CBR Traffic Based Performance Investigations of DSDV, DSR and AODV Routing Protocols for MANET Using NS_2

Payal, Sudesh Kr. Jakhar

Abstract*—A Mobile Ad-Hoc Network (MANET) is self-configuring network of mobile nodes connected by wireless links to form an arbitrary topology without the use of existing infrastructure. This paper does the comparative investigations on the performance of routing protocols Dynamic Source Routing (DSR), Ad-hoc On demand distance vector (AODV) and Destination-Sequenced Distance-Vector (DSDV) for wireless ad-hoc networks in a simulated environment against varying parameters considering UDP as transport protocol and CBR as traffic generator. In this paper, we have studied the effects of varying node mobility rate, scalability and maximum speed on the performance of ad-hoc network routing protocols. Simulation results indicate that despite in most simulations reactive routing protocols DSR and AODV performed significantly better than proactive routing protocol DSDV, DSR is less scalable with respect to network size because DSR introduces high overheads with the increase in network size. Simulations presented clearly show that there is a need for routing protocol specifically tuned to the characteristics of ad-hoc networks.

Index Terms*—CBR, AODV, DSDV, DSR, MANET, NS-2, Performance Evaluation.

I. INTRODUCTION

A mobile ad-hoc network (MANET) is a collection of wireless mobile hosts forming a temporary network without any infrastructure or centralized administration. In such an environment, each node acts as a router or source or destination and forwards packets to the next hop allowing them to reach the final destination through multiple hops [1]. The role of a routing protocol is very crucial in the implementation of MANET due to its dynamic topology. A key issue in MANETs is the necessity that the routing protocols must be able to respond rapidly to topological changes in the network.

Routing in ad-hoc networks is non-trivial as they possess few characteristics [2] which make them different from wired networks. A mobile ad-hoc networking (MANET) working group has been formed within the Internet Engineering Task Force (IETF) to develop a routing framework for IP-based protocols in ad-hoc networks [3]. Many different protocols have been proposed to solve the multi-hop routing problem in ad-hoc networks [4]. Such protocols are traditionally divided into two classes [5, 6]: Proactive routing protocols and Reactive routing protocols.

Proactive routing protocols or Table-Driven routing protocols attempt to continuously determine the network connectivity so that route is already available when a packet needs to be forwarded. Example include Destination sequenced Distance Vector (DSDV) protocol [7]. The DSDV protocol requires each mobile station to advertise, to each of its current neighbors, its own routing table.

Reactive protocols, also called On-Demand protocols, employ a Just-In-Time (JIT) approach; this type of routing creates routes only when desired by the source node on demand. Examples include Dynamic Source Routing (DSR) protocol [8] and Ad-hoc On Demand Distance Vector (AODV) protocol [9, 10]. It computes the routes when necessary explicitly lists this route in the packets header, identifying each forwarding hop by the address of the next node to which to transmit the packet on its way to the destination host.

The papers [11-15] did the comparison of routing protocols for ad-hoc networks considering only few characteristics that should be possessed by routing protocols. This paper is investigative study of routing protocols considering many performance differentials.

This paper is organized as follows. In Section II deals with simulation model. Section III presents the simulation results and conclusion is given in section IV.

II. SIMULATION MODEL

The exhaustive simulations are done using the Network Simulator 2 (NS 2.34). NS-2 is a discrete event simulator that simulates a variety of IP networks.

A. Simulation Environment

Simulation environment consists of 50 wireless nodes forming an ad-hoc network, moving about over a 670 meter X 670 meter flat space for 200 seconds of simulated time, the output is taken with the help of the nam animator with .nam file as the input file (Fig. 1). NAM animation tool is used for viewing network simulation traces and real world packet trace data. Each run of the simulator accepts as input a scenario file that describes the exact motion of each node and the exact sequence of packets originated by each node, together with the exact time at which each change in motion or packet origination is to occur. In order to enable direct, fair comparisons between the protocols, protocols are simulated under identical loads and environmental conditions. We pre-generated number of different scenario files with varying movement patterns and traffic loads.

Manuscript received on September, 2013.
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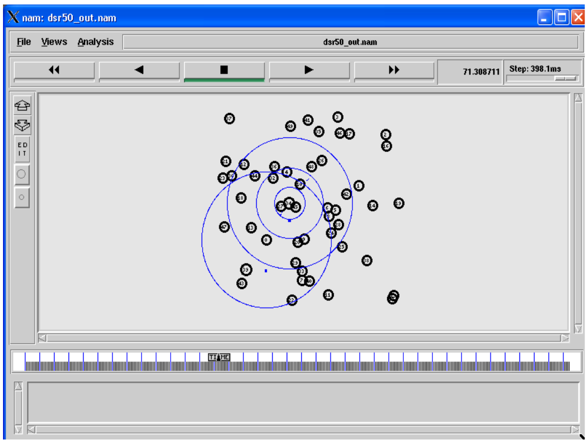

Fig. 1. Simulation Environment consisting 50 wireless nodes forming an ad-hoc network

We run our simulations with movement patterns generated for 5 different pause times: 0, 50, 100, 150 and 200 seconds. A pause time of 0 seconds corresponds to continuous motion and a pause time of 200 seconds (the length of the simulation) corresponds to no motion. Table 1 provides the simulation parameters.

TABLE I
TYPICAL SIMULATION PARAMETERS

Parameter	Value
Maximum Speed	20 meters/second
Simulation Time	200 seconds
Environment Size	670 meter x 670 meter
Packet Size	512 bytes
Traffic Type	CBR (Constant Bit Rate)
Packet Rate	4 packets/second
Mobility Model	Random Way Point
CBR sources	10

B. *Movement Model*

Nodes in the simulation move according to a model that we call the random waypoint model. The movement scenario files we used for each simulation are characterized by a pause time. Each node begins the simulation by remaining stationary for pause time seconds. It then selects a random destination in the 670 X 670 meter space and moves to that destination at a speed distributed uniformly between 0 and maximum speed. Upon reaching the destination, the node pauses again for pause time seconds, selects another destination, and proceeds there as previously described, repeating this behaviour for the duration of the simulation.

C. *Performance Metrics*

We chose following performance metrics to compare the performance of the routing protocols as defined by the RFC 2501 Mobile Ad-hoc Networking (MANET): Routing Protocol Performance Issues and Evaluation Considerations [16]:

Throughput: It is defined as the total number of packets received by the destination. Throughput is a measure of effectiveness of a protocol.

Packet delivery fraction: It is ratio of the data packets delivered to the destination to those generated by the CBR sources. Packet delivery fraction is a measure of efficiency of the protocol.

Average end-to-end delay: It is the average amount of time taken by the packet to go from source to destination. Delay is an important metric which is very significant with multimedia and real-time traffic.

Routing overheads: It is the total number of routing packets transmitted during the simulation. To achieve a given level of data routing performance, two different protocols can use differing amounts of overhead, depending on their internal efficiency and thus protocol efficiency may or may not directly affect data routing performance.

Packets lost: It is the measure of number of packets dropped by the routers due to various reasons.

III. RESULTS AND DISCUSSIONS

Simulations have been conducted with varying different network parameters in order to comprehensively measure the performance of the protocols.

A. *Varying Mobility*

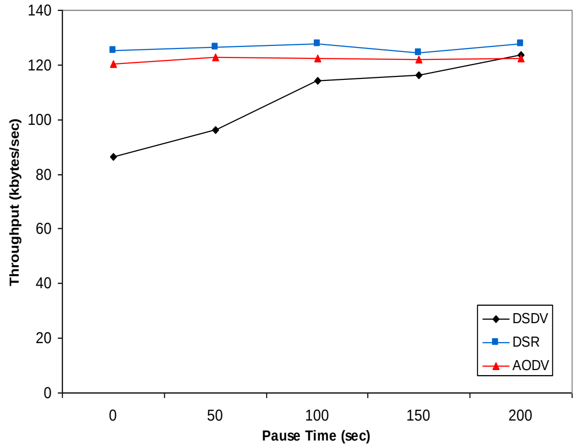

Fig. 2. Throughput vs. node mobility rate (pause time)

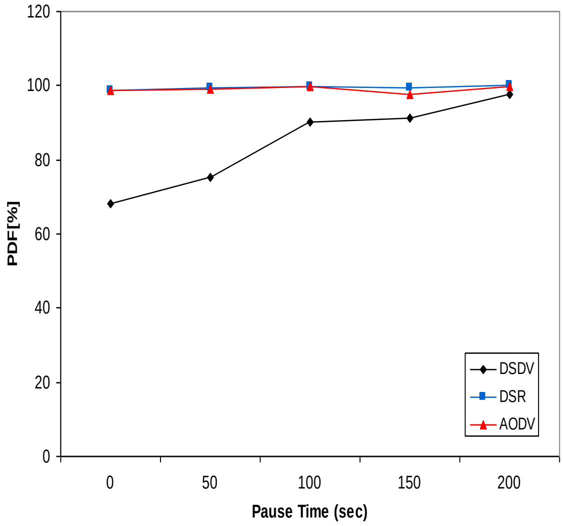

Fig. 3. PDF vs. node mobility rate (pause time)

We observe that DSR outperforms other protocols by delivering maximum throughput of 125 kbytes/second, as shown in Fig. 2. All protocols achieve 100% throughput at low mobility. AODV and DSR maintain constant throughput regardless of the mobility rate. DSDV has difficulties in finding routes when mobility increases. DSDV initially shows throughput of 86.36 kbytes/second at pause time of 0 second, but increases to 123.66 kbytes/ second as the pause time increased to 200 seconds.

All the three protocols DSDV, DSR and AODV deliver a greater percentage of the originated data packets at low node mobility (i.e., at large pause time), converging to 100% delivery of packets when there is no node motion (Fig. 3). DSR and AODV perform particularly well, delivering over 98% of the data packets regardless of mobility rate. At higher rates of mobility (lower pause times), DSDV does poorly, dropping to a 68% packet delivery ratio.

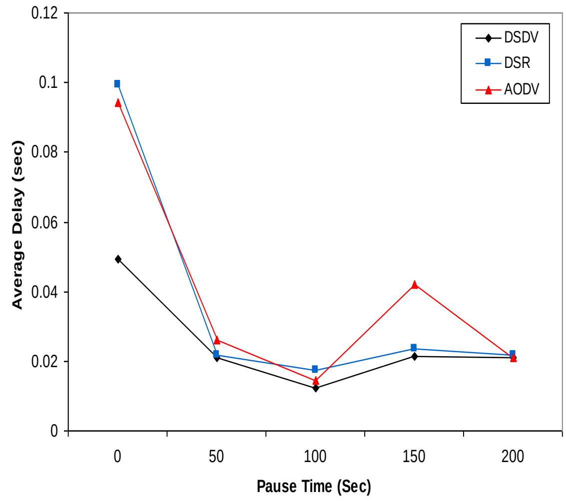

Fig. 4. Avrg .E-E Delay vs. node mobility rate (pause time)

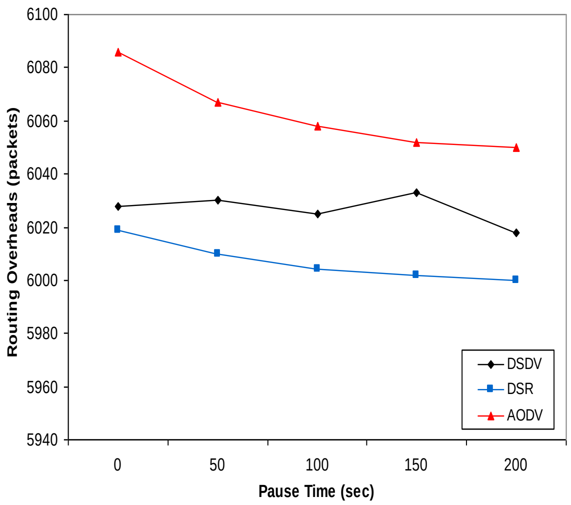

Fig. 5. Routing overheads vs. node mobility rate (pause time)

The average packet delay increases with mobility for all the three protocols as shown in Fig. 4. DSDV shows shortest end-to-end delay of the order of 0.02 seconds when the nodes are in motion because only packets belonging to valid routes at the sending instant get through. The source routing protocols have a longer delay of 0.09 seconds at pause time of 0 second, but gradually decreases to 0.02 second as pause time reaches 200 seconds because their route discovery takes more time as every intermediate node tries to extract information before forwarding the reply.

Fig. 5 shows that routing overhead for source routing protocols decreases as the mobility decreases. AODV shows greater overheads than DSR among source routing protocols because AODV broadcasts periodic HELLO messages to its neighbors and needs to send control messages more frequently to find and repair routes. DSDV imposes a constant overhead to the network at all pause times because of the periodic nature of the routing updates.

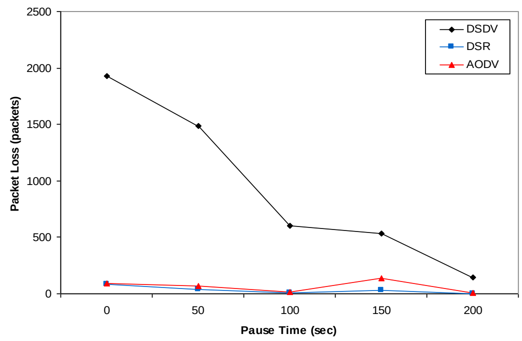

Fig. 6. Packet Loss as a function of node mobility rate (pause time)

The number of packets lost is quite high initially for DSDV dropping 1929 packets at 0 pause time (Fig. 6) because of high movement of nodes but packet loss falls to 142 packets as pause time reaches 200 seconds. It is clear from here that the performance of DSDV mainly depends upon pause time because if the pause time of nodes is quite low then it has to maintain and update the routing information in the routing tables and hence during broadcast of information about a particular node there is a considerable amount of packet loss. For source routing protocols, DSR and AODV, packets lost are quite low dropping 82, 90 packets, respectively at 0 pause time and shows zero packet loss at pause time of 200 seconds.

B. *Varying Maximum Speed*

Mobility of the nodes basically shows how fast the nodes are moving. Simulations are conducted with movement patterns generated for 5 different maximum speeds: 1, 2, 5, 10, 20, and 50 meters/second. We have considered a wide range of speeds for our mobile nodes from 1 meters/second (3.6 kilometers/hour) that corresponds to walking at a slow pace, to 50 meters/second (180 kilometers/hour), the speed of a very fast car.

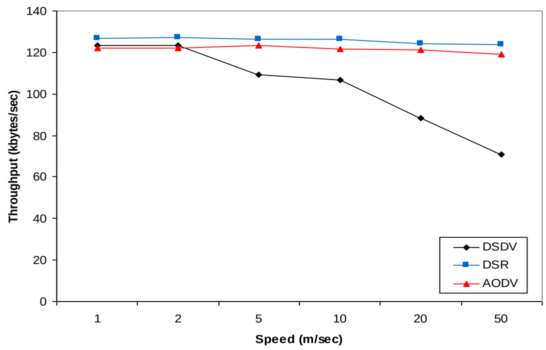

Fig. 12. Throughput vs. maximum speed

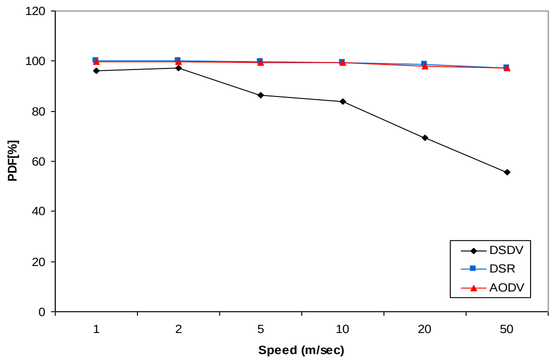

Fig. 13. PDF vs. maximum speed

For source routing protocols DSR and AODV, throughput is independent of the change in maximum speed of nodes (Fig. 12). Where as DSDV suffers decrease in the throughput to 70 kilobytes/second at highest speed of 50 meters/second because of frequent link changes and connection failures.

It is observed that AODV and DSR perform particularly well delivering 100% of the packets irrespective of their node speeds (Fig. 13). DSDV delivers 97% of the packets at low speed but indicates drop in packet delivery ratio upto 55% at higher speeds because of frequent link changes and connection failures.

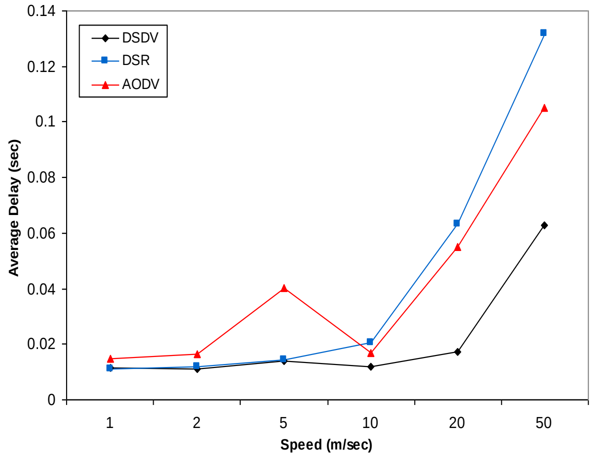

Fig. 14. Avrg. E-E Delay vs. maximum speed

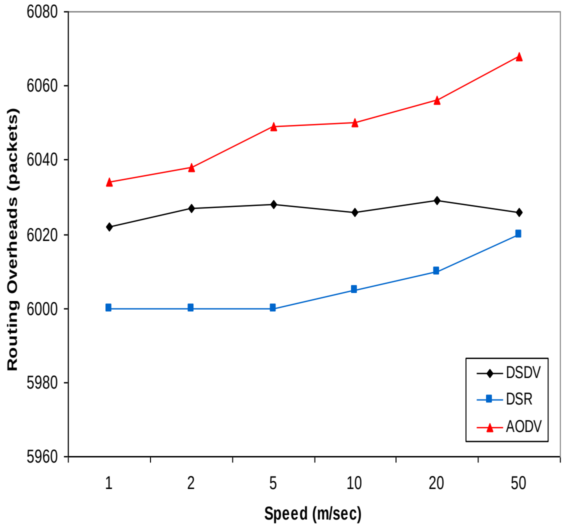

Fig. 15. Routing overhead vs. maximum speed

Fig. 14 shows average end-to-end delay of the three routing protocols as a function of maximum speed. The graph indicates that increase in node speeds results in significant increase in the average end-to-end delay of all protocols. Delay introduced in DSDV is least of the order of 0.01141 seconds but shows considerable increase upto 0.06296 seconds as the speed approaches 50 meters/second. The source routing protocols have a longer delay because their route discovery takes more time as every intermediate node tries to extract information before forwarding the reply. DSR shows delay of 0.01112 seconds at lowest speed of 1meter/second and delay increases upto 0.13183 seconds as the speed approaches 50 meters/second. Whereas AODV shows 0.0146 seconds of delay at lowest speed of 1m/sec and delay increases upto 0.10512 seconds as the speed approaches 50 meters/second.

DSDV presents constant routing overhead regardless of the change in the speed (Fig. 15). However, for DSR and AODV the routing overhead increases with the increase in speed. AODV experiences maximum overheads, transmitting 6068 packets as the speed approaches 50meters/second.

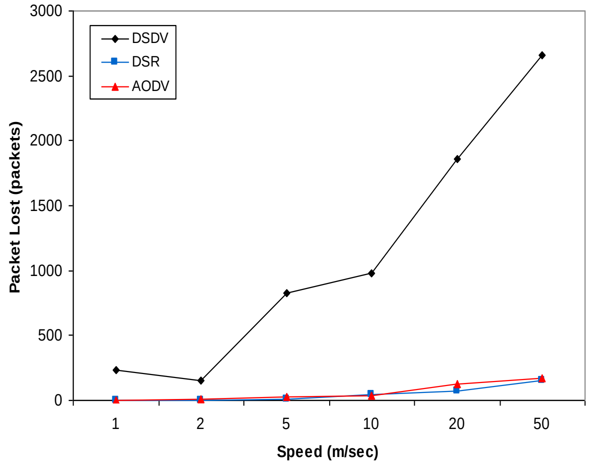

Fig. 16. Packet Loss as a function of maximum speed

Source routing protocols DSR and AODV shows zero packets lost at lowest speed of 1meter/second but shows increase of nearly 150 packets in the number of packets lost with the increase in speed (Fig. 16). DSDV shows drastic increase in the packets lost of the order of 2661 packets as the speed approaches 50meters/second. We observe that even with increased node movement the performance of DSR and AODV protocol is quite high and is better in comparison to DSDV.

IV. CONCLUSION

We compared performance of routing protocols DSR, AODV and DSDV for mobile ad-hoc networks considering UDP as transport protocol and CBR as traffic generator. Our simulations have shown that performance of a routing protocol varies widely across different performance differentials. The simulations clearly shows that the conventional protocols like DSDV have a drastic effect on their performance as the mobility of the nodes and maximum speed of nodes increases so they may not be suitable for the Ad-hoc environments with high mobility and high speed scenarios. Results indicate that reactive protocols AODV and DSR performed significantly better than DSDV regardless of the mobility rates and movement speeds. But it is observed that the overheads of DSR increase with the increase in network size, hence decreasing its performance. If we compare among source routing protocols DSR and AODV, it is observed that DSR performs better than AODV for low traffic loads, since it discovers routes more efficiently. Thus, the results of the simulations show that there is a need of special routing protocol for Ad-hoc networks and the existing protocols doesn't cope with the demanding needs.

So we can conclude that DSR and AODV outperforms DSDV for the CBR based traffic when we talk about the Ad-hoc networking environments and hence DSR and AODV could be used as a base protocol when we talk of developing a new protocol for Ad-hoc networks and the future research must be focused on improving the DSR for making a standard for the Ad-hoc networks.

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