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Research Paper

Achieving throughput in topology by implementing QoS in Wireless Ad Hoc Networks

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ABSTRACT:- In wireless communication QoS is an important parameter needed to be discussed for research analysis. The previous works faces problem in QoS in ad hoc networks increasingly in throughput analysis. Here we adopted a new approach for energy saving control provisions in ad hoc networks. Here a set of nodes is given in a plane which have end-to-end traffic demands and has delay bound between all node pairs so that we can form a network topology which can meet all QoS requirements and where minimization of total power is done. We considered here two cases: 1) The traffic demands are non Splittable and 2) The traffic demands are Splittable. We formulate first case as an integer linear programming problem .The latter case is formulated as a mixed integer linear programming. Also a simulation set up is done for a given set of nodes having weighted distribution using biographs in which link throughput is analyzed for both the cases. Our group first verifies throughput improvement using Splittable as compared to non Splittable as described in this paper. As we compared throughput analysis for both the cases we found a great enhancement in QoS factors by using a Splittable topology for ad hoc network which has been improved by 50% increase in throughput in Splittable case as compared to non Splittable case.

Keywords:- *Energy management, QoS provision, QoS routing, topology control, Wireless ad hoc networks*

I. INTRODUCTION

A wireless network infrastructure is required for personal communication and mobile computing and these infrastructure is fast deployable and have possible multihop and capable of multimedia service support [1]. In multi-hop ad hoc networks which is a wireless network of special type and that does not support a infrastructure that is of wired type, communication between two nodes is not done by direct neighbors but instead the transfer of messages is done by intermediate node between them. In an ad hoc network basically every node act as a router and all set of networks have status which is equally assigned for all nodes on a network and where all nodes are freely moving with other ad hoc network devices and also each node act as a communication end-point. As compared to wireless managed networks, the networks based on Ad Hoc have more suitability for variety of applications for which the central nodes can't be relied on and also since wireless managed networks has theoretical and practical limitation, an ad hoc network are more useful in improving scalability and capacity of networks. The network based on an ad-hoc is made up of multiple nodes which is connected by links. In an Ad Hoc network the links are influenced by the Nodes resources which are basically a transmitter power, computing power and memory and also it depend on some of behavioral properties i.e. Reliability and also it is dependent on some of link properties which are length-of-link and signal loss, interference and noise problems. As in an Ad Hoc networks links can be connected or disconnected at any time so this functioning network should have capability to cope with this dynamic structuring in such a way that is becomes timely, efficient, reliable, robust and scalable. Sine in most ad hoc networks based on wireless technologies are free to move, here nodes has a collision interference problems .In order ot improve decoding of desired signal we use cooperative wireless communication which improves immunity to interference by having the destination node which combine self-interference and other-node interference .In our modern network applications there are several phenomenon i.e. transmission of data which is of multimedia type, collaborative work of real time and interactive distributions of applications which require provisions of QoS in ad hoc networks. In multi-hop ad hoc networks the provisions of QoS such as end-to- end bandwidth and delay are highly dependent on the network topology .Many studies have been done on QoS provisions in ad hoc network, such as QoS routing or admissions control [2,3].In this paper we considered Splittable and Non Splittable traffics of ad hoc networks and compared those using Matlab simulation set up.

II. RELATED WORK

In this section we described some of research work which is already been done in topology control for a network i.e. Ad Hoc .There are some of the earlier work in [4,5] where in [4] Hou et al has studied the relationship between range of transmission and throughput and develops an analytical model such that each node adjusts its transmission power in order to reduce interference and hence achieve high throughput In order to construct highly reliable throughput topology we develop a distributed algorithm and also energy consumption minimization was not concerned in both works. Recently in an ad hoc wireless network an energy efficient topology control was an important topic and mostly works was focused on the construction and maintenance of the network topology so that we can have good connectivity and can achieve energy consumption and summary of this work was given by Lloyd et al. which used a 3-tuple <M, P, O> in order to represent topology control QoS Topology Control with Minimal Total Energy Cost 625 problems, in which the graph model (either directed or undirected) is represented by "M" , the desired graph property (e.g., 1-connected or 2-connected) is represented by "P" and the minimization objective (e.g., Min Max power or Min total power) is represented by "O". Also analysis of NP-completeness of this kind of problems is described and several algorithms have been proposed in works[6].With the objective of minimizing the maximal transmitting power of each node two centralized optimal algorithms were proposed in order to connected and bi-connected static networks and also two distributed heuristics, LINT (local information no topology) and LILT (local information link state topology), were also proposed in order to adaptively adjust node transmitting power so that we can maintain a connected topology in response to topological changes. But these heuristics does not guarantee the connectivity of the network [7]. So in order to achieve network connectivity with minimal power consumption Li et al. proposed a minimum spanning tree based topology control algorithm [8].Huang et al. developed a cone-based distributed topology control since each node gradually increases its transmitting power until it finds a neighbor node in every direction (cone). So as a result, the global connectivity is guaranteed with minimal power for each node in [9] which was further extended by using directional antennas in [10].A method so that we can optimize the topology of Bluetooth is given by Marsan et al. which aims at minimizing the maximal traffic load of nodes (thus minimizing the maximal power consumption of nodes) [11].In order to minimize the maximal transmitting power of nodes we have first proposed and later worked so that our topology can meet all QoS requirements. Although minimizing the this objective may be greater than that using this objective may be greater than that using maximum transmitting power can balance workload on networks, energy consumption using minimizing total transmission power objective. Such a increase of energy consumption result in reduction of lifetime of network in long term[12]. As to minimize total transmission power of nodes in this paper there are different nodes which discussed the QoS topology control problem and lot of works are done on the energy efficient communication in ad hoc network and some of them is done by Singh et al which studied five different metrics of energy efficient routing such as minimizing energy consumed per packet, minimizing variance in node power levels, minimizing cost per packet[13,14] and also by Kawadia et al. who proposed a method of clustering for routing in non-homogeneous networks where nodes are distributed in clusters. The goal is to choose the transmit power level, so that low power levels can be used for intra-cluster communication and high power levels for inter-clusters [15]. Wieselthier et al. proposed some of heuristic algorithms namely the Broadcast Incremental Power (BIP), Multicast Incremental Power (MIP) algorithms, MST (minimum spanning tree), and SPT (shortest-path tree) and studied the problem of adjusting the energy power of each node in such a way that the total energy cost of a broadcast/multicast tree is minimized. [16]. and the quantitative analysis of performances of these three heuristics was presented by Wan et al. [17]. In this paper, we have determined the problem of topology control so that our topology control can meet all QOS requirements and can minimize the transmitting power of nodes [17].

III. SYSTEM MODEL AND PROBLEM SPECIFICATIONS

In our modern network applications there are several phenomenon i.e. transmission of data which is of multimedia type ,collaborative work of real time and interactive distributions of applications which require provisions of QoS in ad hoc networks. So these modern network applications need such a control of topology so that each node in the network to adjust its transmission power (i.e. to determine its neighbors) and can form a good topology. Jie et al. has studied the power of such a network topology such that it can meet all QoS requirements. This section focus on the problem of QoS topology control in ad hoc wireless networks.

In this work, a group of notations will be used where we have adopted the widely used mode of transmitting power of radio networks: $p_{ij} \leq d_{i,j}$ where p_{ij} is the transmitting power needed for node i to reach node j, $d_{i,j}$, is the distance between i and j, and $<$ is a parameter typically taking a value between 2 and 4. The modulation of network is done by G = (V, E), in which w V represent the set of n nodes and E represent set of undirected edges. Here each node has a capacity of bandwidth B and there is maximal level of power in transmission which is represented by Pmax and also the bandwidth is shared in both transmission and receiving of signals such that the total bandwidth for transmission and receiving signals should not exceed B. here an assumption is made that each node can adjust its power level but not beyond the maximum power Pmax such that We assume that each node can adjust its power level, but not beyond some maximum power Pmax such that we denote pi as transmitting power of nodes and the connectivity between two nodes depends on the power of transmission and from such a network model we can control the transmission power of each node so that it affects our QoS provisions of the network. If the topology is too dense (i.e., nodes have more neighbors), there would be more choices for routing, but the power consumption of the system would be high. On the other hand, if the topology is too loose (i.e., with less edges), there would be less choices for routing (hence, some nodes could be overloaded) and the average hop-count between end nodes would be high. Our goal is to find a balanced topology that can meet end-users QoS requirements and has minimum energy consumption. Let $\lambda_{s,d}$ and $\Delta_{s,d}$ denote the traffic demand and the maximally allowed hop-count for node pair(s, d), respectively. Let Pmax = max {pi | 1< i < n}. The topology control problem of our concern can be formally defined as: given a node set V with their locations, $\lambda_{s,d}$ and $\Delta_{s,d}$ for node pair (s, d), find transmitting power pi for 1 ≤ i≤n, such that we can route to all demands of traffic within its boundary of hop-count and can consume total power which is minimized. In this paper one of the case i.e. end-to-end traffic demand are not Splittable is considered where $\lambda_{s,d}$ for node pair (s, d) routes on the same path from s to d and assumed that each node can transmit signals to its neighbors in a conflict free fashion and interference of signal is not considered here. [18,19].

3.1 TOPOLOGY CONTROL FOR NON SPLITTABLE TRAFFICS

This section considered the case that traffic demands between node pairs are not Splittable i.e. All traffic between a node pair routes on the same path. Here we determine p(i) for each node I so that our QoS requirement can be meet and our main concerned is in minimizing the total transmission power of nodes in the network.

GIVEN:

V locations and set of n nodes
B the bandwidth of each node.
$\lambda_{s,d}$, traffic demands for each node pair (s,d).
$\Delta_{s,d}$, maximally allowed hop-count for node pair (s,d)
P maximally allowed transmitting power of nodes.

VARIABLES:

(i) xi, j , Boolean variables, xi, j = 1 if there is a link from node *i* to node *j*; otherwise, *xi*, j= 0.
(ii) $x_{i,j}^{s,d}$, Boolean variables, $x_{i,j}^{s,d}$=1,if the route from *s* to *d* goes through the link (*i*, *j*); otherwise $x_{i,j}^{s,d}$, = 0.
(iii) *pi* , transmission power for node *i*.
(iv) Rmax , power utilization which is max in all nodes

OPTIMIZE:

- Minimize the maximum transmitting power of nodes.

Min

$$Ptotal = \sum_{i=0}^{n} p(i) \quad (1)$$

CONSTRAINTS:

Toplogy contraints:

$$x_{i\,j} \le x_{i\,j'} \quad \forall \text{ i, j.j'} \in V, d_{ij'} \le d_{ij} \quad (2)$$

Transmission power constraints:

$$\text{P} \ge p(i) \ge (d_{ij})^n\, x_{ij} \quad \forall\, i, j \in V \quad (3)$$

- Delay constraints:

$$\sum_{(i\,j)} x_{i,j}^{s,d} \le \Delta_{s,d} \quad \forall \text{ (s,d)} \quad (4)$$

- Bandwidth constraints:

$\sum_{(s,d)} \sum_j x_{ij}^{s,d}{}_{\lambda_{s,d}} + \sum_{(s,d)} \sum_{ji} x_{ij}^{s,d}{}_{\lambda_{s,d}} \leq B \ \forall\, i \in V$ (5)

- Flow conservation:

$$\sum_j x_{i,j}^{s,d} - \sum_j x_{j,i}^{s,d} = \begin{cases} 1 & if\ s = i \\ -1 & if\ d = i \\ 0 & otherwise \end{cases} \quad \forall i \in V \quad (6)$$

- Route validity ;

$$x_{i,j}^{s,d} \leq x_{i,j} \qquad \forall\, i, j \in V \qquad (7)$$

- Binary constraints:

$x_{i,j}$ =0, or 1,$x_{i,j}^{s,d}$=0,or 1 $\forall i, j \in V(s, d)$ (8)

Here the problem is formulated by an integer linear programming problem where the objective and constraints are same as a case of Splittable traffics. As the constructed topology is directed so in order to make it undirected we add a constraint: xi, j = x j,i for ∀i , j ∈ V. Integer linear programming problems belong to the linear programming problems in which some or all of the variables are restricted to be integers. Figure 1 shows the topology of a network with six nodes and six requests, where node 1 is given as a high powering node, node 2 is given as medium powering node, and the rest all nodes are low powering nodes.

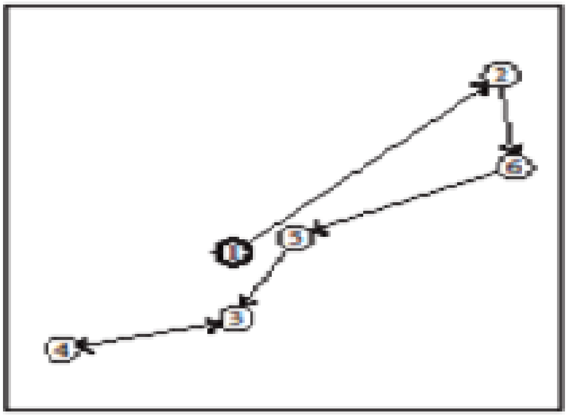

Figure 1: QoS TOPOLOGY Control for non- Splittable case

Table 1: Requests and their routing for figure 1.

s	d	$\lambda_{s,d}$	Route
1	2	29.9568	1—>2
2	3	36.4634	2—>6—>5—>3
3	5	34.2944	2—>6—>5
4	4	29.7357	3—>4
5	3	35.9753	4—>3
6	4	33.5743	6—>5—>3—>4

3.2 TOPOLOGY CONTROL FOR SPLITTABLE CASE

In this case as there is no delay constraint the traffic pattern can be routes to several different paths. We formulate the control problem of QoS topology for Splittable traffic as follows

Objective: The maximum power utilization of nodes can be minimized:

MinRmax

Subject to:

Topology constraints:

$x_{i,j} \leq x_{i,j'}, \forall\, i, j' \in V, d(i,j') \leq d(i,j)$ (9)

Transmission power constraints:

$P_i \geq p_i \geq d^{\alpha}_{i,j}\ x_{i,j}, \forall i,j \in V$ (10)

$R_{max} \geq \frac{p_i}{P_i}, \ \forall i \in V$ (11)

Bandwidth constraints:

$\sum_{(s,d)} \sum_j f^{s,d}_{i,j} + \sum_{(s,d)} \sum_j f^{s,d}_{j,i} \leq B_{i,j}\ \forall i \in V$ (12)

Routes constraints:

$$\sum_j f^{s,d}_{i,j} - \sum_j f^{s,d}_{j,i} = \begin{cases} \lambda_{s,d} & if\ s = i \\ -\lambda_{s,d} & if\ d = i \\ 0 & otherwise \end{cases} \quad (13)$$

$f^{s,d}_{i,j} \leq f^{s,d}_{i,j} x_{i,j}, \ \forall$ i,j∈V,(s,d) (14)

$x_{i,j}$ =0, or1

Variable constraints:

$$f^{s,d}_{i,j} \geq 0, p_i \geq 0, R_{max} \geq 0, \quad \forall i,j \in V, (s,d)$$

Where xi,j are Boolean variables xi,j=1 if there is a link from node i to node j, otherwise xi,j=0; $f^{s,d}_{i,j}$ represents the amount of traffics of node-pair (s,d) that go through link (i,j).As transfer of node can be received to all nodes within its transmission range Constraint 9is given which tells that nodes have ability of broadcasting. The transmission power of each nodes does not exceed the boundation of power is given by constraint 10. Constraint 11determines the maximum power utilization ratio among all nodes. Constraint 12 ensures that the traffic going through a node does not exceed the bandwidth of that node. The first term on the right-hand side of inequality 13 represents all the outgoing traffic at node i transmitting) and the second term represents all the incoming traffic (reception). Constraints 14 ensure that the validity of the route for each node-pair. The QoS topology control problem with traffic Splittable has now been formulated as a mixed integer programming problem. Since the mixed integer linear programming is unable to be solved in polynomial time we solve our problem by considering load balancing QoS routing problem where we have a network topology with a traffic demand between its node-pairs which is routed in a network such that Lmax i.e. maximum utilization of bandwidth is minimized.

The topology of a network with six nodes and six requests in which node 1 is high power nodes and node 2 is medium power nodes and all rest nodes are low powering node which is shown in figure 2 and the details of requests and routing are given in Table 2 as computed by lp solve.

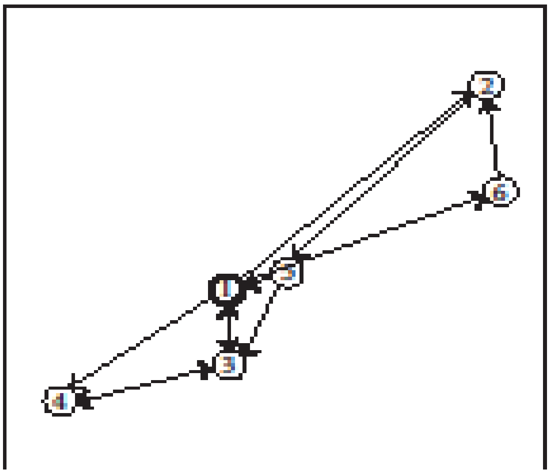

Figure 2: QoS Topology control for Splittable case

Table 2: Requests and their routing for figure 2

s	d	$\lambda_{s,d}$	splitted$\lambda_{s,d}$	Route
1	2	29.9568	16.4993 13.4575	1—>2
2	3	36.4634	14.3784 11.8406 10.2444	2—>5—>1—>4—>3 2—>5—>3 2—>5—>1—>3
2	5	34.2944	34.2944	2—>5
3	4	29.7357	15.6646 14.0710	3—>4 3—>1—>4
4	3	35.9753	35.9753	4—>3
6	4	33.5743	31.0260 2.5483	6—>2—>5—>1—>4 6—>2—>5—>3—>4

3.3 SOLUTIONS

We are facing problems in finding a network topology such that we can route our traffics and we can minimize the power of transmission in a topology. In Splittable traffics we adjust the power to a minimal level i.e., $p(i) = 0$, for $1 \le i \le n$ after that we compare QoS topology by certain:1)node is picked and power is increased in order to reach new neighbor i.e. add new link to network 2) check if the traffics can be routed on the new topology obtained in step 1. If so, the QoS topology is found; otherwise repeat steps 1 and 2. Here in Splittable, problem in step 2 can be transformed as a multi-commodity flow problem which means that for a given network topology we route commodity in a network such that our load of a node i.e. maximal can be minimized. If we find the optimal solution in this topology, we can obtain a set of routes which meet the QoS requirements. Otherwise, we can conclude that the topology cannot accommodate the traffics. The below we considered the QoS routing path of a given network by step 2 as follows

3.3.1 QoS Routing Problem

Consider a network graph G a and there is demand of traffic between node pairs here in this graph we route in such a way that our maximum load in system denoted by Lmax can be minimized .The sum of all traffics that go through node I is represented by node-load of node i. This problem can be formulated as the following:

Objective:

The maximum bandwidth utilization is minimized:

$minL_{max}$ (15)

Subject to:

$$\sum_j f_{i,j}^{s,d} - \sum_j f_{j,i}^{s,d} = \begin{cases} \lambda_{s,d} & if\ s = i \\ -\lambda_{s,d} & if\ d = i \quad \forall i \in V \\ 0 & otherwise \end{cases} \quad (16)$$

$$\sum_{(s,d)} \sum_j f_{i,j}^{s,d} + \sum_{(s,d)} \sum_j f_{i,j}^{s,d} \leq B_i L_{\max}, \forall i \in V \quad (17)$$

$$f_{i,j}^{s,d} \geq 0, \quad (18)$$

$$L_{max} \geq 0, \forall i \in V \quad (19)$$

Function (15) is the objective, which is to minimize the maximal node load. We have obtained maximal load in a given network given (note that all nodes have the same bandwidth capacity) by Constraint (19) and when maxx L< B means that the actual range of bandwidth exceed that capacity that violates constraint (13) and we use constraint (20)by (12) which is a delay constraint which indicates that given topology is unable to accommodate the demands of a traffic .We have to keep on adding more links on topology for such a algorithm of QoS control until maxx L ≤ B which means that the topology can support the required traffics (i.e., no node has the actual bandwidth usage exceeding its capacity). This is a linear programming (LP) problem. The optimal solution can be found in polynomial time. Let |*E*| denote the number of edges in graphs G, and *t* denote the number of node pairs which have non-zero traffic. Time complexity to compute QoS routing problem is *O*((|*E*|×*t*)3.5), where |*E*|×*t* is the number of variables in formulations (15)-(19) [20, 21].

3.3.2 Energy Efficient QoS Topology Control Algorithm

Here we have proposed two methods of energy efficient QoS topology control algorithm and these algorithm are Least Incremental Power First algorithm (LIPF for short) and Least Power First algorithm (LPF for short).In LIPF we minimize incremental power in each step and LPF we add link with the least power in each step as described below:-

LIPF algorithm

In this algorithm we compare the least incremental power of each node such that at when it reaches its new neighboring node it picks such node which has increase in its incremental power and by using such node it has increment in its transmitting range as it reach to its new neighbor after it picks the node we run this algorithm in order to see whether this request of traffic is able to route and we repeat this step until we found the QoS topology such that all nodes reach their maximum power P (the topology that can meet the QoS requirements does not exist in this case).

Input**:** node set V with their locations, $\lambda_{s,d}$ for node-pair (*s*,*d*), and bandwidth capacity *B*.

Output**:** transmitting power *p*(*i*) for each node *i* in V.

a) compute the least incremental power for each node to reach a new neighbor:

$$\Delta_i = \min\{(d_{i,j})^n \text{-p(i)/l} \leq j \leq n, (i,j) \notin E\}, \forall l \leq i \leq n.$$

b) pick the node k that reach a new neighbour j with the minimal incremental power Δ_i=min{Δ_i/ l≤ $i \leq n$},and add new link(k,j) to G.

c) Run the QoS routing algorithm on G to obtain L_{max} if $L_{eff} \leq$ B or all nodes reach their maximal power P, then stop; otherwise, go to (a) and repeat.

LPF algorithm

In LPF algorithm the sorting of nodes (in fact, only the node pairs that can be reached within the maximal transmitting power *P* are considered)are denoted in ascending order according to the Euclidean distance between nodes. Each time we picks the link i.e. has least power cost and increment in power of sender is increased until reach the other node and after that we run this algorithm such a that our requested traffic can be routed and this operation is repeated until the QoS topology is found, or all nodes already reach their maximal power *P*.

Input: node set V with their locations, $\lambda_{s,d}$ for node-pairs (s,d),and bandwidth capacity B

Output: transmitting power p(i) for each node i in V.

a) sort all node-pairs in ascending order according to (note that $p_{ij} = (d_{i,j})^n$ and $(d_{i,j})^n \leq P$)

b) Add the minimal which does not yet exist in the network and get the new G.

c) The QoS algorithms of routing is run on G to obtain if or there is no available link left, then stop; otherwise go to (b) and repeat.

For both algorithm in step© we stop as we reached maximum power P. An error of no solution is reported in this case. In LPF algorithm we use binary search method to find QoS such that we reduced the time needed to call this algorithm and instead of adding such link every time and running the algorithm.
We have found that the LPF algorithm is at most n times of the optimal solutions so we introduce this theorem by giving following lemma.

Lemma 1. In LPF algorithm we find such solution in which maximum transmission power of nodes in a network is minimized and can meet our QoS requirement.

Proof: In LPF algorithm, each time we picks the link i.e. has least power cost and increment in power of sender is increased until reach the other node and after that we run this algorithm such a that our requested traffic can be routed and this operation is repeated until the QoS topology is found in the network.Note that the node power $p(i)$ is gradually increased. So the maximal node power in the solution is minimized.

Theorem 1**:** Approximation ratio of LPF algorithm is O(n).

Proof: If LPF algorithm cannot find solutions, it means that all edges are added into the network and QoS routing cannot be found in this topology. That is, the required traffic cannot be routed in the topology where all nodes use their maximal transmission power. So there does not exist solutions for this case. If LPF algorithm finds solutions, we prove that the total transmission power of the network is at most n times of the optimal solution, where n is the number of nodes in the network. Let Ptotal, Pmax denote the total transmission power and the maximal transmission power of nodes ion the topology found by LPF algorithm, respectively. Let P_{total}^{opt} , P_{eff}^{opt} denote the minimal total transmission power and the minimal maximal transmission power of nodes in the topology that meets QoS requirements.
According to lemma 1, we have $P_{total}^{opt} = P_{eff}$. Then

$$P_{total} = \sum_{i=0}^{n} p(i) \leq \sum_{i=0}^{n} P_{eff} = \mathrm{n}P_{eff} = \mathrm{n}P_{eff}^{opt} \leq \mathrm{n}P_{total}^{opt}$$

Theorem 2: Time complexity of LPF algorithm is O(n2logn+logn(|E|×t)3.5), where is the number of edges in the network and t is the number of node pairs ,which have non-zero traffic .
Proof : in L
PF algorithm step a) costs at most to sort all edges in the network according to their length. In step b), we adopt binary search method, it costs $O(\log n)$ none that step c) costs $O((|E| \times t)3.5)$ [20].Then the total time complexity of LPF algorithm $O(n2\log n + \log n(|E| \times t)3.5)$.

3.4 Experiments

3.4.1 Simulation set up

Let us consider a network with N=30 nodes placed at a random over a 1km *1km area given in figure 1 generated using Matlab using biographs connected by its neighbors by a particular weighted graphs for it and the node positions are chosen from a uniform distributions over the area .Here we perform a simulations based study given under:

A. Network Parameters:

The following network parameters are considered below in this section which has a significant effect on the link and their effects are given below :-

1. Network degree Ndeg

Network degree is that type of parameter in which there is average number of neighbors in a radio transmission. In a noise –free channel transmission where any two radios are neighbors to each other where one of radio depends on single-to-noise ratio of transmission where other simply transmit it and the factor that affects such a single-to-noise ratio is the exponential loss in path in which two radios shared a link that depend on distance between these two radios. Let du denote the maximum link distance for unicast signaling, and let dl(p) and dm(p) denote the maximum link distance for less and more-capable links resp. These distances can be calculated as

dl(p) =du$10^{-D(P)/(10n))}$ (20)
dm(p) =dl$10^{-\delta(p)/(10n)}$ (21)

Where D(p) and $\delta(p)$ are the degradation and disparity resp. For nonuniform QPSK, these simplify to

dl(p)=du$[cos(p)]^{2/n}$ (22)

and

$dm(p)=du[\sin(p)]^{2/n}$ (23)

where n is the path-loss exponent. We take n=4 in all that follows.

Here we develop our interest in considering the coverage area of a transmission which is defined as the area in a given region where there are radios which have links for a particular transmission. Then, the coverage areas for the basic and additional messages are given by πdl^2 and πdm^2, resp. Consider an arbitrary node in a network with nodes uniformly distributed over area A. let pl and pm denote the probabilities the some other node is connected to that node by a less-capable link and more capable link resp .Then pl(p) $\approx \pi[dl(p)]^2$/A , and pm(p) $\approx \pi[dm(p)]^2$/A ,where we have approximation which are as we ignore the edge effects of area which is finite in which all other nodes are placed [22]. Then the network degree is given by

Ndeg (p) = (N -1) pl(p)

$\approx$ (N -1) $\pi[dl(p)]^2/A^2$ (24)

$=$ N deg (0) Cos(p)

2. The proportion of radios with more-capable links Rm.

This can be calculated by

Rm (p) = 1- $[1 - pm(p)]^{N-1}$ (25)

Here du= 381m and N=30. [22]

B. Link throughput :

We apply the convention techniques For link-throughput analysis of slotted ALOHA [23] .let E[Di] be expected value of delay required for a packet transmitted by radio i to be successfully received by designated next –hop radio. The average link throughput for a network of N nodes is given by

S = 1/N $\sum_{i=1}^{N} Si$ (26)

1. Unicast transmission:

In Unicast transmission, Simulcasting is not allowed; each radio sends at most one packet to one next-hop radio during a time slot as shown in Figure 1.It represent Non-Splittable traffics.

2. Simulcast transmission:

In simulcast transmission we can sent more than one packet by a radio during a particular time slot if there has an availability of more capable links which is shown in figure 2 which represent Splittable traffics.

Ss = [1+Rm(p)] (27)

3.4.2 Simulation results and analysis

3.4.2.1 Topologies for non Splittable traffic versus Splittable traffic

We have performed simulation analysis and compared the two different topologies i.e. Splittable and non-Splittable traffics, the topology for non- Splittable traffics which has six nodes and six request showed by figure 1 where node 1 has a high-power ,where node 2 has medium power and rest all nodes are low-power nodes. Table 1 gives a detail description of all request and routing I.e. computed by lp-solve. The topology for Splittable traffic is given in figure 2 where all routing details are given in table 2 respectively. Here we notices that all redundant nodes are removed as seen from figure 1 and 2 and value of Rmax is .7517 and .5965 for non-Splittable and Splittable respectively. Since we know that Splittable traffics split the traffic into multiple routs by taking advantage of short-distance link i.e. is used for transmission we can be cleared i.e. it will have better balance of utilization of energy. By seeing figure 1 and 2 we found that link 6→5 in figure 1 i.e long distance link has contribution for high value of Rmax since value of Rmax is high in this case as compared to figure 2 which have short-distance link to carry the traffic through multiple paths this increase the cost in long-distance path.

3.4.2.2 Results for analysis of N=30 nodes in network parameters and throughput

1. Network Degree: The network degree vs. offset angle is analyzed as shown in Figure 3

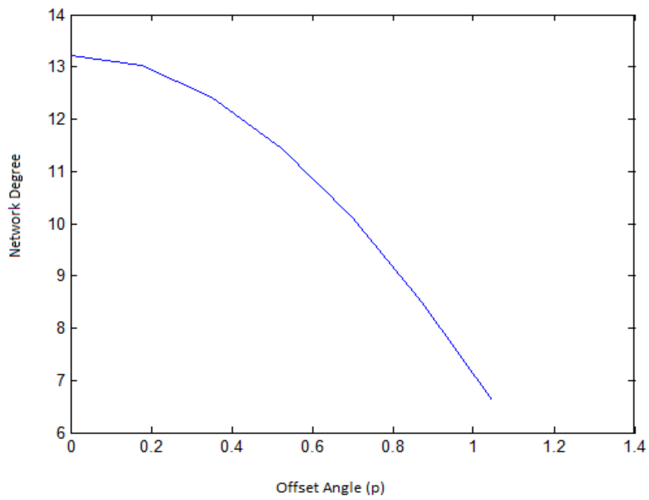

Figure 3: Plot of Network Degree v. Offset angle p.

2. Nodes with more capable links: As p is varied the number of nodes with more capable links changes as Shown in Figure 4

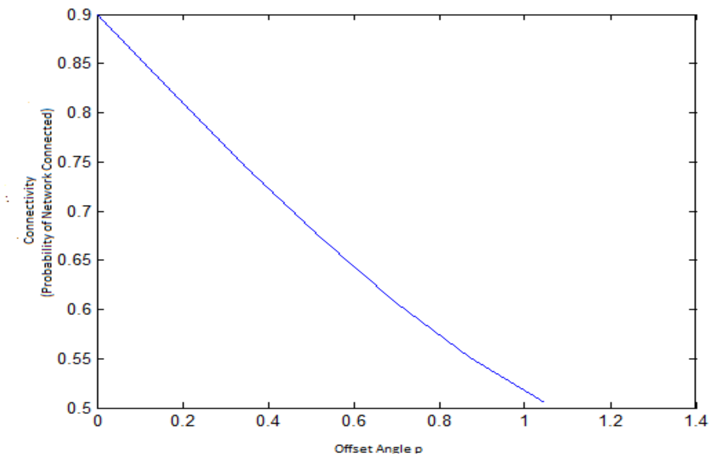

Figure 4: Plot of Rm (Ration of more capable nodes to total nodes) v. Offset angle p.

3. Network connectivity: As p is varied the number of nodes with network connectivity changes as for Simulcasting with nonuniform QPSK in a wireless ad hoc networks with random node placement. As shown in Figure 5

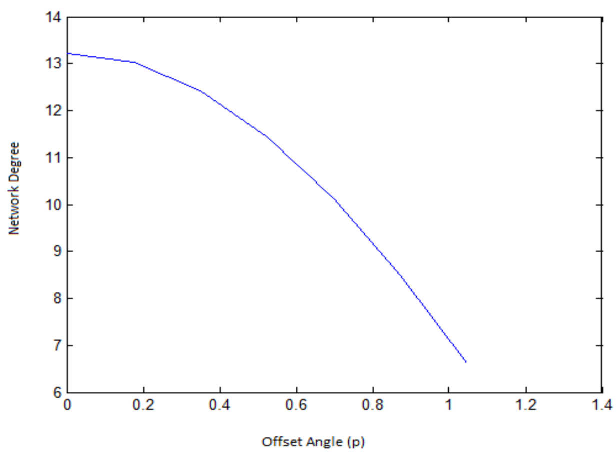

Figure 5: Plot of network connectivity as a function of the offset angle p for Simulcasting with non uniform QPSK in a wireless ad hoc network with random node placement.

4. Average Link-to-Link Throughput:

This test verifies that the Average Link-to-Link Throughput is improved in simulcast vs. unicast transmission. Simulcast transmission is done with nonuniform QPSK with offset angle p = 25° as shown in Figure 6

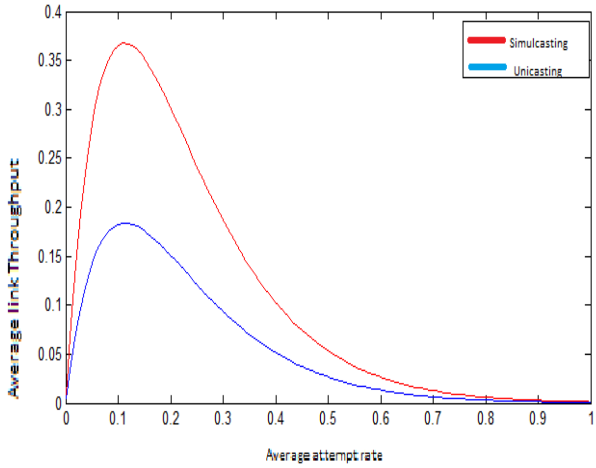

Figure 6: Plot of Link throughput for Unicasting and Simulcasting with nonuniform QPSK with offset angle p = 25°

4.1. Broadcasting topology for dominated traffics

Here we have topologies for broadcast dominated traffics with N=30.which has weighted distribution with requests as shown in Figure 7 in which we perform simulations experiments for network parameters.

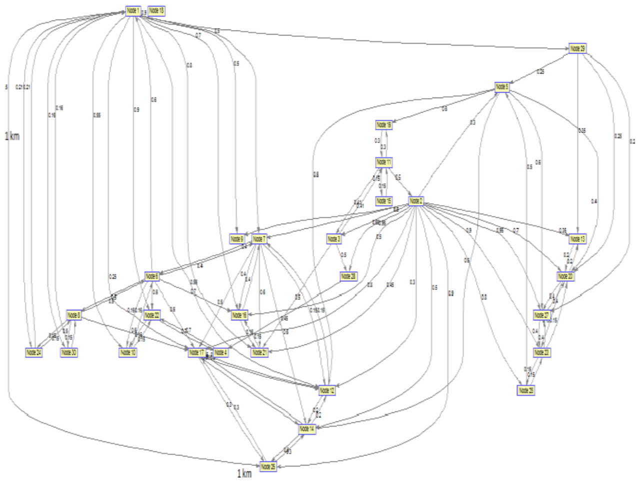

Figure 7: Broadcasting topology for dominated traffics

IV. CONCLUSION

We have discussed the energy-efficient QoS topology Control problem for non homogenous ad hoc networks. This is the first time in the literature that topology control is studied regarding QoS provisions. Both cases of non Splittable and Splittable traffics have been considered. For the former Case, the problem has been formulated as an integer linear programming problem. For the latter case, the problem has been formulated as a mixed integer programming problem .here link to link throughput is analyzed for both cases by seeing graphs it is clear that topology control for Splittable has better throughput as compared to non Splittable as given in graphs for unicast and simulcast transmissions and also effects on network parameters is seen on simulcast signaling is done .We verifies here that traffic at Splittable has better throughput as compared to non Splittable. The QoS improvement factor :throughput has been improved by 50% improvement in Splittable case as compared to non Splittable and shows that our QoS topology has been controlled in Ad Hoc network by using Splittable case and it verifies that it has been topologies control mechanism.

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