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Performance Analysis of MANET and VANET based on Throughput Parameter

[1]Omkar Pattnaik and [2]Binod Kumar Pattanayak

[1] *Assistant Professor, Department of Computer Science and Engineering, Nalanda Institute of Technology (NIT), Bhubaneswar, Odisha, Postal Zip-754005, India.*
[1]Orcid Id: 0000-0003-2804-1595

[2] *Associate Professor, Department of Computer Science and Engineering, Institute of Technical Education and Research, Siksha 'O' Anusandhan University, Bhubanweswar, Odisha, Postal Zip-751030, India.*

Abstract

The Quality of Service (QoS) provides a better performance in networking environment like MANET and VANET in the current development scenario. In these fields the topology is dynamic in nature changing frequently with respect to time. Thus it creates many challenging issues too. In this paper, we have investigated the performance of MANET and VANET based on QoS, where throughput is taken as the desired parameter. We have also compared the results obtained with MANET and VANET based on their respective standard IEEE 802.11 and IEEE 802.11p respectively by simulation study. The performance of VANET with IEEE 802.11p standard achieves the higher throughput than the MANET with IEEE 802.11 standard.

Keywords: Quality of service (**QoS**), Mobile Ad hoc Network (**MANET**), Vehicular Ad hoc Network (**VANET**), Topology.

INTRODUCTION

In the current scenario, the communication based on the wireless medium is on demand unlike the other media. This technology is widely used in mobile communication such as MANET (Mobile ad hoc network). MANET is a self configuring dynamic network of mobile devices connected via wireless links set for a specific purpose. In recent years, the use of MANET has increased as compared to wired network. The idea based on the concept of MANET is also useful for achieving safety and comfort in communication on road. So the Intelligent Transportation Systems (ITS) was devised where the idea of Vehicular ad hoc network (VANET) was introduced.

The concept of MANET was implemented in vehicular communication in a new form called VANET. We can specify MANET is the super class of VANET. This technology provides vehicle to vehicle and vehicle to roadside or infrastructure communication network. To design this environment we assume that an On-Board Unit (OBU) and a Road-Side Unit (RSU) installed along the roads must be associated with each vehicle. The RSUs and OBUs are required to communicate between them through a protocol called Dedicated Short Range Communications (DSRC).

In VANET, there are three types of communication possible like Vehicle to Vehicle (V2V), vehicle to Infrastructure (V2I) and Infrastructure to Infrastructure (I2I). But Vehicle to Vehicle (V2V) uses Dedicated Short Range Communications (DSRC) protocol. It is maintained purely as an ad hoc network. The main objective of DSRC is to provide low communication delay and high data transfers in the network.[1] The Federal Communications Commission (FCC)organization updated the DSRC protocol to WAVE (Wireless Access for Vehicular Environment) afterwards.

The IEEE 802.11 standard is dedicated for MANET. It provides the information about the node mobility. But it was not suitable for VANET due to high mobility in nature. So the standard that is used to modify and develop an advanced one, is IEEE 802.11b [2, 3]. This standard also creates some challenges for VANET like high mobility, vehicle speed and traffic patterns. Eventually the researchers developed the updated version of IEEE 802.11b, I.e. IEEE 802.11p. This standard works on data link layer and physical layer and, the high speed vehicles can be communicated smoothly using it [4].

To avoid the packet loss and collision between the vehicles, IEEE 802.11p standard uses the Time Division Multiple Access (TDMA) scheme.

In V2V communication, reliable data dissemination is provided by TDMA slots and there is no central control on it. It consists of a 75MHz bandwidth which is allocated to six service channels (SCHs) with one control funnel (CCH) including Ch172, Ch174, Ch176, Ch178, Ch180, Ch182, and Ch184, each spanning 10 MHz bandwidth.[5]

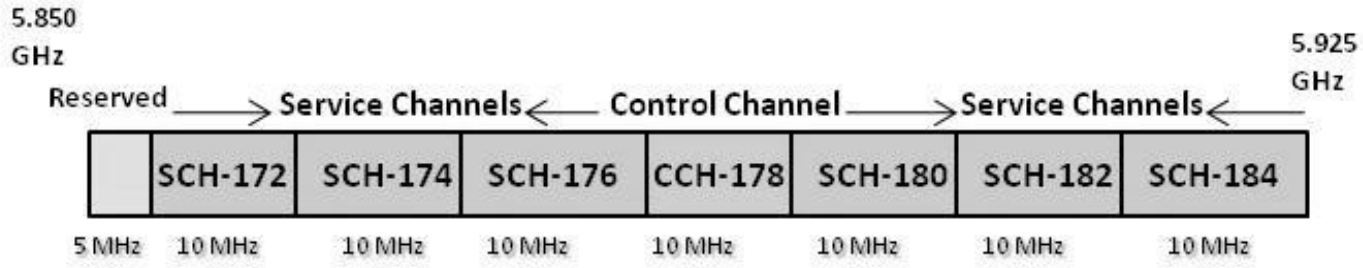

Figure 1: Allocation of DSRC Channels

The user can identify the performance level of a network by the concept of Quality of service (QoS). To utilize the network resources effectively and deliver the information that transfer by the network successfully, will be shown by the deterministic behavior of a network. This is the main objective of QoS. The parameters belong to QoS are required for the communication between the nodes are : bandwidth, throughput, packet loss, jitter and delay etc.

In this paper, we have evaluated the performance of MANET and VANET based on the standards IEEE 802.11 and IEEE 802.11p respectively on QoS. In this case we have taken throughput as the QoS parameter.

The remainder of this paper is organized as follows. In Section 2, an overview of the related work on QoS in MANET and VANET is included. Section 3 details a comparative study of MANET and VANET . section 4 describes the simulation process and result analysis. Section 5 includes conclusion and future work.

RELATED WORK

In the related literature survey it has been observed that the parameters of QoS play an important role in improving the performance of MANET and VANET.

To achieve the guaranteed QoS for the existing protocols used in VANET, a lot of difficulties are raised during implementation. In VANET due to infrastructure less and dynamic properties, challenges appear in achieving guaranteed QoS. The overall performance is measured by a routing protocol which must be aware of the desired QoS [5, 6].

The parameters like throughput, delay and response time are used to enhance the QoS by virtue of a routing protocol performance in VANET which is mentioned in work of authors Gongjun, Rawat and Bista. In VANET the vehicles are mobile in nature that affects its maintenance as well as routing. The author (Subramaniam, Thangavelu and Venugopal, provide an idea that the QoS in VANET is more optimal than MANET [6, 7].

The propagation channel models must be accurate in communication for V2V communications. So this communication must be reliable in nature [10, 11]. Again it is different from cellular communication at the same time [8].

Hiraku, Akira and Kenichi [13]. proposed that due to longer distance in vehicle to vehicle (V2V) communication, the performance of the network based on throughput and packet delivery ratio may tend to degrade. To check this degradation, the authors try to calculate the Expected Progress Distance (EPD) by virtue of choosing the next-hop node among the neighbor nodes.[12].

The authors in [14] explained the features of MANET which are common for VANET environment. Here the authors identify the challenges which may appear in vehicular environment during rural and urban area implementations.

The protocols and mobility models used in MANET are not suitable for urban areas and long distances. So in order to create a new mobility model, attempts are made was mentioned in the survey report. Authors in [15] have tried to solve the issues by using cluster based VANET model.

The authors in [16] provide an idea to enhance the throughput of VANET as compared to that of MANET. In VANET, in order to distribute the information by extending the coverage area and routing of single flow data, the multi hop networking approaches are used.

The low end-to-end packet delays and high throughput rates are essential parameters to deploy the VANET in a successful way and such applications provide efficient results [10]. The authors also focus at the communication between transmitter and a distant node for relaying messages those use repeaters as defined by Urban Multi-Hop Broadcast (UMB) protocol [17].

The parameters required for ideal distribution of information in VANET are:

- Ability to work transparently in the operation of the MAC layer (either contention less or contention oriented MAC is adopted) [17].

- Provide high throughput rate for efficient distribution of Road Side Unit (RSU) flows.
- Extension of coverage area of a RSU.
- Achievement of low end-to-end delivery delays.
- Reduction of broadcast storm problem.

Authors in [17] describe the performance in different environments of VANET like rural area, urban area and suburban areas based on the IEEE 802.11b and IEEE 802.11p standard. The applications of vehicle to vehicle (V2V) and the related research challenges are affected by the above contents, where average delay, throughput and packet delivery ratio are taken as parameters. The authors conclude the concept with specify the advantages of VANET.

Comparative study on MANET and VANET based on QoS

Mobile Ad Hoc Network (MANET) is a self configuring dynamic network of mobile devices connected by wireless links set for a specific purpose.

In MANET, in order to exchange information between nodes which also behave as servers and/or clients are organized in an ad hoc manner. So the rate of data transmission keeps on changing due to mobility and is less reliable than the infrastructure based network [18]. In Vehicular Ad Hoc network (VANET) too, nodes are self-organizing which manage the information in a distributed manner. In this case vehicles act as nodes for the operation.

VANET is a special form of MANET that is distinguished from MANET by different types of characteristics and implementation levels [19, 20].

Different types of characteristics of VANET those differ from MANET are detailed below.

On-board Sensors: As an assumption in VANETs, in order to provide information for routing in the network, nodes are to be equipped with sensors. So vehicle to vehicle (V2V) communication is possible. An on-board system is attached with every vehicle to which a GPS unit is also attached. This unit provides the location information and accuracy of the position [20].

Patterned Mobility: In VANET, the mobility pattern is based on the types of road in rural, urban and semi urban areas, driver's driving behavior and speed limit etc. The protocol used in VANET for routing depends on the mobility and testing is required for simulation work [21].

Highly Dynamic Topology: The vehicles move at a high speed depending on the mobility pattern and frequently change their positions. So the topology used in VANET is dynamic in nature. If the radio range between two vehicles is 125m and vehicles are moving at the speed of 60-70 mph (25 m/sec), then the link between the two vehicles would last at most 10 sec [22].

Unlimited Battery Power and Storage : This is one of the important properties of VANET as compared to that of MANET since in the current scenario, the vehicles move with unlimited battery power. In sensor networks and other classes of ad hoc networks nodes attempt to achieve ample energy and computing power from the resources during communication. So the battery power and storage become challenging in such environments [23].

Frequently Disconnected Network (Intermittent Connectivity):

When two vehicles transmit information between them, the link between the two vehicle is very less or disconnected due to its highly dynamic topology. In VANET separate frequency is designed for different mobility patterns (rural area road, urban area road etc). So if a vehicle changes its path, then there is a chance that it may get disconnected from the network. To resolve this issue a robust routing protocol is required which provides an alternate link for the said problem [22].

In VANET the bandwidth is managed properly and also that is higher than that in MANET. There are some other differences too which are mentioned in Figure 2.

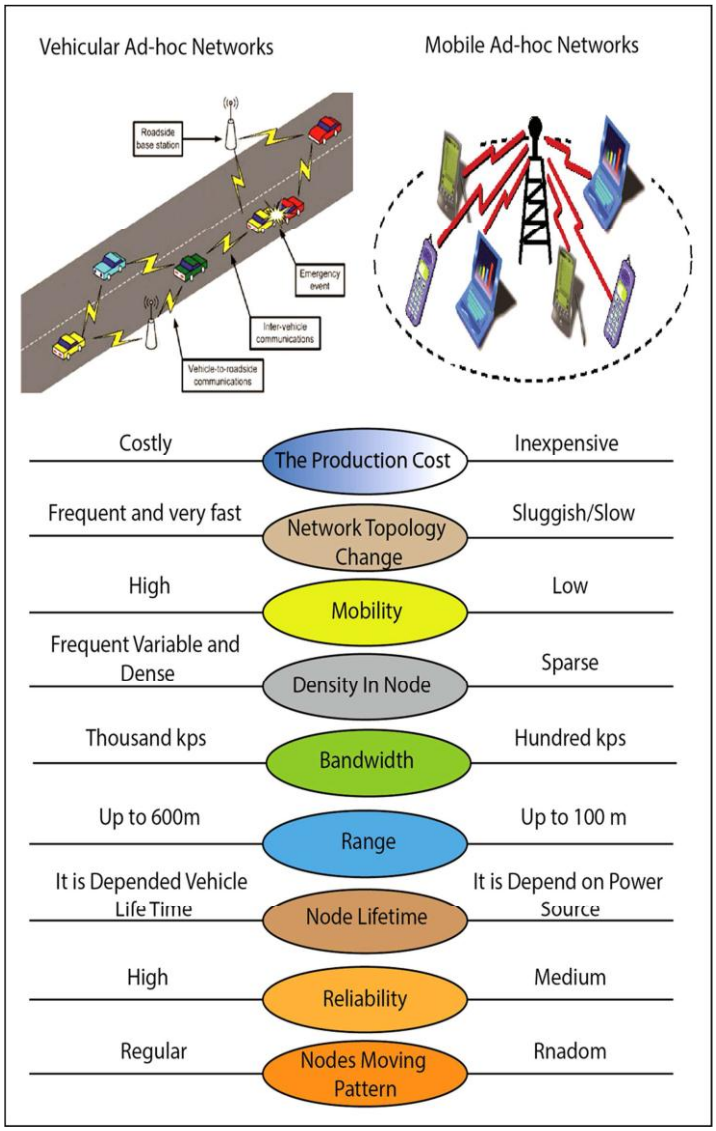

Figure-2: Comparison of VANET with MANET

The performance of the network is determined by analyzing the parameters of QoS. In this paper, we attempt to determine the performance of MANET and VANET based on the QoS with respect to IEEE 802.11 and IEEE 802.11p standards respectively.

The QoS is based on various parameters which are already mentioned in the preceding section of this paper. But here we have considered throughput as our desired parameter. We attempt to study and compare the performance of MANET and VANET based on the IEEE 802.11 and IEEE 802.11p standards respectively by simulation work that follows.

Simulation and Analysis

In this paper by using simulation study we have examined the performance of throughput in MANET and VANET based on IEEE 802.11 and IEEE 802.11p standards respectively. We used the open source network simulator ns-2 with the advanced version ns-2.35 for our implementation work.

Simulation Scenario Setup

We setup a scenario of simulation with 1000m X 1000m area in ns-2.35 version. The NAM (Network Animator) and Tracing Files (TF) are used for both MANET and VANET concepts in NS2 simulation. The simulation based on the IEEE 802.11 standard provides two parameters for MANET which are: Mac802.11 and WirelessPhy. But in VANET two new modules are introduced i.e., Mac802.11Ext and WirelessPhy-Ext based on IEEE 802.11p standard. The IEEE 802.11p standard is represented as IEEE 802.11Ext during simulation work of VANET. To implement the wireless access in vehicular environments (WAVE) a new standard

was developed from IEEE 802.11 standard i.e., IEEE 802.11p. The principle of this standard is to support Intelligent Transportation Systems (ITS) applications [18]. So the exchange of data between vehicle to vehicle (V2V) and vehicle to road side infrastructure (V2I) is possible. The frequency parameter Phy/WirelessPhyExt set freq5.9 GHz (5.85-5.925) represents operation on DSRC band.

The parameters used in ns-2.35 for MANET simulation are summarized in Table 1based on IEEE 802.11 standard.

Table 1: MANET based on IEEE 802.11 standard	
Parameters	Specifications
Network simulator	ns-2.35
Simulation area	1000m X 1000m
Channel type	Wireless Channel
Propagation model	Two Ray Ground
Traffic type	FTP
Simulation time	200 seconds
Visualization Tools	NAM, Tracing
Number of nodes	20,30,40,50,60
MAC Layer	Mac/802_11
Network interface type	Phy/WirelessPhy
Routing Protocol	AODV
Antenna model	Antenna/OmniAntenna
Interface queue type	Queue/DropTail/PriQueue

The parameters used in ns-2.35 for VANET simulation are summarized in Table 2 based on IEEE 802.11p standard.

Table 2: VANET based on IEEE 802.11p standard	
Parameters	Specifications
Network simulator	ns-2.35
Simulation area	1000m X 1000m
Channel type	Wireless Channel
Propagation model	Two Ray Ground
Traffic type	FTP
Simulation time	200 seconds
Visualization Tools	NAM, Tracing
Number of nodes	20,30,40,50,60
MAC Layer	Mac/802_11Ext
Network interface type	Phy/WirelessPhyExt
Routing Protocol	AODV
Antenna model	Antenna/OmniAntenna
Interface queue type	Queue/DropTail/PriQueue

SIMULATION RESULTS AND ANALYSIS

In this simulation scenario we have taken number of mobile nodes to measure the throughput parameter of QoS for both MANET and VANET. In this paper we have calculated the average throughput by taking received packet and its size with respect to time for both MANET and VANET.

The number of nodes with their corresponding generated throughput for MANET are summarized in Table-3 and the result is shown in Figure 3 using Xgraph.

Throughput Performance for MANET in IEEE 802.11standard :

Table 3

Number of nodes	Throughput
20	8532
30	8397
40	7905
50	7701
60	7456

Figure 3: Nodes vs Throughput in MANET

The number of nodes with their corresponding generated throughput for VANET are summarized in Table-4 and the result is shown in Figure 4 using Xgraph.

Throughput Performance for VANET in IEEE 802.11Ext standard:

Table 4

Number of nodes	Throughput
20	9218
30	9238
40	9504
50	9680
60	9735

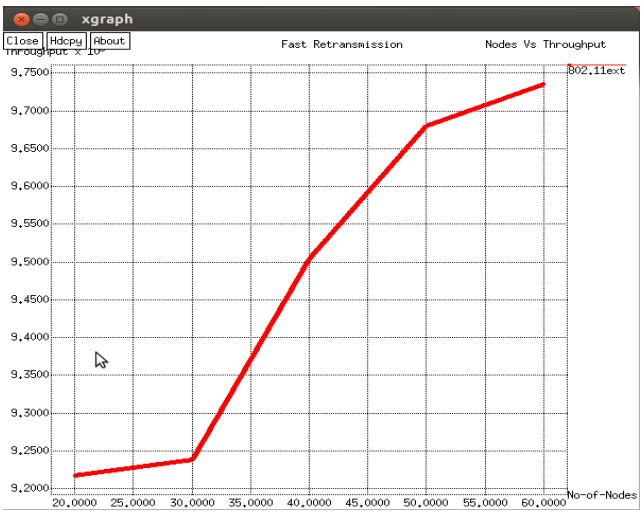

Figure 4: Nodes vs Throughput in VANET

From the above result and analysis, it is found that the performance of VANET based on the throughput parameter is better than the performance of MANET. We conclude that the QoS of VANET contributes an advantage over MANET since the throughput parameter itself has major impact in QoS. In this graph the result of VANET and MANET is shown in Figure 5 which is based on the standards IEEE 802.11Ext and IEEE 802.11 respectively.

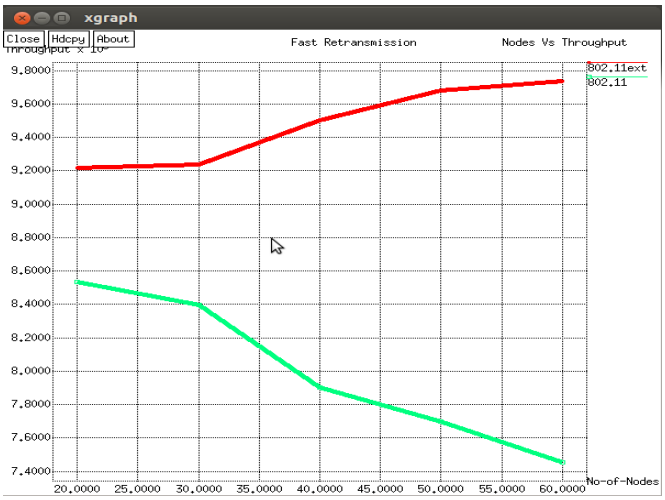

Figure 5: Nodes vs Throughput in VANET (IEEE 802.11ext standard) and MANET (IEEE 802.11 standard)

CONCLUSION AND FUTURE WORK

In this paper we have presented the performance on QoS of MANET and VANET based on the standards IEEE 802.11 and IEEE 802.11Ext. We have considered throughput as parameter in this paper to evaluate the result of QoS in MANET and VANET. We created two separate simulation scenarios for achieving the QoS. Also we have determined from the Figure 5 that the throughput of VANET demonstrates a better result as compared to that of MANET. The simulation results provide an efficient comparison between MANET and VANET. This paper provides an idea for the researchers working in the area of QoS pertaining to Vehicular technology. In future we plan to simulate other QoS parameters like packet delivery ratio, end to end delay, bandwidth management scheme etc and perform a comparison between MANET and VANET based on the said standards.

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