Traffic Control System by Incorporating Message Forwarding Approach

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Abstract

During the last few years, continuous progresses in wireless communications have opened new research fields in computer networking, aimed at extending data networks connectivity to environments where wired solutions are impracticable. Among these, vehicular traffic is attracting a growing attention from both academia and industry, due to the amount and importance of related distributive applications to mobile entertainment. VANETs are self-organized networks built up from moving vehicles, and are part of the broader class of MANETs. Because of these peculiar characteristics, VANETs require new networking techniques, whose feasibility and performance are usually tested by means of simulation. In order to meet performance goals, it is widely agreed that VANETs must rely heavily on node-to-node communication. In VANET, each vehicle acts as a node and communicates with other vehicles within the range or communicates with base stations. The main idea is to deploy a wireless communication network that has a capability of sending and receiving messages between transmitter and mobile devices in the particular network. Results can be shown using an effective VEINS Simulator. This Simulator can produce detailed vehicular movement traces and can simulate different traffic conditions through fully customizable scenarios. The Framework is expected to be employed using such simulator that makes use of traffic modulator, network simulator and coupling module that integrates the traffic and network.

Keywords: Networking Techniques, VANETs, Node-to-node Communication, Modulator.

1. INTRODUCTION

Road and traffic safety can be improved if drivers have the ability to see further down the road and know if they are approaching a traffic jam. The productivity of vehicles is in greater proportion to the number of roads. Under these circumstances, Researches have been done to improve the road safety like safe driving education, roads expansion and speed management etc., has not made much impact. As the road accidents increasing day by day there is much need to think of new approaches like, if drivers and vehicles communicate with each other and with roadside base stations. It is possible to build a multi-hop network among several vehicles that have communication devices. Communication between vehicles [1] can be used to realize driver support and active safety services like collision warning, up-to-date traffic and weather information or active navigation systems.

Vehicular Ad-hoc Networks (VANETs) represent a rapidly emerging, particularly challenging class of Mobile Ad Hoc Networks (MANETs). VANETs are distributed self-organizing communication networks built up from travelling vehicles, and are thus characterized by: (a) trajectory-based movements with prediction locations and time-varying topology, (b) varying number of vehicles within dependent or correlated speeds, (c) fast time-varying channel (e.g., signal transmissions can be blocked by buildings), (d) lane-constrained mobility patterns (e.g., frequent topology partitioning due to high mobility), and (e) reduced power consumption requirements.

VANETs have very high speed and limited degree of freedom in nodes movement patterns. Such particular features often makes standard network protocols are inefficient in VANETs. Thus there is a huge impact in the deployment of VANET technologies and development of communication protocols in vehicular networks. Hence VANETs leads to the need for new system concepts and information dissemination protocols. In addition, new approaches for data and communication security have to be designed to fit the specific network needs and to guarantee reliable and trustworthy services.

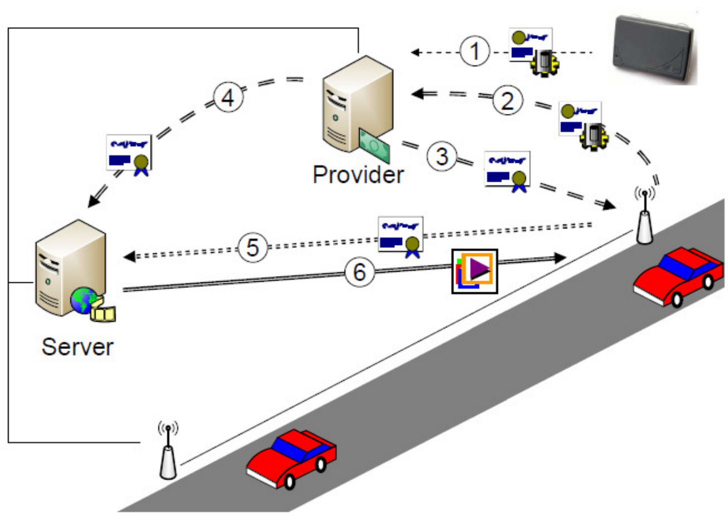

FIGURE 1: Scenario depicts the snapshot of the Vehicular Adhoc Network

(1) User registers device with provider (2) User sends payment/service request
(3) Provider issues temporary credentials
(4) Provider informs server of service purchased and temporary credentials
(5) User requests service using temporary credentials (6) Server delivers content.

Above figure demonstrates the illustration of payment and service requests and temporary credentials. One of the main challenges posed by VANETs simulations is the faithful characterization of vehicular mobility [2][3] at both macroscopic and microscopic levels leading to realistic non-uniform distributions of cars and velocity, and unique connectivity dynamics[4][5][6]. The new approach to solve this problem in the current transportation system is implementing the wireless technology. In VANET the vehicles exchange the information while moving which gives the driver an additional time to react accordingly. The communication in a vehicle is of 2 types: Intra-Vehicle communication and Inter-Vehicle communication. Intra-Vehicle communications references the communication which occurs within vehicle and inter-Vehicle communication represents the communication between the vehicle and roadside units.

In this paper we will focus on implementing the inter-Vehicle communication and analyse the benefits we can bring to the currents transportation system. Security of the VANET is least bothered in the contended methodology. Since, this methodology does not deal with the inner details of the transmitting signals. One way to effectively adapt the security techniques in VANET is by incorporating Certificate Distribution Technique [7] which makes use of the third party to monitor and distribute the certificates. The realistic implementation of VANET is much costly and challenging. Thus, simulation is much practical and cost effective [8],[9]. In this work, a simulator called VENIS (vehicles in network simulation) is used to simulate the real time scenario.

2. RELATED WORK

In traffic applications, we need to simulate the combined performance of wireless protocols and traffic conditions using wireless network simulators and traffic network simulators.

2.1 Vehicular Network Access or Intelligent Vehicular Ad Hoc Networks

InVANET helps in defining safety measures in vehicles, streaming communication between vehicles, infotainment and telematics. InVANET can be used as part of automotive electronics, which has to identify an optimally minimal path for navigation with minimal traffic intensity. The system can also be used as a city guide to locate and identify landmarks in a new city. The main interest is in applications for traffic scenarios, mobile phone systems, sensor networks and future combat systems. Recent research has focused on topology related problems such as range optimization, routing mechanisms, or address systems, as well as security issues like traceability or encryption. In addition, there are very specific research interests such as the effects of directional antennas for InVANETs and minimal power consumption for sensor networks. Most of this research aims either at a general approach to wireless networks in a broad setting or focus on an extremely specific issue.

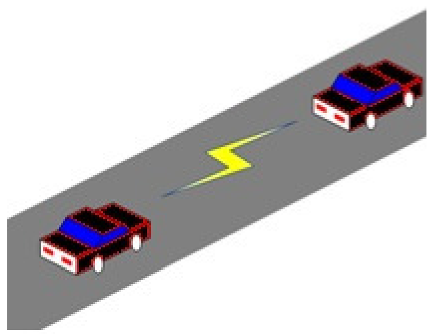

FIGURE 2: Illustration of Car–to–Car communication.

Above figure demonstrates the module of node to node communication[10]. In VANETs each and every node can be treated as vehicles.

2.2 Incorporating Wireless Communications in Traffic Network Simulators

In this section, we explain the work done towards providing a complete system that is proficient at simulating the vehicular communication network as a whole. Two approaches were followed towards this goal. The first one is Merging Traffic and Wireless Simulators which is concerned with integrating two currently available simulators. Second one is Creating New Platform. It involves the creation of a standalone platform which combines both capabilities from scratch. Prior to the idea of merging two existing simulators, several research papers have proposed their own platforms that combine the capabilities of traffic networks and wireless communication simulators, in an attempt to provide a vehicular communication network platform.

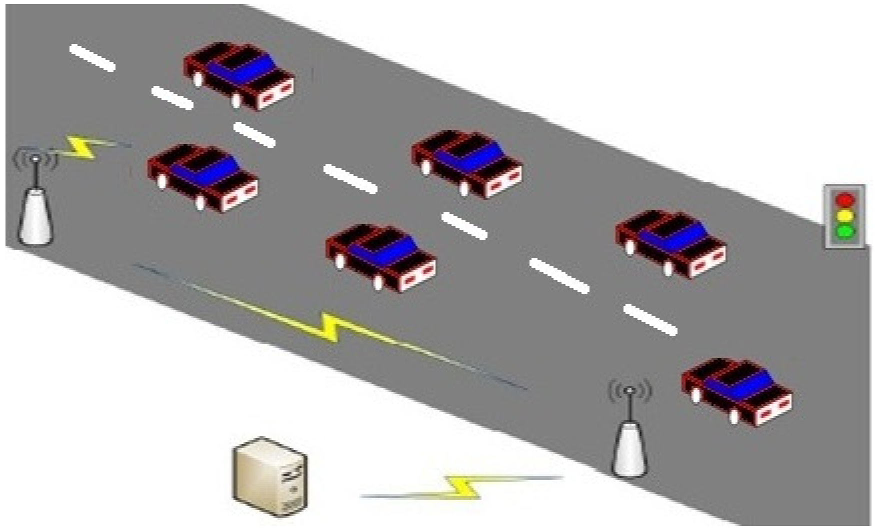

FIGURE 3: Scenario depicting communication between Monitoring server and Scanners that incorporates transmittors.

Above figure demonstrates the communication module that establishes interaction between Monitoring server and Scanners.

2.3 Freeway Management System

A freeway is a limited access highway with high speeds, and ramps to allow entry and exit which may or may not have tolls. Freeways [11] were originally intended to provide free-flowing, high-speed traffic flow over long distances.

Congestion occurs on a freeway when demand exceeds capacity. When this occurs on a freeway section, a bottleneck exists. A bottleneck occurs when:

- Demand increases to a level greater than capacity, or
- Capacity decreases to a level less than demand.

To understand what causes freeway congestion, to understand the theory of traffic flow. Important traffic flow parameters are

- Flow (V) = Number of vehicles passing a certain point during a given time period, in vehicles per hour (veh / hr)
- Speed (S) = The rate at which vehicles travel (mph)
- Density (D) = Number of vehicles occupying a certain space. Given as veh / mi.

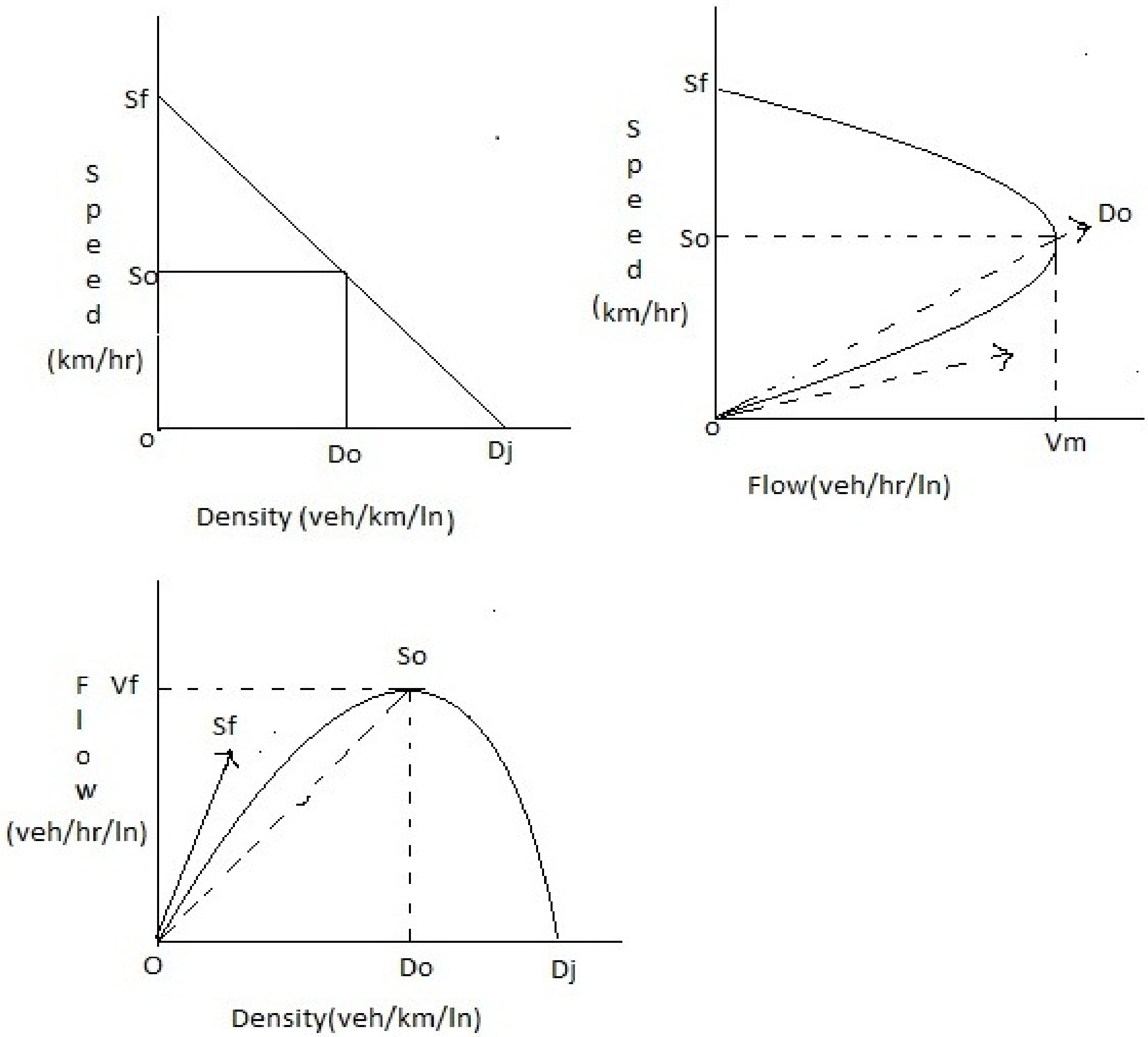

FIGURE 4: Depicts the analysis among various parameters that reflects the performance of Contended methodology

Above figure illustrates the Free flow speed (Sf) occurs during light traffic conditions. When density reaches the critical density (D0), the freeway reaches its maximum flow (Vm). Speed at that point is decreased to S0. When the density increases beyond the critical density, the flow actually decreases, until the density reaches the jam density (Dj), where the flow becomes zero and all traffic is stopped. When the density is below the critical density, the flow is said to be stable, or uncongested. When the density exceeds the critical density, the flow is said to be congested, or unstable, and the freeway capacity decreases. Because more vehicles are processed when the flow is stable, it is best for the density to be as close as possible to, but below the critical value so the freeway can operate at its full capacity.

3. METHODOLOGY

3.1 Modules

The proposed work has been segmented into three phases. The first phase deals with building network environment. The second phase establishes communication among the transmitters, scanners, vehicles, mobile devices. The third phase will explain about the mechanism to forward message which contains the information of vehicle deviation , which avoids the influence of abnormal activities, to control the traffic i.e., by scanning the vehicles through scanner and enabling the transmit to forward the message efficiently.

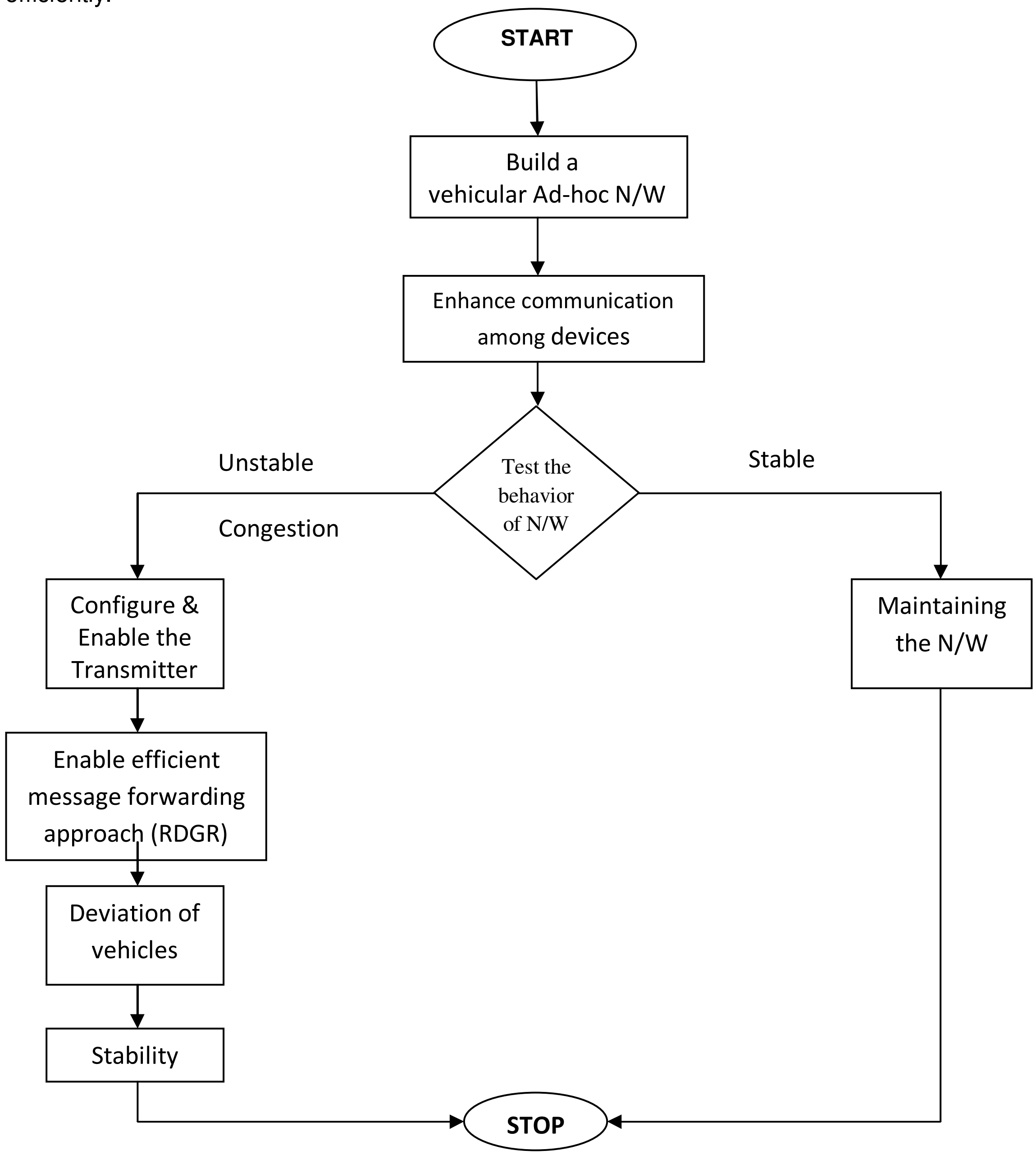

FIGURE 5: Framework depicting the contended methodology.

Above figure illustrates the framework of the contended methodology and the modules implementing it.

3.1.1 Build Network

In the first stage, create VANET with a wide range. VANET is a technology that uses moving cars as nodes in a network to create a mobile network. VANET turns every participating car into a wireless router or node, allowing cars approximately 100 to 300 meters of each other. The property of Mobile Ad-hoc network can be achieved by making the cars fall out of the signal range and drop out of the network, other cars can join in, connecting vehicles to one another so that a mobile Internet is created. In the network, vehicles information can be viewed on electronic maps using the internet. In this work SUMO simulator is used for mobility.

3.1.2 Establish Communication

In the second stage, here communication is established in between transmitter and vehicles. Communication capabilities in vehicles are the basis of an envisioned in VANET. Vehicles are enabled to communicate via access points (vehicle-to-roadside, V2R). Vehicular communication is expected to contribute to safer conditions and more efficient roads by providing timely information to drivers, and also to make travel more convenient. V2R provides better service for sparse networks and long distance communication. Providing vehicle-to-roadside communication can considerably improve traffic safety and comfort of driving and traveling.

3.1.3 Core Module of the Application

After designing the communication module, the next module to be taken into consideration is designing the core part of the contended methodology. The proposed strategy can be explored using efficient and effective procedure.

The network of the proposed framework comprises of transmitters, scanners, vehicles, mobile devices. The core part of the system is, first test the behavior of the network, which has to be scanned thoroughly. If the network is stable, simply maintain the network by controlling the traffic and by examining the routing traces comprised. If there are uneven disturbances in the network or the network is unstable, the following steps have to be taken into consideration.

First, the framework has to be designed in such a way that it has to be efficiently enabled and configure the transmitter devices. Second, enabling an efficient message forwarding approach to create awareness among the communicating parties of the network regarding event notifications and finally, make the mobile devices or vehicles deviate from their respective path and relocate them towards the safer paths.

3.2 Factors that Influence Abnormal State of the Network

While vehicles are passing in the network, nearby scanners are activated. According to the number of vehicles joined in the network, Roadway Congestion Index (RCI) is calculated. It is defined as a mathematical rating of highway capacity derived from the ratio of existing design hour traffic volumes to the practical hourly capacity of a rural highway system. If any variation occurred in the ratio, then congestion occurs.

$$\text{RCI}=\frac{(\text{(Freeway DVMT per Lane}-\text{mile)}*\text{Freeway DVMT})+(\text{(principal Arterial DVMT per Lane}-\text{mile)}*\text{principal Arterial DVMT})}{(14{,}000*\text{Freeway DVMT})+(5{,}500*\text{principal Arterial DVMT})}$$

$$\text{Daily Vehicle Miles Travelled (DVMT)} = \frac{\text{(Annual vechile Miles Travelled (AVMT))}}{365}$$

$$\text{Freeway DVMT} = \text{Urban Freeway DVMT} + \text{Rural Freeway DVMT}$$

$$\text{Principal Arterial DVMT} = \text{Urban principal Arterial DVMT} + \text{Rural principal Arterial DVMT}$$

$$\text{Principal Arterial DVMT per Lane-mile} = \frac{\text{Urban principal Arterial DVMT}}{\text{Urban principal Arterial Lane}-\text{miles}} + \frac{\text{Rural principal Arterial DVMT}}{\text{Rural principal Arterial Lane}-\text{miles}}$$

$$\text{Freeway DVMT per Lane-mile} = \frac{\text{Urban Freeway DVMT}}{\text{Urban Freeway Lane}-\text{miles}} + \frac{\text{Rural Freeway DVMT}}{\text{Rural Freeway Lane}-\text{miles}}$$

3.3 Enable the Transmitter

The network of the proposed framework is configured, in such a way that it locates the scanners at intermediate stages. These Scanners are incorporated with the configurable sensors that have the capability of sensing abnormal events in the network. When disturbances occurred in the network, these sensors will get activated and they activate their respective scanners, which will send signals to the nearby monitoring server. This Server then sends the signal to activate the transmitters that are near by the notified scanners.

3.4 Message Forwarding Strategy

Transmitters have the ability to generate the congestion notification message and forward it to all the communicating parties in the network by implementing the strategy of broadcasting in that particular region. For the efficient message forwarding, Reliable Directional Greedy Routing (RDGR) algorithm [12] is used. RDGR is a reliable position based greedy routing approach. In this approach it takes the position, speed and link stability to choose next appropriate forwarding node.

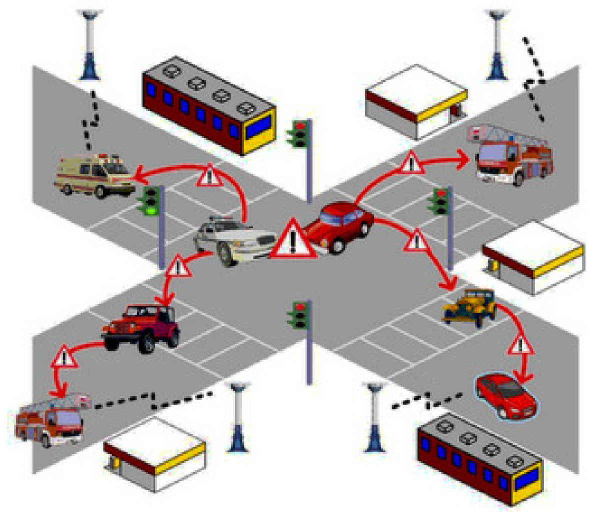

FIGURE 6: Message Forwarding System.

Figure 6 shows the interative module that implements the message forwarding approach.

To identify path stability we need to know individual link stability along the path. We define link stability in terms of link expiration time which means maximum time of connectivity between any two neighbour nodes. In order to calculate the link expiration time we assume motion parameters of any two neighbours are known. Let n_1 and n_2 be two nodes within the transmission range R and x_1' , y_1' and x_2' , y_2' be the coordinate for node n_1 and n_2 with velocity v_1 and v_2 and the directions Θ_1 and Θ_2 respectively. Let after a time interval *t the* new coordinate will be x_1 , y_1 for n_1 and x_2 , y_2 for n_2 . For time *t* let d_1 and $d_2$be the distance travelled by node n_1 and n_2.

Formula for calculating d_1 and d_2 are

$$d_1 = v_1 t$$

$$d_2 = v_2 t$$

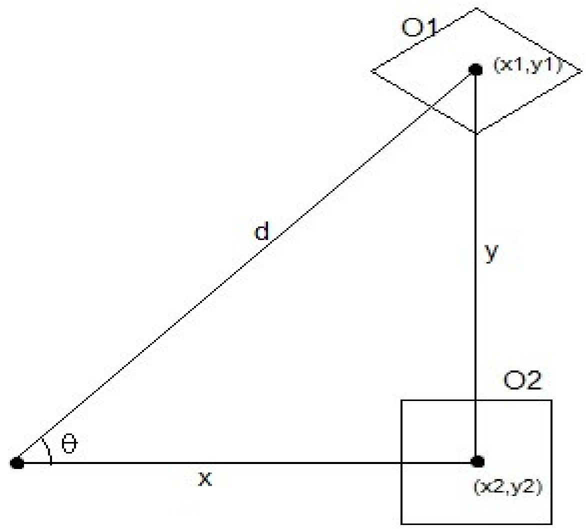

FIGURE 7: Representing the coordinates of two mobile devices.

From the above figure, the coordinates will be generated as

$$x = d\cos\theta$$

$$y = d\sin\theta$$

Formula for calculating new coordinates (with respect to old coordinates) is

$$x_1 = x_1' + x_1 = x_1' + d_1\cos\theta_1 = x_1' + t(v_1\cos\theta_1)$$
$$y_1 = y_1' + y_1 = y_1' + d_1\sin\theta_1 = y_1' + t(v_1\sin\theta_1)$$
$$x_2 = x_2' + x_2 = x_2' + d_2\cos\theta_2 = x_2' + t(v_2\cos\theta_2)$$
$$y_2 = y_2' + y_2 = y_2' + d_2\sin\theta_2 = y_2' + t(v_2\sin\theta_2)$$

Formulas for calculating distance between two nodes at time t are

$$D^2 = \{(x_1' - x_2') + t(v_1\cos\theta_1 - v_2\cos\theta_2)\}^2 + \{(y_1' - y_2') + t(v_1\sin\theta_1 - v_2\sin\theta_2)\}^2$$

Formula for calculating link stability between two nodes at time t is

$$LS = \frac{R}{D} = \frac{R}{\sqrt{\{(x_1' - x_2') + t(v_1\cos\theta_1 - v_2\cos\theta_2)\}^2 + \{(y_1' - y_2') + t(v_1\sin\theta_1 - v_2\sin\theta_2)\}^2}}$$

Where *LS:* link stability between any two nodes over time period t

R: Maximum transmission range

It compares all the ways to find the optimal path in forwarding the message. Finally it will choose optimal way, which has more speed, velocity and link stability and send messages to the vehicles and the mobile devices.

3.5 Deviation of Vehicles

The forwarded message contains the information regarding alternate path, which avoids the influence of abnormal activities, to control the traffic. Receivers equipped in the devices can sense the forwarded message and activates the GPS system configured in that mobile device. This GPS system drives the device to the desired optimal path where there will be lesser or zero impact of the uneven disturbances occurred in the network.

The network is going to be examined at regular levels to check out the stability of the network. If the network is stable, then it is sufficient to maintain the network by analyzing the traffic amount and respective traffic volume information of the network. If the network is not stable, then it is necessary to accelerate the sub modules necessitated to make the unstable network comes under stable state. The proposed strategy incorporates minimum and simple computations in transforming the network from unstable condition to the stable one.

4. RESULTS AND DISCUSSIONS

The realistic implementation of VANET is much costly and challenging. Thus, simulation is much practical and cost effective. In this work, a simulator called Veins (vehicles in network simulation) which consists of three components is used to simulate the real time scenario. These components include SUMO for mobility, OMNeT++ for network simulation and simulation control, and a TraCI to do the coupling.

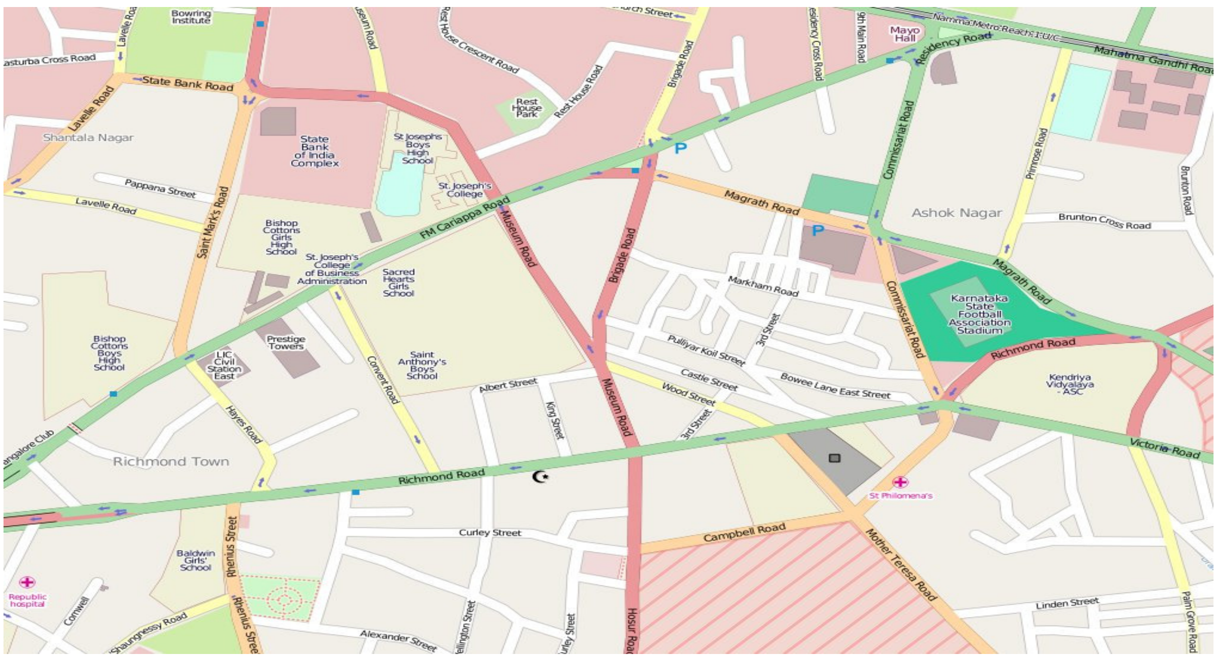

FIGURE 7: Image showing the real time scenario of a Bengaluru, Karnataka region.

Figure 7shows depicts the image real time scenario of a region, which provides input to the simulator that can effectively implements the proposed strategy.

FIGURE 8: behaves as an input image to the simulator on which contended strategy applies.

Figure 8 shows the input image on which the yellow spots represents moving vehicles which forms Vehicular adhoc network.

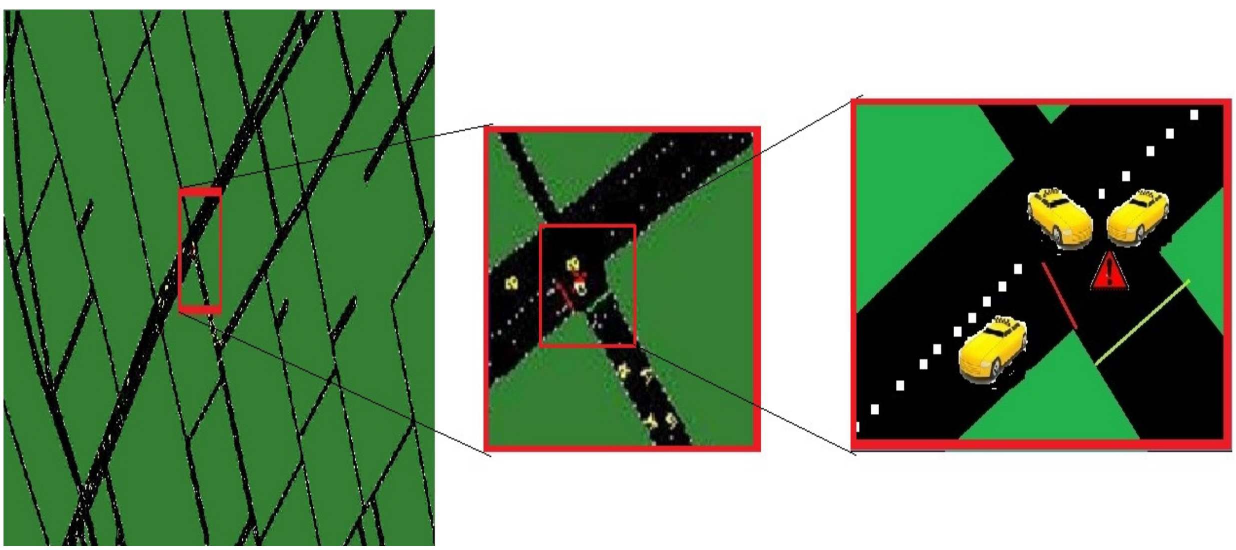

FIGURE 9: Scenario depicting uneven disturbances ocuured in the traffic.

Figure 9 shows the illustration of disturbances occurred among the vechiles in the network traffic .

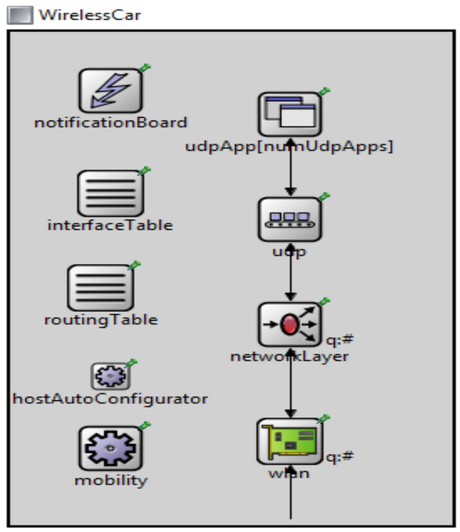

FIGURE 10 shows internal structure of the transmittor configured in the moving vehicles.

Above figure depicts the modules of the Transmittor internal structure that enhance the flexibility of message forwarding approach.

5. CONCLUSION

This works implements the framework capable of producing realistic vehicular mobility traces for network simulator. Simulation results were presented to understand the differences among various mobility levels in terms of vehicular density and speed distribution. The progressive introduction of stop signs, traffic lights, multiple lanes demonstrates how the modeling of each of these features brings the noticeable changes to the system performance.

The core part of the proposed system is, first to test the behavior of the network, which has to be scanned thoroughly. If the network is stable, simply maintain the network by controlling the traffic and by examining the routing traces comprised. If there are uneven disturbances in the network or the network is unstable, then the subsequent steps have to be taken into consideration. It is part of future work to investigate the actual impact of different traffic phenomena on a vehicular network, so to understand which factors must be considered and which can be neglected for a confident VANETs simulation study.

REFERENCES

[1] Gilbert held “inter and intra vehicle communication” by Taylor & Francis Group, LLC, 2008

[2] Vaishali D. Khairnar “Mobility Models for Vehicular Ad-hoc Network Simulation” *International Journal of Computer Applications (0975 – 8887) , Volume 11– No.4, December 2010*

[3] C. Bettstetter, “Smooth is Better than Sharp: A Random Mobility Model for Simulation of Wireless Networks.”, 4th ACM International Work-shop on Modelling, Analysis, and Simulation of Wireless and Mobile Systems (MSWiM 2001), Rome, Italy, July 2001.

[4] Nedal T. Ratout and Syed Masiur Rahman. “ A comparative analysis of currently used microscopic and macroscopic traffic simulation software.” The Arabian Journal for Science and Engineering, 34(1B) :121-133,2009

[5] Transportation Research Board of the National Academies. “Transportation Research Record: Journal of the Transportation Research Board”. Volume 1852/2003, January 2007.

[6] SHANG Lei, “RESEARCH OF URBAN MICROSCOPIC TRAFFIC SIMULATION SYSTEM” Vol. 5, pp. 1610 - 1614, 2005

[7] Baber Aslam and Cliff C. Zou, “Distributed Certificate Architecture for VANETs” School of Electrical Engineering and Computer Science University of Central Florida Orlando, FL, USA

[8] C. Gorgorin, V. Gradinescu, R. Diaconescu, V. Cristea, and L. Ifode. “An Integrated Vehicular and Network Simulator for Vehicular Ad-Hoc Networks.” In Proc. European Simulation and Modelling Conference (ESM), 2006.

[9] Francisco J. Martinez, Chai Keong Toh, Juan-Carlos Cano, Carlos T. Calafate and Pietro Manzoni “A survey and comparative study of simulators for vehicular *ad hoc* networks (VANETs)” WIRELESS COMMUNICATIONS AND MOBILE COMPUTING *Wirel. Commun. Mob. Comput.* (2009)

[10] Brandner, G, Schilcher, Bettstetter, “Proceedings of International Symposium on Communications, Control, and Signal Processing (ISCCSP)” march 2010

[11] John F. Kennedy “Freeway management systems and motor vehicle crashes”. Cambridge, MA 02138, June 2000

[12] K.Prasanth1 Dr.K.Duraiswamy2 K.Jayasudha3 and Dr.C.Chandrasekar4, “IMPROVED PACKET FORWARDING APPROACH IN VEHICULAR AD HOC NETWORKS USING RDGR ALGORITHM”