A Novel Approach for Implementing a Blackbox System in Cloud -VANET

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***Abstract*— Now a days, the road accidents are increasing and the technologies used for analysing the reasons for occurring the accidents have much limitations to keep track the complete details. Thus the importance of efficient data keeping system arises. In this paper, we propose a cloud based black box system for storing the data which is transmitted from each vehicle. Also introduce a new architecture for vehicular black box communication in a cloud VANET environment. This architecture combines the traditional 802.11p standard VANET networks with LTE networks to provide a stable communication among vehicles under emergency situations. With the development of the VANET technology, vehicles can exchange their sensing in- formation and obtain useful traffic information through vehicle- to-vehicle and vehicle-to-infrastructure communications. The main barrier to build up the black box communication system in cloud- VANET is that the communicational overheads for transferring videos and the computational cost for processing images are pretty big. The proposed architecture reduces these overheads.**

Keywords: VANET, Cloud-VANET, Black Box, Clustering; LTE; DSRC.

I. INTRODUCTION

The number of vehicles are increasing day by day and also proportionally the number of accidents too. But many accident cases are still covered by veils because of the unavailability of proper data. Compared to the traditional days, the infrastructure has been improved very much. This includes the CCTV monitoring of all public places. If an accident occurs, the CCTV footages can analyses and can find out who did the mistake[1]. But, if the accident occurred by the failure of its breaking system or any other reasons, how it can be identified by the CCTV footage? Also, this third eye monitoring is not there in some areas and how it can be analyzed? Here the need of tracking the vehicles from inside the vehicles arises. That is, the usage of black box system is very helpful in these cases.

Nowadays, the aircrafts are using the advantages of black box system. This black box keeps the audios, the signals received etc. Thus if any flight crash happens the data can be received from this black box system. But this black box system is keeping safely in aircrafts with heavier protection covering. Thus any fire crash or any other accidents doesnt affect this recording system. Also this will not sink in water or this will not affect by fire. Hence if a flight crash occur, the data can be retrieved and analyzed by obtaining this black box. But in case of aircrafts, the black box is attached with itself and this huge protection is given. But in case of cars, this cannot be possible to keep a hardware until within the vehicle by providing this kind large protection. This is due to

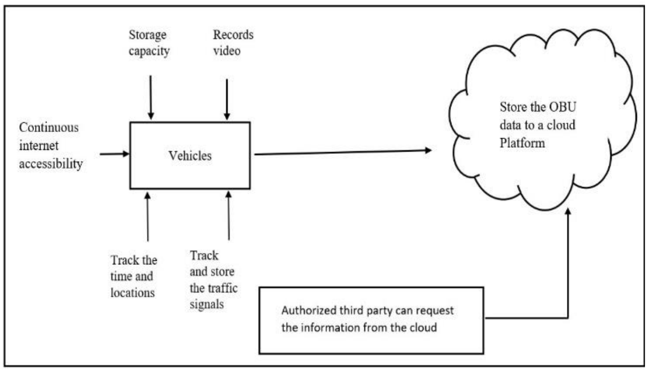

Fig. 1. Vehiclular black box system Design

the space limitation in cars compared to the aircrafts. Then the question is, how the data from the cars can be stored and retrieved securely. This can be done by using the advantages of cloud services[2] and VANET to implement a virtual black box system for each vehicles. The vehicular Adhoc Network (VANET) is the modified form of Mobile Adhoc Network (MANET)[3]. When the routing protocols of MANET is applied on the domain of vehicles, it will be the VANET. When vehicles communicated through VANET, they all are met the basic infrastructure used for VANET. That is, each vehicle is equipped with the cameras, GPS, and the other storage units etc. while communicating though the VANET each signal are digitally ,converted and accessed by the vehicles and these digitally converted signals can be stored in the on board units. The videos or images from the equipped cameras can also be stored in the On-Board Unit (OBU). But, the spatial complexity is very high. Thus, adopt the advantages of cloud service.[4]

There are several cloud services such as infrastructure as a service, storage as a service, platform as a service etc. The storage as a service can be used for implementing this black box system. The signals received by the vehicles from nearby vehicles and nearby road side units can be forwarded to the cloud server and also the videos and GPS information can be sent to the cloud server. Thus is an accident occurred, the data can be returned from the cloud servers based on the location, date and time. Thus clear picture of the accident well get from these data.

In this paper mainly focuses on how the videos and the critical events sent to the cloud server and how the videos

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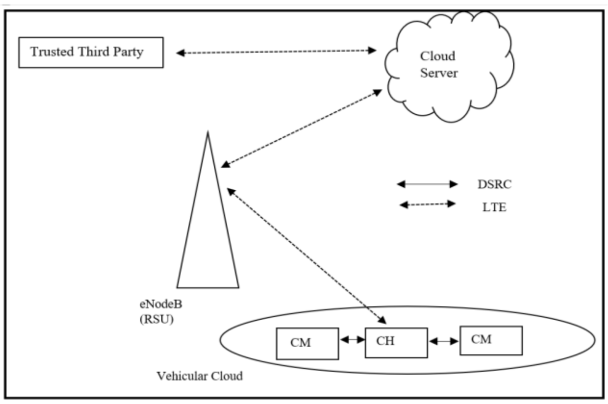

Fig. 2. Black box system Architecture

can be separately forwarded to the vehicles and cloud server respectively.

II. LITERATURE SURVEY

Remy et.al propose [5] a method called LTE4V2X, to organize vehicular networks. In the centralized vehicular networks eNodeB manages vehicles in its coverage and grouped into clusters. This protocol defines how the networks works. In this protocol, the clustering of vehicles done to the largest number of nodes circulating in the same direction. Memedi et.al proposed [6] a scheme which extends the LTE4V@X. The selection of cluster head is done by comparing the distance from vehicles to eNodeB. The system can calculate the transmit power of DSRC channels. Zhao et.al [7] quantifies temporal similarity to measure the relation of two vehicles mobility. Then utilize the relation of two vehicles mobility. Then utilize the relation of vehicle movements to form stable clusters. The locality can also be used for reducing energy consumption [8]. Dong et.al introduces [9] a clustering approach to reduce the total power consumption of DSRC communications. A weighted distance matrix is used to indicate the power consumption. Whaiduzzman et. Al made a review on vehicular cloud computing [4]. The architecture, taxonomy, and challenges are explained in this paper. The various cloud services and its advantages are reviewed here.
Luen et.al [11] proposes a high-integrity file transfer scheme for VANETs on highways named Cluster-based File Transfer (CFT) scheme. In this scheme, CMs help their CH to download file fragments and then transmit fragments to the CH which requests the file. Since the very high speed of vehicles on highways, CFT is a good approach to help the vehicles download files which they have not enough connection time to download. However, CFT just considers the bidirection environment. In addition, with CFT CH broadcasts its request to its neighbors; then, neighbors that receive the invitation join the cluster and broadcast the request to invite more vehicles to join the cluster until there are enough vehicles. Therefore, CFT may not able to apply in complicated environment, and it may cause network congestions.
This paper[13] has been reviewed that the efficiency of various routing algorithms can be calculated and these algorithms are compared using the parameters like throughput, energy consumption etc. During congestion, both DYMO and AODV protocols are dropping their packets. The analysis shows that the DYMO protocol is giving better performance than AODV. Also, AODV consumes more energy compared to DYMO. In terms of throughput, AODV is greater than DYMO. AODV is better in case of signal detection and transmission. Also, the number of beacons received is also less in DYMO than AODV. Therefore, AODV has been said to be better routing protocols than DYMO. A.Khan et.al [12] proposes an evolutionary game theoretic (EGT) framework for clustering and CH selecting. Their protocol is based on game theory. They defined the net utility of a CH to select the CH which may achieve high throughput. A cluster size is added in the utility function for CH to optimize the size of a cluster.

III. PROPOSED SCHEME

The figure 1 shows the basic architecture for the black box system using cloud VANET. While implementing the communication among nodes, the main focus should be on the routing of critical massages among vehicles suppose a vehicle giving an indicator to turn left, this indication should broadcast to all the vehicles by DSRC (Dedicated Short Range Communication). For this the vehicles are grouped to clusters. The clustering is done by the eNodeB. Each vehicle send its data packet containing vehicle ID, Current Position, Current Speed, Maximal Acceleration to the eNodeB and this eNodeB calculates the vehicle density[14]. While designing such a system it is very important to consider the critical messages such as road congestions, accident notifications, indicators etc. The critical messages have to broadcast among vehicles through DSRC. If all the vehicles send their data to the cloud server it causes broadcast storming problem. Thus the data such as critical messages and traffic signals are bind together and send to the cloud server by each cluster head. But the black box system also keep tracks the videos from the vehicles. but the videos will be of high bandwidth and it causes many computational barriers for sending it to the cloud servers.

A. Cluster Formation

In the initialization stage of cluster formation, vehicles send beacon messages to the eNodeB. The beacon message of one vehicle contains the vehicles ID , current position , current speed , maximal acceleration , and direction type [26].Direction type is decided by the angle from the current position to the destination. After receiving the beacon messages, the system analyzes vehicles position information and detects the centers of the ranges where the vehicle density is higher than in other areas. The positions of detected vehicles will be the centers use in the clustering algorithm. All vehicles whose distances to the center are not larger than the range of DSRC are labeled as one cluster. Then, the system selects one nearest intersection for every center among all intersections. Vehicles near those selected intersections are grouped into clusters. Then, eNodeB uses the same way to select intersections near the selected intersections and groups vehicles. After iterations, ungrouped vehicles are grouped into clusters. The distance between two vehicles in the same cluster is not larger than the range of DRSC.

B. *Cluster Head Selection*

Compared to other MANETs, VANETs have lower stability, because of the high mobility of vehicles. To select an appropriate CH which can increase the cluster lifetime and decrease the CH reselecting frequency, calculate the relative mobility of each vehicle. The relative mobility metric evaluates the relative position, speed, and maximal acceleration differences between one vehicle and all other vehicles in the same cluster[22].

The proposed system includes two modules.

- Broadcasting of critical messages
- Broadcasting of captured video streams

C. *Broadcasting of critical messages*

For broadcasting the critical messages to the neighboring vehicles, clustering technique is used. Clustering algorithm groups a set of vehicle nodes into clusters. In cluster-based VANETs, all vehicles send their information to eNodeB. Then, eNodeB maintains the vehicles as clusters. A cluster head (CH) acts as a coordinator to help eNodeB and cloud member (CMs) to exchange information. Assume all vehicles are able to communicate via both LTE and DSRC. The size of cluster is smaller or equal to the range of 802.11p, so that vehicles in the same cluster can exchange messages via DSRC. DSRC coverage radius is about 300 meters. LTE coverage radius is about 1 kilometer. Therefore, a single eNodeB manages many clusters around it. Within a cluster, a vehicle acts as a CH to collect information of all CMs via 802.11p and exchanges data with the eNodeB via LTE. In this algorithm, initially vehicles send beacon messages to the eNodeB. The beacon messages of one vehicle contains the vehicles ID, current position, current speed, maximal acceleration. After receiving the beacon messages, the system analyses vehicles position information and detects the head where the vehicle density is higher than in other areas. Then calculate the distance of each vehicle with respect to the eNodeB. Select the vehicle with shortest distance and make it as cluster head. All vehicles whose distances to the cluster head (CH) are not larger than the range of DSRC are labelled as one cluster.[14] The algorithms 1 to 3 illustrates how the communication among the cloud member, cluster head and a eNodeB happens in this proposed system.

D. *Broadcasting of captured video streams*

The videos can be send to the cloud server through the cluster head. Every vehicle is equipped with the cameras and

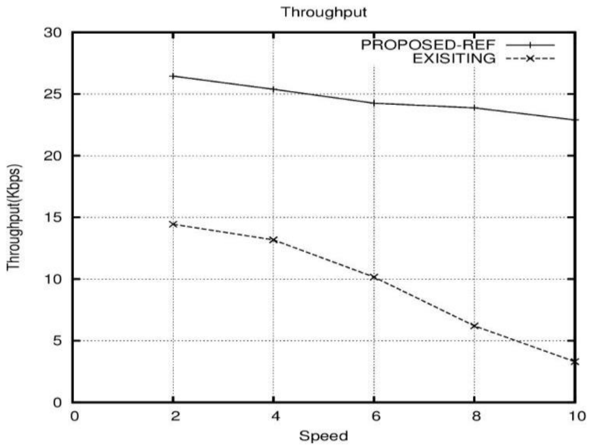

Fig. 3. Throughput

Algorithm 1 Cloud Member Algorithm

- On packet generation
  1) Send the packet to CH and other CM via DSRC
- on packet reception
  1) Filter Data Id from the packet
  2) if (Data Id) $\notin$ V Inf then
  3) save to V Inf
  4) forward to CH via DSRC
  5) else discard the data packet

Algorithm 2 Cluster head Algorithm

- On packet generation
  1) Send to CM via DSRC
  2) Send to eNodeB via LTE
- on packet reception
  1) Filter Data Id from the packet
  2) if (Data Id) $\notin$ V Inf then
  3) save to V Inf
  4) forward to eNodeB via LTE
  5) forward to CM via DSRC
  6) else discard the data packet

Algorithm 3 eNodeB Algorithm

- On packet generation
  1) Send to CM via DSRC
  2) Send to eNodeB via LTE
- on packet reception
  1) Filter Data Id from the packet
  2) if (Data Id) $\notin$ V Inf then
  3) save to V Inf
  4) Forward to CM and eNodeB
  5) else discard the data packet

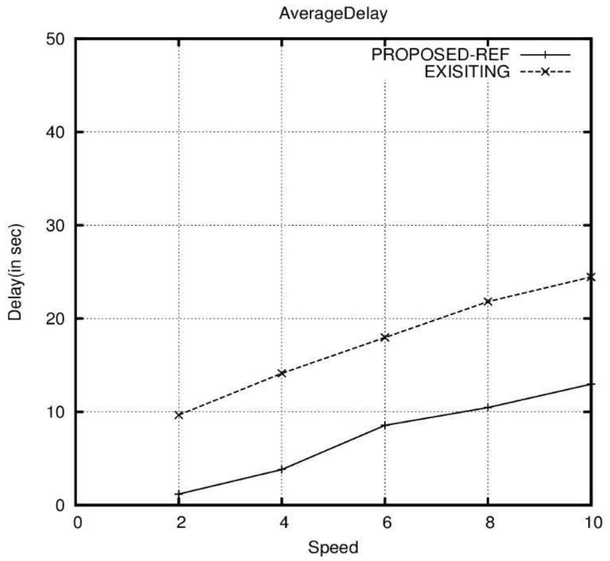

Fig. 4. Average Delay

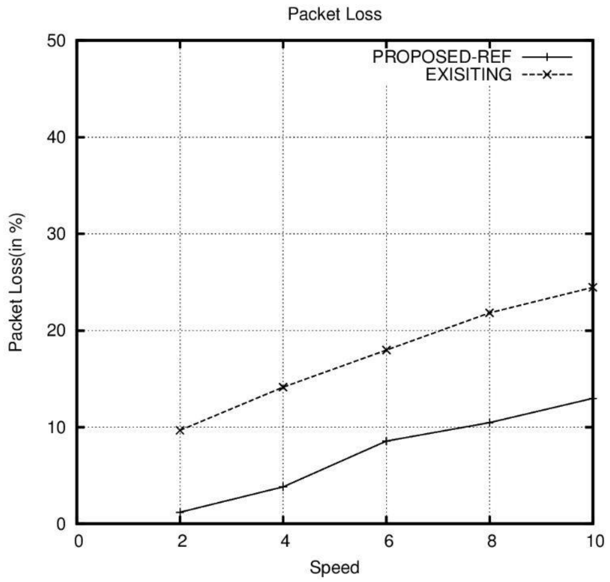

Fig. 5. Packet Loss

they are recording the path of a vehicle. Each vehicle is uploading the recorded video into the cloud server. But in order to efficiently utilize the available bandwidth, the videos of critical moments are uploading to the cloud server. For example, if any sudden drop in the velocity of a vehicle it can be say that there is a critical incident happened in the road such as stopping because of an accident, or stopping towards a pedestrian crossing the road etc. Also, the video should upload when the vehicle speed is more than the permitted speed limit. Thus the required videos can be accessible from the cloud server and this will not advertise the driving pattern of a driver. It can be kept secure through some security measures.

IV. SIMULATION AND ANALYSIS

We have simulated the proposed scheme in NS3. The evalvid framework is used to convert the video file and send it through NS3 and analysed the packet delivery ratio, throughput and packet loss ratio. The throughput and packet delivery ratio are high for the proposed scheme than the existing clustering schemes. The figures showing the graph for the packet deliver ratio, throughput and packet loss ratio.

V. CONCLUSION

We have proposed a practical and secure architecture to communicate vehicular black-box images for traffic analysis in a VANET environment. At this point, in order to minimize the communicational and computational overheads, vehicles send the videos on a critical interrupts.Since the videos are keeping in a secured platform, the driving pattern will be secured.We have simulated the performance of our model. And the simulation results show that the clustering tech- niques we have used are efficient than the existing methods. This black box system can use for further investigations regarding accidents. In this system, we are treating the critical messages and other messages separately and thus

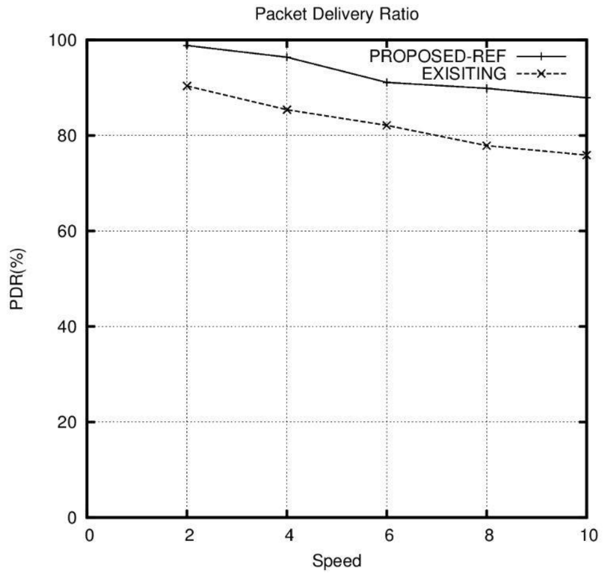

Fig. 6. Packet Delivery Ratio

efficiency will be very high. This work can be extended to a real-time application, because the driver less vehicles are becoming more and more familiar nowadays.

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