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Performance evaluation of dynamic source routing protocol with variation in transmission power and speed

Saad Elsayed[1], Mohamed Ibrahim Youssef[2]
[1]Departement of Electronics and Communications Engineering, High Institute for Engineering and Technology, Al-Obour, Egypt
[2]Electrical Engineering Department, Faculty of Engineering, Al-Azhar University, Cairo, Egypt

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ABSTRACT

Mobile ad-hoc network (MANET) is a set of mobile wireless nodes (devices) which is not rely on a fixed infrastructure. In MANETs, each device is responsible for routing its data according to a specific routing protocol. The three most common MANET routing protocols are: dynamic source routing protocol (DSR), optimized link state routing protocol (OLSR), and ad-hoc on-demand distance vector (AODV). This paper proposes an efficient evaluation of DSR protocol by testing the MANETs routing protocol with variation in transmission power at different speeds. The performance analysis has been given using optimized network engineering tools (OPNET) modeler simulations and evaluated using metrics of average end to end delay and throughput. The results show that the throughput increases as the transmission power increases up to a certain value after which the throughput decreases, also the network work optimally at a certain transmission power which varied at different speed.

Corresponding Author:

Saad Elsayed
Department of Electronics and Communications Engineering, High Institute for Engineering and Technology
Al-Obour, Kilo 21 Cairo/Belbies Rd. High Institute for Engineering and Technology, Egypt-P.O. Box 27-Obour City, Egypt
Email: s.elsayed8585@gmail.com

1. INTRODUCTION

Mobile ad-hoc network (MANET) devices are spread in a wide range of applications such as military, smart cities, healthcare and other applications [1]. Currently, in addition to hierarchical networks, wireless MANETs have become prevalent networks [2]. In the near future, with the rapid development of the internet of things (IoT) networks, the most of devices connected in the network are wireless mobile devices; use machine-to-machine communication. Therefore MANET will continue to be an important research topics, especially, routing protocols improvement to maximize the network lifetime [3]–[5]. MANET supported by several wireless communication technologies such as WiMAX, ZigBee, and Wi-Fi [6].

The routing protocols of MANET can be classified into three categories as shown in Figure 1:

- Proactive routing protocols: A route table about the position of each node is built frequently and routing is based on it. Examples of proactive routing protocols (also named table driven routing) are global state routing (GSR), destination-sequenced distance vector (DSDV), and optimized link state routing (OLSR).
- Reactive routing protocols: This category have no predefined routes. So, the on-demand route is generated dynamically with the request packets. Based on the response, the next node is identified and this process goes on until a fixed path is established and the data packets reach the destination. Examples

of the reactive routing (also named on demand routing) dynamic source routing (DSR), ad-hoc on-demand distance vector (AODV), and temporally ordered routing algorithm (TORA).
– Hybrid routing protocols: It is a mix of both proactive and reactive routing protocols such as distributed dynamic routing (DDR), distributed spanning trees based (DST), and zone routing protocol (ZRP).

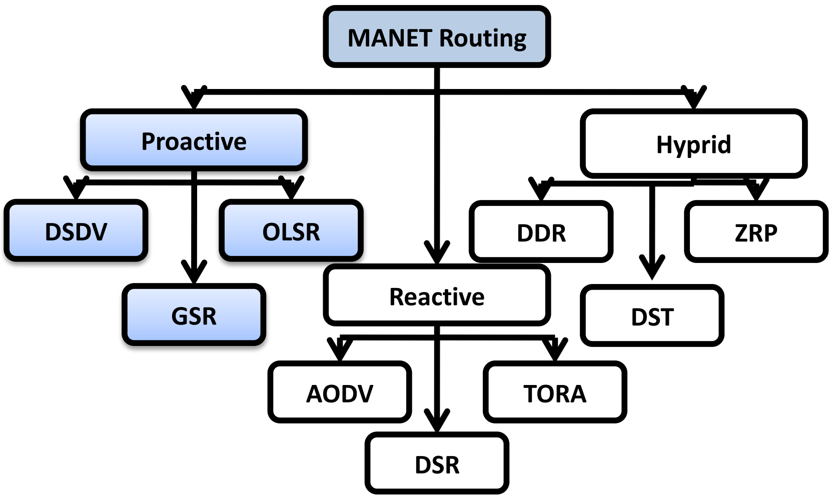


Figure 1. MANET routing protocols classifications

DSR is a most widely used protocol that depends on source routing mechanism. DSR protocol transmits the routing traffic only in the occurrence of data that has ready to transmit is the main reason of acquiring low overhead [7]–[10]. This removes the desire to transmit unwanted routing traffic. Due to much route reply to a single request, AODV has high routing overhead as compared to DSR. This in turn eliminates the need to send unnecessary routing traffic. AODV and DSR use distinct mechanism for route discovery but with same table-driven method. AODV originates maximum overhead than DSR [11].

Three multicast routing strategies for MANET has been presented in [12]. Three routing protocols proposed are a reactive multicast routing protocol for cluster-based MANET by using software defined network, proactive multicast routing protocol for cluster-based MANET by using SDN (PMCMS) and modification called M-PMCMS. Different mobility models have been analyzed [13]–[16]. To enhance the traffic safety, misbehavior detection using machine learning has been studied in [17]. Security issue in MANET has been discussed in many papers such as [18], [19]. The impact of retransmissions of packet lost and energy consumption in order to choose the appropriate routing protocol that can be enhance quality of service (QoS) of MANET are minimized and examined using NS-3 simulator [20].

A scheme called AODV-velocity and dynamic for effective broadcast control packets is proposed [21]. The routing protocol for the ad-hoc on-demand distance vector (AODV) is used to implement the proposed AODV-VD scheme. AODV-VD scheme reduces both the excessive route discovery control packets and network overhead. Network simulator version 2.35 (NS2.35) was used to compare the proposed AODV-VD scheme to the AODV routing protocol in terms of end -to-end latency, average throughput, packet transmission ratio and overhead ratio.

Different mobility models for OLSR protocol was examined. Four mobility models was considered; random direction, random walk, way-point mobility, and steady state random way-point. The simulation results show that the steady state random way-point presents better results from the delay point of view but random way point performs better from the throughput point of view [22]. From the previous discussion, most of papers did not take into account the effect of a change in speed and transmitted power together on the performance metrics such as throughput and delay. The related works parameters summarized in Table 1.

As shown in Table 1, the papers [20]–[27] do not take into account the effect of transmitted power variation. A study of the effect of varying transmitted power at fixed speed (10 m/sec) is given in [28]. It is important to note that, most of related works have been simulated the network for short time.

In this paper the analysis of the performance of the DSR protocol using OPNET is given. Also, an efficient analysis method to evaluate the routing protocol is proposed. The rest of this paper is organized as: in section 2, the research method has been introduced. The simulation results of the proposed model have been discussed in section 3. Finally, section 4 presents the conclusion of the proposed model.

Table 1. The related works summary

Paper	Protocol	Speed (m/sec)	Simulator	Transmitted power	Data Traffic	No. of Nodes	Simulation Area (m^2)	Simulation Time (sec)
[20]	AODV OLSR DSDV	10 to 50	NS-3	1.65 w	CBR	50	1,000×1,000	300
[21]	AODV	5 to 50	NS-2	N.A	CBR	20-100	1,000×1,000	300
[22]	OLSR	20	NS-3	N.A	CBR	20-100	500×1,500	1,000
[23]	OLSR	10	NS-2	N.A	CBR	10-100	1,000×1,000	1,200
[24]	AODV OLSR DSDV DSR	0 to 30	NS-3	7.5 dBm	CBR	50	500, 750, 1,000	200
[25]	AODV DSDV	10 to 80	NS-3	N. A	CBR	50-250	300×1500	300
[26]	M- AODV DSR	10	NS-3	N. A	CBR	50-250	1,000×1,000	100
[27]	DSR, AODV DSDV	5	NS-2	N. A	CBR	20	1,859×550	150
[28]	AODV	10	QualNet	1 - 4 dBm	CBR	40, 80, 120	1,500×1,500	300
Simulated Network	DSR	10 to 40	OPNET	1 – 4mW	FTP	40, 80	1,500×1,500	3,600

2. PROPOSED METHOD

In this section, a research method based on simulation analysis has been presented. There are several network simulators such as OPNET [29], OMNeT++ [30], QualNet [31], NS-2 [32], NS-3 [33] and J-Sim [34]. OPNET modeler was chosen due to its accuracy and to its sophisticated graphical user interface. To perform simulations, a MANET scenario has been designed with the number of nodes of 40 and 80 nodes randomly placed over 1,500*1,500 meters area size using OPNET simulator as shown in Figure 2.

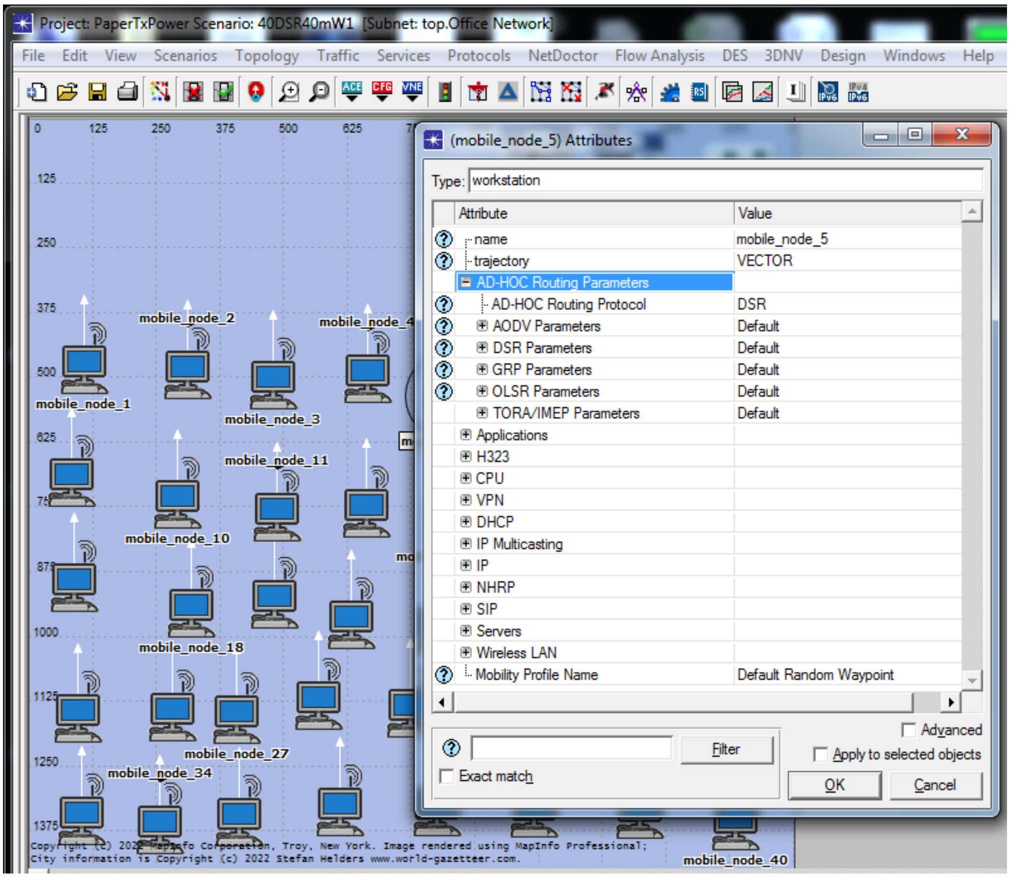


Figure 2. The simulated network using OPNET

The performance of DSR protocol is evaluated for the performance metrics, throughput and end to end delay. The performance of the designed network scenario has been examined with variation of transmitted power. The mobility model used in the designed scenario is random waypoint mobility model (RWMM). Also, the performance of the designed network scenario has been evaluated with variation in node speed. The list of simulation parameters and the values used in the simulated network scenario has been illustrated in Table 2.

Table 2. The simulation parameters

Parameters	Values
Routing Protocol	DSR
Number of Nodes	40 and 80 Nodes
Mobility Model	RWMM
Node Speed (m/sec)	10 – 40 m/sec
Transmitted Power (mW)	1 - 4
Application Protocol	FTP
Simulation Area (m^2)	1500×1500
Simulation Time	3600 sec

As shown in Table 2, the simulation time is 3,600 sec and the transmitted power will be vary from 1 to 4 mW. Two network sizes will be examined 40 and 80 nodes. The node speed will be vary from 10 to 40 m/sec and the simulation area is 2.25 km^2.

3. SIMULATION RESULTS AND ANALYSIS

This section evaluates the proposed model using OPNET. Results have been carried out by varying the transmitted power and node speed. The proposed model has been evaluated by two metrics namely, average throughput, and average end to end delay.

3.1. Performance evaluation of the simulated network at different transmitted power and speeds

In this simulation, the transmitted power may vary between 1-4 mW. Also, the speed varies between 10-40 m/sec. The network size is 40 nodes. The performance in terms of throughput is shown in Figure 3. As shown in Figure 3, it can be observed that, the average of throughput at 3 mW transmitted power is the highest. Results show that, at the speed=10 m/sec, P_T=1, 2, 3, and 4 mW; the average throughput is 114.186, 118.861, 122.175, and 59.038 Kb/sec respectively. It is important to note that, the average of throughput is increases as the transmitted power increases up to 3 mW after which the throughput decreases. At the speed=20 m/sec; average of throughput at 2 mW transmitted power is the highest. The average throughput for different transmitted power (P_T=1, 2, 3, and 4 mW) is 117.099, 121.892, 116.100, and 63.779 Kb/sec respectively.

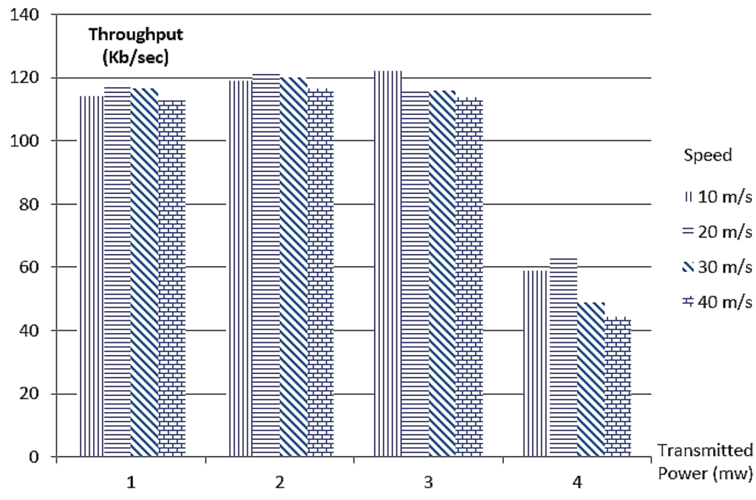


Figure 3. Transmission power impact on the average throughput

As shown in Figure 3, the average throughput for different transmitted power (P_T=1, 2, 3, and 4 mW) is 116.446, 120.021, 115.981, and 48.985 Kb/sec respectively at the speed=30 m/sec. It is also showing that, the average of throughput at 2 mW transmitted power is the highest. P_T=1, 2, 3, and 4 mW; the average throughput is 112.868, 116.436, 113.838, and 44.543 Kb/sec respectively at 40 m/sec node speed.

The performance in terms of average delay is depicted in Figure 4. It can be observed that, the average of delay at 3 mW transmitted power is the lowest. Results show that, at the speed=10 m/sec, P_T=1, 2, 3, and 4 mW; the average delay is 1.83745, 1.826676, 1.791556, and 4.363661 msec respectively as shown in Figure 4.

It is important to note that, the average of delay is increases as the transmitted power increases up to 3 mW after which the delay decreases. Figure 4 shows that, at the speed=20 m/sec; average of delay at 2 mW transmitted power is the lowest. The average delay for different transmitted power (P_T=1, 2, 3, and 4 mW) is 1.834889, 1.734518, 1.804406, and 4.432615 msec respectively. The average delay for different transmitted power (P_T=1, 2, 3, and 4mW) is 1.836479, 1.745199, 1.816238, and 6.0222 msec respectively at the speed=30 m/sec. It is also depicted that, the average of delay at 2 mW transmitted power is the lowest. P_T=1, 2, 3, and 4 mW; the average delay is 1.940127, 1.841685, 1.898932, and 6,234 msec respectively at 40 m/sec node speed.

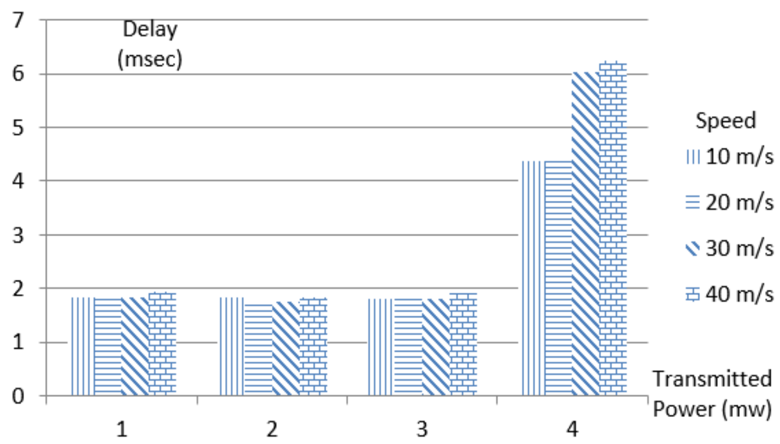


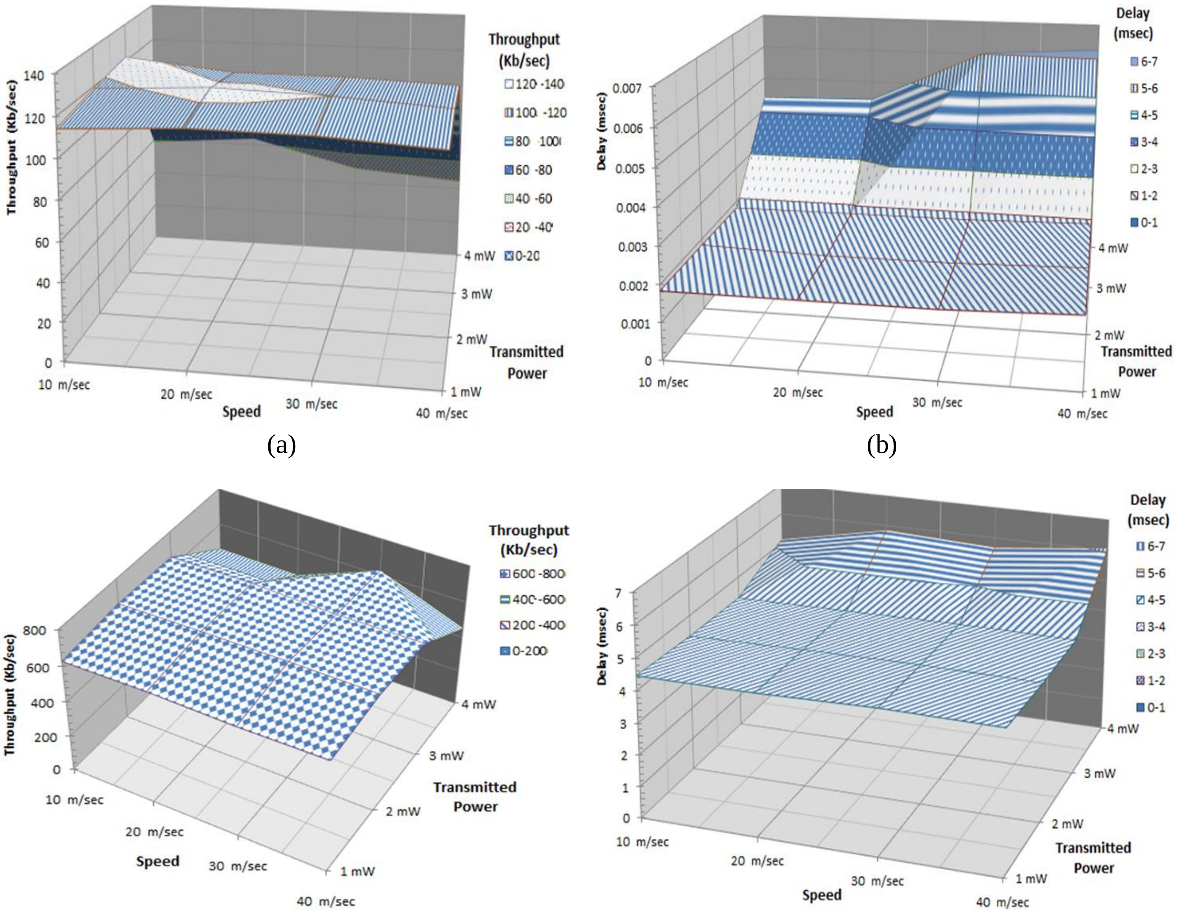
Figure 4. Transmission power impact on the average delay

3.2. Three-dimension performance evaluation of the simulated model

Figure 5 depicts the effect of changing speed and transmitted power on the throughput and delay for a network size of 40 nodes and 80 nodes. The average throughput and the average delay for a network size of 40 nodes have been shown in Figures 5(a) and 5(b) respectively. The results are illustrated in three dimensions form to determine the optimal working point from the viewpoints of the speed and the transmitted power together to obtain the highest throughput and the least delay.

Figure 5(a) shows that the highest value of throughput ranges between 120 and 140 Kb/sec and is achieved at speeds from 10 to 25 m/sec. It also shows that at lower speeds there are more values of the transmitted power at which it can be worked to obtain the highest value of the throughput. By increasing the speeds, the highest values of throughput are achieved at more specific values of the transmitted power. As shown in Figure 5(b), the delay increases with increasing node speed, while it decreases with increasing transmitted power until a certain value and then increases after that. The delay ranges between 1 and 2 msec when the transmitted power is from 1 to 3 mW, while the delay increases dramatically when the transmitted power is 4 mW.

The average throughput and the average delay for a network size of 80 nodes have been shown in Figures 5(c) and 5(d) respectively. Figure 5(c) shows that the highest value of throughput ranges between 600 and 800 Kb/sec and is achieved at transmitted powers from 1 to 3 mW. It also shows that, the maximum throughput is 671.533 Kb/sec which achieved at speed of 30 m/sec and transmitted power is 2 mW. These results show that the maximum throughput of 80 nodes is more than five times that of 40 nodes. Figure 5(d) shows that the delay increases slightly at the beginning and then decreases until it reaches the lowest value at a speed of 30 m/s and a transmitting power of 3 mW. It also shows that the effect of changing the speed on the delay is small. It is possible to benefit from this method in presenting the results by defining the constraints of the system under study or the design, such that the speed has a specific range, so choose the optimal work point from the point of view of the transmitted power, and so on.



(c) (d)

Figure 5. Effect of transmitted power and speed on performance of DSR protocol (a) throughput of 40 nodes, (b) delay 40 of nodes, (c) throughput of 80 nodes, and (d) delay of 80 nodes

4. CONCLUSION

In this paper, the throughput and average end to end delay performance metrics have been analyzed to DSR protocol. The designed scenario is carried out with variation in node speed and transmission power over 40 and 80 nodes. The results show that the throughput increases as the transmitted power increases up to a certain value after which the throughput decreases due to increasing interference. It can be concluded that the designed DSR routing protocol for 40 nodes MANET network performs optimally at a transmission power of 3 mWat speeds 10 m/sec. The results also show that the maximum throughput can be achieved at 2 mW at speeds of 30 m/s for 80 node network size. The results also show that the network performance changes dramatically when the transmitted power increases to 4mW for all simulated speeds, so it is recommended according to the selected parameter that it is suitable for networks where the transmitted power is less than 4 mW. This work can be extended to evaluate routing protocols such as AODV, DSDV, and OLSR.

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BIOGRAPHIES OF AUTHORS

Saad Elsayed is a lecturer in the High Institute for Engineering and Technology, Al-Obour, Cairo, Egypt. He received his B.Sc., M.Sc. and Ph.D. in Electronics and Communication Engineering from the Faculty of Engineering, Al-Azhar University, Cairo, Egypt, in 2008, 2015, and 2019 respectively. His research activities are within wireless communications and communication networks. He can be contacted by email: s.elsayed8585@gmail.com.

Mohamed Ibrahim Youssef is a professor in Electronics and Communications Engineering department, Faculty of Engineering, Al-Azhar University, Egypt since 2002. His research activities are within digital communications, mobile communications and digital signal processing. He can be contacted by email: mohiyosof@gmail.com.