Suresh Gyan Vihar University,
Jaipur International Journal of Converging Technologies and Management (IJCTM)
Volume 1, Issue 2, 2015
ISSN: 2455-7528

# Improvisation of Ad-hoc On Demand Distance Vector (AODV) routing protocol using SUMO on OMNeT++

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**Abstract:** In AODV, the network is silent until a connection is needed. At that point the network node that needs a connection broadcasts a request for connection. Other AODV nodes forward this message, and record the node that they heard it from, creating an explosion of temporary routes back to the needy node. When a vehicular node receives a message of this kind and has already some short route to the desired vehicular node, it transmits a message in a backward direction through a temporary route and take it to the requesting node. The needy node then begins using the route that has the least number of hops through other nodes. The entries which are not used for a longer period are automatically recycled after a course of time. When a link fails, a routing error is passed back to a transmitting node, and the process repeats.

***Keywords:*** VANETs, AODV, Sumo, OMNeT++, ITS, TraCI

## I. INTRODUCTION

The automobile manufacturers are the main stepping stones behind the vehicular network approach. A mechanism was developed and implemented to insure the security of drivers and passengers. In the Academic Industry and Research areas the term vehicular networks is not new. It has acquired vast platform of public attention and the main reason behind that ever-increasing technology is that it has been one of the most valuable and recognizable research concept for ensuring safety and enhancing efficiency measures in near future transportations. Wireless connectivity with high speed internet, which today is much cheaper, reliable, pervasive and innovative form to have end to end communications is the major and certain requirement to implement Adhoc Vehicular Nets.

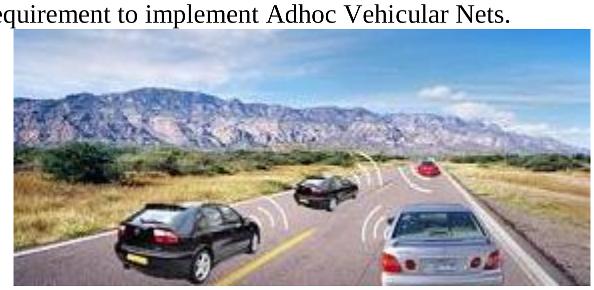

Figure : Communication between Vehicles wirelessly.

For instance, there is a car, which via the implementation of vehicular networks detects huge volume of congestion on a specific road. With the proper management of the vehicular nets, the same information could be transmitted to other vehicles which float in same geographical zone. With such practicality, the required information can be travelled to n- kilo meters where the maximum range of our network is spread. Hence, witnessing such traffic congestions the drivers and other vehicles could opt for different routes and select another traffic free road.

The fact is clear that there is very limited range and limited storage in case of transmission and capacity respectively. Also, there is probability of interference in the wireless links and networks. One of the distinguished features of vehicular networks is high mobility of the automobiles. These vehicles are equipped with certain communication devices in order to confirm high interconnectivity on the roads.

Seeing the comfort and security of the passengers, there are some other benefits too which are provided to them. They are the basic internet connected applications. They include e-mail checking, fetching the files and other data from the internet and play games online as well.

The most imperative application that is observed by implementing vehicular networks is to avoid accidents on roads. This will be achieved by alerts and warning to the running vehicles. Information regarding collisions,

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merging, acceleration or high velocity notification, deceleration warnings, inappropriateness of highway roads will be timely notified to the drivers driving on the roads via wireless internet connectivity. These kind of safety alerts will be helpful in avoiding and preventing critical accidents from nearby vehicles.

## II. PROBLEM STATEMENT

Everyone is aware of present transport system. As per the reports of 2013, from World Health Organization, road traffic injuries had caused as estimation of over 1.24 million deaths worldwide across the globe. This means one person is killed every 25 seconds. The report also states the fact that till today there are only 28 countries accommodating 449 million people which follows strict traffic laws, adding to only 7% of the world's population.

The basic reason behind these calamities are: over-speeding, drink and drive, not wearing helmets and seat belts, unbearable traffic jams, undesired timely delays, pedestrians crossings including child restraints. Hence here arises a need to overcome such huge number of fatalities via some kind of mechanism which can prove far better than the current transport system.

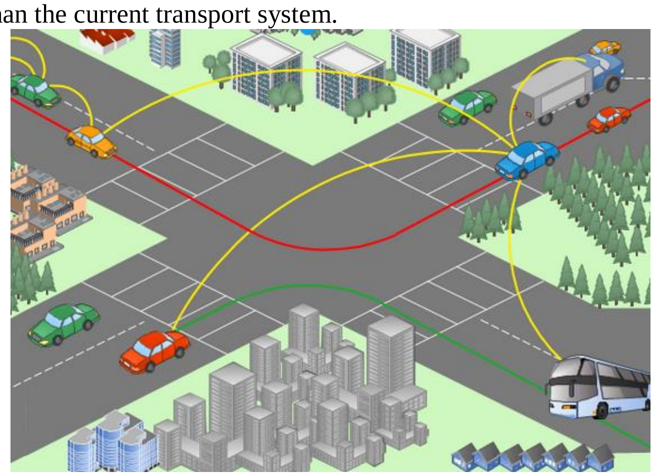

Figure: Accidental issues in transport system

Dedicated Short Range Communications (DSRC) is also extensively used. It is the advance version of Wi-Fi. The technology helps in rapid transfer of the data when the navigation changes on the roads. It has a huge response time in delivering critical messages on time.

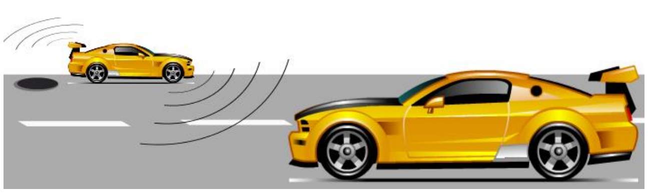

Figure: DSRC

The advantages of Vehicular Nets is that this technology shall contribute in avoidance of accidents, saving off resources and fuel, and saving time and money. The idea is that critical message shall be created and sent to the underlying vehicle on road. The message shall brief him about the traffic in that zone and if any calamity had taken place on the same route. The driver can accordingly, opt for a different route and take a smart decision much before than to get stuck in some traffic or be a part of some accident.

The additional advantage, apart from above mentioned feature, is that VANETs provides facilities as weather forecasting, generation of geographical maps, Multi-media, toll amounts etc.

## III. LITERATURE REVIEW

Over a decade, there had been rigorous research in the field of Vehicular Networks. The author [1] has analyzed the performance of AODV and worked on the parameters like throughput, sending/receiving/ dropping percentage of packets. As per the results, it stated, the number of vehicular nodes affects the performance. More the number of nodes, better is the throughput and less number of packet loss is observed. The practical simulations had taken place using MOVE, SUMO and NS2.

There had been a comparison of AODV with DSDV [2]. DSDV is Destination Sequenced Distance Vector (DSDV) routing protocol. DSDV works on Bellman Ford routing algorithm. Routing tables are used for the management and storage of destination address, number of hops to reach destination and next hop address. In the case of the four node network, the throughput plot obtained for AODV routing protocol is found to be significantly higher than that for DSDV protocol for about half of the simulation time. But, in the case of the network comprising ten nodes the throughput graph shows a significant increase in performance of the AODV over DSDV protocol. For DSDV protocol, the PDF obtained is notably less than that obtained for AODV routing protocol for CBR traffic. From the metric values obtained we concluded that AODV protocol performs better than DSDV in most cases.

Research work is also in progress for E-AODV. It is examined [3] by the simulation results that the performance of E-AODV routing protocol is better than existing AODV routing protocol in terms of packet delivery fraction, average throughput and end to end delay especially in high speed mobility and pause time.

In one of the papers, [4] from the researchers of California, there had been the identification of unsupported events which are essential to perform routing in AODV. A

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comparative study [5] has also been done and an evaluation between DSDV, OLSR, FSR, AODV, TORA, DSR, MOVE and GSR is performed. The factors focused here were: [6] Forwarding Strategy, Routing Maintenance, Scenario Recovery Strategy, Infrastructure Requirements, Digital Map, Control Packet Overhead, and Number of Retransmission.

It is here also focused on the factor that [5] Inter Vehicle Communication and Vehicle to Infrastructure Communications is effectively possible with the help of some strong routing mechanism such as AODV, MDDV or DSDV. Work has also been done to develop a link reliability model. It is based on Vehicular Velocity distribution over the highways using traffic flow models of macroscopic and microscopic approaches. It is here observed that link reliability model is used for improving performance of current traffic control routing protocols.

## IV. Implementation Tool

To design a network and perform some simulations and presentation of the respective results, many simulation tools are available on internet. Some of which are Network Simulator or NS2, Mat lab, Castalia, Qualnett etc. After a thorough statistical review of all these simulators, OMNET++ tool has been chosen for this research work, reason behind its Object oriented approach to handle the network. Here objects are responsible for basic communication between different nodes. And the programming can be done both in C and C++. The underlying feature of OMNET++ is that it can frame up the modules for the ease of understand ability and the clear intentions of what the entire module is supposed to do in a sequential manner, i.e., it is modular.

**Veins in OMNeT++ :**

Veins is basically a package, defined as an open source inter-vehicular communication network or IVC, a network based simulation framework which is supported by OMNET++. To manufacture a road traffic micro-simulation models veins is composed of event based network simulator. In OMNET++ simulation tool, Veins framework is imported to design a road map where the virtual vehicles run. The results are traced under the considerations of traffic and accidental situations of running vehicles.

**SUMO- Road Traffic Simulator:**

Simulation of Urban Mobility or SUMO basically supports OMNET++ simulation tool and veins. SUMO is a described as a road traffic simulator which provides the necessary information of current traffic conditions of the roads. Because on those roads there can be possibilities of high congestion occurrences.

**VANET**

Vehicular ad hoc network (VANET) is used to create a mobile network in MANET which uses cars as mobile nodes. Here cars are allowed to be connected to each other with approximate distance of 100-300 meters in a crated network of wide range. When a car gets disconnected with the network and fall out of the expected range, some other can join the network in such a manner that the mobile internet could be created while vehicles are connected to one another.


Figure: VANETS in OMNeT++

Some of the widely used examples of this technology could be seen in Police and Fire vehicles where they communicate with each other for safety purposes.

**TraCI :**

Network simulators and road traffic can be interlinked with the help of Traffic control interface
or TraCI. On the runtime when the simulation is in running state, TraCI allows to control the behavior of vehicles as well as to understand the influence of VANET application on traffic patterns. In this approach online coupling is used which helps in understanding the drivers behavior during simulation runtime.

**OBU/RSU**: Vehicles and mobile nodes which are prominent compositions in a vehicular network, are equipped with ON BOARD UNITs (OBU) and the stationary nodes as ROAD SIDE UNITs.

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These units can be identified as the units equipped on the infrastructure which is deployed along both sides of the road.

## V. AODV PROTOCOL

It is basically an On demand protocol, which means whenever there is a demand a route has to be established between source and destination. The AODV protocol goes in off state when no route is required. There is a routing table containing a number of fields associated with each node, and is manipulated when there is a need to establish a secured communication route between two nodes. Routing tables do not need to be periodically updated in AODV.

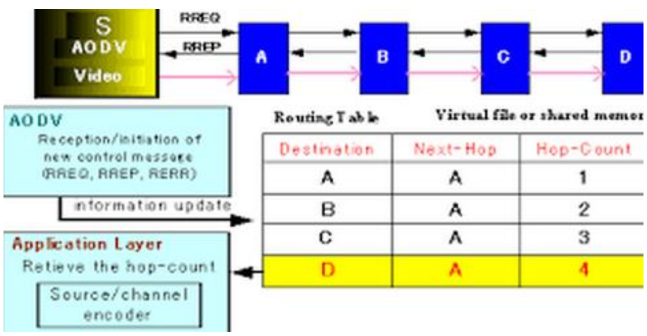


Figure: AODV Protocol Implementation

This makes it more popular among other protocols. Rather than driven by time, AODV prefers to be driven by events. There is a list of active nodes, which is maintained frequently, an inactive node is deleted, when it is not used for long time. For prevention from stale routes of communication from a source to a destination node AODV protocol uses destination sequence number. An ad hoc network can be defined as collective mobile nodes connected together without the intervention of centralized access point or the existing infrastructure. AODV is described as a novel algorithm which is required for operation of such ad hoc networks. In VANET nodes with high mobility, do not tend to be suitable for proactive routing based protocols. Because of large table information and more bandwidth consumption proactive based routing protocols may not work in VANET. When a node has to send a packet, a route is created since AODV is a reactive routing protocol. While AODV repairs broken links at the same time, it can also provide loop free routes. Between neighboring nodes symmetric links are being used by AODV as the protocol does not have any requirements for global periodic routing advertisements. When one of the nodes is not able to hear the other node, it does not try to follow the path between those nodes. Nodes do not take part in any periodic routing table exchanges and they do not keep any routing information so it can be said that nodes do not depend on active paths. It is not required for a node to maintain and discover a route until it has to communicate with some other node unless the last node has offer its services as one intermediate forwarding station to keep connection in ON state between two other nodes. When the local connectivity of the mobile node is of concern, then every mobile node may become aware of other nodes in the neighborhood by using various methods, including HELLO messages or local broadcasts. Within the neighbor area the routing tables are created to optimize response time to the local movements and for the establishment of new routes, the routing tables provide quick response time for new route requests.

The primary objectives of this algorithm is:

1. When there is requirement the discovery packets could be broadcasted.
2. To analyze local connectivity managements neighborhood detection and maintenance of general topologies.
3. To produce all kinds of information about changes in local connectivity to neighboring nodes which require that change information for their own settlement.

The research was done on the basis of following parameters:
1) Throughput of packets send
2) Throughput of packets recieved
3) Average throughput of packets
4) Dropping rate of data packets
5) Size of data packet

Throughput: It is defined as the total amount of data in form of packets, which is delivered through some kind of communication mechanism from the source location to the destination address. The throughput directly depends on total number of packets successfully delivered. It is measured in terms of Packets per Time Interval unit length. It may be also measured in terms of total number of bits per time interval. Average throughput is the average of both send and receive throughput of data packets. Dropping rate of the data packets is measured in terms of total number of data packets which could not successfully reach their destination on time. Here time is a very imperative constraint. Without timely delivery of data packets, the entire technology proves to be a failure. This may generally happen due to huge congestion witnessed in the network, or queue overflow/ overloaded or some kind of hardware fault. More the dropping rate, less will be the throughput protocol performance.

The size of data packets is generally calculated in term of bytes as these are small messages which are to be transmitted.

**Experimental Details:**

| Parameter | Assumptions / Values used |
|---|---|
| Channel type | Wireless |
| Number of Road Lanes | 6 |
| Interface Queue Enabled | Priority Queue (primary) |
| Speed | 15 m/s |
| Radio Propagation model | Three Ray Ground |
| MAC Protocol Used | IEEE 802.11 |
| Routing Protocol Used | AODV |
| Network Interface type | Physically Wireless (complete) |
| Queue Length | 150 packets |
| Time of Simulation End | 3000 simulation seconds |
| X and Y Dimensions of topography | :800*950 square meters |
| Traffic type | TCP |
| Number of nodes in topography | 250 |

## VI. RESULTS OBTAINED

The results obtained are mentioned below:
Throughput of send packets:

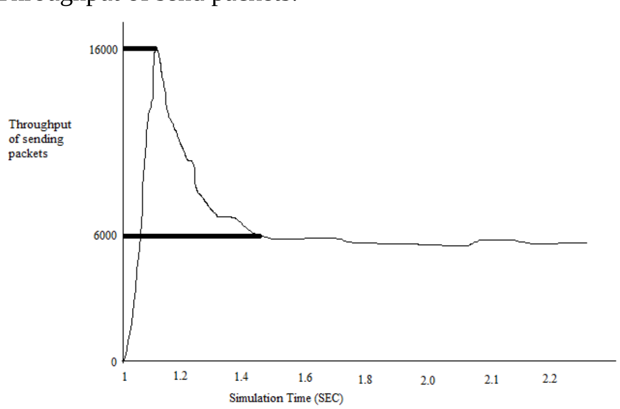


Figure: Throughput of Send Packets Vs Simulation Time

Figure here illustrates the underlying throughput of the packets send over vehicular network using AODV routing protocol. It shows that there had been a increase to 16000 packets/TIL in just 2 sec. Then a tremendous decrease is observed and it reaches 6000 packets/ TIL in just 2.1 sec. Then it remains constant for most of the time assuming that the total number of packets which are transmitted are decreased. At the initial state, the vehicluar nodes are transmitting beacons so that the network is set up.

Throughput of receiving packets:

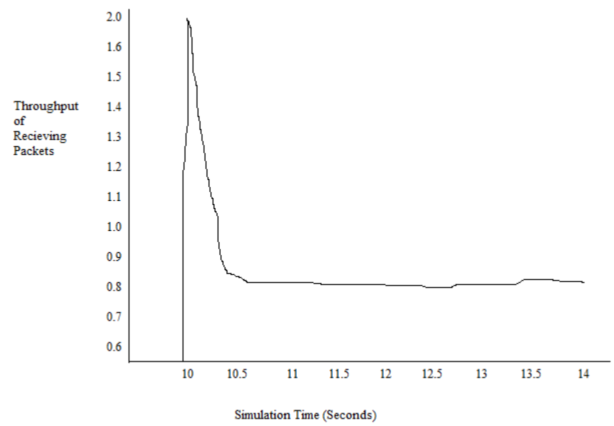


Figure: Throughput of Receive Packets Vs Simulation Time

It is also illustrated in this figure. It explains that for 20 sec the throughput reaches to 20000 packets/ TIL but then drops to 11000 packets/ TIL in just 0.8 sec. Hence average throughput is calculated which is 10500 packets/ TIL.

Throughput of dropping packets:

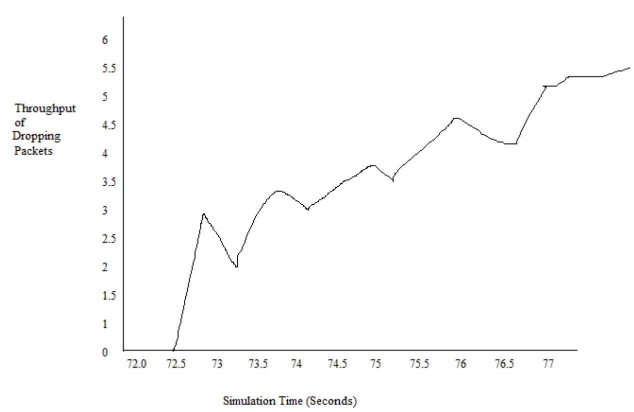


Figure: Throughput of Drop Packets Vs Simulation Time

The figure below shows the throughput of dropping packets. It is analyzed here that after 0.80 sec, packets have dropped constantly.

## VII. CONCLUSION

In this paper design possibilities for AODV implementation have been analyzed. AODV routing protocol simulation has been performed with SUMO and OMNeT++ combined where Veins is used alongside them to produce realistic mobility module for VANET. Various parameters like throughput of receiving and sending packets and throughput of dropping packets are taken under consideration to analyze the performance of AODV for 200 nodes.

Sending messages for ad hoc networks in AODV routing protocol are extremely dependent on route reply messages. A large quantity of route discovery efforts would be wasted if route reply is lost which may cause grave destruction on routing performance. And because of that new route detection has to be initiated by the source node to establish a route to end to end.

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