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# Implementation of Vehicular Networking using OMNeTpp

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**ABSTRACT**

Vehicular networking has been playing a significant role these days, ensuring the non-jeopardization of the drivers. It has a substantial energy to empower various claims associated with traffic safety and efficiency. Many protocols, standards and simulators are being used to enhance the driving performance in different vehicular environments. However, many quandaries are to be clarified on how to increase the performance of the latter cause. One of the solutions lies in augmenting the CSMA/CA mechanism, which is an essential part IEEE standard. Here, there is a opportunity of bottleneck occurring during multiple receptions that try to access the same information broadcasted by a node. The former problem can be avoided using many simulators. However, the current conundrum is being avoided using OMNeTpp simulator, as it is one of the most diligent simulators [1]. This simulator can carry out safety and non-safety road applications more effectively due to the changes implemented in CSMA/CA.

**Key words:** CSMA/CA, DSRC, IEEE 802.11p, OMNeT++,WAVE.

## 1. INTRODUCTION

### Overview

Even though vehicular networking is the existential phenomenon for the past few recent years, it still lacks in some important features that is degrading its performance. The drawback of present VANETs is its CSMA/CA mechanism. It is causing congestion within communication among numerous vehicles. Congestion occurs when a single node broadcasts information to more number of nodes within a topology which results in the collision of recipients at the channel [4]. Because of such situation, the sender will not be able to transmit and/or re-transmit the required information at certain apposite time. OMNeT++ simulation platform will be utilized to overcome the mentioned drawback.

### Intelligent Transport Systems (ITS)

Though there is an increase in mobility in transportation, it has led to some inefficiency such as loss in travel time, safety for vehicles, passengers, and pedestrians, environmental hazards, high consumption of energy sources, and most importantly loss of lives [5]. Hence, ITS refers to the efforts to provide evidence and communication technology to vehicles and other transportation infrastructures like safety, reduced fuel consumption, and entertainment while moving. Thus, a *connected vehicle* scenario is a key to the evolution of next generation ITS and its related applications [6].
The term connected vehicles refers to the wireless empowered vehicles which can communicate with their inner and outer surroundings. Supporting communications include Vehicle-to-Vehicle, Vehicle-to-Infrastructure, and Infrastructure-to-Infrastructure communications [7]. Connected vehicles are well informed about their surroundings, and support various applications like road safety, traffic control and Internet connected vehicles. A typical connected vehicles scenario is shown in Figure 1.

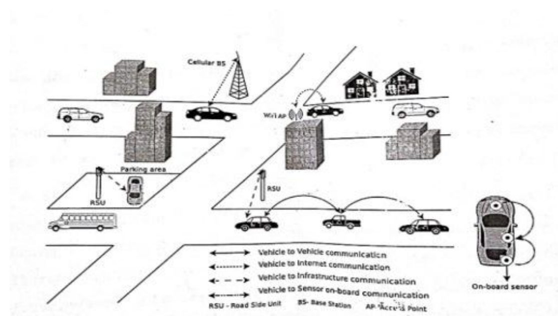

**Figure 1**: Connected vehicles overview

To enable intra-vehicle communication, vehicles are equipped with several sensors which form an intra-vehicle wireless sensor network and communicate with each other. Such sensors are technically known as *On-Board Units (OBUs).*

The most important requirement for efficient and safe transportation is to have exchange of information between vehicles can be supported. This is enabled by having efficient V2V and V2I communication. In this direction, VANET is a main technology and plays a pivotal role in providing continuous communication between vehicles and infrastructures [8]. However, high mobility, dynamic network topology, and strict delay constraints are some challenges which act as barriers in achieving omnipresent connectivity in VANETs.

**Vehicular Ad hoc Networks**

VANETs offer a system where vehicles are aware of their surroundings and help travelers to avoid accidents and ensure life safety and comfort. VANET is kind of Wireless ad hoc network system wherever moving vehicles act as nodes to create a mobile network [9]. Vehicles are armed with wireless devices called as On-Board Units (OBUs )which help to connect with other vehicles and RSUs [10].

**DSRC Spectrum**

The Dedicated Short-Range Communication (DSRC) spectrum is spectrum used for communication in VANETs to cover communication in vehicular environment. The DSRC spectrum is separated into seven channels each ten megahertz wide, as shown in Figure 2 [2]. There is one control channel (CCH) that transmits safety related information. There are four service channels (SCHs) which are used for both safety and non-safety usage [11]. The rest of the two frequencies at the ends of the spectrum are kept for special usage.

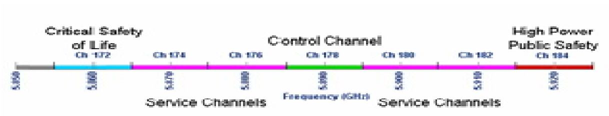


**Figure 2**: DSRC spectrum band and channels

**Table 1**: Contention parameters for IEEE 802.11p CCH and SCH

CCH

| ACI | AC | CWmin | CWmax | AIFSN | TXOP Limit OFDM PHY |
|---|---|---|---|---|---|
| 1 | Background | aCWmin | aCWmax | 9 | 0 |
| 0 | Best effort | (aCWmin + 1)/2 – 1 | aCWmin | 6 | 0 |
| 2 | Video | (aCWmin + 1)/4 – 1 | (aCWmin + 1)/2 – 1 | 3 | 0 |
| 3 | Voice | (aCWmin + 1)/4 – 1 | (aCWmin + 1)/2 – 1 | 2 | 0 |

SCH

| ACI | AC | CWmin | CWmax | AIFSN | TXOP Limit OFDM/ CCK-OFDM PHY |
|---|---|---|---|---|---|
| 1 | Background | aCWmin | aCWmax | 7 | 0 |
| 0 | Best Effort | aCWmin | aCWmax | 3 | 0 |
| 2 | Video | (aCWmin + 1)/2 – 1 | aCWmin | 2 | 0 |
| 3 | Voice | (aCWmin + 1)/4 – 1 | (aCWmin + 1)/2 – 1 | 2 | 0 |

After the specified *Arbitration Inter-Frame Space (AIFS)* of an AC, vehicles check the channel to find if it is free (CSMA/CA mechanism). If the channel is free they transmit information, otherwise they go to the back off state by choosing a contention window (CW), which is chosen randomly between 0 and CW ($CW_{min} \leq CW \leq CW_{max}$) as shown in Table 1.

- Due to dynamic environment in VANETs, vehicles should be ready for communication as quickly as possible. Hence, vehicles do not require authentication and association process for communication [13].

- The WAVE standard introduces *WAVE Basic Service Set (WBSS)* for communication among vehicles, which is analogous to BSS [3]. A vehicle forms a WBSS by transmitting a demand beacon, which contains all the information required for vehicles to join the WBSS.

### 1.1 Backbone Area

**SUMO (Simulation of Urban Mobility)**

It is an open traffic simulation suite. It permits modeling of inter traffic systems including road vehicles, public transport and pedestrians .It can also be enhanced with custom models to simulate remotely.

### 1.2 OLSR (Optimized Link State Routing Protocol)

OLSR is protocol for routing which is utilized as a protocol for adhoc networks and other wireless networks. It is proactive routing protocol, where messages are transmitted periodically.

A proactive routing protocol enables a node to either send messages to only its neighboring nodes or to the entire network based on its needs. One of the advantages of OLSR in adhoc networks is that it immediately updates the routes of the network whenever necessary and required, as the routes are readily in avail.

## 2. LITERATURE SURVEY

VANETs, the subclass of Mobile Ad Hoc Networks (MANETs), are becoming the influential areas for improvement of ITS. They are constantly being improvised and innovated for the safety of automobile drivers and increasing their comfort. Their safety is assisted in terms of communication among other vehicles and transmitting information to avoid critical situations, such as road accidents, traffic jams. Apart from V2V communication, V2I also takes place where the nodes (or cars) communicate with RSUs that are within range that helps in transmitting information to the other RSUs and vehicles. Higher node mobility, speed, and rapid pattern development are the primary features of VANETs.

In the previous years, numerous data dissemination techniques appropriate for VANETs have been proposed. Routing procedures are based on vehicular communication protocols and examine how messages are disseminating in VANETs [14]. The key issue related to vehicular network is that its deficiency in connectivity is due to rapid disconnections, flexible mobility of vehicles and speedily changing Network topology. In these situations, there is direct association among the number of packets, which can be effectively received by vehicle, traffic patterns and the vehicle speed [15]. Data propagation represents a challenge specifically in commercial applications. Where in the entertainment applications, the data drifts are more with respect to safety applications, message propagation should be well-organized to reconstruct whole data flow from a partial number of received messages. This approach offers a quick sharing of real-time messages [16], mainly appropriate for comfort applications. As an case, the fountain codes has been proven to provide well-organized and consistent vehicular communications even in high dynamic networks.

The authors proposed [17] VANETCODE, Assuming the content is separated into smaller block, which were linearly encoded by vehicles in content distribution scheme. Cataldi et al considered the usage of hybrid communication protocols [18]. It is distinctive of night hours, where the traffic density is particular low and data distribution from a source to other relay vehicles is problematic to occur, owed to the notice that traffic density differs severely depending on the specific road, the time of day to the out of the transmission range of the source from the receiver node.In the second state the vehicular density is not constant in the entire vehicular grid. In the third situation represents the vehicular traffic density is exceeding a certain threshold. Some consecutive cars will share the similar wireless medium leading to an excessive number of similar safety messages, and there is a strong increase in packet impacts and medium contentions between vehicles bidding to communicate.

### 2.1 Review on security issues

The security issues like integrity, authenticity, availability, confidentiality as well as non-repudiation goal is to protect communication among V2V and V2I. Privacy issues are disturbed with protecting and revealing drivers personal data.

There are number of attacks in VANETs [12]. The primary aim of the attack is to generate problems for users to provide access to system for collecting the data.

***1. Sybil Attack*****:** It creates several fake nodes and broadcasting false data to the neighbor nodes. A vehicle with OBU could send multiples message copies to other vehicles, where every message is diverse and independent of one another. Several techniques are projected to meet Sybil attack in VANETs [20] namely statistical, signal strength, probability and session keys.

***2. Node Impersonation*****:** An effort by a node to send revised version of message and claim that message was sent by the original node for unidentified purpose. Algorithm to detect and separate the felony is DMV [21] and Outlier detection algorithm [22].

3. ***Sending False Information*****:** Sending false information to other vehicles on purpose to create a chaos. For example, an attacker might transmit information such as congestion or an accident to clear the road. It is one scheme to detect and to apply a group signature that is accessible only through password. However, such scheme is unreliable due to the dynamic topology within networks.

Security is a major issue in VANETs. The following are the attributes that are to be considered for the criteria [19].

1. *Availability:* it deals with network services of bandwidth and connectivity. To maintain the availability, group signature technique is used in case of availability issues [23]. It makes sure that all the vehicles are provided with the message, even when there is network unavailability.

*2. Confidentiality:* it ensures that the classified information is not revealed to unknown identities. It further encloses personal information of the driver. Pseudo encryption is enabled to each message and the psuedo differ with each message.

*3. Authentication:* It verifies the identity among vehicles and RSUs. It also ensures vehicles are the authorized vehicle for the network for communication.

*4. Integrity:* It assures the message transmitted by the node is same as the reception by RSUs and neighbor vehicles, by utilizing digital signature scheme .

*5. Non-repudiation:* It makes sure the sending and receiving parties do not reject that endlessly sending and receiving message. The author has introduced a Power-Aware protocol [24]. The author has implemented the Wireless Body Area (WBA) networks for automatic connection establishment of many sensors [25].

## 3. EXPERIMENTAL RESULTS

### 3.1 End-to-End delay:

Time taken for packet to deliver from source to destination is end to end delay. The delay, in seconds, is plotted against the simulation time in seconds. The delay is compared with the proposed system of VANET and the existing system of VANET.

As shown in graph, it is clearly shown in (Figure 3) that as the simulation time increases, the transmission time is reduced, which makes the proposed system coherently faster.

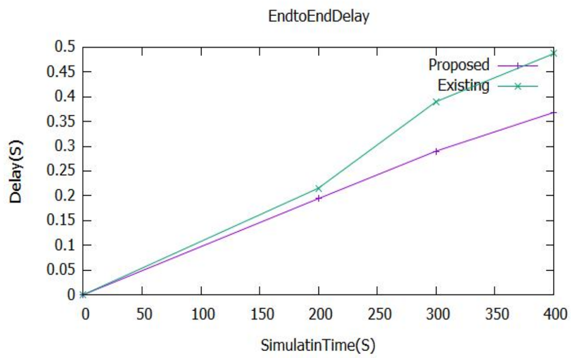


**Figure 3**: End-to-end delay graph **Packet loss**

As the vehicles communicate there is an obvious possibility in loss of packets. It could be due to congestion or due to the lack of retransmission. The graph depicts (Figure 4) the relationship between number of packets lost and the simulation time; in addition, it compares the parameters with proposed and the existing system.

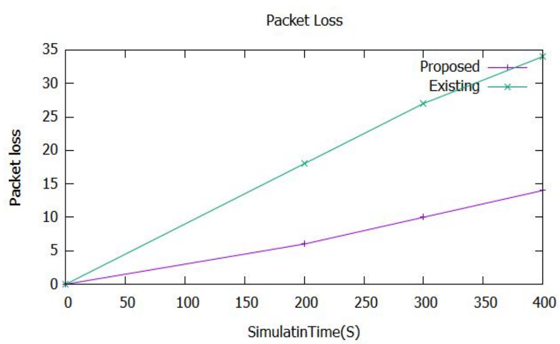


**Figure 4**: Packet loss graph

**Packet Delivery Ratio:**

PDR is the ratio between the transmitted packets to the generated packets. Proposed VANETs can transmit more number of packets when compared to generated packets, than the existing VANETs, as shown in the graph (Figure 5).

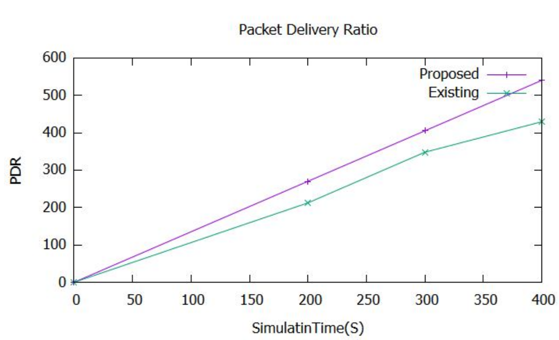


**Figure 5**: PDR graph

**Average throughput:**

Throughput is the amount of work done at a certain period or amount of time. VANETs are said to be more efficient if their throughput is high, which results in more diligent transmission in less amount of time (Figure 6).

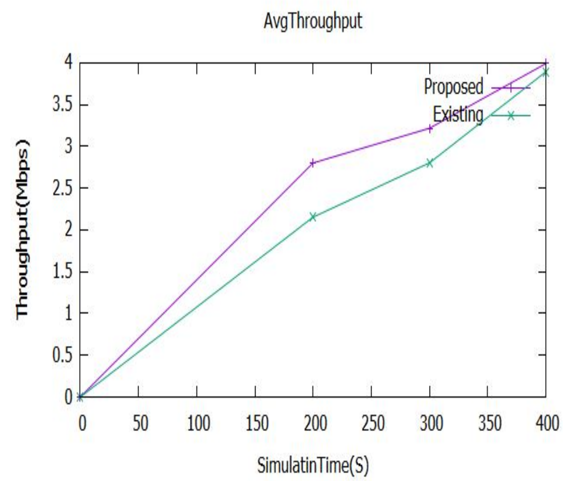


**Figure 6**: Average throughput graph

## 4. CONCLUSION AND FUTURE ENHANCEMENTS

In conclusion, VANETs, subsuming a part of MANETs, are an improvement of ITS, that aspires to offers solutions for road safety applications. The possible types of communications available in VANETs are V2V, V2I, and I2I. VANETs are infrastructure-less networks where either moving vehicles or RSUs are considered as nodes, in addition to nodes, multipoint relays act as intermediate nodes. Its characteristics are high mobility, rapidly changing network topology, frequent exchange of information, anonymity, limited bandwidth, and many more.

Though VANETs are simulated in many simulators, it is highly efficient when VANETs are created in OMNeT++ simulator as it is a C++ based discrete simulator that is utilized in processing multiprocessors and distributed networks, and modeling communication platforms.

The simulation is customizable, and allows embedded simulations into larger applications, such as VANETs and other network planning software. It is well structured, highly modular, and no limitations in network protocol simulation.

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