GPS Free Coordinate Assignment and Routing in Wireless Sensor Networks

Source:INFOCOM2005

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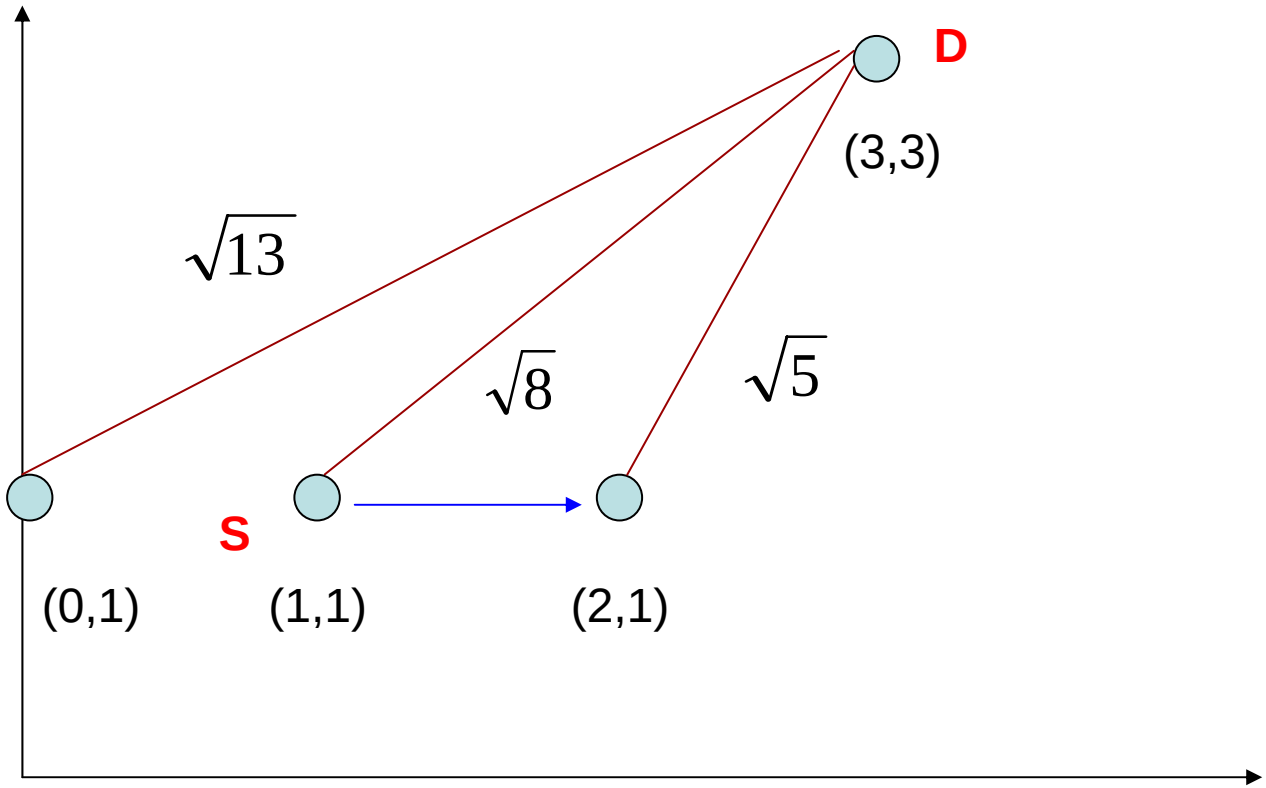
Outline

- Introduction
- The Virtual Coordinate Assignment Protocol (VCap)
- Simulation
- Comparison

Introduction

- Geographic routing



Why need virtual coordinate?

- The virtual coordinate is cheaper than the physical coordinate.

- The virtual coordinate can be used indoors.

  (The physical coordinate can’t be used indoors because needs GPS.)

The Virtual Coordinate Assignment Protocol (VCap)

- The main idea is to assign each sensor a virtual coordinate (X,Y,Z).

Assumptions:

1.The sensor network is composed of a large number of nodes uniformly scattered in a sensing field.

2.The nodes are assumed static

.

3.Every node has the same transmission range.

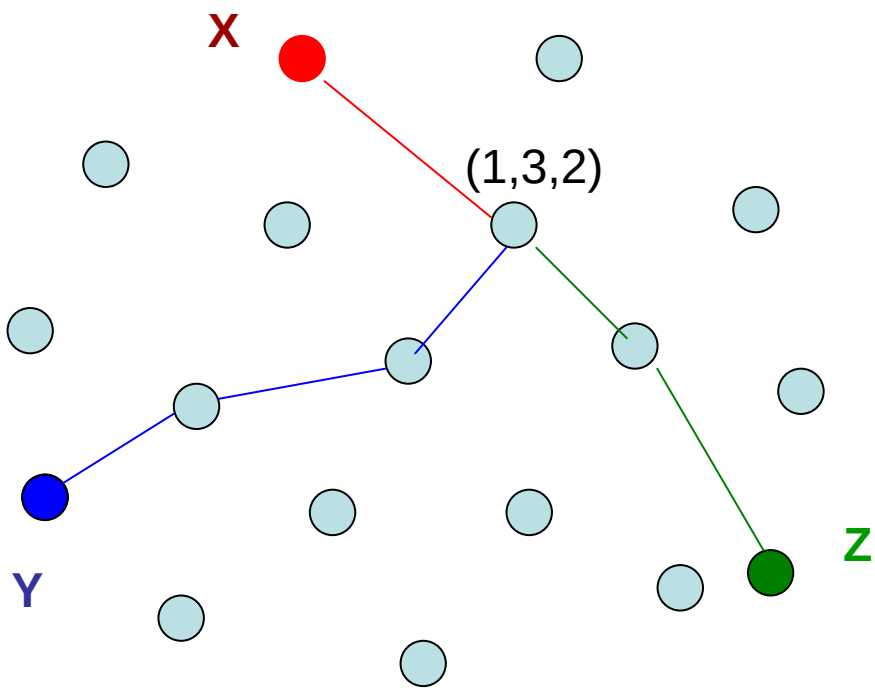
4.Each sensor has a unique ID.

Select Three Anchor Nodes

- Election of W:

  The node W is used to let X,Y and Z be close to the boundary of the network.

- Election of X
- Election of Y
- Election of Z

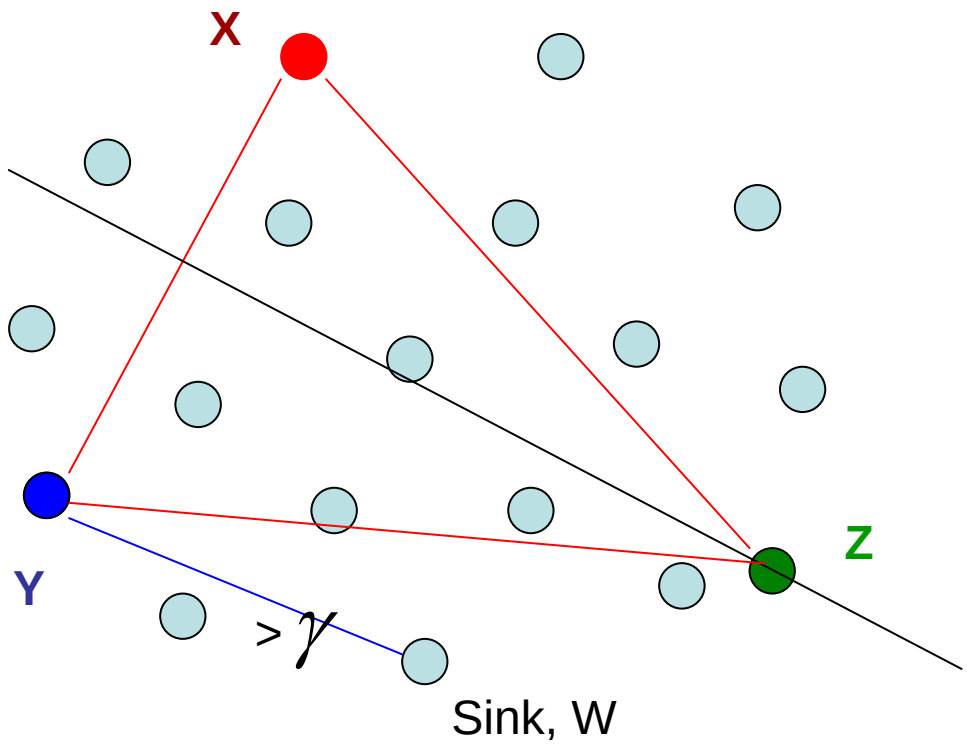


The Position of the Anchors X,Y,Z

1. X,Y,Z are on the border of the sensor network.

2. Y can not be close to W.

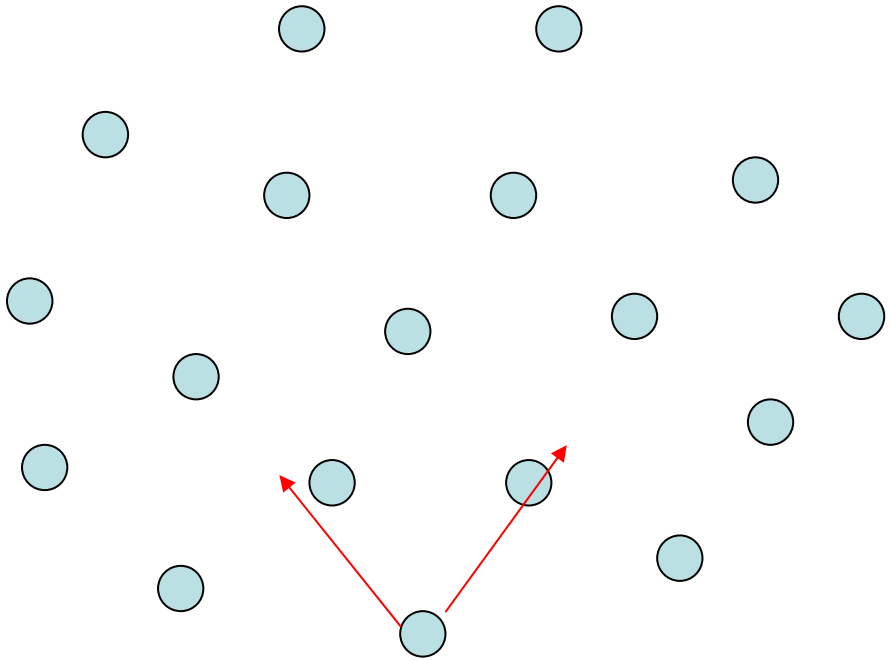
3. X,Y,Z are placed on the vertices of an equilateral triangle.



Election of W

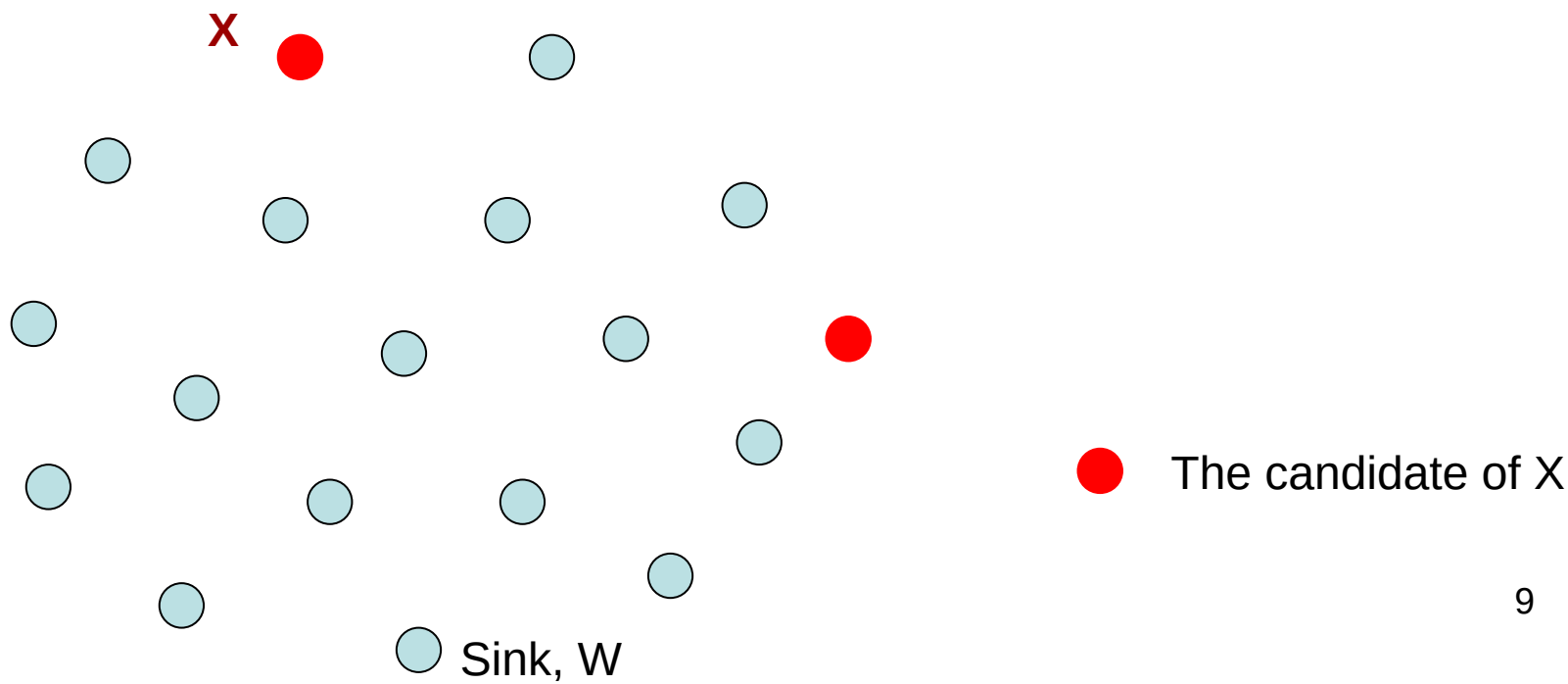
- The Sink generates a W_SET message containing an hop counter initially set to 1.

- After this process, each sensor has a value W.



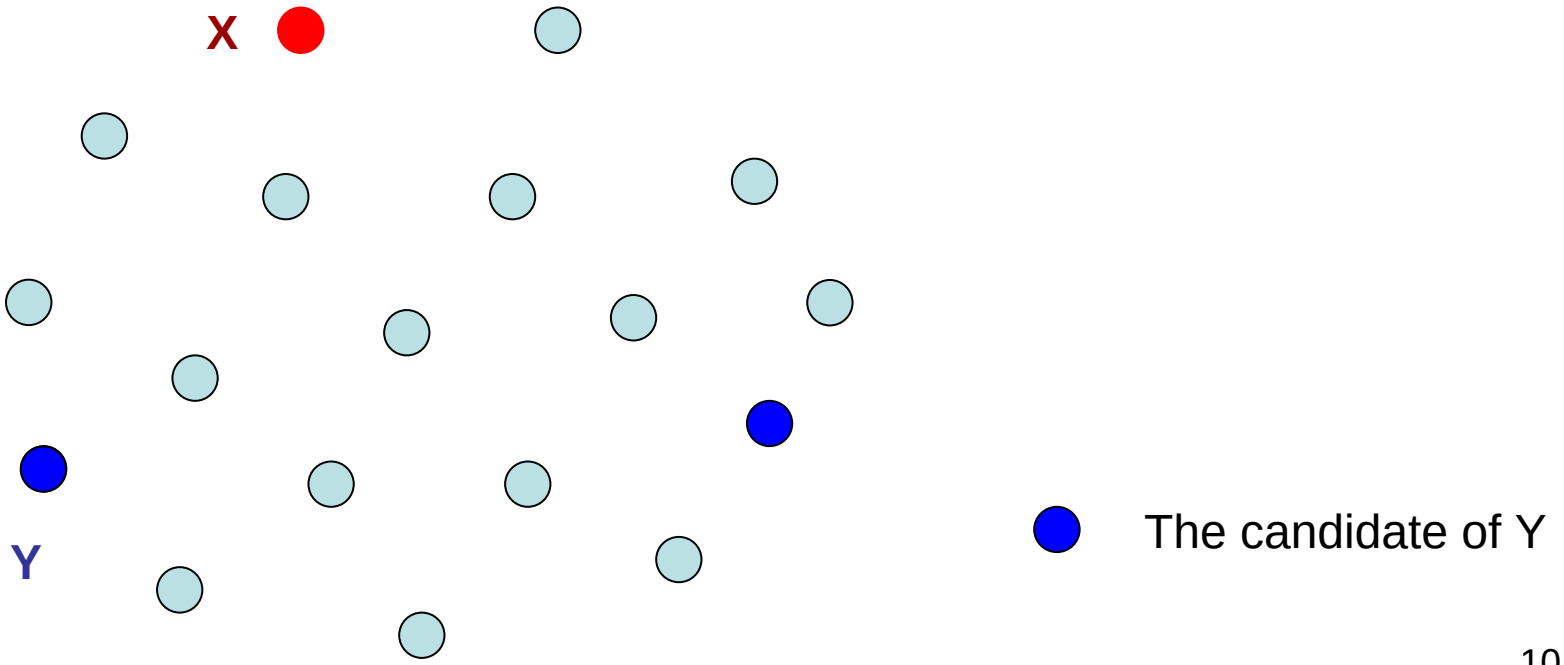
Election of X

- The conditions of the candidates of X:
  - ✓ have the maximum value of W within a two-hop neighborhood.
- The node X must have the maximum W, in case of equal W, the larger ID.
- After this process, each sensor has values W, X.



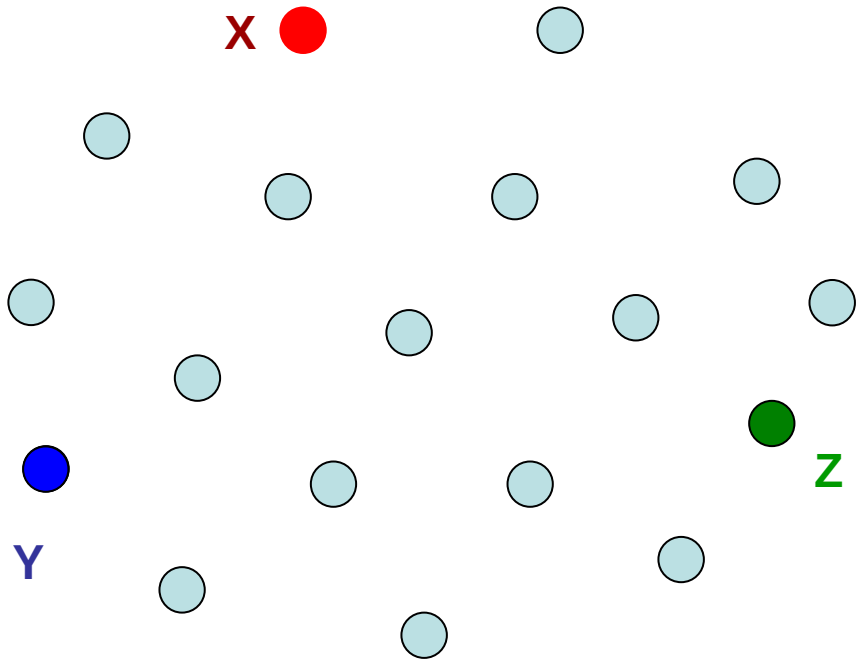
Election of Y

- This phase is similar to the Election of X.
- The conditions of the candidates of the node Y :
  - must have the maximum X within a two-hop neighborhood.
  - W> γ for some parameter γ .
- After this process, each sensor has W,X,Y.



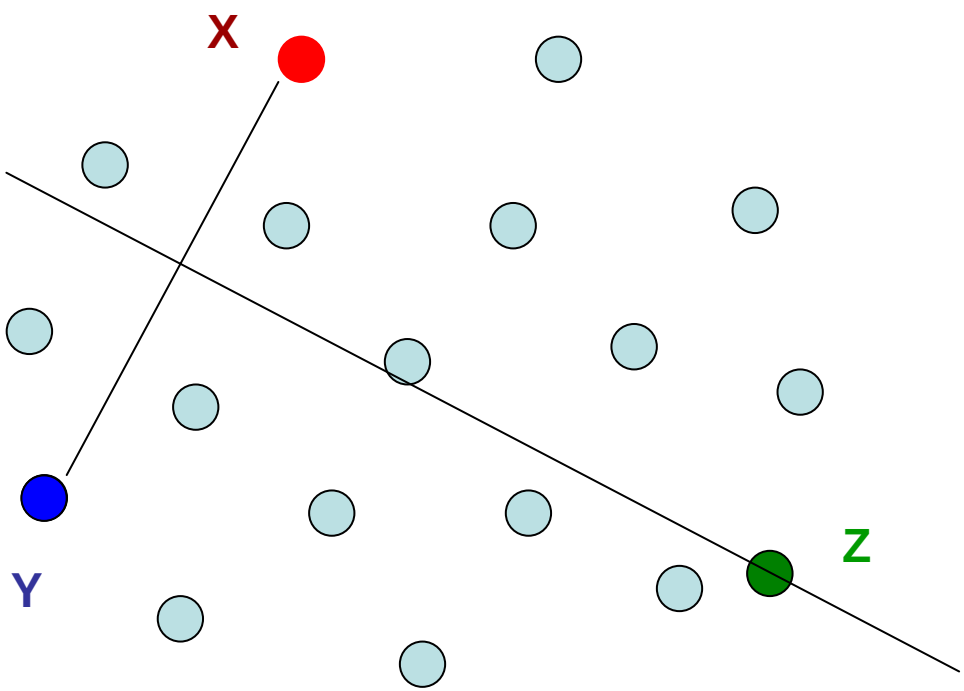
Election of Z(1/2)

- This phase is similar to the previous phrase.
- The conditions of the candidates of Z:
  - The x, y coordinate of the node Z must satisfy some given rule $\phi\ (x\ ,\ y\ )$
  - the value W of the node Z must be maximum within a two-hop neighborhood.
- After this process, each sensor has W,X,Y,Z.

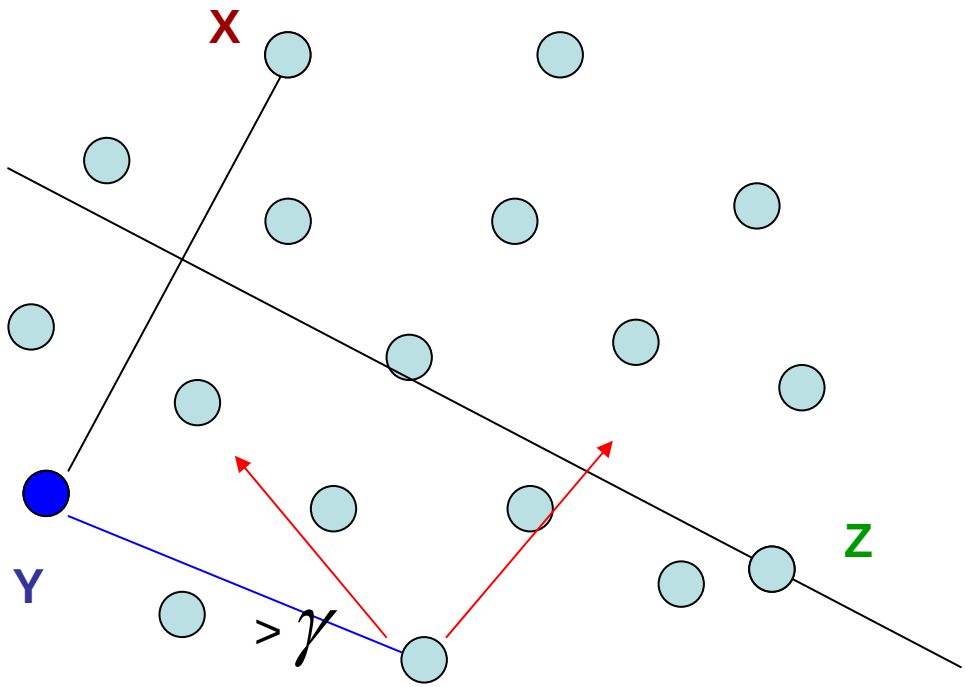


Election of Z(2/2)

$$\phi(x, y): x = y \pm 1$$

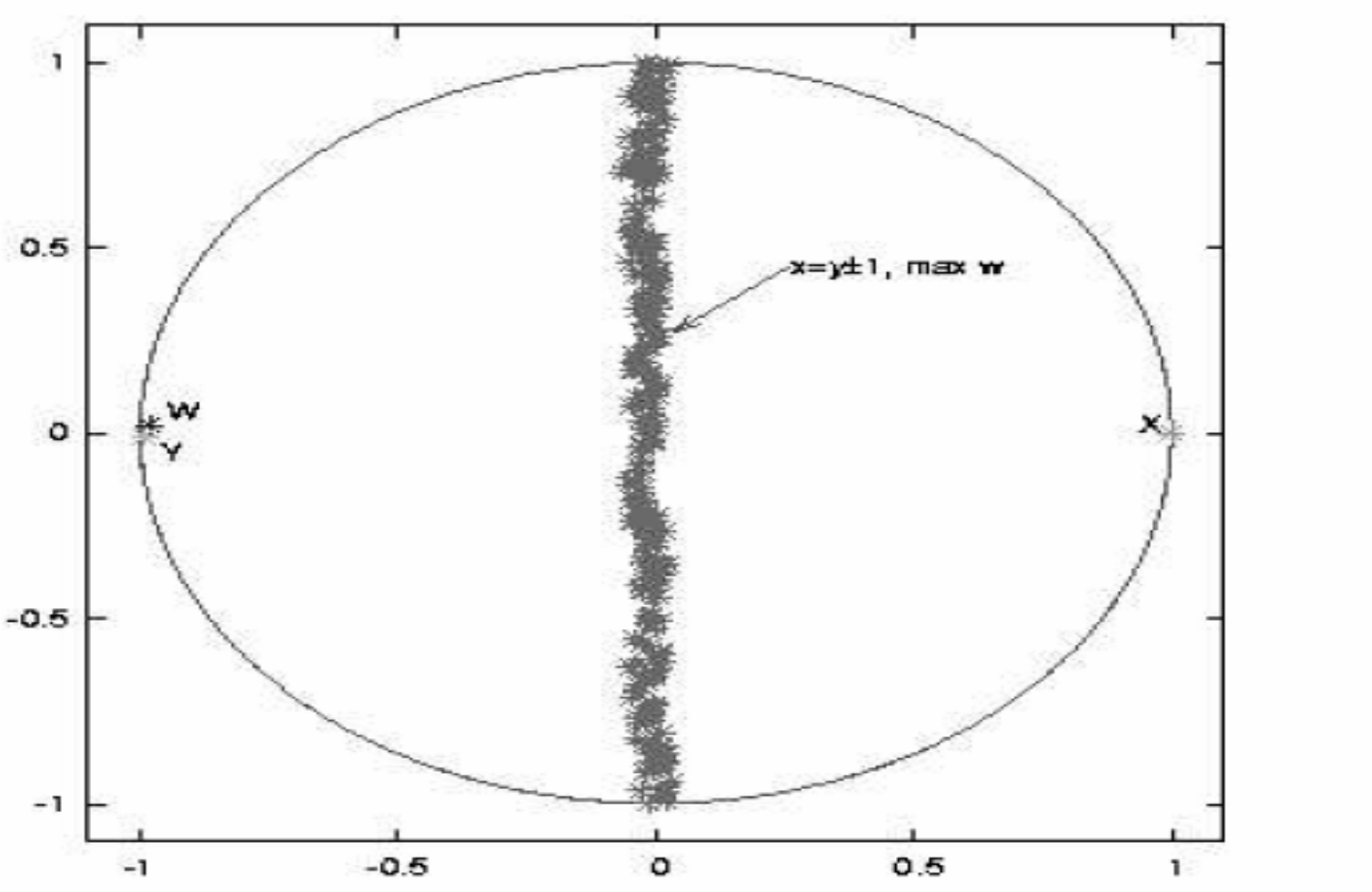


Sink, W

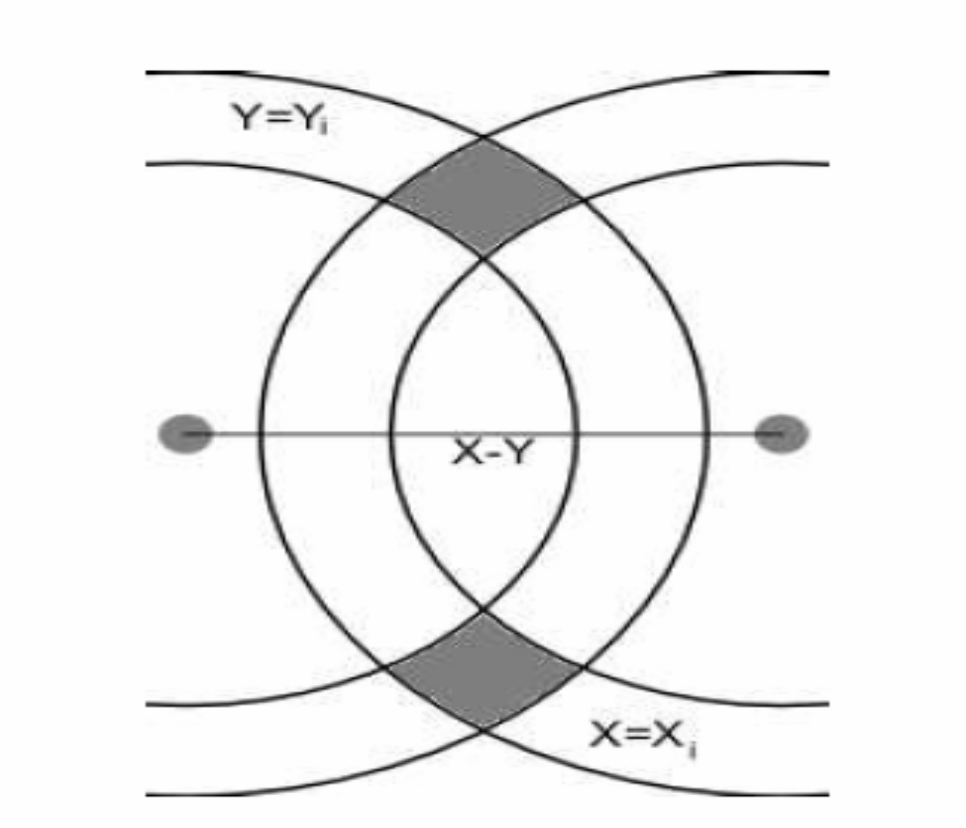


Sink, W

Why the value W of the node Y need > γ ?



Why not only two coordinate?



Protocol Correctness Analysis

- The VCap protocol doesn't avoid that the two nodes have the same triplet of coordinates. Thus, instead of dividing the network in points, it causes a division in zones.

- This paper show that if two nodes are assigned the same virtual coordinates then they should belong to a bounded physical area.

$$d \leq \frac{8}{3} r$$

d: the distance between two node assigned the same coordinates.
r: transmission range

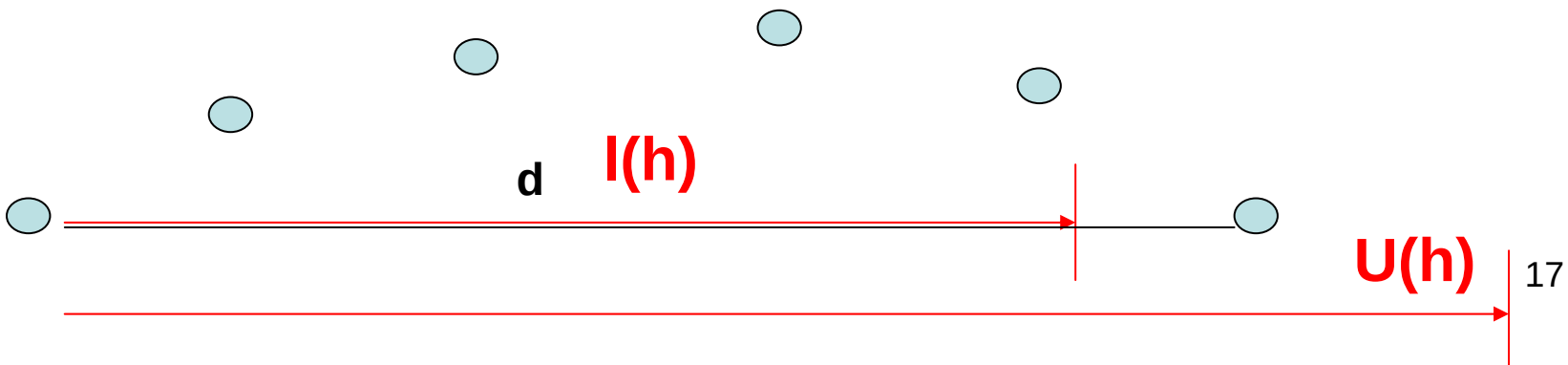
•Assumption :

△:the network density

γ : transmission range of the sensors

◆Consider two nodes at minimum hop distance h, there exist two value l(h) and U(H) such that the Euclidean distance d between the two nodes is bounded, i.e., l(h)<d<U(H). In particular for each h>0,

$$\lim_{\Delta \to \infty} u(h) - l(h) = r$$



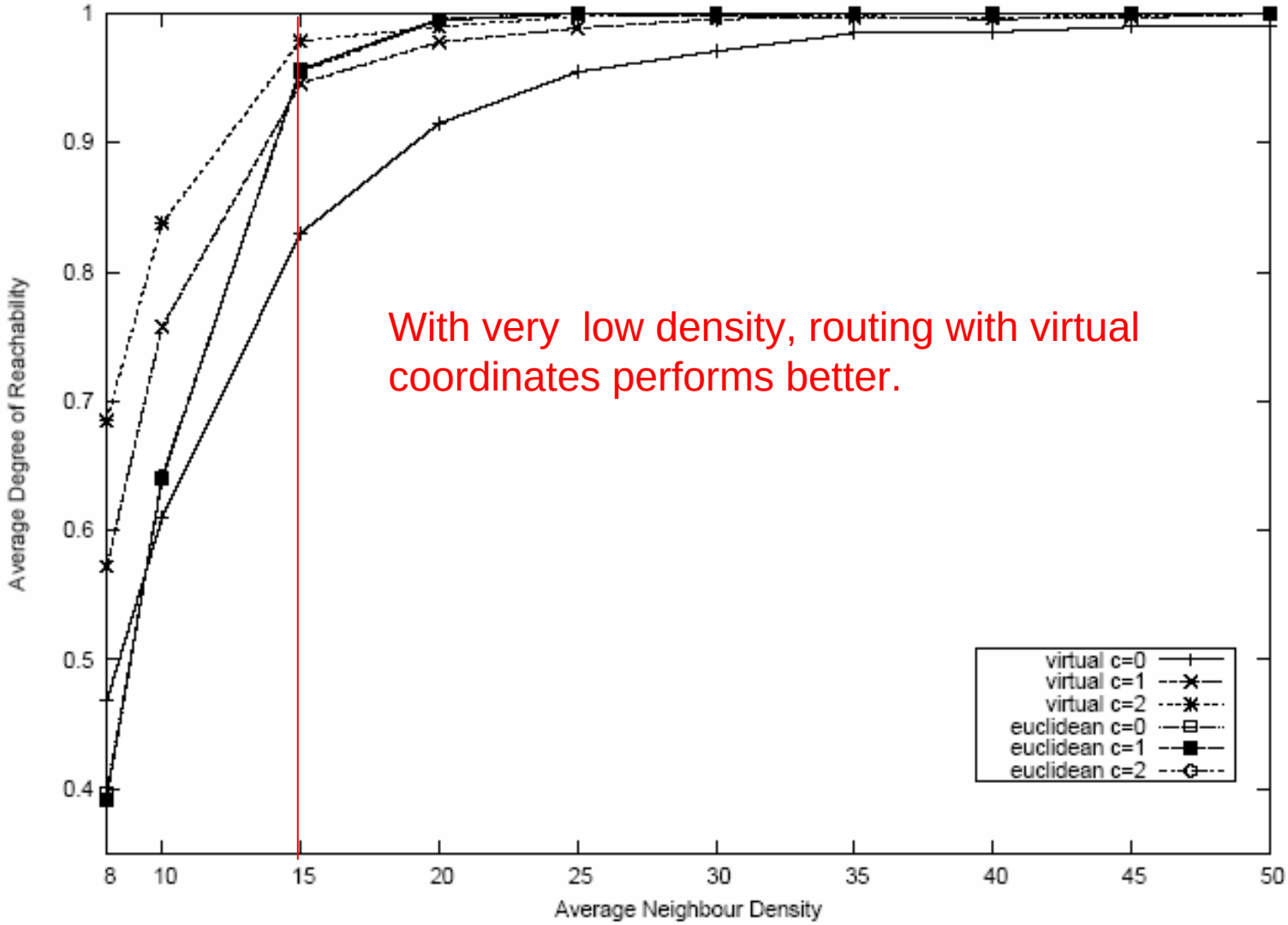
Assumption :

- The sensor network is in a circular space of diameter D.
- Anchors X,Y and Z are placed on the vertices of an equilateral triangle inscribed in the circle of diameter D.

If Assumption 1 holds then the maximum distance between two nodes in the same zone d satisfy:

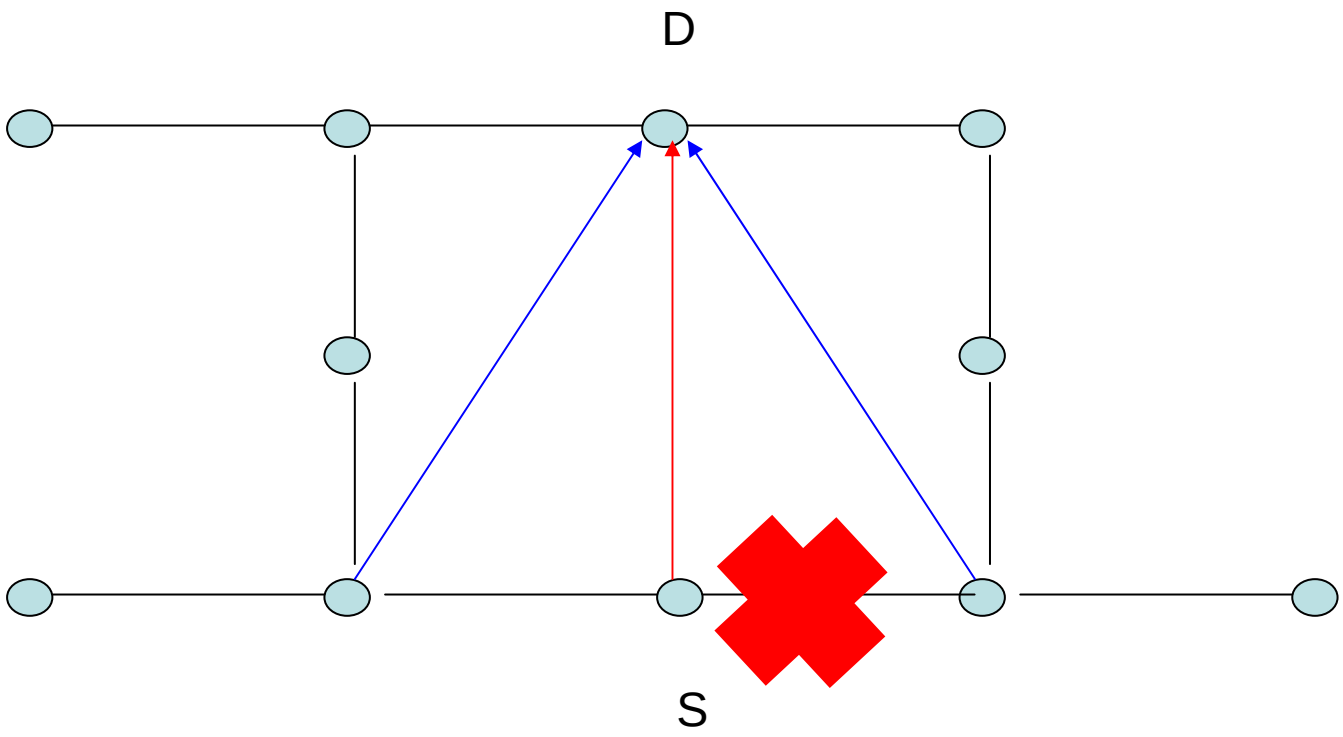
$$\lim_{\Delta \to \infty} d = \frac{8}{3} r$$

Simulation

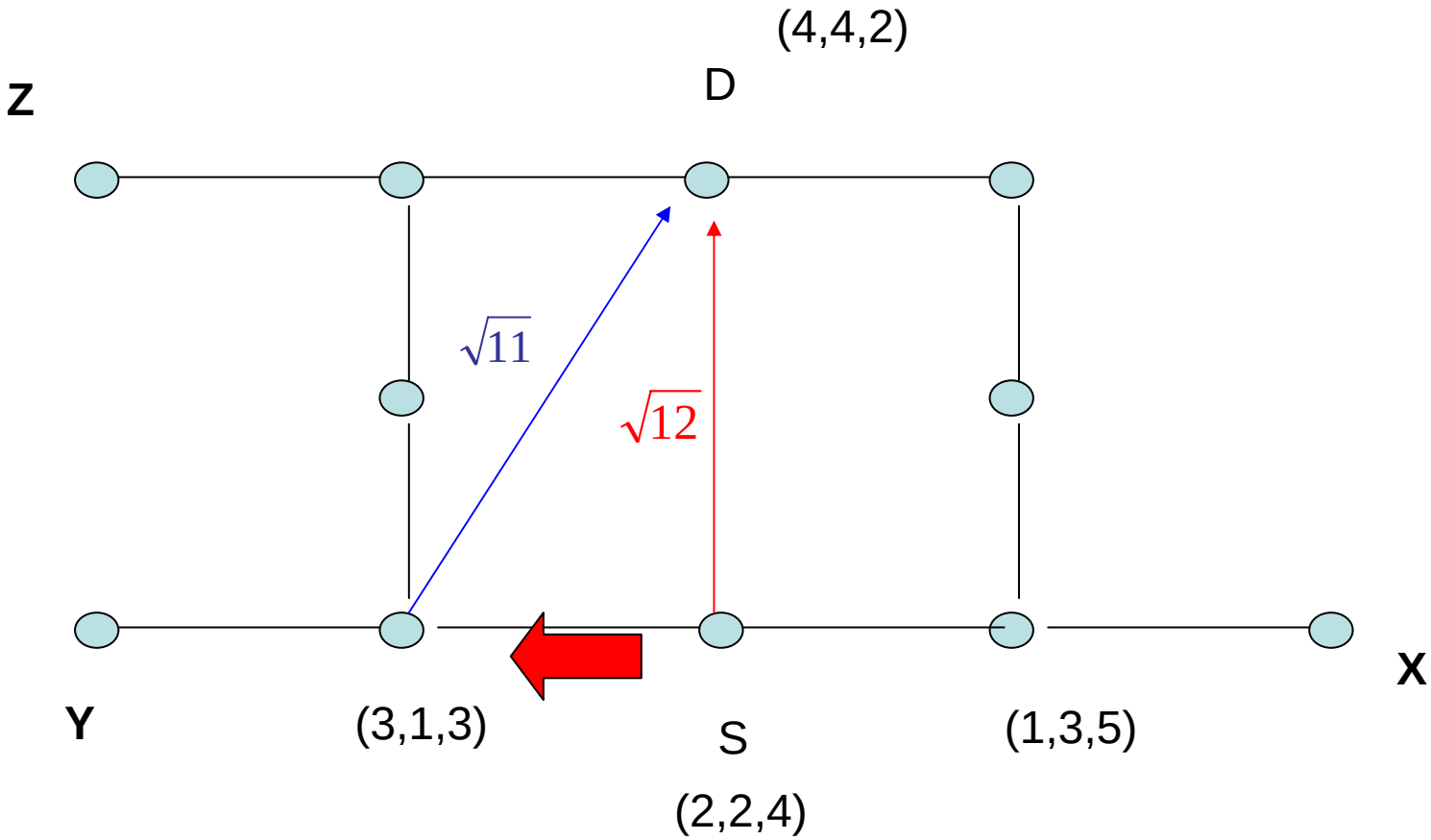


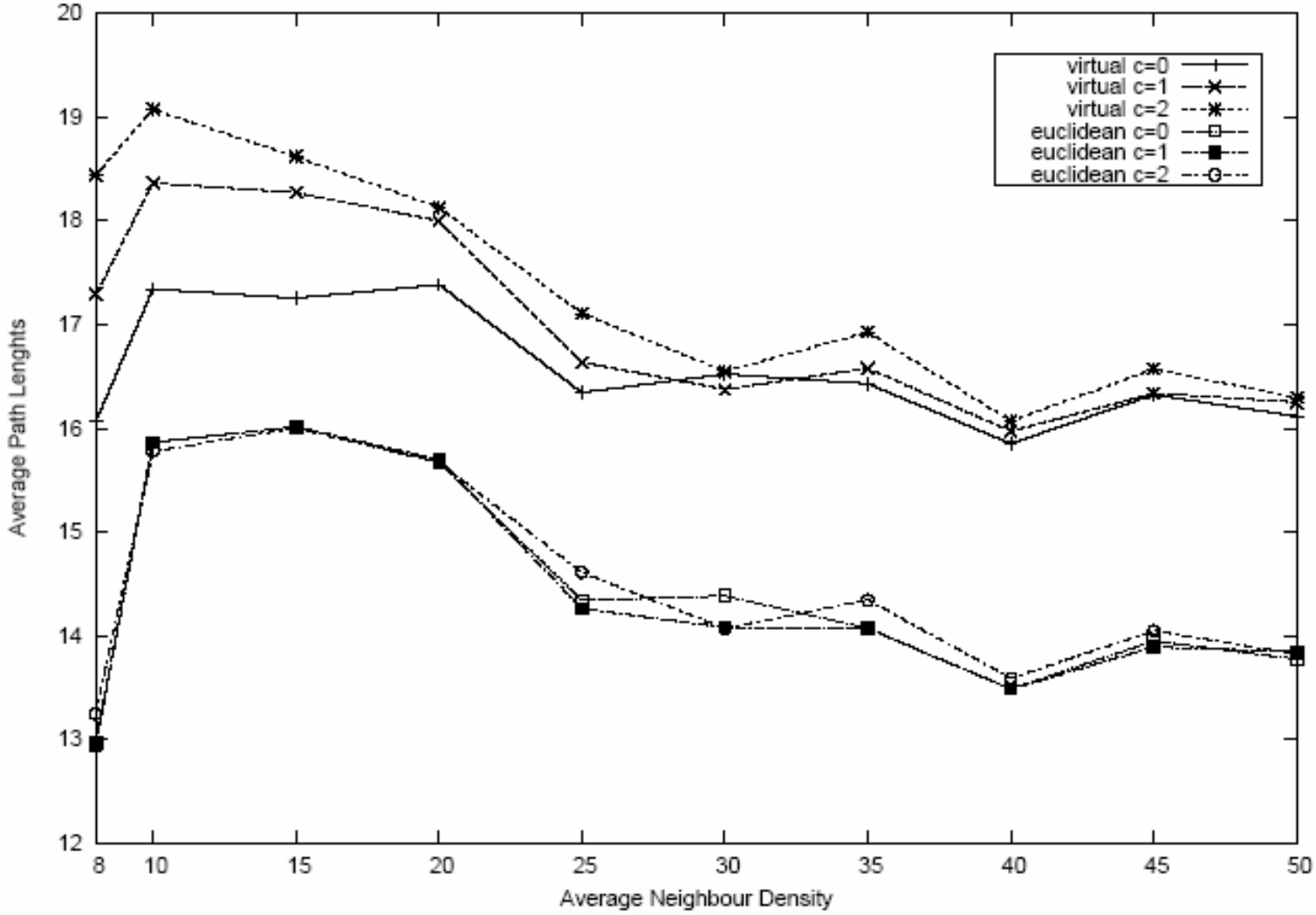
Packet delay rates of greedy geographic routing

Why routing with virtual coordinates performs better with very low density?(1/2)



Why routing with virtual coordinates performs better with very low density?(2/2)





Path lengths of greedy geography routing

Comparison

	physical coordinate	virtual coordinate
advantage	1.Path length is shorter.	1.cheap 2.Packet delivery rate is better with low density. 3.can be used indoors
disadvantage	1.expensive 2.Packet delivery rate is worse with low density. 3.can not be used indoors	1.Path length is longer.