VISVESVARAYA TECHNOLOGICAL UNIVERSITY
Jnana Sangama, Belagavi - 590 018

PROJECT REPORT ON

Performance Analysis Of VANET Clustering Routing Protocol

Project Report submitted in partial fulfillment for the Award of Degree
of **Bachelor of Engineering**
in
Electronics and Communication Engineering

Submitted by

Swathi B S	1RN18EC184
Disha D Shetty	1RN18EC046
Divyashree Tammanna Hegde	1RN18EC047

Under the Guidance of
Mrs. Vanitha K S
Assistant Professor

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING
(Accredited by NBA for the Academic years 2022-2025)

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Channasandra, Dr.Vishnuvardhan Road, Bengaluru-560098
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CERTIFICATE

Certified that the Project work entitled **"Performance Analysis Of VANET Clustering Routing Protocol"** is carried out by **Divyashree Tammanna Hegde** bearing the usn **1RN18EC047**, **Swathi B S** bearing the usn **1RN18EC184** and **Disha D Shetty** bearing the usn **1RN18EC046** in partial fulfillment for the award of degree of Bachelor of Engineering in **Electronics and Communication Engineering** of Visvesvaraya Technological University, Belagavi, during the year 2020-2021. It is certified that all corrections / suggestions indicated during internal assessment have been incorporated in the report. The project report has been approved as it satisfies the academic requirements in aspect of the project work prescribed for the award of degree of **Bachelor of Engineering**.

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Name of the examiners	**Signature with date**
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DECLARATION

We here by declare that the entire work emobodied in this project report titled, **"Performance Analysis Of VANET Clustering Routing Protocol"** submitted to **Visvesvaraya Technological University**, Belagavi, is carried out at the department of **Electronics and Communication Engineering, RNS Institue of Technology, Bengaluru** under the guidance of **Mrs. Vanitha K S**, Asst. Professor. This report has not been submitted for the award of any Diploma or Degree of this or any other University.

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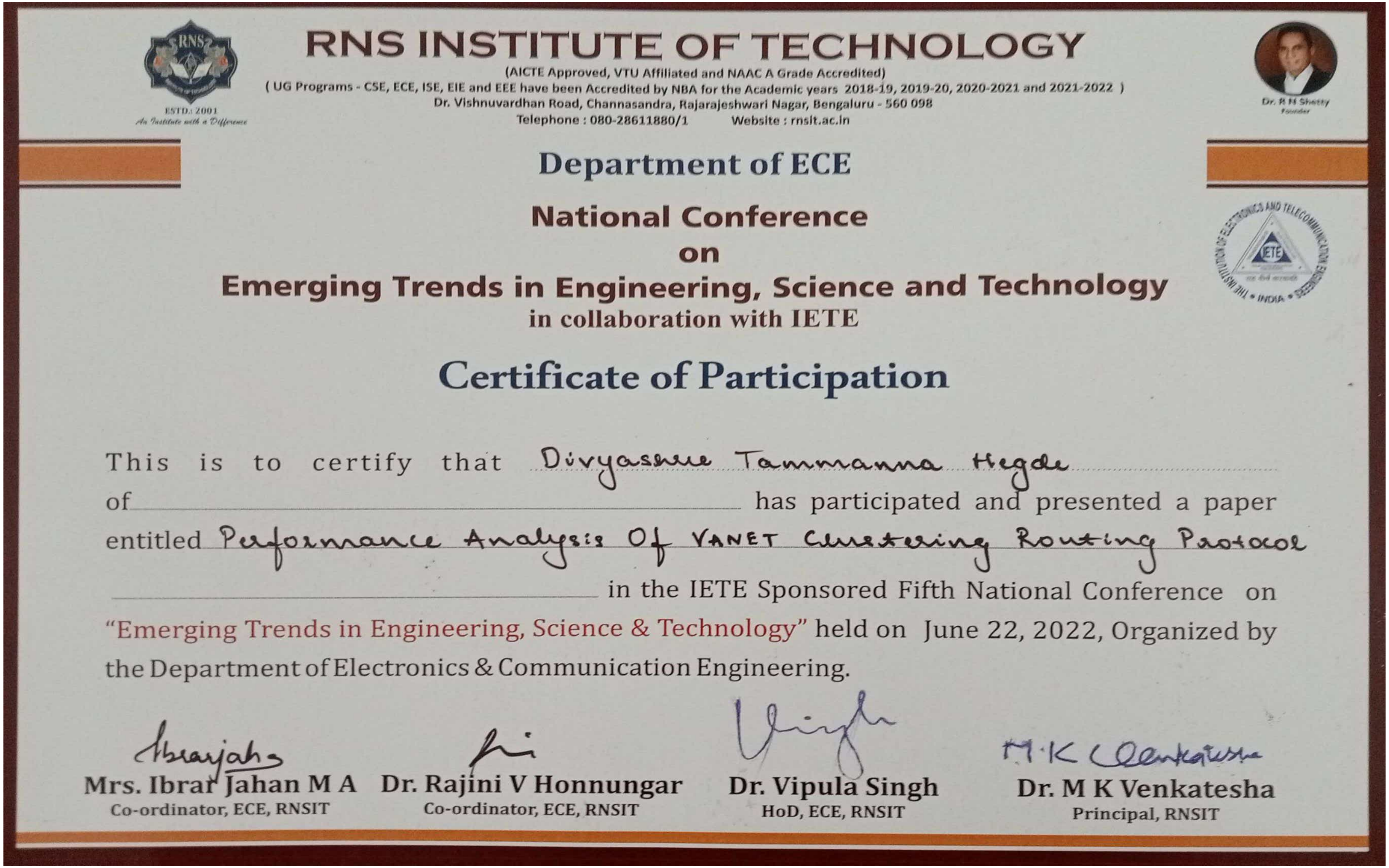

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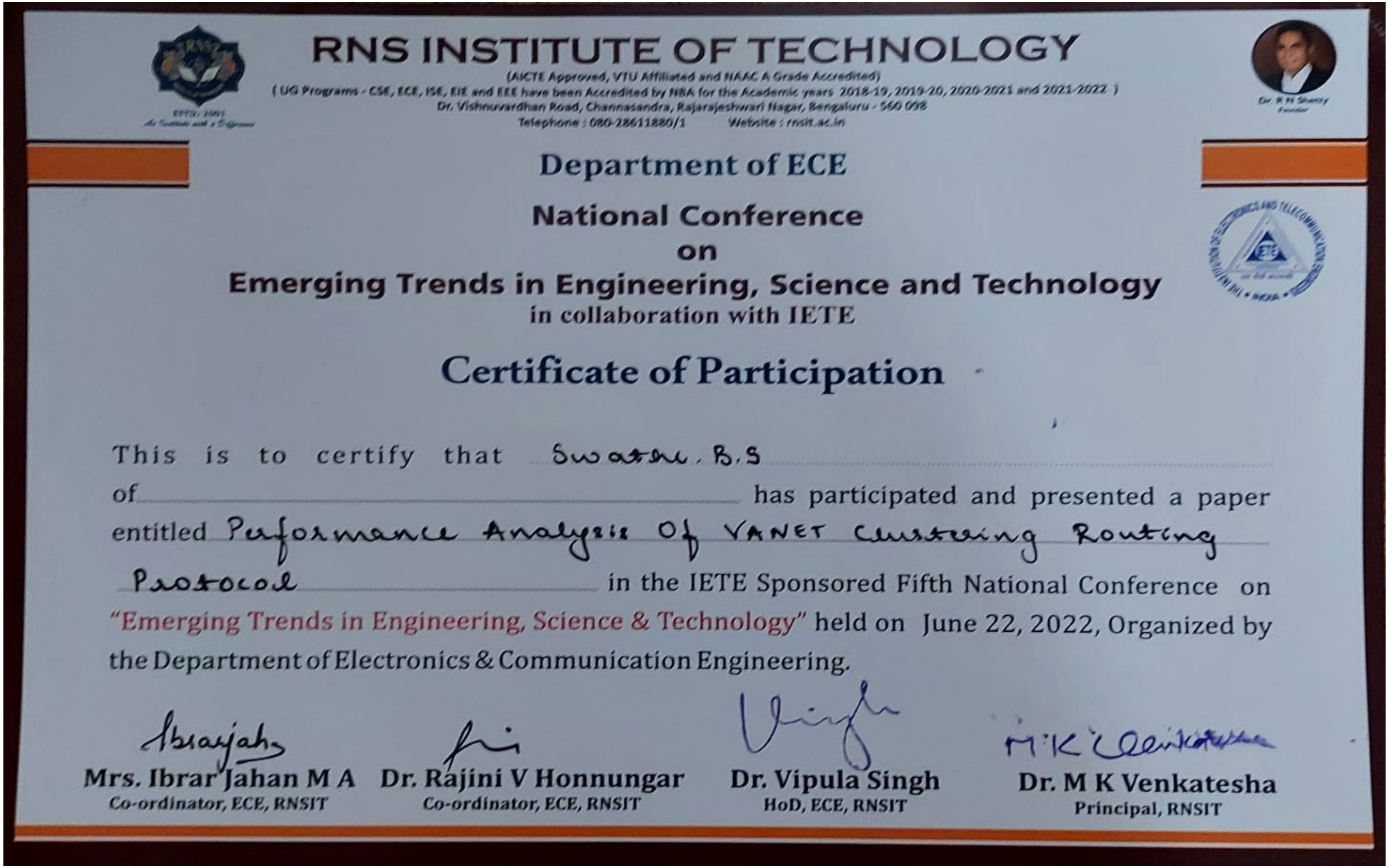

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We express our gratitude to our beloved Chairman Late **Dr.R N Shetty** and Manging Director **Satish R Shetty** for providing state of art facilities.

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Swathi B S

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Abstract

A Vehicular Ad-hoc Network (VANET) is a system of nodes (vehicles) that are being connected with each other by wireless technologies. Usually the nodes are moving with very high speeds and thus, the topology is unpredictable and frequently changing. Such networks can be stand alone and making paths along vehicles or may be connected by an infrastructure or internet. System characteristics such as multi-hop paths, node mobility, large network size combined with device heterogeneity, bandwidth and unlimited battery power make the design of routing protocols a major challenging.

The available routing protocols that have been proposed for Mobile Ad-hoc Networks (MANETs) and Vehicular Ad-hoc Network(VANET) are Ad-Hoc On Demand Distance Vector Routing (AODV), Optimized Link State Routing (OLSR), Destination-Sequenced Distance-Vector (DSDV) and Dynamic Source Routing (DSR). Implementation of a Clustering Based Routing(CBR) protocol for VANETs by employing Ns-2 and improvised Clustering Based Routing(ICBR) protocol by providing the security using SHA algorithm and study of Location Routing Algorithm with Directional Cluster Based Flooding (LORA_DCBF).

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Acronyms

VANET : Vehichular Ad-hoc Networks

V2I : Vehicle to Infrastructure

V2V :Vehicle to Vehicle

ITS :Intelligent Transport system

RSU :Road Side Unit

TA :Trusted Authority

LOCO :Location co-ordinate

LORA_DCBF :Location Routing Algorithm with Directional Cluster Based Flooding.

Chapter 1

INTRODUCTION

During the recent years Vehicular Ad-hoc Networks (VANETs) attract a significant amount of interest in the research community. VANETs can establish connections between Vehicle To Vehicle (V2V) and Vehicle to Infrastructure (V2I), so a great number of applications could be applied. These applications include safety and entertainment applications that require high availability of the communication system. For example in the case of an accident a big amount of messages is being transmitted into a large scale area. Furthermore the topology is quickly changing during the transmission and vehicles are moving with high speed. In order to make the communication of vehicles possible, a stable routing protocol is needed to ensures that the messages is being transmitted efficiently and correctly. So the design of routing protocols is an emergency research area in VANET that have to deal with this particulars problems of frequently topology changing and quickly movements of nodes

VANETs are considered as a special type of MANETs, in which each node is a vehicle (i.e. car,bus,truck). This kind of networks have face up new challenges. They are characterized by very high node mobility and topology changing that dependent by means of wireless technologies. These features make VANETs very prone to transmission errors, topology changes and intermittent connectivity. This is an effect of high moving speed of nodes and highly dynamic operating environments. So the main goals for VANETs are to achieve high packet delivery rates and low packet latency. At the last years, car manufacturers have gave to vehicles the ability to generate and analyse large amounts of data, although this data associated only with a single vehicle. With the VANET technologies vehicles have the new ability to connect each over as well as to network infrastructures that companies in the last year have equipped into the highways (also a hybrid combination of them is possible). Roadside infrastructure can also be used as a gateway to the Internet.

Thus data and context information can be collected, stored and processed somewhere (cloud computing). Communication can be either done directly between vehicles as one-hop communication or vehicles can retransmit messages thereby enabling multi-hop communication. Furthermore packets can be transited with unicast or multi-cast way. Despite of the difficult challenges VANETs represent an emerging wireless technology, allowing efficient communication among vehicles and fixed devices positioned along the street with a very promising area of safety, traffic control and user applications. Ongoing research is exploring novel protocol stacks and network architectures to efficiently afford these challenging issues. The area of ad-hoc networks consists for many years and has a large variety of technologies (e.g. MANETs). Although VANET has some distinguishing feature which make it more challenging from other technologies being summarized as following.

- High dynamic topology: Since the high speeds of vehicles and the large area that its cover the topology is very frequently changing.
- Frequently disconnected network: The often topology changes has the result that a node is become frequently out of range of the networks. This problem is also caused by node density changing.
- Unlimited battery power and storage: Every node is a vehicle so the power of every device is being provided by fuels of the car.
- On board sensors: Nodes consists of sophisticated sensors which provide very useful information such as GPS which gives location informations.

1.1 Motivation

Mobility and flexibility are making wireless technologies prevail over other methods of data transfer, like communications between vehicles (V2V) and between vehicles and roadside infrastructures (V2I). In VANETs, there are two types of applications envisioned: safety and non-safety. Although non-safety applications can be important to provide infotainment to drivers allowing new business areas, safety applications will permit road traffic to be safer, assisting drivers on the detection of dangerous traffic situations in advance by cooperative awareness, which ultimately can reduce fatalities. Motor vehicle accidents are the first cause of death in the age group 1 - 44 years, and it is expected for VANETs to play an important role in reducing these numbers.
VANETs face common challenges of ad hoc networks, e.g., reliability, scalability and stability, but in VANETs, considering the peculiar characteristics of the communications, these problems gain a different insight.
Due to high costs of VANETs deployment, it is necessary to use simulators to perform evaluations. NS-2 is a well-known and widely used network simulator; however, it significantly abstracts the physical layer details and the channel models.

1.2 Problem Definition

The number of accidents are increasing in large numbers. The lifesaving vehicles like ambulances are seen stuck in traffic and many have lost life because the patients could not make it to hospital on time. This is partially because vehicles are independently controlled, for example any accidents happen in highways then that would create road blockage and heavy traffic and as there is no mechanism to gather and process traffic information and provide warnings, so in order to improvise the traffic conditions VANET is used.

1.3 Objectives

- To implement existing VANETS clustering routing protocol .
- To enhance the performance of clustering routing protocol with respect to throughput, delay, PDR & overhead.
- Performance comparison of existing and enhanced clustering protocols.
- To implement the security parameter.

1.4 Application

All services available into a VANET can be classified into three different groups: safety, traffic control and user applications. Safety messages should be exchanged among vehicles for avoiding road accidents and nodes pile-up. The traffic control has been thought for improving the travel quality by preventing traffic jam and congestions. Finally, user applications have been introduced in order to provide entertainment services (i.e. music and video sharing, chat, games and Internet connectivity) to passengers in vehicle.

1. **Safety control**
   In VANET environment the communications allow the development of a large number of applications and can provide a wide range of information to drivers and travelers The on board unit resides in the vehicles, high technology components are used such as sensors, advanced antenna , effective wireless access technologies. With all these it will collect the data from other vehicles and communicate with road side unit to transfer the information to the other vehicle for the safety measures and make travelers feel comfort. . The few applications of VANET are listed bellow to provide the safety and the traveler feels comfort.

- Console-Entertainment applications: This category is referred as a non safety application, the main aim of these application is to make the traveler feel comfort. It provides the nearby restaurant, petrol bunks, weather and traffic information.
- Safety applications: Here the communication between the vehicles or between the vehicle and infrastructure is to provide the safety and emergency information to the other vehicles in that network.
- Accident avoidance in junction area : In the intersection area the probability of accident are more , so have to improve the intersection collision avoidance systems will lead to the avoidance of many road accidents, this system is based on I2V or V2I communication. The vehicle communicate with other vehicle or with RSU through multihop communication, if there is a probability of accident it will send the warning messages to other vehicle to avoid the accident.

2. **Traffic control**
   This kind of application in tied related because they can be combined to achieve road safety driving and prevent a lot of car accidents. There two types of applications that could be useful: car accidents prevision and road congestion.

   - Car accidents prevision: The time reaction of a driver in compare the speed of vehicle is very low. So a car accident could be happen in a few seconds if the drivers has not strongly reflexes. Safety applications could provide warnings and informations about the road situation and other facts that could be useful to driver in order to avoid a car crash.
   - Road congestion: Safety and traffic control applications could provide to drivers with the best routes to reach their destination, considering the traffic jams and car accidents. This would decrease congestion on the road and maintain a smooth flow of traffic, thus increasing the capacity of the roads and preventing traffic jams. It will decrease also, at one point the possibility to have car accident, because drivers would be less frustrated and will be advised to keep the traffic rules.
   - Traffic efficiency and management application: It mainly focus on the optimizing flow of vehicles by reducing the traveler time and to avoid the traffic jam.

3. **User Applications**
   These applications could make the travelling more interesting and

entertainment, given to passengers a pleasant trip. There are two basic types: Internet connection and Peer-to-Peer (P2P).

- Internet connection: Web is a part of people day-life nowadays, so more and more people need to have constant connect to internet social networks, e-mail and all this useful services. VANET is challenging with this issue that also will make new opportunity for already or new-one services by the web.
- P2P: This is an another interesting idea that will allow passengers to share news, music, videos and any kind of information's among vehicles. Furthermore it will be used for online chatting and gaming.

1.5 Organisation of Report

Chapter 1 :Introduction This chapter provides the introduction to our project and discusses the motivation and the different objectives of our project and the applications.

Chapter 2 :Literature Survey This chapter gives a summary of the papers that are used for reference.It explains how the papers contributed to the making of our project and the ideas that we have taken from different papers.

Chapter 3 :Prerequisites This chapter gives insight into the technical details of our project such as hardware requirement specifications,software requirement specifications.

Chapter 4 :System Design of Project This chapter elaborates on the whole process and the methodology behind the implementation of the project in a step-by-step manner.

Chapter 5 :Results This chapter analyses the results obtained in the project.

Chapter 6 :Conclusion and Future Work This chapter provides the conclusions inferred from our project with a future scope that can build upon this prototype model and provide a fully functional model that can be incorporated on a large scale area.

Chapter 2

LITERATURE SURVEY

1. **PassCAR: A passive clustering aided routing protocol for vehicular ad hoc networks**.
   Author: Sheng-Shih Wang and Yi-Shiun Lin.
   Place: Department of Information Management, Minghsin University of Science and Technology, Hsinfeng, 304 Hsinchu, Taiwan.
   Year: 2013.
   Vehicular ad hoc networks (VANETs) are a promising architecture for vehicle-to-vehicle communications in the transportation field. However, the frequent topology changes in VANETs create many challenges to data delivery because the vehicle velocity varies with time. Thus, designing an efficient routing protocol for stable and reliable communication is essential. Existing studies show that clustering is an elegant approach to efficient routing in a mobile environment. In particular, the passive clustering (PC) mechanism has been validated as a more efficient approach compared to traditional clustering mechanisms. However, the PC mechanism was primarily designed for mobile ad hoc networks (MANETs), and may be unsuitable for constructing a cluster structure in VANETs because it does not account for vehicle behavior and link quality. In this paper, it was proposed a passive clustering aided routing protocol, named PassCAR, to enhance routing performance in the one-way multi-lane highway scenario. The main goal of PassCAR is to determine suitable participants for constructing a stable and reliable cluster structure during the route discovery phase. Each candidate node self-determines its own priority to compete for a participant using the proposed multi-metric election strategy based on metrics such as node degree, expected transmission count, and link lifetime. Simulation results show that, compared with the original PC mechanism, PassCAR not only increases the successful probability of route discovery, but also selects more suitable nodes to participate in the created cluster structure. This well-constructed cluster structure significantly improves the packet delivery ratio and achieves a higher network throughput due to its preference for reliable, stable, and durable routing paths.[1]

2. **A New Cluster Based Routing Protocol for VANET**
   Author : Luo, Yuyi and Zhang, Wei and Hu, Yangqing.

Place : 2010 Second International Conference on Networks Security, Wireless Communications and Trusted Computing.
Year : 2010.
In this paper, they have proposed a new routing protocol for VANET which called CBR (Cluster Based Routing) Protocol. Just as its name implies, it's a routing protocol which based on position and clusters. In this protocol, the geographic area is divided into some foursquare grids. Only if there is a vehicle in a grid will a vehicle be elected to the cluster header, and the data packet is routed by cluster header across some grids one by one. When the source node wants to send a message to the destination node, it doesn't discover the route and save route table, but send the data packet to the optimal neighbor cluster header directly according to the geographic Information (including itself, neighbor cluster header's and the destination's geographic information). Then the neighbor cluster header which received the data packet will forward the packet according to this policy until it arrives at the destination node. The greatest advantage of CBR protocol is that it reduces the overhead and packet delivery delay when transporting a data packet to the destination node. It increases the packet delivery ratio and saves the memory space of caching the routing table.[2]

3. **A New Two Level Cluster-Based Routing Protocol for Vehicular Ad Hoc NETwork (VANET)**
Author : Hamedani, Parisa Saraj and Rezazadeh, Arshin.
Place : 2018 UKSimAMSS 20th International Conference on Computer Modelling and Simulation (UKSim).
Year: 2018.
Vehicular ad hoc networks (VANETs) are a subset of mobile ad hoc networks (MANETs). These networks do not have a specific structure, in which network-forming nodes are moving vehicles. Therefore, routing is essential for data dissemination in these networks. The problem of the link failure between vehicles is one of the principal challenges in these networks. In this paper, a reliable two-layer cluster-based algorithm has been introduced in VANETs to mitigate the link failure problem. Using two-layer routing makes route maintaining and the possibility of self-organization easier when topology does not have a steady shape. At the first level of new method, selecting the strong link and at the second level, the greedy algorithm is used in order to select the best route. Velocity, direction, ST and location are all effective parameters involved in this new algorithm. The proposed protocol that was simulated by NS-2.35 improves the network parameters such as end-to-end delay and packet delivery

ratio compared with two similar measured protocols. Increased packet delivery ratio and decreased end to end delay compared with previous protocols showed better performance of the new method.[3]

4. **cluster-based directional routing protocol in VANET**
   Author : Tao Song and Weiwei Xia and Tiecheng Song and Lianfeng Shen.
   Place : 2010 IEEE 12th International Conference on Communication Technology.
   Year : 2010.
   According to the establishing pattern, there are three kinds of routing protocols in VANET, topology-based protocol, positionbased protocol, and map-based protocol. In topology-based protocol, a link must be established from source node to destination node before data transmission. Ad-hoc On-demand Distance Vector routing (AODV) is a typical representative of this type . It will send a large quantity of redundant data packets and increase routing overhead by blind flood. On the contrary, position-based protocol needs no fixed link before data transmission, every hop between source and destination can be selected instantaneously and independently. Greedy Perimeter Stateless Routing (GPSR) is one of this kind . But it has two shortcomings. Firstly, the neighbor table maybe not match the actual position without considering the node mobility. Secondly, the position of destination have never updated after encapsulating in the data packets. In, the author proposes a modified GPSR named as GPSR with Velocity and Moving Direction (GPSR-VMD). But it also takes no measures to update the neighbor table and the destination position. The last one, map-based protocol is applied seldom at the present. It uses the GPS system and digital map to select the best route.[4]

5. **A cluster-based routing algorithm for VANET**
   Author : Jalalvandi, Samira and Rafeh, Reza.
   Place : 2016 2nd IEEE International Conference on Computer and Communications (ICCC).
   Year : 2016.
   In a clustering scheme for VANET, the adjacent mobile nodes are virtually grouped in a cluster. Each node in a cluster may get one of the following roles: cluster head, cluster-gateway, or cluster-member. Normally, a cluster head serves as a local coordinator for its cluster, performing intra-cluster transmission arrangement, data forwarding, and so on. A cluster-gateway is a non-cluster head node with inter-cluster links to establish a connection between the cluster and neighboring clusters. A cluster-member is usually called an ordinary node with no inter-cluster link. Cluster-based routing protocols have several

advantages over flat routing protocols (i.e. those without any hierarchy) which include lower overhead, higher scalability and throughput, and better usage of the system capacity because of better performance in the MAC layer.

At the network layer, clustering reduces the size of routing table and decreases transmission overhead resulted from updating routing tables after topological changes. Although each node stores only a fraction of the total network routing information, clustering is able to achieve topology information by aggregating current nodes information. Consequently, clustering may be considered to create more scalable and stable communication schemes.[5]

6. **Performance Improvement of Cluster-Based Routing Protocol in VANET**

   Author : AHMAD ABUASHOUR AND MICHEL KADOCH, (Senior Member, IEEE).

   Place : Department of Electrical Engineering, École de technologie supérieure, Montreal, QC H3C 1K3, Canada.

   Year : 2019.

   Vehicular ad-hoc NETworks (VANETs) have received considerable attention in recent years, due to its unique characteristics, which are different from mobile ad-hoc NETworks, such as rapid topology change, frequent link failure, and high vehicle mobility. The main drawback of VANETs network is the network instability, which yields to reduce the network efficiency.

   In this paper, algorithms used are: cluster-based life-time routing (CBLTR) protocol, Intersection dynamic VANET routing (IDVR) protocol, and control overhead reduction algorithm (CORA). The CBLTR protocol aims to increase the route stability and average throughput in a bidirectional segment scenario. The cluster heads (CHs) are selected based on maximum lifetime among all vehicles that are located within each cluster. The IDVR protocol aims to increase the route stability and average throughput, and to reduce end-to-end delay in a grid topology. The elected intersection CH receives a set of candidate shortest routes (SCSR) closed to the desired destination from the software defined network. The IDVR protocol selects the optimal route based on its current location, destination location, and the maximum of the minimum average throughput of SCSR. Finally, the CORA algorithm aims to reduce the control overhead messages in the clusters by developing a new mechanism to calculate the optimal numbers of the control overhead messages between the cluster members and the CH. usage of SUMO traffic generator simulators and MATLAB to evaluate the performance of our proposed protocols. These protocols significantly outperform many protocols mentioned in the literature, in terms of many parameters.[6]

7. **PPAS: privacy protection authentication scheme for VANET**
   Author : Hui Zhu, Tingting Liu, Guanghui Wei, Hui Li.
   Place : State Key Laboratory of Integrated Service Networks, Xidian, University, Xi'an, China.
   Year : 2013.
   The statistics of current traffic accidents are notoriously horrific. This is partially because that vehicles are independently controlled, and that there is no mechanism to gather and process traffic information and provide warnings. In order to improve the traffic condition, researchers from all around the world are discovering effective solutions. Vehicular Ad-hoc Network (VANET) seems to be a promising method and has attracted great attention.
   Emerging with the rapid development of computer science, wireless networks and GPS (Global Positioning System) technologies, VANET can provide traffic participants with accurate, real-time traffic information services, by collecting, analyzing, processing and disseminating traffic information. VANET can greatly enhance the degree of traffic information sharing, and effectively alleviate the increasing deterioration of road traffic congestion, traffic accidents and environmental pollution problems. Meanwhile, VANET can provide the community with an open public service platform to meet the diverse needs of users.
   However, VANET also faces many challenges of data security and user privacy while it provides different types of services (including collection of information data in VANET, personal navigation services and information services). These problems may result in the disclosure of the geographical and specific business information associated with the real-world identity of users without the users' awareness, for example, users' locations, hobbies and other personal privacy information. VANET has many features: large number of users, high-speed movement, frequent roaming, and highly dynamic and high scalability requirements. Due to these characters, the existing wired network and traditional wireless network (e.g. ad hoc network and sensor network) security authentication mechanisms are not appropriate to be directly applied to VANET.[7]

8. **Comparative Study of Routing Protocols Performance for Vehicular Ad-hoc Networks**
   Author :Zineb Squalli Houssaini, Imane Zaimi, Mohammed Oumsis,Saïd El Alaoui Ouatik .
   Place :International Journal of Applied Engineering Research.

Year:2017.

Mobile Ad-hoc Network (MANET) is composed of wireless mobile nodes (e.g. mobile phones, PDAs, Laptops, Pocket PCs, smart car...etc.) interconnected with each other through an autonomous configuration in the absence of any infrastructure. Vehicular ad-hoc network (VANET) is a particular kind of MANET, where smart vehicles act as node. Indeed, each vehicle is equipped with transmission capabilities to provide communication services among nearby vehicles (inter-vehicle communication V2V) or nearby roadside infrastructures (Vehicle-to-roadside communication V2I) or both combining architectures (see Error! Reference source not found.). This type of network is considered as an enabler for driverless cars of the future, where future networked vehicles are considered as a future convergence of different technologies (computers, communication infrastructures and automobiles). Though, VANET presents distinctive characteristics; compared to MANET; that offer possibility to increase network performance, but at the same time, they present considerable challenges which hinder the use of a wide range of safety and no safety applications, such as vehicle safety, data transfer, traffic and congestion management, entertainment and providing internet access.[8]

9. **Comparison among Different Routing Protocols of Vehicular Ad Hoc Networks**

   Author: Ahmed Shoeb Al Hasan , Md. Hasan Tareque & Fatema Tuz Zohra.

   Place: Global Journal of Computer Science and Technology Network, Web & Security .

   Year: 2013.

   Vehicular ad hoc network (VANET) is a special type of Mobile Ad hoc Network (MANET) which is designed to facilitate vehicle to vehicle (V2V) and vehicle to roadside communications. It is a promising new technology to achieve intelligent inter-vehicle communications and flawless internet connectivity by integrating the capabilities of new generation wireless networks to vehicles. Analogous to MANET it is autonomous, self-organizing and self-managing wireless communication network. Nodes in VANET involve themselves as servers and/or clients for exchanging & sharing information via shared radio transmission. Three possible network architectures for VANET are: pure cellular/WLAN, pure ad hoc, and hybrid. VANET introduces Intelligent Transportation Systems (ITS) which includes a variety of applications such as co-operative traffic monitoring, control of traffic flows, blind crossing, prevention of collisions, nearby information services and real-time detour routes computation. It can be also used for providing Internet connectivity to vehicular nodes while on the move. The unique characteristics of VANET are the high nodes mobility and unreliable channel conditions which poses the problems of frequent change in network topology. So finding and maintaining routes is a very challenging task in VANETs. The existing routing protocols for MANET shows poor performance when directly applied to VANET environment due to the fast vehicles movement and dynamic information exchange. Thus design of a suitable routing protocol to deal with the highly dynamic nature of VANET has taken significant attention. In this literature we will review the key characteristics in VANET and some of the existing routing protocols for VANET which can be used for better understanding of the routing protocols and future improvement can be made.[9]

10. **A Study on Vehicular Ad-Hoc Network (VANET)**
    Author : Navyshree H M ,Tanuja .K ,Sushma T.M.
    Place : Student Of M.Tech, Dept of ISE Asst. Professor, Dept of ISE ,Acharya Institute Of Technology .
    Year : 2015.
    Vehicular adhoc networks(VANETs)are classified as an application of mobile adhoc network(MANET) that has the potential in improving road safety and in providing travelers comfort. Recently VANETs have emerged to turn the attention of researchers in the field of wireless and mobile communication. They differ from MANET by their architecture, challenges, characteristics and applications. Although, considered a special case of a Mobile Ad Hoc Networks, VANET's hold a vital feature -the possibility to affect people's life or death decisions. Due to the particular characteristics, from highly dynamic topology to intermittent connectivity, VANETs have great challenges lie ahead, to mention a few: different application QoS requirements, and conflicting privacy and safety issues.
    There are many issues arise when efforts are gathered towards running vehicular ad hoc networks in an attempt to provide an improvement to driver behavior, with the aim of reducing the number of fatalities caused by automobile accidents. To realize the requirements that needed to deploy VANET concept, many factors that have a critical impact on achieving the VANET goal need to be taken into consideration, represented by safety applications and nonsafety applications.[10]

11. **Routing and Security in Vehicular Networking**
    Author: Di Yan.
    Place : Computer Science and Engineering, Washington University in St. Louis.
    Year : 2013.
    The security issues in VANETs are very important aspect of the VANETs

research. Some of the application based on VANETs is safety-related, it concerns with driver's safety. Other application is comfort-related which aims at providing convenience and comfort to the driver and passenger on the road. No matter what type of the application is, correctness and reliability of the information must be guaranteed, especially for safety-related applications. Due to the nature of the VANETs, there are several attacks that can be encountered, Sybil attack where 1 node sends several messages to other nodes with forged identity. It aims at causing a traffic jam in 1 route and causing the driver to take another route; denial ofservice attack where it attack the communication medium so that it causes channel jam and preventing the vehicles in the network from accessing the network service. This kind of attack is very severe in VANETs, especially in safety-related application where life critical information must reach the destination on time; the privacy attack where it tries to obtain the sensitive information about the driver and vehicles in the network such as the identity of the driver and location of the vehicles; data trust attack where it alters the original data and makes it inaccurate; replay attack where it retransmit some earlier information. This kind of attack may confuse the authorities and hide the id of the vehicles under certain situation such as hit-and-run incidents. There are other types of attacks that can happen in VANETs however the solutions for strengthen the security of VANETs to avoid certain attacks have been proposed constantly. In this section, we are going to introduce to recently proposed solution to eliminate VANETs security issues.[11]

12. **Topology base routing protocols for VANET and their comparision with MANET**

    Author : Kashif Naseer Qureshi, Abdul Hanan Abdullah.

    Place : Department of Communication, Faculty of Computing, Universiti Teknologi Malaysia, Skudai, Johor Darul Takzim, Malaysia.

    Year : 2013.

    Advancement in Intelligent Transportation System the vehicular communication design and architecture are much more challenging. Vehicular Ad-hoc network technology becoming increasingly popular, and faces some challenges as well for efficient communication, road safety, and improved traffic flow. Some characteristics of VANET and design architecture are described below: VANETs acquire unique network characteristics that differentiate it from other networks. Topology changed frequently due to fast speed and movements of vehicles, due to high-speed mobility models and predictions play a significant role in dissemination and designing of VANET. The chances of disconnections are high because it is a dynamic topology. Mobile wireless networks technologies are using unicast and multicast techniques but the VANETs deals with packets forwarding and based on geographical area. Hence, because of the predictable possible impact of VANETs, a number of researchers have developed unicast routing protocols that are suitable for VANETs. The nodes in vehicular Ad-hoc networks have enough energy and power. In many applications, the hard delay constraints are present because these applications are simpler and less data required. The VANET works through infrastructure and Ad-hoc technology and some time the both technologies works for information distribution. In Vehicular Ad-hoc networks packet is transport by multi-hop method and it is self-organized network.[12]

13. **Geo-Logical Routing in Wireless Sensor Networks**
Author : Dulanjalie C. Dhanapala and Anura P. Jayasumana.
Place : Department of Electrical and Computer Engineering, Colorado State University, Fort Collins, USA.
Year : 2011.
Geo-Logical Routing is the first scheme to combine the advantages of logical and geographic routing techniques. It uses topological coordinates obtained from Virtual Coordinates and virtual coordinate based routing to overcome the deficiencies associated with local minima problem in physical and logical domains. Cartesian coordinate estimation is based on an algorithm that uses the second and third dominant principal component of logical coordinates to produces a topology map, which then is scaled using the first component. Topology based Cartesian coordinates so derived are more effective for geographic routing than the physical geographical coordinates. This is because topological maps preserve neighborhood information as well as connectivity information. Even under conditions favorable to physical coordinate based routing, i.e., no localization errors and grid like node placement, GLR outperforms GPSR in 3 out of 4 complex network topologies. A building network where the GPSR performance seems to be better than GRL is one very favorable for geometric routing; still GRL routability without localization and with only 4 anchors there is noteworthy. The novel concept of combining topological domain routing and virtual domain routing opens the path for designing novel adaptive routing protocols that operate in multiple coordinate domains. Improved anchor placement strategies can further improve the routing effectiveness. It is important to note that many variations of GLR algorithm can be developed, such as moving only a certain distance toward the closest anchor in AM mode before switching, or switching between TC and VC modes more frequently, probabilistically, or based on an adaptive scheme. Evaluation

of such generalized GLR strategies is part of the ongoing work.[13]

14. **An Overview of AODV Routing Protocol**
Author : Velampudi Rohit, Divvela Sai Rohit, Uppalapati Naga Varma, Repaka Venkatesh, Kasilanka Sai Vivek.
Place : Department of Computer Science, Lovely Professional University, Phagwara.
Year : 2021.
There exist various diverse remote organizations differing in the manner the hubs interconnect. They can be ordered in two primary sorts: Networks with fixed foundation and Ad hoc remote organizations Normal for networks with fixed foundation is utilizing of passages. A passageway (AP) can go about as a switch in the organization, or as a scaffold. Models for this sort of organizations are GSM and UMTS cell networks. APs have more information about the organization and can course the parcels the most ideal way. In contrast, ad hoc networks have no fixed framework or administrative help, the geography of the organization changes powerfully as portable hubs joins or leaves the organization. In ad-hoc remote organizations the hubs them-selves utilize each other as switches, so these hubs ought to be more insightful than the hubs in concentrated organizations with APs. There are a ton of situations where ad hoc networks are required: military operations, crisis administrations, conferencing, game gatherings, home systems administration, and so forth On the off chance that the remote hubs are inside the scope of one another, the routing isn't required. If a hub moves out of this reach, and they can't speak with one another straightforwardly, middle of the road hubs are expected to arrange the organization which deals with the information transmission. The motivation behind a routing calculation is to characterize a plan for moving a bundle starting with one hub then onto the next. This calculation ought to pick a few rules to settle on defeating decisions, for example number of jumps, idleness, transmission power, transfer speed, and so forth The geography of versatile ad hoc networks is time-differing, so traditional routing procedures utilized in fixed organizations can't be straightforwardly applied here. There are different procedures for following changes in the organization geography and re-finding new courses when more established ones break. Since ad hoc networks have no foundation these operations ought to be performed with aggregate cooperation, everything being equal. Routing protocols in versatile organizations are partitioned into two fundamental classes . Proactive routing protocols (for example OLSR) are table-driven.. The receptive routing protocols (for example AODV) make and keep up courses only if these are required, on

demand. They ordinarily use distance-vector routing calculations that keep only information about next bounces to adjacent neighbors and expenses for ways to every known destination. Subsequently, connect state routing calculations are more dependable, less transmission capacity concentrated, yet in addition more unpredictable and figure and memory-escalated. In on-demand routing protocols a basic prerequisite for connectivity is to find courses to a hub by means of flooding of solicitation messages. The AODV routing protocol one of a few distributed responsive routing protocols for portable ad-hoc networks, and is presently broadly investigated.[14]

15. **Position Paper: Dijkstra's Algorithm versus Uniform Cost Search or a Case Against Dijkstra's Algorithm**
    Author : Ariel Felner.
    Place : Information Systems Engineering Ben-Gurion University Be'er-Sheva, Israel.
    Year : 2021.
    Consider a case where an implementer needs to solve the shortest path problem when a heuristic estimation is not given or when the implementer does not know how to use it (e.g., is not even familiar with A*). In such cases, the implementer probably remembers that DA exists and starts to implement it. Then, the implementer might realize that the Q as defined by DA is not efficient and modify the code to only include Opened nodes in Q, or in other words, converts DA into UCS. In many other cases, the implementer implements UCS to begin with. Both implementers do not know the term UCS and continue to use the term DA for describing their implementation. This is probably true for scientific papers too. Furthermore, even within the heuristic search community the differences between DA and UCS is not always recognized and/or mentioned. DA is a very well known term and researchers might use this term even if in practice they implement UCS.[15]

Chapter 3

PRE-REQUISITES

This chapter contain software requirements and hardware requirements for implementation of clustering based routing protocol.

3.1 Software Requirement

3.1.1 Ubuntu

Ubuntu is a Linux distribution based on Debian and composed mostly of free and open-source software. Figure 3.1 shows the logo of Ubuntu which is officially released in three editions: Desktop, Server, and Core for Internet of things devices and robots. All the editions can run on the computer alone, or in a virtual machine. Ubuntu is a popular operating system for cloud computing, with support for Open Stack. Ubuntu's default desktop has been GNOME since version 17.10.

Figure 3.1: UBUNTU

3.1.1.1 Features of Ubuntu

- The desktop version of Ubuntu supports all the normal software on Windows such as Firefox, Chrome, VLC, etc.
- It supports the office suite called LibreOffice.
- Ubuntu has an in-built email software called Thunderbird, which gives the user access to email such as Exchange, Gmail, Hotmail, etc.
- There are a host of free applications for users to view and edit photos.

- There are also applications to manage videos and it also allows the users to share videos.
- It is easy to find content on Ubuntu with the smart searching facility.
- The best feature is, it is a free operating system and is backed by a huge open source community.

3.1.2 VMware

VMware Workstation helps organizations deploy many applications and operating system workloads on a single server. Thus, it helps in better resource management. The workstation is an efficient and advisable solution for local desktop virtualization as it lets you securely run an additional operating system as a VM on a single computer. Figure 3.2 shows the logo of VMWare.

Figure 3.2: VMWare logo

What Are VMware and Virtualization?

- In simple terms, VMware builds virtualization software.
- Virtualization software generates an abstraction layer over computer hardware.
- This layer allows the hardware elements (like RAM, memory, storage, and more) to be categorized into multiple virtual machines.

3.1.2.1 Components of virtualisation

CPU

- When a developer installs a hypervisor in a machine, you abstract each CPU into the virtual CPU
- This allows multiple VMs to share a processor core
- In simple words, hypervisor typically assigns one workload per CPU

Memory

- In simple words, virtual memory is the RAM of a computer machine
- The virtual machine settings show how much of the host's memory is allocated to the virtual machine
- The memory size shows how much memory is available to the application available in the virtual machine
- With this resource, a developer can add and modify the virtual machine capacity

Storage

- In virtualization, the storage component is the data cluster from multiple network storage devices
- It manages the storage components from a central console
- You can assign required storage to virtual machines manually
- The extensions on the end of a file are:
    1. VDI
    2. VHDX
    3. VMDK
    4. HDD

3.1.3 NS-2

Ns started as a variant of the important network simulator software in 1989 and has progressed considerably over the past few years. In 1995 ns development was encouraged by agency called DARPA through the VINT project at LBL, Xerox PARC, UCB, and USC/ISI. Currently ns development is sustained through Defense Advanced Research Projects Agency (DARPA) with SAMAN and thru National Science Foundation with CONSER, each united with alternative researchers like ACIRI. Ns has invariably enclosed substantial contributions from alternative researchers, that includes wireless code from the UCB Daedelus and CMU Monarch comes and Sun Microsystems.

NS2 is an open-source simulation tool that works on Linux and Windows(Using VMware). NS2 is a discrete event simulator. It maintains the queue of events and each event is associated with the time. It is focused at networking analysis and supplies substantial pillar for simulation of routing, multicast protocols and Internet protocols such as UDP, TCP, RTP and SRM over wired and wireless (local and satellite) networks. At each loop takes in an event, executes it and moves on to the next event executes it and moves on. NS2 is implemented in OTcl and C++. A class can be installed entirely in C++ or in OTcl. Classes that implement in C++ are typically of the lower functionality and the classes that implement in OTcl provide the flexibility of gluing different objects. It also provides hooks to configure the parameters in the C++ objects.

3.1.3.1 Design of NS-2

Figure 3.3 shows the basic architecture of NS-2. NS-2 provides user two different working language:

1. An object oriented simulator that's written in C++.

2. A OTcl(Object oriented extension of Tcl) interpreter, accustomed to execute user's command scripts.

NS contains a reach library of network and protocol objects. There are 2 class hierarchies: the compiled C++ hierarchy and the depicted OTcl one, with one on one correspondence between them.

The compiled C++ hierarchy permits the user to get efficiency in the simulation and

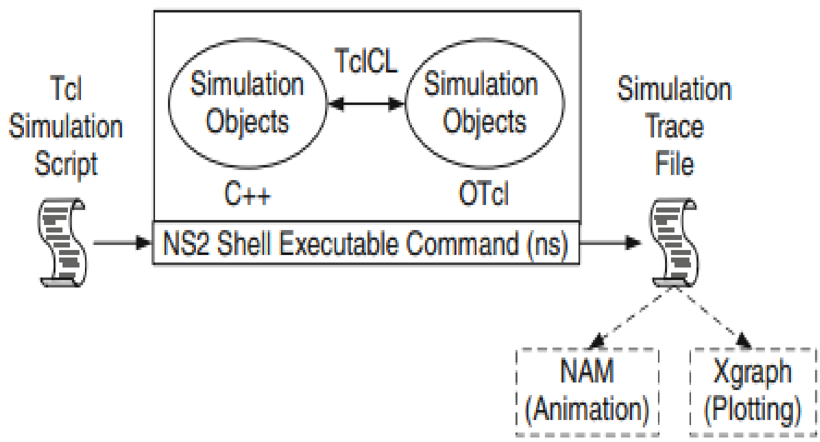

Figure 3.3: Basic Architecture of NS-2

quicker execution times. This is helpful for the elaborated definition and operation of protocols. So the processing time for the packet and the event gets reduced. Then within the OTcl script provided by the user, one can define a network topology, the particular protocols and applications that we want to simulate and the kind of the output that we expect from the simulator. The OTcl uses the objects which are compiled in C++ through an OTcl linkage that makes a matching of OTcl object for each of the C++ codes.

3.1.3.2 Tool Command Language (TCL)

The inventor of TCL programing language is John Ousterhout. It is a very dynamic as well as powerful programing language that is easy to learn. It can be used widely for web and desktop applications, testing, networking and much more. It is an open source programing language that can work with different platforms (allows a very easy integration with other languages) and can be deployed easily. It has a graphical user interface development toolkit called a tk; which is used to make desktop applications very easily then the conventional approaches.

3.1.3.3 Software tools

1. **NAM**
   Nam gives a clear to be seen interpretation of the network configuration developed Figure 3.4 shows the NAM configuration. NAM's features are as follows:

   - It gives a visual Elucidation of the network created.
   - NAM can be executed directly from the TCL script.
   - We can control the simulation by different buttons like play, stop, rewind, fast forward, pause, display speed controller and a packet monitor facility.
   - It displays information such as throughput and number of packets on each link.
   - We can just use drag and drop function to create network topology.

2. **Nscript**
   Nscript is developed in Java. It is a GUI used for building NSTCL scripts. The network topology can be built by simply drawing it in the edit screen. The Nodes agents can be added by using the simple drag and drop function in the edit scre en. Once we create the network topology, the in the TCL script screen. TCL code for this topology is automatically generated The Nscript is used to create different network topologies by simply adding nodes and their respective links. Transport agents like UDP, TCP can be created and added in the topology and the simulation events can be scheduled. The scripts created using Nscript can be exported and executed in NS2.

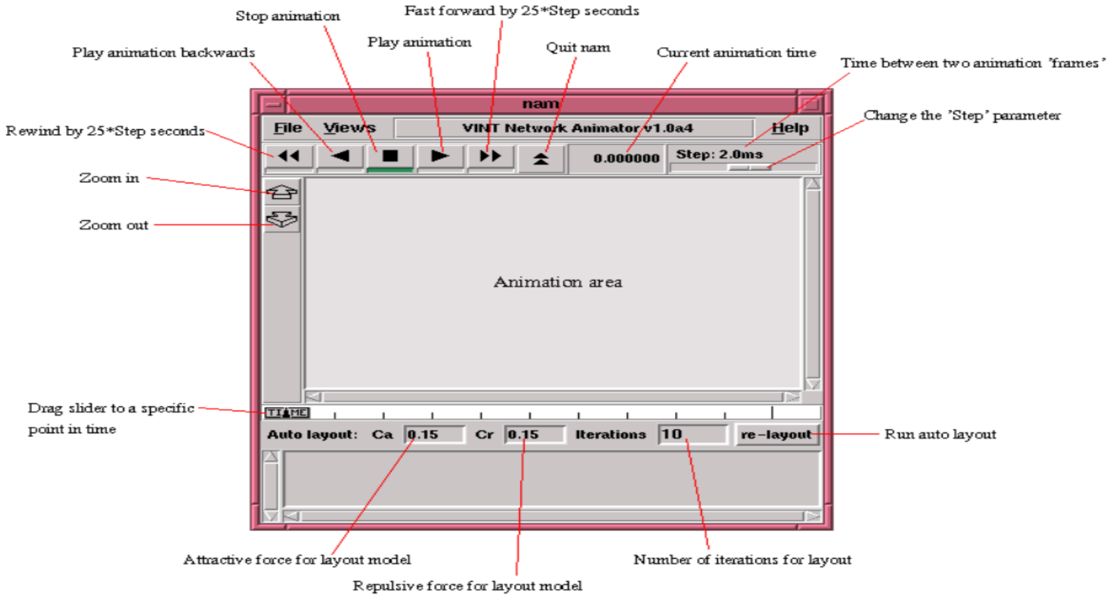

Figure 3.4: Configurations of NAM

3.1.3.4 Installation of NS-2

1. Download the NS2 files from the Internet.
   http://sourceforge.net/projects/nsnam/files/ns-2/2.34/

2. Extract the files.

3. Put the files in the Home folder as shown in Figure 3.5.

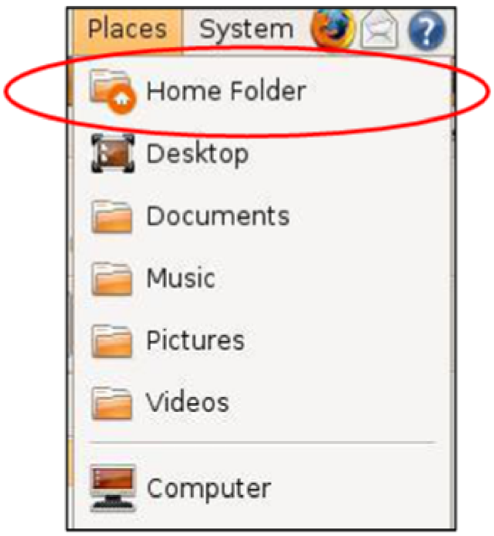

Figure 3.5: Home Folder

4. Set the appropriate permissions as shown in Figure 3.6 for the ns-allinone-2.34 to allow executing the files inside it. To do that: Right click the folder -> Properties

-> Permissions, and choose the appropriate group with the appropriate file access, then click “Allow executing file as program” and then click “Apply permissions to enclosed files”.

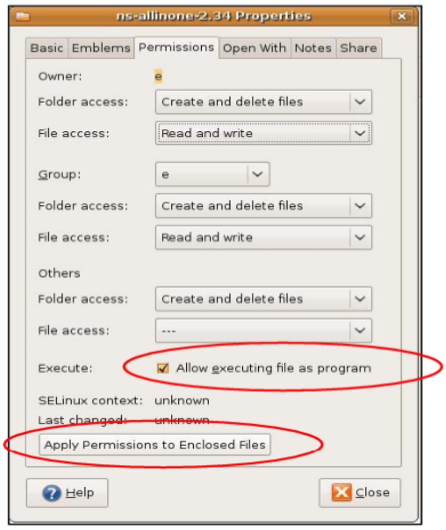

Figure 3.6: Pemission Page

5. From the Accessories -> Terminal 6. Type the following command to know in which directory you are: ~$ pwd.

6. You need to be in the directory where you placed the ns-allinone-2.34 folder.

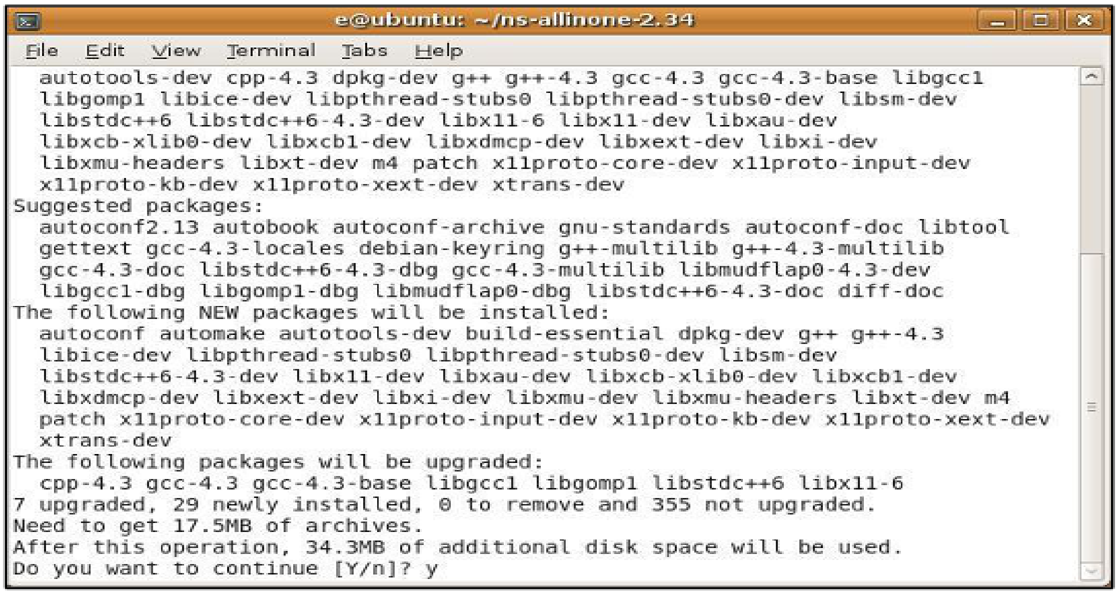

Figure 3.7: Commands to Install NS-2

7. If you are not in the /home/e , then move to it by using the command cd

8. Now, supposing you are in the directory /home/e (e can be any other user) type the following command to move inside the ns-allinone-2.34 using the command cd $ cd ns-allinone-2.34.

9. Then, type the following command (you will be asked to enter the system password to process. Also, you will be asked if you want to continue, type: y to continue): $ sudo apt-get install build-essential autoconf automake libxmu-dev.

10. Type the command as shown in Figure 3.7 to install NS2 $ ./install.

3.2 Hardware Requirements

- 2 GHz dual core processor
- 4 GB RAM (system memory)
- 25 GB of hard drive space (or USB stick, memory card or external drive but see LiveCD for an alternative approach)
- VGA capable of 1024×768 screen resolution
- Either a CD/DVD drive or a USB port for the installer media
- Internet access is helpful

Chapter 4

SYSTEM DESIGN

Systems design is the process of defining the architecture, components, modules, interfaces, and data for a system to satisfy specified requirements. Systems design could see it as the application of systems theory to product development. The objective of the design phase is to produce overall design of the software. It aims to figure out the modules that should be in the system to fulfil all the system requirements in an efficient manner. The design will contain the specification of all these modules, their interaction with other modules and the desired output from each module. The output of the design process is a description of the software architecture. The design phase is followed by two sub phases

- High Level Design
- Detailed Level Design

4.1 Architecture of VANET

VANETs has nodes that can move freely without any movement constraint. Each node will have to be connected by following changes in its locations. Consequently, VANETs have highly dynamic topology. The nodes can communicate with each other either in single-hop or multi-hop channel, and nodes in VANETs can be any vehicle or Road Side Unit (RSU). Every participating vehicle behaves like a wireless router or node to communicate with each other. The fixed roadside units like traffic light towers establish in VANETs as the backbone of a network to provide connectivity for exchanging safety-related information reliably.

The basic architecture of VANETs is shown in Figure 4.1. The architecture for such network is comprised of two types of network: the infrastructureless part deals with the ad hoc vehicles and the infrastructure oriented part deals with Road Side Units (RSUs). The messages are sent to other vehicles or RSUs as required for the purpose of Vehicular-to-Vehicular (V2V) or Vehicular-to-Infrastructure (V2I) communication respectively. RSUs are placed at traffic signals, parking areas or even at specific locations on the sides of roads. These RSUs have two types of network devices: one used for dedicated short range radio transmission and another is used to communicate in between infrastructure components.

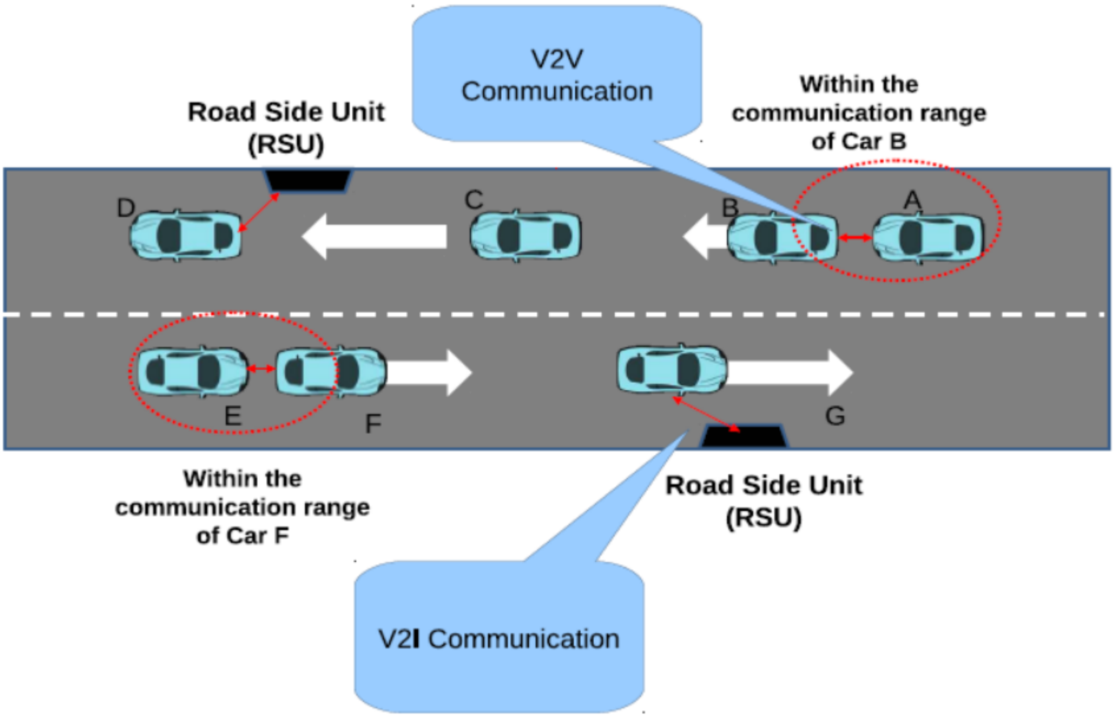

Figure 4.1: Basic Vanet Architecture

The VANETs architecture can be further divided into three layers. First one is the sensor layer which uses On-Board Units (OBUs) installed in vehicle and other devices sense the vehicles around and collect traffic data. Second is the communication layer that includes cellular networks and the internet to communicate among vehicles. The last one is the data process layer providing a framework to collect data and analysis of data.

4.2 Authentication

As one form of mobile ad hoc network in the domain of vehicles, vehicular ad hoc network (VANET) is a promising solution for improving road safety and driving experience. Generally, a VANET is composed of roadside units (RSUs) and vehicles equipped with electronic components such as wheel rotation sensors, radars, and on-broad units (OBUs). Various sensors on vehicle provide continuous monitoring of driving information, such as speed, direction, and position. OBUs enable vehicles to communicate with not only each other but also RSUs via Dedicated Short Range Communications (DSRC) technique. Thus, there are plenty of potential applications on VANETs which can be categorized into safety-related, such as collision avoidance and automatic driving, and other applications, such as traffic navigation and infotainment.

For the security of VANET and its applications, especially safety-related applications, it is crucial to authenticate transmitted messages and identities of their senders, otherwise any unauthorized vehicle could disseminate bogus messages easily or conduct other malicious behaviours without being caught, which might cause great damages to urban transportation systems and even endanger the lives of drivers and pedestrians. To authenticate itself to other entities, vehicle might have to prove the possession of secret information which is usually tamper-proof and saved on vehicle. In addition a copy of secret data is also stored on TA(Trusted Authority). For instance, the simplest way to achieve authentication is using digital signature. Every vehicle is assigned to a public/private key pair, and RSU is responsible for storing private keys and generating signatures.
SHA-1 algorithm is used for hashing. SHA-1 works by feeding a message as a bit string of length less than 2^{64} bits, and producing a 160-bit hash value known as a message digest.At the end of the execution, the algorithm outputs blocks of 16 words, where each word is made up of 16 bits, for a total of 256 bits.

4.3 Methodology

In order to implement the VANETs, it is necessary to identify the required protocols. One among them is clustering based routing protocol. The process is discussed below

4.3.1 Existing

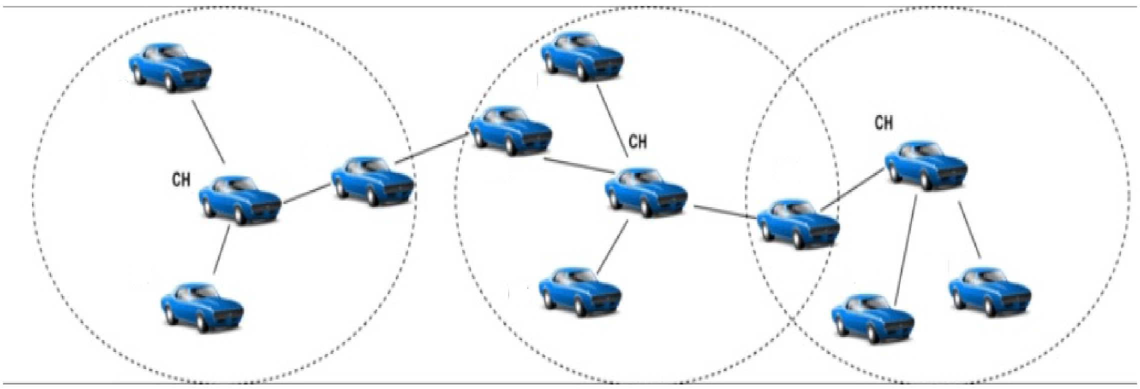

Figure 4.2: Existing clustering based protocol

The existing protocol as shown in Figure 4.2 proposes a reactive algorithm for mobile wireless ad-hoc networks, which is called Location Routing Algorithm with Directional Cluster-Based Flooding (LORA_DCBF). The algorithm inherits the properties of reactive routing algorithms and has the advantage of acquiring routing information only when a route is needed. LORA_DCBF has the following features:

- This protocol improves the traditional routing algorithms, based on non-positional algorithms, by making use of location information provided by GPS.
- It minimizes flooding of its Location Request (LREQ) packets.

. The algorithm consists of four stages:

- Cluster formation
- Location and Direction discovery (LREQ and LREP)
- Routing of data packets
- Maintenance of location information.

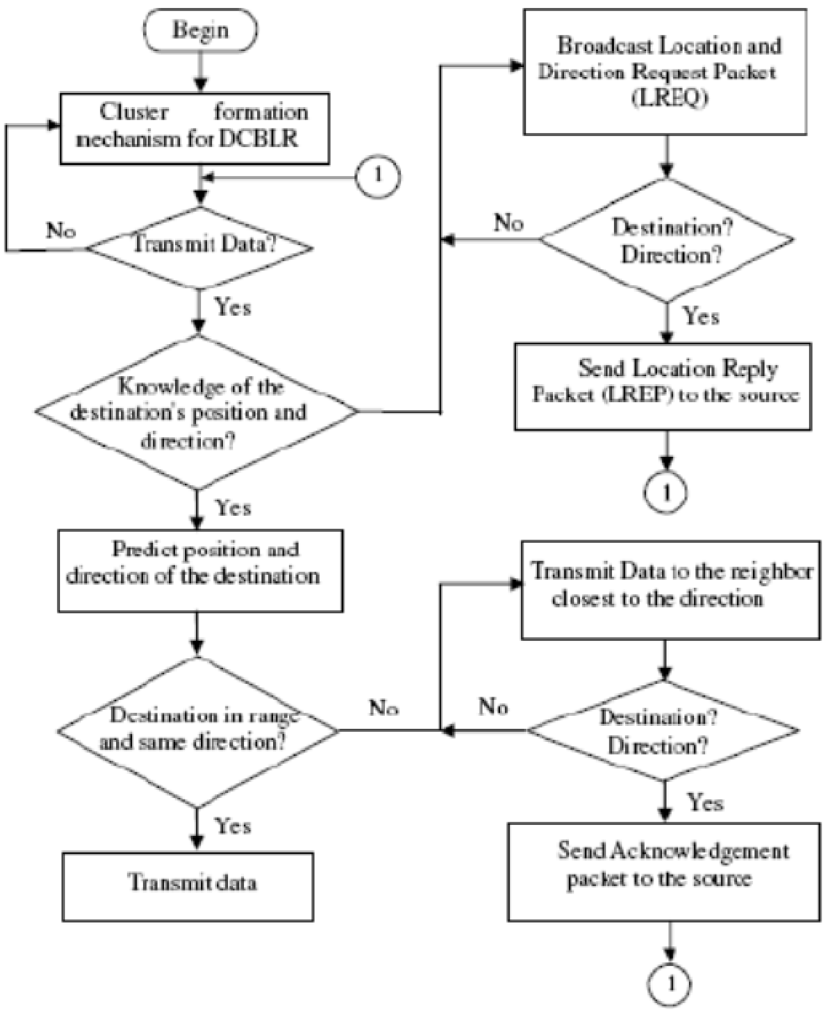

Figure 4.3: LORA_DCBF flowchart

Figure 4.3 shows the Flowchart of LORA_DCBF (Location Routing Algorithm with Directional Cluster-Based Flooding.) in which Cluster heads are responsible for their

clusters and have to send a Hello Message periodically. When a member receives a Hello message, it registers in the cluster head and responds with a reply Hello message. The cluster head then updates the Cluster table with the address, position (longitude and latitude) and direction of every member in the cluster.
When the source of the data packet wants to transmit to a destination that is not included in its routing table, or if its route has expired, it will put the data packet in its buffer and broadcasts a Location Request (LREQ) packet.
Packets from source to destination are transmitted based on the knowledge of their relative position. Because the transmission is in the direction of the destination node, the path found will be shorter and stronger than in other routing mechanisms. In non-positional-based Routing strategies, the shortest path is measured in hops. Therefore, the path found may not be the shortest, but the path found using location information will be significantly shorter. If the source of the data packet does not receive the acknowledgement packet before its timer expires, it will retransmit the data packet again.
LORA_DCBF uses MFR (Most Forward within Radius) as its forwarding strategy. In MFR the packet is sent to the neighbor with the greatest progress to the destination. The advantage of this method is that it decreases the probability of collision and end-to-end delay between the source and the destination.
The source updates its direction and location information before sending each data packet. When the destination receives the data packet, its direction and location information is updated and an acknowledgment packet is sent to the source.[16]

4.3.2 Proposed methodology

The network is partitioned using a distributed clustering algorithm in ICBRP (Improvised Cluster Based Routing Protocol). Clustering is a technique commonly used to establish hierarchical routing infrastructure in VANETs. The key benefit of utilizing clustering technique in VANET is to reduce network traffic and congestion. Clustering limits the network communications into a bounded area (clusters) which results in the reduction of message number. Furthermore, clustering technique allows the cluster-head to collect and aggregate packets that reduces the number of transmitted messages. This results in a reduction of transmitted network traffic, which decreases network resource consumption and congestion.

4.3.2.1 Cluster Division

The setup made to display is a bidirectional road that shall be used to form cluster and surrounded by RSU and has one TA which is shown in Figure 4.4. According to Figure 4.5, each node first generates and broadcasts its LOCO[it is a combination

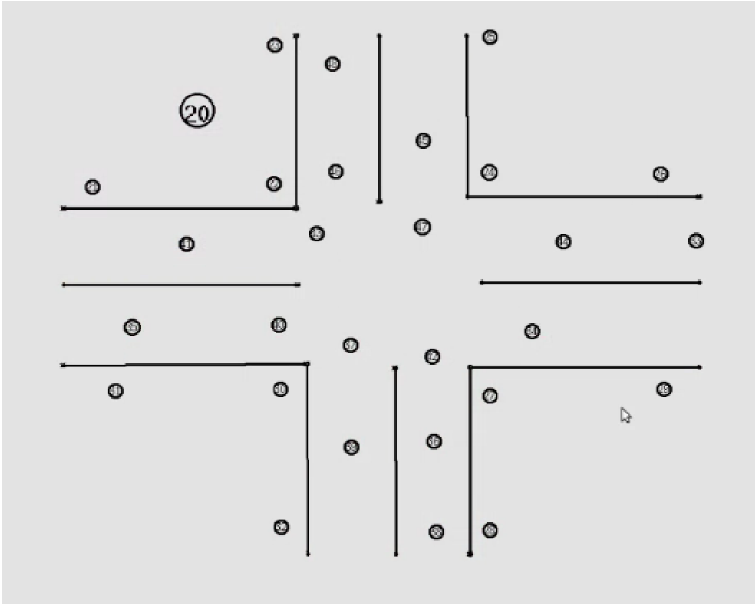

Figure 4.4: Bidirectional Road Setup

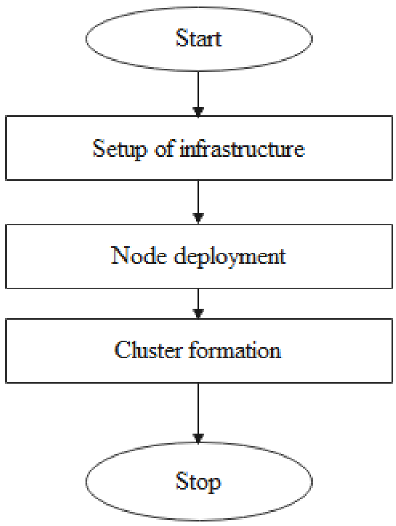

Figure 4.5: Flowchart for cluster division

of road id,lane direction physical location which is shown in Figure 4.6] to form the clusters in CBRP. This allows a node to discover its vicinity using the received LOCO. Assumption has been made that all vehicles have a predefined knowledge of road co-ordinates.

The nodes which have similar LOCO reside in the close regions and have the potential to form the clusters. The similarity of LOCO is considered using distance vector algorithm. Amongst all these nodes, the nodes whose distances are in allowed road range are partitioned as a cluster. This guarantees that all the cluster-members are connected in each cluster. Each vehicle must be assigned at-least one cluster at the time based on its location and a unique ID.

4.3.2.2 Cluster Head Selection

To select cluster-heads (CHs), location coordinate information (LOCO, as shown in Figure 4.6) is used to find the nodes which move as the head of clusters. At each cluster, the node becomes CH if it moves in the front of all the cluster members. Due to this, each cluster member considers the received LOCO messages to find out the nodes which may move front. The node marks itself as CH if no one is found in front. The duty of CHs is to broadcast the road safety and traffic status to the cluster-members.

They also report the situation of traversed road to the RSUs for further processing and utilization such as traffic information and accident report. RSUs are connected through telecommunication infrastructure and are in charge of transportation control. Each RSU is attached by an address which shows RSU's location and lane of coverage. According to Figure 4.4 RSU1(Main RSU 1 of first lane) and RSU1.2(RSU 2 of first lane) respectively cover left-to-right and right-to-left lanes of the road whereas RSU1 manages a sub-road of RSU1.1. RSUs utilize the information reported by CHs to control the road safety and update the information in TA and which broadcasts the information to the other RSUs. RSU also stores the routing table that will be updated using Distance vector algorithm with time.

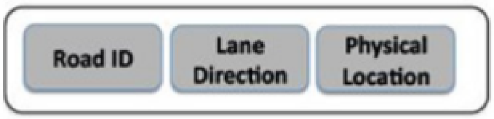

Figure 4.6: LOCO Format

4.3.2.3 Dynamic clustering based routing protocol algorithm 1

The existing protocol is proposed with mobile nodes and hard to understand the real time scenarios. So to implement this algorithm in real time, we have proposed the clustering based routing protocol algorithm1(CBRP1).

As shown in Fig 4.7 in CBRP1, initially the set up of bidirectional roads, trusted authority(TA) and road side unit(RSU) are done. Which is later followed by deployment of dynamic nodes of constant speed.

The nodes which have similar LOCO reside in the close regions and have the potential to form the clusters. The similarity of LOCO is considered using distance vector algorithm. Amongst all these nodes, the nodes whose distances are in allowed road range are partitioned as a cluster.The max road range for a cluster is a lane in the road.

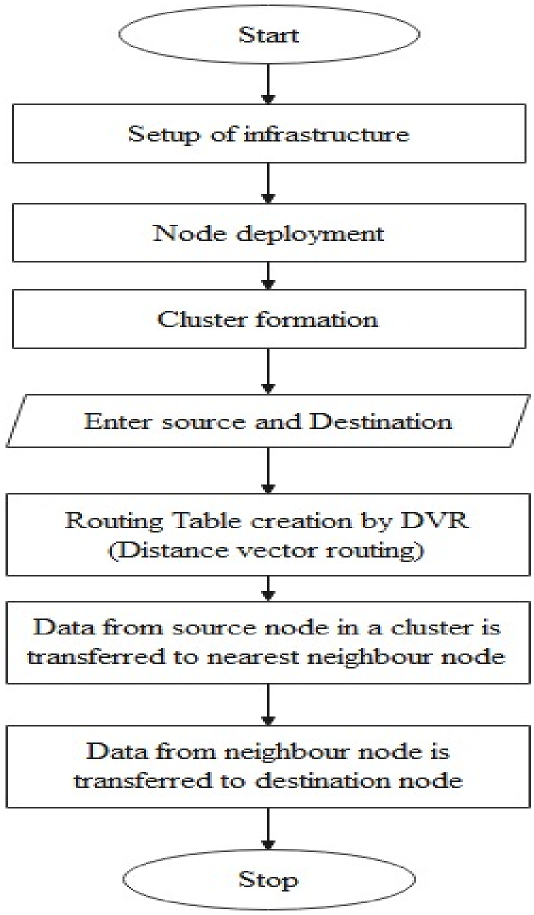

Figure 4.7: Flowchart for CBRP1

To send the information between nodes, the source node and the destination node information needs to be broadcasted to near by RSUs to create the routing table by distance vector algorithm. Once the table is created, the data from source node is transmitted to the cluster head of the cluster to which source node is a member. The cluster head with help of the routing table sends the data to the cluster head in a cluster to which the destination is a member. Finally, the cluster head of destination cluster passes on the data to destination node.This marks the end of algorithm.

4.3.2.4 Improvised Cluster Based Routing Protocol(ICBRP)

ICBRP represents a cluster-based routing protocol to forward network traffic over VANET. Under this protocol, each node firstly gets an ID, which is called LOCO, according to its location and mobility. Then, the network is partitioned into a set of clusters based on the nodes mobility pattern. Distance vector algorithm technique is used to measure the similarities of nodes mobility using LOCO values. The nodes are grouped using a distance vector algorithm. Each cluster is managed by a Cluster-Head (CH) which stays in the duty of dealing with intra-cluster connections especially communicating with RSUs. In the Figure 4.8, each vehicle that enters any cluster

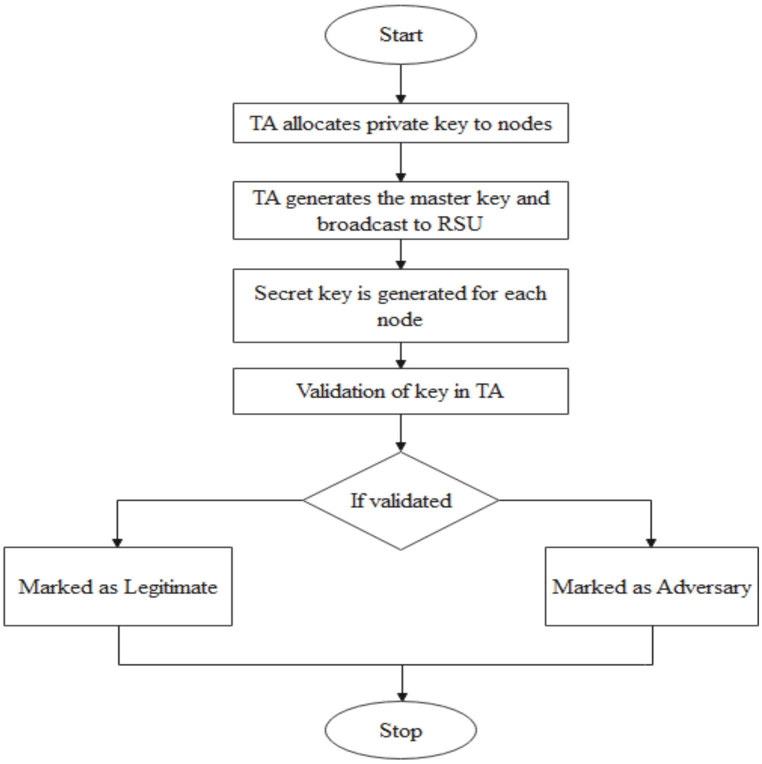

Figure 4.8: Flowchart for authentication

becomes member of the cluster. Then the Distance is calculated for all vehicles within their associated clusters at any given time. Based on distance calculated the vehicle will share private key to RSU. The Master key(Public Key) would be allocated by TA to RSU. RSU will XOR the public key and private key and then applies the SHA algorithm and generate secret key which is then sent to TA for the verification of Key.In TA the encrypted key is decrypted in TA to check for the private key of received node with the database of legal nodes private keys.If found the vehicle is legitimate. If vehicle is legitimate then signature verification is successfull else TA will broadcast it as Adversary node. Once authentication is complete the vehicle sends the information to nearby vehicle until it reaches the destination node.

Working of SHA-1:

1. Padding:
   Referring to Figure 4.9, the original data is been padded with a 1's followed by 0s so that the total length is 64 bits less than the exact multiple of 512.

2. Appending:
   Here the original message length [length modulus 64] is been appended so that the total length is multiple of 512.

3. Dividing:
   Entire output message received in the appending step is divided into sub blocks of 512 bits each.

4. Initializing variables:
   There are 5 chaining variable considered for this process .Each variable consists of 32 bits.Let us consider the variables as A,B,C,D,E which are pre defined variables.

5. Processing:
   Each sub blocks created in the 4th step ,consisting of 512 bits will be processed in this stage.

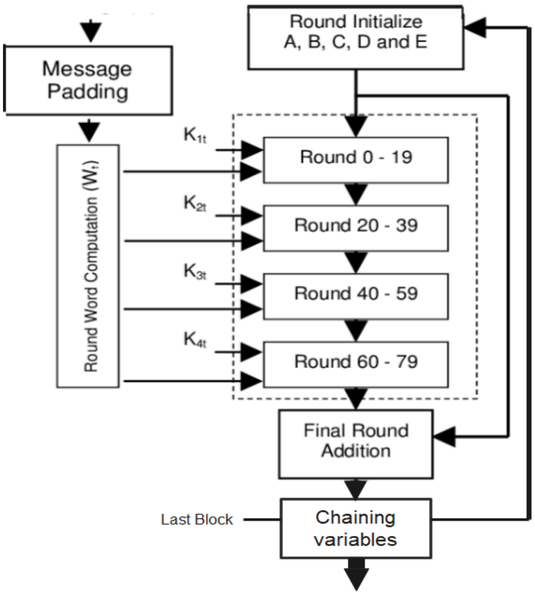

Figure 4.9: Working of SHA1

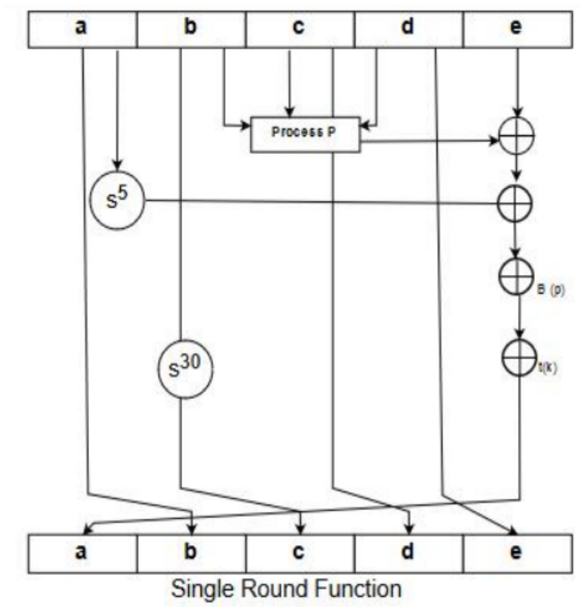

Figure 4.10: Single Round Function

a) place the updated values to the chaining variables A,B,C,D,E.

b) further the 512 bit sub blocks are divided into 32 bits 16 sub blocks.

c) each round of 20 steps are repeated 4 times,

- Where in each round a shown in Figure 4.10, 16 blocks along with chosen constant K and 5 chaining variables will be passed as input.
- Variables B,C,D is passed for processing and the output is this processed value is added[modulo 2] with E.

- Then variable A is left shifted by 5 positions and result is been added with the previous output gained.
- B is left shifted by 30 positions.
- The result obtained from step 3 in rounds is added with the input message.
- The obtained result is added with constant K.The result is stored in variable A.the chaining variables values are right shifted and updated accordingly.

The key duty of CBRP is to forward the network traffic mainly control and synchronization messages throughout a vehicular network. CBRP utilizes two routing protocols: V2V and V2I. V2V utilizes a AODV(Ad-hoc On-Demand Distance Vector which is a reactive protocol where routes are created only when they are needed) communication pattern to forward inter or intra-cluster traffic between the vehicular nodes.

Distance Vector Algorithm

1. A router transmits its distance vector to each of its neighbors in a routing packet.
2. Each router receives and saves the most recently received distance vector from each of its neighbors.
3. A router recalculates its distance vector when:
   - It receives a distance vector from a neighbor containing different information than before.
   - It discovers that a link to a neighbor has gone down.

The DV calculation is based on minimizing the cost to each destination
Dx(y) = Estimate of least cost from x to y
C(x,v) = Node x knows cost to each neighbor v
Dx = [Dx(y): $y \in N$] = Node x maintains distance vector
Node x also maintains its neighbors' distance vectors
For each neighbor v, x maintains Dv = [Dv(y): $y \in N$]

This allows the vehicle nodes communicate in an ad-hoc manner in which each node forwards the network traffic to any other ones residing in the same cluster. In fact, a network packet is dropped out if it is received by a node which resides in a different cluster. This reduces the network transmitted traffic and resource consumption (mainly energy and bandwidth) as unnecessary message broadcasts are estimated.V2I supports back-end communications between vehicular nodes and the

network infrastructure. By this, the CHs report the lane and road status to RSUs. Then RSU stores a copy of this information and cluster head to inform back moving vehicles in the case of traffic jam or accident.The value of LOCO is calculated using the node location, road ID and direction. This is generated at each node using the information taken from location and the local RSU.
As in Figure 4.6, LOCO is represented in three fields: road ID, lane direction and physical location. Road ID is a binary address to show the road which the vehicle moves through. This is taken from the local RSU. Lane direction and physical location fixed. The former keeps the direction of vehicle, left-to-right or right-to-left for example, whereas the latter shows the location/region of the vehicle. LOCO is dynamically updated when the vehicle changes its location, road and direction. By clustering nodes into groups, the protocol efficiently minimizes the flooding traffic during route discovery and speeds up this process as well.
In Figure 4.11, explains the flowchart which starts with the setup of infrastructure and nodes, which helps in the creation of clusters according the location of the vehicles. The authentication of the nodes are done to find the legitimate and adversary nodes.If the nodes are found to be adversary then the nodes are marked malicious by TA and all the information coming from that particular nodes are blocked. And if the nodes are legal then the information from those nodes are accepted and can be passed on to them.The entered source and destination is used to create a routing table on RSU ,which is further used to transmit the data from source to destination through cluster head of that particular cluster.The copy of the data sent from the source is stored in the RSU near source cluster for future information.

IEEE 802.11 standard, popularly known as WiFi, lays down the architecture and specifications of wireless LANs (WLANs). WiFi or WLAN uses high frequency radio waves instead of cables for connecting the devices in LAN. Users connected by WLANs can move around within the area of network coverage.But when vehicle density increases MAC layer suffer from congestion due to increase on channel load and this situation decrease the transmission of safety message within the predefined deadline. Congestion occurs when the packets are increased over the capacity of the network and it results in packets loss, quality of services degradation, etc. However, the MAC layer plays a vital role in controlling congestion. Therefore, congestion control schemes are analyzed based on reliability, scalability and throughput of the congested network. Unfortunately, 802.11 only supported a maximum network bandwidth of 2 Mbps—too slow for most applications. For this reason, ordinary 802.11 wireless products are no longer manufactured, which doesnt help much with congestion control.So a better wireless standard of the MAC layer is used in this proposed algorithm,802.11g.

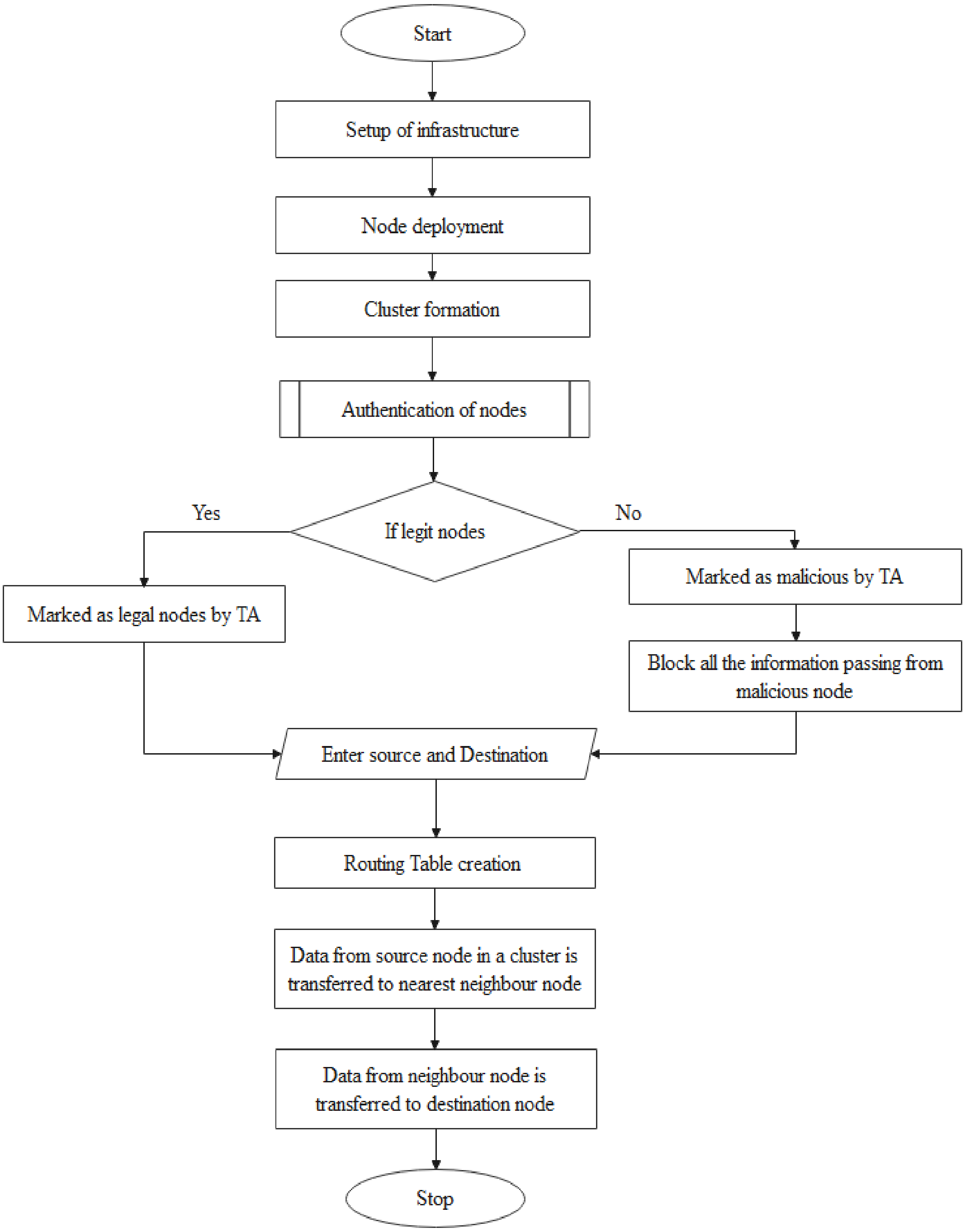

Figure 4.11: Flowchart for Cluster based routing protocol

802.11g attempts to combine the best of both 802.11a and 802.11b.802.11g is also referred to as Wi-Fi 3. 802.11g supports bandwidth up to 54 Mbps, and it uses the 2.4 GHz frequency for greater range. 802.11g is backward compatible with 802.11b, meaning that 802.11g access points will work with 802.11b wireless network adapters and vice versa.The range it supports 38 meters (indoor), 140 meters (outdoor).It is cheaper than 802.11a.Consider the availability of dual band devices while making any procurements. Devices compatible with both 802.11a and 802.11g

(inherently compatible with 802.11b) are a good buy considering future expansion and compatibility in diverse network environments.
So this is used to overcome the channel load and provide fair communication between vehicles.In VANETs, the efficiency of channel and its usage hold great importance in terms of managing the broadcast transmissions.Here we are using 2.4GHz bandwidth for the network interface wireless phy and passing the data at the rate of 54.0 Mbps through MAC 802.11g. The effective and efficient usage of transmission channel assists in reducing the overall interference, which in turn affects the performance of the broadcast reception.

Chapter 5

RESULTS AND DISCUSSION

As Vanet services are an important part of our society, automating these services lessens the burden on humans. Also the transparency of this system helps vehicle user to trust it. The objective of developing this systems is to provide exact location information between the vecicle users.

5.1 Simulation in NS2

5.1.1 Setup of Infrastructure and Nodes

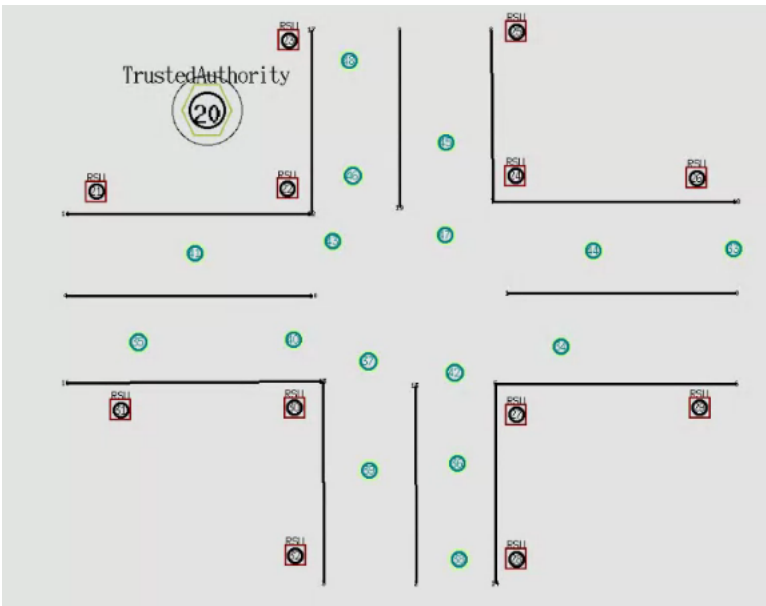

Figure 5.1: Road segments

Figure 5.1 shows the segment which is divided into bidirectional road ,which has RSU(Road Side Unit) as a cluster head. Once the authentication is succeed else the Vehicle or node will be marked as arbitrary nodes,by updating the source and destination address data get transferred from source to destination.

5.1.2 Authentication

Once the authentication is completed the Malicious nodes are marked as advisory and colored with orange which is as shown in Figure 5.2.

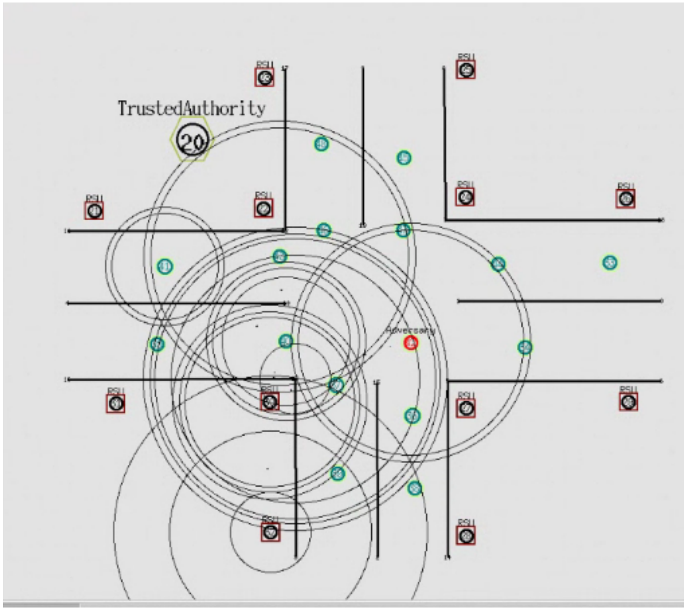

Figure 5.2: Authentication of nodes

5.1.3 Data Transmission

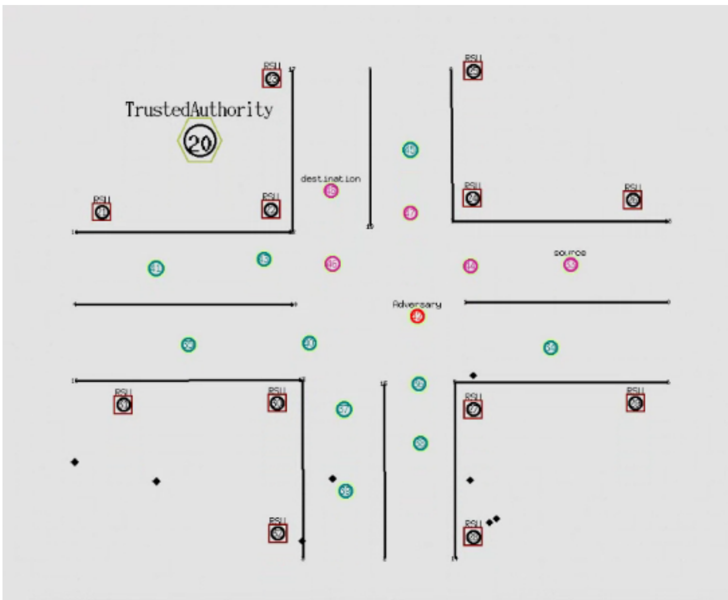

Figure 5.3: Data Transmission

Once the legitimate nodes are identified the data transmission happens from source to destination through V2V communication. The path between source and destination is highlighted by color pink. Figure 5.3 shows the Data transmission.

5.1.4 Simulation Results

Simulation setup is done according to the Table 5.1. Performance comparison

Table 5.1: Simulation setup Parameter

Specifications	Values
Simulation area	1500× 1500
Simulation time	20 seconds
Number of nodes	15
Number of rode side units	12
Number of clusters	4
Road lane	Two lane
propagation model	Two ray ground radio propagation model

between existing(static), clustering based routing with authentication and without authentication and improvised clustering routing protocol.

5.1.4.1 Delay

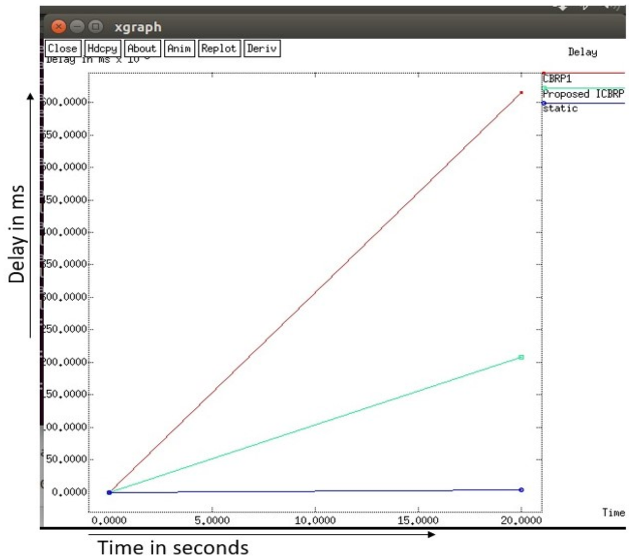

Figure 5.4: Delay with respect to time

Figure 5.4 shows the delay graph, where delay means the time for which the processing of a particular packet takes place. Overhead can be a deciding factor in software design, with regard to structure, error correction, and feature inclusion.

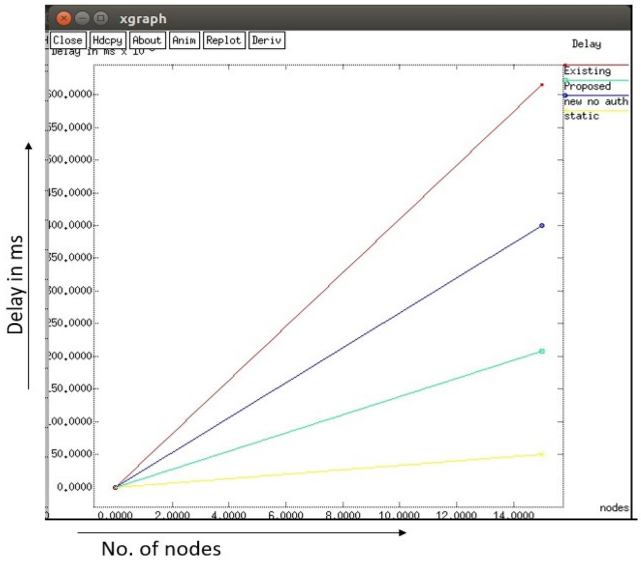

Figure 5.5: Delay with respect to nodes

Performance comparison between existing(static), clustering based routing with authentication and without authentication and improvised clustering routing protocol with respect to number of nodes is shown in the figure 5.5. Delay has been reduced by 76.923% in ICBRP and 66.66% in clustering protocol 1 compared to static clustering protocol.

5.1.4.2 PDR

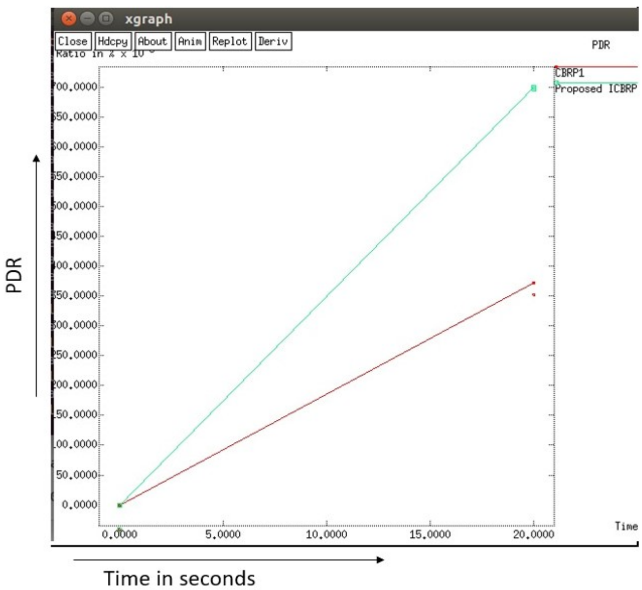

Figure 5.6: PDR with respect to time

Figure 5.6 shows the Packet Delivery Ratio (PDR), which can be measured as the ratio of number of packets delivered in total to the total number of packets sent from source node to destination node in the network. It is desired that maximum number of data packets has to be reached to the destination. PDR is improved by 46.7% in ICBRP compared to clustering routing protocol 1 .

5.1.4.3 Overhead

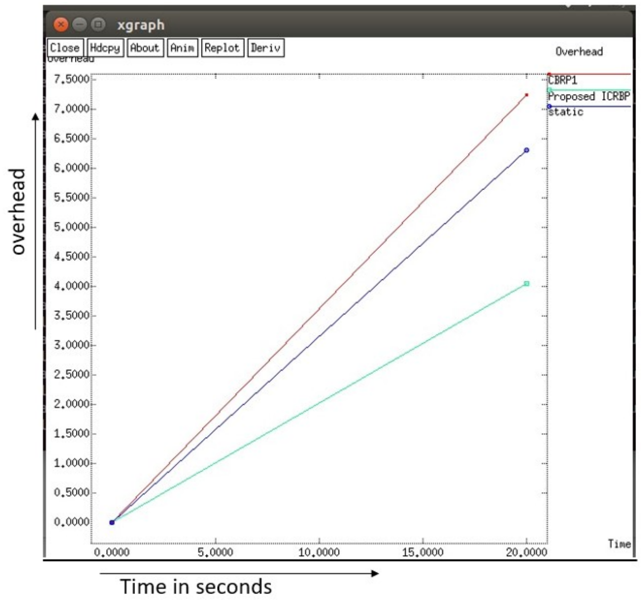

Figure 5.7: Overhead with respect to time

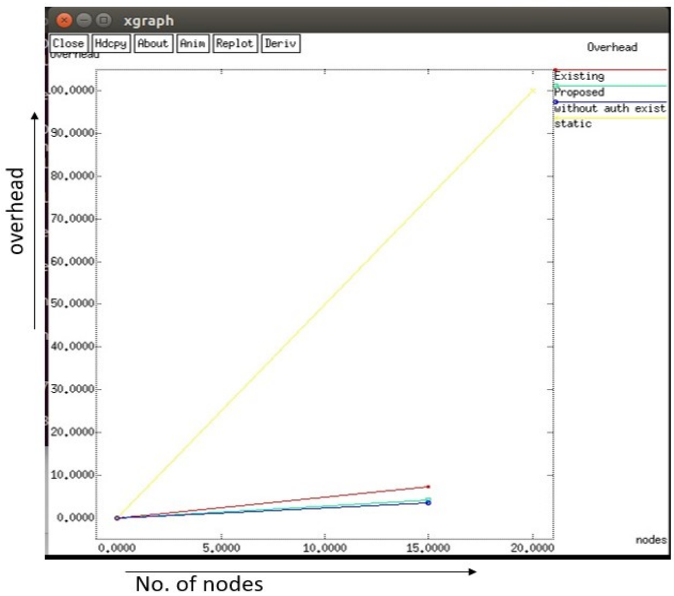

Figure 5.8: Overhead vs with respect to nodes

Figure 5.7 shows Overhead, It is any combination of excess or indirect computation time, memory, bandwidth, or other resources that are required to perform a specific task.Each transmission includes additional information, called overhead, that is required to route the data to the proper location. You can calculate network overhead by sending a fixed-size data transmission across the network and observing the number of extra bytes of data transmitted for the action to be completed. Overhead is decreased by 12.9% in CBRP1 and 35.7% in ICBRP compared to static clustering routing protocol.

Performance comparison between existing(static), clustering based routing with authentication and without authentication and improvised clustering routing protocol with respect to number of nodes is shown in the Figure 5.8. Overhead is reduced by 89.68% in CBRP1 and 92.08% in ICBRP compared to static clustering routing protocol.

5.1.4.4 Packet Received

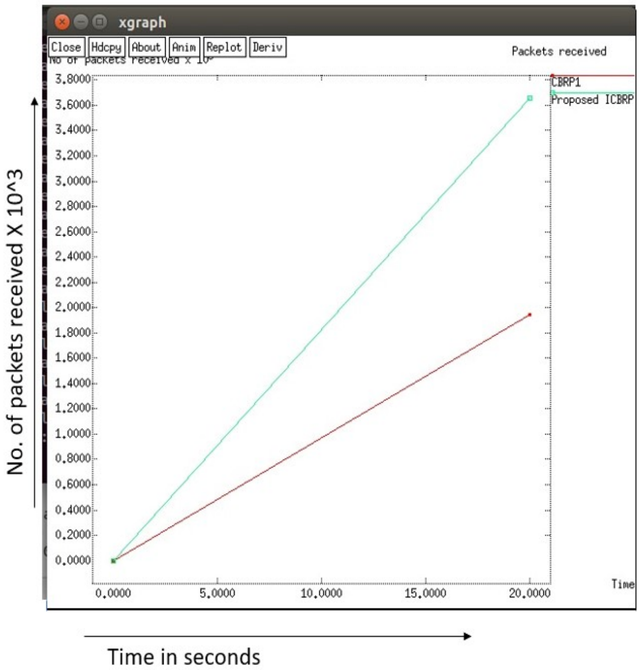

Figure 5.9: Packet Received with respect to time

Figure 5.9 shows the Packet Received,it is the total number of packets received.

5.1.4.5 Throughput

Figure 5.10 shows Throughput,it is a measure of how many units of information a system can process in a given amount of time.In data transmission, network

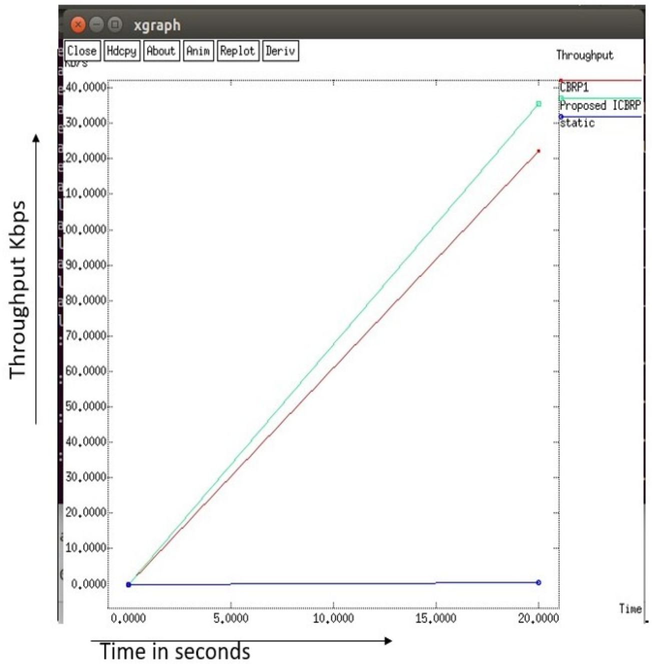

Figure 5.10: Throughput with respect to time

throughput is the amount of data moved successfully from one place to another in a given time period, and typically measured in bits per second (bps), as in megabits per second (Mbps) or gigabits per second (Gbps).Throughput is improved by 89.8% in CBRP1 and 99.5% in ICBRP compared to static clustering routing protocol.

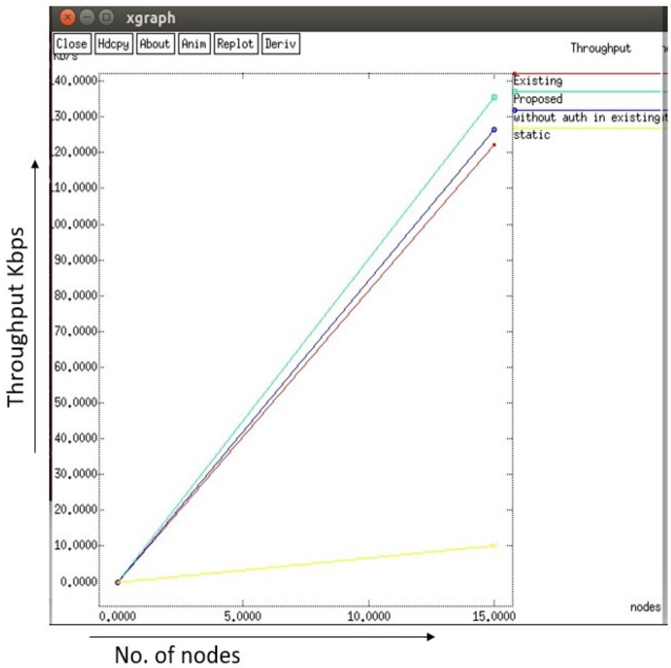

Figure 5.11: Throughput with respect to nodes

Performance comparison between existing(static), clustering based routing with authentication and without authentication and improvised clustering routing protocol with respect to number of nodes is shown in the figure 5.11. Throughput is improved by 92.3% in CBRP1 and 92.8% in ICBRP compared to static clustering routing protocol.

Chapter 6

CONCLUSION AND FUTURE SCOPE

6.1 Conclusion

VANET is an autonomous self organizing wireless network.But in VANETs, the main drawback is the network instability, which yields to reduce the network efficiency. Clustering techniques is mainly used to create a stable clustered topology with minimum clustered control overhead messages.The first objective to implement existing clustering based protocol was achieved.

The next goal was to propose a new improvised clustering based protocol called ICBRP .The objective of this protocol is to enhance routing performance and reduce communication overhead. In which the network is divided into multiple clusters and selecting one of the Cluster Members (CMs) as a Cluster Head (CH). Under this protocol, each node is allocated with an address according to its location and mobility.Then a lightweight technique, called distance vector algorithm, is used in a distributed manner to form the cluster. Using clustering, this is not required that all nodes communicate with RSU to report road status. But, RSUs are only updated when CHs report. This would results in reduction of network traffic received comparing to DSDV which routes packets over at networks.But if there were possibilities of congestion when the traffic load is high in the network,which is also controlled by this proposed approach. And according to the best route found, the communication of information happens.Among all requirements like authentication of nodes are the major issues in VANET which is also solved by ICBRP,which is one of the objective.

Based on the simulation results, ICBRP protocol shows a significant improvement in terms of average throughput,delay,PDR,overhead.The performance analysis of Improved CBRP with respect to existing CBRP is viewed in the comparision graphs plotted.

6.2 Future Scope

- Investigating the correlation between the cluster size and network performance can be addressed as a further work. Increasing the number of nodes in the clusters increases the proactive intra-cluster communications to establish the communication links and forward data packets. In other words, the routing overhead increases if the network deployed densely and the clusters are crowded. This results in the reduction of ICBRP performance. For this, the further experiments are required to figure out how well ICBRP performs if the network gets crowded.
- Considering other mobility parameter, such as acceleration rate and evaluate this parameter in terms of selection of a stable CH.
- To work on user's anonymity and privacy and allow users to choose the privacy they wish to receive.

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