COMPLEX BEHAVIOR AT SCALE: AN EXPERIMENTAL STUDY OF LOW-POWER WIRELESS SENSOR NETWORK

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OUTLINE

- Introduction
- Motivating Scenario
- Related work
- Experiments
- Layer Analysis
- Conclusion

INTRODUCTION

- A new class of networked system means large number of small, low power, wireless devices
- Today, wireless sensor networks consist the hundreds of battery powered nodes
- Algorithms for discovery, routing, multicast and aggregation
- Experiment based on simple protocol and

MOTIVATING SCENARIO

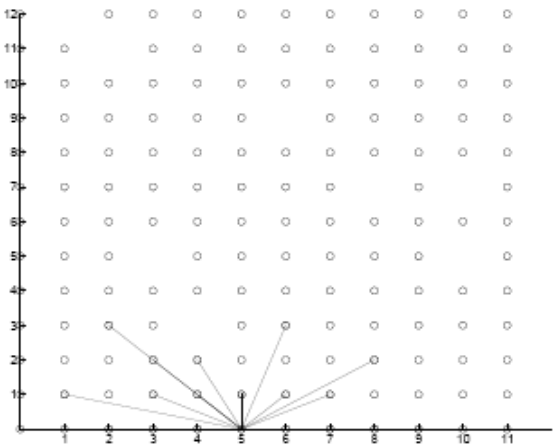
- Flooding is a one of the simplest, most widely used and well studied protocol for dissemminating data in many systems
- A message initiated from a source is rebroadcasted by neighboring nodes and extends outword, hop by hop until the entire network reached

MOTIVATING SCENARIO

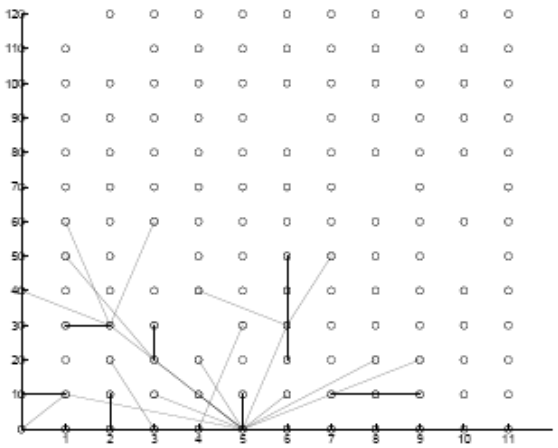
Algorithm 1: Flooding-based Tree Construction

```
if message received for the first time then
    Set Parent on Tree = Source of message;
    Change Source field to MyId;
    Increment HopCount field;
    Rebroadcast Packet;
```

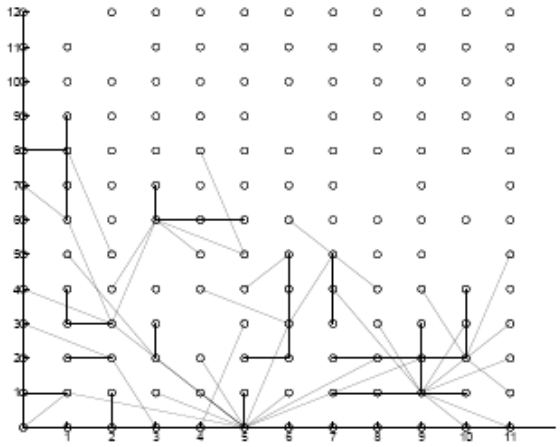
MOTIVATING SCENARIO



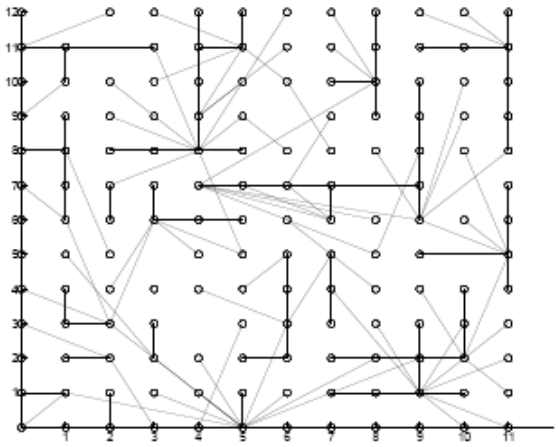
(a) 1 hop



(b) 2 hops



(c) 3 hops



(d) Final

MOTIVATING SCENARIO

Metric	Definition
Straggler	Node that misses a transmission, even though it would be expected to receive a packet with high probability
Backward Link	Link in which the recipient of the flood is closer from the base station than the transmitter
Long link	Link that is significantly longer than expected at given transmit power level
Clustering	Number of nodes attached to a single point on the data gathering tree

TABLE I

MOTIVATING SCENARIO

- There are a number of factors across different layers that impact the dynamics of flooding
- Stragglers due to the MAC- layer collisions

RELATED WORK

- Previous work on analyzing the behavior of routing protocols in large-scale wireless sensor networks
- Not satisfactory because the realistic modelling of link layer characteristics in simulation

EXPERIMENTS

- Two separate sets of experiments
- For both experiments, we used a flat grid distribution of nodes
- First experiment consist the 185 nodes, 2 feet spacing
- Second experiments- 156 nodes, 2 feet spacing

ANALYSIS OF EXPERIMENTS

- Link layers- attempt to quantitatively define and measure the effective communication radius at a given transmit power
- Explore packet reception statistics over distance and define what constitutes a bidirectional link and an asymmetric link and finally measure these effects

ANALYSIS OF EXPERIMENTS

- Medium access control level; use timing information to identify metrics that capture both end to end properties of the flood propagation and local properties such as contention and collision
- Application layer; analyze the resulting structure of the flood

ANALYSIS OF EXPERIMENTS

- Reconstruct the process of the message propagation and explain how the interactions across levels lead to the final global behavior
- A comprehensive understanding of the characteristics of the radio, effective communication range, packet reception behavior, extent of asymmetry, and MAC layer behavior provides guidance for

CONCLUSION

- Packet reception deceases with distance
- Stragglers can be explained by collision effects caused at the MAC layer
- Backward links can be explained as a combination of the effect of long links and collisions

CONCLUSION

- Long links resulted in the flood propagating faster in certain directions, and rebounding to fill areas where the propagation was slower or where stragglers remained, forming backward links