Manet: Comparion on AODV and DSR

Akshat Agrawal

Department of Computer Science Amity University Haryana
Email: Akshatag20@gmail.com

Abstract-A mobile ad hoc network is a collection of wireless nodes that can dynamically be set up anywhere and anytime without using any pre-existing network infrastructure (MANETs). The special features of MANET bring these technology great opportunities together with severe challenges. The routing protocols meant for wired networks cannot be used for mobile ad hoc networks because of the mobility of nodes. Routing in mobile ad hoc networks is a challenging task because nodes are free to move randomly. Routing in wireless mobile ad-hoc networks should be time efficient and resource saving. Each node operates not only as an end system, but also as a router to forward packets. The nodes are free to move about and organize themselves into a network. These nodes change position frequently. In this paper an attempt has been made to compare the performance of two prominent on demand reactive routing protocols for MANETs: - Dynamic Source Routing (DSR) protocols and Ad hoc On Demand Distance Vector (AODV). DSR and AODV are reactive gateway discovery algorithms where a mobile device of MANET connects by gateway only when it is needed. The performance differentials are analyzed using varying simulation time. These simulations are carried out using the ns-2 network simulator. The results presented in this paper will illustrate the importance in carefully evaluating and implementing routing protocols in an ad hoc environment. In this simulation other network parameters such as number of mobile nodes, traffic type-CBR, simulation area etc. are kept constant. Whereas the simulation time is varied different simulation scenarios

Keywords — MANET, AODV, DSR.

I. INTRODUCTION

The people's future living environments are emerging based upon information resource provided by the connections of various communication networks for users. New small devices like Personal Digital Assistants (PDAs), mobile phones, handhelds, and wearable computers enhance information processing and accessing capabilities with mobility. Moreover, traditional home appliances, e.g. digital cameras, cooking ovens, washing machines, refrigerators, vacuum cleaners, and thermostats, with computing and communicating powers attached, extend the field to a fully pervasive computing environment. With this in view, modern technologies should be formed within the new paradigm of pervasive computing, including new architectures, standards, devices, services, tools, and protocols. Mobile networking is one of the most important technologies supporting pervasive computing. During the last decade, advances in both hardware and software techniques have resulted in mobile hosts and wireless networking common and miscellaneous [1].

(a) MANET Concept

A mobile ad hoc network is a collection of wireless nodes that can dynamically be set up anywhere and anytime without using any pre-existing network infrastructure. It is an autonomous system in which mobile hosts connected by wireless links are free to move randomly and often act as routers at the same time. The traffic types in ad hoc networks are quite different from those in an infrastructure wireless network [3], including:

- Peer-to-Peer. Communication between two nodes which are within one hop. Network traffic (Bps) is usually consistent.
- Remote-to-Remote. Communication between two nodes beyond a single hop but which maintain a stable route between them. This may be the result of several nodes staying within communication range of each other in a single area or possibly moving as a group. The traffic is similar to standard network traffic.
- Dynamic Traffic. This occurs when nodes are dynamic and moving around. Routes must be reconstructed. This results in a poor connectivity and network activity in short bursts.

(b) MANET Features

MANET has the following features [3]:

- Autonomous terminal. In MANET, each mobile terminal is an autonomous node, which may function as both a host and a router. In other words, besides the basic processing ability as a host, the mobile nodes can also perform switching functions as a router. So usually endpoints and switches are indistinguishable in MANET.
- Distributed operation. Since there is no background network for the central control of the network operations, the control and management of the network is distributed among the terminals. The nodes involved in a MANET should collaborate amongst themselves and each node acts as a relay as needed, to implement functions e.g. security and routing.

- Multihop routing. Basic types of ad hoc routing algorithms can be single-hop and multihop, based on different link layer attributes and routing protocols. Single-hop MANET is simpler than multihop in terms of structure and implementation, with the cost of lesser functionality and applicability. When delivering data packets from a source to its destination out of the direct wireless transmission range, the packets should be forwarded via one or more intermediate nodes.
- Dynamic network topology. Since the nodes are mobile, the network topology may change rapidly and unpredictably and the connectivity among the terminals may vary with time. MANET should adapt to the traffic and propagation conditions as well as the mobility patterns of the mobile network nodes. The mobile nodes in the network dynamically establish routing among themselves as they move about, forming their own network on the fly. Moreover, a user in the MANET may not only operate within the ad hoc network, but may require access to a public fixed network (e.g. Internet).
- Fluctuating link capacity. The nature of high bit-error rates of wireless connection might be more profound in a MANET. One end-to-end path can be shared by several sessions. The channel over which the terminals communicate is subject to noise, fading, and interference, and has less bandwidth than a wired network. In some scenarios, the path between any pair of users can traverse multiple wireless links and the link themselves can be heterogeneous.
- Light-weight terminals. In most cases, the MANET nodes are mobile devices with less CPU processing capability, small memory size, and low power storage. Such devices need optimized algorithms and mechanisms that implement the computing and communicating functions

(c) MANET Challenges

Regardless of the attractive applications, the features of MANET introduce several challenges that must be studied carefully before a wide commercial deployment can be expected. These include:

- Routing. Since the topology of the network is constantly changing, the issue of routing packets between any pair of nodes becomes a challenging task. Most protocols should be based on reactive routing instead of proactive. Multicast routing is another challenge because the multicast tree is no longer static due to the random movement of nodes within the network. Routes between nodes may potentially contain multiple hops, which is more complex than the single hop communication.
- Security and Reliability. In addition to the common vulnerabilities of wireless connection, an ad hoc network has its particular security problems due to e.g. nasty neighbor relaying packets. The feature of distributed operation requires different schemes of authentication and key management. Further, wireless link characteristics introduce also reliability problems, because of the limited wireless transmission range, the broadcast nature of the wireless medium (e.g. hidden terminal problem), mobility-induced packet losses, and data transmission errors.
- Quality of Service (QoS). Providing different quality of service levels in a constantly changing environment will be a challenge. The inherent stochastic feature of communications quality in a MANET makes it difficult to offer fixed guarantees on the services offered to a device. An adaptive QoS must be implemented over the traditional resource reservation to support the multimedia services.
- Internetworking. In addition to the communication within an ad hoc network, internetworking between MANET and fixed networks (mainly IP based) is often expected in many cases. The coexistence of routing protocols in such a mobile device is a challenge for the harmonious mobility management.
- Power Consumption. For most of the light-weight mobile terminals, the communication-related functions should be optimized for lean power consumption. Conservation of power and power-aware routing must be taken into consideration.

II. ROUTING IN MANET

Routing is the act of moving information from a source to a destination in an internetwork. At least one intermediate node within the internetwork is encountered during the transfer of information. Basically two activities are involved in this concept: determining optimal routing paths and transferring the packets through an internetwork. The transferring of packets through an internetwork is called as packet switching which is straight forward, and the path determination could be very complex. Routing protocols use several metrics as a standard measurement to calculate the best path for routing the packets to its destination that could be number of hops, which are used by the routing algorithm to determine the optimal path for the packet to its destination. The process of path determination is that, routing algorithms find out and maintain routing tables, which contain the total route information for the packet. The information of route varies from one routing algorithm to another. As shown in Fig 1, routing protocols for Ad Hoc network can be classified into three main categories Proactive, Reactive, and Hybrid routing protocols. Many protocols have been developed under each category.

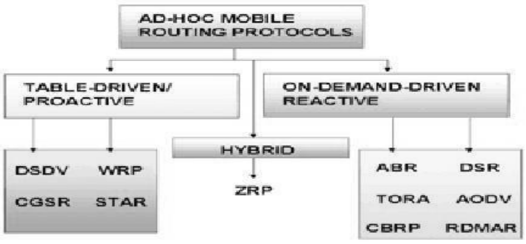

Figure 1. Categorization of Ad Hoc Routing Protocol

In this paper we study two reactive routing protocols namely, Ad Hoc On-Demand Distance Vector (AODV) routing protocol and Dynamic Source Routing (DSR).

1) On-Demand Distance Vector (AODV)

A source node that wants to send a message to a destination for which it does not have a route, broadcasts a request RREQ packet. All nodes receiving this packet update their information for the source node and maintain only the next hop's address in a routing table. A RREQ packet contains the source node's address, broadcast ID, current sequence number and the most recent sequence number of the destination node. The response packet RREP is sent by either the destination or a node that has a route to the destination with the sequence number greater than or equal to the sequence number in the RREQ packet. The route is established once the source node receives the RREP. AODV algorithm includes route maintenance facilities. When a link is broken, the related node sends a RERR message to the neighboring nodes using that route. The main advantage of AODV compared to DSR is the reduced bandwidth due to smaller control and data packet. This algorithm has also good scalability because it needs only two addresses: destination and next hop. However, it works with symmetric links and does not allow for multipath routing. So, new routes must be discovered when a link breaks down [4].

2) Dynamic Source Routing (DSR)

DSR is a simple algorithm based on the concept of source routing: Source nodes determine routes dynamically and only as needed. A source node that wants to send a packet must check its route cache. If there is a valid entry for the destination, the node sends the packet using that route. If no valid route, the source node initiates the route discovery process: it first send a special route request (RREQ) packet to all neighboring nodes and then propagate through the network collecting the address of all nodes visited until it reaches the destination node or intermediate node with a valid route to the destination node. This node initiates the route reply process: it sends a special route reply RREP packet to the source node providing the sequence of all node through which a packet will travel. This algorithm includes also a route maintenance process. Each host sends a route error (RERR) packet if it encounters a broken link. DSR is easily implemented and thus can work with asymmetric links and involves no overhead when there are no changes in the network. Furthermore, it can be improved to support multiple routes from the source to destination. Nevertheless, large bandwidth overhead is inherent in dynamic source routing. Each route cache collects the addresses of all visited nodes and the RREQ packet can become huge. So, the acceptable network's diameter and its scalability are limited [5][7].

3) Comparison on AODV and DSR

The DSR and the AODV protocol are two dynamic routing protocols that initiate routing activities for ad hoc networks on an on demand basis [20, 21]. These protocols were designed for reducing the routing loading in networks.

TABLE 1 COMPARISON BETWEEN AODV AND DSR

Protocol Property	**DSR**	**AODV**
Multicast Routes	Yes	No
Distributed	Yes	Yes
Unidirectional Link	Yes	No
Support Multicast	No	Yes
Periodic Broadcast	No	Yes
QoS Support	No	No
Routes Maintained in	Route Cache	Route table
Reactive	Yes	Yes

III. SYSTEM MODEL

(A) Methodology

The framework and skeleton overview for the performance evaluation of the chosen protocols is given. The techniques used are modeling the network, simulating the network and measuring the performance of the protocols. Performance is the key criteria in all aspect of activity to measure the effectiveness of the system. We need to know the techniques to evaluate the performance of the given system and to know the best performer for the given price. The three techniques used are modeling, simulation and measurement. Simulation is the simplest and best form compared to analytical modeling as it requires fewer assumptions and can have more details. Computer based simulation tool is best suitable as it is cost effective and consumes less time, also at the same time can deliver at a better speed and accuracy. There are number of network simulator tool available for the project like OPNET, Glomosim, Qualnet and network simulator (NS-2) etc. Here we have chosen NS-2 as the computer network simulator.

(B) Advantages of NS-2

NS2 is an open-source simulation tool that runs on Linux. It is a discreet event simulator targeted at networking research and provides substantial support for simulation of routing, multicast protocols and IP protocols, such as UDP, TCP, RTP and SRM over wired and wireless (local and satellite) networks. It has many advantages that make it a useful tool, such as support for multiple protocols and the capability of graphically detailing network traffic. Additionally, NS2 supports several algorithms in routing and queuing. LAN routing and broadcasts are part of routing algorithms. Queuing algorithms include fair queuing, deficit round-robin and FIFO.[14-16]

(C) Simulation Model

The nodes initial placement and movement pattern are given in a scenario file which the NS-2 accepts as one of the input parameters. The communication between randomly chosen source and destination nodes is also given as in a traffic file, which the NS-2 accepts as its second input parameters.

TABLE 2. THE BASIC ARCHITECTURE OF NS-2 SIMULATION

Channel	Channel/WirelessChannel
Propagation	Propagation/TwoRayGround
Network interface	Phy/WirelessPhy
MAC	Mac/802_11
Interface queue	Queue/DropTail/PriQueue
Link layer	LL
Antenna	Antenna/Omni Antenna
Reactive	Yes
Interface queue length	500
No. of nodes	25,50,75,100
Protocols	AODV, DSR
Simulation area size	1000 x 100 M
Simulation duration	100 secs
Type of communication	UDP
Packet size	200 bytes
Packet interval	4 pkts per second

The output generated by the NS-2 simulator consists of a trace file, named *.tr, where each layer agent like UDP, AODV record their activities like sending a packet, receiving a packet etc. The second output generated by NS-2 is a animation file, named *.nam, which when animated using NAM animator tool, will show what happens during the entire simulation period.

IV. SIMULATION AND COMPARISON METHOD ON AODV & DSR

A. Simulation design

The simulation is done under ns-2 using the method we discussed previously. The basic configuration is that our testing is in a 500 * 500 square with total 50 nodes. The traffic sources are CBR (constant bit rate), 512-byte as data packets, sending rate is 4 pkts/second. To use CBR is for a fair comparison purpose, since bit rate vary will make the data packets traffic load unpredictable, which situation we do not want it happen. The number of sources we use is 10. The node movement speed is set to from 0 to 5 which will be closer to the sensor network's application. The mobility are done with various pause time: 50, 100, 150, 220, 325, 575, 800 seconds (pretty high pause time, since we do not want too much mobility occurs in sensor networks application), and the MAC we employ is 802.11 MAC.

B. Simulation result

1. Packet delivery rate

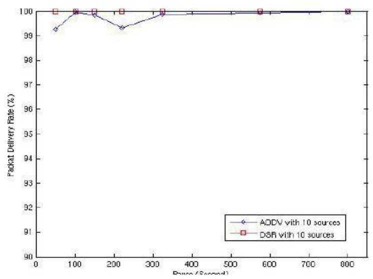

Figure 2. Packet delivery rate comparison

Figure 2, shows the experiment results of packets delivery rate. We can see, under low traffic load as 10 sources. DSR outperform the AODV, but when the sources become more, DSR with small pause time which means high mobility began to perform worse than AODV. This result is what we want to see, since AODV have more routing control packets but may always choose the fresh route, while DSR its smaller number of routing packets under stressfully situation with the network topology continue to change from time to time, will be inclined to choose wrong routes, thus lower the packets delivery rate.

2. Average delay

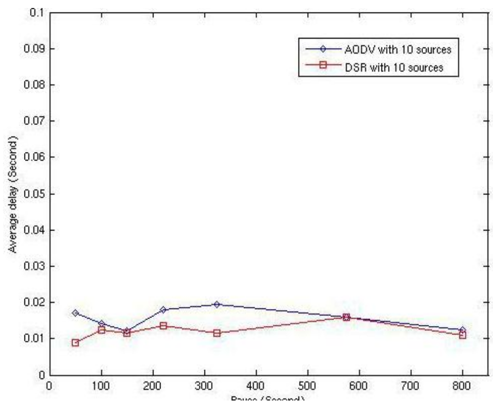

Figure 3. Average delay comparison

Figure 3, shows about the average delay of AODV and DSR. Since AODV has much more routing packets than

DSR, and those routing packets will consume more bandwidth, AODV then will have more delay than DSR. This is due to a high level of network congestion and multiple access interferences at certain regions of the ad hoc network. Neither protocol has any mechanism for load balancing, i.e., for choosing routes in such a way that the data traffic can be more evenly distributed in the network. This phenomenon is less visible with higher mobility where traffic automatically gets more evenly distributed due to source movements.

3. Average routing overhead

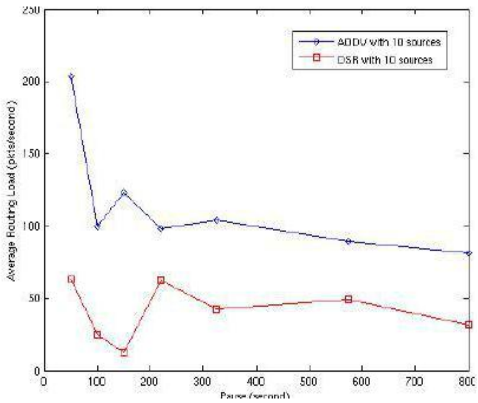

Figure 4. Average routing overhead comparison

Since AODV always has more routing control packets than DSR, the routing overhead of AODV than will always be higher even in stressful environment. Under heavy load, though DSR may incline to choose wrong route, however, under such situation, AODV will also generate far more control packets than DSR.

C. Simulation conclusion

In particular, DSR uses source routing and route caches and does not depend on any periodic or timer-based activities. DSR exploits caching aggressively and maintains multiple routes per destination. AODV, on the other hand, uses routing tables, one route per destination, and destination sequence numbers, a mechanism to prevent loops and to determine freshness of routes. We used a detailed simulation model to demonstrate the performance characteristics of the two protocols. The general observation from the simulation is that for application oriented metrics such as delay and delivery rate. DSR outperforms AODV in less stressful situations. AODV, however, outperforms DSR in more stressful situations. DSR, however, consistently generates less routing load than AODV. The poor delay and throughput performances of DSR are mainly attributed to aggressive use of caching, and lack of any mechanism to expire stale routes or to determine the freshness of routes when multiple choices are available. Aggressive caching, however, seems to help DSR at low loads and also keeps its routing load down. We believe that mechanisms to expire routes and/or determine freshness of routes in the route cache will benefit DSR performance significantly.

V. CONCLUSION

It is difficult for the quantitative comparison of the most of the ad hoc routing protocols due to the fact that simulations have been done independent of one another using different metrics and using different simulators. The successful test on the comparison of AODV and DSR shows that our performance evaluation mechanism developed by this project is really effective for scalable performance test in NS-2. It also could be easy to use for measure the network routing protocols' performance, meanwhile, since it has the fix model of analysis the trace file, with some minor modification, it will then be apply to measure other kinds of stuffs with the whole network simulation.. AODV performs predictably. Delivered virtually all packets at low node mobility, and failing to converge as node mobility increases. Meanwhile DSR was very good at all mobility rates and movement Speeds, Hence for real time traffic AODV is preferred over DSR. However, since we now only explore some important fields of the trace file, in the future, we still need to provide the measurement with other fields of the trace file and analysis more details on the things what we can get in the trace file

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