Local Update-Based Routing Protocol in Wireless Sensor Networks with Mobile Sinks

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outline

- Introduction
- Protocol Design - LURP
- Performance Analysis
- Simulation
- Conclusion

Introduction

* Mobile sinks can be a viable solution to solve the problem that energy consumption is not balanced for all the sensor nodes in Wireless Sensor Networks (WSNs).

* Frequent location updates from the can lead to both rapid energy consumption of the sensor nodes and increased collisions in wireless transmissions.

Introduction

- Local Update-Based Routing Protocol(LURP)
  - When the sink node moves, it only needs to broadcast its location information within a local area rather than among the entire network
  - 1)It consumes less energy in each sensor node

  2)Decreases the probability of collisions in wireless transmissions

  3)used in large-scale WSNs.

Protocol Design - LURP

- Assumptions

1) Each node knows its location by some localization algorithms

2) The sink has no energy constraints, but the sensor nodes have severe constraints on their energy supply.

3) The energy consumed in the computation is very little.

Protocol Design - LURP

* Local Update-Based Routing Protocol

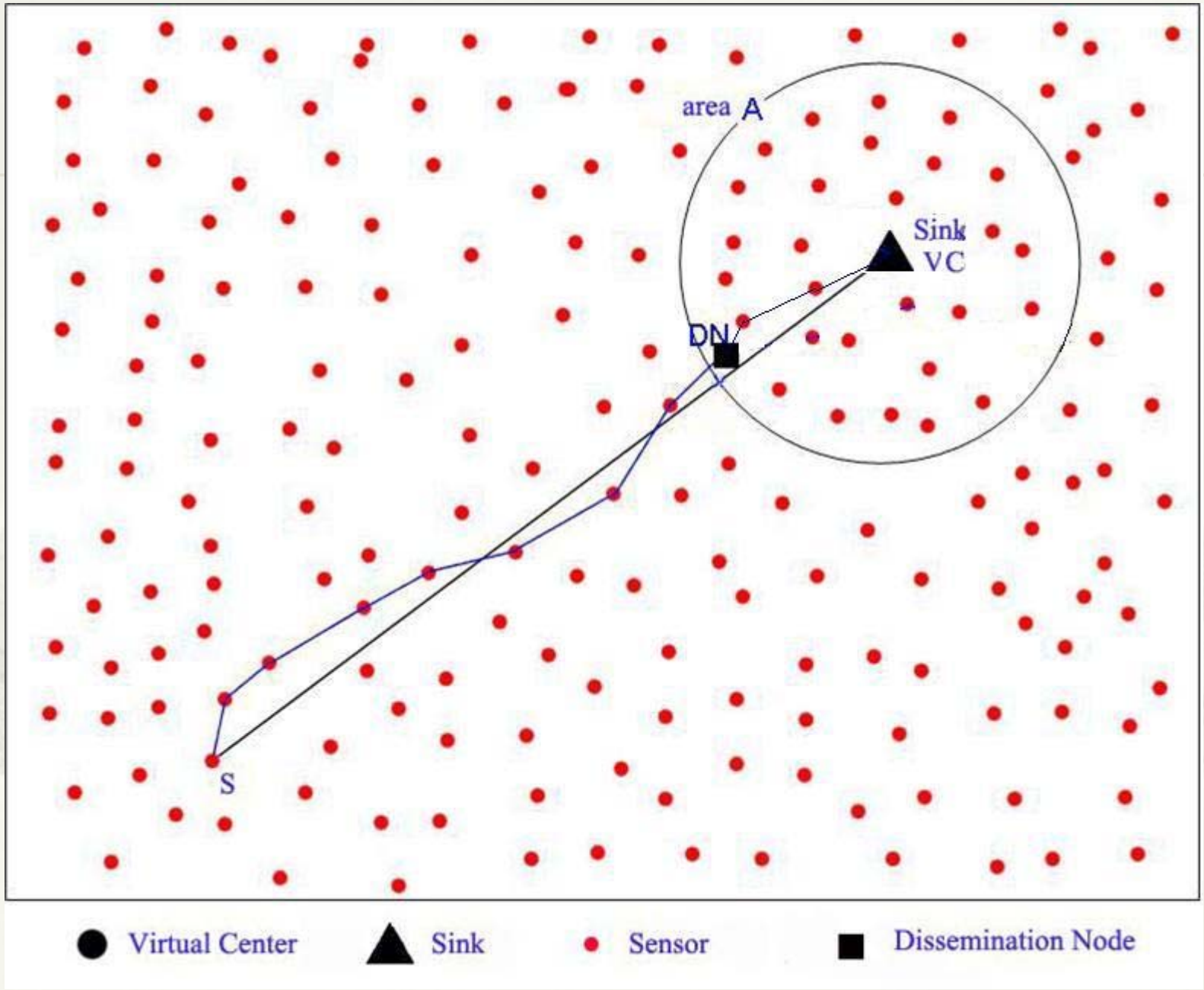
1) the sink broadcasts its location information among the entire network.

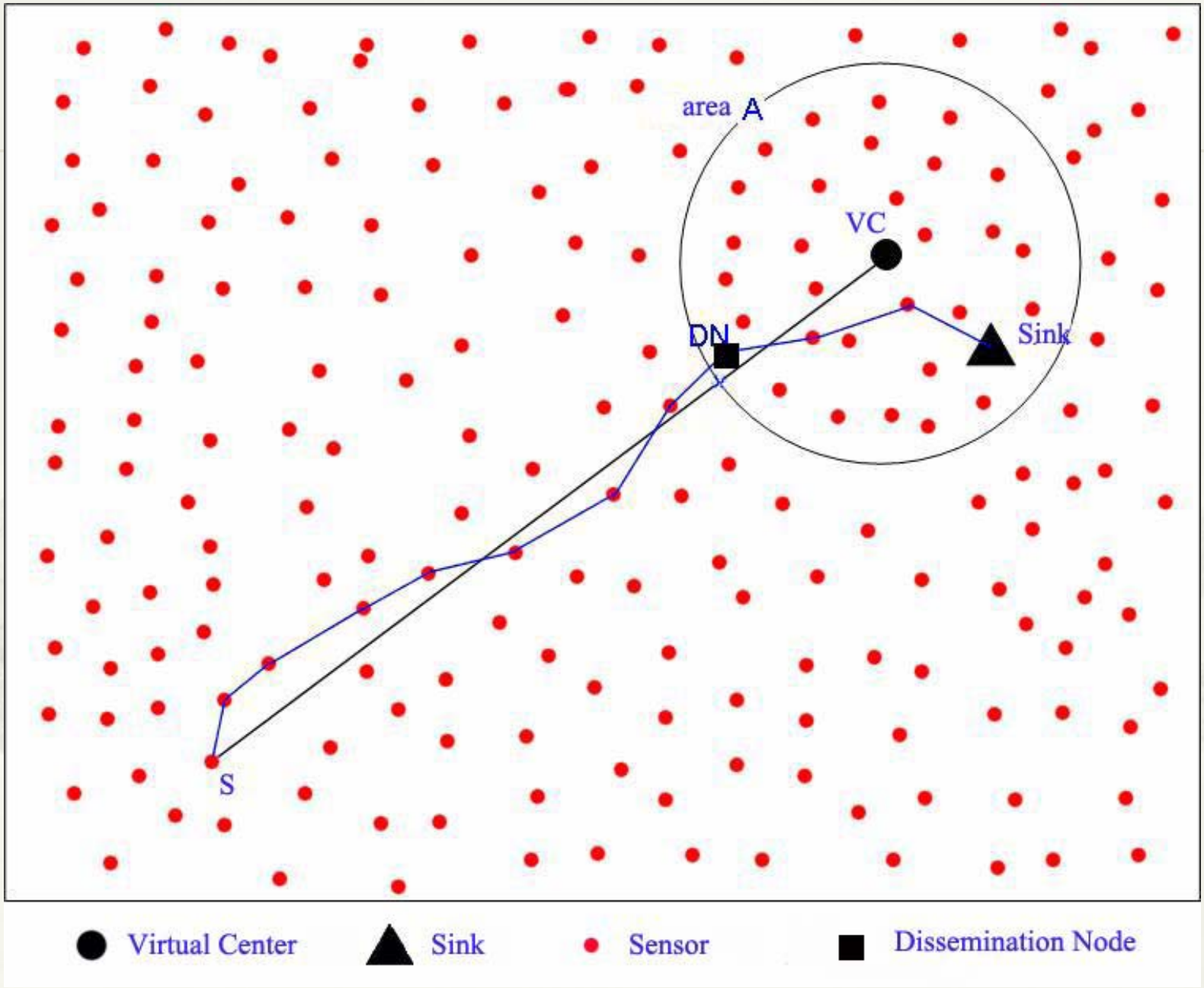
2) Define VC(vertual center) and destination area.

3) the sensor nodes firstly forward the data to a destination area near the sink .

4) the data packets are forwarded to the sink in the destination area.

* When the sink moves, as long as it is still within the destination area, it only needs to broadcast its location information within the destination area.


area A
Sink
VC
DN
S
Virtual Center
Sink
Sensor
Dissemination Node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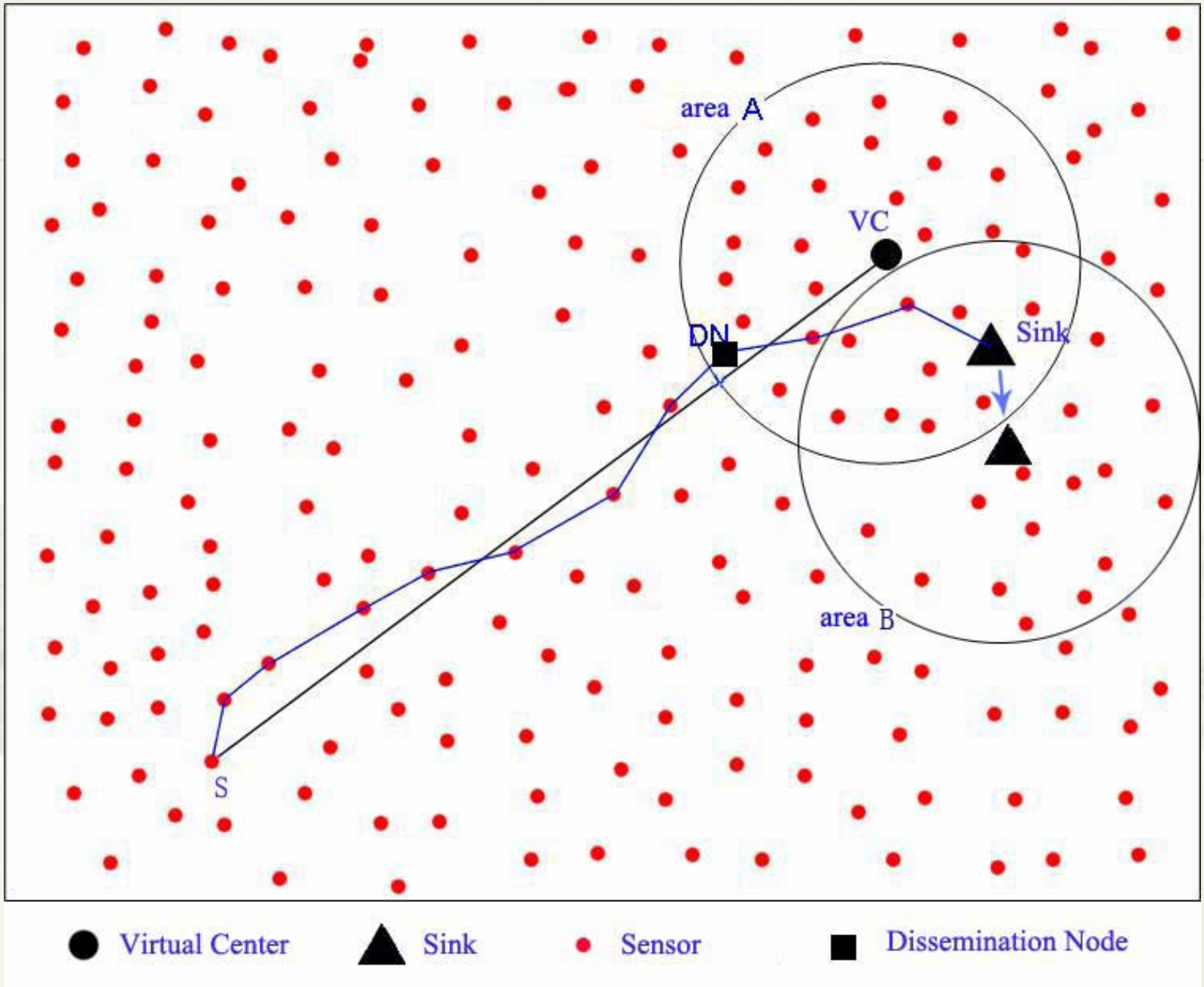

area A
VC
DN
Sink
area B
S
Virtual Center
Sink
Sensor
Dissemination Node

* The size of destination area?

  How to choose R ?

* Too small ➔the sink has to frequently update its location information among the entire network

* too large ➔ the local update cost of the sink's location information will increase.

Performance Analysis

- Some parameters

  L :sensing field whose side length

  N :the # of the sensor nodes

  n :the # of the sensors in the destination area

  v :velocity of the sink

  R :the radius of the destination area

- Its location will change *m* times during the period of time *T*.
- the period of time consumed by the sink to move out of a destination area is denoted by *t*

Location update cost:

the # of the sensor nodes

the # of the sensors in the destination area

$$E_1 = mnh + (\frac{T}{t}) \times Nh \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Calculate n(the # of the sensors in the destination area):

$$n = \pi R^2 \times \frac{N}{L^2} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Put (2) into (1):

$$E_1 = m\frac{\pi R^2}{L^2} \times Nh + (\frac{T}{t}) \times Nh \ldots\ldots\ldots\ldots (3)$$

◆移出destination area 的週期

$$t = \alpha \times \frac{R}{v} \quad \text{.....(4)}$$

$$m = \beta \times Tv \quad \text{.....(5)}$$

◆改變m次sink位置資訊

$\alpha . \beta$ are constant.

Put (4) and (5) into (3)

$$E_1 = NhTv(\frac{\beta\pi R^2}{L^2} + \frac{1}{\alpha R}).....(6)$$

when

$$R = \sqrt[3]{\frac{L^2}{2\pi\alpha\beta}}$$

, E_1 reaches the minimum

Flooding-based Location Update Protocol

$$E_2 = mNh$$

$$E_2 = \beta T v N h \qquad \text{(by(6) } m = \beta \times Tv \text{)}$$

$$E_1 = m\frac{\pi R^2}{L^2} \times Nh + (\frac{T}{t}) \times Nh \text{.....(3)}$$

$$\Rightarrow \quad \frac{E_1}{E_2} = (2^{1/3} + 2^{-2/3})(\frac{\pi}{L^2 \alpha^2 \beta^2})^{1/3}$$

$$\frac{E_1}{E_2} = (2^{1/3} + 2^{-2/3})(\frac{\pi}{L^2 \alpha^2 \beta^2})^{1/3}$$

The larger of the value of *L, the smaller of the value of* $\frac{E_1}{E_2}$ is.

➔LURP greatly decreases the energy cost in the large-scale networks compared with FLUP.

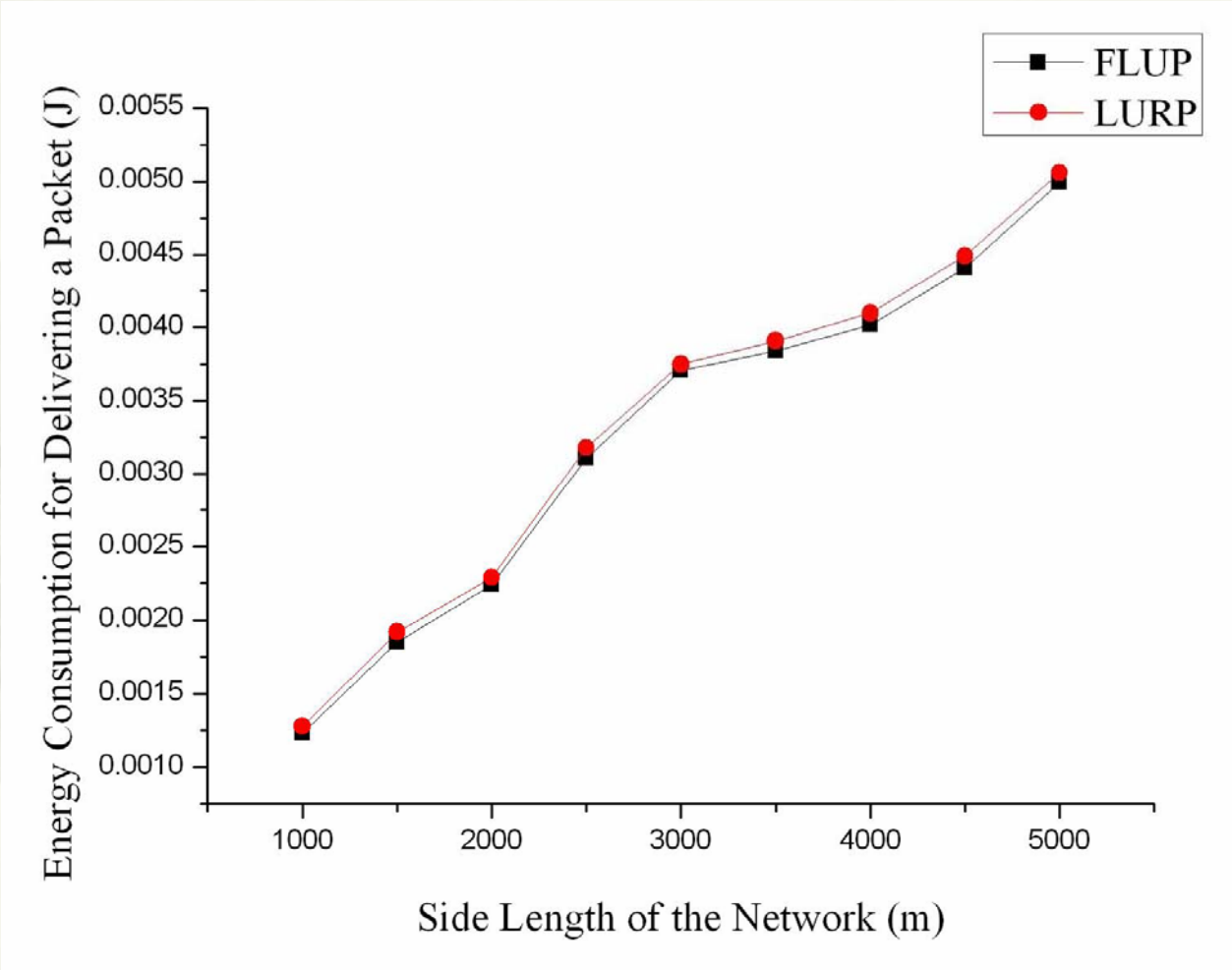
Simulation

- Using C++
- Table I

The simulation parameters

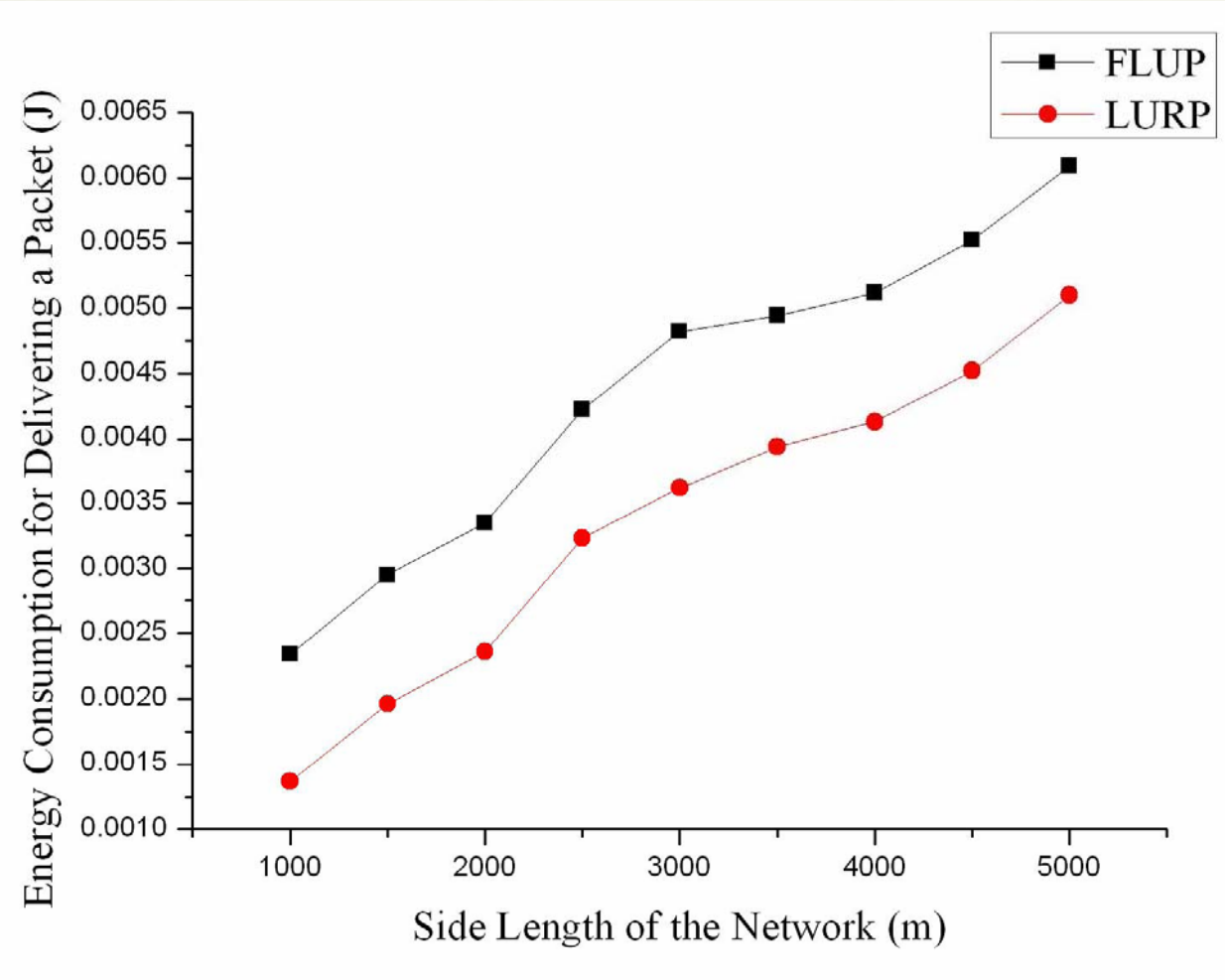
Communication radius	30m
Density of the network	$0.003/m^2$
velocity of the mobile sink	10m/s
Size of the data packet	525Bytes
Eelec	50nj/bit

Simulation



Consider only the communication cost

Figure 5. The total energy comparison between LURP and FLUP



communication cost + the cost of updating the location information of the sink

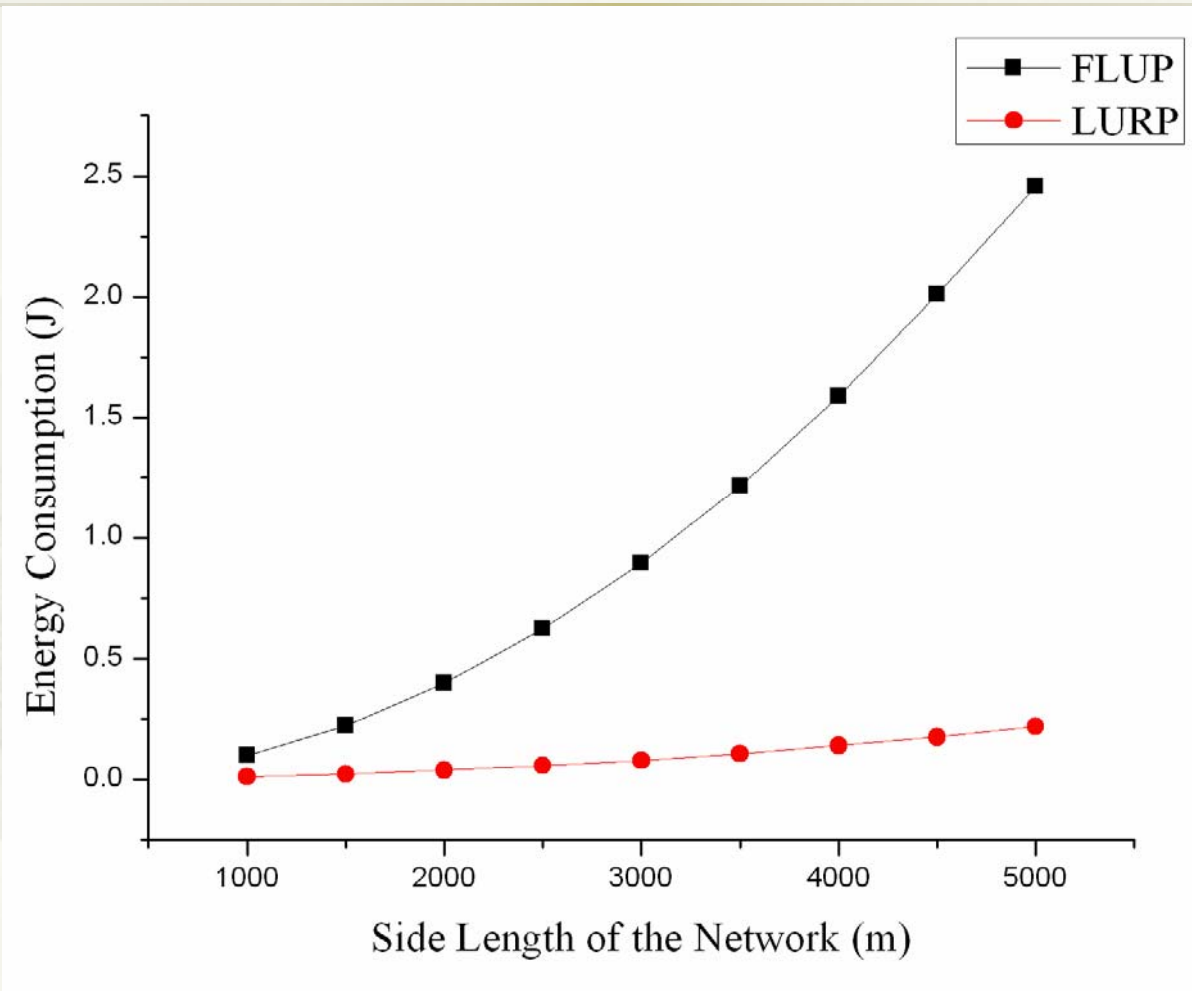


Figure 4. Energy comparison of updating the location information of the mobile sink

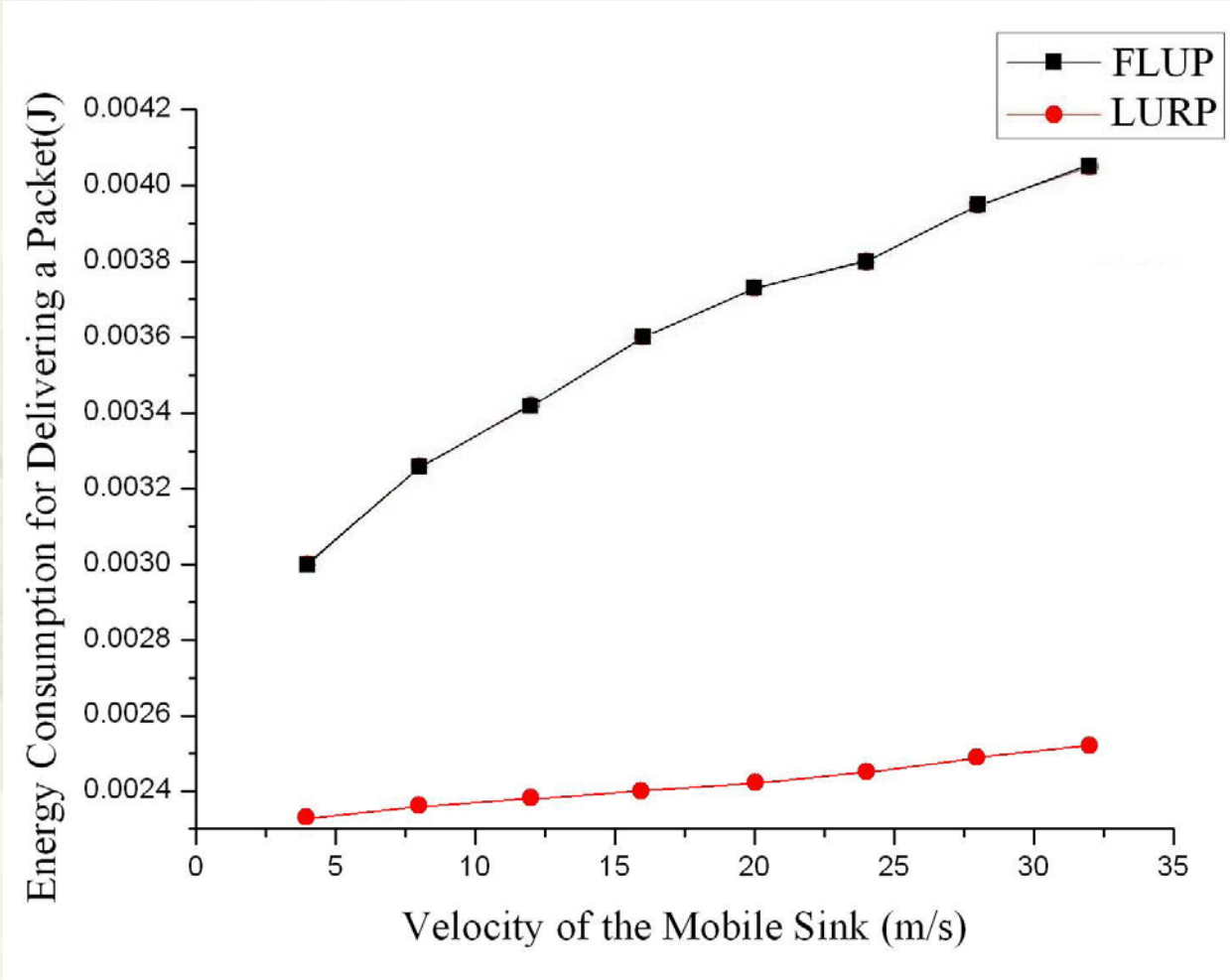


Figure 6. Energy consumption over the velocity of the mobile sink

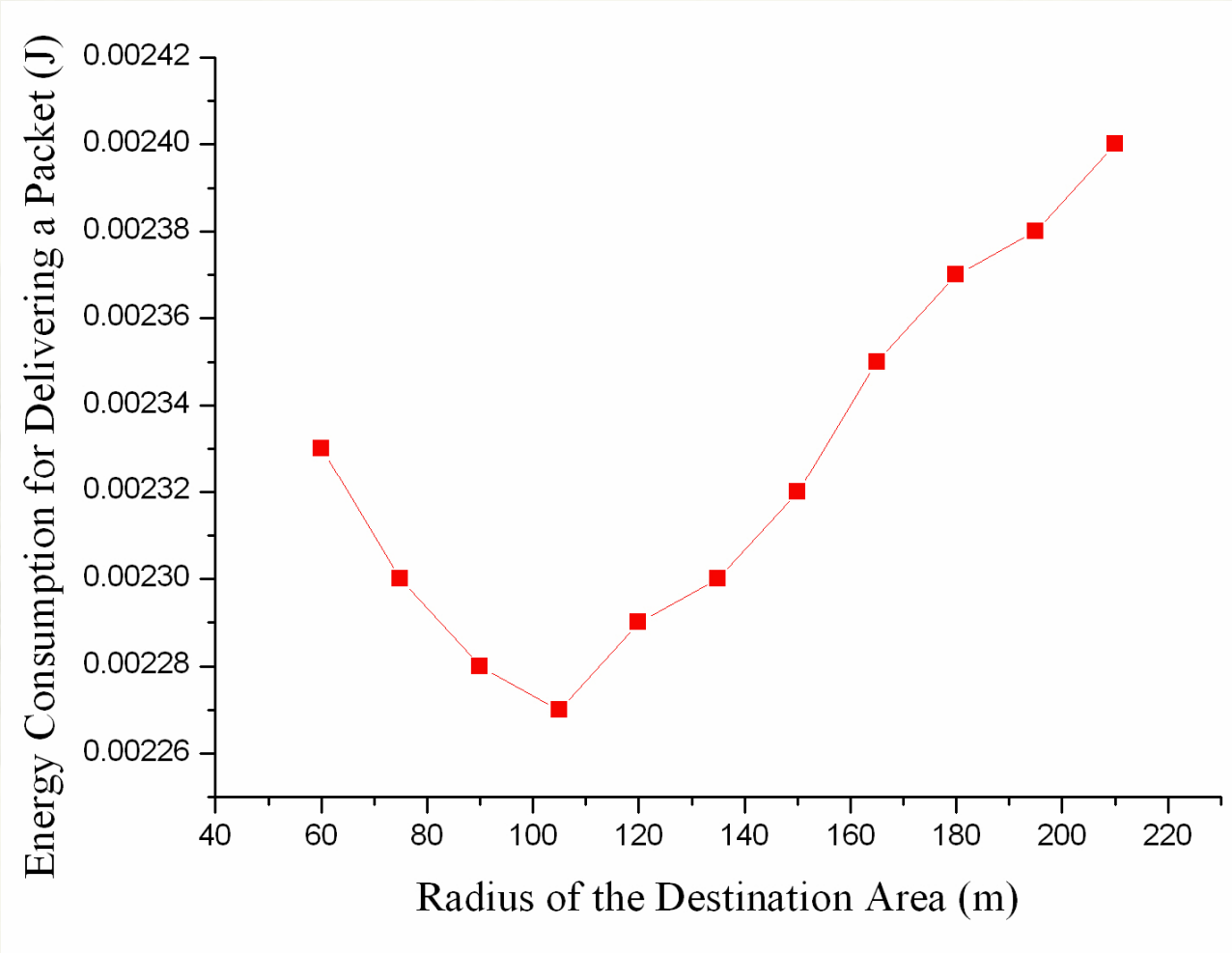


Figure 7. Energy consumption over the radius of the destination area

Conclusion

* In this paper, we proposed a local update-based routing protocol in WSNs with a mobile sink.

* LURP greatly decreases the cost of updating the sink's location information and decreases the collisions in wireless transmissions.