Power Efficient Scheme for Performance Optimization in Ad Hoc Networks

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ABSTRACT
A Mobile Ad-hoc network (MANET) is a self organizing and adaptive in nature. A MANET consists of a set of mobile participants who must communicate, collaborate, and interact to complete an assigned mission. The challenges of MANETs are to provide wireless, high-capacity, secure, and networked connectivity. Node mobility in MANET causes frequent changes of the network topology. Routing protocols are used to discover routes between the nodes. There are many tools available for testing and comparing the MANET routing protocols. But existing tools or simulators have several drawbacks: such as codes are very lengthy, too many header files. This paper concentrates on designing optimized line of coding and easily understandable routing protocol. The proposed protocol is power aware keeping in view the power constraint of nodes being used in the ad hoc network and design its basic structure in C++ and studies its performance on various inputs.

Keywords:
Ad-hoc network, Routing protocol, Battery Power, Throughput, No. of Hop.

1. INTODUCTION
Wireless networks are classified as infrastructure wireless network and infrastructure-less network. Infrastructure-less network are fully dynamic and Ad-hoc network is in class of infrastructure-less network. Mobile Ad hoc Networks (MANETs) [1][2] 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. The nodes are free to move in arbitrary direction with any arbitrary speed. There are no fixed routers in the Ad-hoc network. Nodes are working as a router in network. A MANET working group [2] has been found within the Internet Engineering Task Force (IETF) to develop a routing framework for IP-based protocols in Ad-hoc network. Each node utilizes battery power in searching the path. So we must have power efficient mobile equipment and design such type of algorithm which is based on less power consumption. Distance between source and destination is defined as no. of hop count. If no. of hop is less it means it will use less power in path discovery.

In this paper we optimized battery power consumption of various nodes in MANET. This optimization aim to reduce the battery power in searching path. This paper is organized as follows: in section 2, a short overview of the Routing Protocol is given. In section 3, we introduce issues in MANET. Section 4 introduce about the designing protocol. Section 5; describe result for various no. of node. Paper is concluded in section 6.

2. OVERVIEW OF ROUTING PROTOCOL
Various routing protocols proposed for Ad-hoc networks cope well with the dynamically changing topology. There are two types routing protocol:

- Table driven Protocol: Each node uses routing tables to store the location information. Some of table driven protocols are DSDV, GSR, FSR and WRP.
- On Demand Routing Protocol: If source node requires a route to the destination for which it does not have route information, it initiates a route discovery process which goes from one node to the other until it reaches to the destination. Some of on demand routing protocols are Ad-hoc On Demand Distance Vector (AODV), Dynamic Source Routing (DSR), Fish eye Source Routing (FSR), and Temporally Ordered Routing algorithm (TORA) etc [3] [4].

Ad hoc wireless networks [5] are defined as the category of wireless networks that utilize multi-hop radio relaying and are capable of operating without the support of any fixed infrastructure. The absence of any central coordinator or base station makes the routing a complex one compared to cellular networks. Figure (1) shows the path setup for a call between two nodes, say, node C to node E, is completed through the intermediate mobile node F.

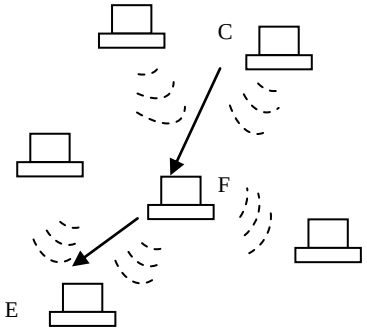

Figure 1: Ad hoc Wireless Network showing path setup between nodes C and E

The table. 1 shows the comparison [6] [7] [8] between different routing protocols. This table compared seven routing protocols on the basis of four parameters like hello message requirement, update destination, routing strategy and method of communication. AODV and CBRP only uses broadcast hello message. DSDV, WRP and AODV uses distance vector routing strategy and DSR and CBRP uses source routing that uses the concept of route cache. DSDV, WRP and TORA broadcast the packets in the network. CBRP uses flooding of the packets and DSR unicast the packet to next neighbor.

Table .1: Comparison of different routing protocols

	DSDV	**WRP**	**DSR**	**AODV**	**TORA**	**ZRP**	**CBRP**
Hello message requirement	No	No	No	Yes	No	No	Yes
Update Destination	Neighbors	Neighbors	Source	Source	Neighbors	Neighbors	Neighbors
Routing Strategy	Distance vector	Distance vector	Source routing	Distance vector	Link state	Hybrid	Source routing
Method of Communication	Broadcast	Broadcast	Unicast	Unicast	Broadcast	Broadcast	Flooding

3. ISSUES IN DESIGNING MANET PROTOCOL

The major challenges [9] [10] [11] [12] [13] that a routing protocol designed for ad hoc wireless networks faces are:

➢ **Mobility**

The network topology in an ad hoc wireless network is highly dynamic due to the movement of nodes; hence an on-going session suffers frequent path breaks. Disruption occur either due to the movement of the intermediate nodes in the path or due to the movement of end nodes. Such situations do not arise because of reliable links in wired networks where all the nodes are stationary. Even though the wired network protocols find alternate routes during path breaks, their convergence is very slow. Therefore, wired network routing protocol can not be used in ad hoc wireless networks where the mobility of nodes results in the frequently changing network topologies. Routing protocols for ad hoc wireless networks must be bale to perform efficient and effective mobility management.

➢ **Bandwidth constraints**

Abundant bandwidth is available in wired networks due to the advent of fiber optics and due to the exploitation of wavelength division multiplexing (WDM) technologies. But in a wireless network, the radio band is limited and hence the data rates it can offer are much less than what a wired network can offer. This requires that the routing protocols use the bandwidth optimally by keeping the overhead as low as possible. The limited bandwidth availability also imposes a constraint on routing protocols in maintaining the topological information. Due to the frequent changes in topology, maintaining consistent topological information at all the nodes involves more control overhead which, in turn, results in more bandwidth wastage. As efficient routing protocols in wired networks require the complete topology information, they may not be suitable for routing in the ad hoc wireless networking environment.

➢ **Error prone shared broadcast radio channel**

The broadcast nature of the radio channel poses a unique challenge in ad hoc wireless networks. The wireless links have time-varying characteristics in terms of link capacity and link error probability. This requires that the ad hoc wireless network routing protocol interacts with the MAC layer to find alternate routes through better-quality links. Also, transmissions in ad hoc wireless networks result in collisions of data and control packets. This is attributed to the hidden terminals problem. Therefore, it is required that ad hoc wireless network routing protocols find paths with less congestion.

➢ **Resource constraints**

Two essential and limited resources that form the major constraint for the nodes in ad hoc wireless network are battery life and processing power. Devices used in ad hoc wireless networks in most cases require more stability, and hence they also have size and weight constraints along with the restrictions on the power source. Increasing the battery power and processing ability makes the nodes bulky and less portable. Thus ad hoc wireless network routing protocols must optimally manage these resources.

4. 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:

The simulator takes following inputs from the user:

- Number of nodes that a network contains.
- Number of iterations.
- Transmission radius or range that is used to find out the neighbor list of each node.
- Source node and destination node.

After having the following information a neighbour list is generated in increasing order of their distances from the neighbouring 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:

- Average number of hopes
- Average number of retransmission
- Average number of throughput
- Average power decapitated per node

4.1 Power Aware Routing Algorithm

The nodes in the ad-hoc network repeat the process of gathering the neighbor's entries in the table until every node has details about their neighboring nodes. In fact, the nodes to forward data packets use this information. Whenever due to mobility of mobile nodes there is a packet loss, the neighbor's entries are updated. However, after a regular interval of time, every node within a cell retransmits a neighbor Request packet in order to readjust the network information about its neighboring nodes. This process helps in maintaining a updated network view. Consider the following step of algorithm:

1. Input number of transmission do you want, number of nodes and transmission range.
2. Positioned all the nodes in a network.
3. Assign 100 units power to each node.

4. Create the neighbor list of each node and arrange the nodes of each neighbor list in increasing order.
5. Input source node and destination node.
6. Assign hop_count= 0, k=0, path[k]=source_node
7. power[source_node]=power[source_node]-2.0
8. if (hop_count<16)

```
{       if (destination_node=current_node)
   {    k++
      path[k]=current_node
       power [current_node]=power [current_node]-1.5
       exit() // path found
}           else
            {       hop-count++
                    path_found()
            }
}           else
            Drop the packet and resend the packet.
```

9. Calculate number of hopes, number of retransmission, number of successful transmission and power left of each node.
10. Calculate

Average number of hopes=no_of_hopes / no_of_transmission

Average power left= sum-of_power /no.-of-transmission

Average number of throughput= no_of_success/no_of_transmission

The algorithm says that, initially the hop count is set to 16 and when the hop count becomes less then 1 the data packet has again to be retransmitted. Consider following network with 10 nodes (see figure (2)) and their neighbor table (see table.2).

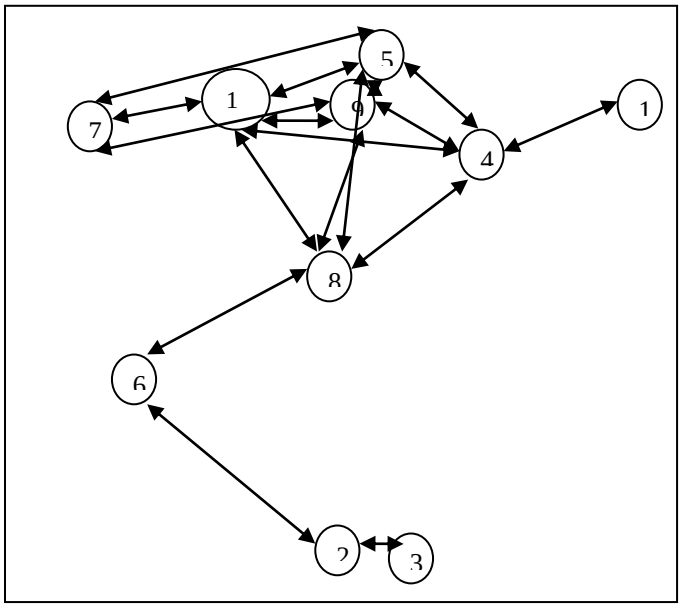

Figure 2: A network with 10 nodes

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

Table.2: Neighbor list table of each 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.

5. RESULT AND DISCUSSION

The aim of proposed 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:

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

1. Number of nodes
2. Transmission Radius of each node
3. Number of iterations

The following outputs were recorded:

- Average power left per node
- Throughput
- No. of Hope count

1. Average power left per node

For measuring average power the following assumption was made

- Each node is assigned 100 units of power
- The node consumes 2 units of battery for transmitting a packet
- 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 Figure (3) . The reason for such behaviour is at lower transmission radius the number of retransmission is quite large.

Table.3: 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

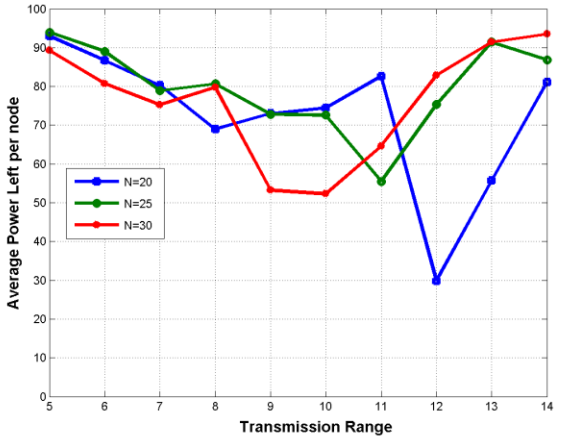

Figure 3: Average power left Vs. transmission range graph

2. 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 Figure (4).

Table .4: 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

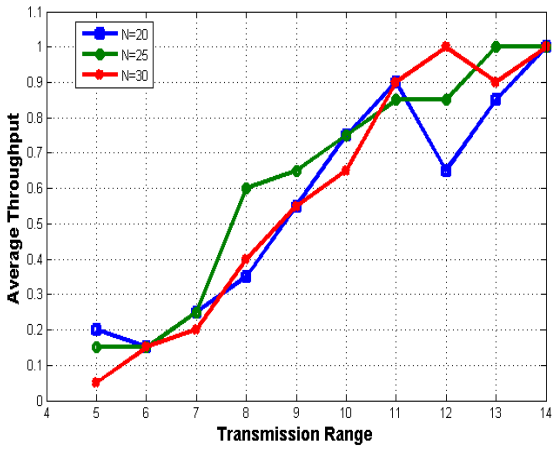

Figure 4: Average Throughput Vs. transmission range graph

3. Hop count

No. of hop count is defined as the number of intermediate nodes between a source and destination. As shown in the Figure (5) with the increase in the transmission radius, the hop count gets increased.

Table. 5: Average no. of hopes for successful transmission

Transmission Range	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

Ex ample:
Following result is example of simulation of the proposed protocol

- No. of times do you want to run program= 1
- No. of nodes= 10
- Transmission range=10
- Source Node is 4 and Destination Node is 9.
- Destination Node 9 is found in the neighbor list of source node 4. So Path found from source to destination is 4, 9.
- Average power left per node is 996.5.
- Average throughput is 1
- Average number of hope is 1.
- Average number of retransmission is 0.

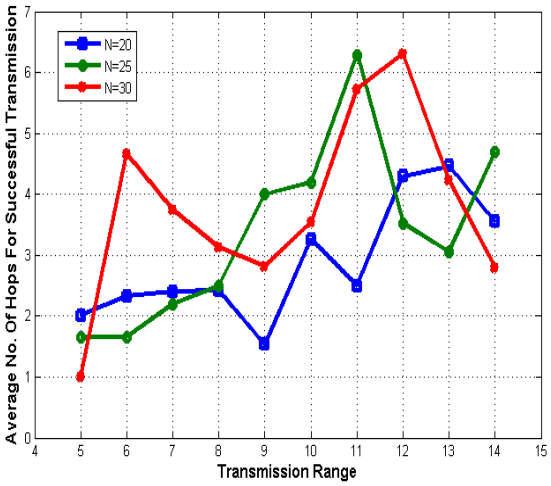

Figure 5: Average Throughput Vs. transmission range graph

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.

6. CONCLUSION

In this work a new routing protocol has been proposed for implementing routing protocol for ad hoc network. The proposed protocol is power aware keeping in view the power constraint of nodes being used in the ad hoc network.

To test the performance of the protocol a program has been designed in C++. This implementation in C++ has allowed us to check the performance of the protocol under various conditions. This performance has been illustrated in the forms of the graphs and tables. The results are quite satisfactory indicating that the proposed protocol has feasible implementation.

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