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DIRECTION AND TRAJECTORY BASED DATA HANDOVER ALGORITHM (DTBD) FOR BUS VEHICULAR NETWORK

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Abstract

VANET is a promising communication technology that enables communication among V2V and V2I for improving driving safety and efficiency. In VANET, data transfer is done with the help of multi-hop communication in which vehicles act as data carrier. Intelligent Transportations System (ITS) has deployed a no of RSU (Road Side Units) along the roads to collect and deliver traffic information from TCC (Traffic Control Centre) to the vehicles. This paper proposes a data handover algorithm called Direction and Trajectory-Based Data handover (DTBD), tailored for Bus Vehicular Adhoc Network(BUS-VANET).The key idea of DTBD is to effectively utilize the direction and trajectory ie., moving path of smart vehicles provided by GPS-based navigation systems. Through theoretical analysis and extensive simulation, it is shown that our handover algorithm provides significant performance improvement in terms of packet delivery rate and throughput under a variety of vehicular traffic conditions.

Keywords- VANET, BUS-VANET, IVC, ITS, RSU, Vehicle trajectory, DTBD

I. INTRODUCTION

Recently, it has been widely accepted by the academic society and Industrial Corporation that the cooperation between vehicles and road transportation systems can significantly improve driver's safety and road efficiency. Vehicular Ad-hoc NETwork (VANET) is a subgroup of Mobile Ad-hoc NETwork (MANET), where communicating nodes are replaced by moving vehicles. It is an important component of ITS. Recognizing its importance, IEEE has approved a standard 802.11p for Wireless Access in Vehicular Environment (WAVE) in 2009. Much work has been conducted to provide a common platform to facilitate inter-vehicle communications (IVCs). IVC enables the service of exchange and distribution of data IVC is necessary to realize traffic condition monitoring, dynamic route scheduling, emergency-message dissemination and, most importantly, safe driving. In VANETs, [1] vehicles can able to communicate each other (V2V, Vehicle-to-Vehicle communications) also they can connect to an infrastructure (V2I, Vehicle-to-Infrastructure) to get some service like accident alerts, traffic alerts, road condition and weather information. This infrastructure called Road Side Units (RSU) is located along the roads to ensure service coverage. Nodes in VANETs are highly mobile, thus the network topology is ever-changing. Accordingly, the communication link between two vehicles suffers from fast variation, and it leads to disconnection due to the vehicular movements. Fortunately, the vehicle mobility can be predictable along the road because it is subjected to the traffic network and its regulations. In general, VANETs [1] have a normally higher computational capability and higher transmission power than MANETs. The vehicular communication [5] for the driving safety and efficiency has been feasible through the standardization of Dedicated Short Range Communications (DSRC) as IEEE 802.11p in 2010. IEEE 802.11p [5] is an extension of IEEE 802.11a, considering the features of vehicular networks, such as the high-speed mobility and high node density in roadways. As an important trend for the vehicular-based networking, Global Positioning System GPS-based navigation systems [5] are popularly used by drivers.

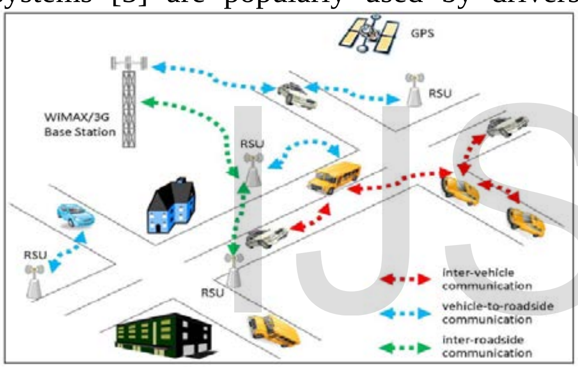

Fig 1: Architecture of VANET

Fig. 1 shows the components and communications with a typical VANET. In a typical VANET, Vehicles communicate with each other through V2V communication in an Ad hoc network fashion, and V2I communication through road-side-units (RSU) and mobile broadband (e.g. 4G/LTE). OBUs (On Board Units) of various vehicles form a mobile ad hoc network (MANET). OBUs and roadside units together will form an ad-hoc network. An RSU can be attached to an infrastructure network, which in turn can be connected to the Internet. RSUs can also communicate to each other directly or via multi-hop. RSUs allow OBUs to access infrastructure and the internet. The summary of the related work of vehicular networking is elaborated in section II. This is followed by a brief description of BUS-VANET architecture in section III. Then the proposed handover algorithm and its working are provided in section IV. The performance of proposed handover algorithm is evaluated in Section V. Section VI concludes with suggesting the extension of proposed work.

II. RELATED WORK

Most of the data forwarding schemes in VANET are designed aiming at building a path with a shorter delivery delay from a source to a destination vehicle. The delay of data forwarding between each hop is very small while most of the latencies can be potentially caused by the *carrying* delay. Vahdat et al. and Becker et al. proposed a routing algorithm with a transmission model in a partially connected MANET [17] in order to maximize the delivery rate and minimize the delivery latency. They introduced the idea of the *carry* and *forward* which is used in dealing with frequent network partitioning and merging. Packets can be forwarded if there are nodes nearby. Otherwise, the packets have to be carried until the carrier reaches neighboring nodes in its communication range. However, this protocol is not specifically designed for VANET and ignored the fact that the trajectory of a moving vehicle. In order to modify the model and let it become suitable for VANET, Zhao et al. and Cao et al. proposed a data forwarding scheme and constructs a link delay model called vehicle carry-and-forward model (VADD [4]). Based on the traffic density, VADD decides which portion of the street that data will be forwarded and which portion of the street that data will be carried. The VADD [5] does not use the vehicle trajectory available for a better forwarding metric computation. TSF is a trajectory based data forwarding scheme to select an RSU as the target point in VANET, which is proposed by Jeong et al. In [2]. Jeong et al. Also proposed the trajectory based statistical forwarding scheme (TBD) for finding the vehicle as the next hop to minimize the delivery delay from a vehicle to an RSU [13]. Xu et al. designed a shared trajectory based forwarding scheme for V2V transmission [4] which used the predicted encounter graph to minimize the delivery delay. However, these trajectory based data forwarding schemes are hard to be realized in the real-world since people may not want to share their own trajectories considering the privacy issue. The concept of using public transportation for data delivery has been considered nowadays. Wong et al. proposed architecture of BUSNet. They attempted to take advantage of public transportation with predictable routes for improving the inter-vehicle communications. The basic idea of BUSNet is to build the data forwarding path by buses for two vehicles that are geographically far away. If two vehicles are far away from each other, then the package delivery will be finish by buses instead of common vehicles.

III. PROPOSED BUS-VANET ARCHITECTURE

The proposed two-tier BUSVANET is fully integrated with RSUs and TCC as traffic infrastructures. The two tiers are named as a low tier and high tier. The high tier is composed of high bandwidth vehicles like BUS [12]. And the low tire is composed of low bandwidth vehicles like a car. In this new architecture, the communications of vehicles, not only benefit from the existence of scheduled buses but also consider the effects of using RSUs and TCC [17]. RSUs are used to ensure network coverage while TCC is helpful for locating the destination vehicle quickly.

To get data delivery service, each vehicle needs to register with a nearby Bus or RSU directly or through multi-hop communication. High-tier nodes [17] (buses and RSUs) occasionally broadcast beacon messages containing their locations and speeds. Vehicles that received such messages need to broadcast these beacons and chooses one high-tier node to finish its registration.

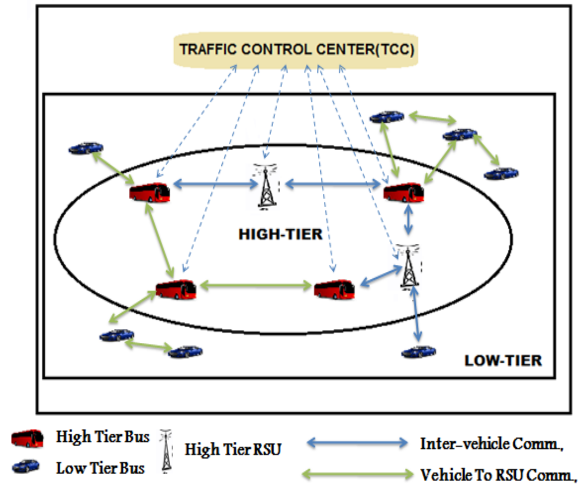

Fig 2: The proposed BUS-VANET Architecture

All the beacon messages must have a lifetime that indicates whether it is still active or not. If a beacon message exceeds its lifetime [14], it will be ignored by the received vehicles and no longer be transmitted. When a low tier node loses connection to its current registered BUS or RSU [13], it needs to switch to another high-tier node for getting further delivery service.

IV. HANDOVER ALGORITHM

Handover generally occurs when a vehicle or user switches from serving base station [16] to another neighboring base station. It usually depends on the signal strength of the base station.

When the user/vehicle moves away from the serving base station the intensity of the signal strength [8] decreases, once its signal value reaches the threshold value the handover process comes into the role. At this point the user/vehicle analysis [9] the signal strength of all the neighboring base stations and then select the target base station based on a specific metric for handover.

A. PROPOSED DIRECTION AND TRAJECTORY BASED DATA HANDOVER(DTBD) ALGORITHM:

The goal of DTBD handover algorithm is to reduce the handover latency in a vehicular environment. The scheme considers a normal traffic scenario on the city in a two lane road, whereby some buses are within the transmission range of the low-tier vehicle, some buses moving in opposite directions to the destination and few buses moving towards the destination. The bus with the smallest delivery delay [15] and shortest distance to the destination will be selected as the registration node from the candidate set.

ALGORITHM:

R= Registration set; **D**=Discard set; **b(i)=**Bus, i=1,2,...n;

d_t= Direction towards destination; **d_o**=Direction opposite to Destination;

T = maximum delivery delay can be tolerated;

while atleast one entry in R

do

compute moving direction ‘d’ for bus and vehicle that has been checked

compute and record delivery delay ‘t’ for each bus b(i)

for every bus b(i) do

if d(b(i))==d_t then,

put this node into R;

if d(b(i))==d_o then,

put this node into D;

end for

if [d(b(i))== d_t && d(b(i+1))= d_t] // case 1 : more bus moves towards destination

for every bus b(i) do

d_1 = distance between x initial position and desti., pos

d_2 = distance between x current position and desti., pos

if $d_1 > d_2$

put this node into R;

else if $d_1 = d_2$

if $t < T$

put this node into R;

end if; end else if;

else

put this node into D;

end for; end if;

else if [d(b(i))== d_o && d(b(i+1))= d_o] // case 2 : more bus moves opposite to desti.,

for every bus b(i) do

if $t > T$

Put this node into D;

else

Put this node into R;

end for;

end else if; end while;

if R has more than one bus then

REG = one with smallest delivery delay && low d_2 value in R;

else if no bus in R then

REG = one with smallest delivery delay in D ;

else

REG = the only one bus in R;

if no bus in R then

REG= select RSU

return REG;

V. SIMULATION RESULTS

In order to evaluate the proposed handover algorithm with realistic traffic flows on a realistic road system, we have implemented the handover method on the traffic flow simulator SUMO [17] and the network simulator NS2 [11], [12]. Then we have conducted a simulation to confirm if the proposed handover algorithm can select next registration node more efficiently than our previous work without buses.

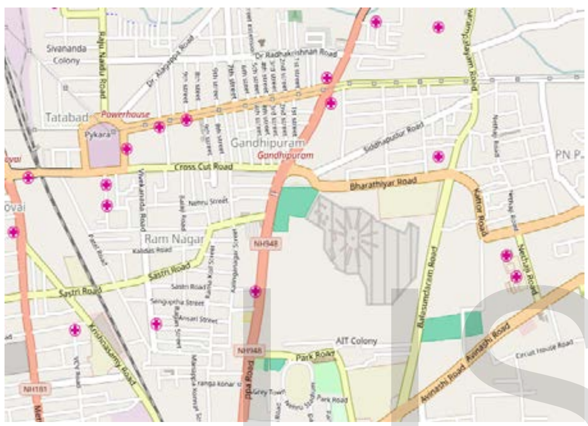

Fig 3: Map of Downtown GANDHIPURAM and Bus System

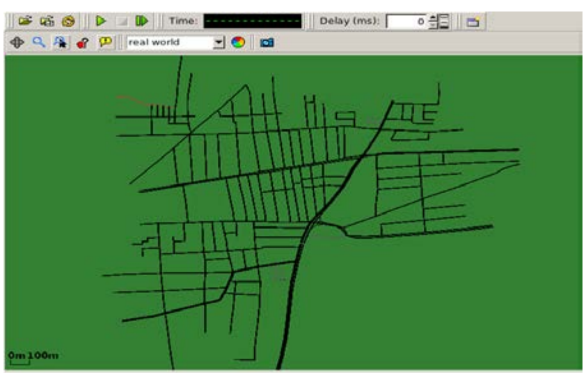

Fig 4: Translated Map in Simulation.

SUMO is a microscopic traffic simulation. Each vehicle is given explicitly, defined at least by an identifier (name), the departure time, and the vehicle's route through the network. If wanted, each vehicle can be described more detailed.

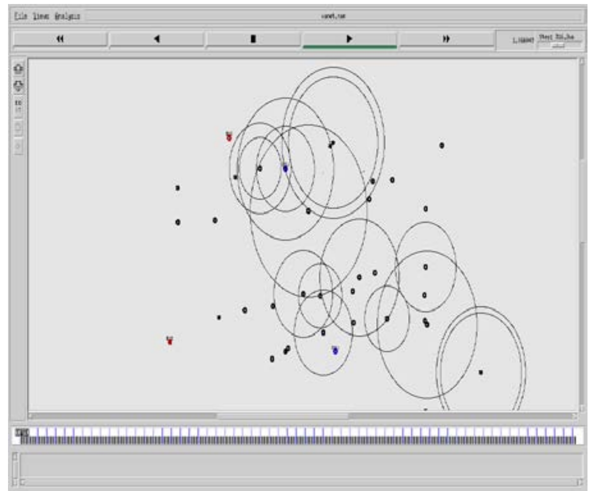

Fig 5: Broadcast of beacon messages

The departure [9] and arrival properties, such as the lane to use, the velocity, or the position can be defined. Each vehicle can get a type assigned which describes the vehicle's physical properties [5] and the variables of the used movement model. Each vehicle can also be assigned to one of the available pollutant or noise emission classes. Additional variables allow the definition of the vehicle's appearance within the simulation's graphical user interface.

VI. PERFORMANCE ANALYSIS

i. Throughput Vs No of vehicles :

The throughput is calculated by using the AWK [7] program. It is an interrupted programming language designed for text processing. The delivery rate comparison of registration time based handover and DTBD handover algorithm is shown in fig 6. The throughputs under various packet sizes are considered as CBR are: 15000, 20000, and 25000. From the graph we can conclude that the throughput and the size of CBR packets are related exponentially. As the no of vehicles increases there is increase in the throughput, but by using the DTBD algorithm the throughput get increased by 1.2 % comparing to the performance of existing registration algorithm.

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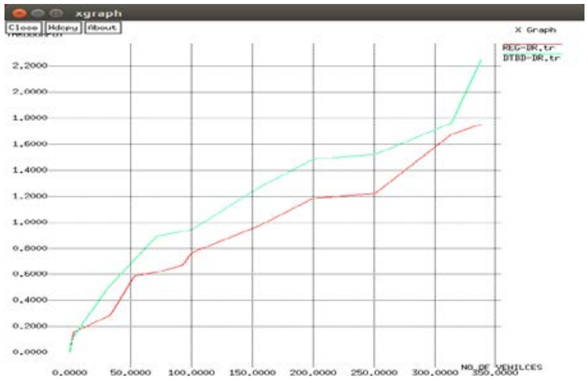

Fig 6: Throughput Vs No of vehicles

Handover Delay Vs Packet Loss

Fig 7 represents the number of packet lost during the handover course of action, while the CBR packet size is held constant at 15000 bytes, speed of the vehicle is also set constant. Thus there will be more number of packets lost. Another factor which influences the data packet loss is the length of disconnected period. We observe from the graph that the number of lost data packet increases as the number of vehicle increases because in reality the more there are vehicles doing handover the more packets are sent and increased probability of dropped data packets. As throughput is made independent of the vehicle speed, data packet loss is reduced.

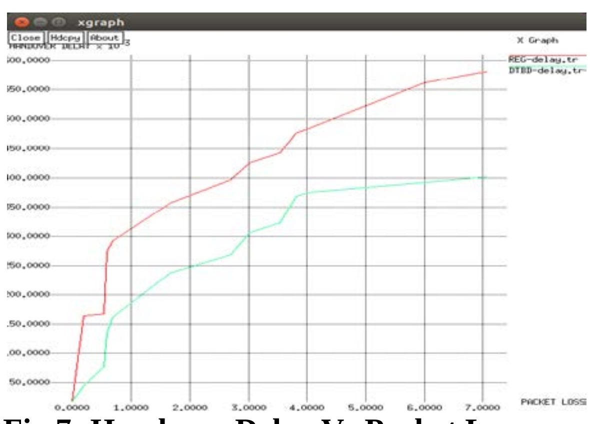

Fig 7: Handover Delay Vs Packet Loss

VII. CONCLUSION

Data handover is one of the important parameters in vehicular communication. In this paper, we propose a new two-tier BUS-VANET that fully integrated with traffic infrastructures for improving the performance of VANET. Comparing to traditional handover, better performance of our proposed handover DTBD BUS-VANET can be achieved with less delivery delay and higher delivery rate. From the performance results, the VANET network implemented has many important applications such as collision control etc. But the actual handover in a VANET has large handover delays which produce several network degradation. It had overcome by the implementation proposed handover algorithm, which is based on the direction, trajectory information and architectural design of proposed BUS-VANET.

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