Simulation Based Performance Comparison of AODV and DSR Routing Protocols in MANETS

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Abstract
Mobile ad-hoc networks (MANETS) are formed by a collection of mobile nodes that have the ability to form a communication network without the help of any fixed infrastructure. Because of the nature of these networks, routing protocols play a prominent role in their scalability and overall performance. Due to limited radio transmission range, multiple hops may be required in order to exchange data among the communicating nodes. So, a key requirement of any efficient routing protocol is to find a route between two communicating nodes quickly and with low bandwidth overheads. This study inspects two MANET protocols (i.e. Ad-hoc On-demand Distance Vector routing (AODV) and Dynamic Source Routing (DSR)) and examines their performance based on variation of node density and mobility. The performance is determined on the basis of throughput and average end-to-end delay with varying node density and mobility. AODV with higher node density shows an extreme degradation in performance.

Keywords: MANETS, AODV, DSR.

INTRODUCTION
A mobile ad-hoc network is a collection of mobile platforms that form a dynamic infrastructure-less communication network wherever it is required. The absence of a fixed infrastructure means that the communicating nodes in the network must also handle routing. Quick and easy establishment of such networks make them feasible to use in military, disaster area recovery and in other environments where no infrastructure exists or it has been destroyed. Routing is a well studied feature of such networks because mobile nodes may move in various directions, which can cause existing links to break and the establishment of new routes. The mobility (i.e. how nodes move) of mobile nodes plays an important role on the performance of routing protocols. Routes between two communicating nodes may consist of multiple hops through other nodes in the network. Therefore, finding and maintaining routes in MANET is nontrivial.

Due to bandwidth constraints, it is readily understandable that an on demand approach (i.e. the route discovery is initiated only if there is a demand for communication) is often used in wireless ad-hoc network scenarios.

The most famous routing approach in ad-hoc networks is that of reactive protocols and the most popular on-demand routing algorithms are Ad-hoc On-Demand Distance Vector routing (AODV) [1] and Dynamic Source Routing (DSR) [2]. So, since they are widely used, this paper discusses the impact of random waypoint and a variation of random waypoint with attractions on the performance of AODV and DSR with varying node density and mobility patterns.

The network simulator ns-2 [3] is a commonly used tool for MANETS protocol evaluation. In this study, ns-2.35 is used for all simulation results.

II. AD-HOC ROUTING PROTOCOLS
Several routing protocols have been developed for ad hoc
Mobile networks [1] [13]. Such protocols must deal with typical limitations of these networks which include high power consumption, low bandwidth and high error rates. As figure 2 shows the categorization of these routing protocols.
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A different approach from table  

Driven Routing Protocols  

Table-driven routing protocol [1] [8] attempt to maintain  

consistent, up-to-date routing information from each node to  

every other node in the network. These protocols require each  

node to maintain one or more tables to store routing  

information, and they respond to changes in network topology  

by propagating updates routes through out the network in  

order to maintain a consistent network view. The Destination-  

Sequenced Distance- Vector Routing (DSDV) protocol shown  
in figure 2 is a table driven algorithm that modifies the  

Bellman-Ford routing algorithm to include timestamps that  

prevent loop-formation. The Wireless Routing Protocol  
(WRP) is a distance vector routing protocol which belongs to  

the class of path-finding algorithms that exchange second-to-  

last hop to destinations in addition to distances to destinations.  

This extra information helps remove the “counting-to-infinity”  

problem that most distance vector routing algorithms suffer  

from. It also speeds up route convergence when a link failure  

occurs.  

On Demand-Driven Routing Protocols  

A different approach from table-driven routing is on-demand  
routing [5] [6] [4]. This type of routing creates routes only  

when desired by source node. When a node requires a route to  
a destination, it initiates a route discovery process within the  
network. This process is completed once a route is found or all  
possible routes permutations have been examined. Once a  
route has been established, it is maintained by a route  
maintenance procedure until either the destination becomes  
 inaccessible along every path from the source or until the  
route is no longer desired. On-demand routing protocols were  
designed with the aim of reducing control overhead, thus  
increasing bandwidth and conserving power at the mobile  
stations. These protocols limit the amount of bandwidth  
consumed by maintaining routes to only those destinations for  
which a source has data traffic.  

Therefore, the routing is source-initiated as opposed to  
table driven routing protocols that are destination initiated.  
There are several recent examples of this approach (e.g.,  
AODV [5], DSR [4], TORA [5], ZRP [12]) and the routing  
protocols differ on the specific mechanisms used to  
disseminate flood search packets and their responses, cache  
the information heard from other nodes’ searches, determine  
the cost of a link, and determine the existence of a neighbor.  
However, all the on-demand routing proposals use flood  
search messages that either: (a) give sources the entire paths to  
destinations, which are then used in source routed data packets  
(e.g., DSR); or (b) provide only the distances and next hops to  
destinations, validating them with sequence Numbers (e.g.,  
AODV) or time stamps (e.g., TORA).  

Hybrid Routing Protocols  

Based on combination of both table and demand driven  
Routing protocols, some hybrid routing protocols are proposed  
to combine advantage of both proactive and reactive protocols.  
The most typical hybrid one is zone routing protocol [12].  

III. ON-DEMAND ROUTING PROTOCOLS  
A. Dynamic Source routing (DSR)  

DSR uses source routing and caching [4] where the sender  
node includes the complete hop-by-hop route to the  
destination node in the packet header and routes are stored in a  
route cache. When a node wants to communicate with another  
node to which it does not know the route, it initiates a route  
discovery process with a flooding request of route request  
(RREQ) packets. Each node receiving the RREQ packets  
retransmits it unless it is the target node or it knows the route  
to the destination from its cache. Such a node replies to the  
RREQ message with a route reply (RREP) packet. The RREP  
packet takes the traverse path back to the source node  
established by the RREQ packet. This route is stored in the  
source node cache for future communication. If any link of  
this route is broken, the source node is informed by a route  
error (RERR) packet and this route is discarded from cache.  
Intermediate nodes store the source route in their cache for  
possible future use.  

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

AODV is a destination based reactive protocol. This protocol  
inherits the feature of route discovery from DSR. However,  
AODV resolves the problem of large headers found in DSR.  
This problem can cause significant performance degradation  
especially when the actual data contents are small. AODV  
maintains routing tables on the nodes instead of including a  
header in the data packet. The source node initiates the route  
discovery process in the same way as in DSR. An intermediate  
ode node may reply with a route reply (RREP) only if it knows a  
more recent path than the one known by the sender node to the  
destination. A destination sequence number is used to indicate  
how recent the path is as follows. A new route request  
generated by the sender node is tagged with a higher sequence  
number and an intermediate node that knows the route to the  
destination node in the packet header and routes are stored in a  
route cache. When a node wants to communicate with another  
ode to which it does not know the route, it initiates a route  
discovery process with a flooding request of route request  
(RREQ) packets. Each node receiving the RREQ packets  
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possible future use.  

IV. PERFORMANCE ANALYSIS  

The following two quantitative [12] performance metrics are  
used for this study.
1. Average end-to-end delay: Delay caused by latency, buffering, queuing, retransmission and route discovery all are included in this performance analysis. This delay is measured in milliseconds.

2. Throughput: This is the average number of packets delivered per unit time. Throughput of received bits is measured in kilobits per second.

V. RELATED WORK AND OBSERVED PROBLEM
There is a large number of studies about performance of routing protocols in MANETS for different scenarios [2,5,6,13,14,15] in the literature. In [15], the author mentions that the performance of reactive routing protocols is highly dependent upon the scenario. It was observed during our simulation analysis that AODV and DSR suffers severely with performance degradation with the scenarios considered in our experiments. With increasing node density in a fixed area, the performance of AODV and DSR is affected very badly with all performance metrics taken into consideration for this study.

VI. RESULTS AND DISCUSSION
To evaluate the performance of two protocols, we took two scenarios, in the first the node density was varied by changing the number of nodes in a fixed area and in the second the nodal pause time was varied.

Performance analysis with varying node density
The key simulation parameters employed in simulating the effect of varying the node density are shown in Table 1. A flat area of 1200*1200 m is chosen with IEEE 802.11b equipped radios and with Two Ray Ground as a propagation model by taking into consideration both direct and indirect paths between communicating nodes. This propagation model would not necessarily give realistic results in a heavily built-up area. A nominal radio coverage range of 250 m is chosen for these experiments. A zero pause time is used to simulate a mobility level with nodes that are continuously moving in the simulation area.

Table 1 Simulation parameters with varying node density

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protocols</td>
<td>AODV, DSR</td>
</tr>
<tr>
<td>No. of Nodes</td>
<td>10,20,30,40,50</td>
</tr>
<tr>
<td>Area Size</td>
<td>1200x1200 m</td>
</tr>
<tr>
<td>Traffic Type</td>
<td>CBR</td>
</tr>
<tr>
<td>Packet Size</td>
<td>512 bytes</td>
</tr>
<tr>
<td>Queue length</td>
<td>50</td>
</tr>
<tr>
<td>Propagation Path loss Model</td>
<td>Two Ray Ground</td>
</tr>
<tr>
<td>Antenna Type</td>
<td>Omni-directional</td>
</tr>
<tr>
<td>Simulation Time</td>
<td>1000 sec</td>
</tr>
</tbody>
</table>

a. The first analysis is based on varying the number of nodes from 10 to 50 in an area of 1200x1200m. The End-to-End delay shown in Fig1 reveals that DSR shows better performance than AODV as End-to-End delay is lower in DSR as compared to AODV. Higher node density increases the number of neighboring nodes and that causes more route reply messages to the source node and thus increasing delay.

b. From the simulation results in figure 2, it is observed that Throughput decreases linearly with increasing number of nodes for both AODV and DSR.

c. The second analysis is based on varying the Pause time. The effect of pause time on end-to-end delay is given in fig 3. We observe that DSR shows the lower delay as compared to AODV. So the performance of DSR protocol is better than the AODV routing protocol.
We observed that DSR protocol has better throughput as compared to AODV protocol, because of the proper receiving of packets and less packet drop.

VII. CONCLUSION

This paper provides explanation and simulation analysis of on-demand routing protocols like AODV and DSR for ad-hoc mobile networks and also provides a classification of these protocols according to the routing strategy (i.e. table driven, on-demand and hybrid routing protocol). It has also presented a comparison of these on-demands routing protocol under variation of number of nodes and Pause Time, simultaneously measured performances under various performance metrics including end to end delay and throughput.

From different analysis of graphs and simulations it can be concluded that DSR performs well than AODV. DSR protocol shows best results in measuring end to end delay and throughput than AODV protocol.

Different initial node position patterns, more sources, additional metrics (such as path length difference from shortest) may be used in future.

REFERENCES