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A Novel Approach for Detection of Traffic Congestion in NS2

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Abstract— ***Traffic congestions are formed by many factors; some are predictable like road construction, rush hour or bottle-necks. Drivers, unaware of congestion ahead eventually join it and increase the severity of it. The more severe the congestion is, the more time it will take to clear. In order to provide drivers with useful information about traffic ahead a system must: Identify the congestion, its location, severity and boundaries and Relay this information to drivers within the congestion and those heading towards it. To form the picture of congestion they need to collaborate their information using vehicle-to-vehicle (V2V) or vehicle-to-infrastructure (V2I) communication. Once a clear picture of the congestion has formed, this information needs to be relayed to vehicles away from the congestion so that vehicles heading towards it can take evasive actions avoiding further escalation its severity. Initially, a source vehicle initiates a number of queries, which are routed by VANETs along different paths toward its destination. During query forwarding, the real-time road traffic information in each road segment is aggregated from multiple participating vehicles and returned to the source after the query reaches the destination. This information enables the source to calculate the shortest-time path. By allowing data exchange between vehicles about route choices, congestions and traffic alerts, a vehicle makes a decision on the best course of action.***

Keywords— VANET, PDR, AODV, NS2, END TO END DELAY.

I. INTRODUCTION

1.1 Prologue

VANET is stand for vehicular ADHOC network. In VANET technology transport vehicle are consider as mobile node. In 2006 MANET (Mobile ADHOC network) is research area and VANET is an application of MANET. Now VANET is a different search area and consider a more attention in recent years. Now it is a special form of MANET which is a vehicle to vehicle i.e. inter vehicle communication (IVC) & vehicle to roadside unit wireless communication network (RVC).

VANET belongs to wireless communication networks area. It is the emerging area of MANETs in which vehicles act as the mobile nodes within the network. The basic target of VANET is to increase safety of road users and comfort of passengers. VANET is the wireless network in which communication takes place through wireless links mounted on each node (vehicle) [1]. Each node within VANET act as both, the participant and router of the network as the nodes communicates through other intermediate node that lies within their own transmission range. Higher node mobility, speed and rapid pattern movement are the main characteristics of VANET. This also causes rapid changes in network topology [3].

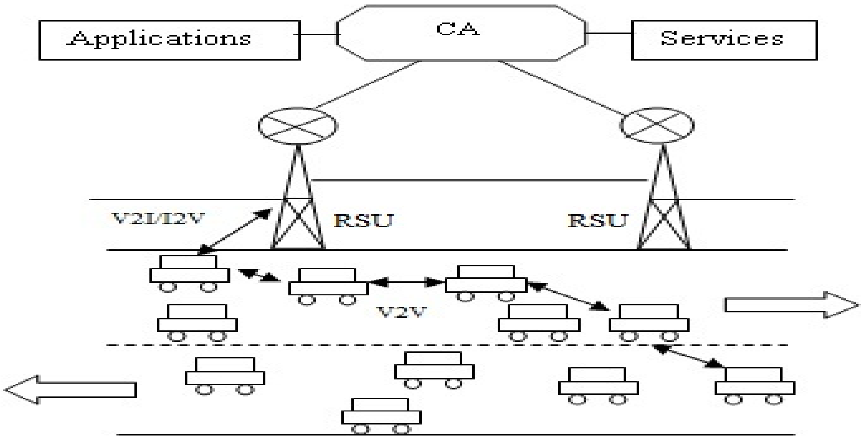

Figure 1.1: VANET Architecture.

1.2 Intelligent Transportation System

Intelligent Transportation System means the vehicle itself acts as a sender, receiver and router for broadcasting information. As discussed earlier, the VANET consists of RSUs and the vehicles are installed with OBU, GPS, ELP, etc. ITS provides two types of communication in VANET: first is Vehicle to Vehicle (V2V) and second is Vehicle to Infrastructure/Infrastructure to Vehicle (V2I/I2V). Fig. 1.1 shows V2V communication and V2I/I2V communication. V2V communication uses multi-hop communication (multicasting/broadcasting) for transmission of data. Inter-vehicle communication consists of two types of communication: first is nave broadcasting which produces beacons at regular interval. The main demerit of using nave broadcasting is collision of messages due to much more generation of messages. Second is Intelligent Broadcasting which generates messages on demand. The collision reduces in this method of data transmission. V2I communication uses single hop communication (RSU broadcasts message to the vehicles in range). It has a high bandwidth link between the vehicles and RSUs. RSUs determine the vehicle speed and if the vehicle speed is more than the limit than RSU broadcasts a message in the form of visual warning or alarm.

1.3 VANET Standards

DSRC is a standard developed by United States [3]. It is a short to medium range communication service used for both V2V and V2I communication. US Federal Communication Commission (FCC) sets 75 MHz of spectrum at 5.9 MHz for DSRC. DSRC spectrum has 7 channels [3]. Each channel is 100 MHz wide. In 2003, American Society for Testing and Materials (ASTM) sets ASTM-DSRC which was totally based on 802.11 MAC layer and IEEE 802.11a physical layer [3]. The main problem with IEEE 802.11a with Data Rate of 54 Mbps is it suffers from multiple overheads. Vehicular scenarios demands high speed data transfer and fast communication because of its high topological change and high mobility.

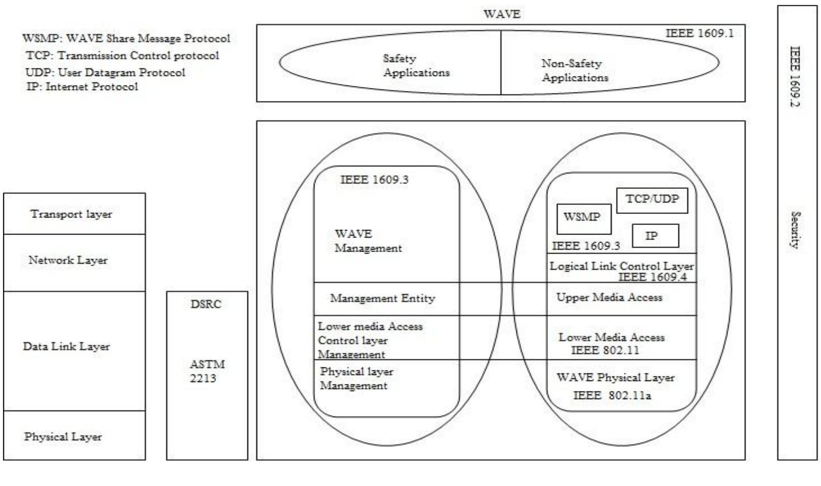

Figure 1.2**:** WAVE, IEEE 802.11p, IEEE 1609 and OSI model [3]

For this the DSRC is renamed to IEEE 802.11p Wireless Access in vehicular Environments (WAVE) by the ASTM 2313 working group. This works on MAC layer and physical layers. WAVE consists of Road Side Unit (RSU) and On-Board Unit (OBU). WAVE uses OFDM technique to split the signals. Fig. 1.2 shows the WAVE, IEEE 802.11p, IEEE 1609 and OSI model.

1.4 Routing

Routing is a vast concept used in MANET and VANET environment. Many routing protocols have been designed for communication between the nodes in an ad hoc environment. In VANET, routing is a difficult task to achieve because of its high mobility. The main issues in VANET which requires routing are network management, traffic management, broadcasting, mobility, topological change, Quality of Service (QoS), fast data transfer, etc. These are the challenging elements which require efficient routing techniques. Routing protocols are divided into Topology Based, Position Based, Cluster Based, Geo Cast Based and Broadcast Based. In this section, we survey briefly on different routing protocols used in VANET implementations.

1.4.1 Topology Based Routing

Topology based routing protocol is divided into proactive and reactive routing protocols [6]. In proactive routing protocols, no route discovery takes place as the routes are predefined. Maintenance of unused routes leads to high network load. DSDV: Destination-Sequenced Distance-Vector Routing, OLSR: Optimized Link State Routing Protocol, FSR: Fisheye state routing, CGSR: Cluster Head Gateway Switch Routing, WRP: The Wireless Routing Protocol, TBRPF: Topology Dissemination Based on Reverse-Path Forwarding, etc. are some of the proactive routing protocols.

In reactive routing protocols, the route discovery takes place on demand. So, the network load reduces as only the route currently in use is maintained. DSR: Dynamic Source Routing, AODV: Ad Hoc on Demand Distance Vector, TORA: Temporally Ordered Routing Algorithm, JARR: Junction-based Adaptive Reactive Routing, PGB: Preferred Group Broadcasting, etc. are some of the reactive routing protocols.

Hybrid routing protocols discovers the routes between the zones to reduce network load. Proactive protocols are used in intra-zone routing and reactive protocols are used in inter-zone routing. ZRP: Zone routing protocol, HARP: Hybrid Ad Hoc Routing Protocol, etc. are some of the zone routing protocols.

1.4.2 Position/Geographic Based Routing

Position based routing uses geographic location information for the selection of next hop to forward the message. It uses beaconing to broadcasts the messages [6]. GPSR: Greedy Perimeter Stateless Routing, DREAM: Distance Routing Effect Algorithm for Mobility, CAR: Connectivity Aware Routing Protocols, GSR: Geographic Source Routing, A-STAR: Anchor-Based Street and Traffic Aware, PRB-DV: Position-Based Routing with Distance Vector Recovery, GRANT: Greedy Routing with Abstract Neighbour Table, GpsrJ+, STBR: Street Topology Based Routing,

GyTAR: Greedy Traffic Aware Routing protocol, LOUVRE: Landmark Overlays for Urban Vehicular Routing Environments, DIR: Diagonal-Intersection-Based Routing Protocol, ROMSGP: Receive on Most Stable Group-Path, AMAR: Adaptive movement aware routing protocol, EBGR: Edge node based greedy routing protocol, B-MFR: Border-node based most forward within radius routing protocol, ARBR: The Associativity-Based Routing, MORA: Movement-Based Routing, VGPR: Vertex-Based predictive Greedy Routing, MIBR: Mobile Infrastructure Based VANET Routing, DTSG: Dynamic Time-Stable Geocast Routing, TO-GO: Topology-assist Geo-Opportunistic Routing, CBF: Contention-Based Forwarding, VADD: Vehicle-Assisted Data Delivery, GeOpps: Geographical Opportunistic Routing, GeoDTN+Nav, etc. are some of the position based routing protocols.

1.4.3 Cluster Based Routing

In cluster based routing, a group of nodes are identified as a cluster and in each cluster a cluster head exists which sends the message [6]. CBR: Cluster Based Routing, CBLR: Cluster Based Location Routing, CBDRP: Cluster-Based Directional Routing Protocol, TIBCRPH: Traffic Infrastructure Based Cluster Routing Protocol with Handoff, LORA-CBF: Location Routing Algorithm with Cluster-Based Flooding, COIN: Clustering for Open IVC Network, HCB: Hierarchical Cluster Based Routing, etc. are some of the cluster based routing protocols.

1.4.4 Geo Cast Based Routing

In this routing, message is delivered to a region by multicasting [6]. IVG: Inter-Vehicle Geo Cast, DG-CASTOR: Directionbased Geo Cast Routing Protocol for query dissemination in VANET, DRG: Distributed Robust Geo Cast, ROVER: Robust Vehicular Routing, DTSG: Dynamic Time-Stable Geo Cast Routing, etc. are some of the Geo Cast routing protocols.

1.4.5 Broadcast Based Routing

This is a frequent routing technique in which messages are broadcasted and shared among the vehicles and between vehicle and infrastructure. BROADCOMM, UMB: Urban Multi-hop Broadcast Protocol, V-TRADE: Vector Based Tracing Detection, DV-CAST: Distributed vehicular broadcast protocol, EAEP: Edge-aware epidemic protocol, SRB: Secure Ring Broadcasting, PBSB: Parameter less Broadcasting in Static to Highly Mobile Wireless Ad Hoc Network, etc. are some of the broadcast based routing protocols [6].

In VANET vehicles communicate with each other via Inter Vehicle communication (IVC) as well as with road side base stations via road side to vehicle communication (RVC) and third approach is HVC(hybrid vehicle communication) in which vehicle communicate with road side base station by multi hop.

Vehicular ad-hoc networks (VANETs) are self-organized and self-configuring networks built up from moving vehicles and roadside units [8]. It does not rely on any fixed network infrastructure. Although some fixed nodes act as the roadside units to facilitate the vehicular networks for serving geographical data or a gateway to internetetc [2]. Vehicles are equipped with On Board Units (OBUs) that helps to form a wireless network that helps them to communicate and exchange information during their movement on roads. Figure 1.3 gives an overview of VANET in which IVC is shown by blue dotted arrow line and RVC is shown by red arrow line.

VANET is a special type of MANET, but it is different in some aspects like vehicles move on predefined roads, vehicles velocity depends on the speed signs and in addition these vehicles also have to follow traffic signs and traffic signals [10]. These characteristics pose technical challenges to implement a high performance VANET

There are many challenges in VANET that are needed to be solved in order to provide reliable services, frequent network partition, constraints on roads, high mobility of nodes, etc. Stable & reliable routing in VANET is one of the major issues. Hence more research is needed to be conducted in order to make VANET more applicable. As vehicles have dynamic behavior, high speed and mobility that make routing even more challenging.

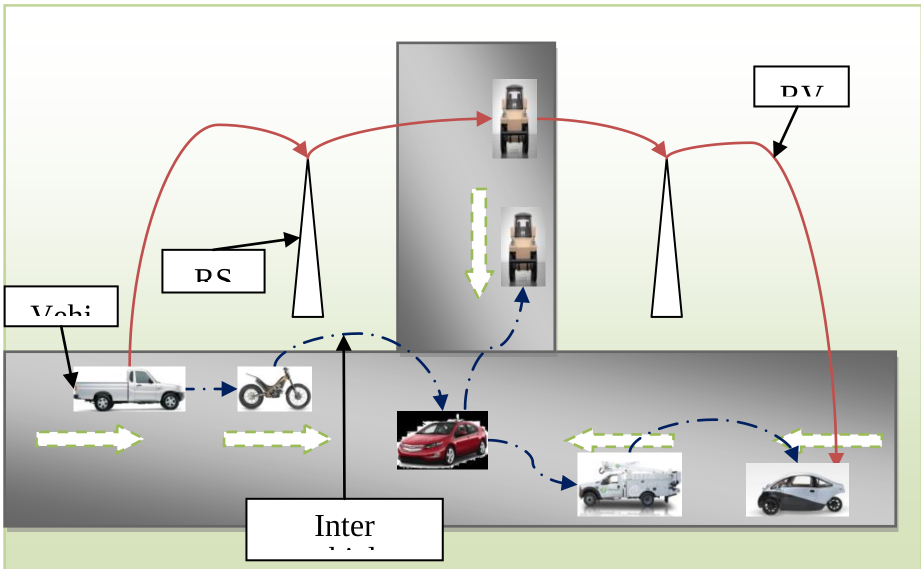

Figure 1.3 Inter vehicle communication [2]

II. LITERATURE REVIEW

In this section we thoroughly discussed about different routing methods used for VANET. The reason of conducting detailed literature review for VANET routing methods was to check how the VANET routing is influenced by routing protocols which are currently being used by MANET and VANET. Furthermore, MANET routing protocols which are suitable to some extent for

VANET were also kept in context while conducting the literature review. In addition, it also assisted us in selecting the suitable routing protocols in order to make comparison with VANET routing protocols. This comparison was based on evaluating the performance of these routing protocols in VANET.

In general, there are two methods of vehicle detection: intrusive technologies (pneumatic road tubes, inductive loop detectors, piezoelectric sensors) and non-intrusive technologies (video image processors, microwave radars, infrared sensors, and ultrasonic sensors) [25]. An inductive loop detector consists of three components: a loop, a loop extension cable and a detector [26]. Loop detectors are placed at specified locations on roadways to count vehicles and to estimate vehicle speed based on the occupancy time of vehicles on the detectors. However, installing these detectors requires a great number of saw-cuts on roadway surfaces, which makes them difficult to deploy and maintain. This work is much more expensive on roadway sections which need a large number of loop detectors. Moreover, loop detectors can provide data only from vehicle to infrastructure and not vice versa.

In order to improve the vehicle detection technique for ITS, wireless communication systems have already been studied. Wireless communication systems used in ITS can be classified into 2 types: vehicle-to-vehicle communication (V2V) and vehicle-to-infrastructure communication (V2I). Some systems such as VETRAC [14] and COC [15] which employ V2V and V2I to provide more functions for roadway security and management are being developed.

Karp's et al. (2000) [25] is one of the most cited works, having proposed Greedy Perimeter Stateless Routing (GPSR), a geographic routing scheme for wireless networks in 2000. It uses position of nodes to make packet forwarding decisions. A Mobicom paper was published on GPSR. Dynamic Source Routing (DSR), Ad-Hoc On-Demand Distance Vector Routing (AODV), and Zone Routing Protocol (ZRP) avoid topology information being constantly pushed to nodes, as in OSPF, or reachability information being pushed, as in BGP. Instead this data is acquired on-demand as required by the nodes' packet forwarding needs. In GPSR, there is a beaconing scheme, in which nodes learn their neighbours' geographic locations a priori (it does have this proactive routing-protocol messages avoided by DSR and AODV). In addition, it assumes that locations of packet destinations are known; this information is assumed to be available "through a location registration and lookup service that maps node addresses to locations" e.g., Grid Location Service (GLS). Ad hoc routing protocols can be classified as proactive, reactive (on-demand) or position-based.

Carlos, Hrishikesh Gossain et al. (2003) [23] conveys that mobile ad-hoc networks (MANETs) have been gaining tremendous attention owing to the advances in wireless technologies accompanied by many applications and implementations. However, there are still a number of issues in MANETs which require further investigations and efficient solutions. Out of these issues, broadcasting in MANETs has been a major problem for both industry and the research community. The broadcast communication is usually required to disseminate a message to all the nodes of a network. This operation is highly required in MANETs to distribute necessary information and ensure efficient control and coordination over the network nodes. However, broadcasting in MANETs is usually susceptible to several challenging communication issues, including, flooding, packets contentions and collisions, i.e., these problems all together are called the Broadcast Storm Problem (BSP). Despite a number of suggested solutions for BSP, the probabilistic scheme is considered the most promising solution due to its simplicity and suitability for MANETs. Under the umbrella of this scheme, many dynamic probabilistic broadcasting algorithms have been proposed in the literature to solve the BSP. However, most of them are not suitable for many applications including those real life scenarios as there are many limitations such as the probability of rebroadcasting operation and thresholds rebroadcasting permission, which is caused by collecting local neighborhoods' connectivity by broadcasting HELLO packets. In an attempt to enhance and promote the quality of the probabilistic scheme, this paper proposes a new probabilistic approach to overcome these limitations. Their proposed approach is augmented with a well-know ad-hoc routing protocols including Ad-hoc On-demand Distance Vector protocol (AODV). They have conducted intensive simulation experiments under different operating condition. The simulation results show that their proposed approach outperforms its counterparts including the well known blind flooding, fixed probabilistic and traditional dynamic probabilistic approaches.

Lochert et al. (2003) [35] proposed a protocol known as GPCR in which the forwarding node is selected to be the junction node and the recovery strategy for GPCR is same as GPSR.

Venkata C. Giruka et al. (2005) [24] conveys that the hello protocol is a fundamental protocol for wired and wireless networks. In mobile ad-hoc networks, a hello protocol helps nodes to establish a neighbour table for link detection. If nodes exchange position information in hello packets, then it also helps them in packet forwarding decisions. In ad-hoc networks, due to node mobility, neighbour relationship changes frequently. To cope with mobility and to have up-to-date neighbour table, nodes advertise hello packets periodically. These hello packets create congestion in the network, which may drop control and data packets in the network. In this paper, they study the impact of hello protocols on ad-hoc networks. They present three new hello protocols, which reduce network congestion. The main idea behind all the three protocols is to beacon as minimum as possible without compromising the accuracy of the neighbour table. To evaluate the performance of our protocols and their impact on ad-hoc networks, we simulated them in GloMoSim 2.03. Simulation results showed that the proposed hello protocols incur much lower overhead and increase the network performance compared to periodic hello protocol, while maintaining identical neighbour table accuracy.

Mangharam et al. (2005) [31] report Groovesim simulation results evaluating Groovenet, a routing scheme. Wang et al. evaluate the performance of IEEE 802.11p MAC protocol using an ns-2 simulation, and show that the fixed back off window sizes could affect throughput adversely. Two schemes are proposed to adapt window sizes based on local observations or the number of simultaneously transmitting vehicles. Eichler reports on a performance evaluation of the IEEE 802.11p standard using OMNeT++. The key finding is that the channel switching between a service channel and control channel causes extra delay for safety critical broadcasts queued for the CCH time interval.

Mangharam et al. (2005) [26] propose Groovenet, a geographic routing protocol for multi-hop vehicular networks. This paper also notes that Mobile Ad hoc Networking (MANET) routing protocols are not suitable for vehicular networks in four key ways: "Vehicular networks are characterized by rapid (relative speeds up to 300 kmph) but predictable topology changes, a small effective diameter, frequent fragmentation and limited redundant paths. Furthermore, vehicular networks have well-specified application categories which favour broadcast protocols over generic path-based end-to-end MANET protocols.

Chen, Jiang and Delgrossi, in a 2006 [32], simulate, using ns-2, the effect of IEEE 1609.4 multichannel operations. They show that with channel switching enabled, the performance for safety related communications becomes "unacceptably poor" and recommend an update/revision to the standard. An excellent detailed simulation study on the reception rates of broadcast messages using IEEE 802.11e EDCA priority access is presented. This study compares the two-ray ground reflection model and a non-deterministic radio propagation model using the two-parameter Nakagami distribution, which has been shown to fit signal amplitudes at different distances in wireless channels. This paper notes "actual measurements indicated that the Nakagami model fits better to VANETs than log-normal or pure Rayleigh shadowing.

Tanikella et al. (2007) [30] use ns-2 to simulate a one-lane road, with the number of cars varied from 4 to 196, speeds set at 0, 48, or 96 km/hr, and inter-car distance varied from 5 m to 26 m. Each node broadcasts 500 B messages every sec on a service channel. One-hop V2V communications is assumed. The Nakagami distribution is used for the channel model, and the IEEE 802.11e enhanced MAC scheme was simulated. Throughput, delay, and packet loss were characterized. Their conclusion is that speed does not matter, and therefore, vehicle speed was fixed at 48km/h for inter-car distance studies. Vehicle density was a big determinant of increased loss and throughput, and average delay converged. On throughput, loads were not increased to a point at which thrashing could be observed; instead throughput was shown to simply increase with density.

Azzedine Boukerche et.al (2008) [17] paper proposes a vehicle volume and speed measurement method using wireless communications between roadside equipment and vehicles. Vehicles are equipped with Global Positioning System (GPS) receivers and wireless communication devices, to detect their geographical location and to provide ad-hoc network connectivity with the roadside unit respectively. To carry out the functions of a loop detector, roadside equipment collects data from vehicles to detect their locations periodically and then counts the number of vehicles passing a given position in a period, but the authors have taken the scenario that the ranges of RSUs are set in such a way that they do not overlap with each other but also there should not be any gap in the coverage range of the RSUs. This scenario gives a good detection result but could not be applied to the sparse RSUs region where no of RSUs are less.

Agarwal, Starobinski and Little et al. (2008) [28] propose a routing scheme that leverages connectivity in a fragmented VANET, and carry out an analytical/simulation study of its performance. A modified version of AODV, called AODV-DFR (AODV with Directional Forward Routing) was proposed and evaluated for the vehicular environment using ns-2. 3 A differentiated reliable routing (DRR) protocol is proposed in for VANETs. For sparsely connected VANETs, a Vehicle-Assisted Data Delivery (VADD) protocol is described. It adopts the idea of "carry-and-forward" in which nodes "carry" packets when there are no routes to the destination under sparse conditions. A simulation study of VANET routing protocols, which uses realistic vehicular traces, is described in, and shows that the mobility model keenly influences the relative performance of AODV and GPSR. Performance limitations are addressed with suggested improvements to these protocols.

Jatinder Pal Singh et al. (2009) [21] conveys that Mobile Ad-hoc Network is one of the types of Wireless Ad-Hoc Networks which has distinguished characteristics like: self configuring, decentralized and infrastructure less. Mobile nodes in such a network communicate with each other through wireless links since the nodes are always on move, routing in such a set up is always a challenge. To overcome this challenge, Internet Engineering Task Force (IETF) has developed Dynamic MANET On-demand (DYMO) routing protocol which is successor to the popular Ad-hoc on Demand Distance Vector Protocol(AODV), so it is also known as AODVv2. This paper presents a comprehensive study about the working of the DYMO protocol and also discusses its comparison with the working of the AODV protocol. In this paper, they have reviewed the working of DYMO Routing Protocol in comparison with the existing AODV protocol. Since it is an enhanced version of AODV protocol it is also known as AODVv2, which aims at simplifying AODV by removing unnecessary features and adopting successful features from DSR like path accumulation. Their overall study shows that DYMO is a better protocol when it comes to networks with high mobility and changing topology, moreover its performance outperforms the conventional AODV protocol when it comes to large networks with large number of nodes and changing topology.

Randall Berry et al. (2009) [33] compare three different radio propagation models that capture the effects of distance attenuation and the presence of buildings on VANETs. These were compared to the two-ray ground reflection model using ns-2 simulations.

Gongjun et al. (2009) [34] proposed a protocol GPSR which stands for Greedy Perimeter Stateless routing and it is a well known position based routing protocol in which two strategies are used to send the data from S to D. In the first strategy, vehicle V1 sends the data to vehicle V2 which is nearer to D, but if vehicle V1 itself nearer to D than other vehicles, it uses the recovery strategy by switching to perimeter mode.

Hossain et al. (2010) [36] designed a protocol known as A-STAR which mainly focuses on the connectivity of routes and the main goal is to send the packets successfully to the D. The main challenges behind such routing protocols are high mobility and security. Due to high probability link failure occurs and the recovery strategies discussed above work well to this situation. But at some time, the recovery strategies may fail due to huge sparse regions in the network. So, if a past knowledge (K) about the CV region is known then there is a less chance of encountering a sparse region in the path. SGIRP protocol uses this recovery technique to avoid CV regions in the path. Security is also a major issue in the routing protocols and there should be a security module to check the malicious attacks form the malicious drivers. SGIRP routing protocol provides a robust security module to check vehicles authentication and protect vehicles from attacks. SGIRP also solves the shortest path problem by using Dijkstra algorithm.

Veeraraghavan et al. (2011) [27] propose a secure routing protocol for VANETs called Geographic Secure Path Routing (GSPR), and evaluate it with the ns-2 simulator tool. Oh et al. compare different broadcasting schemes: simple flooding, probability-based method, location-based method, and neighbour knowledge-based method, for multi-hop forwarding of broadcast messages such as emergency warning messages. The simulation tool used was ns-2.

Rodolfo Oliveira, Miguel Luis et al. (2012) [22] conveys that several routing protocols for Mobile Ad-hoc Networks (MANETs), including the well known Ad-hoc On-Demand Distance Vector Routing (AODV) and Optimized Link State Routing (OLSR), propose the use of periodic messages (Hello messages) to detect neighbour nodes. After receiving the first Hello message from one of its neighbours, a node starts the link sensing task by setting up a sensing timer. Each time a new Hello message is received from the same neighbor, the sensing timer is restarted and the link duration is prolonged. If the sensing timer expires, it indicates a long time interval without receiving a Hello message and, consequently, the link is considered broken. The transmission frequency of the Hello messages and the expiration value of the sensing timer truly depends on node's mobility: if the nodes are moving quickly and the Hello messages are rarely transmitted, the neighbour nodes can be in communication range but they are not detected; in the same scenario, if the expiration value of the sensing timer is too high, a link is sensed broken too late. In this paper, they consider a MANET under the Random Waypoint mobility model. They investigate the relationship between the transmission frequency of the Hello messages and the sensing timer expiration value with the network node's mobility. They formally deduce the probability of link existence after β periods of transmission of the Hello message. The probability is later used to define the sensing timer expiration value, considering a given probability that the Hello message transmission fails. Finally, they evaluate their study through both numerically analysis and simulations, which confirms the effectiveness and accuracy of our approach.

III. EXPERIMENTAL RESULTS

Evolution Methodology

The performance of I-AODV and OLSR routing protocol is compared against representatives from the main classes of routing protocols that are AODV and OLSR. where AODV and OLSR are topology based routing protocols. A review of these routing protocols already taken in previous chapters. In this chapter, we describe how simulation is done and what the results of the simulation are. The simulation is done in 2 phases and two different simulator have been used One is SUMO (Simulation of Urban Mobility) for road traffic simulation and Veins (Vehicular environment in Network Simulation) for network simulation.

Simulation setup

We use simulation to evaluate the performance of the proposed I-AODV, AODV and OLSR routing protocols with respect to PDR (packet delivery ratio) and end to end delay time features. We simulate network consisting of nodes field of 2500m × 8000m square area. Nodes have different transmission rate 100, 200, 300, 400, 500, 600, 700 and 800. The simplest and usually the first thing to setup a network is creating a node. A network is build up from its layers components such as Link layer, MAC layer and PHY layer. The components have to be defined before a node can be configured. Table 5.1 shows the parameters used in the simulation.

Table 1.1: Network parameter definition

Parameter Name	Parameter Value
channel type	Channel/Wireless Channel
mac protocol	Mac/802_11
number of nodes	10, 20, 30, 40, 60
routing protocol	AODV, IAODV,OLSR
grid size	2500 x 800 sq.m
packet size	1000
simulation time	Different
traffic type	Cbr

The experiments were conducted in networks of different Transmission rate. Now we discuss about the open scenario implementation of proposed routing protocol with the help of snapshots of SUMO and NAM file.

Firstly we have to create network file which are present in the real world for that purpose SUMO incorporate by which we can download real world road map Form the openstreetmap.org show map from openstreet.org

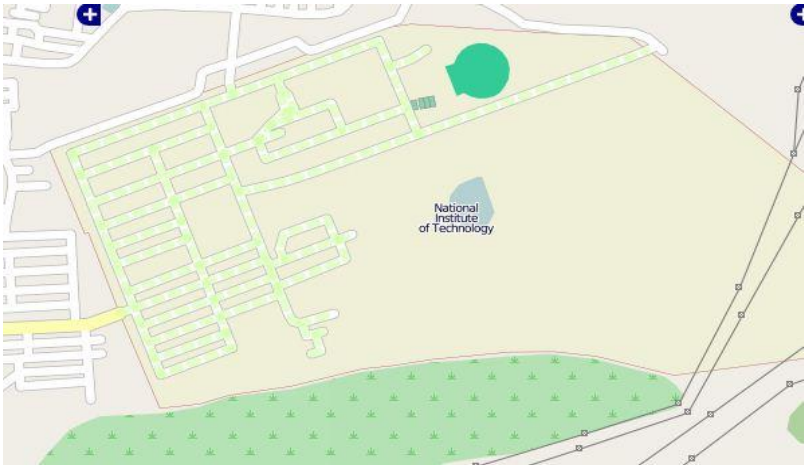

Figure 1.4: Map form open street Org

The map are downloaded are OSM file, after downloading map from the website the OSM file edited using JOSM Java Open Street Map Editor . IN this process all the unwanted route and path are removed to simplify the network file.

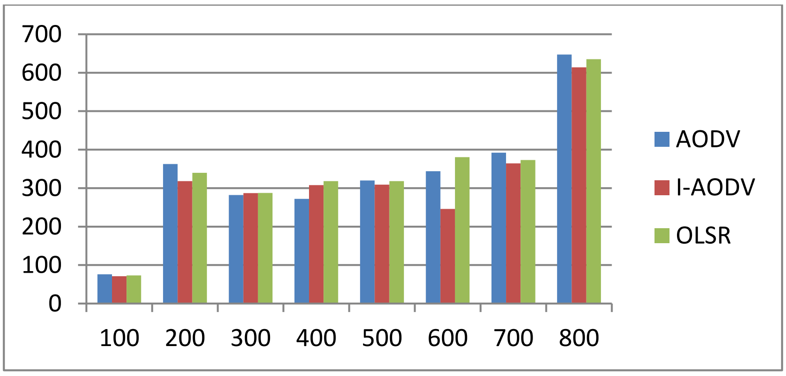

Figure 1.5: End to End delay comparison of AODV, OLSR and I-AODV

End to end delay in highway scenario: The simulation results of end to end delay in highway scenario vehicle environment is shown in below figure 5.20 from this figure it is clear that I-AODV and OLSR are perform better than AODV routing protocols. It means that end to end delay is reduced while we uses I-AODV and OLSR routing protocols in highway scenario. In highway scenario it is clear from below figure 5.20 that AODV is worst routing protocol when we considering end to end delay. AODV routing protocol working very well in MANET but in VANET area it is not give optimium results as it give in MANET environment. When we talking about end to end delay then I-AODV has also better perform than OLSR because I-AODV.

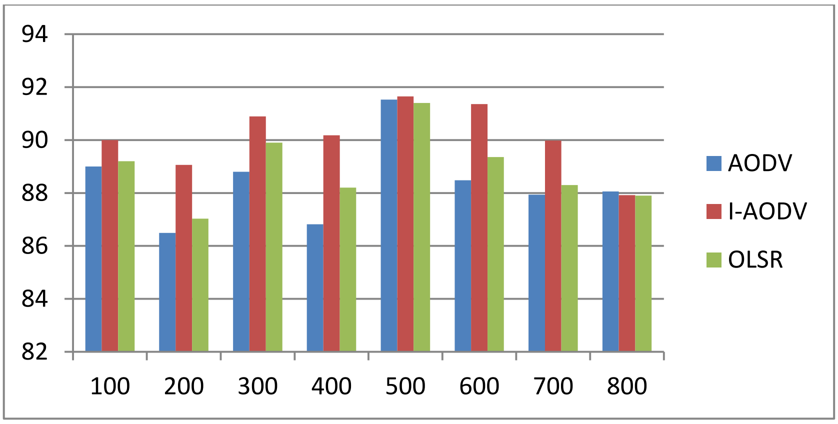

Figure 1.6: Packet Delivery ratio of AODV, OLSR and I-AODV

PDR in highway scenario: The simulation results of highway scenario vehicle environment is shown in below figure 5.21 from this figure it is clear that I-AODV is perform better than AODV and OLSR routing protocols. It means that packet drop is reduced while we uses I-AODV routing protocol either in open scenario or highway scenario. In highway scenario it is clear from below figure 5.21 that AODV is worst routing protocol when talking about PDR values.

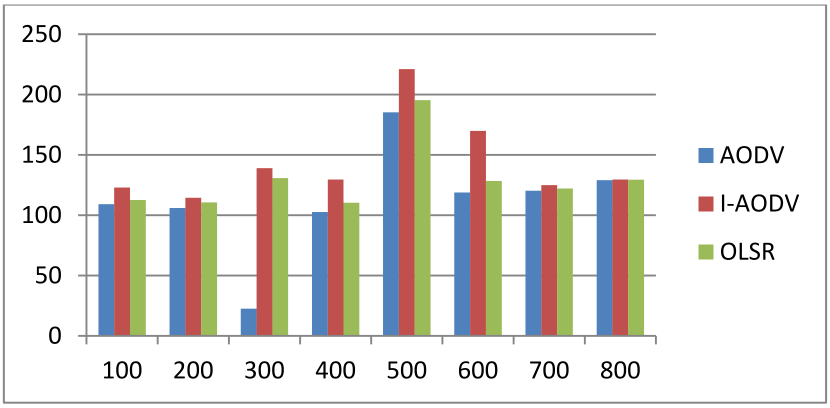

Figure 1.7: Comparison of throughput between AODV, OLSR and I-AODV

Throughput in highway scenario: The simulation results of highway scenario vehicle environment is shown in below figure 5.22 from this figure it is clear that I-AODV is perform better than AODV and OLSR routing protocols. It means that throughput increases while we uses I-AODV routing protocol either in open scenario or highway scenario. In highway scenario it is clear from below figure 5.22 that OLSR is worst routing protocol when talking about THROUGHPUT values.

IV. **CONCLUSIONS**

This thesis work briefly describes about the routing protocols for VANETS. It includes detailed discussion of AODV and OLSR which are the most widely used protocols that perform better than the rest of protocols. These are compared with our proposed routing protocol I-AODV which takes the benefit of AODV. I-AODV improves the PDR as compared to AODV because I-AODV selects the node on basis of trust value and trust value for any node becomes low if that node drops packets. If we have two equidistant nodes form source and destination, then we select the node with higher trust value to forward the packet. This approach results in reducing the total number of packets dropped and hence will result in increased packet delivery ratio of the network.

The advantage of I-AODV protocol is that it selects the most trustworthy node which drops less number of packets. So the selection of the node with highest trust value increases packet delivery ratio of I-AODV in comparison to AODV and OLSR. By ensuring higher PDR we substantially increase throughput and also improve End to end delay of the protocol.

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