Cooperative Data Scheduling in Software Defined Vehicular Ad-Hoc Network (SDVAN)

Swapna Choudhary, Sanjay Dorle

Abstract*: Vehicular Ad-hoc Network (VANET) is the form of mobile ad-hoc network (MANET) in which the movement of vehicle is restricted by direction of road and traffic regulation. Real-world applications of vehicular communications are restricted due to rigidity in the deployment of protocol. To cover up this limitation in VANET, Software Defined Network (SDN) should be used for better utilization of channels and wireless resources. Due to dynamic nature of vehicles, finding and maintaining data dissemination is essential. Various applications uses different data from different sources, but for short period, high speed vehicles lives in the locality of road side unit (RSU) which results in latency issue. Therefore, to reduce delay scheduling of data is important so that it can serve as much requests as possible. The paper aims to implement SDN architecture along with flow management and Cooperative Data Dissemination (CDD) algorithm which will increase the speed of data dissemination. The performance of proposed algorithm is analyzed on the basic of parameters such as service ratio, service delay and gain of scalability. System performance is improved by improving CDD with peer to peer network.

***Keywords* : VANET, SDN, data dissemination, OpenFlow.**

I. INTRODUCTION

Recently, VANET have received a valuable position in the vehicular communication. It includes vehicle to vehicle (V2V) and Infrastructure to vehicle (I2V) communication. This technology integrates the features of new generation wireless networks into existing vehicles. One of the major applications of VANET is the Intelligent Transportation System (ITS). A transport system that use communication's technologies to link people, vehicles and road which aims at absorbing traffic related issues. Traffic efficiency, Road safety and infotainment are some traditional VANET services. Aim of the vehicle and road safety services is to minimize the traffic accidents. Better traffic flow, map and local information and traffic coordination are provided by VANET services. Yet there are challenges in implementing VANET's like imbalance flow traffic in multipath topology and improper network usage. As a requirement vehicular architecture must be open and flexible.

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This will permit the investigators to try their solutions in productive environment and to get better management of network resources, applications and users. To resolve the challenges in VANET, SDN is seems to be a solution. The paper focuses on implement SDN to the VANET. SDN uses Open Flow as a protocol that gives the path to control the network in a efficient manner. This flexible approach helps to gratify the requirements of VANET. SDN have ability to directly program network behavior therefore networking is switching in software discipline. As a result network management is simplified and enables new services of V2V and V2I.

SDN facilitates separate control plane and data plan. Here the control plane is used for network traffic control and other is used for forwarding. The separation of plane makes the configuration faster and network connection easily. Each network device need not to be configured and accessed individually, instead network behavior is programmed in a centralized way by a programmer. The programming of base station's wireless data plane is enabled with the integration of SDN and Open Flow. Also it increases the functionality of core networks. The use of SDN in VANET will bring down the interference and get better use of wireless resources and channels along with improved data routing in multi-path and multi hop scenarios.

Factors like mobility, data scheduling and routing would help to get better applications in VANET. So along with the architecture of software defined VANET, we concentrate on the data scheduling. Lots of data are shared with/from host vehicle, road side unit and neighboring vehicles. The data should be transferred with a high reliability within the time having minimum delay. So to schedule the necessary data we are considering available data scheduling approaches. The scope of the paper is efficient data dissemination to each client vehicle by scheduling data to proceed within time.

II. RELATED WORK

Authors [1] have described hybrid I2V and V2V communication system. They have also proposed an online scheduling algorithm for Cooperative Data Dissemination. (CDD). CDD performs better as it uses V2V communication in heavy traffic situation. Author conclude that number of requests served by CDD are more than MRF and FCFS algorithm in every situation.

Authors [2] This paper has integrated SDN with VANET to produce flexible and programmable network which is adaptive to the variable conditions and requirements. SDN architecture and its operation modes are described that would be beneficial in further research.

Some software-Defined VANET's benefits are highlighted such as path selection in which routing decisions are made with the awareness of SDN system. Secondly, for the emergency services channels can be reserved. Another benefit is the power selection where in case of sparse density all nodes will be informed to raise the power to get improved packet delivery. SDN-based routing is compared with traditional Ad hoc routing prptocols. Author conclude that SDN system responds much faster to the topology changes.

Authors [13]. The data dissemination model based on RSU has been presented. In this model, the data is categorized into safety and non-safety critical.

The available spectrum is divided into seven segments. As the safety critical data requires short period of time and small bandwidth, it uses only one control channel. Remaining six segments are used for service channel to provide non-safety services. For Non-safety services , efficient use of available bandwidth is the prime objective . Authors presented that adaptability of Data Dissemination is must for varying traffic pattern. Vehicle dwell time and data access pattern are examined for finding the dynamic traffic characteristics. For increasing Vehicle dwell time ,Push based and on-demand services gives better performance .

Authors [11] presented Motion Prediction Optimization (MPO) system.

To balance the workload and better bandwidth utilization requires requests to be transferred between RSUs, which forms cooperative scheduling. Also MMPS scheme is offered. The multi item requests may have popular and non-popular data. For popular data items, broadcasting from single RSU can host multiple requests simultaneously. There are chances of deadline missed in case of non-popular data which gives weak performance. This is called as request starvation issue. So while making schedule the data popularity along with deadline must be considered.

Author [4] described a token-based policy to admission control for reserving the lane. In this policy, number of tokens maintained to supervise and mark the workload of lanes. Reservation table include time slots and related vehicles that received the tokens of reservation. Based on this policy, paper presents scheduling algorithm for the best use of high priority lane. This algorithm makes the decision of granting reservation and token that should be allowed to the selected request.

III. NETWORK ARCHITECTURE

As compared to the other network architecture, the separate control and data plane in SDN permits both planes to be developed independently as shown in Fig. 1. SDN architecture has 3 layers. Infrastructure layer which is bottom layer is called as data plane.

It has forwarding elements like switches. It used for forwarding data, maintain the local information and statistics. Next layer at the middle is called as control plane. It is used to program and manage the forwarding plane. It identified the network operation and routing.

It contains software controllers that connect with the nodes of data plane via standardized connections which are mentioned at south band interface. Open-Flow is the standardized interface which considers switches. Third layer is the application layer. It supports control layer in configuring the network. It consists of application that can add new characteristics like security and manageability. Application layer can have global view of network from controller by using that information it can guide the control layer via northbound interface.

A. Open-Flow protocol

The most commonly used southbound interface is Open-Flow. Initially the Stanford University proposed

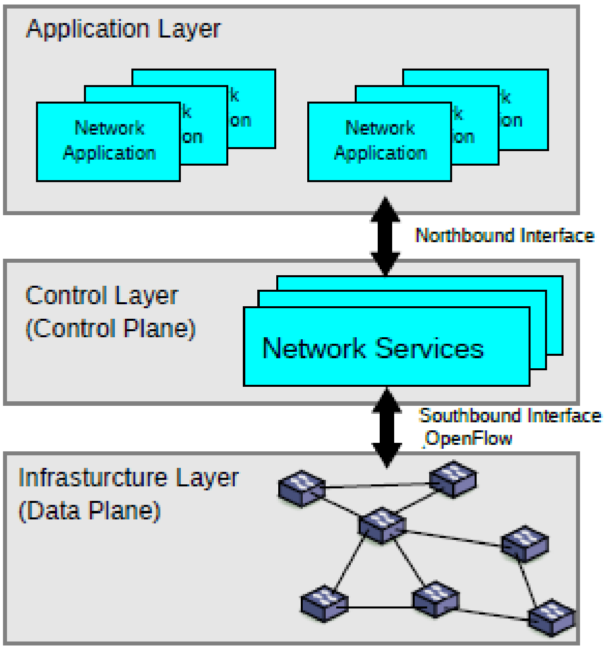

Fig.1: SDN architecture

Open-Flow and standardized by Open Networking Foundation (ONF). The connection provided by the Open-Flow protocol grant controller to program the switches. By modifying the flow table, forwarding manner of a switch can be altered. So it is viewed as controller needs to configure the Open-Flow switch.There basic things are involved in Open-Flow such as Open flow-enabled switches which in turn comprises data plane, open flow controller and control channel to link the switches with controller. The fundamental forwarding device is an Open flow-Obedient switch that carries over packets as per the flow table. Flow table entries create the table which includes match fields, counters and actions as shown in Table 1.

The packet for which entry is applicable is given in the 'header fields' also that matches different protocols. Counters are used to gather statistics of flow. It counts the packets obtained and bytes along with its duration. To manage the flow of packets there are actions like forward, drop and modify. Open flow tables maintain counters against the rules.

Table 1: Entries of Flow table

Header fields	Counters	Actions

Open-Flow protocol describes data delivery from controller to device. The controller is nothing but a software program and the forwarding deportment of the switches can be modified using the controller by insertion, deleting and changing the flow entries. This way controller is able to instruct switches using a safe control route.

B. Flow Management

IV. MATH

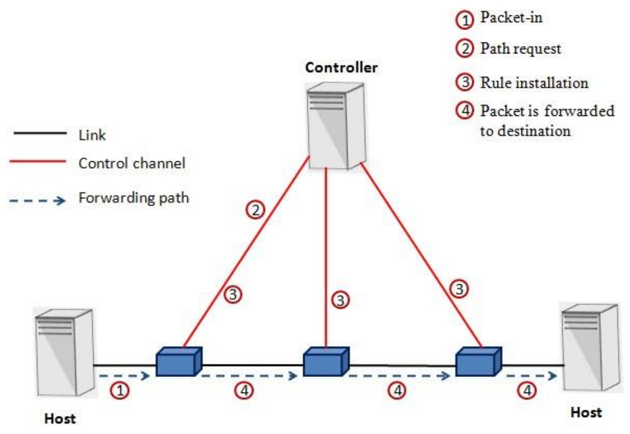

Fig.2 Flow Management

1. When packet arrives at the switch or node, it will check its flow table entries. If flow entries are available and matched then packet will be forwarded according to the action associated.
2. If packet does not meet, it shows table miss. In that case, open flow allowed switch should send the request to the controller by encapsulating the packet.
3. In the acknowledgement controller will install the rules into the switch by sending flow-mods message which are used to adapt the content of flow tables. Rules can be added either proactively or reactively. In proactive way, the controller add rules before packet goes into the network. In reactive way, the controller responds to the request if flow entry missed.
4. After rule addition, packet is forwarded to the destination.

When matching entries present into flow table, there is no need to further contact with open flow controller. As open flow enabled switch have knowledge of how to treat the flow as shown in Fig. 2.

V. DATA DESSIMINATION

The novel problem of cooperative data scheduling (CDS) is formulated. Vehicles travels at high speed and for a short duration of time, they will stay in the area of RSU. Hence, scheduling of data is very critical for serving more requests and reducing delay. For accessing the data in vehicular environment, scheduling plays an important role.

Logic behind CDD is as follow

- Identify conflicting nodes
- Select best nodes among the tree.
- Send data

For cooperative data dissemination (CDD), firstly number of nodes for the cooperation are selected here k=2 i.e. nodes for cooperation, according to the calculated distance of destination node. The selection of best cooperative node is done on the basis of calculated factor which is the ratio of distance to the energy of a node. Calculated factor should be less than a calculated distance of a destination node. These best nodes are connected to forward data to the destination.

Peer to peer (P2P) network will be formed when two or more nodes will link and share resources without using the separate server computer as shown in Fig 3. Peers have the equal importance and are potential participants in the application. It form a P2P network of nodes. In P2P enabled CDD, when the source node start sending data to its cooperative node, the first cooperative node will also start forwarding it to second node and followed by to the destination without waiting for complete data to come to them. This way it took less time than CDD algorithm. So the service delay is less along with efficient service ratio and gain of scalability.

VI. SIMULATION RESULTS

To examine the CDD and P2P enabled CDD algorithm mechanism, it is analyzed with different number of parameter such as service delay, service ratio, and gain of scalability. In this mechanism, NS2 is used (Network Simulator 2) to simulate our protocol, the various simulation parameters setting are shown in Table 2:

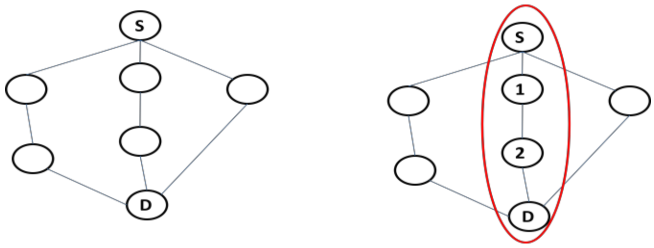

Fig.3: Tree diagram

Table 2: Simulation Parameter for varying no. of nodes

Simulation Parameter	
Simulator	NS- 2.34
Simulator Area	300m * 300m
Packet Size	1000bytes
Mac type	Mac/802_11
No. of nodes	30
Interface	queue /drop tail
Maximum Packet in ifq	50
Packet Interval	0.01 sec
Stop Time	nn+3

We have placed the number of vehicles equals to 30 and the controller is placed at the middle lane of 3lane's road for the efficient conduction of data. Node no. 30 as a controller is placed at 150 meter in y direction. In this we generate the total area for simulation equals to 300 meter *300 meter. Total area is divided into 3 lanes of 100m each and vehicles are shown in blue green and red colored accordingly. For the proper receptions of data packet the server is placed at the middle lane. The controller is static in nature and all the remaining nodes i.e. vehicles are dynamic in nature.

A. Service Delay

Fig. 4 shows difference in service delay due to the difference of number of no. of communications between vehicles. Service delay measures the waiting period of served requests that is the duration from the time when the request is submitted to the time when the required data is retrieved.

P2P enabled CDD algorithm requires less time than CDD algorithm to serve the request. All the served requests are used to derive the mean service delay .

So from the simulation result we conclude that for the better performance of the system time required to serve the request placed should be less or delay should be as low as possible. In case of P2P enabled CDD service delay is reduced as compared to CDD with the increasing no. of communications.

B. Service Ratio

The Fig. 5 shows difference in service ratio due to difference in number of communications among vehicles. Service ratio is given by ns/n , where ns is the ratio of total number of served requests and n is total number of submitted requests if traffic density will increase then the service ratio of above mentioned algorithms will be higher which is explained as follows:.

Fig.4: Service Delay

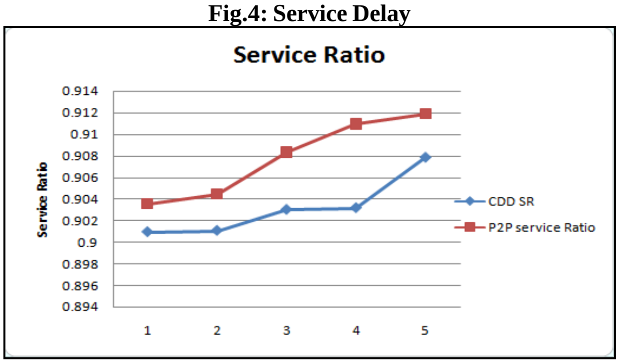

Fig.5: Service Ratio

At low traffic density, even though the vehicles travel with high velocities through the service region, the system will attain good performance as the number of total submitted requests are less. When the traffic density increases, the velocities of vehicles decreases consequently. More number of requests will decorate the performance, which will decrease the service ratio. As the vehicle velocities goes on decreasing in a high traffic density scenario , the dwell time of vehicles increases progressively which is affecting the performance. Service ratio is more in P2P enabled CDD as compared to CDD algorithm. From the simulation result it is found that this ratio of the requests should be as high as possible which shows better efficient system. So we conclude that the service ratio of P2P enabled CDD is achieved that shows good efficiency in disseminating data as compared to CDD.

C. Gain of Scalability

The gain of scalability is the total number of vehicles that are served via either I2V or V2V communication in a scheduling period it is shown in Fig. 6 . If given the data item Di(t) transmitted from RSU, in I2V communication and Dv(t) be the data item transmitted via sender vehicle in V2V communication and RV is the set of receiver vehicles.

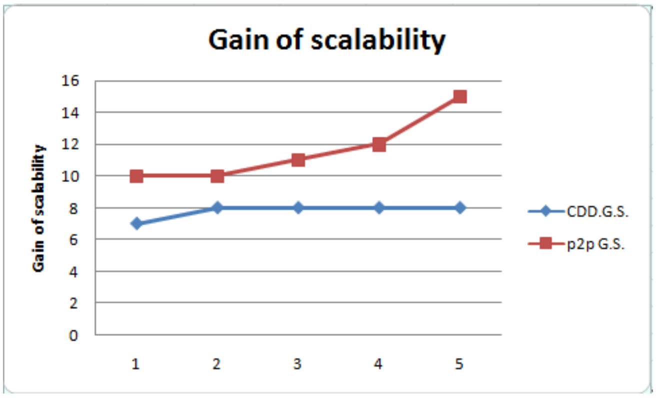

Fig.6: Gain of Scalability

Then gain of scalability G(t) would be computed as

$$G(t) = [RV(Di(t))]+[RV(Dv(t))]$$

From the simulation result it is found that as the number of communications increases more vehicles are served. So from the simulation result we conclude P2P enabled CDD has served more request than CDD shows the better performance of the system.

VII. CONCLUSION

The Software Defined VANET architecture is designed. Simulation results demonstrates that the use of SDN in VANET simplifies the vehicular communication. Data dissemination system is presented with CDD algorithm . Performance of proposed algorithm is evaluated on the basis of various parameters such as service ratio, service delay, gain of scalability. The peer-to-peer network is used in CDD to enhance data dissemination performance. The simulation results shows that comparison of CDD algorithm with P2P enabled CDD is improved under varying traffic of different number of communication . From the simulation result it is observed that CDD applied with P2P network takes less time to transmit data therefore service delay is less. Service ratio is more as compared to CDD means more efficient network utilization. Gain of scalability is also improved . System performance is improved by improving CDD with P2P.

In future , CDD may be improved using innovative techniques. This work will be further carried out by considering the set of RSU along with centralized controller environment . Further addition of rules by controller will help to improve dissemination of data. The technological development will stimulate new applications aiming to improve the SDVAN architecture and transmitting strategies.

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