Route Update and Repair in Wireless Sensor Networks

Xuhui Hu, Yong Liu, Myung J. Lee, Tarek N. Saadawi

Consumer Communications and Networking Conference, 2004.
CCNC 2004

Outline

- Introduction
- Route Dynamics in wireless sensor networks
- Efficient Route Update Protocol (ERUP)
- Simulation
- Conclusion

Introduction

- Wireless sensor networks
  - ☑ a large number of sensors, some relay devices, and a few data collectors (named "sinks")
  - ☑ Restriction : energy, transmission range
  - ☑ sources have to build and maintain multihop routes toward sinks to report sensory data

Introduction (cont.)

- wireless ad hoc networks
  - ☑mobility
  - ☑Omni-directional flooding
- wireless sensor networks
  - ☑topology is assumed to change infrequently and slowly
  - ☑energy conservation and power balancing are more important

Introduction (cont.)

- Route Update and Repair in wireless ad hoc networks
  - ☑AODV
    omni-directionally
  - ☑Query Localization (QL)
    hard to discover a new fresh route

Route Dynamics

- Endpoint (Sink and Target) Mobility
- Death of Individual Sensors
- Route-wide Power Depletion

Efficient Route Update Protocol

- Route update process is called
  1. sink moves
     - ☑ sink initiates process
  2. target leaves
     - ☑ broadcast – backoff – new source
     - ☑ cannot contact the downstream neighbor of the old source
  3. most nodes along the route are running out of power
     - ☑ warning signal
     - ☑ 70% nodes
     - ☑ source initiates process
  4. individual sensor exhausts its power or drifts away
     - ☑ the upstream node of the failed sensor

Efficient Route Update Protocol

- Definition of Route Discovery Region
- New Route Discovery

Efficient Route Update Protocol

- Definition of Route Discovery Region
  1. initiator marks itself as IN_REGION node
  2.broadcasts a Route Discovery Region (RDR) packet with TTL value
     - ☑case 1, 2, 4 => the TTL value is 2
     - ☑case 3 => the TTL value is 1
  3. node on the old route =>
     resets TTL to 1 and rebroadcast
     node not on the old route =>
     check、decreases the TTL value、rebroadcast
  4. All nodes receiving the RDR mark themselves as IN_REGION nodes

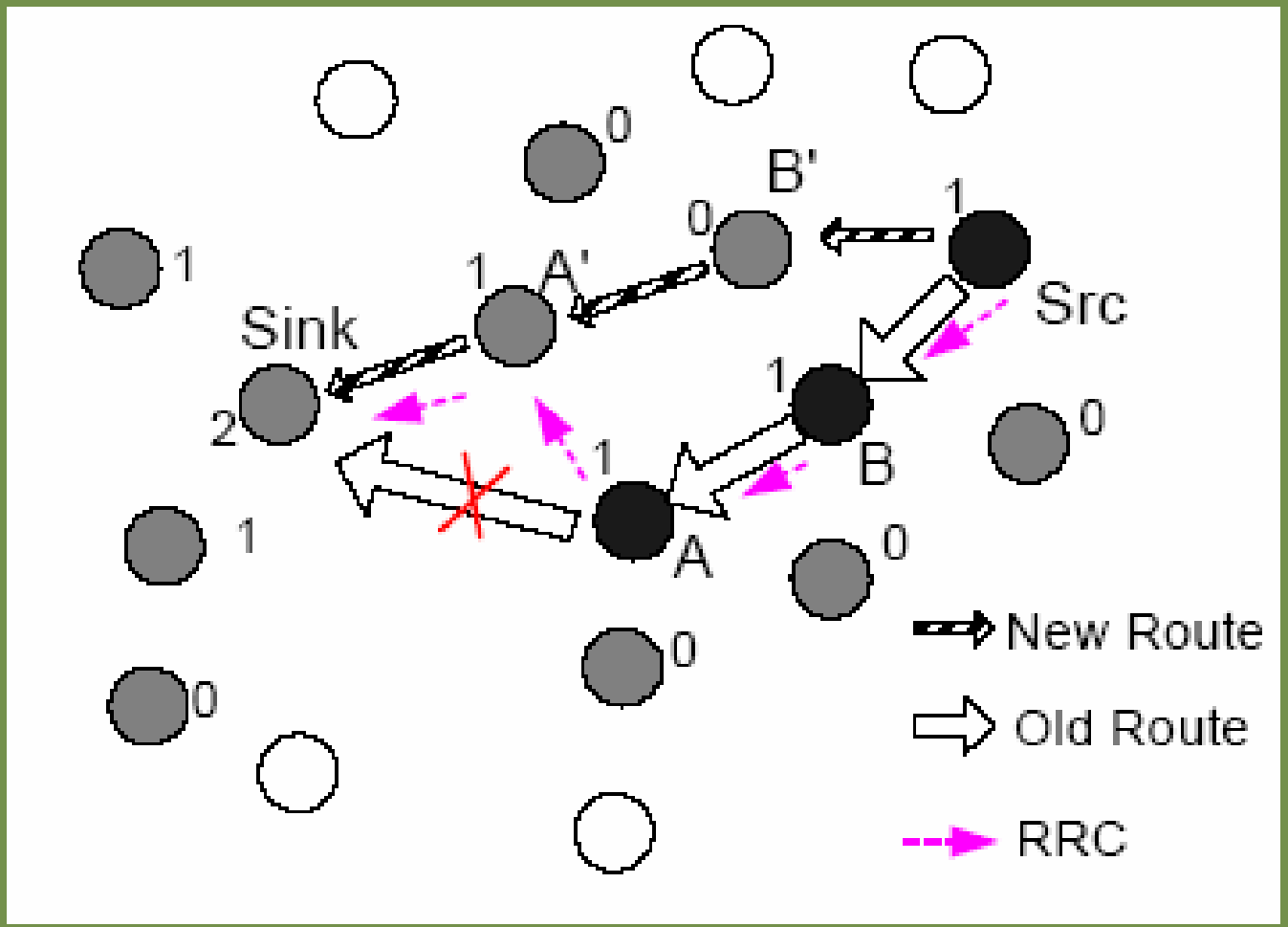
Efficient Route Update Protocol

- New Route Discovery
  - ☑ initiator broadcasts a RRQ packet
  - ☑ Only nodes with the IN_REGION marked and have residual battery larger than a threshold can rebroadcast the RRQ.

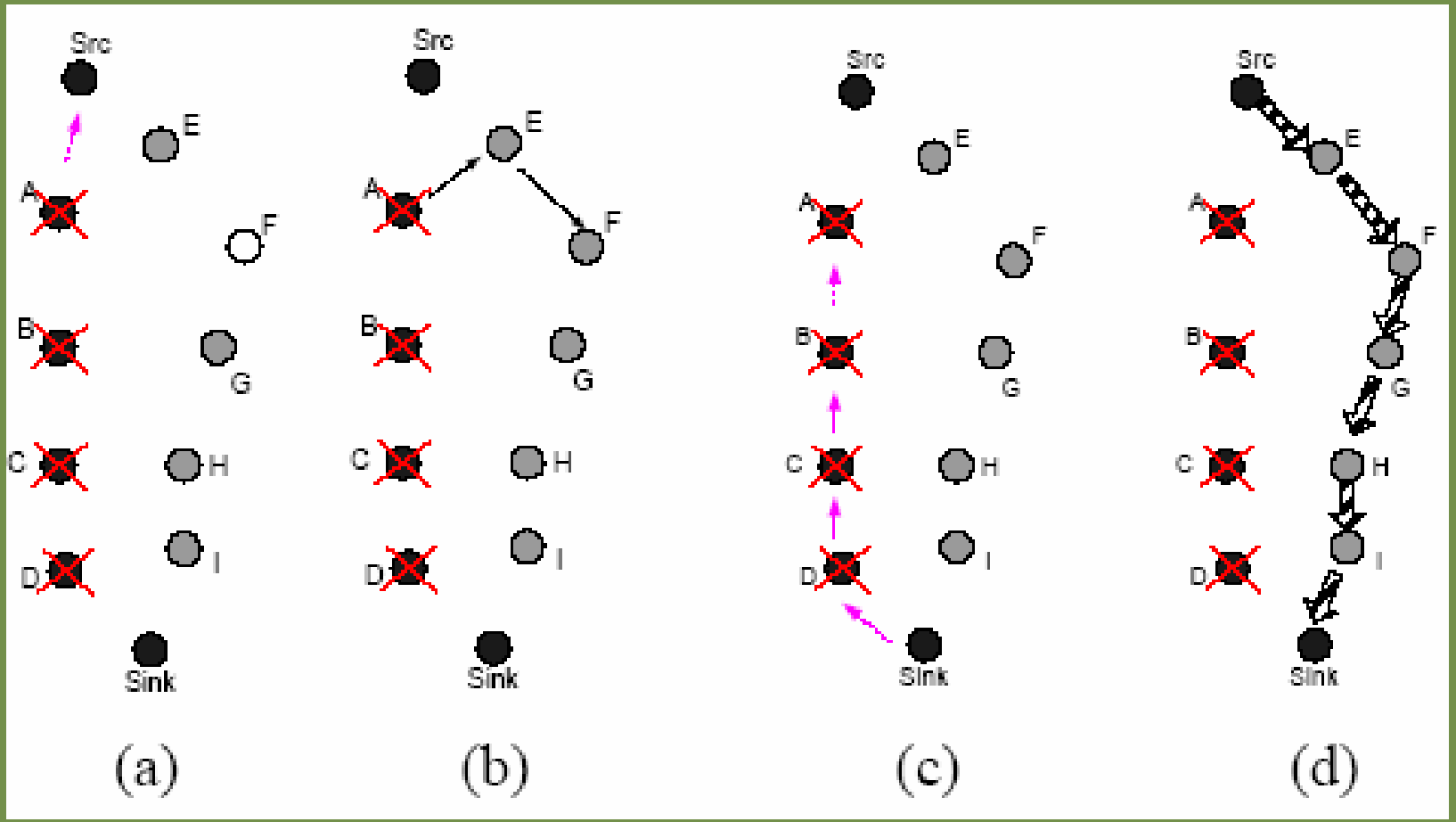
Efficient Route Update Protocol

- densely deployed around the old route
  - ☑ the RRQ should be able to propagate to the RD_Dest
- the sparse area
  - ☑ blocks the propagation of RDR or RRQ toward the RD_Dest
  - ☑ Route Request Confirmation (RRC)
  - ☑ new RDR with increased TTL

Efficient Route Update Protocol



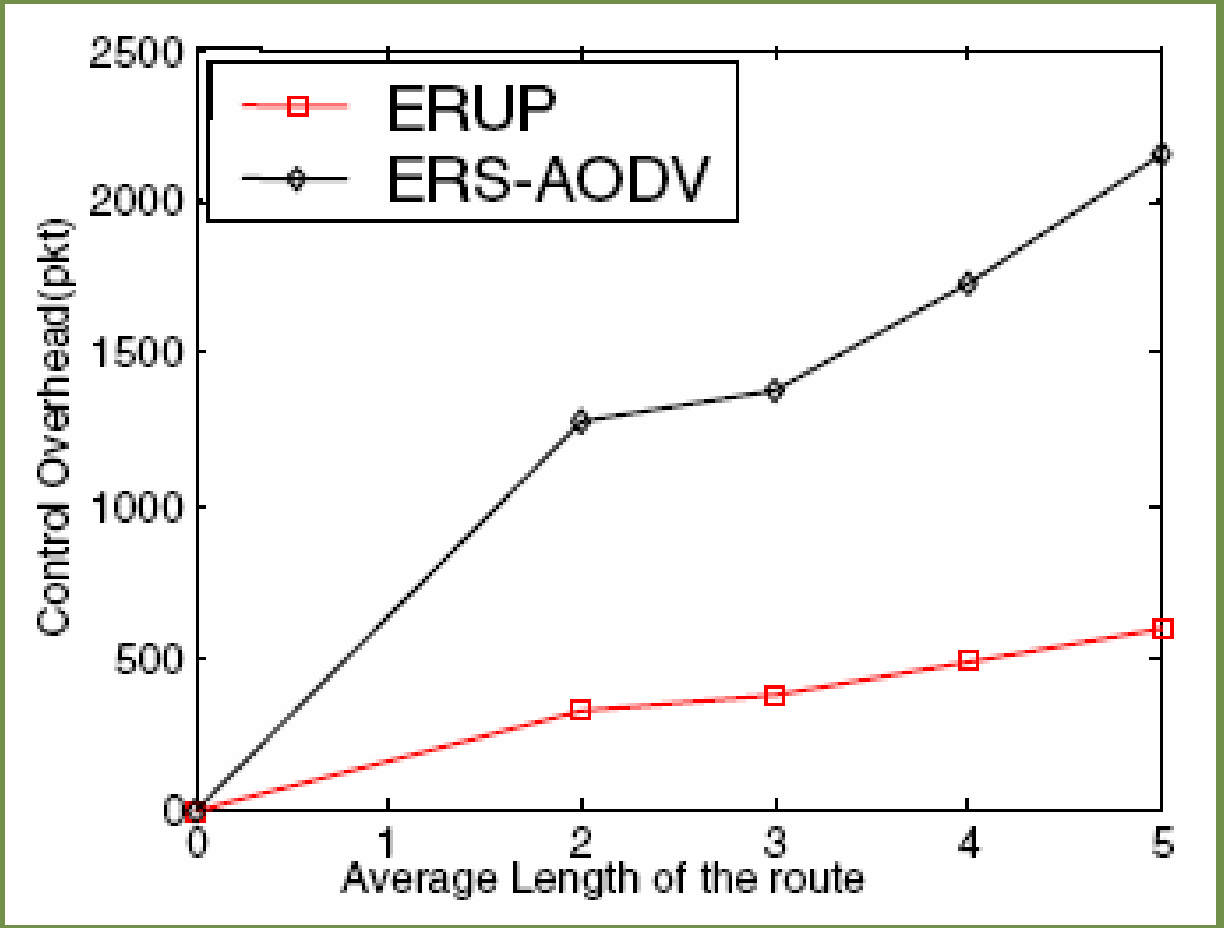
Efficient Route Update Protocol



Simulation

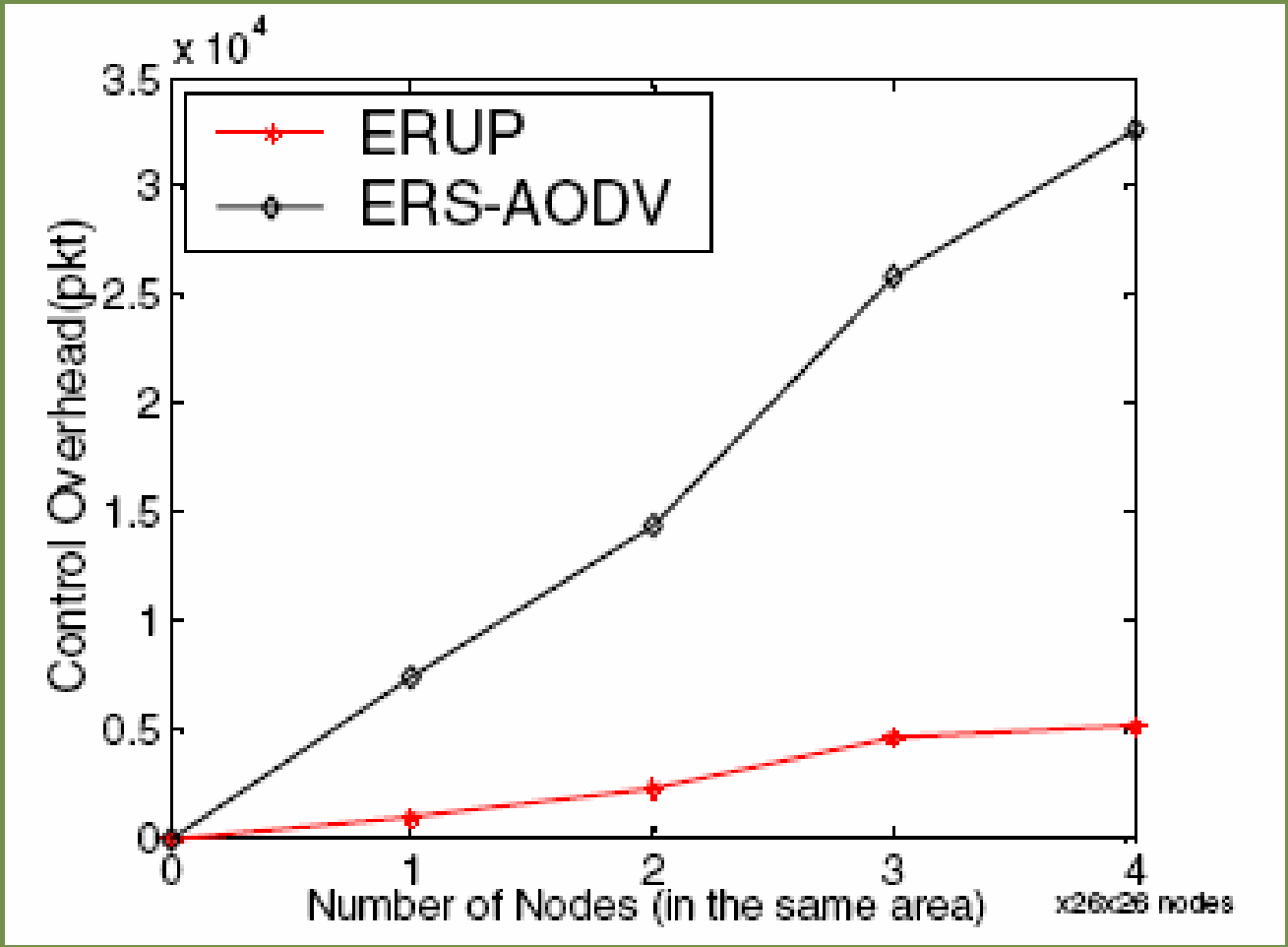
- OPNET 7.0
- compare the performance with AODV and QL
- transmission range of each node is 30m.
- simulation time is 200 second
- Each source generates one data packet per second

Simulation

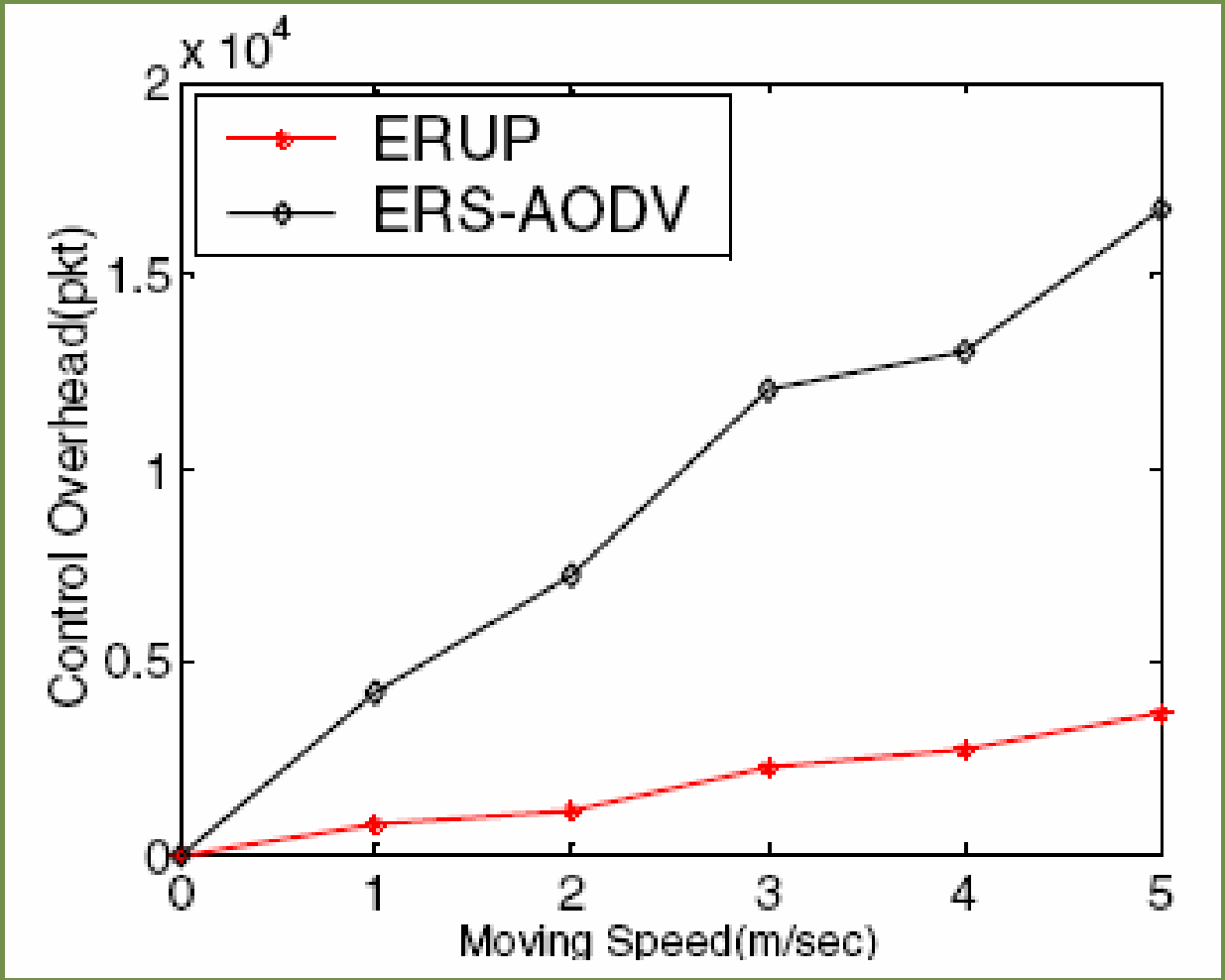


676 sensors in a 500m by 500m square
the speed of the mobile sink is 2m/s

Simulation

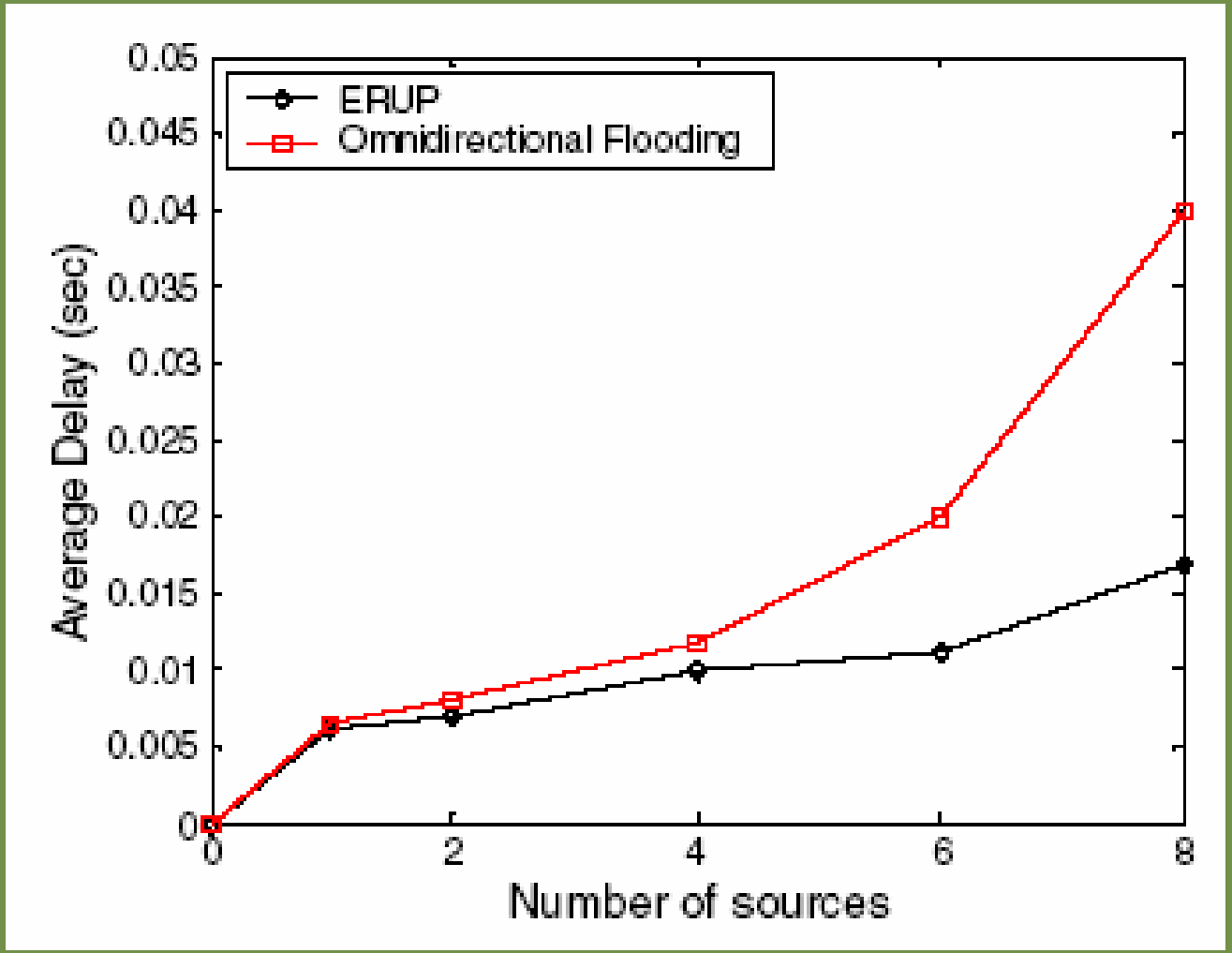

x 10^4
3.5
3
2.5
2
1.5
1
0.5
0
ERUP
ERS-AODV
Control Overhead(pkt)
0
1
2
3
4
Number of Nodes (in the same area)
x26x26 nodes

Simulation

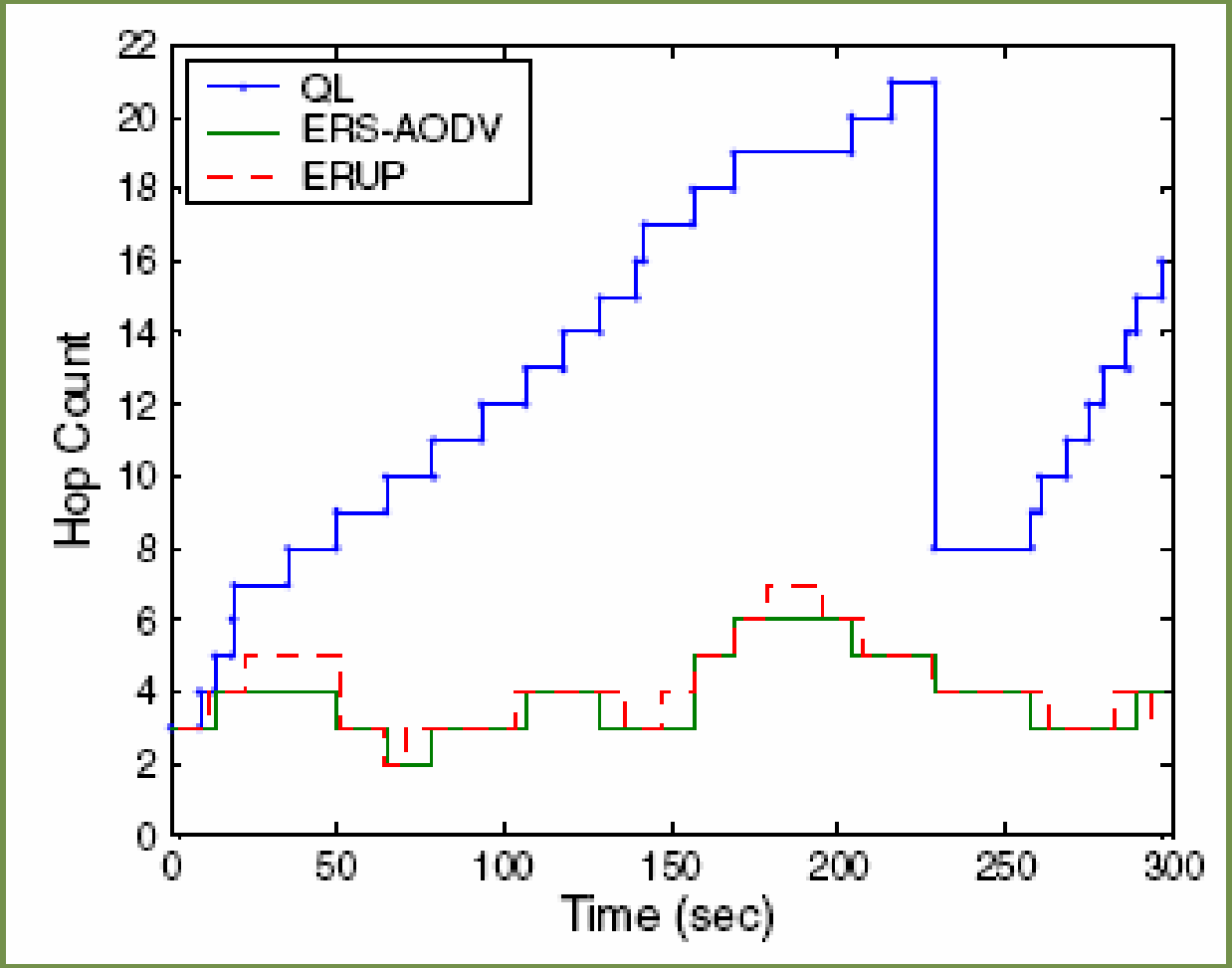


841 sensors in a 500m by 500m square

Simulation


ERUP
Omnidirectional Flooding
Average Delay (sec)
0.05
0.045
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
0
2
4
6
8
Number of sources

Simulation


QL
ERS-AODV
ERUP
Hop Count
Time (sec)
0
2
4
6
8
10
12
14
16
18
20
22
0
50
100
150
200
250
300

Conclusion

- provide energy-efficient and scalable routing in large-scale sensor networks
- reduce communication overheads of route reconstruction


Thank you