International Journal of Engineering Inventions
ISSN: 2278-7461, www.ijeijournal.com
Volume 1, Issue 3 (September 2012) PP: 32-39

On Demand Routing Protocols for Mobile Adhoc Network

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Abstract—In an ad hoc network, mobile nodes communicate with each other using multi-hop wireless links. There is no stationary infrastructure such as base stations. The routing protocol must be able to keep up with the high degree of node mobility that often changes the network topology drastically and unpredictably. Most of the on demand routing protocols for Manets namely AODV and DSR perform well with uniform output under low network load, mobility, traffic sources. The objective of the proposed work is to evaluate the performances of each of these protocols under large number of traffic sources, greater mobility with lesser pause time and varying offered load. Also the metrics taken into account are: Packet Size /average throughput of generating packets, Packet size / average simulation end to end delay, packet send time at source node / end-to-end delay. On the basis of the obtained results the performances of the above-mentioned on demand routing protocols for Manets is compared using network simulator-2 (NS2).

Index Terms—AODV - Ad Hoc On-demand Distance Vector Routing, DSRP - Dynamic Source Routing Protocol, TORA - Temporally Ordered Routing Algorithm, NAM- Network Animator, NS- Network Simulator.

I. INTRODUCTION

Mobile Adhoc Network : Wireless networking [1,6] is an emerging technology that allows users to access information and services electronically, regardless of their geographic position. Wireless networks can be classified in two types: -

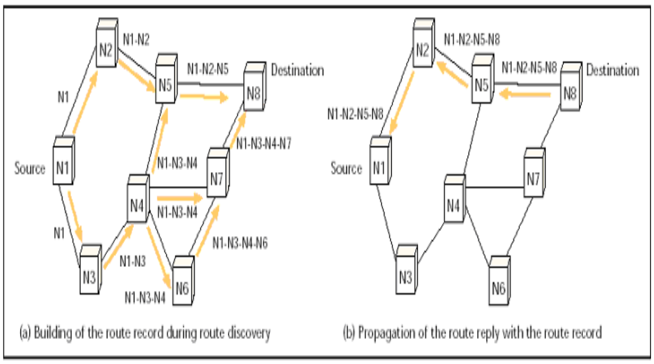
- **Infrastructured Network:** Infrastructured network consists of a network with fixed and wired gateways. A mobile host communicates with a bridge in the network (called base station) within its communication radius. The mobile unit can move geographically while it is communicating. When it goes out of range of one base station, it connects with new base station and starts communicating through it. This is called handoff. In this approach the base stations are fixed.
- **Infrastructure less (Ad hoc) Networks:**In ad hoc networks all nodes are mobile and can be connected dynamically in an arbitrary manner. All nodes of these networks behave as routers and take part in discovery and maintenance of routes to other nodes in the network. Ad hoc networks are very useful in emergency search-and-rescue operations, meetings or conventions in which persons wish to quickly share information, and data acquisition operations in inhospitable terrain.

  1.1The ad-hoc routing protocols can be divided into two categories:
- **Table-driven routing protocols.** In table driven routing protocols, consistent and up-to-date routing information to all nodes is maintained at each node.
- **On-Demand routing protocols:**In On-Demand routing protocols, the routes are created as and when required. When a source wants to send to a destination, it invokes the route discovery mechanisms to find the path to the destination. The motivation behind the on-demand protocols is that the "routing overhead" (typically measured in terms of the number of routing packets transmitted, as opposed to data packets) is typically lower than the shortest path protocols as only the actively used routes are maintained. There are four multi-hop wireless ad hoc network routing protocols that cover a range of design choices:

Destination-Sequenced Distance-Vector (DSDV)
Temporally Ordered Routing Algorithm (TORA)
Dynamic Source Routing (DSR)
Ad Hoc On-Demand Distance Vector Routing (AODV).
While DSDV is a table-driven routing protocol, TORA, DSR, AODV, fall under the On-demand routing protocols category.

1.2 Dynamic Source Routing (DSR)

The Dynamic Source Routing Protocol [2] is a source-routed on-demand routing protocol. A node maintains route caches containing the source routes that it is aware of. 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. To limit the number of route requests propagated, a node processes the route request packet only if it has not already seen the packet and it's address is not present in the route record of the packet. A route reply is generated when either the destination or an intermediate node with current information about the destination receives the route request packet. A route request packet reaching such a node already contains, in its route record, the sequence of hops taken from the source to this node.



Route Creation in DSR

As the route request packet propagates through the network, the route record is formed. If the route reply is generated by the destination then it places the route record from route request packet into the route reply packet

1.3 Ad Hoc On-Demand Distance Vector Routing (AODV)

AODV is a reactive protocol or on-demand protocol [1]. Ad-hoc on demand distance vector routing protocol uses destination sequence number to offer loop free routing and fresh route to the destination. Unlike tables driven protocols it does not maintain status of the network via continuous updates. This approached help in reducing the number of messages and the size of the routes tables.

AODV provides both multicast, and uni-cast connectivity in an ad-hoc environment. One of the main features of AODV is to respond quickly whenever a link breakage in active route is found.

AODV is a combination of both DSR and DSDV. It inherits the basic on-demand mechanism of route discovery and route maintenance from DSR plus the use of hop-by-hop routing sequence numbers and periodic beacons from DSDV.

II. METHODS

Problem Definition: The objective of the dissertation work is to analyse and then do a simulation comparison of two on demand routing protocol for mobile ad hoc networks. The two reactive protocols that have been simulated and compared are: Dynamic source routing (DSR) protocol and Ad-Hoc On Demand Distance Vector (AODV) routing protocol. Although both of these protocols share the common feature of being Reactive in nature, yet they behave differently when subjected to identical network conditions in terms of packet size, number of traffic sources, mobility rate, topological area, number of nodes, mobility model.

2.1 Tool Used: The simulations were conducted on an Intel Pentium IV processor at 2.8 GHz, 256 MB of RAM running **Red Hat Linux 10**

- **Network Simulator-2 (NS-2):** The version of network simulator used for simulation is **NS-2.27**.
- **Mobility Model**: Random Waypoint Model

2.2 Metrices considered for performance evaluation are:
1.Packet size Vs Average Throughput Of Generating Packets.
2.Packet Size Vs Average Simulation End-to-End Delay.
3.Packet Send Time At Source Node Vs Simulation End-to-End Delay.
2.2.1 Now to get a clear picture of the above mentioned metrices I define them as:

- **Average Simulation End-to-End Delay:** This implies the delay a packet suffers between leaving the sender application and arriving at the receiver application.
- **Average Throughput or Packet Delivery Ratio:** The ratio between the number of packets sent out by the sender application and the number of packets correctly received by the corresponding peer application

2.3 Network Simulator:

Background on the ns-2 simulator: NS simulator [12,11] is based on two languages :an object oriented simulator ,written in c++ ,and a Otcl (an object oriented extension of Tcl) interpreter ,used to execute user's command scripts.

NS has a rich library of network and protocol objects. There are two class hierarchies: the compiled c++ hierarchy and the interpreted Otcl one ,with one to one correspondence between them.

The compiled c++ hierarchy allows us to achieve efficiency in the simulation and the faster execution times.This is in particular useful for the detailed definition and operation of protocols. This allows one to reduce packet and event processing time.

2.4 Tcl and Otcl programming:

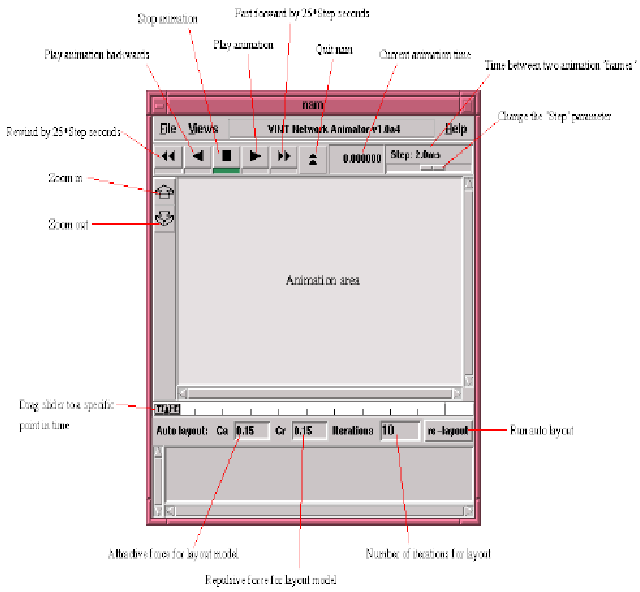
Tcl (Tool Command Language) [12,11] is used by millions of people in the world. It is a language with a very simple sintaxis and it allows easy integration with other languages. Tcl was created by Jhon Ousterhout. The characterstics of these languages are:

- It allows a fast development
- It provide a graphic interface
- It is compatible with many platforms
- It is flexible for integration
- It is easy to use
- It is free

2.5 Visualisation : Using NAM

NAM stands for network animator. Network Animator (NAM) is an animation tool for viewing network simulation traces and real world packet traces .It supports topology layout, packet level animation and various data inspection tools. Before starting to use NAM, a trace file needs to be created. This trace file is usually generated by NS. It contains topology information, e.g. nodes and links, as well as packet traces. During a simulation, the user can produce topology configurations, layout information and packet traces using tracing events in NS. Once the trace file is generated, NAM can be used to animate it. Upon startup, NAM will read the trace file, create topology, pop up a window, do layout if necessary and then pause at time 0. Through its user interface, NAM provides control over many aspects of animation. In Figure a screenshot of a NAM window is shown, where the most important functions are explained.

Although the NAM software contains bugs, as do the NS software, it works fine most of the times and causes only little trouble. NAM is an excellent first step to check that the scenario works as expected. NS and NAM can also be used together for educational purpose and to easily demonstrate different networking issues.



III. RESULTS AND CONCLUSIONS

Following table gives a glance of the parameters that were considered for the simulation.

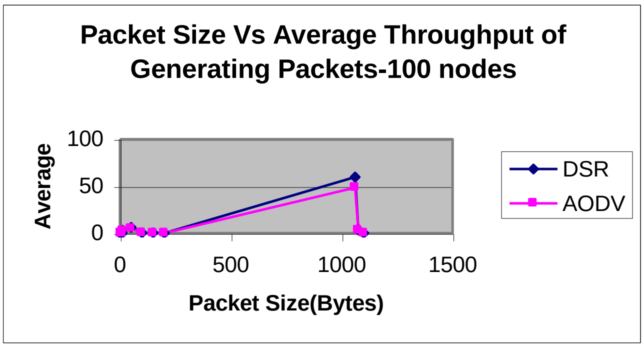
Parameter			
No. of Mobile Nodes	40	80	100
No. of Traffic sources	20	27	30
Type of traffic	TCP	TCP	TCP
Nodes Speed	(0-20) m/s	(0-20) m/s	(0-20) m/s
Packet Size	1024 bytes	1024 bytes	1024 bytes
Topology Area	1100* 1100 m* m	1100* 1100 m*m	1100* 1100 m*m

3.1 Metrices considered for performance evaluation are:

1.Packet size Vs Average Throughput Of Generating Packets.
2.Packet Size Vs Average Simulation End-to-End Delay.
3.Packet Send Time At Source Node Vs Simulation End-to-End Delay.

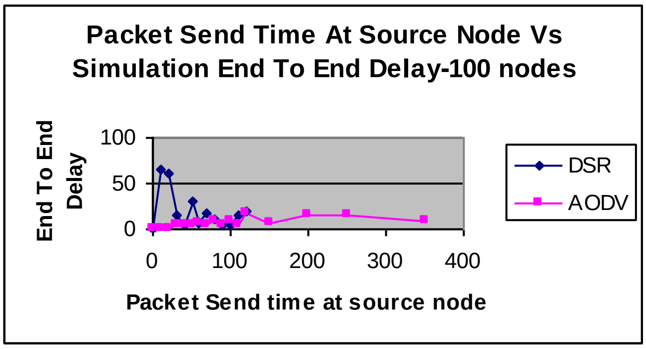
The table given above shows the three different sets that were considered for the experiment. The number of nodes was varied as 40,80,100 with the traffic sources 20,27 and 30 respectively. Also the type of traffic sources were TCP.The packet size was taken to be the same 1024 bytes. Each of the mobile nodes select a random destination at the specified time and moves towards it. The simulation ends just one second before the total simulation time, which is taken to be 400 seconds. When the packet size was further increased to 2048 bytes, there was a lot of network congestion and both of the protocols failed to deliver any results.
The following graphs shows the results that were obtained and the comparison of the two On-Demand routing protocols: DSR and AODV.

Graph A-For 100 nodes
1-Packet size Vs Average Throughput of Generating Packets



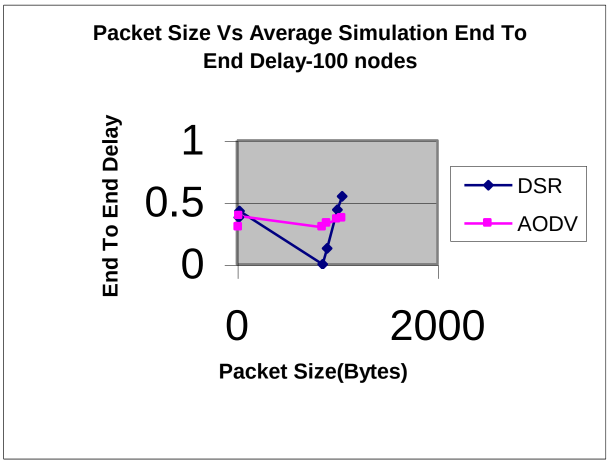
From this graph we observe that as the packet size is increasing the average throughput of generating packets for DSR is slightly greater than AODV.

2-Packet send time at Source node Vs. Simulation End To End Delay



Here we observe that the end to end delay of DSR is greater than AODV.

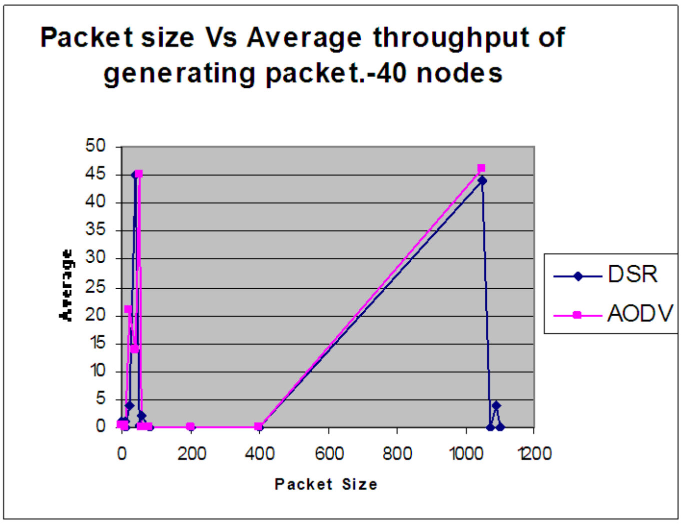
3-Packet Size Vs Average Simulation End to End Delay



This graph shows that as the packet size is increasing the average simulation end to end delay of DSR increases and is greater than AODV.

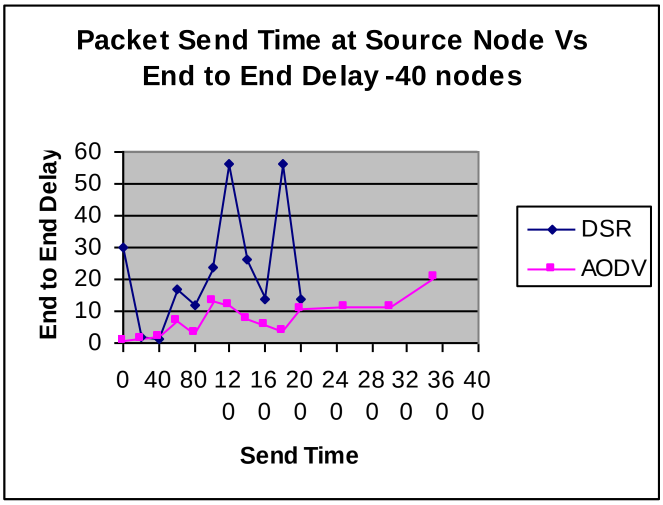
Graph B-For 40 Nodes

1-Packet size Vs Average Throughput of Generating Packets



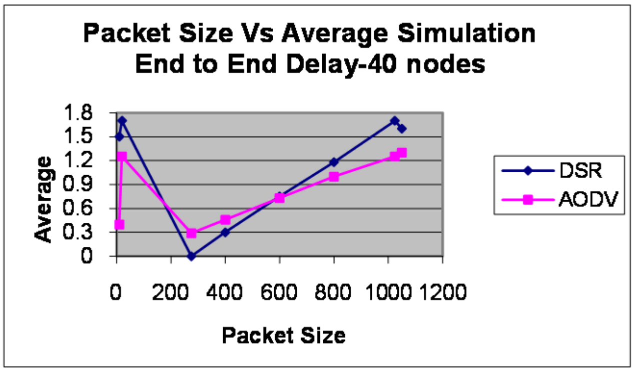
From this graph it is clear that the average throughput of generating packets for AODV is greater than DSR.

2-Packet send time at Source node Vs. Simulation End To End Delay



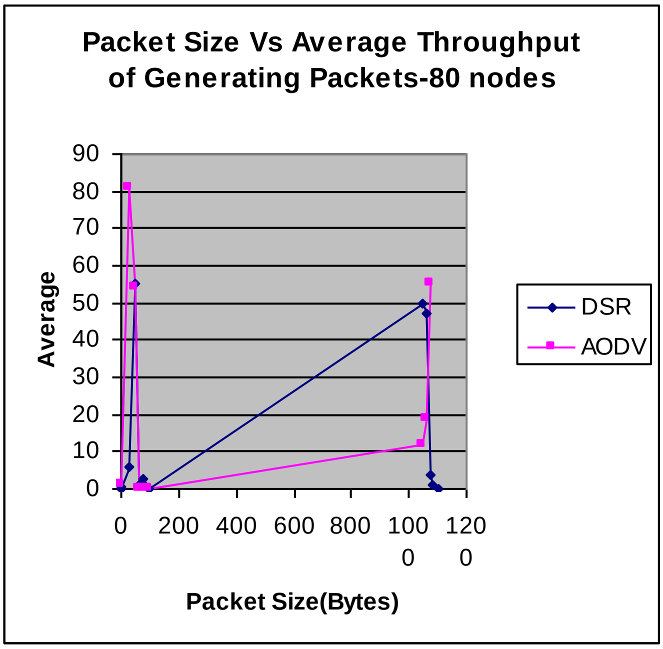
Here also we can see that the end to end delay of DSR is much greater than AODV

3-Packet Size Vs Average Simulation End to End Delay



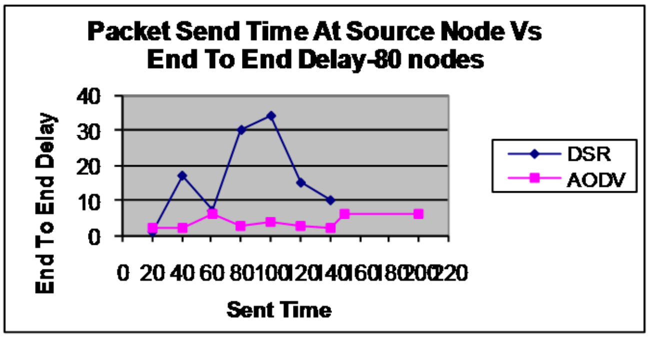
From this we observe that the average simulation end to end delay of DSR is increasing as the packet size is increasing.

Graph C- For 80 Nodes
1-Packet size Vs Average Throughput of Generating Packets



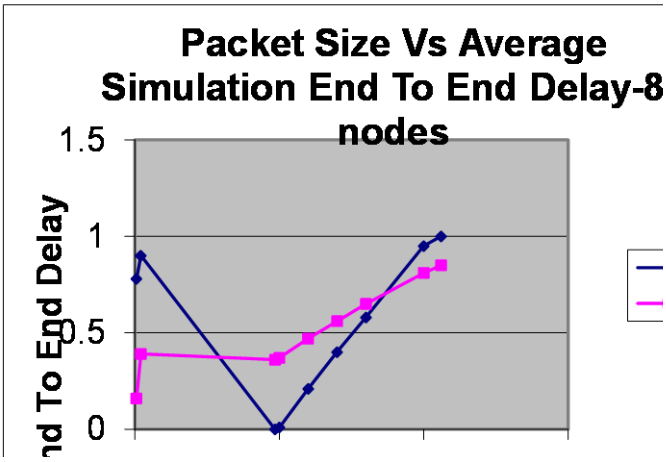
One can clearly notice that the average throughput of generating packets for AODV increases as the packet size keeps increasing.

2-Packet send time at Source node Vs. Simulation End To End Delay



Here we observe that the end to end delay of DSR is much greater than AODV.

3-Packet Size Vs Average Simulation End to End Delay



This graph shows that average simulation end to end delay of DSR goes on increasing as the packet size increases.

3.2 Conclusion:

The On-Demand routing protocols are much efficient to handle the dynamics of mobile ad-hoc networks than the table driven routing protocol. We need to undertake much deeper study of all these reactive routing protocols which could prove beneficial to make enhancements in performance of these protocols. It is highly recommended that we start with the basic building blocks of these protocols and see how each of these blocks interact with each other and thereby observing how the interaction could be coordinated more effectively so as to lead to increase in performance differentials.
The protocols I took for my study are: AODV and DSR.

AODV although is an On-Demand routing protocol yet it maintains routing tables. We can say that it has features of both table driven and reactive routing protocol. It has only one entry per source/destination pair, so it has to resort to route discovery more often than DSR. DSR do not make use of any routing tables. Instead it can have more than one route per source/destination pair. It makes complete use of source routing, that means the source or the initiator of the data packet has to determine the complete hop by hop route to the destination. Due to the availability of many alternate routes it has to resort to route discovery less often than AODV.

On the basis of result, it was concluded that as the packet size is increased the end-to-end delay of AODV is lesser than that of DSR for larger number of nodes; average throughput of generating packets for DSR is larger than that of AODV for larger number of Nodes and traffic sources. However the average throughput of generating packets for AODV is greater when the numbers of nodes are 40 and 80. Delay is an important metric which decides the efficiency of the routing protocol.

DSR (Dynamic source routing) protocol is not a winner when it comes to the large size of the network. The end-to-end delay is increased when the packet size is increased. The degraded performance might be because of the aggressive use of caching. The basic problem is that in highly dynamic environment, the cache becomes stale and could lead to significant downfall in performance. There is a lot of scope related to the use of caching in DSR.
So AODV gave the best performance overall, making it suitable for medium as well as larger networks.

3.3 Future Scope:

We need to evaluate these protocols AODV, DSR using different mobility models: Reference Point Group Mobility, Freeway. Also none of these protocols have any mechanism for load balancing, so there is much scope related to this work. Apart from this the caching strategy used by DSR needs to be more efficient in order to handle frequent topology changes when the simulation environment is highly dynamic. So there is a need to remove stale entries from the cache more effectively thereby the performance of DSR could be considerably improved.

ACKNOWLEDGMENT

I deem my proud privilege to express my sincere thanks and gratitude to NCCE, Panipat to provide me an opportunity to pursue this work. My special thanks & regards to **Mr. SUKHVIR SINGH (HOD)** who has guided me with all his relevant knowledge regarding this evaluation.

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