T.C.
AKSARAY UNIVERSITY
GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCE

DEPARTMENT OF ELECTRICAL-ELECTRONIC AND COMPUTER ENGINEERING

VEHICULAR ADHOC NETWORK TO SUPPORT TRAFFIC SAFETY ON HIGH-WAYS

MASTER OF SCIENCE THESIS

Omar Sabri HAMZA

SUPERVISOR

Asst. Prof.Dr. Yusuf Erkan YENİCE

AKSARAY, 2021

T.C.
AKSARAY UNIVERSITY
GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCE

DEPARTMENT OF ELECTRICAL-ELECTRONIC AND COMPUTER ENGINEERING

VEHICULAR ADHOC NETWORK TO SUPPORT TRAFFIC SAFETY ON HIGH-WAYS

MASTER OF SCIENCE THESIS

Omar Sabri HAMZA

SUPERVISOR

Asst. Prof.Dr. Yusuf Erkan YENİCE

AKSARAY, 2021

Aksaray University, Institute Of Science and Technology Approval Omar Sabri HAMZA, M.Sc. with thesis, Student No. 172335807, successfully presented the M.Sc. thesis titled "**VEHICULAR ADHOC NETWORK TO SUPPORT TRAFFIC SAFETY ON HIGH-WAYS**", prepared after Satisfying all the requirements identified in the concerned bylaws, before the jury whose signatures are affixed below.

Thesis Advisor: Asst. Prof. Dr. Yusuf Erkan YENİCE

Aksaray University

I approve that this thesis is a Master Thesis in scope and quality .....

Member: Asst. Prof. Dr. Abdül Kadir GÖRÜR

Çankaya University

I approve that this thesis is a Master Thesis in scope and quality .....

Member: Asst. Prof. Dr. Yasin ÇELİK

Aksaray University

I approve that this thesis is a Master Thesis in scope and quality .....

Date of Defence: 08/01/2021

I agree that this thesis, which is accepted by the jury, has fulfilled the requirements for being a Master Thesis.

.....

Assoc. Prof. Dr. Mehmet Ali HINIS

Director of Natural and Applied Science

DECLARATION

The idea for this present study which I submitted as a master's thesis, was taken from the literature regarding the topics. It was announced here that the whole work presented in this project has been composed and originated by myself unless otherwise specified. The study was conducted completely under the supervision of Asst. Prof. Yusuf Erkan YENİCE.

Omar Sabri HAMZA

ACKNOWLEDGMENT

Dear Asst. prof. Dr. Yusuf Erkan Yenice. It's hard to find words to express my gratitude. Thank you so much for staying and helping to prepare my thesis. I benefited a lot from your suggestions, your support to me. I'm glad to work with you, my dear supervisor. I Wish you more scientific progress and a life full of science. And more thanks to every doctor in the department, I spent two years with them it was full of the lesson until I reached my goal I appreciate it. And I want to shear my success with my lovely family my Dad (Sabri Zangana) my mom (Aalya Zangana) they were with me in everything I needed it, they supported me to give me motivation, my sisters and my brother, and many thanks to my friend Abbas Mahmoud Ibrahim he's helped me much thank you for all.

Omar Sabri HAMZA

AKSARAY, 2021

TABLE OF CONTENTS

YÜKSEK LİSANS TEZİ

YOL KENARI ÜNİTESİ KULLANILARAK AD-HOC TABANLI GEZGİN ARAÇ PERFORMANSİNİN İYİLEŞTİRİLMESİ

Omar Sabri HAMZA

Aksaray Üniversitesi
Fen Bilimleri Enstitüsü
Elektrik-Elektronik ve Bilgisayar Mühendisliği Anabilim Dalı

Danışman: Dr. Öğr. Üyesi Yusuf Erkan YENİCE

ÖZET

VANET, sürücülerin kazalara karşı uyarılması amacıyla taşıtlar arasında güvenlik sinyalleri verilmesi amacıyla kullanılmakta, bu sayede taşıtlar ya rotalarını değiştirmekte ya da çarpışmayı önlemek amacıyla başka önlemler alabilmektedir. Bu tür ağların kullanılmasındaki amaç, bu ağların diğer gezgin ağlara kıyasla daha düşük maliyetli olması ve yerleştirilmesinin kolay olmasıdır. Bu çalışmada, otoyollarda seyir halinde iken kaza yaptıklarında durmaları sonrasında kaza alanının birden fazla araç için müsait olup olmama durumu konu edilmektedir. Aşırı hızda araç kullanılmasından dolayı sürücüler kaza mahalini fark edemeyip yeni kazalar meydana gelebilmektedir. Dolayısıyla problem büyüyebilmektedir. Diğer yandan, adhoc ağlar ile kaza alanına yaklaşan sürücülere güvenlik bilgileri konusunda paylaşım yapılabilmektedir. Araçların kısıtlı radyo alıcı mesafeleri ve seyir hızlarının yüksek olması gibi sebeplerden ötürü, verilecek mesajın ulaşılabilirliği önemlidir. Dolayısıyla, ağın geliştirilmesi zorunlu hale gelmiştir. Ağdaki yükün mevcut nod kapsama alanına uzak olan nodlara genişletilerek Mevcut RSU rahatlatılması sağlanabilmektedir. Bu noktada gezgin nodun RSU olarak kullanılması ve yol kenarı ünitesinin yaptığı veri paketi yönlendirmesinin bu gezgin nod tarafından yapılması önerilmektedir. Çok sayıda RSU kullanılmasındaki temel problem veri iletiminde uzun süre geçmesinden dolayı performans düşmesidir. Çalışmada, klasik yol kenarı ünitelerinden farklı olarak daha çok sayıda gezgin nod kullanılmıştır. Gezgin nodlar, static olan klasik yol kenarı ünitelerine göre hareket halinde olmalarından dolayı daha dinamiktir. Çalışmanın sonuçları, çok sayıda gezgin nodun RSU olarak kullanılmasının bağlantı iyileştirme süresini azaltarak ve bağlantıyı daha uzun süre devam ettirerek bağlanabilirliği iyileştirilebileceğini ortaya koymuştur.

Anhatar Kelemleri : VANET, MANET, RSU, TCP, UDP, Yönlendirme, Trafik.

Ocak, 2021; 43 sayfa

M.Sc. THESIS

VEHICULAR ADHOC NETWORK TO SUPPORT TRAFFIC SAFETY ON HIGH-WAYS

Omar Sabri HAMZA

Aksaray University
Graduate School of Natural and Applied Science
Department of Electrical-Electronic and Computer Engineering

Supervisor: Asst. Prof. Dr. Yusuf Erkan YENİCE

ABSTRACT

VANET is used basically to exchange safety signaling between vehicles to alert drivers of accidents existence; so, they can change their root or to take other precautions to prevent car crashing near accident zone. The motivations of using this kind of networks are their lower cost as compared to other mobile networks and their ease of deployment. In this study, mobile vehicles are randomly moving in the high ways and hence in case on car crashing, car will assume stopped and the place of crashing is susceptible to intake more than one vehicle. As vehicles are being droved in high speed and drivers; due to their unawareness of accident zone, they can get into it and hence problem is enlarging. On the other hand, ad-hoc network is attempting to share safety norms to the inward drivers to avoid the crashing in that particular location. For some reasons more likely due to car limited radio converge and speed of the cars running on the high way, the reachability of this message is critical and hence, network further development was mandatory. The presence of RSU is helped network payloads to be extended to other nodes which is already far from recurrent node coverage. We proposed using the mobile node to act as RSU and perform data packet routing as RSU does. The main problem of using large number of RSUs is performance degradation be consumption of large time for data delivery. In our study, we attempted using different number of mobile nodes as RSUs which is differs from classical RSUs as the last is static and other is dynamic (in motion). Outcomes of this study shown that large number of mobile nodes as RSUs may enhance the connectivity by reducing the link re-healing time and maintaining the connection for longer time.

Keywords: VANET, MANET, RSU, TCP, UDP, Routing, Traffic.

January, 2021; 43 pages

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

AM	Amplitude Modulation
AODV	Ad-hoc On-Demand Distance Vector
DN	Destination Node
FFT	Fast Fourier Transform
MANET	Mobile Ad-hoc Network
MN	Mobile Node
N	Node
PU	Primary User
R	Relay
RSU	Road Side Unit
SN	Source Node
SS	Spread Spectrum
SU	Secondary User
TCP	Transmission Control Protocol
UDP	User Datagram Protocol
UMAV	Unmanned Aerial Vehicle
VANET	Vehicle Ad-hoc Network
WN	Wireless Network

1. INTRODUCTION

1.1. Preface

Internet and data exchanging networks are made to facilitate people lives where people can share data such as important text messages, locations and geographical data, finical news and business-related information. It is seen for last three decades that individuals were able to communicate with each other much easier with presence of internet network. Internet had provided that facility to link people and permit them unlimited data sharing capability (Jeyaprakash and Mukesh, 2013). One more challenge was raised after the popularity of internet network which related to the mobility of users, as they demanded to have free to move facility while connecting the internet. That posed big challenge for network engineers before they proposed what so called cellular communication network or mobile cellular network. This kind of network was earlier developed to provide phone calls and short text messages facilities to their users. Hence after, cellular network is becoming more useful after providing the internet facility to their users (Islam and Shaikh, 2008).

The concept of cellular communication can be descripted more likely as several base stations or network service providers exhibiting a particular, known and limited place. The coverage of this network is limited to the number of those slots (areas) that being used to propagate the base stations towers. In other word, cellular network is covering set of geographical areas called as cells and permit transmission of data through those cells (Tomer and Chandra, 2010). Soon after, the demand is increased for a network to perform particular and specific task more likely to exchange safety messages or to share the sensing information. Such network is known as ad-hoc networks. It formed the infrastructure to many applications such as VANET, MANET, flying ad-hoc network, sensor network, etc.

VANET is exploited for implementing special network for traffic safety insurance. Each node of this network is moving on some road and collecting information related to traffic condition, traffic accidents and alarm signaling, that information are being exchanged amongst the mobile nodes where each driver will get real-time update about the traffic information.

Network is consisting of two major sections, the ground nodes (mobile nodes) and the RSUs or infrastructure unit (as termed by many researcher). Communication which begins between the nodes themselves is termed as node to node link whereas communication between the RSU and nodes is termed as node to infrastructure link.

RSU is defined by many research papers as intelligent traffic system used to facilitate the network payload transmission between nodes. Basically, nodes are sending information to each other in form of warn message to alert drivers of accidents coexistence.

1.2. Problem Statement

VANET is used basically to exchange the signaling between vehicles to alert the drivers of the accidents existence so they can change he root or to take other precautions to prevent car crashing near accident zone.

Literature review in chapter two shown verity of research activity on VANET. The focus of those researches was about the routing problems and how the packets can be shared on the network. The problems that being faced in ad-hoc vehicular networks can be listed as below:

1. Vehicular ad-hoc network is unstable topology that keep on changing as network's node in continuous mobility. Hence, no constant topology can be made out of network nodes, routing of data packets posed a big routing challenge.
2. Several routing protocols are existed to facilitate the network packets routing; those routing protocols are not keeping similar performance especially when application is changed.
3. In many cases, routing process may utilize the network resources due to their overhead information that exhibit large space from data packets.
4. In mobile nodes is VANET, two factors are noticed suffering from network mobility, namely: time delay and re-healing time, they both can be used as performance metrics to judge network performance. Otherwise, other metrics more likely, throughput, packet drop rate and packet delivery ratio can be used to monitor the performance of static node of ad-hoc sensor network.

5. Because of existence of large size overhead, the routing process suffers from high delay to deliver data packets from the source node to destination node.
6. Due to the speed of nodes and their density, active link that exists between two mobile nodes or between a mobile node and RSU may get disconnected when mobile node exceeds the coverage (node transmission limit).
7. The number of RSUs (network infrastructures) that located in stationary position on the road (network coverage) to enhance the transmission of the nodes may directly affect the communication quality by degrading the performance of network as large number of RSUs may increase the transmission delay and enlarge the rehearing time.
8. Time delay in such application more likely human safety is essentially undesired and may cause lives loss. Every small slot of time is important to safe life in car accidents on the highways especially when car crashed in remote location and no nearby help can be ensured.

1.3. Research Objectives

In order to overcome the network drawbacks mentioned in the above section "problem statement"; number RSUs which term to network infrastructure may be selected carefully in order to avoid network unnecessary delay and to enhance the re-healing time.

In this dissertation work, the effects of number of RSUs on the network performance are studied with aim to elect the optimum number of RSUs which may optimize the overall performance.

Considering that network consists of many mobile nodes in continuous movement on the network workstation. One of those nodes might get an accident (assuming car crashing scenario) and stop moving. This node may begin of sending alarm messages to the neighbor's nodes intimating them of accident and may request them for help or ambulance. Well, this node might not get any nearby RSU, for this purpose, this work is made to elect nearby mobile cars to be as RSU.

RSU will extend the node coverage to reach many other nodes even far from it by re-broadcasting the alarm message. Using the mobile nodes as RSUs may increase network efficiency and save more lives.

1.4. Thesis Organization

This dissertation report is consisting of five technical chapters made to intensively illustrate the project sections. The study begins with this chapter that termed as "Introduction" which demonstrates the preface of the study and formulates the research problem and research objectives.

Chapter one ends with thesis organization which states the structure of the said dissertation report.

In the second chapter which termed as "Literature Survey", a wide scope of recent researches that made in favor of MANET are displayed and discussed in order to formulate the aforementioned research problem.

In the third chapter; namely "Methodology" the concepts of ad-hoc network and network structures both stationary and MANET reaching to the concept of VANET and sensor ad-hoc network.

The chapter of Methodology may provide all the technical aspects to establish the network in virtual phase and to establish the simulation model for testing.

In fourth chapter; namely "Outcomes and Discussion", a display of the obtained results and graphs are made along with discussion of each one in large scale.

In Fifth Chapter; namely "Conclusion", will involve concluding the facts observed in the study with lights of the numerical and graphical results.

The ultimate section of this dissertation report is illustrating the references that used to construct this report, the same is entitled as "Bibliography".

2. LITERATURE SURVEY

At Jeyaprakash and Mukesh (2013) VANET has made extended attention to the field of vehicle communication due to their easy structure and low-cost adaptation. Ad-hoc backbone can be used as integrated part with any mobile vehicle to exchange information such as location details, temperature, dense of traffic and many more parameters which may be interested by different nature of applications.

Hence, ad-hoc network gain more popularity in vehicle communication areas, it was a focal of large number of researchers who paid efforts to enhance the said network or to utilize the technology in their applications to gain its advantageous service.

In study of Jeyaprakash and Mukesh (2013) author mentioned that ad-hoc network can be employed in military applications where network mobile part (chip) can be integrated with military vehicles so that such vehicles can share information about the vicinity such as enemy vehicle locations and vehicle self GPS location.

Author mentioned that network parts (which are used to establish the communication by gathering the information from different sensors such as Global Positioning Sensor and Radar sensor and send it across the network); such devices are being integrated with the mobile vehicles as a built-in device. Those devices are able to share the attack information (in-case of any) with each other and hence, immediate help can be taken from the nearest node (vehicle) in the field in case attack is captured.

At Tomer and Chandra (2010) author stated that MANET is the generalized form of ad-hoc network same to that in VANET paradigm which used to establish a communication between mobile nodes. However, the study here proposed to facilitate a routing mechanism to become more adaptable with routing problems. The mechanism of information sharing between mobile nodes involves finding the nearest mobile node at the network vicinity and hence forwarding the information to that particular node. New routing algorithm is developed over here to establish connectivity by two approaches more likely finding the nearest node at the vicinity and to access that node.

Here, it is noteworthy that accessing nodes in ad-hoc network may note required that level of authentication due to network simple administration procedure. It is also not experiencing a base station strategy unlikely mobile (cellular) network which have large infrastructure of administrations and security.

At Nayyar et al. (2018) VANET is new approach proposed to facilitate the driving experience in may contrast such as providing internet access to the drivers along the roads while driving and to provide navigation information more likely to mitigate the traffic congestion in roads.

It also applied to ensure safety norms more likely enabling mobile vehicles to spread accidents of car crashing alarms so that other drivers will be aware of it and then accidents could be avoided.

Hence, in order to implement the above objectives of the network and to enable those services over mobile vehicles, large payload of research is required. The main challenges posed by this kind of network are their continuous topology change which acts as big challenge to the routing mechanism.

The author mentioned that network may require large infrastructure more likely, combination of more than one network standard. The vehicle area network consists of wireless local area network and some structure of cellular network with the main infrastructure of ad-hoc network. Routing, is the main objective of any network and in VANET it is done using several type of routing protocols more likely, Destination Sequenced Distance Vector and ad-hoc on demand distance vector).

At Tripathi and Venkaeswari (2015) in recent years, several modern communication networks have been standardized and came into light more likely, rather the MANET; the Sea ad-hoc network and flying ad-hoc network are proposed. The working method of those network is sharing the information over several nodes using dynamic routing algorithms where the nodes are transmitting cooperatively.

Flying ad-hoc network is evolved from the need of unmanned flying vehicles that used in both civil and military applications.

This network is firstly developed to serve military application by designing unmanned flying vehicle that can access the high alarmed areas which man cannot do in normal conditions. Furthermore, this technology has also deployed in civil applications that serving agriculture and aerial surveillance a video shooting.

This study pledgee undertaking of performance comparison among several routing protocols used over flying ad-hoc network. There are several types of such protocols are widely used in ad-hoc network such as AOMDV, DSR, OLSR and HWMP; those protocols are performing differently according to network type and applications. This study has found that HWMP routing protocol is fit to be used in flying ad-hoc network in terms of latency and throughput over the other aforementioned routing protocols.

At Karyemsetty and Samatha (2015) another approach is introduced in this study based on the concept of the technology of VANET. The author mentioned that such technology have extended the data network capability to be enabled in VANET where the wired networking is impossible. Furthermore, it was known that deploying ad-hoc network can be done after considering the fact of no big infrastructure can be ensured. However, due to fewer infrastructures over ad-hoc network, each mobile node acts as network host as well as router where node can establish the communication and can decide to which node it can forward its data.

This paper conducted in fever of MANET where network is modulated in Network Simulator Version II and tested for routing mechanism and security purpose. Author stated that security is important concern in ad-hoc network since administration infrastructure is missed and no centralized routing mechanism. So any node can join the network and stat sharing the data which pose big security challenges.

At Rahim and Sher (2009) cooperative communication which is existed between the nodes of ad-hoc is being explained in this study; such kind of communication can be initiated to foreword data packets from one moving vehicle to another or from moving vehicle to the RSU. RSU is firstly introduced in this study as intelligent system used for transportation purpose and can be installed on the road side as stationary unit to facilitate the communication between the vehicles.

In this study, authors have developed a network in Network Simulator Version II that ensure data transmission between five of mobile vehicles and the RSU. All the vehicles are communicating with the RSU, that information including the location details as taken from GPS sensor and consequently, RSU can keep track of the vehicles all the time. Author proposed comparing this technology with the same network in case of Zigbee instead of adhoc.

At Bharath and Sivagurunathan (2014) authors mentioned that VANET is an integral part of MANET which is dedicated for communication establishment on mobile vehicles. However, this study is discussing the post routing producer which involves how the receiving node will deal with routed data packets.

It is necessary to state that ad-hoc network is entity of less security which make it more susceptible to other malicious node attacks. Malicious node may join the network due to none stick administration. Another challenge in ad-hoc network is unsupervised queuing which means data packets can be queued without priority or without concept of content awareness.

That makes all kind of data packets even those related to different information source to form one queue which may cause unnecessary delay and packet dropping. It also gives chance to malicious nodes to spread their data across the network since not content awareness strategy is made.

This study proposed an approach to support routing relativeness which means packets of the same nature or those who are related to same information source are to form one queue; likely, otherwise, packet of different relativeness to be set in different queue.

At Takimoto and Obana (2008) the main goal of establishment of VANET is to mitigate the effects of automobile collision on highways. This network takes the necessary steps to spread a warning message among the drivers revealing the collision location and the exact distance to read that place of crashing. It is however required to spread large number of RSUs in order to cover the all roads and to reach even to the far most drivers.

Deployment of RSUs may involve cost increment which is unpleasant for all network designers. This study paved the way to establish a VANET with less possible RSUs to reduce network establishment cost and also to reduce the delay required to deliver the message if large number of RSUs are presented. The information might be collected from the vehicles are spread out to the other vehicles in vicinity by the RSU or what is so-called intelligent transportation system, that may require proper awareness of the delays and network payload management.

At Vaghela and Gyamlani (2012) for network alike vehicular networks, communication establishment and maintaining is pretty difficult due to the continuous varying in topology of the network. As vehicles are moving away along the road, no fix channel can be established for transmission and reception of data packets. As stated in this study, in order to ensure reliable data transmission over unstable vehicles network, multi-channel transmission is being the thought.

Some technology alike flooding protocol are used to overcome the communication drops in VANET. Those are called as flooding protocols and they being used to create multiple channel for packets to be transmitted from source node to receiver node.

Source node may send the data to the receiver as a burst of packets, receiver node keeps moving and hence the location of that node might be periodically updated in the source node. In practical situation location of node may node get rapidly updated in the source node routing table; for this purpose, flooding protocols are made to create multiple paths to send the data packets from source to destination.

At Tan and Zhou (2015) Large of the recent communication approaches are focused on vehicular communication under laid by MANET, said by the author of this research. However, routing of data is remained as constant dispute in most of the available approaches, in this study, author mentioned that large numbers of routing protocols are presented and they are differing from each other in terms of performance and security as well as in the cost.

Authors stated that location-based routing might be considered while dealing with MANET. The idea of location-based routing is about finding the location of

distention node and updating of location information to the source node. Such process to be repeated periodically during the transmission phase of the network. Author stated that main purpose of establishment the vehicle network is to provide safety tips for the drivers for traffic accidents prevention.

At Kim and Choi (2018) intelligent transportation system is made to safeguard the lives of drivers in high ways by initiation of alert messages to convey risk prevention messages to drivers who are approaching the region of accidents.

This intelligent system is made by participation of several technologies more likely wireless sensor networks and ad-hoc network, as stated by the authors; sensor network may attempt to collect the necessary information about the vicinity circumstances and transmit it to the other network nodes such as neighbor node and RSUs.

The mechanism of transmitting the information into other nodes may be decided using the concept of nearest neighbors, for that, nodes may update their location to each other after sending the hello message. Hello message is a request message that to be broadcasting by any node (which is willing to transmit the information) and can be received by every node within the coverage.

Accordingly, hello message is revealing many routing information such as node location, the packet identification number, acknowledgment number and capacity. It may involve other authenticity information such as the what nature (sort) of data is required to be shared and encryption type.

At Kumar and Sivakumar (2016) another approach is made about flying routing protocols that supports the aerial unmanned vehicles. These kinds of machines are being used to send information (monitoring) while they fly up within specific area. Researches are mostly concern about how data can be routed from the aerial unmanned vehicles to the base node? The aerial unmanned vehicles are functioning as group of vehicles that flying over geographical area and collecting information from environments and send it across to the ground server.

Collection of data from aerial environment is achievable with help of sensor networks. In current applications of aerial unmanned vehicles, video records are popular data type which is demanded by most of users. The machine is formed as quadcopter shape or as small helicopter which capable to fly for sets of hundred meters during the normal weather conditions.

Aerial unmanned vehicles are being used in varied applications such as video films shooting or for monitoring some targets on ground from sky as in some military applications. The study here had reviewed a new proposed routing technology for aerial unmanned vehicles called as hierarchical routing protocols which made to reduce the overhead of routing information located at the data packets.

This overhead might include an information about the congestion conditions at the network and that overhead can make other congestion problem due to its size. In high traffic network, packets overhear may take large size and that pose congestion and delay issue. This study proposed using cluster routing as two or more cluster hears will be located as a top level router to manage the traffic in all sub heads within the cluster. Cluster head may relay the data into other cluster head if in case the current cluster is experiencing congestion.

At Chen, Cheng and Shin (2014) after illustration of vehicular ad-hoc network essential role to address the communication difficulty for mobile vehicles; author of this study stated that routing problem is major concern of current research activity due to various reasons more likely, the dense of the vehicle in the road, the data rate of the network routes and availability of enough number of RSUs.

Routing paths are the major concern of routing protocols, the effect of routing path can be seen at the packet overhead which means none accurate routing overhead might increase the size of the packets overhead and hence causing undesired delay.

Traditionally, routing paths are calculated by identification of hopes number that node need to follow for sending its data to the destination node. Hope number may not reveal the exact knowledge about routing information, due to high speed node movement and dynamical nature of network topology. This study proposed using

two kind of metrics to validate the route path namely: connectivity metric and rout reliability metric.

At Naim and Hossain (2019) for VANET, sensor networks are the main role player in the game of data collection and exchanging amongst the network nodes. Another technology such as wireless local area network and Zigbee can be applied to enhance the network performance but that won't change the fact of sensor network dependency.

However, sensor network is set of microchips that works to collect information such as temperature, pressure, modality and other things, it sends the said information to other nodes (closer) using the single or multiple hope transmission. By whole, the information sent by an individual node may have a target to reach particular destination which set far away from it. since nodes are in continuous motion (considering the speed is fixed/constant) the area to destination is subjected to vary (shortening or increasing).

Author stated that energy consumed by the sensor (micro-devices) is directly proportional to the distance that packet need to travel reaching the destination. Hence, the micro sensors are empowering by small micro-battery, the life of those sensors are limited to the battery life and however, more energy consumption may reduce the life of entire sensor network.

At Li Zhao and Wang (2011) since vehicular sensor network are functioning to enhance the transportation engineering system by providing the server with vital data that critical to driver's life and property losses. RSU is acting as base station (as in cellular network) which collects the data from the other nodes and processes it and re-rout it to the other vehicles.

In this study author stated that routing enhancement technology can be built-up using ad-hoc agrid concept, it simply integrates a processing of information unit at the mobile vehicles which perform data processing and knowledge derivation in order to meet network traffic and delay mitigation criteria.

This approach had proven it performance as any mobile node in the network can obtain the data from the neighbors hood and from itself and process the data using the integrated computing unit of her own, further, the outcomes of data processor might be sent to the system RSU or whatever destination in form of encapsulated knowledge.

At Singh and Verma (2017) new terminology has brought out in this study named as vehicle to vehicle communication which stands for the ad-hoc network specification that supports the communication between two vehicles as a direct data sharing without the concern of higher layer. Other term is also defined over this study called as vehicle to infrastructure or vehicle to base station RSU, which stands for the data transmission between the nodes to the base station.

The routing of data in both scenarios may exists with help of routing protocols, in this study, Varity of routing protocols were tested to derive the performance of each one and compare their performance. Metrics of performance are used in approach such as jitter, end-to-end delay and throughput.

At Kombate, et al., 2016, Ashtankar (2015) for VANET, the network topology is continuously changing over two parameters namely: time and space. These two components are changing continuously due to vehicle mobility. In simulation environments, mobility of vehicles is generally assumed to be random which make it difficult to image the ground situation in real-life environments.

Author of this study proposed using a concept that depend on changing the tie and space component to generate new movement for the vehicles and attempting to achieve network condition same to that in real-life.

3. METHODOLOGY

3.1. Overview

Data networks are developed to tackle the challenges of sharing information in large amounts between the users. A plenty of data networks are established to facilitate information exchanging process. Computer networks are the first version of this development which made an interface between a group of computers and permits them a facility of sharing the information and peripheries.

With help of local area network, set of computers had become sharing same printer and same applications installed in the server computer. Networks by whole are managed by supper computer called as server. This supper computer is nothing but one of the hosts that existed in the network and might reserve some qualities such as higher storage and higher random access memory.

First computer network called as local area network was interfaced using a coaxial cable which grant it a capability of connecting a limited number of computers. Hence after, the interfacing of computer networks has further developed as broadband cables (twisted pairs cables) are invented with the RG 45 interfaces. The twisted pairs cable grants additional hosts (capacity) to the computer network.

Channels are essential terminology in networks and communications context; it is considered as data path or medium that allows data to propagate along with their overheads from the source to destination. In computer communications, channels are differed from each other especially after development of wireless communication. So-to-say, two kinds of channels can be recognized in communication and computer networks namely wire channels and wireless channels.

Wireless communications have taken large scaled development in communication systems as more standard of network had come into light such as mobile networks and cellular communication. Furthermore, another special type of networks has developed to exchange data over short or particular know area, this called as ad-hoc networks.

This kind of wireless networks are mostly seen in short range communications between laptops, mobile handsets. Ad-hoc networks are further developed to be used in vehicular communication and specifically used for intelligence transportation system enhancement. In this chapter, packets generation and propagation methodology are being discussed, furthermore, concept of adhoc networks and routing of packets are discussed also.

3.2. Switching Networks

Data is generated from the source and busted to destination through the channel (wire or wireless). The voyage of data from source to destination is not smooth so that data will remain stable and safe until it reaches destination. Considering that network is consists of several nodes as in Figure 3.1; those nodes are communicating with each other by wireless channel (Tripathi and Venkaeswari, 2015).

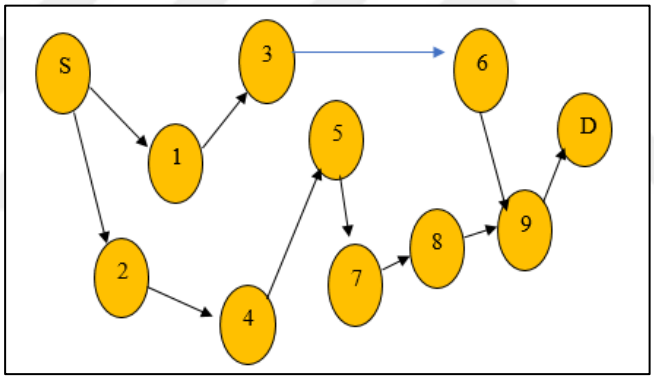

Figure 0.1. Depict of number of network node along with their interfaces (channels).

Firstly, data to be generated at the source node, this node can be any node among the others in the same network which is willing to communicate other node (called as distinction) by transmitting its data to it with help of channel. Data can be generated from the sensors integrated to the node.

Two types of payload can be recognized from the networks more likely, payload related to the data itself which producible by sensors attached to the nodes and other payload called as signaling payload which include routing information and all guidance required to route the data within network till it reaches the destination. Further, data can be propagated in the network by either of following technologies.

3.2.1. Circuit switching

Data in every node can be headed to the destination as one go type crossing all the nodes which might be exist in their way as illustrated in Figure 3.2. It is known that data may suffer from network degradation factors such as nose of jitter phenomena and hence the train of data sent from source node to destination node might get impacted by the said degraders which lead to information loss (Karyemsetty et al., 2015).

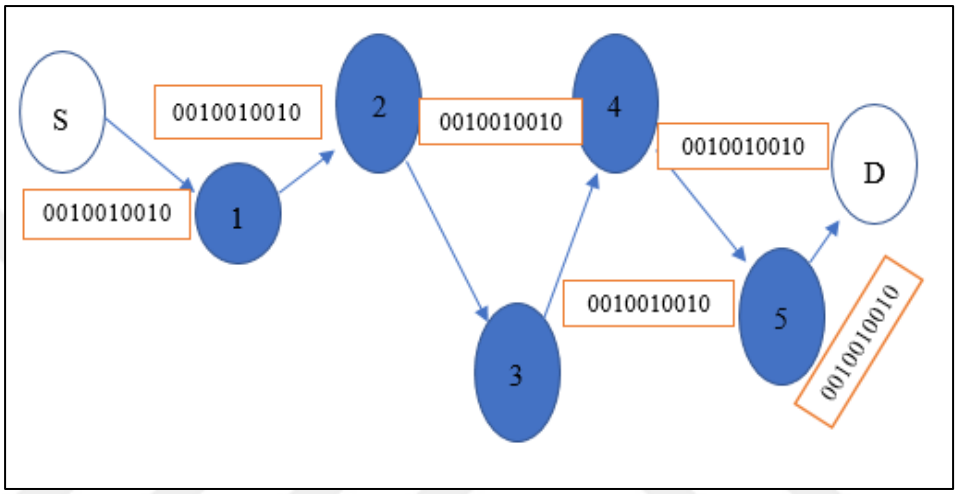

Figure 0.2. Circuit switching network (ordinary procedure).

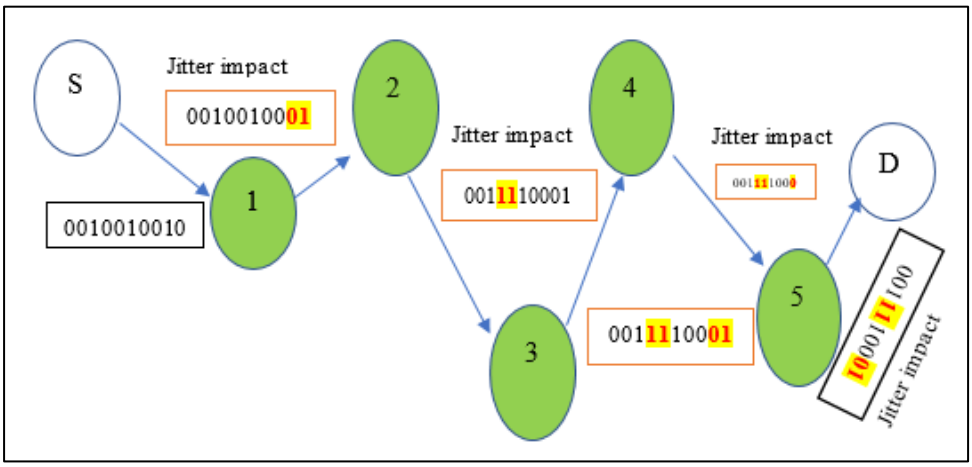

Figure 0.3. Circuit switching network (Jitter impact).

Figure 3.3. Demonstrates the impact of jitter on the data in circuit switching network which changes the data bit and hence the data reaches destination may have a lot of error which degrade the system performance.

3.3. Packet Switching

The new terminology of networks data transmission is called packets switching network. This kind of data transmission involves breaking down the data bulks into smaller blocks called as packets. So, instead of sending the whole data at once, it can be sent as a series of block (packets) that heading to destination through several paths (routs) as shown in Figure 3.4. Packets are taking different routes in the network reaching the destination and once all packets reach destination, data re-fabrication may begin them to recover the same form of transmitted data. This method of data transmission is developed to prevent noise and jitter phenomenon of the data burst. So, if noise of any kind of interference hits the data stream in case of circuit switching network, it might destroy the entire data. On the other hand, if data is broken into smaller blocks as in Figure 3.4. and sent to destination in many streams. In case of packet switching network, if noise or any other interference hits one packets, it cannot affect the whole data, it is also pave the road to recover original data information as recovery of small part of data is much easier then recovering the entire data (Rahim et al., 2009).

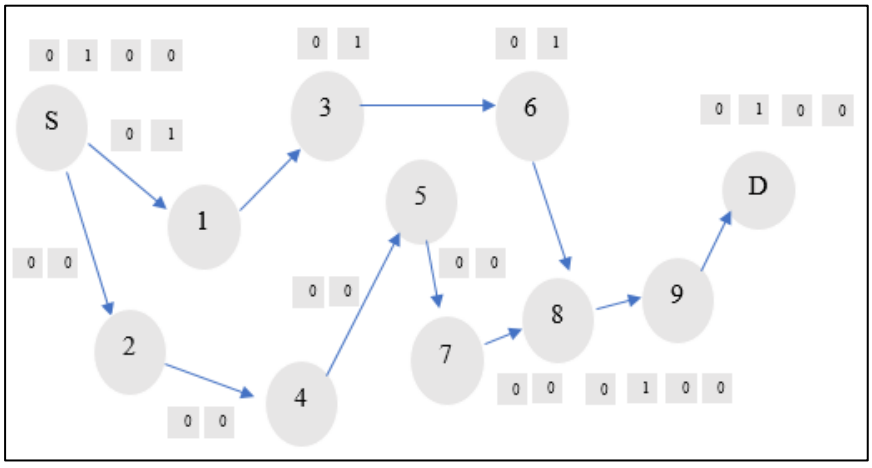

Figure 0.4. Packet switching technology for data transmission.

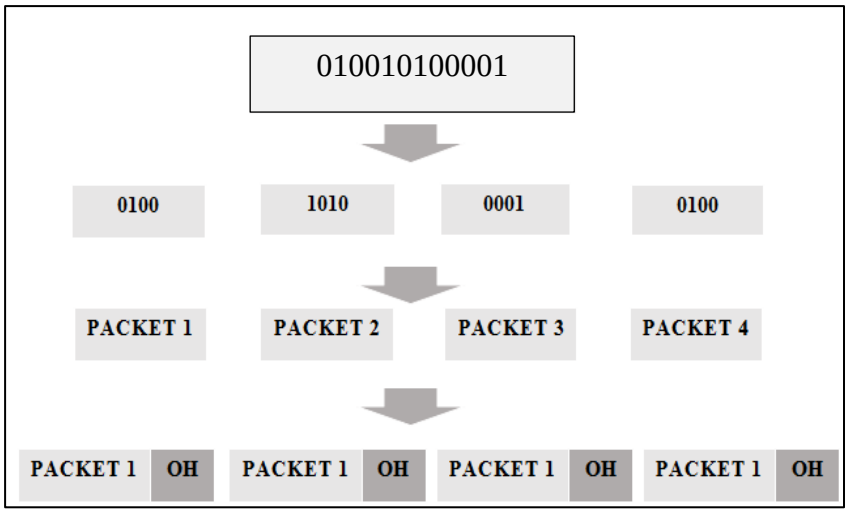

Figure 0.5. Packet generation process and overhead appending.

In order to understand how data is routed inside the network it is important to discuss the so call overhead or data overhead as depicted in Figure 3.5. This term is referred to the information appended by the routing algorithms in every node on the data entering that node. The content of this overhead can be listed in below:

1) Request number: referred to the number of packets that demanded by the node. In other word, it refers to the next packets required by a source node to be sent by the source node. This number is allotted to each packet and considered as packet identification number to recognize the packets and to reconstruct the data in the destination for retrieving the same sequence of packets at the source.
2) Acknowledgment number: referred to the packets receiving numbing which conforms the reception of packets.
3) Flag: refers to kind of packets more likely if that is queued packet or dropped or retransmitted.
4) IP address: in most of wireless applications, Internet protocol is used to rout the data into network and hence it allots four octets number more likely 23.50.22.10 to the rout that packet need to flow for reaching the destination.
5) MAC address: it's a combination of numerical as well as alphabetical values that refers number of network device used to rout the data and this is allotted to the packets in their overhead for security and authentication purpose. This address is allotting to packets by their medium access protocol.

The above information is appended to each packet while they travel from source to destination and however, the packet final form will be seem as shown Figure 3.6.

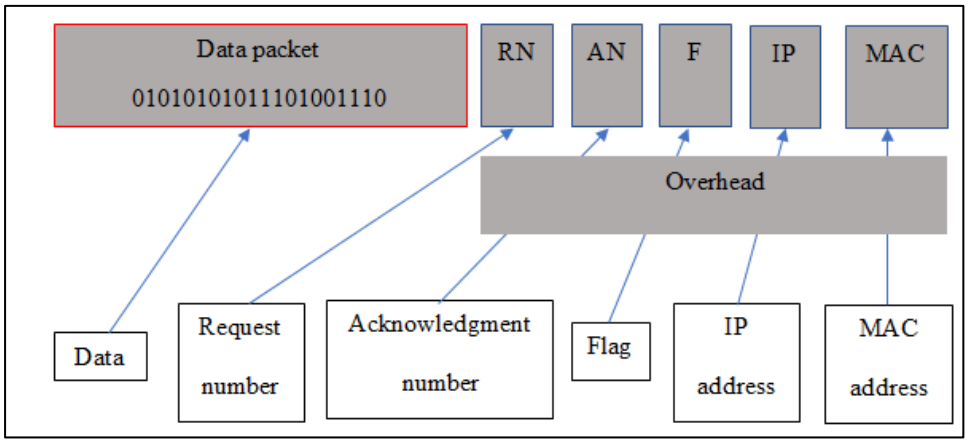

Figure 0.6. Packets structure which shown the contains of data and overhead.

3.4. Mobile Adhoc Network

MANET is evolved network technology that established to exchange data in small scale distances. However, this technology is introduced mostly in two standards namely: wireless sensor network and wireless vehicle network; the both network standards are infrastructure by ad-hoc network standards. Ad hoc is regular network standard which is similar to any other data exchanging network. It consists of five functional layers as shown in Figure 3.7. (Bharath and Sivagurunathan, 2014).

The contains and functions of each layer can be detailed as below:

a. Physical layer: it forms the first layer in the network paradigm and represent the medium that connects the network to other network or connects the nodes themselves. It provides physical interfaces that needed by network to establish any communication.
b. Data link layer: it also called as link layer and acts as traffic controller in the network. This layer performs medium access control on the data which helps the network to provide collision avoidance between the packets and to treat the packets fairly as they demand some network services. So-to-say, in this layer, all the required steps to ensure quality of service in the network are performed.

c. Network layer: it exhibits the third level of ad-hoc network complex, the main task of this layer is performing the routing of data between network nodes in the following steps:

   i. Internet protocol address assignment for each node which helps the node to get recognized in the network pool.

   ii. Route establishment between any pair of nodes, this route will represent the logical path of network payload to travel form any node (source) to other (destination).

   iii. Routing protocols such as DSR, ADOV, etc. are existing over this layer to rout data packets between the nodes.

d. Transport layer: this layer performs the most important task of networking in ad-hoc network. It takes the responsibility of traffic establishment and regulation. It includes the TCP technology that responsible to send packets in order sequence from source to destination. Eventually, this particular layer of ad-hoc network might act against any performance degradation and error existence in data transmission and maintain an acceptable level of quality of service.

e. Application layer: this layer represents the end user framework which take the responsibility of data generation and preparation. Another process might take place over this layer such as coding and decoding of data. Usually sensors are integrated for gathering some environmental data and forward it to the application layer where application layer is diverting the data to the transport layer and hence to network layer reaching the physical layer after crossing the data link layer.

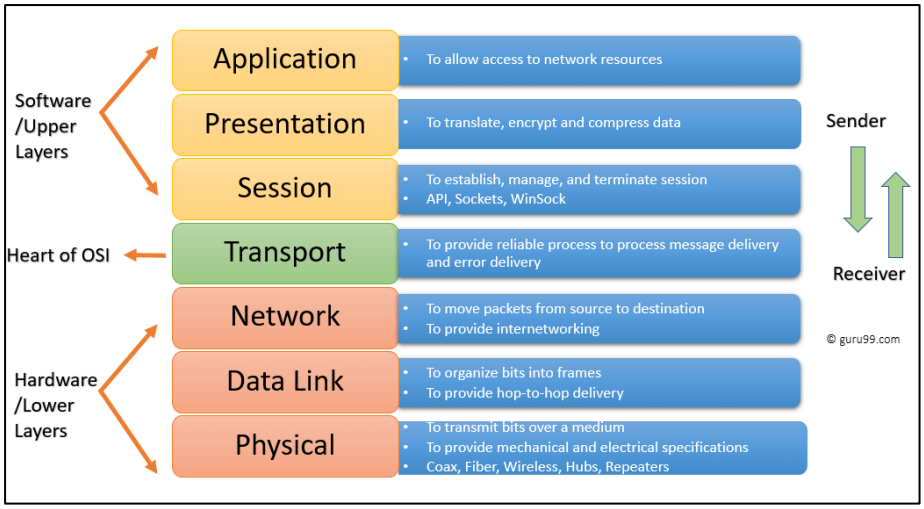

Figure 0.7. Ad-hoc network functional layers.

3.5. Communication Establishment

Data broke down into smaller blocks called as packets and hence, packet switching technology (demonstrated in preceding sections) is being used. the procedure taking place in transport layer where TCP or UDP are exists may begin to share the packets between nodes and to avoid collision and congestion of sharing the data (Takimoto et al., 2008).

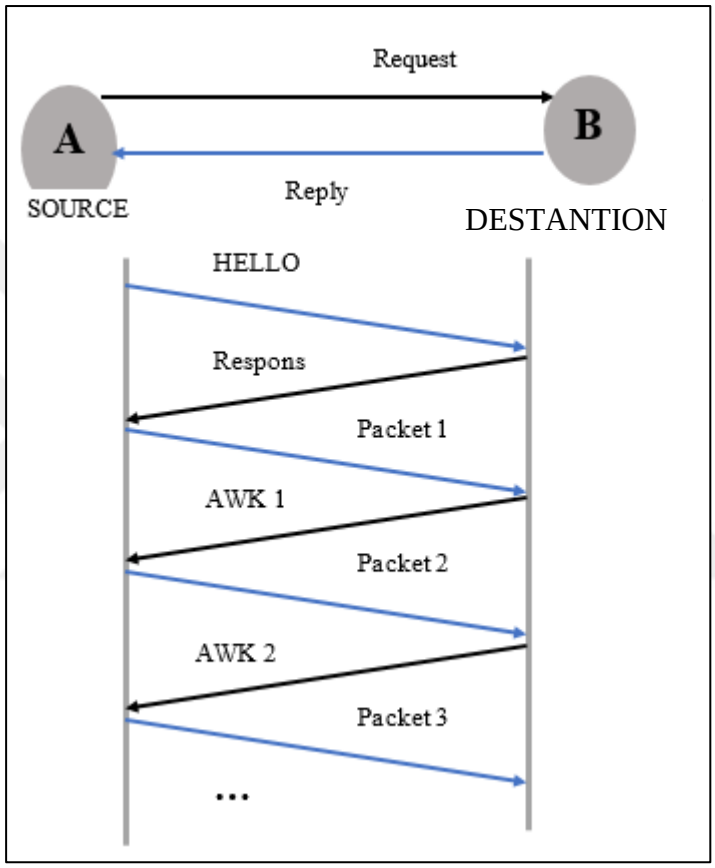

Figure 0.8. Two-way-hand shaking method in TCP.

In TCP technology a process called two-ways-hand-shaking is made to ensure packet delivery to destination without delay or dropping. Looking to the Figure 3.8. below, two nodes A and B willing to start packet transmission along the logical path (route), hence the following process may be applicable:

a) Node A is a part of ad-hoc wireless network and willing to share its payload to other node say the destination node termed as B. the destination node is also ad-hoc node located in the range of transmission of A.

b) Node A is firstly broadcast a HELLO message that can be received by all the nodes in vicinity and wait till an answer reflected from any of the nodes.

c) In this point of time, only the entitled node (B) might reply of to the node (A) as A was asking about B node only. From the other hand, any other node can reply and establish a logical link with A rather than B which make a security gap in such in of networks. A malicious node may join the network without granting any permission and start receiving the payload of any node. The snooping on the nodes might make a serious risk of losing the data as malicious node may receive that payload and instead of re-routing it to the next entitled node, it might drop it or ignore it. The same termed as security malfunctioning of ad-hoc wireless network.

d) Assuming that node B which is the entitle node is only replied back with its readiness, node B, by its positive reply, is agreeing to establish a logical link with node A and hence start the signaling and data packet reception.

e) As soon as the logical link established between the pair of nodes; the source node (node A) will start to send the first packet (packet 1) to the node B.

f) In the same time, Node B (as it agreed to receive the payload from node A) will start time counter that node B can wait for particular time only for the node A to share the payload. Otherwise, Node B will terminate the connection and change the flag in to Request Time Out.

g) Node A, as it sends the packet 1 before the ending of the allowable time made by node B, node B is in turn required to send an acknowledgment called as AWK 1 which indicates the successful reception of packet 1 and intimate the node A to share the next packet if any.

h) In case (for any kind of reason) node A failed to send packet 1 within the permissible time of node B or node A could not at all to send the packet A, node B will request the node A to retransmit (again) the same packet i.e. packet 1. This kind of request are managed by the so called TCP protocol and provides the following facilities of packet sharing:

1) Prevent duplication as node does not need to receive the same content again and again which may degrade the network performance by consumption of large space by the same packets.

2) No logical connection to last for longer that planned to prevent the time delay and to mitigate the load on the network so that packets will deliver in the expected quality of service level to the destination.

i) The aforementioned steps will be repeated unit the either of nodes A or B or both of them will terminate the logical connection. Termination of logical connection may be chosen by the either of nodes due to completion of task as node will rebroadcast the Hello message and it might get another shorter path to reach the destination. So-to-say, node might terminate the logical connection and begin with new one if new shorter and free path is found that might reduce the time delay and increase the throughput. On the other hand, as ad-hoc network nodes in some applications more likely MANET are keep moving, node might automatically terminate the connection and handover the link to some their node as node goes out of its coverage.

3.6. Vehicular Adhoc Network

As application of mobile wireless network, ad-hoc network is more adoptable standard that serves plenty of applications. The demand increased for a network facility with lesser cost to link the vehicles while it travels in high ways. This network called as VANET, and differs from the popular standards such as cellular network by its simplest and easy to adopt infrastructure, lower cost (free at most) and also by its efficiency (Vaghela and Shah, 2012).

VANET is dedicated to support the intelligence transportation system by providing the same with important data about the traffic in the high ways. The mobile cellular network is and other wireless standards are mainly differing from wireless Mobile Ad-hoc Network MANET in the following concerns:

a) Simple structure and hence easy to being adoptable with any applications (wherever that seems required).

b) Lower installation cost, as network card can be integrated with the said application and empowered using any portable DC supply (could be batteries at most). That is the major concern for this network to get populated in the wireless

applications and preferred from other cellular communication networks i.e. mobile network.

c) As draw back, this kind of networks is missing the central management unit where any nodes (could be millhouse) can join the complex and inject the malfunctioning data. The positive impression about this network is that, using it in less sensitive application such as traffic management where no malfunctioning node is probable.

d) The most feasible application for wireless ad-hoc network can be the VANET as this low cost network standard can be adopted by car manufacturers to collect traffic information from the roads and share it with main tower called as RSU.

e) VANET is basically formed of the cars which are moving in high ways so that, cars can communicate with each other sharing the traffic status in that road. Saying that one car had crashed at somewhere in the road and the place of crashing is more susceptible to affect the other cars which are coming forward without knowing the situation. In other word, more cars can be involved in such accident when they drive in high speed as illustrated in Figure 3.9.

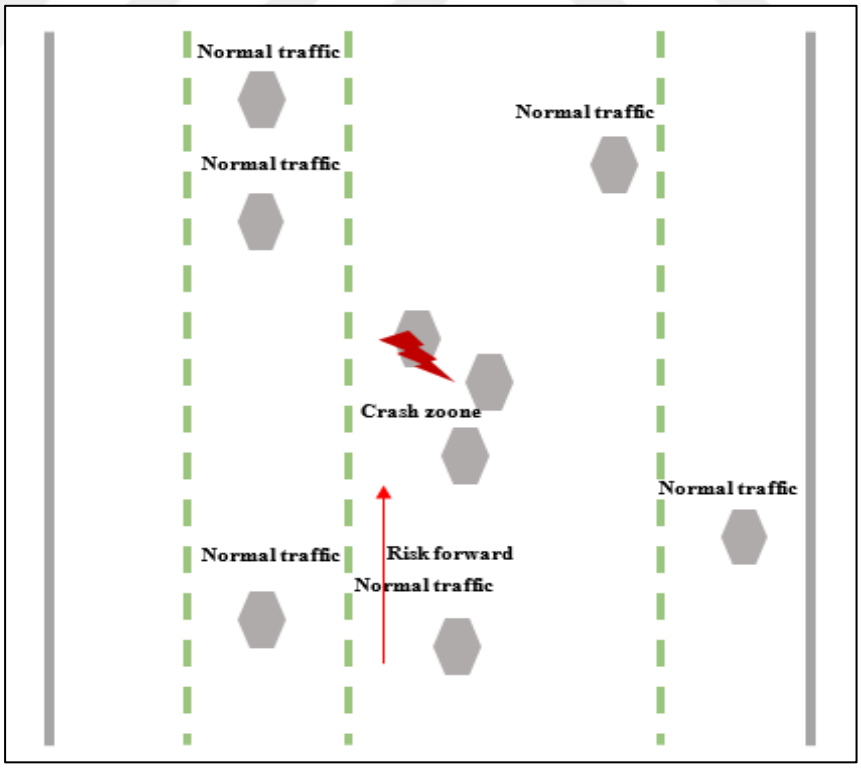

Figure 0.9. Traffic condition depict the accident scenario.

f) The actual structure of (VANET) can be depicted in Figure 3.10. figure shown three different communication phases more likely one is the car to car or (vehicle to vehicle) communication, other is vehicle to infrastructure communication and last is infrastructure to server room communication.

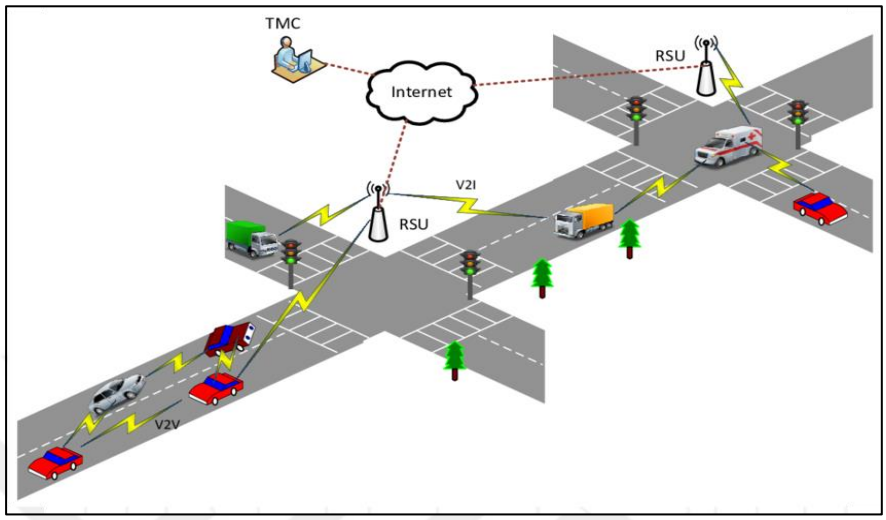

Figure 0.10. Demonstration of real-life Vehicle Adhoc Network.

g) RSU is a network node acts as server to collect the data from mobile vehicle and re-route it to the node (vehicles) which located far away from the crashed node coverage (communication limit). It also doses the required job to collect data from vehicles and forward it to higher network back office using higher network standard such as (WIMAX) or internet (Tan and Zhou, 2015).

3.7. Simulated Model

In order to study the network in real-life conditions, wireless vehicle network is made in virtual phase using special network simulator (NS version 2). However, the aim of this study is to derive a model that supports network performance when links are disconnected between two nodes due to their mobility and node radio limit (Kim and Choi, 2018).

The problem was as node of the mobile nodes got crashed and for preventing further accident and also to seek help or ambulance. In case of car crashing the following concerns are the objectives of the network:

1) Reaching the ambulances (nearest and fastest) so the action of message conveying might be delivering as rapid as possible. That must safe guard the driver and car passengers lives as every minute is critical in such unfortunate coexistence.
2) Other coming forward cars are most susceptible to the same accident as they approach from infected point. For that, rapidly, warning message should be speeded to all other nodes so they will be aware about the infected area and so they may speed down or take another root.
3) The main problem of this network is the delay and link re-healing time. Firstly, delay can be defined as the time taken by the node to deliver the packet to the destination. This delay must be minimized for quick signal delivery to fulfil the prementioned requirements of road safety.
4) Re-Healing time is defined as the time taken by the node from the recurrent link disconnection until new route is developed. The link disconnection can be termed to the node limited radio coverage and also node mobility.
5) We proposed using the mobile nodes are RSU to support the network, in this proposal, node can reach easily to large coverage and also can convey the message in more rapid fashion. The objectives now is to reduce the re-healing time and to reduce the time delay. The study is further proposed using various number of relay nodes and calculate the effects of that on the mentioned performance metrics.

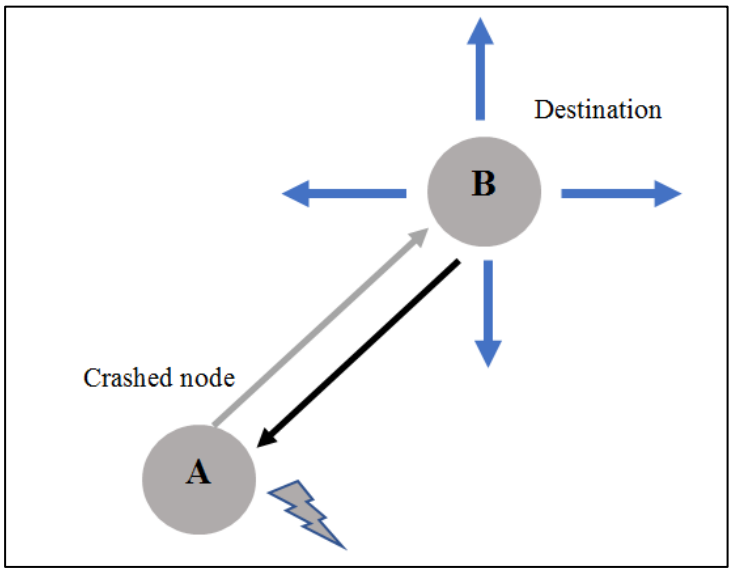

Figure 0.11. First simulated model.

6) Four functional models are established in Network Simulator version 2, the first model is source node and destination node are both signaling without using any help of RSU (no relay node is inserted). The time delay and re-healing time are calculated in this model. It is noteworthy that destination node is in continuous motion according to the specification listed in Table 3.1. this model is depicted in Figure 3.11.
7) Second model involves applying single relay node (node as RSU), that may increase the crashed node capability to reach the destination much easier. Similarly, the time delay and re-healing time are calculated in this model as well. model is depicted in Figure 3.12.

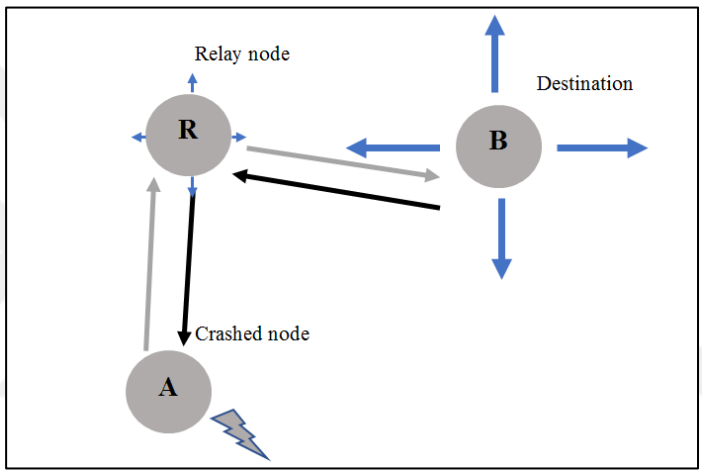

Figure 0.12. Second simulated model.

8) Third model is made consist two relay nodes where each is can connect the crashed node with the destination. It is note-worthy mentioning that both relay nodes are in continuous motion and the destination node is also in continues random motion. Figure 3.12 demonstrates the model.

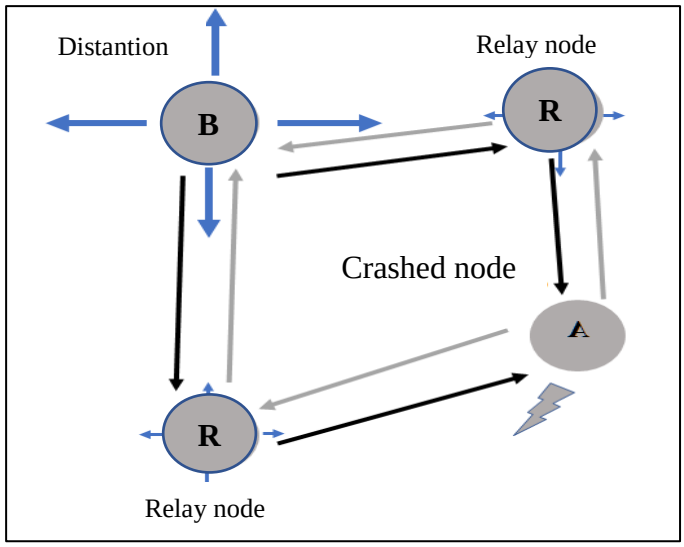

Figure 0.13. Third simulated mode topology.

9) Fourth and last model is made as in Figure 3.14, it consists of three relay nodes (node as RSU), all of the relay nodes in continues movement and the destination node is also moving in random directions. Same like other models, the time delay calculated between the source and destination along with the re-healing time of the logical connection between the source and destination. The system specification can be listed as below in Table 3.1.

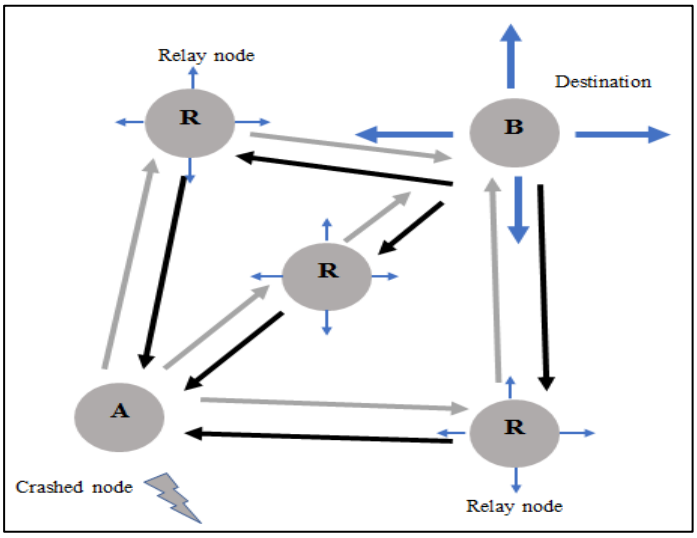

Figure 0.14. The fourth simulated model topology.

Table 3.1. Network configuration and details used in the four simulated models.

Particle	Details
Number of mobile nodes	1
Number of relay nodes	1, 2, 3
Motion of mobile (*destination node)	Random
Motion of relay node	Random
Speed of nodes	40, 80 ,120 km/h
Topology size	300 m x 300 m
Radio range of any node	150 m
Routing protocol	AODV

4. OUTCOMES AND DISCUSSION

As four network model are set in Network Simulator NS-II, every model was treated individually, the calculations efforts made in every model attempting to evaluate the time delay and re-healing time. while the speed is 40 km/h. The results of the so called the link duration between the source node and destination node are listed in Table 4.1. the data given in this Table is representing every model outcome.

Table 4.1. Time of link life calculated between source node and destination node in each mode while the speed 40 km/h.

0 Relay	1 Relay	2 Relays	3 Relays
0.00583792	0.00551792	0.01472809	0.01453703
0.00571793	0.05667462	0.00571792	0.00555792
0.00593793	0.14964194	0.21395352	0.13683998
0.00589793	0.16322167	0.19054402	0.3103948
0.00553793	0.29901603	0.17736351	0.12775673
0.00563793	0.13934812	0.18940808	0.14447859
0.00569794	0.02654603	0.28466603	0.05098428
0.00571794	0.1736064	0.10158792	0.21414064
0.00555794	0.00575794	0.1990186	0.27102899
0.00599794	0.14048351	0.27327237	0.20860052
0.00577794	0.06153972	0.17895374	0.03604489
0.00571795	0.16838884	0.08245644	0.16817393
0.00571795	0.0667781	0.09549771	0.08152805
0.00549795	0.00563795	0.27470951	0.20393825
0.00577795	0.18960118	0.16227236	0.09378869
0.00573796	0.17731209	0.13425041	0.18783756
0.00553796	0.05086467	0.33116493	0.17909049
0.00569796	0.02181967	0.00585795	0.11714746
0.00575796	0.14391012	0.23774712	0.49723145
0.00583796	0.1487929	0.1738479	0.39123112

The above table can be represented graphically as in Figure 4.1.

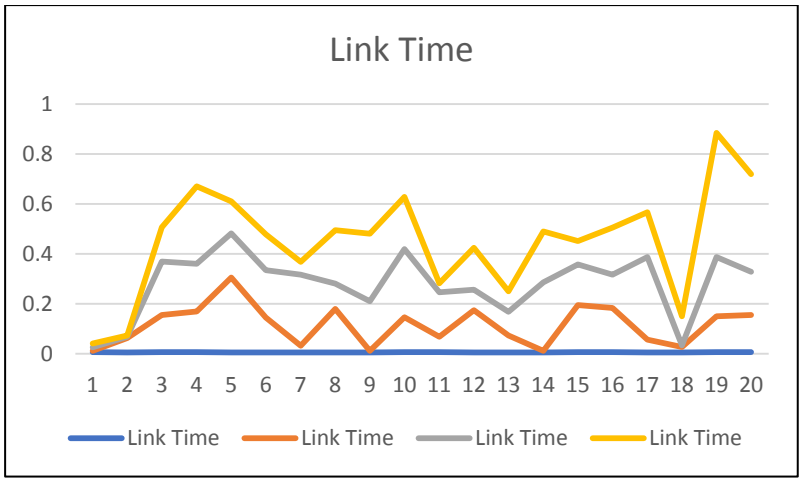

Figure 4.1. The graphical representation of link duration in the four simulated models.

Figure shows that link duration last for more time in case of one relay node and increases up in case of two relay nodes reaching the maximum link time when the number of relays is three.

From the other hand, the re-healing time is calculated as well for the four simulation models and results are listed in Table 4.2. and Figure 4.2. respectively. The hereinafter results representations shown that link duration is increased as number of relay nodes increases whereas the re-healing time is decreased as soon as number of nodes is increased.

Table 4.2. Re-healing time calculated for the four simulated models.

0 Relay	1 Relay	2 Relays	3 Relays
0.16858132	0.19004199	0.11607472	0.11610578
0.21240526	0.3344963	0.34712089	0.15322783
0.2546222	0.35135637	0.18900844	0.36280326
0.34015682	0.36184624	0.17162558	0.34232237
0.18540641	0.18884844	0.34108436	0.26625128
0.31561798	0.23136182	0.32556297	0.2504462
0.15231962	0.31861394	0.14581747	0.2312531
0.34670089	0.24773043	0.20545371	0.30308187
0.15344783	0.23010502	0.31921555	0.22159534
0.27353685	0.27176812	0.2214831	0.14401804
0.29209598	0.32086376	0.18422517	0.34926204
0.26120549	0.12498364	0.3231095	0.20772386
0.26348992	0.21629183	0.36145602	0.24590323
0.20710925	0.20545371	0.21989933	0.18175047

Table 4.2 (continue). Re-healing time calculated for the four simulated models.

0.36166405	0.31416887	0.14390933	0.23675219
0.29853432	0.1287393	0.3636221	0.23395738
0.14799923	0.17875801	0.1648648	0.14337063
0.34133637	0.34896022	0.30078104	0.27751649
0.23038502	0.16951121	0.2335776	0.32975269

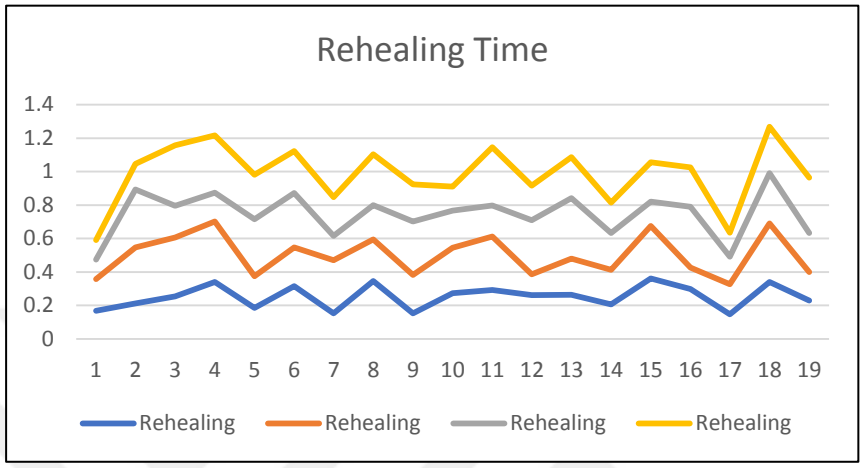

Figure 4.2. The re-healing time of four simulated models.

While the speed 40 km/h the mean re-healing time and mean link duration in Figure 4.3 and Figure 4.4 are obtained and hence are listed as below in Table 4.3.

Table 4.3. Average link duration and average re-healing time of the four models.

Relay Nods	Link Time	Re-healing Time
0	0.00572994	0.25297973
1	0.10972297	0.24915259
2	0.16635091	0.24620482
3	0.17201657	0.24195232

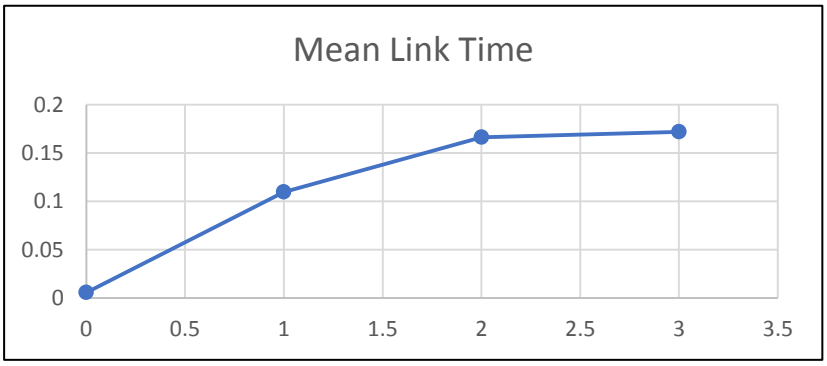

Figure 4.3. Mean link duration of the four models.

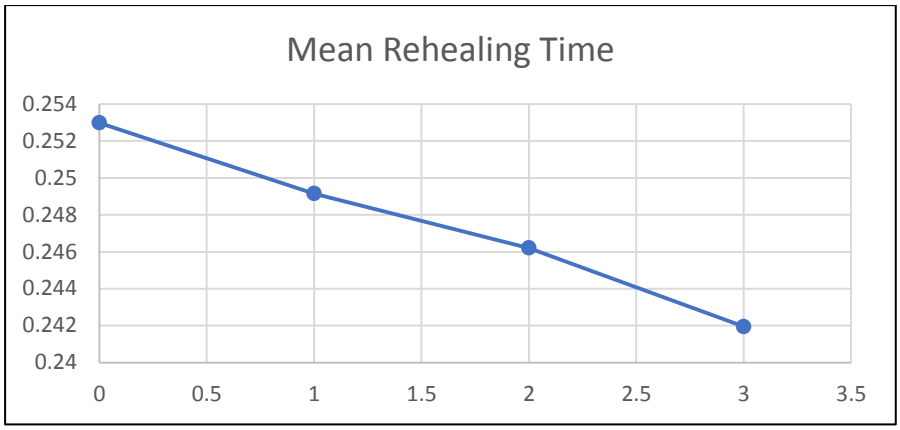

Figure 4.4. Mean re-healing time of the four models.

while the speed is 80 km/h the results of the so called the link duration between the source node and destination node are listed in Table 4.4. and Figure 4.5, the data given in this Table is representing every model outcome.

Table 4.4. Time of link life calculated between source node and destination node in each mode while the speed 80km/h.

L Time R1	L Time R2	L Time R3	L Time R4
0.01157	0.02102	0.01473	0.01454
0.00576	0.1006	0.00572	0.10064
0.00604	0.05667	0.00598	0.13684
0.00574	0.14964	0.19054	0.12671
0.00584	0.16322	0.10447	0.12776
0.00572	0.00598	0.18941	0.12941
0.00594	0.00558	0.28467	0.05098
0.0059	0.00552	0.10159	0.21414
0.00554	0.00392	0.19902	0.13135
0.00564	0.00576	0.19178	0.2086
0.0057	0.14048	0.17895	0.03604
0.00572	0.06154	0.08246	0.15943
0.00556	0.00572	0.0955	0.08153
0.006	0.00566	0.13309	0.20394
0.00578	0.00564	0.16227	0.17295
0.00572	0.00566	0.13425	0.18784
0.00572	0.00602	0.09857	0.15311
0.0055	0.00576	0.00586	0.14295
0.00578	0.00598	0.23775	0.22355
0.00574	0.00574	0.17385	0.20246
0.00554	0.00608	0.23388	0.19073
0.0057	0.00602	0.05983	0.16344

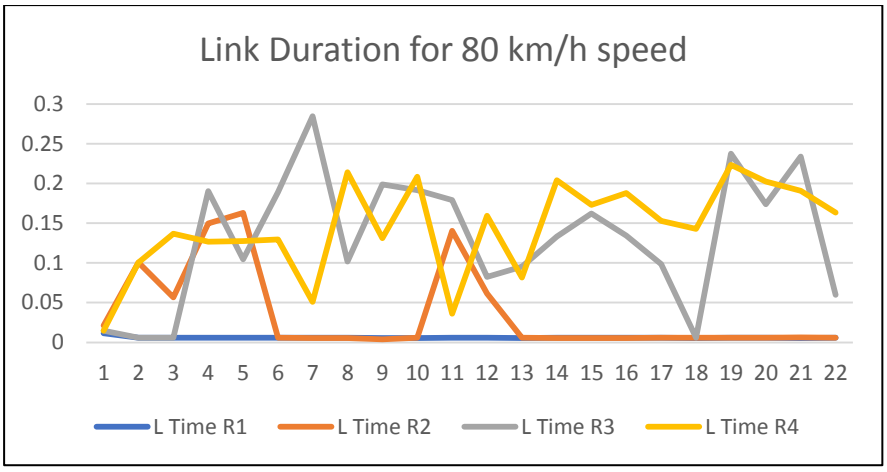

Figure 4.5. The graphical representation of link duration while the speed 80km/h.

From the other hand, the re-healing time is calculated as well for the four simulation models and results are listed in Table 4.5. and Figure 4.6. respectively

Table 4.5. Re-healing time calculated for the four simulated models while the speed is 80km/h.

Re-healing R1	Re-healing R2	Re-healing R3	Re-healing R4
0.11927	0.10958	0.11611	0.116074723
0.285	0.19004	0.15323	0.34712089
0.16574	0.3345	0.3628	0.189008436
0.15355	0.35136	0.34232	0.171625583
0.16858	0.36185	0.26625	0.341084355
0.21241	0.18885	0.25045	0.325562968
0.25462	0.23136	0.23125	0.145817474
0.34016	0.31861	0.30308	0.205453705
0.18541	0.24773	0.2216	0.319215547
0.31562	0.23011	0.14402	0.221483095
0.15232	0.27177	0.34926	0.18422517
0.3467	0.32086	0.20772	0.323109496
0.15345	0.12498	0.2459	0.361456021
0.27354	0.21629	0.18175	0.219899329
0.2921	0.20545	0.23675	0.143909331
0.26121	0.31417	0.23396	0.363622104
0.26349	0.12874	0.14337	0.164864804
0.20711	0.17876	0.27752	0.300781037
0.36166	0.34896	0.32975	0.233577597
0.29853	0.16951	0.19219	0.282868893
0.148	0.3325	0.1732	0.335064283

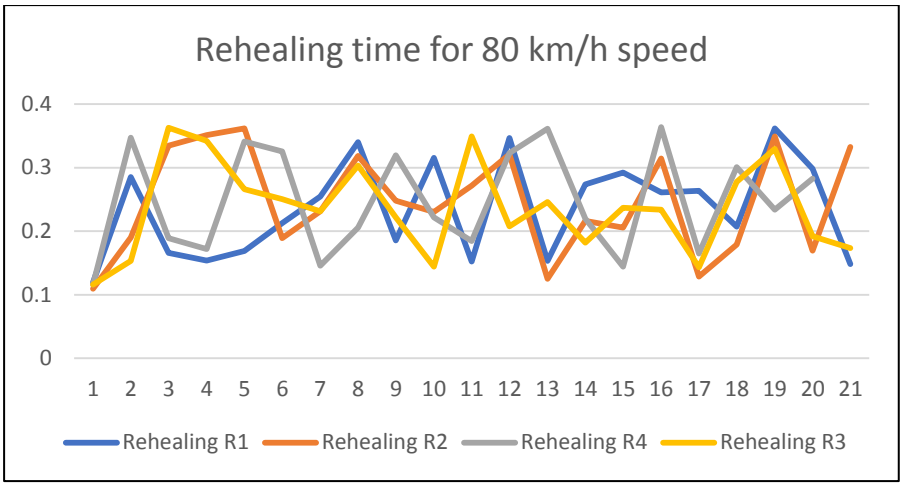

Figure 4.6. The re-healing time of four simulated models while the speed 80km/h.

The average link duration, average re-healing time and end to end of the four models are obtained and hence are listed as below in Table 4.6.and Figure 4.7. While the speed 80 km/h.

Table 4.6. Average link duration, average re-healing time and end to end of the four models while the speed is 80 km/h.

No. Relays	L Time	Re-healing	ENE
1R	0.006	0.23612	0.23038
2R	0.03537	0.24648	0.21042
3R	0.1311	0.25218	0.11554
4R	0.14622	0.23631	0.08658

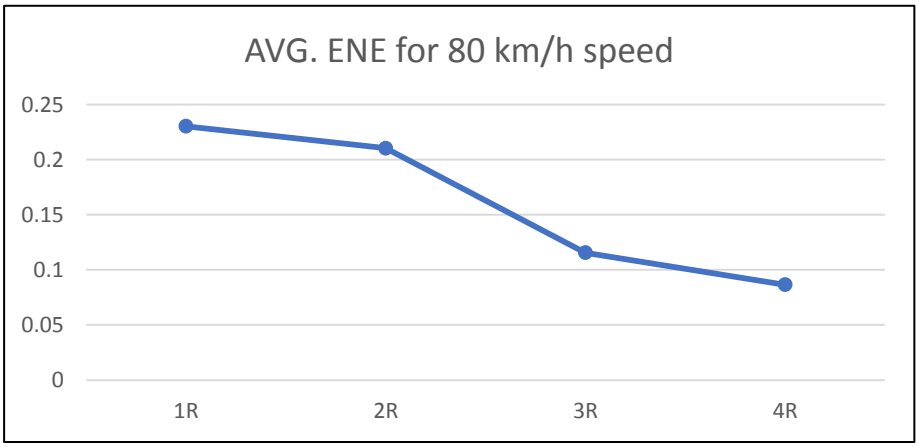

Figure 4.7. Average re-healing time and end to end in speed 80 km/h.

while the speed is 120 km/h the results of the so called the link duration between the source node and destination node are listed in Table 4.7. and Figure 4.8. The data given in this Table is representing every model outcome.

Table 4.7. The link time calculated for the four simulated models while the speed 120km/h.

L Time R1	L Time R2	L Time R3	L Time R4
0.01157303	0.02102083	0.01472809	0.01453703
0.00575792	0.00551792	0.00571792	0.03064281
0.00603792	0.05667462	0.00597792	0.13683998
0.00573792	0.14964194	0.18054402	0.12671074
0.00583792	0.16322167	0.10446636	0.12775673
0.00571793	0.15941538	0.18940808	0.12940587
0.00593793	0.13934812	0.28466603	0.05098428
0.00589793	0.02654603	0.10158792	0.21414064
0.00553793	0.00595794	0.00565793	0.13135451
0.00563793	0.00575794	0.19177619	0.20860052
0.00569794	0.14048351	0.00567794	0.03604489
0.00571794	0.06153972	0.08245644	0.15943168
0.00555794	0.16838884	0.09549771	0.08152805
0.00599794	0.0667781	0.13308825	0.20393825
0.00577794	0.00563795	0.00605795	0.16994631
0.00571795	0.18960118	0.00561795	0.18783756
0.00571795	0.17731209	0.0985746	0.15310611
0.00549795	0.05086467	4.8249E-05	0.14294785
0.00577795	0.02181967	0.23774712	0.22355427

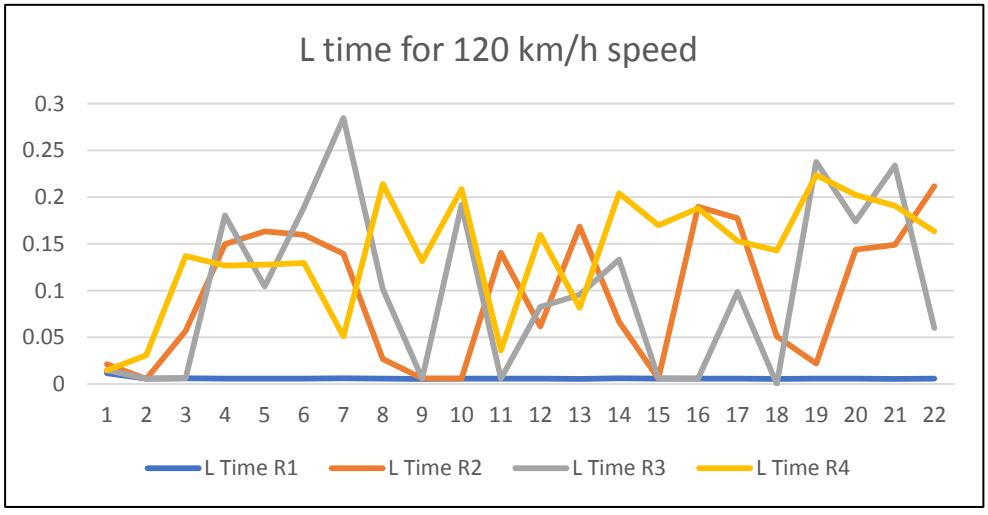

Figure 4.8. The graphical representation of link duration while the speed 120km/h.

The re-healing time is calculated as well for the four simulation models and results are listed in Table 4.8. and Figure 4.9. Respectively in speed 120 km/h.

Table 4.8. Re-healing time calculated for the four simulated models while the speed is 120km/h.

Rehealing R1	Rehealing R2	Rehealing R3	Rehealing R4
0.11926978	0.10958198	0.11610578	0.11607472
0.28499629	0.19004199	0.15322783	0.34712089
0.16573635	0.3344963	0.36280326	0.18900844
0.15355206	0.35135637	0.34232237	0.17162558
0.16858132	0.36184624	3.81208643	0.34108436
0.21240526	0.18884844	0.2504462	0.32556297
0.2546222	0.23136182	0.4816993	0.14581747
0.34015682	0.31861394	0.30308187	0.20545371
0.18540641	0.24773043	0.22159534	0.31921555
0.31561798	0.23010502	0.14401804	4.95401375
0.15231962	0.27176812	0.34926204	0.18422517
0.34670089	0.32086376	0.20772386	0.3231095
0.15344783	0.12498364	0.24590323	0.36145602
0.27353685	0.21629183	0.18175047	0.21989933
0.29209598	0.20545371	0.23675219	0.14390933
0.26120549	0.31416887	0.23395738	0.3636221
0.26348992	0.1287393	0.14337063	0.1648648
0.20710925	0.17875801	0.27751649	0.30078104
0.36166405	0.34896022	0.32975269	0.2335776
0.29853432	0.16951121	0.19218844	0.28286889
0.14799923	0.33250033	0.17319809	0.33506428

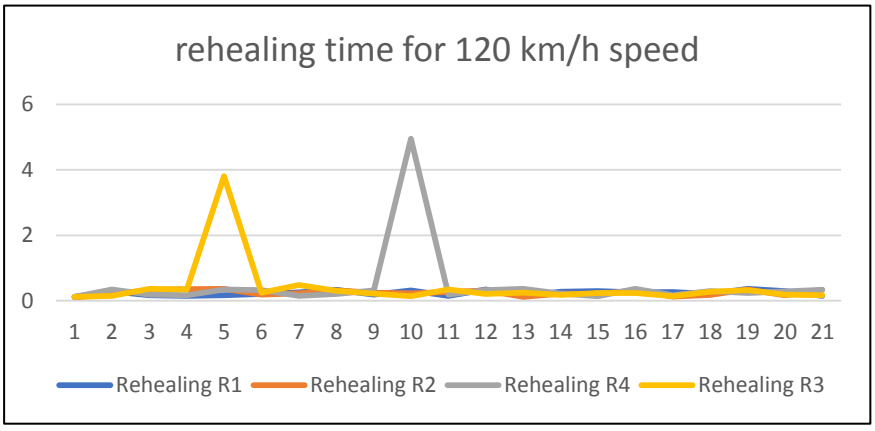

Figure 4.9. The re-healing time of four simulated models while the speed is 120 Km/h.

The average link duration, average re-healing time and end to end of the four models are obtained and hence are listed as below in Table 4.9.and Figure 4.10. While the speed 120 km/h.

Table 4.9. Average link duration, average re-healing time and end to end of the four models while the speed is 120 km/h.

No. Relays	L Time	Re-healing	ENE
1R	0.00600499	0.23611657	0.23037672
2R	0.09500391	0.24265401	0.14356684
3R.	0.10242232	0.26485255	0.16849639
4R	0.17194877	0.22221135	0.04182555

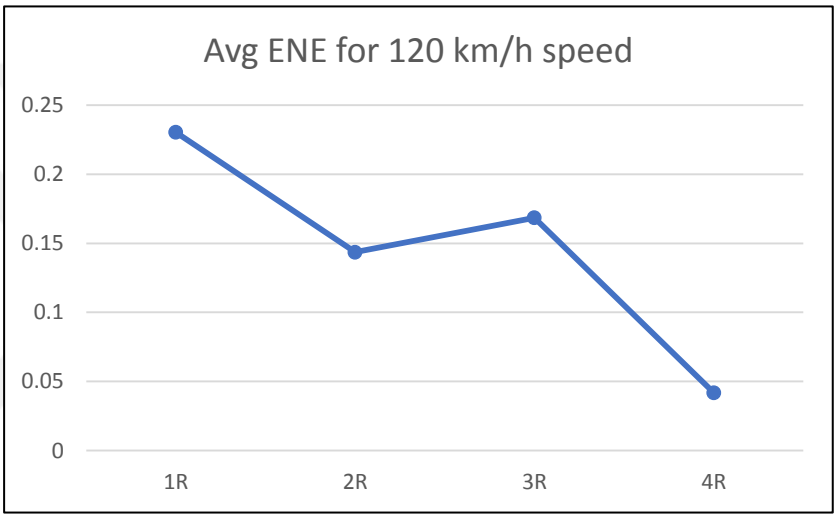

Figure 4.10. Average re-healing time and end to end in speed 120 km/h.

5. CONCLUSION

MANETs gain extended attention in wireless data transmission, it paved the way to develop simple infrastructure network in low cost supports mobile data transmission. In this study, wireless VANET is developed to establish a communication between mobile vehicles. VANET is commonly used to support the intelligence transportation system. It provides the server with real-time traffic information so that server can enhance the traffic by many procedures such as congestion avoidance and safety alarm.

In this study, mobile vehicles are randomly moving in the high ways and hence in case on car crashing, car will assume stopped and the place of crashing is susceptible to intake more than one vehicle. As vehicles are being droved in high speed and drivers; due to their unawareness of accident zone, they can get into it and hence problem is enlarging. On the other hand, ad/hoc network is attempting to share safety norms to the inward drivers to avoid the crashing in that particular location. For some reasons more likely due to car limited radio converge and speed of the cars running on the high way, the reachability of this message is critical and hence, network further development was mandatory.

We treated the mobile vehicles as relay in other word as RSU which convey the crashed car messages to the far most hosts in the network as an attempt to ensure rapid ambulances and to prevent further losses. For that, we tried using different number of more likely no relay, one relay, two and three relays and hence we calculated the link duration between source node and destination node and the time taken by the nodes for reconnection after link goes down. The observations made from this study is increment of relay nodes may help to maintain the link between source and destination for longer time and reduce the time required to reconnect the nodes if that links goes down due to nodes speed or any other event.

REFERENCES

Anda, J., LeBrun, J., Ghosal, D., Chuah, C.N. and Zhang, M., 2005. VGrid: Vehicular adhoc networking and computing grid for intelligent traffic control, In 2005 IEEE 61st Vehicular Technology Conference, IEEE, Vol. 5, pp. 2905-2909, Stockholm, Sweden.

Ashtankar, P.P. and Dorle, S.S., 2015. A design approach based on design strategies and simulation of wireless adhoc communication network using intelligent transportation system, In 2015 International Conference on Communication Networks , IEEE, pp. 23-26, Gwalior, India.

Bharath, A. and Sivagurunathan, P.P., 2014. Collision avoidance system in vehicular adhoc network utilizing dichotomized headway model, in 2014 International Conference on Circuits, Power and Computing Technologies (ICCPCT-2014), IEEE, pp. 1349-1353, Nagercoil, India.

Chen, T. Y., Wei, H. W., Cheng, Y. C., Shih, W. K. and Chen, H.Y., 2014. An efficient routing algorithm to optimize the lifetime of sensor network using wireless charging vehicle. in 2014 IEEE 11th International Conference on Mobile Ad Hoc and Sensor Systems, IEEE, pp. 501-502, Philadelphia, PA, USA.

Islam, N. and Shaikh, Z.A., 2008. A novel approach to service discovery in mobile adhoc network, In 2008 IEEE International Networking and Communications Conference, IEEE, pp. 1-5, Lahore, Pakistan.

Jeyaprakash, T. and Mukesh, R., 2013. A tactical information management system for unmanned vehicles using vehicular adhoc networks, in 2013 4th International Conference on Intelligent Systems, Modelling and Simulation. IEEE, pp. 472-474, Bangkok, Thailand.

Karyemsetty, N., Samatha, B. and Rao, K.H., 2015. Design and deployment of vehicle tracking system in vanets using xbee pro: prototype model, in 2015 International Conference on Communication Networks, IEEE, pp. 97-100, Gwalior, India.

Kim, B.S., Kim, K.I., Roh, B. and Choi, H., 2018. hierarchical routing for unmanned aerial vehicle relayed tactical ad hoc networks, in 2018 IEEE, 15th . International Conference on Mobile Ad Hoc and Sensor Systems (MASS), IEEE, pp. 153-154, Chengdu, China.

Kombate, D., 2016. The internet of vehicles based on 5g communications, in 2016 IEEE International Conference on Internet of Things (iThings) and IEEE Green Computing and Communications (GreenCom) and IEEE Cyber, Physical and Social Computing (CPSCom) and IEEE Smart Data (Smart Data), IEEE, pp. 445-448, Chengdu, China.

Kumar, T. A., Reza, A. T., and Sivakumar, T. 2016 . A reliable path selection for vehicular adhoc network using reliability matrix and connectivity matrix, in 2016, IEEE, International Conference on Engineering and Technology (ICETECH), IEEE, pp. 61-65, Coimbatore, India.

Li, Y., Zhao, M. and Wang, W., 2011. Intermittently connected vehicle-to-vehicle networks: detection and analysis. in 2011, IEEE Global Telecommunications Conference-GLOBECOM, IEEE, pp. 1-6, Houston, TX, USA, USA.

Naim, Z. and Hossain, M. I., 2019. Performance analysis of AODV, DSDV and DSR in vehicular adhoc network (VANET). in.2019, International Conference on Robotics, Electrical and Signal Processing Techniques , IEEE, pp. 17-22, Dhaka, Bangladesh.

Nayyar, A., 2018. Flying adhoc network (FANETs): simulation based performance comparison of routing protocols, AODV, DSDV, DSR, OLSR, AOMDV and HWMP. In 2018, International Conference on Advances in Big Data, Computing and Data Communication Systems (ICABCD), IEEE, pp. 1-9, Durban, South Africa.

Rahim, A., Yasin, M., Ahmad, I., Khan, Z. S. and Sher, M., 2009. Relevance based approach with virtual queue for vehicular adhoc networks, in 2009 2nd International Conference on Computer, Control and Communication, IEEE, pp. 1-4, Karachi, Pakistan.

Singh, K. and Verma, A.K., 2017. Threat modeling for multi-UAV Adhoc networks. in TENCON 2017-2017, IEEE Region 10 Conference, IEEE, pp. 1544-1549, Penang, Malaysia.

Takimoto, E., Kondo, Y., Itaya, S., Suzuki, R. and Obana, S., 2008. Evaluation of multi-channel flooding for inter-vehicle communication, In 22nd, International Conference on Advanced Information Networking and Applications-Workshops (aina workshops 2008), IEEE, pp. 960-965, Okinawa, Japan.

Tan, F. Y. and Zhou, L., 2015. The network capacity issues on designing routing protocol of vehicular adhoc network, in, 2015 2nd International Conference on Information Science and Control Engineering, IEEE, pp. 504-507, Shanghai, China.

Tomer, P. and Chandra, M., 2010. An application of routing protocols for vehicular ad-hoc networks, in, 2010 International Conference on Networking And Information Technology, IEEE, pp. 157-160, Manila, Philippines.

Tripathi, V. K. and Venkaeswari, S., 2015. Secure communication with privacy preservation in VANET-using multilingual translation, in, 2015 Global Conference on Communication Technologies (GCCT), IEEE, pp. 125-127, Thuckalay, India.

Vaghela, V. B., Shah, D. J. and Gyamlani, S., 2012. Novel routing protocol for vehicular adhoc networks, in, 2012 2nd IEEE International Conference on Parallel, Distributed and Grid Computing, IEEE, pp. 706-710, Solan, India.

CURRICULUM VITAE

Name and Surname : Omar Sabri HAMZAH

Address : Kirkuk-Iraq.

EDUCATION INFORMATION

Undergraduate : AL-Qalam University College /Kirkuk, 2011-2015.

Master : Aksaray University, 2017-2021.

PROFESSIONAL EXPERIENCE AND AWARDS

1) Training course for projects by ARDUINO.
2) Training course for projects by MATLAB.
3) Training course for projects by AUTOCAD.
4) Training course for projects by CAD-CAM.

PUBLICATIONS, PRESENTATIONS, AND PATENTS

Hamza, O. and Yenice, Y. E., 2020. Vehicular ad-hoc network to support traffic safety on highways, International Journal of Trend in Research and Development (IJTRD), ISSN, 7, 1, 2394-9333.