# Distributed Voronoi Diagram Computation in Wireless Sensor Networks

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## ABSTRACT

We present a distributed algorithm to compute the Voronoi Diagram (VD) of a wireless network in the plane. Our contribution is twofold: the complete VD is computed, as opposed to the approximate or the bounded VD, and the number of transmissions used is relatively small.

**Categories and Subject Descriptors:** C.2.1[Computer-Communication Networks]:Network Architecture and Design —*distributed networks, network topology*; F.2.2[Analysis of Algorithms and Problem Complexity]Nonnumerical Algorithms and Problems: —*geometrical problems and computations*

**General Terms:** Algorithms, Theory

**Keywords:** Voronoi diagrams, sensor networks, distributed, algorithm

## 1. INTRODUCTION

Given a connected sensor network, where connectivity complies with the unit disk graph model, the Voronoi Diagram (VD) of the network is a partition of the plane such that each (sensor) node is assigned the set of points that are closer to itself than to any other node. We propose a distributed algorithm, Completly Cooperative (CC), for computing VD's. Among other non-trivial approaches, a recent algorithm by Bash and Desnoyers (BD07) [1] computes the best approximation of the VD (VD of a bounded region). The CC algorithm offers two main advantages over their approach: (1) no region boundary is required, therefore, the VD of the entire plane is computed; (2) the CC algorithm uses less communication according to our experiments (See Figure 1). Moreover, the CC algorithm can compute the Delaunay triangulation and the convex hull of the set of nodes.

## 2. THE ALGORITHM

The following is a description of the CC algorithm that runs at each node in its simplest form. Optimizations are not included. The node itself is referred to as *this*. Each node is equipped with information about its *location*, the current approximation to the Voronoi *cell* being computed, and a message *queue*. A message contains information about a node's location. At each iteration a node's cell is *refined*, that is, reduced to the intersection of itself with the halfplane defined by the bisector between the node and the neighbour in question. If the refinement produces a smaller cell, the node notifies the other involved neighbours about each other.

```
Set this.cell = ENTIRE_PLANE
Broadcast this.location to all neighbours
While there exists message m in this.queue
    Refine this.cell with respect to m
    For each new vertex v in cell boundary
        Send message to m.node about the third node involved in v
        Send message to the third node involved in v about m.node
    end
end
```

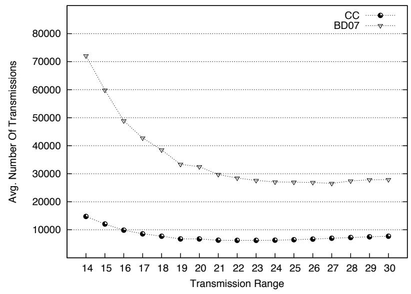


**Figure 1: Number of transmissions of CC vs. BD07**

## 3. EXPERIMENTAL RESULTS

The testsets consist of 100 nodes randomly placed in a $100 \times 100$ unit grid. We test transmission ranges from 14 to 30 units at increments of 1. Opaque obstacles are also included to make the scenario more realistic. For each transmission range 1000 topologies are generated and the two algorithms, CC and BD07, are run. The results are shown in Figure 1.

## 4. REFERENCES

[1] B. A. Bash and P. J. Desnoyers. Exact distributed voronoi cell computation in sensor networks. In *IPSN '07: Proceedings of the 6th international conference on Information processing in sensor networks*, pages 236–243, New York, NY, USA, 2007. ACM Press.

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