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SIMULATION BASED PERFORMANCE ANALYSIS OF ROUTING PROTOCOLS USING RANDOM WAYPOINT MOBILITY MODEL IN MOBILE AD HOC NETWORK

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Simulation Based Performance Analysis of Routing Protocols Using Random Waypoint Mobility Model in Mobile Ad Hoc Network

Santosh Kumar[1], SC Sharma[2], Bhupendra Suman[3]

Abstract: A mobile ad hoc network is collection of self-configuring and adaption of wireless link between communicating devices (mobile devices) to form an arbitrary topology without the use of existing infrastructure. In wireless network technology, simulative analysis is a significant method to understand the performance of routing protocol. In this paper an attempt has been made to compare the performance of two prominent on-demand reactive routing protocols for mobile ad hoc networks: DSR and AODV, along with the traditional proactive DSDV protocol. The On-demand protocols, AODV and DSR perform better under high mobility simulations than the table-driven DSDV protocol.Although DSDV perform well with respect to all included performance matrices in the paper if it has no constraints of bandwidth. The performance differentials are analyzed using varying network load, mobility, and network size.

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I. Introduction

A Mobile ad hoc network (MANET), sometimes called a mobile mesh network, is a self-configuring network of mobile devices connected by wireless links. Each device in a MANET is free to move independently in any direction, and will therefore change its links to other devices frequently [1, 2]. Each must forward traffic unrelated to its own use, and therefore be a router. MANET nodes are equipped with wireless transmitters and receivers using antennas, which may be Omni directional (broadcast), highly directional (point-to-point), possibly steerable, or some combination thereof. Routing protocols occupied to determine the routes subsequent to a set of rules that enables two or more devices to communicate with each other's. In the mobile ad-hoc networks routes are enabled in between the nodes in multi-hop fashion, as the propagation range of the wireless radio is limited. A good routing protocol should minimize the computing load on the host as well as the traffic overhead on the Network. This paper has an outline of protocol evaluation that highlight performance metrics that can help promote meaningful comparisons and assessments of protocol performance.

Routing protocols in mobile networks are subdivided into two basic classes-

- Proactive routing protocols
- Reactive routing protocols

The proactive routing protocols are also called table-driven protocols it maintains the routing information of the all participant nodes and update their routing information frequently irrespective of the routing request. This makes it bandwidth scarce though the routing is simple with prior updated routing information. They usually use link-state routing algorithms flooding the link information [3, 4]. Link-state algorithms maintain a full or partial copy of the network topology and costs for all known links. Examples include the Destination-Sequenced Distance Vector (DSDV) protocol [5, 6]. The reactive routing protocols create and maintain routes only if these are needed, on demand. It uses connection establishment process for communication. These protocols usually use distance-vector routing algorithms that keep only information about next hops to adjacent neighbours and costs for paths to all known destinations. Some pitfalls of reactive protocols are high latency in searching the network and also in finding the routes if there is excessive flooding over the network with route request it may cause network clogging .Examples include the Ad hoc On Demand Distance Vector (AODV) protocol and Dynamic Source Routing (DSR) protocol [7, 8, 9]. Section 2 describes ondemand routing protocols, section 3 describes table-driven protocol, section 4 describes simulation model, section 5 describes performance evaluation & simulation results and section 6 describes conclusion of the paper.

II. The On-Demand Routing Protocols

In this section, paper investigates the on demand routing protocols. The basic idea of these algorithms is

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to find and maintain a route only when it is used for communication.

1) *AODV (AD-HOC On-Demand Distance Vector)*

AODV is a routing protocol for mobile ad hoc networks and other wireless ad-hoc networks. This protocol is capable of both unicast and multicast routing [4, 10]. In AODV, the network is silent until a connection is needed. At that point the network node that needs a connection broadcasts a request for connection. Other AODV nodes forward this message, and record the node that they heard it from, creating an explosion of temporary routes back to the needy node. When a node receives such a message and already has a route to the desired node, it sends a message backwards through a temporary route to the requesting node. The needy node then begins using the route that has the least number of hops through other nodes. Unused entries in the routing tables are recycled after a time. When a link fails, a routing error is passed back to a transmitting node, and the process repeats. Each request for a route has a sequence number. Nodes use this sequence number so that they do not repeat route requests that they have already passed on. AODV requires more time to establish a connection, and the initial communication to establish a route is heavier than some other approaches.

2) *DSR (Dynamic Source Routing)*

DSR is a simple and efficient routing protocol designed specifically for use in multi-hop wireless ad hoc networks of mobile nodes. The sender knows the complete hop by hop route to the destination. These routes are stored ina route cache [8, 9]. This protocol is composed of the two main mechanisms of "Route Discovery" and "Route Maintenance", which work together to allow nodes to discover and maintain routes to arbitrary destinations in the ad hoc network. Other advantages of the DSR protocol include easily guaranteed loop-free routing, support for use in networks containing unidirectional links, use of only "soft state" in routing, and very rapid recovery when routes in the network change. The DSR protocol is designed mainly to work well with very high rates of mobility.

III. Table-driven Protocol

There are few routing table-driven protocols discussed in the literature [4, 5, 6]. In a table-driven type of protocols, one needs periodically to determine the network topology. If any changes happen to the network, this information should be broadcasted, and all of the host in this network will run the route discovery again and store new routing information in the table. In general, when compared to on-demand protocols, table-drive protocols allocate one entry for each host of the whole network, instead of only the destinations of the packets. However, in table-driven protocols, any time when a route is needed, a route is already available in the table, therefore, table-driven can reduce the average delay per packet. This paper describes a destination sequenced distance vector (DSDV) protocol.

1) *DSDV (Destination Sequenced Distance Vector)*

DSDV is a table-driven routing scheme for ad hoc mobile networks based on the Bellman-Ford algorithm [5, 6]. The main contribution of the algorithm was to solve the routing loop problem. Each entry in the routing table contains a sequence number, the sequence numbers are generally even if a link is present; else, an odd number is used. The number is generated by the destination, and the emitter needs to send out the next update with this number. Routing information is distributed between nodes by sending full dumps infrequently and smaller incremental updates more frequently. If a router receives new information, then it uses the latest sequence number. If the sequence number is the same as the one already in the table, the route with the better metric is used. Stale entries are those entries that have not been updated for a while. Such entries as well as the routes using those nodes as next hops are deleted. DSDV requires a regular update of its routing tables, which uses up battery power and a small amount of bandwidth even when the network is idle. Whenever the topology of the network changes, a new sequence number is necessary before the network re-converges; thus, DSDV is not suitable for highly dynamic networks.

IV. Simulation Model

A detailed simulation model based on ns-2 is used in the evaluation. The Distributed Coordination Function (DCF) of IEEE 802.11 for wireless LANs is used as the MAC layer protocol.

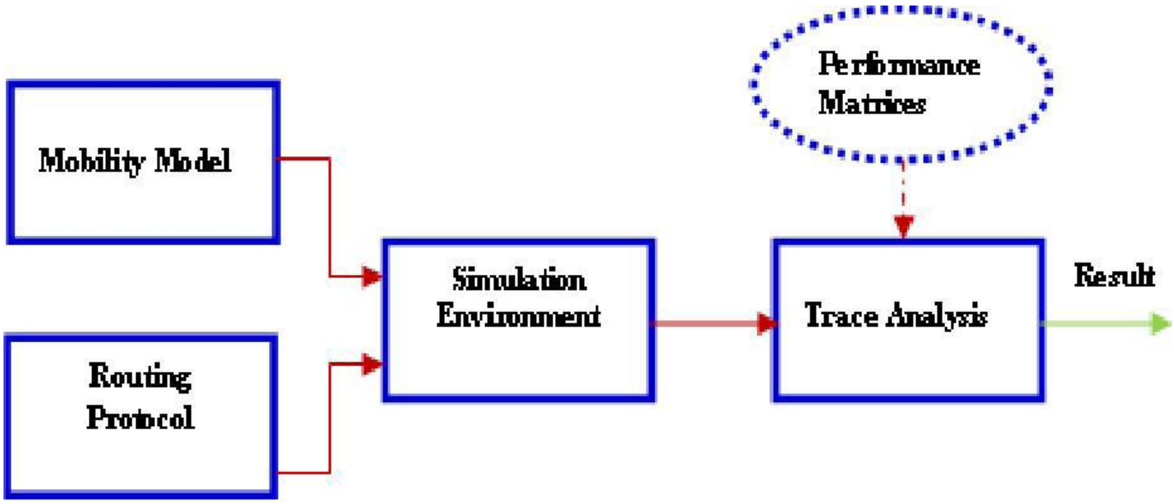

Figure: Implementation Method

1) *The Traffic and Mobility Models*

Constant bit rate (CBR) traffic sources are used. The sourcedestination pairs are spread randomly over the network. Only 512-byte data packets are used. The number of sourcedestination pairs and the packet-sending rate in each pair is varied to change the offered load in the network. The mobility model uses the random waypoint model in a rectangular field. The field configurations used is: 500 m x 500 m field with 10, 30 and 50 nodes. Here, each packet starts its journey from a random location to a random destination with a randomly chosen speed (uniformly distributed 20 m/s). The pause time, which affects the relative speeds of the mobiles, is varied. Simulations are run for 100 simulated seconds. Identical mobility and traffic scenarios are used across protocols to gather fair results.

2) *Performance Metrics*

This paper analyzed the following important performance metrics:

a) *Packet delivery fraction*

the ratio of the data packets delivered to the destinations to those generated by the CBR sources. It reflects the reliability of routing. Figure 3, 7 & 11 demonstrate pd-fraction among the protocols.

b) *Average end-to-end delay of data packets*

This includes all possible delays caused by buffering during route discovery latency, queuing at the interface queue, retransmission delays at the MAC, and propagation and transfer times. Figure 4, 8 and 12 depicts end-to-end delay among protocols.

c) *Normalized routing load*

The number of routing packets transmitted per data packet delivered at the destination. Each hop-wise transmission of a routing packet is counted as one Transmission. Figure 2, 6,& 10 explore normalized routing load among the protocols.

The first two metrics are the most important for best effort traffic. The routing load metric evaluates the efficiency of the routing protocol. However, that these metrics are not completely independent. For example, lower packet delivery fraction means that the delay metric is evaluated with fewer samples. In the conventional wisdom, the longer the path lengths, the higher the probability of a packet drops. Thus, with a lower delivery fraction, samples are usually biased in favour of smaller path lengths and thus have less delay.

I. *Generating Traffic and Mobility Models*

a) *Traffic model*

Random traffic connections of CBR have been established between mobile nodes using a traffic scenario generator script. The simulations carried out, traffic models were generated for10, 30 and 50 nodes with CBR traffic sources, with maximum connections of 8, 25, 40 at a rate of 8kbps.

b) *Mobility models*

Mobility models were created for the simulations using 10,30 and50 nodes, with pause times of 0, 10,20,30,40, 50, 60, 70 and100 seconds, maximum speed of 20m/s, topology boundary of 500x500 and simulation time of 100secs

V. Performance Evaluation & Simulation Results

In this paper, an attempt was made to compare all the three protocols under the random way mobility scenario. For all the simulations, the same movement models were used, the number of traffic sources was fixed at 10, 30 and 50, the maximum speed of the nodes was set to 20m/s, the pause time was varied as 0, 10, 20, 30 40, 50, 60, 70, 100s, and a fixed topology boundary of 500x500. The On-demand protocols, DSR and AODV performed particularly well, delivering over 85% of the data packets regardless of mobility rate. The average end-to-end delay of packet delivery was higher in both DSR and AODV as compared to DSDV. Routing overhead of DSDV is approximately constant at varying pause time from beginning and end of the simulation as compared to the AODV and DSR. As no. of sources increases at certain limit, it results that the DSDV perform well with respect to all included performance matrices as compared to AODV and DSR.

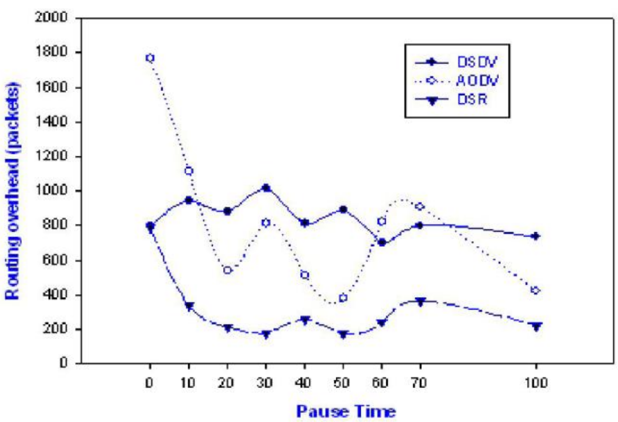

Fig.1 Pause Time vs routing overhead (packets)-Fixed 10 nodes

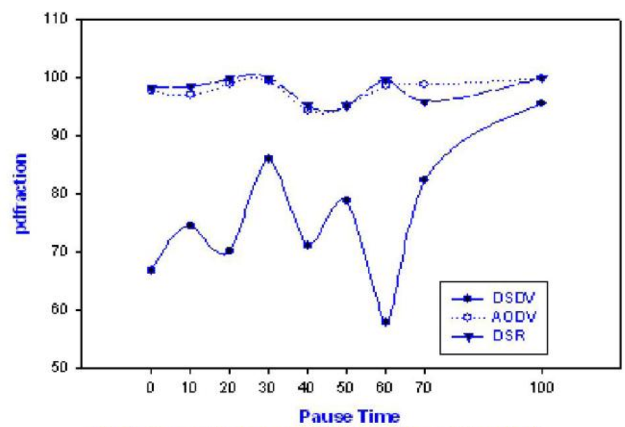

Fig.3 Pause Time vs pdfraction (Fixes 10 nodes)

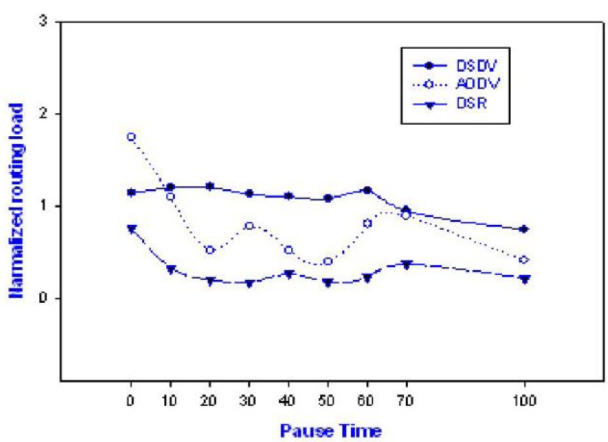

Fig.2 Pause Time vs Normalized routing load (Fixed 10 nodes)

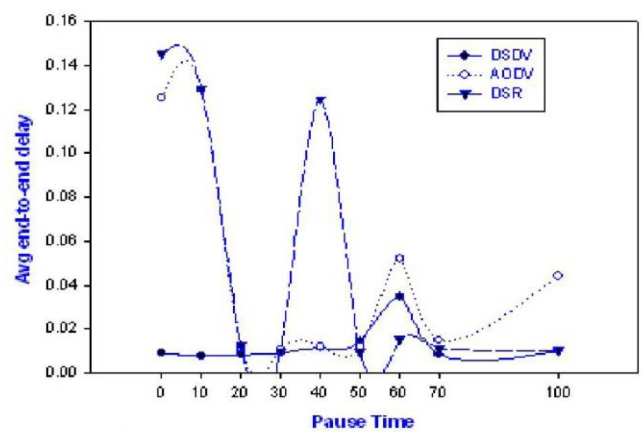

Fig.4 Pause Time vs Avg End-End delay(Fixed 10 nodes)

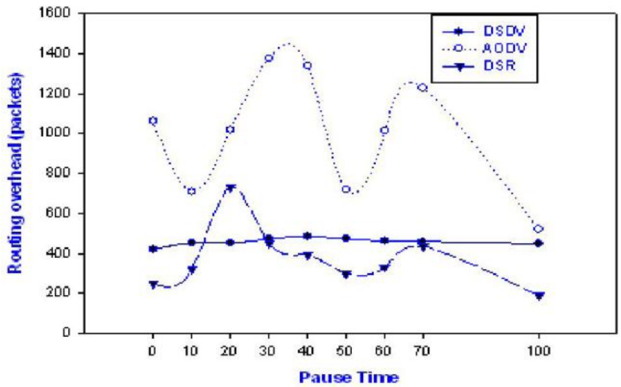

Fig.5 Pause Time vs routing overhead (packets)-fixed 30 nodes

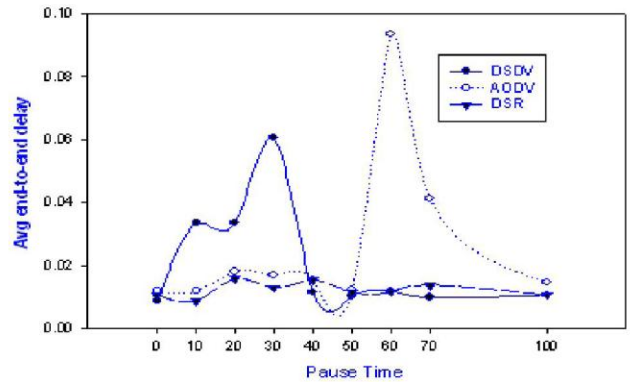

Fig.8 Pause Time vs **Avg end-to-end delay(fixed 30 nodes)**

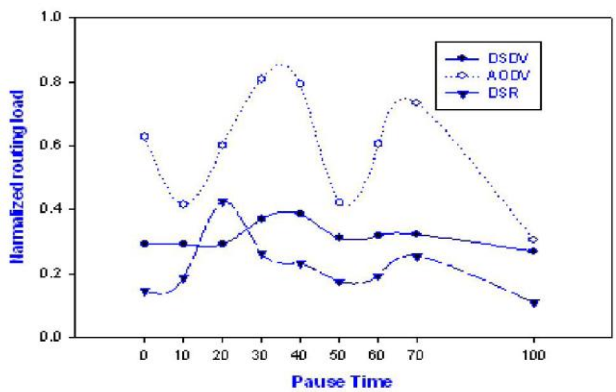

Fig.6 Pause Time vs Normalized routing load (Fixed 30 nodes)

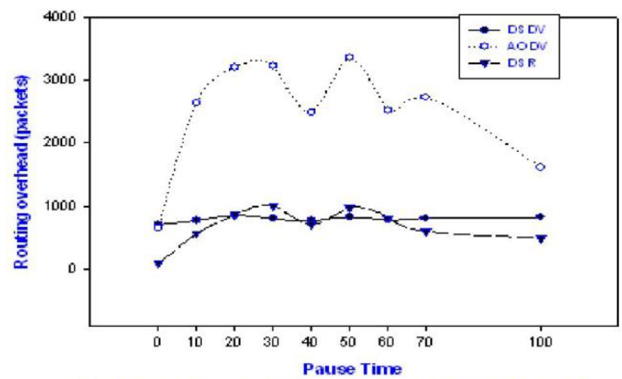

Fig.9 Pause Time vs Routing overhead (Fixed 50 nodes)

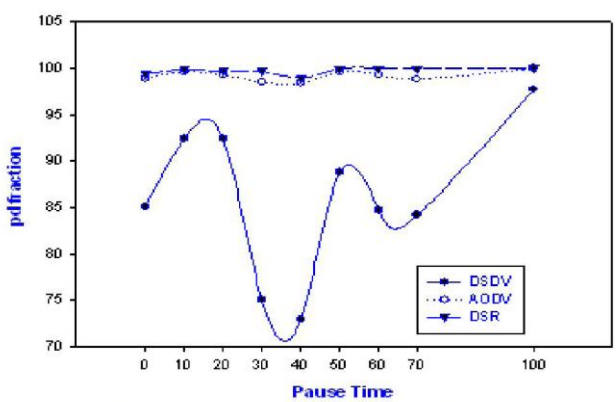

Fig.7 Pause Time vs pd fraction (Fixed 30 nodes)

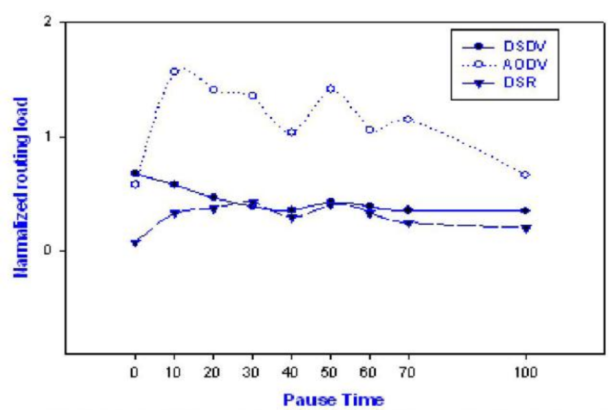

Fig.10 Pause Time vs Narmalized routing load (Fixed 50 nodes)

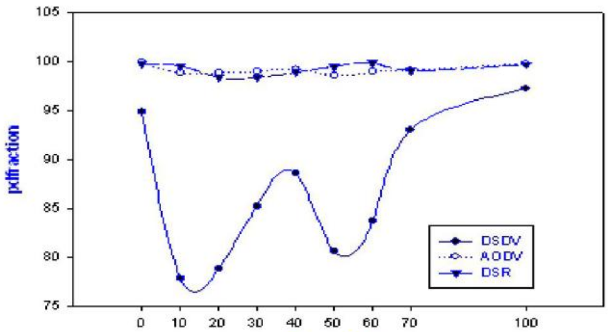

Fig.11 Pause Time vs pdfraction(Fixed 50 nodes)

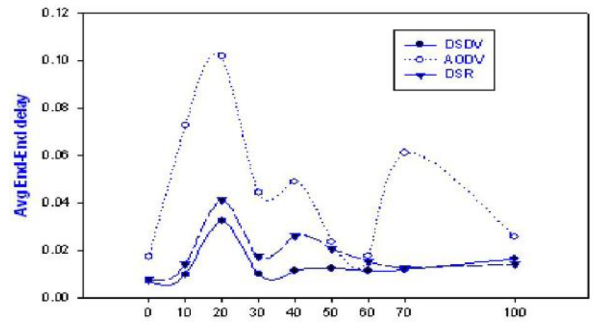

Fig.12 Pause Time Vs Avg End-End delay (Fixed 50 nodes)

VI. Conclusions

Once the route is established, the performance of the AODV protocol for different load condition shows better results throughout the simulation time except the beginning and ending time. The average end-to-end delay of packet delivery was higher in both DSR and AODV as compared to DSDV, when number of nodes increased. Routing overhead of DSDV is approximately constant at varying pause time from beginning and end of the simulation as compared to the AODV and DSR. As number of sources increases at certain limit and no big constraint of bandwidth, it results that the DSDV perform well with respect to all included performance matrices as compared to AODV and DSR. Both AODV and DSR perform better under high mobility simulations than DSDV. In lover mobility scenario generally DSR perform better than AODV due to caching strategy used by DSR but it could be possible only at low offered load. Although AODV, outperforms DSR in more "stressful" in case of increasing more load and higher mobility. High mobility results in frequent link failures and the overhead involved in updating all the nodes with the new routing information as in DSDV is much more than that involved AODV and DSR, where the routes are created as and when required.

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