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Performance Analysis of AODV, DSR & DSDV Protocol by Varying Mobility, Speed and Network Load

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Abstract— A Mobile Ad-Hoc Network (MANET) is a self-configuring network of mobile nodes connected by wireless links to form an arbitrary topology without the use of existing infrastructure. In MANET, the nodes are free to move randomly and the network's wireless topology may be unpredictable and may change rapidly. Thus, routing becomes a challenging task. The communication within the network is facilitated through a protocol which discovers routes between nodes. A variety of routing protocols with varying network conditions are analyzed to find an optimized path from a source to destination. In this paper, performance of three popular mobile Ad-hoc network routing protocols: AODV, DSR and DSDV are analyzed by variation in Speed, Mobility and Network Load based on different network metrics such as Throughput, Packet Delivery Fraction (PDF) and Number of Packets Dropped.

Keywords — AODV, CBR, DSDV, DSR, MANETs, PDF, Pause Time, Speed, Throughput.

I. INTRODUCTION

Wireless communication networks are either infrastructure based networks or Ad-hoc networks: Infrastructure based networks uses fixed base stations which are responsible for coordinating communication between the mobile hosts. Ad-hoc network consists of mobile nodes which communicate with each other through wireless medium without any fixed infrastructure. A mobile ad-hoc network (MANET) is basically called as a network without any central administration or fixed infrastructure. It consists of a number of mobile nodes that use to send data packets through a wireless medium. There is always a need of a good routing protocol in order to establish the connection between mobile nodes since they possess the property of dynamic changing topology. The routing protocols should minimize the computing load and traffic overhead for each node in the network. The traditional routing protocols such as link- state or distance vector are not suitable for Ad-hoc networks as they are aimed at finding optimal routes to every host in the network. In MANETs routing protocols play a major role to find routes for packet transfer and make sure that the packets are reached to the correct destination. Several routing protocols for MANETs have been proposed and their performance under various network situations and traffic conditions has been considered. Routing protocols are broadly categorized as: proactive and reactive. Proactive or table-driven protocols attempt to maintain consistent up-to-date routing information from each node to every other node in the network. Each node maintains tables to store routing information, and any changes in network topology need to be reflected by propagating updates throughout the network. Proactive Routing Protocol are: Wireless Routing Protocol (WRP), Destination-Sequenced Distance Vector (DSDV) routing protocol, Optimized Cluster Head Gateway Routing (CGSR). Reactive or on demand protocols are based on source- initiated on-demand reactive routing. If a node wants to send a packet to another node then this protocol searches for the route in an on-demand manner and establishes the connection in order to transmit and receive the packet. Then, it initiates a route discovery process, which ends when the route is found. Various Types of reactive based Routing Protocols are: Dynamic Source Routing (DSR) protocol, Ad-hoc On-demand Distance Vector (AODV) protocol, Temporally Ordered Routing Algorithm (TORA).

A. Destination Sequenced Distance Vector (DSDV)

In DSDV, every mobile station maintains a routing table that lists all available destinations, the number of hops to reach the destination and the sequence number assigned by the destination node. The sequence number is used to distinguish stale routes from new ones and thus avoid the formation of loops. The stations periodically transmit their routing tables to their immediate neighbors. A station also transmits its routing table if a significant change has occurred in its table from the last update sent.

B. Ad-hoc On-Demand Distance Vector (AODV)

The Ad-hoc On-Demand Distance Vector (AODV) minimizes the number of required broadcasts by creating routes in an on-demand manner. When a source node desires to send data to other destination node, it needs to initiate a path discovery process to locate the other node. A source node broadcasts a route request (RREQ) packet to its neighbors, which then forward the request to their neighbors, and so on, until the destination is located. Once the RREQ reaches the destination, the destination node responds a route reply (RREP) packet back to the source node with the best possible. Hence, all the nodes participating at route discovery process will have the ability to update their routing tables accordingly.

C. DSR (Dynamic Source Routing)

In DSR, a node maintains route caches containing the source routes. The node updates entries in the route cache as and when it learns about new routes. The two major phases of the protocol are: route discovery and route maintenance. When the source node wants to send a packet to a destination, it looks up its route cache to determine if it already contains a route to the destination. If it finds that an unexpired route to the destination exists, then it uses this route to send the packet. But if the node does not have such a route, then it initiates the route discovery process by broadcasting a route request packet. The route request packet contains the address of the source and the destination, and a unique identification number. Each intermediate node checks whether it knows of a route to the destination. If it does not, it appends its address to the route record of the packet and forwards the packet to its neighbors. A route reply is generated when either the destination or an intermediate node with current information about the destination receives the route request packet. If the route reply is generated by the destination then it places the route record from route request packet into the route reply packet. On the other hand, if the node generating the route reply is an intermediate node then it appends its cached route to destination to the route record of route request packet and puts that into the route reply packet.

This paper is organized as follows: Section II discusses about the related work in this field. Section III described the performance analysis of AODV, DSR, DSDV protocols. Section IV discusses about simulation parameters and shows the evaluated results based on these parameters. Section V brings the conclusion and future scope of the paper.

II. RELATED WORK

There are numerous papers [8, 9, 4, 12, 14, 6] related to the performance evaluation of routing protocols in MANETs.

Das M. et al. [8] analyzed performance of AODV protocol affected due to change in mobility. It is observed from the detailed analysis that the PDF is less when network load is high and PDF is high when load is less. The cause of lower PDF at higher load is high packet drop at network interface due to overflow.

Panda B.K. et al. [9] analyzed performance of AODV and DSR protocol affected due to change in mobility. From the analysis it is observed that the PDF is more in AODV routing protocol than DSR routing protocol at high mobility condition and the PDF will increase when Mobility will decrease. The End-to End delay is more in AODV routing protocol than DSR routing protocol at high mobility condition and almost equal in low mobility.

Harpal et al. [4] evaluates the performance of AODV & DSR protocols based upon Manhattan Grid (MG) Mobility Model with varying Speed of the mobile nodes in two different traffic Patterns: CBR and an Exponential Traffic Pattern. It is observed from results that performance of an Exponential traffic pattern in Manhattan Grid mobility model is better than the CBR traffic pattern and AODV gives better results in throughput and DSR in PDF and normalized routing load with exponential traffic pattern.

Ambhaikar A. et al. [12], compared the performance of AODV, DSDV and DSR protocols using two different parameters Throughput and No. of Dropped Packets. They found AODV and DSR are performing better as compared to DSDV. Performance of DSR is better among AODV, DSR and DSDV in case of average throughput and number of dropped packets for increasing speed with varying terrain range.

Yadav, N.S. et al. [14] compared the two ad hoc routing protocols. AODV and DSDV in terms of PDF, normalized routing load and average delay, while varying number of nodes, and speed. It is found that PDF of both the protocols decreases as speed increases, but DSDV's PDF decreases in a steeper and more rapid fashion. AODV has less Average End-to-End Delay when compared to DSDV. The normalized routing load for AODV increases drastically as the number of nodes increases. The routing load also increases as the node mobility increases. But for DSDV the normalized routing load is almost the same with respect to node speed

Perti, A. et al. [6], evaluated the dynamic source routing protocol performance based on the different parameters such as throughput, PDF, packet dropped, and routing overhead and end to end delay. It is observed from results that the performance of DSR which uses source routing is it delivers more packets at the destination with lowest routing overhead.

III. PERFORMANCE ANALYSIS OF AODV, DSR AND DSDV PROTOCOL

The proposed work is carried by using simulator NS2.35 by taking three scenarios. In the first scenario, Speed and Number of mobile nodes is kept unchanged & Pause time is varied. In the second scenario, Pause time and Number of mobile nodes is kept unchanged & Speed is varied. The third scenario deals with the network density to determine how the Ad-hoc routing protocols perform against various network loads. In this scenario, Speed and Pause time is kept unchanged & Number of mobile nodes is varied. CBR sources are roughly taken as one-third of the number of nodes to maintain consistency. The following metrics are used to evaluate the performance of our proposed approach:

Throughput: Throughput is defined as the number of packets successfully transferred from sender to the receiver per unit time.

$$Throughput = \frac{\text{No. of bits received x 8}}{Simulation\ time\ x\ 1000}\text{Kbps}$$

Packet Delivery Fraction (PDF): This is the ratio of the number of data packets successfully delivered to the receiver to those generated by the sender.

$$PDR = \frac{\text{No. of packet recieved}}{\text{No. of packet sent}} \times 100$$

Drop Packet: Packet Loss is the difference between the number of data packets sent and the number of data packets received. It is calculated as follows:

PL=Number of data packets sent - No. of data packet received

IV. SIMULATION RESULTS AND DISCUSSIONS

All the work was performed on Network Simulator-2.35 and we set simulation parameter like Simulation time, Simulated area, Packet Size, Traffic Type, Packet Rate, CBR sources, Speed, Pause Time, Number of mobile nodes. The simulation described in this paper was tested using the NS-2 set test that allows users to create dynamic network topologies. By changing the logical topology of the network, NS-2 users can conduct tests in an Ad-hoc network without having to physically move the nodes. NS-2 controls the test scenarios through a wired interface, while the Ad-hoc nodes communicate through a wireless interface.

The first and the second simulation environment consists of 50 nodes forming an Ad-hoc network, moving over a 670 meter by 670 meter flat space for 200 seconds of simulation time. The number of CBR sources used in these two simulation environments is kept as 10. In the third simulation environment, the scalability of the networks is measured by varying the load of the network.

Table 1: Simulation Scenario I

Parameters	**Values**
Simulation Time(seconds)	200
Simulation Area	670x670
Packet Size(bytes)	512
Traffic type	CBR
Packet rate	4 packets/second
Mobility model	Random Way-point model
CBR sources	10
Speed	20 m/s
Pause Time	0,50,100,150,200
Protocols	AODV,DSR,DSDV
Number of mobile nodes	50

Table 1 shows the simulation parameters used in phase 1 of the research. In this simulation, the number of mobile nodes is kept constant at 50 and the pause time of the nodes is varied.

Table 2: Simulation Scenario II

Parameters	**Values**
Simulation Time(seconds)	200
Simulation Area	670x670
Packet Size(bytes)	512
Traffic type	CBR
Packet rate	4 packets/second
Mobility model	Random Way-point model
CBR sources	10
Speed	1,2,5,10,20,50 m/s
Pause Time	0
Protocols	AODV,DSR,DSDV
Number of mobile nodes	50

Table 2 shows the simulation parameters used in phase 2 of this research. In this simulation, the number of nodes is kept constant at 50 and the speed of the nodes is varied.

Table 3: Simulation Scenario III

Parameters	**Values**
Simulation Time(seconds)	200
Simulation Area	670x670
Packet Size(bytes)	512
Traffic type	CBR
Packet rate	4 packets/second
Mobility model	Random Way-point model
CBR sources	One-third of the nodes

Speed	20 m/s
Pause Time	0
Protocols	AODV,DSR,DSDV
Number of mobile nodes	20,40,60,80,100

Table 3 shows the simulation parameters used in phase 3 of this research. In this simulation, the number of nodes has been varied from 20 nodes to 100 nodes so that a small, medium and a large network can be simulated. Since the number of nodes is varied, the number of CBR sources is also changed. So the number of CBR sources is 40 roughly taken as one-third of the total number of nodes to maintain consistency in traffic. The speed is kept at 20 meters/second and pause time at 0 seconds to simulate maximum mobility variance.

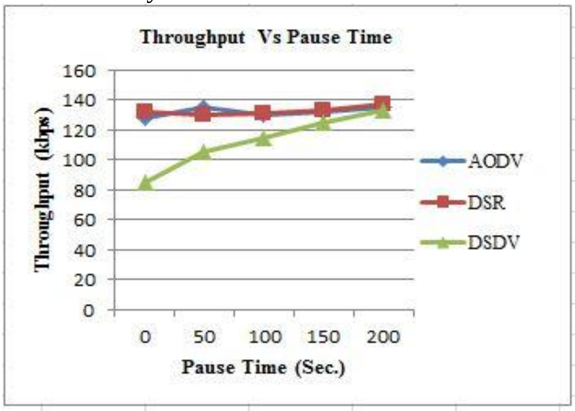

Figure 1: Throughput Vs Pause Time

Figure 1 shows the throughput of AODV, DSDV and DSR protocols with constant speed and number of mobile nodes and varying pause time from 0 to 200 Seconds. X-axis represents Pause time & Y-axis represents Throughput. Experimental results shows that DSDV does not have a significantly higher throughput when mobility is high but when mobility decreases, performance of DSDV gets better and results also shows that AODV and DSR maintains consistency in varying mobility and performs better than the proactive protocol DSDV.

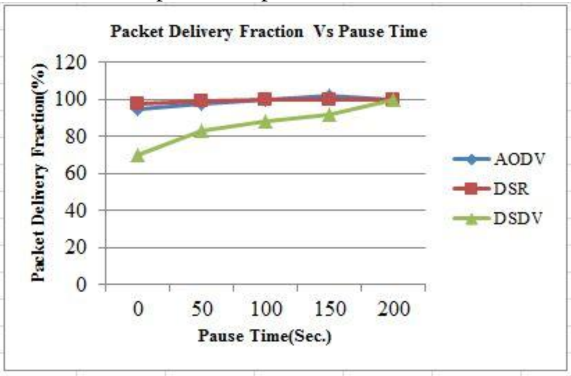

Figure 2: Packet Delivery Fraction Vs Pause Time

Figure 2 shows the packet delivery fraction of AODV, DSDV and DSR protocols with constant speed and number of mobile nodes and varying pause time from 0 to 200 Seconds. X-axis represents Pause time & Y-axis represents Packet Delivery Fraction. Experimental results shows that performance of DSDV drops down to as low as 70% at higher mobility and AODV and DSR's packet delivery fraction proves better performance compared to DSDV protocol.

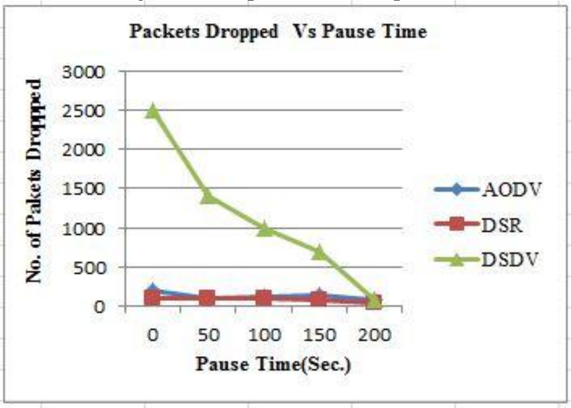

Figure 3: Packets Dropped Vs Pause Time

Figure 3 shows the Number of packets dropped of AODV, DSDV and DSR protocols with constant node speed and number of mobile nodes and varying pause time from 0 to 200 Seconds. X-axis represents Pause time & Y-axis represents No. of Packets Dropped. Experimental results show that DSR performed more efficient than AODV and DSDV because only 97 packets are dropped at maximum mobility. The result also shows that DSDV performed worst because the number of dropped packets was close to 2514 at maximum mobility and when the mobility is decreased, DSDV performs well because the nodes get enough time to update the routing tables.

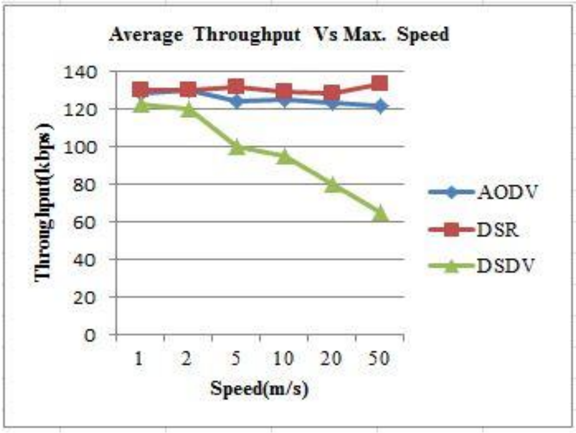

Figure 4: Throughput Vs Speed

Figure 4 shows the throughput of AODV, DSDV and DSR protocols with constant pause time and number of mobile nodes and varying node speed from 1 to 50 m/s. X-axis represents Speed & Y-axis represents Throughput. Experimental results shows that DSR gives maximum and consistent throughput because the average speed of 131 kbps which is higher than AODV (129 kbps). The result also shows that DSDV suffers decrease in throughput close to 68 kbps at maximum speed (5 meters/sec). This is because of frequent link changes and connection failures.

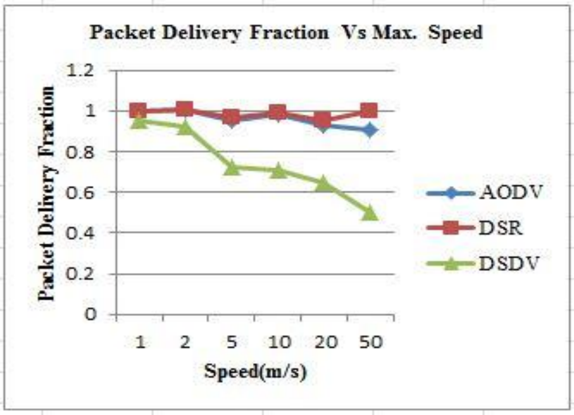

Figure 5: Packet Delivery Fraction Vs Speed

Figure 5 shows the packet delivery fraction of AODV, DSDV and DSR protocols with constant pause time and number of mobile nodes and varying node speed from 1 to 50 m/s. X-axis represents Speed & Y-axis represents Packet Delivery Fraction. Experimental results that DSR again outperforms all the protocols at all speeds maintaining a packet delivery fraction close to 100% and AODV's performance is comparable to DSR delivering almost 98% of the packets. The results also shows that DSDV delivers close to 96% of the packets at low speed but could not keep the same rate with the increase in speed because of its frequent link changes and connection failures. Packet delivery in DSDV drops to as low as 51% in high speed.

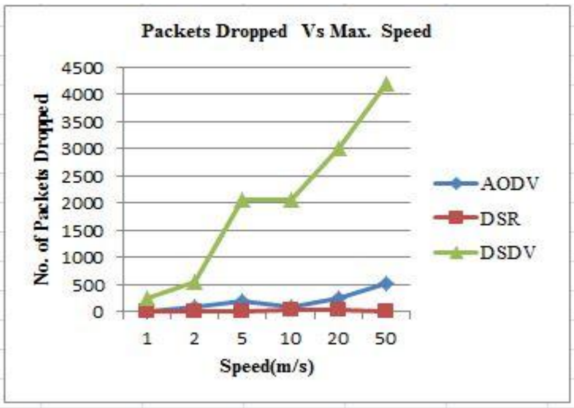

Figure 6: Packets Dropped Vs Speed

Figure 6 shows the Number of packets dropped of AODV, DSDV and DSR protocols with constant pause time and number of mobile nodes and varying node speed from 1 to 50 m/s. X-axis represents Speed & Y-axis represents No. of Packets Dropped. An experimental result shows that DSR once again shows optimum results with the number of dropped packets being significantly low. Even high speed, DSR is able to maintain a low drop rate because of its efficiency in its dynamic routing algorithm. The results also shows that AODV performed well in low speed but as the speed increased, the number of dropped packets also increased and DSDV once again failed to perform well in high speed as the number of dropped soared well above 4000 at a maximum speed of 50 meters/second.

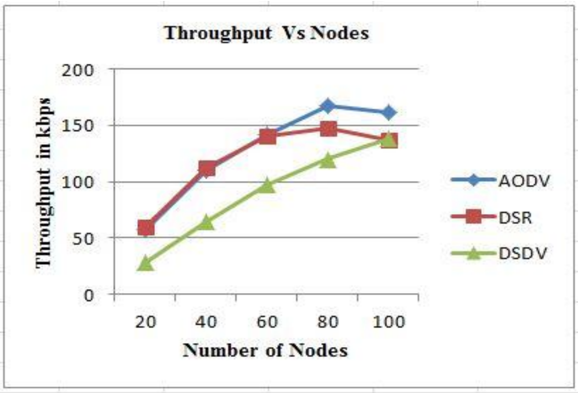

Figure 7: Throughput Vs Numbers of Mobile Nodes

Figure 7 shows the throughput of AODV, DSDV and DSR protocols with constant pause time and node speed and varying number of mobile nodes from 20 to 100. X-axis represents Number of mobile nodes & Y-axis represents Throughput. . Experimental results shows that AODV performs the best compared to the other protocols with a peak throughput of 167.5 kbps. The result also shows that DSR could not sustain the performance at higher network load and DSDV significantly has lower performance because of frequent link changes and connection failures.

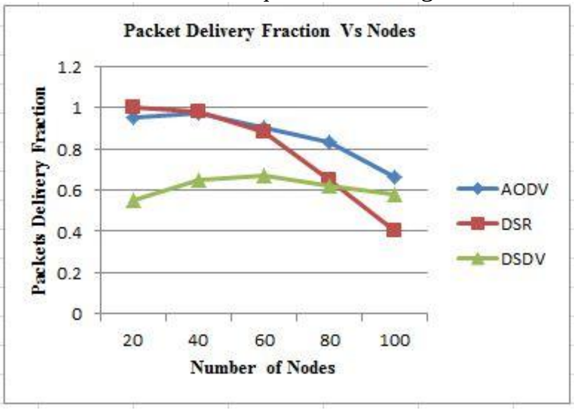

Figure 8: PDF Vs Number of Mobile Nodes

Figure 8 shows the packet delivery fraction of AODV, DSDV and DSR protocols with constant pause time and node speed and varying number of mobile nodes from 20 to 100. X-axis represents No. of mobile nodes & Y-axis represents Packet Delivery Fraction. Experimental results shows that DSR has a peak packet delivery fraction of close to 100% when it is a small network i.e. number of nodes is 20. But as the load is increased, the performance degrades. For a large network scenario (100 nodes), packet delivery comes down to as low as 39% which shows that DSR does not perform well when the network size is complex. The results also shows that AODV shows better performance in small and large networks and DSDV has a low packet delivery fraction throughout the different scale of networks but it has a certain kind of consistency.

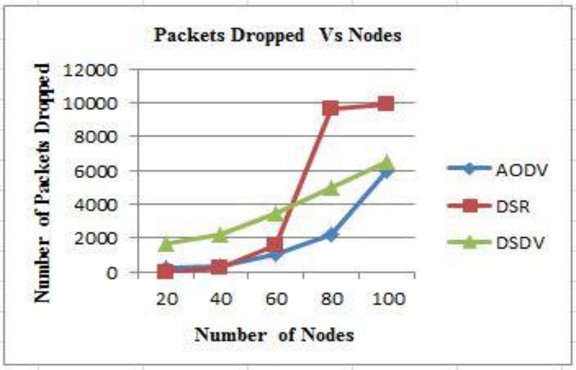

Figure 9: Packets Dropped Vs Number of Mobile Nodes

Figure 9 shows the No. of packet dropped of AODV, DSDV and DSR protocols with constant pause time and node speed and varying number of mobile nodes 20 to 100. X-axis represents No. of mobile nodes & Y-axis represents No. of Packets Dropped. Experimental results that all the protocols are vulnerable to large networks as more number of packets started dropping after 60 nodes. DSDV started dropping packets as many as 1542 even in small scale networks and more than 6700 packets in large scale networks. The results also shows that DSR performs better in small network but lose as many as 9800 packets when the size of the network is increased and for large networks, AODV lost close to 5900 packets.

V. CONCLUSIONS

In this paper, performance of the three most widely used protocols – AODV, DSDV and DSR have been evaluated under different conditions of mobility, speed and network load. The experimental results have shown that DSR has the optimum performance in terms of mobility and speed and small scale networks. Performance of DSR protocol is less when the load in the network is increased. AODV has shown consistent results irrespective of the network load, speed and mobility. It fails to outperform DSR in small scale networks but maintains its superior performance even in large scale networks. DSDV perform good only in small scale networks and when the mobility is low. Hence it is concluded that DSR is the first preference in terms of small scale networks with any mobility or speed and AODV is considered when the load of the network is increased.

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