Improving the Data Delivery Latency in Sensor Networks with Controlled Mobility

Seminar: Ad-hoc networks

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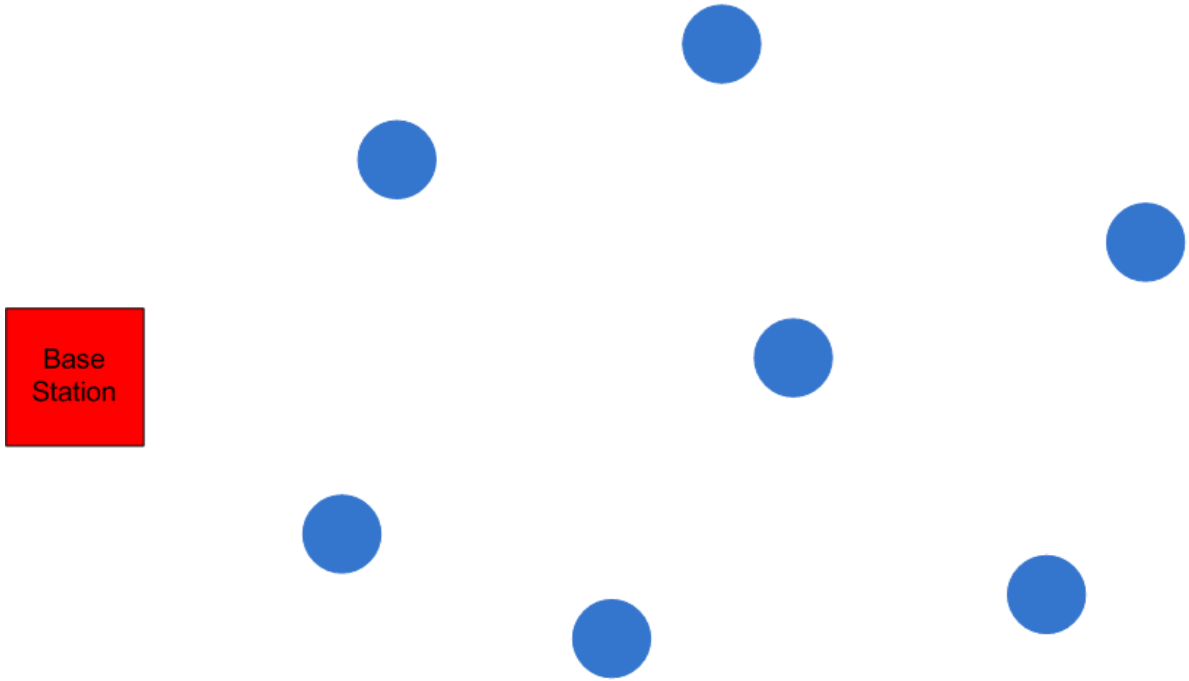
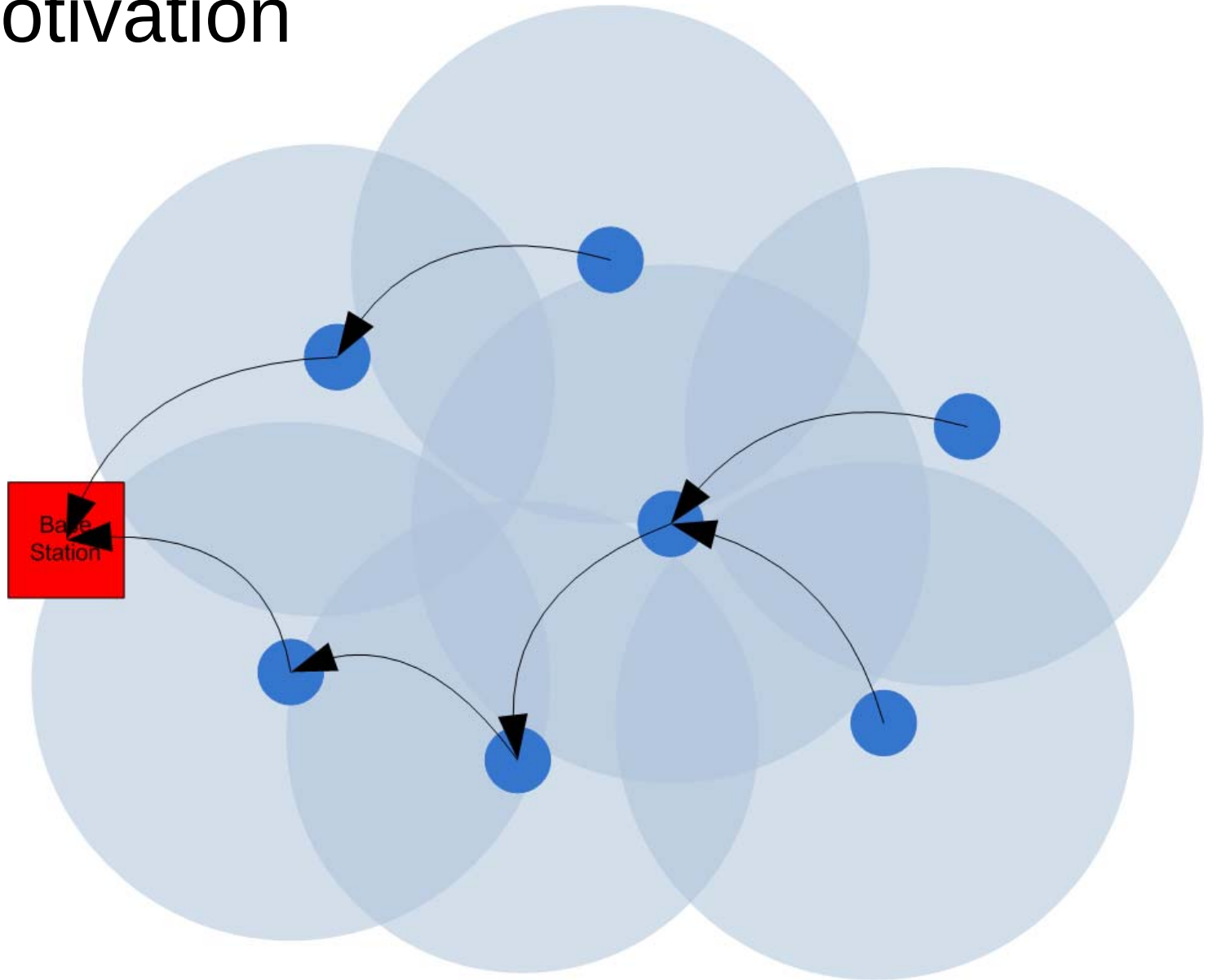
Outline

1. Motivation
2. Path Selection Problem
3. Approximation Algorithm
4. Application Scenario
5. Experiments

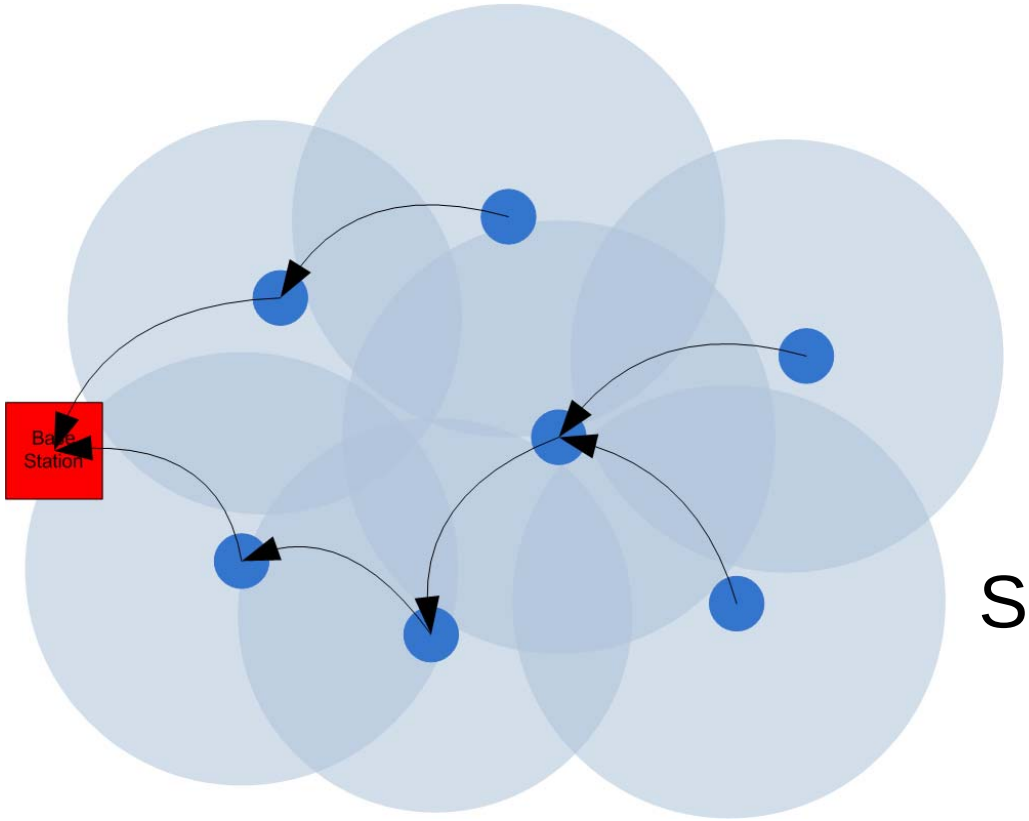
Motivation



Motivation



Motivation – Energy Problem



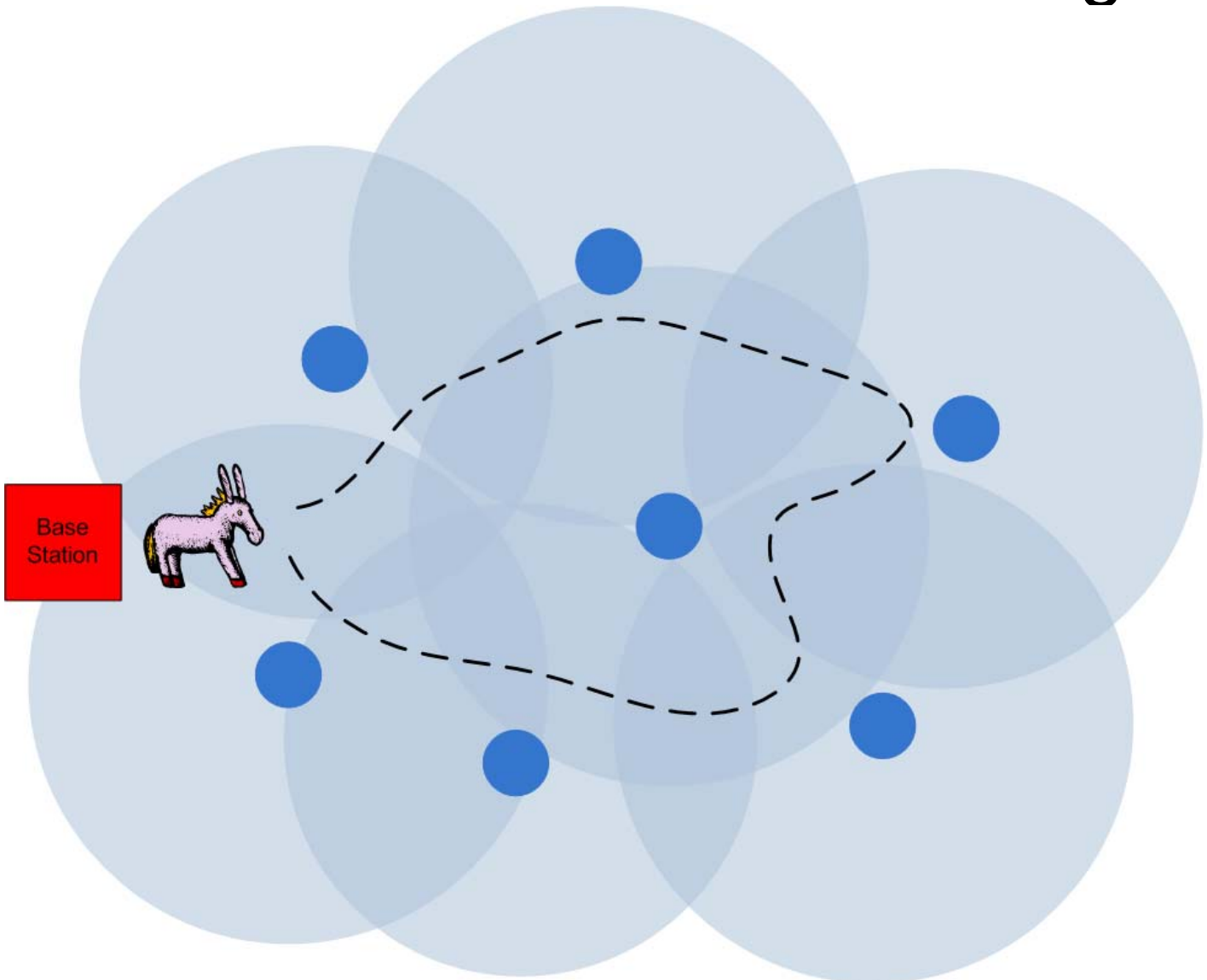
- Complex algorithms
- Continual data forwarding
- Long communication ranges

Solution:

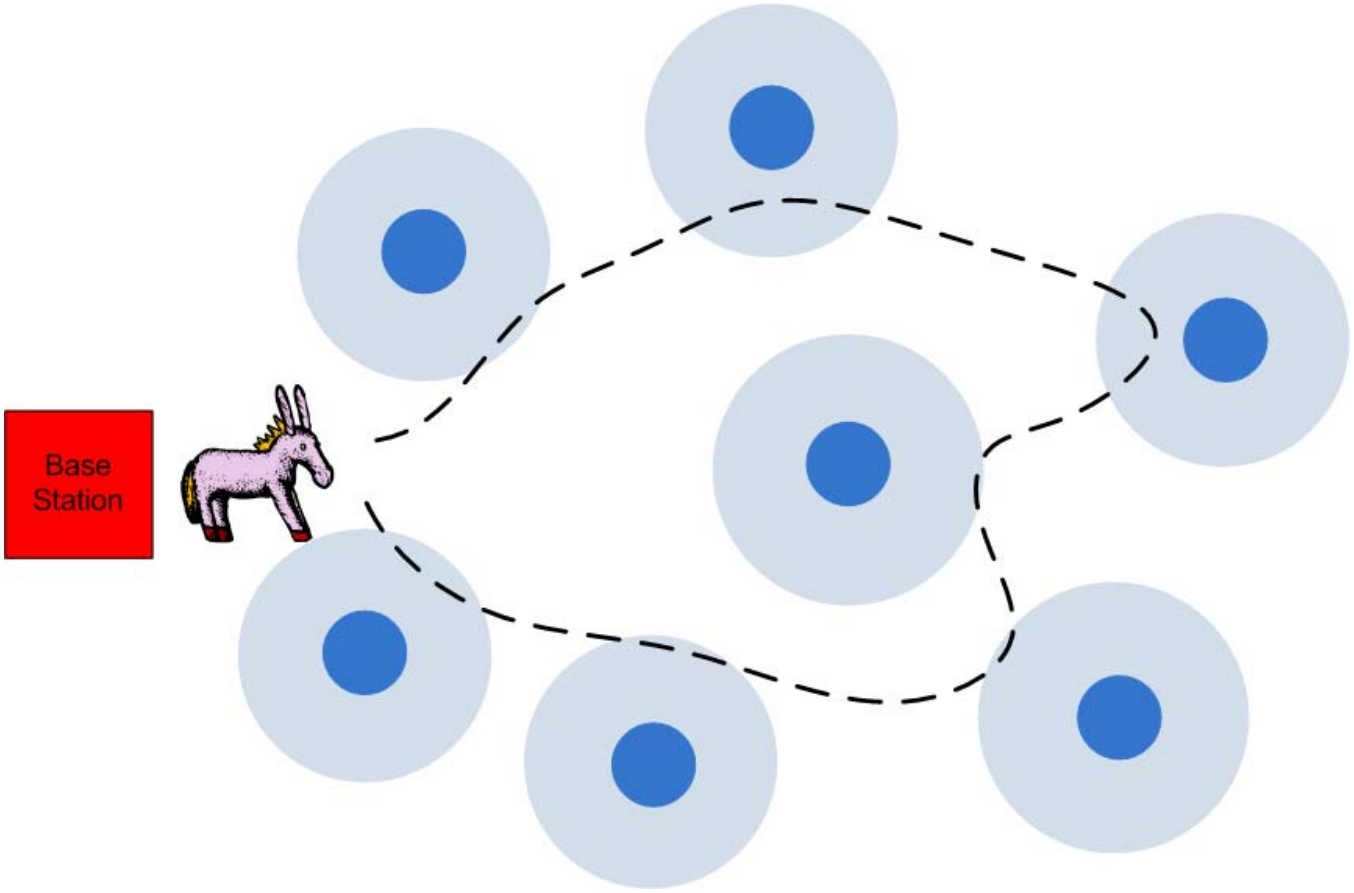
Mobile data collector

(Data Mule)

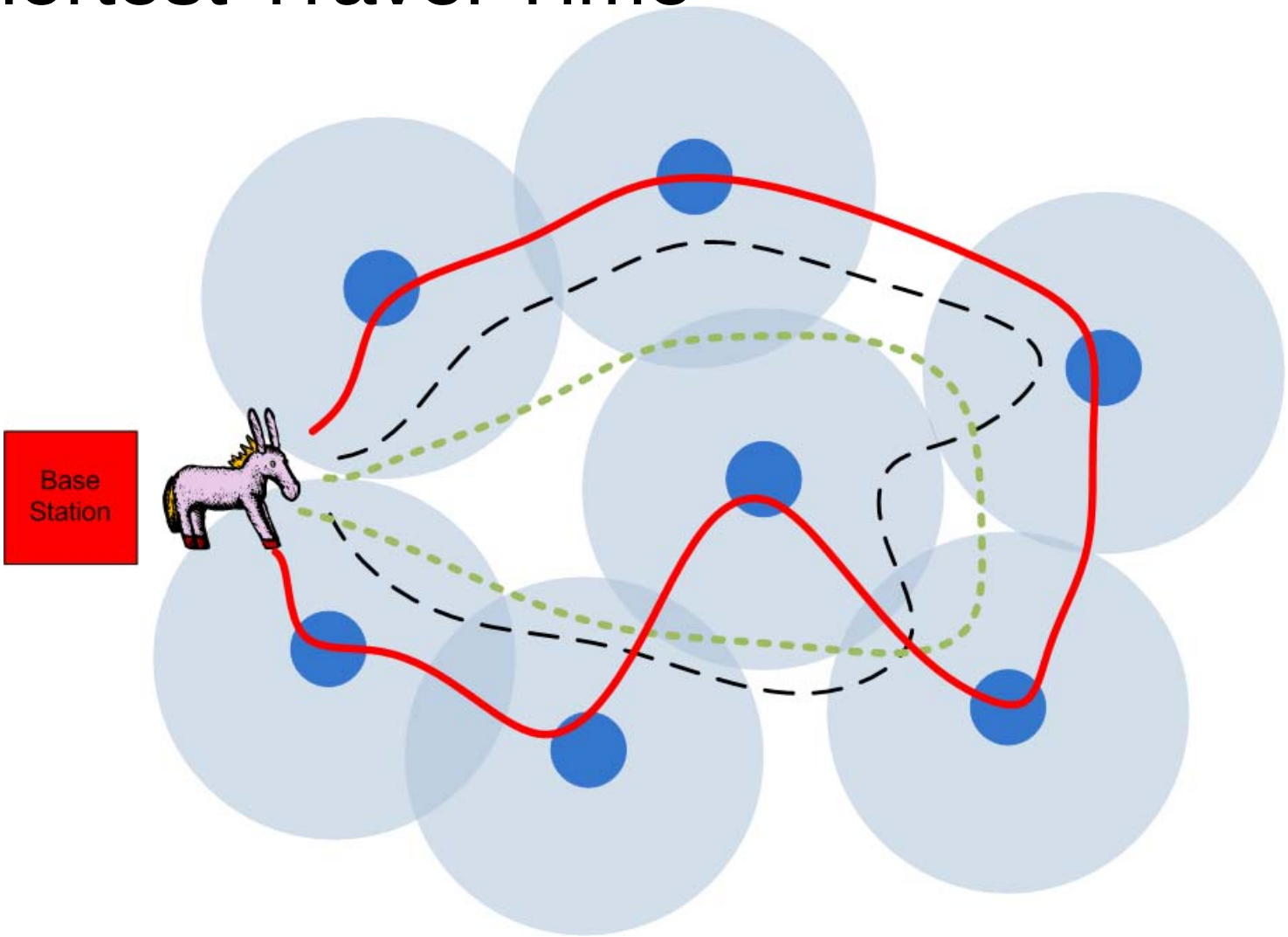
Motivation – No Data Forwarding



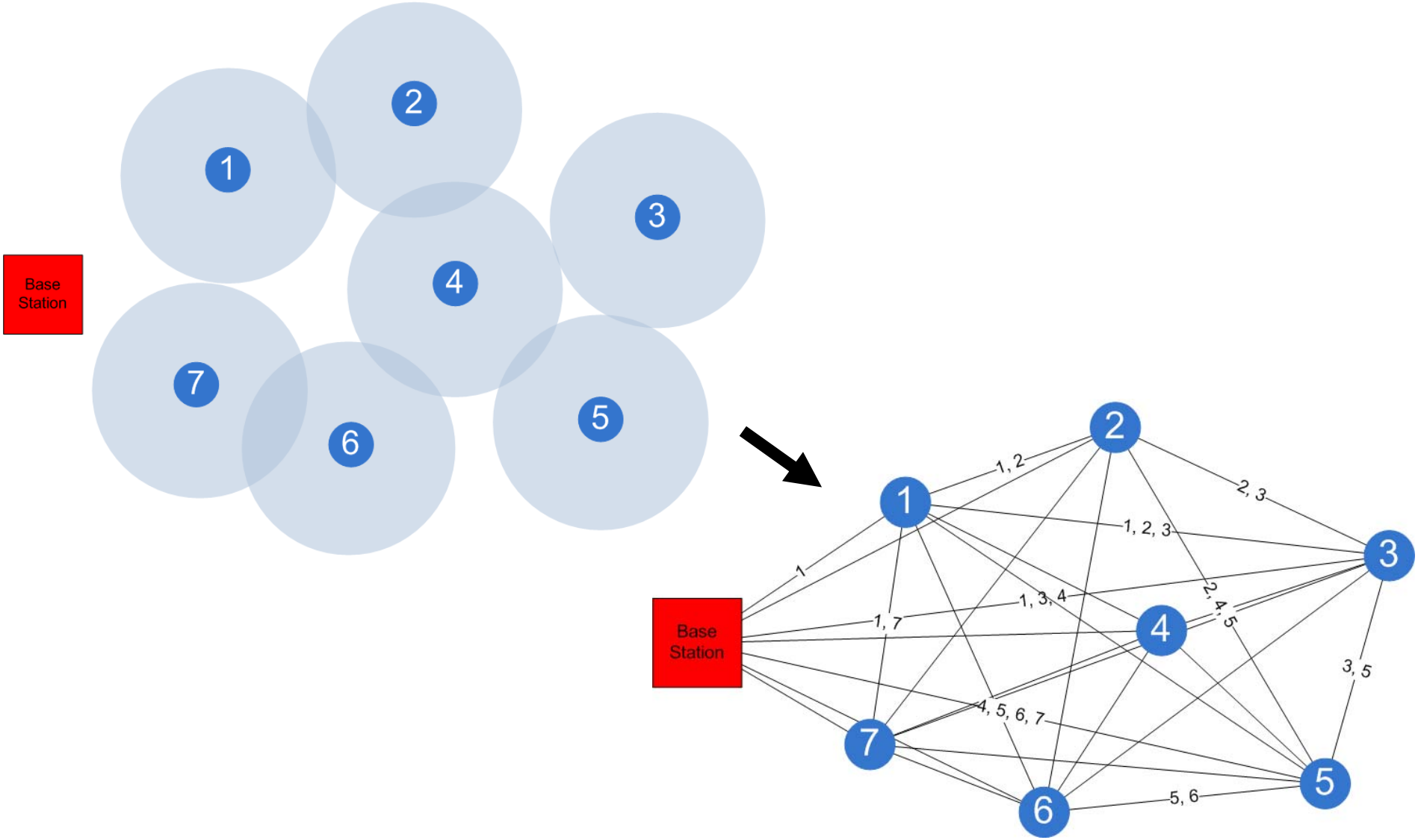
Motivation – Short Communication Ranges



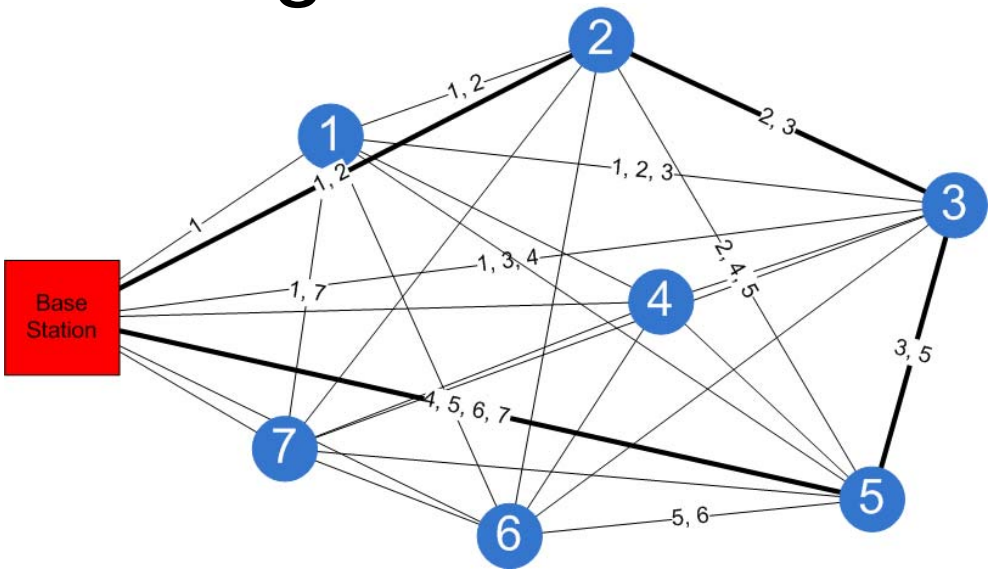
Path Selection Problem – Shortest Travel Time



Simplifying the Problem



Label-Covering Tour



Definition:

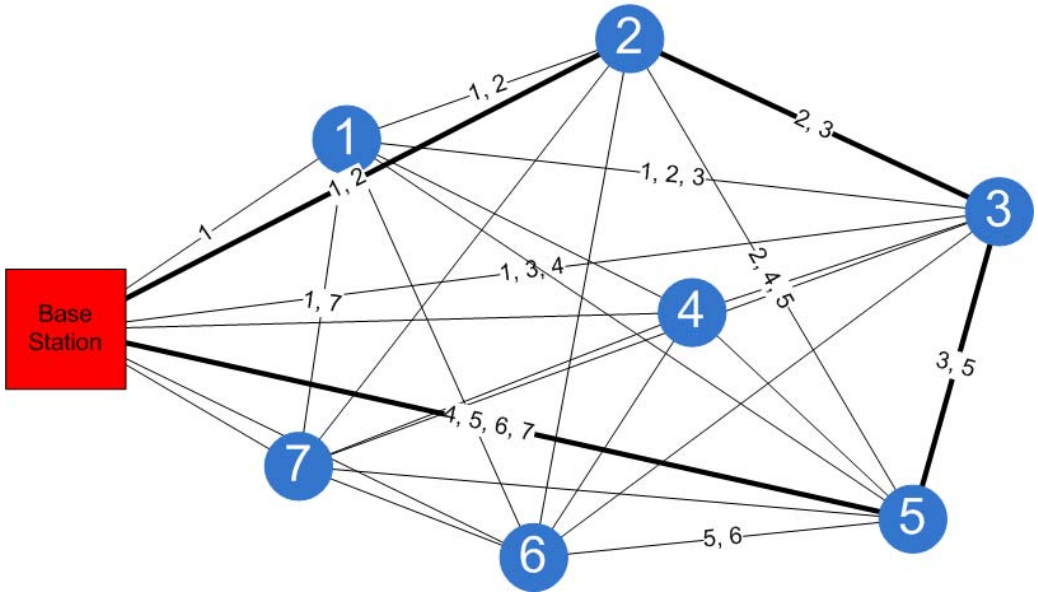
- vertices are points in R^2 (static nodes)
- edges are possible paths
- labels on edges indicate possible communication of nodes
- cost for each edge to indicate travel time (not shown)

Problem:

Find a set of edges that covers all labels and minimizes the costs.

Choice of Cost Metric

- Number of edges
- Euclidean distance
- Uncovered distance



Choice of Cost Metric

- Creation of different node deployments
- Simulation of a random walk
- Calculate correlation to the total travel time

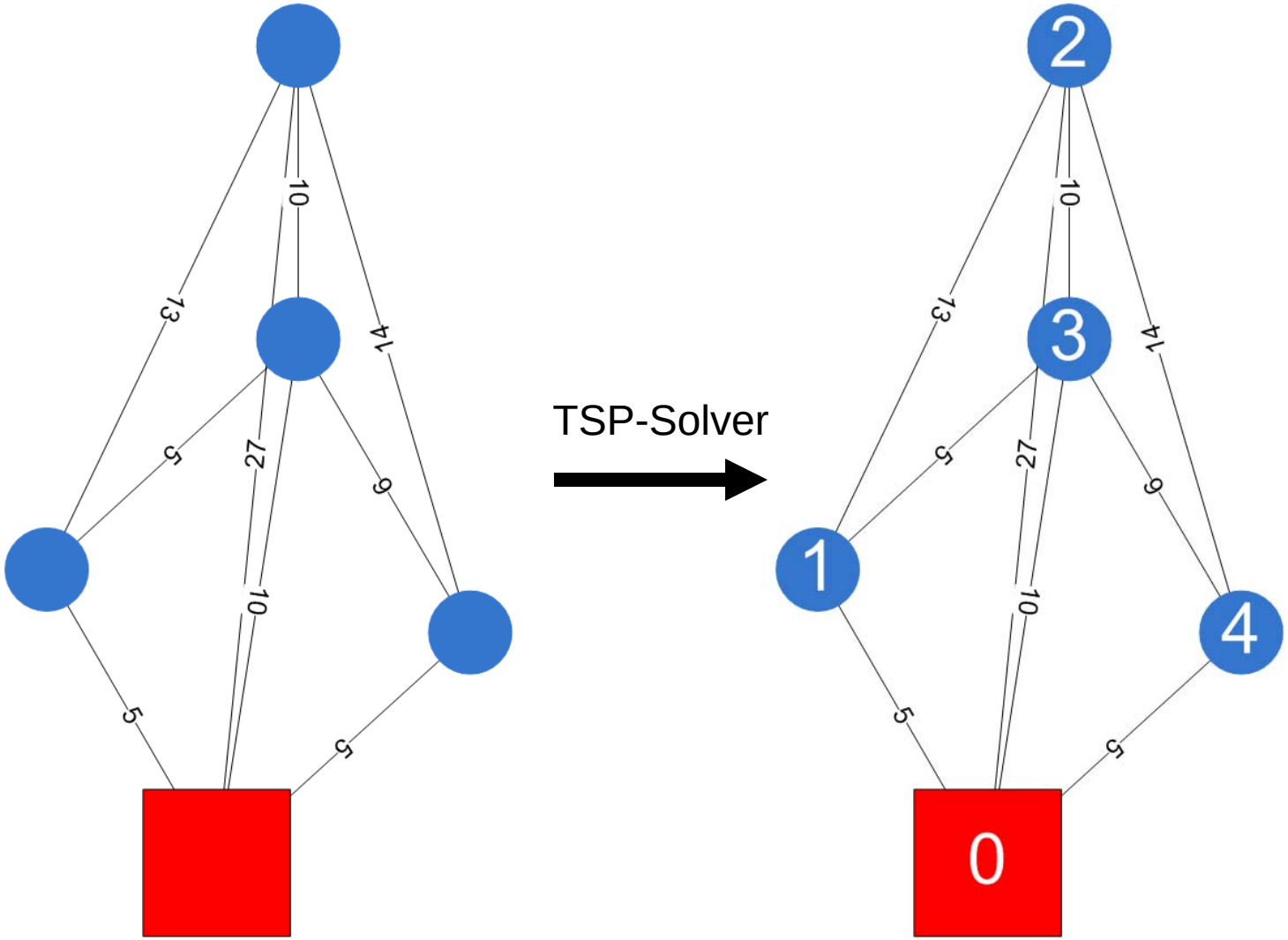
Radius (d)	150				500			
Comm. range (r)	10		100		10		100	
Exec. time (e)	2	20	2	20	2	20	2	20
Num. edge	0.992	0.987	0.982	0.850	0.984	0.982	0.988	0.988
Euclidean dist.	0.997	0.996	0.990	0.835	0.999	0.999	0.999	0.999
Uncovered dist.	0.992	0.993	—	—	0.999	0.999	0.935	0.935

Label-Covering Tour is NP-Hard

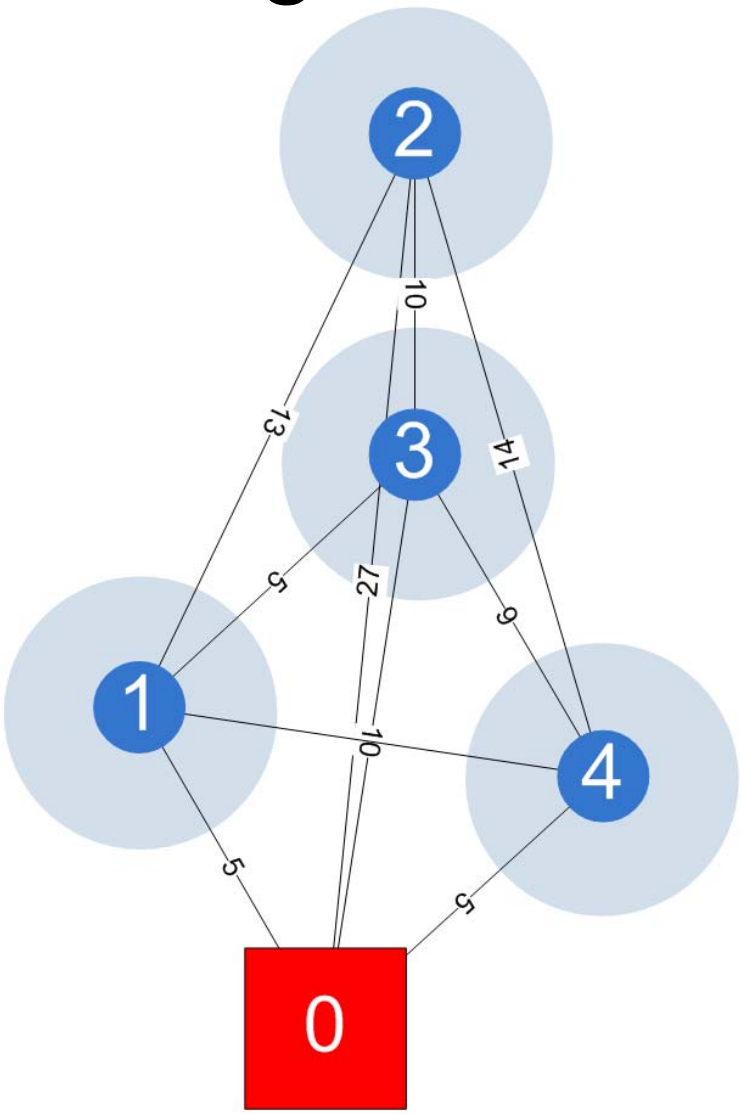
Choose a small communication range

- → Max two labels on each edge
- → Label-Covering Tour must visit all nodes
- → Problem is equivalent to TSP

Approximation Algorithm



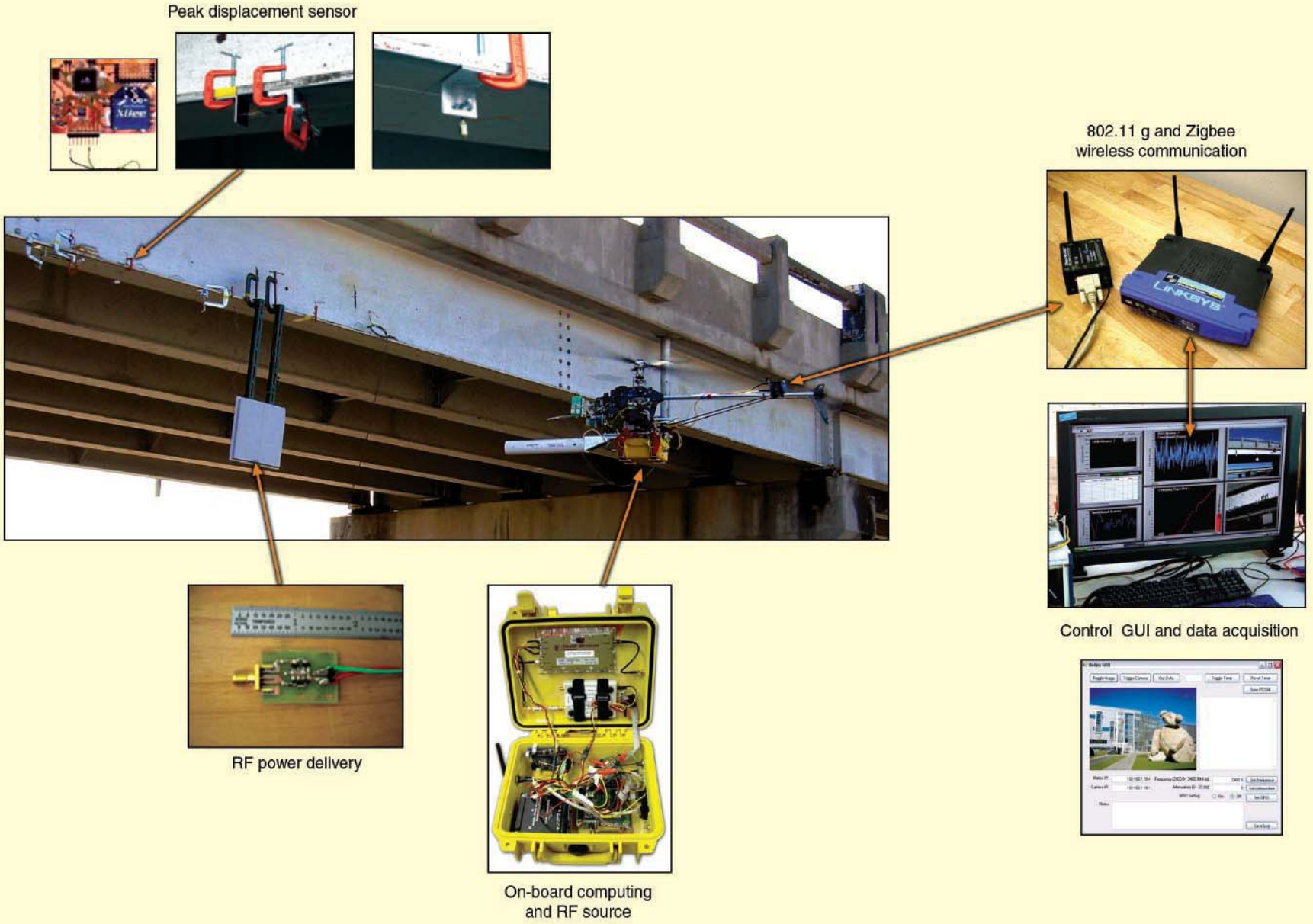
Approximation Algorithm



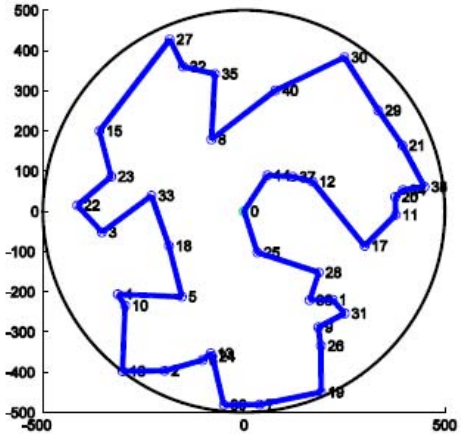
Approximation Algorithm - Analysis

- Costs of TSP depends on the algorithm
- Costs of suggested Approx-Algorithm: $O(n^3)$
- Finding Label-Covering Tour:
  $C(TSP) + O(n^3)$

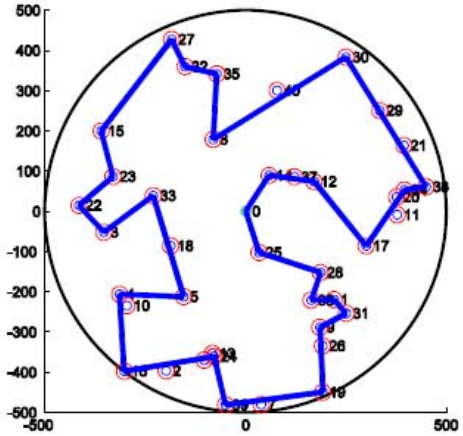
Example Application



Experiments



r = 1



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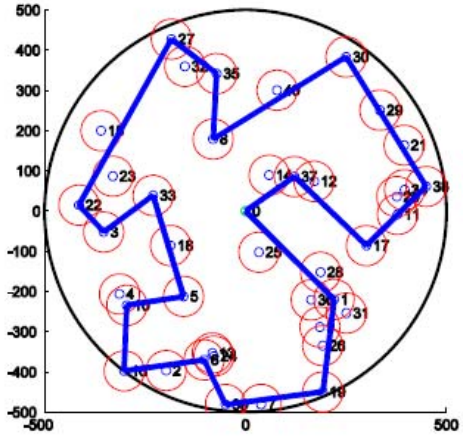
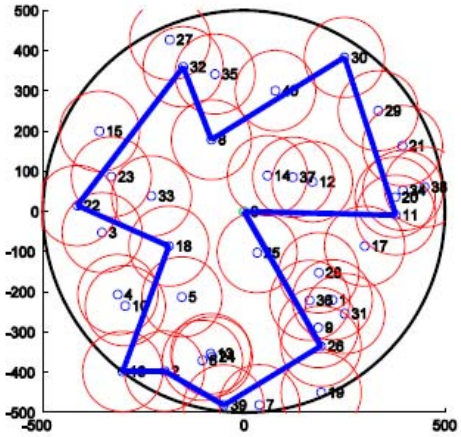


r = 50



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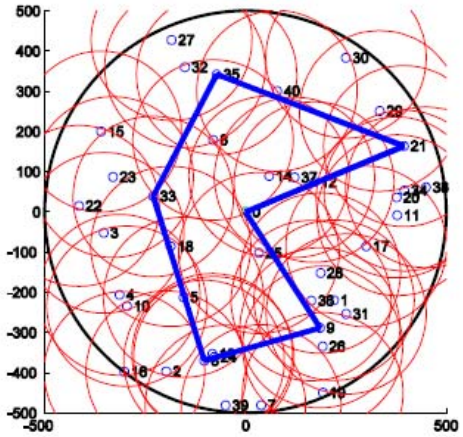
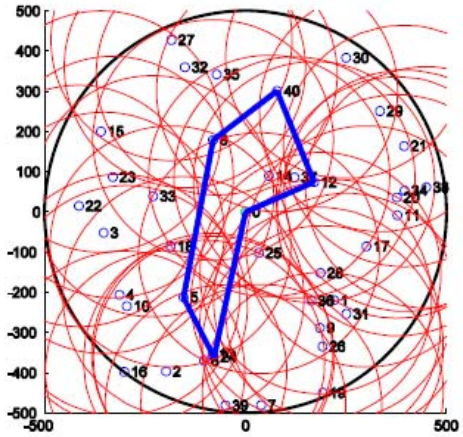


r = 200

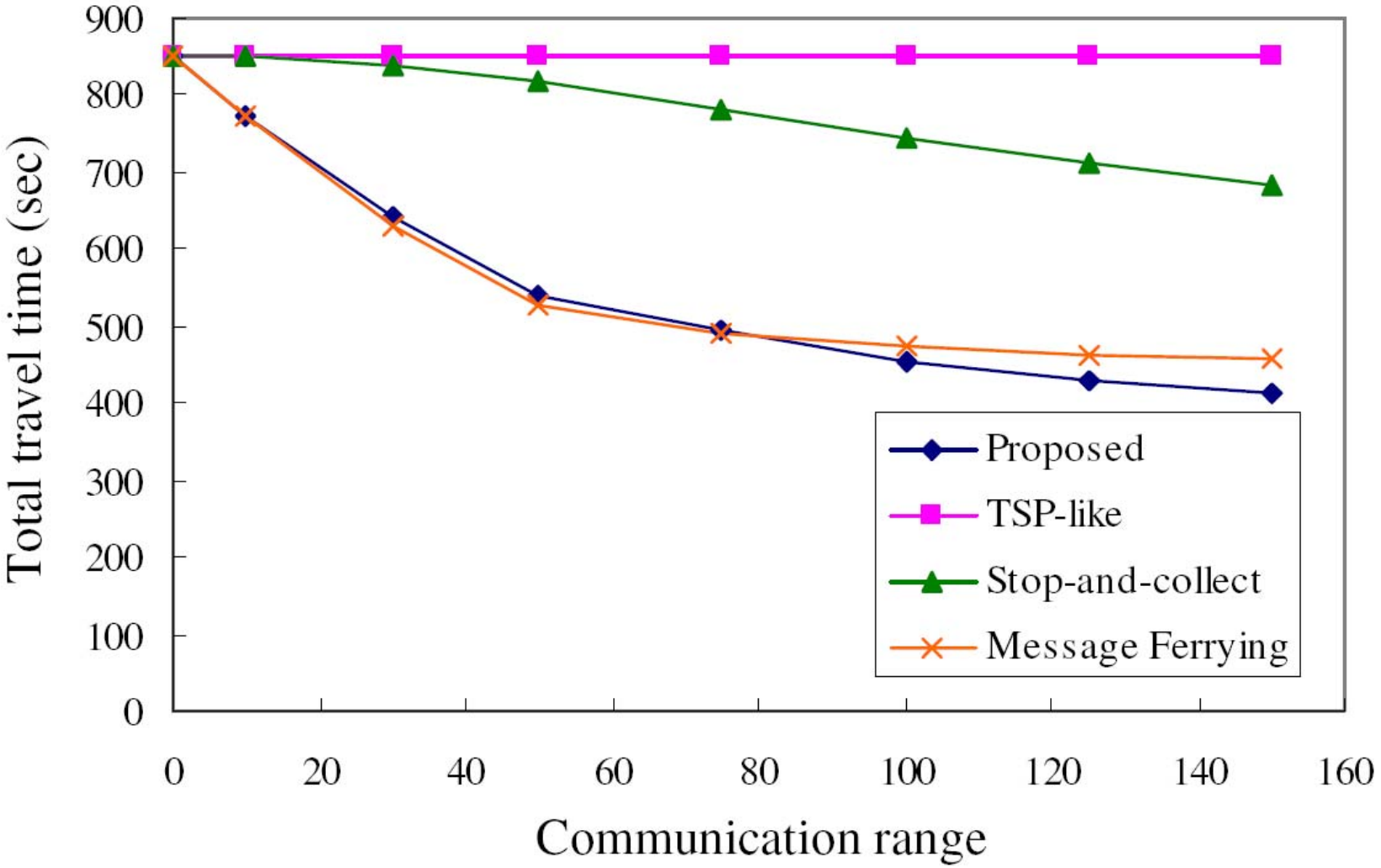


r = 300

Comparison with Other Strategies

- TSP-like
- Stop-and-collect
- Message-Ferrying

Comparison with Other Strategies



Conclusion

- Limited energy is a problem in sensor networks
- Mobility for data collection prolongs network lifetime
- Path selection is essential for data mules
- Approximation algorithm finds near-optimal solutions