The power stretch factors of RNG (G) and YG_k (G) could be as large as $N - 1$ and $1 / (1 - 2\sin(k/\pi))$, respectively.

3. OUR LOCALIZED ALGORITHM

Due to the characteristics of wireless ad hoc networks, it is preferred that the underlying network topology can be constructed in a localized manner [4]. In our case, a distributed transmission power control algorithm is called localized if every node u can decide its transmission power based only on the information of the nodes reachable in a small number of hops. The local topology view of node u, denoted by $LTV(u, k) = (V', E')$, is a subgraph of G such that (1) a node $v_i \in V'$ if the hop distance between v_i and u is no more than k; (2) an edge $(v_i, v_j) \in E'$ if $\|v_iv_j\|$ is less than the transmission radius of v_i.

Our localized algorithm operates based on $LTV(u, 1)$. The location information of the one-hop neighbors can be obtained by using some form of beacon messages that are sent periodically and asynchronously by each node; the weight of each edge in $LTV(u, 1)$ can thus be derived. Each node u applies Dijkstra's algorithm independently to get the shortest-paths from the source node u to the other nodes in $LTV(u, 1)$. As a result, the local shortest path tree of node u, denoted by $LSPT(u)$, can be obtained. The direct children of node u, $DC(u)$, is defined as $DC(u) = \{v \in V' \mid h(LSPT(u), v) = 1\}$, where $h(LSPT(u), v)$ is the height of a child node v in $LSPT(u)$. Node u then removes the edge set $\{(u, w) \mid w \notin DC(u)\}$ from its edges and decides its logical links. Each node sends the result to its one-hop neighbors. The topology generated under the above descriptions is denoted as G^1. Since for each node u, only the one-hop neighborhood information is available for constructing $LSPT(u)$, some links in G^1 may be uni-directional. However, uni-directional links are unfavorable in wireless ad hoc networks. Our solution to remove uni-directional links is simple: since all nodes are aware of the logical links of its one-hop neighbors after the above process is completed, each node deletes the uni-directional links and adjusts its transmission radius according to the remaining logical links. The resulted topology is denoted as G^2. An example is illustrated in Fig. 1; the gray circle is the initial transmission range of p_1 and the dashed circle represents the transmission range after adjustment.

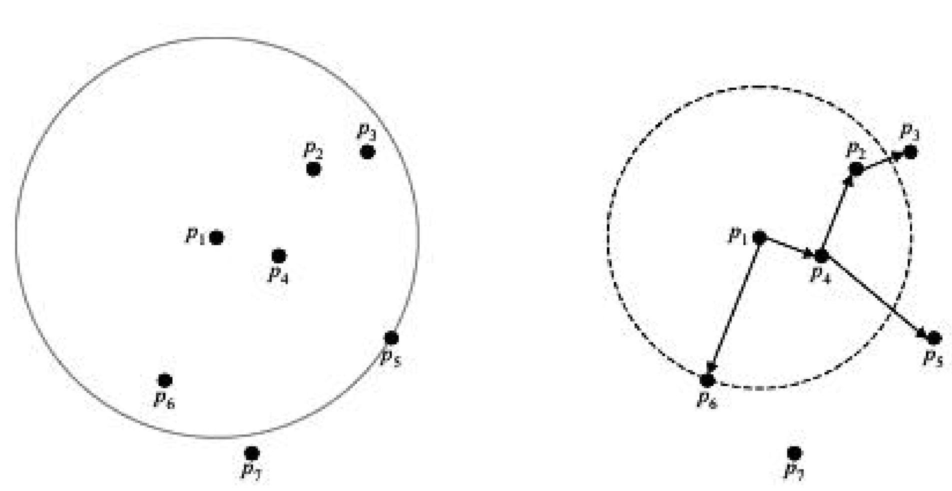

Fig 1. Illustrative example.

The critical properties of the topology generated by our algorithm are listed below. Due to the limited space, we omit the proofs here.

Lemma 1: The minimum-energy path between any two nodes in G is preserved in G^1.

Lemma 2: The minimum-energy path between the two end nodes of each deleted link in G^1 is preserved in G^2.

Lemma 3: G^2 preserves the network connectivity of G.

4. PERFORMANCE COMPARISONS

Via simulations, we compared the performance of our algorithms with that of others in terms of the total power consumption (denoted as *tpc*) and the average/max node degree (denoted as *avg*/*max nd*) of the topologies constructed by the algorithms being compared. The experimental results are summarized in Table 1. Our algorithm is denoted as LSPT. The unit disk graph (denoted as UDG) is chosen as a basis for comparison. We chose the algorithm proposed by Li and Halpern [3] (denoted by SMECN) since it performs significantly better than the one proposed by Rodoplu and Meng [2] in terms of total power consumption. Likewise, the constrained Gabriel graph (denoted by GG) has the minimum-energy property and outperforms those described in [1]; it is thus chosen for comparison here. In our simulations, α was set to 4.0 and the receiver power was ignored. Be advised that *tpc* is normalized to lie in between 0.0 and 1.0 by dividing its values by the total power consumption of UDG. The transmitter range R is fixed at 500 meters. The map sizes are equal to $s \times R$ by $s \times R$, for $s = 3$ and 5. The x and y coordinates of each node are selected at random in the interval $[0, m]$, where m is the map size. The experimentation was performed for $N = 100$.

Table 1. The performance measurements

	[illegible]			[illegible]		
	tpc	*avg nd*	*max nd*	*tpc*	*avg nd*	*max nd*
UDG	1.0	25.[illegible]408	[illegible]	1.0	10.4232	27
GG	0.05339	3.59	[illegible]	0.245597	3.4496	[illegible]
SMECN	0.026874	2.7016	[illegible]	0.139539	2.6596	[illegible]
LSPT	0.01495	2.4284	[illegible]	0.122629	2.43	5

From Table 1 we observe that the topology constructed by our algorithm has a *tpc* much less than that of UDG, GG and SMECN. Our algorithm also outperforms the others in terms of average and max node degree.

5. CONCLUSIONS

In this paper, we develop a distributed algorithm that requires only local information for constructing a logical topology on the given unit disk graph. The concept of k-redundant edges is proposed by Li and Halpern [3]. The algorithm in [3], however, comes with 2-redundant edges only. Our proposed algorithm tackles k-redundant edges for $k \geq 2$. That is, we achieve a better result by a means that is totally different from those given in [2, 3]. Moreover, the topology constructed by our algorithm has several desired features such as low total power consumption and the minimum-energy property.

6. REFERENCES

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