Performance Evaluation of Different Routing Protocols Using Different Parameters in Mobile Ad-Hoc Network (MANET)

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Abstract: Mobile Ad-hoc Network (MANET) has been introduced to use in many applications. To design the networks, the factors needed to be considered are the coverage area, mobility, power consumption, communication capabilities etc. The challenging goal of this work is to create a simulator to support the MANET simulation. The main challenge in WSN is routing. Many routing protocols for MANET have proposed but no one is suitable for all situations. Dynamic source Routing Protocol (DSR) and Ad-hoc On Demand Distance Vector Routing Protocol (AODV) protocol are popular in MANET. Both DSR and AODV is reactive protocol. DSR routing protocol consumes more bandwidth because of the frequent broadcasting of routing updates. So when the network size is large in that case packet header overhead is increased. AODV doesn’t maintain any routing tables at nodes. So AODV have low overhead and more bandwidth. It reduces overhead of packet header and performs better in both high mobility and large size network. So the main focus of this work is to find the best routing protocol by evaluating the performance of different routing protocols (DSR, AODV) using different network parameters for terrain area (1500m x 1500m) in MANET. These protocols are simulated on NS-2.35 with the help of network parameters (Packet Delivery Fraction (PDF), Average Throughput and Normalized Routing Load (NRL), and Average end-to-end Delay).

Keywords: MANET, DSR, AODV, NS-2.35.

I. INTRODUCTION

A MANET is a collection of mobile nodes which can self-organize freely and dynamically into arbitrary and temporary network topologies. It consists of mobile platforms (e.g. a router with multiple hosts and wireless communications devices) simply referred to as nodes which are free to move about arbitrarily. The nodes may be located in or on airplanes, ships, trucks, cars, perhaps even on people or very small devices, and there may be multiple hosts per router. A MANET is an autonomous system of mobile nodes. The system may operate in isolation, or may have gateways to and interface with a fixed network.

Characteristics

Mobile Ad hoc Network (MANET) is a collection of independent mobile nodes that can communicate to each other via radio waves. The mobile nodes that are in radio range of each other can directly communicate, whereas others need the aid of intermediate nodes to route their packets. These networks are fully distributed, and can work at any place without the help of any infrastructure. This property makes these networks highly exile and robust.

The characteristics of these networks are summarized as follows:

- Communication via wireless means.
- Nodes can perform the roles of both hosts and routers.
- No centralized controller and infrastructure. Intrinsic mutual trust.
- Dynamic network topology. Frequent routing updates.
- Autonomous, no infrastructure needed.
- Can be set up anywhere.
- Energy constraints
- Limited security

Application Areas

Some of the applications of MANETs are:
- Military or police exercises.
- Disaster relief operations.
- Mine site operations.
- Urgent Business meetings
- Robot data acquisition

II. Routing Protocols in MANET

In this section this dissertation determines the routing protocols state art for MANET. Basically the routing protocols of MANETs are categorized into flat based routing, location based routing, and hierarchical based routing depending on the network structure. In the flat based routing all sensor nodes are equally performs functionalities or assigned equal roles while the hierarchical based routing however all nodes plays different roles in the network. In the location based routing all sensor nodes positions are divided to route data in the network.

III. LITERATURE SURVEY

MANETs are very important type of networks used in various organizations. But MANETs are vulnerable to a number of attacks. Sleep deprivation attack is also one of them. It is basically a denial of service kind of attack in which the main aim is to drain off limited resources in the mobile ad-hoc nodes (e.g. the battery powers), by constantly making them busy processing unnecessary packets. The power resource is a very important component in case of MANETs as the nodes are continuously moving. So confronting the sleep deprivation torture is a very necessary aspect.

IV. CHALLENGES

The major challenges MANETs have to deal with are as follows:
1. In a MANET, nodes cooperate to route traffic. Any routing algorithm must contend with nodes that may be under an attacker’s control.

2. Bandwidth is locally shared and often highly-constrained in a MANET. How can this congestion be handled while simultaneously detecting nodes that are maliciously flooding the network or dropping traffic.

3. Battery life is often a concern for MANET designers, as roaming nodes often wish to act selfishly in order to conserve power. Thus, CPU cycles and wireless power management are extremely valuable commodities.

4. As the traffic observed by a node depends greatly on network topology, it is difficult for systems to learn what good traffic patterns look like, and what constitutes an attack.

5. Nodes frequently enter or leave the network, causing frequent changes in network membership and contributing to localized changes in topology.

6. There is no central authority for network monitoring and management, as the network can become disjoint at any time.

V. RELATED WORK

As a promising network type for future mobile application, MANETs are attracting more and more researchers. Mobile ad hoc networks are resource constrained and hence Routing in mobile ad hoc networks is more challenging task. Many researchers have done work on analyzing the characteristics of different routing protocols in mobile ad hoc networks. Rachit Jain, Lakshmi Shrivastava [10] analyzed the performance of AODV & DSR on the basis of Path Loss Propagation Models based on various performance metrics in order to create a substantial understanding of choosing the correct protocol for any active operating environment. Dhananjay Bisen et al. [11] studied the effect of pause time on AODV, DSR and DYMO routing protocols in mobile ad hoc networks based on parameters like Packet Drop Ratio (PDR), Throughput, Jitter and End to End Delay with variations in Pause Time of network. They concluded that DSR performs better than AODV and DYMO in different situations with variation in pause time and performance of DYMO is better than DSR in some situations. Monika at el. [12] compared AODV, DSDV and DSR Routing Protocols in Vehicular Network Using EstiNet Simulator based on parameters like throughput, number of packets dropped. The performance of AODV found to be better in most situations. M.L. Sharma et al. [13] analyzed the performance of MANET routing protocols under CBR and FTP traffic classes under different network scenarios like pause time, offered load (i.e. number of source destination pairs), node speed. The results show that for CBR traffic, AODV performs better than DSR and WRP in terms of Packet Delivery Ratio (PDR), Throughput and routing overhead and for FTP traffic, DSR performs better than AODV and WRP in terms of packet delivery ratio and throughput. Liang Qin, Thomas Kunz [14] provides a method to increase the packet delivery ratio in DSR by link protection through link breakage prediction algorithm. They also proposed that Enhanced route cache maintenance based on the link status can further reduce the number of dropped packets.

VI. DYNAMIC SOURCE ROUTING (DSR)

It uses the concept of [5] source routing in which the creates routes only when source requires [6]. It is based on link state algorithm [4]. As it is on demand routing protocol, the routing overhead is less [14]. This Protocol is composed of two essential parts of route discovery and route maintenance. Route Discovery: When a source node S wants to send a packet to the destination D, it first checks its route cache. If there is an entry for the destination node, then the source uses the available route in cache. If route not found or the the route cache has an expired route, then it initiates the route discovery process. Route cache contains the recently discovered routes. Route discovery requires 7 fields during this process such as sourceid, destid, ReqId, AddressList, HopLimit, NetworkInterFaceList, AckList. Acknowledgment list. Then source node broadcasts the message to its neighbour. Moreover, source node also maintains a replica of messages sent in its send buffer. Packets can be dropped if send buffer is full or the time limit for route discovery is over. When a nodes destination or the intermediate node having route to destination receives the route request message, it generates route reply [6]. Route Maintenance: Route maintenance includes monitoring the routes against failure through route error messages and route cache [5]. There is no need of keeping routing table in DSR [3] protocol. Route cache can further decrease route discovery overhead. DSR reduces overhead of route maintenance. However DSR is not scalable to large networks and packets Size grows with length of the route due to source routing.

VIII. SIMULATIONS

The simulations were performed using Network Simulator 2 (NS2), particularly popular [9] in the ad hoc networking

RES Publication © 2012
www.ijmece.org

International Journal of Modern Electronics and Communication Engineering (IJMECE)
Volume No., Issue No., Month, Year
ISSN: 2321-2152

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community. The traffic sources are UDP. The source-destination pairs are spread randomly over the network. During the simulation, each node starts its journey from a random spot to a random chosen destination. Once the destination is reached, the node takes a rest period of time in second and another random destination is chosen after that pause time. This process repeats throughout the simulation, causing continuous changes in the topology of the underlying network. Different network scenario for different number of nodes and pause times are generated.

IX. EXPERIMENTAL RESULTS

The purpose of this experimental study is to measure the ability of the routing protocols to react to the network topology change while continuing to successfully deliver data packets to their destinations. To measure this ability, different scenarios are generated by varying the pause time and Maximum speed in the network that also over different terrain areas.

Using the DSR and AODV routing Protocol with 25 nodes, pause time 10 s, varying node speed (20-100 m/s by interval of 20 m/s) and 1500 m. x 1500 m. terrain area, this dissertation examine that Packet Delivery Fraction in 1500 m. x 1500 m. of AODV is more optimal than 1500 m. x 1500 m. of DSR.

(2) Average Throughput:- The throughput metric measures how well the network can constantly provide data to the sink. Throughput is the number of data packets arriving at the sink per ms. Throughput refers to the amount of data (in bits) transferred successfully from one node to another in a specified amount of time.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transmitter range</td>
<td>350m</td>
</tr>
<tr>
<td>Bandwidth</td>
<td>2 Mbps</td>
</tr>
<tr>
<td>Simulation time</td>
<td>500 s</td>
</tr>
<tr>
<td>Number of nodes</td>
<td>25</td>
</tr>
<tr>
<td>Max Speed</td>
<td>20, 40, 60, 80, 100 m/s</td>
</tr>
<tr>
<td>Pause time</td>
<td>10 s</td>
</tr>
<tr>
<td>Environment size</td>
<td>1500 m. x 1500 m.</td>
</tr>
<tr>
<td>Traffic type</td>
<td>Constant Bit Rate</td>
</tr>
<tr>
<td>Packet rate</td>
<td>4 packets/seconds</td>
</tr>
<tr>
<td>Packet size</td>
<td>512 bytes data</td>
</tr>
<tr>
<td>MAC type</td>
<td>802.11</td>
</tr>
<tr>
<td>Antenna type</td>
<td>Omni-Antenna</td>
</tr>
<tr>
<td>Radio propagation method</td>
<td>Two Ray Ground</td>
</tr>
</tbody>
</table>

Table 6.1 Simulation Parameter

(1) Packet Delivery Fraction: The packet delivery fraction is defined as the ratio of number of data packets received at the destinations over the number of data packets sent by the sources.

<table>
<thead>
<tr>
<th>Node Speed</th>
<th>20</th>
<th>40</th>
<th>60</th>
<th>80</th>
<th>100</th>
</tr>
</thead>
<tbody>
<tr>
<td>1500 m. x 1500 m. (AODV)</td>
<td>97.29</td>
<td>98.36</td>
<td>96.04</td>
<td>99.62</td>
<td>98.88</td>
</tr>
<tr>
<td>1500 m. x 1500 m. (DSR)</td>
<td>95.32</td>
<td>86.54</td>
<td>93.03</td>
<td>87.24</td>
<td>86.83</td>
</tr>
</tbody>
</table>

Table 6.2 Evaluating Parameters: Packet Delivery Fraction

![Figure 6.1 Node Speed versus packet delivery fraction when terrain area is 1500 m. x 1500 m.](image)

![Figure 6.2 Node Speed versus Average Throughput (kbps) when terrain area is 1500 m. x 1500 m.](image)

Using the DSR and AODV routing Protocol with 25 nodes, pause time 10 s, varying node speed (20-100 m/s by interval of 20 m/s) and 1500 m. x 1500 m. terrain area, this dissertation examine that Average Throughput in 1500 m. x 1500 m. of DSR is more optimal than 1500 m. x 1500 m. of AODV.

(3) Normalized Routing Load:- The normalized routing load is defined as the fraction of all routing control packets sent by all nodes over the number of received data packets at the destination nodes.

<table>
<thead>
<tr>
<th>Node Speed</th>
<th>20</th>
<th>40</th>
<th>60</th>
<th>80</th>
<th>100</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000 m. x 1000 m. (AODV)</td>
<td>0.044</td>
<td>0.067</td>
<td>0.059</td>
<td>0.051</td>
<td>0.046</td>
</tr>
<tr>
<td>1000 m. x 1000 m. (DSR)</td>
<td>0.037</td>
<td>0.038</td>
<td>0.041</td>
<td>0.043</td>
<td>0.045</td>
</tr>
</tbody>
</table>

Table 6.4 Evaluating Parameters: Normalized Routing Load
packet delivery fraction is always low in DSR on varying node speed. The average throughput and normalized routing load are greater in AODV on varying node speed. DSR routing protocol consumes more bandwidth, because of the frequent broadcasting of routing updates. So, according to the results the performance of AODV routing protocol is much better than DSR routing protocol in wireless sensor network.

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[7] Mehran Abolhasana, Tadeusz  Wysockia, Eryk Dutkiewicz b,* “A review of routing protocols for mobile ad hoc networks”, Telecommunication and Information Research Institute, University of Wollongong, Wollongong, NSW 2522, Australia b Motorola Australia Research Centre, 12 Lord St., Botany, NSW 2525, Australia Received 25 March 2003; accepted 4 June 2003