Throughput Analysis of Different Routing Protocols of Vehicular Adhoc Network (VANET)

A Project Work

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Abstract

Vehicular network is a network where one vehicle communicates with another vehicle through a pre-defined network based on some specific protoclos.The vehicular network consisted of two communication parts vehicle-to-vehicle(V2V) and vehicle-to-infrastructure(V2I).With the increasing number of vehicles traffic control,critical moment notifications,post accidental notifications,correct route selection has become very important and it can be implemented through vehicular adhoc network.Various protocols are used for VANET system to control the network perfectly.This project is about to analysis the throughput of some major VANET protocols and to select the best one for the network.The mostly used protocols AODV,DSDV and DSR were testified by a specific network with some basic criteria. After the total analysis the most prominent one is found.

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Chapter 1

Introduction

1.1 Introduction

Now-a-days with the development in the auto mobile industry and wireless com-mu-nication technologies vehicular adhoc network has become one of most promising research fields.VANET, literally which is a successsful decendent of MANET(mobile adhoc network).VANET uses vehicles as the mobile nodes used in MANET to pro-vide communication among nearby vehicles and with nearby roadside infrastruc-ture.VANET is different from other networking sectors for its own characteristics. VANET specially works only on roadside topology when the vehicles are moving along with the road.By comunicating with other vehicles one can Know its right position to avoid collisions, traffic jam and by using GPS it can move to the correct direction.The vehicles which are used as nodes should car-ry some capabilities like significant computing ,communication and sensing.For proper communication among different types of vehicles the networks works on various types of routing protocol.The routing protocols help the vehicles to move in the correct direction,-to obtain their perfect position and most conveniently vehicle to vehicle(V2V) and vehicle to infrastruture (V2I) communications to avoid different types of hazards which may cause an adverse effect on human life.

1.2 What is Vehicular Adhoc Network (VANET) :

Vehicular Ad hoc NETworks (VANETs) belong to a subcategory of traditional Mo-bile Ad hoc NETworks (MANETs). The main feature of VANETs is that mobile nodes are vehicles endowed with sophisticated "on-board" equipments, traveling on constrained paths (i.e., roads and lanes), and communicating each other for mes-sage exchange via Vehicle-to-Vehicle (V2V) communication protocols, as well as between vehicles and fixed road-side Access Points (i.e., wireless and cellular net-work infrastructure), in case of Vehicle-to-Infrastructure (V2I) communications [1].

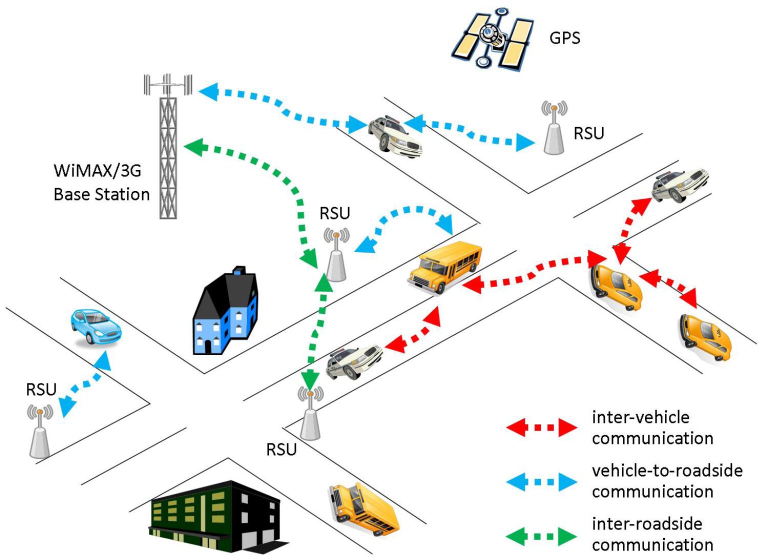


Figure 1.1 : Vehicular Adhoc Network

Future networked vehicles represent the future convergence of computers, com-munications infrastructure, and automobiles [2]. Vehicular communication is con-sidered as an enabler for driverless cars of the future. Presently, there is a strong need to enable vehicular communication for applications such as safety messag-ing, traffic and congestion monitoring and general purpose Internet ac-cess.

VANET is a term used to describe the spontaneous ad hoc network formed over vehicles moving on the roadway. Vehicular networks are fast emerging for dev-el-oping and deploying new and traditional applications. More in detail, VANETs are characterized by high mobility, rapidly changing topology, and ephemeral, one-time interactions. Basically, both VANETs and MANETs are characterized by the movement and self-organization of the nodes (i.e., vehicles in the case of VANETs). However, due to driver behavior, and high speeds, VANETs characteris-tics are fun-damentally different from typical MANETs. VANETs are characterized by rapid but somewhat predictable topology changes, with frequent fragmenta-tion, a small effective network diameter, and redundancy that is limited temporal-ly and func-tionally.[3]

1.3 Architecture of VANET :

This part describes the system architecture of vehicular ad hoc networks. We first introduce the main components of VANETs architecture from a domain view.

Then, we explain their interaction and introduce the communication architecture.

Besides, we provide a presentation of the layered architecture for VANETs.[10]

1.3.1 Main Components :

According to the IEEE 1471-2000 [4, 5] and ISO/IEC 42010 [6] architecture stan-dard guidelines, we are able to achieve the VANETs system by entities which can be divided into three domains: the mobile domain, the infrastructure domain, and the generic domain .

As is shown in Figure [1.2], the mobile domain consists of two parts: the vehicle domain and the mobile device domain. The vehicle domain comprises all kinds of vehicles such as cars and buses. The mobile device domain comprises all kinds of portable devices like personal navigation devices and smartphones.

Within the infrastructure domain, there are two domains: the roadside infra-struc-ture domain and the central infrastructure domain. The roadside infrastruc-ture domain contains roadside unit entities like traffic lights. The central infra-structure domain contains infrastructure management centers such as traffic management centers (TMCs) and vehicle management centers [7].

However, the development of VANETs architecture varies from region to region. In the CAR-2-X communication system which is pursued by the CAR-2-CAR com-munication consortium, the reference architecture is a little different. CAR-2-CAR communication consortium (C2C-CC) is the major driving force for vehicular com-munication in Europe and published its “manifesto” in 2007. This system architec-ture comprises three domains: in-vehicle, ad hoc, and infrastructure domain.

As shown in Figure [1.2], the in-vehicle domain is composed of an on-board unit (OBU) and one or multiple application units (AUs). The connections between them are usually wired and sometimes wireless. However, the ad hoc domain is composed of vehicles equipped with OBUs and roadside units (RSUs). An OBU can be seen as a mobile node of an ad hoc network and RSU is a static node likewise. An RSU can be connected to the Internet via the gateway; RSUs can communicate with each other directly or via multihop as well. There are two types of infrastruc-ture domain access, RSUs and hot spots (HSs). OBUs may communicate with In-ternet via RSUs or HSs. In the absence of RSUs and HSs, OBUs can also communi-cate with each other by using cellular radio networks (GSM, GPRS, UMTS, WiMAX, and 4G) [8].

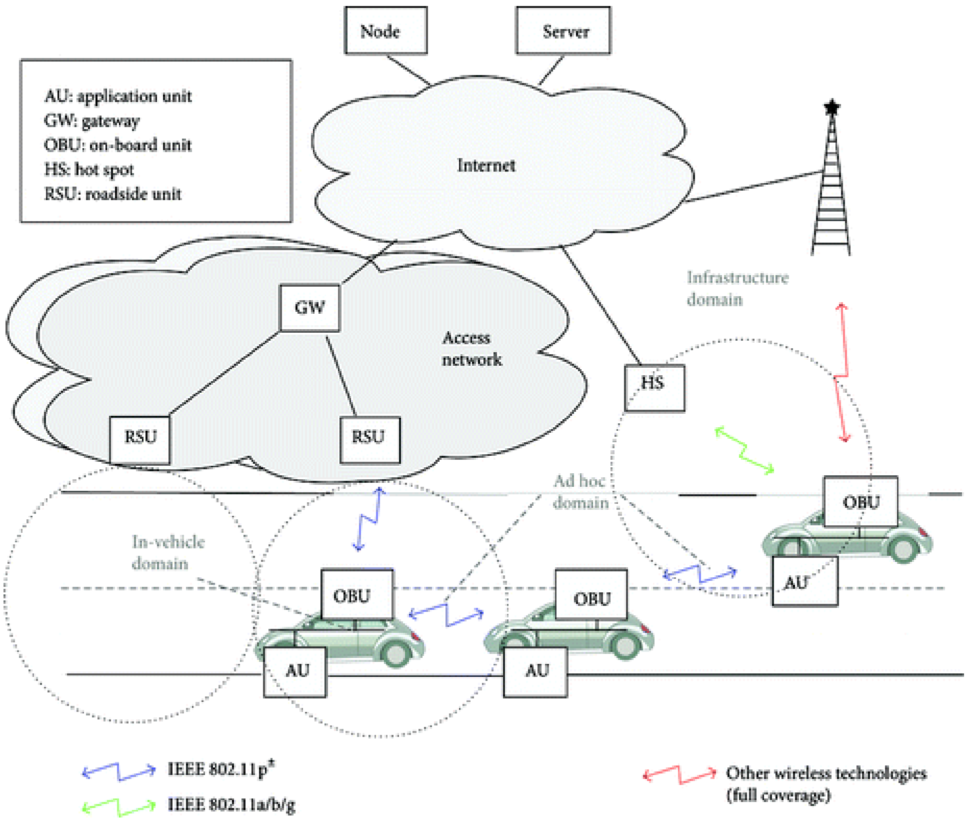


Figure 1.2 : Architecture of VANET

1.3.2 Communication Architecture :

Communication types in VANETs can be categorized into four types. The cate-go-ry is closely related to VANETs components as described above. Figure [1.3] de-scribes the key functions of each communication type [9].

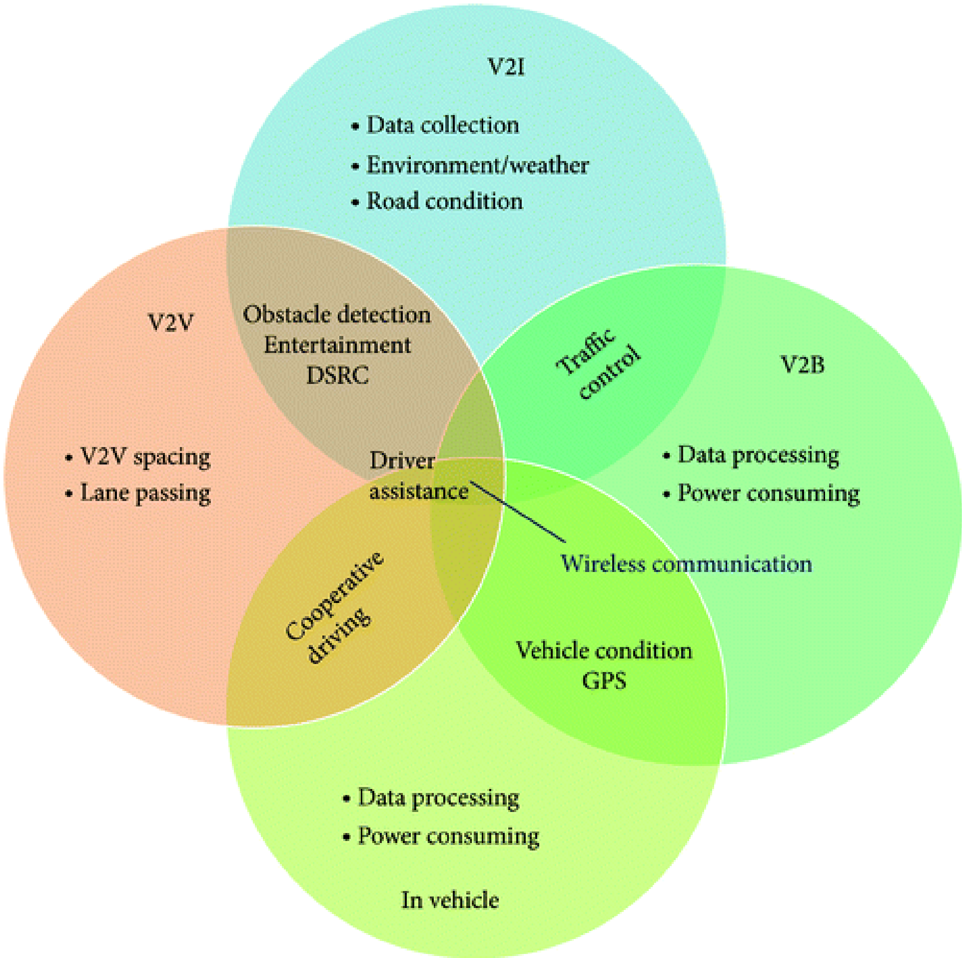


Figure 1.3 : Communication Architecture

In-vehicle communication, which is more and more necessary and important in VANETs research, refers to the in-vehicle domain. In-vehicle communication sys-tem can detect a vehicle's performance and especially driver's fatigue and drows-iness, which is critical for driver and public safety.

Vehicle-to-vehicle (V2V) communication can provide a data exchange platform for the drivers to share information and warning messages, so as to expand driver assistance.

Vehicle-to-road infrastructure (V2I) communication is another useful research field in VANETs. V2I communication enables real-time traffic/weather updates for drivers and provides environmental sensing and monitoring.

Vehicle-to-broadband cloud (V2B) communication means that vehicles may com-municate via wireless broadband mechanisms such as 3G/4G. As the broad-band cloud may include more traffic information and monitoring data as well as info-tainment, this type of communication will be useful for active driver assis-tance and vehicle tracking.[10]

1.4 Application of VANET :

There are various applications based on different types of attacks.They also clas-sified by the communication type either V2V or V2I.We apply the applications by the following classes :

1. Safety Oriented.
2. Commercial Oriented.
3. Convenience Oriented.
4. Productive Applications.

1.4.1 Safety Applications :

Safety applications include monitoring of the surround-ing road, approaching ve-hicles, surface of the road, road curves etc. The Road safety applications can be classified as :

Real-Time Traffic : The real time traffic data can be stored at the RSU and can be available to the vehicles whenever and wherever needed. This can play an im-por-tant role in solving the problems such as traffic jams, avoid congestions and in emergency alerts such as acci-dents etc.

Co-Operative Message Transfer : Slow/Stopped Ve-hicle will exchange messag-es and co-operate to help oth-er vehicles. Though reliability and latency would be of major concern, it may automate things like emergency braking to avoid poten-tial accidents. Similarly, emer-gency electronic brake-light may be another appli-cation.

Road Hazard Control Notification : Cars notifying other cars about road having landslide or information regarding road feature notification due to road curve, sudden downhill etc.

Traffic Vigilance : The cameras can be installed at the RSU that can work as in-put and act as the latest tool in low or zero tolerance campaign against driving of-fenses.

Cooperative Collision Warning : Alerts two drivers potentially under crash route so that they can mend their ways [11].

Post Crash Notification : A vehicle involved in an accident would broadcast warning messages about its position to trailing vehicles so that it can take decision with time in hand as well as to the highway patrol for tow away support as depicted.

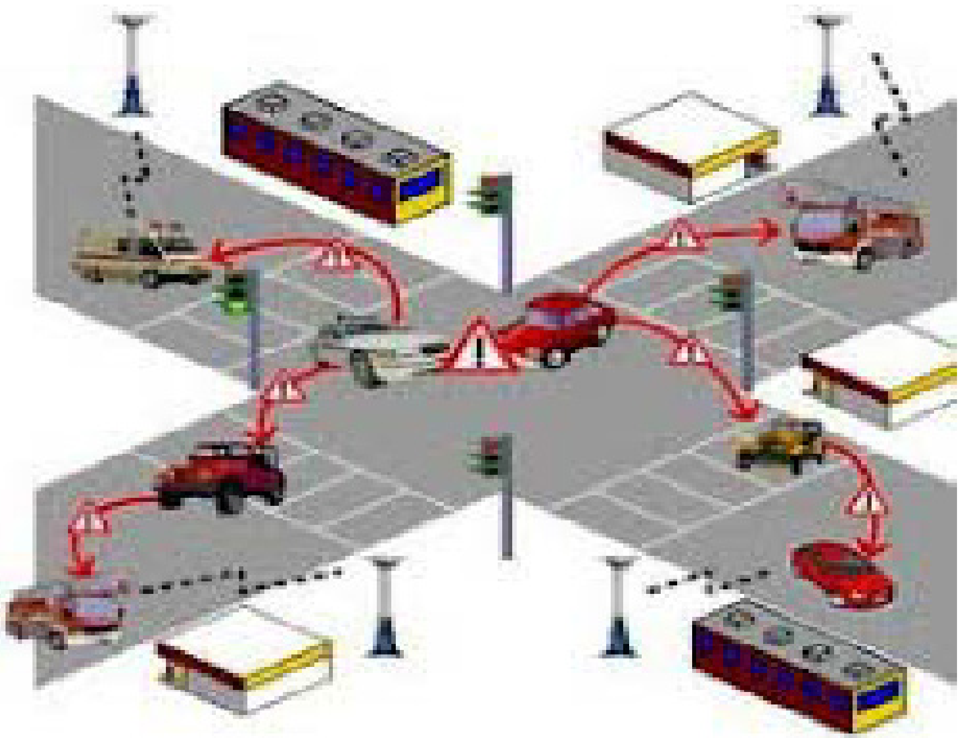


Figure 1.4 : Emergency Situation Notification

1.4.2 Commercial Applications :

Commercial applications will provide the driver with the entertainment and services as web access, streaming au-dio and video. The Commercial applications can be classified as :

Remote Vehicle Personalization/ Diagnostics : It helps in downloading of personalized vehicle settings or uploading of vehicle diagnostics from/to infrastructure.

Internet Access : Vehicles can access internet through RSU if RSU is working as a router.

Digital Map downloading : Map of regions can be downloaded by the drivers as per the requirement before traveling to a new area for travel guidance. Also, Content Map Database Download acts as a portal for getting val-uable information from mobile hot spots or home sta-tions.

Real Time Video Relay : On-demand movie experi-ence will not be confined to the constraints of the home and the driver can ask for real time video relay of his favorite movies.

Value-Added Advertisement : This is especially for the service providers, who want to attract customers to their stores. Announcements like petrol pumps, highways restaurants to announce their services to the drivers within communi-cation range. This application can be available even in the absence of the Internet.[12]

1.4.3 Convenience Applications :

Convenience application mainly deals in traffic manage-ment with a goal to enhance traffic efficiency by boosting the degree of convenience for drivers. The Convenience applications can be classified as :

Route Diversions : Route and trip planning can be made in case of road conges-tions.

Electronic Toll Collection : Payment of the toll can be done electronically through a Toll Collection Point as shown in Figure [1.5]. A Toll collection Point shall be able to read the OBU of the vehicle. OBUs work via GPS [13] and the on-board odometer or techograph as a back-up to determine how far the Lorries have travelled by reference to a digital map and GSM to authorize the payment of the toll via a wireless link. TOLL application is beneficial not only to drivers but also to toll op-erators.

Parking Availability : Notifications regarding the availability of parking in the metropolitan cities helps to find the availability of slots in parking lots in a certain geographical area.

Active Prediction : It anticipates the upcoming to-pography of the road, which is expected to optimize fuel usage by adjusting the cruising speed before starting a descent or an ascent. Secondly, the driver is also assisted.

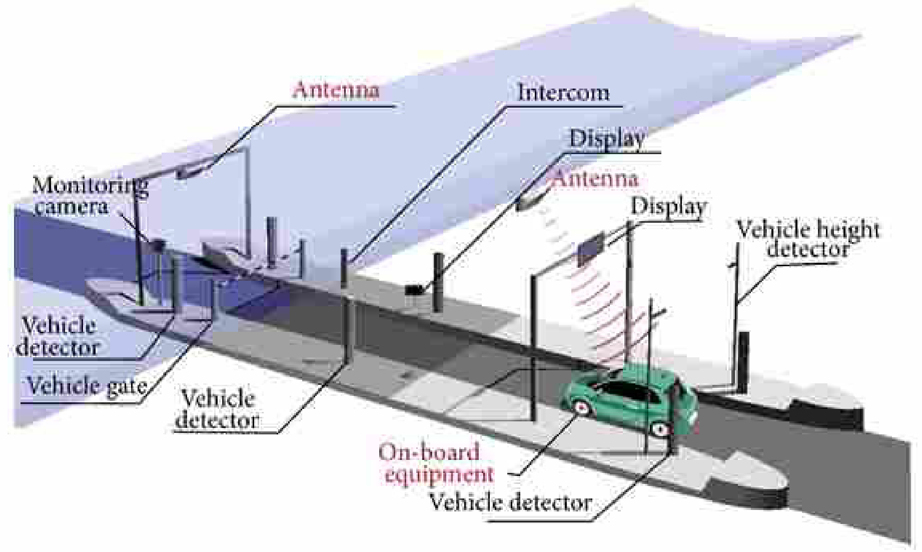


Figure 1.5 : Electronic Toll Collection

Parking Availability : Notifications regarding the availability of parking in the metropolitan cities helps to find the availability of slots in parking lots in a certain geographical area.[12]

1.4.4 Productive Applications :

We are intentionally calling it productive as this applica-tion is additional with the above mentioned applications. The Productive applications can be classified as :

Environmental Benefits : AERIS research program is to generate and acquire environmentally-relevant real-time transportation data, and use these data to create actionable information that support and facilitate "green" transportation choices by transportation system users and operators. Employing a multi-modal approach, the AE-RIS program will work in partnership with the vehi-cle-to-vehi-cle (V2V) communications research effort to better define how connected vehicle data and applica-tions might contribute to mitigating some of the negative en-vi-ronmental impacts of surface transportation.

Time Utilization : If a traveler downloads his email, he can transform jam traf-fic into a productive task and read on-board system and read it himself if traffic stuck. One can browse the Internet when someone is waiting in car for a relative or friend.

Fuel Saving : When the TOLL system application for vehicle collects toll at the toll booths without stop-ping the vehicles, the fuel around 3% is saved, which is con-sumed when a vehicles as an average waits normally for 2-5 minutes.[12]

Chapter 2

Overview of
Major Routing Protocols of
Vehicular Adhoc Network
(VANET)

2.1 Introduction :

For the communication process between vehicle to vehicle (V2V) and vehicle to infrastructure (V2I) they uses various types of routing protocols.The routing pro-tocols gives the interface for the proper communication between nodes on the road topology.

There are different types of routing protocol which are classified as unicasting or geocassting,multicasting and hybrid.They can also be classsified as on-demand driven,table driven or combination of them.

2.2 Major Routing Protocols : Among various routing protocols the major protocols which are used are given below -

01. AODV
02. DSDV
03. DSR
04. TORA
05. VADD
06. GEOpps
07. GPSR
08. GPSR+AGF
09. GRANTS
10. PBR-DV

2.2.1 Ad hoc On-Demand Distance Vector (AODV) :

There are many routing protocols for ad hoc networks. One of the most important of them is AODV . AODV is an on demand routing protocoThis protocol finds routes for a node only when it has data packet for transmission. AODV routing consists of three phases: route discovery, data trans-mission and route maintenance. Route discovery phase starts when a node wants to transmit data and has no route to destination. Now, AODV call route discovery process. In this phase, source node broadcasts a Route Request Packet (RREQ) to its neighbor. Nodes that receive RREQ packets divide into three categories: the receiver node is the destination of route, the node that has a route to destination or none of both. In the two first situations, receiver unicast a Route Reply (RREP) packet to the route that received Route Request (RREQ) packet from it. The route that RREP packet traverses, selected as one of the main routes for source that has been sent RREQ packet. In the last situation receiver generate another RREQ packet and broadcast it to its neighbors [14][15][16].

The Last situation repeats until one of the first two situations occurs. After routing phase, routing process calls data transmission phase, then it transmits data packets across selected route. In this phase, it is possible that a link is broken and results in route expiration. In this situation, the maintenance phase calls to repair broken route or find a new route to destination. Now, node that its link was broken, unicast a Route Error (RERR) packet to the source node. The Source node after receiving RERR packet, searches in its routing table if find another route to old destination select that route as new main route for data transmission, else re-broadcasts new RREQ packet and seeks new route to continue data transmis-sion. If source node cannot find new route to destination, data transfer stops and failure happen. One advantage of AODV is that for any pair of source and destination finds more than one route. Although this appears as advantage but more often this advantage acts as disadvantage. Finding several route need to exchange more control packet. This leads to increase routing overhead. In addi-tion, it increases bandwidth consumption. Obviously, some of scenarios use all of discovered route and others only use part of discovered route and rest of routes are wasted. All of unused routes are routing overhead and all control packets for this route are wasted. [17] [18][19]

Pros :

- An up-to-date path to the destination because of using destination sequence number.

-It reduces excessive memory requirements and the route redundancy.

-AODV responses to the link failure in the network. - It can be applied to large scale adhoc network.[20]

Cons :

- More time is needed for connection setup & initial communication to establish a route compared to other approaches.

-If intermediate nodes contain old entries it can lead inconsistency in the route.

-For a single route reply packet if there has multiple route reply packets this will lead to heavy control overhead.

- Because of periodic beaconing it consume extra bandwidth.[20]

2.2.2 Destination Sequenced Distance Vector (DSDV) :

To planned routing technique allows a group of mobile computers, which may not be close to any base station and can switch over data along shifting and sub-jective paths of interconnection, to manage to pay for all computers among their number a (possibly multi-hop) path along which data can be exchanged. In adding together, the solution must stay well-matched with operation in cases where a base station is available. Each routing table, at all of the station, lists all accessible destinations, and the number of hops to each. Each route table entry is tagged with a progression number which is originated by the objective station. To sustain the reliability of routing tables in an animatedly changeable topology, each station sometimes transmits updates, and transmits updates instantly when important new information is available. Routing in sequence is advertised by dissemination or multicasting the packets which are transmit occasionally and incrementally as topological change are detect for illustration, when stations move within the net-work. Data is also reserved about the distance end to end of time between en-trance of the first and the arrival of the best route for each exacting destination.

Based on this data, a choice may be made to delay promotion routes which are regarding to modify quickly, thus damp fluctuations of the route tables. The an-nouncement of routes which may not have stabilized yet is postponed in or-der to reduce the number of re-broadcasts of possible route entries that in gen-eral arrive with the same succession number.The DSDV protocol requires each mobile station to advertise, to each of its existing neighbors, its individualdirec-tion-find-ing table (for instance, by broadcasting its entries). The entries in this list may change fairly energetically over time, so the commercial must be made frequently enough to ensure that each portable PC can approximately forever stablish all other mobile computer of the collection. All the computers interoper-ating to create data paths between themselves broadcast the essential data peri-odically, say once every few seconds. In a wireless intermediate, it is significant to keep in mind that broadcasts are limited in range by the physical distinctiveness of the intermediate. This is dissimilar than the condition with wired media, which fre-quently have a much more precise range of response.[21]

Pros :

-It can be applied to MANETs with few modifications. The updates are propagated throughout the network in order to maintain an up-to-date view of the network topology at all the nodes.

Cons :

-The DSDV suffers from excessive control overhead that is proportional to the number of nodes in the network and therefore is not scalable in MANETs, which have limited bandwidth and whose topologies are highly dynamic.

-In order to obtain information about a particular destination node, a node has to wait for a table update message initiated by the same destination node. This delay could result in stale routing information at nodes.

2.2.3 Dynamic Source Routing (DSR) :

The Dynamic Source Routing Protocol is an on-demand reactive routing proto-col. In DSR a node maintains route cache which contains the source routes that it is aware of. The node updates records in the route cache when a new route is found [18]. Route Discovery and Route Maintenance are the two main parts of DSR. When a node wants to send a packet as a source to a specific destination, it searches in its route cache in order to determine if it already contains a route to the destination. If it finds a route to the destination exists, then it uses this route to send the packet. But if the node does not have a route to the destina-tion, then it initiates the route discovery process by broadcasting a route request packet. Each intermediate node checks if there is a route to the destination in its cache. If there is no route, it appends its address to the route record of the packet and forwards the packet to its neighbors [22]. A route reply message is generat-ed when the destination or an intermediate node that have current information about the destination receives the route request packet. A route request packet reaching such a node already contains, in its route record, the sequence of hops taken from the source to this node. For route maintenance DSR uses two types of packets: Route Error packet and Acknowledgements. When a node encounters a transmission problem, it generates a Route Error packet. When a node receives a route error packet, it removes the hop in error from its route cache. All routes that contain the hop in error are truncated at that point [22]. Acknowledgment packets are used to verify the correct operation of the route links. This also in-cludes pas-sive acknowledgments in which a node hears the next hop forwarding the packet along the route.[23]

Pros :

-Beacon less.

-To obtain route between nodes, it has small overload on the network. It uses caching which reduce load on the network for future route discovery.

-No periodical update is required in DSR.

Cons :

-If there are too many nodes in the network the route information within the header will lead to byte overhead.

-Unnecessary flooding burden the network.

-In high mobility pattern it performs worse.

-Unable to repair broken links locally.[20]

2.2.4 Temporally Ordered Routing Protocol (TORA) :

Temporally Ordered Routing Protocol is based on the link reversal algorithm that creates a direct acyclic graph towards the destination where source node acts as a root of the tree. In TORA packet is broadcasted by sending node, by receiving the packet neighbor nodes rebroadcast the packet based on the DAG if it is the sending node's downward link.[24]

Pros :

-It creates DAG (Direct acyclic graph) when necessary.

-Reduce network overhead because all intermediate nodes don't need to re-broad-cast the message.

-Perform well in dense network.

Cons :

-It is not used because DSR & AODV perform well than TORA.

-It is not scalable.[20]

2.2.5 Vehicle-Assisted Data Delivery (VADD) :

Vehicle-Assisted Data Delivery is based on the idea of carry & forward ap-proach by using predicable vehicle mobility. Among proposed VAAD protocols H-VAAD shows better performance.[25]

Pros :

-Comparing with GPSR (with buffer), epidemic routing and DSR, VADD performs high delivery ratio.

-It is suitable for multi-hop data delivery.

Cons :

- Due to change of topology & traffic density it causes large delay.[20]

2.2.6 Geographical Opportunistic Routing (GeOpps) :

Geographical Opportunistic Routing (GeOpps) protocol utilizes the navigation system suggested routes of vehicles for selecting the forwarding node which is closer to the destination. During this process if there is any node which has mini-mum arrival time the packet will be forwarded to that node.[26]

Pros :

-By comparing with the Location-Based Greedy routing and Move routing algo-rithm GeOpps has high delivery ratio.

-To find a vehicle which is driving towards near the destination GeOpps need few encounters.

- The delivery ratio of GeOpps rely on the mobility patterns & the road topology but not dependent on high density of vehicles.

Cons :

-Privacy is an issue because navigation information is disclosed to the network.[20]

2.2.7 Greedy Perimeter Stateless Routing (GPSR) :

Greedy Perimeter Stateless Routing selects a node which is closest to the final destination by using beacon. It uses greedy forwarding algorithm if it fails it uses perimeter forwarding for selecting a node through which a packet will travel.[27]

Pros :

-To forward the packet a node needs to remember only one hop neighbor lo-ca-tion.

-Forwarding packet decisions are made dynamically.

Cons :

-For high mobility characteristics of node, stale information of neighbors' position are often contained in the sending nodes' neighbor table.

-Though the destination node is moving its information in the packet header of intermediate node is never updated.[20]

2.2.8 GPSR+AGF :

In GPSR we see that stale information of neighbors position are often contained in the sending nodes neighbor table. For this reason an approach which is called Advanced Greedy Forwarding (AGF) is proposed.[28]

Pros :

- Though the destination node is moving its information in the packet header of intermediate node is updated.

-Stale nodes of neighbor table can be detected.

Cons :

- To find the shortest connected path it may not give desired optimal solution.

2.2.9 Policy Based Routing (PBR-DV) :

PBR-DV consists of various approaches such as a greedy, position-based and a reactive, topology-based routing strategy & if packet falls in local maximum it uses AODV approach recovery.

Pros :

- No comparison is done with any other routing protocol so uncertain about pack-et delivery ratio & overhead.

Cons :

-For non-greedy part excessive flooding is required.[20]

2.2.10 Greedy Routing with Abstract Neighbor Table (GRANT) :

To avoid local maximum Greedy Routing with Abstract Neighbor Table (GRANT) applies extended greedy routing algorithm concept. Abstract Neighbor Table of GRANT divides the plane into areas and includes per area only one represen-tative neighbor[29].

Pros :

-In city scenario with obstacles this extended greedy routing approach works well than as usual greedy approach.

Cons :

- VANET has a high mobility characteristics but the performance evaluation of GRANT is done on static traces.

-The overhead of beacon and possible inaccuracy in packet delivery are not measured.[20]

Chapter 3

Implementation of Routing Protocols of Vehicular Adhoc Network(VANET)

3.1 Introduction :

The total project was completed through several steps by using various tools.In this chapter the total imlementation process and the implementation tools will be discussed.This chapter will also provide the comparison of throughput,delay,jitter between the movable and non-movable nodes network.The basic criteia for the project and the flow chart of the total processing will be also described here. The basic tools used for the project :

3.2 The Basic Tools : The basic tools used for the project are as follows-

Hardware : A laptop with intel core i3 Processor and 2GB RAM

Operating System : Windows7

Software :

1. Cygwin Offline Installer.
2. Network Simulator(V 2.35).
3. NS-2 Wireless Trace Analyzer.
4. Editor (Sublime Text 3).

3.2.1 Cygwin Offline Installer :

Cygwin is a command-line interface for Microsoft Windows. Environment of Cygwin is similar to Unix. Cygwin provides Unix like environmental softwares run on Microsoft Windows. Unix softwares can run from the Cygwin environment on Microsoft Windows. Cygwin was developed by Cygnus Solutions. Later Cygnus Solutions was acquired by Red Hat.

Figure 3.1 : Cygwin Offline Installer.

3.2.2 Network Simulator 2 :

A network simulator is software that predicts the behavior of a computer network. Since communication Networks have become too complex for traditional analytical methods to provide an accurate understanding of system behavior, network simulators are used. In simulators, the computer network is modeled with devices, links, applications etc. and the performance is analysed. Simulators come with support for the most popular technologies and networks in use today such as Wireless LANs, Mobile Adhoc Networks, Wireless Sensor Networks, Vehicular Adhoc Networks, Cognitive Radio networks, LTE / LTE- Advanced Networks, Internet of things (IOT) etc.

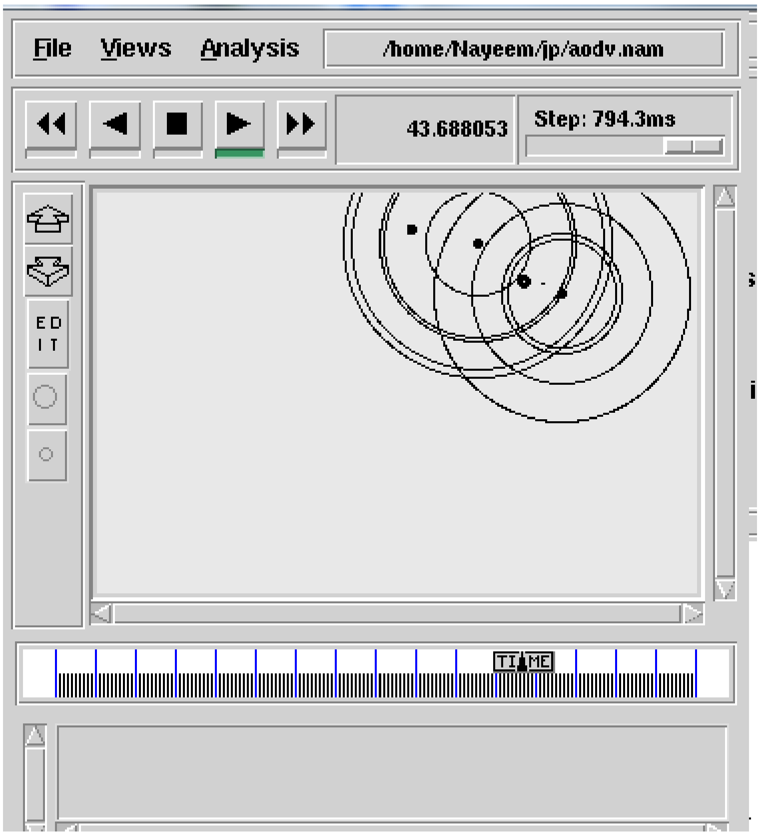


Figure 3.2 : Network Running in Network Simulator.

3.2.3 NS2 Visual Trace Analyzer :

This tool provides an easy way to fulfil this exhaustive task allowing users to trace graphics, filter packets, visualize nodes position, calculate node and traffic statistics, and so on. This standalone application, with a user friendly interface, no need to install and no external libraries requirements, satisfies most user needs.

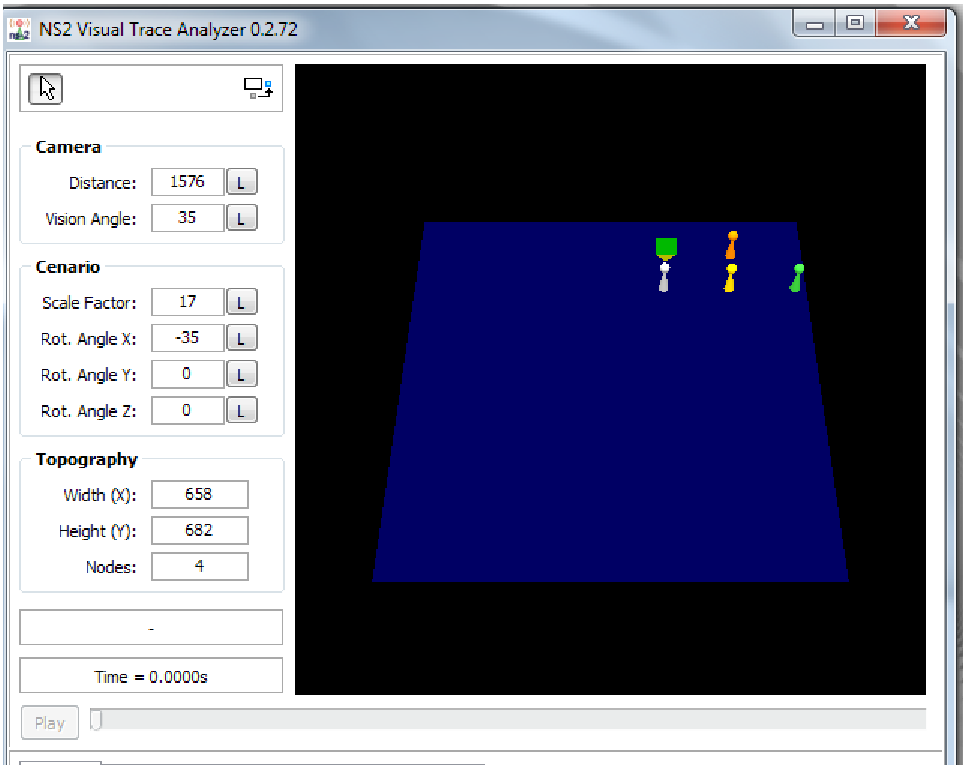


Figure 3.3 : NS2 Visual Trace Analyzer.

3.2.4 Editor (Sublime Text 3) :

Sublime Text 3 is a proprietary cross-platform source code editor with a Python application programming interface (API). It natively supports many programming languages and markup languages, and functions can be added by users with plugins, typically community-built and maintained under free-software licenses.

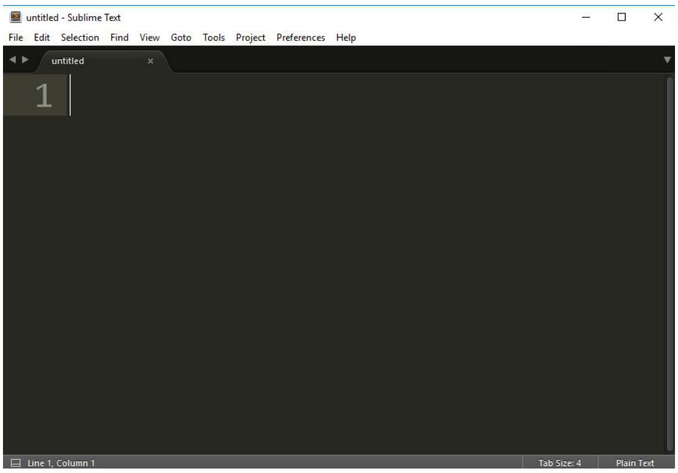


Figure 3.4 : Editor (Sublime Text 3).

3.3 The Basic Criteria Table for the Project is Given Below :

Criteria	Parameter
Propagatioon Model	Two-Ray Model
Network Interface Type	Phy/Wireless PHY
MAC Type	MAC/802.11p
Interface Queue Type	Droptail
Antenna Model	Omni Antenna
Number of Nodes	4
Link Layer Type	LL
Routing Protocol Used	3
Name of Routing Protocol	AODV,DSDV,DSR
Simulation Time	10.0
Maximum Packet in Queue	256
Application Type	FTP
Agent Type	TCP

Table No. 3.1 : The Basic Criteria.

3.4 Sequential Steps for Implementation :

The steps followed to complete the project are described :

1. Establish the network using any editor with tcl scripting.

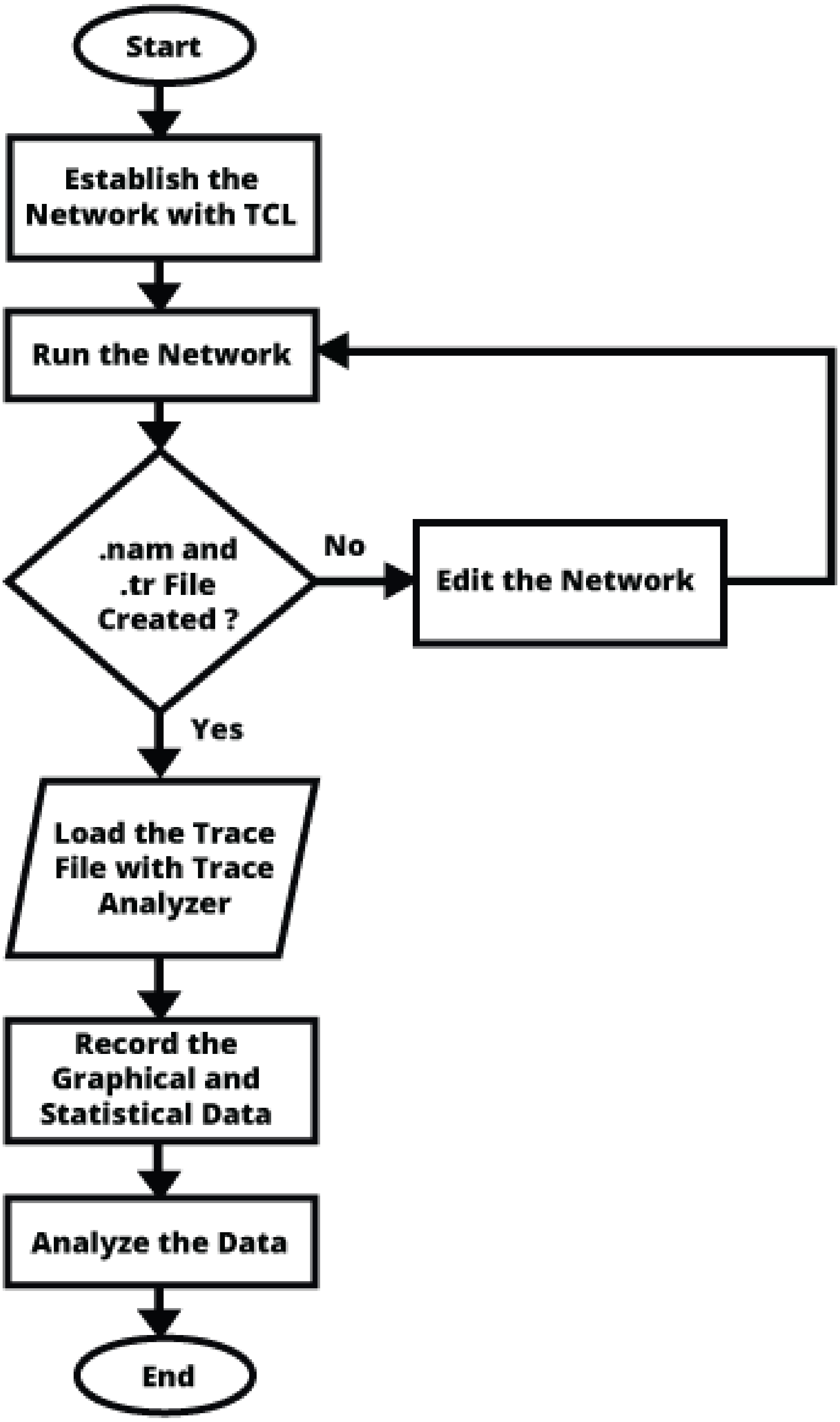
2. Run the network using network simulator NS2.

3. Change the routing protocol again and again for the same network to understand the performance.

4. Load the trace file with visual trace analyzer and obtain the statiscal data of throughput and delay.

5. Compare the obtained data and analysis them to find the proper result.

3.4.1 The Total Procedural Flow Chart for the Project is Given Below :



Flow Chart 3.1 : Total Procedure.

3.5 Total Execution Of the Network with Network Simulator 2 :

To run the network in windows with NS2 we need to install the offline cygwin installer.By executing the created network we get the network animated file called .NAM file.I create network for three major protocols AODV,DSDV,DSR with four nodes.The created animated files for same network with different protocols when the nodes are stable or moveable are given below :

3.5.1 AODV .nam File :

These figures are the network animation shown in NS2.This output is shown by the network which fulfil above mentioned basic criteria.This network simulated for the above mentioned time based on the adhoc routing protocol AODV.The nodes in the first figure are moveable and in the second figure they are stable.

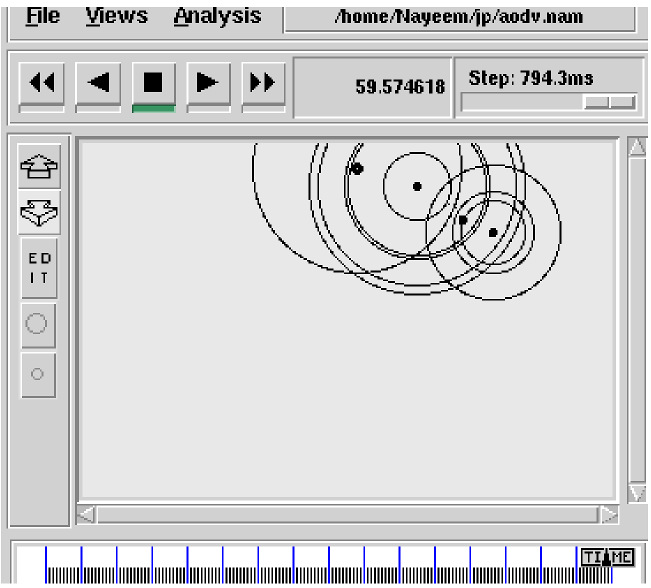


Figure 3.5 : AODV Movable.

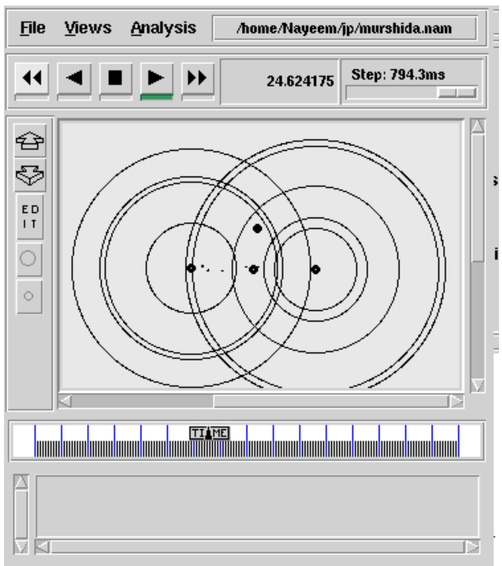
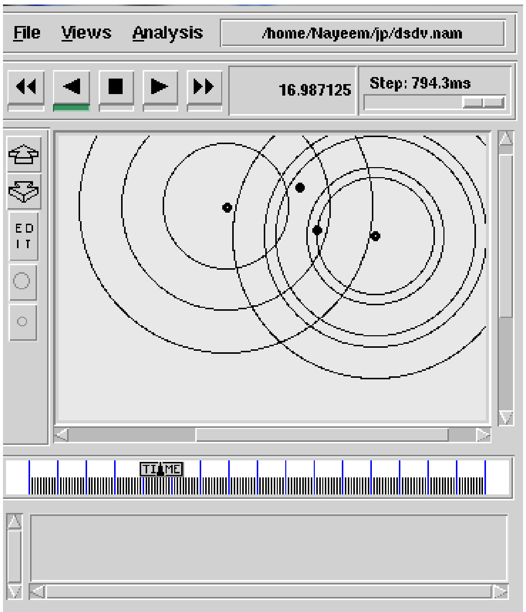


Figure 3.6 : AODV Non-Movable.

3.5.2 DSDV .nam File :

These figures show the .nam file for DSDV routing protocol.The first figure shows the network animator file when the nodes are moveable and the second figure shows when the nodes are stable.



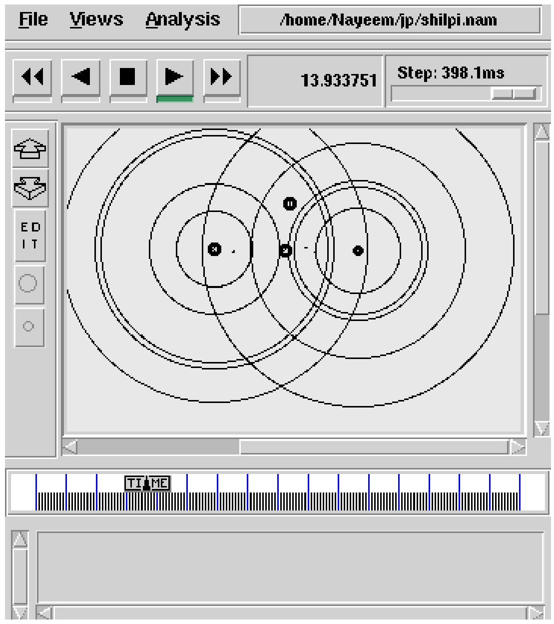
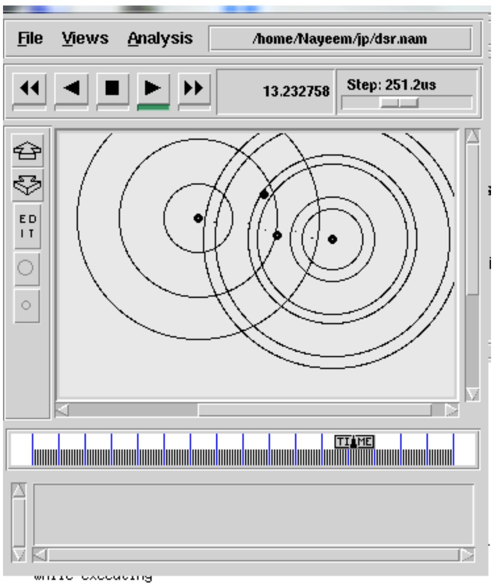


Figure 3.7 : DSDV Movable.

Figure 3.8 : DSDV Non-Movable.

3.5.3 DSR .nam File :

These figures are the network animation shown in NS2.This output is shown by the network which fulfil above mentioned basic criteria.This network simulated for the above mentioned time based on the adhoc routing protocol DSR.The nodes in the first figure are moveable and in the second figure they are stable.



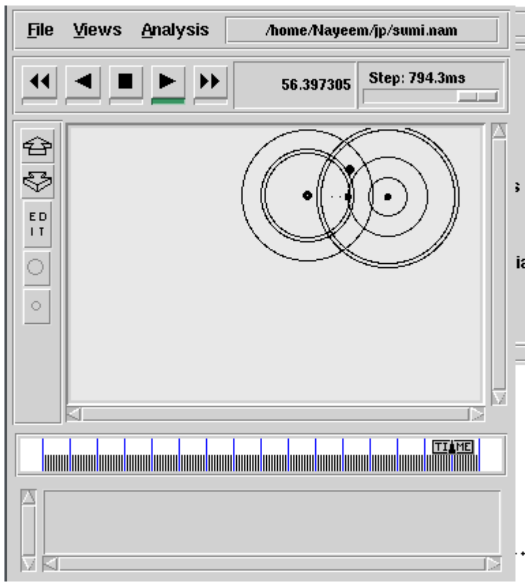


Figure 3.9 : DSR Movable.

Figure 3.10 : DSR Non-Movable.

Chapter 4

Performance Analysis of Different Routing Protocols of Vehicular Adhoc Network (VANET)

4.1 Introduction :

After a long processing the result of the project will be studied here.By analysing and comparing the statistical and graphical data found in the visual trace analyzer the result can be found.The three protocols AODV,DSDV and DSR are examined for some basic parameter to obotain their performance in a specific given network.After the study and analysis of the following given data the result would be easily found.

4.2 The Performance For Movable And Non-Movable Nodes of The Network :

The visual trace analyzer gives the graphical representation and statistical data for the analysis of the same network with different routing protocol.Here I analyze the network for the three major routing protocol AODV,DSDV and DSR.The graphical view of the throughput,delay and jitter of the three routing protocols are shown below.

4.2.1 Needed Terms for Processing : Before the analysis here I introduce some terms which will be needed for this section :

1. Connection Types : There are several types of connection pattern in VANET. For our simulation purpose we have used CBR and TCP connection pattern.

(i) Constant Bit Rate (CBR) : Constant bit rate means consistent bits rate in traffic are supplied to the network. In CBR, data packets are sent with fixed size and fixed interval between each data packets. Establishment phase of connection between nodes is not required here, even the receiving node don't send any acknowledgement messages. Connection is one way direction like source to destination.

(ii) Transmission Control Protocol (TCP) : TCP is a connection oriented and reliable transport protocol. To ensure reliable data transfer TCP uses acknowledgement, time outs and retransmission. Acknowledge means successful transmission of packets from source to destination. If an acknowledgement is not received during a certain period of time which is called time out then TCP transmit the data again.

2. Parameters : For network simulation, there are several performance metrics which is used to evaluate the performance. In simulation purpose we have used three performance metrics.

(i) Throughput : Throughput is the amount of work that a computer can do in a given period of time. The work can be measured in terms of the amount of data processed or transferred from one location to another by a computer, computer-network or computer component.

(ii) Jitter : In electronics and telecommunications, jitter is the deviation from true periodicity of a presumably periodic signal, often in relation to a reference clock signal. In clock recoveryapplications it is called timing jitter. Jitter is a significant, and usually undesired, factor in the design of almost all communications links.

(iii) Packet Delivery Ratio : Packet delivery ratio is the ratio of number of packets received at the destination to the number of packets sent from the source. The performance is better when packet delivery ratio is high.

(iv) Average End-to-End Delay : This is the average time delay for data packets from the source node to the destination node. To find out the end-to-end delay the difference of packet sent and received time was stored and then dividing the total time difference over the total number of packet received gave the average end-to-end delay for the received packets. The performance is better when packet endto-
end delay is low.

(v) Loss Packet Ratio (LPR) : Loss Packet Ratio is the ratio of the number of packets that never reached the destination to the number of packets originated by the source.

4.2.2 The Visual Analysis of the AODV Protocol :

4.2.2.1 Throughput :

The avobe figures represent the transferred throughput for the movable and non-movable nodes of the same network based on the AODV protocol.The transferred throughput for the non-movable nodes is higher than the movable nodes because the the non movable nodes do not drop any packets.

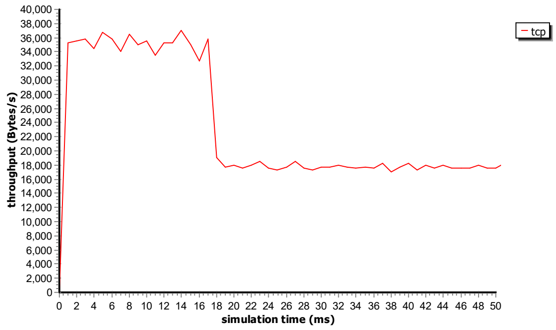


Figure 4.1 : Transferred Thoughput for AODV (Movable Nodes).

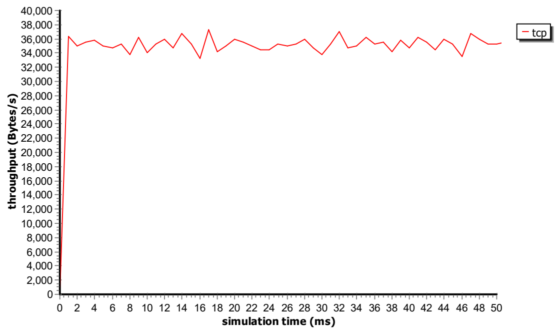


Figure 4.2 : Transferred Thoughput for AODV (Non-Movable Nodes).

4.2.2.2 End to End Delay Per Packet :

The figures represent that the end-to-end delay per packet of the network based on AODV protocol.The end-to-end delay is more in the network where the nodes are movable than the network where the nodes are stable.Because of the velocity of nodes the network may be affected by varous kinds of noise, interference etc. And the information packet send to the receiver may get delayed.

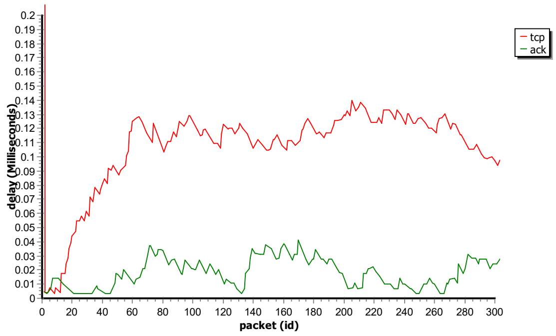


Figure 4.3 : Delay for AODV (Movable).

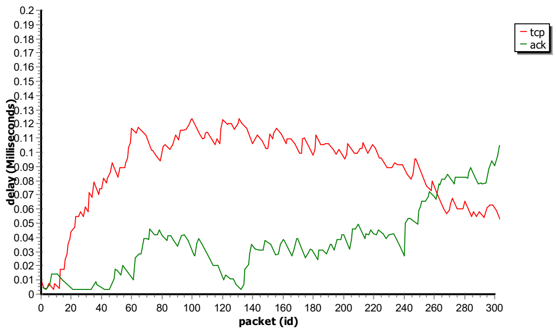


Figure 4.4 : Delay for AODV (Non-Movable).

4.2.2.3 Jitter Per Packet :

The above figures represent the jitter per packet for the AODV protocol.The first figure is about the network with movable nodes and the second one is for the network with non-movable nodes.The higher jitter is bad for any network because it is responsible for adding noise and interference to the network.Here the jitter per packet is greater for the network with movable nodes than the network with non-movable nodes.For the speed of the nodes jitter gets increased.

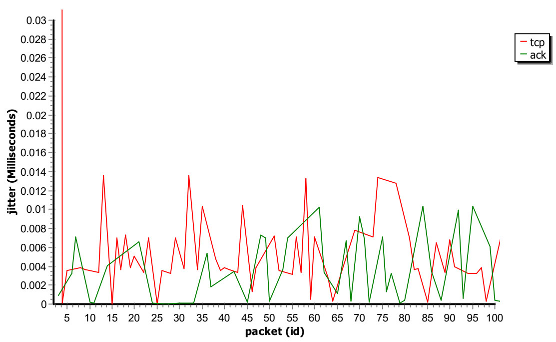


Figure 4.5 : Jitter for AODV (Movable).

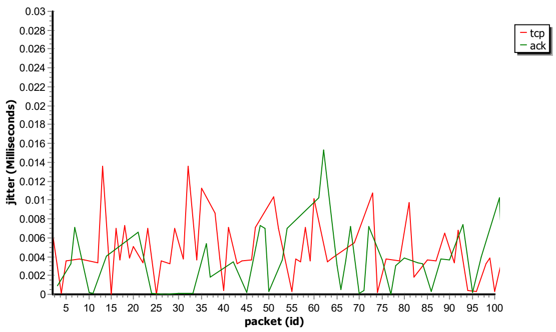


Figure 4.6 : Jitter for AODV (Non-Movable).

4.2.3 The Visual Analysis of the DSDV Protocol :

4.2.3.1 Throughput :

The avobe figures represent the transferred throughput for the movable and non-movable nodes of the same network based on the DSDV protocol.The transferred throughput for the non-movable nodes is higher than the movable nodes because the the non movable nodes do not drop any packets.When the network does not drop any packet the packet ratio gets increased hence the throughput increase.

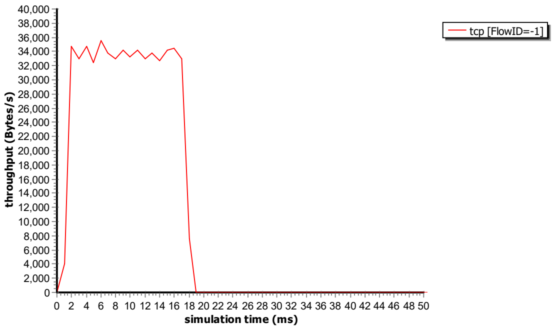


Figure 4.7 : Transferred Thoughput for DSDV (Movable Nodes).

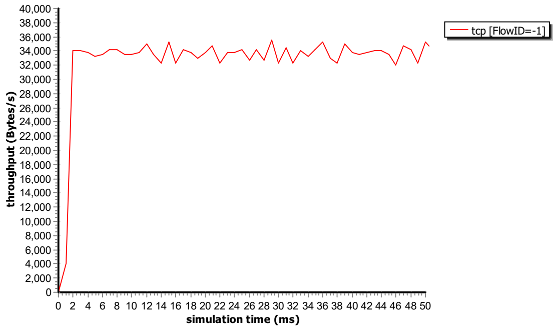


Figure 4.8 : Transferred Thoughput for DSDV (Non-Movable Nodes).

4.2.3.2 End-to-End Delay Per Packet :

The figures represent that the end-to-end delay per packet based on the DSDV routing protocol.It is more in the network where the nodes are movable than the network where the nodes are stable.Because of the velocity of nodes the network may be affected by varous kinds of noise, interference etc for the sent signal may be delayed to to reach to the receiver.

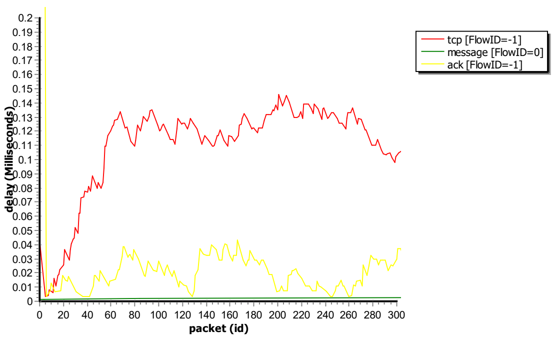


Figure 4.9 : Delay for DSDV (Movable Nodes).

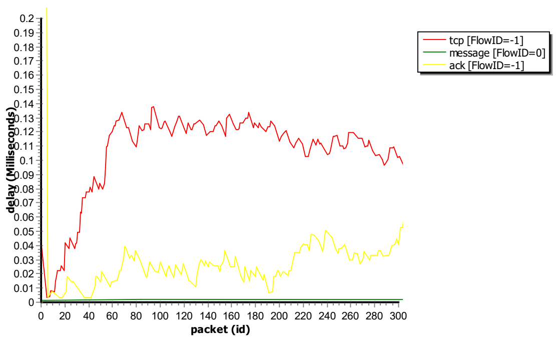


Figure 4.10 : Delay for DSDV(Non-Movable Nodes).

4.2.3.3 Jitter Per Packet :

The figures represent that the jitter per packet for the DSDV protocol.The jitter is more in the network where the nodes are movable than the network where the nodes are stable.Because of the velocity of nodes the network may be affected by varous kinds of noise, interference etc. And the information packet send to the receiver may get delayed.

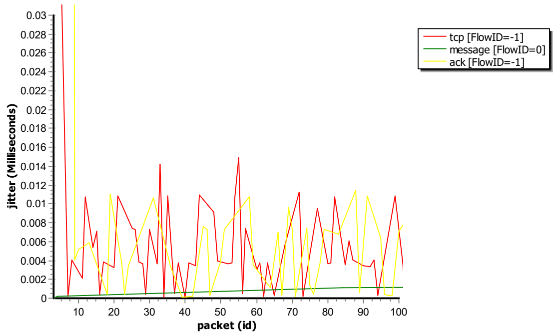


Figure 4.11 : Jitter for DSDV (Movable Nodes).

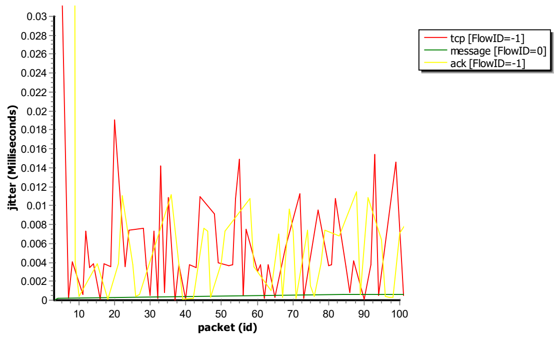


Figure 4.12 : Jitter for DSDV (Non-Movable Nodes).

4.2.4 The Visual Analysis of the DSR Protocol :

4.2.4.1 Throughput :

The above figures represent the transferred throughput for the movable and non-movable nodes of the same network based on the DSR protocol.The transferred throughput for the non-movable nodes is higher than the movable nodes because the the non movable nodes do not drop any packets.

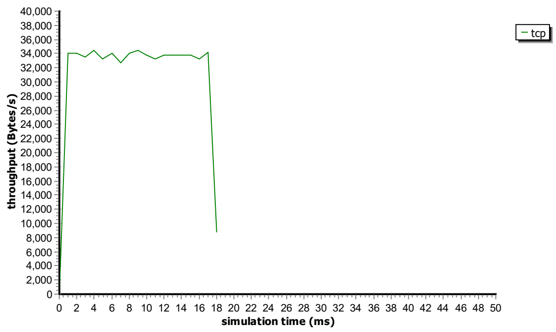


Figure 4.13 : Transferred Thoughput for DSR (Movable Nodes).

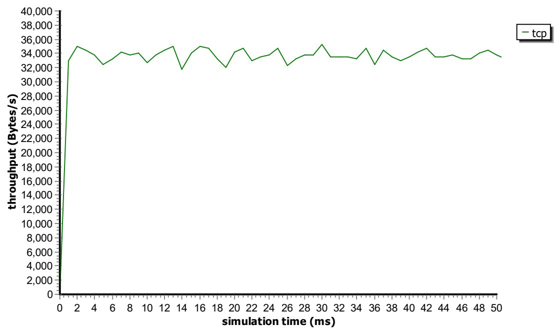


Figure 4.14 : Transferred Thoughput for DSR (Non-Movable Nodes).

4.2.4.2 End-to-End Delay Per Packet :

The figures represent that the end-to-end delay per packet of the network based on DSR protocol.The end-to-end delay is more in the network where the nodes are movable than the network where the nodes are stable.Because of the velocity of nodes the network may be affected by varous kinds of noise, interference etc. And the information packet send to the receiver may get delayed.

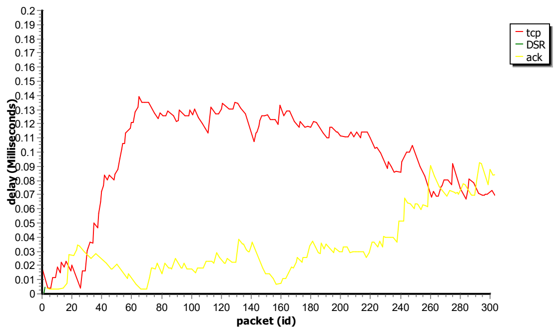


Figure 4.15 : Delay for DSR (Movable Nodes).

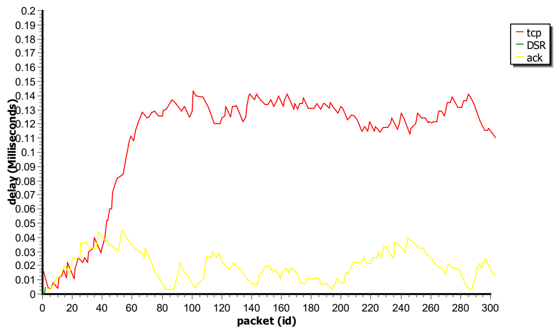


Figure 4.16 : Delay for DSR (Non-Movable Nodes).

4.2.4.3 Jitter Per Packet :

The above figures represent the jitter per packet for the DSR protocol.The first figure is about the network with movable nodes and the second one is for the network with non-movable nodes.The higher jitter is bad for any network because it is responsible for adding noise and interference to the network.Here the jitter per packet is greater for the network with movable nodes than the network with non-movable nodes.For the speed of the nodes jitter gets increased.

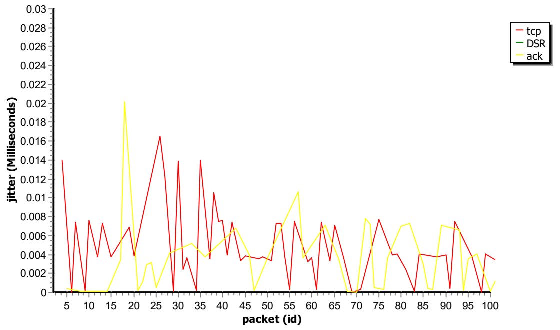


Figure 4.17 : Jitter for DSR (Movable Nodes).

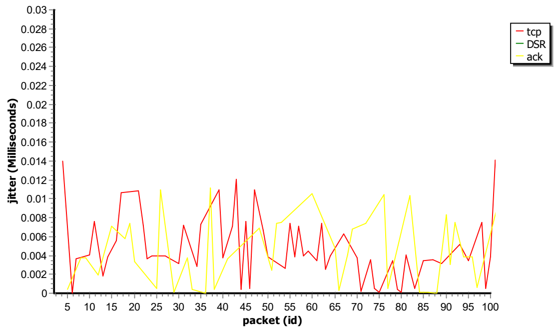


Figure 4.18 : Jitter for DSR (Non-Movable Nodes).

4.3 Statistical Data :

Protocol	Movable Nodes			Non-Movable Nodes		
	AODV	DSDV	DSR	AODV	DSDV	DSR
			Generated Data			
Packets	5468	2232	2340	8475	7978	8105
Data	1 Mb	545 Kb	571 Kb	2 Mb	2 Mb	2 Mb
Ratio Packets Bytes	 50.082% 54.425%	 49.955% 54.543%	 50.064% 54.420%	 50.050% 54.395%	 49.937% 54.345%	 50.021% 54.371%
			Dropped Data			
Packets Data	6 1 Kb	24 6 Kb	0 0 bytes	0 0 bytes	0 0 bytes	0 0 bytes
Ratio Packets Bytes	 0.109% 0.109%	 1.075% 1.075%	 0.000% 0.000%	 0.000% 0.000%	 0.000% 0.000%	 0.000% 0.000%

Table No. 4.1 : Statistical Data

Protocol	Movable Nodes			Non-Movable Nodes		
	AODV	DSDV	DSR	AODV	DSDV	DSR
		Throughput Transferred				
Minimum	17 KB/s	4 KB/s	9 KB/s	32 KB/s	4 KB/s	31 KB/s
Average	22 KB/s	30 KB/s	32 KB/s	34 KB/s	32 KB/s	33 KB/s
Maximum	36 KB/s	35 KB/s	34 KB/s	36 KB/s	35 KB/s	34 KB/s
		Throughput Generated				
Minimum	16 KB/s	0 B/s	9 KB/s	32 KB/s	7 KB/s	31 KB/s
Average	22 KB/s	12 KB/s	32 KB/s	34 KB/s	32 KB/s	33 KB/s
Maximum	39 KB/s	34 KB/s	36 KB/s	37 KB/s	35 KB/s	37 KB/s

Table No. 4.2 : Statistical Throughput

Protocol	Movable Nodes			Non-Movable Nodes		
	AODV	DSDV	DSR	AODV	DSDV	DSR
		Packets Delay				
Minimum	0.003	0.003	0.003	0.003	0.003	0.003
Average	0.108	0.059	0.051	0.063	0.074	0.081
Maximum	17.524	0.148	0.146	0.143	0.148	0.150
		Packets Jitter				
Minimum	0	0	0	0	0	0
Average	0.009	0.004	0.003	0.003	0.003	0.003
Maximum	17.520	0.038	0.029	0.045	0.038	0.037

Table No. 4.3 : Statistical Delay

Protocol	Movable Nodes			Non-Movable Nodes		
	AODV	DSDV	DSR	AODV	DSDV	DSR
			Defined			
Packets	13	0	8	17	5	9
Data	3 Kb	0 bytes	2 Kb	4 Kb	1 Kb	2 Kb
Ratio Packets Bytes	 0.237% 0.237%	 0.000% 0.000%	 0.341% 0.342%	 0.200% 0.200%	 0.062% 0.062%	 0.111% 0.111%
			Total Link Losses			
Packets	13	0	8	17	5	9
Data	3 Kb	0 bytes	2 Kb	4 Kb	1 Kb	2 Kb
Ratio Packets Bytes	 0.237% 0.237%	 0.000% 0.000%	 0.341% 0.342%	 0.200% 0.200%	 0.062% 0.062%	 0.111% 0.111%
			Packet Delivery			
Packets	19	24	8	17	5	9
Data	5 Kb	6 Kb	2 Kb	4 Kb	1 Kb	2 Kb
Ratio Packets Bytes	 0.347% 0.347%	 1.075% 1.075%	 0.341% 0.342%	 0.200% 0.200%	 0.062% 0.062%	 0.111% 0.111%

Table No. 4.4 : Statistical Link Losses

4.4 Overall Performance Analysis of the AODV,DSDV and DSR :

4.4.1 Packet Ratio : Packet ratio is the ratio of the total packet received in the receiver node to the total packet send from the sender.Here the highest packet ratio is recorded for the AODV protocol for the both situation when the nodes ae movable in the network and also when the nodes are non-movable.This parameter is expressed as percentage here where the packet ratio fluctuates around 50% for all the protocol AODV,DSDV,DSR.So for higher packet ratio AODV is the mostly used protocol.

4.4.2 Dropped Packet : Dropped packet provides the information about the packet dropped per second.According to above mentioned data the DSR protocol drop no packets when routing happens.The number of dropped packet is 0 for both the movable and non-movable nodes of the network for the DSR protocol. The AODV and DSDV protocol drop packets where the DSDV drop the maximum packets.So for minimum drop packet we can use DSR.

4.4.3 Average End-to-End Delay : The average end to end delay per packets is lowest in DSR protocol for the movable nodes of the network.But for stable nodes the AODV protocol gives the minimum average delay.From the above statistical data we can see that in the movable network it is efficient to use DSR for lowest end-to-end delay .

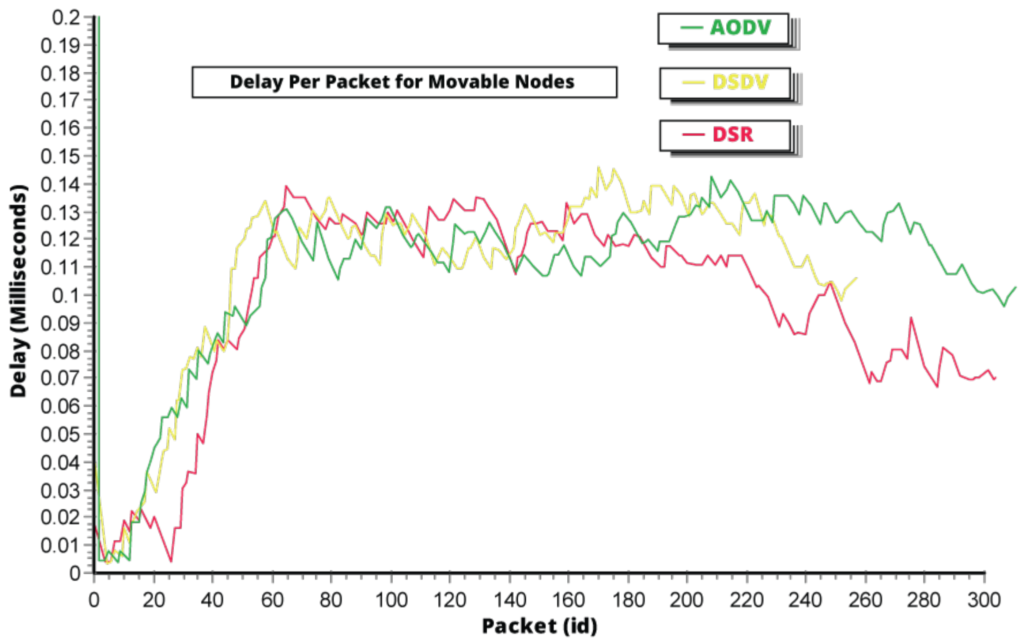


Figure 4.19 : Delay Per Packet for Movable Nodes

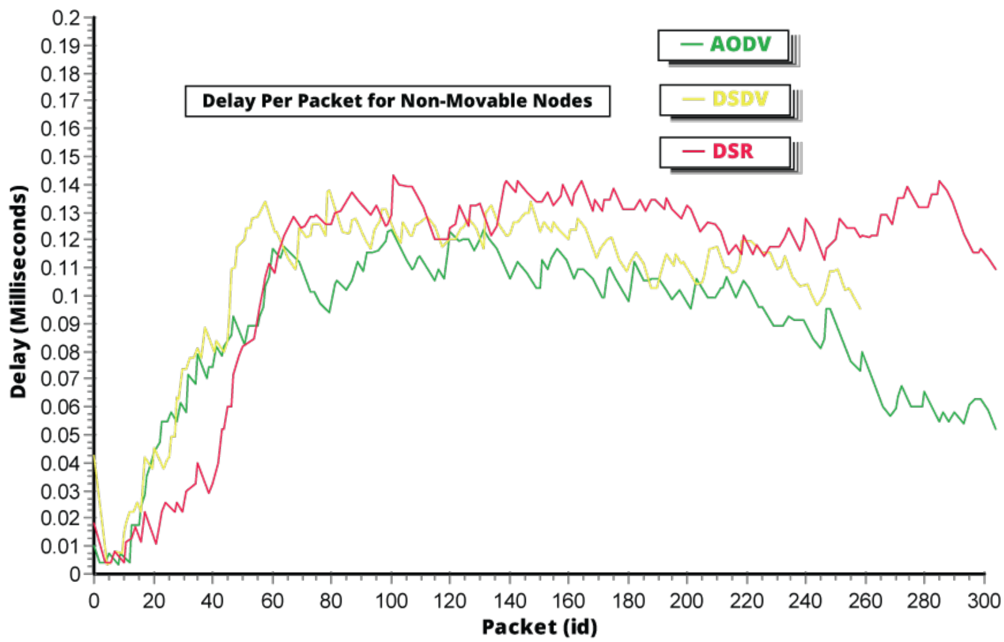


Figure 4.20 : Delay Per Packet for Non-Movable Nodes

4.4.4 The Average Jitter : Jitter can cause some bad impact for the network such as noise ,interference etc.So for all network low jitter is expected.From the above chart we can say that for movable nodes the DSR algorithm provides the mnimum jitter and for non-movable nodes AODV provides the minimum jitter.

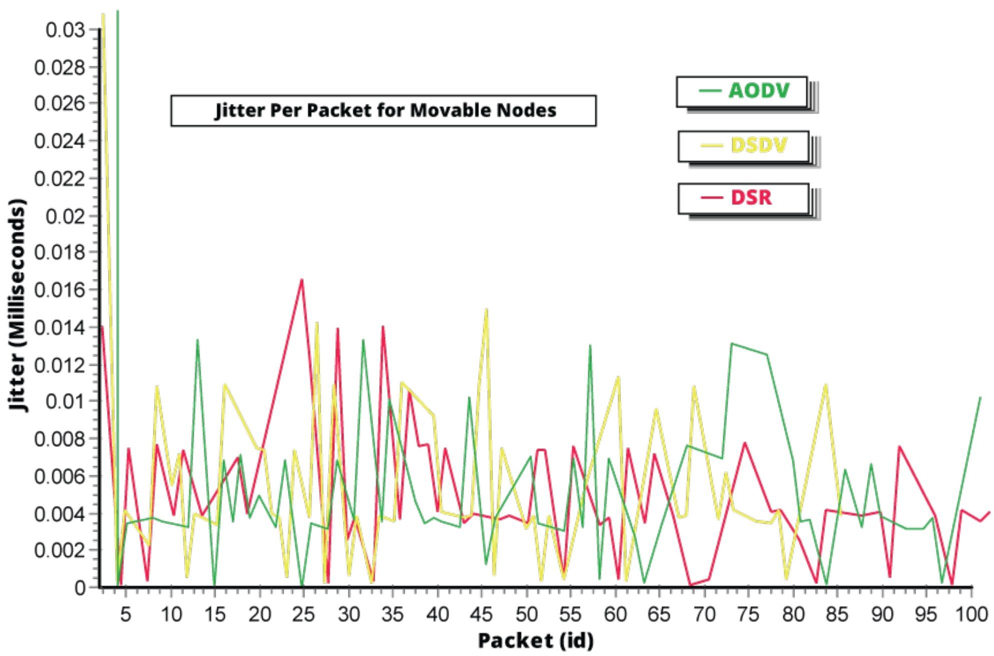


Figure 4.21 : Jitter Per Packet for Movable Nodes

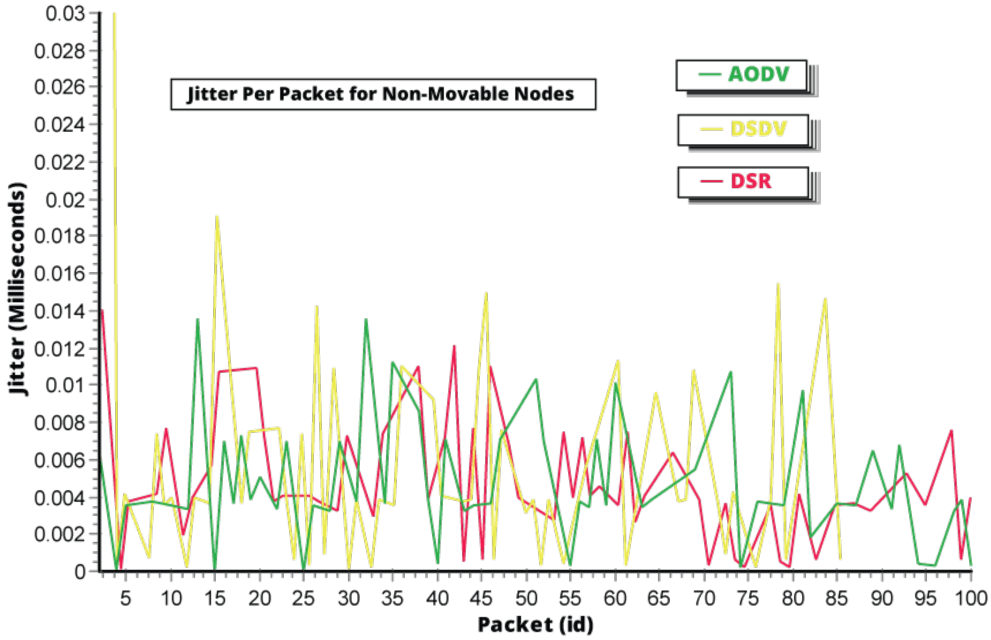


Figure 4.22 : Jitter Per Packet for Non-Movable Nodes

4.4.5 Throughput : Throughput provides the maximum rate of data transferred from the sender to the receiver.From the above mentioned data the maximum transferred throughput is highest in AODV protocol for both the movable and non-movable nodes network.The AODV provides the maximum throughput among the above three protocols AODV,DSDV and DSR.So for maximum throughput we can select the AODV algorithm for our networks.

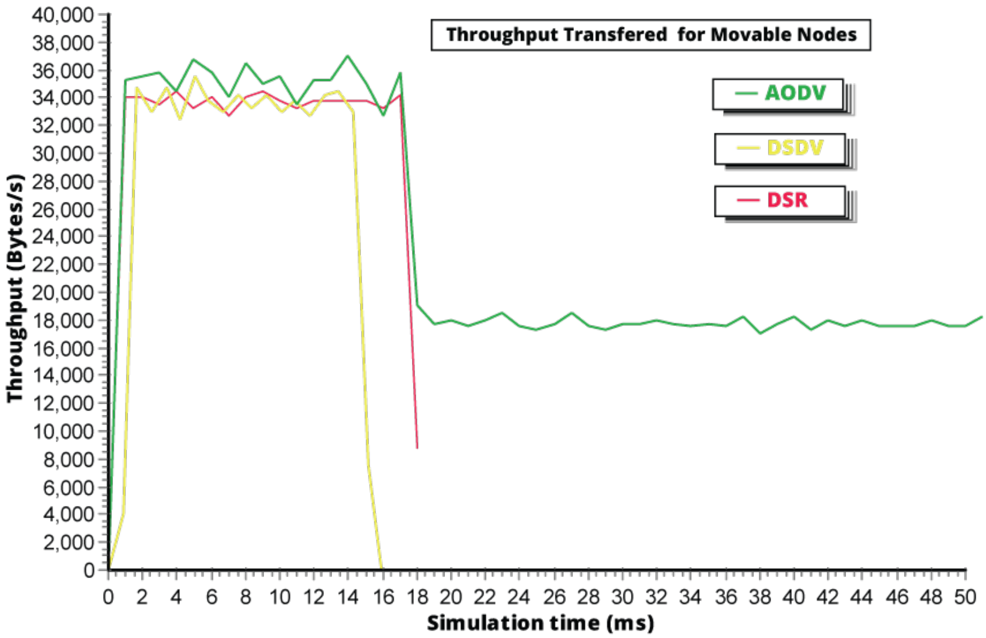


Figure 4.23 : Throughput Transfered for Movable Nodes

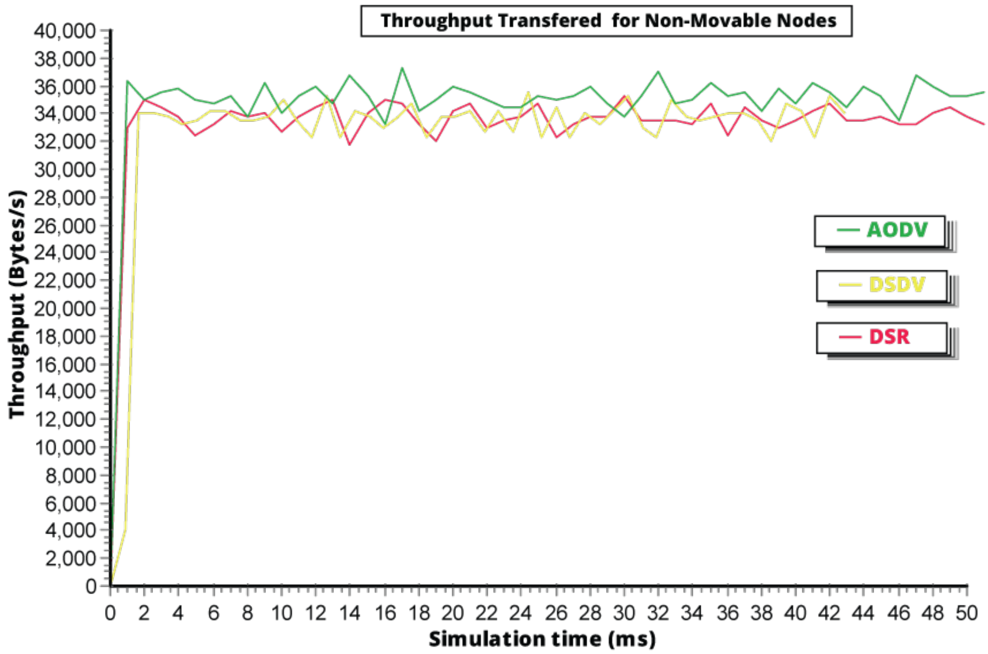


Figure 4.24 : Throughput Transfered for Non-Movable Nodes

4.4.6 Total Link Losses : The total link losses is lowest for both the moable and non-movable nodes network is in DSDV protocol.It has a total 0 link losses for movable nodes.So if we want to select the protocol with less link losses we can select DSDV protocol.

4.4.7 Total Lost Packet : The DSR protocol drop less packets than the two other protocol in the mentioned network when the nodes are movable.And the DSDV protocol lose the lowest number of packets in the non-movable nodes network.

Chapter 5

Conclusion & Future Work

Here in the project,the different parameters are discussed for the same network with three different protocols AODV,DSDV and DSR.From the study of this project it can be concluded that among the three protocols one is suitable for one parameter or more.But from the analysis of the total project it is found that the AODV protocol is more convenient for applying on any nework though it is stable or non-stable.The AODV protocol is most suitable because it provides greater throughput, less average end-to-end delay and average jitter.The DSDV and DSR protocols are also suitable for some parameters like delay dropped packet and link losses.

As mobiles are familiar and used by us in our day to day life, similarly the future of VANETs is undoubtedly se-cure. It has become the part of the government projects. In India, National Highways Authority of India (NHAI) is planning to replace manual toll collections at pla-zas with electronic toll collection (ETC) systems across the country. The ETC system will be based on radio fre-quency identifica-tion (RFID), which will be comple-mented by a wireless on-board unit (OBU) on a vehicle, as well as a stationery roadside unit (RSU) at the toll plaza. [30]

Australian police in New South Wales (NSW) and Victoria are considering the intro-duction of a new type of laser speed camera, which can catch drivers using mobile phones, as well as speeding motorists from half a mile away . The cameras, known as Concept II, have been manufactured by Tele-Traffic UK and are already in use by UK's Dorset police as the latest tool in their zero tol-erance campaign against driving offenses. Similarly, various projects are running in various countries to employ VANETs in traffic safety and efficiency.

There are many other challenges left that will have a strong influence on the future of VANETs. Although, to show the impact of VANETs on traffic safety, and effi-ciency, a number of simulators are available namely Es-tiNet, ns-2, TRANS and many more, but study of driver’s behavior and reaction [31] when additional in-formation is provided through VANETs is also a chal-lenge. The adoption of VANETs in the market is another challenge as there are many players in the game. [12]

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