



A Bidding Protocol for Deploying Mobile Sensors

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Outline

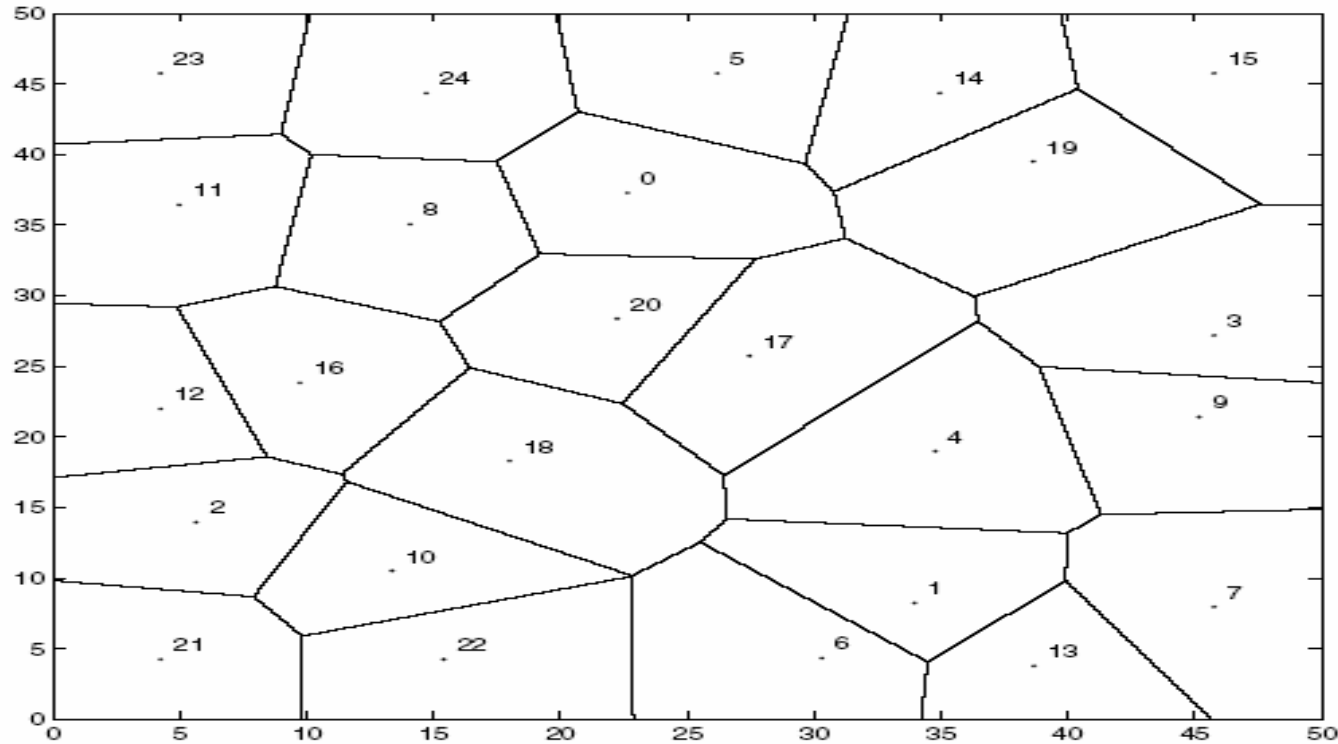
- Assumption
- The Voronoi Digram
- The Bidding Protocol
 1. General idea
 2. Bid Estimation
 3. Duplicate Healing Detection
 4. Local adjustment with the VEC algorithm
- Performance Evaluation



Assumption

- The two kinds of sensors are static sensors and mobile sensors.
- Each sensor can know its neighbor and the distance between it and its neighbor.

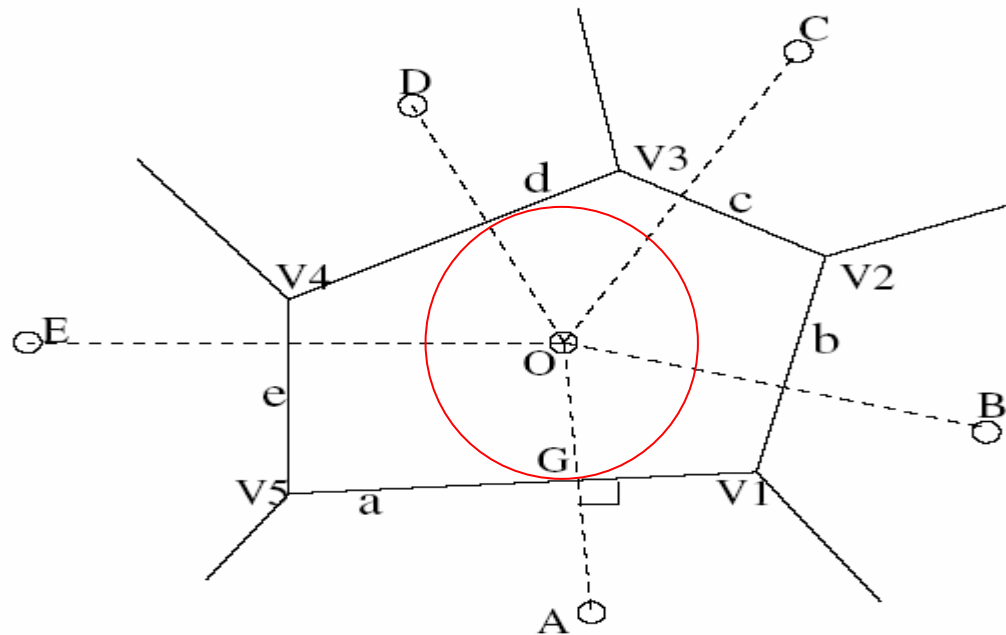
The Voronoi Diagram(1/2)



(a) Voronoi diagram

If the sensor cannot detect the expected phenomenon in a Voronoi cell, no other sensor can detect it.

The Voronoi Diagram(2/2)



(b) Voronoi Cell

- A,B,C,D,E are O's neighbors
- V1,V2,V3,V4,v5 are Voronoi vertice

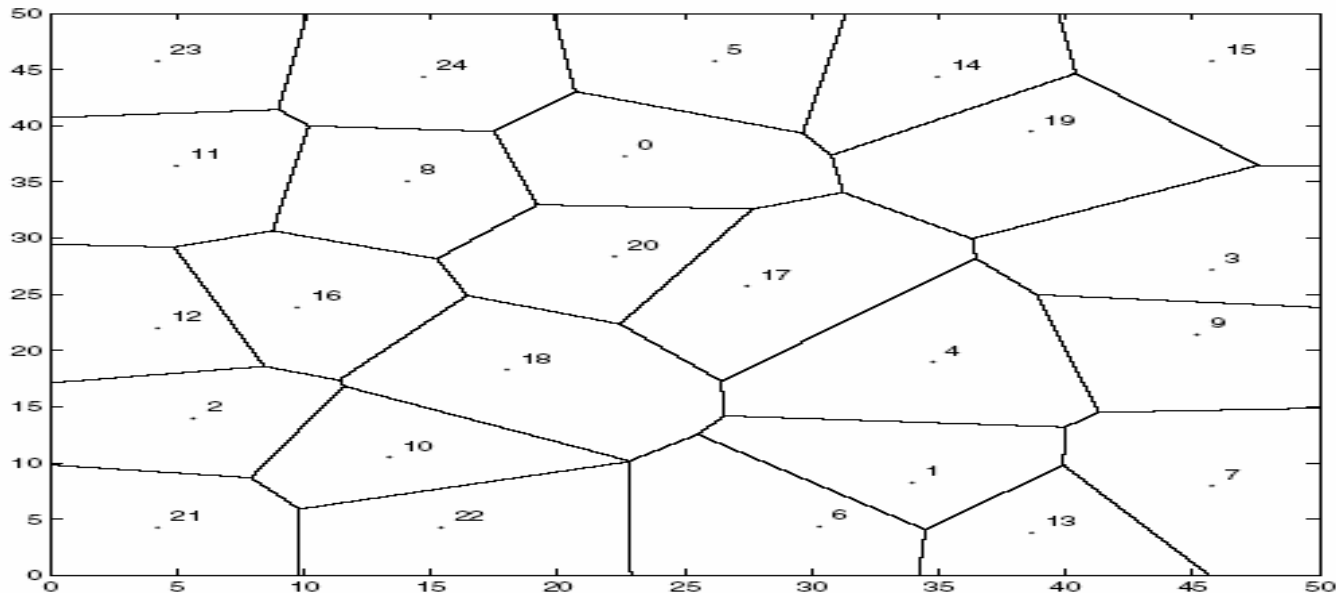
The Bidding Protocol(1/2)

Step1:initialization(static sensors broadcast their **locations** and **identities** locally.)

Step2:

- Service advertisement
- Bidding
- Serving

Step3:repeat until no static sensors can give out a bid higher than the base price of the mobile sensors.

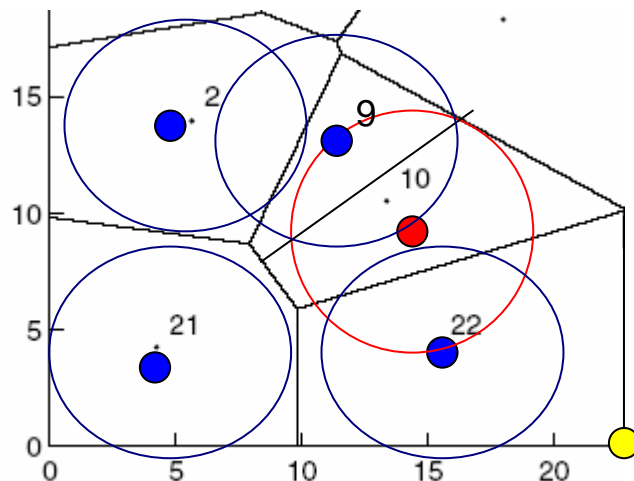


(a) Voronoi diagram

The Bidding Protocol(2/2)

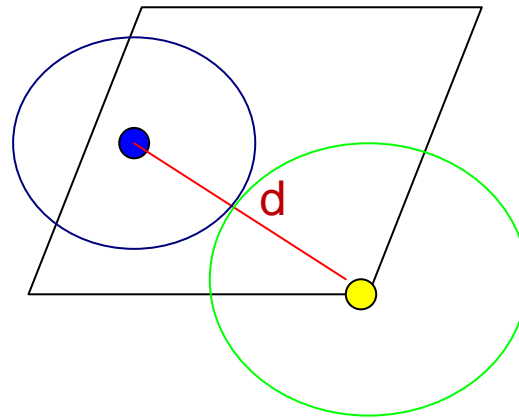
Step2:

- **Service advertisement:** mobile sensors broadcast their **base prices** and **locations** in a local area.
- **Bidding:** static sensors detect coverage holes locally and calculate the **bid** of the farthest **target location**. If the bid is larger than base price of mobile sensor, the static sensors will send a **bidding message** to mobile sensor.
- **Serving:** the mobile sensor chooses the highest bid and moves to heal that coverage hole.



- Static sensor
- Mobile sensor
- Target location

Bid Estimation



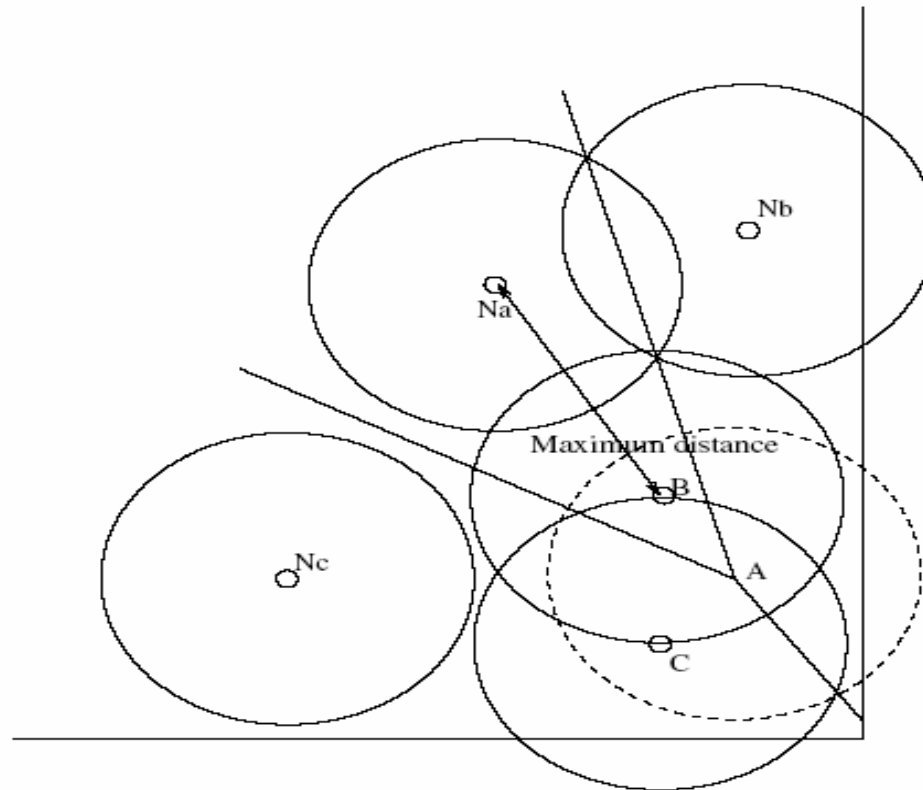
- Static sensor
- Target location

- $\pi * (d\text{-sensing range})^2$

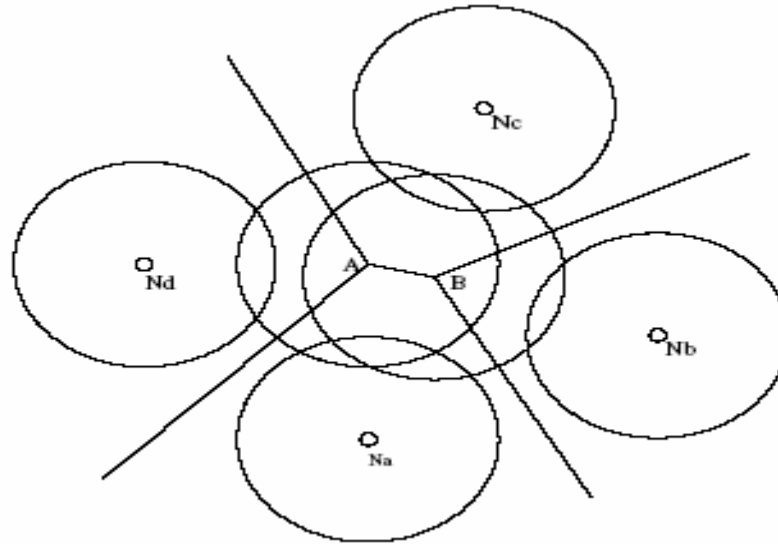
d:the distance between the bidder and target location

Special Case of target location

Solution: set a maximum distance



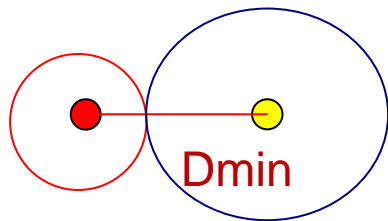
Duplicate Healing Detection



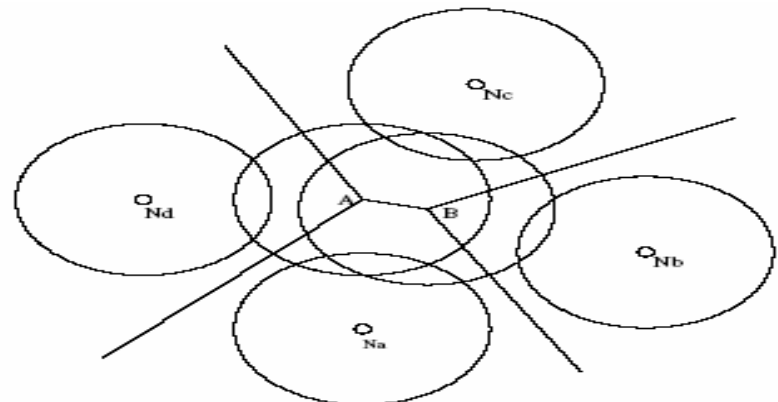
- **Solution:** If a mobile sensor hears that another mobile sensor in his neighbor has a higher base price than its own, it will run the **detection algorithm**.
- If yes, the mobile sensor reduce its base price to zero and it will likely to move to cover a different hole.

Detection Algorithm

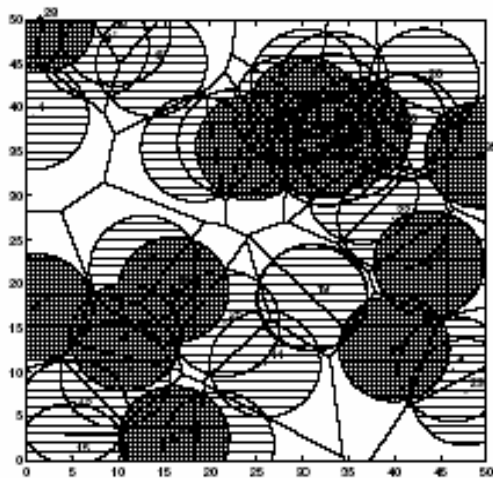
- The mobile sensor calculates a **detecting threshold**, equal to $\pi * (D_{min}\text{-sensing range})^2$
Dmin:the distance to its closest neighbor
- If below situations occur, Duplicate Healing occurs:
 1. **detecting threshold** < new base price
 2. **Dmin** < sensing range



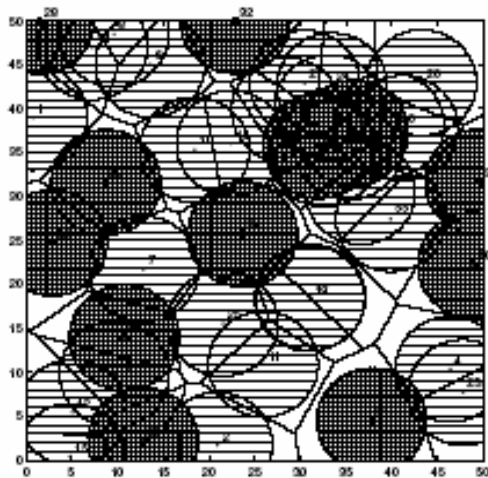
● :Mobile sensor ● neighbor



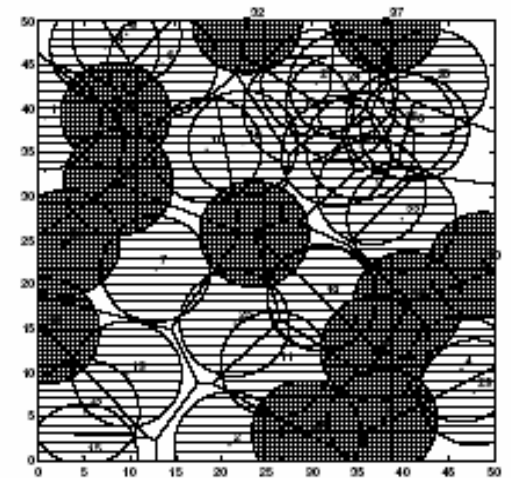
The execution of the bidding protocol



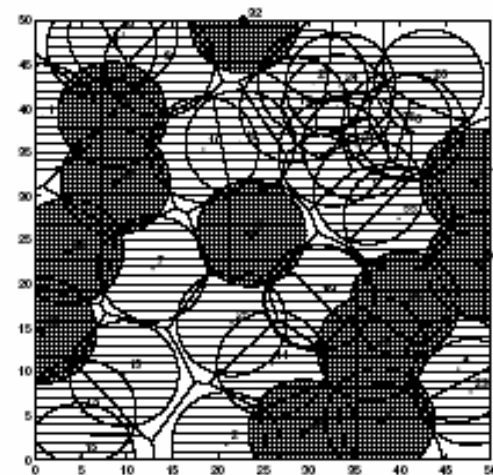
(a) Original



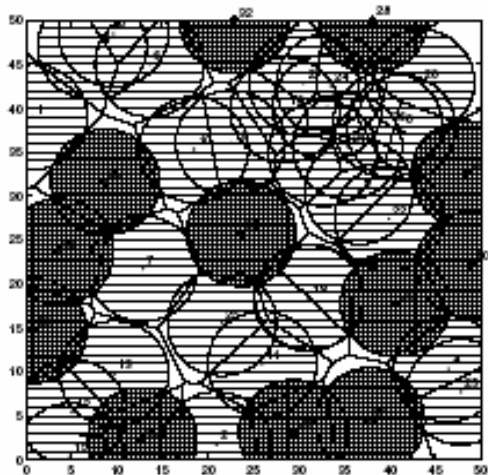
(b) Round 1



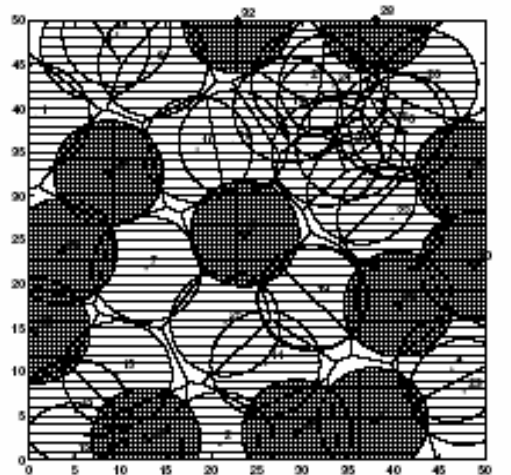
(c) Round 2



(d) Round 3



(e) Round 4



(f) Round 5

Local adjustment with the VEC algorithm

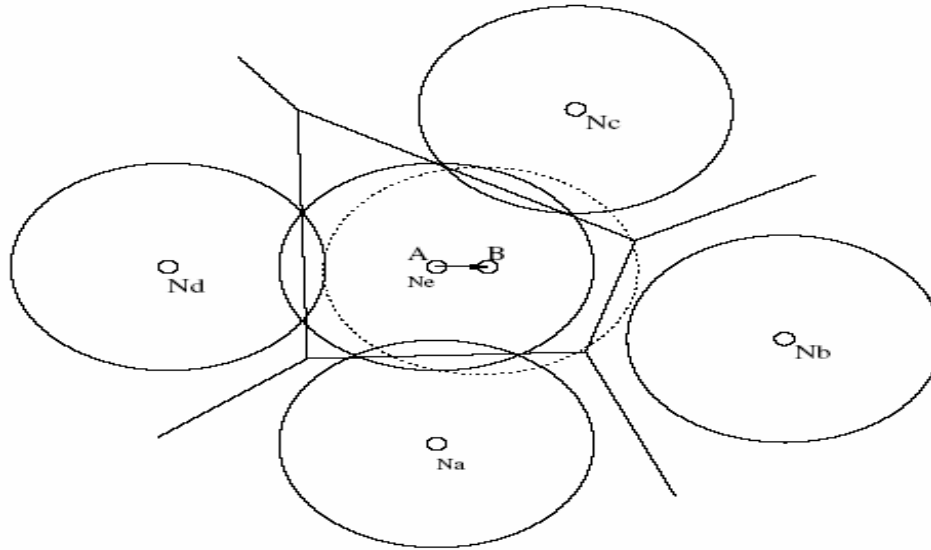


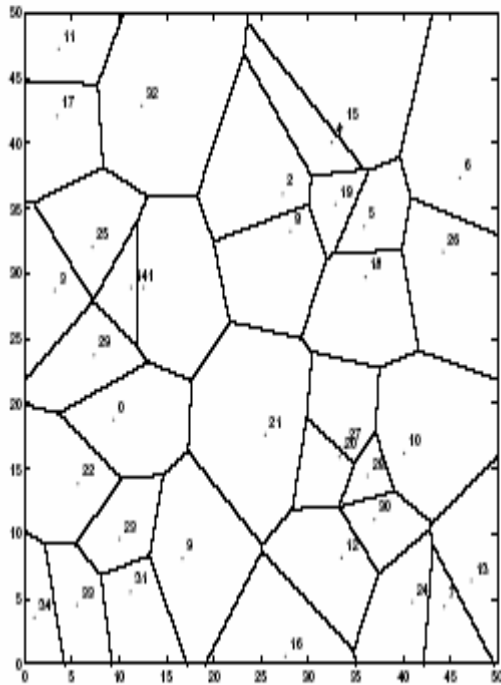
Figure 7. Local adjustment

VEC algorithm

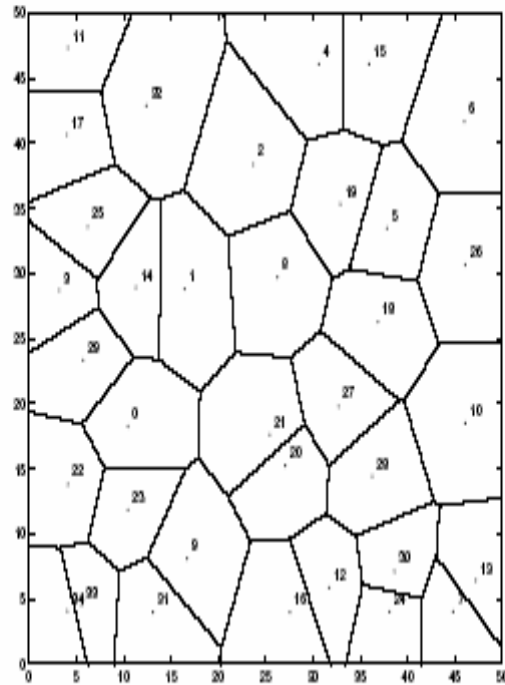
$$q = \frac{d_a - d_{i,j}}{2}$$

- d_a is the average distance between two sensors
- $d_{i,j}$ is the distance between sensor i and sensor j
- There is a force that will push the nodes to move q length away from each other.

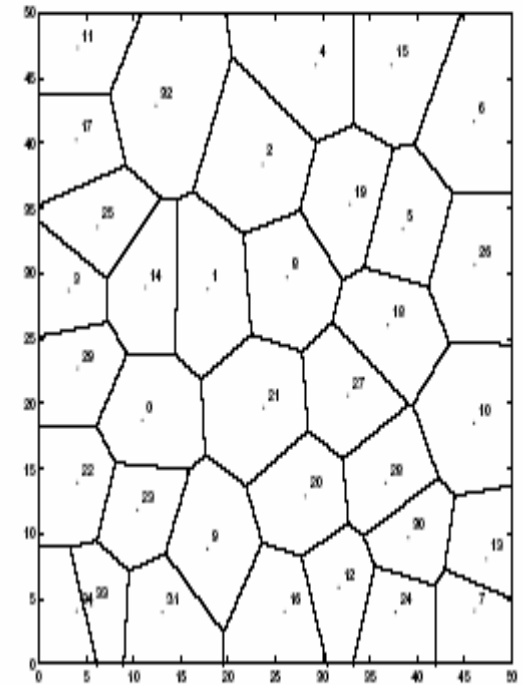
Execution of VEC algorithm



(a) Round 0

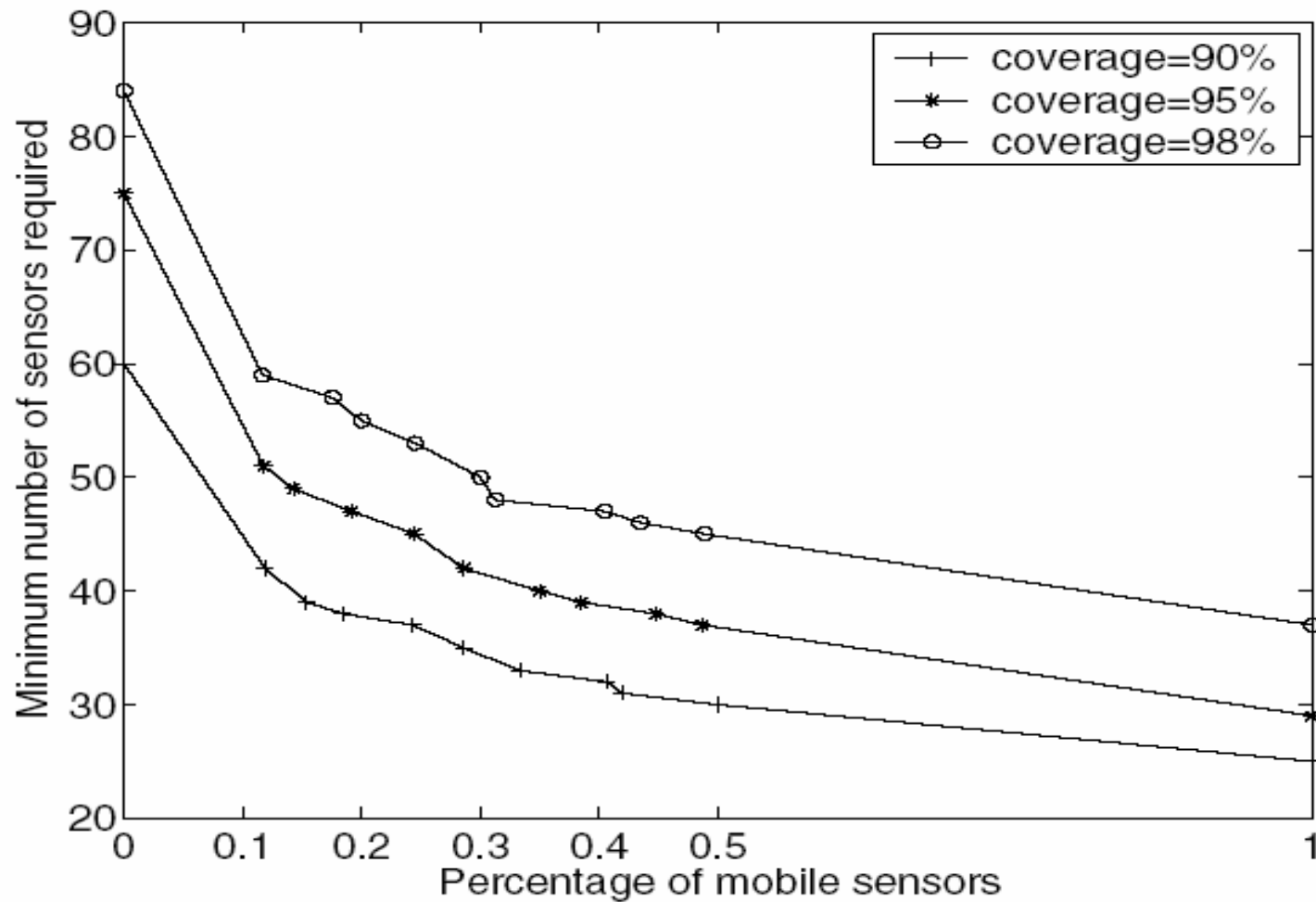


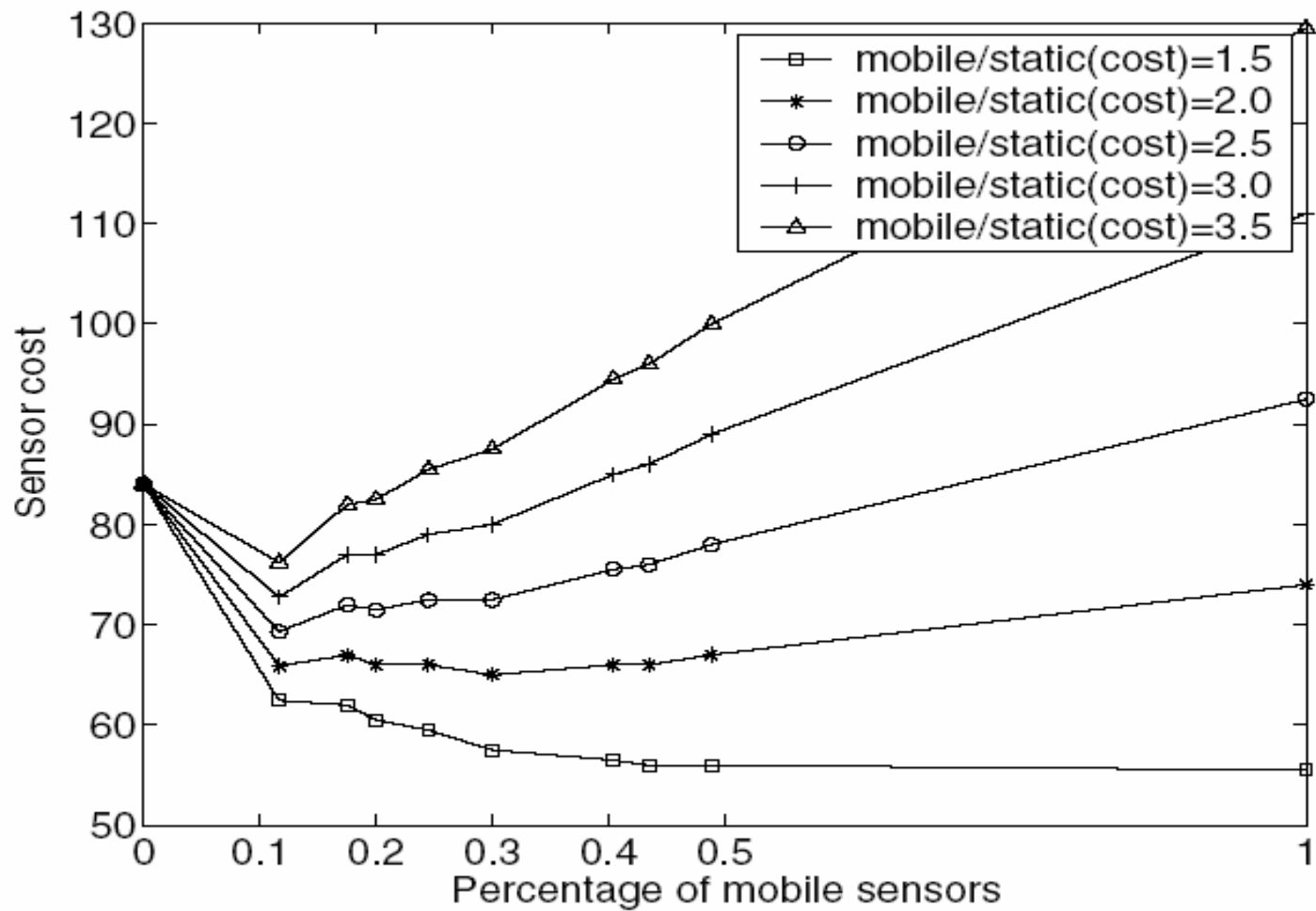
(b) Round 1



(c) Round 2

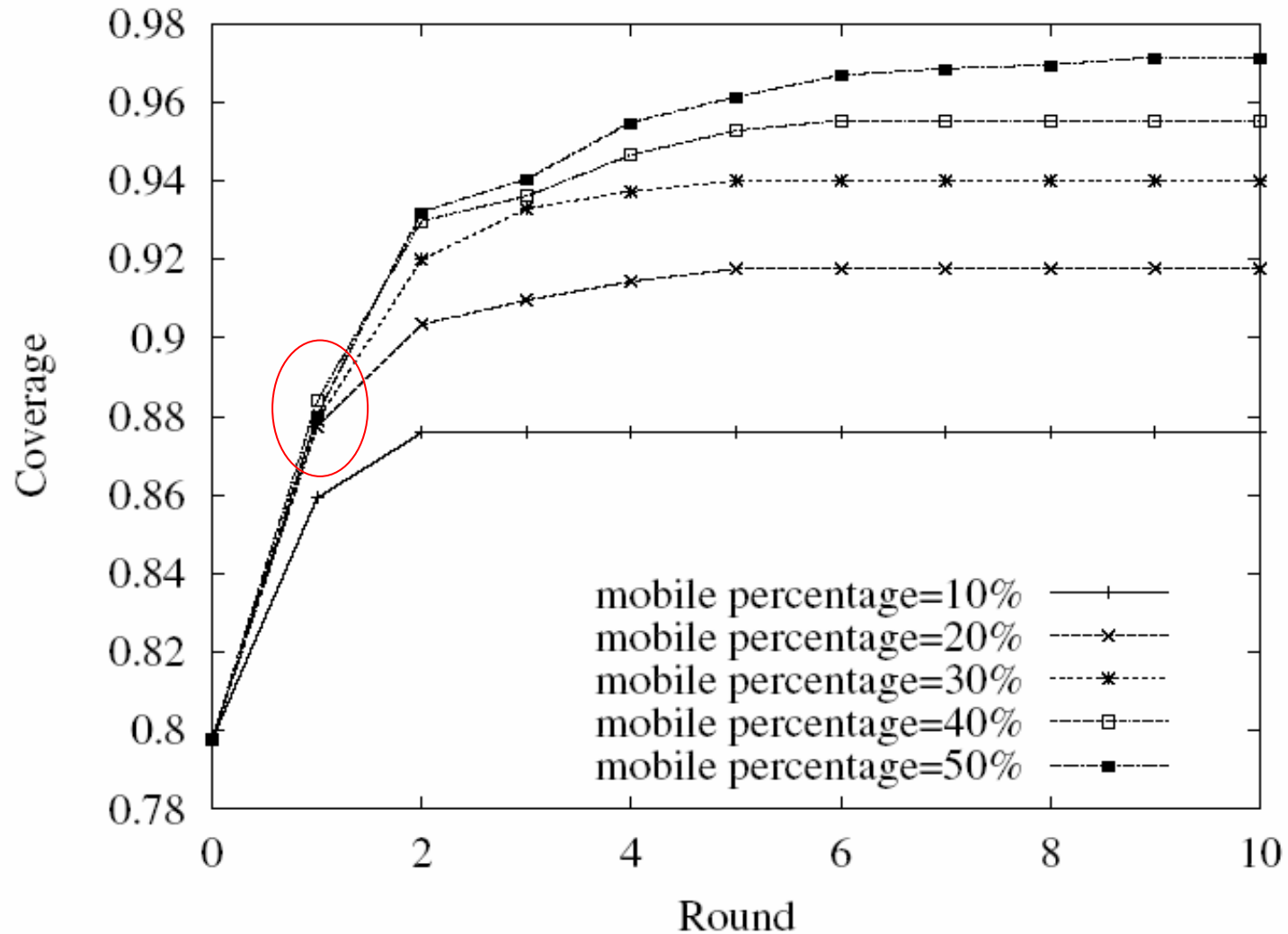
Performance Evaluation



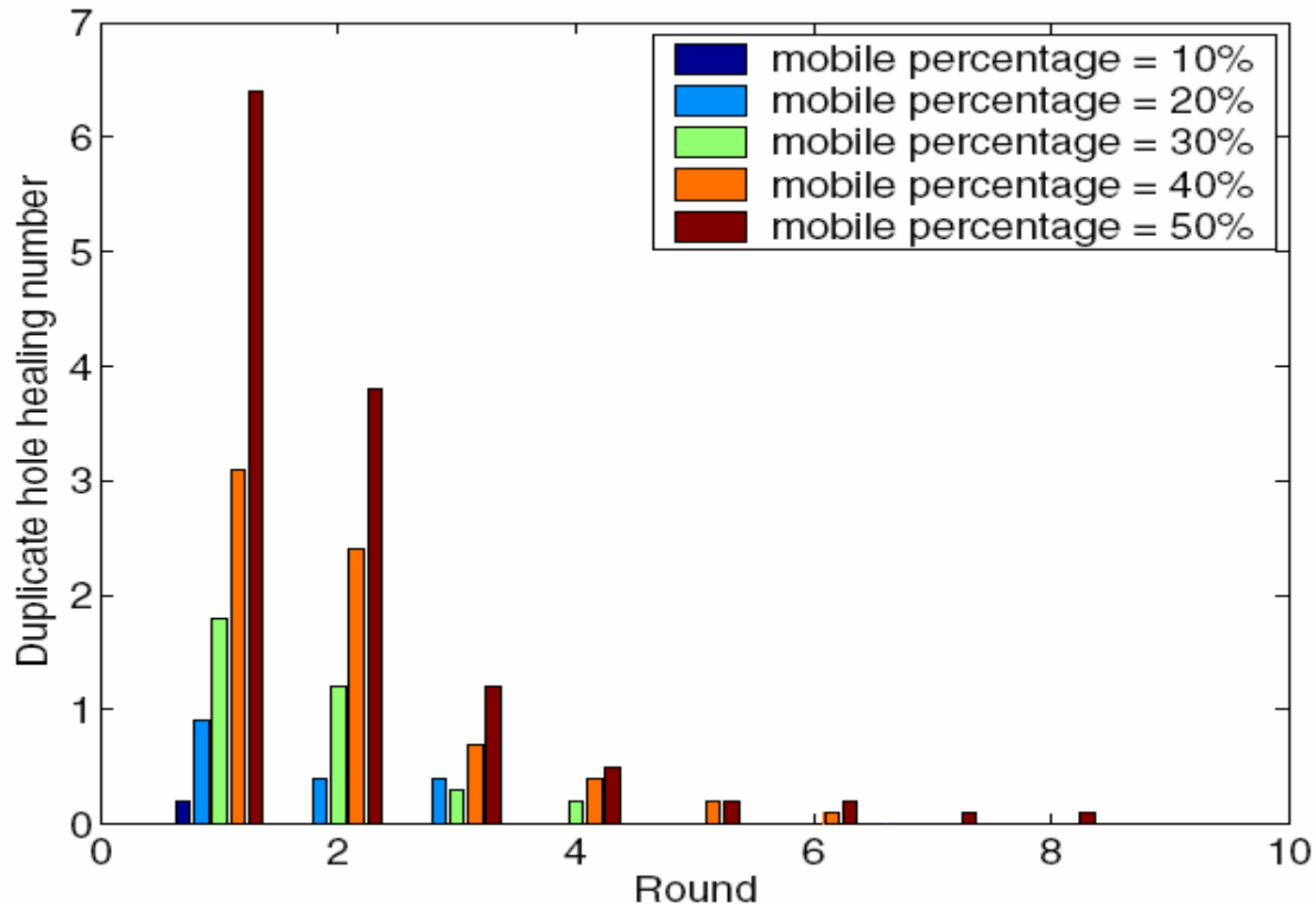


(c) To reach 98% coverage

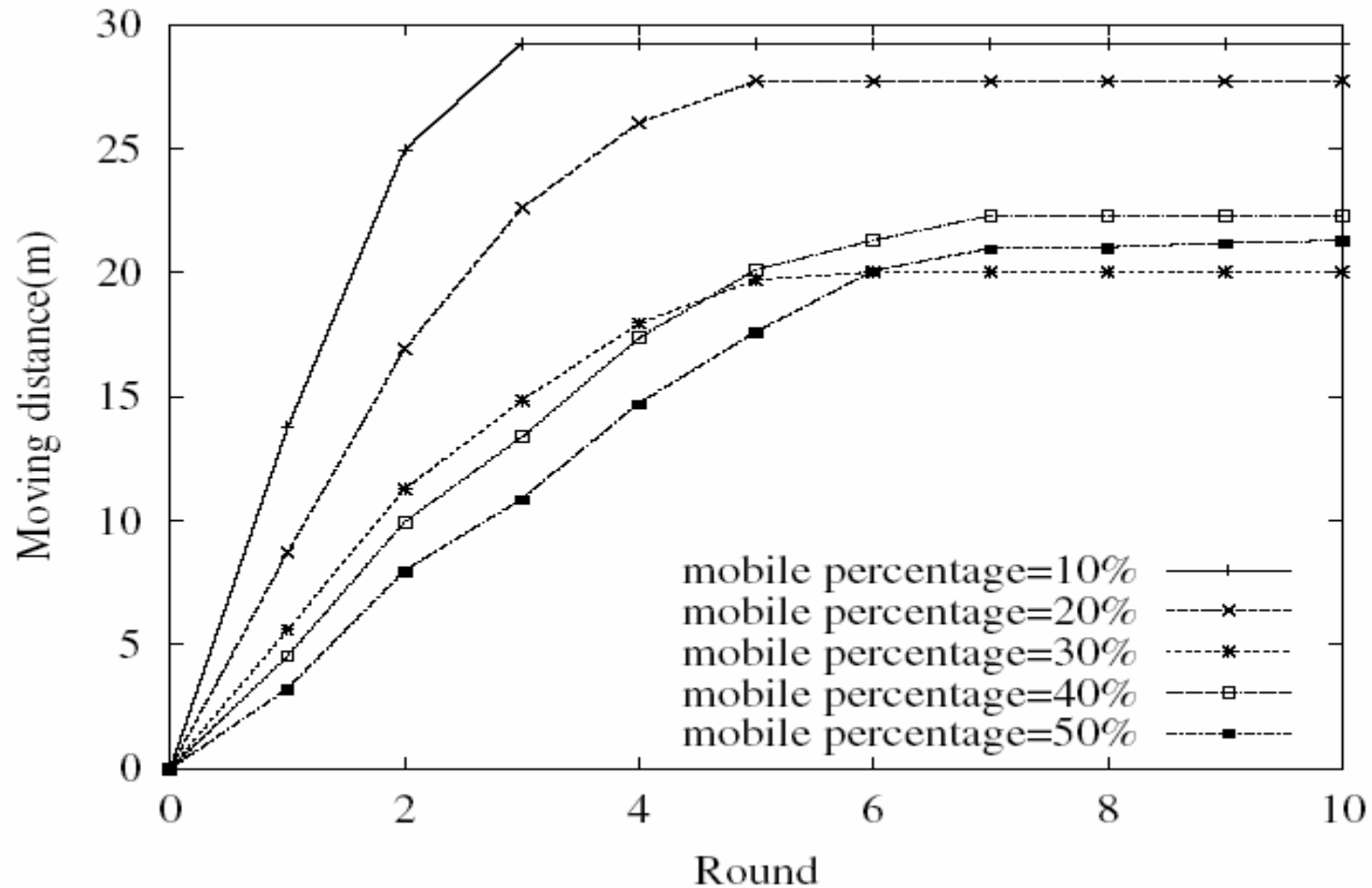
Sensor Coverage(n=40)



Duplicate healing number (n=40)



Average moving distance of mobile sensors(n=40)



Conclusions of bidding protocol

Advantage:

- It is simple.
- It can cover the almost area.

Disadvantage:

- The mobile sensors move unnecessarily.
- It has the duplicate healing problem.