THECONTROLOFTRAFFICLIGHTBASEDONARCHITECTU REOFVANETANDSENSORDEVICES

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THECONTROLOFTRAFFICLIGHTBASEDONARCHITECTU REOFVANETANDSENSORDEVICES

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Submitted By **Ayad AL-WINDAWI**

Approval of the Graduate School of Natural And Applied Science, Çankaya University.

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This is to certify that we have read this thesis and that in our opinion, it is fully adequate, in scope and quality, as a thesis of the degree Master of Science (M.Sc.) in Mathmatics and Computer Science – Information Technology Program.

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ABSTRACT

THECONTROLOFTRAFFICLIGHTBASEDONARCHITECTU REOFVANETANDSENSORDEVICES

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Traffic coordination in streets is a very important and challenging issue. The project gives an adaptive traffic light system based on wireless communication between vehicles and embedded controller nodes existed in intersections and roadside. We have developed an integrated simulation environment. It is discussed that our system can improve traffic fluency in the streets and has clear advantages regarding performance, time saving and fuel consumption. We have used Intelligent Transportation Systems (ITS) to overcome the road limitation resultants. We are proposing a system design with its protocol and set of algorithms to balance the road traffic load and make the driving on highways and urban cities roads easier and more comfortable. By applying this system on roads, we expect to see an easy traffic flow and more efficient and comfortable driving. Given application results were got from simulation studies, are compared with our system to show the significance or the need for a proposed system with its protocol's control actions and strategies.

Keywords: VANET, Vehicles, Cars, Roads, Traffic, Information, Ad-Hoc, Access Point.

ÖZ

VANET MİMARİSİNE DAYALI TRAFİK IŞIĞI KONTROLÜ VE SENSÖR CİHAZLARI

AL-WINDAWI, AyadNozad

Yüksek lisans, Matematik – Bilgisayar Anabilim Dalı

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Tez Yöneticisi : Prof. Dr. AbdülKadir GÖRÜR

Ocak 2015, 31 sayfa

Sokaklardaki trafik koordinasyonu çok önemli ve sorunlu bir konudur. Proje; cihazlar ile gömülü kavşaklarda ve yol kenarlarında mevcut gömülü kontrol edici nodlar/devreler arasında telsiz iletişimine dayalı uyarlanabilir bir trafik ışık sistemi sunmaktadır. Bir entegre simülasyon ortamı geliştirmiş bulunuyoruz. Sistemimizin sokaklardaki trafik akışını artırabileceği, bilahare performans, zaman tasarrufu ve yakıt tüketimi itibariyle bariz avantajları olduğu söylenmektedir. Yol sınırlaması ile sonuçlanan hususları aşmak için Akıllı Ulaşım Sistemleri kullandık. Yol trafik yükünü dengelemek ve karayollarında ve şehir içi yollarda daha kolay ve rahat bir sürüş imkanı sağlamak amacıyla protokolü ve algoritma dizi ile birlikte bir sistem tasarımı öneriyoruz Bu sistemi yollarda uygulamak suretiyle, daha kolay trafik akışı ve daha etkin ve rahat sürüş imkanı görmeyi bekliyoruz. Verilen uygulama sonuçları simülasyon çalışmalarından elde edilmiş ve protokolün kontrol faaliyetleri ve stratejileriyle birlikte önerilen bir sistemin önemini ya da böyle bir sistem duyulan ihtiyacı göstermek üzere bizim sistemimiz ile karşılaştırılmıştır.

Anahtar kelimeler:VANET, Araçlar, Arabalar, Yollar,Trafik, Bilgi Buna Mahsus, Giriş Noktası.

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LIST OF ABBREVIATIONS

VANET VehicularAd-Hoc Network
MNMobile Network
SNSensorNetwork
WLAN WirelessLocal Area Network
MANETMobile Ad-HocNetworks
RSURoad Side Unit

AUApplication Unit

OBUOn Board Unit

GPSGlobal PositioningSystem

IDIdentityInformation

EUEuropean Union

ITSIntelligent Transportation Systems

SUB-BSSub Base

MAIN-BSMain Base

GPSRGreedyPerimeterStatelessRoutin

CHAPTER 1

INTRODUCTION

1.1IntroductiontoTransportationSystemandVANET

Trafficcongestionisanincreasingandseriousproblemaroundtheworld duetothe architecturalandpopulationexpansion,technicaldevelopmentandthegreatnumber ofcars.Theresultsoftrafficcongestionaretimewasting, fuel consumptionsandtheenvironmentis harmedbypollutantscausedbyengines.Farworsethanthis,thecongestion sometimesprovokesdriversinto a dangerousbehaviour,suchasrunningredlights,to compensatelosttime.So,thisthesisdescribes howadjustingcity's trafficsignalscanreducecongestionwhichresultsintimesavings,environmental benefits, and safety[1].

Infact,whenthefirsttrafficsignalwasinstalledataClevelandintersectionin1914, theonlyobjectivewastopreventaccidentsbyshowingtherightwaywithno interest giventominimizetrafficdelay,pollutionandfuelconsumption. Acrosstime, trafficvolumeshavebeenincreased andtheobjectivesexpandedtoinclude maximizingthe capacityof theroadwaysystem andimprovingtraffic flow. Togoforwardinthisregard,wehaveproposedasimulationenvironmentreactingto rushhourswhichmakesconnectionamongcars a n d withcentralmanagement as well.Nodes(cars)areconnectedtoexchangedatato determinethebestpaththatcanbetakentogoto their destinations infast and less consuming way.

VehicularAd-HocNetwork(VANET)whichisa formofMobileAd-HocNetwork isused, in this thesis,toestablishshortrange communications(DSRC)amongnearVehicles(V2VCommunications)andbetween vehiclesandnearexistedinfrastructureequipment;Roadsideequipment(V2I Communications).

Sincephysicalcarshavenotbeenused,IhaveusedsoftwareJavaprogramming (Eclipes) to mimic myproposed work. Thereason why the simulation environment is developed is to design smart management traffic light system for anentire city.

Thetrafficlight management system usesVehicle Ad-Hoc Network protocol and Vehicle with Infrastructure devices. ApplyingVANET techniques in real life leads to:

- Reducingthe production of Co2 and the consumption ofthe fuel.
- Enhancingthe safetyandcomfortability for the drivers.
- Reducing air pollutions

So,theusedsystemrepresentsan approach thatdescribesaspontaneousAd-Hocnetwork whichisformedovermovingvehiclethroughtheroads.Thevehicularnetworksare continuouslyappearing,improvinganddeveloping. These are usedfor a newand traditional application.

Thecharacteristicsofthesenetworksinclude:changingtopology,highmobility,and ephemeral,one-timeinteraction.InFigure1 shows thevehicularAd-Hocnetworkclearly[2].

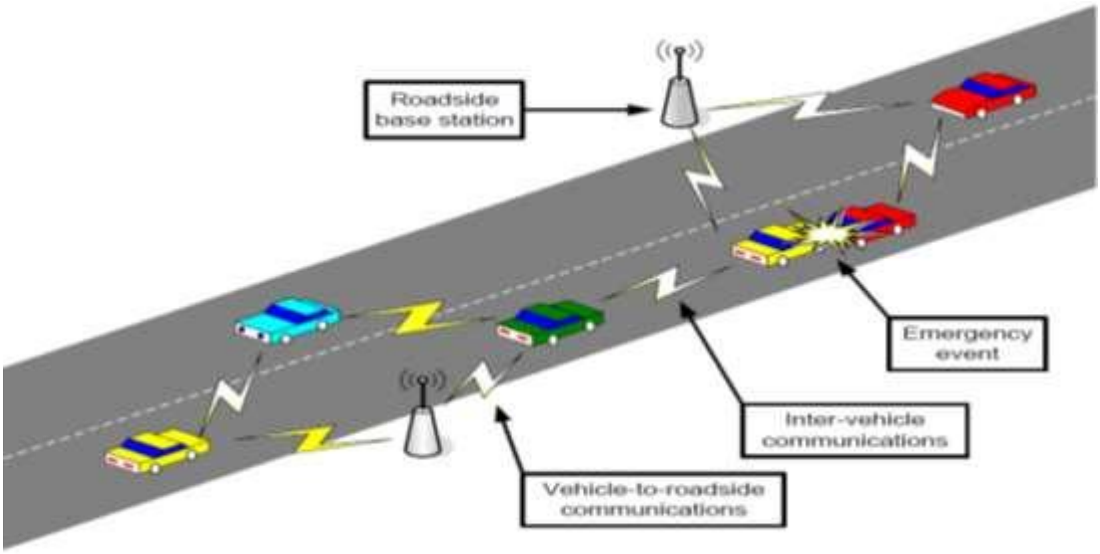

Figure1 VehicularAd-Hoc network

Anotherimportantterminthisthesisissmartvehicle whichis avehiclethat isequippedwithsensorsandcomputers.Thenumbersofsmartvehiclesare increasingfortheefficienttransport,themanagementapplicationsfocusedon optimizedflowsofvehicles by reducingthetimethatistakentotravelandavoidany trafficcongestion inthe roads.

1.2ThesisOrganization

This study develops a simulation environment which is an adaptive on short- wireless communication range between the cars (Vehicles V2V and V2I). Starting with an introduction about VANET and moving forward to the background theory, this study aims to manage traffic light in short range communication. The study uses many algorithms with results. TherearesixchaptersinthisthesisChapteronecontainsanintroductiontoVANETandsome otherterms.Chaptertwoincludesbackgroundtheory.Inchapterthreea literaturereviewofmanysimilaroradjacentworksisgivenandcompared.Chapterfourinclu desmethodsandexperimentwithgoalsandobjectives.Chapterfive includesthe experimentresults.Finally,the conclusionandfuturearementionedin chaptersix.

1.3SmartVehicles

Fromtheverybeginningoftheartificialintelligence,therehadbeenattemptsfor usingatotallyautomatedintelligentvehicle.Manyexperimentshavebeen doneandsomeofthemendedwith fruitfulresults.Asaresultforwhathadbeen donewehave intelligentsmartcars.Thesecarsareintelligentandarecapableof takingsomeofthedecisions andtheyactuallyassistthedriversince theyare totally automated. We can say that a fully automated transportationcanonlybepossiblethroughhavingagroupofintelligentvehicles, the developed trafficsystemandthe environmentsare very essential for this kind of transportation. So,smartvehiclesarethosevehiclesthatareequippedwithsensorsand computers. At any time,theradarthatispresentedontheon-boardcouldbe usedtosensethetrafficcongestionandautomaticallymakethevehicletobemore slowly.Inanyotheraccidentswarningsystems,thesensorscanbeusedtoshowthat thecrashmaybeoccurredifheairbagsweredeployed;thistypeofinformationisrelayed then via V2IorV2Vwithin the used vehicular network.

Thedifferentlevelsoffunctionalityareprovidedbyusingnumberofsystemsand sensorswhich includes:

- The crash sensors
- The data recorder.
- The breakingsystem.
- The engine control unit.
- The electronic stabilitycontrol.
- The information system.
- The integrated startergenerator.
- The electronic steering.
- The tirepressuremonitoringsystem.
- The power distribution and connectivity.
- The lightingsystem, seatbelt sensors.

Inthebrakingsystems,therearealsotheanti-lockbrakesystemandtheparkingbrake system.

Theparkingbrakeisreferredalsotoanemergencybrake;itisusedtocontrolthe rear brakesbyusing aseries ofsteel wires(steel cables).Byusing this parkingbrake, itispossibletomakethevehiclestoppedwhenasuddenfailureoccurfortheevent ofatotalbrake.Thecameraswhichmountedwiththevehiclesaremainlyusedto displayimages on the vehicle console ofsmart vehicle [2](As in figures 2).

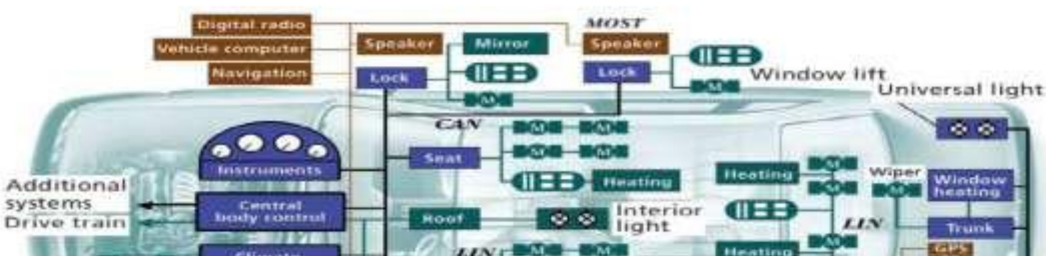

Figure2 Smart vehicle systems

Inthisthesiswork,weproposedaprojectbyusingaVANET-V2IandSensorNetwork(SN)thatisusedtocalculateinformationoftheroadandsendthedata toa specialunitnameddatacontrollingcentral.Inthisproject,theVANETisemployed tomakeconnectionthroughthecollectedtrafficdatafromtheroadforthetrafficlight controllerstomanagethetrafficlightphasing,managethetimingandmakingthe trafficflowmoreeasily.

CHAPTER 2

BACKGROUND THEORY

2.1InfrastructureWirelessCommunication

WLANsare very importantin every infrastructures network.Theinfrastructure networkisnot providingaccesstotheothernetworksonly,buttheyalsoincludefunctionsforwarding,medi umaccesscontrolandetc.Inthesebasedwirelessinfrastructure networks, typicallythe communication takes place between thenodesofwirelessand theaccesspointonly,butnotdirectlybetweenthenodesofwireless[3].(As in figure 3),

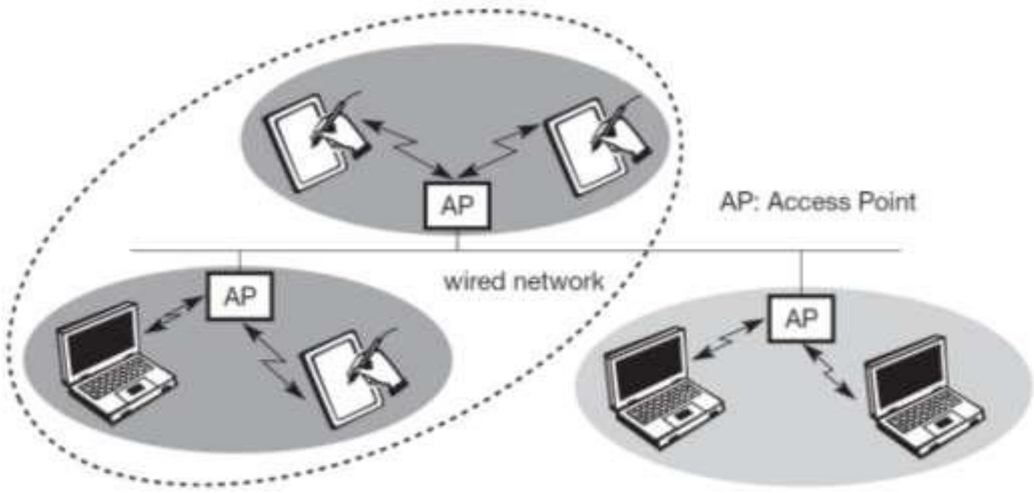

Figure3 Infrastructurewirelessnetwork

Theaccesspointdoesn'tcontrolthemediumaccessimmediately,buttheyactasa bridgealsotootherwirelessorwiredtypesnetworks.Figure3thatshowsthree accesspointsornodesincludingtheirthreewirelessnetworkstypesandalsoawired networktype.Manywirelessnetworksmayhaveaformofonelogicalwireless network. Thus,theaccesspointswiththefixednetworktogetherinbetweencan connect several wireless networks in order to build a large network behind theactual coverageoftheradio. Usually,theinfrastructurewirelessbased on networkdesignis verysimplebecausemostofthenetworkshave functionsworkingwithinthe access point region, while the clients of the wireless can stayverysimple. ThisstructureisreminiscentofswitchedEthernetorotherformsofthestar-based networks,whereanelementinthecentre(aswitch)willcontrolthenetworkflow. Differentaccessschemescanbeusedbythiskindofnetworkwith or without acollision. The collisionsmaybe occurred if themedium accessof thewireless nodes andtheaccesspointarenotarranged.So,iftheaccesspointonly controlsthemedium access,collisionsareimpossibletohappen.Thissettingcanbeusefulforthequality oftheserviceguaranteessuchasthebandwidthofminimumforthecertainnodes. The access point cannotbe as asingle wireless node to insurethe datarate[3].

2.2AD-HocWirelessCommunication

TheAd-Hocwirelessnetworksdonotneedanyinfrastructuretowork.Everynode cancommunicatewithothernodesdirectly,thus,itisnotnecessaryfortheaccess pointtocontrolthemediumaccess.Figure4shows the two networksofad-hocwith threenodesforeach one. Thenodeswhichareinsidethead-hocnetworkthatcanbecommunicatedonlyif theyphysicallycanreachoneeachother,forexampleiftheyareoverlappedwith theirradiorangeorifthemessagecanbeforwardedbyothernodes.ThenodesshowninFigure 4canbecommunicatedonlywitheachotheriftheyareinthesame rangeof the radio. Inthead-hocnetworks,ahighcomplexityisthereforeachnodebecausemedium accessmechanismshavetobeimplementedbyeverynode,themechanismstohandle the hiddenorexposedproblemsoftheterminalandprobablyprioritymechanisms,to provideaservicewithacertainquality.Thiskindofwirelessnetworkisflexible that exhibitedthegreatestpossibilityasitis,asanexample,anunexpectedmeetingthat is needed,promptcommunicationscenariosorreplacementsofinfrastructureisvery farfrom anynetwork oftheinfrastructuretype[3].

Figure4 Ad –Hoc wireless network

2.3MobileAd-HocNetworks(MANET)

ThemobileAdHocnetworksareveryflexiblewirelessnetworksthatdonotrelyon anyexternalinfrastructurelikeroutersorradiotowers.Thenetworkisbuiltbythe nodesthemselves,andusuallythemessagesaresentusingmulti-hoproutingin whichthenodesofthenetworkactasrouterstodelivermessagesoutsideofthe sender'stransmissionrange.ThebasicallychallengeforbuildingaMANETisfor eachdevicetomaintaintherequiredinformationcontinuouslytoroutetraffic properly.EachnodeoftheMANETmaybeabletomoveindependentlyinamanner that is not necessarilypredictable byother nodes[4].

2.4VehicularAd-HocNetwork(VANET)

Manymanufacturesofthecarinsidetheresearchinstitutionsinvestigatemanywaysforthevehicularnetworksestablishing.Theyrepresentanattractivesolutionfor inter-vehicularcommunicationsbecauseoftheflexiblenatureof the MobileAdHoc Networks(MANET)[5, 6].

VANETshavemanyuniquecharacteristicsthatarenotsharedbyothertypesofMANETs and accordingto the following:

a.The vehicles move at a high speed.

b.Patternsofthemobilityarepredictablesometimeasaconstrainedmovement byroadinfrastructure.Insomesituationslikethehighwaytraffic,the mobilitypatterns becomehighlypredictable.

c.Large coveragearea. Here the vehiclesaretravelled over longdistanceswith a traffic information that maybe useful to vehicles in hundreds of miles away.

d.Powerconsumption isnot a majorconcern. Vehiclesaremobile power plants.

e. TheVehicleshaveahighcostandthereforecanbeequippedwithadditional

sensorswithout significantlyimpactingthe total cost.
f.TheVANET'stopologyisdynamicextremelylikethevehiclesthatgoin and out transmission rangequiterapidly.
g.TheVehiclestravellongdistancesinasmalltimeamountwhencompared with other mobile networks.

2.5VANETArchitecture

Communicationamong the vehiclesand the RoadSideUnit(RSU)oramongvehicleswith each other can be established byawireless medium known as"wave". Thiscommunicationapproachhastheabilitytoprovidedriversandtravellerswitha widerangeofinformationandsafetyapplicationswhichsupportthesafetyofthe streetsandgive more comfortabledriving.
The mainsystemconsistsofthefollowingcomponents:theapplicationunit(AU),on board unit (OBU), androad side unit (RSU).
1- Road Side Unit(RSU) hosts application which has services.
2-OnBoardUnit(OBU)isapoordevisewhichusesthedeliveredapplicationsservices.
3 -Application Unit (AU)can beresided either in OBU orin RSU.
Thisapplicationishostedonadevisethatiscalledtheproviderandthetermuser describes thedeviceusingtheapplication.
Vehiclesinthesystemareequippedwithasetofsensorsand OBUforthefavourof datacollectinganddataprocessingoperations,beforesendingthepacketofdatato RSUorothervehiclesviathewirelessmedium.Furthermore,itcanbeoneormore AUstobeusedbytheproviderregardingtheonboardunitconnectionfacilitiesand capabilities.AlsoRSUmightbeconnecteddirectlytotheinternetortoaspecific serverwhichconnectstheapplicationunits(AUs)ofothervehicle together with the internet [7, 8].

2.6OnBoardUnit(OBU)

Thisunitisawavedevice orvehicle basedontheonboardwhichexchangesthedata withotherdevicesorRSUs.AtypicalOBUconsistsofaresourcecommand processor(RCP),alongwithotherrecoursessuchas:redrightmemory,user interface,interface thatconnectsOBUstogetherandashortrange wirelessdevice for communication(i.e.IEE802.11Pradiotechnology).ThiswirelessdeviceconnectsONU tootherOBUsortoRSU byusingIEE802.11Pradiochannel.Additionally,it supportsservicesofcommunicationtoAU,andbroadcastingthedatatoits destination.ThemaintasksofOBUaread-hocnetnetworkcongestioncontrol, wirelessaccess,geographicalrouting, datasecurity,transfermassagereliably,andIP mobility[9].

2.7ApplicationUnit(AU)

Thisdeviceisequippedinthevehiclessthatusetheprovided applicationsbythe provider through communication serviceofOBU.

AUdevicecanbeusedeitherasadedicateddevice(e.g.insafetyapplications)oras anormaldevice(e.g.personaldigitalassistantPDA).AUconnectiontotheOPU couldbeawiredorwirelessmanner.AlsoitcouldberesidedtheOBUinonesingle unit,asthedestinationbetweenOBUandAUislogical.AUcanonlyreachthe internet through OBU[7, 9].

2.8RoadSideUnit(RSU)

Thisunitisawavedevicethatisfixedontheroadonspecificlocationssuchas: parkingspaces,squares,andjunctions. RSUcouldbeequippedwithasingle networkdevice(i.e.basedonIEE802.11P).Furthermore,itcouldbeequippedwith othernetworkdevicesinordertobeusedforcommunicationin t h e network infrastructures. (Figures 5-6-7).

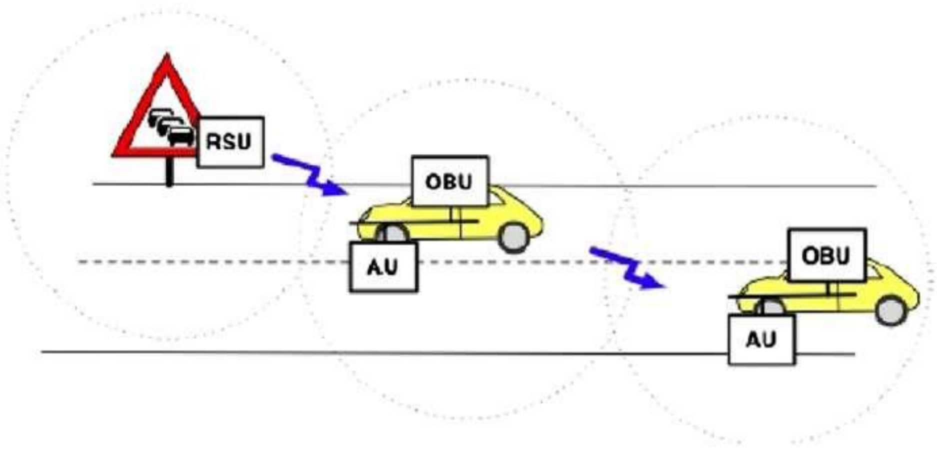

Figure5 RSUworks asinformation source (runningthe safetyapplications)

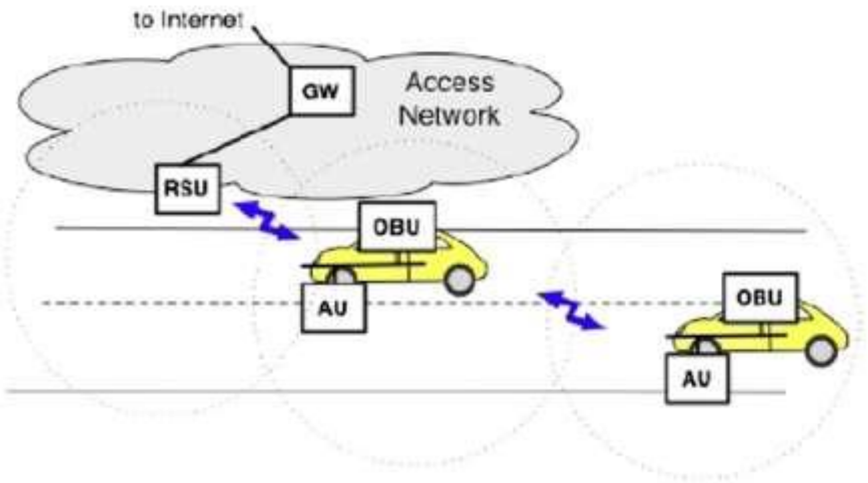

Figure6 RSUprovidesinternet connectivityto the OBUs

According to Figure (7), the main task and procedure of RSU can be summarized as:

1-Expanding the communication range of the ad-hoc network (i.e. Redistribution of the data to OBUs and sends the data to other RSUs for the favour of resending it to other OBUs.

2- Executing safety applications such as accident warning and low bridge warning, using the infrastructure vehicle (I2V) technique, and routing as a source of data.

3- Providing internet connectivity to OBUs

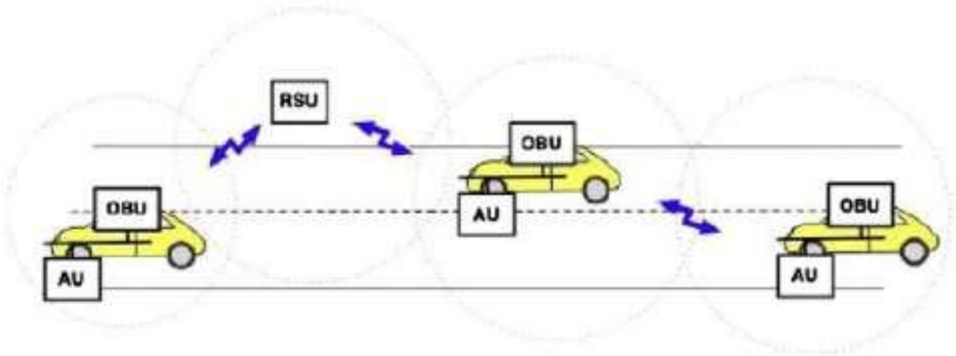

Figure7FRSUextends the rangeof the Ad Hoc networkbyforward thedata ofOBUs

CHAPTER 3

LITERATUREREVIEW

ManyresearchesofVANETh a v e focusedonsimulatingvehiculartrafficand multi-hop routing. Fewresearches have studied theproblem ofusing VANETsfor the purposeofdiscoveringthetrafficcongestion.Usingthevehicles thatarebasedonthe VANETsystems cancreateAd-Hocwirelessnetworkthatcanbeusedtofindand publicize the traffic congestion information. Sincemanyyearsago,theissueofthedistributeddetection,thetrafficcongestion andtheinformationpropagationhasbeenaddressedbyseveralresearchers. Fukumotoetal[16]proposedasystemthatusesvehiclebasedGPSsystemsto discoveranddisseminatetrafficcongestioninformation.ThesystemiscalledCOC that usesVANET.Thissystemmaintainsanddisseminatesthreetypesofinformation: RawInformation(level1),densityinformation(level2)andcongestionareas information(level3).Higherlevelscontainaggregatedinformation.In[17], Donrbush, et.al proposeda novel system for congestion detection in VANET. SmartStreetwhichusestheclusteringasatechniqueforthedataaggregation tocombinetheunusualrelateddatathathasaslowspeed.SmartStreetusesthe clusteredalgorithmsthatworkoveradistributednetworkinwhicheverynode investigatesthecollectedstatisticsandeliminatingtheneedforacentralentity.The clusteringoperationcanbedefinedasacombinationprocessthatcontainsdata points;these points have asimilarity one to each other that usemanymeasure types. In[19],Yoon,NobleandLiuproposedasystemfortrafficestimationthatisbased onroadsegmentationandfocusedonthecomplexinner-city.Someofthesesystemsrely,eitherexplicitlyorimplicitly,onhavingthelocationforallvehiclesinthe availablecongestioninordertomakethedeterminationthatthecongestionexists andwhereitislocated.Whencongestionsizesexceedtransmissionranges, that are common infreewayscenarios,theuseofmulti-hopcommunicationsarerequiredinanorder that represents allvehiclesinthe

congestiontohaveknowledgeofallothervehiclesinthe congestion. This presents a problem if we want to keep location information anonymous; a vehicle may receive fresh information directly from a vehicle and re-broadcasted information (older) from the same vehicle. Because of the vehicles constantly movable, these two pieces of information will be indistinguishable from the two pieces referring to the two vehicles different from one to each other. Because of this reason, these systems rely on unique vehicle IDs as a mechanism to identify the source of each one of these pieces of information and maintain a unique location for each one of these vehicles. The broadcasting of unique vehicle ID's at the application level opens the door for the location purpose of the tracking raising major privacy concerns. Most of the recently companies realize the potentials of using these vehicles as collectors of the traffic information, Dash Navigation, Inc. [20] a start-up in Sunny Valley, CA started service offering in 2009 which is called the Dash Driver Network that makes the passengers able to broadcast the location using a high speed depending on exchanging operations to receive the information of the updated traffic that is obtained from other vehicles in the network. This system is centralized and relies on wireless connectivity of the internet which is widely unavailable on the streets and the highways roads around the world. The trusted location, privacy concerns are mitigated due to the centrality of the collecting entry.

The CAR 2 CAR communication (two cars communication) Consortium [21] is an organization that is non-profit initiating by the manufacturers Western vehicle that has an objective which is used to enhance the safety traffic's road, the efficient publishing in 2007 a manifesto that is proposed as standards for V2I and V2V communications through many things. The other organizations [30] are obtained from the industry, the universities and the governments which have started similar efforts in the last many years.

In 2008, the European Union took a major first step towards deployment of thesystems that are relying on the V2I and V2V communications by doing new reserved operations for the radio frequency across the EU that is used for the applications of the vehicle used at the co-operative enabled systems between the makers' car [22]. The EU looks forward through this action that leads to the eventual roll-9.

CHAPTER 4

METHODANDEXPERIMENTS

4.1Introduction

The(ITS)IntelligentTransportationSystemsismostlyusedtosolvethe road limitations.Inthisthesisweproposedasystemdesignincluding aprotocoland manyalgorithmsthatassisttobalancethetrafficoftheroadandtofacilitatethe drivingontheurbancitiesandthehighwaysroadsandmakeitmorecomfortable. Thesystemcontainssomebasicdevices. Thesedeviceswouldcooperatetogetherto provide thesafety,assistance,andtomake thepassengers (drivers) more comfortable. Wheneverweusethissystemonstreets,weexpecttoseeaneasyflowforthe trafficand more efficientand drivingthat is verycomfortable.

Theselectedresultsoftheapplicationaregottenfromt h e studiesofthesimulation. Theseresultsarecomparedwithoursystemtoprovethatthesignificanceortheneed forthe presented systemwith its control actions of the protocol and itsstrategies.

4.2GoalsandObjectives

Themainobjectivesofthisprojectaretoimplementtheprotocolonavehicleinside the protocol creation in order to get thedataprocessingwhich is collected in the firstobjective. Thewritingoperationofthealgorithmthatmakesanoptimumdecision fortheplanofthephaseofthetrafficlight, is another goal.Insidetheseobjectiveswecanmanage thecitytrafficnetworkandalsodecreasethefuelconsumption and time taken by the driver to go to their destination. Alsoreducing the production of Co2.

Togoforwardandtogetadvantagesoftheresearchesdone onVANETapplications, arethe mainthefactorthatmotivated u s inordertoproposetheprotocol. Intheir effortstoenhancethedrivingsafetyandthecomfort-ability,themanufacturesof thesecarsmanufacturesarewaitingfornewtechnologiesandapplicationstobe madeinordertousewiththeirproducts.Theprotocolofoursystemisvery importantandsuitabletousebyotherapplicationsinfutureworks.Duetothe increasingairpollution,newmethodsandtechnologiesareneededforsuddenurgent toreduce thisproblem.Tomaketrafficflowworkingeasilyatintersections,the vehicleshavenottoletstoppedforalongtimeatthetrafficlightspoints.Many technologiesandmethodscanbeusedtocontrolthevehiclesmovementandstore theirinformationcontinuouslybyusing thisVANETsysteminroads,main gates and cities.

4.3SystemDesignandImplementations

Aswehave proposed infirstchapterthat we aregoingto design a smart management trafficlightsystemforanentirecity.Thetrafficlightmanagementsystemisusing VehicleAd-HocNetworkprotocolandVehicletoInfrastructure(VANET-V2I);thereceipts are employedtohelpincollectingtrafficdatafromtheroadsand streetsbyaccountingeachcarembeddedbyamobiledevicesupportVANET connection;thenforwardingthecollecteddatatothelocalbasestation.Thenthe management system will take the best decision of traffic managing.

4.3.1 Infrastructuredesign

1.We have assumedthateachormostofthevehicles (cars)ofthecityhaveamobile devicewhichisworkingonVANETprotocolforsendingandreceiving information with recipient deviceswith a unique ID.

2.Todistributerecipientdeviceswithinregularspaces;weuseOmni antenna[23].

3.Each area that has astationis called sub base station (SUB-BS).

4.Therecipients ofeach area are connected bySUB-BS.

5.All of the SUB-BSs are connected to the main base station MAIN-BS.

6.TheMAIN-BSisconsistedof:Omniantenna,Databasecentreandprocessorwhicharereresponsibletoget decisionfortrafficlightcontrollingbycalculating the rates ofcars per eachstreet.

Figure8illustratesthedistributionandthehierarchy ofthesystemmodules.Figure9shows the interaction between unites.

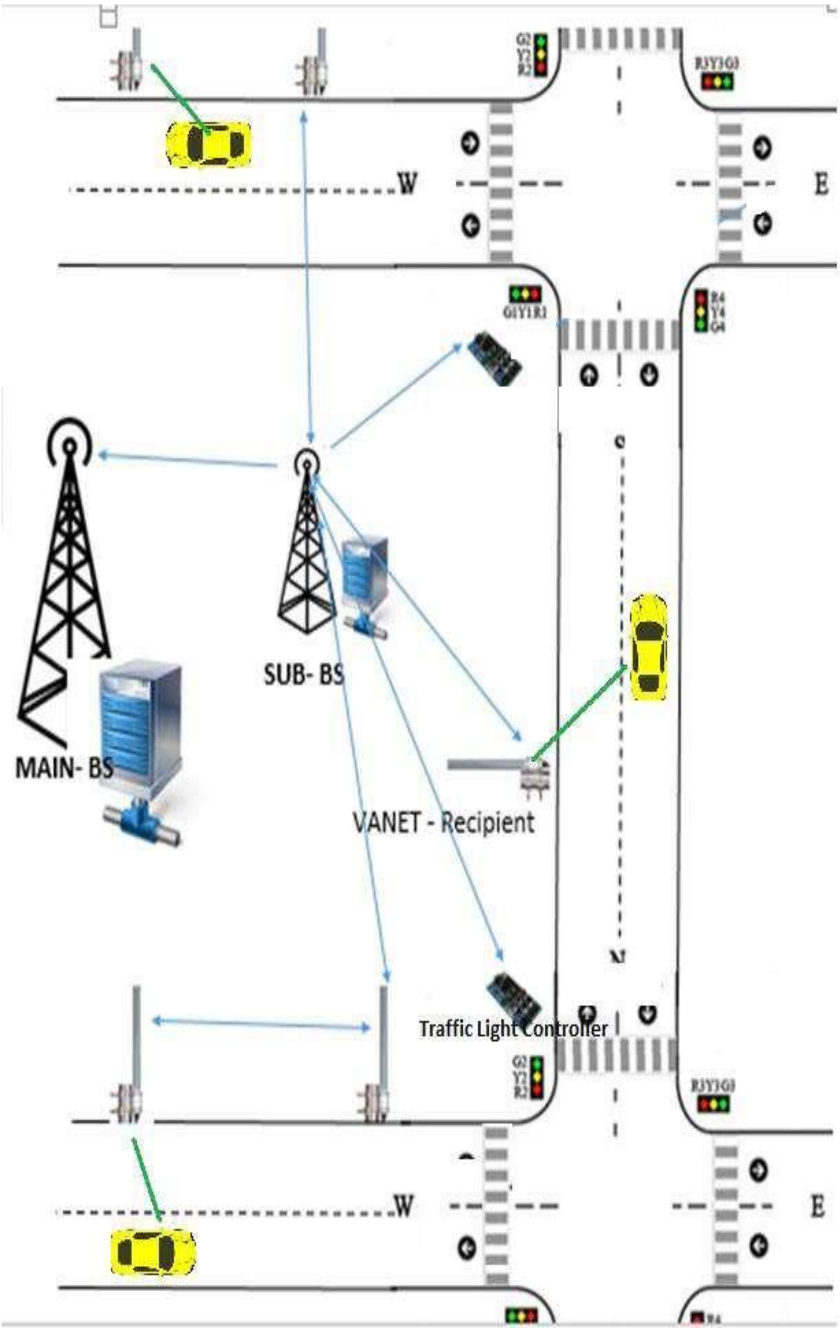

Figure8 Overall system

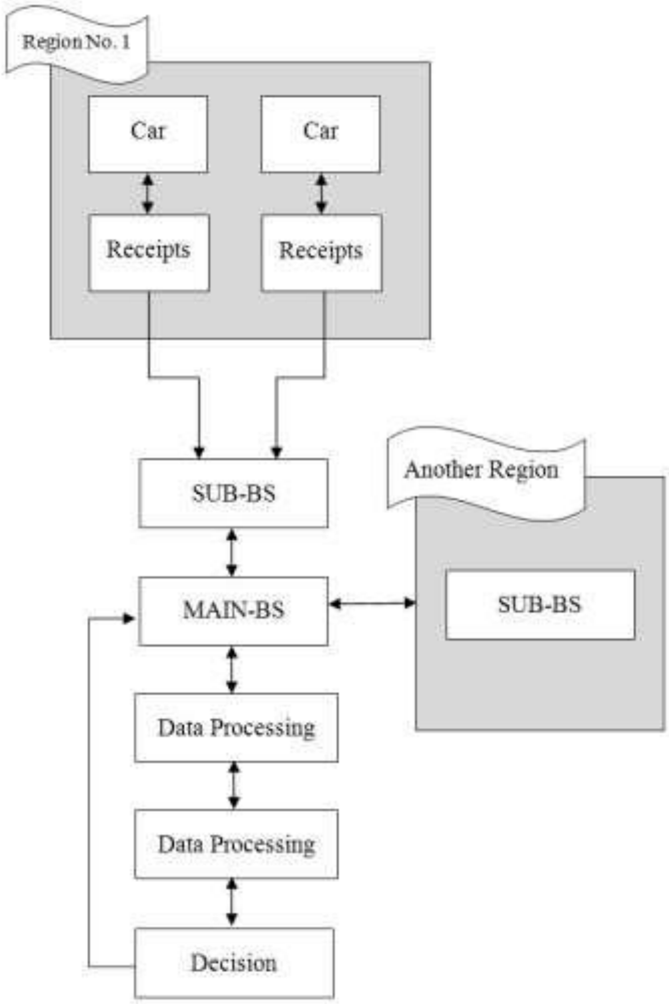

Figure9 Flowchart ofunits interaction

Wegotstreetinformationandthenumberofcarsthroughexistedsub-basedstations. Thenandaccordingtocertaindatathemainbasestationwillmakethedecisionthen resend it tothe sub- basestationto do what isrequired.

4.4SystemScenario

4.4.1 VANETconnection

1.CarswithVANETmobiledeviceisperiodicallybroadcastingaHELLOmessagewhichin cludestheuniqueID.WehaveusedGreedyPerimeterStatelessRouting(GPSR) protocol for network layer in VANET.

2.Whentherecipientsget a messagewith a newID,it willbe transmitted totheSub-BSbut when the message is the same, it willbe discarded.

3.Sub-BSperiodicallywillbeforwarding thenumberofcarspassedthewayper that moment.

4.Main-BSwillcalculatethedensityofcars flowonthattimeforeachstreetthen it willtakethebestdecision.Inourprojectwe have assumedthatthecapacity ofall the roadsare the sameso thatthedecisionwillbetakendependonthecarsrateonlywithouttakinginto account thecapacityofroadsasshown in the followingFigure.

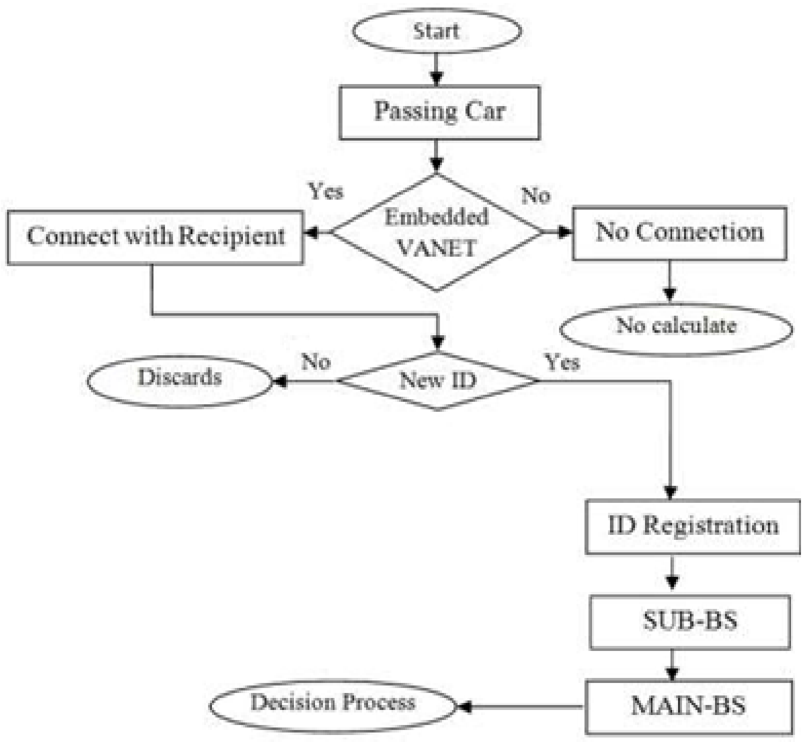

Figure10 Flowchart of connection steps

Afterwegetthenumberofthecarspassingonthestreets,wemakean inquiryaboutwhetherthecarenteringisoldor a newone.Ifitisnew,itwillbegiven ID.Theinquirywillbesenttothesub-stationandthesamewill be forthe othercars.Theinquiryalsocanbesentfromthesub-basestationexistedinotherstreets to the main basestation.

Aftergettingfullinformationfromsub-basestation,processcanbemadethrough certainprocessers.Then,decisionwillbemadeaccordingtowhatitisplanned. Finallythedecisionwillbesenttoacertainstationandresendittothecarssothat the drivercan do what itis necessary.

4.4.2 Centraltrafficlightmanagement(CTLM)

1-Thecentraltrafficlightmanagement,whichwe haveproposed,isthemaincomputer that is connected with the“MAIN-BASE STATION”.

2-TheMain-BSincludesdatabasemanagementcentrewhichcontainsthe gathered date brought bySUB-BS.

3-Weassume,inourproject,thatallstreetswithsamecapacityso that thedecision will be easier.

4-We would applyoursystem onfew number ofroads(streets).

5-The decision should be taken depending on the number ofcarsforeach street as the following:

a.Whenthenumberofcarsarenotexceededthethresholdvalue, thetimewillbe the same with no change.

b.Whenthenumberofcarsisexceedingthefirstthresholdvaluebutnot the second threshold value, thetime ofGREENwillbe increased.

c.When the numberofcarsisexceedingthefirstthreshold,andsecondthreshold values,thetimeofGREENwillbeincreased,andthetimeofREDwill be decreased.

Thefollowingflowchartisshowingstepsofthecentraltrafficlightmanagement decisions.

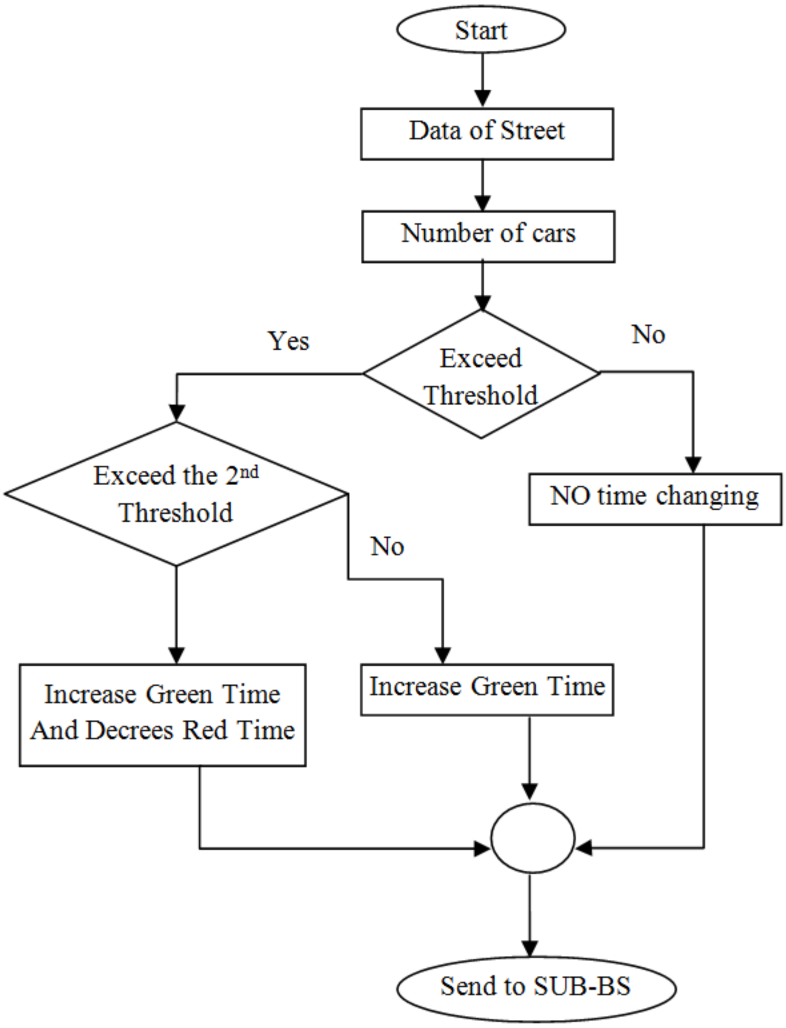

Figure11 Flowchart ofthe central traffic light management decision

Inthisalgorithm,wedividethecongestionintotwotypes:thenormalandseverone. Wheneverthenumberofcarsisincreasedfromthefirstlevelthatweputinthe algorithm,wewillincreasethetimeofgreensignalandifitdoes notexceedthefirst level,notimechangingwillbeseen.Ifitisexceededthesecondlevelwhichis consideredasevereone,weincreasethetimeofgreensignalanddecreasethered one.

CHAPTER5

EXPERIMENTRESULTS

5.1 TheImplementationofModules

Inourthesis,thejavaenvironmentisusedtoimplementthework,Javaplatform enterpriseedition(JavaEE), whichisusedhere,isthestandardincommunitydriven enterprisesoftware.TheJavaEEisdevelopedbyusingtheJavacommunityprocess, with contributions given bythe experts, the opensource and the commercial organizations.Thepurposeofusingthisenvironmentisbecauseofitsflexibility andhighsecurity. Itisusedmostlytoincreasethedeveloperproductivity,The implementation of ourwork is done in threesteps(modules)asfollowing:

1.**Thefirstmodule.** Themainobjectiveofthismoduleisto study,design and implement the system (oncarorvehicleandonthestreetdevices)tocreateand collectdatafromstreetsandtheobjectsonthatstreets.Furtherpurposeisthe protocolcreationforthedataprocessingthathasbeencollectedandapplied.

2.**Thesecondmodule**:Throughoutthismodule,ourmainobjective willbethe writingofanalgorithmforcreatinganoptimumdecisionfortheplanofthe trafficlightphasetocontrolthetrafficandtomakethedecisionfortraffic signal.ThereductionofCo2productionandthefuelconsumptionis consideredas afinal objective.

3.**ThethirdModule:**InthisModulewearecreatingperformanceevaluations of theproject throughoutgraphs. i.e.

- The averageofwaitingtime for thevehicles.
- The numberofpassed vehicles.
- The numberofcarsreaching their destinations; Adaptive TrafficLights.
- The average control delayfor the simulated period.
- The average of fuel consumption

5.2 ProjectInterfaces

Regulatorytrafficsignsplayacriticalroleinroadtransportationsincetheyprovide informationthatdriversmustfollowtoensureroadsafetyandimprovetraffic control.Replacingt h e traditionaltrafficlightsbyvirtualtrafficlights,isprobably the mostchallengingsituationwherevirtualtrafficsignscanbeapplied,wehave chosenanumberofdifferentscenarioswherevirtualtrafficlightscanbetested.In fact,virtualtrafficlightscanbeplacednotonlyatintersections,butinavarietyof environmentswhere the crossing conflicts need to be solved.

Trafficlightintersectionismanagedbythemainprocessingcentre,whichis connectedbythemainbasestation.Themainprocessingcentregetsdatafromthe sub-basestationas isshownintheFigure12.Returningbackhowlongtimeshould begiventotheparticularintersectiontrafficlightcontroller.Figure12representsthe firstmoduleofthesystemwhichdevelopedtenmainstreetsandeighttrafficslight intersectioncontrollersandthreebasestations.Allthesebasestationsareconnected withinonemainbasestation,asshownintheFigure12.Thetimeoftrafficslightsis not fixed, but it changesaccordingto thecongestion of the way.

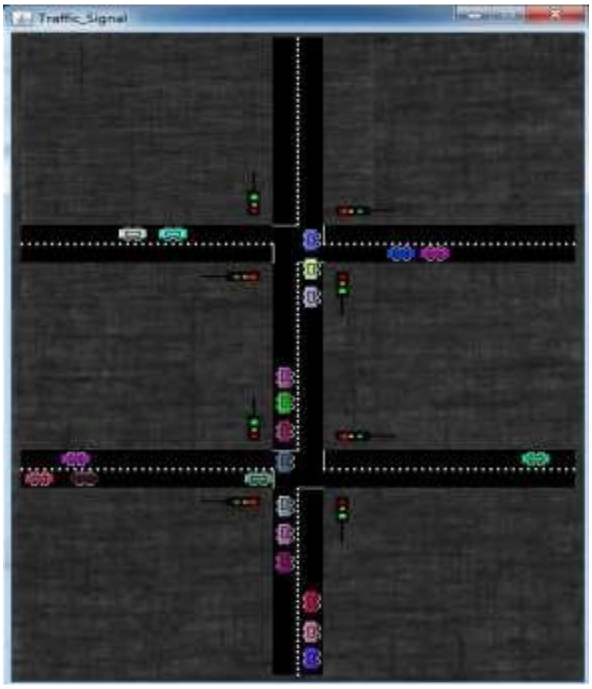

Figure12 Traffic light intersection

Thishelpstoregulateandcontrolconflictsbetweenvehiclesindifferentlanes, improvingthe traffic efficiencyand safetyin the onlylane available. Thesecondmodelwehavemademorethan10nodes(cars)movingonthepaths(roads)inrand omly-mannertogetseveralresultsa s s h o w n i n (Figure13).Therearemany thresholdsusedaccordingtothecases.Thefirstthresholdvalue(noofcarsgreater orequal)hasassignedfivecarsataninstanceinaparticularintersection.Wherethe secondthreshold has assignedseven carsat an instancein aparticular intersection.

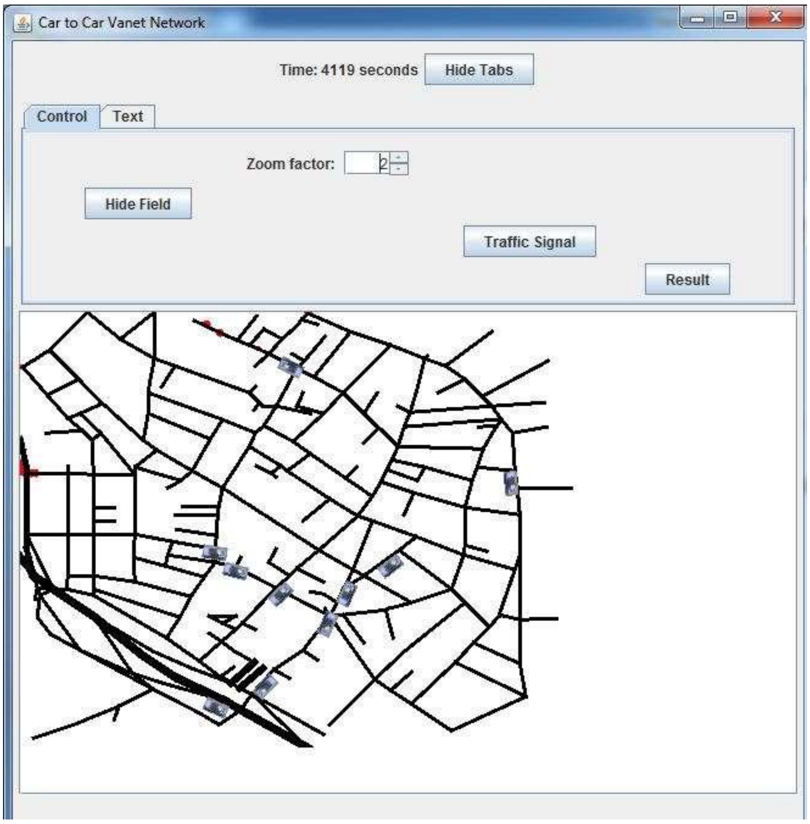

Figure13 Ten main streets and ten traffic light intersection controllers

Whenthenumberofcarsreachesthefirstthreshold,theprocessingcentrewill increasethegreenlightvaluedependingontheroadclassnumber(1,2,3,4,5,6)by0.25,0.27, 0.29,0.29,0.3,and0.3secondsrespectively.Butwhenitincreasesthe secondthresholdvalue, theprocessingcentrewillincreasethegreenlightbysame second valuesaswellasdecreasingtheredvaluebythegreenlightthroughavalue dependsontheroadclassnumber(1,2,3,4,5,6)by(0.25,0.27,0.29,0.29,and 0.3)seconds respectively.

Thresholdvalueischangingdynamically;itdependsonthe numberof cars in the street that increases and reducesthecongestion ofcars in thestreet. So, it can be said that threshold value is changeable according to the to the number of cars. If there are four cars in street A and five in street B, threshold value will be changed according to the number of cars in street A and B and the timing of traffic light changing, from green to red or from red to green, will be changed accordingly.

Generally speaking, in any dynamic environment such as VANETs, it is difficult to determine these threshold values since they are changing dynamically. The reason behind this dynamic changeof the values is because they minimize the number of redundant massages during keeping good latency and reachability.The back lines (roads)areasshown in Figure 14.

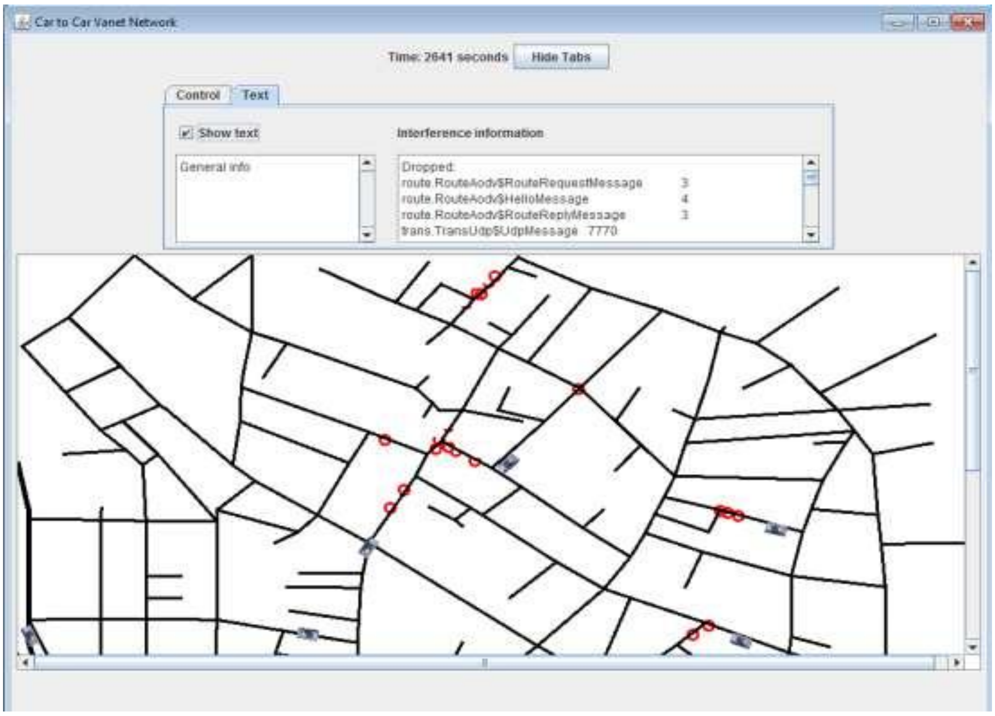

Figure14 Ten movingnodes

Theinformationofeachroadcanbeshownfromthe(text)buttonaswellasthe exchangeof data packet detailsareshown in thefollowing Figure (15). ThegreenbarthatisshownintheFigurebelowshowsthepaththatthecaraimsto go.Attheentireroad,thevehiclesendsandreceivesmessagesfromthecarsin aroundtopreventcollisionandcongestion and this i s donebyslowingdown vehiclespeedand stops itif it is possible. TheareaaroundthevehicleisshowninFigure (15). Thisareaisrepresentedbyacircle aroundthevehicle,throughthisrangethevehiclecouldcontact,send andreceive messagesfrom other vehicles.

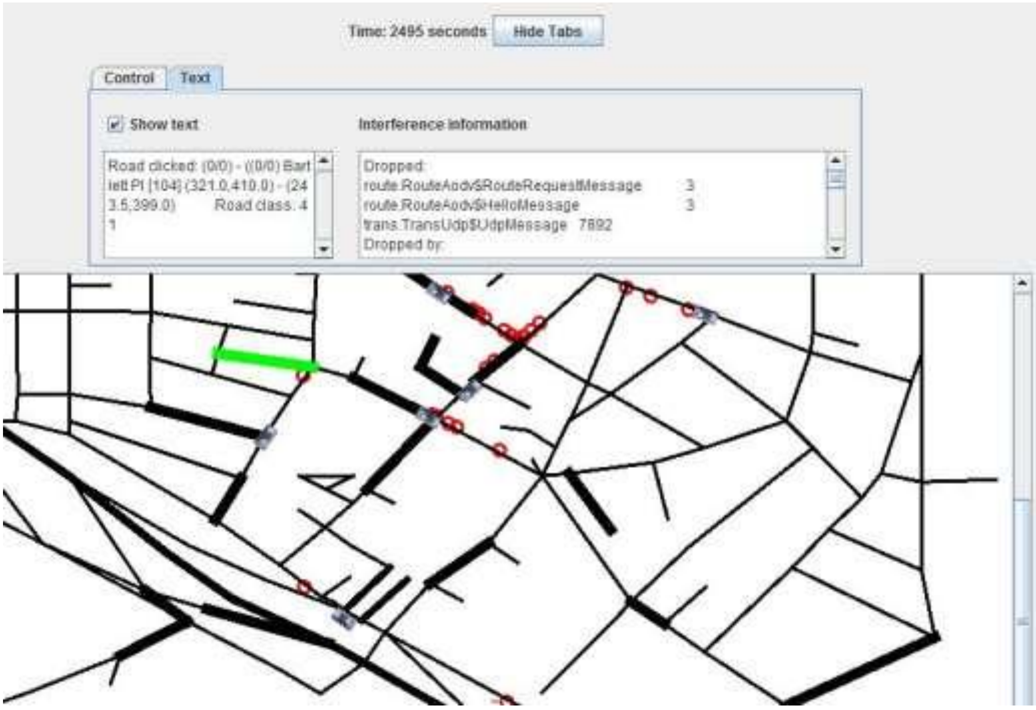

Figure15 Interference information

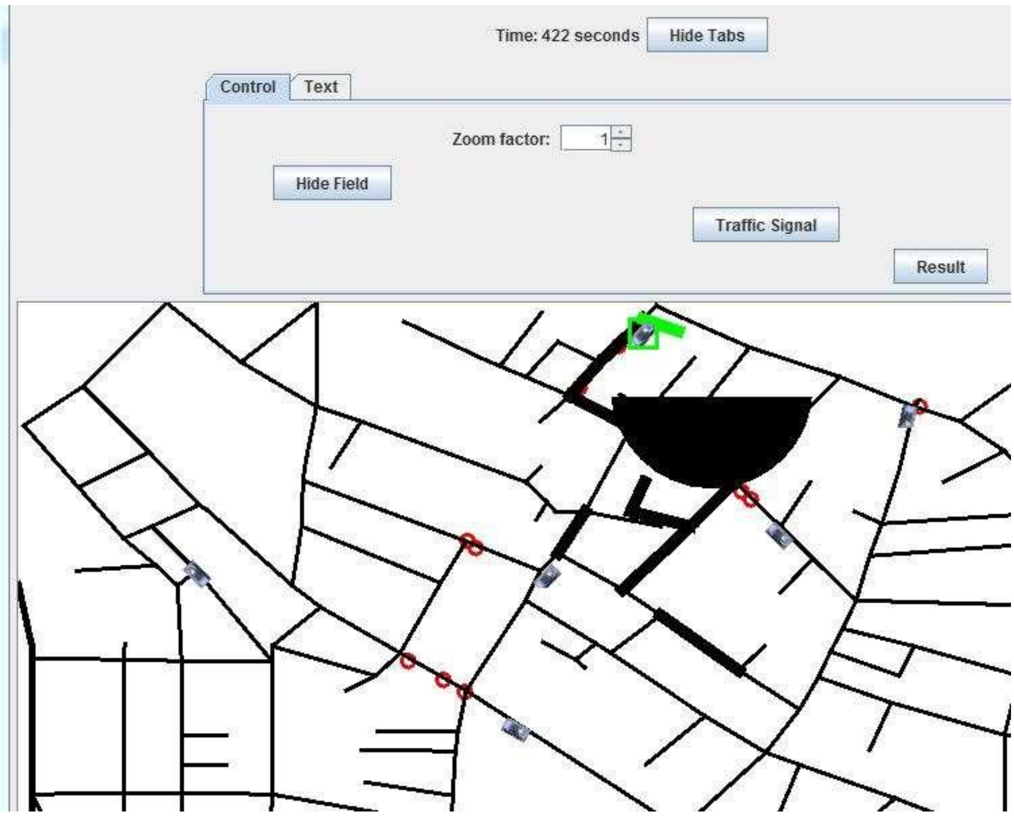

Figure16 Searching area around the vehicle

Wehavemadeourdesigntoselectaparticularcartobeinteractedwiththedata processingcentretogiveittheshortestpath(withminimumcongestion).As it is shown inFigure (17).Wehavecomparedtheresultsofouralgorithmwithinbluecolour,fixed time algorithm to be withgreen colourand the DT3Palgorithm with red colour as in the following:

1.Theaverageoft h e waitingtimeforthecarsinthesamescenariowithin50 secondshasdecreasedthespenttimedoing the same scenario compared with the others as showninthe algorithm.

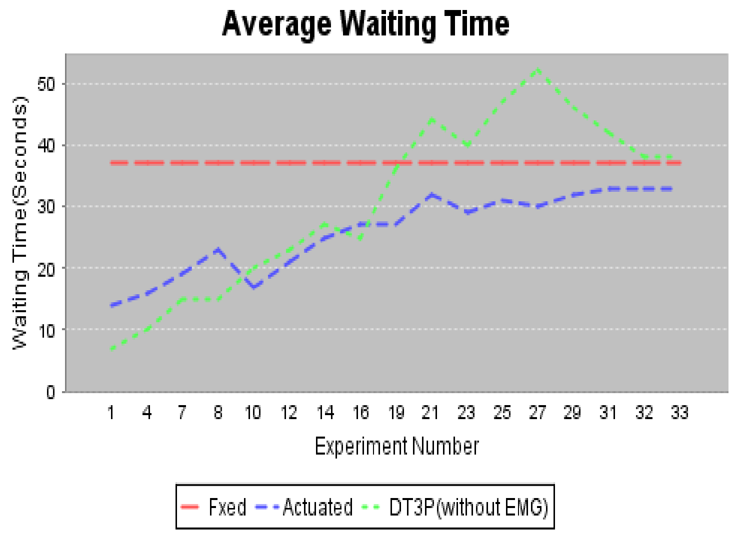

Figure17 Averageofwaitingtime

2.Total number ofpassed cars per hour in 31 tries.Figure 18 shows the representation of thesepassed cars.

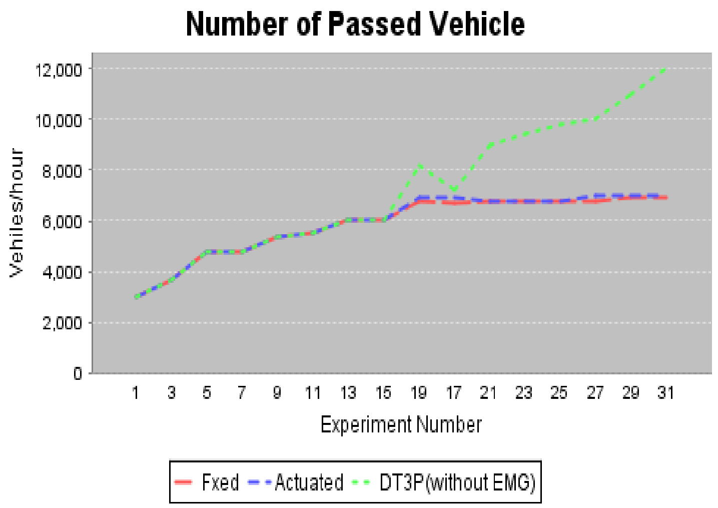

Figure18 Numberof passed cars per hours

3.Averagefuelconsumptiondependsontheaveragewaitingtimeforcars,as inthefollowingFigure (19).Alltheshortestpath,thedynamicpath (routing week1)andthedynamicpath(routingweek2)haveveryadjacenttime values. Thegivenresultsfromweek1andweek2dynamicroutingare similarwith asmall difference from the shortest path.

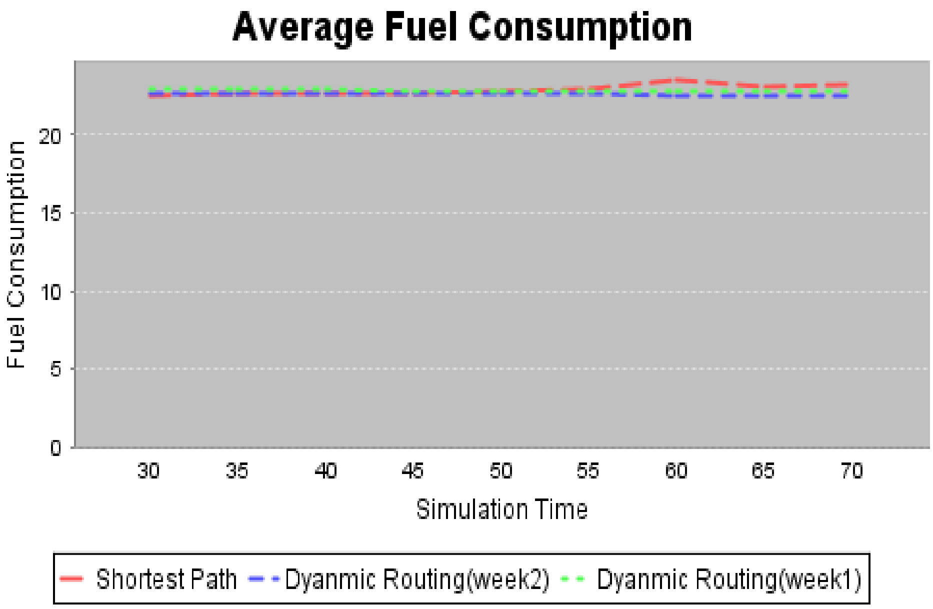

Figure19 Average fuelconsumption

4.Theaveragedelaytimeforcarsduringusedsimulation,as it is showninFigure (20),includesthreerepresentations(Pre-timed,AdaptiveIdeal,Adaptive-Real).Thegivenresultsremainsimilarfromthe beginning up tothe65minutes. After thistimetheadaptiverealremains similar tothePre-timeduntilthe75 minutes. Thenitbeginsdifferentone,while theadaptiverealisdifferenttoboththeadaptiveidealandthePre-timedfrom the 75 minutes to the end ofthe period.

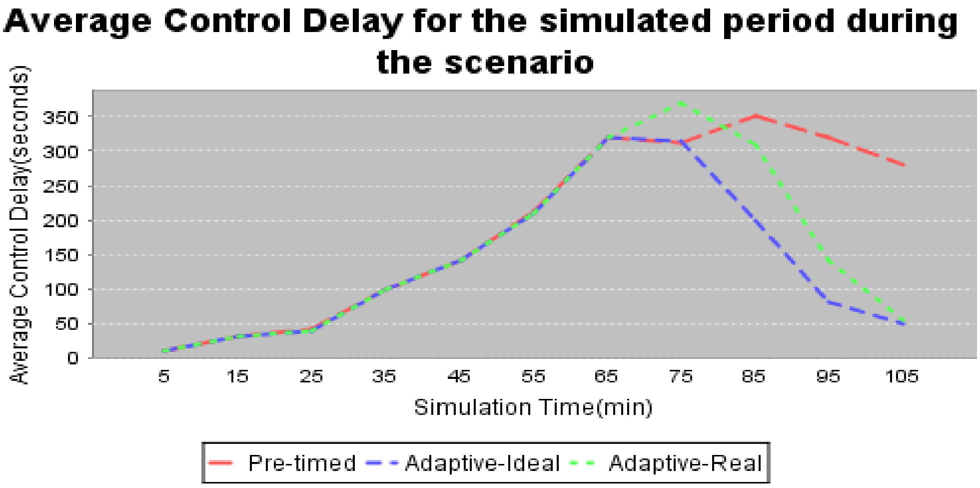

Figure20 Averagedelaytime

Thenumberofcarsthat reachesthe destinationsbyusingouralgorithmisingreen colour and withoutusingthebluecolour.Figure (21)showsthehistogramsthatrepresentthe neededtimetoreachthetargetfromtheinstantincludingtheshortestpathsandthe dynamicrouting.Althoughthereisasmalldifferencebetweenthedynamicrouting andtheshortestusedpathbythecarsbuttheystillveryadjacentonetoeach other. Thus, it has ahigh qualityto reach theactualtime values.

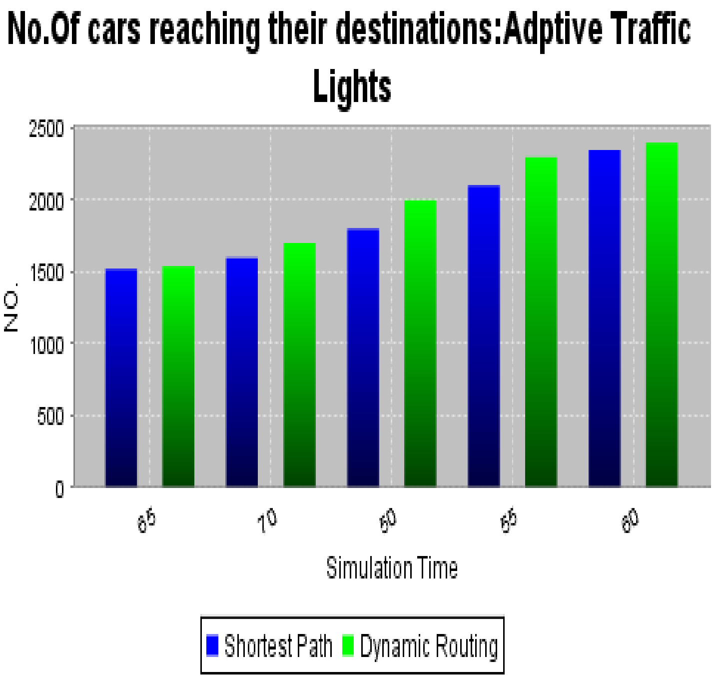

Figure21 Numbersof carsreachingdestinations

CHAPTER6

CONCLUSIONANDFUTUREWORK

6.1 Conclusion

Wehavebasedatrafficlightsystemthatisveryadaptiveont h e short-wireless communicationrangebetweencarsand infrastructure. Thesystemrestson anodeofwirelesscontrollerthatissituatedattheintersection. Itspecifiesthe exacted amounts(value)forthephasesofthetrafficlights. We have improved also a simulator that is integratedfor validatingthe system.

Theframeworkofthesimulation consists ofamodelwitharealmobilitymodelfor carsorvehiclesandasimulatorofawirelessnetwork. Wehavedealtwithtwomajor intersectionsinmanyplacesandwehaveseenthatthesystemsignificantlydevelops trafficfluency,comparedtotheexisting.Ithasbeen designedasananalysable actionsystemtorushhours andweh a v e gotacceptable results.Theaveragedelay,fuelconsumptionandthepollutionweretremendously decreased.

6.2 FutureWork

Ourprojecthasbeendoneonasimulationenvironment.Thus,theresultisnot occurredsowesuggestdoingthisprojectonrealtimeenvironment.Wesuggestto optimizethesecurityoftheVANETnetworkasthissystemshouldbeworkedin veryhighsecureandreliableenvironment.Also,wesuggestenhancingtherouting protocolsalgorithmwhichhasdirecteffects.Finally,itcancontainmanyapplication benefitsforthe last usersuch as trading announcements and so on.

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APPENDICES A

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