Web Application and Emulation for Traffic Monitoring Using Simulation Tool

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Abstract— **In modern times, significance of mobile service sector progressed so fast in the world and it is major phenomenon in the development of telecommunications field. Wireless technology has got the ability to develop new communications systems, multimedia services and others. Related to the continued growth of the vehicular industry and the increasing needed of road safety a new concept in the communications field was born: vehicular ad hoc networks (VANET). Vehicular sensor network (VSNET) is a promising technology, which combines wireless communication offered by vehicular ad hoc networks (VANET) with sensing devices installed in vehicles. VSNET generates opportunity to develop the road-side sensor infrastructure of current Traffic Monitoring Systems (TMS). VANETs are getting more and more attention from car manufacturers and governments both because of the wide-range of applications and services they can provide, such as car assistance, road safety systems, crash avoidance, Internet access, etc. This paper provides a simulation and emulation study of the proposed platform design which focuses on the possibility of the use of simulation tools to help build and develop an effective traffic monitoring system, so this system provides useful information for both: the vehicle driver and the authorized person at the traffic control center in order to contribute reduce the negative effects of traffic congestion. A web application design and the simulation and emulation process is presented and open source simulator tool is used for this study namely-NCTUns-6.0 (National Chiao Tung University Network Simulator).**

Index Terms: **VANETs, VSNET, VANETs applications, NCTUns-6.0 simulator.**

I. INTRODUCTION

Traffic congestion is a significant issue around the world. It causes a number of problems including economic costs due to delay travel times particularly during peak hours, air pollution and accidents.

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Therefore, improvement in the traffic management and control system should be given attention to improve the transportation system in the metropolis. This would enhance worker productivity and ultimately increase Gross Domestic Product (GDP).

One of the basic issues in VSNET applications development is the efficient use of the wireless communication medium. VANETs are getting great significance at car manufacturers and governments because of the wide-range of applications and services they can provide, such as car assistance, road safety systems, crash avoidance, Internet access, etc. - besides designing and implementing VANETs it is complex and demands extensive research. The world is progressing at a very fast rate, the same thing is happening in an interesting field called "wireless sensor networks".

In general, the wireless networks that have spread widely, are considered, as a kind of communication technology. Thus, it presents a scientific challenge in the field of research that catches the interest of many researchers around the world. Also, WSNs are being used in different areas. It is difficult to expect that in the coming years, the world will be covered with wireless sensor networks within, possibility of having an access to them via the Internet. This can take into consideration that Internet is becoming a physical network. There are many contributions in ad hoc networks, such as WSNs and VANETs have been proposed [1] [2]. Both WSNs and VANETs are considered as kind of ad hoc networks which can operate without any predefined or centralized management. The organization of network is accomplished by the nodes themselves. Every node is able to work as a sender, receiver or as a routing platform for forwarding packets. WSNs are interesting alternatives to other technologies traditionally used for monitoring. They require low installation and maintenance costs and enable the development of distributed collective applications, thus acquisition of data does not limit their functionalities.

In general WSNs are composed of small, low-cost devices that have the capabilities of processing, sensing and storing and communicating wirelessly. The nodes frequently self-organize after being deployed in an ad hoc mode. It is an infrastructure comprises of sensing (measuring), communicating, and computing elements

that make the user able to observe, instrument, and take a suitable action to the phenomena and events in specific environment. In addition, the tiny weight and size of nodes gives the ability to quick deployment in the environment under study. WSN also has some limitations against other types of networks such as small transmission range, limited memory, scarce energy, and low processing capacity. In addition, WSNs have the ability to work in conjunction with other technologies which make the opportunity for making more complex applications. As an example for this conjunction: the applications consist of WSN and VANET which can be categorized in four various groups : (a) Traffic control, (b) traffic law enforcement, (c) traffic safety, and (d) smart parking applications [2]. The Intelligent Transportation Systems (ITSs) considered as one of many applications benefited from the capabilities of VANET and Wireless Sensor Networks (WSNs).

Simply VANET is a kind of Mobile ad hoc networks which provide a characterized way to Intelligent Transport System (ITS). It also supplies two types of communications: inter-vehicle communications and vehicles to Road Side Units (RSU) communications. These networks consist of sensors and On Board Units (OBU) installed in the vehicle beside the RSU. The data collected from the sensors on the vehicles can be displayed at drivers screen, sent to the RSU or even broadcasted to other vehicles depending on its nature and importance. The RSU distributes this data (road state-current weather) along with other data in two directions: from vehicles, other road sensors to traffic control center and from control center to vehicles among RSU. In addition, it gives safety-oriented applications that include notifications of emergency situations, such as car accidents or bad weather conditions. Also, it offers entertainment applications such as downloading of music and video files, and distributing games played among passengers in neighboring vehicles, and commercial services such as parking space booking, Internet access and gas payment [3]. Figure 1 illustrates the VANET System Architecture.

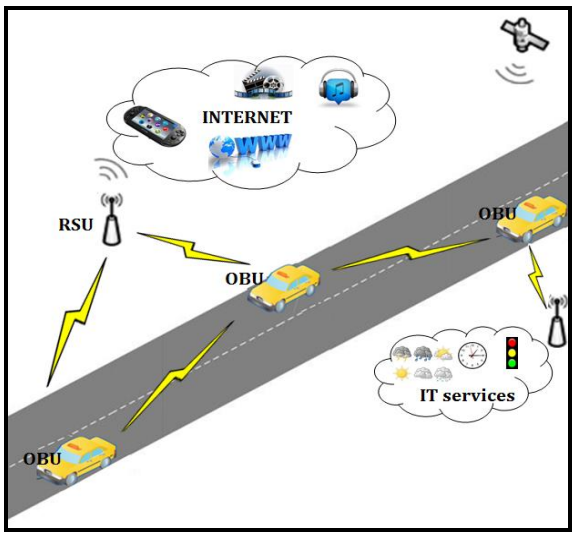

Figure 1. VANET System Architecture

The VSNET network [4], [5] is developed as a new sensor network application for monitoring the physical world of urban environments, that is also considered as type of VANET [6]. Simply VSNET is a mobile wireless sensor network consists of a set of smart vehicles which are equipped with different types of on-broad units sensors (OBU). It is able to communicate via wireless medium with pre deployed road side units (RSU) and with each other.

The main objective of VSNETs is to provide comprehensive, effective sensing and networking capacities for mobile users on the road and supporting a set of urban monitoring and safety applications. In the near future, VSNETs will become one of the significant elements of the next generation of Internet and Internet of Things due to the growing salability of mobile wireless devices and smart vehicles [5]. This type of developed network is being established and evaluated in this paper, and The IEEE802.11p protocol is used for communication issue in the simulated VSNET to carry out the trace file. This file represents the simulated information gathered by the VSNET (car numbers, weather state, car accident, etc.). In addition, the used protocol was evaluated, and NCTUns-6.0 simulator tool [7] is selected for this study to generate the trace file of the proposed VSNET platform design. The NCTUns-6.0 simulator tool is an amazing tool which enhances various advantages over other simulators like VanetMobiSim [8], TraNs [9], SUMO [10], etc. The NCTUns is open source software that provides easy and efficient simulation results. NCTUns 6.0 is supported by the RED-HAT LINUX with the Fedora flavor v.12. This simulator is purely written in C++. NCTUns uses Linux TCP/IP protocol stack for packet passing. It supports both wired and wireless networks [11].

II. RELATED WORK

Many researchers have conducted some studies on the ability of using WSN in different applications such as: traffic monitoring, intelligent transportation systems, smart cities, traffic jams, collision avoidance, etc. They had evaluated the proposed systems by means of different performance metrics and using different simulators such as:

- The work presented [12] describes the platform design and presents prototypical implementations that use Simulator of Urban Mobility (SUMO), TinyOS Simulator (TOSSIM), a 3D sensor simulation environment, and a test-bed of miniature vehicles called Gulliver. The proposed system opens the door to new ideas towards intelligent transportation systems for smart cities. In addition, the design provides cost efficiency, flexibility, and mountable testing chances for future vehicular systems. Finally, based on a prototypical implementation results, it is concluded that combined method extended to examine that phenomena of real world traffic, such as shock-waves and stop-and-go traffic jams, can

be generated using mixed digital and physically simulated vehicles that navigate through the same map. This enables the demonstration of safety critical applications that are related to collision avoidance in the context of different traffic phenomena. Also intelligent balloon vehicles can be added to the test-bed to validate safety critical applications. The useful results gained from using miniature vehicles can then be used with full-scale vehicles on testing grounds. The proposed platform gets new opportunities for testing and validating new planning for traffic situations in complex systems.

- The Design and Implementation of Traffic Monitoring System Based on Embedded Web Technology [13] is presented to exploit the technologies such as the internet, design a Traffic Monitoring System that can remotely monitor and control a network of traffic. The system adjusts an embedded Web server technology to make an implementation of collected data and monitoring through using modular structure and heterogeneous network seamlessly connected. The traffic monitoring system depends on the embedded Web technology that has the high integration, low power consumption and real-time efficiency. It is also able to efficiently manage the complexity of the system resources.
- In the similar work [14], another method is presented that combines embedded WEB technology with Internet to implement remote traffic monitoring through Web Server applications solidified in embedded ARM processor. They can monitor and control the traffic conditions by using web browser and divide the system into two main design units. The first one is arm unit used to monitor and the other is signal unit used to control. The system can be extended to desired demands, and the authors conclude that the traffic monitoring system based on embedded Web technology possesses is able to effectively manage the increasing complexity of system resources and makes some hardware virtualization. Also the commercial implementation of this idea will give effective monitoring and control using embedded web technology. The results show that a sustained near- real-time system can be setup with the web browser. It easily makes the system flexible to be assembled, upgraded, and replaced. Thus an increase of benefits is for the traffic monitoring system based on embedded Web technology.
- In another paper [15], the authors see that it is very necessary to build an intelligent traffic control and monitoring system to resolve the traffic congestion of roads and reduce accidents, and the management of the traffic at road intersections in a city represents the major factor that affects the traffic flow. The managers can monitor and manage the situations of traffic through the Web browsers. They tested the use of embedded web server technology to design a web-based traffic management system that can remotely control and monitor the traffic at various road intersections simultaneously. The system target is improving the classical traffic monitoring system by combining better management and monitoring schemes as well as providing real time information to road users. The system presents the idea of merging the embedded WEB technology with Internet to perform remote traffic control and monitor through the Web Server applications. Therefore, the remote real-time monitoring and control of traffic management is provided to authorize personnel through Web browsers without any constraints of time and geographical repercussion.
- The work in [16] presents the needed capabilities of combining a simulator for road traffic scenarios and wireless sensor networks. It offers an overview of the needed capabilities for current wireless sensor networks and road traffic simulators intended to cooperate to solve common problems in Intelligent Transport Systems.
- The developed scheduling and optimization algorithm is presented by the authors [17]. They develop and test this algorithm for traffic lights using Intelligent Transport Systems by connecting different simulators to evaluate their efficiency. They also give the overview of current road traffic and WSNs simulators to demonstrate that the current ITS simulators can be used to test the developed algorithm aimed at effectively controlling traffic in cities.
- A virtual sensor methodology is presented for collecting, storing and processing large volumes of network-level data [18]. The opportunities in utilizing the real-time traffic data provided by online services are also discovered. To evaluate the reliability of the collected data via the proposed methodology, they make a comparison between the collected data and the data from physical loop detectors and electronic toll tag readers. The statistical result analyses illustrate that there is a forceful association between measurements of travel time from virtual sensors and infrastructure based sensors. At the end, they conclude that the gaining results are hopeful results for next work in implementation and research.

III. THE PROPOSED VSNET WEB APPLICATION

By using available wireless technologies like mobile ad hoc network (WSN, and VANET) this paper proposes framework that accompanies virtual world and real world. The virtual world is presented by means of simulation, while real world is presented by using the

simulation outcome data through the web application to get useful information for different users. The proposed web application provides users with important information such as: traffic state and weather state. This information helps the users to avoid congestions in order to manage their trip.

In addition the paper supports the Traffic Control Center with real time information for the road users' interest. This real time monitoring is an emulation of the running of the simulated scenario.

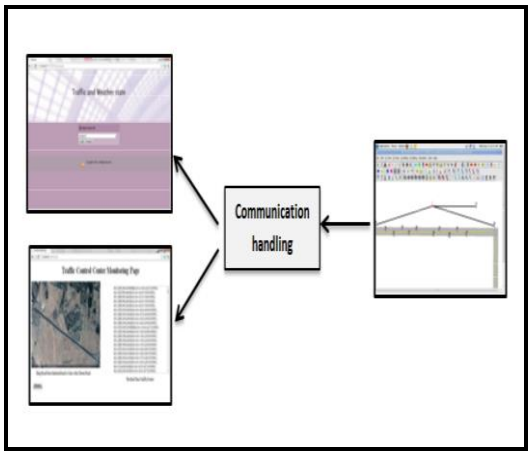

Figure 2.The proposed VSNET Framework.

VANETs and WSNs are issues of current research activities. Also they have very different characteristics. In the Vehicular Sensor Networks (VSNET) concept both networks can benefit from the strengths of each other and avoid weaknesses.

There are two kinds of sensor nodes in VSNET: sensors that deployed in predetermined distances besides the highway road is called Road Side Sensor (RSS) nodes and others are embedded on the vehicles-vehicular nodes. On the other hand, the vehicular nodes are used to sense road conditions and to communicate with both static road side sensors and vehicular sensors. RSS nodes receive the data from mobile nodes and retransmit towards the server.

This paper will focus on the part of handling the coming information form simulation to prepare and provide them to different users, while the information related to how using simulation, used protocol, communication scenario was presented and discussed in the work [19]. The main interface for the end user is aimed to be a platform independent, so the work developed a web site application. The apache2 server [20], php5 [21], and MySQL [22] are used to design this web application because of their availability and free of charge licenses. The following is a brief introduction to each one of them:

The Apache Web server is written in the C programming language and supports server side programming language support interfaces such as Perl and PHP. The virtual hosting feature of Apache allows a single Apache installation to serve multiple websites.

Apache is free for all users, from individuals to large companies. The Apache license allows vendors to customize and sell their Apache installations with proper attribution. PHP is a server-side programming language used to create web pages that are more interactive than their HTML counterparts. PHP also optimizes the speed of web pages since processing occurs on the server and not on the side of the end user.

To create a website with PHP, it needs a basic understanding of the language plus some knowledge of web development. There are websites and books where anyone can learn the proper syntax for PHP. Because PHP is an open source language, it is less expensive to use than its counterparts. PHP and MySQL are common technologies to use within a website, and the key skills required are not difficult to learn. Even if the user has no programming knowledge, he can learn how to use PHP and MySQL by focusing on one task at a time and building on his skills as he goes along. The details of the MySQL database and PHP code will depend partly on what the purpose of his website is.

PHP and MySQL are two programming platforms for controlling the server functions on a website. If a user wants his visitors to interact with his website, he can do so by leaving comments, sending him an email through the page, filling out forms and performing other tasks but he needs a server-side platform in place to perform such tasks. PHP and MySQL work together to provide a database for the user website and a way to interact with that database directly from a web page. While it can involve considerable programming skill, it is possible to build a dynamic website using PHP and MySQL even if the user has little knowledge of these platforms.

PHP is a scripting language while MySQL is a relational database. Using PHP and the free MySQL together, the user can easily create fully dynamic and database driven sites. There are many online tutorials available to help get started and working with database driven sites. One can download MySQL free of charge from Microsoft site.

Actually, the presented web site application contains four pages. The first page contains two main tips to the user to choose from. These tips include Traffic and Weather. Figure 3 illustrates the first page. When the user clicks on Traffic button on the first page, it will display the page of traffic state. It contains a map and markers placed on it. The marker in traffic page displays the information of traffic: Road name, Traffic state (congested, free), and time as it is shown in Figure 4. When the user clicks on Weather button on the first page, the page of weather state will display. It contains a map and markers placed on it. The marker in weather page displays the information of weather: Road name, Weather Mode (Rainy, not rainy), Rain Density, Temperature, and time as shown in Figure 5.

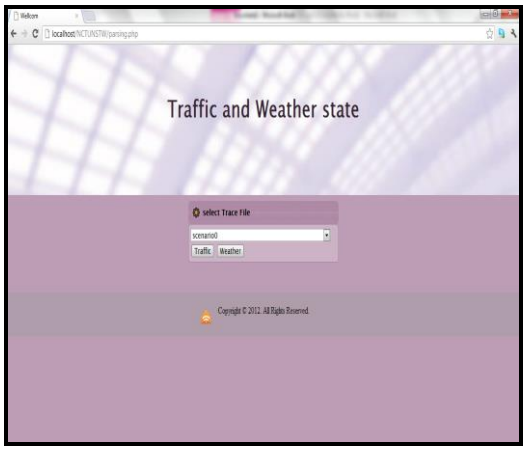

Figure 3.The First Page.

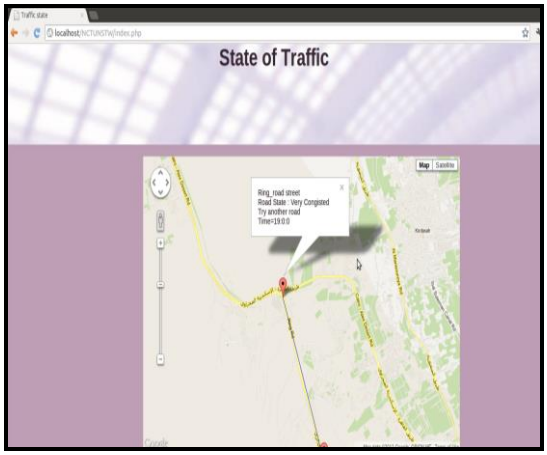

Figure 4.Traffic State Page

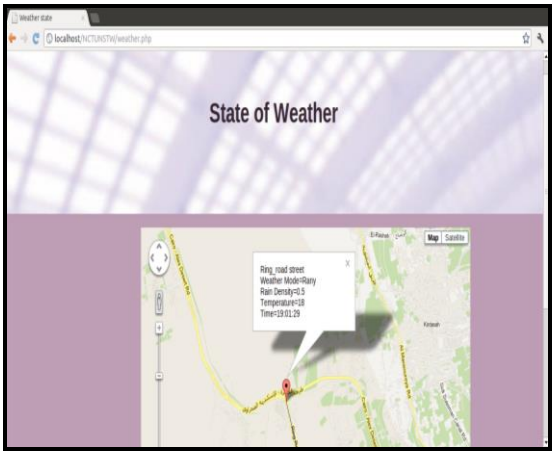

Figure 5.Weather State Page

IV. THE VSNET FRAMEWORK EMULATION

To insure the effectiveness of the proposed VSNET framework the paper stimulates the emulation feature that is provided by NCTUns simulator. The emulation results will be displayed on a webpage at the Traffic Control Center. This webpage has an authorized access for the traffic center users. This is also where only the specialized users can browse the traffic information, understand the meaning of this information and take the suitable decision or action.

In order to provide that emulation feature within the paper, the authors, as illustrated in Figure6 has established a network scenario consisting of two computers (computer 1 and computer 2), which are actually implemented with virtual machines.

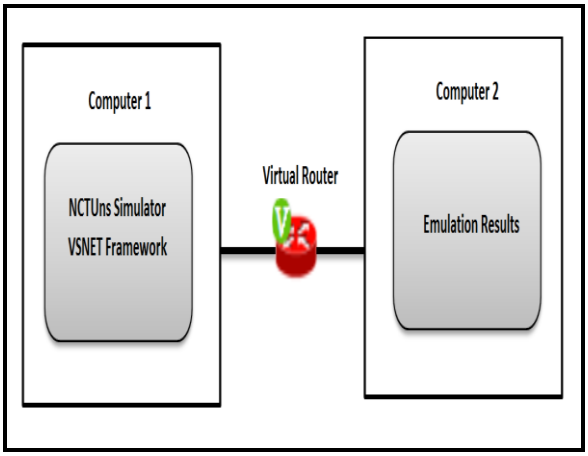

Figure 6.The Network Scenario of the Emulation Process

Computer 1 is used to run the proposed VSNET framework on NCTUns simulator to generate the acquired data from the road environment. Computer 2, meanwhile, hosts the emulation of the running scenario which receives these generated data to emulate the scene. Figure 7 shows the simulation scenario.

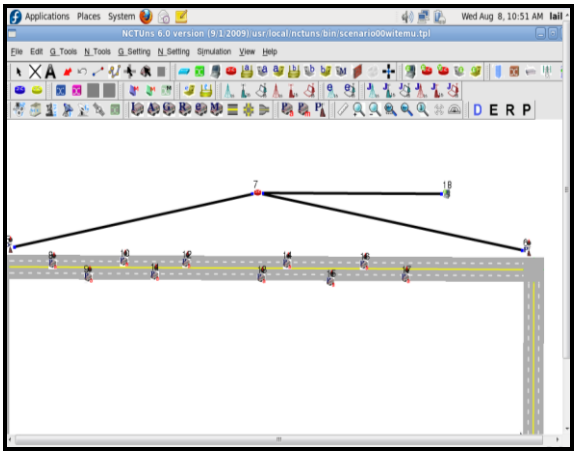

Figure 7.The network scenario of the simulation process

Figure 8 illustrates the result of emulating real world traffic scenario. In the right side of the webpage there is a map of the street of interest, which is the Ring Road from Mariotia Road to Cairo-Alex Desert Road. In the other side of the webpage there is a window that displays real time traffic events information, such as:

- The used protocol.
- Event that happened (e.g. broadcast transmit “BTX”, transmit “TX”, broadcast re-transmit “BRX”, or

received "RX".
- The event started time.
- The duration of the event.
- The packet type such as:
    - (DATA) that means a Data packet,
    - (ACK) that means an Acknowledgement,
    - (BCON) that means a Beacon packet.
- The node IDs based on the IP address.
- The node IDs based on the MAC address.
- The packet's ID.
- packet's length>
- The packet length with bytes.
- The count of successive re-transmit packet.
- The drop reason such as:
    - COLL (collision)
    - CAP (capture)
    - DUPX (duplicate)
- The frequency channel.

Figure 8.The Emulation Interface

When the user clicks on Statistics button on the bottom of the left side, the page of Statistics state will display. It contains a table displays the information of traffic management and this information are: packets transmitted, packet received, packet Losses, and the Throughput as it is shown in Figure 9.

Using such emulation process within the Traffic Control Center, it can provide an effective real time monitoring of traffic events, and support decision makers to deal with each event once it happens.

At the end, this work is trying to take advantage of the possibilities in the field of wireless Adhoc communication to reach a solution and even contributes as much to provide a reliable framework.

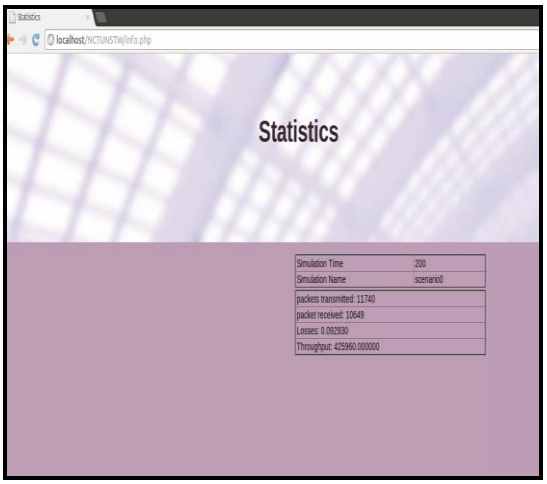

Figure 9.The Statistics Page

From the proposed VSNET framework it concludes that IEEE 802.11p performs a good performance in VSNET environments. Also through the proposed web application the user can manage his time and trip correctly, and save his money by discovering congested areas and eventually avoiding them.

V. DISCUSSION

This paper is trying to highlights the importance of using simulation tools for studying, implementing, evaluating, and testing different wireless communication. It proposes the VSNET framework using NCTUNs simulator, web application design and emulation of the simulated VSNET framework. It replaces real information that should be collected from sensors with simulation process (trace file). The core aim of web application is to reduce accidents substantially and thereby help solve the congestion problem, which has a great impact in the people's daily lives. In further work it can be make real implementation rather than simulation, and introduce other services to users by web application.

VI. CONCLUSIONS

The information gathered from cooperative architecture between the WSNs and VANETs (VSNET) can be processed, analyzed and broadcasted and made available to the public through services such as web applications and Google Map. A network following this architecture is inexpensive and easy to deploy because the price of motes continues to drop. A vehicle simply needs to be enhanced with the capability of communicating with sensors. Given the need of deploying many sensor nodes in a WSN, simulations become a more realistic choice in researching and understanding of their application, protocols, design, topologies, and security among others. These simulators help researchers avoid the otherwise large and expensive real hardware network deployment. VSNET is a promising wireless communication

technology and created to improve highway safety and information services. This paper addresses the approach of handling simulation outcome information which simulates Vehicular Sensor Network on the road to implement an efficient ITS system and increases the safety of road travel by discovering the road traffic information through the web application.

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