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Design and Implementation of a Simulator for Ad Hoc Network Routing Protocols

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Abstract— **In consideration of adaptability to the environment and flexibility in protocol construction, a power aware routing protocol methodology is proposed in this paper. The major aim of proposed work is to design a simulator for the routing protocols so that we will find out the some parameters like average number of nodes needed to get path from source to destination, average number of retransmission during finding the path from source to destination, average number of throughput and average power remaining of each node.**

***Index Terms*—Ad Hoc; simulator; routing**

I. INTRODUCTION

An ad hoc wireless network consists of a set of mobile nodes (hosts) that are connected by wireless links. Since nodes in ad hoc wireless are mobile, network topology in such a network may changes frequently. The routing protocols used in traditional wired networks cannot be used for ad hoc wireless networks due to their highly dynamic topology, absence of established infrastructure for centralized administration, bandwidth constrained wireless links, and resource (energy) constrained nodes. MANETs are the collection of wireless nodes that can dynamically form a network anytime and anywhere to exchange information without using any pre-existing fixed 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. This is a very important part of communication technology that supports truly pervasive computing, because in many contexts information exchange between mobile units cannot rely on any fixed network infrastructure, but on rapid configuration of a wireless connections on-the-fly. MANETs themselves are an independent, wide area of research and applications, instead of being only just a complement of the cellular system. Mobile Ad-Hoc Networks (MANETs) are wireless networks that continually re-organize themselves in response to their environment without the benefit of a pre-existing infrastructure. A MANET consists of a set of mobile participants who must communicate, collaborate, and interact to complete an assigned MISSION.

II. CLASSIFICATIONS OF ROUTING PROTOCOLS

A. Table Driven Routing Protocols

These protocols are extensions of the wired network routing protocols.

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They maintain the global topology information in the form of tables at every node. These tables are updated frequently in order to maintain consistent and accurate network state information.

B. Distance Sequenced Distance Vector (DSDV) Routing Protocol

DSDV [5] is one of the first protocols proposed for ad hoc wireless networks. It is enhanced version of the distributed Bellman-Ford algorithm where each node maintains a table that contains the shortest distance and the first node on the shortest path to every other node in the network. It incorporates table updates with increasing sequence number tags to prevent loops, to counter the count-to-infinity problem, and for faster convergence.

C. Wireless routing protocol (WRP)

The wireless routing protocol (WRP) [6], similar to DSDV, inherits the properties of the distributed Bellman-Ford algorithm. To counter the count-to-infinity problem and to enable faster convergence, it employs a unique method of maintaining information regarding the shortest distance to every destination node in the network and the penultimate hop node on the path to every destination node. Since WRP, like DSDV, maintains an up-to-date view of the network, every node has a readily available route to every destination node in the network.

D. Reactive Routing Protocols routing protocol

Reactive protocols, on the other hand, invoke a route determination procedure on demand only. Thus, when a route is needed, some sort of global search procedure is employed. The family of classical flooding algorithms belongs to the reactive group. e.g. AODV (Ad-hoc On Demand Distance Vector routing protocol), DSR (Dynamic Source Routing protocol)

1) AODV

AODV [7] routing protocol uses an on-demand approach for finding routes, that is, a route is established only when it is required by a source node for transmitting data packets. It employs destination sequence number to identify the most recent path. The major difference between AODV and DSR stems out from the facts that DSR uses source routing in which a data node and the intermediate nodes store the next hop information corresponding to each flow for data packet transmission. In an on-demand routing protocol, the source node floods the Route Request packet in the network when a route is not available for the desired destination. It may obtain multiple routes to different destinations from a single Route Request.

2) DSR

Dynamic source routing (DSR) is an on-demand protocol designed to restrict the bandwidth consumed by control packets in ad hoc wireless networks by eliminating the periodic table-update messages required in the table-driven approach. The major difference between this and the other on-demand routing protocols is that it is beacon-less and hence does not require periodic hello packet (beacon) transmissions, which are used by a node to inform its neighbors of its presence. The basic approach of this protocol (and all other on-demand routing protocols) during the route construction phase is to establish a route by flooding Route Request packet, responds by sending a Route Reply packet back to the source, which carries the route traversed by the Route Request packet received.

III. Designing The Routing Protocols

The aim of the routing protocol is to find a path that consumes minimum battery power from source node to destination node. The strategy used in routing protocol design is as follows:

a) Number of nodes that a network contains.

b) Number of iterations.

c) Transmission radius or range that is used to find out the neighbor list of each node.

d) Source node and destination node.

After having the following information a neighbor list is generated in increasing order of their distances from the neighboring nodes. Using this sorted list the source node checks whether the destination node is in its vicinity or not if the destination node is in its vicinity then it directly unicast the request packet to the destination otherwise the first member of the sorted list is given the request packet if it has not seen this packet before otherwise the packet is given to the next member of the sorted list. The next node in turn repeats the source node procedure to find the destination node. The process goes on until the hop count maximum limit exceeds or the packet reaches the destination. The following parameters were recorded in text file as follows:

a) Average number of hopes.

b) Average number of retransmission

c) Average number of throughput

d) Average power decapitated per node

IV. Implementation Of Routing Protocols

Here only one class named Network is created. The description of data members and member functions of this classes are as follows-

A. Data Members

a) n- number of nodes

b) no_of_trans- number of transmission do you want to run the program

c) sng- source node

d) dng- destination node

e) trans_range- transmission range

f) nodes [ ][ ]- double dimension array that store the x and y coordinates of the nodes.

g) D [ ][ ]- double dimension array that store the distance between all the nodes.

h) neighbors list[ ][ ]- double dimension array that store the neighbor list of each node.

i) count[ ][ ]- double dimension array that store the number of neighbors of each node.

j) fail_count- store the number of failures.

k) succ_count- store the number of successful transmission.

B. Member Functions

a) getdata()- This function is used to take the coordinates of the nodes.

b) get_range()- This function is used to take input number of nodes and transmission range.

c) get_power()- This function is used to initialize the power to each node.

d) create_network- This function is used to place the nodes in the network.

e) distance()- This function is used to calculate the distance between all the nodes.

f) neighbors(int)- This function is used to generate the neighbor list of each node.

g) path_found()- This function is used to calculate the path from source to destination.

h) avg_power(int)- This function is used to calculate the average power left of each node.

i) avg_hopes(int)- This function is used to calcualte the average number of intermediate hopes.

j) display(int,int,int)- This function is used to display the various outputs.

k) avg_retrans(int)- This function is used to calculate the avrage retransmission of the packet.

l) avg_thrput(int)- This function is used to calculate the average successful transmission of the packet.

V. Simulation

A. Example

a) No. of times do you want to run program= 1

b) No. of nodes= 10

c) Transmission range=10

d) The Source Node is 4 and Destination Node is 9.

e) Destination Node 9 is found in the neighbor list of source node 4. So Path found from source to destination is 4, 9.

f) Average power left per node is 996.5.

g) Average power left per node is 996.5.

h) Average throughput is 1.

i) Average number of hopes are 1.

j) Average number of retransmission is 0.

Table 1. Neighbor list table of each node

Nodes	Neighbor list				
1	4				
2	3				
3	2				
4	9	5	1	8	10
5	9	4	10	8	7
6	8				
7	5	9	10		
8	4	9	10	6	5
9	5	4	10	8	7
10	9	5	4	7	8

VI. RESULTS

The simulator was designed in C++. It takes the following parameters as input:

a) n- number of nodes

b) Transmission Radius of each node

c) Number of iterations

The following outputs were recorded.

A. *Average power left per node*

For measuring average power the following assumption was made

a) Each node is assigned 100 units of power

b) The node consumes 2 units of battery for transmitting a packet

c) The node consumes 1.5 units power in receiving a packet

The average power decreases for lower transmission radius but as the transmission radius is increased the average power left per node also get increased as shown in Fig. 1. The reason for such behavior is at lower transmission radius the number of retransmission is quite large.

Table 2. Average power left per node

Transmission Range	Average Power left per node		
	Number of Nodes=20	Number of Nodes=25	Number of Nodes=30
5	93	93.98	89.26
6	86.69	89.08	80.75
7	80.24	78.86	75.25
8	69.02	80.68	79.8
9	73.05	72.83	53.25
10	74.44	72.59	52.26
11	82.67	55.48	64.63
12	29.82	75.32	82.84
13	55.7	91.45	49.45
14	81.09	86.83	93.46

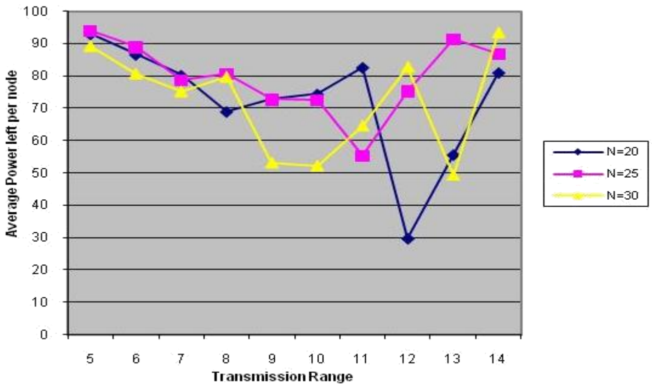

Fig. 1. Average power left Vs transmission range graph

B. *Throughput*

It may be defined as the number of successful transmission to the total number of transmissions. The average throughput increases as the transmission range increases due to the fact that the information regarding neighboring nodes gets increased as shown in fig.2.

Table 3. Average throughput

Transmission Range	Average Throughput		
	Number of Nodes=20	Number of Nodes=25	Number of Nodes=30
5	0.2	0.15	0.05
6	0.15	0.15	0.15
7	0.25	0.25	0.2
8	0.35	0.6	0.4
9	0.55	0.65	0.55
10	0.75	0.75	0.65
11	0.9	0.85	0.9
12	0.65	0.85	1
13	0.85	1	0.9
14	1	1	1

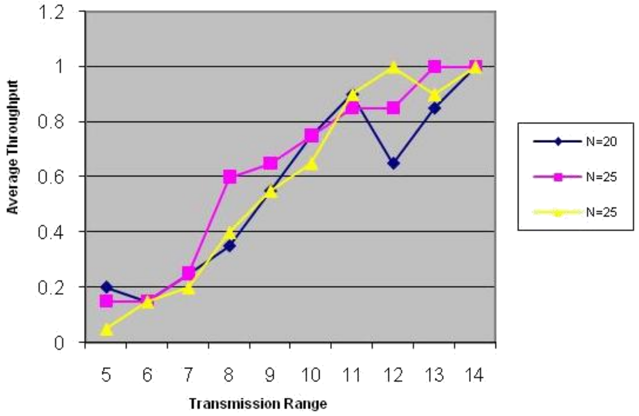

Fig. 2. Average Throughput Vs transmission range graph

C. Hop count

Defined as the number of intermediate nodes between a source and destination. As shown in the Fig. 3 with the increase in the transmission radius, the hop count gets increased.

Table 4. Average no. of hopes for successful transmission

Transmission	Average no. of hop count for successful transmission		
	Number of Nodes=20	Number of Nodes=25	Number of Nodes=30
5	2	1.66	1
6	2.33	1.66	4.66
7	2.4	2.2	3.75
8	2.42	2.5	3.125
9	1.54	4	2.81
10	3.26	4.2	3.53
11	2.5	6.29	5.72
12	4.3	3.52	6.3
13	4.47	3.05	4.22
14	3.55	4.7	2.8

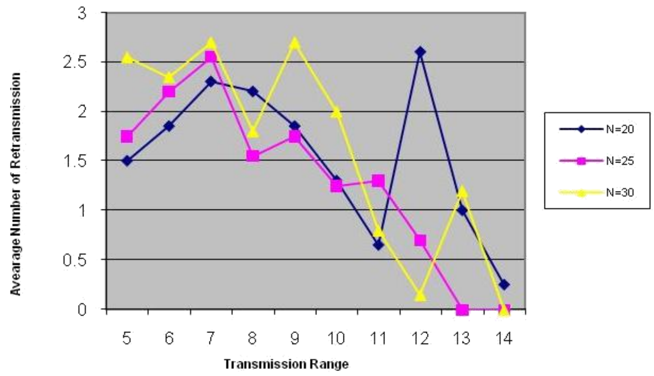

Fig. 3. Average no. of hopes for successful transmission Vs transmission range graph

D. Average number of retransmission

The average number of retransmission is more when the transmission radius is low since there are limited numbers of neighbor but as the transmission radius is increased the probability to reach destination gets increased and hence retransmission reduces as shown in fig.4.

Table 5. Average no. of retransmission

Transmission Range	Average no. of retransmission		
	Number of Nodes=20	Number of Nodes=25	Number of Nodes=30
5	1.5	1.75	2.55
6	1.85	2.2	2.35
7	2.3	2.55	2.7
8	2.2	1.55	1.8
9	1.85	1.75	2.7
10	1.3	1.25	2
11	0.65	1.3	0.8
12	2.6	0.7	0.15
13	1	0	1.2
14	0.25	0	0

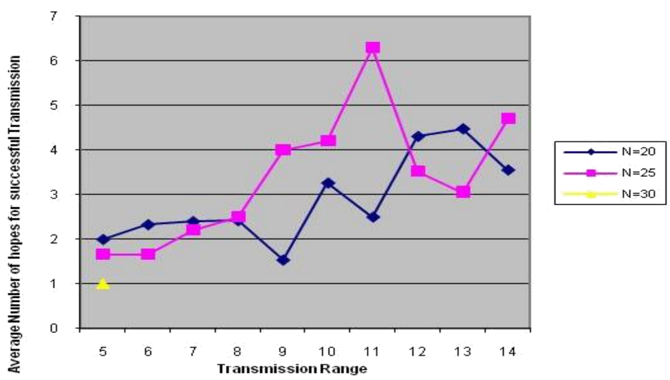

Fig. 4. Average no. of retransmission Vs transmission range graph

VII. DISCUSSION ABOUT RESULTS

The power consumption in transmitting a packet is directly proportional to the square of the distance between the source and destination, more is the distance more is the power consumed and lesser is the effective network life time. The nodes thus tries to select their intermediate nodes to relay the packets in order to increase its effective life time, reduce average power consumption of the overall network but at the same time introduces congestion since the number of nodes involved in routing process gets increased by adopting the strategy proposed.

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