

# **Towards the analysis of Adhoc Routing Protocol in VANET Environment**

**Pranav Kumar Singh<sup>1</sup> and Kapang Lego<sup>2</sup>**

<sup>1</sup>Department of Computer Science and Engineering  
Central Institute of Technology, Kokrajhar, Assam-783370(India)  
e-mail: sngpranav@gmail.com

<sup>2</sup>Department of Computer Science and Engineering  
NERIST, Nirjuli, Arunachal Pradesh, India  
e-mail: klegoh@gmail.com

## **Abstract**

*A vehicular network is a mobile adhoc network and its characteristics can be summarized as high dynamics, mobility constraints, predicable mobility, large scale and low energy constraints A Vehicular Ad- Hoc Network (VANET) is an instance of MANETs that establishes wireless connections between cars. The VANET play a very important role to provide safety, communication and infotainments. This paper presents the analysis of proactive and reactive adhoc routing protocols in real map scenario (urban scenario). The protocols evaluated are Ad hoc On-demand Distance Vector (AODV), Optimized Link State Routing (OLSR) and Dynamic Source Routing (DSR). The comparison and performance analysis is done on the basis of end to end delay, packet delivery ratio and routing overhead. The Simulator used for this purpose is MOVE (Traffic Simulator) over SUMO and Network Simulator (NS2).*

**Keywords:** VANET, Adhoc, AODV, DSR, OLSR, MOVE, SUMO, NS-2.

## **1 Introduction**

A VANET (Vehicular Adhoc Network) is effectively a subset of MANETs(Mobile Adhoc Network). The adhoc network can be quickly deployed, feasible, less expensive and require less effort for administration.

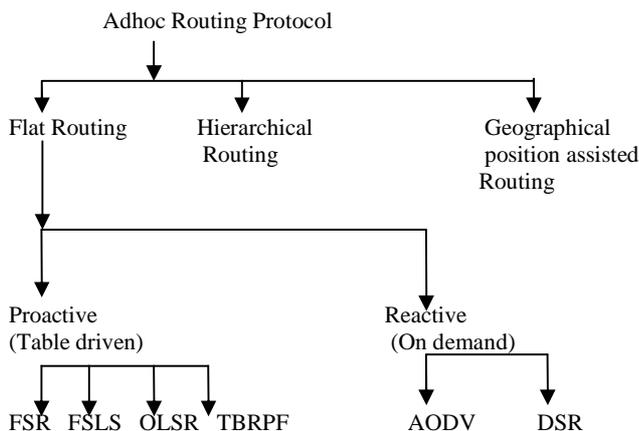
Various projects like DSRC [2], FleetNet, ITS, NoW [5], CarTALK2000, SeVeCom, PATH, SmatWay and EVITA in the different countries are working to create new network algorithms or modify the existing for use in a vehicular environment.

MANETs and VANETs have many similar characteristics, early prototypes and studies about VANETs made use of the routing protocols developed for MANETs.

The recent studies are now developing the protocol that can best suited for the VANET even there is lack of systematic comparison of MANET routing protocol performance.

Routing protocol in MANET can be classified into several ways depending upon their network structure, communication model, routing strategy, and state information and so on but most of these are done depending on routing strategy and network structure. Based on the routing strategy the routing protocols can be classified into two parts: 1. Table driven and 2. Source initiated (on demand) while depending on the network structure these are classified as:

Flat routing, hierarchical routing and geographic position assisted routing. Flat routing covers both routing protocols based on routing strategy.



**Fig1.** Classification of Adhoc Routing Protocol.

## 2 Application Scenario

The VANET application can be divided into two major categories [1,17]:

1. Safety and
2. Non-safety.

### 2.1 Safety applications

Safety applications have the ability to reduce traffic accidents and to improve general safety. It can be further categorized into safety critical and safety-related.

**a) Safety-critical:** These are used in the case of hazardous situations (e.g. like collisions). It includes the situations where the danger is high or danger is imminent. Such applications can access the communication channel with highest priority. Safety-critical applications involve V2V or V2I/I2V.

**b) Safety-related:** These include safety applications where the danger is either low (curve -speed warning) or elevated (work zone warning), but still foreseeable. Safety-related applications can be V2V or V2I/I2V.

## 2.2 Non-safety applications

These are applications that provide traffic information and enhance driving comfort. Non-safety applications mostly involve a V2I or I2V communication. These services access the channels in the communication system, except the control channel. They access the channel in a low priority mode compared to safety applications [1, 17].

Non-safety applications include applications for

**a) Traffic optimization:** Traffic information and recommendations, enhanced route guidance etc.

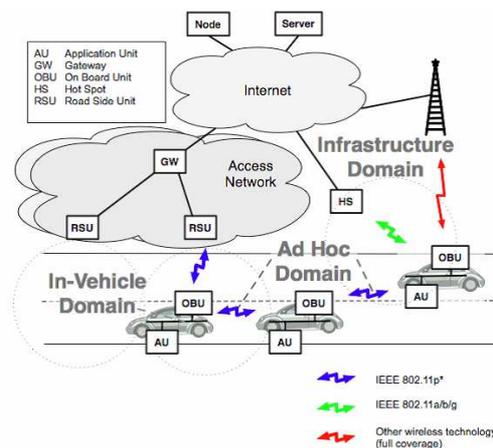
**b) Infotainment:** Internet access, media downloading, instant messaging etc.

**c) Payment services:** Electronic toll collection, parking management etc.

**d) Roadside service finder:** Finding nearest fuel station, restaurants etc. This involves communication of vehicles with road side infrastructure and the associated database.

## 3 System Architecture

A VANET system architecture consists of different domains and many individual components as depicted in Figure 2.



**Fig 2.** VANET System Architecture [5]

The figure shows three distinct domains in-vehicle, ad hoc, and infrastructure domain, and individual components (application unit, on-board unit, and road-side unit) [5].

### 3.1 In-vehicle domain

This consists of an on-board unit (OBU) and one or more applications units (AU) inside a vehicle. AU executes a set of applications utilizing the communication capability of the OBU. An OBU is at least equipped with a (short range) wireless communication device dedicated for road safety [5].

### 3.2 Ad hoc domain

An ad hoc domain is composed of vehicles equipped with OBUs and road-side units (RSUs), forming the VANET. OBUs form a mobile ad hoc network which allows communications among nodes without the need for a centralized coordination instance.

### 3.3 Infrastructure domain

The infrastructure consists of RSUs and wireless hotspots (HT) that the vehicles access for safety and non-safety applications. While RSUs for internet access are typically set up by road administrators or other public authorities, public or privately owned hot spots are usually set up in a less controlled environment.

## 4 Simulation Setup and Design

The main methodology used to perform the simulation using MOVE (MObility model generator for VEhicular networks) build on SUMO (Simulation of Urban MObility) and NS2 (Network Simulator 2).

### 4.1 MOVE (MObility model generator for VEhicular networks)

MObility [13] allows users to rapidly generate realistic mobility models for VANET simulations. MOVE is built on top of an open source micro-traffic simulator SUMO.

The output of MOVE is a realistic mobility model and can be immediately used by popular network simulators such as ns-2 and qualnet [13].

The two main function of MOVE is:

1. MAP Editor
2. Vehicle Movement Editor

### 4.2 Simulation of Urban MObility (SUMO)

SUMO is an open source, portable microscopic road traffic simulator. It allows the user to build a customized road topology, in addition to the import of different readymade map formats of many cities and towns of the world. The later feature helps in generating real world road topology [10].

Table 1: Simulation Setup

NS version	ns-allinone-2.34
MObility version[13]	2.64
SUMO version[10]	0.11.0
TraNS version[12]	V 1.2
AODV	NS2 default
DSR	NS2 default
OLSR	UM OLSR patch

Number of Nodes	30
Number of Connection	4,8,12,16,20
Scenario	Urban
Downloaded files	Tiger shapeline
Speed	40 kph
Data type	CBR
Data Packet Size	1000 bytes
MAC protocol	IEEE 802.11
MAC Rate	2 Mbits/s
Radio Propagation Model	TwoRayGround
Simulation Time	200 seconds

SUMO also supports feature of microscopic simulation model, like imposing speed limits, defining number of lanes, junctions and traffic lights etc.

### 4.3 NS (Network Simulator)-2

NS2 is an object oriented network simulator, written in C++, with an OTcl interpreter as a frontend [6]. This means that most of the simulation scripts are created in Tcl(Tool Command Language). If the components have to be developed for ns2, then both tcl and C++ have to be used.

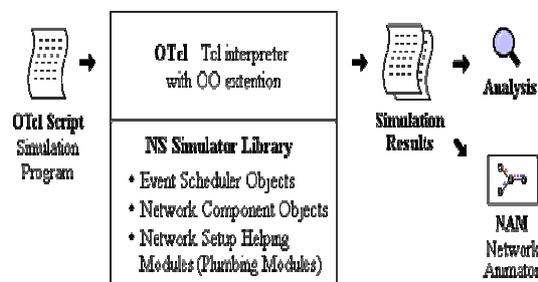


Fig 3. NS-2 structure and working

## 5 Simulation Metrics

The following metrics are used in this paper to evaluate the performance of AODV, DSR and OLSR [7] routing protocols.

1. Packet Delivery Ratio
2. Average End to End Delay
3. Routing Overhead

### 5.1 Packet Delivery Ratio (PDR)

The following equation is used to calculate the PDR,

$$\text{PDR} = (\text{DataR} / \text{DataS}) * 100,$$

Where DataR = Data packets received by the CBR agent at destination node  
 DataS = Data packets Sent by the CBR agent at source node

## 5.2 Average End-to-End Delay

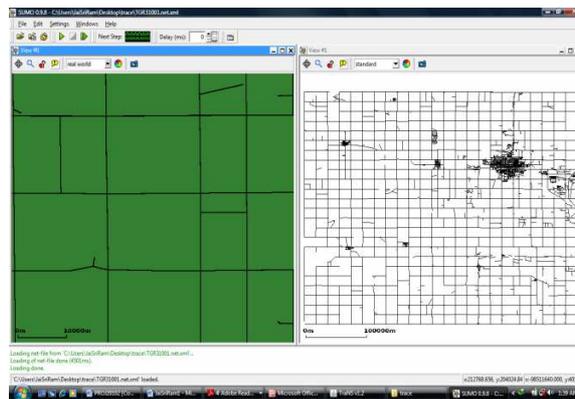
The following equation is used to calculate the average end-to-end delay,  
 Average End-to-End Delay =  $(T\_DataR - T\_DataS)$ ,  
 Where  $T\_DataR$  = Time data packets received at destination node  
 $T\_DataS$  = Time data packets sent from source node

## 5.3 Normalized Routing Overhead (NRO)

This metric indicates the number of routing packets transmitted per data packet delivered to the destination. This includes all routing packet types (request, reply, error) in the network. The following equation is used to calculate the NRO,  
 $NRO = (CPSent + CPForw) / DataR$ ,  
 Where  $CPSent$  = Control packets sent by all nodes  $CPForw$  = Control packets forwarded by all nodes  $DataR$  = Data packets received at the destination node.

## 6 Simulation Scenario

In this paper we used one realistic scenario the Urban scenario of one of the state of USA downloaded from tiger shape line.

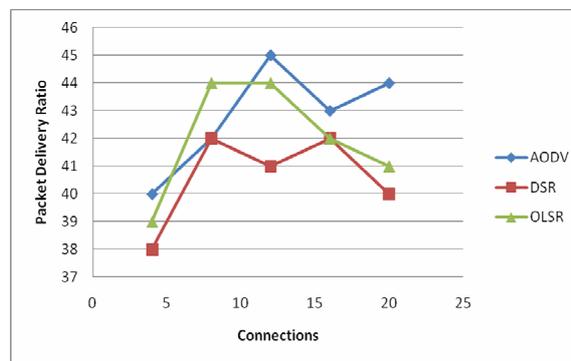


**Fig 4.** Urban scenario used in the simulation

The map above represents the scaled downloaded version of a downtown area. The total area considered is 5KM X 5 KM. The map perfectly shows the urban environment found in most metropolitan areas around the world. Using SUMO, movement patterns of variable number of vehicles were generated randomly.

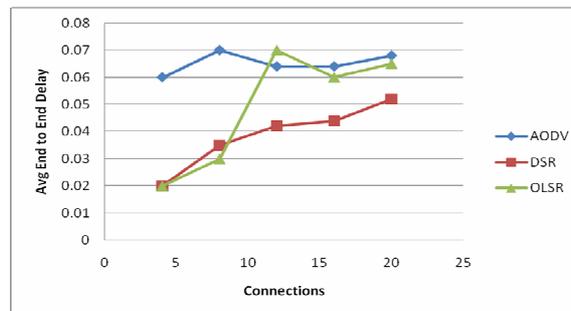
## 7 Simulation Result

Scenario: Urban  
 Area: 5km x 5km  
 Node speed: 40 kmph  
 Packet size: 1000 bytes  
 No. of Lane: 2  
 No. of Connection: 4, 8, 12, 16, 20



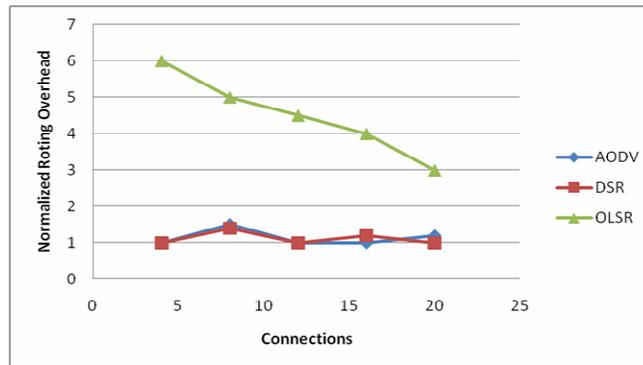
**Fig 5.** Packet Delivery Ratio VS Communication Sessions

Figure above shows that all the three routing protocols perform average, AODV performs little bit better than other protocols as no. of connections increases.



**Fig 6.** Average End-to-End Delay VS Communication Sessions

Figure above shows that AODV does not perform well and has highest end-to-end delay as number of communication sessions increases. The end-to-end delay of OLSR and DSR starts increasing as the communication sessions increase.



**Fig 7.** Normalized Routing Overhead VS Communication Sessions

Figure above shows that both AODV and DSR have very low NRO compared to variants of OLSR. Initially with least number of communication sessions OLSR had large values of NRO, but as the number of communication sessions increased with varying number of nodes, their NRO decreases.

## 8 Conclusion

We presented in this paper the performance analysis of reactive and proactive routing protocols in real world scenario.

The resulting performance of AODV is better than the DSR and OLSR in terms of PDR and NRO but not very much suitable for VANET environment as having high end to end delay where safety is main concern.

The overall performance of adhoc routing protocol AODV, DSR and OLSR is not good enough as having low rate of PDR, high end to end delay and high NRO in the Urban scenario and is not suitable for use in VANET environment.

## 9 Open Problem

The analysis of adhoc routing protocol in VANET environment in this paper is done by using offline simulation, In future we have planned to check the performance of adhoc routing protocol in realistic scenario (accidental scenario on road, traffic congestion etc) by using bidirectional coupled simulation where vehicles is considered to exchange messages that will result to change their speed, lane etc, hence communication scenario is totally different than offline. We hope, this will be very helpful for research to analyze the performance of various routing protocol in realistic scenario of VANET.

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