Stateless Reliable Geocasting

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Context & Motivation
Wireless Sensor Networks
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Reliability vs. Redundancy
Reliability vs. Redundancy
Dynamicity vs. Global State
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A routing algorithm is **stateless** if it is designed such that devices store *no information* about messages *between transmissions*. It is **stateful** otherwise.
Flooding
Stateless Flooding
Stateless Flooding
Stateless Flooding
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Stateless Flooding
Stateless Flooding
Stateless Flooding
Stateless Flooding
Stateless Flooding
Stateless Flooding
Stateless Flooding
Stateless Flooding
Stateless Flooding
Flooding v2
TTL Flooding
TTL Flooding
TTL Flooding
TTL Flooding
TTL Flooding
TTL Flooding
TTL Flooding
Flooding v3
Stateful Flooding
Stateful Flooding
Stateful Flooding
Stateful Flooding
Stateful Flooding
Stateful Flooding
Stateful Flooding
Geometric Routing

- Each node is aware of its coordinates (and those of its neighbors)
- The message contains the coordinates of the destination
- **Goal**: deliver the message to the destination *without routing tables*

Greedy Routing
Greedy Routing
Greedy Routing
Greedy Routing
Face Routing

Face Routing
Face Routing
Face Routing
Face Routing
Concurrent Face Routing

Concurrent Face Routing
Concurrent Face Routing
Concurrent Face Routing
Concurrent Face Routing
Geocasting
Geocasting

Geometric Unicast, then stateful flooding within region

Geocasting

Geocasting

Precompute surrounding faces, unicast to region, then flood

Precompute surrounding faces, unicast to region, then flood: **Stateful, Reliable**

Geocasting

Geocasting

Assumes subdivisions (edge belong to 2 faces)

Geocasting

Assumes subdivisions (edge belong to 2 faces): Stateless, Reliable

Geocasting

Assumes subdivisions (edge belong to 2 faces): Stateless, Reliable, May Livelock

Our Contributions
Stateless Planar Geocast
Stateless Planar Geocast
Stateless Planar Geocast
Stateless Flooding
Stateless Flooding
Stateless Flooding
SPG + Stateless Flooding
SPG + Stateless Flooding
Theoretical Complexity

- **Guaranteed delivery** to all nodes in the target area (if connected to the source)
- **Latency** is quadratic in distance to destination (*optimal*)
- **2E** messages in the **worst** case (E messages for SF), but much better for UDG networks
Experimental Results
Abstract vs. Concrete Simulation

- **Abstract**
  - Instantaneous message transmission, no implementation details
  - Theoretical performance

- **Concrete**
  - Radio communication, Network protocol stack
  - Practical performance aspects
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Abstract: Overhead by Density

![Graph showing message cost, number of messages vs density, devices per unit circle. The graph includes lines for SPG, SF, SF+SPG, SF+SPG+G, with different markers for each.]
Abstract: Overhead by Density

Abstract: Overhead by Region Size
Abstract: Latency By Density

![Graph showing latency by density](image-url)
Abstract: Analysis

- **SPG** achieves near optimal latency
- The use of **SF** within the region improves overhead
- The use of **G** lessens concurrency and increases latency
Concrete: Delivery Ratio

![Graph showing delivery ratio vs. density (devices per unit circle).]
Concrete: Overhead by Density

![Graph depicting message cost by density](image)
Concrete: Latency by Density

![Graph showing latency by density](image)
Concrete: Overhead by Density and Signal Strength
Concrete: Latency by Density and Signal Strength
Concrete: Delivery by Density and Signal Strength
Concrete: Analysis

- **SPG** is reliable
- **SPG** has less packet collision than flooding, for improved latency and reduced overhead
- Higher signal strength leads to higher probability to reach next hop
Conclusion

- **Concurrent face routing** is an interesting building block for ad hoc routing

- In **Abstract**, fast but costly

- In **Concrete**, not the fastest, but increased reliability

- Source code and data:

Thank You