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COMPARATIVE ANALYSIS OF REACTIVE ROUTING PROTOCOLS FOR MANET AT DIFFERENT TRAFFIC LOAD AND MOBILITY

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ABSTRACT

No infrastructure, no centralized administration and self-configuration are the main characteristics of MANETs. The primary motivation of MANET deployment is to increase portability, mobility and flexibility. However, this mobility causes an unpredictable change in topology and makes routing more difficult. Many routing algorithms have been proposed and tested over the last few years in order to provide an efficient routing in Ad Hoc networks. In this paper we will show our conducted study with AODV and DSR routing protocols. The performance of routing protocols have been evaluated carefully by analyzing the effects of changing network parameters such as Traffic load and pause time for four performance metrics: packet delivery ratio, throughput, end-to-end delay and normalized routing load. All the simulation work has been conducted in NS2. Our simulation results show that AODV gives better performance in all designed simulation models in terms of packets delivery ratio, throughput, end-to-end delay and normalized routing load.

Keywords: MANET, route request, route reply, route discovery and route maintenance, route cache.

1. INTRODUCTION

Mobile Ad Hoc Network (MANET) is a collection of communication devices or nodes that wish to communicate without any fixed infrastructure and pre-determined organization of available links. The nodes in MANET themselves are responsible for dynamically discovering other nodes to communicate. It is a self-configuring network of mobile nodes connected by wireless links the union of which forms an arbitrary topology. The nodes are free to move randomly and organize themselves arbitrarily; thus, the network's wireless topology may change rapidly and unpredictably. Routing is a core problem in networks for sending data from one node to another. Mobile Ad Hoc Networks (MANETs) are characterized by a dynamic, multi-hop, rapid changing topology. Such networks are aimed to provide communication capabilities to areas where limited or no communication infrastructures exist. MANET's can also be deployed to allow the communication devices to form a dynamic and temporary network among them. A mobile Ad Hoc network (MANET) is receiving attention due to many potential military and civilian applications. Some examples of the possible uses of ad hoc networking include students using laptop computers to participate in an interactive lecture, business associates sharing information during a meeting, soldiers relaying information for situational awareness on the battlefield and emergency disaster relief personnel coordinating efforts after a hurricane or earthquake.

MANETs have several salient characteristics:

- Dynamic topologies.
- Bandwidth-constrained links.
- Energy constrained operation.
- Limited physical security.

Therefore the routing protocols for wired networks cannot be directly used for wireless networks. A MANET uses multi-hop routing instead of a static network infrastructure to provide network connectivity. Several routing protocols have been proposed for mobile Ad Hoc networks.

The main objective of this paper is to study the routing protocols [1] in a mobile ad hoc network using a simulator software NS-2 [2]. This paper carryout the analysis of the results to find out which protocol is best between AODV [3] and DSR [4].

1.1. Ad-Hoc on Demand Distance Vector Routing (AODV)

The Ad-hoc On Demand Distance Vector (AODV) [5] [10] is classified under reactive protocols. The operation of the protocol is divided in two functions, route discovery and route maintenance. In this first all the nodes send a Hello message on its interface and then receive Hello messages from its neighbors. In Ad-hoc routing, when a route is needed to some destination, the protocol starts route discovery. Then the source node sends Route Request Message to its neighbours. And if that node does not have any information about the destination node, it will send the message to all its neighbours and so on. And if that neighbour node has the information about the destination node, the node sends Route Reply Message to the Route Request Message initiator. On the basis of this process a path is recorded in the intermediate nodes. This path identifies the route and is called the reverse path. Since each node forwards Route Request Message to all of its neighbours, more than one copy of the original Route Request Message can arrive at a node. A unique id is assigned, when a Route Request Message is created. When a node received, it will check this id and the address of the initiator and discarded the message if it had already processed that request.

Node that has information about the path to the destination sends Route Reply Message to the neighbor from which it has received Route Request Message. This neighbor does the same. Due to the reverse path it can be possible. Then the Route Reply Message travels back using reverse path. When a Route Reply Message reaches the initiator the route is ready and the initiator can start sending data packets.

1.2. DYNAMIC SOURCE ROUTING (DSR)

DSR [4] [7] is designed specifically for use in Multihop wireless ad hoc network. This protocol is composed of two mechanisms of route discovery and route maintenance, which work together to allow nodes to discover and maintain source routes to arbitrary destinations in the ad hoc network. Route discovery takes place when source already does not know route to destination. Route cache is also maintained where all learned routes to any given node in the network exist. When a source sends a packet to destination, it obtains a route from route cache of previously learned routes. If no route is found then route request message is broadcasted to initiate route discovery protocol. When a node receives a route request message it returns route reply message to the initiator, if it is the target of the request. Simply when a node receives a route request it searches the route cache where all routes are stored. If not found then route request is broadcasted and flooded over the network until the destination node is found. In fact there is an aggressive use of source routing and caching in DSR.

2. METHODOLOGY

We run the simulation in Network Simulator (NS-2) [2] [6] accepts as input a scenario file that describes the exact motion of each node and the exact packets originated by each node, together with the exact time at which each change in motion or packet origination is to occur. The detailed trace file created by each run is stored to disk, and analyzed using a variety of scripts, particularly one called file *.tr that counts the number of packets successfully delivered and the length of the paths taken by the packets, as well as additional information about the internal functioning of each scripts executed. This data is further analyzed with AWK file and Microsoft Excel to produce the graphs.

2.1. Communication Model

The simulation models are built using the Network Simulator tool (NS-2) version 2.34. The experiments use a fixed number of packet sizes (512-bytes). In our simulation, we use CBR traffic sources. The simulation used fixed number of source nodes which are 50 nodes and with varying packet rate of 0.1 and 10 packets per seconds.

2.2. Movement Model

The mobility model used is a random waypoint model in a rectangular field. The field configurations used is 1000m × 1000m with 50 nodes and the stations are assumed to be evenly distributed in the area. Here, each packet starts its journey from a random location to a random destination with a randomly chosen speed. Once the destination is reached, another random destination is targeted after a pause. The pause time, which affects the relative speeds of the mobiles, is varied. Simulations are run for 600 simulated seconds. Identical mobility and traffic scenarios are used across protocols to gather fair results.

We vary the traffic load to compare protocol performance for low and high traffic load, pause times 0, 240 and 600 seconds (0 as a perpetual mobility, 240 as high mobility, and 600 as low mobility).

3. SIMULATION RESULTS AND ANALYSIS

The simulation result brings out several differences in two protocols. We report four performance metrics for the protocols.

3.1. Packet Delivery Fraction

The ratio between the number of data packets received and the number of packets sent.

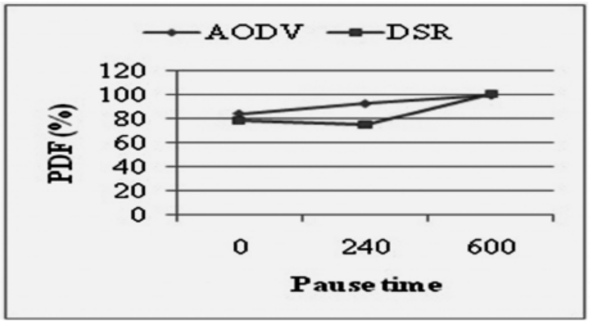

Figure 1: PDF v/s Pause Time at Low Traffic Load (0.1 Packets Per Sec).

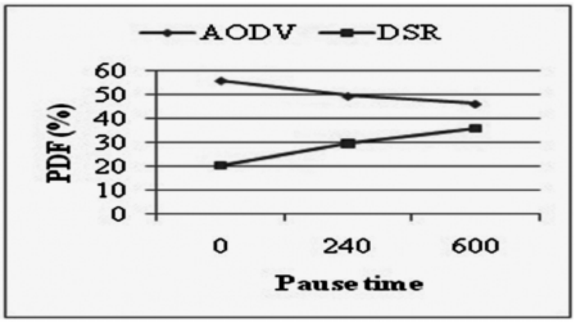

Figure 2: PDF v/s Pause Time at High Traffic Load) (10 packets Per Sec)

Analysis of result: Refer to the figures 1 and 2, with low traffic load AODV outperform DSR except at very high pause time 600sec (low mobility). With high traffic load, DSR always losses about 30-50% more packets than AODV for lower pause times (higher mobility). It is clear that DSR gives comparatively poor performance for PDF in more stressful situations (i.e., higher mobility and high traffic load) however DSR performed better in less stressful situations (low mobility). The reason for both these phenomena is the use of route caching in DSR. DSR does not have mechanism in knowing which route in the cache is stale or to determine the freshness of the routes when multiple choices are available. In contrast AODV choose fresher route (based on sequence number) when faced with more than one route choices for route, thus AODV will deliver more packets through the network.

3.2. Throughput

Throughput is total packets successfully delivered to individual destination over total time divided by total time.

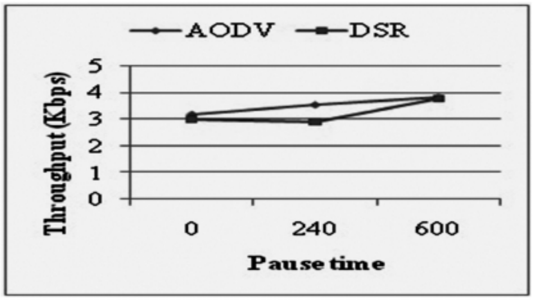

Figure 3: Throughput v/s Pause Time at Low Traffic Load (0.1 Packets Per Sec).

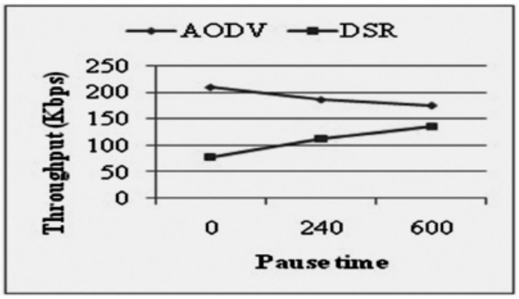

Figure 4: Throughput v/s Pause Time at High Traffic Load (10 Packets Per Sec).

Analysis of the result: Figure 3 and 4 show that throughput curves for different protocols with a packet size of 512 bytes. The throughput curves for all protocols are very similar to the PDF curves. This is because large packet drops will of course mean lower throughput. As the traffic load increases throughput also increase. The reason for this is in throughput calculation no control packets are included; only the data packets are involved. The result for AODV is always better than DSR because DSR uses source route in each data packet. This increases load on the network and cause more packets to be dropped; thus AODV we will get more packets though the network.

3.3. End to End Delay

It is the ratio of time difference between every CBR packet sent and received to the total time difference over the total number of CBR packets received.

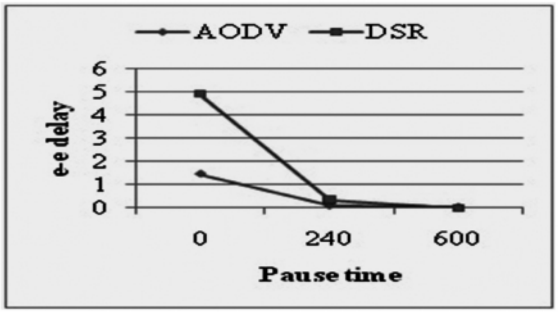

Figure 5: End to End Delay v/s Pause Time at Low Traffic Load (0.1 Packets Per Sec).

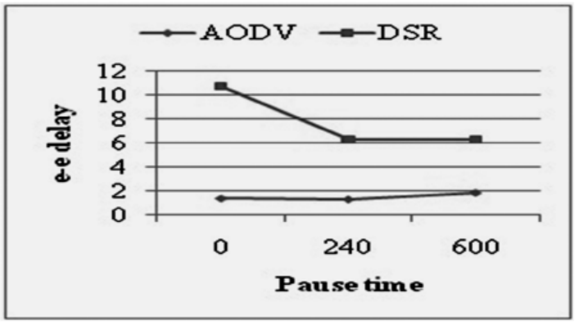

Figure 6: End to End Delay v/s Pause Time At High Traffic Load (10 Packets Per Sec).

Analysis of the result: Refer to the figures 5 and 6, at low traffic load and pause time 600 second (low mobility) DSR has better performance than AODV. This is because of source routing concept of DSR. Due to source routing, DSR learns routes to many more destinations than AODV. This will mean that while DSR already has a route for certain destination, AODV would have to send a specific request for that destination. This will take some time and will therefore increase the delay. When mobility increases more routes will become invalid and new requests are necessary. In DSR when RREQ is sent, the destination replies to all the RREQ it receives, which makes it slower to determined least congestion route. AODV has somewhat better technique in this regard as the destination replies only to the first arriving RREQ.

3.4. Normalized Routing Load

The Normalized routing loads measures by the total number of routing packets sent divided by the number of data packets delivered successfully.

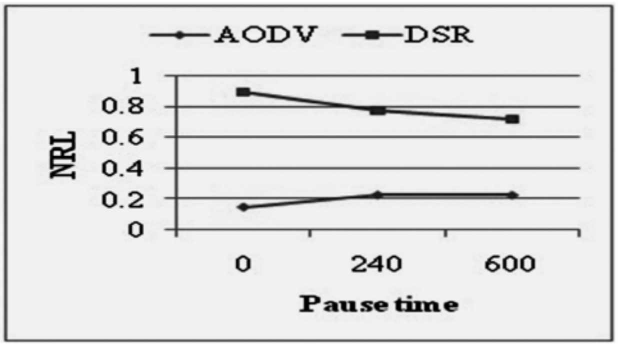

Figure 7: NRL v/s Pause Time at Low Traffic Load (0.1 Packets Per Sec).

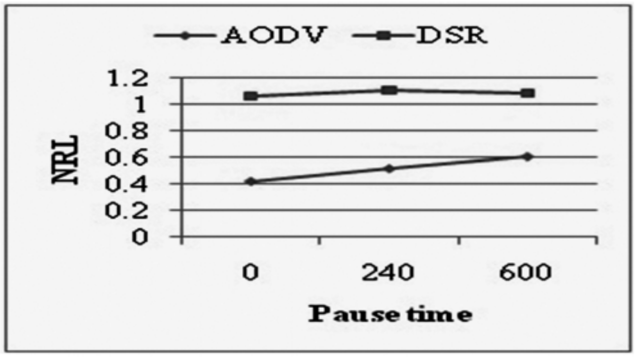

Figure 8: NRL v/s Pause Time at High Traffic Load (10 Packets Per Sec).

Analysis of the result: From figures, it is clear that DSR has high normalized routing load compared to AODV in all simulation scenarios. The reason for larger normalized routing load for DSR is the source route in each packet. DSR data packets carry routing information in the form of source routes and these could be counted as part of routing load. Also DSR typically uses larger routing packets because of source routing. We found that AODV has routing load mainly by RREQ packets on the other hand DSR has routing load mainly by RREP packets, primarily due to multiple replies from destinations.

We know that RREP use the RTS/CTS/Data/ACK exchanges in the 802.11 MAC. RREQs on the other hand do not use any additionally MAC control packets thus AODV have less routing load than DSR.

4. CONCLUSION

The main objective of this thesis is to compare the performance of DSR and AODV; two routing protocols for ad hoc networks. AODV and DSR is the representative of reactive routing protocols. Performance, advantages and disadvantages of these protocols are investigated in randomized scenarios with varying traffic load and mobility.

AODV and DSR both use on demand route discovery but with different routing mechanism. DSR uses source routing and route caches and does not depend on any periodic routing update activities. We used varying traffic load and mobility simulation model to demonstrate the performance characteristics of the two protocols. Simulation result shows that DSR outperforms AODV in less stressful situations i.e. less traffic load and mobility. Under stressful conditions AODV gives better performance than DSR in all metrics like PDF, throughput, delay and routing load. Therefore in general AODV is preferred over DSR for mobile ad hoc network with high traffic load and mobility.

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