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Constraintless Approach of Power and Cost Aware Routing in Mobile Adhoc Networks

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ABSTRACT

Wireless mobile ad-hoc networks require certain mechanisms of tracking and managing power consumption as they are using non-renewable energy sources i.e. the battery sources. A number of cost aware and power aware algorithms have been proposed so far to cope up with the problem of proper utilization of battery lifetime. This paper deals with creating a constraint less power and cost aware routing algorithm for MANETs. The thresholds and cutoffs involved in the previous algorithms are not kept into the consideration .This paper employs the cost aware mechanism when multiple numbers of nodes are capable of receiving and transmitting the packets. This is done to obtain an optimal path for communication.

The model proposed by the paper deals with determining the sufficiency of power available in each node to receive and transmit the packet and comparing the available nodes' distances to reduce the cost of the total transmission. The power-cost algorithm tends to identify the nodes with certain energy, such that they can receive and transmit a packet of certain size which would be acknowledged by the listening packet, which creates the flexibility of optimal usability of the power of available nodes.

General Terms

Computer Science, ad-hoc communication, algorithms.

Keywords

wireless, MANETs, constraint less, sufficiency, dispensed, lifetime.

1. INTRODUCTION

A Mobile Ad-hoc network (MANET) is an infrastructure-less network where the nodes involved in it are dynamic [11,12]. The nodes are arbitrarily mobile such that we can determine their path easily at every instances of inspection. Thus, the communication can be possible through the on-demand communication between such nodes .i.e. Ad-hoc on Demand Vector routing (AODV) protocol. This protocol makes ease of communication between the nodes. When a source code requires transmitting the packet, it can simply send the listening packet in its transmission range through multicasting mechanism. Then, the node which satisfies the required constraints for that network participates in the communication. Hence, on doing so, multiple number of hops can be established in the communication process, to send the source node packet to the destination node, thus creating possibilities of multipath routing.

Mobile Ad-hoc network has found its applications in wide range of areas, especially in the emergency rescues; natural calamities affected areas, battle fields and topologically hindered locations. Also, it has gained popularity through its ease to make the communication channel and movable nodes. Basically, these nodes utilize the non-renewable energy sources like battery power. It becomes highly essential to make proper usage of battery power, as in the cases of emergencies. There are various algorithms that have tried to optimize the power consumed or cost required or both power and cost for the transmission and receiving of the packets in MANETs. We intend to bring out a new approach of dealing with both power consumption and cost reduction for the communication.

Certain conditions where the energy is spent in the network were identified. [4, 5] viz. transmission, receiving, sleep and idle states. Thus, it is necessary to take those conditions into consideration. We have tried to assess the amount of power consumption for both receiving and transmission of the packets. This has led to the removal of the constraints like 'threshold' & 'cut-off' from our proposed algorithm unlike in previous algorithms [1,3]. The total energy calculated as in Section (7,8) would directly imply the capability of each node for the communication, thereby requiring no further constraints to be considered. Wireless scenario implies that it is a shared environment.[4,5] Here, certain amount of power of a node is spent when a neighbor is transmitting. The energy consumption model proposed by Feeney et al.[4,5], gives a good support towards the removal of the above mentioned constraints.[1,3,6,7,8]

In any emergency scenario, the size of packet sent shall be very less. Thus, if we construct a network depending merely on battery lifetime, it might hamper the cost or the time consumption for communication. E.g. If any network has kept certain cut-off constraint, and there comes a packet of smaller size such that the node whose lifetime is below cut-off can easily involve in the communication of that packet. In this condition, the involvement of cut-off would not allow that node to participate in the network. This would probably affect the optimum utilization of the node's lifetime. Furthermore, the node might give a cost and power optimal route, but this won't fall into consideration, when cut-off is used. Therefore, we have eliminated the cut-off and the threshold constraints from the algorithm (Section 6). This would allow any node with any amount of lifetime to assess its capability to participate in the network, hence optimum usage of battery lifetime and creating the situation of optimal power and cost utilization.[2,5]

In the situations of availability of multiple nodes capable of participating in the network, we have deployed the minimal cost algorithm and minimal power algorithm through dynamic programming approach.[9]Eventually, we can keep both power and cost into consideration as the two deterministic factors in the proposed mobile Ad-hoc environment.

2. RELATED WORKS

2.1 Multicast Multipath Routing

Multicast is the delivery of a message or information to a group of destination , simultaneously in a single transmission from the source, creating copies automatically in other network elements, such as routers, only when the topology of the network requires it.[1]

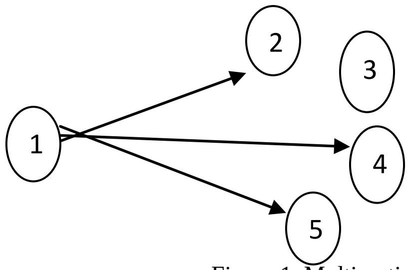

Figure 1. Multicasting.

Multipath routing is the routing technique of using multiple alternative paths through a network.

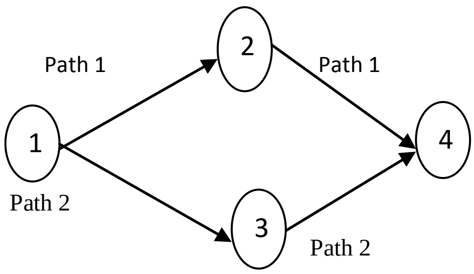

Figure 2. Multipath

2.2 Single Source Shortest Path

In the situations when multiple numbers of neighboring nodes are capable of receiving and transmitting the packets, it is essential to identify the most appropriate path. Thus, single source shortest path method [9] is used for the purpose.

The goal of employing this algorithm is to calculate the distance of each node from the source and obtain the minimal value.

Thus, $dist^k[u]$ is calculated as:

$$dist^k[u] = min\{dist^{k-1}[u], min_i(dist^{k-1}[i] + cost[i,u])\}$$

During the calculation of distance of each node, dynamic programming method is employed [9]. The following observations are considered:

1. If the shortest path from vertex ‘v’ to vertex ‘u’, with at most k, k>1, edges have no more than k-1 edges, then $dist^k[u] = dist^{k-1}[u]$.

   If the shortest path from ‘v’ to ‘u’ with at most ‘k’, k>1, edges have exactly ‘k’ edges, then it is made up of a shortest path from ‘v’ to some vertex ‘j’ followed by the edge (j,u). The path from ‘v’ to ‘j’ has k-1 edges and its length is $dist^{k-1}[j]$. All vertices ‘i’ such that the edge (i,u) is in the graph are candidates for ‘j’. As we intend to determine the shortest path, the value of ‘i’ which minimizes $distk^{-1}[i] + cost[i,u]$ is the appropriate value for ‘j’.

2.3 Previous Version of Power Aware Algorithm

The previous versions have kept in account the cut-off values for the battery lifetime. This has constrained the node to utilizing its power until its lifetime is 10% but no lesser than that.[1,3,7]

threshold = 50%;success = 0;cutoff = 10%;

A:=S;

Repeat

if g(A)>=threshold then

B:=A;

Let A be a neighbor of B that minimizes pc(B,A)=power-cost(B,A)+v(s)f’(A);

Send message to A;

Success=1;

Until A=D(*Destination reached*) or if success<>1 then

if threshold>cutoff then

threshold=threshold/2;

or A=B(*Delivery failed);

This algorithm would perform better if the density of the nodes in the network is high [1,6]. Also when any node is to be selected, the algorithm constrains that node to have its power more than the threshold value.

Also, Rodoplu and Meng[10] proposed a general model which depicts the power consumption between two nodes at distance ‘d’ as $u(d)=d^{\alpha}+c$ for some constants ‘α’ and ‘c’, which describes various properties of power transmission. This could aid in determining the neighbors in which the direct transmissions would be of best choices. Thus, they adopted a model known as *RM-model* i.e. $u(d)=d^4+2*10^8$.

3. MOTIVATION

Mobile Ad-hoc network does not have any centralized controlling station or a base station [4]. The nodes are to participate in the communicating network and build the routes, which consumes energy. In the past, many energy aware algorithms have been proposed with different aims. With the increasing usage of the wireless ad-hoc networks, it is of prime concern to properly utilize the energy available in each node. There sprouts no meaning in reserving the energy in the name of cut-offs, rather energy can be employed in communication if it is capable of doing so. This would imply the proper usage of the energy available. The situations of emergencies won't require large data transmission. Thus, even a low energy node can serve as a participating entity in the faster and cost effective communication between the source and destination at times.

We seek to maximum utilization of each node's power. This methodology shall create a dimension of making the best use of the available resources, if it is beneficial as per our given constraints (Section 1). Thus, the paper utilizes the energy calculation algorithm of Feeney et. al.[4,5] This algorithm calculates the amount of time and energy required to receive and transmit and the acknowledgement as well as the data packets. Eventually, the source shall not restrict any node having enough power for the communication, despite it having battery lifetime below cut off powers considered by previous algorithms [1, 3, 6, 7, and 8].

4. PROPOSED OPTIMUM POWER AND COST UTILIZATION ALGORITHM

We have proposed three different sub-sections to implement optimum power and cost utilization. The algorithms are:-

a.)Power-cost-optimal algorithm

b.)Node-algorithm

c.)Power-calc algorithm

The power-cost-optimal algorithm is applied in the source nodes of each steps. It determines the size of the packet to be sent to the destination. Thus, the listening packet is constructed which shall further contain the address of source. The algorithm continues its iterations until a destination has reached or else the delivery has failed. In the process, it deploys node-algorithm so as to determine the best possible path in terms of power and cost.

```
Algorithm power-cost-optimal
{
reply->value:=0; //For delivery failure.
S:=source(A);
/*Now, eliminate source as neighbor to any other node*/
send(listening-packet);
reply:=node-algorithm();
if(multiple relies)
{
reply:=reply(of node which has minimal routing distance i.e.|AB|);
if(minimal distance same for multiple nodes)
reply:=reply(of node having highest battery power);
}
if(reply->value)
send(reply->address);
else
Delivery failure or destination reached;
}
```

The node algorithm is used in each of the nodes, so as to obtain the comparison of the power or battery lifetime of each node with the amount of energy required in sending the defined packet towards the neighboring node. Also, this algorithm determines the least cost and more power efficient path for the transmission of the packet when two or more paths are available.

```
Algorithm node-algorithm(B)
{
//Initially all nodes have reply->value==0
if(Destination reached)
{
 return(reply );
stop the process;
}
size:=listening-packet->size;
while(power(B)>power-calc(B)
{
reply->value:=1;
power-cost-optimal(B);
}
return(reply);
}
```

Feeney et al.'s formula for the measurement for energy consumption is utilized in the power-calc algorithm so as to determine the amount of energy required to receive and transmit the certain sized packet.[4,5]

```
Algorithm power-calc(B)
{
return(m*size + b);
}
```

Here, we have considered the two different structures for listening packet and the reply packet. They are visualized as follows:

4.1 Listening Packet*:*

```
struct listening-packet{
char listening-packet->name;   /*It gives the name of the source  which is sending the packet.*/
int listening-packet->value;   /*It gives the size of the packet which is to be send upto the destination.*/
};
```

4.2 Reply packet:

struct reply

{

char reply->name; /* It contains the name of the replying neighbor node*/

int reply->value; /*Initially this value is initialized to 0.*/

int reply->power; /*Returns the remaining lifetime of the node*/

};

5. CALCULATION OF ENERGY CONSUMED BY EACH PACKET AT A NODE

Four different states for energy consumption are taken into consideration [4]: transmit, receive, idle, sleep. When a node transmits packet it is said to be in the transmit state and it is said to be in the receive state when it tends to receive the packet. In the idle state, node waits for the packet transfers and sleep state signifies very low power state where the node can neither receive nor transmit.

We can present the cost associated with each packet at the node as:

$$cost = m*size + b$$

where,

'm' is the incremental cost,

'size' is the packet size ,

'b' is the fixed cost associated with channel acquisition.

6. MEASUREMENT METHODOLOGY

As per the model proposed by [4,5], we can determine the energy spent at each node due to a flow. Depending on the position of the nodes in the flow and the affect of neighboring node, the following node was proposed [4,5]:

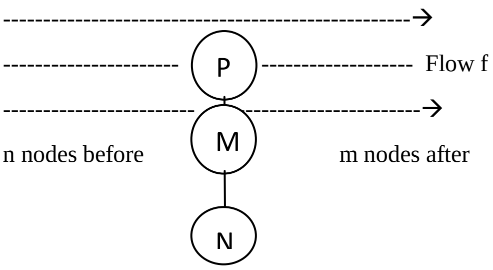

Figure 3. Effect on node N due to node M

$$1_{n>0}(1_{M=N}E_{Tack}+1_{M<>N}E_{Rack}) +1_{m>0}(1_{M=N}E_{Tack}+1_{M<>N}E_{Rack})$$

where,

$E_{N=M}$ = energy spent at node N due to node M,

E_{Tack} = energy spent for transmission of one acknowledgement (ACK) packet,

E_{Tpck} = energy spent for transmission one data packet,

E_{Rack} = energy spent for reception of one ACK packet,

E_{Rpck} = energy spent for reception of one data packet.

$$1_p=\{^{1,\text{if } p \text{ is true}}_{0,\text{otherwise}}$$

6.1 Energy Required for Each Packet

The methodology for the calculation of energy consumed deploys the calculation of time for the transmission and reception of each packet. It can be illustrated through an example[4,5] as follows:

6.1.1.For data packets:

Packet length = 1500 bytes, bit rate = 250 kbps

Total packet size = sizeof(preamble + PLCP header +MAC header +IP header +data)

= (144+48+28*8+20*8+1500*8) bits

The preamble and PLCP header are transmitted at 1Mbps. Thus, time needed to transmit them =0.19ms.

Rest other components are transmitted at 11 Mbps. Thus, time required for transmitting them = (8*1548)/(11*106) = 1.128ms.

Therefore, total time for transmitting a packet =

1.128+0.19 = 1.318 ms

6.1.2. For Acknowledgement packets:

Packet length = 14 bytes, bit rate = 250 kbps

Total packet size = sizeof(preamble+ PLCP header +ACK) = (144+48+14*8) bits

So, transmission time for single packet=0.304ms

6.1.3. Calculating the amount of energy spent:

The usage of Lucent Silver card [4,5] was done for testing the transmission and reception. A transmission power of 1.3 W and a reception power of 0.9 W were used. Thus,

$E_{Tpck} = 1.3*1.318*10^{-3} = 1.713$ mJ

$E_{Rpck} = 0.9*1.318*10^{-3} = 1.186$ mJ

$E_{Tack} = 1.3*0.304*10^{-6} = 0.395$ mJ

$E_{Rack} = 0.9*0.304*10^{-6} = 0.274$ mJ

7. CONCLUSION

This paper proposes a power-cost-optimal algorithm with other supporting algorithms like , an algorithm to calculate energy consumed at each node and an algorithm to determine the shortest path when multiple hops are available to transmit and receive the data packets. The main objective is to determine the appropriate path which utilizes the maximum of the energy resource available in each node thereby, sprouting a perspective of proper usage of the ad-hoc networks in the emergency situations like difficult topography, emergency rescues, natural calamities, battle fields and many more.

In the emergency scenario, the network is bound to transmit the packets as soon as possible. For such cases, it is quite important to make the best usage of the available resources viz. ad-hoc network communication. We aim to make best possible use of available life time of each node, such as to making relief in the emergencies.

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9. FUTURE WORKS

The overhead in the listening-packet can be reduced, if a mechanism of determining the battery power can be obtained for the source node. Also, the inverse relation between the signal strength of the node and the distance can be employed to determine distance as well as the battery strength of the corresponding node.

10. REFERENCES

[1] S. Gunasekaran and Dr. K. Duraiswamy, "Multicast multipath power efficient routing in mobile ad-hoc networks" ,International Journal of Computer Science and Network Security, vol.10, no.4, April 2010.

[2] Geraud Allard, Pascale Minet, Dang-Quan Nguyen and Nirisha Shrestha,"Evaluation of the energy consumption in MANET",Institut National De Recherche En Informatique Et En Automatique, February 2006.

[3] Ivan Stojmenovic and Xu Lin,"Power Aware Localized Routing in Wireless Networks", IEEE transactions on parallel and distributed systems, vol. 12, no. 10, October 2001.

[4] L. M. Feeney, "Energy Efficient Communication in Ad Hoc Wireless Networks", Computer and Network Architecture Laboratory, Swedish Institute of Computer Science,2003.

[5] L. M. Feeney, M. Nilsson, "Investigating the energy consumption of a wireless network interface in an ad hoc networking environment", Proceedings of IEEE Infocom, April 2001.

[6] Jharna Chokhawala and Albert Mo Kim Cheng, "Optimizing Power Aware Routing in Mobile Ad Hoc Networks", Real-Time Systems Laboratory, University of Houston- University Park.

[7] Ivan Stojmenovic and Susanta Datta, "Power and cost aware localized routing with guaranteed delivery in unit graph based ad hoc networks", Wireless communications and mobile computing,2004.

[8] Saswati Sarkar and Maria Adamou, "A framework for optimal battery management for wireless nodes", IEEE Journal on Selected Areas in Communications, vol.21, no.2 ,February, 2003.

[9] Ellis Horowitz, Sartaj Sahni and Sanguthevar Rajsekaran, "Fundamentals of Computer Algorithms",Galgotia Publications Pvt. Ltd., 2001.

[10] V.Rodoplu and T.H.Meng, "Minumum Energy Mobile Wireless Networks", IEEE J.Selected Areas in Comm.,vol.17.no.8.pp.1333-1344, August, 1999.

[11] Loay Abusalah, Ashfaq Khokhar, and Mohsen Guizani "A Survey of Secure Mobile Ad Hoc Routing Protocols" IEEE communications surveys & tutorials, VOL. 10, NO. 4, FOURTH QUARTER, 2008

[12] Sunil Taneja and Ashwani Kush" A Survey of Routing Protocols in Mobile Ad Hoc Networks", International Journal of Innovation, Management and Technology, Vol. 1, No. 3, August,2010