Improving the performance of VANET using Ant Queue Optimization(AQO) Scheme

A dissertation submitted in partial fulfillment

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Master of Technology

in

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by

Kambhampati Jyothi

14MCS1030

School of Computing Science & Engineering,

VIT University Chennai,

Vandalur-Kelambakkam Road,

Chennai - 600127, India.

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Declaration

I hereby declare that the dissertation ***Improving the performance of VANET using Ant Queue Optimization(AQO) Scheme*** submitted by me to the School of Computing Science and Engineering, VIT University Chennai, 600 127 in partial fulfillment of the requirements for the award of **Master of Technology** in **Computer Science & Engineering** is a bona-fide record of the work carried out by me under the supervision of ***Prof.J.Christy Jackson***.
I further declare that the work reported in this dissertation, has not been submitted and will not be submitted, either in part or in full, for the award of any other degree or diploma of this institute or of any other institute or University.

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Certificate

This is to certify that the dissertation entitled ***Improving the performance of VANET using Ant Queue Optimization(AQO) Scheme*** submitted by ***Kambhampati Jyothi*** **(Reg. No. 14MCS1030)** to VIT University Chennai, in partial fulfullment of the requirement for the award of the degree of **Master of Technology** in **Computer Science & Engineering** is a bona-fide work carried out under my supervision. The dissertation fulfills the requirements as per the regulations of this University and in my opinion meets the necessary standards for submission. The contents of this dissertation have not been submitted and will not be submitted either in part or in full, for the award of any other degree or diploma and the same is certified.

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Abstract

Over a decade, Vehicular Adhoc Networks (VANETS) has been evolved and there are lots of challenges in the present network situation out of which traffic congestion is one. In this paper, to address this problem and also to improve the performance of VANET in terms of capacity, size, topological changes and maintaining the shortest routes, a new scheme Ant Queue Optimization Scheme(AQO) have been introduced in extension of Ant Colony Optimization(ACO). The proposed Ant Queue Optimization Scheme combines both proactive and reactive mechanisms. Unlike the ACO, the AQO dynamically makes decision in choosing shortest best route in highly congested areas. Route selection is dynamically at each intersection irrespective of the size of the traffic. Experimental results shows that the performance of the AQO is better than ACO. . . .

Acknowledgements

I express my sincere gratitude to our beloved Chancellor Dr. G. Viswanathan for providing us with all the necessary facilities.I place on record my sincere gratitude to Dr.Jeganathan L, Professor and Dean of School of Computer Science and Engineering for his encouragement and support to carry out this project successfully. My heart felt thanks to my guide Prof.J.Christy Jackson,M.Tech Professor, School of Computer Science and Engineering, for his timely and valuable guidance to carry out this major project. He has taken pain to go through the project and make necessary correction as and when needed.I owe our sincere thanks to my parents and for the moral support and encouragement given by them in every aspect of my life. My sincere thanks to all those teachers and the lab staff of our school who helped me in getting much support in the preparation of this report. I am indebted all our well wishers and folks who helped me directly or indirectly for their valuable suggestions. . .

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For/Dedicated to/To my…

Chapter 1

Introduction

1.1 Background

VANETS is a special type of wireless network where the vehicles itself acts as nodes and they form network among themselves. Though VANETS are difficult to construct but has several advantages. In a Vehicular Adhoc Network, the node exhibits dynamic nature with respect to mobility. Most of the VANETS uses Dedicated Short Range Communication (DSRC). The model of a regular VANET consists of set of nodes and few Road side units(RSU). These RSUs are fixed at road side and they act as a communication medium between nodes. This kind of configuration is possible only in the cities where mobility of the vehicles is less and more number of RSUs. This configuration becomes difficult if the mobility of the vehicles is high and less number of RSUs. Hence if there are more vehicles in a network, the information passing would be difficult and in case of high congestion, the vehicles must take decision to change its route in a optimal way. Several real time solutions have been raised to overcome this problem. These real time solutions have been introduced in order to increase the uency of the trafc.
The existing approaches have deal with this problem and have found a solution. The Ant Colony Optimization(ACO) is been introduced as a solution for this problem. According to this approach, the ants sent information packets to its neighbouring ants in the form of pheromone packets. The upcoming ants receive these pheromone information to decide its next best route. To obtain the trafc condition of entire area, accurate trafc evaluations of each and every road segment is to be done. In the literature survey there are many protocols like proactive, reactive and hybrid to evaluate the trafc patterns in the congested areas as well as in the highways. To evaluate these characteristics, some basic information about the vehicle like speed, location, direction, source and destination must be gathered and analysis must be done on the data. In order to gather the trafc

data we used various equipments such as microwave radars, induction loop detectors, video recorders and IR technologies. Each and every detector maintains xed points and stores the vehicle information that is crossing the detection zone. These sensors are very expensive and moreover it is difcult to install and therefore the capacity of the sensors is restricted only to a certain distance. The communication in VANETS can happen in two ways i.e., either as Vehicle to Vehicle Communication(V2V) or Vehicle to Infrastructure Communication(V2I). In V2V the information among the vehicles is gathered and it is utilized for detecting the trafc congestion whereas in V2I the communication will happen between Vehicles and Road side units (RSUs). The VANETs technology denes vehicles as the mobile nodes and sensors in those nodes can detect the trafc data. This technology though seems to be interesting but it too has several challenges such as redundant data, ooding of bandwidth, reliability and the evaluation of the trafc is also inaccurate. The accuracy of the evaluation of trafc is proportional to the analyzed data. Generally in any trafc scenario the congestion will happen only in the one side of the road while the other side will have less trafc.

1.2 Objective

The Objective of the project is to improve the performance of the VANET using Ant queue Optimization scheme(AQO). Also to compare the performance of Ant Colony Optimization (ACO) and Ant Queue Optimization (AQO) in terms of time. AQO is a route Optimization scheme which dynamically selects its next best shortest route. The working of the Ant Queue scheme would be similar to that of Ant Colony Optimization. In ACO, the forward ants send some information about the traffic route in the form of pheromone packet. The natural ants exhibits the behaviour of releasing the pheromone which is a chemical substance and it gets evaporated after sometime. In technical terms the ants are nothing but the vehicles and these vehicles send their pheromone packet information to their later nodes in the same network. Based on the experience of the forward ants, the later ants would take decision at its next intersection of the road. In case of high congestion the ants may change its path and chooses the best optimal path. AQO also works in the same way but in addition to ACO, the AQO exhibits some efficient features. The main drawback in ACO is, only the later ants are getting benefited using the pheromone information sent by their previous ants. The forward ants though they know the information, they cannot use it because they have already crossed the road. So they lay their pheromones to notify their later ants. The drawback has been identified and rectified using AQO scheme. Using Ant queue optimization (AQO) scheme all the ants are processed in the same way dynamically. The main advantage of AQO is, each and every ant in the network would get processed with the updated information about all of its neighbours. Unliike in ACO, not the later ants get updated information but also the previous ants would be able to communicate and get processed as fast as possible. This scheme decreases the time complexity for a highly congested traffic roads.

1.3 Problem Statement

The VANET is a vast network where the vehicles transfer its route information to all its neighbouring nodes. In a large network, the most challenging part of the VANET is route discovery and information processing. The existing system uses Ant Colony Optimization scheme for finding the best shortest route. Though the scheme was easy to implement and was a success, it too has many challenges in route discovery and information processing. In the process of searching food, the biological ants lays a pheromone packet as shown in the below figure1 at an intersection of a road. The next coming ants would understand that there is no food at that particular place and then they change their path. Similarly, in Ant Colony Optimization the ants lays pheromone packets which consists of route information, location information of the ants. Using that pheromone packet information the later ants gets updated but not the previous ones. This has become the main drawback of the ACO scheme. So in order to improve the performance of the VANET we opted for a better scheme than ACO i.e., AQO.

1.4 Motivation

Now a days, Optimization techniques has its prominent role in every field such as Engineering, medicine, industry etc. There are various applications which uses Optimization techniques. Optimization can be done in several forms such as minimizing the cost, reducing the consumption of energy, route optimization, improving the overall performance of a system, maximizing the profit, improving the efficiency of the output etc. The Optimization techniques are crucial in the real world applications and it has its limitations such as money, time and resources. These optimization problems are very difficult to implement and the solutions are not always determined. The reason for complexity while searching for the optimal solutions is uncertainty. Many of the problems are non-linear and they are often NP-hard. To find out the optimum solution in terms of size of problem, we need exponential time.

For searching an optimal solution is a big challenge and it is not determined always. In order to improve the Optimization techniques, several attempts were made for dealing with NP problems. There are several approaches such as meta heuristic approach and

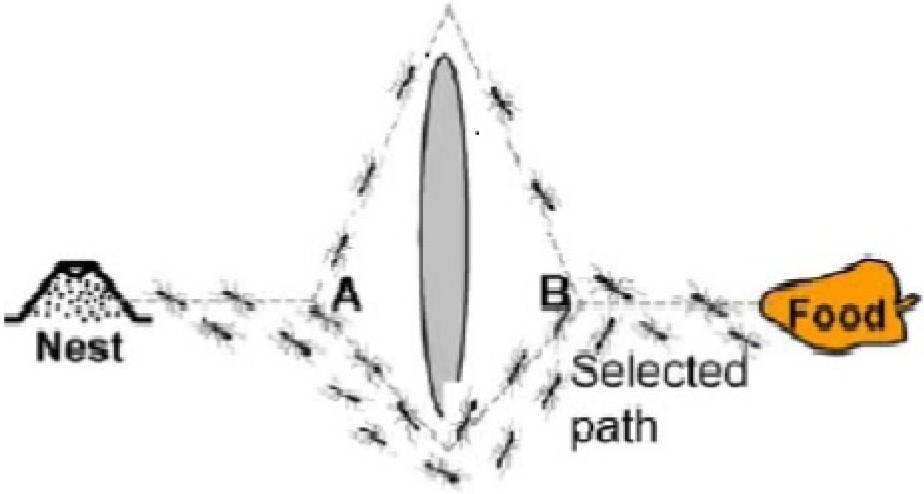


FIGURE 1.1: Ants lays phersomone packet

problem specific approach. In problem specific approach, using the theoretical analysis the problem characteristics have been derived and also several algorithms are developed. In meta heuristic approach, in case of few assumption or if there is no assumption then algorithms are used to find out the solution. In meta heuristic approach, the solutions cant be predicted. Stochastic Optimization method which randomly determines the optimal solution is been followed by meta heuristics. The randomization helps in dealing with modelling errors. The randomization approach is a simple approach which effectively obtain solutions with good performance to all kinds of problems.
The Stochastic Optimization are a part of evolutionary algorithms and swarm intelligence. The swarm intelligence deals with real behaviour of animals that have no system for controlling the non-intelligent creatures/agents. The best example for swarm intelligence is Bee Colony algorithms and Ant Colony Optimization algorithms (ACO). In ACO, the forward ants send some information about the traffic route in the form of pheromone packet. The natural ants exhibits the behaviour of releasing the pheromone which is a chemical substance and it gets evaporated after sometime. In technical terms the ants are nothing but the vehicles and these vehicles send their pheromone packet information to their later nodes in the same network. Based on the experience of the forward ants, the later ants would take decision at its next intersection of the road. In case of high congestion the ants may change its path and chooses the best optimal path.

1.5 Aim and scope

The aim of the project is to improve the performance of the VANET by using Ant Queue Optimization Scheme which is a model developed from Ant Colony Optimization algorithms. Also to compare the overall performance of ACO and AQO and present the experimental results. To achieve this, the following work has to be done:

- To check whether the new proposed scheme can be applied in ACO successfully or not. According to the proposed theory, decision making is done dynamically like human decision which are used for both continuous and discrete optimization problems.

- To test the proposed scheme in the real time scenario which is having highly congested traffic roads.

- To compare the results obtained by AQO with the results obtained by ACO. Based on the results reported, the best scheme is derived.

Chapter 2

Literature Survey

Now a days, the science has become more specific and there are so many solutions for optimization problems in which heuristic solutions is one among them. According the literature, there were many algorithms to solve optimization problems but all the algorithms are not good enough for solving large scale realistic optimization problems. Probably, only few could be able to derive the theoretical values. The heuristic optimization methods couldnt always gives a global optimum solution but it could give us a better or good solution which may be a local optimum and also heuristic solutions usually take less computational resources. The meta heuristics has many set of optimization schemes of which Ant Colony Optimization(ACO) algorithms is one among them. The Ant colony optimization scheme deals with the natural behaviour of ants. ACO is been used in many combinatorial optimization problems and it is also used to outperform other heuristics problems such as genetic algorithms. Therefore, there is a lot of scope for ACO algorithms in future research. The contribution of this paper is to provide an efficient optimization scheme to solve all the meta heuristic problems.

2.1 Evolution of Ant colony optimization

2.1.1 ACO in the Travelling Salesman Problem

In the year 1995, Dorigo et first conducted a research on Travelling salesman problem (TSP) which is one of the applications of Ant Colony Optimization (ACO) meta heuristics. Dorigo et has founded a similarity between TSP and the way the real ants try to make their efficient route in the process of finding their own food resources. So, it is first domain where ACO meta heuristics was implemented. According to the theory of TSP, the objective is to find out the most optimal best route so that each and every node in

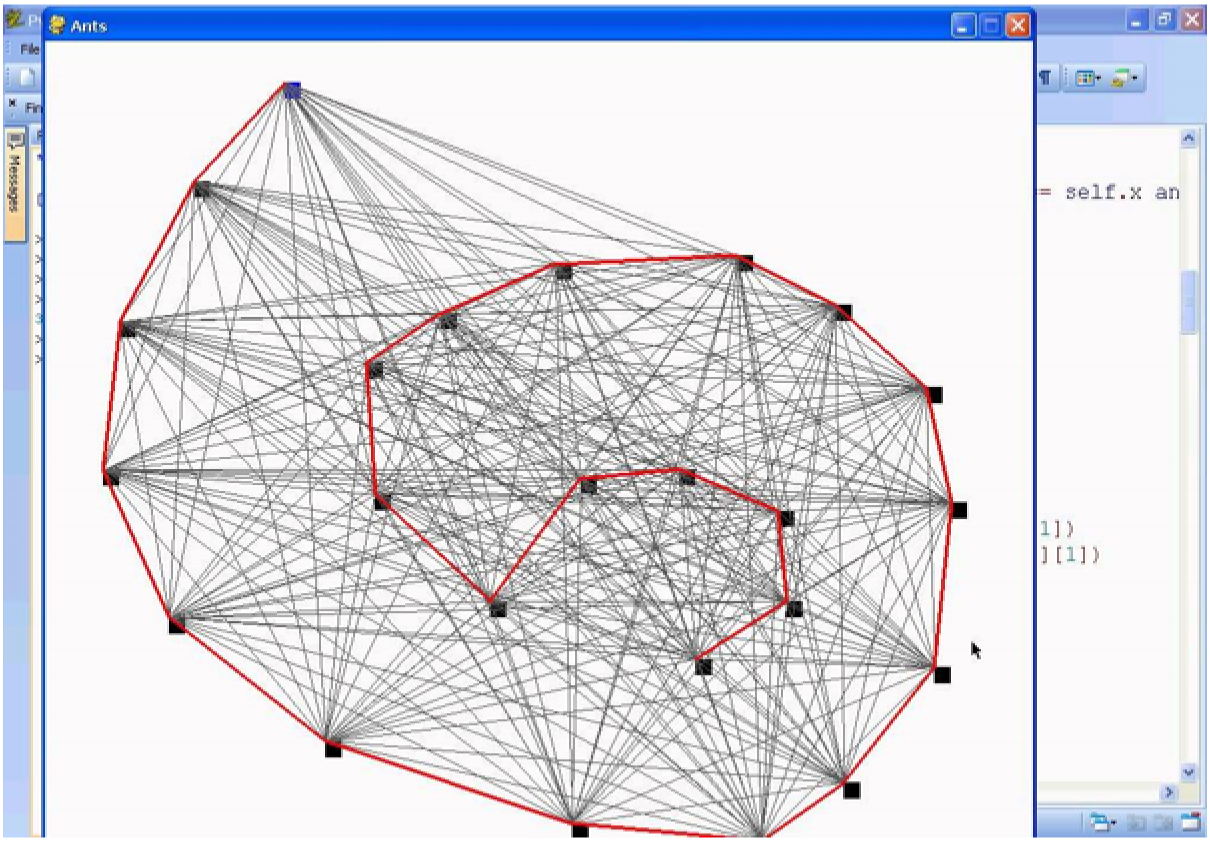


FIGURE 2.1: Applying ACO for travelling salesman problem

a connected graph is visited at least once. The node visiting helps in making efficient route plan for both physical traffic and electronic traffic. The implementation of ACO is tested and compared with many other efficient algorithms such as Self Organising map(SOM), Simulated Annealing and Elastic Net. All the tests were performed on the same hardware configuration having a set of 40 nodes each. Experimental results shows that Ant Colony Optimization algorithm was always the best methodwhen compared to all other algorithms. The ACO in its early stage of research has been proved to be an efficient method for all heuristic problems.

2.1.2 Racing Algorithm Meta heuristics

Meta heuristics has many problems and several solutions have been found out of which Racing algorithm is one of technique applied for meta heuristics. This method gives out the optimal solution or efficient solution with respect to time constraint. It is done by selecting the most possible efficient solution from a finite set of solutions. Most of the problems under meta heuristic is best suited for repetitive problems. For example, consider travelling salesman problem where the best route is found out efficiently even

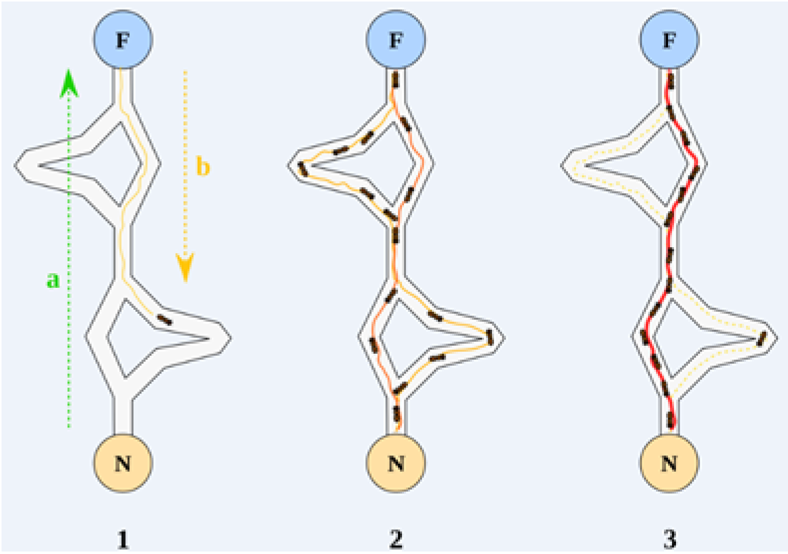


FIGURE 2.2: Racing Algorithm using ACO

though there is a repetition. In the previous work, each and every node in the network is visited atleast once so that the best route is found out between source and destination. But visiting the nodes is not an important issue as it does not give the optimal solution. Instead the node which is visited more often is considered as a optimal solution. The experimental results based on the ACO problem, two of the racing algorithms were compared out of which one is not suitable for multiple executions of tn race and the other is suitable for tb race and the results shows that F race gives the better optimum results. Working under multiple instance is a good step for any algorithm where time constraint is considered. Testing an instance would definitely lead to wastage of execution time and does not allow a algorithm to produce an optimal solution.

Test were been made on different samples in which three different algorithms were executed. The objective of the racing algorithms is to find out an optimal solution or a nearby optimal solution with respect to time constraint so that the results could be taken as the no. of possible instances left out in the solution space once the time period gets expired. The experimental results shows that the F race has 7.9 optimal solutions, tn race has 31.1 solutions and tb race has 253.8 solutions which are left out after a period of time. The rest of the solutions were tested to find out which one to be removed next and F race were tested several times i.e., 77.9 times which is more than the other algorithms. It is use to select an efficient algorithm that could discard the solutions much more faster.

The F race, an efficient ant colony optimization approach has reduced the solution space and hence it is proved that the F race approach is most efficient algorithm when compared to remaining two approaches. All the approaches has used the same hardware configuration. F race is considered as the bravest algorithm compared to the other two algorithms as it discards most of the solutions within a period of time.

2.1.3 ACO in the Single Machine Total Tardiness Problem (SMTTP)

Another application of Ant Colony Optimization scheme is Single Machine Total Tardiness Problem (SMTTP). The SMTTP is an efficient approach which is used to process the tasks in non multithreaded processor. It is used to reduce the idle time of a processor. There are many solutions for SMTTP which are very successful. The main purpose of using this approach is improve the throughput of the processor. The solution requires the computation as the solution is itself has become a part of the problem. The time required for a processor to compute its next task and the time taken for a processor to save the task efficiently has been differentiated. In this paper, the processor states are represented on a connected graph as the nodes are in TSP which allows to function in the same way. The experimental setup uses 250 tests in which large amounts of tasks waiting to get processed by the single processor. The experimental results shows as a NBR i.e., NET BENEFIT RELOCATION as an overall efficiency. There is an existing approach known as M-NBR executes by selecting the two different optimal solutions and also a comparison is done between M-NBR and NBR. It has been proved that the existing M-NBR works less than half of remaining all ACO solved problems which is damn efficient solution.

The experimental results shows that the instances with large set of problems gives the good optimal solutions. This approach is one the leading approaches in the heuristic optimization.

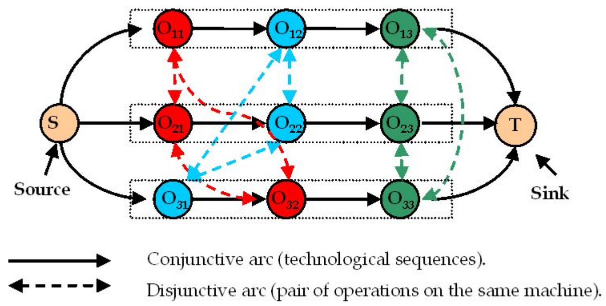


Figure 2.3: SMTTP algorithm

The ant colony optimization has considered to be the best solution as long as the size of the problem is large. Until now the ACO is proved to be a good solution for single processors and single threaded processors but the research in this field has a great scope in working with multiple processors and multi threaded processors. Implementation of ACO using multiple processors and multi thread processor is a challenging task.

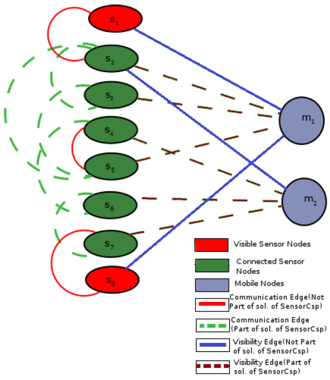


FIGURE 2.4: constraint satisfaction problem

2.1.4 ACO in Constraint Satisfaction Problems (CSPs)

In the year 1965, Golomb and Baumert has initiated developing the programming after proposing a chronological backtracking system. The Constraint satisfaction programs uses a technique known as linear programming for solving several heuristic problems. The Ant colony optimization in constraint satisfaction problems has been proven to be a best optimization technique.

In search of optimal solution, the finite set of optimal solutions is been narrowed down slowly. Another technique known as filtering technique is used to reduce the set of improbable solutions. The Ant colony optimization(ACO) in constraint specification problem(CSPs) has been proved to be the best and efficient method because the ACO do not make search for all the possible solution but does follow a path laid by the ants through the pheromone trails. The experimental results shows that the ACO works more efficiently than normal constraint programming. The normal constraint programming can solve only a small set of problems where as the ACO could give good solutions for small problems and even works very efficiently in case of large problem size.

Therefore the ACO is considered to be the best technique for solving all the constraint problems. The real complexity arises when the problem size increases as the variables added. In this particular case the ACO works extremely well. The constraint specification problems are also used for large problems like designing timetables for train or bus routes, cost maximisation. Finally, the ACO is the most efficient method for finding solutions for optimization when compared to constraint specification programming.

Chapter 3

Experimental Design & Setup

3.1 UML Diagrams

3.1.1 useCase Diagrams

3.1.2 Class Diagrams

3.1.3 Class Diagrams

3.1.4 Sequence Diagrams

3.1.5 Sequence Diagrams

3.1.6 Activity Diagrams

3.1.7 Activity Diagrams

3.1.8 Component Diagrams

3.1.9 Deployment Diagrams

3.2 Requirements Specification

3.2.1 Functional Requirements

The present application has been divided in to four modules.

1. Simulator Set Up and Deploy Module.

2. Operation Modules

- Load Data
- Set timer, Start Simulation
- Events
- Reports

Simulator Set Up and Deploy Module:
Due to complexities involved in signing applets. The application has a difficult deployment scenario. This module is used to set up the simulator with proper applet signatures which are provided to the user while deployment.
Operation Modules:
By using this module user will get access to all the services provided by the application. This module is having following sub functionalities.

- Load Data: The user needs to load configurations data that is required by the application.

- Set timer, Start Simulation: By using this functionality user can specify the amount of time for which the simulation should be active.

- Events: Due to dynamic and distributed nature of RSUs implemented in the system, the network delays, counter measures(especially in Traffic lights changing mode) using scheduling policies can be seen real time in the simulator.

- Report: Total report pertaining to the entire activity during simulation process is displayed in the form of easy to understand tables.

3.2.2 SOFTWARE REQUIREMENTS

Operating System : Windows Technology : Java Web Technologies : None Web Server : None Database : None Software Tools : 1. Jdk 8 2. Windows for development 3. Netbeans v8

3.2.3 HARDWARE REQUIREMENTS

Hardware : Minimum Dual Core 2.8 Ghz (recommended for best simulation) RAM : 2GB (minimum) Others : Standard Monitor, Keyboard, Mouse etc.

Flow Pattern represents how the requests are flowing through one layer to another layer and how the responses are getting by other layers to presentation layer through java sources in architecture diagram.

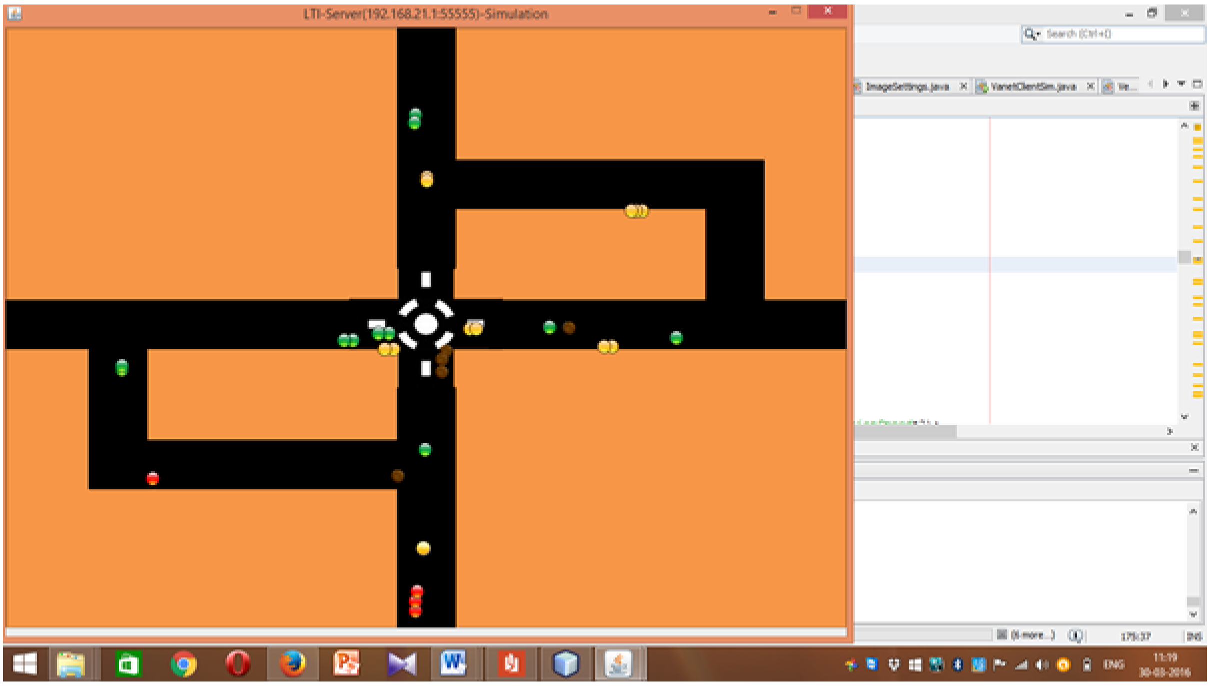


Figure 3.1: Use Case Diagram

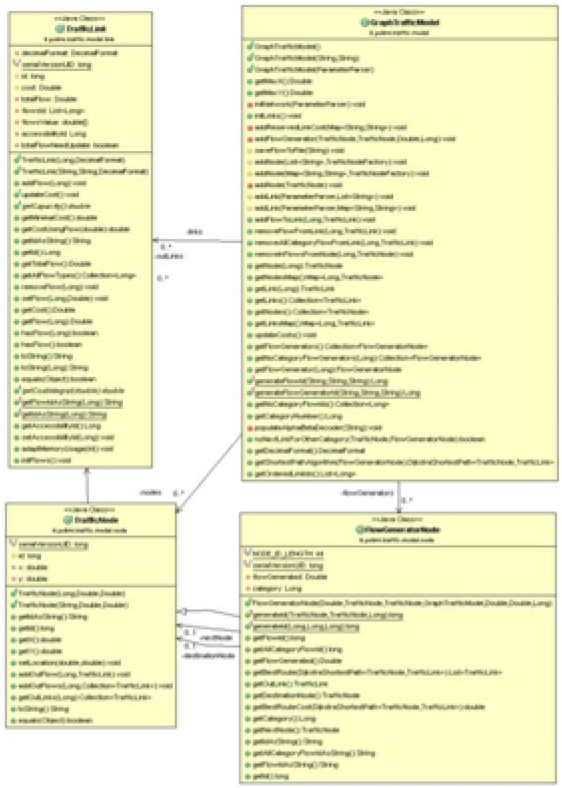


FIGURE 3.2: Class Diagram

FIGURE 3.3: class diagram two

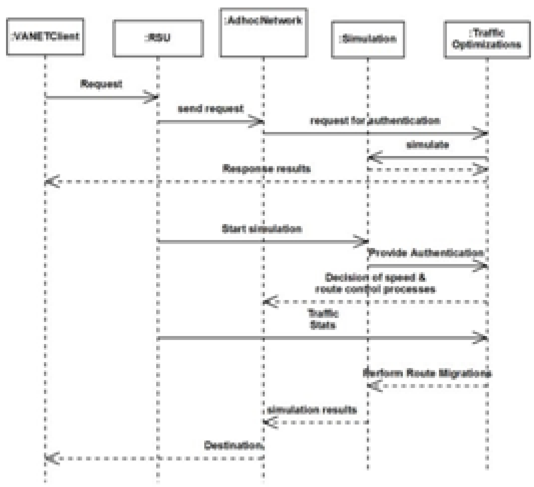


FIGURE 3.4: Sequence Diagram1

Figure 3.5: Sequence Diagram two

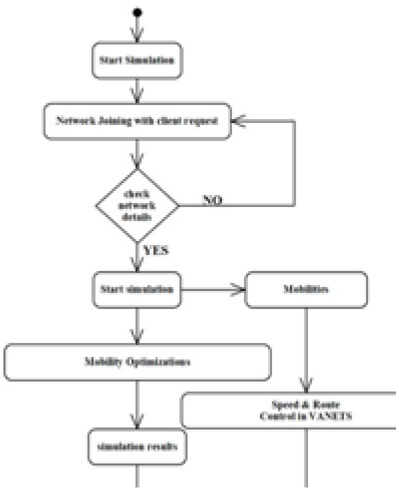


Figure 3.6: Activity Diagram1

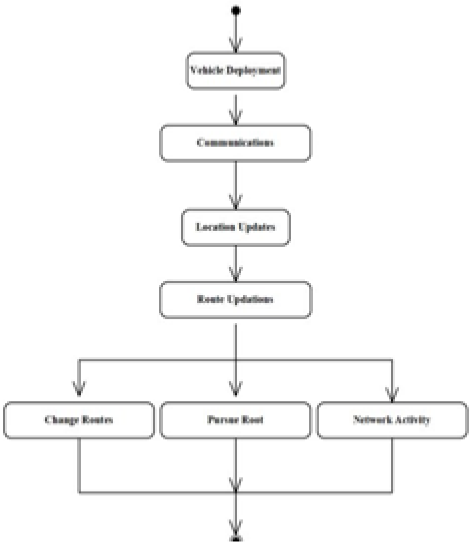


FIGURE 3.7: Activity Diagram2

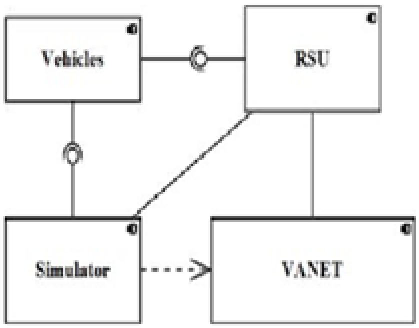


FIGURE 3.8: Component Diagram

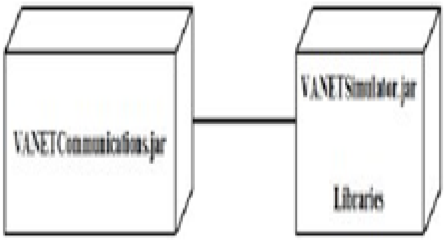


FIGURE 3.9: Deployment Diagram

Chapter 4

Experiments & Results

4.1 Existing System

1) No. of vehicles=10 Time taken =4sec 2)No of vehicles=30 Time taken=3sec 3) No. of vehicle=50 Time taken=6sec 4) No. of Vehicles=70 Time taken=8sec 5) No.of vehicles=100 Time taken=7sec 6)No.of Vehicles=200

4.2 Proposed System Results

Time Taken=6sec 1) No.of Vehicles=10 Time Taken=4sec 2) No. of Vehicles=30 Time taken=3sec 3) No.of Vehicles=50 Time taken=4sec 5) No.of Vehicles=100

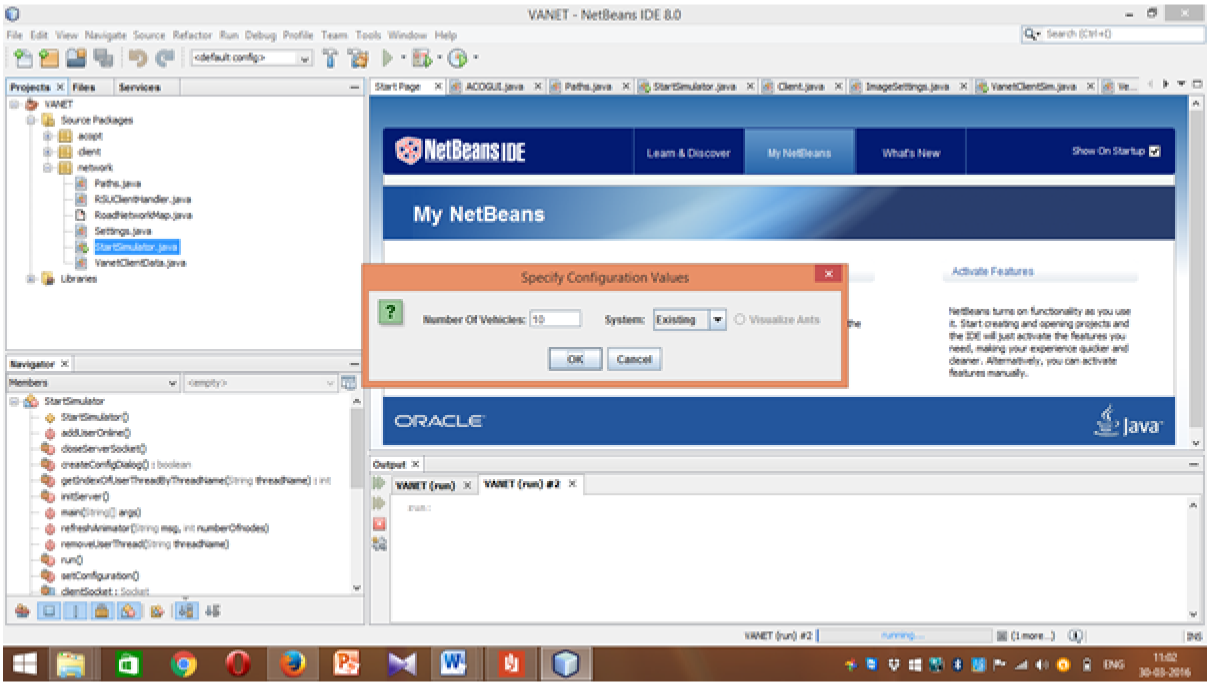


Figure 4.1: Capture 15

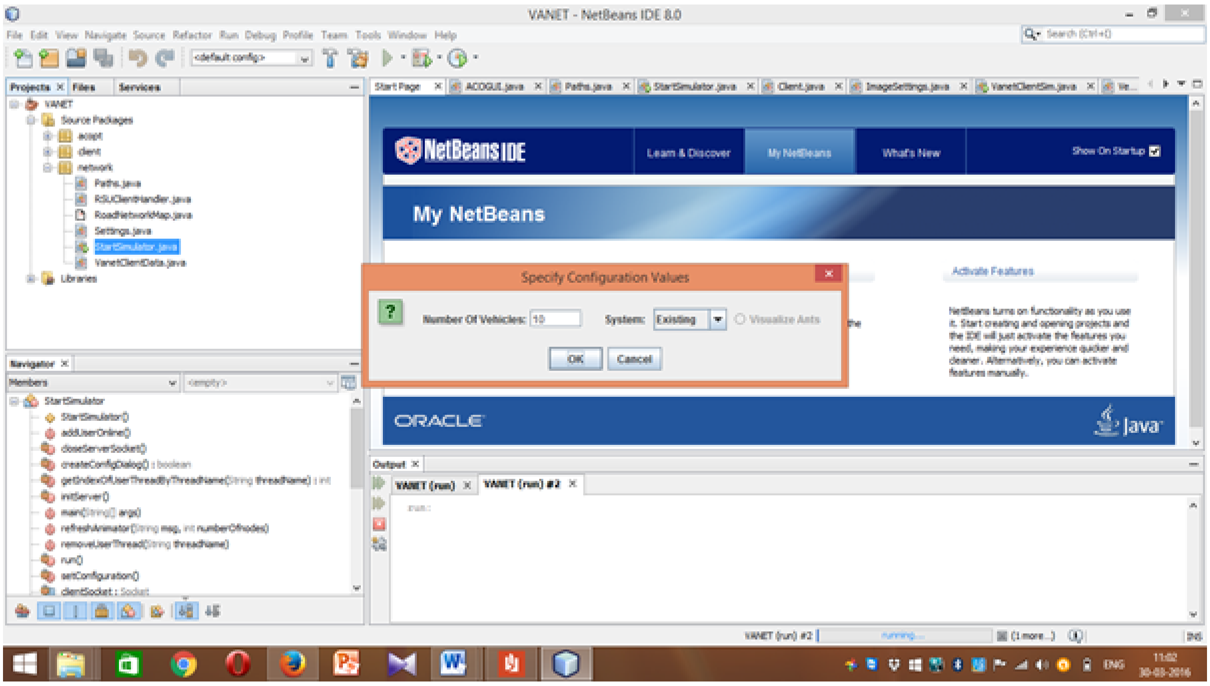


FIGURE 4.2: Capture 16

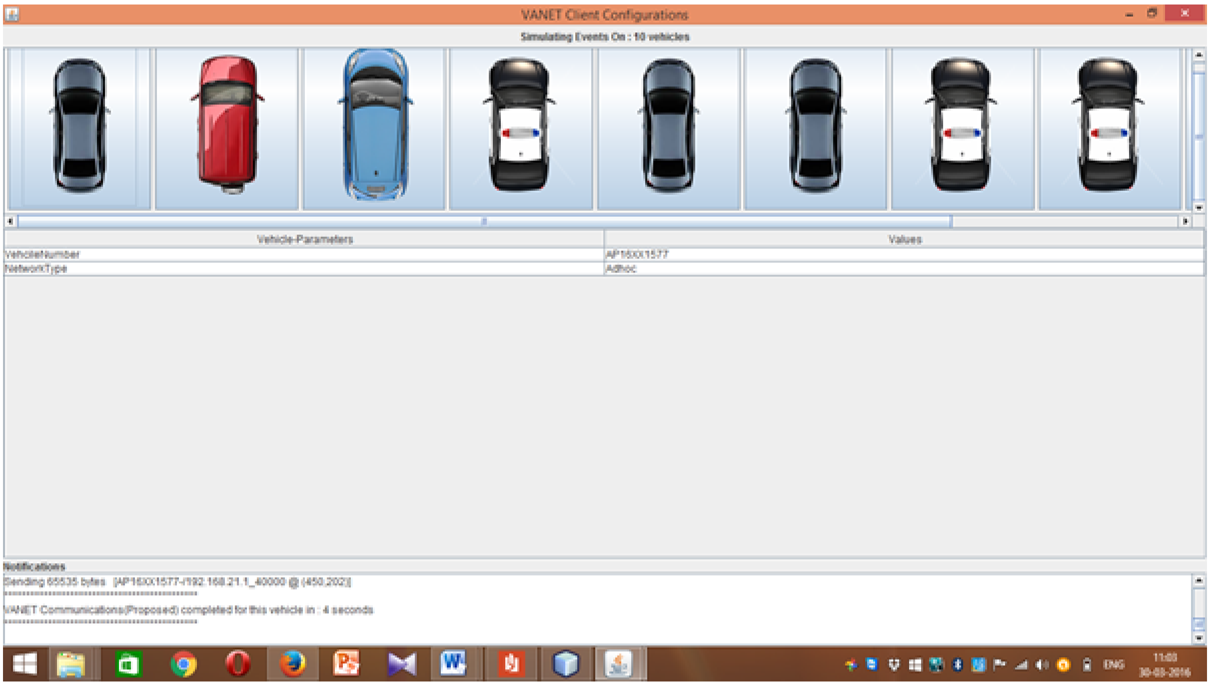


FIGURE 4.3: Capture 17

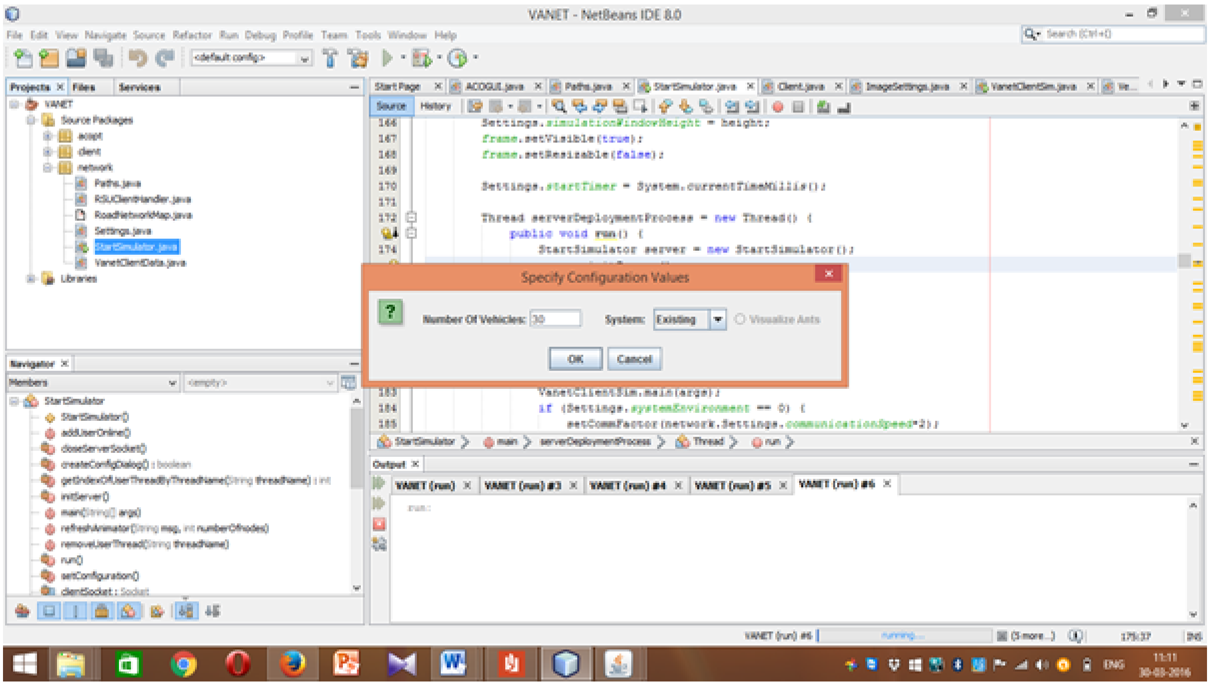


FIGURE 4.4: Capture 18

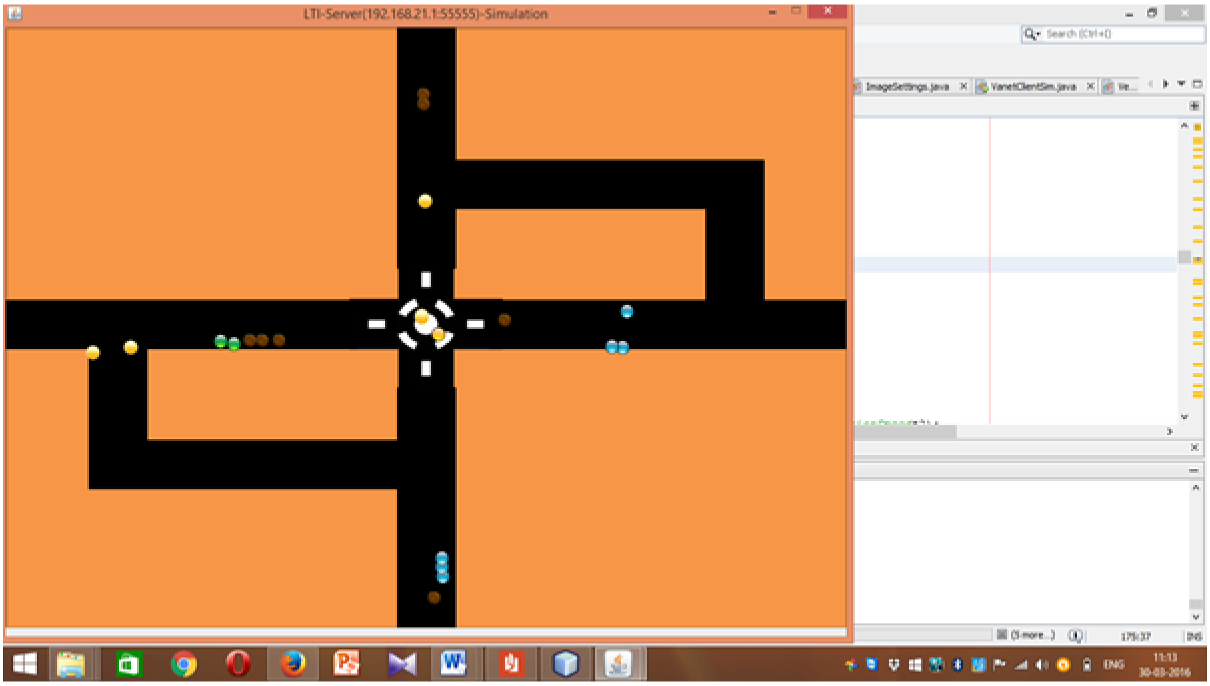


FIGURE 4.5: Capture 19

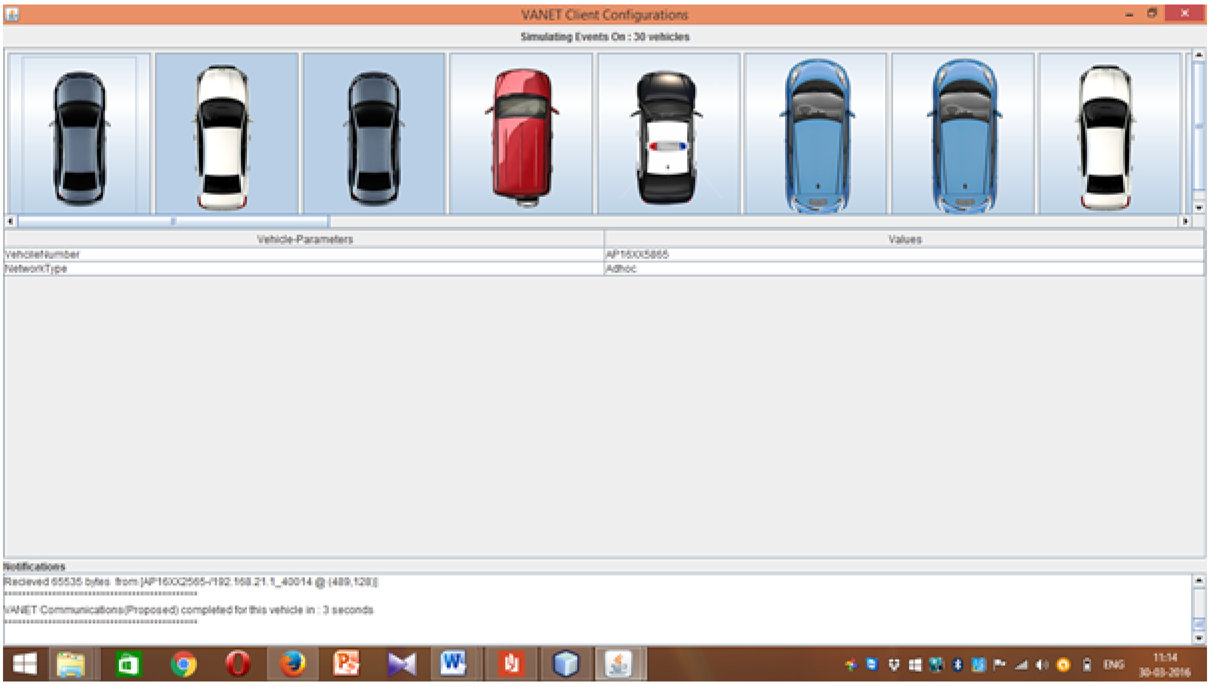


FIGURE 4.6: Capture 20

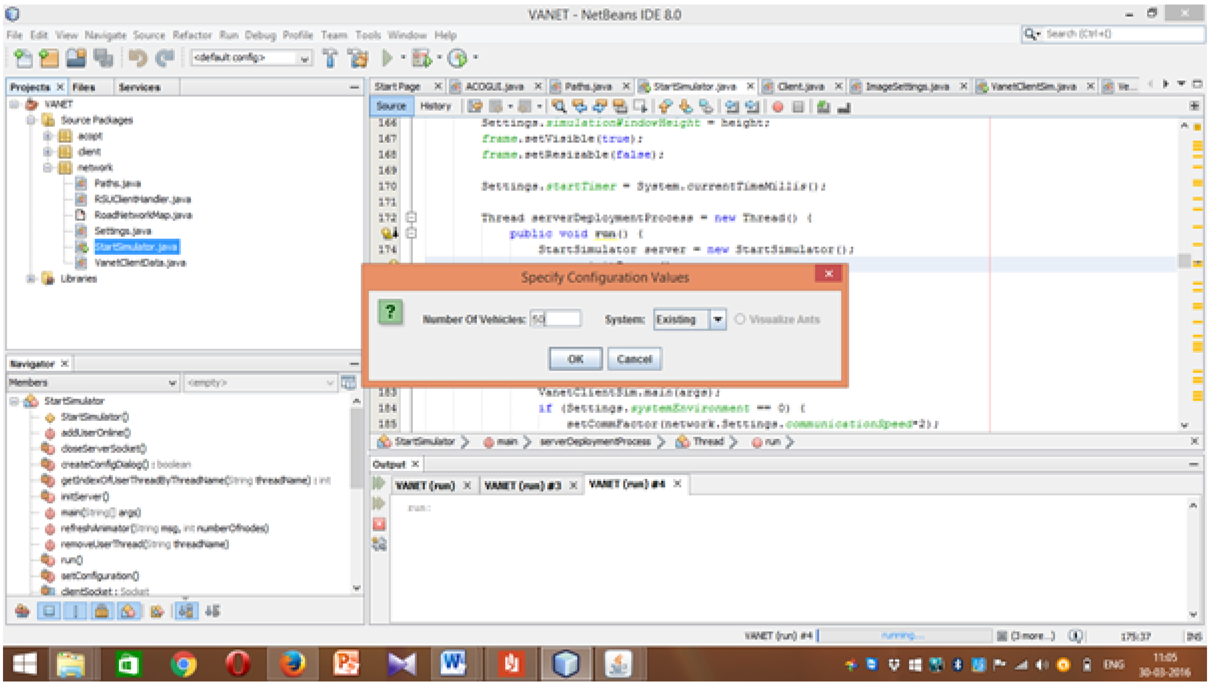


FIGURE 4.7: Capture 21

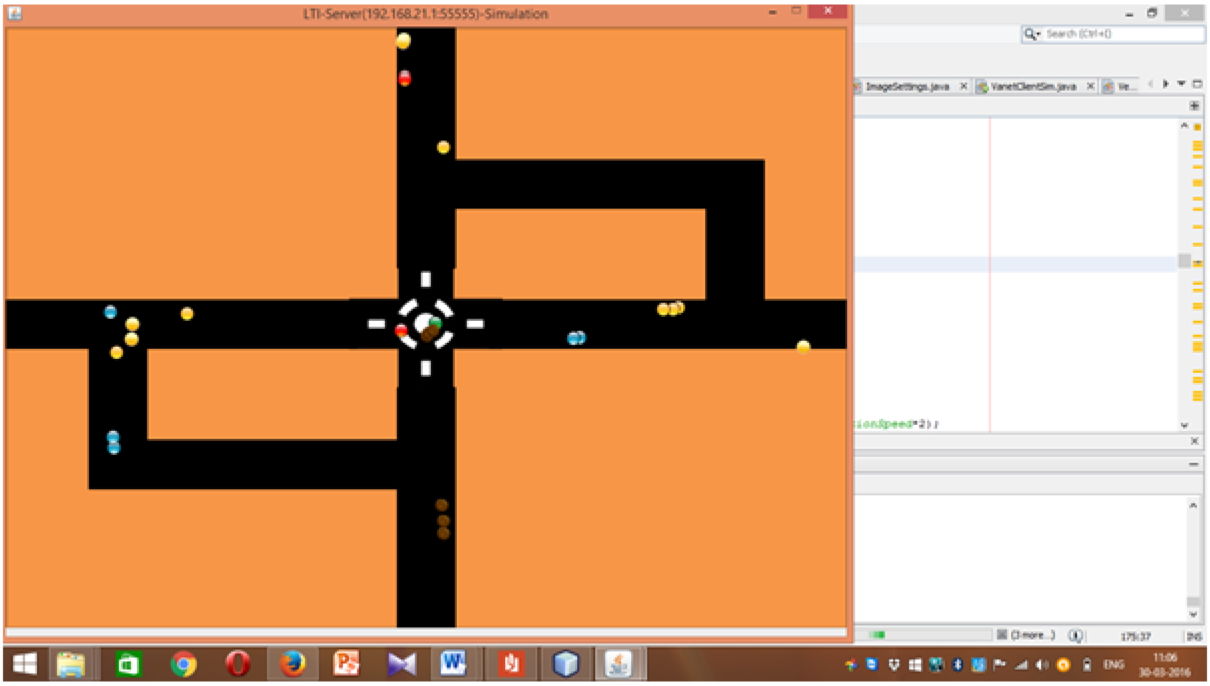


FIGURE 4.8: Capture 22

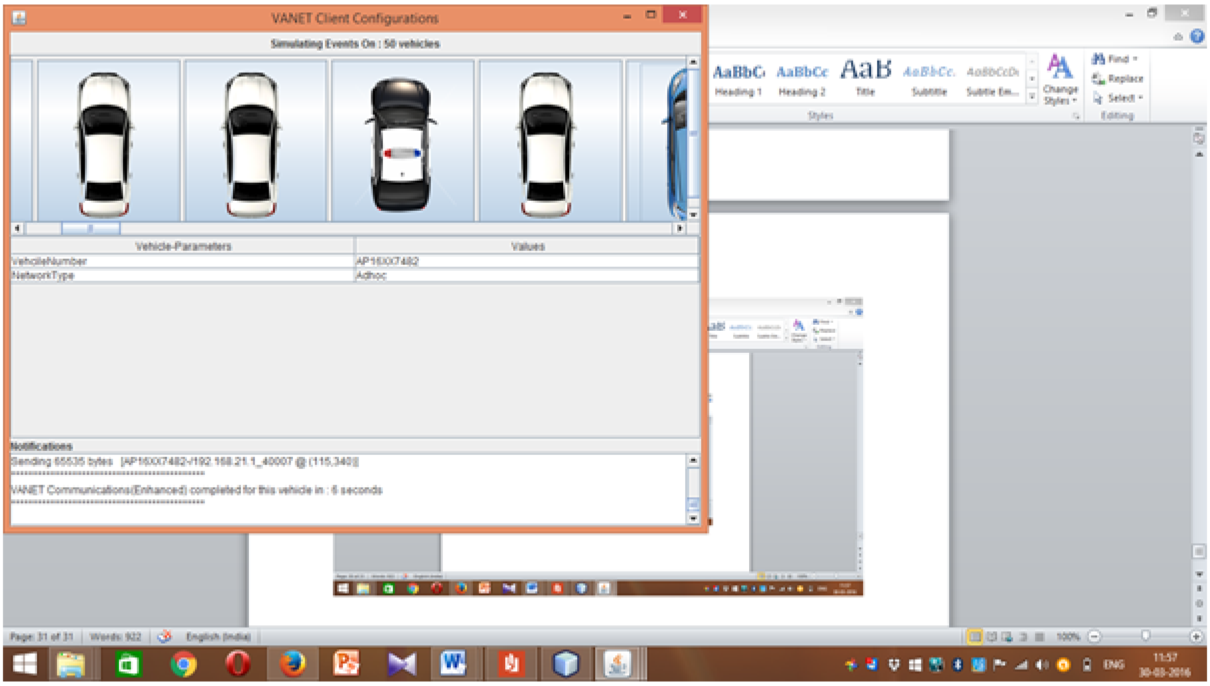


FIGURE 4.9: Capture 23

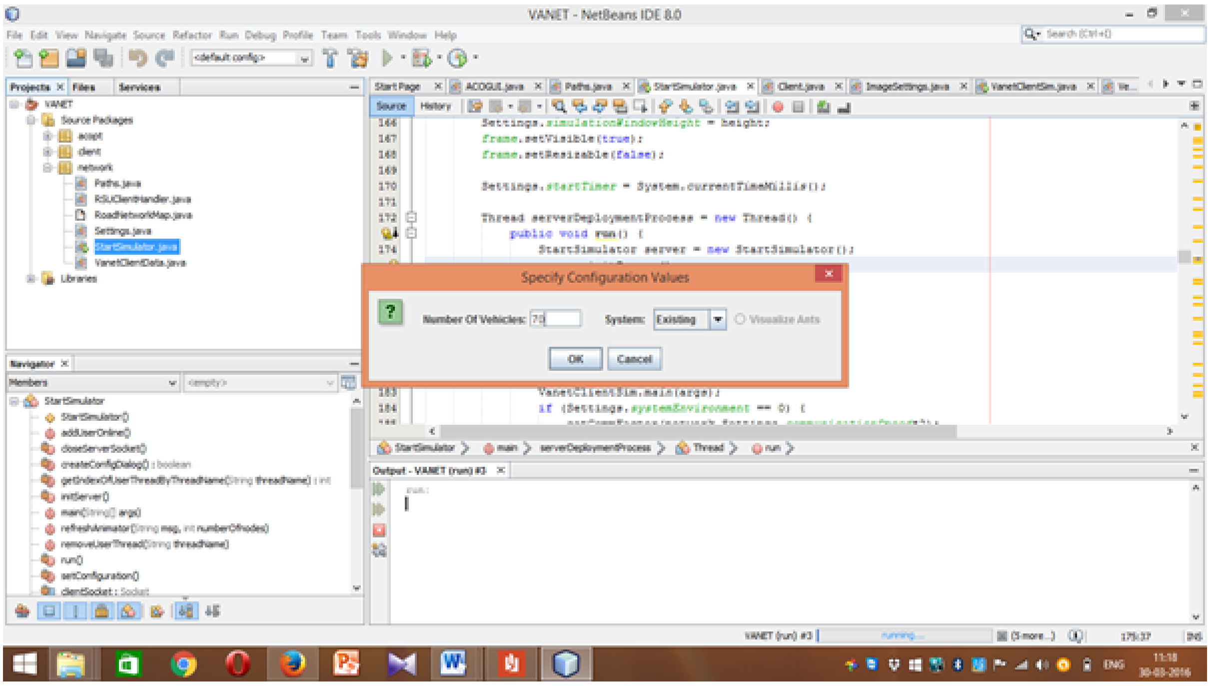


FIGURE 4.10: Capture 25

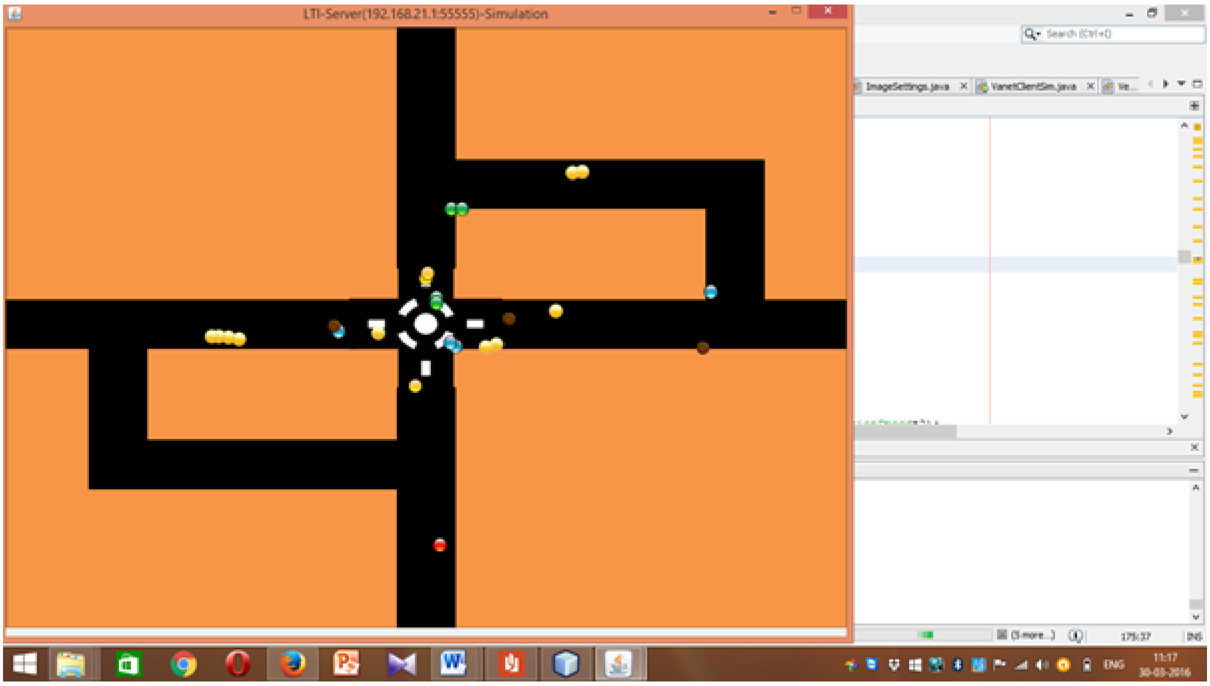


FIGURE 4.11: Capture 26

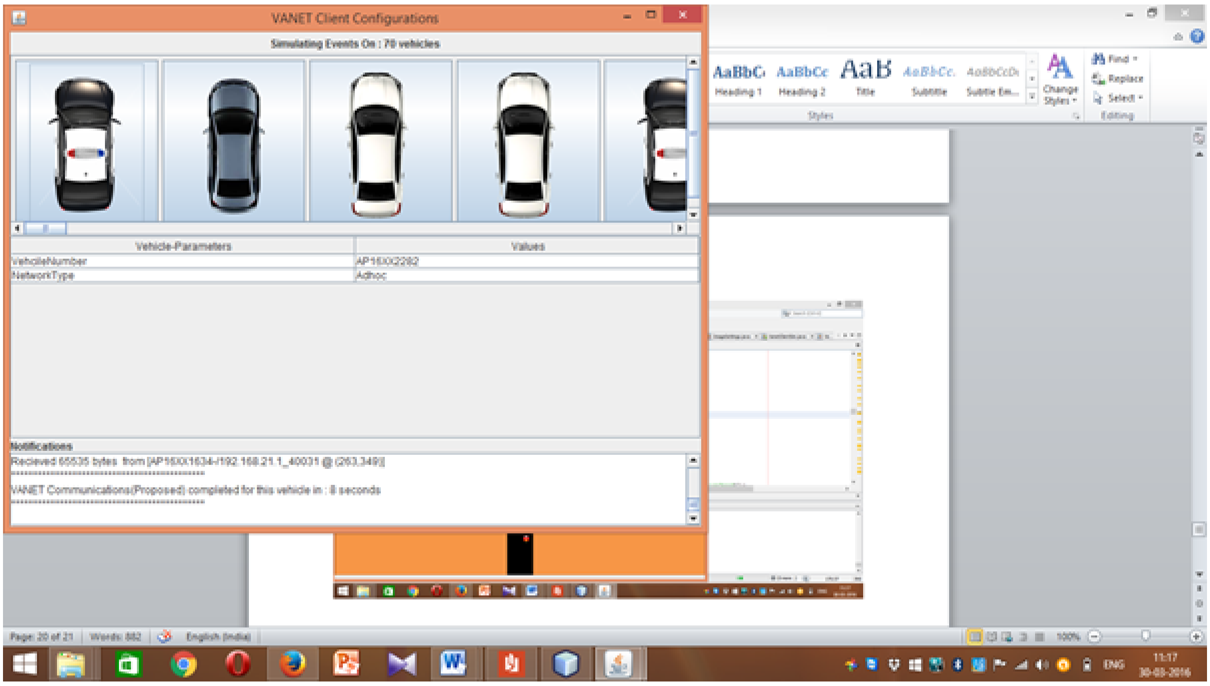
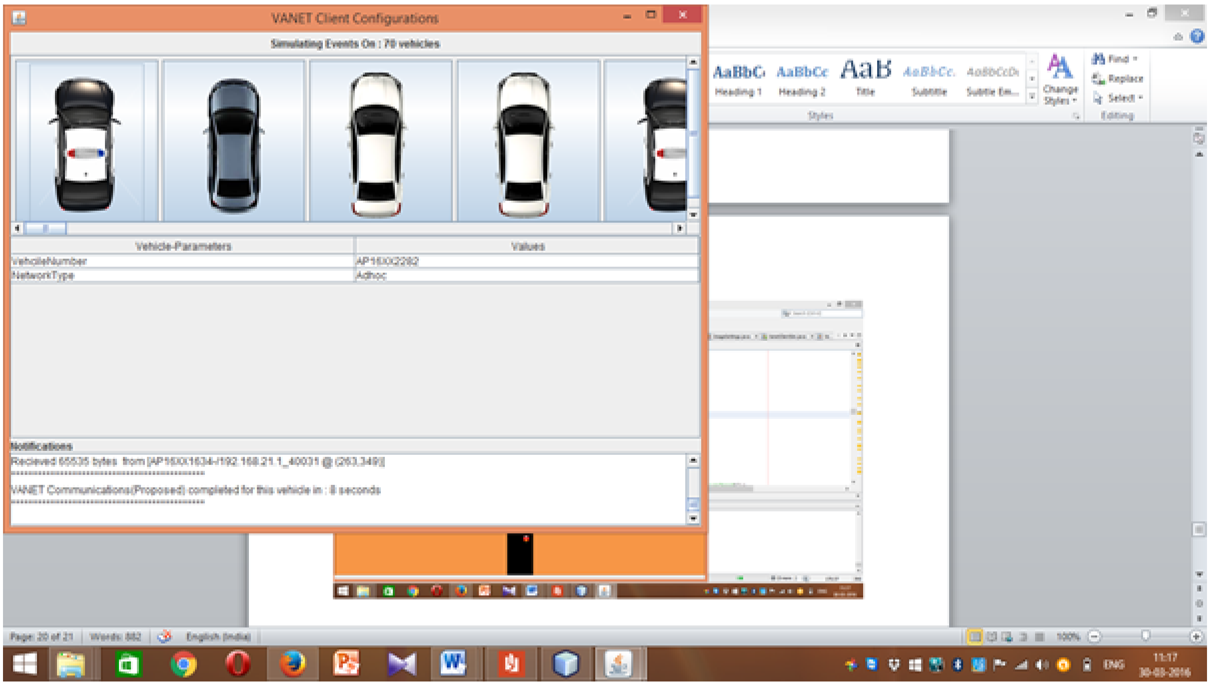


FIGURE 4.12: Capture 28



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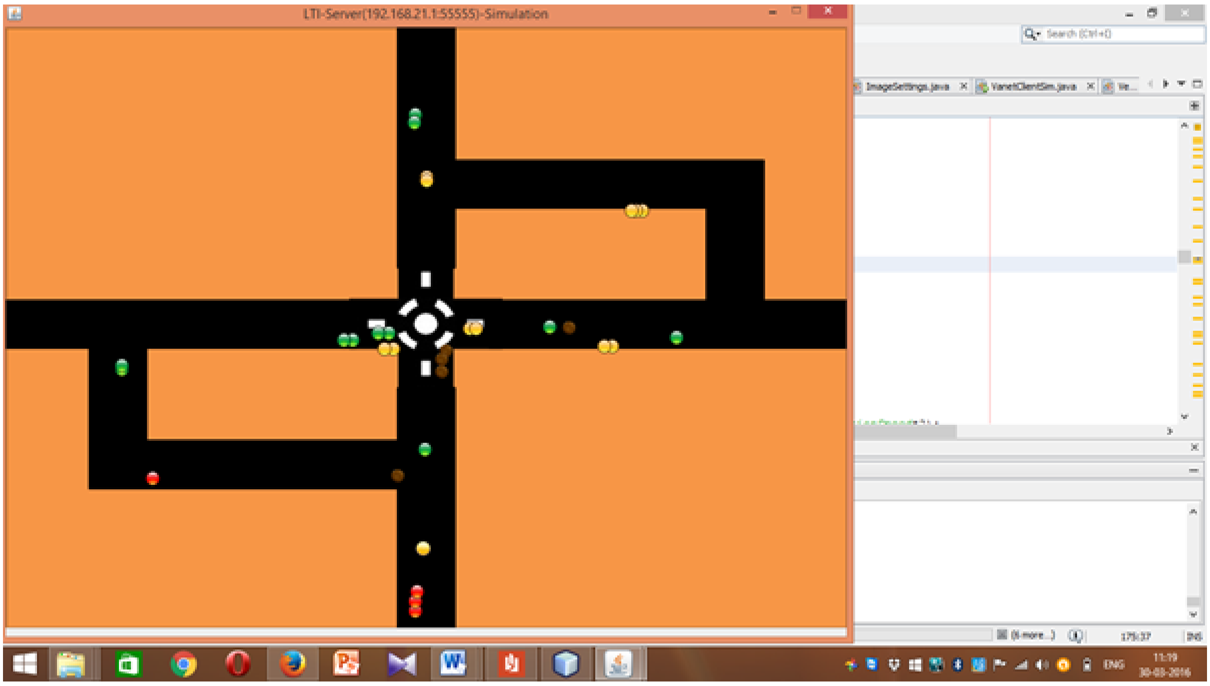

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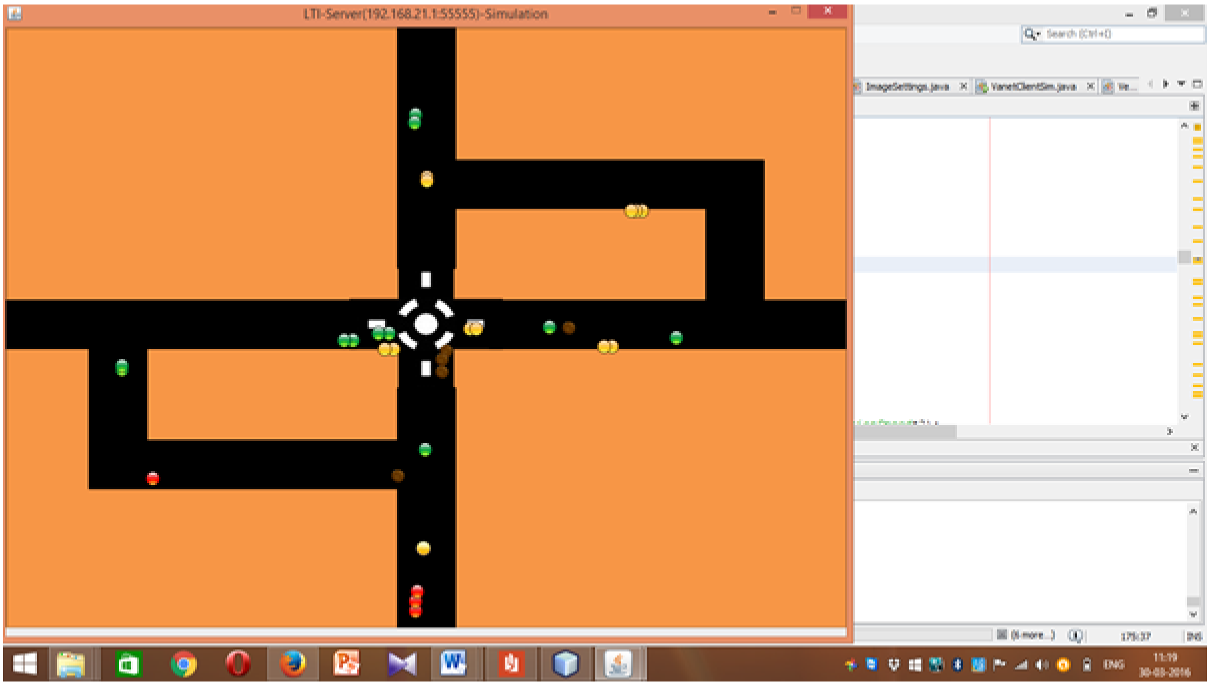

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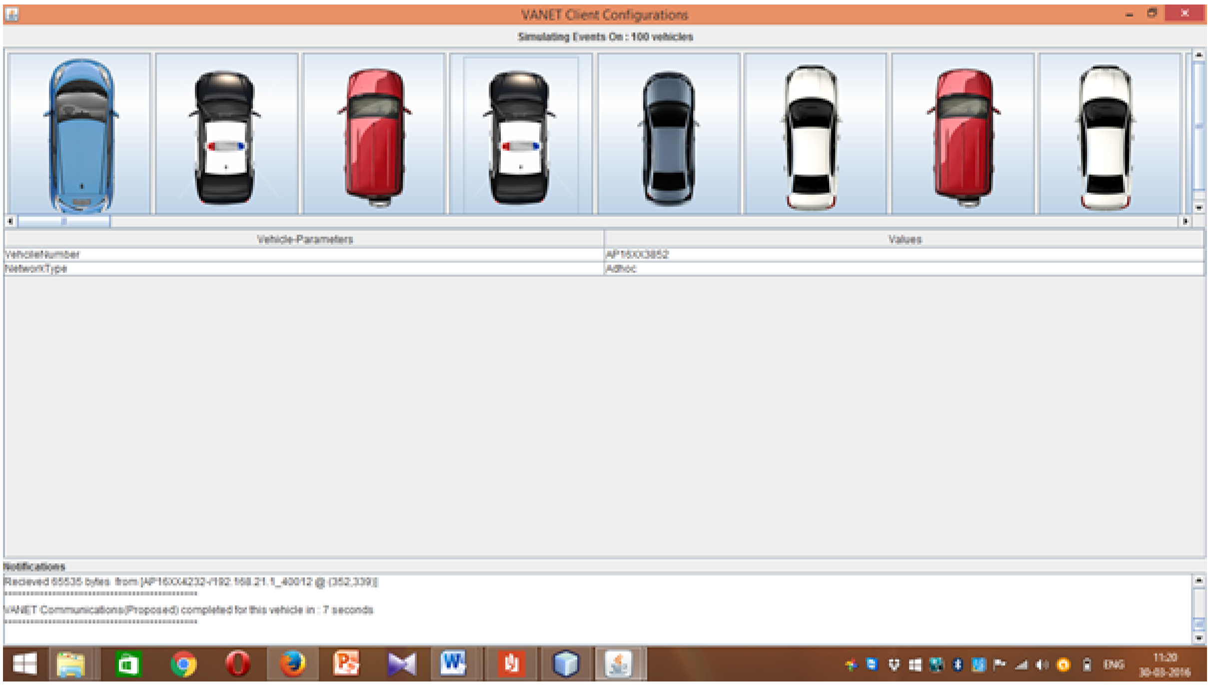

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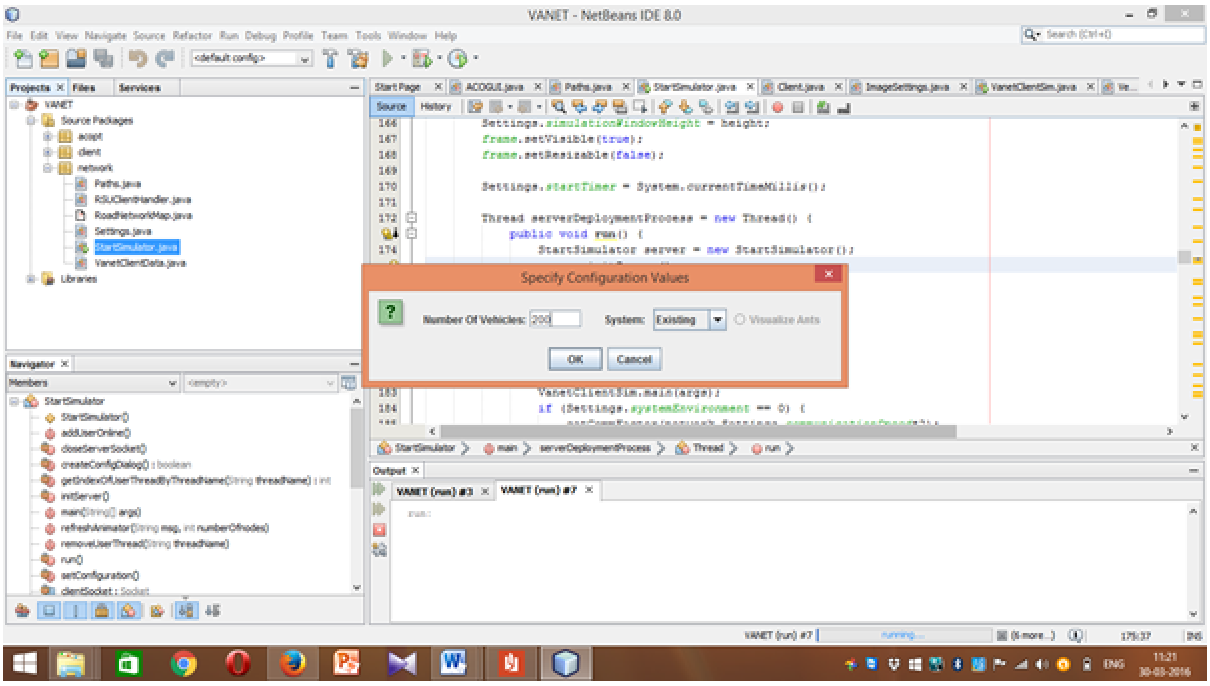

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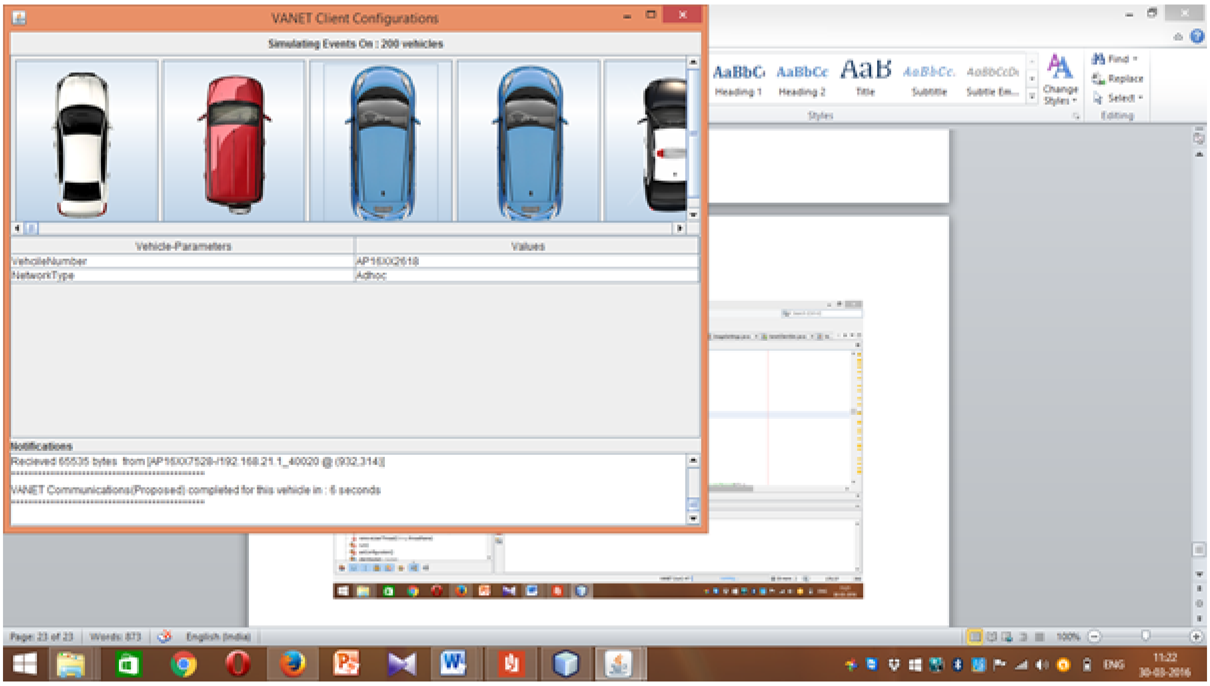

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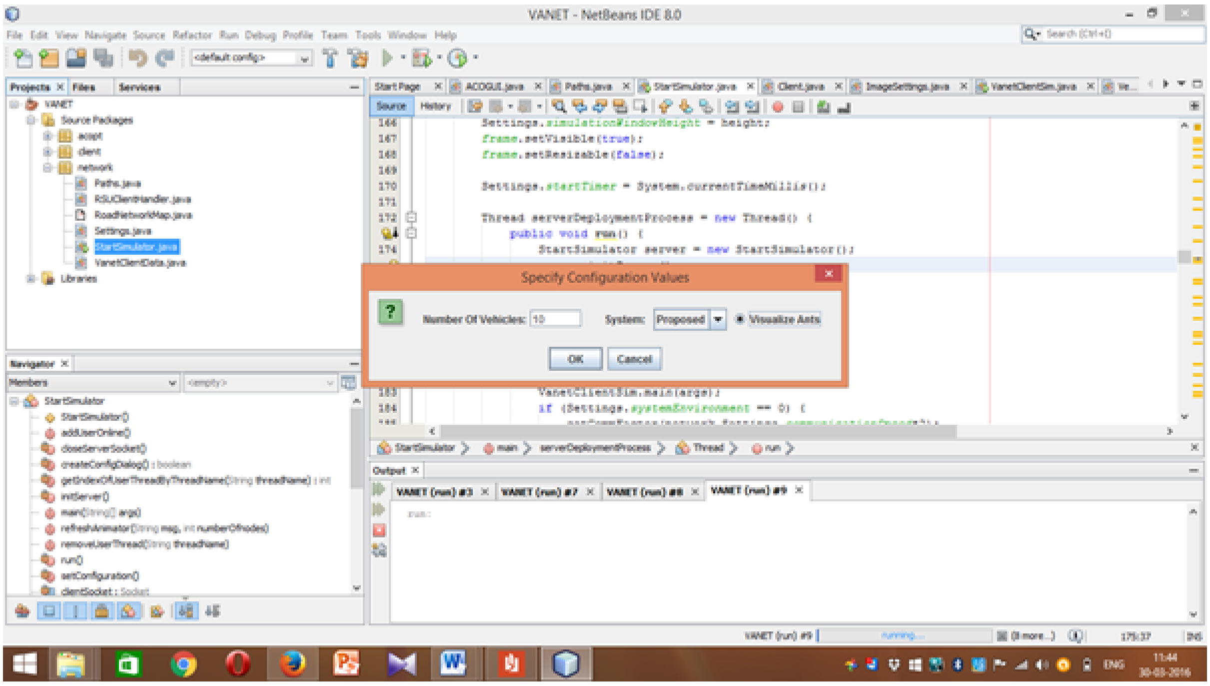

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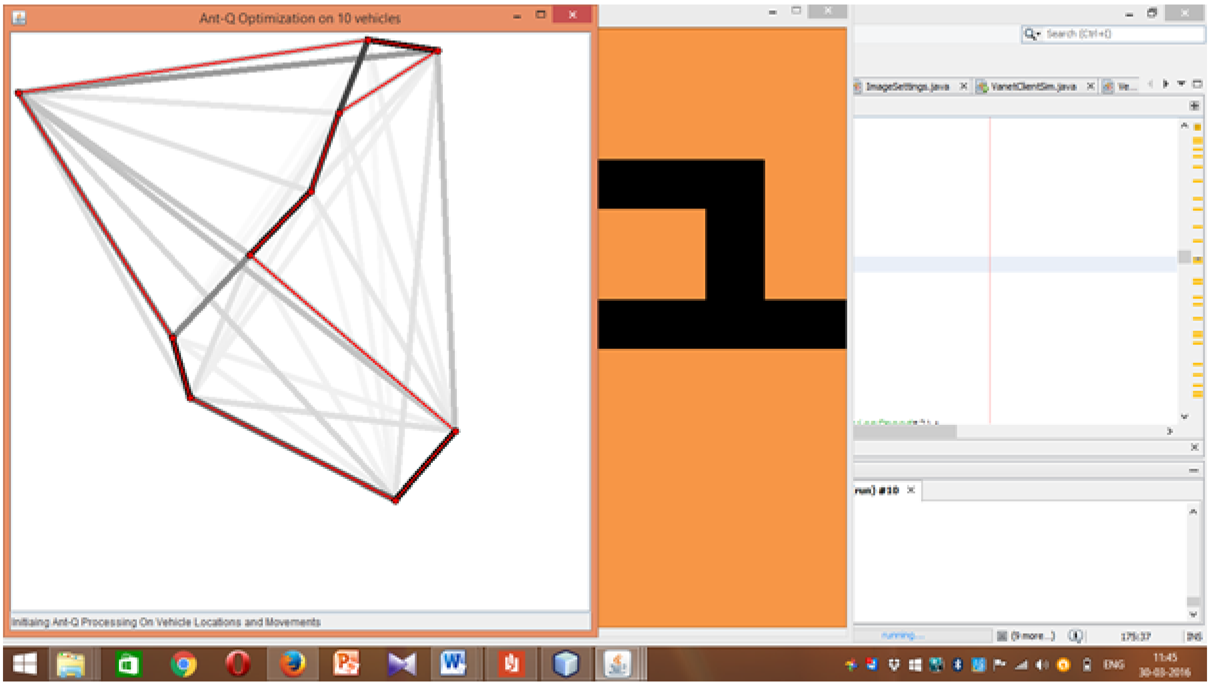

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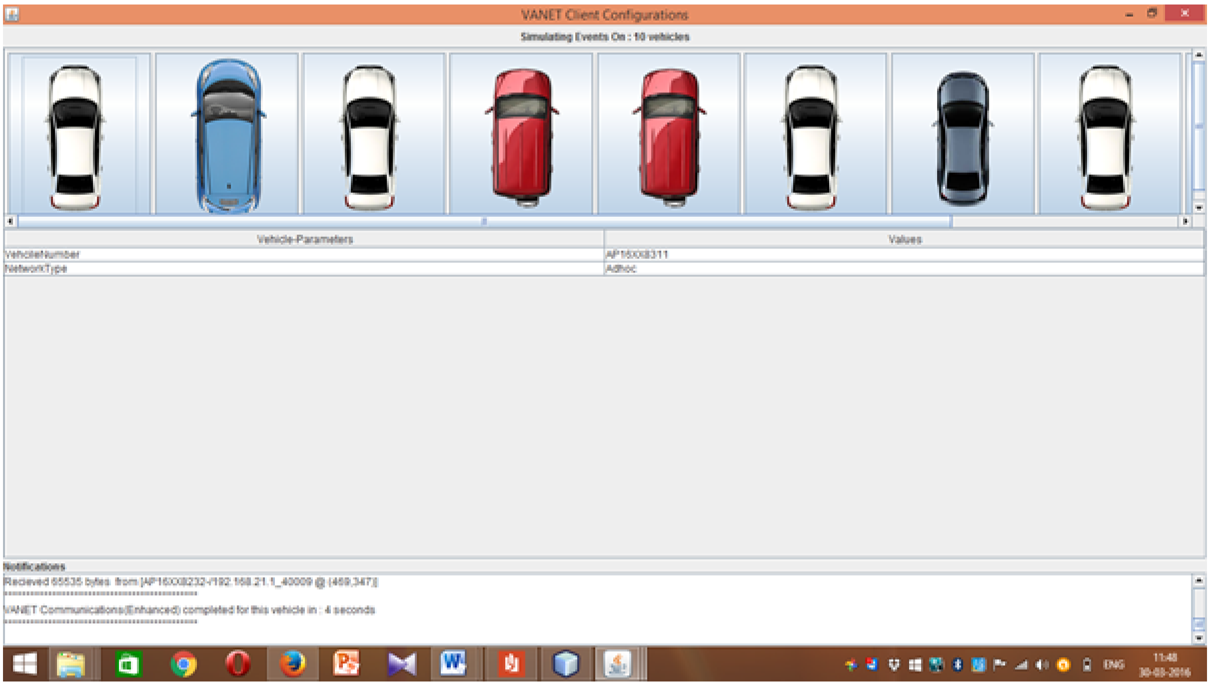

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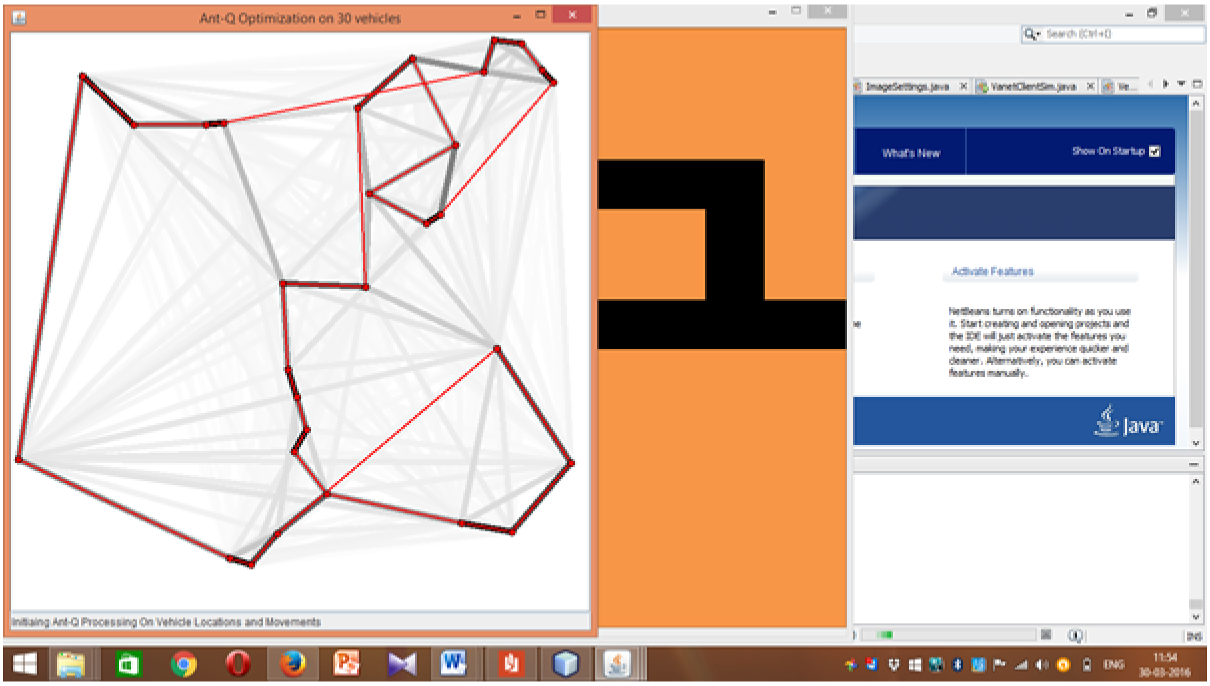

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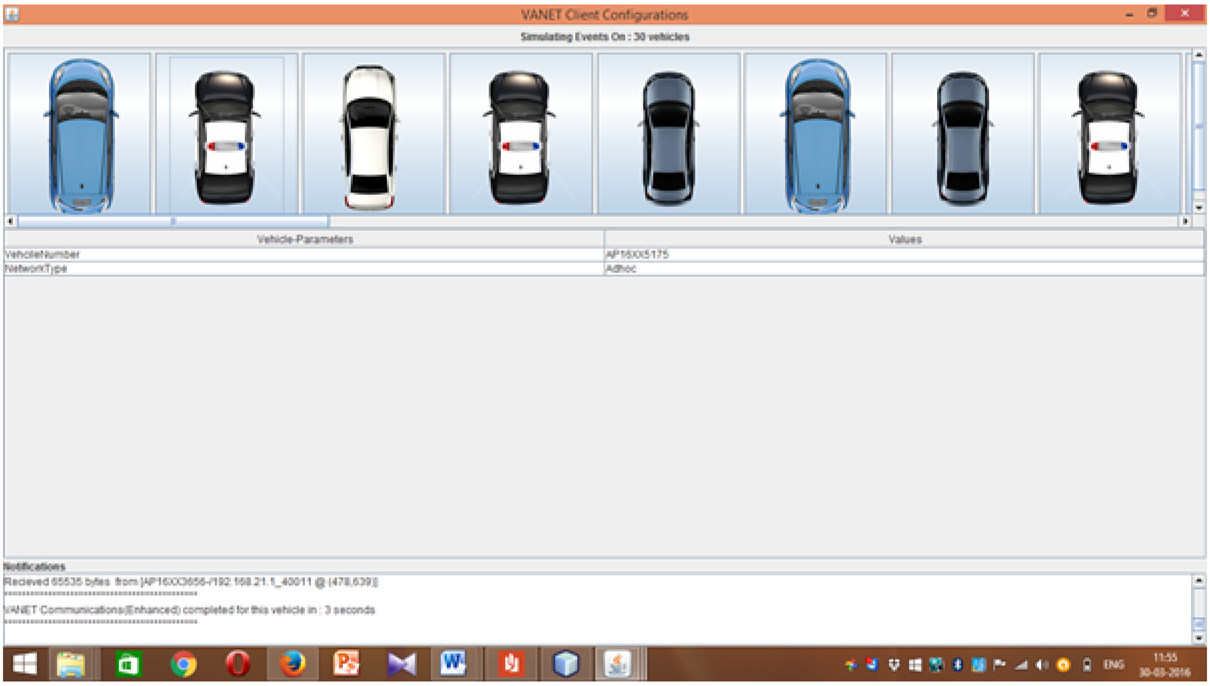

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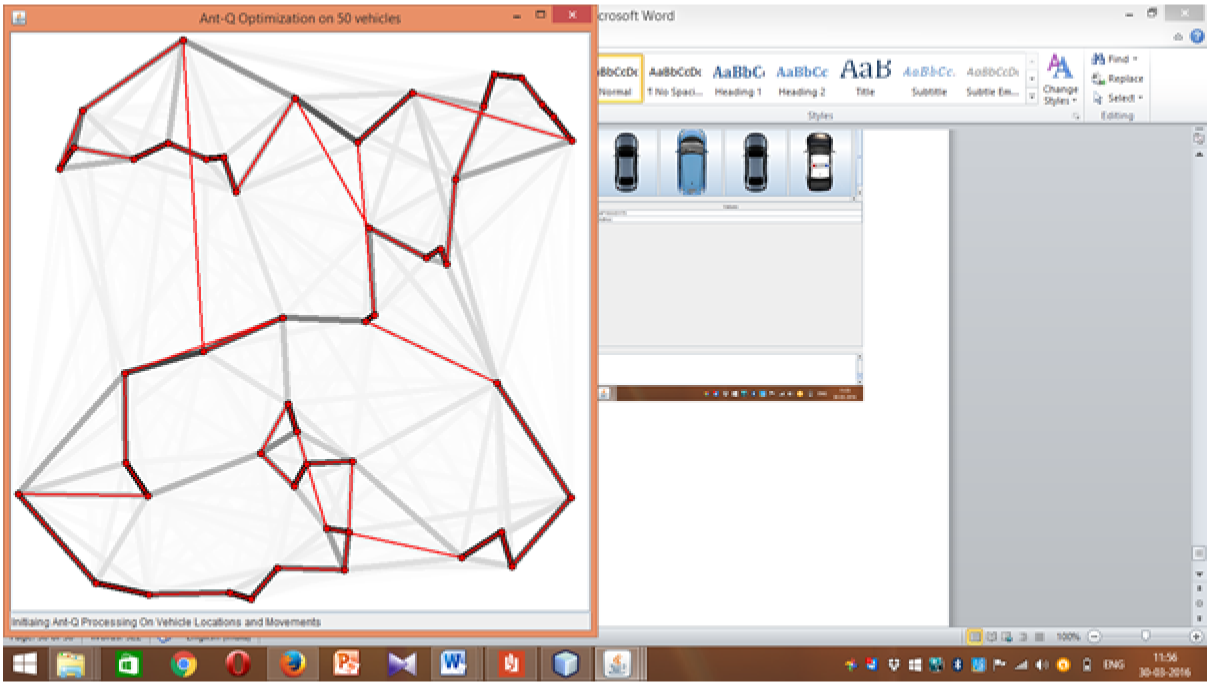

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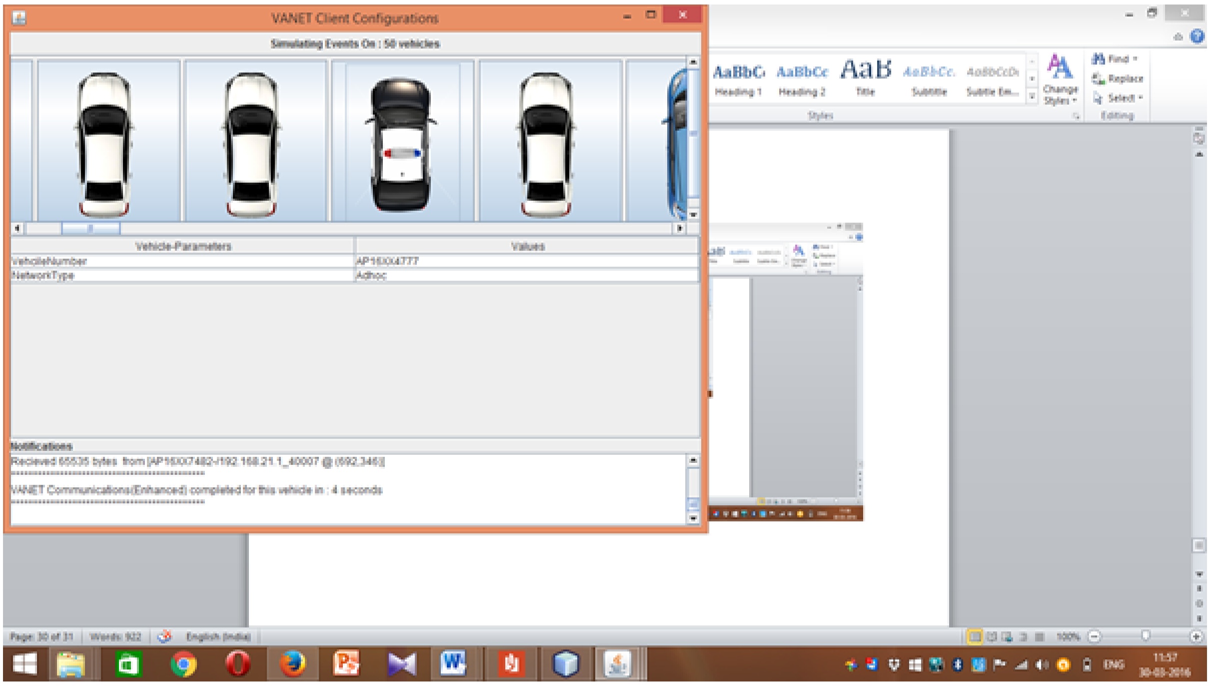

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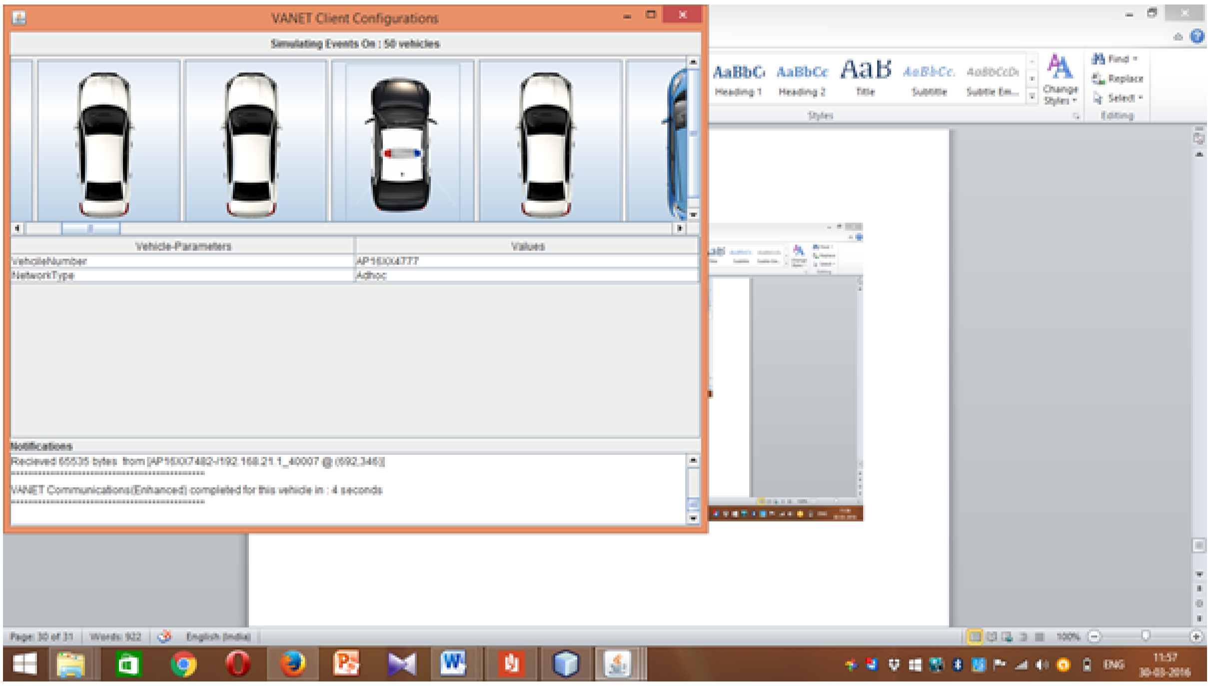
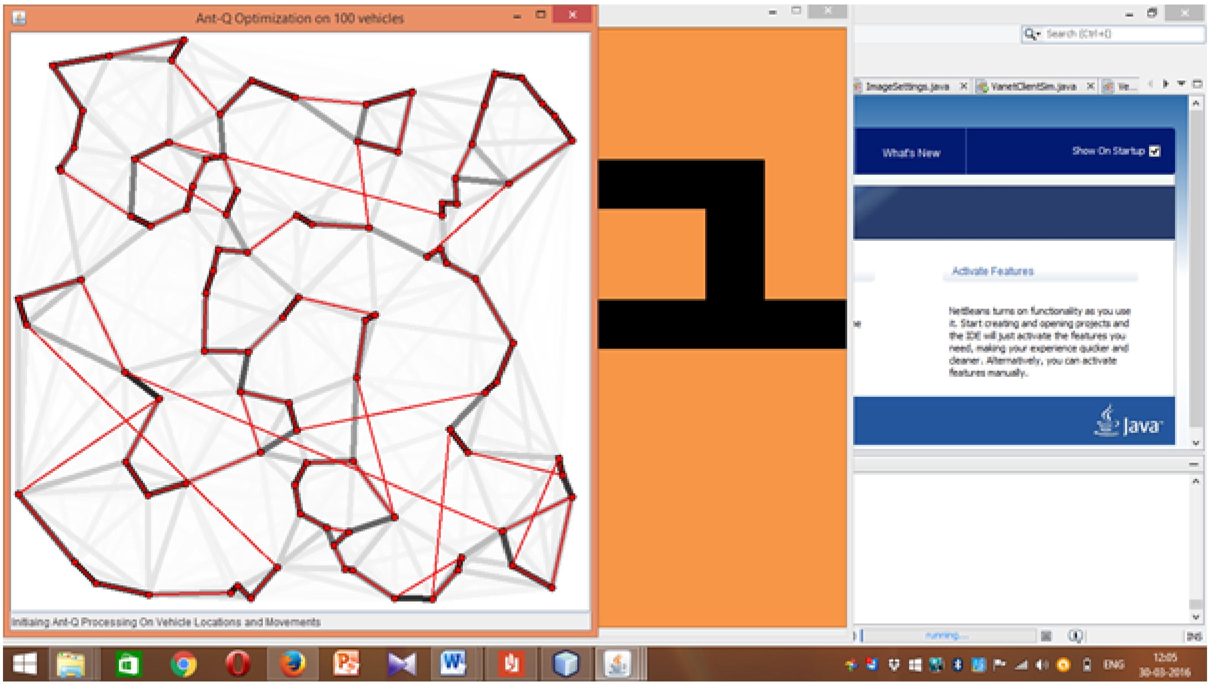


FIGURE 4.26: Capture 42



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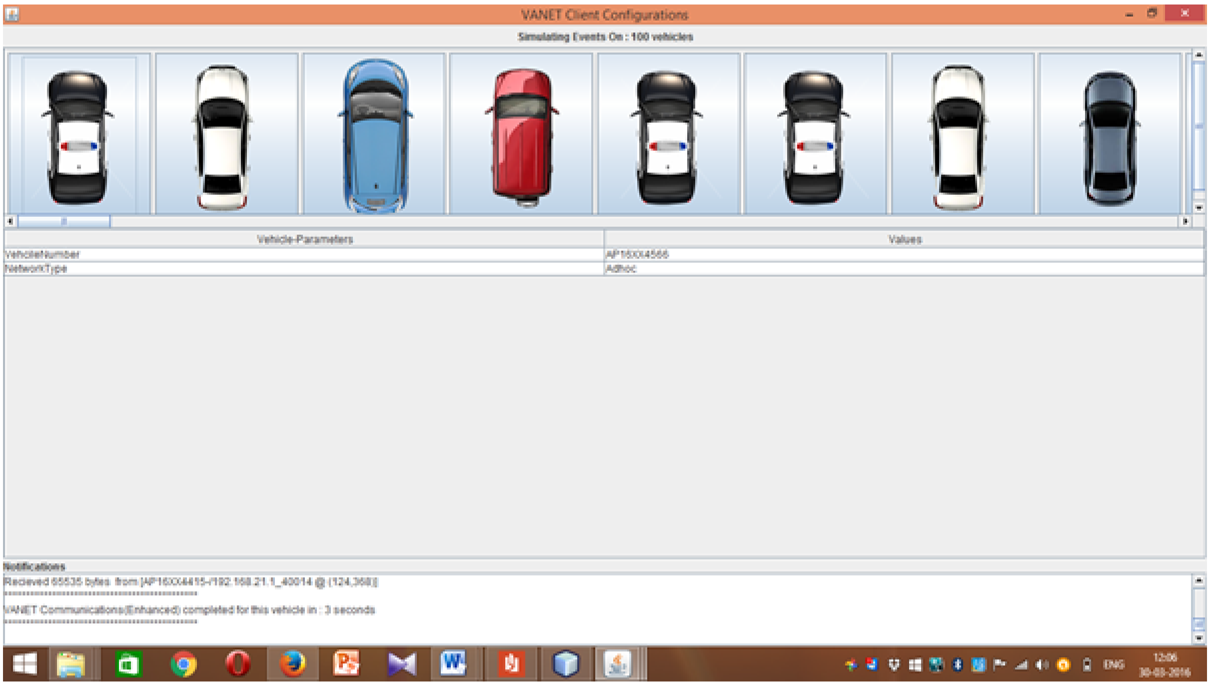

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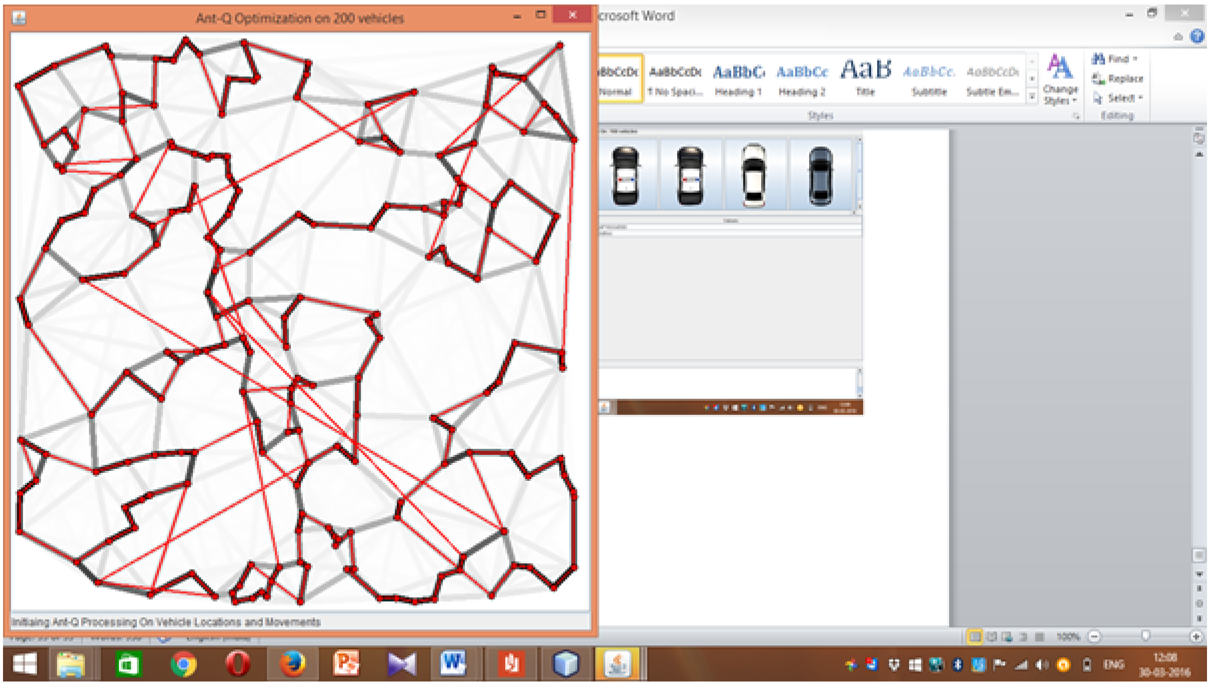

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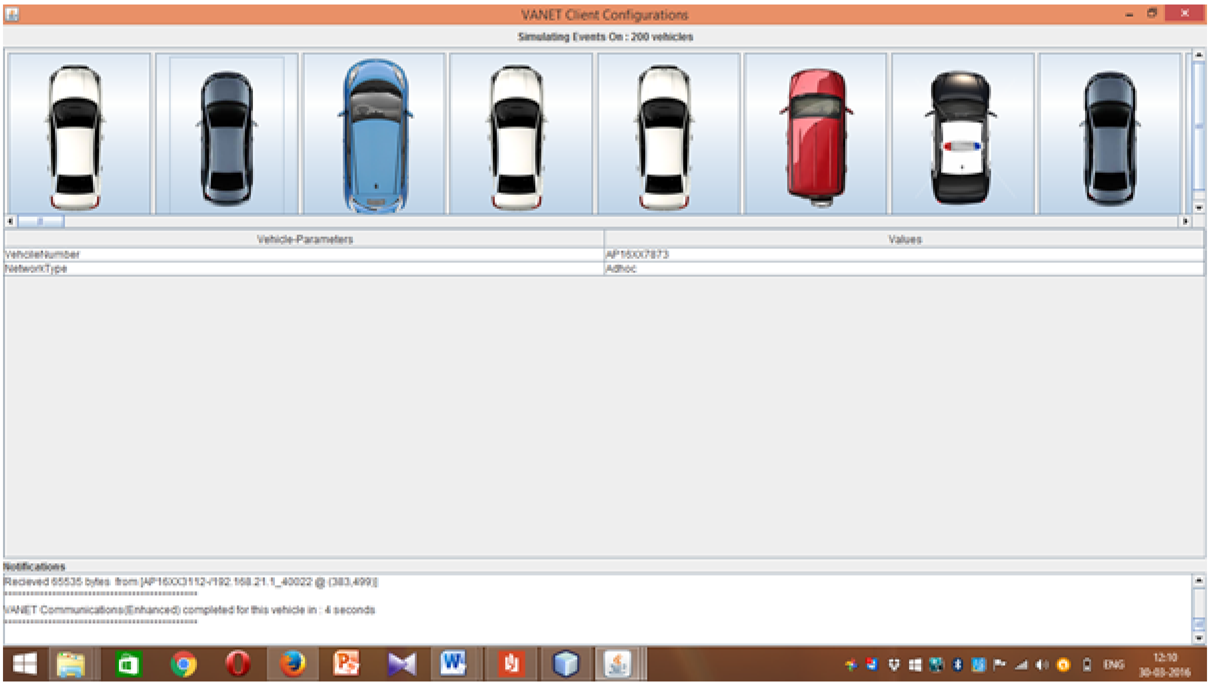

Figure 4.30: Capture 47

Chapter 5

Conclusions

5.1 Conclusions and future work

In this paper, we proposed a new algorithm Ant Queue Optimization (AQO) which is an extension of Ant colony optimization algorithm. Actually, ACO is a meta heuristic approach which is based on natural behaviour of the real ants. The real ants in search of food lays a pheromone packet which is an indication of path to rest of the ants. But the drawback in this approach is only the later ants get to know about the path information correctly where as the previous ants couldnt get it. This problem is been rectified by AQO which acts dynamically in choosing the best optimal paths. The AQO could process each and every ant or vehicle within the network. Several experiments are been carried out to compare ACO and AQO with several set of vehicles i.e., 10, 30,50,70, 100,200. Time taken to process all these set of vehicles is been recorded in a tabular form as shown above. The experimental results shows that the AQO has taken less time to process all the vehicles within a given network when compared to ACO. In this paper, the experiments are carried out within the same network but in future work, there is a lot of scope for AQO in working with the different networks.

Appendix A

Appendix Title

A new algorithm Ant Queue Optimization(AQO) which is an extension of Ant colony optimization algorithm is developed

Bibliography

[1]E. K. Burke, M. Hyde, G. Kendall, G. Ochoa, E. Ozcan, and R. Qu. A survey of Hyperheuristics. School of Computer Science and Information Technology, University of Nottingham, In Computer Science Technical Report No. NOTTCS-TR-SUB-0906241418-2747, 2009.

[2]I. Khamassi, M. Hammami and K. Ghdira. Ant-Q Hyper-heuristic approach for solving the 2- Dimentional Cutting Stock Problem.In Proceeding of IEEE Symposium Series on Computational Intelligence (SSCI 2011), Paris, France, April 2011.

[3]L. M. Gambardella and M. Dorigo. Ant-Q: A reinforcement learning approach to the traveling salesman problem. In Proceedings of ML-95, Twelfth International Conference on Machine Learning, Tahoe City, CA, A. Prieditis and S. Russell (Eds.), Morgan Kaufmann Morgan Kaufmann, pp. 252.260. 1995.