

Performance Evaluation of AODV and DSR Routing Protocol on Varying Speed and Pause Time in Mobile Ad Hoc Networks

Anil Saini and Rajender Nath

Abstract MANET is an emerging approach to wireless communication with potential applications in random and dynamic environments. In MANET, there cannot be a central administrator due to mobile nodes and frequent breakage of links. Thus, routing in MANETs becomes a challenging job, and the motivation behind this paper is to discover and study the effect of pause time and mobility of nodes on Dynamic Source Routing (DSR) and Ad hoc On-Demand Distance Vector (AODV) routing protocols. Network Simulator version 2.35 has been used to perform the experiment.

Keywords AODV · DSR · End-to-end delay · MANET · PDR · Pause time Throughput

1 Introduction

Ad hoc wireless technology is an emerging approach to wireless communication with potential applications in random and dynamic environments. In contrast to cellular and infrastructure-based networks, it does not possess any fixed infrastructure or central administrator such as router. MANET is a set of independent system of mobile nodes that move freely and randomly. Its network topology is dynamic in nature and may change speedily and randomly. Due to this, the inter-communications among nodes keep on changing. MANET [1] depends on many other aspects including location of request initiator, topology of network, optimum selection of routers, and specific underlying features that could work on finding the path rapidly and efficiently. In MANETs, routing protocols are used to decide the

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optimal route for packet transfer and make sure that the packets are reached to the desired destination. Several routing protocols for MANETs have been given, and their performance under different network situations and traffic constraints has been considered. Routing protocols are categorized as: proactive and reactive. Proactive-based routing protocols [2, 3] are also known as table-driven routing protocols. It maintains optimal routing information for each node in the network by spreading route update information at periodic intervals. Many proactive routing protocols have been proposed in the literature such as Wireless Routing Protocol (WRP), Destination-Sequenced Distance Vector (DSDV) routing protocol, Optimized Cluster-Head Gateway Routing (CGSR). Reactive-based routing [2, 4] protocols, also known as on-demand routing protocol, take a different method for routing as compared to proactive protocols. The advantage is that when a path is desired, it is immediately available which reduces the routing overheads. Various types of reactive-based routing protocols are as follows: Dynamic Source Routing (DSR) [5, 6], Ad hoc On-demand Distance Vector (AODV) [7, 8], and Temporally Ordered Routing Algorithm (TORA). Among these protocols, on-demand routing protocols are commonly used because they find routes in reactive fashion. AODV routing protocol uses an active approach to discover routes; it uses the destination sequence number to determine fresh path to the destination, which distinguishes it from other reactive-based routing protocols; it also uses a broadcast route discovery process to find a path to the target, and then, target node uses the unicast route reply message to reply back to the source, whereas DSR is designed mainly to use in multi-hop mobile ad hoc networks.

This paper analyzes the AODV and DSR protocols for varying speed and pauses time by using performance evaluation metrics such as packet delivery ratio, throughput, and end-to-end delay.

The following sections are organized as follows: Sect. 2 discusses the related work. Section 3 presents the proposed work and simulation activity process for simulation scenarios. Section 4 discusses the simulation results. Section 5 presents the concluding remarks.

2 Related Work

There are numerous papers [6, 8–11] related to the performance evaluation of routing protocols in MANETs.

Lego et al. [6] compared the performance of DSR, DSDV, and AODV protocols on varying pause time. They found the value of PDR for AODV and DSR were almost equal when pause time was taken as 0, and it increased when pause time was increased.

Khattak et al. [8] analyzed various routing protocol by changing the mobility and density of nodes with TCP and UDP traffic. They show that all routing protocols did well under TCP traffic type, whereas PDR was less in case of UDP due to unreliable transmission.

Gupta et al. [9] compared the performance of AODV and DSR protocols considering three different scenarios by using network routing load, packet fraction rate, and end-to-end delay metrics. They found DSR started losing data packets when mobility of nodes and network resource were increased.

Lee [10] evaluated the performance of DSR and AODV routing protocols and found packet loss of DSR is more as compared to AODV for a less amount of time while it is almost equal to a greater amount of time. They further found DSR was more stable than AODV protocol due to absence of periodic packet broadcast and multiple paths.

Taksande et al. [11] studied DSR and AODV protocols by keeping network pause time and node speed as constant with changing network size. They concluded DSR protocol performs better for lesser no. of nodes as compared to AODV, whereas AODV protocol outperformed DSR protocol in terms of end-to-end delay.

3 Proposed Work

As discussed in the forgoing section, AODV and DSR protocols have not been studied for varying speed and pause time in MANETs [12–14]. Hence, this paper focuses on evaluating AODV and DSR protocols by changing both the speed and the pause time. For evaluation, following metrics are used: throughput, PDR, and end-to-end delay [15, 16]. Figure 1 shows the methodology of studying the performance of the protocols. A tcl script with wireless scenario and traffic pattern of mobile nodes is created, which is run on the network simulator. The outcomes of the simulation are trace file and the awk script, which are used for analysis.

The experiment is performed on NS2.35 by taking two scenarios, as shown in Tables 1 and 2. In Scenario 1, speed is kept constant and pause time is varied. In scenario 2, pause time is kept constant and speed is varied. The following three metrics are used to evaluate the performance of the proposed approach:

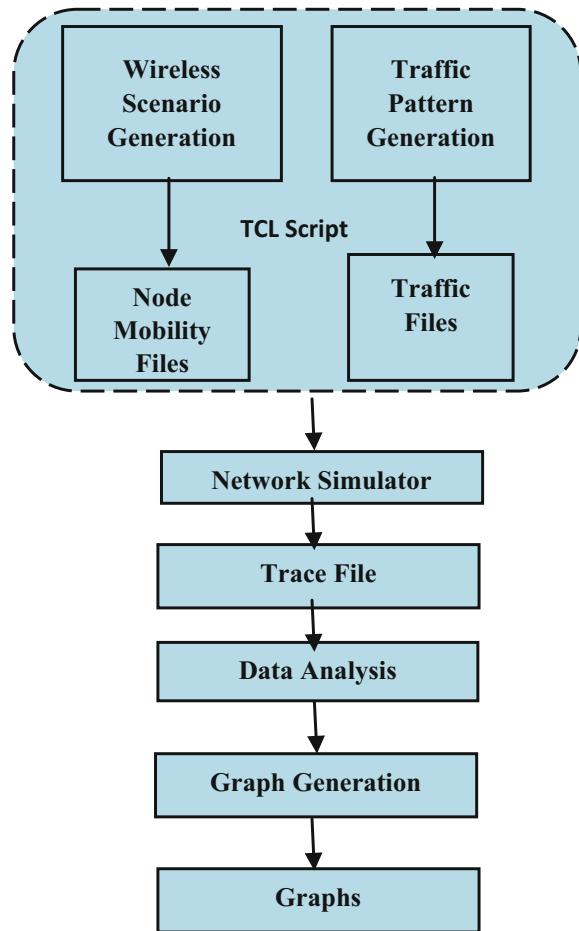
Throughput: Throughput is defined as the number of packets successfully transferred from one end to other per unit time [17].

$$\text{Throughput} = \frac{\text{No. of bytes received} \times 8}{\text{Simulation time} \times 1000} \text{ Kbps} \quad (1)$$

Packet Delivery Ratio (PDR): It is the ratio of the received packets at the target node to the generated packets at the source node [18].

$$\text{PDR} = \frac{\text{No. of packet received}}{\text{No. of packet sent}} \times 100 \quad (2)$$

End-to-End Delay: It is average time required to transfer the data packets from source to destination [19].

Fig. 1 Simulation activities

$$\text{End to End Delay} = \frac{\sum(\text{arrive time} - \text{send time})}{\sum \text{no. of connections}} \quad (3)$$

4 Simulation Results and Analysis

Tables 3 and 4 show the experimental values of end-to-end delay, throughput, and PDR for AODV and DSR protocols with varying speed of the nodes and constant pause time, i.e., 100 s. Tables 5 and 6 show the experimental values of end-to-end delay, throughput, and PDR for DSR and AODV protocols and varying pause time with constant speed, i.e., 2 m/s [20–22].

Table 1 Simulation scenario 1

Parameters	Values
Simulator	Ns 2.35
Media access control	802.11
Simulation period	500 s
Channel	Wireless channel
Protocols	AODV, DSR
Antenna model	Omnidirectional
Simulation range	670 m × 670 m
Traffic type	FTP
Radio propagation	TwoRay Ground
Interface queue type	DropTailPriQueue (AODV), CMUPriQueue (DSR)
No. of nodes	25
Speed	2 m/s
Pause time	0, 100, 200, 300, 400 (s)
No. of connections	8

Table 2 Simulation scenario 2

Parameters	Values
Simulator	Ns 2.35
Media access control	802.11
Simulation period	500 s
Channel	Wireless channel
Protocols	AODV, DSR
Antenna model	Omni
Simulation range	670 m × 670 m
Traffic type	FTP
Radio propagation	TwoRay Ground
Interface queue type	DropTailPriQueue (AODV), CMUPriQueue (DSR)
No. of nodes	25
Speed	1, 2, 5, 7, 10 (m/s)
Pause time	100 s
No. of connections	8

Table 3 AODV (TCP Agent) for 25 Nodes with 8 connections with constant pause time (100 s)

Pause time (s)	Speed (m/s)	End-to-end delay (s)	Throughput	PDR
100	1	0.52911	626543.65	99.12
	2	0.56479	614041.53	99.16
	5	0.49337	646147.81	98.99
	7	0.50525	628833.35	98.96
	10	0.48529	664151.94	98.61

Table 4 DSR (TCP agent) for 25 nodes with 8 connections with constant pause time (100 s)

Pause time (s)	Speed (m/s)	End-to-end delay (s)	Throughput	PDR
100	1	0.79886	642652.09	99.60
	2	0.77235	657537.17	99.64
	5	0.84206	641226.70	99.56
	7	0.93346	615488.76	99.52
	10	0.80645	642658.09	99.57

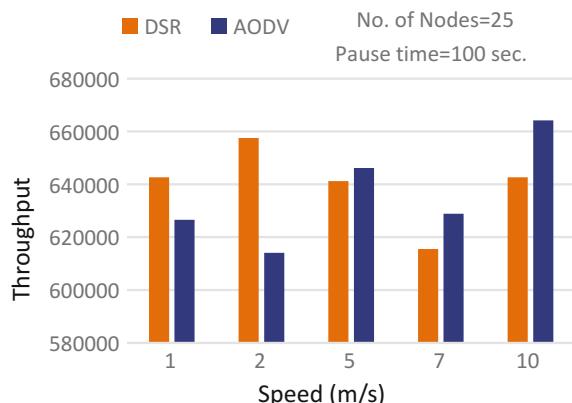
Table 5 AODV (TCP Agent) for 25 nodes with 8 connections with constant speed (2 m/s)

Speed (m/s)	Pause time (s)	End-to-end delay (s)	Throughput	PDR
2	0	0.58293	560884.56	99.31
	100	0.56479	614041.53	99.16
	200	0.46952	615804.76	99.11
	300	0.45677	632733.06	99.05
	400	0.50547	620460.62	98.74

Table 6 DSR (TCP Agent) for 25 nodes with 8 connections with constant speed (2 m/s)

Speed (m/s)	Pause time (s)	End-to-end delay (s)	Throughput	PDR
2	0	0.84075	652952.68	99.37
	100	0.77235	657537.17	99.64
	200	0.71514	650040.38	99.48
	300	0.75970	629148.62	99.69
	400	0.68679	628442.59	98.78

Figure 2 shows the throughput of DSR and AODV protocols with constant number of nodes, i.e., 25, constant pause time, i.e., 100 s, and varying speed (from 1 to 10 m/s), which is indicated on *x*-axis. The results show that in “low-speed”

Fig. 2 Throughput versus speed (m/s) with constant pause time (100 s)

situation, DSR protocol outperforms AODV but in “high-speed” situation AODV outperforms DSR protocol.

Figure 3 shows the throughput of DSR and AODV protocols with constant number of nodes, i.e., 25, constant speed, i.e., 2 m/s, and varying pause time (from 0 to 400 s), which is indicated on x-axis. The results show that in the beginning and intermediate phase, DSR protocol outperforms AODV in “low-mobility” situation. On the other hand, in “high-mobility” situation, both AODV and DSR protocols give similar throughput value [23–25].

Figure 4 shows the PDR of DSR and AODV protocols with constant number of nodes, i.e., 25, constant pause time, i.e., 100 s, and varying speed (from 1 to 10 m/s), which is indicated on x-axis. The result shows that in both AODV and DSR Protocols when the speed of the node is increased, the PDR gets decreased. But in low-to-high mobility situation, DSR protocol gives better result as compared to AODV Protocol.

Figure 5 shows the PDR of DSR and AODV protocols with constant number of nodes, i.e., 25, constant speed, i.e., 2 m/s, and varying pause time (from 0 to 400 s), which is indicated on x-axis. In this scenario, it is observed that the DSR protocol gives better result than AODV in all situations.

Fig. 3 Pause time (s) versus throughput with constant speed (2 m/s)

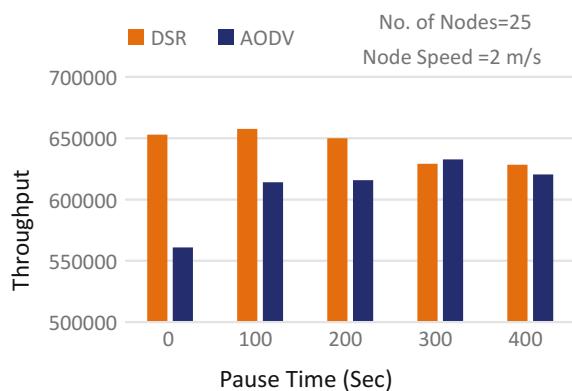


Fig. 4 Speed (m/s) versus PDR with constant pause time (100 s)

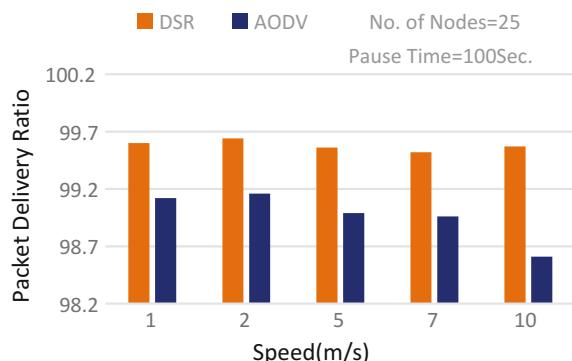


Fig. 5 Pause time (s) versus PDR with constant speed (2 m/s)

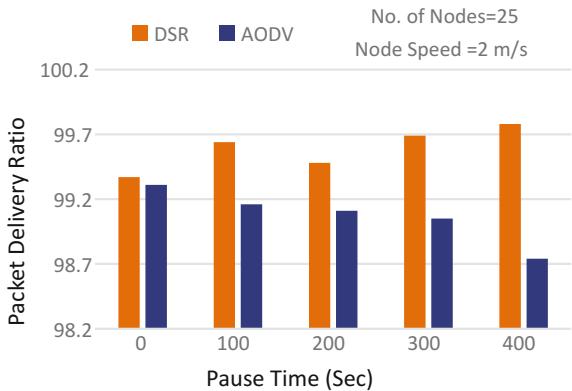


Fig. 6 Speed (m/s) versus end-to-end delay (s) with constant Pause Time (100 s)

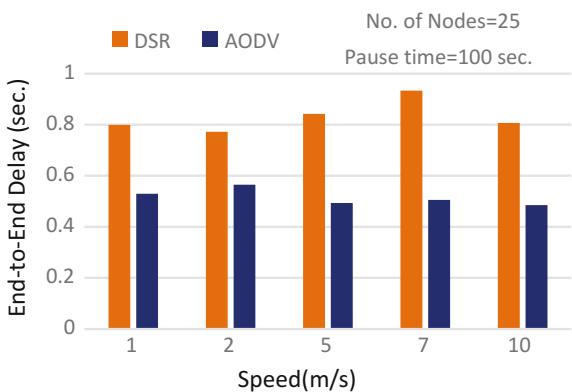
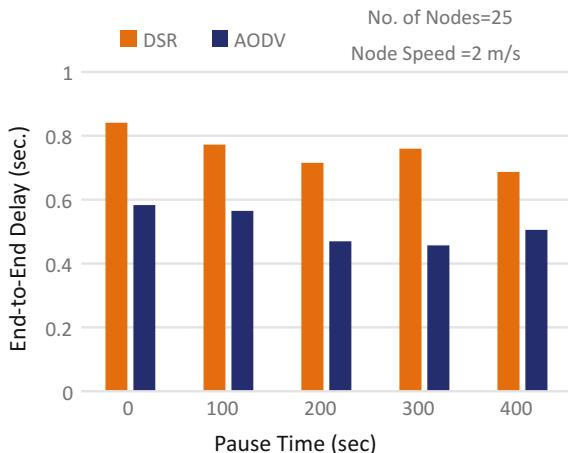


Figure 6 shows the end-to-end delay of DSR and AODV protocols with constant number of nodes, i.e., 25, constant pause time, i.e., 100 s, and varying speed (from 1 to 10 m/s), which is indicated on x -axis. The result shows that in AODV protocol, when the speed of the node is increased the end-to-end delay gets decreased, but in DSR protocol, the delay is increased when the speed of the node is increased. So DSR has comparatively high delay than AODV in all situations.

Figure 7 shows the end-to-end delay of DSR and AODV protocols with constant number of nodes, i.e., 25, constant speed, i.e., 2 m/s, and varying pause time (from 0 to 400 s), which is indicated on x -axis. The result shows that in AODV protocol, when the pause time is increased the end-to-end delay gets decreased, but in DSR protocol, the delay is increased when the pause time is increased. So DSR has relatively high delay than AODV in all situations.

Fig. 7 Pause time (s) versus end-to-end delay with constant speed (2 m/s)



5 Conclusion

In this paper, performance of the two most widely used protocols—DSR and AODV—has been evaluated by varying speed and constant pause time. The experiment results have shown that AODV has outperformed DSR when speed of the node is low and pause time is kept constant. While AODV has performed well under high mobility of the nodes. It has also been found that the DSR has better results as compared to AODV in terms of throughput and end-to-end delay when pause time is kept constant. On the other side, AODV is performed better when pause time is varied.

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