Comparison Of Reactive Routing Protocols For MANET

Chintan N. Patel [1] ,
[1]Research Student,
[1]Dept. of E.C. Engineering,
Govt. Engg. College,
Surat, Gujarat, India

Prof. Milind S. Shah [2] ,
[2]Asso. Prof.,[2] Dept. of E.C. Engineering,
Govt. Engg. College,
Surat, Gujarat, India

Prof. Vyomal N. Pandya [3]
[3]Assi. Prof., [3]Dept. of E.C. Engineering,
C.K.P.C.E.T, Surat,
Gujarat, India

Abstract

A MANET is a collection of mobile nodes by wireless links forming a dynamic topology without any network infrastructure such as routers, servers, access points/cables or centralized administration. The nodes are free to move about and organize themselves into a network. These nodes change position frequently. The main classes of routing protocols are Proactive, Reactive and Hybrid. A Reactive (on-demand) routing strategy is a popular routing category for wireless ad hoc routing. It is a relatively new routing philosophy that provides a scalable solution to relatively large network topologies. The design follows the idea that each node tries to reduce routing overhead by sending routing packets whenever a communication is requested. DSR and AODV are reactive route discovery algorithms where a mobile device of MANET connects by gateway only when it is needed. The performance differentials are analyzed using performance metrics like throughput, average throughput and packet delivery ratio. These simulations are carried out using the ns-2 network simulator.

Keywords: *MANET, Reactive routing protocols, AODV, DSR, NS-2, Comparison, Performance Metrics.*

1. Introduction

The wireless networks are classified as Infrastructured or Infrastructure less. In Infrastructured wireless networks, the mobile node can move while communicating, the base stations are fixed and as the node goes out of the range of a base station, it gets into the range of another base station. In Infrastructure less or Ad Hoc wireless network, the mobile node can move while communicating, there are no fixed base stations and all the nodes in the network act as routers.

In areas in which there is little [2] or no communication infrastructure or the existing infrastructure is expensive or inconvenient to use, wireless mobile users may still be able to communicate through the formation of an Ad-hoc Network. In such a network, each mobile node forwarding packets for other mobile nodes in the network that may not be within direct wireless transmission range of each other. Each node participates in an ad hoc routing protocol that allows it to discover "multi-hop" paths through the network to any other node. The idea of ad hoc networking is sometimes also called infrastructure less networking.

1.1. MANET

The MANET [2] is a collection of nodes, which have the possibility to connect on a wireless medium and form an arbitrary and dynamic network with wireless links. This means that links between the nodes can change with time, new nodes can join the network, and other nodes can leave it. A MANET may be expected to be of larger size than the radio range of the wireless antennas, because of this fact it could be necessary to route the traffic through a multi-hop path to give two nodes the ability to communicate. There are neither fixed routers nor fixed locations for the routers as in cellular networks - also known as infrastructure networks.

1.1.1 THE CHARACTERISTICS OF MANET [4]

- Communication via wireless means.
- Nodes can perform the roles of both hosts and routers.
- Bandwidth-constrained, variable capacity links.
- Energy-constrained Operation.
- Limited Physical Security.
- Dynamic network topology.
- Frequent routing updates.

1.1.2 ADVANTAGES OF MANET [4]

- They provide access to information and services regardless of geographic position.
- These networks can be set up at any place and at any time.

1.1.3 DISADVANTATES OF MANET [4]

- Limited resources and less physical security.
- Intrinsic mutual trust vulnerable to attacks.
- Lack of authorization facilities.
- Volatile network topology makes it hard to detect malicious nodes.
- Security protocols for wired networks can not work for ad hoc networks.

1.1.4 APPLICATIONS OF MANET [4]

- Military or police exercises.
- Disaster relief operations.
- Mine cite operations.
- Urgent Business meetings.

2. REACTIVE ROUTING PROTOCOLS

2.1 Ad hoc On-demand Distance Vector (AODV):

Ad hoc On-demand distance vector (AODV) [3] is a variant of classic distance vector routing algorithm, based on DSDV and DSR. It discovers routes on and as needed via a similar route discovery process. However, AODV adopts traditional routing tables; one entry per destination which is in contrast to DSR that preserves multiple route cache entries for each destination. The early design of AODV is undertaken after the experience with DSDV routing algorithm. Like DSDV, AODV provides loop free routes in case of link breakage but unlike DSDV, it doesn't need global periodic routing advertisement. AODV uses a broadcast route discovery algorithm and then the unicast route reply message.

2.1.1 Advantages and Drawbacks of AODV [1]:

The routes are established on demand and destination sequence numbers are used to find the latest route to the destination. The connection setup delay is lower. It also responds very quickly to the topological changes that affects the active routes. It does not put any additional overheads on data packets as it does not make use of source routing. It favours the least congested route instead of the shortest route and it also supports both unicast and multicast packet transmissions even for nodes in constant movement.

The intermediate nodes may lead to inconsistent routes if the source sequence number is very old and the intermediate nodes have a higher but not the latest destination sequence number, thereby having stale entries. The various performance metrics begin decreasing as the network size grows. It is vulnerable to various kinds of attacks as it based on the assumption that all nodes must cooperate and without their cooperation no route can be established. The multiple route reply packets in response to a single route request packet can lead to heavy control overhead. The periodic beaconing leads to unnecessary bandwidth consumption. It expects that the nodes in the broadcast medium can detect each others' broadcasts. It is possible that a valid route is expired and the determination of a reasonable expiry time is difficult too. The reason behind this is that the nodes are mobile and their sending rates may differ widely and may change dynamically from node to node.

2.2 Dynamic Source Routing (DSR):

The Dynamic Source Routing (DSR) [3] is one of the purest examples of an on-demand routing protocol that is based on the idea of source routing. It is designed specially for use in multihop ad hoc networks for mobile nodes. It allows the network to be completely self-organizing and self-configuring and does not need any existing network infrastructure or administration. 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.

2.2.1 Advantages and Drawbacks of DSR [1]:

DSR is beaconless routing protocol means it doesn't use periodic hello messages like AODV, thereby reduces network bandwidth overhead, conserves battery power and avoids large routing updates. There is no need to keep routing table so as to route a given data packet as the entire route is contained in the packet header. The routes are maintained only between nodes that need to communicate. This reduces overhead of route maintenance. Route caching can further reduce route discovery overhead. A single route discovery may yield many routes to the destination, due to intermediate nodes replying from local caches. The DSR protocol guarantees loop-free routing and very rapid recovery when routes in the network change. It is able to adapt quickly to changes such as host movement, yet requires no routing protocol overhead during periods in which no such changes occur. In addition, DSR has been designed to compute correct routes in the presence of asymmetric (uni-directional) links. In wireless

networks, links may at times operate asymmetrically due to sources of interference, differing radio or antenna capabilities, or the intentional use of asymmetric communication technology such as satellites. Due to the existence of asymmetric links, traditional link-state or distance vector protocols may compute routes that do not work. DSR, however, will find a correct route even in the presence of asymmetric links.

DSR protocol is not totally free from drawbacks as it is not scalable to large networks. It is mainly efficient for mobile ad hoc networks with less than two hundred nodes. DSR requires significantly more processing resources than most other protocols. In order to obtain the routing information, each node must spend lot of time to process any control data it receives, even if it is not the intended recipient. The contention is increased if too many route replies come back due to nodes replying using their local cache. The Route Reply Storm problem is there. An intermediate node may send Route Reply using a stale cached route, thus polluting other caches. This problem can be eased if some mechanism to purge (potentially) invalid cached routes is incorporated. The Route Maintenance protocol does not locally repair a broken link. The broken link is only communicated to the initiator. Packet header size grows with route length due to source routing. Flood of route requests may potentially reach all nodes in the network. Care must be taken to avoid collisions between route requests propagated by neighbouring nodes.

3. Network Simulator-2

Ns-2 [4] 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 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). The simulator was originally developed by the University of California at Berkeley and VINT project the simulator was recently extended to provide simulation support for ad hoc network by Carnegie Mellon University (CMU Monarch Project homepage, 1999). The ns-2 simulator has several features that make it suitable for our simulations.

A network environment for ad-hoc networks, Wireless channel modules (e.g.802.11), Routing along multiple paths, Mobile hosts for wireless cellular networks. Ns-2 is an objectoriented simulator written in C++ and OTcl. The simulator supports a class hierarchy in C++ and a similar class hierarchy within the OTcl interpreter. There is a one-to-one 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 [4] 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.

4. Performance Metrics

There are different quantitative metrics [2] to compare the performance. They are

(1) Throughput:

It is the ratio of the total packets delivered to the destination to the time taken for deliver the packets.

Throughput = (total packets delivered to the destination)/(time taken for deliver the packets)

(2) Average Throughput:

It is the ratio of total throughput divided by the total number of count for throughput.

Average Throughput = (total throughput)/(total number of count for throughput)

(3) Packet Delivery Ratio:

Packet Delivery Ratio in this simulation is defined as the ratio between the number of packets sent by constant bit rate sources (CBR) and number of packets received by CBR sink at destination.

CBR = ∑(total packets received) / ∑(total packets sent)

5. Simulation Results

Compare AODV and DSR routing protocols using network simulator-2 for TCP and UDP traffic as well as for Fixed and Dynamic intermediate nodes. For comparing AODV and DSR routing protocols we consider five cases with different parameters.

The parameters for simulation are as follows:

Parameter	Value
Simulation Time	150 sec
Number of Nodes	20
Routing Protocols	AODV, DSR
Simulation Area	400x400 meter^2
Packet Size	500
Interval	0.05

CASE 1: Simulation for Throughput and Average Throughput of Fixed network containing 20 nodes with TCP traffic.

Throughput is more in DSR than AODV until 90sec, but after that as the time increases throughput is more in AODV than DSR. Average throughput is higher in DSR than AODV.

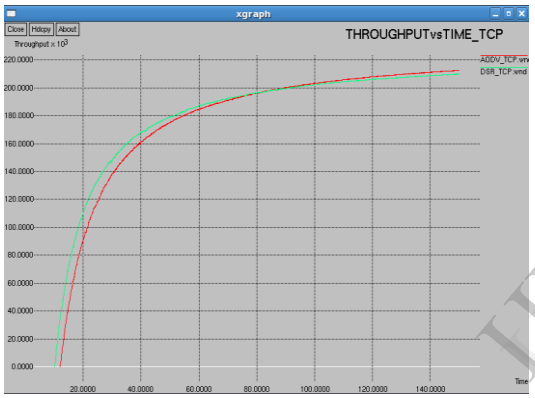

Figure 1: Throughput for Fixed nodes with TCP traffic

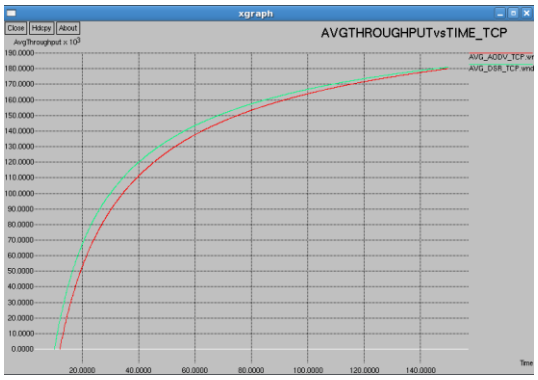

Figure 2: Average Throughput for Fixed nodes TCP traffic

CASE 2: Simulation for Throughput and Average Throughput of Dynamic network containing 20 nodes with TCP traffic.

Throughput is more in AODV than DSR. Average throughput is also higher in AODV than DSR.

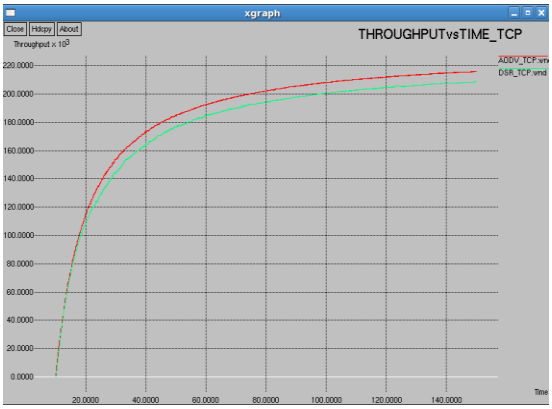

Figure 3: Throughput for Dynamic nodes with TCP traffic

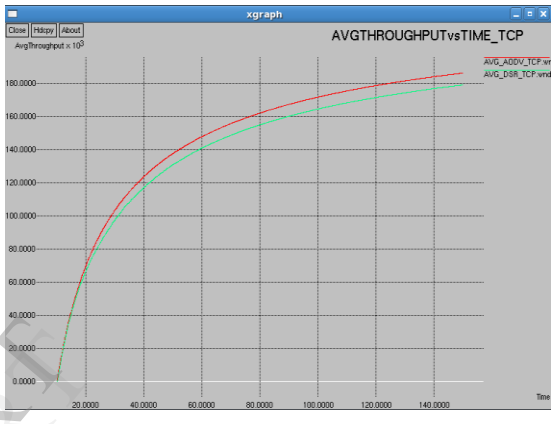

Figure 4: Average Throughput for Dynamic nodes with TCP traffic

CASE 3: Simulation for Throughput and Average Throughput of Fixed network containing 20 nodes with UDP traffic.

Throughput is higher in DSR than AODV until 30sec, but after that as the time increases throughput is higher in AODV than DSR. Average throughput is also higher in DSR than AODV until 38sec, but after that as the time increases throughput is higher in AODV than DSR.

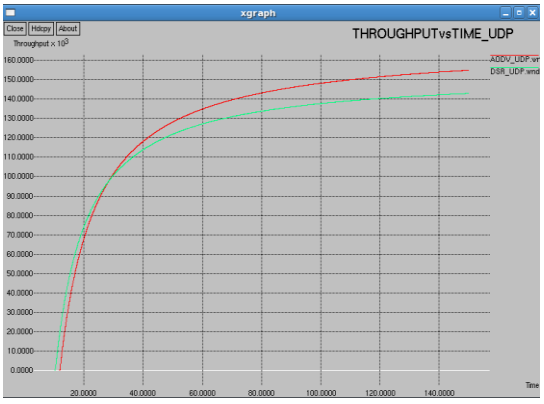

Figure 5: Throughput for Fixed nodes with UDP traffic

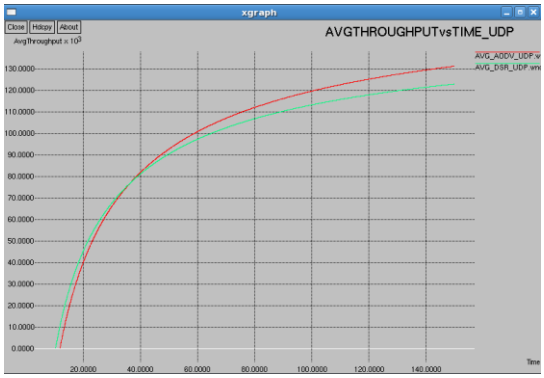

Figure 6: Average Throughput for Fixed nodes UDP traffic

CASE 4: Simulation for Throughput and Average Throughput of Dynamic network containing 20 nodes with UDP traffic.

Throughput is higher in DSR than AODV until 37sec, but after that as the time increases throughput is higher in AODV than DSR. Average throughput is also higher in DSR than AODV until 43sec, but after that as the time increases throughput is higher in AODV than DSR.

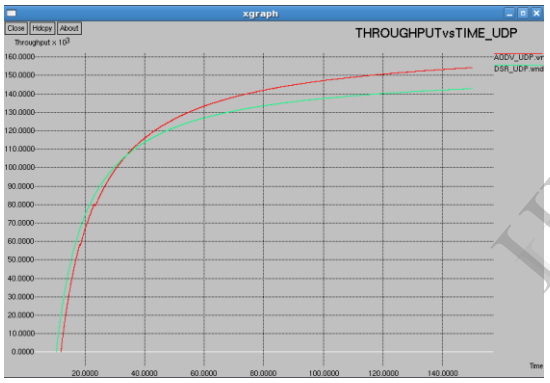

Figure 7: Throughput for Dynamic nodes with UDP traffic

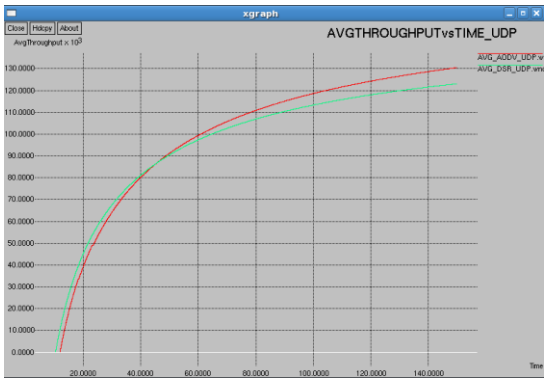

Figure 8: Average Throughput for Dynamic nodes with UDP traffic

CASE 5: Simulation for Packet Delivery Ratio of Dynamic network containing 20 nodes with UDP traffic:

Packet delivery ratio is higher in DSR than AODV until PDR reaches 0.338 and transmitted bits are 1MBits, but after that as the transmitted bits increases the PDR is higher in AODV than DSR.

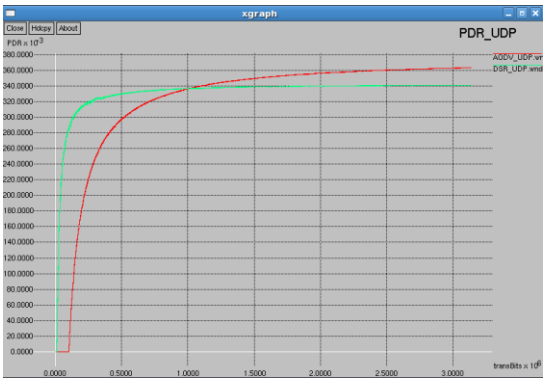

Figure 9: PDR for Dynamic nodes with UDP traffic

6. Conclusion

We have compared two On-demand Routing Protocols, namely, Ad hoc On-Demand Distance Vector Routing (AODV) and Dynamic Source Routing (DSR). As the traffic parameter we have used File Transfer Protocol (FTP) and User Defined Protocol (UDP). We analyze both protocols in terms of Throughput, Average Throughput and Packet Delivery Ratio. As the time increases, the Throughput, Average Throughput and Packet Delivery Ratio increase in AODV and DSR. By comparison of performance metrics of both the routing protocols, we can observe that AODV gives higher throughput, Avg. Throughput and PDR compared to DSR in wireless ad hoc network.

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