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Consideration of Power Control Algorithms in Mobile Adhoc Network

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Abstract: There are some probabilistic and deterministic techniques which are used in power control algorithm for building network topology for minimizing the cost, power consumption and improving the network life time. Also review the functions performed by power aware routing protocols.

Keywords: Power Consumption, Network Life Time

1. Introduction

In all probabilistic and deterministic techniques, Graph theory technique is most important technique for solving the problem of power consumption and improvement of the network life time.In this approach a limited number of nodes has to be considered as vertices of the graph and the wireless links between the nodes is to be considered as the edges of the graph.In that way, an adhoc network can be assumed as a topological graph G consisting of V sets of nodes and E sets of links.If there is no any loop and parallel link between nodes, then that type of topological graph is said to be simple graph or strongly connected graph means a path lies between two nodes of that topological graph.The distance between two nodes of simple graph is Euclidean distance.

Graph Theory Technique

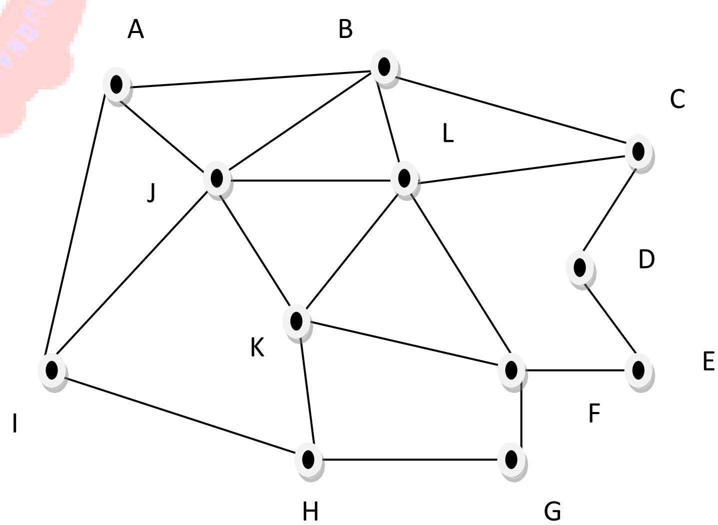

Figure-1

This approach helps to reduce the number of links between the node and its neighbor through shortest distance spanning tree or minimal spanning tree.In weighted connected graph there are different spanning tree can be obtained and the spanning tree with the smallest weight is known as minimal spanning tree (MST).So in this paper we will try to obtain the connected circuit free graph in random adhoc network for minimizing its cost and improving the quality of network.

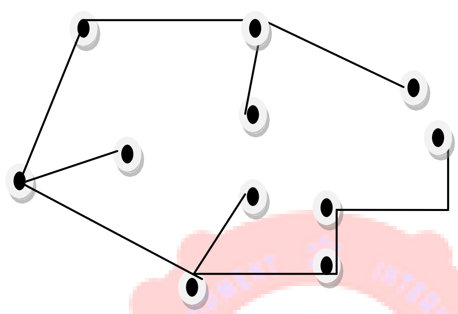

Figure-2 Minimal Spanning Tree (MST) Of A Random Adhoc Network

In figure-(2) there is a minimal spanning tree in which a connected circuit free graph is reached.
Hop to hop shortest path routing mechanism is the minimum power routing algorithm in which link cost determine the transmitted power level.

The routing algorithm can be understand with the following steps:-

- With the help of routing table, mobile node makes the set of all possible routes from source to destination.
- The routing algorithm are employed with in the adhoc network of shortest path routing.From source to destinationit searches the minimum cost route of mobile node
- Determine the next relay node on the minimum power route.
- Modify the next node ID in the data packet which is being routed.
- Until the successful reception at the next node is indicated by an acknowledgement message, copy the packet to the retransmission buffer.
- After that packet is sent to the MAC module for transmission to another node .

Graph Theory Approach

Graph theory mainly considers placing graphs with vertices as points in space and the edges as line segment joining select pairs of these points.Due to the inherent simplicity, graph theory has a wide range of application in topology.Control graph theory optimization can be applied to adhoc networks to build a topological graph G.It helps to minimize the cost function.So an adhoc network can be represented by a topological graph G in which N sets of nodes and L sets of links. If no links and parallel links between the nodes are considered, the topological graph is considered to be simple.Means, a simple graph is said to be strongly connected if for each node u and v in {N}, there exists a path from u to v and v to u.A relative neighbourhood graph (RNG) T of the graph G=(N,L) is defined as T=(N,L') where there is a link between node u and node v if and only if there is no other node w belongs to N that is closer to either u and v than the distance between u and v formally.Max{d(u,w), d(v,w)}<{d(u,v)}. Where d(u,v) is the Euclidean Distance between the two nodes.RNG is a subgraph of a Delaunay Triagulation (DT) and has been implemented in the Topology control algorithmwhich is proposed by Cartigny etal to reduce the number of links between a node and its neighbors.

Power Aware Routing

In MANET mobile nodes are connected to each other. These mobile nodes are free to transmit either send or receive data packets to one another respectively and require power for such activities.There are four important power components.

- Transmission Power
- Reception Power
- Idle Power
- Overhearing Power

Transmission Power :- Whenever a node sends data packet to other nodes in the network, some amount of energy is required for transmission and such energy is called transmission energy (Tx) of that node and this energy is dependent on size of the data packet.The transmission energy is formulated as-

$$Tx=(330*plength)/2*10^6$$

and

$$Pt=Tx/Tt$$

where Tx is transmission energy, Pt is transmission power, Tt is the time taken to transmit a data packet and Plength is the length of data packet in bits.

Reception Power:- Whenever a node receives data packets from other nodes then some amount of energy is taken by the node to receive data packet, which is called reception energy (Rx). Reception energy is formulated as-

$$Rx=(230*plength)/2*10^6$$

and

$$Pr=Rx/Tr$$

where Rx is the reception energy, Pr is the reception power, Tr is a time taken to receive data packet, and plength is the length of data packet in bits.

Idle Power:- In this situation, node neither transmit nor receive any data packet. Power is consumed because it needs to listen to the wireless medium continuously in order to detect a packet that it should receive so that the node can then switch into receiving node from idle node. Idle power is a wasted power that should be eliminated or reduced to a minimum. Thus, idle power is,

$$Pi=Pr$$

Where Piis Idle Power and $P_R$is Reception Power.

Overhearing Power:- In This case a node picks up the data packets that are destined to other nodes and this is called overhearing and it may consume power. This power is called overhearing power. Unnecessarily receiving such data packets will cause power consumption .

Pover=Pr

Where Pover is Overhearing power and Pr is Reception power.

Power Aware Metrics

The main objective of power aware metric is to carefully share the cost of routing which will ensure that node and network life is increased. The power aware metrics result in power efficient route, which are detailed below:-

Minimize Energy Consumed Per Packet :- This is one of the most obvious metrics that conserves power efficiently, Assume that same packet j traverses n1-----nk nodes, where n1 is the source nk is the destination. Let T(a,b) denote the energy consumed in transmitting and receiving one packet over one hop from a to b. Then the energy consumed for packet j is-

$$ej=\sum_{i=1}^{k-1} T(ni, ni+1)$$

Thus the goal of this metric is to minimize ej, for all j. It is easy to see that this metric will minimize the average energy consumed per packet. In fact it is interesting to observe that, under light loads, the route selected using this metricwill be identical to routes selected by shortest hop routing. This is not a surprising observation because if we assume that T(a,b)=T=constant for all(a,b) belongs to E,where E is the set of all edges, then power consumed is (k-1)T. To minimize this value, we simply need to minimize k which is equivalent to finding the shortest hop path. This metric will tend to route packets around congested area (possibly increasing hop count). One serious drawback of this metric is that nodes will tend to have widely differing energy consumption profile resulting in early death of some of the nodes. Consider the networks illustrated in Figure(3). Here node 6 will be selected as the route for packet going from 0-3, 1-4 and 2-5. As a result, node 6 will spend its battery resources at a faster rate than the other nodes in the network and will be first to die.

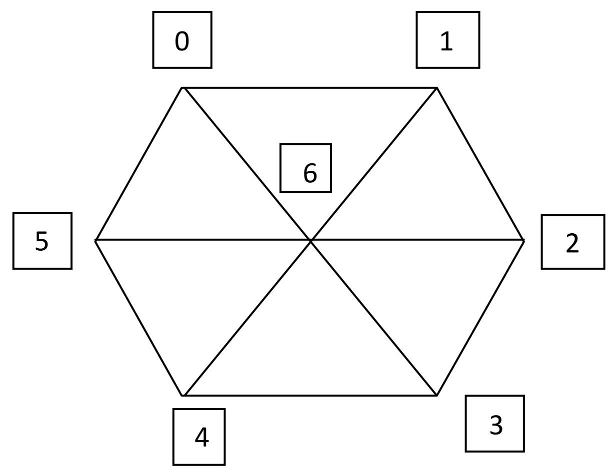

Figure-3Energy Packet As A Metric

Maximum Time To Network Partition :- One of the difficulties in implementing the metric is that given a network topology. Using the max_flow_min_cut theorem, we can find a minimal the network to partition. The routes between these two partition must go through one of these critical nodes.A routing procedure therefore must divide the work among these nodes to maximize the life of the network. If we don't ensure that these nodes use up their power at equal rates then we will observe that delay will increase as soon as one of these nodes dies. Problem is similar to the load balancing problem where tasks need to be sent to one of the many servers available so that the response time is minimized. This is known to be an NP-complete problem.

Minimize Variance In Node Power Levels :- This metric ensures that all the nodes in the network remain up and running together for as long as possible. This problem is similar to load sharing in distributed systems. Where the objective is to minimized response time while keeping the amount of unfinished work in all nodes the same. This is an intractable problem, because the execution times of future arrivals are not known. Join the Shortest Queue(JSQ) policy can be used to achieve this goal. Here each node sends traffic through a neighbor with the least amount of data waiting to be transmitted.If all packets are of same length, then we can achieve the equal powerdrain rate by choosing next hop in a round robin fashion so that on the average, all nodes process equal number of packets.

Minimize Cost Per Packet :- This metric is used to maximize the life of all nodes in the network. The path selected using this metric should be such that nodes with depleted power reserves do not lie on many paths. Let fi(xi) be a function that denotes the node cost or weight of node I, where xi represents the total energy spent by node i. The total cost of sending a packet along some path is the sum of costs at individual nodes from n1 to nk through a intermediate nodes n2 to nk-1 and can be represented as:-

$$cj = \sum_{i=1}^{k-1} fi(xi)$$

The goal of this metrics is to minimize cj, for all packets j. If fi is a monotonically increasing function, then nodes will not be over used thus increasing their life, where fi can be tailored to reflect a battery's remaining life time.

$$fi(xi)=(1/1-g(xi))$$

Where g(xi) is the normalized battery capacity.

Review For Power Aware Routing Protocol

Routing is one of the key issues in MANETSdue to their highly dynamic and distributed nature. In particular, the power aware routing may be the most important design criteria for MANETS since mobile nodes are powered by batteries with limited capacity.Power failure of a mobile node affects the ability of a node to forward packets on behalf of others and thus the overall network lifetime.For this reason, many research efforts have been devoted to developing power aware routing protocols. One important goal of a routing protocol isto keep the network functioning as long as possible. This goal can be accomplished by minimizing mobile nodes, energy not only during active communication but also, when they are inactive. Three approaches to minimize the active communication energy are-

(i) Transmission power control approach
(ii) Load distribution approach
(iii) Power management approach
(iv) Sleep/power-down mode approach.

With the help of these approaches classification, the respective power routing protocol and their functions are given in Table (1).

<u>Table-1 Functions Performed By Various Power Aware Routing Protocols</u>

Approach	**Protocols**	**Function**
Transmission Power Control	OMM PLR MER	Used to Minimize the total transmission power by avoiding, low energy nodes
	COMPOW PAAODV	They are used to minimize the total transmission energy while considering retransmission problem .
Load distribution	LEAR CMMBCR	Load is distributed to energy rich nodes.
Power Management	PAMAS PDTORA	Two separate channels one for data and other for control are used for minimizing the power consumption.
Sleep/Power–Down Mode	SPAN GAF	At the time of idle state of node, minimizes power consumption.

Conclusion

One of the most creativeand demanding areas of wireless networking is a MANET and it is increasingly appear in our daily life. Here I will try to show the deterministic and probabilistic approaches for building a network topology power control algorithm in mobile adhoc network. I have consider the technique for building network graph which is used to minimize the cost function and improving the network life time. Also review the functions performed by different power aware routing protocols

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