Sensor Network Architectures

Objectives

• Be familiar with how application needs impact deployment strategies
• Understand key benefits/costs associated with different topologies.
• Understand key benefits/costs associated with homogeneous and heterogeneous node deployments
Objectives (cont.)

• Apply simple metrics to assess network connectivity
• Understand common routing protocols
• Synthesize these concepts to ascertain the energy requirements for various network topologies

Outline

• Deployment strategies
• Network topologies
• Connectivity and Coverage
• Routing protocols
• Example Application: Energy use for various topologies
Deployment Strategies

- Motivation

- Application needs?

Random vs. Structured

Random

Structured
Incremental vs. Over-deployment

Incremental vs. Over-deployment

Outline

- Deployment strategies
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Network Topologies

• Motivation

• Star – single hop
• Flat mesh – multi-hop
• Tiered – multi-hop
Mesh

Tiered
Node Capabilities

Homogeneous  Heterogeneous

Topologies

Single vs. Multi-hop

Single hop  Multi-hop

Topologies
Outline

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Connectivity

• Motivation

• Graph Theory Tools
Random Graph Model

- $G(n, R)$

Graph Connectivity

Connectivity
Problem with Random Graph Model

Propagation environments are not isotropic

K-connectivity

Connectivity
Improving connectivity

Approaches                                       Costs

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Coverage

• Motivation

• Tools

Voronoi Diagram
K-coverage
Problems with Coverage Metrics

Topology Control

Idea

Motivation
Method 1: PEAS

Method 2: ACK
Outline

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Routing protocols

• Motivation

• Metric-based
• Diversity-based
Greedy Forwarding

ETX Metric
Opportunistic (ExOR)

Routing protocols

Gradient-based

Routing protocols
Lifetime and Load-balancing

Lifetime       Load

Data Mules

Routing protocols

Deployment of 10 nodes
Outline

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Comparison: Single-hop vs. Double-hop
Scenario 2: Single-hop vs. Double-hop

Conclusions

• Multi-hop networks promise broader coverage and robustness at the cost of increased complexity
• Homogeneous node architectures simplify deployment strategies but may require more capable hardware
• Node connectivity is dependent on the node placement and the communication channel
Conclusions - 2

• Network coverage requirements may not coincide with network connectivity requirements
• Routing schemes depend on defining an appropriate ‘cost’ metric
• Network architectures drive node and system design and therefore energy and bandwidth requirements

Want to learn more?