International Journal of Innovative Technology and Exploring Engineering (IJITEE)
ISSN: 2278-3075 (Online), Volume-8 Issue-10, August 2019

Detection of Traffic Congestion and Marine Border Intrusion using Vehicular ad-hoc Networks

R.Raja Kumar, R.Pandian, P.Indumathi, Sheik Mohammed Shoaib

Abstract—The Vehicular Ad-hoc network, or VANET, is for sharing of emergency and safety information among vehicles to ensure safe travelling of users in road. It is the technology that considers moving cars as nodes to create a mobile network. VANET turns every participating car into wireless router or node, allowing cars to establish communication. Vehicles can communicate within themselves (V2V) and also with the road side units (V2I). Vehicles communicating with other vehicles are likely to enhance the driving experience, awareness, situation perception and thus safety. In response to the problem of drastically increasing road accidents and climatic disasters like smoke, fog etc., we have designed and tested in various traffic scenarios of Kathipara(area in Chennai Tamilnadu), T.Nagar(area in Chennai, Tamilnadu), highway and a village . Each scenario is very different from each other; like Kathipara having moderate real time traffic, T.Nagar having extensive dense traffic, highways with irregular traffic and villages which having very few vehicles for most time. We designed the placement of RSUs(Road Side Units) in each scenario and we analyzed the delay and packet delivery ratios(PDR) in each scenario. These results would guarantee the use of VANET in real time. Yet another traffic scenario we have considered is what happens in marine environment. Unintentional International border crossing by fishermen and hardships encountered by fishermen due to extreme weather conditions are the motivation behind our conceptualizing a network for communication among boats which can be called a BANET (Boat Adhoc Vehicular Network).

Keywords—VANET, V2V, V2I, BANET

1.INTRODUCTION

A. OVERVIEW OF VANET

INDIA is toppest player among developing countrieswhen the number of vehicles and vehicle density is considered. Hence it is important to provide security to the drivers and passengers alike in the congested traffic prevalent in our country. India has consistent growth in economy due to logistics sector. Freight movement in India is one among the highest globally.. Traffic Management is cumbersome in India.

Manuscript published on 30 August 2019.
***Correspondence Author(s)**
Dr.R.RajaKumar,Mathematics Department, Sathyabama Institute of Science and Technology ,Chennai,India,e-mail:,rrkmird@gmail.com.
Dr.R.Pandian, Electronics and Instrumentation Engineering, Sathyabama Institute of Science and Technology,Chennai,India. rpandianme@gmail.com
Dr.P.Indumathi,Electronics Engineering Department, MIT Campus Anna University Chennai, India, indu@mitindia.edu.
Sheik Mohammed Shoaib, Engineer in Electronics, Nissan Renault, MahendraCity,Near Maraimalar Nagar, Chengalpattu, Tamil Nadu, India shoaibmohammed97@gmail.com

Congestion occurs when the number of vehicles across the street outnumber the available road or street capacity.High traffic density arises due to predictable and unpredictable construction sites or peak hours of travel (i.e. office hours) about which drivers are aware, whereas unpredictable factors. Predictable factors include traffic during peak hours or that at construction sites.Unpredictability of traffic arises due to weather, accidents and human behavioural anomalies. We can avoid congestion in roads, if only the drivers get to know the full picture of traffic scenes in the roads.

B. PROBLEM STATEMENT

1) PROBLEM 1

India experiences 17 deaths every hour due to accidents on the road, which is the largest figure worldwide. This is due to lack of road-safety infrastructure, high number of vehicles leading to heavy traffic jams and fatal collisions.

Heavy traffic jams with increasing population, especially in urban areas act as the primary reason for this cause. Negligence of attention of drivers, lack of proper visibility during bad weather also effect in accidents. Also modes to report for emergency purposes in rural/sub-urban areas are lacking and thereby immediate attention is not received.

2) PROBLEM 2

Fishermen cross international borders due to lack of alert systems and very weak inter-boat communication. This has costed lives of many fishermen. As of today Pakistan has 537 Indian fishermen in their custody and Sri Lanka has 144 fishermen.

Also, there are a huge number of cases registered stating fishermen's hardships at the sea during the case of extreme weather conditions such as storms or irregular seismic activity. Deep sea fishermen who are already into the sea, neither have a mode to receive alerts from the land nor to report them back. Due to this absence of this technology, they are unable to be known of the conditions they are going to face, against which they can take necessary preventive measures to safeguard themselves or even return to the land before the event arises. Also it is not possible for them to report to the land in case of any emergency.

C. VEHICULAR AD-HOC NETWORKS (VANET) - A SOLUTION

Vehicular Ad-Hoc Network is an upcoming technology to achieve intelligent transportservices.The technology is a culmination of WLAN/cellular and Ad Hoc networks to achieve continuous connectivity. VANET makes every member car into a node, facilitating cars almost 100 to 300 meters from each other to join and, in turn, generate a network with a wide range.

When signal range is exceeded, the cars move out of the network, while other cars join, connecting them toeach other so that a mobile Internet is formed.

VANET facilitates communication in three ways:

i. Vehicle-to-Vehicle (V2V)
ii. Vehicle-to-Infrastructure (V2I)
iii. Infrastructure-to-Infrastructure (I2I)

Here, Vehicles are mobile nodes while Road-Side Units/Road-Side Infrastructures are stationary nodes.

Vehicles in motion are nodes communicating with other nodes as well as fixed infrastructure. The VANET technology would warn hazards to other vehicles averting accidents. The information from VANET relate :

i. To integrate the data from node such as position, density & distance from traffic congestion site.
ii. To transferthis information to the driver.

The traffic information is collected dynamically and gets continuously traversed to all moving nodes in the network and also to a Central Traffic Data System via RSUs. Thereby, the traffic density or the occurrence of events get updated statistically and are broadcasted to the nodes.

D. CHARACTERISTICS OF VANET

VANET is an application of MANET but it has its own distinct characteristics such as high mobility, changing topology, unbounded size, frequent information exchange, time critical information and partitioned network.

2.ARCHITECTURE OF VANET

A. AODV ROUTING

The popular routing protocol AODV can be applied to VANET as shown in the figure below.

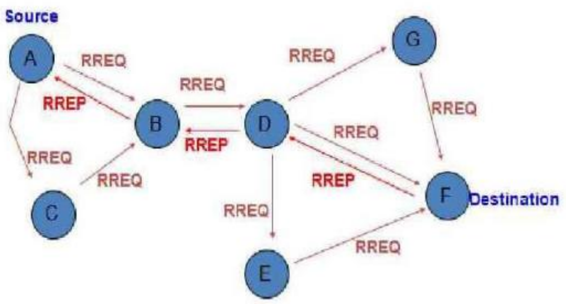


Fig. 1. AODV Routing

B. PROPOSED SYSTEM MODEL

A complete VANET system model is established with Vehicles as Mobile Nodes and RSUs as stationary nodes. RSUs are some base stations which broadcast the message alerts to every node in its range. RSUs are assumed to be always connected with each other through a gateway. Also all the RSUs are maintained at a central data centre.

RSUs receive data packets from:

i. Central Traffic Management Centre
ii. Other RSUs
iii. Moving Vehicles

RSU maintains a database of the number of vehicles in its area, emergency message alerts it received from TMC/Vehicles and the data to be broadcasted. The RSU then broadcasts the data packets to the nearby vehicles which reach the destination directly or through ad hoc.

For example, in case of an accident occurred in a region, the RSU receives the alert message from that vehicle and it transfers this alert to nearby RSUs that broadcasts the message to the vehicles which are actually far-away from the area where the accident occurred. This provides an opportunity to these vehicles to take an alternate route in order to avoid the accident zone where roads may have got blocked or a high density of traffic congestion could have occurred.

Also, the occurrence of accident could be forwarded to an Ambulance/Police vehicle via other vehicles/RSUs or even from the TMC in case of no emergency vehicle in nearby area. Thus, quick recovery of normal traffic scenario can be restored and much waste of time could be avoided.

Also, in our model, every vehicle communicates with each other by broadcasting messages. This could prove very useful in case of extreme weather conditions where even the visibility of nearby vehicles could be difficult and also in case of sharp turnings or road damage.

Thus, three communication scenarios are used:

i. V2V – Vehicle to Vehicle
ii. V2I – Vehicle to Infrastructure
iii. I2I – Infrastructure to Infrastructure

By using this combination of communication, maximum interconnectivity can be achieved in the VANET scenario and data packets can be transferred to every vehicle in the network.

C. VANET FOR BOATS

We extended this idea of VANET to a common problem of fishermen communication. The idea is to use an inter boat communication. This specific network used for boat to boat communication may be called BANET (Boat Adhoc Network).

Presently fishermen in most parts of the world have no way of contacting the people in the shore in case of any emergency or in case of dangerous weather forecast when they are deep into the sea for fishing. There are many deaths or many missing cases of fishermen due to bad weather. If the fishermen are alerted of the weather forecasts earlier, they could return or at least take safety measures required. Also by establishing boat-boat communication, they can save each other in case of emergencies and can also report to the base station at the shore. Using this model, we can give a warning message to the fishermen from the shore and the other way too.

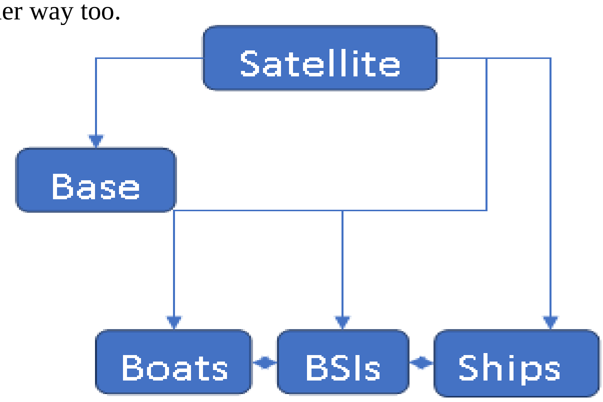


Fig. 2.VANET for Boats – Architecture

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication (BEIESP)

International Journal of Innovative Technology and Exploring Engineering (IJITEE)
ISSN: 2278-3075 (Online), Volume-8 Issue-10, August 2019

D. BASE STATION AT LAND

This is from where we send a warning message. It could be the meteorological centre or any other data centre.

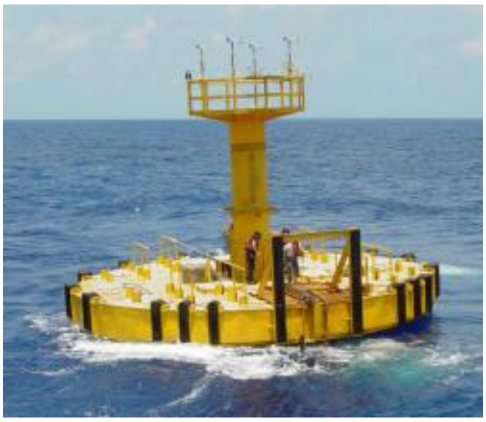


Fig. 3. Boat Side Infrastructure (BSI)

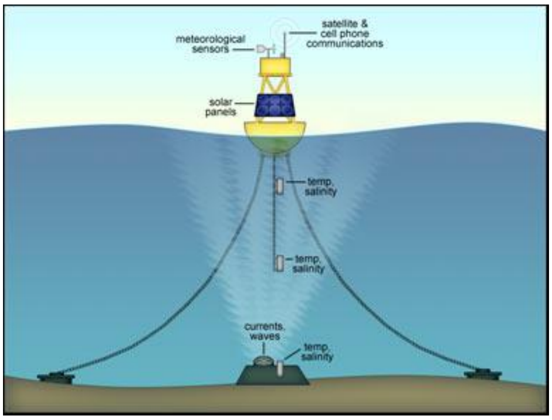


Fig. 4. Boat Side Infrastrcutre– Buoy

The infrastructure we plan to use are buoys which are used in the sea. Buoys are presently used for meteorological purpose, to measure depth of sea, to warn boats of rocks ahead or to measure seismic activities at the sea. The measurements monitored are reported to the land via satellite. But, in our model, we will use these buoys for communication purposes too. Base stations at the land communicate with boats through these buoys. These buoys will have a range which varies based on the transceiver on it. Fig. 1. is a Large Navigational Buoy which is about 12m high and Fig. 4. is how a meteorological buoy or any other buoys are attached to a place in the sea. Solar energy and battery would be used to power the buoy.

E. PROPOSED SYSTEM MODEL

With the system we propose we will able to communicate boats within 100km range of BSI we are going to keep and these BSI will communicate to the shore via satellites. The frequency range we would use is 2 to 5 MHz and modulation would be selected based on the bits per rate for example 3200bps could be given using QPSK or 9600bps using 16-QAM.

3.ANALYSIS & INFERENCE

We simulated traffic models for both land and marine scenarios and the results were analysed for optimal performance of the model. SUMO software was used for Traffic modelling and Ns2 for implementing communication scenario for the Traffic model obtained from SUMO software.

3.1 MODELLING

Simulation of VANET scenario is done in 2 parts, namely:

i. Traffic Model
ii. Communication Model

3.1.1 TRAFFIC MODEL

In Traffic modelling, the paths are designed and routes are established for the movement of vehicles. The simulation is first tried in manual by manually creating nodes and paths for roads and routes are entered using lines of code. Further, upon the checking of this simulation, it is then

extended for real-time traffic in which a real-time map is established with paths and random movements are provided to the vehicles and simulated.

3.1.2COMMUNICATION MODEL

Once the Traffic model is established, the next step is to enable communication between nodes for VANET scenario. For simulation purposes, the communication model for manually established nodes is first simulated and

Location	Packet Delivery Ratio	Average Delay(ms)
T Nagar	98.77	60.1012
Kathipara	97.86	97.9086
Highway	99.32	17.9835
Village	99.45	55.2659

analysed for their performance. Routing models are simulated and the protocol which is found to be most suited is selected for real-time simulation. Once, the manual simulations are done and analysed for optimal performance, the communication model is established for the real-time traffic simulated. The performance of VANET scenario is determined and results are published.

Various Simulations executed are as follows:

Traffic Model:

i. Manual Traffic Simulation using SUMO
ii. Real-time Traffic Simulation using SUMO

Communication Model:

i. Simulation for V2V communication using manually established mobile nodes using Ns2.
ii. Simulation for I2I communication using manually established stationary nodes using Ns2.
iii. Simulation of complete VANET scenario using manually established mobile and stationary nodes using Ns2.

Retrieval Number: J90080881019/19©BEIESP
DOI: 10.35940/ijitee.J9008.0881019
Journal Website: www.ijitee.org

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication (BEIESP)

iv. Simulation of complete real-time VANET scenarios using the real-time traffic models derived from SUMO software. The real-time traffic models are simulated as follows:
   a. Regular Traffic
      i. Densely populated area:
         1. Kathipara
         2. T.Nagar
      ii. Sparsely populated area:
         1. Rural - Village
   b. Irregular Traffic
         1. Highway

3.2 TRAFFIC MODELLING - MANUAL ROAD DESIGNING

Before trying out in real time scenario, it is important to check the credibility of SUMO. So we tried out SUMO by enabling it by manually designing the roads, vehicles, delay time and various polygons.

F. ANALYSIS OF VANET – REAL TIME (Land)

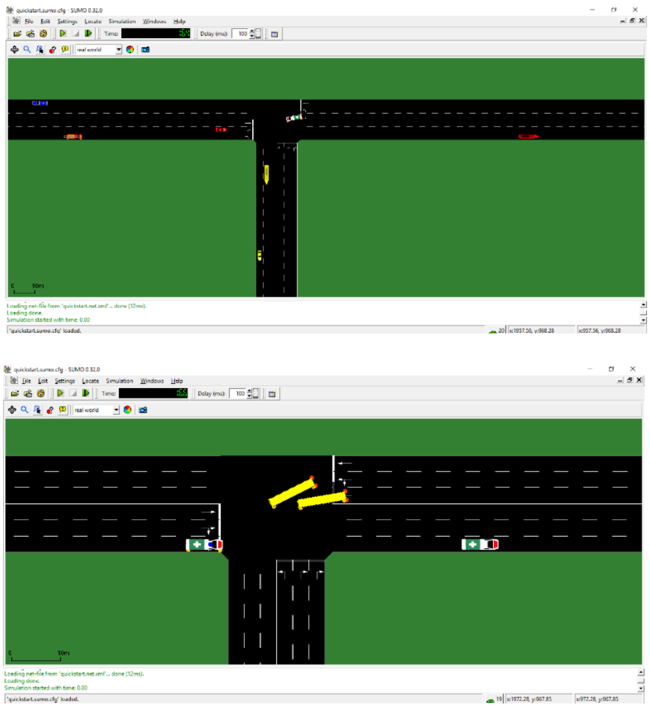


Fig 5Simulation of Traffic Model

We also tried to add various vehicles like cars, ambulances, buses, police vans, trucks and we analysed their mobility by adding routes to each vehicle in sumo. We also modified the lanes and observed the working.

3.2.1 THE KATHIPARA SCENARIO

We simulated SUMO using real time scenario of Kathipara. Area of Kathipara experiences moderate traffic round the clock. We have specified the number of vehicles and analysed the traffic in the area.

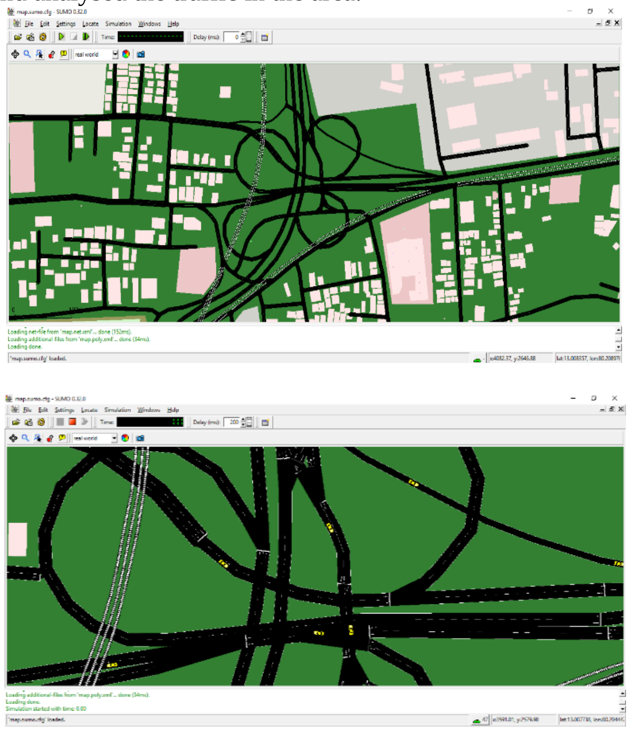


Figure6 Real time simulation –Kathipara

3.2.2 T.NAGAR SCENARIO

After analysing the mobility of moderate traffic areas like Kathipara, we also analysed an area where the roads are highly populated with vehicles for most of the time, like T Nagar which is considered as the Times Square of India.

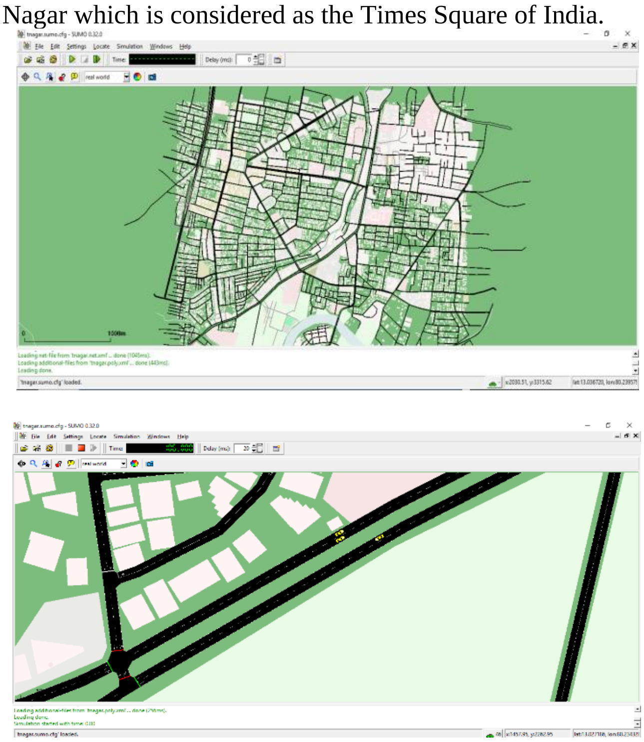


Figure 7 Real time scenario – TNagar

Retrieval Number: J90080881019/19©BEIESP
DOI: 10.35940/ijitee.J9008.0881019
Journal Website: www.ijitee.org

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication (BEIESP)

3.2.3 VILLAGE SCENARIO

68.84% of Indian population reside in villages. Therefore this project would be incomplete without village scenario assessment. The roads are very much under-developed in rural areas and also the number of vehicles here are significantly lower than those in urban areas.

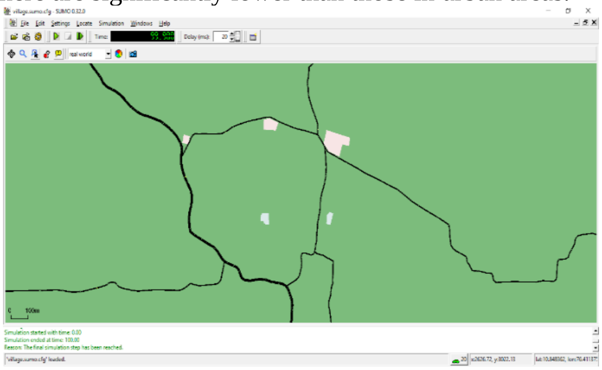


Figure 8 Village scenario

3.2.4 HIGHWAY SCENARIO

India has 228 highways in total. Hence, VANET modelling for highway is indispensable in our project. But, the modelling of a highway differs from the previous ones as the traffic is irregular in Highways. The traffic can vary from a dense population during weekends to very low population of vehicles and the prediction becomes very difficult.

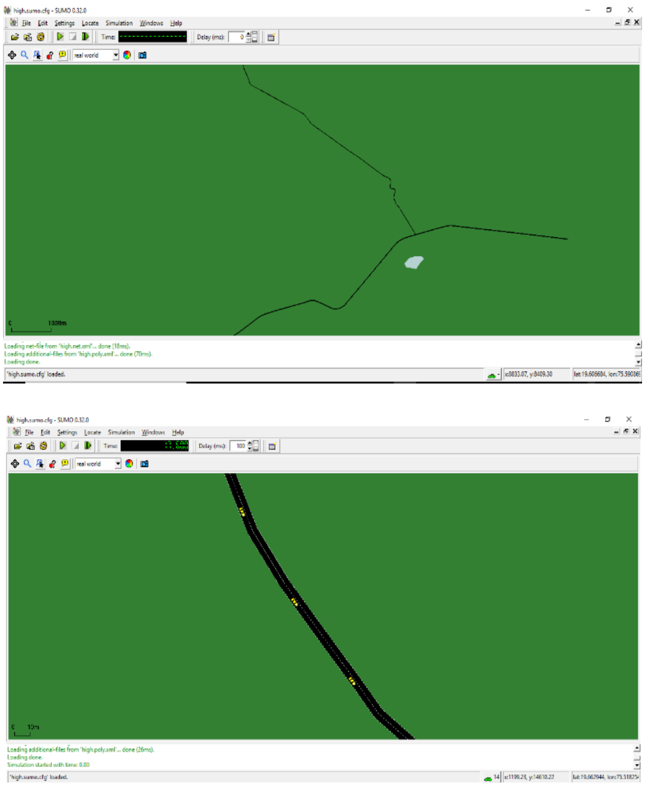


Figure 9 Highway scenario

Thus the traffic models are designed and simulated for various scenarios using SUMO. Once the traffic simulations are analysed, the next step is to establish communication between nodes.

3.3 COMMUNICATION MODEL

Ns2 is used to simulate communication models. Before trying out the real-time scenario, it is important to verify the behaviour of various communication models such as I2I, V2V, V2I in order to confirm for optimal results. Also, the wireless scenario using AODV protocol needs to be analysed and confirmed that it could yield fruitful results in real-time.

3.3.1 AODV ANALYSIS

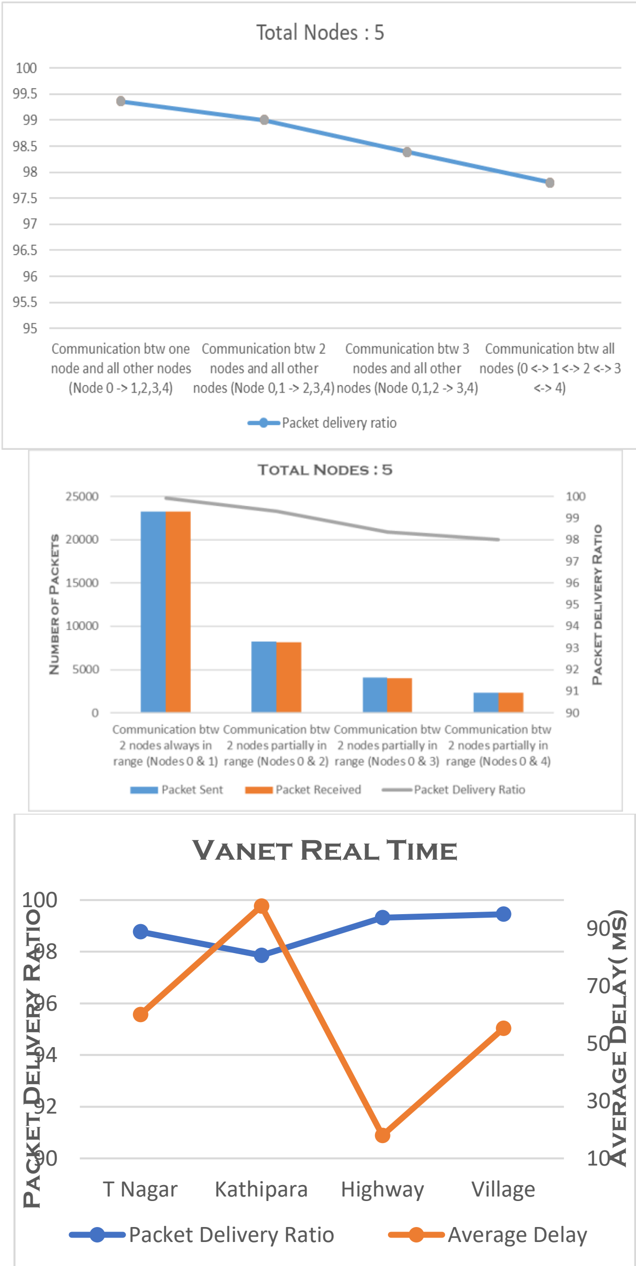


Fig. 10. Analysis of VANET-Real time

Retrieval Number: J90080881019/19©BEIESP
DOI: 10.35940/ijitee.J9008.0881019
Journal Website: www.ijitee.org

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication (BEIESP)

TABLE 1 PDR FOR VANET

	Packet Sent	Packet Received	Packet Delivery Ratio
No. of vehicles: 5	33687	33393	99.13
No. of vehicles: 10	33574	33135	98.69
No. of vehicles: 25	32005	31289	97.76
No. of vehicles: 50	30108	28979	96.25
No. of vehicles: 100	29774	27578	92.62

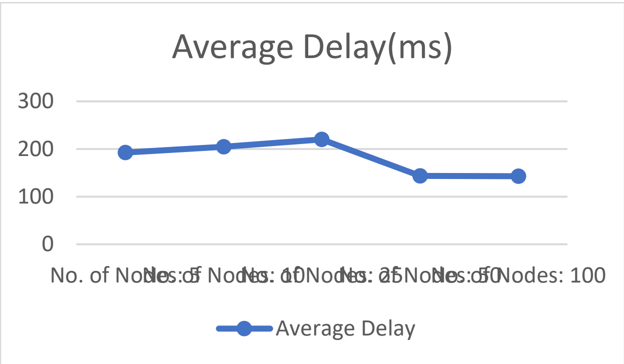


Fig 11 E2E delay for VANET

Table 2 E2E delay for VANET

	Average Delay
No. of Nodes: 5	192.267
No. of Nodes: 10	204.886
No. of Nodes: 25	219.986
No. of Nodes: 50	143.407
No. of Nodes: 100	142.825

3.3.2 INFERENCE:

From the results obtained, it is found that the overall delivery of packets and delay on an average from end to end are optimal for every scenario.

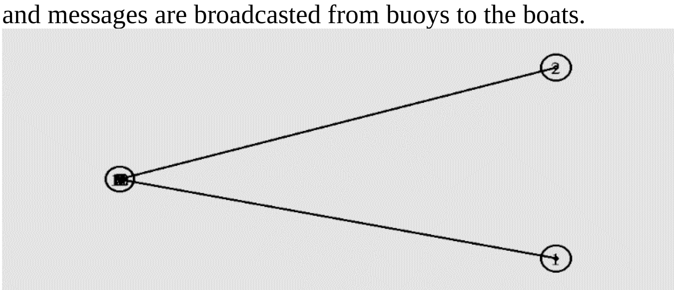
i. The PDR is always >90% and it can be concluded that most of the generated packets reach the intended receive end.

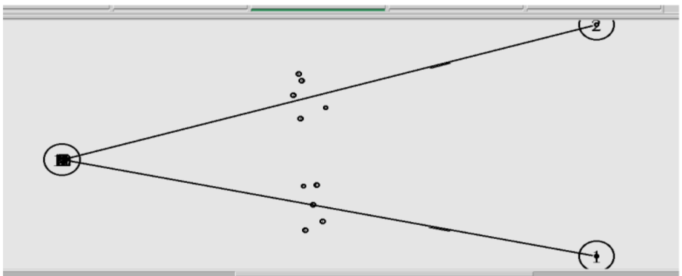
ii. The Delay is also found to be <100ms and it is very much satisfactory for transferring information to vehicles.

Therefore it can be said that the message alerts reach every commuter in required time interconnected in the VANET scenario.

4.VANET FOR BOATS – SIMULATION

We simulate the VANET scenario for boats. Here, buoys are connected to the base station at land via satellite and messages are broadcasted from buoys to the boats.





Retrieval Number: J90080881019/19©BEIESP
DOI: 10.35940/ijitee.J9008.0881019
Journal Website: www.ijitee.org

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication (BEIESP)

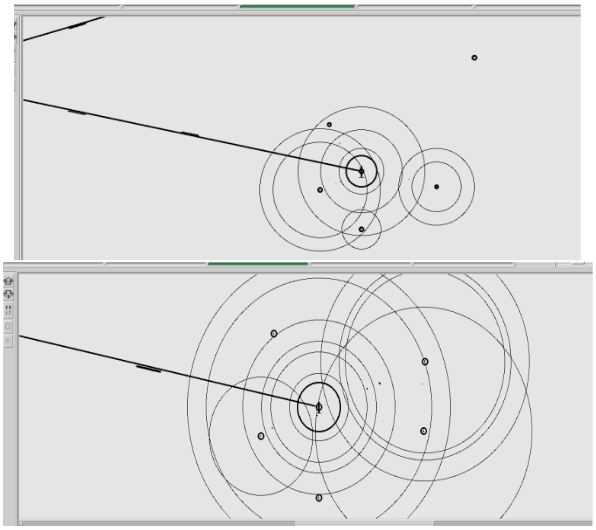


Fig 12 VANET for boats – Simulation

We have set up a simulation scenario. We have simulated by establishing a node for satellite, buoys and boats. The area surrounding the buoys is assumed to be fishing zone. Buoys are always connected with satellites. But buoys connect with the boats for every interval of time which we have set. In figure-1, circle 1 and circle 2 are the buoys and the third circle is the satellite. The wired connection is just to indicate that they are always connected but technically wirelessly. In figure-2, it indicates boats going to fishing zone in groups. These boats when they are inside the range of buoy they start to communicate with each other and also with the buoy which is shown in figure -3. Each boat will be fixed with an equipment to receive or send any messages. Each boat will be using TCP packets because it is connection – oriented and every boat will have an IP address too. The buoy will have a routing table to know what are the boats are in range. The buoy will receive a packet for example every 5 seconds from all the boats and it will send an acknowledgment and so this way it knows that all the boats are in range and no one is lost. In figure-4 , a boat is gone out of the range and so in this case the buoy will not receive a packet . The buoy will wait for some and still if not receives the packet, the buoy will send a packet to other boats with a message that a boat is gone missing.

Analysis for Marine scenario:
Packets Sent: 38503
Packets Received: 38491
Packets Delivery Ratio: 99.97%
Inference: The PDR is found to be almost perfect and thus information is communicated to its destination and thus the boat at deep-sea is alerted.

5.CONCLUSION

In this project, we have successfully established Vehicle-Vehicle, Vehicle-RSU and RSU-RSU communication and have executed simulation of real time scenarios of Kathipara(area in Chennai, Tamilnadu), T.Nagar (area in Chennai,Tamilnadu), Highways, Kadambur Village (in Tamilnadu) and analysed the traffic and communication for each model through an ad-hoc network using AODV protocol. We have also analysed the packet delivery ratio and average delay and also eliminated any errors which have occurred during the course of this project, in order to establish reliable communication which can used in real time situation.

For the boat scenario, we were able find a possible design which could benefit thousands of lives along the coast. The establishment of boat to boat and boat to buoy communication, would certainly benefit fishermen in communicating alerts with the shore and increase their safety in the midst of the sea. We have proposed a suitable solution to the problem supporting with simulation results and analyses.

REFERENCES

1. M. Shahzamal, M. F. Pervez, “Mobility Modelling Of Marine Fishing Boats For Communication Network Simulation,” In Informatics Electronics and Vision (ICIEV), India, May. 122-128, 2016.
2. C. S. Evangeline and S.Appu, “An Efficient Data Transmission in VANET Using Clustering Method”, *Intl. Journal of Electronics and Telecommunications*, vol. 63, 2017, pp. 303-319.
3. D. Singh, S. Kimbahune and V.V. Singh, “Strategy for Deep Sea Communication or Safe Fisheries,” *Journal of ICT Standardization*, vol. 4, 2017, pp. 199-204.
4. G. Singh, N. Chakrabarty, K. Gupta, “Traffic Congestion Detection and Management Using Vehicular Ad-Hoc Networks (VANETs) In India,”, *International Journal of Advanced Computer Technology (IJACT)*, Vol. 3, 2014.
5. J. Jain, N. Chahal, “A Review on Vanet, Types, Characteristics and Various Approaches”, *International Journal of Engineering Sciences &Research Technology*, ISSN: 2277-9655, 2016

AUTHOR’S PROFILE

Dr.R.Raja Kumar completed his post-graduation in Mathematics in 1991 from ManonmaniamSundaranar University. He received his Ph.D from Sathyabama University in the interdisciplinary domain of Chaotic Communications in 2013. He is working as a Professor in Sathyabama Institute of Science and Technology (formerly Sathyabama University) from 2013 onwards. He has a total of 28 years of teaching experience.

Dr.R.Pandian is currently working as an Associate Professor in the Department of Electronics and Instrumentation Engineering at Sathyabama Institute of Science and Technology, Chennai, Tamil Nadu, India. He has graduated from Madras University, Chennai in 1999 with Bachelor's Degree in Electrical and Electronics Engineering. He has obtained his M.E Degree in Applied Electronics from Anna University, Chennai 2007. He has obtained his Ph.D from Sathyabama Institute of Science and Technology, Chennai, Tamil Nadu, India. He has gained a teaching experience of more than 16 years. His research interests are Image Processing and Neural Network. He has published papers more than twenty five papers in SCI and Scopus Journals.

Dr.P.Indumathi obtained her Bachelor of Engineering degree in Electronics and Communication Engineering in 1989 from Anna University. She completed her Master of Engineering in Communication Systems in 1994 from Anna University. She obtained her Ph.D from Anna university in 2007 by working on Asynchronous Transfer Mode Networks. She is passionate about Communications.

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication (BEIESP)

She joined as Lecturer of Electronics in MIT Campus of Anna University in 1996.Currently she is a Professor in Electronics Engineering in MIT Campus of Anna University. As of now, she has 23 years of teaching experience. She dreams about an India that is really strong in Communications.

Sheikh Shoaib Mohammed., graduated from Electronics and communication engineering from Madras institute of technology, Anna University in 2018. His area of interest is in telephony and wireless communications. He is working in Renault Nissan in Chennai specializing in Automotive Electronic hardware.

Retrieval Number: J90080881019/19©BEIESP
DOI: 10.35940/ijitee.J9008.0881019
Journal Website: www.ijitee.org

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication (BEIESP)