A Distributed Load Balancing Guiding Protocol in Wireless Sensor Networks

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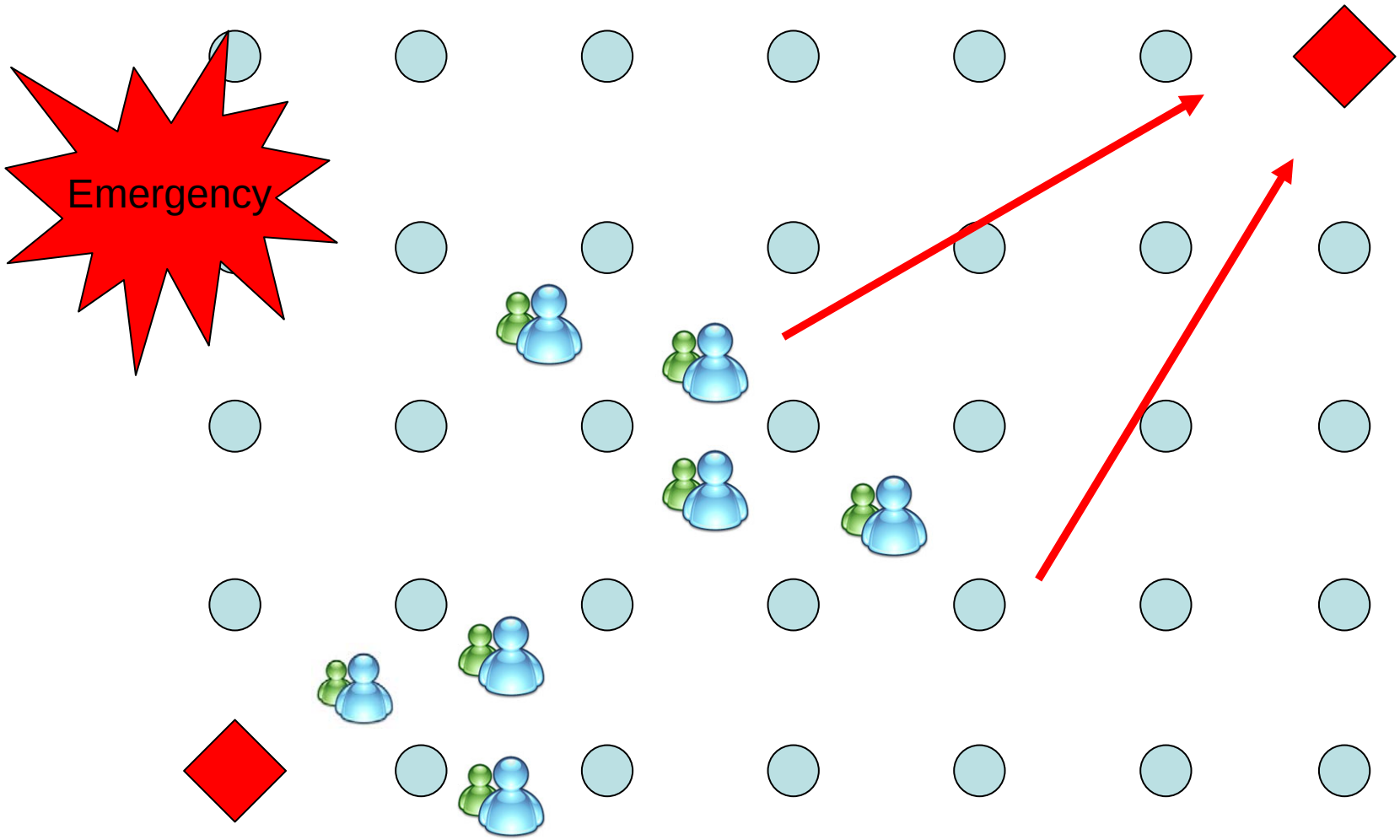
Outline

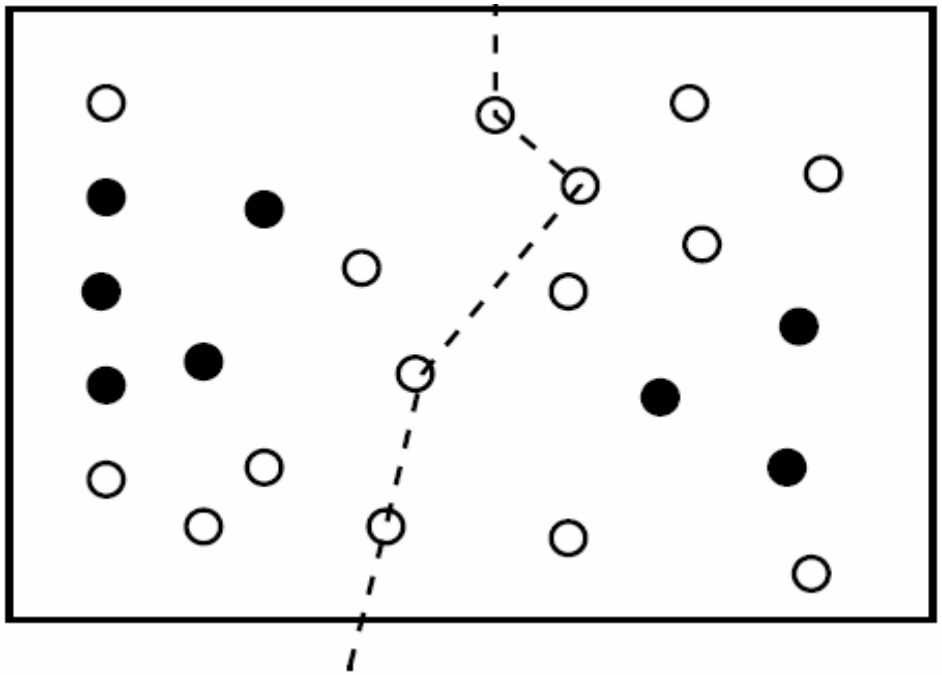
- Introduction
- Relative Work
- The distributed load balancing guiding protocol
- Simulation Results
- Conclusions

Introduction



Relative Work

- Distributed Algorithm for Guiding Navigation across a Sensor Network (Mobicom 2003)

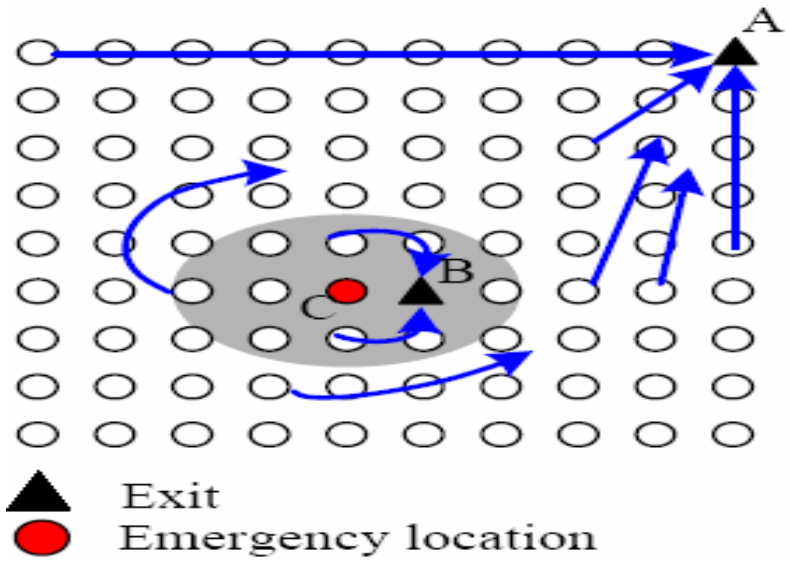


sensor

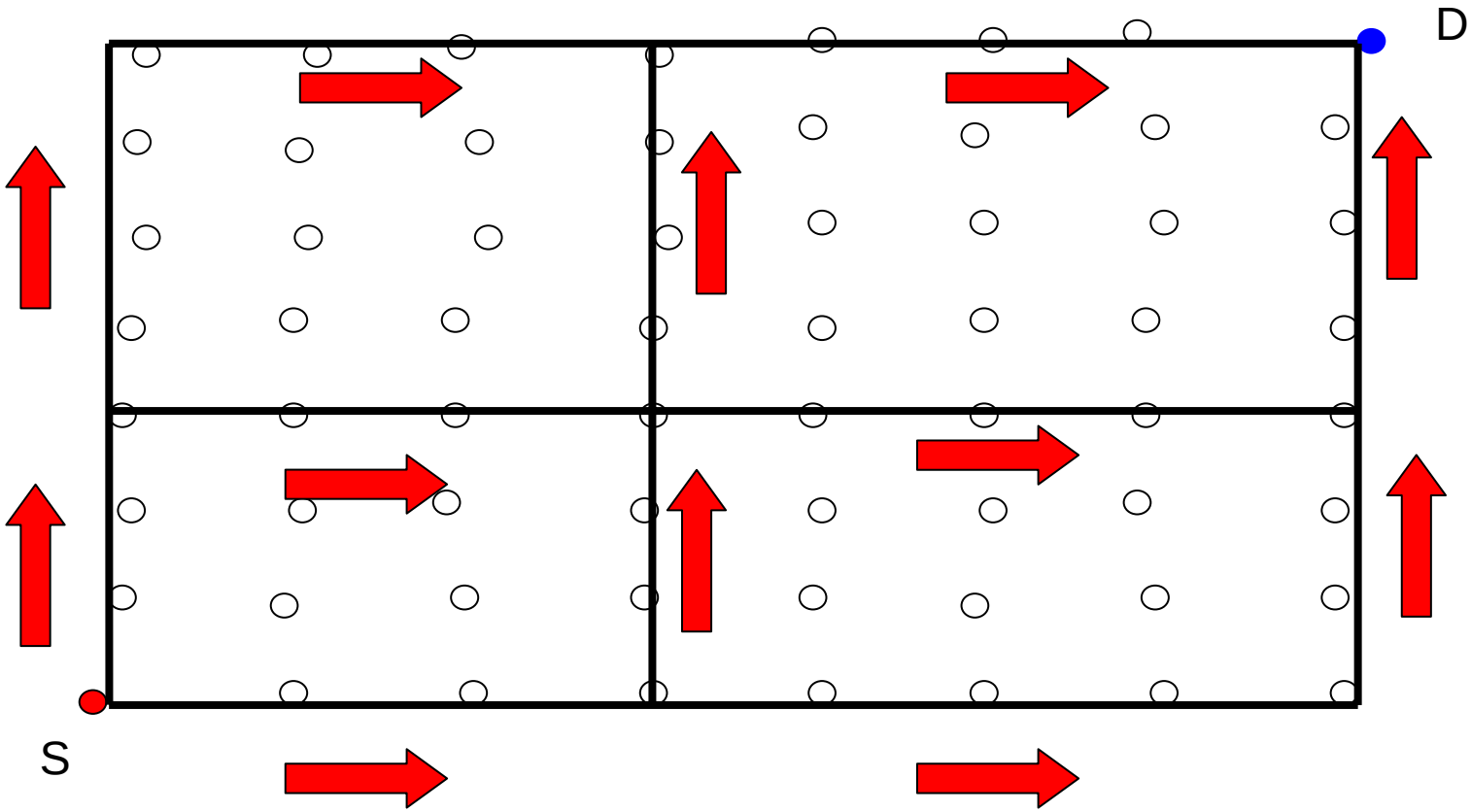
sensor that detects danger

A Distributed Emergency Navigation Algorithm for Wireless Sensor Networks

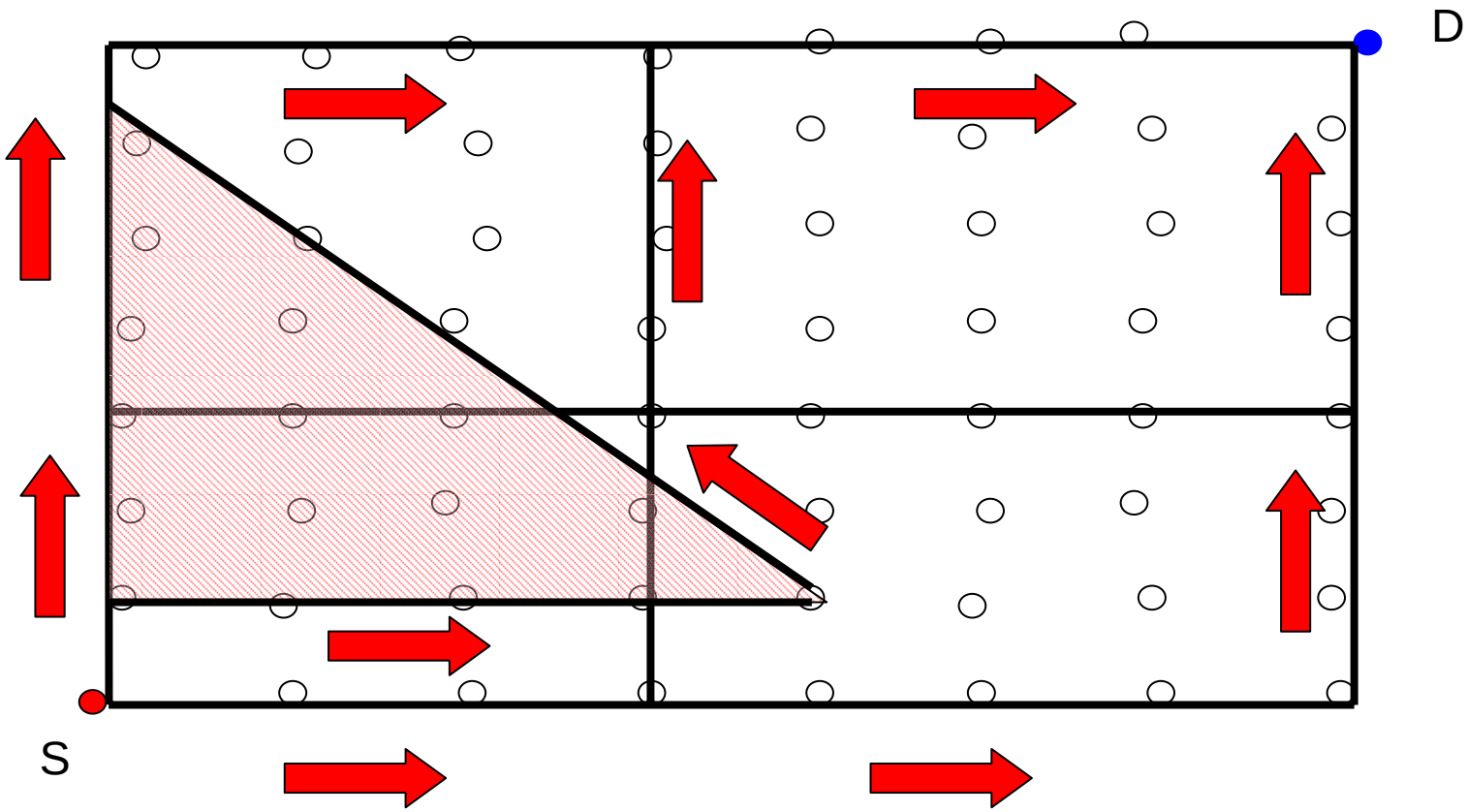
- It considers the dangerous area.
- It considers local minimal problem.



Distributed Navigation Algorithms for Sensor Networks (INFOCOM 2005)



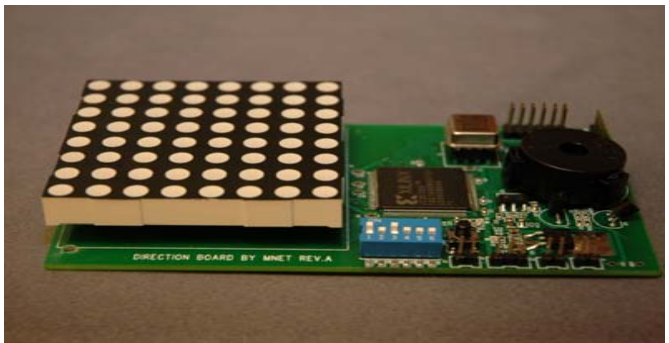
Distributed Navigation Algorithms for Sensor Networks (INFOCOM 2005)



The Distributed Load Balancing Guiding Protocol

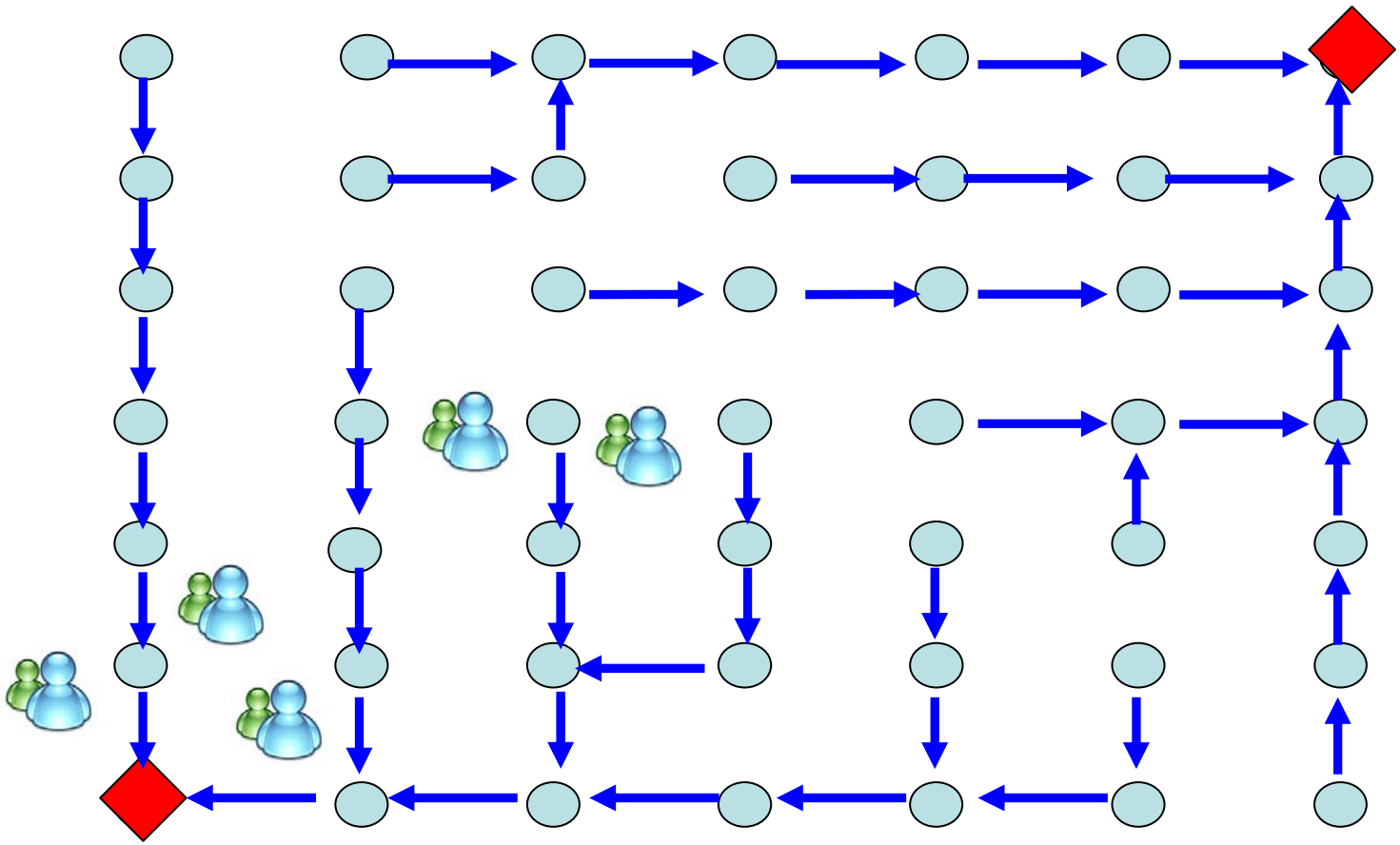
Assumptions

- Each sensor knows its own location and its one-hop neighbors' locations.
- Each sensor is aware of its neighbors by overhearing wireless signals.
- Each sensor can know how many people are in the area through a device that could emit some signals to sensors and be carried by people.
- Each sensor is equipped with a "direction board" which is a LED panel that can show users guiding direction.



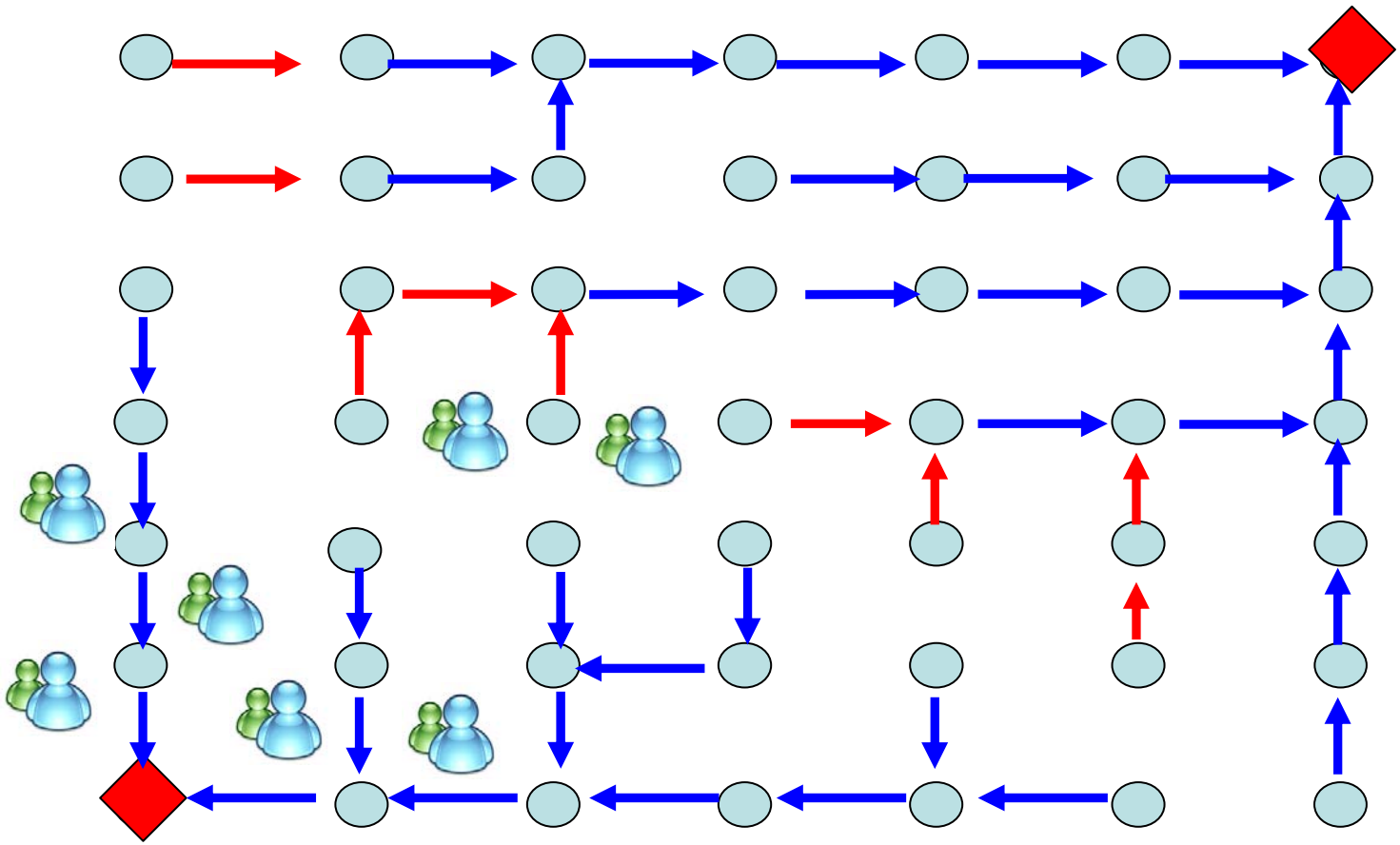
The Features of Our Algorithm

Feature One



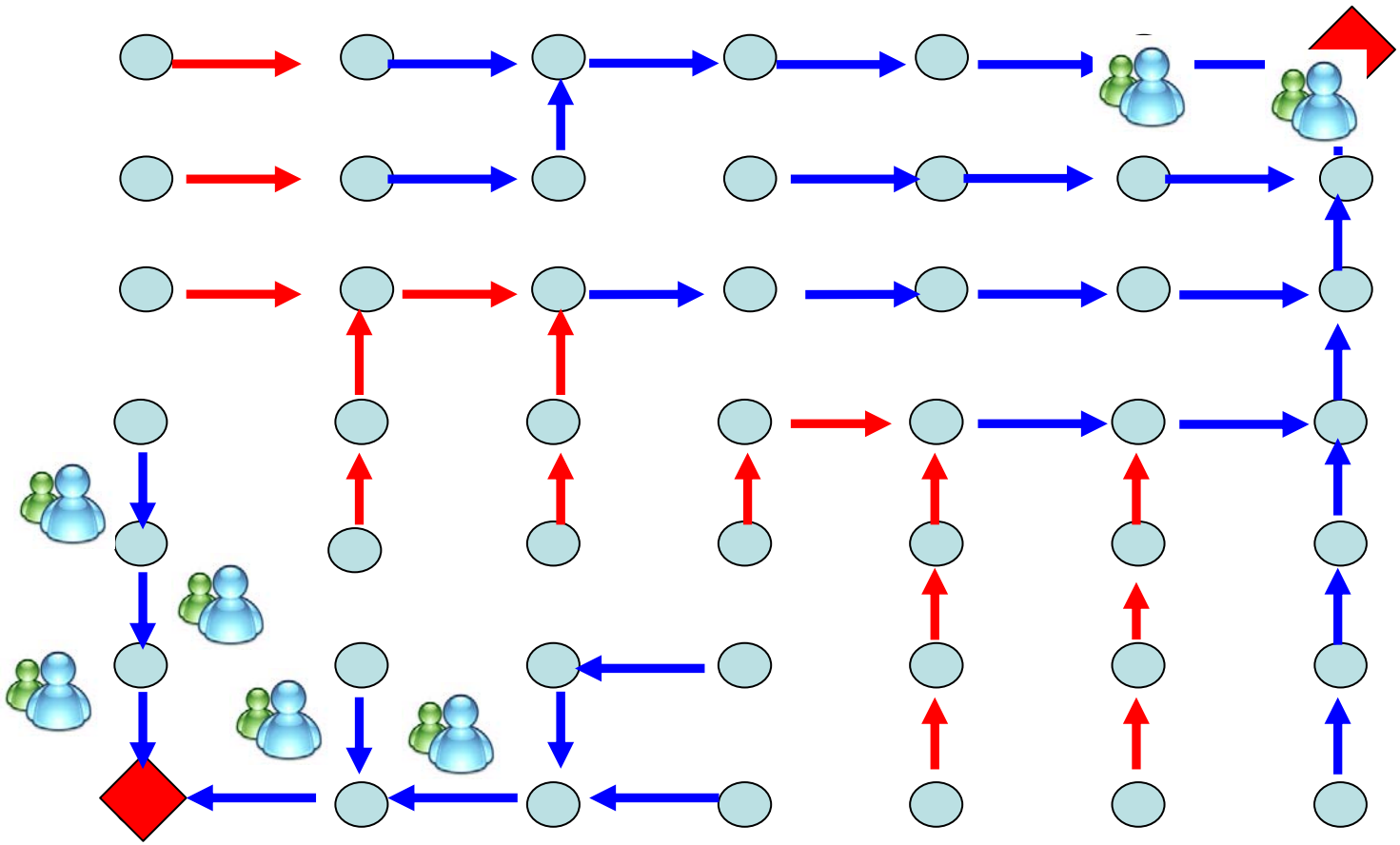
:Exit :Sensor

Feature One



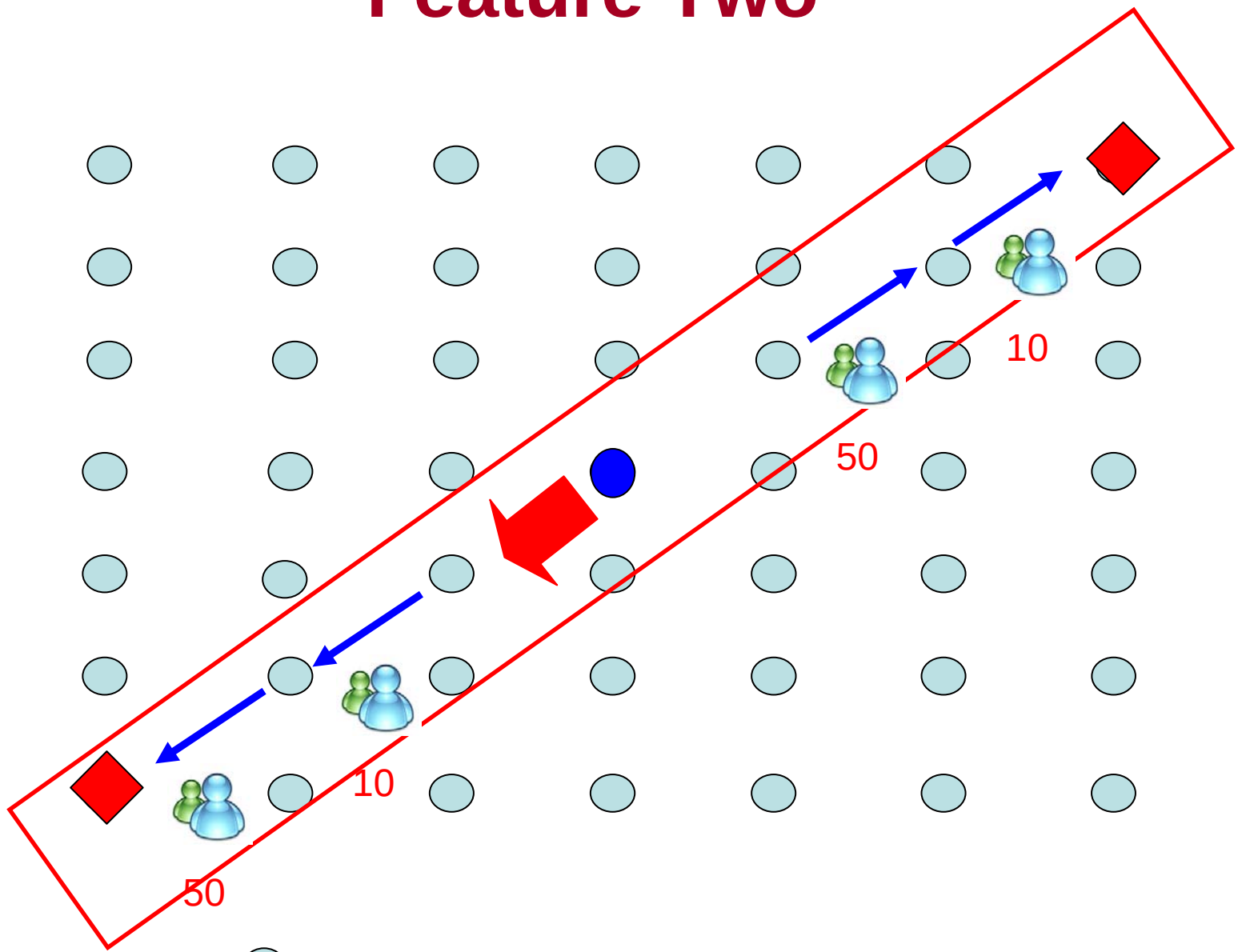
:Exit :Sensor

Feature One

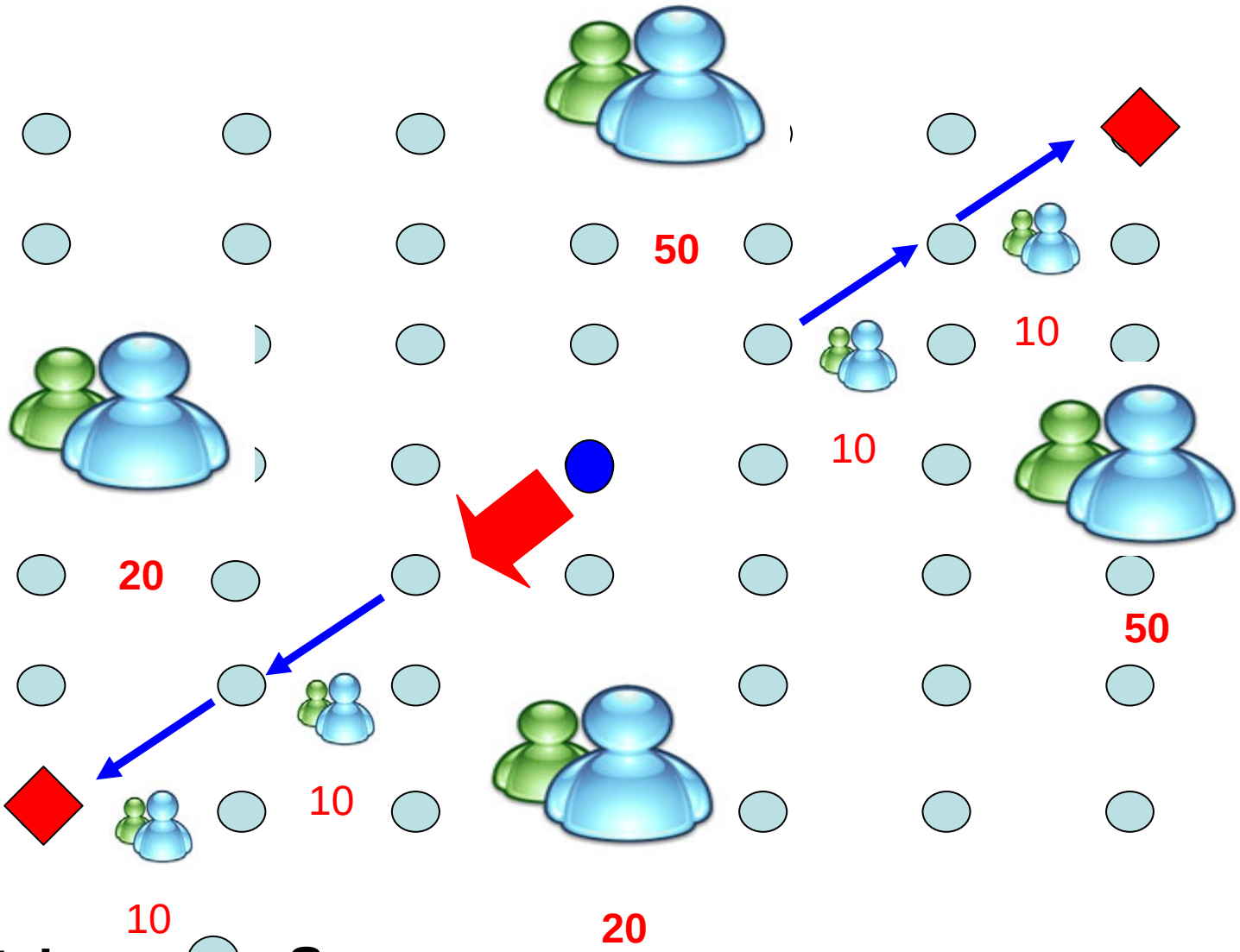


:Exit :Sensor

Feature Two



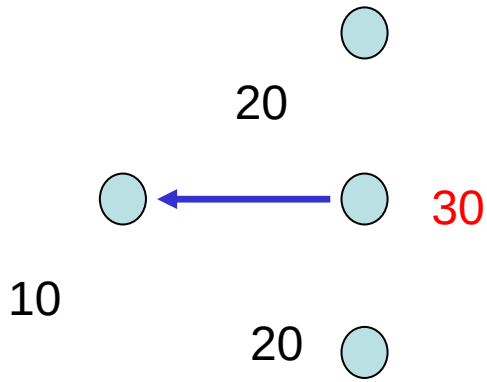
Feature Three



:Exit :Sensor

The Distributed Load Balancing Guiding Protocol

- Each sensor is assigned a *potential* which can be seen as a degree of congestion on the guiding path.
- Each sensor computes its potential according to the distance to nearest exit and the number of people on a guiding path.
- Each sensor selects the neighbor with minimal potential as its guiding direction to the exit.

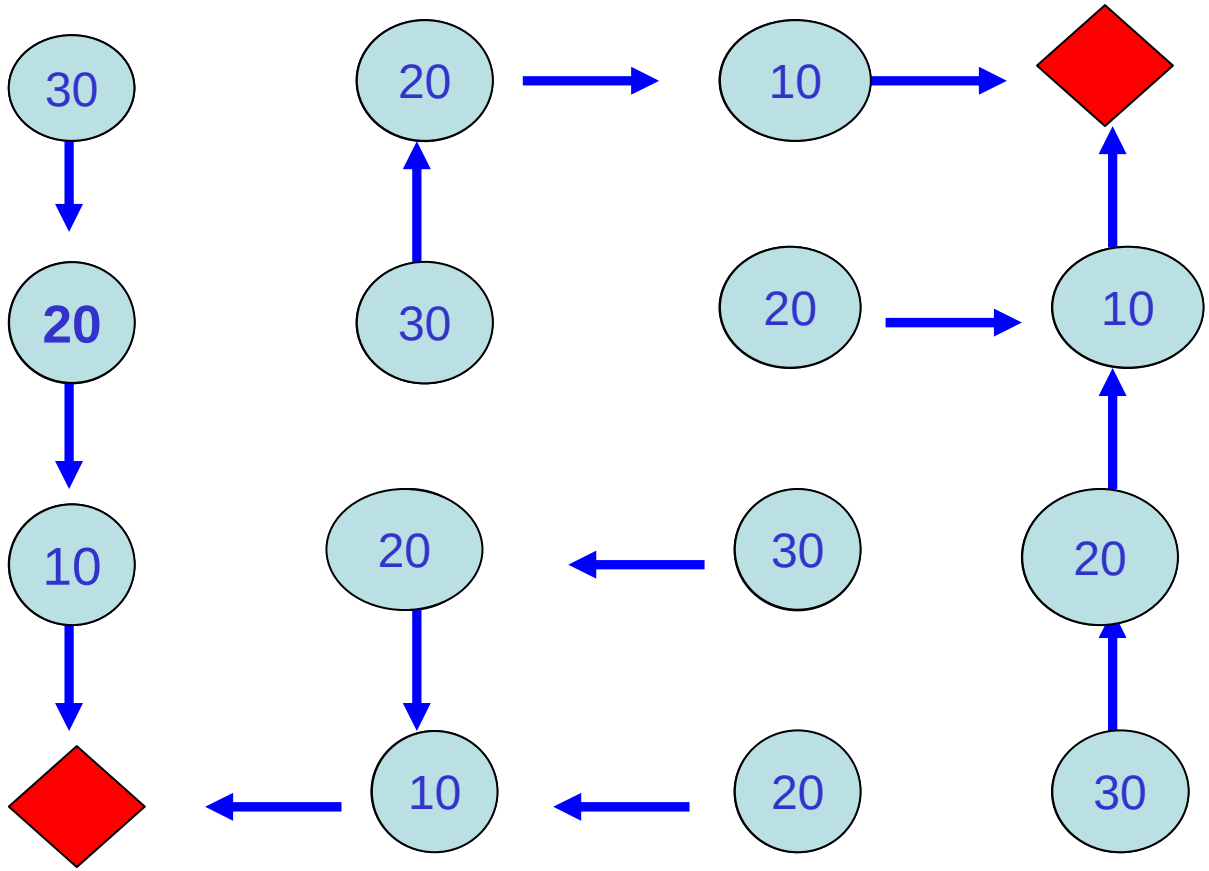


The Distributed Load Balancing Guiding Protocol

- Phase 1 : Network Initialization

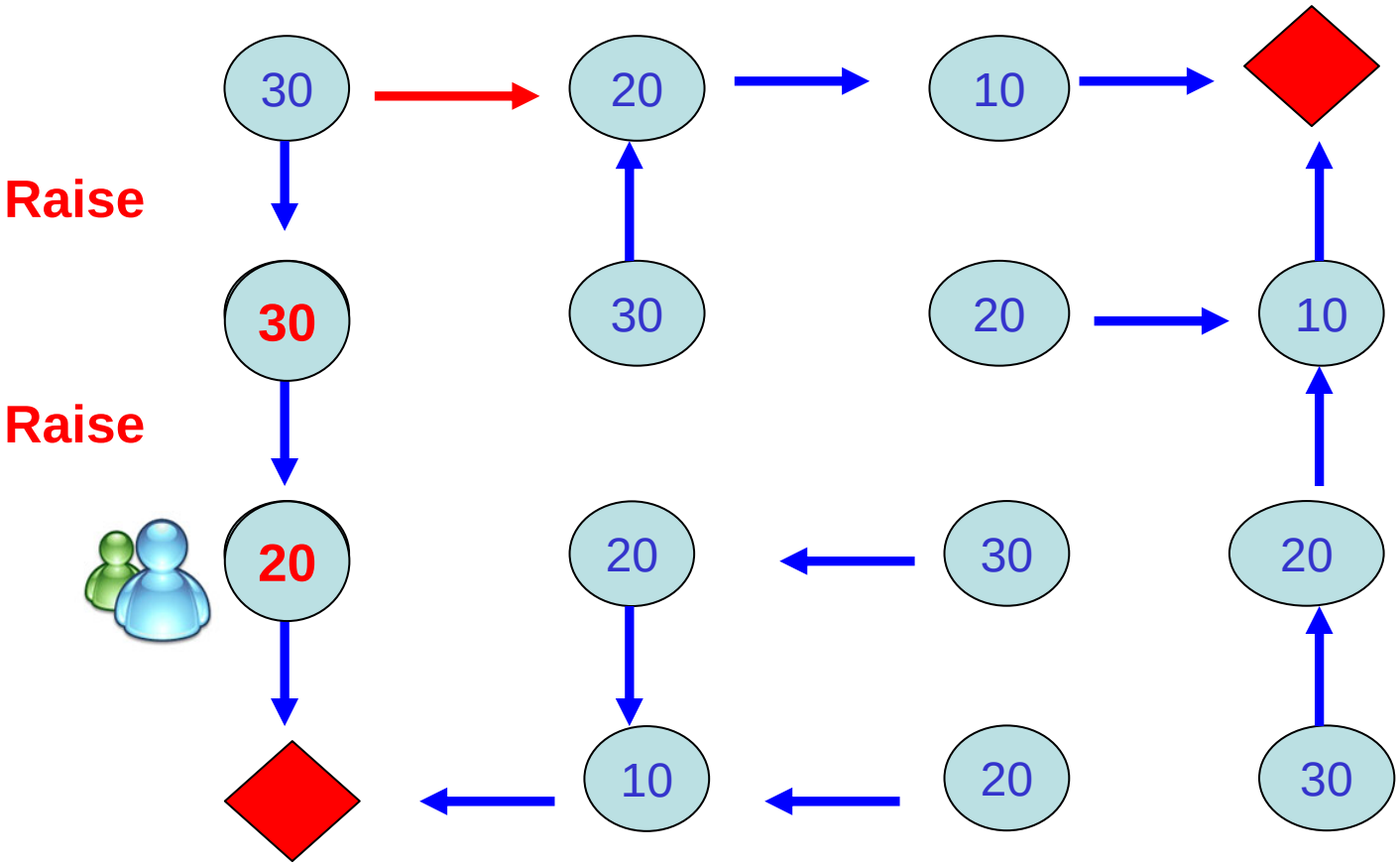
- Phase 2: Maintaining Potential

Phase 1: Network Initialization

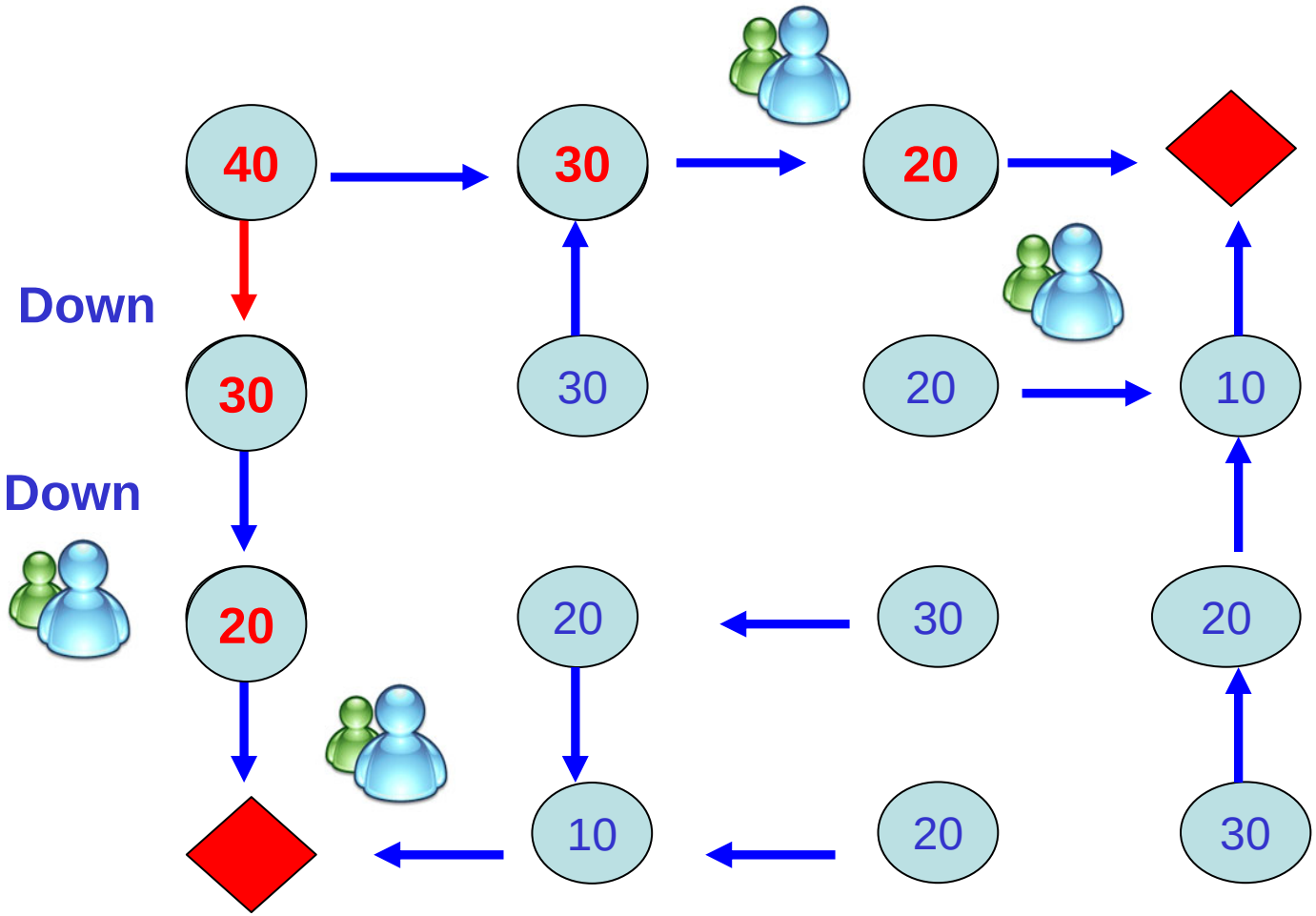


:Exit :Sensor **Potential**

Phase 2: Maintaining Potential



Phase 2: Maintaining Potential



:Exit :Sensor Potential

The Calculation of Potential

$$p_i = a_i + f_0 \times p_{DS_i} + f_1 \times na_i + f_2$$

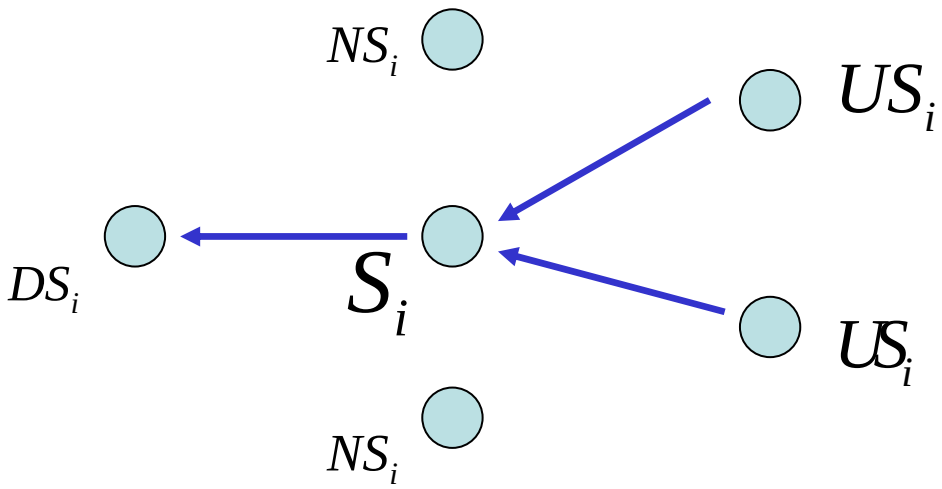
p_i: the potential of S_i

a_i : the amount people that S_i senses

$na_i = \{$the amount of people that S_k senses$|S_k \in NS_i\}$

f_0, f_1 and f_2 are system constant.

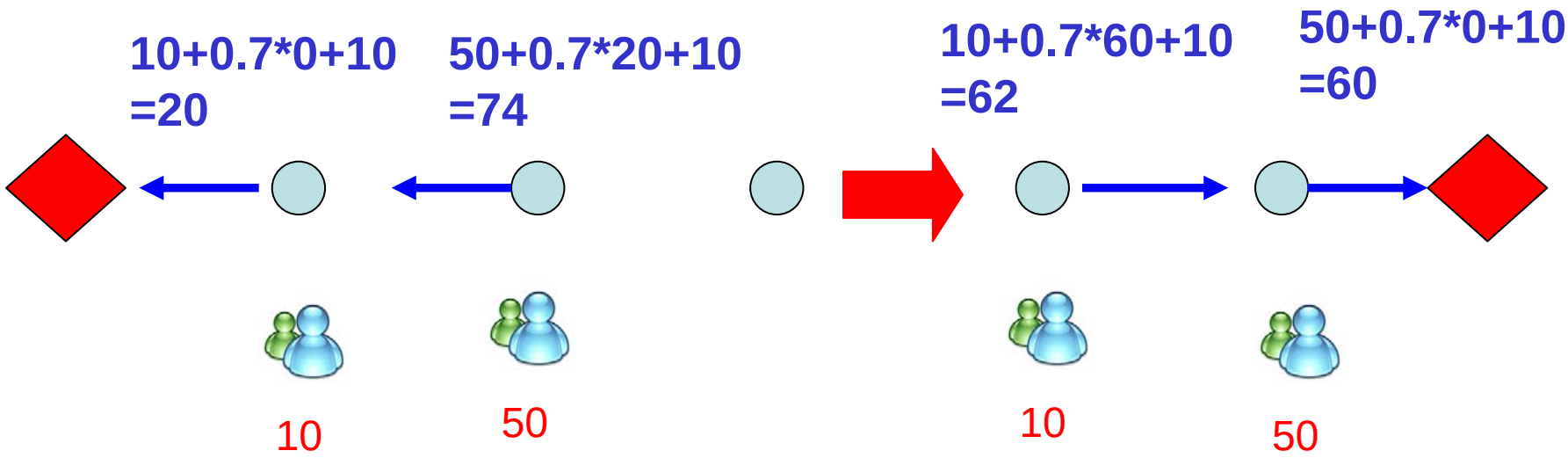
$0 < f_0, f_1 < 1$



Why 0< f_0 <1 ?

$$p_i = a_i + f_0 \times p_{DS_i} + f_1 \times na_i + f_2$$

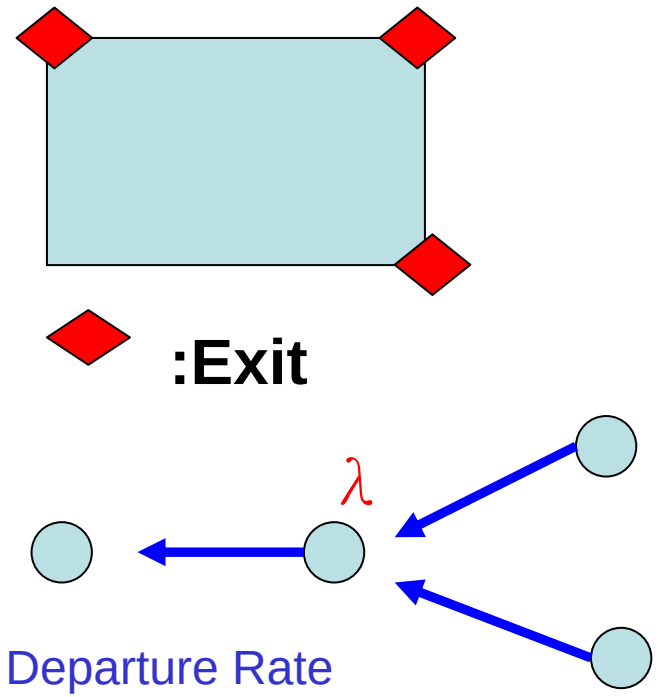
$$\text{Ex}: f_0 = 0.7,\ f_1 = 0,\ f_2 = 10$$

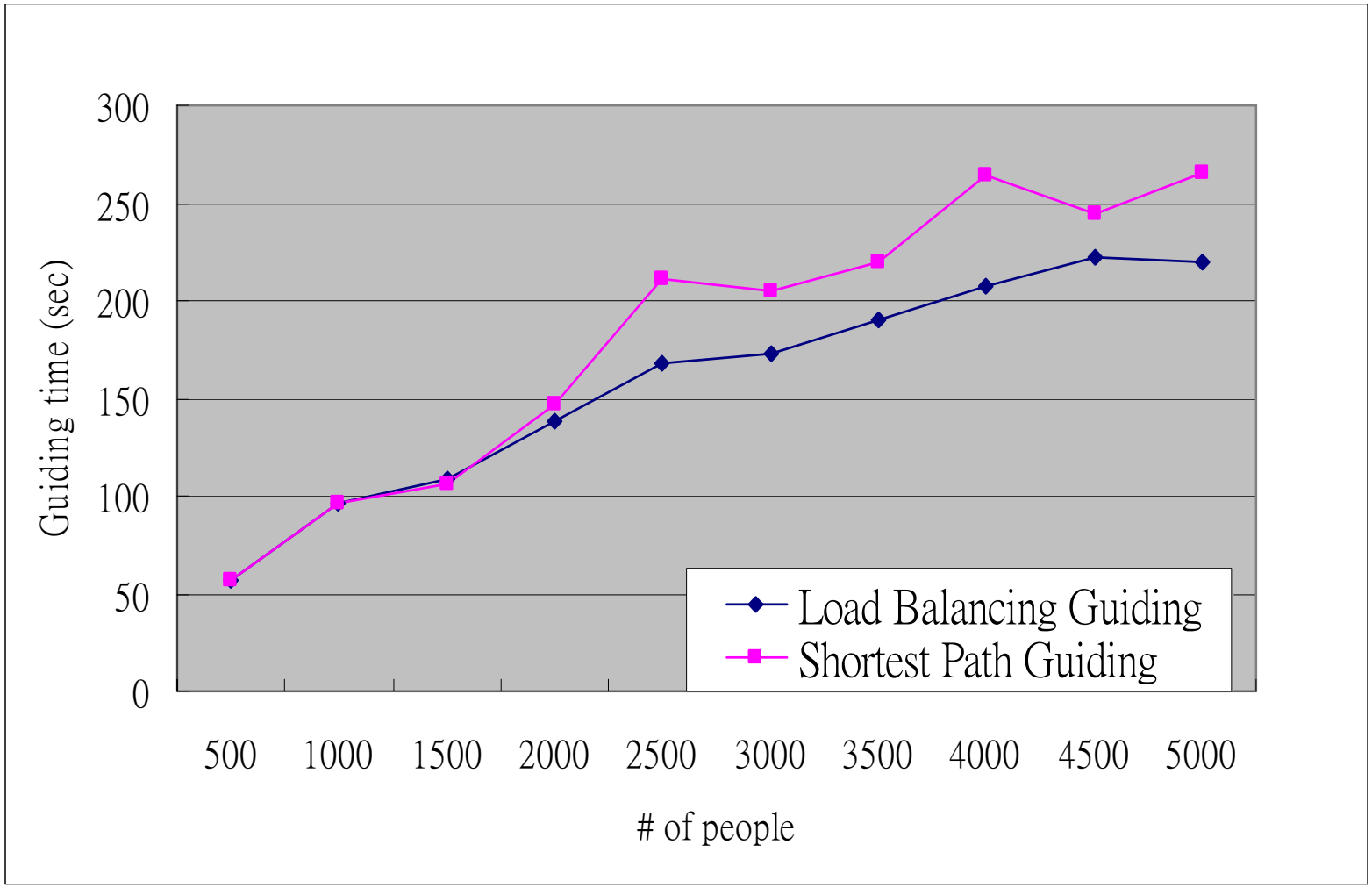


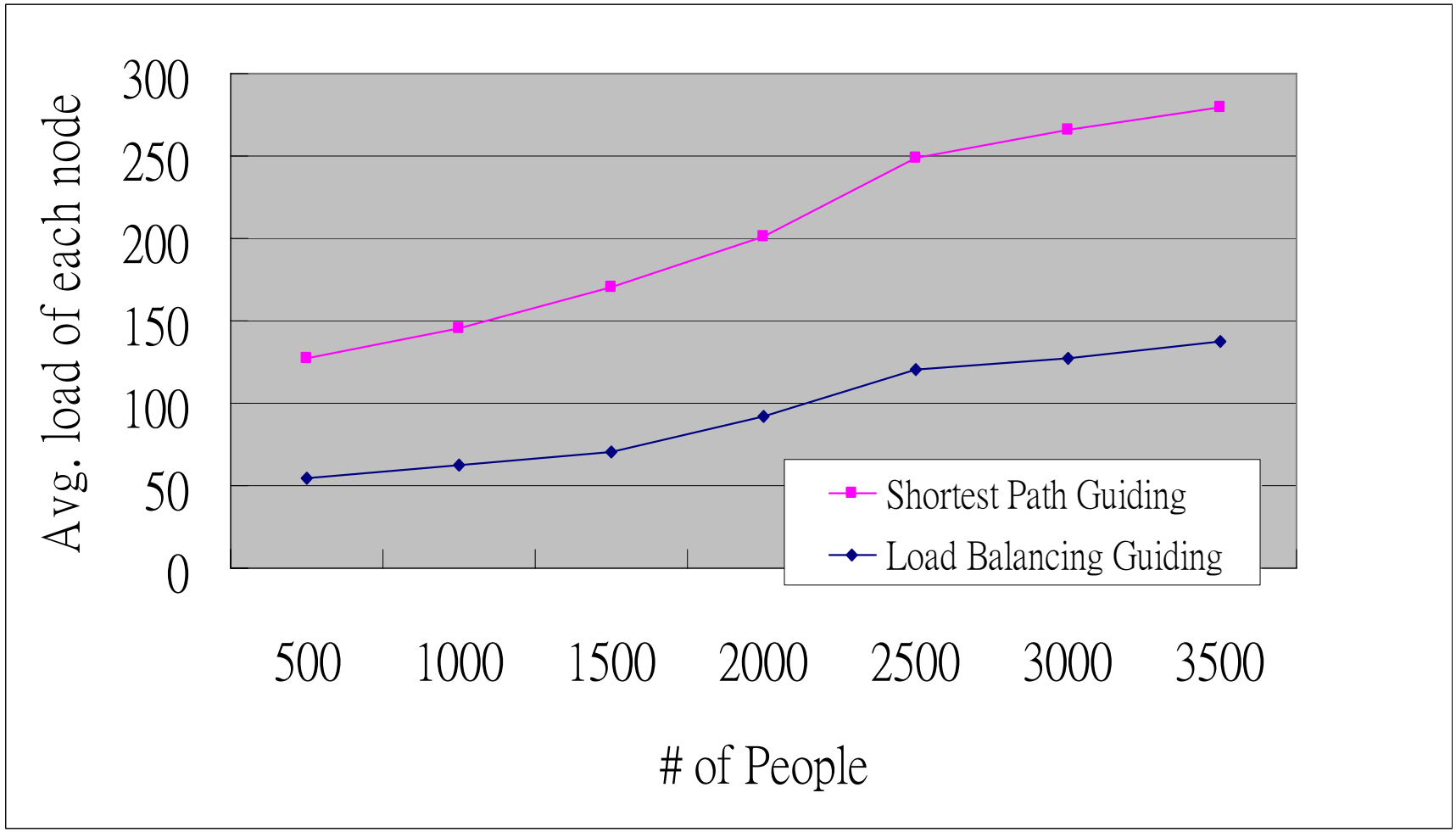
Simulation Results

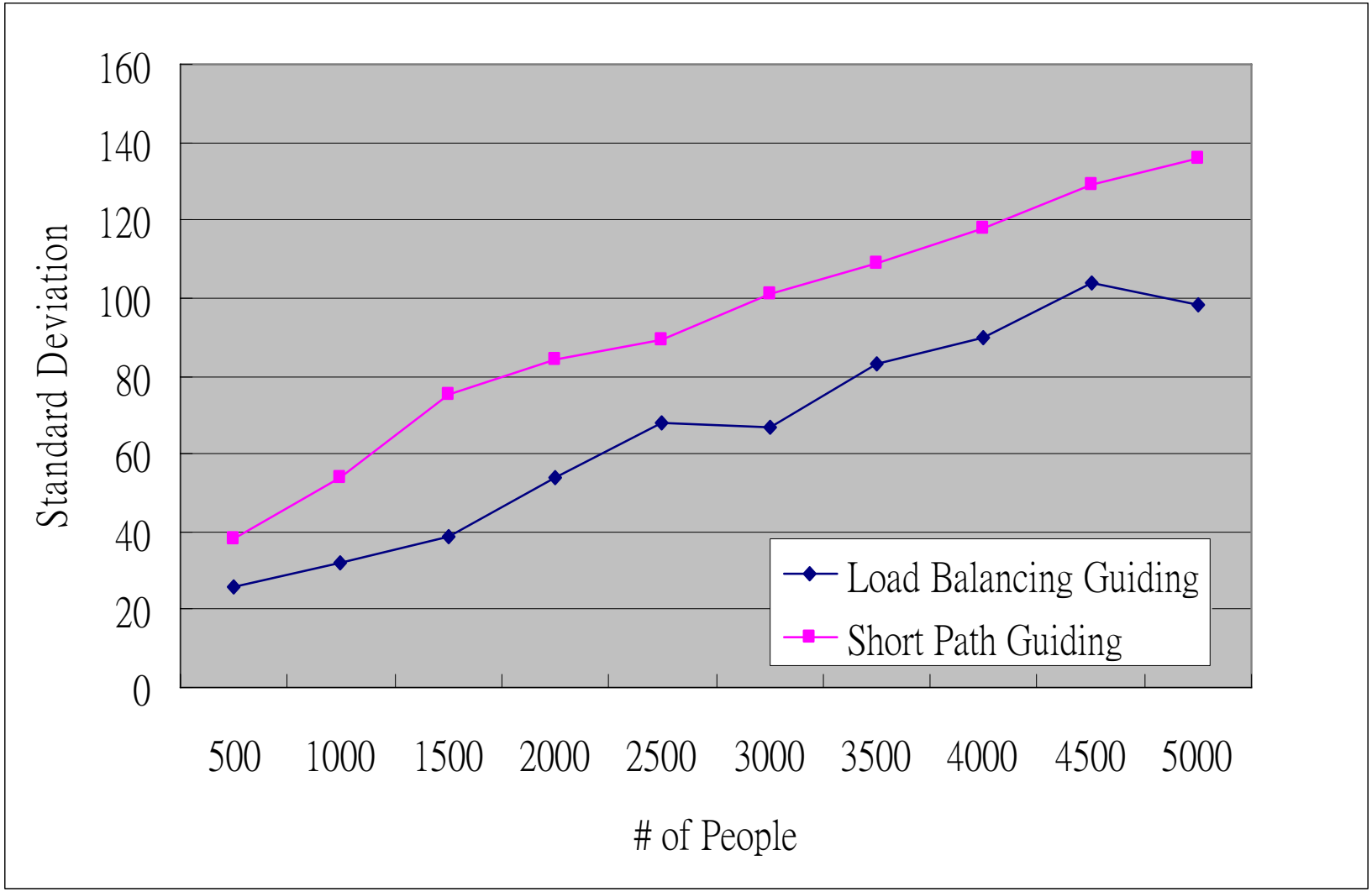
- 10 x 10 sensor nodes are deployed uniformly in a 50m x50m area.
- 3 Exits
- Departure rate : 5 people/sec
- Arrival rate : n x λ people/sec
- Date rate: 20 kbps
- # of people: 500~ 5000

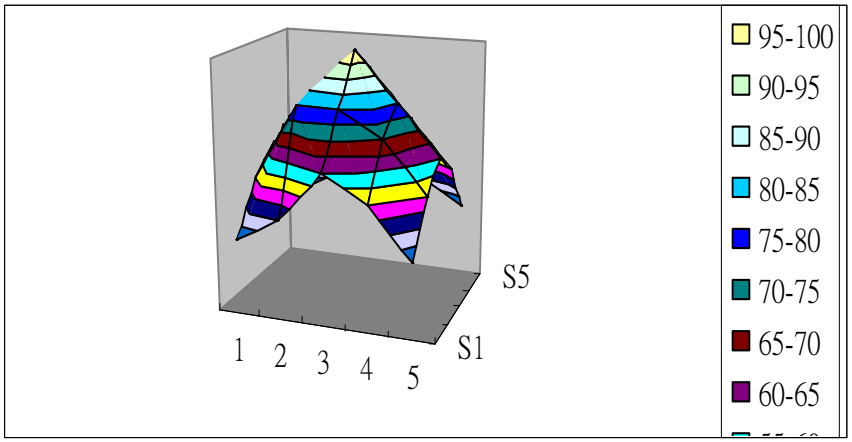
$$f_0 = 0.9,\ f_1 = 0.5,\ f_2 = 50$$

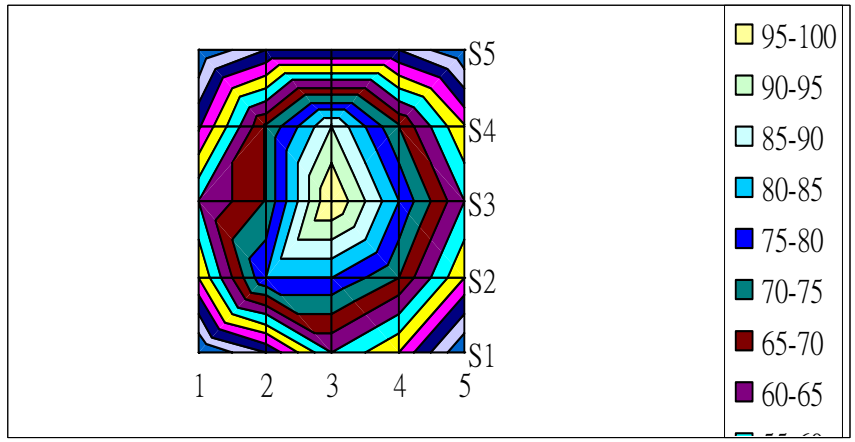



300
250
200
150
100
50
0
Guiding time (sec)
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
# of people
Load Balancing Guiding
Shortest Path Guiding

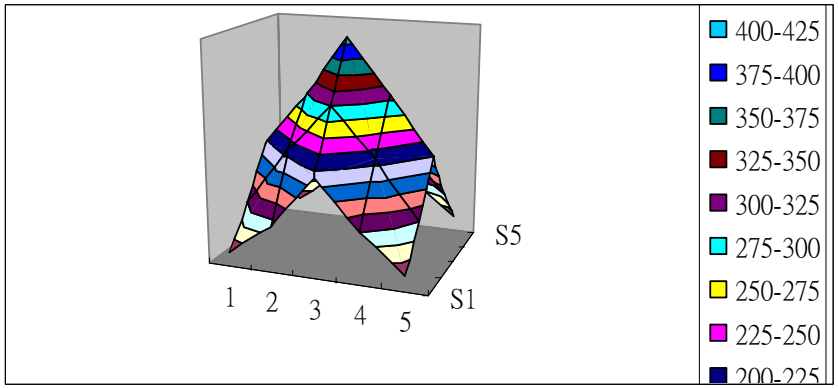

Avg. load of each node
300
250
200
150
100
50
0
500
1000
1500
2000
2500
3000
3500
# of People
Shortest Path Guiding
Load Balancing Guiding

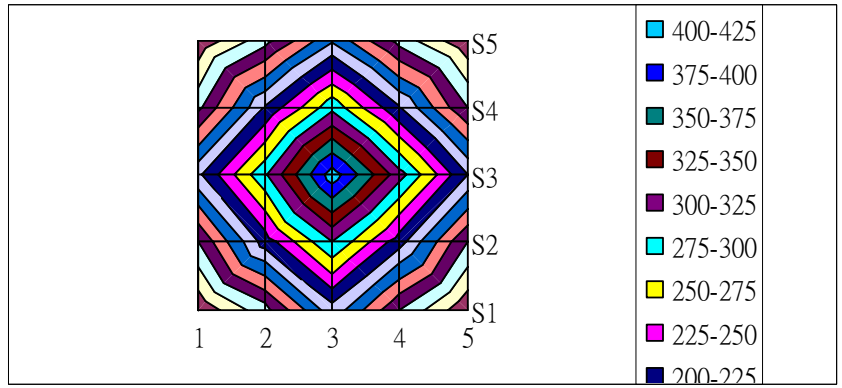

160
140
120
100
80
60
40
20
0
Standard Deviation
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
# of People
Load Balancing Guiding
Short Path Guiding





People Distribution





Potential Distribution

Conclusions

- We proposed a new distributed guiding method considering the load balance of each guiding path.
- The proposed method really balances the load of guiding people on each node.
- Our guiding protocol can guide people to exits in a short time.
- The method can also apply to a large scale sensor networks.