Simulative Analysis of AODVv2-02 Routing Protocol Using OMNET++

Vikram Rao
Department of Computer Science and Engineering
Research Scholar, BGIET, Sangrur

Dr. Anuj Kumar Gupta
Department of Computer Science and Engineering
Associate Professor, BGIET, Sangrur

Abstract-The work presented here is a implementation of revised version of DYMO i.e. AODVv2-02 and Then summary of the results obtained when routing protocols viz. AODVv2-02, DYMO, AODV were simulated using virtual hosts on a discrete-event simulator: OMNeT++ v4.6. These three protocols are run on a simulation setup of 20 nodes without any mobility models. This allows us to focus our attention on solely the MAC properties and related results derived from the three protocols. We describe and compare the three routing protocols on available parameters like Packet Collision, Packet Error Rate, Transmission count and more. We conclude by stating the AODVv2-02 emerges as the better protocol of the three examined here.

Keywords – MANET (Mobile Ad hoc Network) , AODV (Ad hoc on Demand vector routing) , Routing Protocols , DYMO (Dynamic On-demand MANET routing protocol) , AODVv2-02, OMNeT++, network simulation

I. INTRODUCTION

In our progression into the world of network simulation, we have chosen to taken up a subject, which is in the center of many important developments in the modern world. A MANET (Mobile Ad hoc Network) is a collection of self-governing mobile nodes that can communicate to each other through wireless links. By using a simulation technique allows one to analyze the performance of network protocols at large scale – subject to available computing power. There are a large number of simulation tools available. In this implementation, we focus on OMNeT++.

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The paper goes on to describe various aspects regarding routing protocols used in MANET i.e. mobile ad-hoc networks. Section 2 describes OMNeT++ with its various features and its importance with the network simulation space and also describe INET framework as extension for OMNeT++ network simulator. Section 3 implementation of AODVv2-02 using INET framework in OMNET++ Section 4 lists out the simulation setup used, and describe the different hardware and software parameters of the simulation workbench. Section 5 and 6 analyze the results obtained, while depict some conclusions. Finally, the paper end with a look at future steps in the direction and list of works referenced which were helpful in guiding us in our work.

II. OMNET++

A. Introduction to OMNET++ –

OMNeT++ is a network simulator environment free for academic use. The OMNeT++ engine runs discrete, event-driven simulations of communicating nodes on a broad variety of platforms and is becoming progressively prominent in the field of network simulation.

OMNeT++ simulator provides a component-based, hierarchical, modular and extensible architecture. These Components, or modules, are programmed in C++ and new ones are also developed using the C++ class library which consists of the network simulation kernel and utility classes for generation of random number, statistics collection, topology discovery etc. New modules can be derived from basic object classes like modules, gates or connections . A high-level language called Network Description (NED) is used to assemble individual network components into larger components and models of networks .The simulation kernel library, the simulation environment contains a Graphical Network Editor (GNED), a NED compiler, graphical (Tkenv) and command line (Cmdenv) interfaces for execution of simulation ,different graphical tools are also available for plotting simulation result (vector, Scalars), a model documentation tool, utilities (random number seed generation tool, etc.), documentation and sample simulations. The simulator includes modules for Application Layer and Network Layer of OSI model as well as a Network Interface Card module which combines both MAC and PHYSICAL layers. OMNeT++ has extensive GUI support.

B. Introduction to INET Framework

The INET Framework extension is a set of simulation modules released under the GPL. It provides OMNeT++ modules that represent various layers of the Internet protocol suite, e.g. the TCP, UDP, IPv4, and ARP protocols. The INET Framework also features models for wireless radio communication including radio distribution models and various MAC protocols such as IEEE 802.11. Mobility modeling was introduced into OMNeT++ with the Mobility Framework. It was later incorporated into the INET Framework for modeling spatial relations of mobile nodes.

INET Framework contains IPv4, IPv6, TCP, SCTP, UDP protocol implementations, and several application models. Static routing can be set up using network auto configurations, or one can use routing protocol implementations [6].

C. INET-MANET

INETMANET is based on INET Framework and is regularly developed. It provides the same functionality as the INET Framework, but it also contains other protocols and components that are especially useful while modeling and simulating wireless communication [9].

In conclusion, OMNeT++ and the INET Framework provide all the necessary components for simulating MANET routing protocols in general and other Internet protocols. Because of its modular architecture and its ability to directly access, monitor and alter all modules' internal states, OMNeT++ is very well suited for the implementation of complex protocols.

III.OVERVIEW OF AODV, DYMO & AODVV2-02

An AODV (Ad hoc distance vector) is a distance vector routing technology that discovers routes whenever it is needed. It does not maintain routes from every node other node in the network but it improve the system performance by minimizing wide broadcasting of packets in the extreme networks. The different control messages used to discover route from source to destination are Route Requests (RREQs), Route Replay (RREPs), Route Errors (RERRs).

The DYMO MANET routing protocol is a successor of AODV routing protocol and it is also known as AODVv2 as shares many of its features [8, 9]. DYMO share features of AODV like route discovery methodology and route maintenance. DYMO protocol can be work as both reactive and proactive protocol. Its route discovery procedure is same as AODV except path accumulation function. With the path accumulation function, during the route discovery by flooding the RREQ message in the network, the intermediate node will attach its own address to the message.

AODVv2-02 MANET routing protocol is a revised version of AODVv2 (DYMO), IETF has published its revised version as a draft 'draft-ietf-manet-aodvv2-02' and is still in progress. It is purposed by C. E. Perkins, S.Ratliff, J.dowdell[7] Similar to DYMO , the basic operation of AODVv2-02 protocol are route discovery and route maintenance[5]. The main difference of AODVv2-02 MANET routing protocol is to maintain a received RREQ table, in-order to eliminate the duplicate RREQ message by comparison of incoming RREQ message with received RREQ table entries. Two RREQ incoming request message can be compared if they were sent to find a route for the same destination with same Metric type by same AODVv2 router. Whenever a router receive an RREQ message, it must check it with previous RREQ message , in order to assure that its response RREP message would not contain any duplicate information. So to avoid retransmission of these duplicate RREQ message, each AODVv2 router needs to save a list of certain information of recently received RREQ messages.

IV. SIMULATION SETUP

We chose to execute the simulation of the MANET routing protocols on OMNET++ 4.6. The hardware and Software Setup for the simulation is given below table 1.

Table 1: The Hardware and Software Setup

Operating System	**Microsoft Window 7**
Processor	**Intel Core 2 Duo**
Memory	**2GB**
Compiler	**GCC**
Simulation Environment	**OMNET++ 4.6**
INET Framework	**INET2.99**
Simulated Using	**Cmdenv, Tcl/Tkenv**

After executing many simulations that led to the final ones presented here, we understood that OMNeT++ is a highly resource intensive simulation package. When a network was simulated using the Tcl/Tkenv graphical environment, it was noticed that the simsec/sec was subsequently low. We attributed this procedure to the additional resources necessary to support the graphical environment.

Simulation has been done in MANET consisting of 20 wireless nodes with 600 * 600 simulation areas. The simulation setup configurations are shown below in table 2.

Table 2: Simulation Setup Configuration

Constraint Area	**600 m X 600 m**
No. Of Wireless Hosts	**20**
Mobility Model	**Stationary mobility**
Radio Transmitted Power	**2.0mW**
Radio Tx Power	**2.0mW**
Radio Bitrate	**2 Mbps**
Broadcast Delay	**0s – 0.005s**
Simulation Time	**1800 s (30 Min)**
Network type	**RDYMO**
Routing Protocols	**AODVv2-02 , DYMO ,AODV**
Simulation Style	**Cmdenv-express-mode**

It is admitted that the software configuration used is with respect to the real world conditions. With a simulation times of 20 hosts randomly spread out on a simulated area of 600 * 600 m have been deployed exactly half an hour.

Figures 1 represents illustrations using a computer screenshot taken during the simulation progress of the network using the Tcl/Tkenv graphical environment. These screenshots were taken on the Microsoft window 7 Machine.

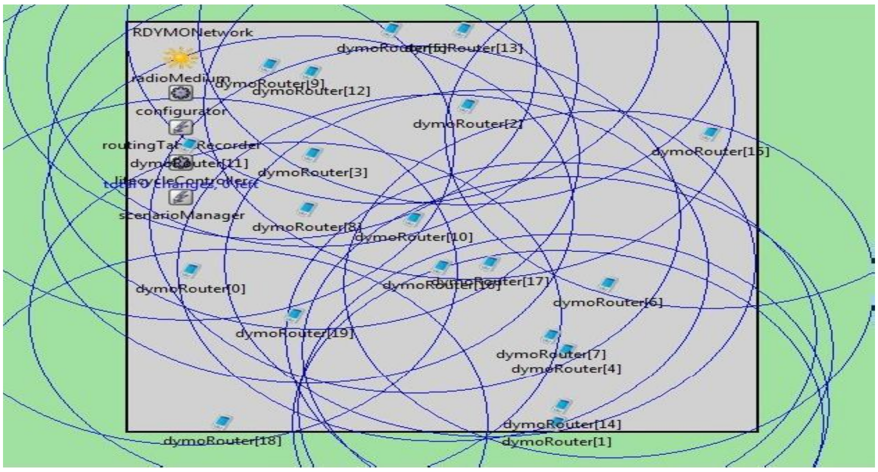

Figure 1 : Simulation graphical environment

A wireless host contains routing, mobility and battery components. It supports only IPv4 protocol, TCP and UDP as transport protocol. This is a typical mobile node which can participate in ad-hoc routing.

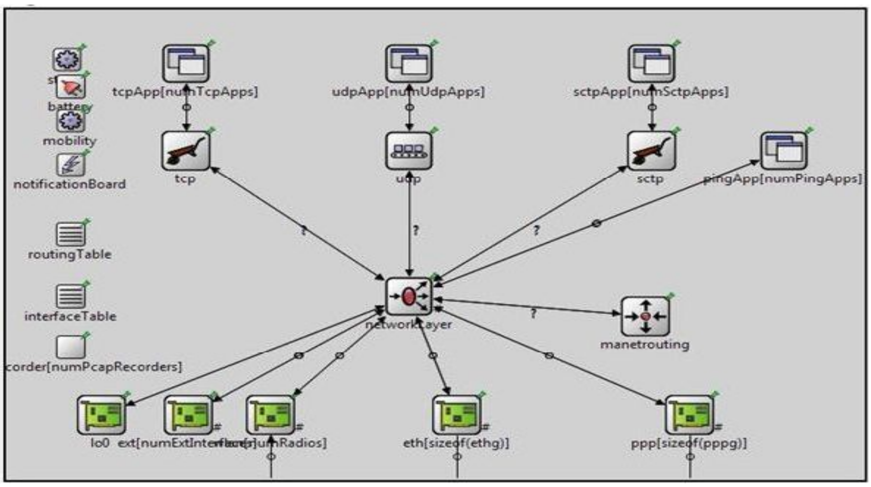

Figure 2: The internal structure of AODVv2-02, AODV and DYMO host

V. RESULTS

The results of simulation are shown in the form of graph. In this an attempt has been made to evaluate the performance of AODVv2-02 MANET routing protocol and also comparison with other MANET routing protocols to analyze the difference between them. The graphical representation of the simulation values for few of the parameters with varying pause time and network size of 20 nodes that were analysed in research work are presented as follows.

A. Packet Collisions-

The idea of a packet collision is self-explanatory. When two or more packets cross each other's path at the same time, it causes mutual interference which may render one or either of the packets unusable by the intended physical layer. The lower the number of packet collisions the better it is for the network.

Figure 3 shows statistics related to the packet collisions in the network on all three protocols. AODV has the highest number of packet collisions, while DYMO being lower than AODV. However AODVv2-02 has the least number of packet collisions.

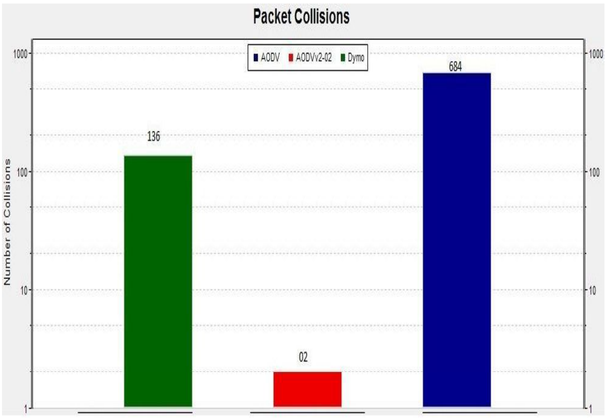

Figure 3 : Packet collision recorded

B. Packet Error Rate-

Packet Error Rate (PER) is used to test the performance of an access terminal's receiver. The packet error ratio (PER) is the number of incorrectly received data packets divided by the total number of received packets. A packet is declared incorrect if at least one bit is erroneous. The lower Packet Error Rate is better for the network.

Figure 4 shows statistics related to the packet error rate in the network on all three protocols. AODV has the highest number of packet error rate, while DYMO have less packet error rate than AODV and AODVv2-02 has the lowest packet error rate.

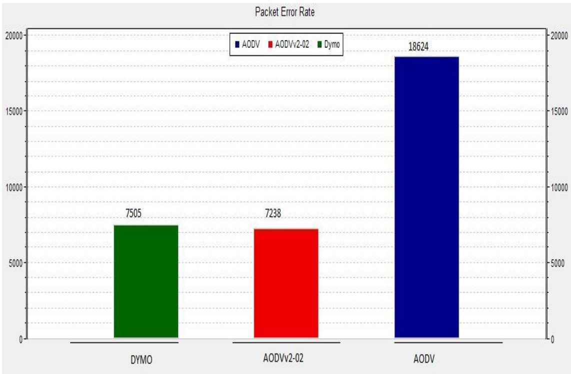

Figure 4 : : Packet Error Rate record

C. Transmission Count-

The Transmission Count is one of the routing metrics specifically designed for MANETs. It estimates the number of transmissions (including retransmissions) required to send a packet over a link. Minimizing the number of transmissions does not only optimize the overall throughput, it does also minimize the total consumed energy. So less transmission count is better for Mobile ad-hoc network.

Figure 5 shows the transmission Count in the network of all three protocols. AODV has the highest transmission count, while DYMO have less transmission count than AODV and AODVv2-02 has recorded the least transmission count.

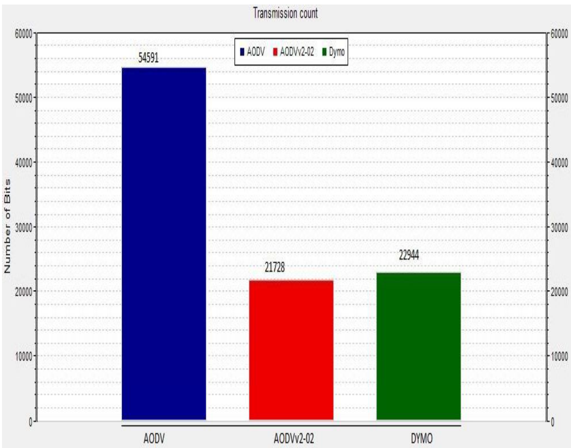

Figure 5 : Transmission Count record

D. Goodput-

Throughput is the number of successful messages delivered from one host to another host through a communication link per unit of time. Throughput is measured in bits per second whereas good-put is the application level throughput, i.e. the number of useful information messages delivered by the network to a particular destination per unit of time. The amount of data messages considered excludes protocol overhead bits as well as retransmitted data packets. Typically, protocol overhead is included in the throughput, but is excluded from the good-put. Retransmission of lost or corrupt packets caused by packet errors is excluded in the good-put but not in the throughput. AODVv2-02 may exhibit less throughput than AODV and DYMO because it eliminates the duplicate RREQ message, but it shows higher good-put than other protocols.

Figure 6 shows the throughput of all three protocols in the network. AODV has shows high throughput, while DYMO have less than AODV and AODVv2-02 has recorded the least.

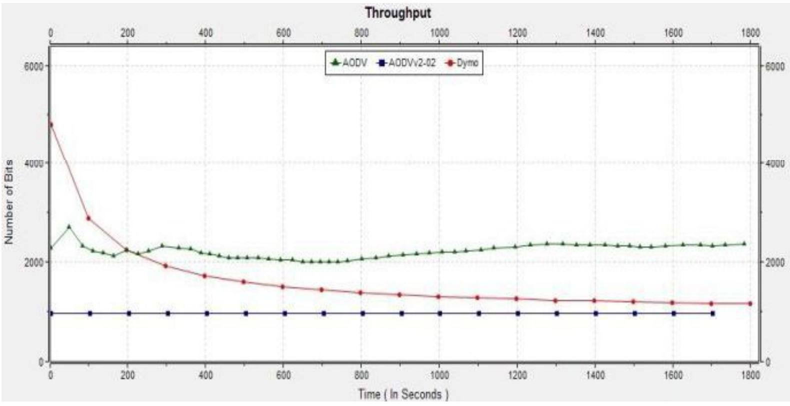

Figure 6 : Throughput record

VI. PERFORMANCE COMPARISON

The Table 3 shows the overall comparison of all the three protocols simulated in Omnet++ network simulator. It has been observed that AODVv2-02 has a high good-put and very low Packet Collision. On the other hand its predecessor DYMO has shown a low performance in case of Packet Collision. AODvv2-02 and DYMO shows less difference in Transmission Count and Packet Error Rate, but AODVv2-02 as revised version of DYMO performs better in all the metrics. Whereas AODV incurs a high Packet Collision, Packet error rate and Transmission count values.

Table 3
Performance Comparison of MANET Routing Protocols

Performance metrics	***Packet Collisions***	***Packet Error Rate***	***Transmission Count***
AODVv2-02	**02**	**7238**	**21728**
DYMO	**136**	**7505**	**22944**
AODV	**684**	**18624**	**54591**

VII. CONCLUSION AND FUTURE SCOPE

In this paper, we have compared and evaluated the three routing protocols: AODV, DYMO and AODVv2-02 over a range of parameters. In conclusion, we believe that AODVv2-02 has proved as a better MANET routing protocol. Our overall study shows that AODVv2-02 is a better protocol when it comes to networks with high mobility and changing topology. It has been observed that AODVv2-02 being the successor of DYMO performs better in all the terms. This paper will act as basis for many researchers to work upon the AODVv2-02 protocol and in future an effort will be done to enhance the performance of AODVv2-02 by using swarm intelligence based ACO technique and simulations will be performed under varying network scenarios.

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