Performance Evaluationof OLSR and AOMDV Ad Hoc Routing Protocols Using VBR Traffic Model

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Abstract: Wide spread of network equipped devices tempted the researchers to concentrate their efforts on developing new technologies and applications that contribute enhancing data transmission over Mobile Ad Hoc Network(MANET). Routing algorithms are considered the most challenging part in the ad hoc technology due to dynamic nature of MANETs. Building the suitable routing algorithm is vital for data to be effectively transmitted in this kind of networks, thus, many protocols and algorithms have been proposed to serve exchanging and relaying data between ad hoc nodes. To accurately find out the suitable protocol, used traffic model should be as real as possible. Many studies used Constant Bit Rate (CBR) as a traffic model which generates a constant traffic patterns. Multimedia becomes the dominant applications in the modern networks, therefore, new traffic model should be used when evaluate these networks as CBR doesn't fulfill such need. Variable Bit Rate (VBR) is more appropriate traffic model for this kind of applications. In this paper, a comparison study between two ad hoc routing protocols, Ad-hoc On-demand Distance Vector Routing (AOMDV) and Optimized Linked State Routing (OLSR) routing protocols is presented using VBR traffic model. This study indicates that when using VBR as a traffic model, AOMDV outperforms OLSR at high node density fields for the most of the performance metrics, while the opposite happens at low node density fields except for PDF that gives AOMDV the superiority in all cases.

Keywords: AOMDV, MANET, OLSR, , PDF, Proactive, and Reactive.

Introduction

Mobile ad hoc network is a multi-hop packet radio network. As its name implies, it doesn't depend on any stationary infrastructure [2]. It is defined as a collection of wireless nodes that can dynamically be set up anywhere and anytime without using any pre-existing network infrastructure [1][4][6]. Due to the limited of Mobile Ad Hoc Network (MANET) nodes resources, it is important to eliminate power consumption, preserve bandwidth, and increase network throughput [2][5][6][7]. To achieve such goals, effective and accurate routing mechanism should be used. The comparison studies are the best approach to find out which algorithm is better to be used in a specific situation.

MANET Routing: As ad hoc networks don't have an infrastructure that supports the network traffic redirecting, MANET nodes should be provided with routing functionality. This functionality increases the complexity of ad hoc networks operations. Many routing algorithms have been proposed to address these issues and optimize the ad hoc networks performance.

Variable Bit Rate (VBR): As opposed of Constant Bit Rate (CBR), VBR model uses the variable transmission rate. In this model, connection channels are not fixed. They change based on the rate of transmission rates. VBR model is more realistic than CBR as it simulates the traffic that most applications generate. Most of the ad hoc researches used CBR traffic models in their simulations which generate results based on unrealistic traffic patterns. To overcome such drawbacks, VBR model can be used instead. Results generated from VBR based simulation are more accurate and can accommodate CBR traffics as well.

Related Works: To the best of our knowledge, however many comparison studies for ad hoc routing protocols have been conducted, none of them addressed the comparison between AOMDV and Optimized Linked State Routing (OLSR)using VBR together with CBR, and TCP traffic models. These researches dealt with several types of routing algorithms such as proactive vs. reactive protocols, distance vector vs. link state algorithms, and single-path vs. multipath protocols. In addition, P. Periyasamy limited to the performance evaluation of the AOMDV protocol and didn't compare it with any other protocol [8].This research compared between two ad hoc protocols, AOMDV and OLSR. AOMDV was selected in this research due to its edge over other protocols in various aspects such as routing load and reducing delay [8]. Similarly, OLSR has been selected in this study as it is one of the most popular MANET routing protocol. One of the

great features of the OLSR protocols is it preserves the bandwidth through optimizing the message flooding.The available studies addressed mainly the performance metrics evaluation based on CBR traffic modeling which is a simple model. 10, 20, 30, and 40 traffic sources were generated with packet size of 512 KB and transmission rate of 4 Mbps. The simulation data rate was 2 Mbps.

Contribution of the Paper: As pervasive computing growing, performance becomes an important argument which attracts customers towards certain products. For such products to be competitive, they should use an effective routing algorithm. Although there are many studies about performance evaluation of ad hoc networks, to the best of our knowledge, there is no study compares between the performance of AOMDV and OLSR using VBR traffic model along with different mobility models. In this research, the performance variables were studied under different scenarios and three traffic patterns as well as four mobility models on both types of protocols using the simulation program and built a clear idea about which algorithm is better for which scenario.

Methodology

In this paper, simulation approach was used to generate and analyze the performance results of the studied protocols. The NS-2 was used as a network simulator as it is a free, open source simulation program. NS-2 is a discrete event driven simulator which translates physical activities to events and used for networking research (Kumawat et al., 2001). Another application, called Bonnmotion was used for generating four mobility models, Random Way Point (RWP), RPGM, MANHATTAN, and Gauss-Markuv. VBR Traffic model was generated using traffic pattern file created by cbrgen add-on in NS-2 simulator. To represent the simulation results in graphical from, MS Excel was used.
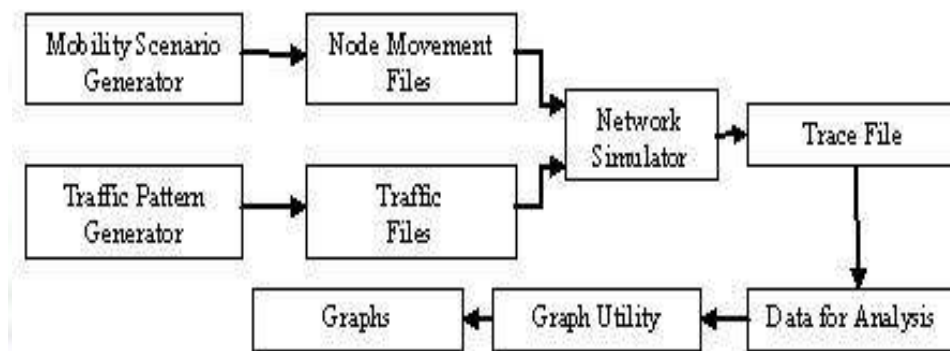

Figure 2.1 The simulation process steps.

Simulation Environment: In this research, VBR traffic model was used together with RWP, RPGM, MANHATTAN, and Gauss-Markuv mobility models. Simulation time was 180 seconds. Number of nodes was 10, 20, 30, 40, 50, 80, and 100 nodes. table 2.1 summarizes the simulation environment parameters.

Table 2.1 The simulation environment parameters.

Parameter	Value
Traffic type	VBR
Simulation Time	180 seconds
Number of nodes	10, 20,30,40 , 50 ,,80, and 100
Pause time	8 seconds
Maximum connections	20
Maximum nodes' speed	15 meter per second
Transmission rate	40 packet per second
Area of the network	2000m X 2000 m
Mobility model	RWP, RPGM, MANHATTAN, GUASS-MARKOV
Routing Protocols	OLSR and AOMDV

Performance Metrics:

In this study, specific performance metrics have been chosen as follows:

Throughput: This metric is one of the most important performance measurements. It measures the average rate of successfully delivered messages over the communication channel measured in bit per second (Ismail & Hassan, 2010). It can be calculated by the total number of packets received by the destination node divided by the simulation time. High throughput means better performance. Following function is used to calculate the throughput:

$$\text{Throughput} = \sum(\text{received packets})/(\text{simulation time})$$

Packet Delivery Fraction (PDF): Also called Packet Delivery Ration (PDR), this metric measures the ratio between number of received packets and number of sent packets. Higher pdf value means higher number of received packet and hence; better performance. Following mathematical function is used to calculate the PDF:

$$\text{PDF} = \sum(\text{Received Packets}) / \sum(\text{Sent Packets}).$$

Average End-to-End delay: The average time the data packets take to reach the destination. The delay happens due to some arguments such as buffering at intermediate nodes, interface queuing, retransmission delays, and propagation and transfer time. Higher delay indicates to bad performance. Following function is used to calculate this metric:

$$\text{Average-End-to-End Delay} = \text{Total-Delay}/\text{Packet-Received}$$

Routing overhead: It is a metric that measure the routing packets. More routing packets consumes the transmission channels bandwidth, and hence; bad performance.

Packet loss: Packets that don't deliver their destination. Obviously, high number of lost packets indicates to bad performance.

Results and Discussion

Following are the results found based on the chosen performance metrics.

1. Throughput:

1.1. RWP Model:

As obtained from the figure 3.1, the throughput of AOMDV protocol is higher than that of OLSR protocol.
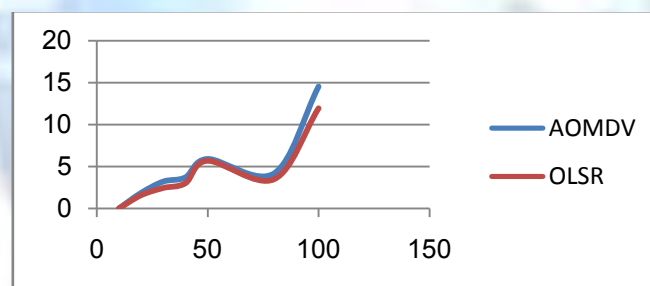

Figure 3.1: TH-RWP

1.3. MANHATTAN:

It is clear from the figure 3.3 that using VBR and MANHATTAN models, the throughput of AOMDV is higher than OLSR's throughout.
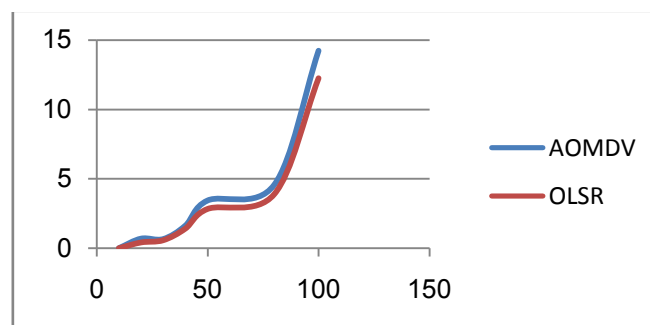

Figure 3.3: TH-MANHATTAN

1.4. Gauss-Markuv Model:

The throughput of AOMDV protocol with VBR and GM models is better than that of OLSR. Figure 3.4 supports this conclusion.
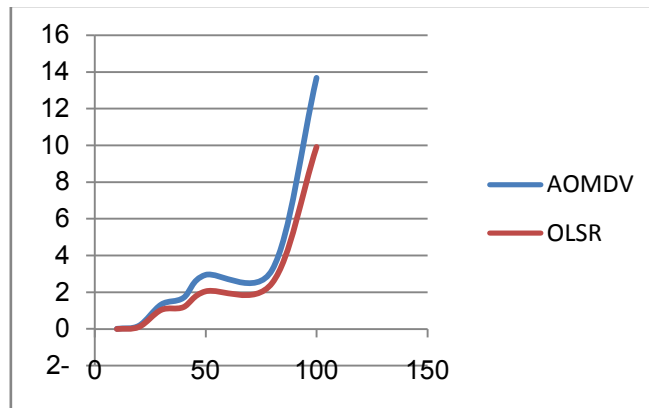
Figure 3.4: TH-GM

2. End-to-end Delay:

2.1. RWP Model:

Figure 3.5 shows that the delay of OLSR ranges from high in low/ moderate node density fields and low in moderate/high node density fields and increases again in the high node density fields. In this scenario, AOMDV outperforms the OLSR most of the time.
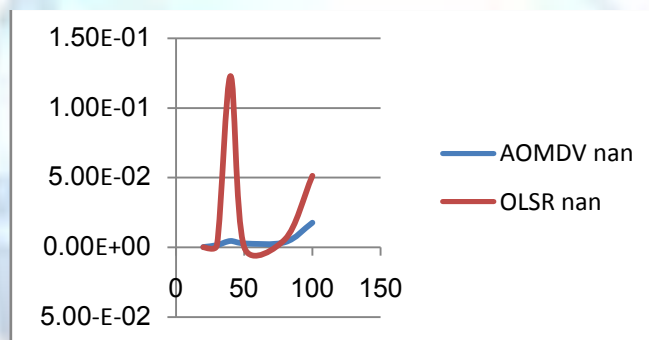
Figure 3.5: E2ED-RWP

2.2. RPGM Model:
As figure 3.6 shows, OLSR protocol has lower end-to-end delay than that of AOMDV protocol when using VBR with RPGM mobility model.
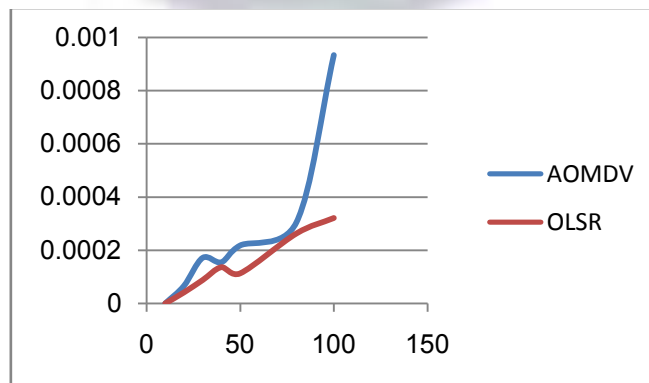
Figure 3.6: E2ED-RPGM

2.3. MANHATTAN Model:
Figure 3.7 illustrates that AOMDV has lower end-to-end delay than OLSR when using VBR with MANHATTAN mobility model.
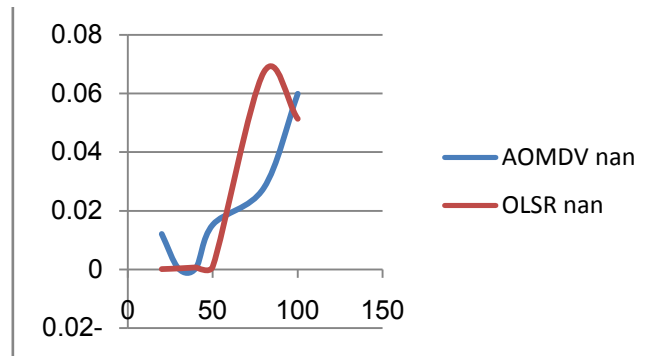
Figure 3.7: E2ED-MANHATTAN

2.4. GM Model:

When using variable bit rate traffic model with GUASS-MARKOV mobility model, OLSR protocol outperforms the AOMDV in terms of end-to-end delay. Figure 3.8 illustrates this conclusion.
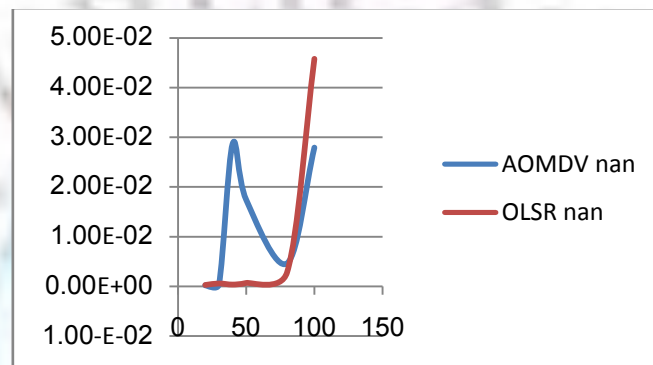

Figure 3.8: E2ED-GM

3. Routing Overhead

3.1. RWP Model:

Figure 3.9 illustrates that when combining VBR traffic pattern with RWP mobility model, OLSR has higher routing overhead at moderate to high node density scenarios. The other notice is, at low node density scenarios, AOMDV has a slightly higher routing overhead than that of OLSR.
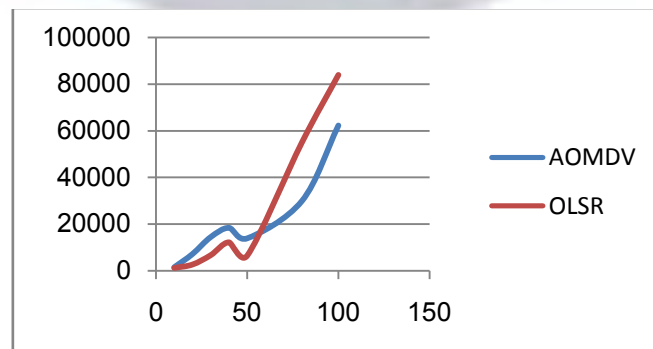
Figure 3.9: RO-RWP

3.2. RPGM Model:

According to figure 3.10, when combining VBR with RPGM mobility model, AOMDV has higher routing overhead than that of OLSR.

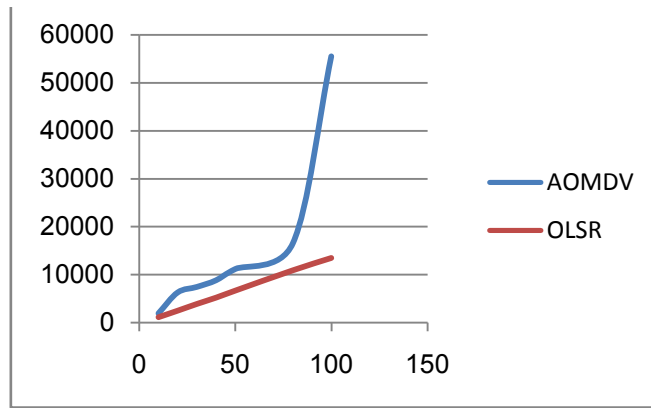**Figure 3.10: RO-RPGM**

3.3. MANHATTAN:

Using VBR along with MANHATTAN mobility model, AOMDV has high routing overhead at low to moderate node density scenarios while OLSR has slightly high routing overhead at moderate to high node density. Figure 3.11 illustrate this conclusion.
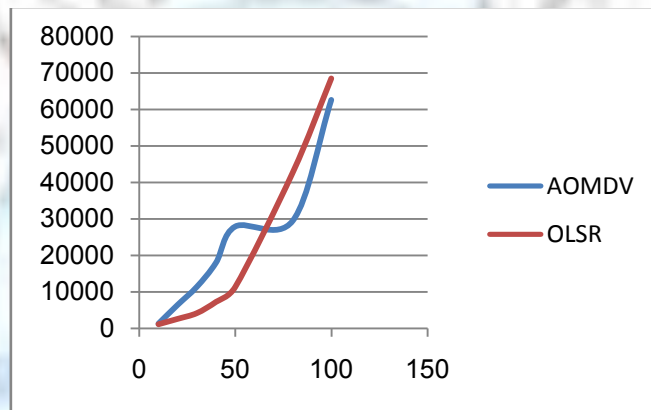
Figure 3.11: RO-MANHATTAN

3.4. GM Model:

As figure 3.12 illustrates, when using VBR along with GUASS-MARKUV, AOMDV generates a high routing overhead rate. The other thing to be noticed is that OLSR also generates a high routing overhead especially at high node density scenarios but still lower than that of AOMDV.
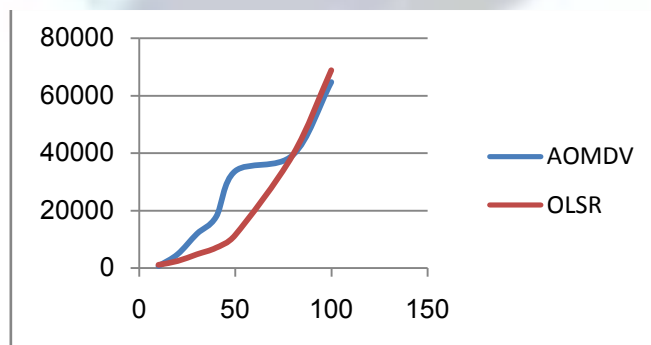
Figure 3.12: RO-GM

4. Packet Loss

4.1. RPGM Model:

As illustrated in figure 3.13, using RWP mobility model with VBR generates a higher packet loss of OLSR than that of AOMDV.
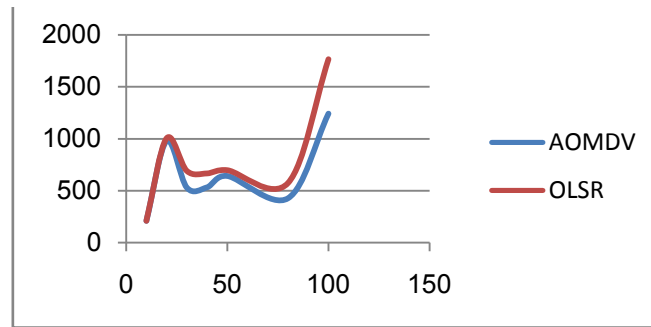
Figure 3.13: Packet Loss

4.2. RPGM Model:

According to figure 3.14, by combining VBR with RPGM, packet loss rate of AOMDV and OLSR are so close with some deviations in favor of OLSR at low node density fields.
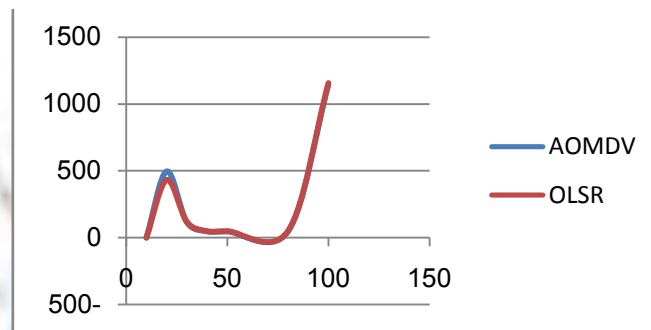

Figure 3.14 RPGM Model

4.3. MANHATTAN Model:

With MANHATTAN mobility model, figure 3.15 shows that using CBR, OLSR generates a higher packet loss rate than that of AOMDV.
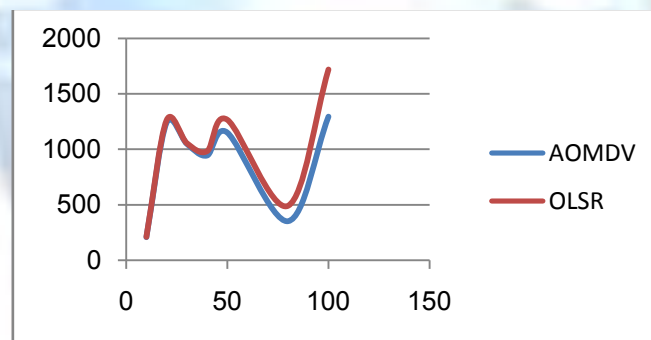

Figure 3.15 MANHATTAN Model

4.4. GM Model:

OLSR also has higher packet loss rate in case of using GM mobility model along with VBR traffic pattern. Figure 3.16 illustrates that.
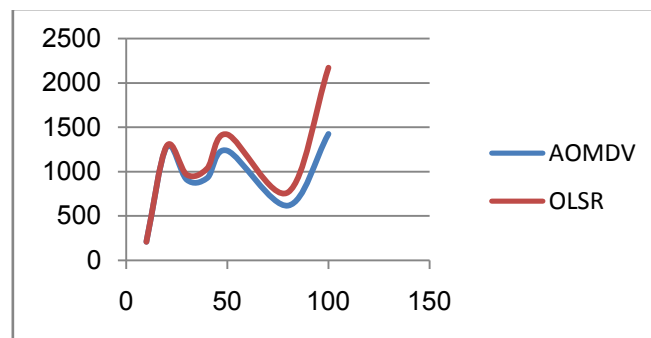

Figure 3.16: PL-GM

5. Packet Delivery Fraction (PDF)

5.1. RWP Model:

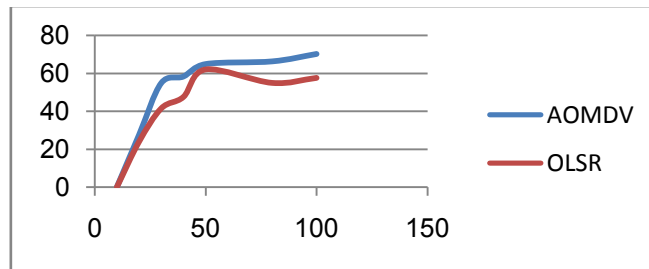According to figure 3.21, when using RWP mobility model with VBR, AOMDV has higher pdf values than that of OLSR.

Figure 3.21: PDF-RWP

5.2. RPGM Model:

As figure 3.22 shows, when using RPGM mobility model with VBR traffic pattern, AOMDV and OLSR generates almost same pdf values.
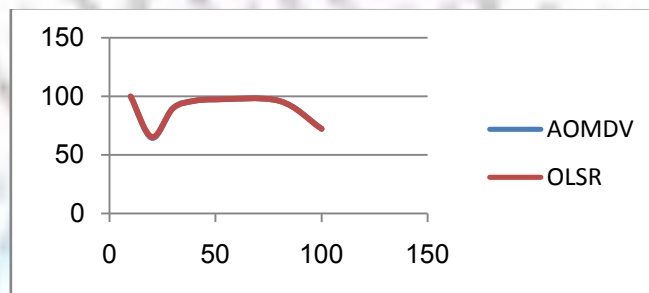

Figure 3.22: PDF-RPGM

5.3. MANHATTAN:

According to figure 3.23, when using MANHATTAN mobility model along with VBR traffic pattern, AOMDV generates a higher pdf values than that of OLSR.
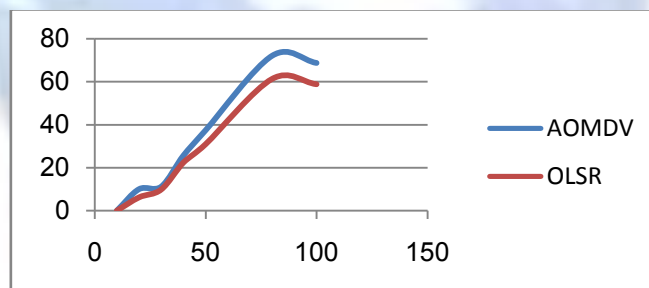

Figure 3.23: PDF-MANHATTAN

5.4. PDF-GM:

As figure 3.24 shown, using GM as a mobility model along with VBR generates higher values for AOMDV than that of OLSR.
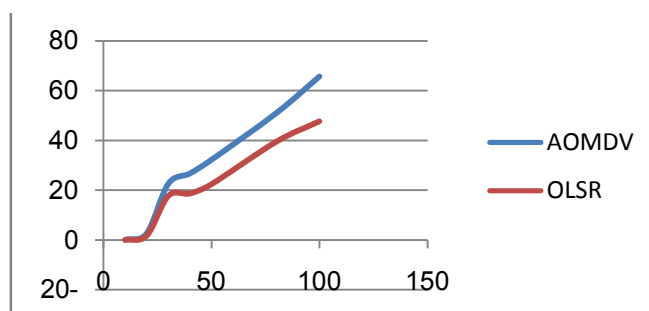

Figure 3.24: PDF-GM

Conclusions
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Based on the simulation results, this study concludes the following:

At low node density, AOMDV outperforms OLSR regarding to routing overhead while the opposite happens at high node density fields in all mobility models except RPGM, which always gives the preference for AOMDV. For PDF, packet loss, and throughput, it is clear that A OMDV has better results than that of OLSR. Using RPGM model, OLSR has less end to end delay results. For Gausses- Markuv, OLSR outperforms AOMDV at low node density areas while the opposite happens at high node density areas. RWP and MANHATTAN gives divergent results. In terms of NRL, OLSR outperforms AOMDV at low node density areas and the opposite happens at high node density areas except RPGM which always give the preference for OLSR.

References

[1]. F. Bai, N. Sadagopan, and A. Helmy., "Important : a framework to systematically analyze the impact of mobility on performance of routing protocols for adhoc networks", in Proceedings of IEEE Information Communications Conference (INFOCOM 2003), San Francisco, 2003.

[2]. Boppana, R.V., and Zhi Zheng., "Designing Ad Hoc Networks with Limited Infrastructure Support", in Proceedings of the Consumer Communications and Networking Conference, 2005. CCNC. 2005 Second IEEE, Las Vegas, Nevada, USA, pp. 7-12, 2005.

[3]. Magnus Frodigh, Per Johansson and Peter Larsson., "Wireless ad hoc networking: The art of networking without a network", Ericsson Review, Vol. No.4 , pp. 248-263, 2000.

[4]. Zahian Ismail and Rosilah Hassan., "Evaluation of Ad Hoc on Demand Distance Vector Routing Protocol in HetMAN Architecture.", Journal of Computer Science, Vol. 6 Issue 7, pp. 830-836, 2010

[5]. Ramprasad Kumawat., "Comparative Study of On-demand Routing Protocols for Mobile Ad-hoc Network.", International Journal of Computer Applications, Volume 27, No.10, pp. 6-11, 2011

[6]. May Zin Oo & Othman M., "Performance Comparisons of AOMDV and OLSR Routing Protocols for Mobile Ad Hoc Network.", in Proceedings of the Computer Engineering and Applications (ICCEA) , Bali Islan, Indonesia, pp. 129-133,2010.

[7]. Victor 0. K. Li and Zhenxin Lu., "Ad Hoc Network Routing.", in Proceedings of the 2004 IEEE International Conference on Networking, Sensing & Control, Taipei, Taiwan, Vol. No. 1, pp. 100-105, 2004.

[8]. P.Periyasamy & Dr.E.Karthikeyan., "Performance Evaluation of AOMDV Protocol Based on Various Scenario and Traffic Patterns.", International Journal of Computer Science, Engineering and Applications (IJCSEA), Vol.1, No.6, pp 33-48., 2011.