CONGESTION CONTROL USING ON-BOARD DATA UNITS IN VANET SCENAR IOS

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Abstract **-** Vehicular communications becomes the rising technology in the research areas in the recent years, which gives some apparent results and their applications getting increased day-by-day. There are several applications like weather monitoring, traffic control, road safety warnings, driving assistance etc., generates enormous amount of data by sensing the physical phenomenon in order to distribute them among the communication parties. These leads to a huge amount of a load in the centralized network transportation infrastructure even if the frequently accessed data cached at the specified locations either in vehicles or Road Side Units (RSU). On board data units (OBDU) are placed in each vehicle to sense and cache the information in order to reduce the service access delay, which acts as an Access Points (AP) are placed along with the RSU's so that the required data can be sent according to the service access time without any delay even the area is not covered by the particular RSU frequency range. Hence, the packet delivery ratio and throughput can be efficiently increased with the decrease in query latency**.**

Keywords **-** RSU, OBDU, VANET, Vehicle-to-Infrastructure, V2R**.**

1. Introduction

Vehicular Ad-hoc Network (VANET) is a type of Wireless Ad-hoc Network (WANET) here the concept of varying vehicular motion is distributed systematically. The vehicles and RSU's are the communicating units, providing information's like road side traffic conditions as well as household equipments while on move. Daily unheralded accidental conditions are encountered on the road causes harmful danger to the human life and also lot of damage to the vehicle as well. Generally, vehicular networks are considered to contain two types of nodes: mobile nodes (vehicles) and static nodes (access points or road-side nodes).

The sensor nodes are generally Dedicated Short Range Communication (DSRC) devices and it works in the range 5.9 GHz band with bandwidth of 75 MHz and approximate range of 1000 metres. For both private data communications and public data (mainly safety) communications the network system should maintain the supporting features but the superiority should be given to public data communications because more users will access the data in the public region. Vehicular communications is frequently developed as a part of Intelligent Transport System (ITS). VANET has highly propulsive environment due to the very speed movement of vehicles and hence the topology changes continuously. Without having the fixed infrastructure, the data is exchanged wirelessly among the vehicles and RSU. Figure 1 shows the placement of RSUs through which the vehicle on that particular road communicates with each other without going for the centralised network gateway.

Fig.1. Placement of RSUs for vehicle communication

In VANET, each RSU constitutes a cell with a particular region, the radio range of vehicles in each cell covers about 300m and within this range the vehicles can join and leave the cell frequently. In order to reduce the congestion in the network Caching mechanism is introduced which in turn reduces the service access delay by accessing the required data from the caching unit itself. In data caching technique, the most frequently accessed data are buffered and served when the particular vehicle is in need of that data without going for centralized control unit or RSU's.

The integration of Vehicle to Vehicle (V2V) and Vehicle to RSU (V2R) communication is useful because V2R provides better service for dense networks and extended distance communication, whereas V2V enables direct communication for small to average distances/areas and at locations where roadside access points are not accessible.

2. Related Works

Numerous caching techniques have been proposed over the years with the objectives of decreasing the network congestion and for providing constant services to the end users. In self-organizing inter-vehicle communication system the data dissemination scheme such as Co-Operative Collision Avoidance (CCA) have been demonstrated for transferring the information between the vehicles using the packet routing protocols. CCA approach is mainly designed for avoiding the chain collisions when the front car meets an emergency event, by passing the information to all the following vehicles of that accidental car lying under the same network infrastructure and this improves highway safety applications [2]. When a vehicle cannot directly transmit its data to the adjacent RSU, it can relay its data to other vehicles in a peer to peer manner until the data are reached to the RSU using a multi-hop transmission strategy. When direct communication is not available for data communication, then multi-hop scheme for vehicular ad-hoc network can be used. Without the acquaintance of topology, the proposed scheme capably forwards and receives the information from the vehicles in a particular segment of the road. This scheme has high packet forwarding tempo and improved channel utilization than the existing schemes [3]. A technique has been proposed which is the combination of Global Positioning System (GPS) receiver and simple digital radio equipment, through these the available traffic information can be monitored and buffered based on road identifiers of the digital map as a substitute of its raw geographical position. Traffic messages are collected and processed individually in each vehicle, and every node has the same internal structure. Current traffic information of a node is stored in the knowledge base known as database region. The amount of information that is stored in the knowledge base is limited to a specific area around the current position of the vehicle (e.g. a radius of 50km**)** [14]. Peer to peer based decentralised web caching scheme is a technique implemented for enabling the Web browsers on desktop machines so that the local caches can be shared with the other nodes [9].Peer to peer network describes mutual caching scheme in which data is disseminated among the vehicles by using Markov chain model in which the vehicle states get changed according to their updates in the probability manner. The model consists of three states namely initial, wait and update. Once the query is generated, passed to all vehicles present at the same RSU's, which describes the initial state. If the requested data is available in a vehicle's cache, then the data is passed at once to the client and the process is completed said to be updated state. If the respective query is not available, then it is passed to some other RSU's, here the client is kept in the wait state. After the result of that query is passed to the client then the state gets updated or to the initial state for the next query [11]. Re-routing algorithm for finding stable and efficient path among the vehicles was proposed to improve Quality of Service (QoS). The reliable and minimum hop distance nodes are selected for sending the requested information to the destination.

3. Proposed Work

In VANET, the vehicles share the information in a peer to peer manner to reduce or avoid the overcrowding of data in the centralised network. The RSU's and AP's are placed in the highways or in the roadside vehicular environment. The passage of message in the network can be done either single hop or multi hop techniques so that the requested information was distributed to the group of automobile receivers. Each vehicles are equipped with an electronic device called On Board Data Units (OBDU) in vehicles which consists of event data recorder to process the signal information between the vehicles and RSU's provide them signal range or the internet connectivity with distributed environment for the communication. RSU's are linked with the network infrastructure which is connected to the internet. There are the possibilities for connectivity issues when a vehicle travels in the lesser frequency range circumstances or out of coverage area, as a result it may permit OBUs to access network infrastructure.

A. Implementing OBDU Technique

Initially, the request is demanded from the vehicle and broadcasted to all the vehicles present in the same RSU. If the nearby or ahead moving vehicle has the respective query reply, the requested information is passed to the vehicle and the communication between the vehicles is done. If the nearby vehicles do not have the requested information, then the query will be put into the wait state. A certain delay ∂ will occur during this waiting state.

The service access delay or query latency can be calculated by the transmitted and the received signal information which is recorded in the event data recorder.

$$\partial=\int(x(t)-x(r)) \quad (1)$$

If the transmitted time is equal to the received time without any delay or query latency i.e., negligible delay, then the service access delay includes only the packet processing time. The approximate delay α will be

$$\int x(t)=\int x(r), \text{ then} \quad (2)$$

$$\partial=x(\alpha) \quad (3)$$

All the vehicles in the road segment moving in the same RSU's within the transmission range and with constant speed, the cost of accessing the service at the peer nodes will be only the processing delay 'x'. The Processing delay can be calculated by transmitting time and receiving time of a data.

B. Traffic Prototype

The considered traffic model is shown in the figure.3 in which the vehicles can move in bidirectional. A gateway is connected to the internet so that users may download or upload the contents during mobility. For vehicle to infrastructure communication RSU's and OBU's are deployed in the various geological regions used to send and receive the information to the centralised control. For vehicle to vehicle communication, each vehicle communicates and shares the information in a peer to peer manner.

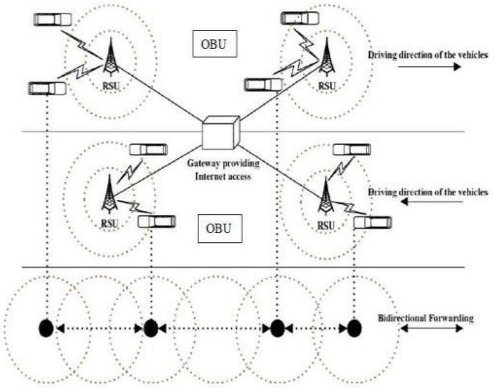

Fig.2. Traffic Prototype for bidirectional movement of vehicles

In the proposed method, the on board units are considered to improve the network coverage, communication range between the vehicles and the data's are cached at the OBU's buffer placed in the road side in order to minimize the load on the centralised control. The vehicles those move away from the RSU's may utilise the OBU for data transmission. Implementing OBU in the vehicles and along roadside as access points greatly reduces the delay and query latency and the message load on the centralised control. Placing RSU's in the roadside infrastructure is simultaneously reduced, because of placing onboard units in the vehicles as well as between the Access points.

4. Simulation Results

The dedicated simulation tool used to evaluate the proposed scheme is network simulator 2. It is an event discrete simulator and comprised of back-end C++ and front end OTCL (Object Oriented Tool Command Language).

This software has in-built vehicle motion model comprises of existing database, separate directional flows, supporting multilane roads and traffic signs at intersection. A road is classified in to different sectors and each sector has different density of vehicles. Hybrid model of mobility is used to determine the movement pattern. The vehicles move according to the roadways from the start position to the end position.

The simulated results includes query latency, cache size, message load, throughput, packet delivery speed with respect to time taken for the query reply and number of replicas.

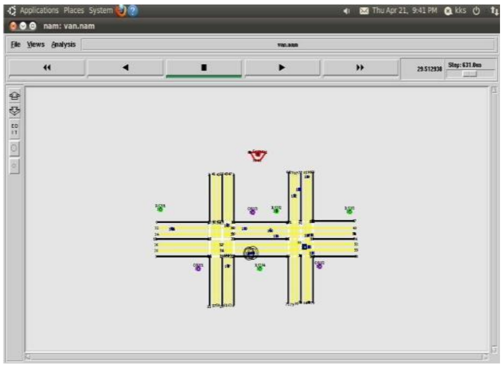

Fig.3. Data Transfer through OBU

The simulation is continued until all the packets are delivered or dropped due to Time to Live (TTL) expiration. The simulation constraints and values are given in the table 1.

Table 1: Constraints and values

S. No	Constraints	Values
1.	Number of vehicles	100
2.	Average velocity of vehicles	15-30 miles/h
3.	Wireless communication range	300m
4.	Query interval	10sec
5.	Query update	10sec

Simulation parameters of OBDU are shown in the table.2. CBR traffic model illustrates that the packets sent between the nodes or vehicles is Constant Bit Rate attached to the network.

Table.2 Simulation Parameters

Parameter	Value
Channel Type	Wireless Channel
Total Simulation Time	50 s
Number of nodes	100
MAC type	802.11
Traffic model	CBR
Simulation Area	1000×1000
Transmission range	250m
Network interface Type	WirelessPhy
Mobility Model	Hybrid Random Way Point

A. Query Latency versus Cache Size

The impact of request and update time on the query latency is presented. The time taken for processing a query is said to be request time and updating the processed query with certain operations is said to be update time.

The cache size taken here is up to 50 MB, with an increase in the cache size in respective OBU's, the query latency gets decreased up to 10% when compared to the P2PCC.The contents are searched in the OBU, so there is no need for contacting the RSU or server that helps to reduce the network load and access time. When the cache size increases then the cache hit also increases, hence with an increase in the cache size, the cache hit performance also increased in the less congestion area when compared to the more congestion area i.e. high density of vehicles.

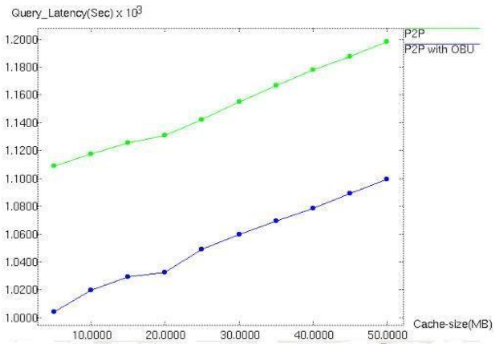

Fig.4. Query Latency Vs Cache Size

B. Replicated Data versus Cache Size

The projected scheme is examined for the replicated data and cache size. When node density and the cache size increases, then the average number of replicas gets increased. This is due to the fact that with an increase in both the values such as replicas and cache size, there is an enhancement of space for data items.

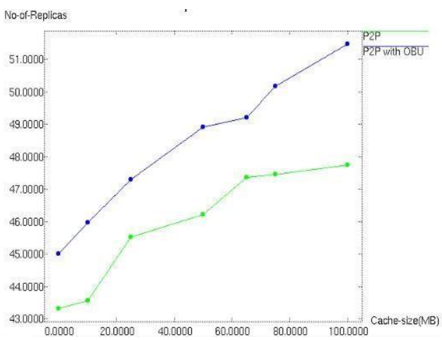

Fig.5. Replicas Vs Cache Size

Hence, availability of memory space would be more to store maximum number of data with the increased cache size. This results in reducing the access time for particular query which in turn increases the effectiveness of the query selection.

C. Delivery Rate Versus Time

The effects of varying the contention window size and the number of nodes are examined on the probability of packet delivery rate. Here, TTL value is divided into different time slots then the searching and updating the information operations are performed during this particular time slot. When

Time-to-Live increases, then the latency to access the remote information or message also increases. Therefore, the cache hit ratio decreases when the TTL gets increased.

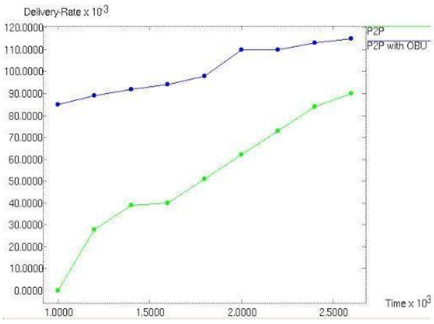

Fig.6. Packet Delivery Rate Vs Time

The window size can be changed by increasing the number of nodes. As shown in the figure 3.1 the packet delivery rate ratio gets increased with increasing the contention window size.

Probably more time would be provided for updating the information leads to collision free packet transmission and less packet loss. The successful packet delivery rate ratio has increased by 30% in this proposed scheme.

D. Throughput Versus Message Load

The proposed scheme has efficiently increased throughput value with the increase in message load. The data transmission rate between the vehicles can be measured through throughput by giving various input messages.

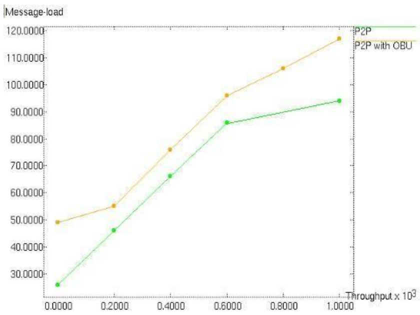

Figure.7. Throughput Vs Message Load

5. Conculsion

To avoid the query latency and to minimize the load on the road side units and the server, OBDU cache mechanism is widely used. The information among the vehicles in the network is shared in a peer to peer manner by using OBU and RSU in the roadside infrastructure. The vehicles disseminate the information by taking reliable path and the routing protocol distance sequenced destination vector is taken for optimal routing. The sensed information can be cached in an on board units or access points in an efficient manner in this proposed scheme. If vehicle to vehicle communication fails and the query initiated vehicle travels apart from the frequency range of that particular road side unit, then the vehicle could approach on board unit for the query reply. The service access delay can be reduced by placing OBDU's in different regions in the network infrastructure. The performance of the projected scheme is evaluated and compared to those existing scheme P2PCC and the result shows that the proposed scheme has reduced the query delay by 2% and data delivery rate by 20% respectively.

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