"Analysis and Measurement of TCP Performance Under Vehicular Environment"

Realization of a Dissertation Report

Submitted By
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Under the Guidance of
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In partial fulfillment of the Requirement for the award of the Degree of

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TOPIC APPROVAL PERFORMA

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3	Project Academic Inputs: Project topic is relevant and makes extensive use of academic inputs in UG program and serves as a culminating effort for core study area of the degree program.	7.00
4	Project Supervision: Project supervisor's is technically competent to guide students, resolve any issues, and impart necessary skills.	7.00
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Final Topic Approved by PAC: **Analysis and measurement of TCP performance under High Speed mobility scenarios.**

Overall Remarks: Approved

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CERTIFICATE

This is to certify that the Report titled "Analysis and Measurement of TCP Performance under Vehicular Environment" that is being submitted by "**KULDEEP KUMAR**" is in partial fulfillment of the requirements for the award of "MASTER OF TECHNOLOGY" Degree, is a record of bonafide work done under our guidance. The contents of this report, in full or in parts, have neither been taken from any other source nor have been submitted to any other Institute or University for award of any degree or diploma and the same is certified.

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Objective of the Dissertation is satisfied / unsatisfied

Examiner I   Examiner II

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Date : April, 2017 Kuldeep Kumar

Place : LPU, Jalandhar Reg. No.11508252

DECLARATION

I, **KULDEEP KUMAR**, student of **M. TECH** under Department of **ELECTRONICS AND COMMUNICATION ENGINEERING** of **Lovely Professional University**, **Punjab**, hereby declare that all the information furnished in this thesis report is based on my own intensive research and is genuine.

This report does not, to the best of my knowledge, contain part of my work which has been submitted for the award of my degree either of this university or any other university without proper citation.

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ABSTRACT

In this report, we present as efforts were made to integrate emerging Vehicular Adhoc Network (VANETs) with the mobile internet architecture through Road Side Unit (RSU) to enhance its operational capabilities for safety and non-safety applications. Vehicular Adhoc Networks (VANETs) are made in integrate emergent with the help of wireless internet design over road side units to enhances the operational capability for user based applications. One of the prominent protocol, Transmission Control Protocol (TCP) which contribute a substantial quantity of internet traffics as the majorities of web application like file transfers, mail services, message service, etc. was based on transmission control protocol. However, TCP performs not up to the mark under transport wireless situation because of wireless channel errors and high mobility such as interference and fading that results in unexpected packets drop. In this report, interactive aspect of existing standard of TCP variants such as New Reno, BIC, Westwood, Cubic, Vegas, and Compound are analyzed and strictly tested underneath vehicular environments for traffic and variable speed. We have analyzed procedures are very helpful for foundation works in designing TCP completely for Vehicular environments. TCP is one of the prominent protocol that contributes a considerable amount of internet traffic as the vast majority of internet applications such as file transfer, messaging service, mail services, etc. was based on TCP. However, TCP performs poorly under vehicular wireless environment due to its high mobility and wireless errors such as fading and interferences that lead to unpredicted packet drop. In this paper This analysis forms a foundation work in designing TCP exclusively for vehicular environments.

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LIST OF ABBREVIATIONS

ITS	:	Intelligent Transportation System
TCP	:	Transmission Control Protocol
V2V	:	Vehicular to Vehicular
V2I	:	Vehicular to Infrastructure
RTT	:	Round Trip Time
LFN	:	Long Fat Network
RSU	:	Road Side Unit
BIC	:	Binary Increase Congestion
ACK	:	Acknowledgement
Ssthresh	:	Slow Start Threshold.
Cwnd	:	Congestion Window
Dwnd	:	Delay Window
Awnd	:	Advertised Window from Receiver
DSRC	:	Dedicated Short Range Communication.
AODV	:	Ad hoc On Demand Distance Vector
WAVE	:	Wireless Access in Vehicular Environment
IEEE	:	Institute of Electrical and Electronics Engineers
SACK	:	Selective Acknowledgement
QoS	:	Quality of Service
GPS	:	Global Positioning System
MANET	:	Mobile Ad hoc network
VANET	:	Vehicular Ad hoc network
VBR	:	Variable Bit Rate
CBR	:	Constant Bit Rate

CHAPTER 1
INTRODUCTION

1.1 Overview of VANETs

Vehicular Adhoc Networks (VANETs) are sub category of Mobile Adhoc Networks (MANETs), which identify vehicles such as cars act as node and each vehicle are having the transmission capability which are connected to form a networks. To form a network, we create mobile nodes using cars to design a mobile network. VANET is most distinguished vehicular wireless technologies that form wireless communication systems known as Intelligent Transportations System (ITS) [3]. This technology leads to various initiation of research area that increases the security and the efficiency of transportation system in the presence of the ambient condition or traffics in the road condition.

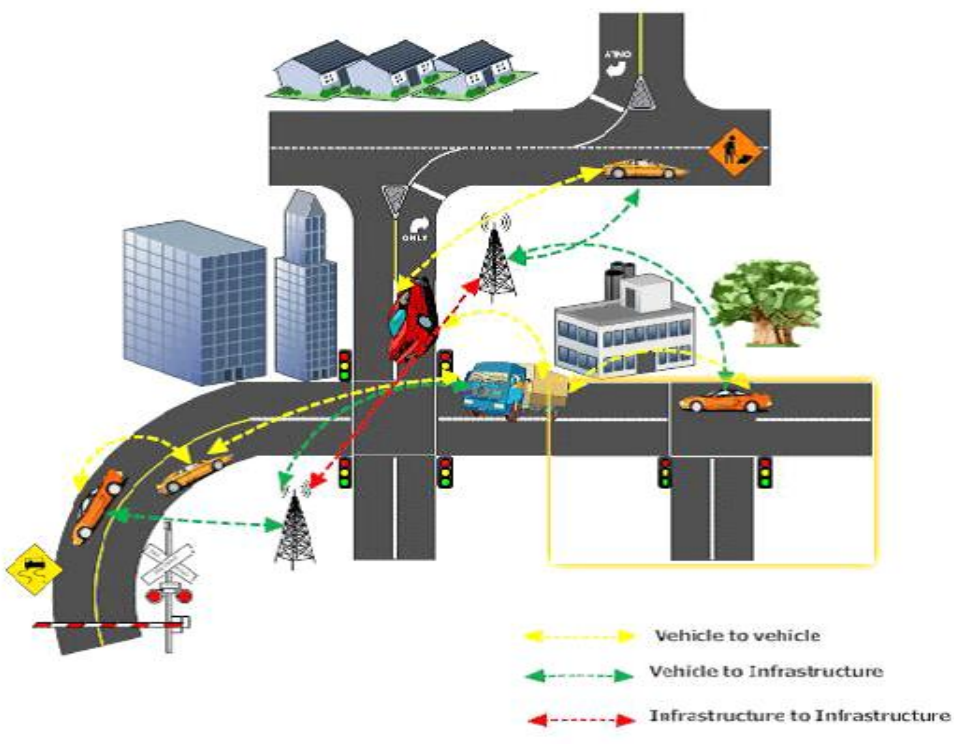


Fig. 1.1 Vehicular Ad hoc Networks Overview

The Vehicle networks system requires [5] authorities to govern it with exceeding limit of 800 million in the world today, consists of various number of nodes, provided communication range with other vehicle using the short radio signal. Dedicated Short Range Communications (DSRC) (5.850 to 5.925 GHz) with seven allocated non overlapping channels. This network is ad-hoc network, thus using routers as Road Side Units (RSU). So, the road side units work as a router between two or more vehicles and to other network devices. In a VANETs, vehicle will depend on the usual data from the others vehicles [2]. Thus depending upon the received data, further control decision can be made. If the information is false, then decision can be more dangerous.

As VANET does not have fixed topologies and architecture, it depends upon the moving vehicles that how they are connected in the network. In urban areas and highways VANET [6] follows some fixed path. VANET provides communication to improve the support of wireless products. These products can be PDAs (Personal Digital Assistants), mobiles, laptops, keyless entry devices etc.

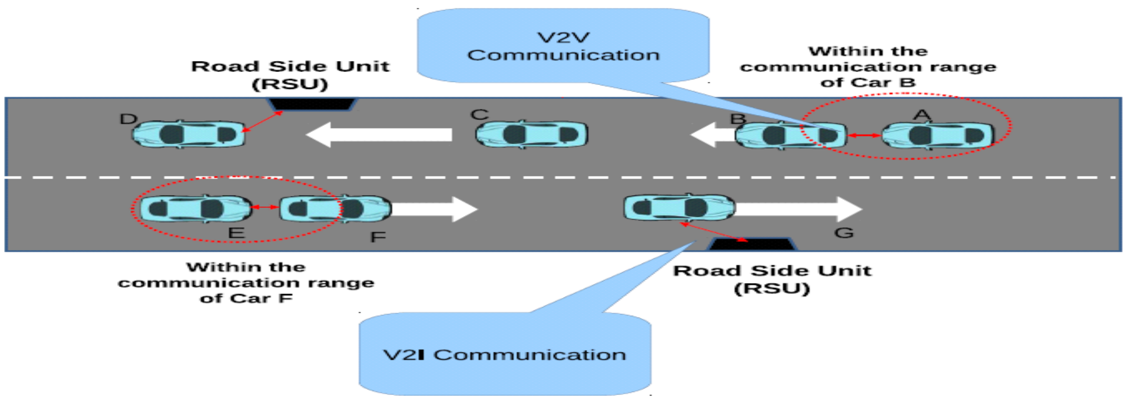


Fig. 1.2 Generating an Adhoc Networks using Vehicles (VANET)

Communication modes:

(1) Inter-Vehicle Communication or vehicles-to-vehicles (V2V) communication

(2) Vehicular-to –road side Communication or vehicles-to-Infrastructures (V2I) communication.

(3) Inter-roadside Communication

• **Inter-Vehicle Communication**: In this communication, to transmit the traffic related data to the multiple users, it uses the multi-hop configuration i.e. multicast/broadcast network. [29] In intelligent transportation systems, the communication activity should be in forward path in order to avoid the collision in emergency situation. [5]

VANET follows two types of packets forwarding techniques: simple broadcast technique and intelligent broadcast technique. In simple broadcasting technique, vehicles only receive data from forward side and ignores if the data comes from behind. Thus send the broadcast messages at regular interval of time.

Fig. 1.3 Inter vehicles communications

• **Vehicles to Roadside Unit's Communication**: In this kind of communications, configuration represent a single hop broadcasting where the roadside units send a broadcasted message to all equipped vehicle in the neighborhood. For the safety of the vehicle drivers it uses acknowledgement address to solve the problem of immature broadcasting.

In Fig. 1.4, this can be accomplished by reducing the number of message broadcasting for particular events. If one signal is received from the backside user assuming signal has reached, then it will stop broadcasting the messages signal.

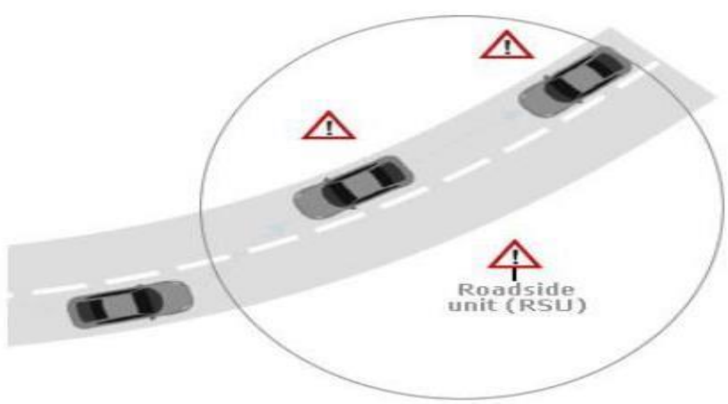


Fig. 1.4 Vehicles to roadsides communications

• **Inter roadsides unit communications**: This type of communications is also called as hybrid communications. Vehicle can use current environment or infrastructure to create a network and then broadcast massages information to other ad-hoc networks. Infrastructure can be single hop or multi hop dependent upon their locations and provides greater flexibility.

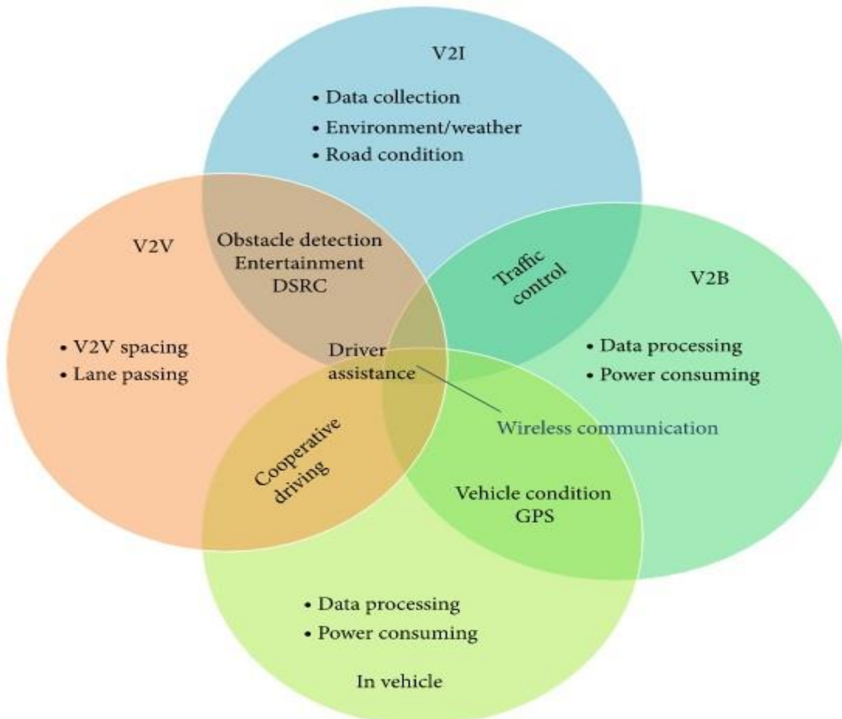


Fig. 1.5 Key functions of each communication type.

V2I depends on wireless or WiMAX at the same time as vehicular to vehicular relies upon on dedicated short range communications. Vehicular to infrastructure communication refers to the communications among automobile and roadside units. It can like wises be applied for internet access. Vehicular to vehicular to communication refers to the directed or multi jumps communication amongst automobile in VANETs. It is proficient and financially savvy due to its short range information's transfer capacity potential gains.

1.2 Layered Structure View of Vehicular Network

Vehicular network layered view can be described by the five classifications as shown in Table 1.2.1 First is to provide safety and comfort applications to the user. Chances of accidents and collision are less as it enhances the driving conditions. VANET can provide many other applications such as: incident management, emergency video streaming etc.

Table 1.2.1 Layered View of vehicular networks

Vehicular Network	Based on applications	• Can provide safety and comfort applications to the user • provide intelligent transport application
	Based on Quality of Service	• Non real condition • Soft real times • Hard real times
	Scopes of network	• LAN • WAN
	Networks types	• Adhoc network • Infrastructures based
	Communications types	• Vehicular to Infrastructure (V2I) • Vehicular to Vehicular (V2V)

Efficiency and accuracy can be enhanced by transport application as it delivers the fastest traffic information. Traffic pattern, vehicle tracking can be observed by the intelligent transport application in VANET. Communication in the network depends upon the scope of the network. LAN and WAN can be used accordingly by the scope of network. Also communication can be defined as two types: V2V and V2I. Based on the QoS parameters, [18] the performance of routing protocol in VANET is determined. It can be in real time scenario or in no real time simulation depends upon the condition of the network.

1.3 Comparison Between MANET and VANET

VANETs are different from MANETs in case of the following parameters such as VANETs having high mobility, random topologies, infrastructure less domains and having highly densed network. Depending upon these characteristic different routing protocols are evaluated.

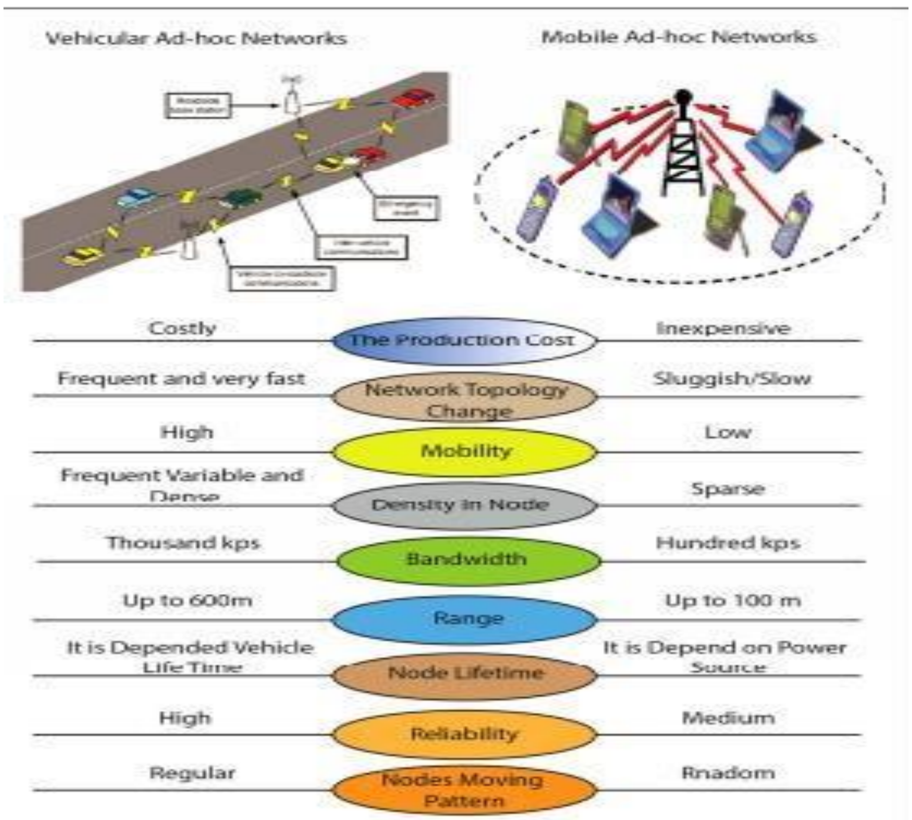


Fig. 1.6 Comparison between MANET and VANET

However, even VANET do have dynamic topology that are not random. As the travel limits is on the road, thus movement of nodes can be predicted. Power is not the constraint in the VANETs; They do not depend upon additional weight and additional antennas. Thus it has become a popular research area in academic. It is defined as infrastructure less network, thus the mobile [31] nodes are connected through wireless medium. so that each node can move freely in any direction of the network and it can be also change links according to the directions.

1.4 Applications in VANETs

Vehicular networks will play important part of application categorized in to following types.

1.4.1 Safety Related Application: VANET is mainly used [3] for providing safety to the vehicles. This can be done in following methods:

1.4.1.1 Collision Avoidance: Many researcher survey states that if drivers provided warning messages prior to the collision then 60% accidents can be avoided.

1.4.1.2 Cooperative Driving: This method provides the safe driving and can also help from the uninterrupted signals or messages. These users can also get some information regarding curve speed warning, lane change warning etc.

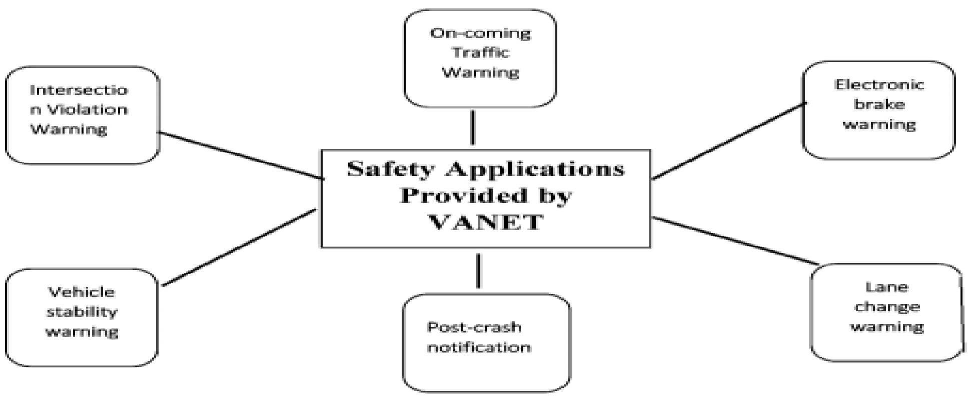


Fig. 1.7 Safety related applications

1.4.2. Convenience Oriented Application: In convenience oriented application, main focus is on saving driver's times and wastage of money and enhanced proficiency of intelligent transportation system in the road.

Fig. 1.8 Convenience Oriented Applications

1.4.3 User Based Application: They depend on the users to provide the services to the vehicles.

1.4.3.1 Peer–to-peer application: These applications provide important information services like entertainment sources, music and movies can be shared etc. between the vehicles in the network.

1.4.3.2. Internet Connectivity: Nowadays, internet has become the most priority in all the fields. Hence, users always want internet to connect with the network. VANET provides the internet connectivity to the vehicle users.

1.4.4 Safety Related VANETs Application

The probable safeties application in the vehicular network:

- Inter-sections Violation Warning (IVW)
- Electronics Brake Warning (EBW)

• **Intersection Violation Warning (IVW):** The IVW applications warn driver while they are going to passing over red lights as shown Fig. 1.9. It's possibility to achieve these applications by way of placing road side units with traffic's light controller, so that Road Side Unit (RSUs) broadcasting related to traffic lights information. Vehicle receives this information and it can be warning the vehicle drivers approximate the presence of a red lights signals to avoids accident in time.

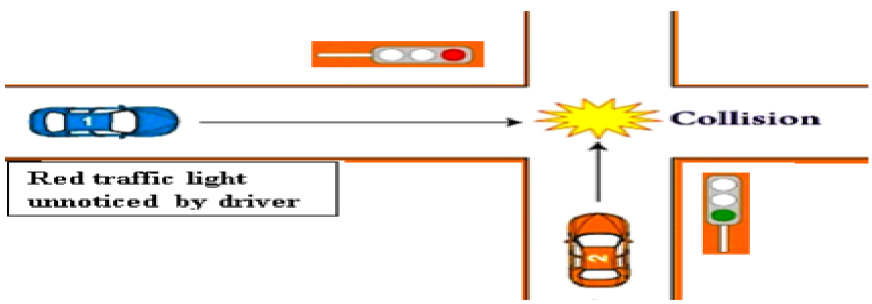


Fig. 1.9 Without IVW

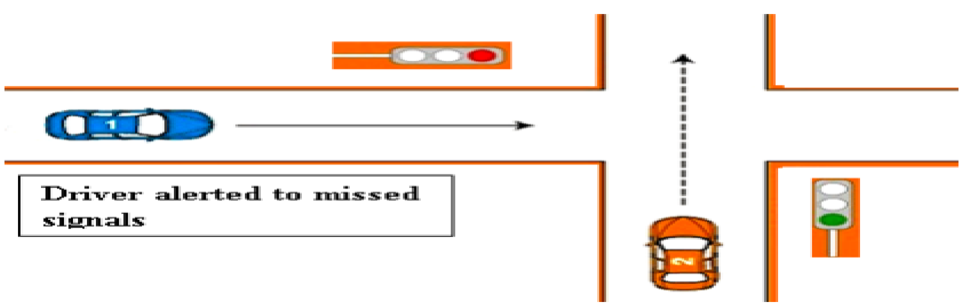


Fig. 1.10 With IVW

• **Electronics Brakes Warning (EBW):** The electronics brake warning applications report to the drivers that earlier vehicles have perform a suddenly brake. It is mainly useful when the views of the braking vehicles are obstructing by another vehicle as shown in Fig. 1.11-1.13.

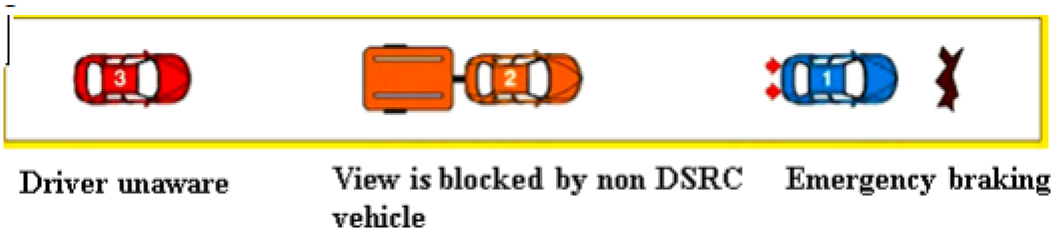


Fig. 1.11 Breaking Situations

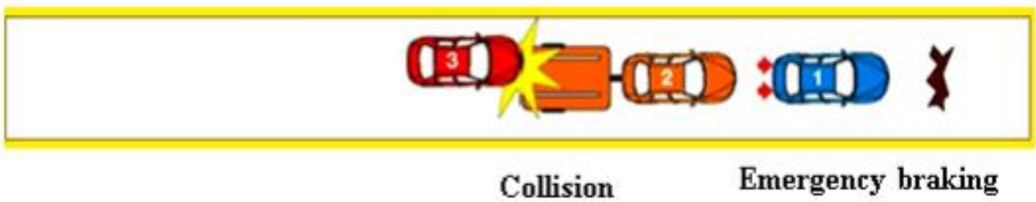


Fig. 1.12 Without Electronic Brake Warning

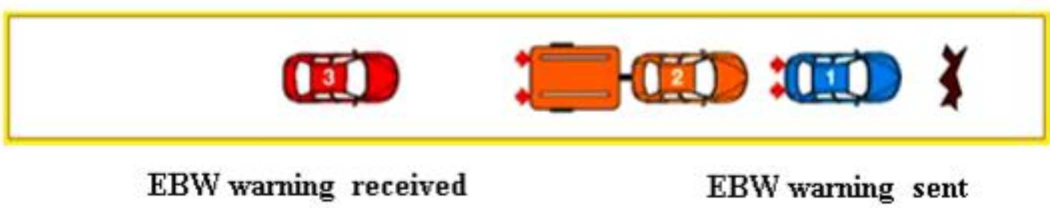


Fig. 1.13 With Electronic Brake Warning

1.5 Characteristics of Vehicular Ad Hoc Networks

The characteristics of Vehicular Ad hoc Networks are mainly a combination of wireless medium characteristics. A VANET can be utilized to offer following characteristics in the communication. [48] VANETs has its own separate characteristics given below:

1.5.1 High Mobility: In VANETs, nodes are frequently moving at high speed. A node predicts its positions and creating security of node privacy.

1.5.2 Unbounded networks size: Vehicular network can be built for small city, numerous cities, countries, and for worldwide. So network size in Vehicular ad hoc network is geologically unbounded.

1.5.3 Anonymity of the support: Wireless medium is generally used in data transmission. Transmitter operating on the same frequency band can transmit and hold the band for data transmission.

1.5.4 Rapidly changing network of dynamic topology: The position of node changes regularly due to high node mobility, dynamic topology in rapidly changing vehicular network changes frequently.

1.5.5 Enough Energy: The nodes do not have issue of energy and computation power resources. Because we can provide power from battery also.

1.5.6 Frequent disconnections: The rapidly changed network topology and high mobility of nodes along with another different conditions such as weather, climate mass of traffic perform disconnection of vehicles.

1.5.7 Better Physical Protection: Vehicular Ad hoc network nodes are physically superior protected. Thus, nodes are more challenging to settlement physically and decreases the effect of infrastructure attack in VANETs.

1.5.8 Availability of the transmission medium: The transmission medium of Vehicular Ad hoc Network is air. We can transmit the data wirelessly but in wireless transmission the major concern is security advantages in Inter Vehicular. Communication (IVC), becomes the starting point of some security matters.

1.5.9 Time Critical: The information in vehicular ad hoc network should be delivered to the node with in real limit so a choice will be created by the nodes and perform action consequently.

1.5.10 Limited bandwidth: The standardized DSRC band (5.850–5.925 GHz) for VANET are often thought-about as restricted, the dimension of the complete band is just 27 megahertz rate. Restrictions of use in some countries recommend that these 27 megahertz rate are not at all allowed and the most theoretical output is 27 Mbps.

1.6 Research Challenges in VANETs

VANET is emergent as some significant areas for the research technologies and thus having many research challenges [1,19] that need to be mention. Numerous issue emerges when endeavors are accumulated toward consecutively vehicular particularly chosen structures try to gives a changing to driving force conducted, with the factor of reducing the amount of mortalities added on through automobile crash. [1] The principle superior problems in VANETs and the keys problems from the technical factors of viewing are as in step with the subsequent.

1.6.1. WIRELESS ACCESS TECHNOLOGY

For VANET connectivity, several wireless access technologies are there can help to providing the secure network [2]. This particular technique is used for providing the high speed network for the vehicle communication using the media or medium.

1.6.1.1 Cellular Technologies (2/2.5/3g): The mainly used cellular technology is 2/2.5G technology due to the high coverages and reliability security and 3G, gradually but progressively taking over providing better capacities and higher bandwidth.

1.6.1.2 IEEE 802.11p Based Technologies: For the communication among vehicle, and roadside unit, IEEE 802.11 standards [28] are used. At the speed up to 200km/hr., the communication range between vehicles can be handled as high as 1000mtr.

1.6.1.3 Combined Wireless Access: ISO TC 204 WG16 (named CALM M5 (Continue Air Interfaces for Long and Medium ranges)) is an important aspect in ITS (intelligent transport system) which is responsible for combing those wireless technologies [2] which having sets of various interface protocols. System includes Infrared Communication and wireless systems in 60 GHz band.

1.6.2. SPECTRUM ISSUES

In VANET, for the vehicle communication, the desired bandwidth is used to provide safety and non-safety critical applications and services. IEEE 802.11spectrum provide the best technology for the communication system like spectrum resources and quality of services. Due to high vehicle density, spectrum scarcity is more.

1.6.3. BROADCASTING AND MESSAGE DISSEMINATION

Broadcasting technique is implemented when there is a huge amount of data to be broadcast. These techniques include narrow bandwidth solutions (FM signals) and wider bandwidth. For the real time traffic information services, satellite broadcasting emerges as a better solution for broadcasting. There are many techniques or broadcast schemes which are used for message dissemination (single-hop, multi-hop broadcasting) [2].

1.6.4. ROUTING ISSUES

For the better communication, in the VANET, routing protocols are used. Routing is used for selecting the best path for forwarding network traffic between network. MANETs routing protocols are very much similar to VANETs routing protocols to some extent based on performance. [11] The challenges in the routing protocols are due to frequent changes and high mobility in topologies and limited lifetime and these challenges are concerned with the safety so that the vehicles can be escape from danger.

1.6.5. POWER MANAGEMENT

The major concern in the VANET is for the safety of drivers and the passengers. Thus when the transmission power is too high, the wirelessly exchanging of information among vehicles may be frequently collapsed or could disrupt the transmission of each other due to interferences. So the transmission power for exchanging the information should be less to minimize interferences and for maximum throughput. The network should be denser, so that less transmission power can be used.

1.6.6. SECURITY AND PRIVACY

Security is an important issue for the VANET that need to be handled careful and address in the design of the vehicular network. As the information among vehicles are wirelessly distributed so there are high chances of data being lost or attack by the attackers. This can lead to great harm to drivers as well as passengers thus leads to decrease the performance of whole network. Privacy is also the main concern in this network as information about the vehicle for example driver's private information should not be leaked. Keeping a practical's agreement in the middle of the safety and protections is one of the principal problem in VANETs.

1.6.7 SIGNAL BLURRING

Objective set as obstacle between two offering automobiles are one of the problems that may affect the productiveness of VANETs. These stumbling blocks may be exclusive motors or structure convey alongside street in particular inside the urbans area [16] community bandwidths confinement. Additional key issues inside the VANETs is the nonattendances of a central facilitators that control the communication among node, and which have responsibility of handling with the control transferring capability and struggle operations.

1.6.8 CONNECTIVITY

Owing to the excessive portable and quick change of topologies in the network, which main to continuous breakage in structure, time period mandatory to increase the existence lifetime of the relationship communications must be as far is probably feasible. In this errand may be proficient by using expanding the transmitted powers, anyways, which could rapid throughput corruptions. In like way, connective is concept to be an imperious difficulty in VANETs, attributable to the slight successfully gadget distances crossways of a VANETs that cause a power less connectivity in the communication among node.

1.7 Routing Protocol Used in VANETs

For the design of vehicular networks, routing protocol is the main challenge due to nature of dynamic topology. As routing is the best path to transmit data from one side to another side. Conversely, the challenges remain same about the delay parameter reduction. To provide the protection or comfortable zones to the individually, exchanging of message ought to be done with inter vehicles communications [14]. Routing is more challenge in VANETs compare to MANETs because of high changes in dynamic topology characteristic. So to find and maintain the best path of communications in necessary environments is the most difficult tasks in VANETs.

Position based and topology based routing protocol are mainly used by the VANET system. As in topology based routing protocol, for sending packets from sender to receiver it uses link’s information within the network. It can be defined by two approach: proactive and reactive routing protocol. [8] Proactive is table driven protocol which uses shortest path algorithm to transfer packets.

The tables are also shared with the neighbors to find the optimum paths between sources and the destinations because if any update needed, then every node can update their routing table. Re-active routing protocols is known as on demand protocol because it maintains route discovery process with in the network. [14]

The routing protocol are categorized as shown in Fig. 1.14.

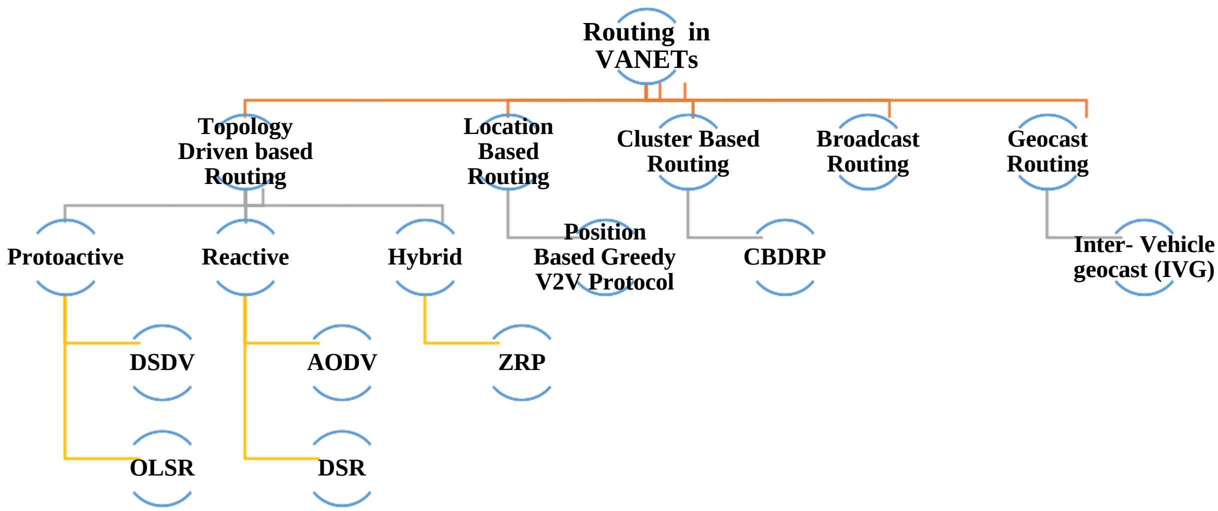


Fig. 1.14 Routing protocols used in VANETs

1.7.1 TOPOLOGY DRIVEN BASED ROUTING PROTOCOL

These protocol are finding the route and maintaining it in a tables (so called table driven) before the actual communication starts with the nodes. They are further classified into reactive, proactive and hybrid protocol.

1.7.1.1 Pro-active Routing Protocol: In this routing protocol, all the data of node is store in the form of table because these protocols are based on table. In this type of protocol, no requirement for route discovery and having low latency for real-times application. e.g. TBRPF, OLSR etc.

1.7.1.1.1 Destination Sequence Distance Vectors (DSDV) Routing Protocols: DSDV [4] is based on the shortest algorithms. The main purpose of this algorithm is to solve the routing loop problems. Only one single loop or rout is implemented from one node to another node. Each node is having routing table and own the sequence number to be accessible in the network zone.

1.7.1.1.2 OLSR Routing Protocols: The Optimize Link State Routing Protocols (OLSR) [3, 4] is a pro-active link-state routing protocols which is used for stability and accuracy of the nodes. The concept of multipoint relay is used in this protocol which's used for forwarding broadcast message during the overflowing process, thus reducing the message overhead.

1.7.1.2 Reactive Protocols: When one node wants to communicate with neighbor node, then this protocol starts the discovery of path which causes more routing overhead but reduces traffic overhead e.g. DSR, AODV, TORA etc. [14]

1.7.1.2.1 AODV (Ad Hoc on Demand Distance Vector): This is a table driven routing protocol can be used in unicast and multicast protocol. This protocol maintains a table to the nodes when a request is made by the source.

1.7.1.2.2 The Dynamic Source Routing (DSR): DSR protocol in the network utilize source routing & maintain active routes. It has two phases: route discovery & route maintenance.

1.7.1.3 HYBRID PROTOCOLS: Combination of reactive and proactive routing protocol which leads to reduction in the initial route discovery delay in reactive routing protocols e.g. HARP, ZRP etc.

1.7.1.3.1 ZRP (Zone routing protocol): A routing zone is provided to all the nodes and divided into overlapping zones. ZRP provides border casting by IARP to control traffic between zones. This is used to increase the efficiency of route mechanism. This zone is a combination of locally provided nodes or the nodes which are outside the location zone. Nodes are easily available with the local zone but for the outside zone, it requires route discovery which can help local routing information.

1.7.2 LOCATION BASED ROUTING PROTOCOLS

The primary purpose of this routing protocol is to find out the location of the destination node hence in position based routing protocol [15] each node determine location of itself as well as destination node. In this geographical position of the node is used to find the best route. There are many location services protocols are assumed and also various models were also implemented for the location based protocols. Location based routing is further classified as:

1.7.2.1 Position Based Greedy V2V Protocols: In this greedy [13,44] forwarding strategy is used. Next node is passing the message to the farthest node to obtain the next destination. In this approach, intermediate node should know the location of itself, location of the neighbor and location of farthest node. The delay should be minimum while transmitting the data from source nodes to destination node.

1.7.3 CLUSTER BASED ROUTING PROTOCOLS

Clustering is the process in which the network is divided into interconnected sub structure called clusters. Each cluster having a cluster-head which act as a router between all the clusters and perform management functions. Gateway nodes provide communication between the cluster heads. This technique minimizes the routing overhead and decrease the network traffic.

1.7.3.1 Cluster-Based Directional Routing Protocol (CBDRP): When the packets are forwarding, the only interesting thing in this protocol [9] is speed, velocity and direction. While moving in same direction, source node is sending data to cluster head. Now the responsibility of this is to forward the package to the clusters within the range.

1.7.4 BROADCAST PROTOCOLS

Broadcast protocols are used for broadcasting messages to all the nodes in the network. This mainly provides the information about traffic efficiency, sharing, weather and forecasting, road conditions among vehicles and delivering announcements. Multi-hop packets are used for message broadcasting. In VANETS, it can be used for small numbers of nodes. The various broadcast routing protocols are UMB, BROADCOMM, DV-CAST and VTRADE.

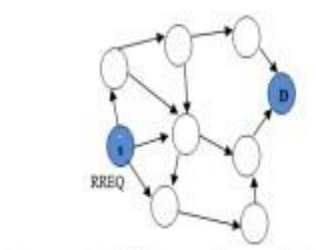
1.7.5 GEOCAST PROTOCOLS

Routing protocol in geo-cast, is mainly used for the safety purpose, traffic efficiency etc. Geo-cast routing is basically a location based multicast routing. it transmits the information from one source vehicle to all vehicle which are locate at a specific place or region called ZOR (Zone of Relevance).

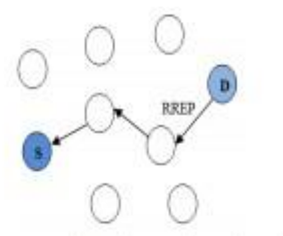
1.7.5.1 Inter-Vehicle Geo-cast (IVG): The main purpose of the IVG routing protocol is to inform vehicles about any danger at the highway located at risk areas called multicast group. Thus provide safety by getting message alerts.

1.8 Adhoc On Demand Distance Vector Routing (AODV)

AODV is an on demand routing protocols which is further improvement of the DSDV (Distance Vector Routing Protocols). DSDV has limitation that it works only for limited networks; it cannot be used for wider network as it leads to more complexity. [20] AODV can be used for wider network as it operates on demand. It only communicates when it is needed. It can be done by route discovery process which using RREQ. Then it maintains the table of routing costs.



(a) Source S initiate the path discovery process



(b) RREP packets is sent back to the source

Fig. 1.15 AODV Path Discovery Process

If there is a breakage in the link, then the nodes send route error RERR to the neighbors or all the nodes in the network.

1.9 Transmission Control Protocol (TCP)

Transmission Control Protocol is one of the leading protocol of the Internet's protocols suites. It originates inside the preliminary networks implementation wherein it complements the Internet Protocol Consequently; the whole suites are commonly called TCP/IPs. Transmission control protocol gives dependable, order, and blunders-check transport [32] of a streams of octet among programs going for walks on hosts speaking with the aid of an IP community. Major Internet packages including the World Wide Web, electronic mail, remote management, and data transfer depend upon TCP. Applications that don't require reliable statistics move provider may additionally use User Datagram Protocol, which provide a connection less datagrams services that emphasizes reduce latencies in excess of reliability. The latter turned into first established in TCP around 1988 in a success attempt to fight the incidence of congestion fall apart, and has end up a vital elements of transmission control protocol, valuable to make sure the stables, green operations of the existing Internets.

Transmission control protocol is connections oriented. A Transmission control protocol connections are installation over two stop system after these agrees on a few parameters setting. Individually reserved sources like recollection spaces for the transmissions through TCP. The transmissions end when the connections are close and resource reserve used by stop structures may be release.

The transmission connection protocol are duplexer connections. Both end system can have transmitted and received records. However, we will abstractly aware on one side transmissions under TCP connections to keep away from unnecessary complication. Furthermore, in reality the majority of statistics transmission overs TCP connections take vicinity in one side from some internet servers to web client. Consistently, the end structures that transmit and gets records are known as transmission control protocol (TCP) sender and receiver, respectively.

Transmission control protocol senders successively assign byte number to it transmit information byte, and TCP receivers expect the range of obtained records byte to be successively order. When receiver a records packets, TCP receivers notifies the senders of correctly deliver information thru an acknowledgments packets that contain acknowledgments range, specifically the numbers of next bytes it expects. The times elapse among whenever TCPs senders transmit a facts packets and when the packets are acknowledgement is called Round Trip Time (RTT).

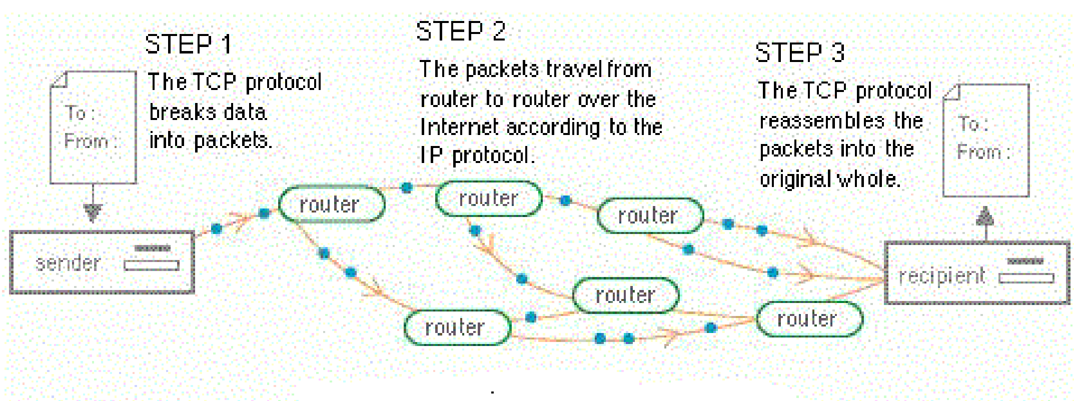


Fig. 1.16 Transmission Control Protocol (TCP) / Internet Protocol

A transmission control protocol sender applied a windows primarily based manipulate to alter the amounts of top notch information, specifically the information has been transmitting however no longer yet mentioned by the receivers. The splendid statistics includes records buffer by using the receivers, facts packet in transited, and statistics packet whose corresponding Acknowledgement are in transits. The amounts should not exceed the minimal of receivers marketed windows (awnd) and sender congestions windows (cwnd). Awnd are sets by receivers and feedback to the senders thru ACKed for indicate the to be had areas in receiver's buffering. It is preventing quick senders from overwhelming a slowly receivers. Cwnds is determined by using senders, represent the latter estimations of the burden reasonable through the networks.

The acknowledgement window based schemes are totally transmissions providing a foundation for understanding the essential feature of stop to stop congestions manipulate and reliability transmissions. In pleasurable the formers function, cwnd must be enthusiastically adjust in the course of the TCPs sessions according with the ever converting accessible community capability. Signal of community under loaded and over load are wished for trigger the increases and reduce of congestion window, respectively. In satisfying the letters characteristic, alerts of packets losses are wished for trigger retransmissions of lost statistics packet to make certain the ultimate transport of each records bytes.

A transmission control protocol (TCP) senders use successfully, set off facts shipping as a signals that networks can doubtlessly carried greater load than current presented. The gradual begins and congestions avoidances algorithm are devise in this premised, and governs the increments of cwnd while it's smaller than and better than slow starts thresholds (ssthresh), separately. Slows begin will increase congestion window (cwnd) via one statistics packets size upon receive a non reproduction ACKed that acknowledge the successful transport of recent information. Congestions avoidances will increase congestion window by way of one facts packets size in keeping with rount trip time if all facts packet transmit within the formerly round trip time (RTT) are acknowledgement.

1.10 TCP Congestion Control

Traffics congestions on the road has become large problems in big city. TCP provides a reliability delivery provider among two approaches running on exclusive hosts. Another extremely main components of transmission control protocol are the congestions manipulate mechanisms. [32] As we indicate in the earlier segment, TCPs have to uses end to end congestions manage in place of network assisted congestion manage, for the reason that IP layers affords no remarks to the end structures concerning community congestions. Earlier divine in to the detail of TCP congestions manage, permit's firstly gets an excessive-level views of transmission congestion control congestions manage scheme, in addition to the general purpose of TCPs strive for when a multiples of TCPs connection need to sharing the bandwidth of a congestion hyperlink.

A transmission congestion control (TCP) connections control transmissions rate via proscribing its wide variety of transmit nevertheless yet to be mentioned segment. Let us denoted this range of allowable un-acknowledge segment as W, regularly called as TCPs windows length. Preferably, TCPs connection need to allow to transmit as fastest possibility (i.e. have as massive some first-rate un-acknowledged packet as feasible) as well as segment are not misplaced (delivered to router) due to congestions. In extensive term, TCPs connections begins within a smaller values of W after which "probes" for the life of extra un-used link bandwidth at the link on give up to quit direction by way of increase W. A Transmission control protocol connection keeps [19] to increasing W till phase losses occur (as detection by way of a time-out or replica acknowledgement). When the sort of losses takes place, the TCPs connections reduce W to a "safe stage" and then starts off evolved probe once more for un-used bandwidth by means of slow increases W.

A significant measurement of the overall performances of some TCPs connections is throughput at which its transmit information from the senders to receivers. Obviously, throughputs will be relying upon the rate of W. If TCPs senders transmit all W segment returned to backs, its ought to then wait round ride time till it’s receive acknowledgment for these segment, at which points it could be sending W added segment. If some connections transmit W segment of sizes Maximum segment size (MSS) byte every round trip time second, then relationship's throughputs, or transmissions rate, is [(W*MSS)/RTT] byte in step with seconds.

Transmissions Control Protocols (TCP) makes use of a networks congestions avoidances techniques set of rules that consists of numerous components of an AIMD (Additive increases / multiplicative decreases) schemes, with other schemes along with gradual starting and congestions windows to attain congestions avoidances. The TCPs congestions avoidances techniques is the principal foundation for congestions manipulate in the Internets. There are several versions and version of the algorithms applied and in used at the internets.

1.11 TCP Standard Variants

In this report mainly behavior aspect of present standard TCP variant which include NewReno, BIC, Compound, Vegas, Westwood and CUBIC have been carefully examined and analyzed over the vehicular surroundings for variable traffic and speed.

The general TCP variant [49] that are carried out in operational system are taken in to evaluation and they are widely categorized based totally on their functionality which include loss-based TCP congestions controls, delay-based TCP congestions controls and loss delay-based TCP congestions controls as shown in Fig.3. The subsequent are carried out TCP variations that have been experimental analyzed and simulated by means of vehicular surroundings environments.

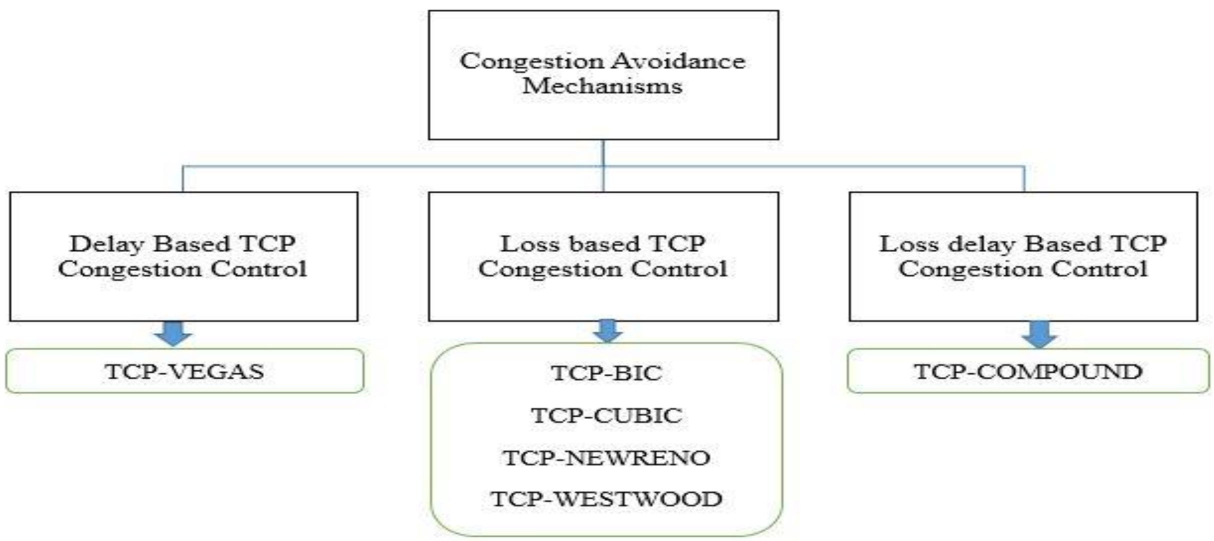


Fig. 1.17 TCP Standard Variants

1.11.1 TCP NEWRENO

In TCP New Reno we incorporated some minor modifications over the TCP Reno. It is capable to detect multiple packets loss. In this algorithm, mainly we introduce enhanced Fast Recovery (FR) algorithm if we observe that RENO experience which can be avoiding several of the retransmission timeout activities and get recover more than one loss in a single windows of data. TCP selective acknowledgements (SACKs) possibility was projected to permit receiver to acknowledgements (ACKs) out of orders information. TCP NewReno is used that with selective acknowledgement Transmission Control Protocol (TCP) sender could get recover multiple loss more rapidly comparison in to with NewReno. In this algorithm, we modify Reno fast recovery conduct on receipts of a non-duplicates acknowledgement, by identifying stuck between a partial acknowledgements and full acknowledgements.

TCP NewReno [22] is mainly define by RFC 6582 and improvement of retransmission for the duration of FR approaches of TCP Reno. For the period of fast recovery for each duplicates ACKed that is return back to TCPs NewReno and novel unsent packets from the finish of the congestions windows is transfer in to the hold on transmits windows occupied. TCP NewReno suffered from the facts that it taken one round trip time to detection each packets losses. When the acknowledgements (ACKs) for the first retransmitting section is receive only then we can have deduced which others section was not having. The special algorithmic descriptions are given under [49].

Algorithm:

1. TCP NewReno = Reno + Enhanced Fast Recovery (FR) Algorithm

2. Fast Recovery (FR) Algorithm:

Set ssthresh = cwnd/2

Where cwnd is congestion window.

ssthresh is Slow start threshold.

3. If (cwnd = ssthresh)

cwnd = cwnd/2

4. for each duplicate acknowledgement (dup ACK)

dup ACK = dup ACK + 1

5. Maximum Window =Min (cwnd+dup ACK, awnd)

Awnd is a advertised window from receiver

6. If new data receive acknowledgement (ACK)

Set dup ACK = 0

Else

Exit Fast Recovery

7. When Retransmission timeout (RTO) Expires

cwnd = 1

1.11.2 TCP WESTWOOD

TCP West-wood (TCPW) is a congestions control technique [23] mainly design to worked for both wired and wireless network. TCPW works as TCP Reno or NewReno but with little modifications. TCPW losses cause the windows to be resets to the sender's estimation of the bandwidth delay creation, which is the lowest measure round trip time instance from the observed amount of receiving acknowledgement. TCPW is only sender sides simplest modifications to TCP New-Reno. So it is better to manage huge bandwidth delay with possible packets losses because of transmissions or other errors [4]. TCP Westwood is calculating suitable rate to updates the congestion window (cwnd) from the round trip time and received acknowledgement. In this algorithm, congestions window (cwnd) increase or decrease entirely based on estimation of bandwidth. In brief, the information bandwidth estimation is employed to set slow start threshold (ssthresh) and congestions window (cwnd) value with regards to the estimation of bandwidth. The description specific algorithm [49] is given under.

Algorithm:

1. TCPW works as TCP Reno but with smallest changes.
   1.1. After 3 ACK losses or congestion occure
        ssthresh = (BWE * RTTmin)/seg_size;
2. If (cwnd > ssthresh) cwnd = ssthresh;
3. Timeout expiration
   ssthresh = (BWE * RTTmin)/seg_size; (minimum 2)
   cwnd = 1;

1.11.3 TCP BIC (BINARY INCREASE CONGESTION)

TCP BIC stands for Transmission Control Protocol Binary Increase Congestions controls. TCP-BIC [24] is mainly developed for highly speed network with highly latency known as Long Fats Network (LFN) in RFC 1072. In this algorithm, an implementations of TCP with optimize congestions controls procedure. By using binary search algorithm which finds out the maximum throughput where we maintain the window for long period of time. The BIC makes utilization of two congestion control mechanisms in particular binary search increases and additive increase are for substantial and smalls congestions window. Mainly binary search mechanism can decrease the packets losses and to make sure the RTT fairness and quicker convergence. It integrates with additive increase known as binary increase mainly for making it bandwidth efficient. It makes use of binary increases schemes and it does not increase the round trip time fairness issue of significant TCP, even as accomplishing the better throughput. The certain set of rules description [49] is given under.

Algorithm:

1. Some preliminaries

β multiplicative decrease factor

Wmax = cwnd size before the reduction

2. Wmin = β*Wmax – just after reduction

3. midpoint = (Wmax + Wmin)/2

4. BIC performs binary search between Wmax and Wmin looking for the midpoint.

5. while (cwnd != Wmax){

5.1 If ((Wmin – midpoint) > Smax)

cwnd = cwnd + Smax → Additive Increase

5.2 else If ((Wmin – midpoint) < Smin)

cwnd = Wmax

5.3 else

cwnd = midpoint → Binary Search

6. If (no packet loss)

Wmin = cwnd

6.1 else

Wmin = β*cwnd

6.2 Wmax = cwnd

midpoint = (Wmax + Wmin)/2

}

6.3 while (cwnd >= Wmax)

{

7. If (cwnd < Wmax + Smax)

cwnd = cwnd + Smin → Slow Start

7.1 else

cwnd = cwnd + Smax → Additive Increase

(Slow Start and Additive Increase: Max Probing)

8. If (packet loss)

Wmin = β*cwnd

Wmax = cwnd }

1.11.4. TCP CUBIC

In TCP CUBIC is a much a lesser amount of aggressive and additional systematic derivative of BIC that is develops for Long Fat Network (LFN), wherein the windows are a cubic role of time for the reason that previous congestion occasion, with the variation points set to the windows priority to the occasion. [25] TCP CUBIC is implemented with an associate optimize congestion control set of rules for highly bandwidth network with excessive latency. TCP CUBIC is utilized by defaults in Linux kernel from version 2.6.19 [33] and Android.

TCP CUBIC is higher model of BIC Algorithm. Its congestion window growing feature is design to make simpler and improve the windows controller of BIC. This algorithm makes simple to BIC window control and improve RTT fairness and good bandwidth utilization for small bandwidth delay network. Cubic is mainly increasing cwnd slower around loss events. The Cubic characteristic guarantees intra protocols fairness the various competing flow of the same protocols. It is having better throughput while size of buffers is less than bandwidth delay. CUBIC can show off slow convergences by following networks disturbance inclusive the begin up of latest flow. The special set of rule description is given underneath [49].

Algorithm:

1. If ACK received

Cwnd = C. $(T\text{-}K)^3$+Wmax

Cwnd is a congestion window.

Wmax is the window size just before the last window reduction.

T is the elapsed time from the last window reduction.

K is updated at the time of last lost event.

C is a cubic parameter scaling factor.

2. Recovery: Packet Loss

$K=\sqrt[3]{\boldsymbol{\beta}.\mathbf{Wmax/C}}$

β is a constant window multiplication decrease factor

3. Update K :

K = β .Wmax/C

4. Update Wmax :

Wmax= β .Wmax

1.11.5. TCP VEGAS

TCP Vegas is one of the best congestions avoidances mechanism that detect packets delay rather than Packets loss faster than TCP Reno and can recover from multiples drop more efficiently. It is fair bandwidth estimation scheme. This algorithm is based on correct or exact calculation of BaseRTT and verifies network capability, mainly [26] TCP Vegas uses Round Trip Time (RTT) estimation. It doesn't rely upon packet loss like as TCP Reno or TCP NewReno to estimated networks capability. As soon as for every Round Trip Time (RTTs), TCP Vegas computes the predicted real throughput and average throughput.

TCP Vegas doesn't depend on lost packet so as to estimate networks capability, another it is uses RTT measurement to work out the availability networks capability. Thus TCP-Vegas carry out superior than TCP New Reno in retransmission lost packet just in case of triple duplicates acknowledgement. For each RTT, TCP Vegas [4] modify the cwnd supported on the distinction between calculate prediction and actual throughput. The particular algorithmic description [49] is given under.

Algorithm:

1. Let BaseRTT (Round Trip Time) be the minimum of all measured RTTs (commonly the RTT of the first packet).

2. If not overflowing the connection, then

Expected Rate = Congestion Window/BaseRTT

3. Source calculates sending rate (Actual Rate) once per RTT

4. Source compares Actual Rate with Expected Rate

Diff = Expected Rate - Actual Rate

5. if Diff < α (too little extra data)

increase Congestion Window linearly in next RTT

else if Diff > β (too much extra data)

decrease Congestion Window linearly in next RTT

6. else leave Congestion Window unchanged.

1.11.6. TCP COMPOUND

TCP Compound is combine both of loss-based and delay-based technique of congestions avoidance. It mainly focuses on efficiency and friendliness and maintain the delay window and congestion window used to determine send window. It keeps the congestion avoidance and slow start part. Mainly two phases dwnd (delay window) and cwnd (congestion windows) are the variable to enforce TCP-Compound. But, TCP-Compound can also send both cwnd and dwnd packet in a single RTT (in place of one packet) whenever dwnd represent the delay window that control delay based element. TCP Compound [27] is mainly having the advantage of fast ramp up, more fair to flow with different RTT and disadvantage must be estimated RTT, which is very challenging. The designated [49] set of descriptions is given below in this algorithms.

Algorithm:

1. TCP sending window:

Win = min (cwnd+dwnd, awnd)

cwnd- congestion window

dwnd- delay window

awnd- advertised window from receiver

2. cwnd is updated as in conventional TCP.

3. if ACK received,

cwnd (T+1) = cwnd(T) + (1/win(T))

4. if loss detected,

cwnd(T+1) = cwnd(T)/2

5. Expected=win/base RTT

6. Actual= win/RTT

7. Estimates the bottleneck queue size:

Diff= (Expected – Actual) *base RTT

1.12 AOMDV Routing Protocol

Adhoc on demand for multipath distance vector (AOMDV) protocols is an examples of multi path routing protocols for wireless adhoc network. This is extensions of AODV protocols mentioned previous. The principal ideas in AOMDV is to compute multiple redundant path in the course of course discoveries. The AOMDV protocols use routing records even now availability inside the essential AODV protocols as much as possibility. So slight extra overheads are needed for the computations of a couple of path. Two mainly component of the AOMDV protocol [7] are is given below.

1. A routes updated rules to establishment and maintains multiples loop loose path at every nodes
2. A distribute protocols to find hyperlink disjoints path.

In AODV protocols, each reproduction of the Route request (RREQ) packets arrive at a nodes define a change course returned to the supply. But accept all such copy to constructed route will be lead to routing loop. To take away any opportunity of loops, AOMDV makes use of an invariants based on a belief of “marketed hope be counted” as shown in Fig. 1.17.

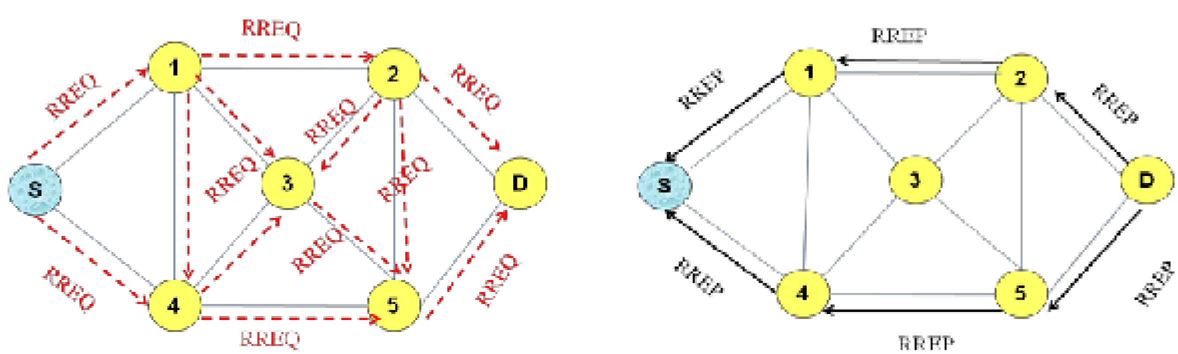


Fig. 1.18 (a) Propagation of RREQs in AOMDV (b) RREP multi path in AOMDV

These allotted protocols to locate link disjoints direction makes the more than one loop unfastened path disjoint. Paths dis-jointness has fine assets that path fail independent. The varieties of disjoints path are nodes disjoints and link disjoints. Nodes disjoints path do now not have any node in commonly another than sources and destinations. Likewise, links disjoints path don’t have any commonplace hyperlink, on the other hand they may have commonplace node. Even throughout nodes dis-jointness guarantee that hyperlinks fail independent, smaller variety of such disjoints route cause them to less powerful compare to hyperlink disjoints route, when the importance is main faults tolerances. Conversely, with simple amendment, AOMDV may be allows the discoveries of both nodes or hyperlink disjoints path.

Performance Comparison

About some study evaluate the overall performances of AOMDV within recognize of AODV the usage of Network Simulator- 2 simulations underneath sort of traffic scenario and high mobility.

They advocate that AOMDV routing protocol is capable to attain a first-rate development in the long run to cease put off and is also capable to lessen routing overheads by way of 20%.

1.13 Stackelberg Game Theory Approach

The Stackelberg game theory approach is like a leadership model. There are leaders and followers. Based on the energy level of the nodes leader nodes are selected. So leaders will send the packets to destination node and followers will send to packet to leaders. It is strategic recreation in economic in which chief firm's actions first after that the follower's corporations flow in sequence. It's known as after the Germans economists Heinrich Freiherrvon Stackelbergs who posted Markets Structures and Equilibriums (Market form and Gleichgewichts) in 1934 which describe in this model.

In sport idea term, the player this games are a leaders and followers and that they contend on amount. The Stackelberg leadership is occasionally known as the Markets Leaders. There are a few furthers constraint upon the maintaining of Stackelberg equilibriums. The leaders need to understand exacta that followers observe it is motion. The followers must have no manner of commit to a destiny non Stackelberg followers motion and leaders need to recognize this. Certainly, if the 'followers' may want to decide to Stackelberg chief motion and 'leaders' know this, chief's fine reaction might be to plays a Stackelberg followers motion.

Firm can also interact in Stackelberg opposition if one has a few type of benefit enable it is move firstly. Additional general, the leaders ought to have dedication electricity. Move observable firstly is the furthermost obvious approach of dedication: once the leaders have makes it's moves; it can't undo's. it's miles commit to that actions. Move first may be possibility if the chief turned into the compulsory monopolies of the industries and the followers is a brand new entrants. Hold extra ability is any other way of dedication.

The Stackelberg ideas have been extend to dynamics Stackelberg video game. See Cruz and Simaan (1973 a, 1973 b). Within this adding of times as a size, pheno-mena now no observed in statics game have been discover, including violations of the principles of optimum by using leaders, Cruz and Simman (1973 b), For a review of application of Stackelberg differentials video game to supply's chaining and advertising channel, sees He et all. (2007) In latest year, Stackelberg game have contribute a lot in this protection area in which it's miles critical for the safety employees to defend a few valuable aid and look for any ability threat to it. This is in which its includes the safety personnels (chief) to layout his / her method first so that no matter the approach followed by using the attacker (followers), the aid stays safety.

Summary:

Vehicular adhoc networks (VANETs) is specially kind of MANETs that consist of vehicles to vehicles communications and vehicles to roadsides unit communications. In this chapter, there is discussion of different type of adhoc routing protocol in VANETs. The managements of the VANETs networks must be securely routing over networking most crucial is to be establishment. It is make V2V (Vehicle to vehicle) and V2I (Vehicle to infrastructures) communications secure and maintains privacy during communications. In this chapter also discusses the application and characteristics of VANETs and transmission control protocol, TCP variants, and stackelberg game theory, AOMDV routing protocol.

CHAPTER 2
LITERATURE REVIEW

This chapter provides a brief review of the past work in the VANETs field. Historical perspective of the experimental and theoretical studies on the VANETs during the past few decades is explained in this chapter.

Sherali Zeadally (2010) et al. paper titled **"VEHICULAR AD HOC NETWORKS (VANETS): STATUS, RESULTS, AND CHALLENGES", [6]** describes about the various research fields available in VANETs. Various parameters are defined such as quality of service, routing, broadcasting, securities. This paper also describes about the advantages, disadvantages and limitation of these parameters. There is also need of some modification regarding the reliable and secure VANET.

Bhuvaneshwari.S, (2007) et al. paper titled **"A SURVEY ON VEHICULAR AD-HOC NETWORK", [18]** describes the favorable approach for the Intelligent Transport System (ITS). In this paper, author describes the various constraints to be addressed while employing VANET. Due to high dynamic topology in the dense area, traditionally MANETs protocol unfavorable for VANETs. The main aim of this papers is to gives an overviews of the vehicular ad-hoc network and the VANETs routing protocol.

Rakesh Kumar (2011) et al. paper titled **"A COMPARATIVE STUDY OF VARIOUS ROUTING PROTOCOLS IN VANET", [14]** states the comparison between various routing protocols. The packets are forwarded by the scheme of Prior forwarding method. The only delay parameters use the prior forwarding method while others use the multi-hop method for the transmission of data. GPS [12] provided the traffic maps and density statistics at different levels. Cluster based protocol is used.

Jagadeesh Kakarla (2011) et al. paper titled **"A SURVEY ON ROUTING PROTOCOLS AND ITS ISSUES IN VANET", [11]** states that routing protocol is the important link to communicate between the vehicles. For all VANETs system, the development of an efficient routing protocol is mainly considered a difficult job. However, this paper represents the routing protocols and also issues associated with these routing protocols. The performances of these protocol depend upon the various characteristics such as high mobility, driving environment and many more. Then comparison between these protocols is also considered. As a result, position based, cluster based and Geocast are the more reliable routing protocols.

Saif Al-Sultan, Moath M. Al-Doori (2014) et al. paper titled **"A COMPREHENSIVE SURVEY ON VEHICULAR AD HOC NETWORK", [4]** is elaborate the survey of VANETs that is very useful for researchers and developers to understand. This is also distinguishing the primary functions environment VANETs in one stable report without the needs to go through different applicable paper and article starting from VANETs structure and finishing up with the maximum propose simulation gear to simulated VANET protocol and programs. In This article presents a comparison survey coping with all the problems going through VANETs, in particulars, VANETs architecture additives, VANETs conversation domain names, wi-fi access technology, VANETs characteristic, challenge and necessities, VANETs Application and simulation equipment.

Claudio Casetti, Mario Gerla, (2002) et al. paper titled "**TCPWESTWOOD: END TO END CONGESTION CONTROL FOR WIRED/WIRELESS NETWORKS", [23]** In this paper, author proposed a new edition of the TCP-Westwood scheme [23] to improve the throughput over wi-fi links and equity in comparison to TCP Reno and NewReno in wired network. Westwood is a senders side most effective modifications of the TCP-Reno protocols stacks that optimize the performances of TCP congestions controls under both wireless and wireline network. TCP Westwood adaptive units a sluggish starts threshold and congestions windows which take under consideration the bandwidths use on the times congestions is experience.

Yun-Wei Lin (2009) et al. paper titled **"ROUTING PROTOCOLS IN VEHICULAR AD HOC NETWORKS: A SURVEY AND FUTURE PERSPECTIVES", [8]** describes the routing protocols for the VANET. In this papers, there is a detailed explanation of the unicast, Geo-cast and multicasting routing protocol. The unicast routing protocols having two methods:

min-delay and delay-bound based. In Geocast routing protocol, packet is forward to the vehicle in some geographic area. Multicast and broadcast routing protocols are also defined in this paper. For high tendency of the networks, there should be low delay, low communication overhead etc. depend upon the highway and rural environments.

Lisong Xu, Khaled Harfoush (2004) et al. **"BINARY INCREASE CONGESTION FOR LONG DISTANCE NETWORKS", [24]** Describes the new set of rules Binary Increase Congestion (BIC) controls is implemented of TCP within the optimize congestions manage algorithms for excessive speed network [24] with highly latency (known as LFN, lengthy fat network, in RFC 1072). The proposed congestion algorithm manages decrease by way of a multiplicative factors below loss. Although those makes use of two windows sizes manage policy known as additive increases and binary search increases. The simulation results confirm these property of the protocol.

Azzedine Boukerche (2008) et al. paper titled **"VEHICULAR AD HOC NETWORKS: A NEW CHALLENGE FOR LOCALIZATION-BASED SYSTEMS", [45]** this paper illustrates the, Localization Systems for VANETs. In this paper, importance or problems associated with GPS receiver is describes depending upon number of situations. Then discussed that how these localization problems can effect most VANET applications. This paper also describes about the techniques used in positions based [45] routing protocols.

Akhtar Husain (2009) et al. paper titled "**A STUDY OF LOCATION AIDED ROUTING (LAR) PROTOCOL FOR VEHICULAR AD HOC NETWORKS IN HIGHWAY SCENARIO", [17]** In this paper performances of LAR routing protocols have evaluated based on the mobility of the nodes or vehicle in the networks. The LAR [9] was tested agonists node densities for various metrics. The simulation was performed at significantly high node speed of 100km/h. The protocols show good performances in vehicular communications environments. It is found that LAR is sensitive to node density and number of lanes.

Sangtae Ha, Injong Rhee (2011) et al. paper titled "**CUBIC: A NEW TCP FRIENDLY HIGH SPEED TCP VARIANT", [25]** In this paper advise a new TCP version referred to as CUBIC for immediate and long distance network. This paper document its layout, implemented, overall performances and evolutions as the defaults TCP set of rules of Linux. CUBIC is a much less competitive and greater systematics spinoff of BIC, wherein the window is a cubic characteristic of time for the reason that closing congestions events, with the variation points set to the windows previous to the events. CUBIC [25] is a more advantageous versions of TCP BIC. It is simplifying the TCP BIC windows manage and improves its TCP friend-liness and RTTs equity.

L. S. Brakmo (2006) et al. paper titled **"TCP VEGAS: END TO END CONGESTION AVOIDANCE ON A GLOBAL INTERNET", [26]** describes the TCP Vegas [26] uses additive will increase inside the congestion window. Vegas is an implemented of TCP that achieve among 37 and 71 % improved throughput at the Internets, with one fifths to one half loss, in comparison to the implemented of TCPs inside the Reno distributions of BSD Unix. In this paper motivate and describe the 3 keys strategies hired with the aid of Vegas, and present the outcomes of a complete experimentally overall performances have a look at-the use of each simulation and measurement on the Internets the Vegas and Reno implementation of TCP.

Kashif Naseer Qureshi (2013) et al. paper titled, **"TOPOLOGY BASED ROUTING PROTOCOLS FOR VANET AND THEIR COMPARISON WITH MANET", [10]** the survey of topology based routing protocol for vehicular Adhoc network. Also, the characteristics of vehicular Adhoc network after which assessment of vehicular adhoc community with Mobiles Adhoc network are discussed and along with the protocols. In this 3 kinds of networks in VANET are taken into consideration, Ad-hoc Networks, Pure Cellular /WLAN Networks and Hybrid Architecture. The paper states the exceptional topology based routing protocols together with their routing issues. Various papers studied rapidly approximately the performance and comparisons of protocols of VANET with MANET however we discussed the protocols in element and compared with every different. This painting allows the researcher for buying the concept of fields and about the same protocol.

Kun Tan, Jingmin Song (2006) et al. paper titled "**A COMPOUND TCP APPROACH FOR HIGH SPEED AND LONG DISTANCE NETWORKS", [27]** We recommended an innovative TCP Compound approaches, that is synergies of delaybased totally and lossbased technique. In C-TCP, we upload a scalability delay primary based aspect into the standards TCP Reno congestions avoidances algorithms (i.e., lossbased totally factor). The sending charge of C-TCP is managed via both components. CTCP affords excellent bandwidth scalable with stepped forward RTTs fairness's, and on the identical time achieve appropriate TCPs-equity, beside the point to the window sizes. And develop an investigative version of C-TCP and applied it on the Window working device.

Romisha Arora (2014) et al. paper titled **"A BEHAVIORAL COMPARISON OF LAR WITH AODV AND DSR ROUTING PROTOCOLS", [46]** In this paper, author describes the routing technique to forward the packets in the network. Router characteristics are defined to find the suitable path in the network. This paper describes the behavior of AODV, DSR and LAR protocols and then compare the performances of these three routing protocol based on numbers of node and simulations.

R. S. Raw (2012) et al. paper titled **"THROUGHPUT AND DELAY ANALYSIS OF NEXT-HOP FORWARDING METHOD FOR NON-LINEAR VEHICULAR AD HOC NETWORKS", [47]** Positioning based totally routing play a large function in multi hops Vehicular Adhoc Network (VANET), due to excessive nobilities of node. Selections of subsequent hop nodes is critical to improvement the overall performances of routing. In this paper, He proposed a way for deciding on subsequent hop forward node based on the space between the sources and next hops nodes and links first-class. Next hops nodes are chosen based totally on Expected Progress Distances (EPD) standards. The EPD is predicted in phrases of expect distance among the sources and subsequent hops nodes. The predicted delays (ED) and throughputs (Th) are also estimation for the propose approaches. The mathematically version derive for calculate EPD, throughput and delay are simulation in MATLAB and evaluate the performances of the propose methods.

Ruchi Aggarwal (2014) paper titled **"PERFORMANCE ANALYSIS OF AODV, DSDV, DSR AND LAR ROUTING PROTOCOLS IN MANET- A REVIEW", [20]** this paper describes about the routing protocol in the MANETs. Also describes how to find the routes between node to provides communications between the nodes. Also describe the characteristics of routing protocol such as AODV, LAR and DSR routing protocol which helps to maintain route and improve packets delivery ratios in the networks. At the end, author provides a comparison and discussion of their characteristics based on merits and demerits.

Henderson (2012) et al., paper titled **"RFC 6582: THE NEW RENO MODIFICATION TO TCP's FAST RECOVERY ALGORITHM", [22]** In this paper describe describes a selected algorithm for responding to partial acknowledgment, known as "New Reno". [22] This response to partial acknowledgment became first proposed with the aid of Janey Hoe. New Reno rapid retransmit and rapid recovery algorithms for TCP. This New Reno amendment to TCP may even be essential for TCP implementations that guide the SACK alternative, due to the fact the SACK choice can most effective be used for TCP connections whilst both TCP end-nodes aid the SACK choice. New Reno plays higher than Reno in a number of situations mentioned in previous variations of this RFC.

G. Karagiannis, O. Altintas (2011) et al., paper title **"VEHICULAR NETWORKING: A SURVEY AND TUTORIAL ON REQUIREMENT, ARCHITECTURES, CHALLENGES, STANDARDS AND SOLUTIONS", [30]** In this paper survey and academic introduce the fundamental traits of vehicular networks, provide a top level view of packages and associated necessities, at the side of challenge and them propose answers. In adding are supplied an overviews of the modern-day and pasting fundamental ITS program and tasks inside the Europe, Japan, USA. Furthermore, vehicular networks architecture and protocols suite hired in such applications and project in Japan, Europe and USA are also mentioned.

Mario Gerla (2011) et al., paper title **"VEHICULAR NETWORKS AND THE FUTURE OF THE MOBILE INTERNET", [31]** Is paper describe take a look at this interplay between wired and wi-fi and extract a message for the layout of a extra green Future Wireless Internet. And on the focus of vehicular network considering that this area is better established and commercially extra possible than that of private, P2P communications among Smartphones. In this paper has addressed advanced wi-fi community architectures and programs focused on automobile network.

Macura, Kordic (2012) et al., paper title, **"COMPARISON OF WESTWOOD, NEW RENO AND VEGAS TCP CONGESTION CONTROL" [21]** in this paper ambitions at evaluation and evaluating 3 manipulate algorithm, which are New Reno, Vegas, Westwood TCP. Simulation scenario are cautiously design so as to analyze throughput, equity and friend-liness supplied by means of every of the algorithm. In this paper compare Vegas, Westwood, and New Reno TCP. It is turn that Westwood + (plus) provide throughput improvement range from 23% to 53% w. r. t. New Reno. TCP NewReno has been taken into consideration because it's far the main Internet congestions protocols.

G.Mary Valantinaa (2015) et al., paper title **" Q-LEARNING BASED POINT TO POINT DATA TRANSFER IN VANETS", [35]** Vehicular adhoc network are profoundly versatile faraway networks. VANETs is turns into the furthermost suitable solutions for using helps and movements tracking inside the presents situations. A VANETs provides automobile to automobile connectivity's and can be applied as geared up frameworks as a parts of the automobiles. In any case, because of car adaptability, constrain far flung asset, and the lossy attribute of a remotes channels, achieving a dependent multi jump communique in VANET is specially checking out. In this paper, creator propose PP AODV, that is a handy VANETs routing conventions that take in the precise courses by way of utilising a fluffy constraints Q gaining knowledge of calculations in view of adhoc on demand distance vectors (AODV) routing. The conference can realize automobile improvement in mild of neighbor facts while function statistics is distracting. Simulation demonstrates that the propose conference indicate outstanding executions with some ascents in package deal convey proportions, diminish end to stop defers, and occasional overheads.

Ankita Agrawal (2013) et al., paper title **"SECURITY ON VEHICULAR ADHOC NETWORKS (VANETS): A REVIEW PAPER", [36]** Vehicular adhoc network (VANET) are accept expand attention from academic and sending endeavor from production, due to the unique application and potentials big benefits they provide for destiny VANETs client. That is the reasons securities is an imperatives situation quarter for vehicular systems utility. For verification motive this type of large numbers of file transfers capacities is consume up and the executions turn outs to be lowest. In VANETs some authentic systems attacks, as an instance, guy in middle attack, masquerading as practicable. In this paper analysis are went to tosses some mild on the pasting examine finished round there could examine the special downside of those explore. After that they are gives one of a kind troubles on VANETs ultimately conclude with propose calculations.

Wenshuang Liang (2015) et al., paper title **"VEHICULAR ADHOC NETWORKS: ARCHITECTURES, RESEARCH ISSUES, METHODOLOGIES, CHALLENGES, AND TRENDS", [37]** Vehicular adhoc networks (VANETs) were a vast hot exam vicinity inside the maximum latest pair of year. Because in their remark attribute, as an example, excessive elements topologies and unsurprised movability, VANET pull in this sort of tremendous quantity of interest of each academic and industries. In this paper, creator supply an outlines of the essential elements of VANET from an examinations points of views. This papers begin within the essential designed of network, then talk approximately three widely well-known examinations issue and generals explorations technique, and finally ends up within the investigate on difficulty and futures pattern of vehicular network.

Sabih ur Rehman (2013) et al., paper title **"VEHICULAR ADHOC NETWORKS (VANETS)- AN OVERVIEW AND CHALLENGES", [38]** Vehicular adhoc networks (VANET) innovations have grown as an important explorations ranges inside the direction of the furthermost recents pair of year. Being adhoc in natures, VANETs is a type of network this is crafted from this idea of build up a gadget of vehicles for selected want or situations. Primaries discovery of this papers are that effective and sturdy VANETs is one which achieves all configurations parameter, as an example, QoS, smallest state of being inactive high PDR and low BER. Some keys exploration area and problems in VANETs are displayed towards the ends of the papers.

Bijan Paul (2011) et.al., paper title **"VANETS ROUTING PROTOCOLS: PROS AND CONS", [39]** In this paper VANETs (Vehicular Adhoc Networks) is every other innovation which has taken significant interest inside the past due year. Because of brief topologies changing and go to disconnections make it tough to plans a talented routing conference for routing facts amongst cars, known as V2V or car to car verbal exchange and automobile to road facet based, called Vehicular to infrastructure. The modern routing convention for VANETs are not effective to meets every activities situation. From this time outlines of a capable routing conference has taken critical interest. In this paper indicates the upside and downside of VANETs routing convention for hide automobile communications.

Venkatesh, A Indra (2014) et al., paper title **"ROUTING PROTOCOLS FOR VEHICULAR ADHOC NETWORKS (VANETS): A REVIEW", [40]** In this paper mainly describe the Routing in Vehicular Adhoc Network is a checking out challenge due to the notable characteristic of the systems, for instance, excessive portable of hub, steadily converting topologies and surprisingly partition gadget. It is a take a look at to assure solid, non-stop and regular conversation inside the sight of dashing automobiles. The execution of routing conventions is predicated on upon different inner additives, as an instance, portable of hub and outdoor variable, as an example, avenue topologies and stumbling blocks that squares signal. This needs a completely adaptives manner to address manages the dynamics situation by means of deciding on the great routing and send methodology and by way of utilising appropriate adaptability and spread fashions. In this paper professional review, the modern-day routing convention for VANET and set up them into a classification in views of keys houses, as an examples, machine engineer, application upholds, routing strategies, send methodology, adaptability model and natures of administrations measurement. Convention belong to unicasting, multicasting, geo-cast and broadcasting classification are mentioned. Quality and inadequacies of various convention utilizing topologies based totally, function base totally and groups base totally methodology are tested.

Shilpi Dhankhar (2014) et al., paper title **"VANETS: A SURVEY ON ROUTING PROTOCOLS AND ISSUES", [41]** In current year, VANETs (Vehicular Adhoc Networks) has turn into a notable vicinity for explorations examinations and development. VANETs is a sub-group of MANETs. VANETs and MANETs both are far off network which might be portray as self-configure and independent adhoc network. VANET evaluation from MANET as some distance as dynamics topologies and high portable. Because of in secures connectives, highly adaptability and devices partition, statistics routing in VANET receives to be trouble-some and tested, in this manner make some requirements for productizes VANETs routing convention. This papers give a define on VANETs and give it routing convention which concentrate on vehicles to vehicles verbal exchange. This paper is going for characteristic convention on the basis of routing data and contrast them utilising taken after parameter to be unique machine utilised, benefits/features and barriers. In this paper also analyze receptive and pro-active routing convention in view of their advantage and disadvantage, moreover speak me about the problems and explorations associated problems for routing additives that existence in VANET.

Kevin C. (2013) et al., paper title **"SURVEY OF ROUTING PROTOCOLS IN VEHICULAR ADHOC NETWORKS", [42]** The parts give an outline of routing convention in vehicular adhoc network. The routing convention reduction in to remarkable classification of topologies based totally and positions based routing. The segment examines the benefits and downsides of those routing convention, investigate the incentive at the back of their configurations and comply with the evolutions of those routing convention. At last, it is concluding phase with the aid of indicating out some open troubles and workable route of destiny exam related VANET routing.

Bilal Mustafa (2010) et al., paper title **"ISSUES OF ROUTING IN VANET", [43]** In this paper analyst explore approximately diverse advert hoc routing convention for VANETs. The precept factor of this look at become to understand which advert hoc routing method has higher executions in actual adaptable environments of VANETs. To compute the executions of routing convention in VANETs, they consider unique conditions i.e. Cites and expressway. Routing convention were choosing intentionally in the wakes of doing inscription survey. The choose convention were then assessments throughout simulations as a long way as executions measurement i.e. Throughputs and bundle drops.

Summary: Literatures over similar research work carried over clearly states that, the accurate identification of routing protocol was indispensable controlling, measurement and analysis and would not be competitive for the present market scenario. The possibilities of identifying a suitable protocol that helps to enhance the road security. The objectives of this work is to present an efficient work which is based on previous research efforts in VANETs. Therefore, this chapter we gave overview of variety of existing techniques related to VANETs.

CHAPTER 3
OBJECTIVES

The unique designs of the Transmission Control Protocol (TCP) worked reliably, but was unable to provide suitable overall performance in a huge and congested network. Several TCP versions have been proposed when we consider that then (TCP NewReno, Vegas, Westwood, Compound, BIC, CUBIC) with mechanisms to control and keep away from congestion. The objective of this homework is for me to investigate the overall performance of these unique TCP variations. We use the NS-2 network simulator to carry out experiments to help developer or manufactures recognize the behavior of the TCP variations under diverse load situations and queuing algorithms in vehicular environment.

- **To compare Quality of Service (QoS) like average throughput, end to end delay and packet drop w.r.t. number of nodes.**

In this objective a comprehensive assessments and analyzed to be made studies the TCP behavior aspects and performances under the vehicular environments. We have analyzed the behavior of the TCP for various number of node (Vehicles) and behavior of the TCP for varying of time. To comparison of all standard TCP variants following three metrics average throughput, delay and average packet drop with respect to number of node i.e. 50 ,100 and time were chosen mentions in Quality of Service (QoS).

- **To reduce TCP congestion and increase the performance of network using novel algorithm.**

In this Objective, we have proposed of new novel scheme, called as Stackelberg Game Routing Protocol (SGRP) for improving the network performance over vehicular network. The objectives of our novel scheme is to reduces the congestion control in the network and enhance the performance of vehicular network. Novel scheme is to overcome the packet drop rate and average delay which are degrading the throughput performance of the exiting variants of TCP. The solution for which has reached by novel scheme of SGRP which resolve the all previous work problem. The thorough investigations are done in Network Simulator (NS2) whose version is 2.34.

- **To compare the performance of TCP with other routing protocols for enhancing the network performance.**

This objective was conducting using the NS-2 network simulator. The performances of TCP over different routing (AODV and AOMDV) protocols in vehicular network was studied by simulation experiments and results are reported. To comprehensive the performances of different standard TCP variant such as NewReno, Vegas, BIC, Cubic, Westwood, Compound on the different number of nodes test scenarios would be investigated and also enhancing the network performance results. The results are helpful for congestion control protocol designer.

CHAPTER 4
RESEARCH METHODOLOGY

We represent the implementation of the standard TCP variants model and also the algorithm based on vehicular environment. The final intends of this work to take a look at the behaviors assessment of all standard TCP variant [21] which include NewReno, Westwood, Compound, Cubic, Vegas, and BIC over the vehicular environments for varying mobility and traffic. New transport protocols are always evolving with an objective to increase throughput and decrease the chance of getting into congestion. All these variants basically differ in the way they deal with congestion, control the data rate, and react with the lack of arrival of acknowledgments. The distinction of packet loss due to congestion or corruption is also an issue especially for Satellite based networks.

4.1 Network Simulation (NS-2)

NS2 is an open-source simulation tool that runs on Linux. [34] It is a modest occasion simulator targeted at networking studies and presents significant support for simulation of routing, multicast protocols and IP protocols, consisting of UDP, TCP, RTP and SRM over stressed and Wi-Fi (neighborhood and satellite TV for pc) networks. It has many advantages that make it a beneficial device, consisting of help for a couple of protocols and the capability of graphically detailing community visitors. Additionally, NS2 supports several algorithms in routing and queuing. LAN routing and declares are a part of routing algorithms. Queuing algorithms include honest queuing, deficit round-robin and FIFO.

NS2 commenced as a variant of the REAL community simulator in 1989 (see Resources). REAL is a network simulator at the start intended for analyzing the dynamic behavior of waft and congestion control schemes in packet-switched statistics networks.

Currently NS2 development by means of VINT organization is supported through Defense Advanced Research Projects Agency (DARPA) with SAMAN and through NSF with CONSER, each in collaboration with other researchers together with ACIRI (see Resources). NS2 is available on several systems including FreeBSD, Linux, SunOS and Solaris. NS2 also builds and runs under Windows.

Simple eventualities must run on any affordable machine; however, very large situations benefit from big amounts of reminiscence. Additionally, NS2 calls for the subsequent packages to run: Tcl release 8. Three.2, Tk release eight. Three.2, OTcl launch 1.0a7 and TclCL release 1.0b11.

4.2 Implementation of Standard TCP Variants

The commonly used standard all TCP variant that are implementation of Network Simulator 2 (NS-2). We have taken following modules to the broadly categorized based on their functionalities'.

4.2.1 MODULE 1: Let we started the first scenario, we considered the number of nodes and then communicate to each other in wireless environment. We implement the source to destination data transfer in basic protocol and check for QoS factor like as throughput, delay and packet drop. We also consider congestion and packet loss between Sender to Receiver data transfer.

4.2.2 MODULE 2: In module 2, we consider that delay based congestion control of TCP Vegas is standard TCP variants. TCP Vegas one of the congestion avoidance algorithm. So we have taken three different scenarios low traffic, medium traffic, and high traffic i.e. 50 nodes, 75 nodes and 100 nodes and implement. And analysis the throughput, delay and packet drop with respect to number of nodes and time.

4.2.3 MODULE 3: We consider that loss based congestion control of TCP NewReno is standard TCP variants. TCP NewReno are improve Fast recovery algorithm. So we have taken three different scenarios 50 nodes, 75 nodes and 100 nodes and implement. And analysis the throughput, delay and packet drop with respect to number of nodes and time.

4.2.4 MODULE 4: In this module we consider that loss based congestion control of TCP Cubic. Its improved version BIC algorithm that is develop for Long Fat network. So we have also taken three different scenarios 50 nodes, 75 nodes and 100 nodes and implement. And analysis the throughput, delay and packet drop with respect to number of nodes and time.

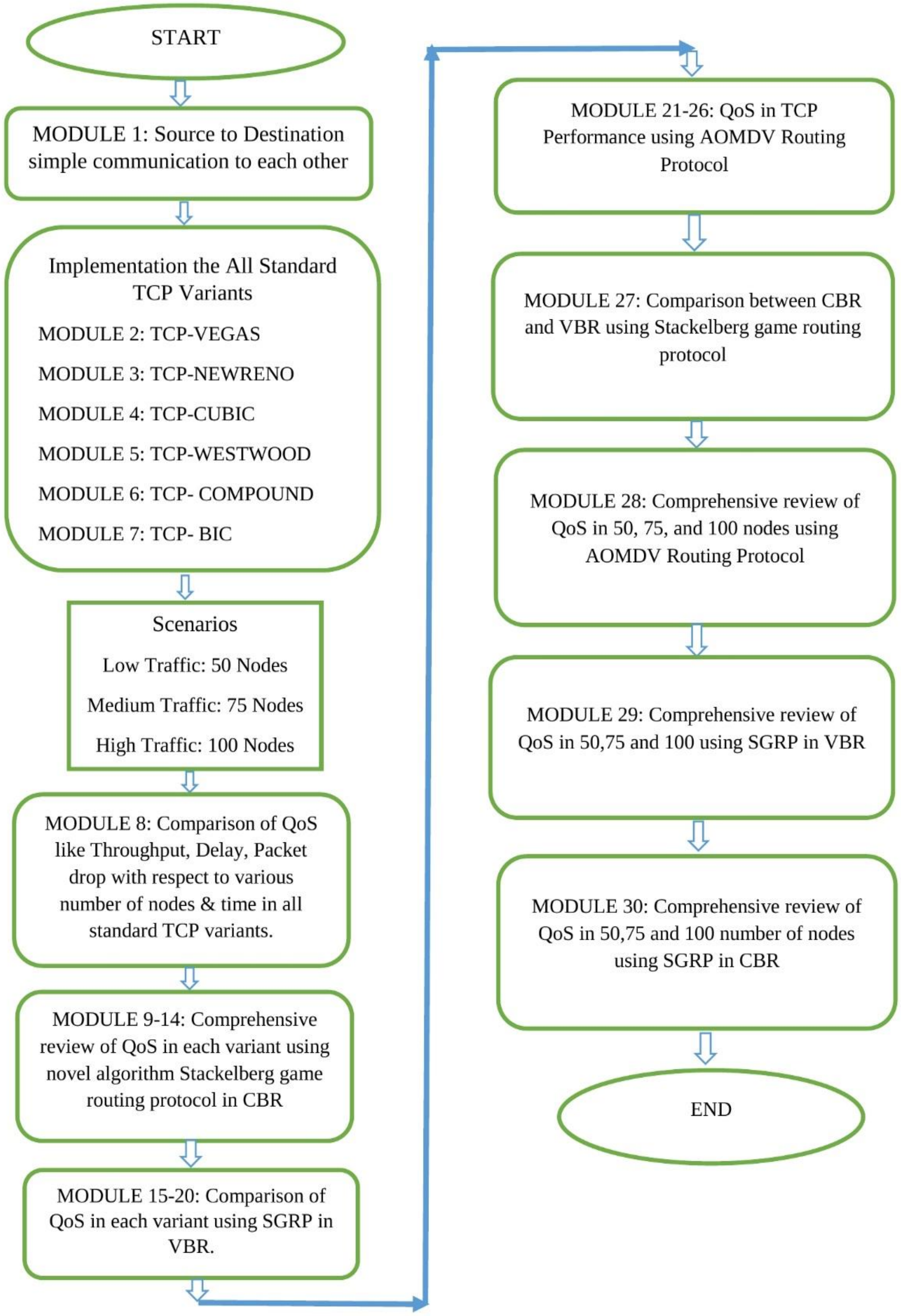


Fig. 4.1 Research Methodology Flow Chart

4.2.5 MODULE 5: In module 5, we consider that loss/delay based congestion control of standard TCP Westwood. Its TCP Westwood variants one of the congestion control algorithm. So we have taken three scenarios 50 nodes, 75 nodes and 100 nodes and implement. And analysis the throughput, delay and packet drop with respect to number of nodes and time.

4.2.6 MODULE 6: We consider that loss-delay based congestion control of standard TCP Compound. Its TCP variants standard one of the congestion avoidance phase algorithm. So we have taken three scenarios 50 nodes, 75 nodes and 100 nodes and implement. And analysis the throughput, delay and packet drop with respect to number of nodes and times.

4.2.7 MODULE 7: We consider that loss based congestion control of standard TCP BIC. Its TCP variants standard is use two congestion control algorithm. So we have taken three scenarios 50 nodes, 75 nodes and 100 nodes and implement. And analysis the throughput, delay and packet drop with respect to number of nodes and time.

4.2.8 MODULE 8: We consider all TCP variants and comparison of Quality of service (QoS) like average throughput, end to end delay and dropped packets with respect to nodes and times. So we have analysis the three scenarios 50 nodes, 75 nodes and 100 nodes in all standard TCP variants. I have look for all TCP variants in reduce congestion control in transmission control protocol.

4.2.9 MODULE 9-14: Mainly this module we have make a novel algorithm Stackel berg game Routing protocol. It's mainly find the location of node and Stackel berg game approach was used in the transmission of packets. In this modules we have analysis the individual all standard TCP variants using the technique of Stackelberg Game Routing Protocol (SGRP) in constant Bit Rate (CBR). And we have also investigate the QoS like as average packet drop, average delay and throughput with respect to various scenario 50 nodes, 75 nodes, and 100 nodes in all TCP variants.

4.2.10 MODULE 15-20: This module assessment and analysis to novel algorithm SGRP. We have taken in this module Stackelberg game theory model in Variable Bit Rate (VBR). And the simulation set up carefully chosen to vehicular environment. We have taken three different scenarios 50, 75 and 100 nodes. And analyze the performance of TCP in all standard TCP variants Such as TCP-NewReno, Vegas, Westwood, Compound, BIC, and Cubic. We have observed the following three metric throughputs, delay and packet drop in all standard TCP variants techniques.

4.2.11 MODULE 21-26: In this module we have used to another routing protocol Ad hoc On demand Multipath Distance Vector (AOMDV). We have analyzed all three traffic condition 50, 75 and 100 number of nodes. In this section assessment and simulation set up the representative nature of vehicle environments. And the simulation is to analysis the behavior of the TCP for various number of nodes. (vehicle) and QoS in all standard TCP Variants algorithm.

4.2.12 MODULE 27: After all, above module analyze the its module comprehensive in different traffic scenarios we found the behavior of the TCP for various number of nodes (vehicle). We have analyzed all traffic condition and given the graphical representation. Finally, we have taken all standard TCP variants algorithm to analyzed the quality of service like average packet drop, delay and throughput with respect to various number of nodes.

4.2.13 MODULE 28: This module we have consider the above all TCP standard variants using AOMDV routing protocol. In module we have taken three different scenarios 50 nodes, 75 nodes and 100 nodes to comprehensive graph shown in separate figure. And analysis the throughput, delay and packet drop with respect to number of nodes and time.

4.2.14 MODULE 29: In module 29, mainly consider the Stackelberg game routing protocol (SGRP) in variable bit rate (VBR) of all standard TCP variant. All TCP variant in comparisons graph shown in single figure. So we have taken three different scenarios low traffic, medium traffic, and high traffic, i.e. 50 nodes, 75 nodes and 100 nodes and implement. And analysis the throughput, delay and packet drop with respect to varying of particular time and number of nodes.

4.2.15 MODULE 30: It's finally module so we have considered the Stackelberg game routing protocol in constant bit rate (CBR) of all standard TCP variant's. And we have taken three scenarios in low traffic, medium traffic and high traffic to compare the QoS of three metrics delay, throughput, and average packet drop with respect to number of nodes and time. It's normally to comprehensive results to easily analyzed the behavior of TCP.

CHAPTER 5
RESULTS AND DISCUSSION

In this chapter, for depth assessment and evaluation to be made we observe the TCP behavioral aspects and its overall performance over the vehicular environments. The simulation [21] setup have been carefully selected to resemble the sensible nature of vehicular surroundings. The simulation chosen in the selected two class, the first class is number of node (vehicles) and second class in research is the behavior of the TCP with respect to time. For evaluation, following three metrics throughput, average delay and average packet drops are calculated. The outcomes of these metrics are simulated in NS-2 simulator.

Table 5.1. Simulation Parameters in NS-2.

Parameters	
Number of Nodes	50, 75, 100
Propagation Model	Two Ray Ground
Antenna Type	Omni Directional Antenna
Routing Protocol	AODV
MAC	802.11
Packet Size	200 Bytes
Standard TCP Variants	Vegas, BIC, NewReno, Cubic, Compound, Westwood
Simulation Area	1000*1000

5.1 Quality of Services for TCP Variants

In this section especially, evaluation is made to observe the TCP behavioral issue and its performance below the vehicular surroundings. Firstly, we have analyzed the conduct of the TCP for quantity of nodes (car) and behavior of the TCP for different time instant. We have analyzed performance metrics like average packet drop, average delay and throughput, they are as follows:

5.1.1. AVERAGE PACKET DROP

Packet loss takes place when one or more number of packet of record passing through a computer networks fails to reaches the destination. Packet loss is commonly due to congestion of network [49]. Packet loss is defined as a percentage of packet losses w. r. t. packet send. The TCP detects packets loss and perform retransmission to make certain reliability of messaging. In TCP connection the packet loss is likewise use to avoid the congestion and decreases the connection of throughput.

Packet loss= (Number of lost packet / Number of transmitted packet) * 100.

As shown in Fig. 5.1 first we have seen that comparison between average packet drop with respect to number of nodes. Fig 5.1 shows the implementation of all standard TCP variants such as TCP-Vegas, TCP-BIC, TCP-new Reno, TCP-cubic, TCP Compound and TCP-Westwood. We have found that TCP Vegas has minimum average packet drop with respect to other TCP variants Techniques. TCP Vegas is low average packet drop because of proactive in nature.

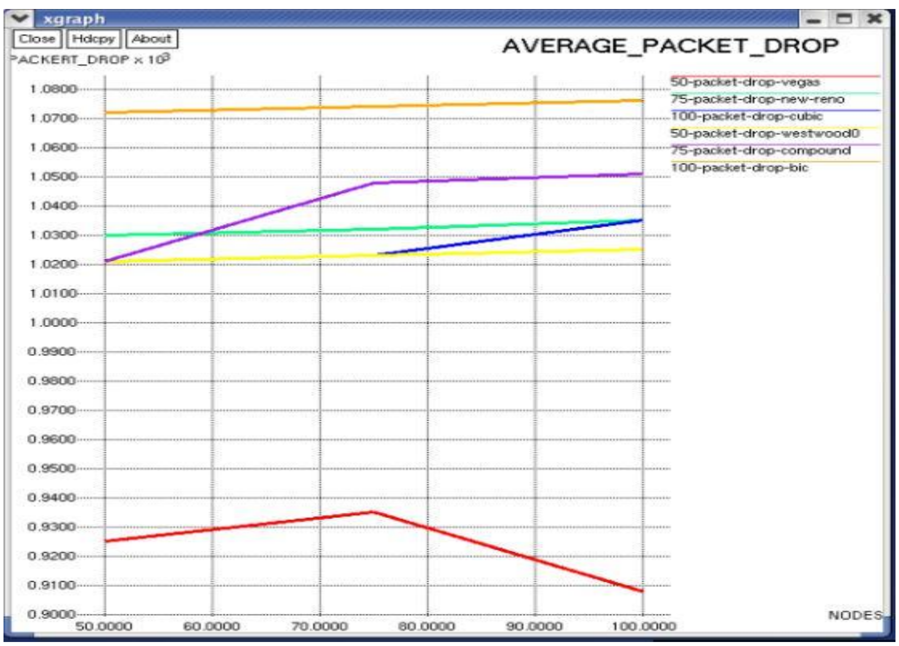


Fig. 5.1 Comparison Between Average Packet Drop Vs Number of Nodes

5.1.2 AVERAGE DELAY

Average packet delay is a measure of overall time taken for an information packet transferred from source node to the destination node. In this place variety of node is extended, the average delay also increases because of the related delay together with queuing delay, contention delay and rerouting delay additionally will increase for all the standard TCP variant except TCP Vegas. In all TCP variants, it is observed that TCP Vegas is having very minimum average delay because of it is pro-active nature.

As shown in Fig. 5.2 we have seen that comparison between average delay is with respect to various number of nodes. This shows that the implementation of all standard TCP variants such as TCP Vegas, TCP BIC, TCP New Reno, TCP Westwood, TCP Compound and TCP Cubic. We have observed that TCP Vegas has minimum average delay in comparative to another TCP standard variants techniques.

Fig. 5.2 Comparison Between Average Delay Vs Number of Nodes

5.1.3 THROUGHPUT

Throughput is a measurement of the entire number of efficient packet successful delivery from source to the destination over a time period. Throughput is normally measure in bit per seconds (bps or bit/s), megabit per seconds (Mbps) or gigabit per seconds (Gbps) but sometimes data packets measured in packet per second (pps or p/s) or data packet per time period. The aggregate throughput or device throughput is the summation of data rate which might be deliver to all terminal in a networks. In spite of data transmission, networks throughput is the quantity of data successfully delivered from one region to another region in some given particular time periods.

As shown in Fig.5.3, we have seen that comparison between throughput is with respect to various number of node shows the implementation of all standard TCP variants such as TCP-Vegas, TCP-Cubic, TCP-NewReno, TCP-Westwood, TCP-Compound and TCP-BIC with respect to throughput of varying number of node under the vehicular environment. All the standard TCP variants shows the performance of throughput. TCP Vegas is showing maximum throughput in 100 number of nodes as compare to other TCP variant.

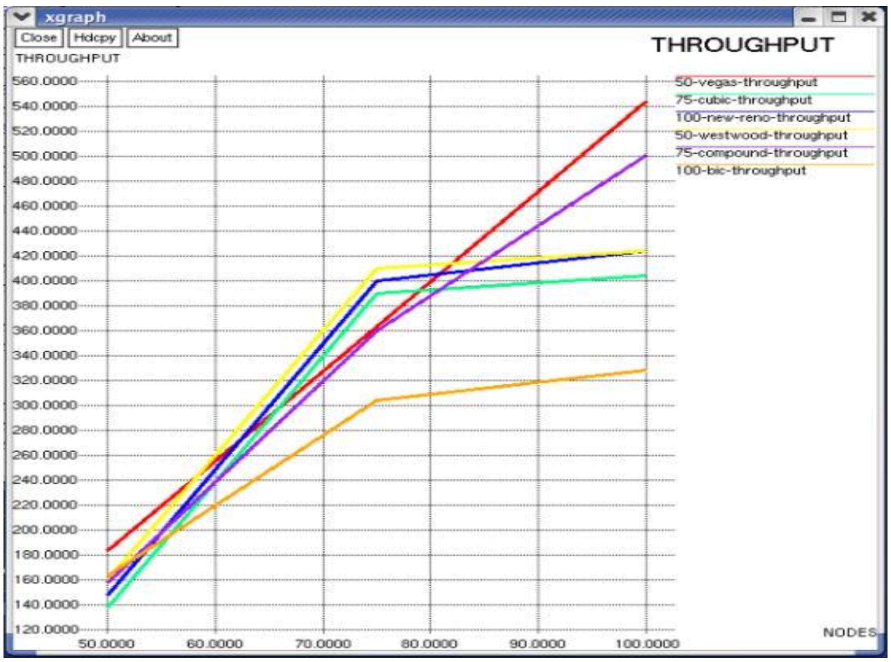


Fig. 5.3 Comparison Between Throughput Vs Number of Nodes

QoS for 50 Nodes:

- **Throughput:** As shown in Fig. 5.4., throughput of all standard TCP variants w. r. t. variation of time. we have taken 50-nodes in first scenario. Among all the standard TCP variants, TCP Vegas is having maximum throughput. Since TCP Vegas is the congestion avoidance algorithm which detect packet loss based on round trip time of the packets. Whereas TCP New Reno depend on network capacity.

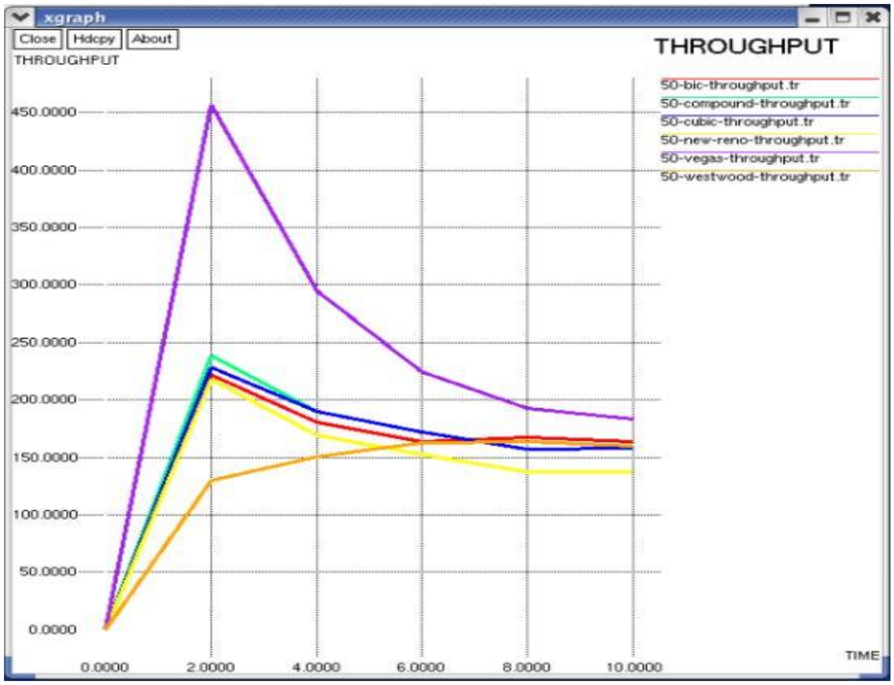


Fig. 5.4. Throughput w.r.t Number of 50 Nodes

Table 5.2 Throughput of different TCP Variants (50-Nodes)

TIME	TCP BIC	TCP COMPOUND	TCP CUBIC	TCP NEWRENO	TCP VEGAS	TCP WESTWOOD
0	0	0	0	0	0	0
2	221.67	238.29	228.29	218.29	456.57	129.86
4	180.87	189.53	189.53	169.53	294.51	150.86
6	163.99	172.06	172.06	152.06	224.16	162.40
8	166.93	157.13	157.13	137.13	192.89	163.39
10	166.64	157.57	157.57	137.57	183.09	159.74

Average Delay: In this Fig. 5.5, average delay of all standard TCP variants with respect to variation of particular time. So we have taken first scenario of 50 number of nodes. All the standard TCP variants shows the performance of average delay under the vehicular environments. So that comparative to another TCP variants TCP westwood and vegas techniques is showing minimum average delay.

Fig. 5.5. Average Delay w.r.t Number of 50 Nodes

Table 5.3 Average delay of different TCP Variants (50-Nodes)

TIME	TCP BIC	TCP COMPOUND	TCP CUBIC	TCP NEWRENO	TCP VEGAS	TCP WESTWOOD
0	0	0	0	0	0	0
2	346.39	290.64	290.6	294.0	0.51	11.42
4	972.80	613.07	612.2	616.87	384.96	492.21
6	1064.91	696.43	696.4	700.23	617.60	381.97
8	1184.26	822.98	822.9	826.78	534.09	394.84
10	1053.90	765.80	765.2	769.60	326.46	381.07

Average Packet Drop: As shown in Fig. 5.6, average packet drops for all standard TCP variants with respect to variation of particular time. So we have taken first scenario 50 number of nodes. All the standard TCP variants shows the performance of average packet drop under the vehicular environments has been shown in Fig. 5.5. TCP Vegas is showing minimum average packet drop in comparison with all other TCP variants techniques.

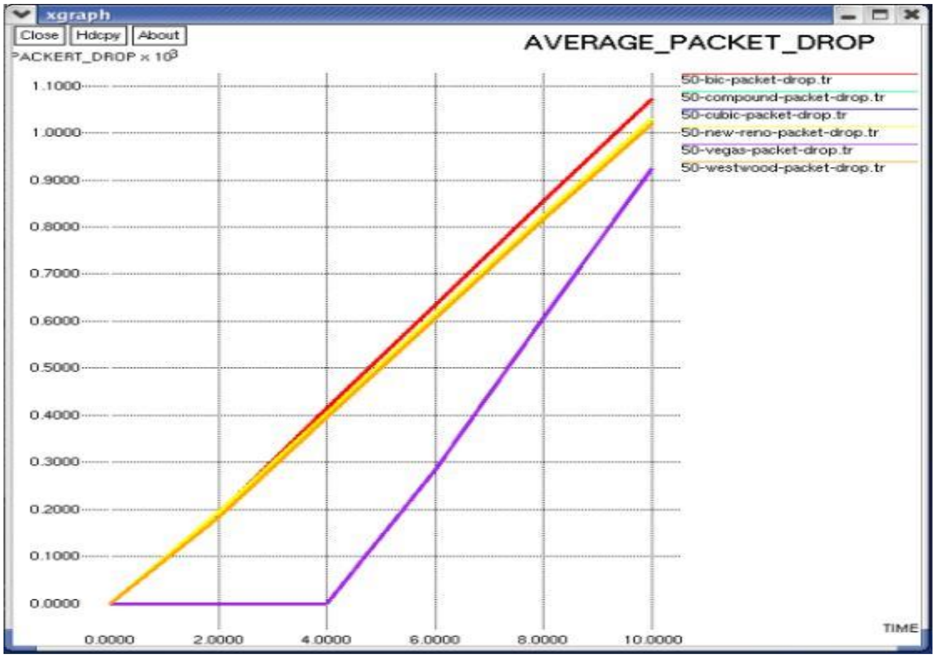


Fig. 5.6. Average Packet Drop w.r.t Number of 50 Nodes

Table 5.4 Average Packet Drop of different TCP Variants (50-Nodes)

TIME	TCP BIC	TCP COMPOUND	TCP CUBIC	TCP NEWRENO	TCP VEGAS	TCP WESTWOOD
0	0	0	0	0	0	0
2	192	185	186	194	0	185
4	415	396	396	405	0	396
6	635	606	606	615	286	606
8	855	816	816	825	606	816
10	1072	1021	1021	1030	925	1021

QoS for 100 Nodes:

Average Delay: Fig. 5.7 shows that average delay of all standard TCP variant w. r. t. variation of particular time. So we have taken second scenario more number of node i.e. 100 nodes. All the standard TCP variants shows the performance of average delay under the vehicular environments has been shown in Fig. 5.7 TCP Vegas is showing minimum average with all other TCP variants technique.

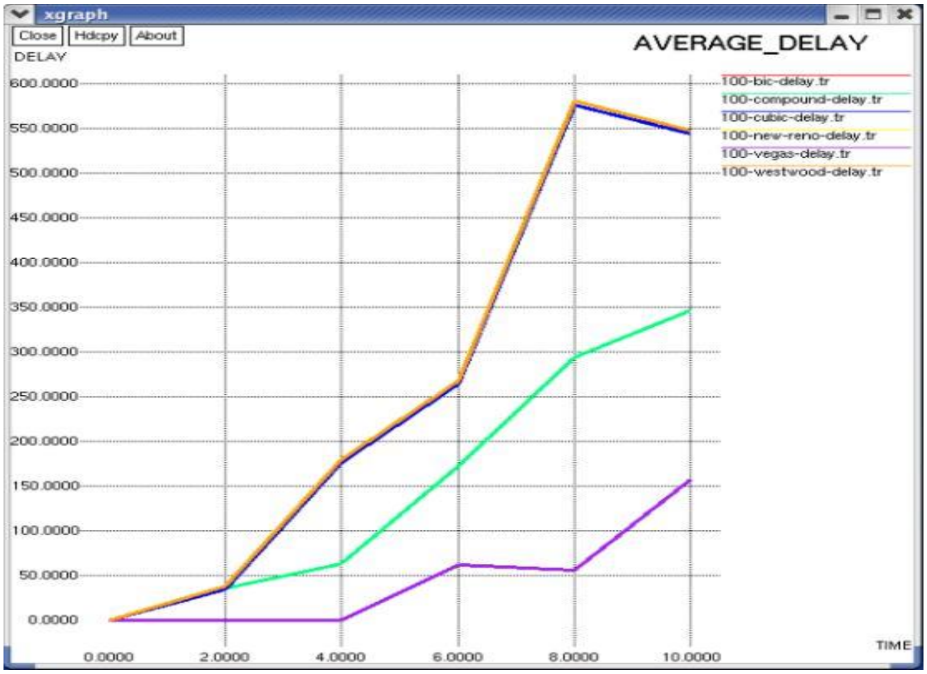


Fig. 5.7. Average Delay w.r.t Number of 100 Nodes

Table 5.5 Average delay of different TCP Variants (100-Nodes)

TIME	TCP BIC	TCP COMPOUND	TCP CUBIC	TCP NEWRENO	TCP VEGAS	TCP WESTWOOD
0	0	0	0	0	0	0
2	33.7	35.15	33.7	37.54	0	37.54
4	175.98	63.05	175.98	179.18	0	179.18
6	264.22	172.36	264.22	268.02	61.47	268.02
8	576.6	293.6	576.6	580.40	55.77	580.40
10	543.89	345.64	543.89	547.69	156.57	547.69

Average Packet Drop: As shown in Fig. 5.8, average packet drops of all standard TCP variant with respect to variation of particular time. So we have taken second scenario 100 number of nodes. All the standard TCP variants shows the performance of average packet drop under the vehicular environments has been shown in Fig. 5.8 TCP Vegas is showing minimum average packet drop with all other standard TCP Variants techniques.

Fig. 5.8. Average Packet Drop w.r.t Number of 100 Nodes

Table 5.6 Average Packet Drop of different TCP Variants (100-Nodes)

TIME	TCP BIC	TCP COMPOUND	TCP CUBIC	TCP NEWRENO	TCP VEGAS	TCP WESTWOOD
0	0	0	0	0	0	0
2	199	193	199	199	0	189
4	410	410	410	410	0	400
6	610	625	610	620	269	610
8	830	840	830	830	589	820
10	1035	1051	1035	1035	908	1025

Throughput: In this figure 5.9 shows the throughput of all TCP variants with respect to varying of particular time. So third scenario we have taken 100 number of nodes. All the TCP variants is analyses the performance of throughput under the vehicular environments. Fig 5.9 show the measuring of throughput for the varying time for all TCP variants such as New Reno, BIC, Cubic, Compound, Vegas, and Westwood.

Fig. 5.9. Throughput w.r.t Number of 100 Nodes

Table 5.7 Throughput of different TCP Variants (100-Nodes)

TIME	TCP BIC	TCP COMPOUND	TCP CUBIC	TCP NEWRENO	TCP VEGAS	TCP WESTWOOD
0	0	0	0	0	0	0
2	505.36	505.51	505.36	485.36	823.19	505.36
4	443.54	428.74	443.54	423.54	603.65	443.54
6	375.07	455.27	375.07	355.07	479.3	375.07
8	377.58	485.71	377.58	357.58	481.37	377.58
10	424.40	501.29	424.40	404.40	544.01	424.40

6.2 Quality of Service for Novel Algorithm

In this section, especially evaluation to be made to observe the Quality of Services (QoS) analysis to be made to examine the TCP behavior component for vehicular environment. We have analyzed overall performance of TCP for number of nodes and behavior of the TCP with variation of time. QoS is measured with respect to three metrics i.e. average packet drops, throughput and average packet delay.

6.2.1 QUALITY OF SERVICE FOR STACKELBERG GAME ROUTING PROTOCOL

Normally we have used in this section mainly novel algorithm Stackelberg Game Routing Protocol (SGRP) to analyzed and observed the performance of TCP. SGRP to find the location of nodes and then transmission of packets. The simulation setup conduct by Network Simulator 2 is to observer the behavior of the TCP in following Quality of Service.

Throughput: In this Fig. 5.10 shows the throughput of all standard TCP variant with respect to particular time. In first scenario we have taken 50 number of nodes. All the standard TCP variant is analyzed and observed the performance of TCP under the vehicular environments. Fig. 5.10 and 5.11 shows the measure of throughput for varying time for all TCP variant with Stackelberg game routing protocol respectively. Constant Bit Rate (CBR) and Variable Bit Rate (VBR) with respect to changing the time interval under the vehicular situation all the standard TCP variants shows the performance of throughput. We observed that TCP Cubic is highest throughput show in SGRP CBR in compare to another TCP variant.

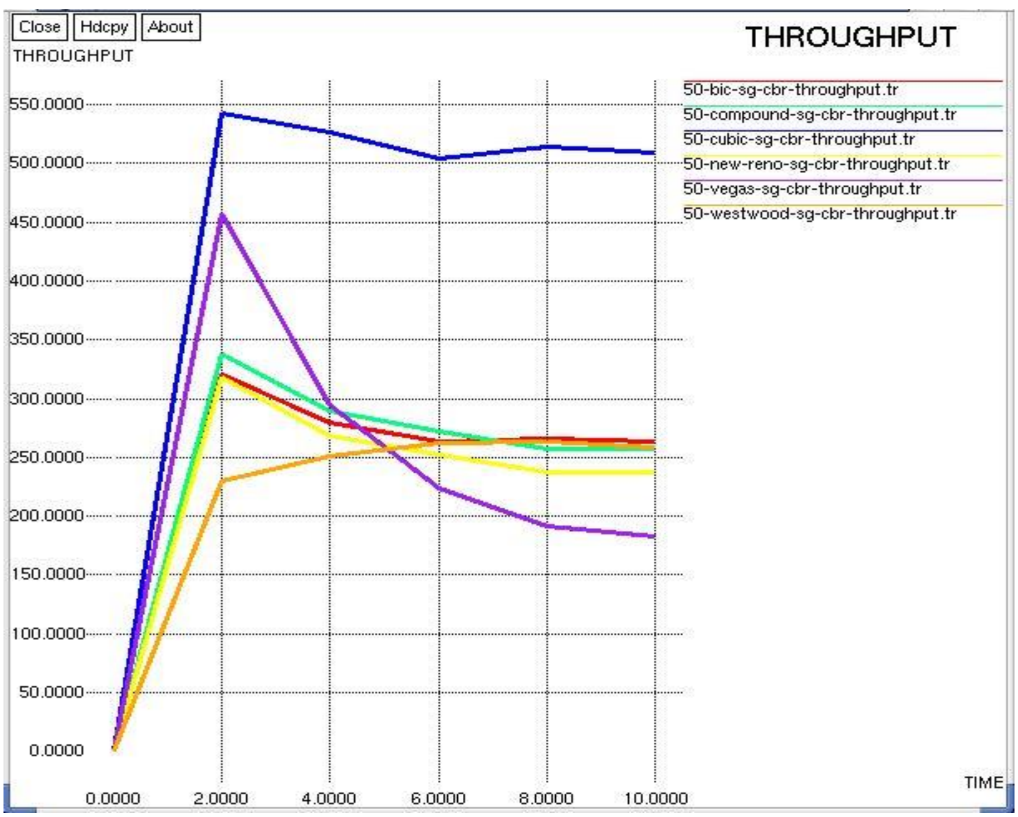


Fig. 5.10 Throughput w.r.t. 50 nodes using SGRP (CBR)

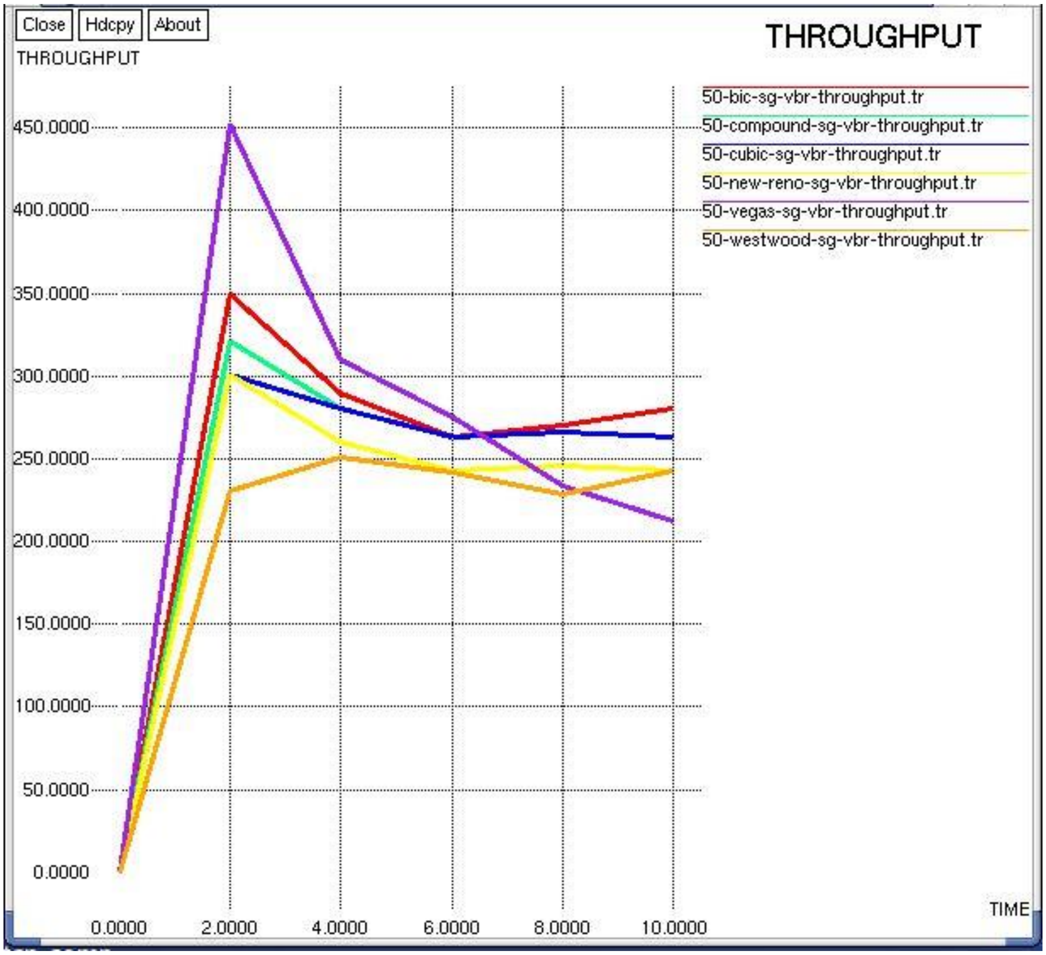


Fig. 5.11 Throughput w.r.t. 50 nodes using SGRP (VBR)

Table 5.8 Throughput of different TCP Variants using SGRP CBR (50-Nodes)

TIME	TCP BIC	TCP COMPOUND	TCP CUBIC	TCP NEWRENO	TCP VEGAS	TCP WESTWOOD
0	0	0	0	0	0	0
2	321	338	543	318	456.57	229.86
4	280	289	527	269	294	250.86
6	263	272	504	252	224	262
8	266	257	514	237	192	263
10	263	257	509	237	183	259

Table 5.9 Throughput of different TCP Variants using SGRP VBR (50-Nodes)

TIME	TCP BIC	TCP COMPOUND	TCP CUBIC	TCP NEWRENO	TCP VEGAS	TCP WESTWOOD
0	0	0	0	0	0	0
2	350	321	301	301	452	231
4	290	280	280	260	310	251
6	263	263	263	243	275	242
8	270	266	266	246	234	229
10	280	263	263	243	212	243

Average Packet Drops: As shown in Fig. 5.12, average packet drops for all standard TCP variants with respect to variation of particular time. So we have taken consider low traffic scenario 50 number of nodes. All the standard TCP variants shows the performance of average packet drop under the vehicular surroundings. We have been used SGRP technique in CBR and VBR as shown in Fig. 5.12 and 5.13 respectively. TCP Vegas is showing minimum average packet drop in comparison with all other TCP variants techniques.

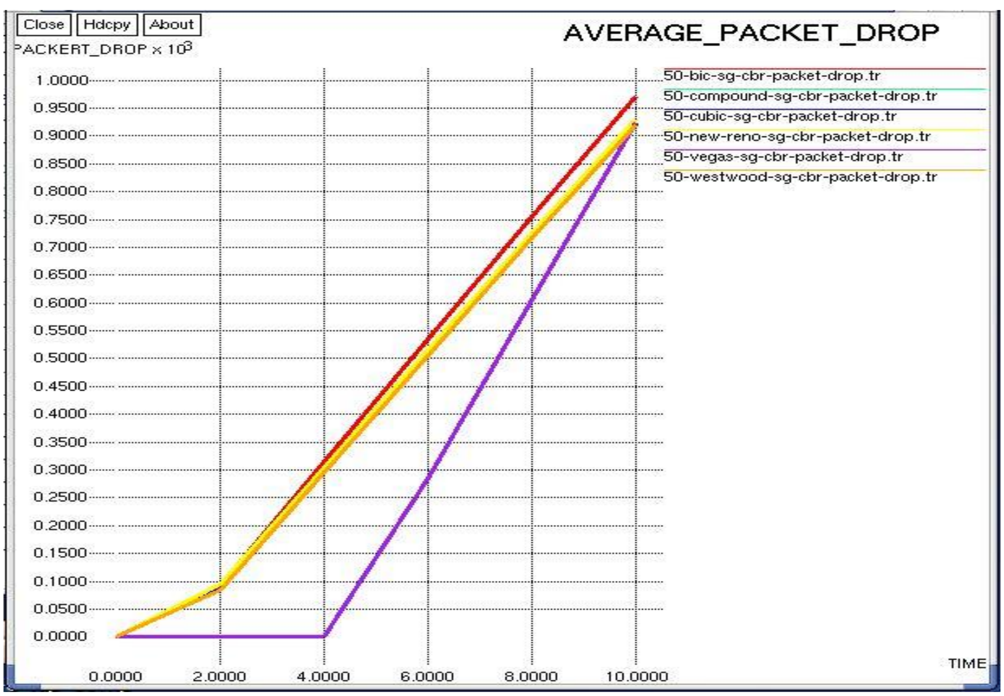


Fig. 5.12. Average packet drop w.r.t 50 nodes using SGRP (CBR)

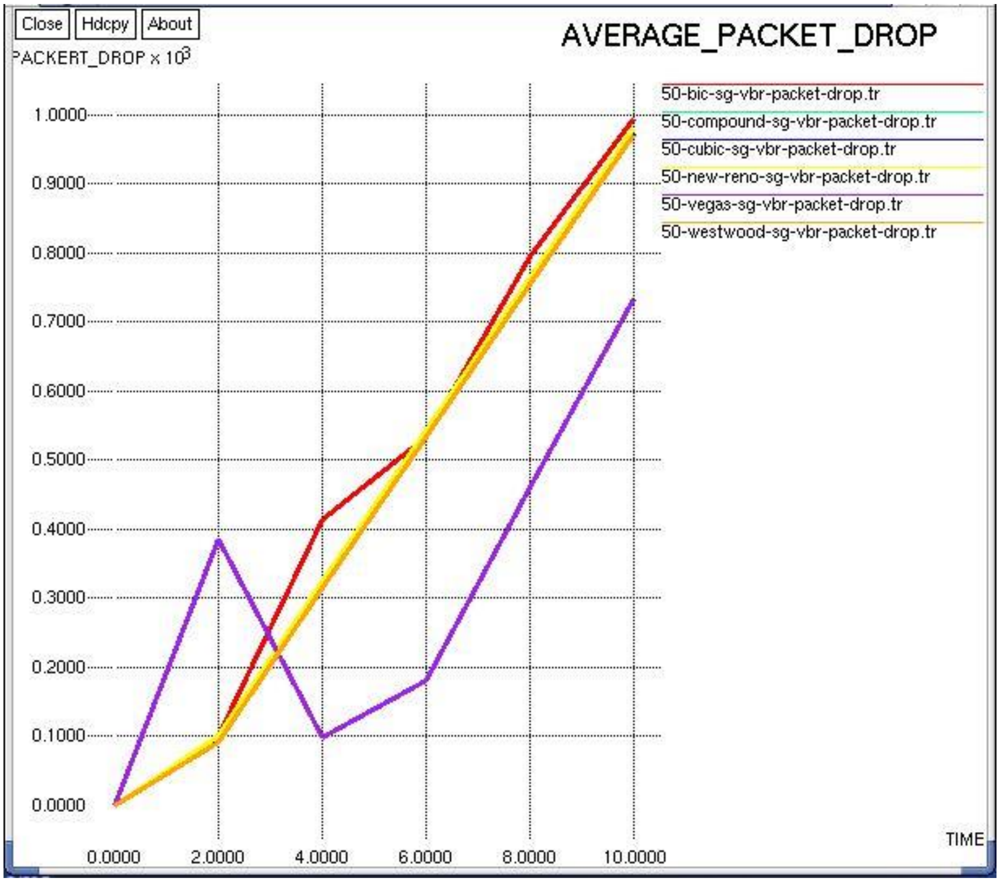


Fig. 5.13. Average packet drop w.r.t 50 nodes using SGRP (VBR)

Table 5.10 Average Packet Drop of different TCP Variants using SGRP (CBR) (50-Nodes)

TIME	TCP BIC	TCP COMPOUND	TCP CUBIC	TCP NEWRENO	TCP VEGAS	TCP WESTWOOD
0	0	0	0	0	0	0
2	92	85	86	94	0	85
4	315	296	297	305	0	296
6	535	506	507	515	286	506
8	755	716	717	725	606	716
10	972	921	922	930	925	921

Table 5.11 Average Packet Drop of different TCP Variants using SGRP (VBR) (50-Nodes)

TIME	TCP BIC	TCP COMPOUND	TCP CUBIC	TCP NEWRENO	TCP VEGAS	TCP WESTWOOD
0	0	0	0	0	0	0
2	102	92	93	101	385	92
4	415	315	316	324	98	315
6	535	535	536	544	182	535
8	795	755	756	764	462	755
10	995	972	973	981	735	972

Average Delay: As shown in Fig. 5.14. and 5.15 we have seen that comparison between average delay is with respect to time. This shows that the implementation of all standard TCP variants such as TCP Vegas, TCP BIC, TCP New Reno, TCP Westwood, TCP Compound and TCP Cubic with used stackelberg game routing protocol in CBR and VBR. We have observed graph is TCP Vegas techniques show the high delay in comparative to another TCP standard variants techniques.

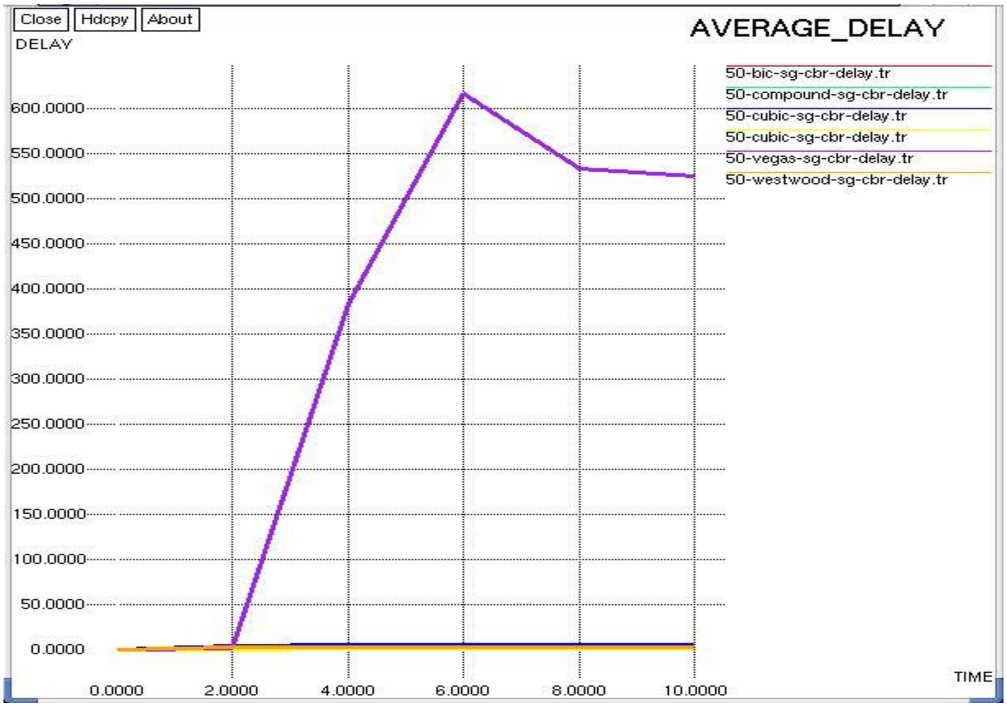


Fig. 5.14 Average Delay w.r.t 50 nodes using SGRP (CBR)

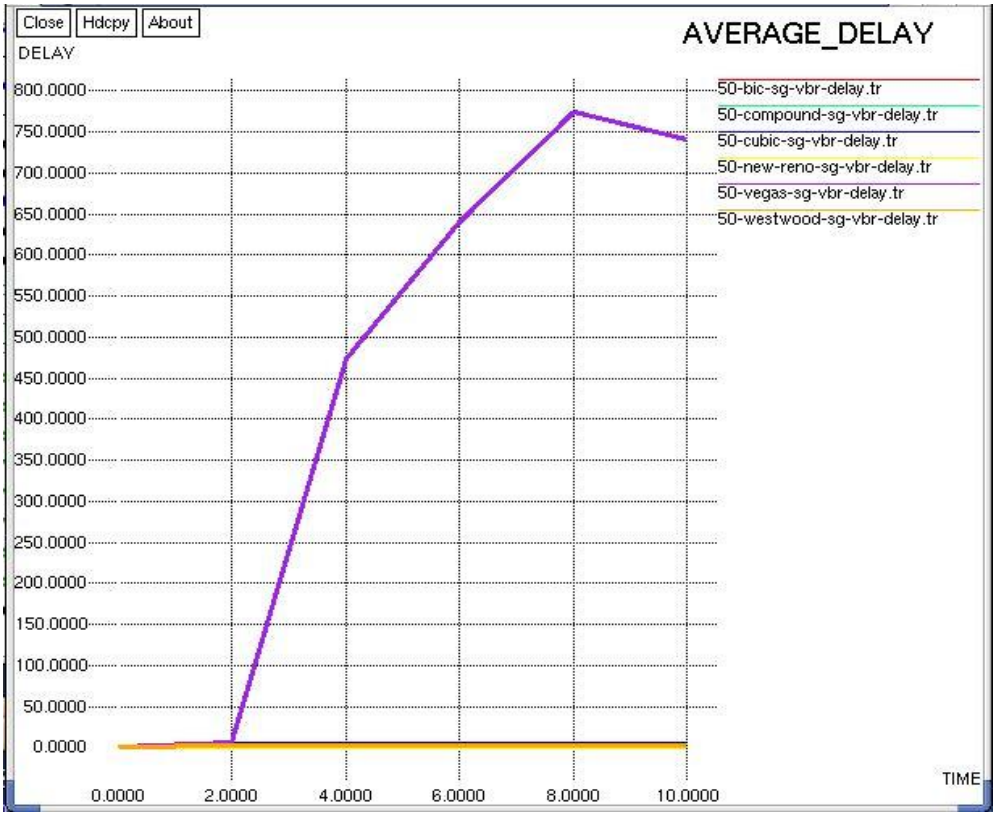


Fig. 5.15 Average Delay w.r.t 50 nodes using SGRP (VBR)

Table 5.12 Average delay of different TCP Variants using SGRP (CBR) (50-Nodes)

TIME	TCP BIC	TCP COMPOUND	TCP CUBIC	TCP NEWRENO	TCP VEGAS	TCP WESTWOOD
0	0	0	0	0	0	0
2	2.72	2.7	4.52	0.29	0.51	2.79
4	2.82	2.8	4.62	0.62	384	2.83
6	2.83	2.8	4.63	0.70	617	2.84
8	2.84	2.8	4.64	0.83	534	2.84
10	2.84	2.8	4.64	0.77	526	2.84

Table 5.13 Average delay of different TCP Variants using SGRP (VBR) (50-Nodes)

TIME	TCP BIC	TCP COMPOUND	TCP CUBIC	TCP NEWRENO	TCP VEGAS	TCP WESTWOOD
0	0	0	0	0	0	0
2	2.85	2.7	4.52	0.35	6.2	2.79
4	2.91	2.8	4.62	0.98	474	2.83
6	2.83	2.8	4.63	1.07	640	2.84
8	2.97	2.8	4.64	1.19	775	2.84
10	2.99	2.8	4.64	1.06	740	2.84

100 Nodes Using SGRP (CBR & VBR):

Throughput: As shown in Fig. 5.16. and 5.17 throughput of all standard TCP variant technique with used new algorithm stackelberg game routing protocol in constant bit rate and variable bit rate. with respect to particular time. In third scenario we have consider high traffic area so we have taken 100 number of node. All the standard TCP variants shows the performance of throughput under the vehicular environments. In Fig. 5.16 and 5.17, TCP Vegas show maximum throughput in sometime with comparative to all another TCP variant.

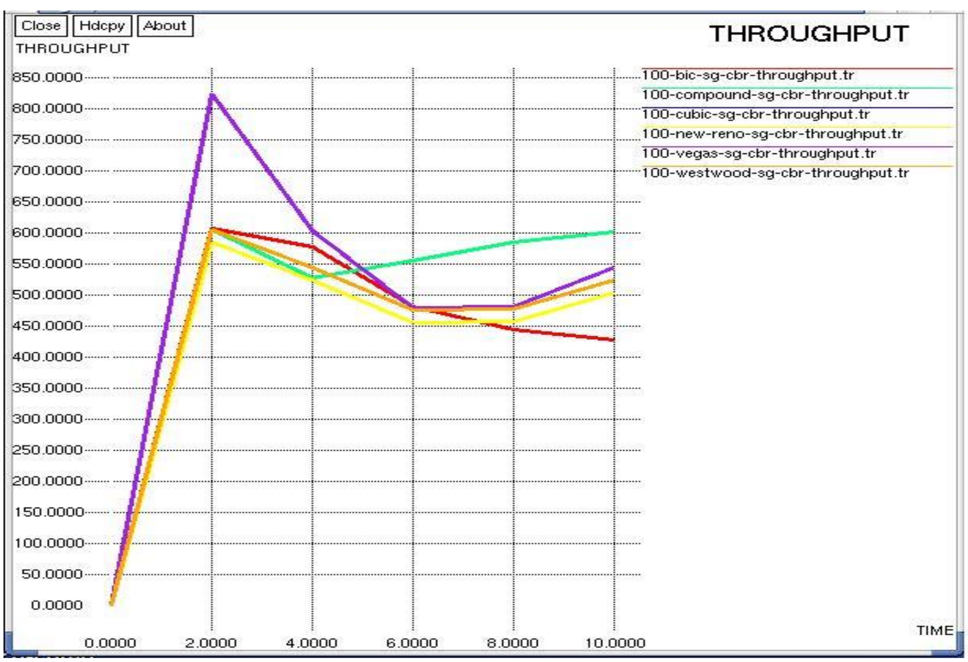


Fig. 5.16. Throughput w.r.t 100 Nodes using SGRP (CBR)

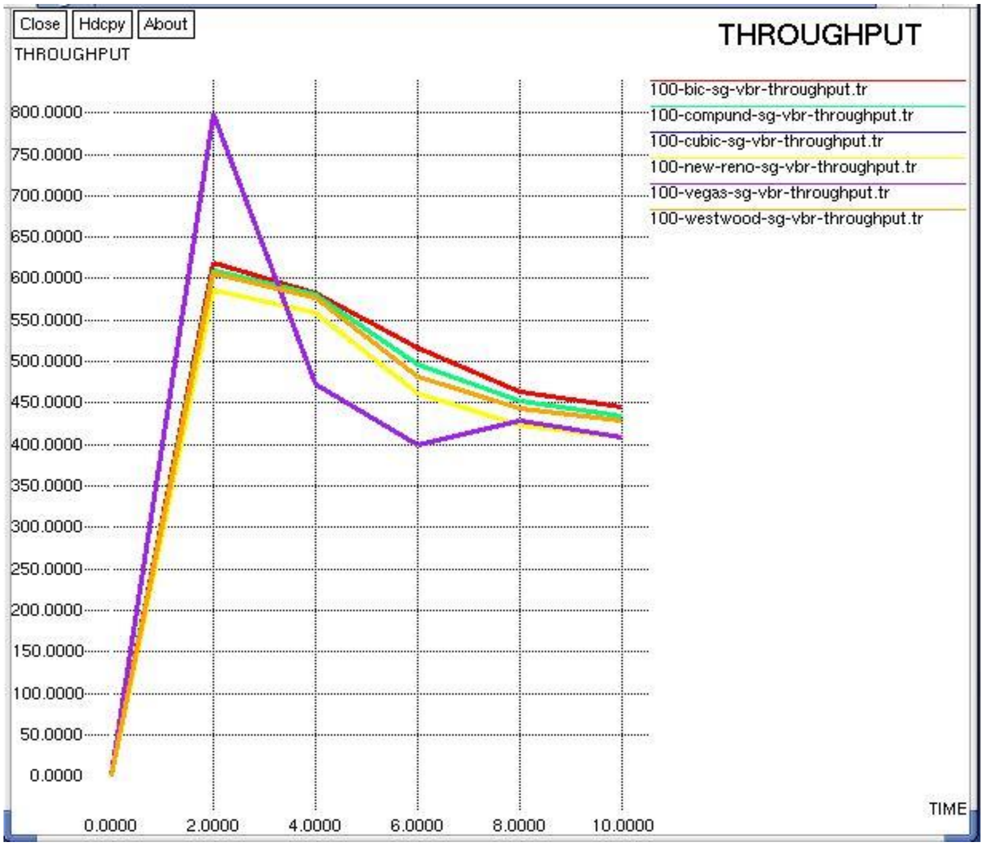


Fig. 5.17. Throughput w.r.t 100 Nodes using SGRP (VBR)

Table 5.14 Throughput of different TCP Variants using SGRP CBR (100-Nodes)

TIME	TCP BIC	TCP COMPOUND	TCP CUBIC	TCP NEWRENO	TCP VEGAS	TCP WESTWOOD
0	0	0	0	0	0	0
2	607	605	605	585	823	605
4	578	528	543	523	603	543
6	481	555	475	455	479	475
8	443	585	477	457	481	477
10	428	601	524	504	544	524

Table 5.15 Throughput of different TCP Variants using SGRP VBR (100-Nodes)

TIME	TCP BIC	TCP COMPOUND	TCP CUBIC	TCP NEWRENO	TCP VEGAS	TCP WESTWOOD
0	0	0	0	0	0	0
2	620	610	607	587	799	607
4	582	581	578	558	472	578
6	517	497	481	461	399	481
8	463	453	443	423	429	443
10	445	435	428	408	408	428

Average Packet drops: In Fig. 5.18 and 5.19, we have seen average packet drops for all standard TCP variant with respect to variation of particular time. In this scenario we consider high traffic condition so we have taken 100 number of nodes. All the standard TCP variants using stackelberg game routing protocol in CBR and VBR the observed the performance of TCP under the vehicular environments has been shown in Fig. 5.18 and 5.19. TCP Vegas is showing minimum average packet drop with comparative all other TCP Variant.

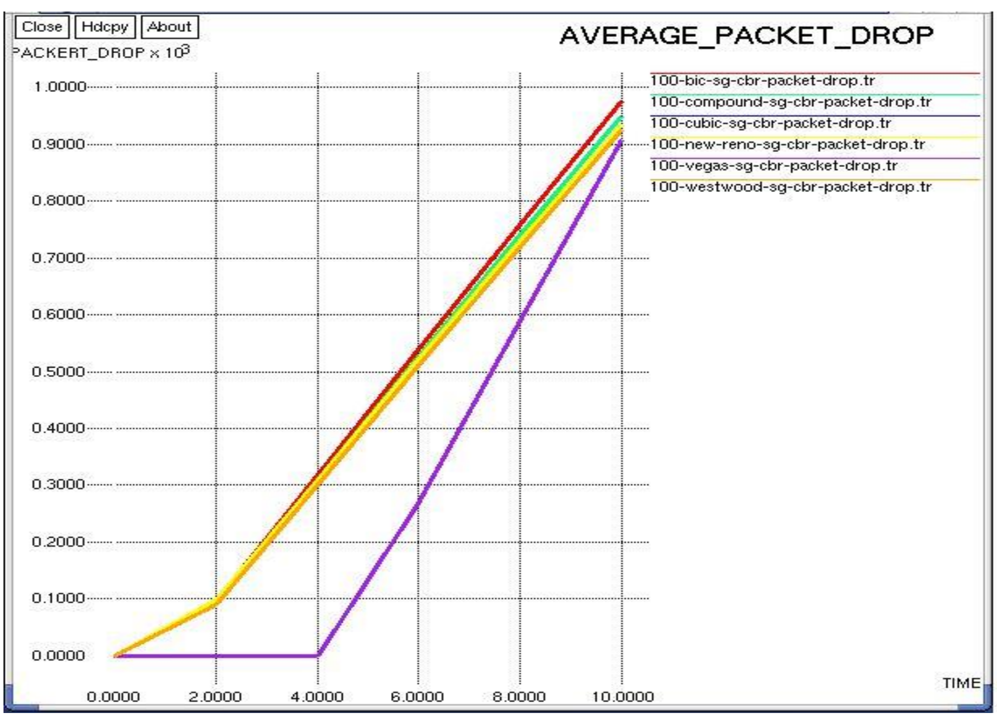


Fig. 5.18 Avg. Packet Drop w.r.t 100 Nodes using SGRP (CBR)

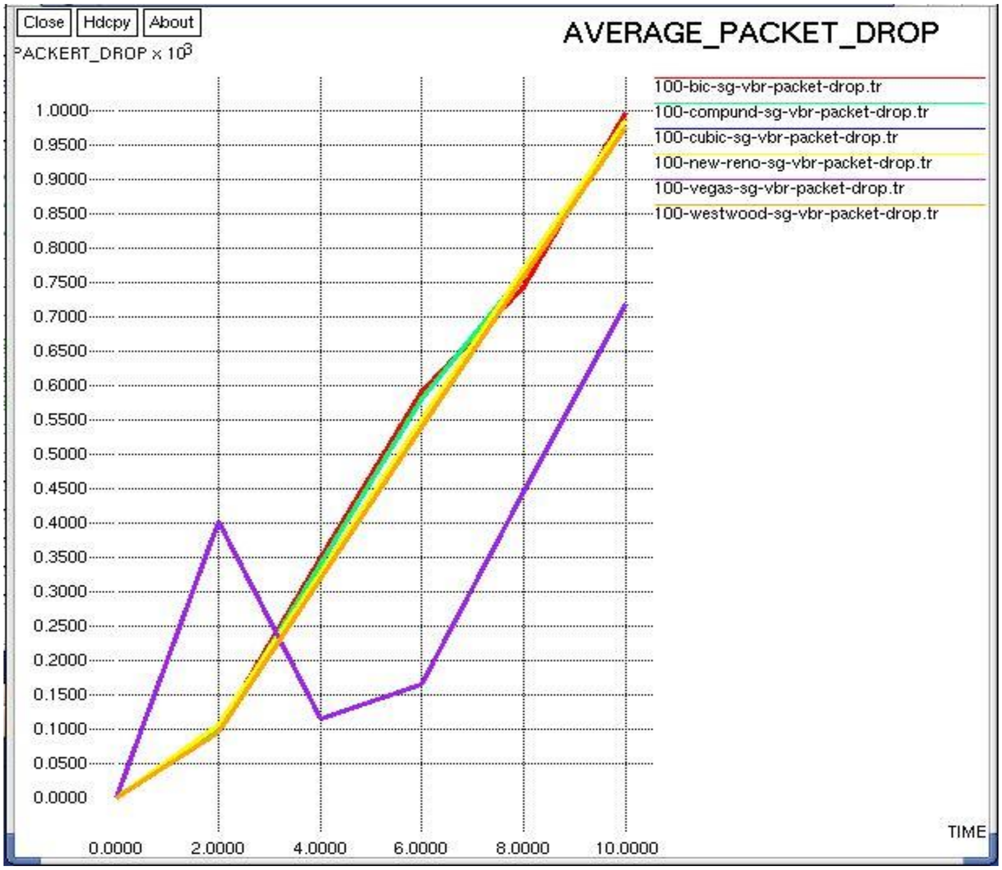


Fig. 5.19. Avg. Packet Drop w.r.t 100 Nodes using SGRP (VBR)

Table 5.16 Average Packet Drop of different TCP Variants using SGRP (CBR) 100-Nodes)

TIME	TCP BIC	TCP COMPOUND	TCP CUBIC	TCP NEWRENO	TCP VEGAS	TCP WESTWOOD
0	0	0	0	0	0	0
2	96	93	89	99	0	89
4	319	310	300	310	0	300
6	539	525	510	520	269	510
8	759	740	720	730	589	720
10	976	951	925	935	908	925

Table 5.17 Average Packet Drop of different TCP Variants using SGRP (VBR) (100-Nodes)

TIME	TCP BIC	TCP COMPOUND	TCP CUBIC	TCP NEWRENO	TCP VEGAS	TCP WESTWOOD
0	0	0	0	0	0	0
2	101	98	96	106	402	96
4	350	340	319	329	115	319
6	590	580	539	549	165	539
8	743	763	759	769	445	759
10	997	987	976	986	718	976

Average Delay: As shown in Fig. 5.20 and 5.21, average delay (ms) evaluation of all standard TCP variant w. r. t. variation of particular time. So we have taken third scenario in high traffic situation so we have numerically taken number of nodes 100. All the standard TCP variants using SGRP in CBR and VBR shows the performance of TCP under the vehicular environments has been shown in Fig. 5.20 and 5.21. We have observed in TCP Vegas is showing maximum average delay with comparative all other variant technique.

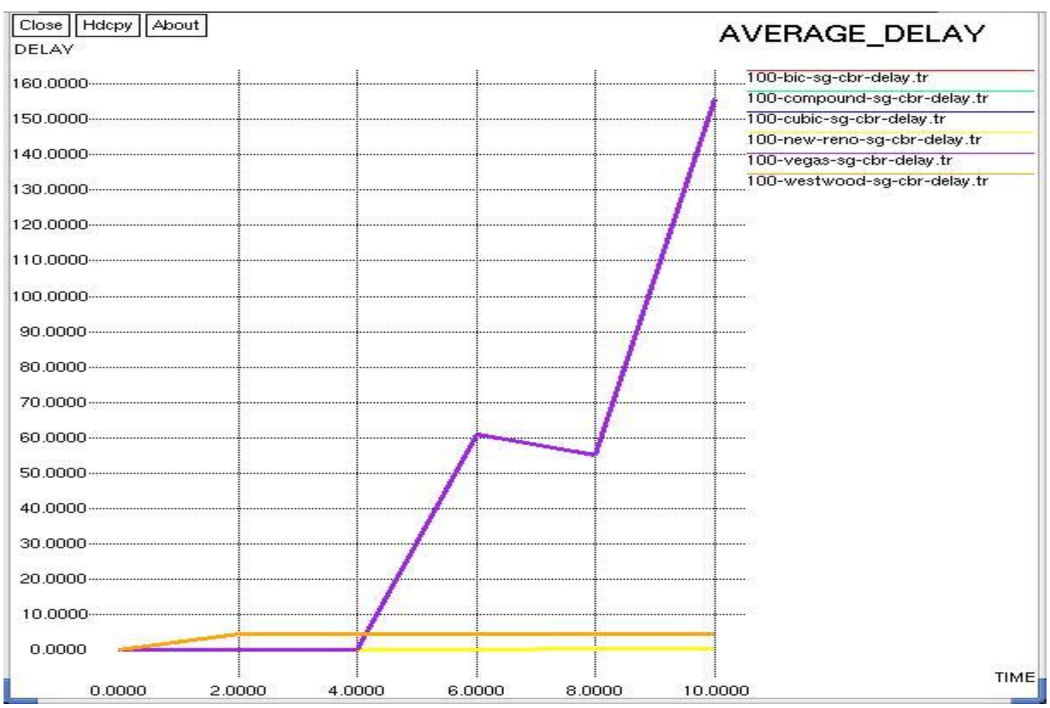


Fig. 5.20. Average delay w.r.t 100 Nodes using SGRP (CBR)

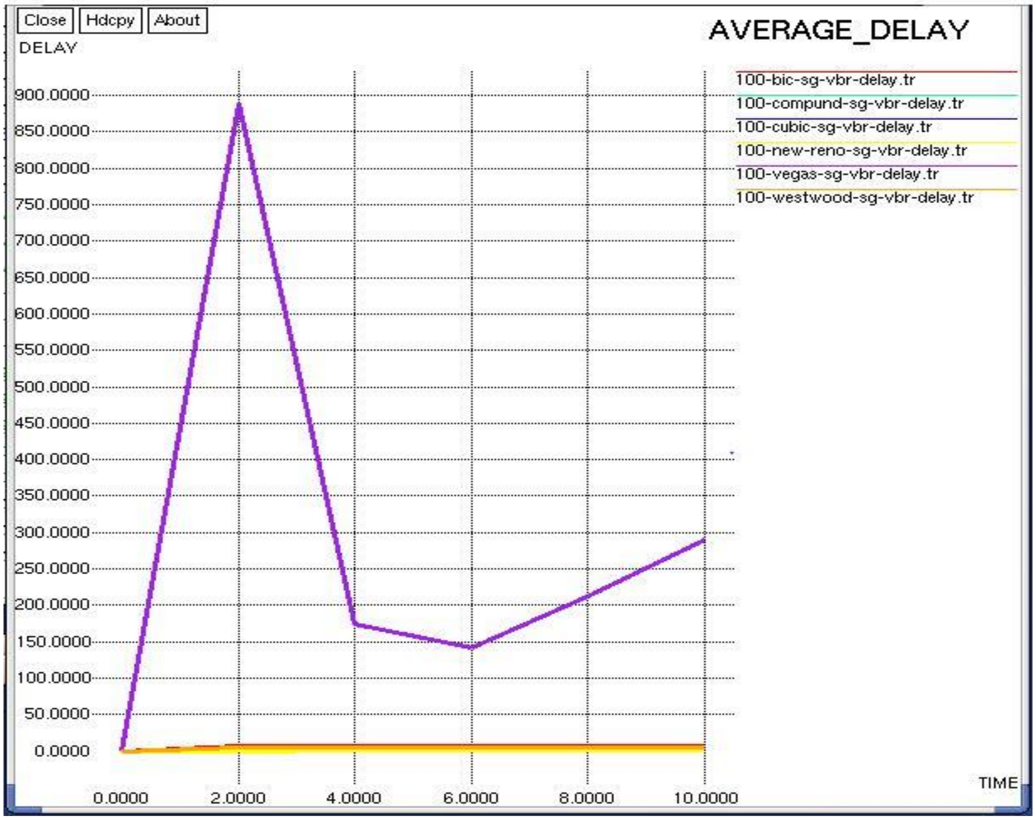


Fig. 5.21. Average delay w.r.t 100 Nodes using SGRP (VBR)

Table 5.18 Average delay of different TCP Variants using SGRP (CBR) (100-Nodes)

TIME	TCP BIC	TCP COMPOUND	TCP CUBIC	TCP NEWRENO	TCP VEGAS	TCP WESTWOOD
0	0	0	0	0	0	0
2	4.5	4.5	4.54	0.04	0	4.54
4	4.6	4.6	4.61	0.18	0	4.61
6	4.6	4.6	4.63	0.27	61	4.63
8	4.6	4.6	4.64	0.58	55	4.64
10	4.6	4.6	4.64	0.55	156	4.64

Table 5.19 Average delay of different TCP Variants using SGRP (VBR) (100-Nodes)

TIME	TCP BIC	TCP COMPOUND	TCP CUBIC	TCP NEWRENO	TCP VEGAS	TCP WESTWOOD
0	0	0	0	0	0	0
2	6.51	5.12	4.54	0.04	888	4.54
4	6.28	5.86	4.62	0.93	174	4.62
6	6.58	5.75	4.64	0.79	142	4.64
8	6.24	5.41	4.64	0.85	213	4.64
10	6.17	5.81	4.64	1.01	290	4.64

6.3 Quality of Service for AOMDV Routing Protocol

Quality of Services (QoS) analysis to be made to examine the TCP behavior component for vehicular environment. We have used to AOMDV routing protocol in TCP variants and analyzed overall performance of TCP for number of nodes and behavior of the TCP with variation of time. QoS is measured with respect to three metrics i.e. Avg. packet drops, throughput and delay.

Throughput for 50 Nodes Using AOMDV: As shown in Fig. 5.22, throughput of all standard TCP variants using AOMDV routing protocol w. r. t. variation of particular time. So we have taken low traffic scenario of 50 number of nodes. All the standard TCP variant shows TCP Vegas is showing maximum throughput in comparison with all other TCP variants techniques.

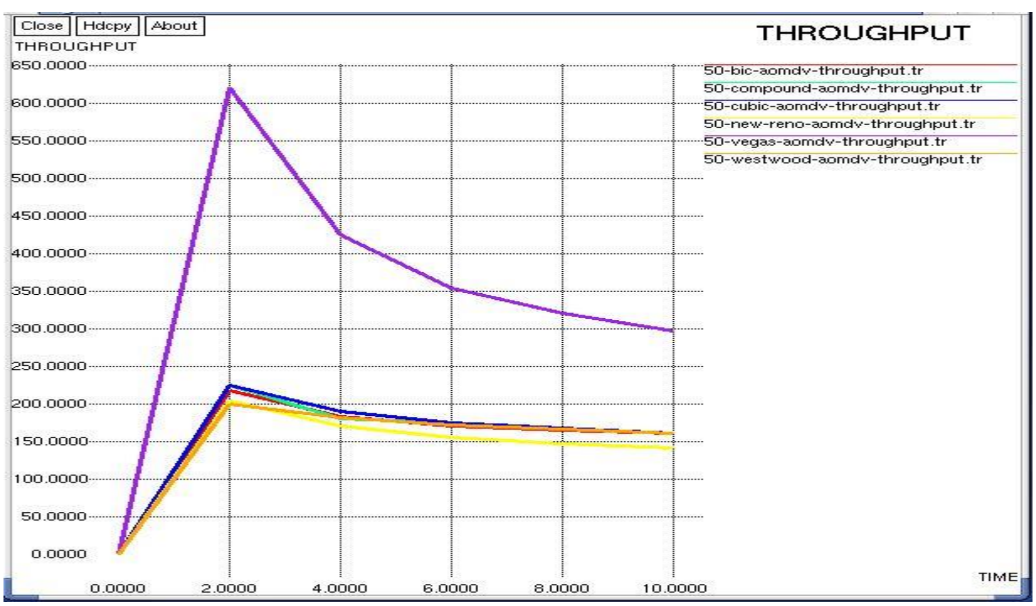


Fig. 5.22. Throughput w.r.t 50 Nodes using AOMDV

Average Packet Drop for 50 Nodes Using AOMDV: As shown in Fig. 5.23, average packet drops for all standard TCP variants using AOMDV routing protocol with respect to variation of particular time. So we have taken first scenario in low traffic situation 50 number of nodes. All the standard TCP variants shows the performance of average packet drops under the vehicular environments has been shown in Fig. 5.23. TCP Vegas is showing after sometime minimum average packet drop in comparison with all other TCP variant algorithms.

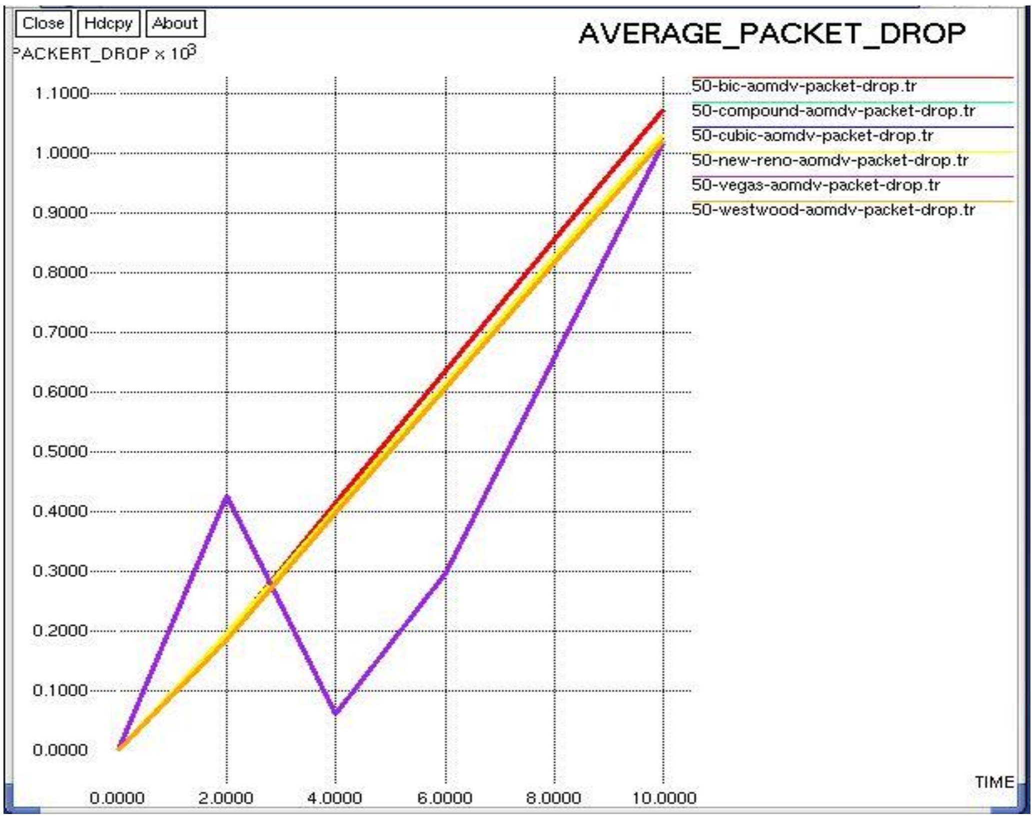


Fig. 5.23 Average packet drops w.r.t 50 nodes Using AOMDV

Average Delay for 50 Nodes Using AOMDV: In this Fig. 5.24, average delay of all standard TCP variants using AOMDV routing protocol with respect to changing of particular time. So we have taken low traffic scenario of 50 number of nodes. All the standard TCP variants shows the performance of TCP under the vehicular environments. So that comparative to another TCP variant initially westwood show the minimum and after some time newreno, bic techniques is showing minimum average delay.

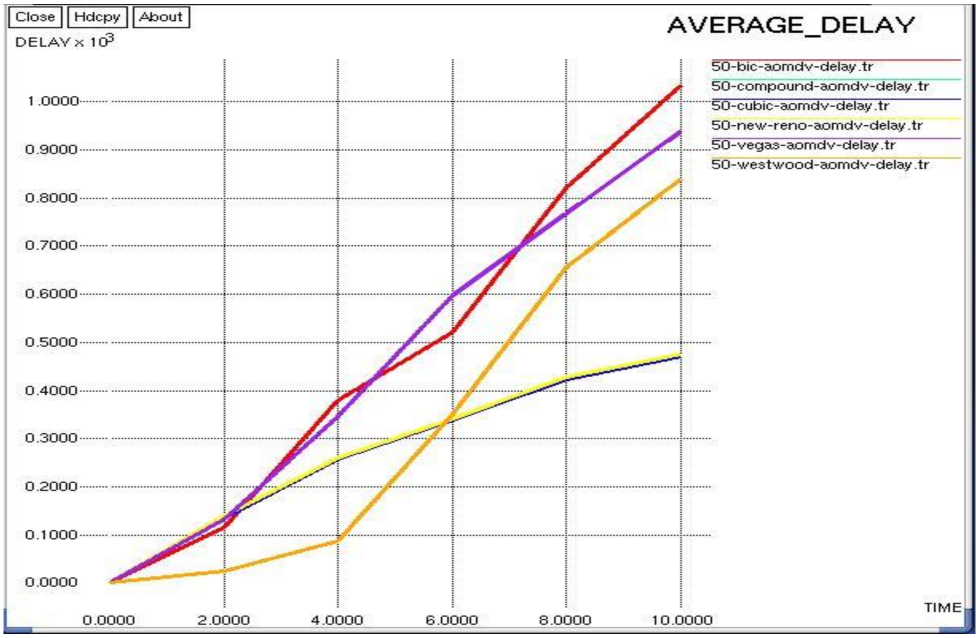


Fig. 5.24 Average Delay w.r.t 50 Nodes Using AOMDV

Throughput for 100 Nodes Using AOMDV: As shown in Fig. 5.25. throughput of all standard TCP variant using AOMDV routing protocol w. r. t. variation of particular time. In this scenario we have consider high traffic situation so we have taken 100 number of node. All the standard TCP variant shows the performance of throughput under the vehicular environments has been shown in Fig. 5.25. TCP Vegas show maximum throughput with comparative to all standard TCP variants algorithm.

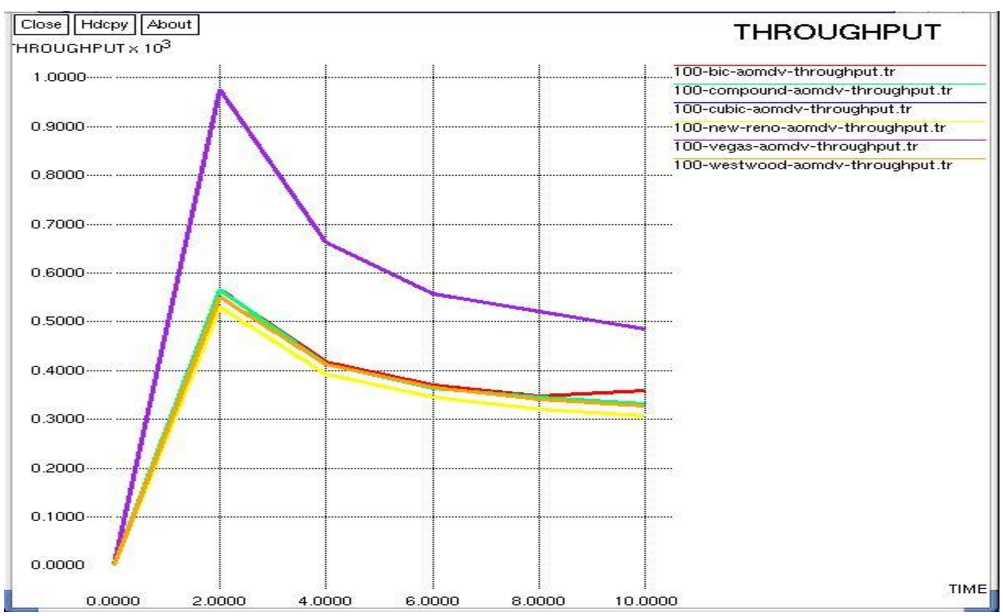


Fig. 5.25 Throughput w.r.t 100 Nodes Using AOMDV

Average Packet Drop for 100 Nodes Using AOMDV: As shown in Fig.5.26, average packet drops of all standard TCP variant using AOMDV routing protocol with respect to variation of particular time. So we have taken in this scenario 100 number of nodes. All the standard TCP variants shows the performance of average packet drop under the vehicular environments has been shown in Fig.5.26. TCP Vegas is after sometime showing minimum average packet drop with all other standard TCP Variants techniques.

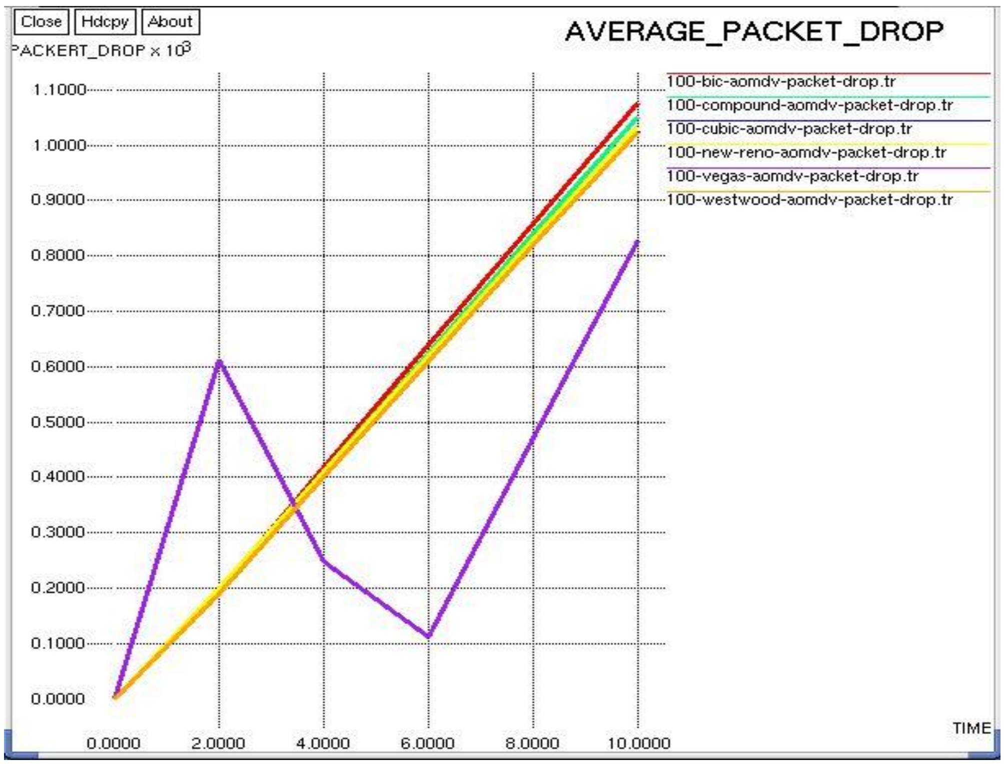


Fig. 5.26 Average packet drop w.r.t 100 nodes Using AOMDV

Average Delay for 100 Nodes Using AOMDV: As shown in Fig. 5.27 average delay of all standard TCP variant using AOMDV routing protocol w. r. t. variation of particular time. So we have considered high traffic scenario so we have taken 100 number of node. All the standard TCP variants shows the performance of average delay under the vehicular environments has been shown in Fig. 5.27. TCP Vegas is showing fluctuation average delay with respect to time.

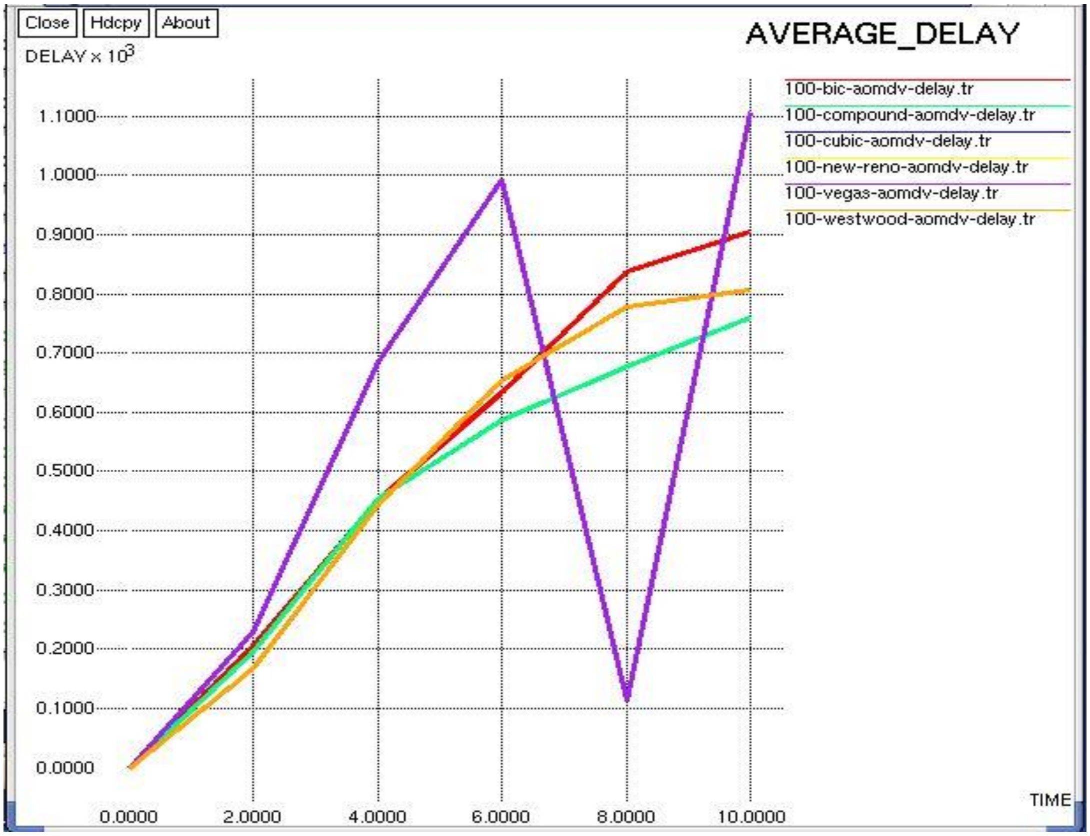


Fig. 5.27 Average delay w.r.t 100 Nodes Using AOMDV

Summary: We have implemented our proposed technique in vehicular environment over low and high traffic scenario. We have found that TCP Vegas have best QoS among all standard TCP variants**.** These results are help us to deployment of internet architecture in VANETs.

CONCLUSION AND FUTURE SCOPE

CONCLUSION

In vehicular environment, evaluation offers a perfect representation about the vulnerability in implementation of all standard TCP variant. We have seen that Transmission Control Protocol (TCP) overall performance of average packet drop, average delay and throughput for various number of nodes. If you see for vehicular environment, we observed that one of the best technique is TCP Vegas because average packet drops and average delay is minimum in various number of nodes under the vehicular surroundings and throughput is also maximum in TCP Vegas technique. We have also used novel algorithm stackelberg game routing protocol with compare of the quality of service under the low, medium, and high traffic in vehicular environments. And we have also compare in different routing protocol namely AOMDV to improve results in TCP performance. The resulting conclusion become draw from the analyzed for complete scales deployments of internets architectures in Vehicular Ad hoc Networks. Firstly, Design TCP need to be nature in cross layer, so that it will rapidly adapting the vehicular networks conditions and development of TCP within emergent congestions notifications at the wireless nodes so that it can readjusting the transfer rate. Secondly, TCP must be design to counter the receivers buffering contentions and buffering overflowing at the intermediates wireless nodes. In order to keep away from spurious timeouts, a brand new retransmissions timeouts (RTO) algorithms ought to be design that must resist traffics put off spikes due to rerouting and mobility.

FUTURE SCOPE

In future, we can evaluate another QoS factors such as delivery of packet ratio, end to end delay, routing cost, average throughput, and packet drop depend upon the performance of standard TCP variants. Further, using another TCP variant namely H-TCP, FAST and TFRC (TCP-Friendly Rate Control), these evaluations can also be compared.

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