TEST Engineering & Management

March - April 2020
ISSN: 0193-4120 Page No. 7341 - 7348

A Feasible Model for a Smart Transportation System using a Vehicular Ad-Hoc Network

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Article Info
Volume 83
Page Number: 7341 - 7348
Publication Issue:
March - April 2020

Article History
Article Received*: 24 July 2019*
Revised*: 12 September 2019*
Accepted*: 15 February 2020*
Publication*: 07 April 2020*

Abstract

The current scenario in the transportation system needsappropriate means and organization of transport channels, which eventually defines the living standard of people in the recent, modern cities by exploiting the advanced electronic and telecommunication technology. To devise a solution for a research problem in order to implement an efficient and intelligent transport system,it is likely to improve the overall effectiveness of the system to ensure a fast, safe, and the smart mode of travelling.

The sole aim of this paper is to use the conformist VANETs to augment traffic-safety and efficiency by means of real-time onboard communication modules with wirelessly accessible technologies, which are enabled in vehicles with the help of roadside infrastructure.

Recently, with the progress in the automobile electronics sector and wireless model of communication, vehicular-ad-hoc networks (VANET) are few of the most encouraging research areas. VANETs are a subfamily of mobile-ad-hoc networks (MANETs).

Keywords; *VANET, MANET, Simulator,IoT.*

I. INTRODUCTION

In India, on an average 10 to 15 Lac people live in each urban area/city, mostly at a district place. In 2015, the Government of India has initiated the concept of the making of a smart city. In such nation-building efforts, transportation has a significant role to play. In urban areas, thousands of people choose one or the other public transportation mode for travelling. Public conveyance has a number of advantages over private vehicles. While sharing the benefits from public transportation, citizen, consumers, as well as the governing body, faces challenges like road traffic congestion, safety, vigilance, crime, etc.

Continuous growing urban population and usage of private/public vehicles for transportation demands to implement an intelligent transportation system which will support Maha-Nagarpalika officials and other administrative / law enforcement agency (which is hereby collectively referred as the governing body) to produce a better living atmosphere for its digital natives.

This research paperfocuses issues of socio, technical and/or policy-relevance. It has less importance on discipline-related academic outcomes but more significant for research fields. The important points to be considered here are –

(i) The subject into consideration is transport which is interdisciplinary in nature.
(ii) The project expects to transfer the solution devised at the lab for the real-world

(iii) The research is more user-control and less commercially control.
(iv) The research is particularly relevant to Maha/Nagarpalika officials and other administrative / law enforcement agency which are policymaking institutes.

Through this research project has less importance on discipline-related academic outcomes, the contributions of experts and competent researchers from academic disciplines such as mechanical engineering, transportation engineering, Information technology, Electronics and communication engineering, social sciences, etc will be integrated to provide holistic or systemic outcomes.

In short, it is a good interdisciplinary research proposal. Various technologies and disciplines involved will be integrated as per scope and pre-formal analysis and the research objectives are involved to assure the quality of integration.

II. RELATED WORK

The USA, Japan and Europe and other developed nations have developed vehicular networking based architectures and protocols to suit their applications. A representative application based scenario of IoT and vehicular networks (VANETs) for controllingthe probability of traffic accidents and for enhancing both the driving and infotainment experience. It is mentioned in the literature [1]. Another paper focused on folkloricsafety-related vehicular applications, such as police surveillance/vigilance and road safety.

In February 2014, the U. S. Transportation-Secretary declared that the National-Highway Traffic-Safety administrative rulemaking method started and finally it will mandate Dedicated-Short Range-Communications (DSRC) to be fitted in all new cars and light trucks from 2017. A collective program sponsored by various researchers and innovative methodologies for administration [2].

BITS - Pilani organization is working on a project called “Project i-VANET”. This project objective is to devise strategies and algorithms for robust and efficient network communication in the context of Intelligent Transportation Systems (ITS). It includes issues related to routing, quality of service (QoS) and security for VANET, V2V and V2I communication in ITS.

A project implementing an effective smartphone mounted driving with the safety application and a traffic module for signal preclude control method is cited in the literature [3]. It is an approach for handling emergency situations in transportation. The system made of an On-Board-Unit (OBU), an android application called “SMaRTDRIVE”, a server with Road-Side-Unit (RSU).

The significance of the study:VANETs are used for interaction among moving vehicles in a defined environment [4]. A direct Vehicle to Vehicle (V2V) communication or a vehicle with roadside station/infrastructure (V2I) communication model and suitable network will be presented in this research project. The model validity and its simulation results will be presented with consideration to sizable VANET, desired specifications and the suitable applications as mentioned below:

- ✓ *Road Traffic Safety* –alert the driver in advance to reduce fatalities/injuries on the roads.
- ✓ *Traffic-Engineering methodsfor Efficiency* – improve whole transportation concert in terms of cost, travelling time and congestion.
- ✓ *Comfort, Quality of Road-Travel*- giveseasy applications for travelers like ‘panic situation alert to nearby help station’, ‘electronic payment systems’, ‘electronic toll collection’ etc.
- ✓ *Traffic regulation*: provide the assistance to traffic regulating corps to penalize the driver based on the traffic rules e. g. traffic signal violation, vehicle speed limit violation, parking in ‘no parking zone’, wrong direction travelling, unauthorized vehicle movement, collecting the taxes at intermittent stages, etc.

March - April 2020
ISSN: 0193-4120 Page No. 7341 - 7348

✓ *Use of other Technology*: integrate the vehicle with any other access technologies such as Global-Positioning-System (GPS), Wi-Fi, etc.

City traffic regulating authority/Corps:Road Transportation Officer (RTO) and traffic police corps need to regulate the traffic in the city on a regular basis. They are equipped with limited infrastructure and human resources to discharge their duty. This project will attract these government authorities based on the following application:

- With a distinct electronic device installed inside each vehicle which will enable ad- hoc network connectivity for vehicles to interactin between nearby available vehicles and among traceable vehicles and closely fixed road-side station. With the proper scalable model, the on-board unit can get and relay on another signals through the wireless network from traffic police about the traffic scenario, a pre warning for collision, road indications and alarms and help to a driver for deciding the best path [5].
- Woman safety and comfort is a more burning issue in the city. This wireless connectivity will facilitate woman passengers to convey the emergency and untoward conditions to the nearby support system [6].
- Tracking of un-authorized vehicle, vehicles under suspension and vehicle thefts and vehicles under search after the crime, etc. is also the possible extension of application with proper alignment of existing support systems and adequate scaling of the network [7].

Municipal Corporation / Mahanagarpalika Authority**:** In the current scenario, Municipal Corporation / Mahanagarpalika authority need to address challenges regarding vehicles and parking system. This project will attract these semi-government authoritiesof real-time payment for parking lots and toll collection at a time can be done.

With the inclusion of electronic display integrated with technologies such as WiFi, Bluetooth, etc. passenger can be entertained and effective things such as media communication can be achieved which will improve the safety aspects in vehicles, streaming communication between vehicles, and infotainment [8].

Objectives:VANET enables a set of pre-installed vehicles to set-up and maintain ainteraction networkingin-between them and nearby roadside station on the absence of any centrally availablebase-station which may be any available controller. Based on the latest developments in this technology and the need for a research problem, the proposed research project has the following objectives:

- To show a comprehensivereview of network-architecture with various topologies and network-modelling and develop the feasible model of an intelligent transportation system.
- To research and develop a sizable VANET with limited road topology to guess the future position of a vehicle.
- To establish important computing, communication, and sensing capabilities which will support to improve road safety and communicate during an emergency situation.

To simulate and analyze the pattern of public transportation vehicles that will support the law enforcement agency.

III. THE PROPOSED METHOD

In principle, VANET does not need to follow a fixed architecture or topology. As stated in earlier VANET is unlike than a MANET in the logic that moving vehicles do-not move haphazardly as happened in MANETs. In VANET moving vehicles adopts some allocated paths such-as urban-roads and high-ways. The detailed methodology included here is presented with the help of schematics diagrams, all relevant technical details and rationale etc. In order to evaluate the performance of VANET with due focus on network architecture, protocol's, algorithm's, and application's, an effective-research methodology is required [9].

March - April 2020
ISSN: 0193-4120 Page No. 7341 - 7348

Architecture: As shown in Figure 1, this part refers to the system-architecture of vehicular-ad-hoc-networks, which includes following components/domains, as per the IEEE-1471-2000 and ISO/IEC 42010 standards:

1. Mobile domain: contains two-parts: the vehicle-module and the mobile -module.

Vehicle-module:includes all types of vehicles such as busesandcars. There are two modules: the roadside-infrastructure/hardwaremodule and the central-infrastructure/hardwaremodule. The road-side-infrastructure modulehas road-side unit entities like traffic-lights. The central infrastructure/hardwaremodulehas infrastructure/hardware management centers such as traffic-management and vehicle- management centers [13].

1. Generic module**:**This moduleincludes all types of portable/mobile devices like personal-navigation devices and smart-phones.

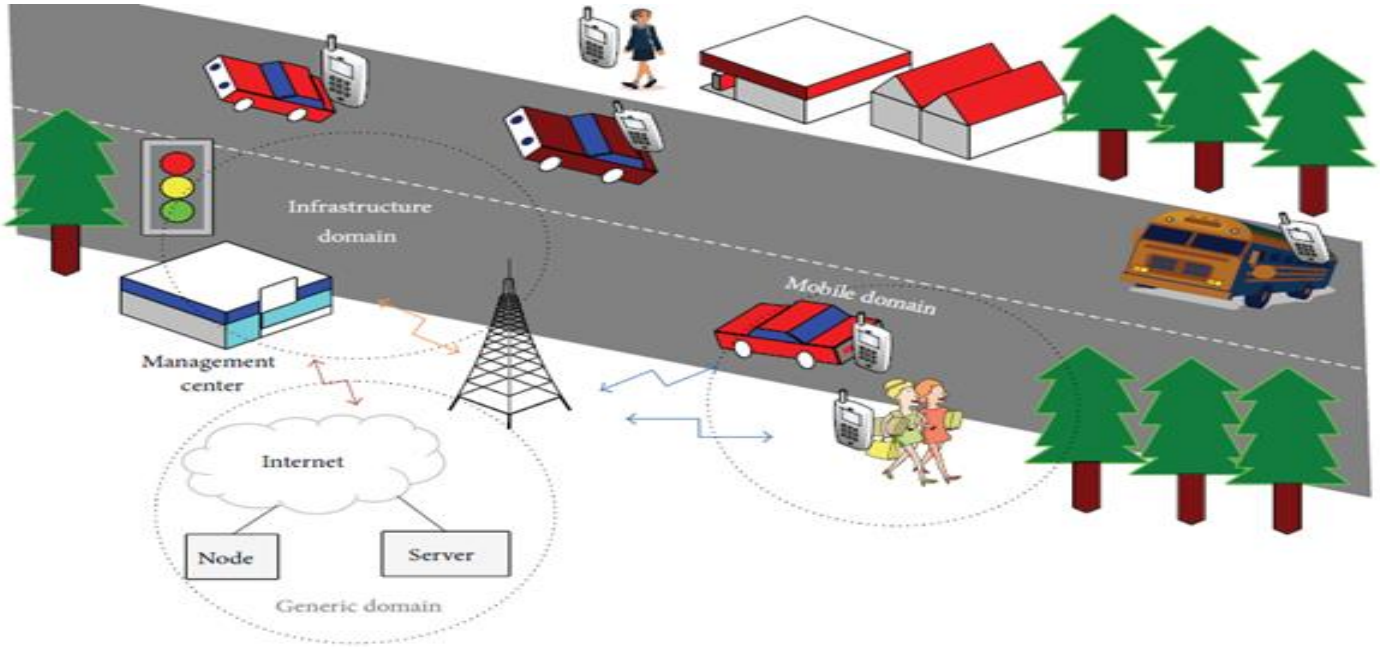

Figure 1: Main components or domains in VANET

Communication Model: Mode ofCommunication in VANETs has following types: (6) Vehicletovehicle (V2V), (7) Vehicletoroad infrastructure (V2I) and (8) Vehicletobroadband cloud (V2B). The typical communication model is shown in **Figure 2**. The proposed research project will consider the following four sub-models for different aspects [14]:

(a) **Driver vehicle Module -** This moduleis to analyze the performance of a single unit of vehicle with consideration to various mode of driving and features of vehicles.

(b) **Traffic-Flow Module -** This module is to shows interactions in-between vehicles and roadside-infrastructures which will also help to develop a sizable macroscopic road network model.

(c) **Communication Module -** This model will give emphasis on the performance of the different OSI communication-layers, communication-environment, and the routing strategies.

(d) **Application Module -** This model will be based on the specific application. Our current focus is on safety-oriented applications, such as to increase the safety of road and other users. These include: women safety, vehicle collision avoidance, cooperative driving and traffic police support mechanism [10].

March - April 2020
ISSN: 0193-4120 Page No. 7341 - 7348

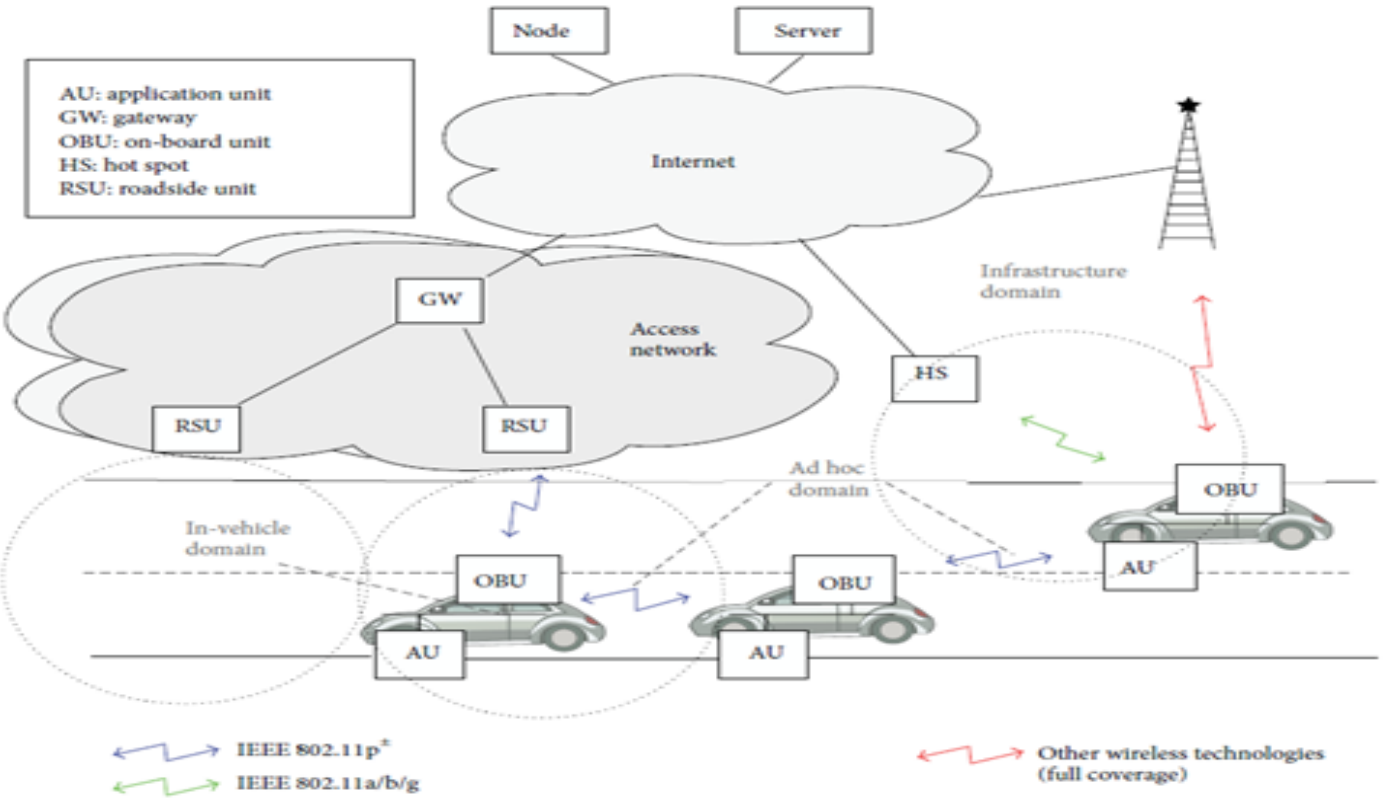

Figure 2: Typical vehicle to vehicle communication architecture

Simulation Techniques: Simulation is no-doubt a necessary before the real implementation of new proposedmethodologies in VANETs. In the simulation of VANET, it needs two different components: a traffic module simulator and a network module simulator.

1. **Traffic module Simulators:** To interpret vehicular-ad-hoc network features and the performance of protocol, traffic module simulators are required to make locations with reference to movement data of a unit vehicle in VANET-environment. Many researchers usetraffic module simulators like SUMO (urban-mobility) and VISSIM (locations with reference to movement data of vehicle as well as city and highway-traffic) [11].

2. **Network module Simulators:** To represent and view the functionality of VANETs, a reliable network-simulator along with efficient routing protocols like AODV (ad-hoc on-demand distance vector), and communication standards like IEEE 802.11[p] and IEEE 1609 specifications will be used [12].

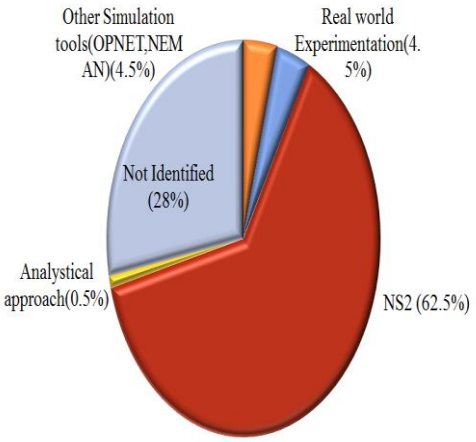

Figure 3: Survey of network simulators

March - April 2020
ISSN: 0193-4120 Page No. 7341 - 7348

Figure 3, shows the percentage usage of network simulators, in this ns-2 simulator, occupies maximum space. Figure 4, represent proposed feasible model for VANET implementation. In this,each wireless module is installed in each vehicle and all these will get connected to the roadside unit or server. The data is easily available accessible through the internet to administration,

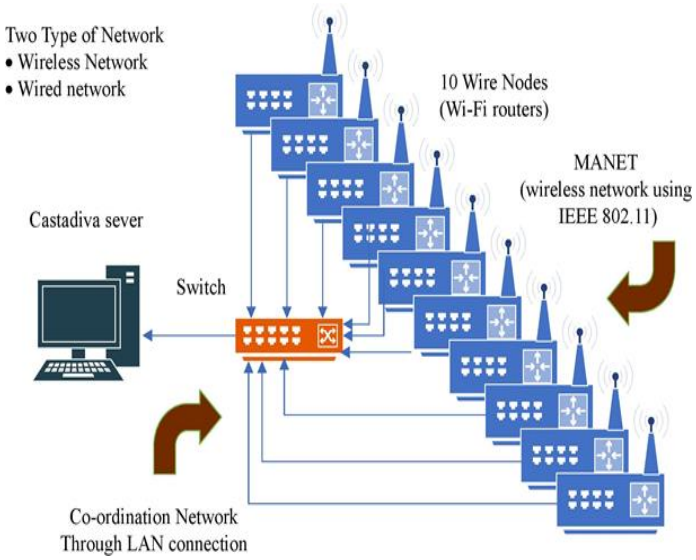

Figure 4: Structure of the network emulator hardware module

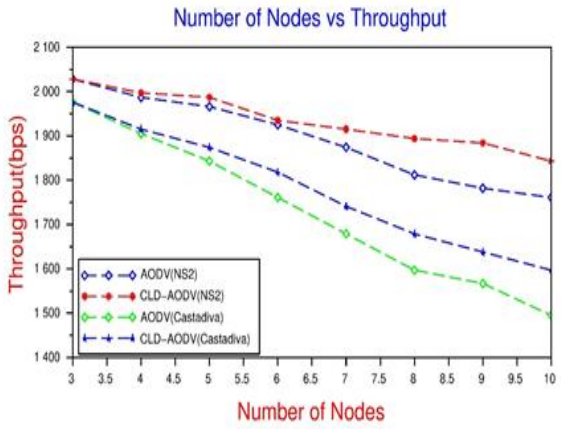

Figure 5: Number of nodes vs throughput in simulator and emulator

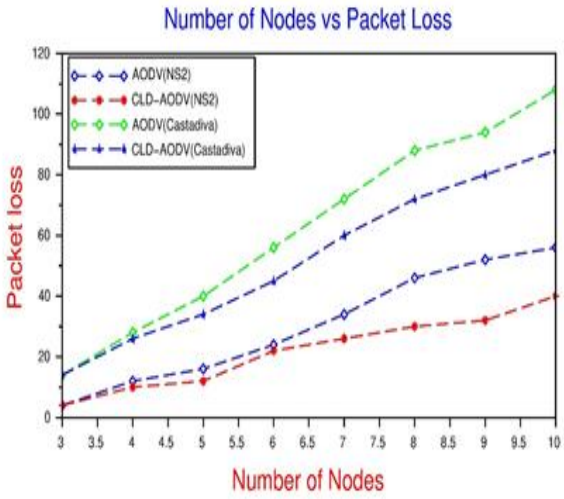

Figure 6: Number of nodes vs packet loss in simulator and emulator

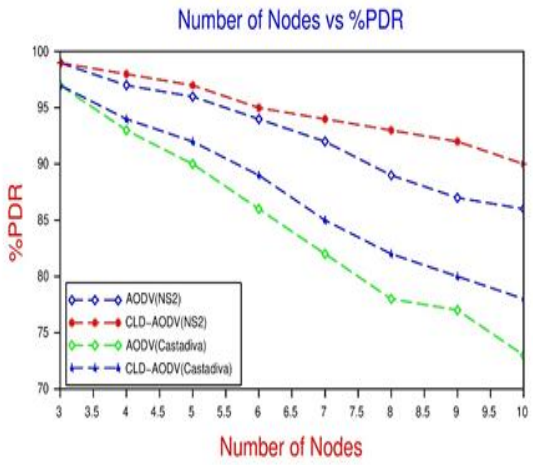

Figure 7: Number of nodes vs %PDR in simulator and emulator

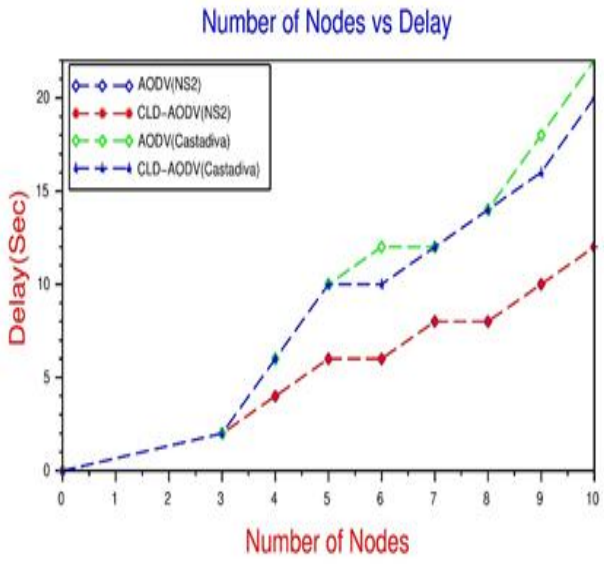

Figure 8: Number of nodes vs delay in simulator and emulator

Figure 5, 6, 7, and 8, shows the comparison of simulation and emulation results with reference to throughput, packet loss, %PDR and delay. The results show emulation results in hardware are less than simulation results.

IV. CONCLUSION

This project typically required the standard Network Simulator with few modules. Also at present, the size of nodes in the network is 10, which is viable consideration looking the pilot prototype development. The first option, into consideration, is to use the licensed software (NetSim) for simulation and emulation. The purchase of licensed software (NetSim) and other hardware will incur approximate 2 Lac cost. But, we plan to take the help of consulting agencies or research institutes to simulate the proposed model. Another option is to simulate the same using the open-source platform called NS2/NS3.

This paper is mostly concerned with building a sizable simulation model and working model. It is not proposed to enforce the model into the existing infrastructure at public or Institute set-up.

This paper comprises undertaking a study, analysis and feasibility of developing the model for the traffic safety and vehicular communication. By completing the project, project investigators are thinking for its real-time deployment as per the action plan that full-fill the requirements find out in the objectives at the phase of system-development.

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