Performance Evaluation Of Mobile Ad-Hoc Network (MANET) Routing Protocols (Reactive) By Using Network Simulator-2

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Abstract

A Mobile Ad-hoc NETwork (MANET) consists of a number of mobile wireless nodes, among which the communication is carried out without having any centralized control. MANET is a self organized, self configurable network having no infrastructure, and in which the mobile nodes move arbitrarily. In this work a study has been carried out on the behavioral aspect of two different MANET reactive routing protocols i.e. AODV (Ad Hoc On-Demand Distance Vector) and DSR (Dynamic Source Routing Protocol) using the NS-2[1] simulation tool. The performance of these routing protocols is analyzed in terms of their average through-put, end to end delay & packet delivery ratio and their results are shown in graphical forms. To determine the efficiency of protocol, we have undergone comparison study of DSR and AODV protocols using different scenarios.

Keywords: MANET, Network Simulator-2, Routing protocols

I. Introduction

A MANET [2,3] consists of a number of mobile devices that come together to form a network as needed, without any support from any existing Internet infrastructure[4] or any other kind of fixed stations. Each device in a MANET is free to move independently in any direction, and will therefore change its links to other devices frequently. Depending upon the nature of application, appropriate routing protocol is implemented. Proactive and reactive protocols are the two classes of MANET routing protocols and each constitute a set of protocols as described below.

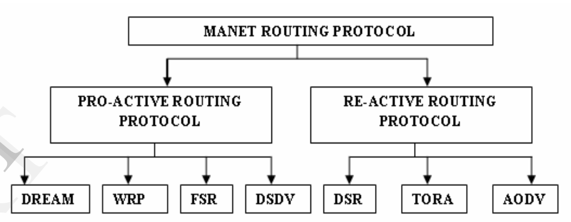

Figure 1.Classification of various Routing Protocols.

2. Simulation Environment

Ns-2 is a discrete event simulator targeted at networking research. It provides substantial support for simulation of TCP, routing and multicast protocols over wired and wireless networks. It consists of two simulation tools. The network simulator (ns) contains all commonly used IP protocols. The network animator (nam) is use to visualize the simulations. Ns-2 [1] fully simulates a layered network from the physical radio transmission channel to high-level applications. Version 2 is the most recent version of ns (ns-2) [1]. The ns-2 simulator has several features that make it suitable for our simulations. Ns-2 is an object-oriented simulator written in C++ and OTcl. The simulator supports class hierarchy in C++ and a similar class hierarchy within the OTcl interpreter. There is a correspondence between a class in the interpreted hierarchy and one in the compile hierarchy. The reason to use two different programming languages is that OTcl is suitable for the programs and configurations that demand frequent and fast change while C++ is suitable for the programs that have high demand in speed. Ns-2 is highly extensible. It not only supports most commonly used IP protocols but also allows the users to extend or implement their own protocols. It also provides powerful trace functionalities, which are very important in our project since various information need to be logged for analysis. The full source code of ns-2 can be downloaded and compiled for multiple platforms such as UNIX, Windows and Cygwin.

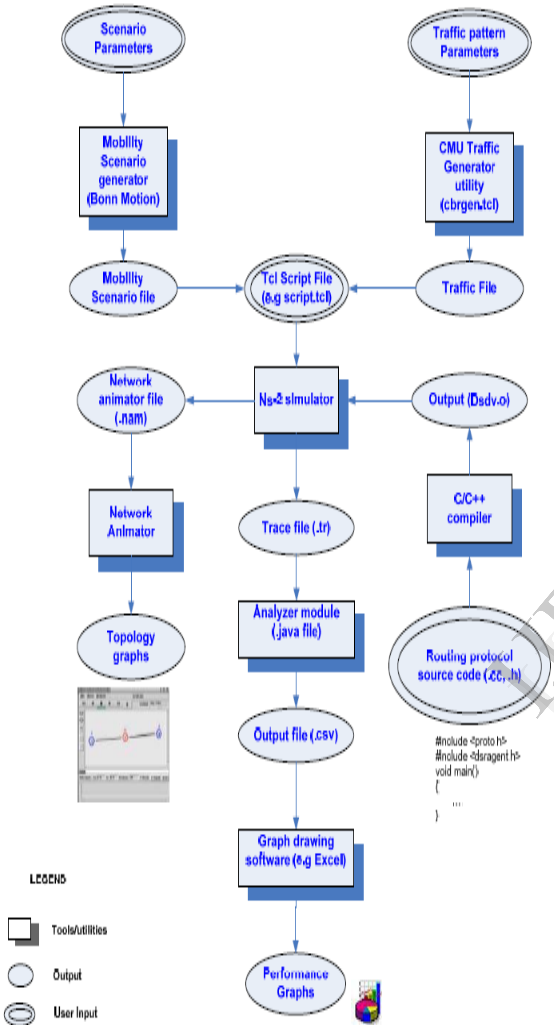

Figure 2.Flow Diagram for MANET Routing Protocols using NS-2[5]

3. Routing Protocols

Among various routing protocols available for MANETs, we worked with two protocols AODV, DSR.

Reactive Routing Protocols:
Reactive routing protocol is also known as on demand routing protocol. In this protocol route is discovered whenever it is needed Nodes initiate route discovery on demand basis. Source node sees its route cache for the available route from source to destination if the route is not available then it initiates route discovery process. The on- demand routing protocols have two major components:

Route discovery: In this phase source node initiates route discovery on demand basis. Source nodes consults its route cache for the available route from source to destination otherwise if the route is not present it initiates route discovery. The source node, in the packet, Includes the destination address of the node as well address of the intermediate nodes to the destination.

Route maintenance: Due to dynamic topology of the network cases of the route failure between the nodes arises due to link breakage etc, so route maintenance is done. Reactive protocols have acknowledgement mechanism due to which route maintenance is possible Reactive protocols add latency to the network due to the route discovery mechanism. Each intermediate node involved in the route discovery process adds latency. These protocols decrease the routing overhead but at the cost of increased latency in the network. Hence these protocols are suitable in the situations where low routing overhead is required. There are various well known reactive routing
Protocols present in MANET for example DSR, AODV,TORA.

3.1 Dynamic Source Routing (DSR):

The Dynamic Source Routing (DSR) [6] is one of the purest examples of an on-demand routing protocol that is based on the concept of source routing. It is designed specially for use in multi-hop ad hoc networks of mobile nodes. It allows the network to be completely self organizing and self-configuring and does not need any existing network infrastructure or administration. DSR uses no periodic routing messages like AODV, thereby reduces network bandwidth overhead, conserves battery power and avoids large routing updates. Instead DSR needs support from the MAC layer to identify link failure. DSR is composed of the 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 network. DSR has a unique advantage by virtue of source routing. As the route is part of the packet itself, routing loops, either short – lived or long – lived, cannot be formed as they can be immediately detected and eliminated. This property opens up the protocol to a variety of useful optimizations. Neither AODV nor DSR guarantees shortest path. If the destination alone can respond to route requests and the source node is always the initiator of the route request, the initial route may the shortest.

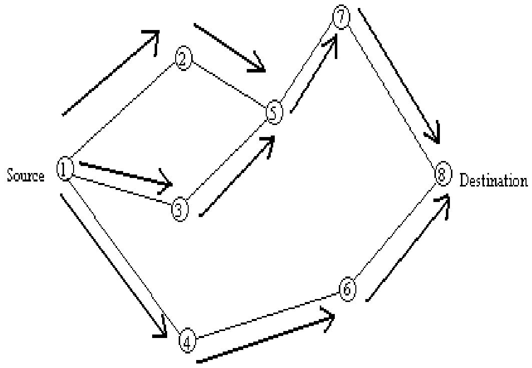

Figure 3. Propagation of request (RREQ) packet

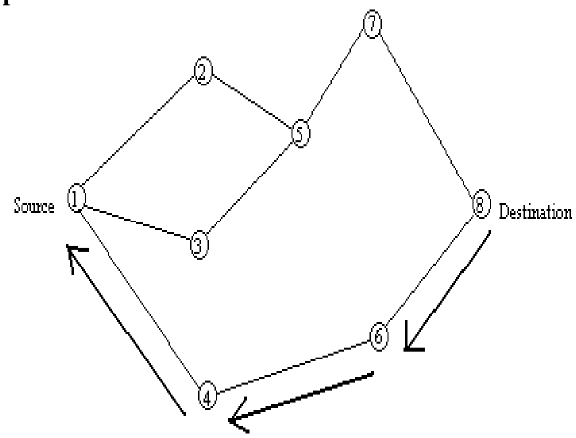

Figure 4. Path taken by the Route Reply (RREP) packet

3.2 Adhoc On Demand Routing Behavior (AODV) Protocol:

The Ad hoc On-Demand Distance Vector (AODV) [7] algorithm enables dynamic, self-starting, multi-hop routing between participating mobile nodes wishing to establish and maintain an ad hoc network. AODV allows mobile nodes to obtain routes quickly for new destinations and does not require nodes to maintain routes to destinations that are not in active communication. AODV allows mobile nodes to respond to link breakages and changes in network topology in a timely manner. The operation of AODV is loop-free, and by avoiding the "Bellman-Ford counting to infinity" problem offers quick convergence when the Adhoc network topology changes (typically, when a node moves in the network). When links break, AODV causes the affected set of nodes to be notified so that they are able to invalidate the routes using the lost link. Route Requests (RREQs), Route Replies (RREPs) and Route Errors (RERRs) are message types defined by AODV.

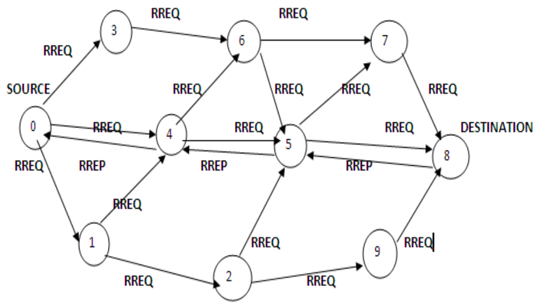

Figure 5. A possible path for a route replies if 0 wishes to find a route to 8

4. Performance Metrics

The Internet Engineering Task Force MANET working group suggests two different types of metrics for evaluating the performance of routing protocols for MANETs in RFC 2501 [9]. In accordance with RFC 2501, routing protocols should be evaluated in terms of both qualitative metrics and quantitative metrics. In the phase, the routing protocols are located that may be suitable in high speed wireless communications based on qualitative metrics. In the second phase, the selected protocols are evaluated from the first phase based on quantitative metrics.

4.1 Quantitative Metrics

1) Throughput [10]: Additional metrics can be used to measure the throughput of the protocol. One can use them to measure the portion of the available bandwidth that is used by the protocol for route discovery and maintenance. Another measurement calculates the packet delivery ratio over the total number of packets transmitted and the energy consumption of the protocol for performing its task.

$$\text{Throughput} = \frac{\text{No of delivered packets} * \text{Packet size} * 8}{\text{Simulation time}}$$

2) Packet Delivery Ratio [11]: This is the number of packets sent from the source to the number of received at the destination.

$$\text{PDR} = \frac{\text{Number of received packets}}{\text{Number of sent packets}}$$

3) Average end-to-end delay [11]: This is the average time delay for data packets from the source node to the destination node.

$$\text{AED} = \frac{\sum(\text{time received} - \text{time sent})}{\text{Total data packets received}}$$

5. Performance Analysis and Comparison Table Based on Simulation Results:

5.1 Average Throughput

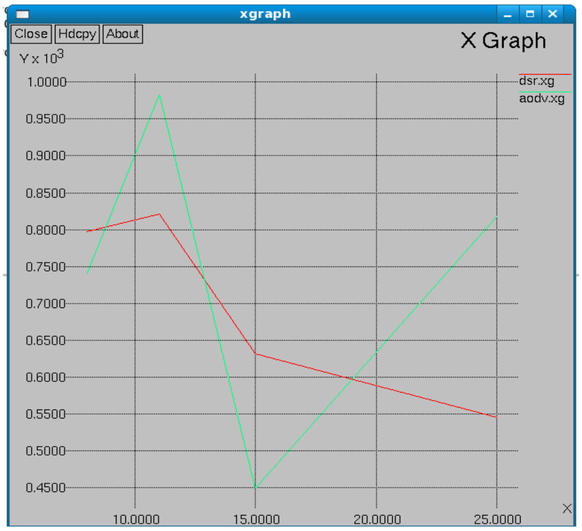

Figure 6 .Average Throughput with varying number of nodes.

Fig 6 shows the clear result of Average Throughput. AODV performs best in terms of Average Throughput. The performance of DSR is good only for less no. of nodes. AODV performs better for large number of nodes.

5.2 Packet Delivery Ratio

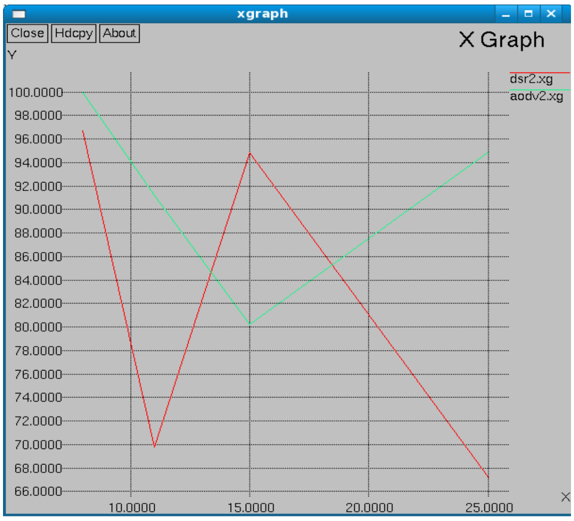

Figure 7.Packet Delivery Ratio with varying number of nodes.

AODV outperforms DSR in terms of Packet Drop Ratio. DSR shows the worst performance. AODV have very good packet receiving ratio comparing to DSR.

5.3 Average End-to-End Delay

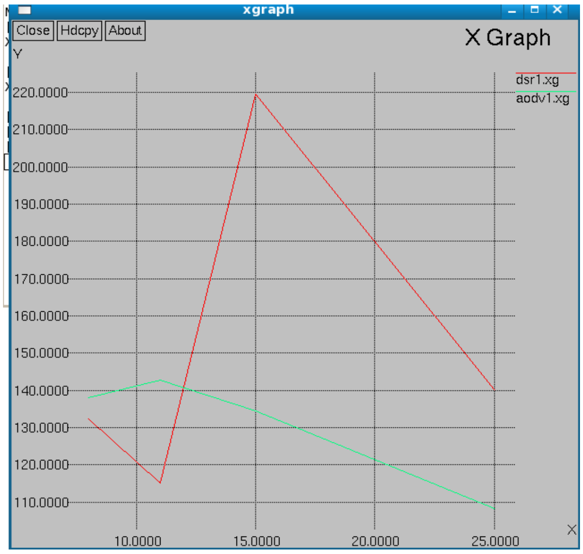

Figure 8. Average End-to-End Delay with varying number of nodes.

AODV performs best in case of average end-to-end delay. AODV shows the less Average end-to-end delay when the number of nodes increases. So it performs best on large number of nodes and less number of nodes also. The performance of DSR is poor in terms of Average end-to-end delay.

6. Conclusion & Future work

The goal of this paper was performance evaluation of MANET reactive routing protocols such as AODV and DSR In this paper, the performance of MANET reactive routing protocols have been analyzed under random mobility model with respect to three quantitative performance metrics(Throughput, Packet-delivery ratio and End to End Delay).The simulation results in Table 1 shows that throughput and packet delivery ratio is high for less number of nodes in DSR and high for more number of nodes in AODV ,where as in End to End Delay the performance is high for DSR and low for AODV in all the four scenarios(8,11,15,25 nodes) as well. AODV shows better overall performance in our simulation results. AODV have very good packet delivery ratio comparing to DSR. This work can be extended to the real time network which consists of more number of nodes. It would be interesting to observe the behavior of these protocols by varying the number of nodes.

Table 1.Comparison of Two Protocols using Different Metrics in Various Scenarios

Metrics	Dynamic Source Routing Protocol(DSR)				Adhoc On Demand Routing Protocol(AODV)			
	Number of nodes							
	8	11	15	25	8	11	15	25
Throughput	797.54	820.98	631.71	545.87	740.31	983.76	448.71	817.23
Packet Delivery Ratio	96.7213	69.764	67.18	94.8418	100	91.2088	94.9153	80.198
End To End Delay	132.426	115.12	140.282	219.636	138.047	142.802	108.202	134.592

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