used data dissemination technique is flooding. In this mechanism, data is retransmitting if there is message drop, and then it is retransmitted. But, this technique causes broadcast storm problem. Edward David Moreno [11] proposed a scheme in which messages are exchanged in a secure way by using cryptography. In [12] the authors proposed MHVB to retransmission of packets in the sender proximity. Sofiane Zemori et al. [13] has proposed a distributed dissemination protocol which was derived from a novel cooperative forwarding mechanism for exchanging messages to control communication among nodes in VANET system. In [14],[15] authors proposed one solution to solve the data dissemination problem due to traffic density by using geographic clusters and controlling the data by one node, called “head node” and selected that dynamically. In [16] the authors proposed STEID (Spatio-Temporal Emergency Information Dissemination Protocol) based on hybrid architecture. This mechanism aims at resolving disconnection problem. In [17] authors proposed a protocol called DDP (Direction Propagation Protocol). This mechanism allows vehicles to group into clusters. In each group, vehicles are elected as header and trailer and are in charge of propagating the message. It uses store and forward technique to solve the disconnection problem. In [18] the author proposes ODAM (Optimized Dissemination of Alarm Messages) to give alarm message in emergency situations. In [19] authors propose UMB (Urban Multi-hop Broadcast) which is an IEEE 802.11 based dissemination protocol for urban areas. It resolves main three problems: one is Broadcast problem, second is hidden node problem and third is reliability problem in multi-hop broadcast. This works with repeaters. Repeaters are installed in the intersections to disseminate messages in VANET system. In [20], authors proposed MDDV. It is based on geographical forwarding technique. This is mostly used in situations vehicles do not know about anything neighbors coordinates and focuses on vehicular node mobility. MDDV factors are strongly warped in VANET environment.

III. METHODOLOGY

A. *Data Frame Format*

The actual data frame which is sending by source node is named as PSDU (PLCP Data Unit) converts into the PPDU (PLCP protocol Data Unit) in the PLCP convergence procedure.

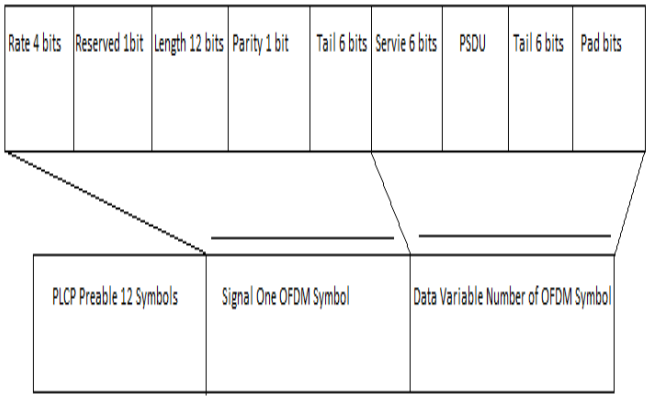

Figure 3. The IEEE 802.11 PPDU frame format

In this procedure, the Preamble and header are appended to the PSDU in order to get the PPDU. The preamble consists of 12 training symbols, out of them 10 symbols are short in size and used for creating automatic gain control. The receiver uses 2 long symbols for channel and fine frequency offset estimation. The SIGNAL field (header) of the PPDU frame is transmitted at 6 Mbps by using BPSK (Binary Phase Shift Keying) modulation technique. Modulation is the process of converting data on a low pass signal to a band pass analog signal. It also contains information about the transmission data rate and type of modulation in the RATE field and the length I number of octets of the PSDU that the MAC is currently requesting to transmit in the LENGTH field, parity field, and a tail field with all bits set to 0. The PSDU itself is a pre-pended with service field, and appended with the tail field as well as pad bits field.

B. *MAC Role and Architecture in VANET System*

The MAC provides services by PCF (Point Coordination Function), HCF (Hybrid Coordination Function through the services of the DCF (Distributed Coordination Function). It is a coordination function that enables the Quality of Services facility. The HCF uses both HCCA (HCF Controlled Channel Access) and EDCA (Enhanced Distributed Channel Access). HCCA works similar to PCF. With HCCA, QoS configured with great precision. The DCF is the Fundamental MAC technique in the IEEE 802.11 standard. It employs an access function performed by the CSMA/CA algorithm and a collision management function carried out by the binary exponential back-off mechanism.

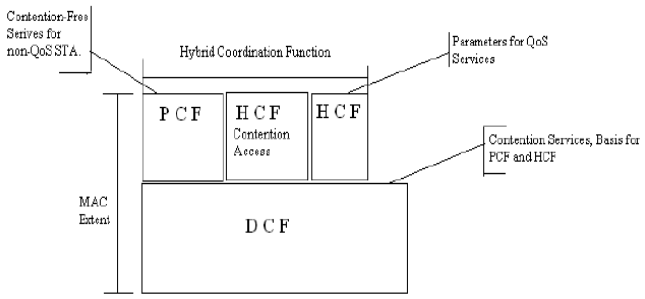

Figure 4. IEEE 802.11 MAC Architecture

C. *Data Dissemination Methods in VANET*

In order to provide better services to users, data dissemination mechanism among vehicular nodes must be initiated. During data exchange, we must consider some parameters like intermittent connection among nodes, vehicles speed, and location. Different data dissemination techniques which are involved in VANET system are:

- **V2V Forwarding:**

This V2Vdata forwarding mechanism uses mainly two approaches: flooding and relaying. In flooding approach, the information is made and received region-wise. Here, every node takes interest in spreading data. This mechanism is useful for delay responsive application especially reasonable for distributed networks in low movement conditions. The relaying is a kind of information dispersal in the system. The functioning principle of this method is it decreases blockage and is adaptable to heavy network. This is most suited for congested networks.

- **V2I or I2V Communications:**

It is a form of request and respond type model used in enquiry system about the parking slot. There are two types of data dissemination in V2V or I2V: Push based and pull based. In push based mechanism, the message can be easily transferred from the movable vehicular node or RSU to another node or RSU. Pull method is used mostly in dense vehicle conditions or in e-advertisement. In pull based mechanism, every vehicular node is given right to ask information about specific location in VANET system environment.

- **Opportunistic Forwarding:**

This mechanism is information-driven and in which applications are not troubled with exchanging the information to the correct spot. This mechanism follows the store and forward principle. Here, routes among vehicular nodes are established progressively.

- **Geographical Forwarding:**

If there is consistently change in topology, then geographical forwarding is used to exchange the data among vehicular nodes in VANET system. Here, geo-casting technique is also used in a geographical range.

- **Peer-to-Peer Forwarding:**

This mechanism is proposed for delay-tolerant application. In this mechanism, the source vehicular node stores the information in its storage device and do not send that data in the network till another node request it.

- **Cluster based forwarding:**

In order to solve broadcast storm problem, this mechanism transmits data packet in middle of the transmission from the source node to destination node. Here, all types of devices and vehicular nodes arranged in a cluster fashion.
Besides these, commonly used mechanisms are:

Opportunistic data dissemination: Information is retrieved from infrastructure/vehicles as the target vehicle encounters them.
Co-operative data dissemination: Partial information can be downloaded by the vehicles that can be shared, later to obtain the complete information. This mechanism is mainly used in content dissemination.
Vehicle-assisted data dissemination: All vehicular nodes carry information from sender and transmit same to receiver.

D. Data Disemination Protocols in VANET

A protocol is set of rules that govern the communication in a dedicated network environment. Various data dissemination protocols inside VANET system are:

- **ROD (Road Protocol Oriented Dissemination) Protocol:**

This efficient dissemination protocol scheme is organized into two modules. One is ODDT (Optimized Distance Defer Transfer) module, second is SNF Store and Forward) module. The ODDT module is used to optimize data dissemination in road sections and in intersections. Here, if no retransmitting is found in a vehicular node, the vehicle in charge of the message uses the store and forward module to keep data until to find a better retransmitted. Most of the protocols do not consider the real conditions of the traffic inside the VANET. The, ROD not only resolves this problem but also optimize the use of bandwidth providing better services to users in VANET system environment.

- **DDT (Distance Defer Transfer) protocol:**

DDT principle consists in relaying messages only by receiver that is the farthest from the sender. To do so, each vehicular node receives a message waits for a back-off timer. Back-off timer inversely proportional to the sender-receiver distance before retransmitting it. In this way the farthest vehicle retransmits the message first. Thus, the DDT protocol permits to optimize the bandwidth use.

- **SRD (Simple and Robust) protocol:**

The main responsibility of this protocol is to proficiently forward information in both distributed and thick vehicular systems. It increases propagation delay with best delivery ratio.

- **Acknowledge-based Broadcast Protocol:**

The main responsibility of this protocol is to proficiently forward information in both distributed and thick vehicular systems. It increases propagation delay with best delivery ratio. The utilization of affirmation makes the protocol more powerful to transmission disappointments while, in the meantime, spares excess retransmissions.

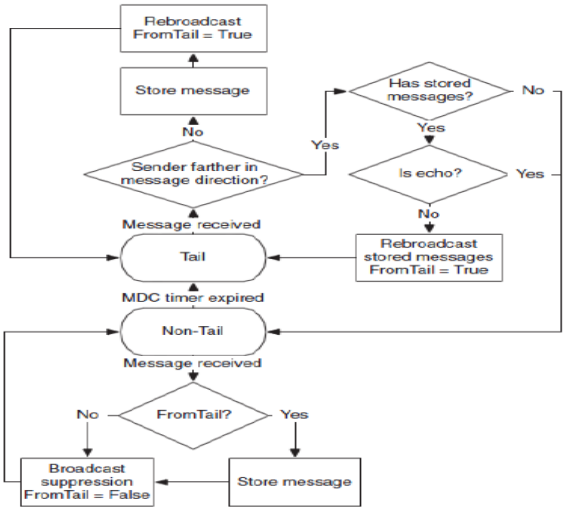

Figure 5. SRD Operations

- **The Sass-GP(Semantic and Self-decision Geocast Protocol):**

The proposed methodology is expected to geocast a accident message in and to a particular area. It is presumed that there is no contribution from RSU, or mobile administrations. In this mechanism principle is, that at the edge of the transmission extent to the vehicular node is the regular contender for transmitting the message. Likewise, every vehicular node over and over runs SGA at whatever point it gets or before sends messages.

- **TRADE (TRack Detection) Protocol:**

in this protocol, each vehicular node knows its neighbors positions periodically. This information could be used to exchange beacons. Contrary to DDT, TRADE relies on an active method to choose vehicles in charge of retransmitting

the information. Therefore, TRADE is not effective protocol in case of dense networks.

- **PVCast Protocol**

In all situations, vehicular nodes equipped with GPS device that enables time synchronization and positioning features. Each vehicle can identify its road condition through preloaded digital map which provides a street level map.

IV. CONCLUSION

The communication technologies used in different road conditions will play a pivotal role in the achievement of successful dissemination of data or information in VANET. In this paper we have discussed the various data dissemination challenges while transferring the data, data dissemination techniques and various dissemination protocols. The most important component of a real-time V2V communication system is the MAC protocol. This paper helps us in identifying the data dissemination technique inside VANET system and also we provide terminology of a data communication system with MAC protocol architecture. We, carefully observed that techniques from the past decade in VANET environment. Data dissemination strategy is different based on road conditions.

V. ACKNOWLEDGMENT

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