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Performance Evaluation for High Speed Vehicle in VANET

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Abstract

Vehicular Ad hoc Networks (VANETs) is a high dynamic emerging technology for supporting wireless communication among vehicles. Communication via routing packets over the high-speed vehicles is a challenging task. Vehicles mobility speed can varies depending on the road specification. However in highways speed can be increased up to 120 – 200 Km/hr. moving in high speed can affect the efficiency of data delivery. In particular V2I traffic where moving car trying to deliver data to fixed space units which are designed to collected and process data from vehicles. In this paper, we investigated the consequences on increasing vehicle mobility speed in term of data delivery evaluation metrics including network throughput, delay and packet delivery ration. Results shows that in high speed mobility VANET, network throughput it decreased, and packet delivery ration is decreased as well.

Keywords: About; Vehicular Ad hoc Networks, performance evaluation, speed, mobility

INTRODUCTION

Recently, Vehicular Ad-hoc Networks (VANET) becomes more popular and widely deployed all over the roads across the world. Most of modern cars are equipped with Wireless modules which provides vehicles to communicate with each other's and with communication control points [1]. Enhancing Inter-Vehicle communication and roadside communication are considered as the most popular wireless communication research topic. VANET allows road vehicles to notify other vehicles about traffic jams, sudden stops and other hazardous road conditions[2]. The huge number of expected benefits of VANET and number of supporting vehicles are likely become the most realized implementation of mobile Ad hoc networks Short range IEEE 802.11 can be used for vehicles communications using suitable radio interface technology[3]. However a new slandered for both physical and MAC layer has been developed to meet the requirement of communication between vehicles, IEEE 802.11p [4] is an approved amendment to the IEEE 802.11 standard which provides Wireless Access in Vehicular Environments (WAVE). Enhancements were applied to 802.11 to support the applications of the Intelligent Transportation Systems[5].

The navigation systems availability of on each vehicle allow it to recognize geographic location in addition to its neighbors. On the other hand, Geographic Routing which is a specific type of routing approach, becomes possible where choosing a neighbor who is geographically closer to that destination where frames are simply forwarded to a destination. With the vehicles rapid growth and increasing number of roadside traffic monitors, the enhancement of navigation systems, and the wireless network devices low cost promising peer-to-peer (P2P) applications and externally driven services to vehicles became available. For this purpose, the Wireless Access in Vehicular Environments (WAVE) standards is proposed by the Intelligent Transportation Systems (ITS) to define an architecture which enables vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) wireless communications collectively [6].

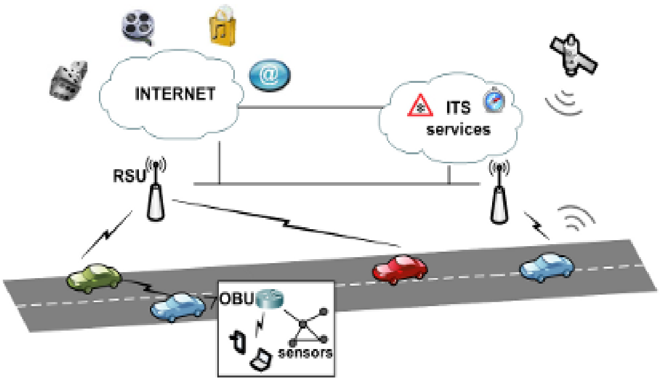

Figure 1. VANET Network Communication

In this paper we investigate how can vehicle speeds can affect the performance of data delivery in term of data communication performance metrics like throughput, end to end delay and packet delivery ratio.

The rest of this paper is organized as follow: In section 2 related work is presented, section 3 illustrated the simulation scenarios for data delivery performance evaluation, section 4 illustrate the results measurement and analysis and finally a conclusion is presented

RELATED WORK

In VANET, different issues are consider critical and particularly for safety application where data delivery is critical and may threat human lives. Authors in [7] provide performance evaluation for using dedicated short range communication standard (DSRC) in data delivery for VANET communication , the new DSRV standard solution provide a multi-channel which can server multiple application types and provide high performance for future VANET communication . Performance evaluation include different communication parameters including throughput, collision probability and delay. Different scenarios have been built to simulate different scenarios and analyze results. Performance evaluation shows that new standard can prioritize data packets, however for dense and loaded scenarios. Network throughput has been decreased significantly and delay has been increased as well.

A cooperative collisions avoidance CCA for highways has been investigated in [8] for VANET where vehicular safety application has been emerged widely. Proposed approach has been designed depending in IEEE-and ASTM adopted Dedicated short range communication DSRC standard the implementation requirement of CCA have been presented. the performance evaluation of VANET network using CCA was built using simulated vehicle crash experiments .depending on the experimental results the performance sensitivity of CCA for unreliable wireless communication channels was discussed.

VeMAC which is a medium access control protocol which support an efficient single-hob broadcast services has been proposed and evaluated in [9] it mainly designed for VANET high priority data of safety applications. The measured performance metrics include service delay which has been measured using D/G/1 and M/G/1 queueing systems which are mainly estimate the average queueing delay of the safety message which are periodic and event-driven . a real city traffic scenario has been considered and other different network scenarios has been measured including network good put , channel utilization , protocol fairness, protocol overhead. Collision probability and message delivery delay.

A performance evaluation for VANET using LTE and IEEE 802.11p has been proposed in [10]. A detailed study of performance evaluation for both standards for different parameters configuration including vehicle density and transmission frequency. Different performance evaluation considerations have been checked including reliability, mobility support, delay and scalability for different VANET applications context. Intensive simulation experiments have been implemented to evaluate the standards effectiveness. Results indicates that 802.11p provides acceptable performance for sparse network topologies. On the other hand, LTE meets most of the application requirements in terms of reliability, scalability, and mobility support; however, it is challenging to obtain stringent delay requirements in the presence of higher cellular network traffic load.

In this paper , investigation is performed to find out how vehicle speed changing can reflect in term of communication performance. The mechanism of data delivery can be affected in case of frequent distance changes away from the road side unit where data is delivered. Different vehicles speed need to be measured to cover a wide range of vehicles possibilities. .

SIMULATION TOPOLOGY

To evaluate the performance of VANET , a real simulation environment is need to be built. In this study a real high way has been selected. We have utilize the openstreetmap (OSM) project [11] . OpenStreetMap (OSM) is a collaborative project to create a free editable map of the world. The creation and growth of OSM has been motivated by restrictions on use or availability of map information across much of the world, and the advent of inexpensive portable satellite navigation devices. Rather than the map itself, the data generated by the OpenStreetMap project is considered its primary output. The data is then available for use in both traditional applications.

In this study we have selected the map which has the address of High Speed Way, Wilmington, New Castle County, Delaware, 19801, United States of America. The coordination of the used map is -75.5875 * -75.5348 H and 39.7272 / 39.7096 V. Figure 2. illustrate the details of the selected map.

Figure 2. High Speed Way, Wilmington Simulation Map

Exported osm file is then input to SUMO simulator to generate traffic simulation, the first step is to generate the traffic network where vehicles can drive. After that the vehicles trips is generated by specifying the required time of the simulation. Finally SUMO create complete simulation file which include all vehicles, paths and trips details for each vehicle depending on the provided map.

A python based script is then used to translate SUMO simulation file to an NS2 mobility and NS2 configuration files.

In NS2 simulator the mobility speed of vehicles is adjusted at the mobility file, a grid of road side units is inserted in the network to cover the whole simulation area. Data are forwarded to the central communication location for storing and processing.

Figure 3. illustrate the location of the vehicles in the simulating network before inserting the RSUs

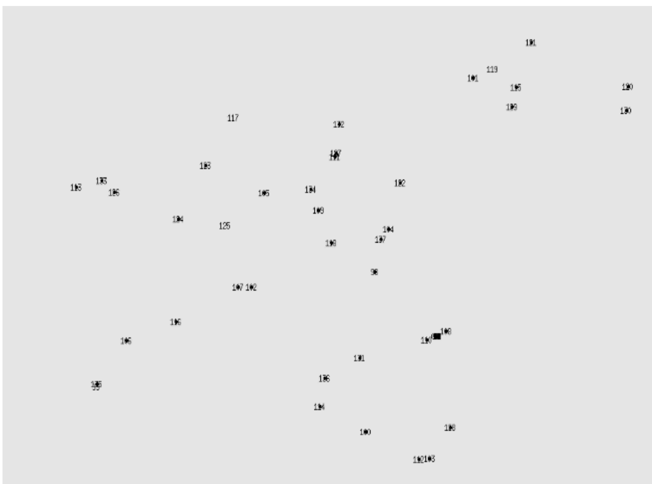

Figure 3. NS2 simulation network before adding RSUs

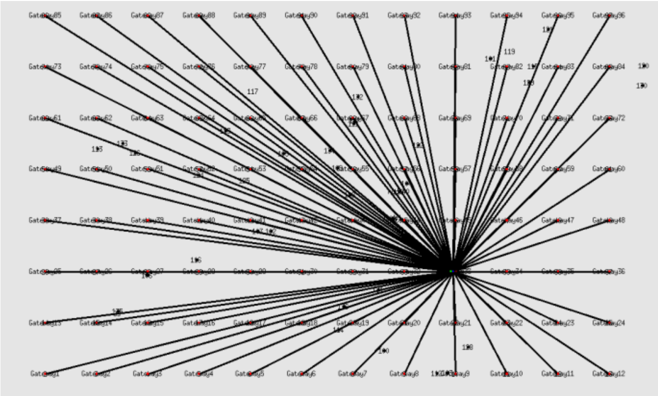

Figure 4. Simulation network after adding RSUs

Simulation parameters

The network simulation parameters which assigned to network nodes are listed in Table 1, different simulation scenarios have been implemented using different simulation times. Different vehicle speeds have been simulated and performance comparison have been investigated.

Table 1. Netwrok Simulation parameters values

Parameter	Value
Channel type	WirelessChannel
Radio-propagation model	TwoRayGround
Network Interface Type	Wireless Phy
Antenna type	OmniAntenna
Interface queue type	DropTail/PriQueue
Maximum packet in Queue	50
MAC type	802_11
Topographical Area	13000 x 13000 sq.m
Routing protocols	DSDV
Number of mobile nodes	40
Simulation Time	60 seconds
Data Flow	CBR
Packet Size	256 byte
Data Bit rate	0.5 MB/s
Vehicle speed	10,20,30,40,50,60,70,80,90,100, 110,120,130,140,150,200 Km/h

Performance metrics

Different evaluation metrics can be measured including:

End to End Delay

The end-to-end delay represents the average amount of time which is taken by each vehcile packets to traverse the path from vehicle to other vehicle or RSU. End to End delay is accumulative of different network delay types. It mainly include processing delay for buffering delay, route discovery and intermediate node forwarding delay. E2E delay is considered as a significant network performance indicator where small values E2E delay represents better network performance. Increased delay can caused by routing overhead or links failure. To estimate the average E2E delay for a network, the following equation is used,

$$T_{E2E} = \frac{(T_R - T_S)}{number\ of\ packets}$$

Where, T_{E2E} is the Average End to end Delay, TR is packets received time at destination node, TS is packets sent time from source node.

Packet Loss

Packet loss is obtained by subtracting the number of packets received at Access Point from the total number of packets transmitted.

$$Packet\ lost = \sum transmitted\ Packets - \sum received\ Packets$$

$$Packet\ loss\ Ratio = \frac{(Packets\ losts * 100)}{\sum transmitted\ Packets}$$

Network throughput

Throughput referred to the vehicles packets number which are correctly delivered over the network for a specific time. To measure throughput put for a link between two nodes total number of packets that have been successfully delivered to the desired nodes are counted. Increasing throughput values is a great indicator for enhanced performance. It is measured in bits per second (bit/s or bps). Throughput can be represented mathematically as in equation below

$$Throughput = \frac{no.of\ delivered\ packet * packet\ size * 8}{total\ simulation\ time}$$

RESULTS MEASUREMENT AND ANALYSIS

The estimated results of the experimented various main scenarios of different speeds is shown in the following diagrams.

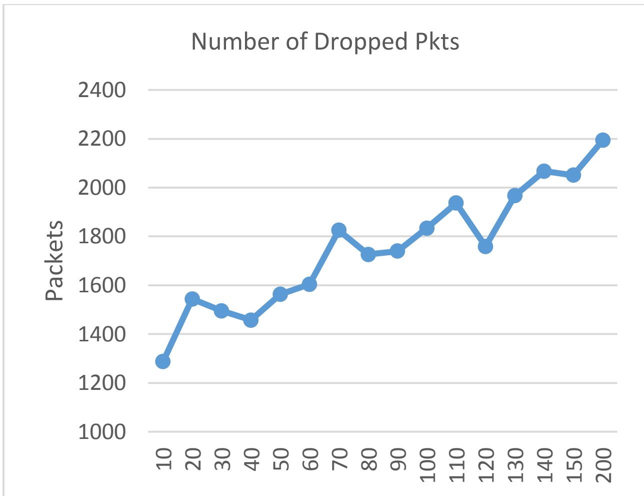

Figure 5. Packet dropping rates

When the vehicle mobility speed is increased the rate of dropping packets is increased as illustrated in Figure 5 on the other hand, the network throughput is decreased as the speed of the vehicles is increased as illustrated in Figure 6.

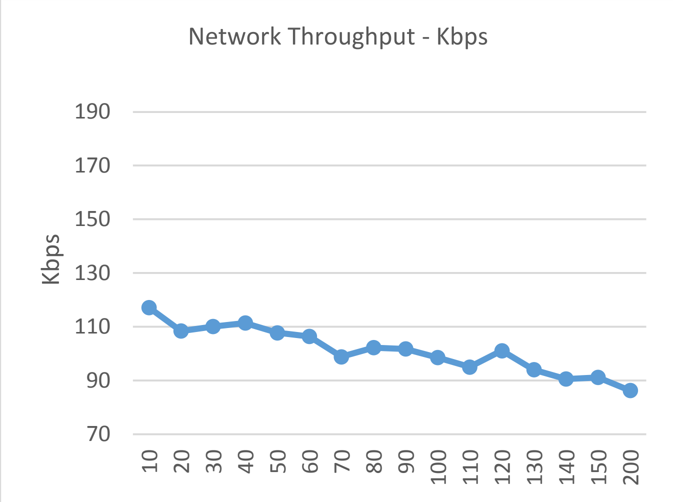

Figure 6. Network throughput of different vehicles speeds

The network end to end delay is illustrated in Figure 7, the end to end network delay is decreased When the vehicle speed is increased.

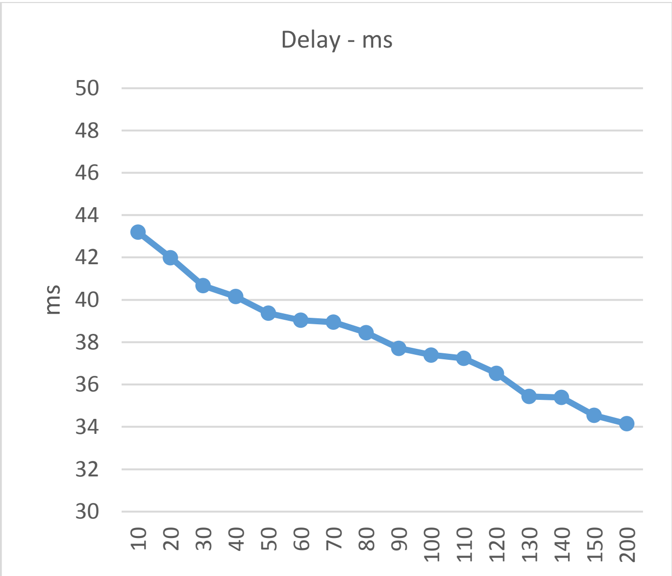

Figure 7. The end to end delay of vehicles network

As shown in Figure 8, the received packets is decreased when the speed of the vehicles is increased, which indicate that higher speed vehicles suffer from decreased data delivery efficiency than lower speed vehicles.

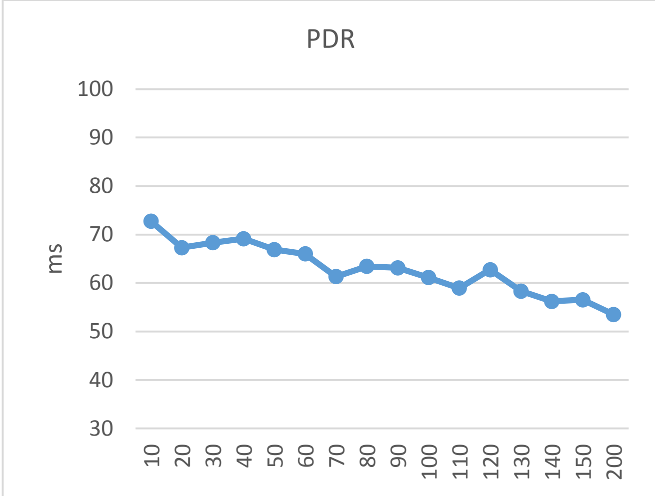

Figure 8. Packet delivery ratio of different network vehicles speeds

CONCLUSION

This paper present performance evaluation of VANET for high speed vehicles mobility model. A real environment based simulation scenario has been built where different vehicle speed have been simulated , to evaluate the performance various data delivery evaluation metrics have been measured including network throughput ,network relay and packet delivery ratio. Results shows that when the vehicles speed is increased, the network throughput and packet delivery ratio is decreased which indicate degraded performance where packet loss has been increased when the vehicle mobility speed is increased.

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