Practical and Robust Geographic Routing
In Wireless Networks

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Introduction: Geographic Routing

Primitives of Geographic Routing
Greedy forwarding on radio full-graph
Perimeter forwarding on planarized sub-graph
Planarization based on ideal assumptions

Fragile assumptions in real deployments
Regular radio range (UDG)
- Existence of obstacles
- Non-circular antenna emissions
- Asymmetric radio links
- Multi-path interference
Almost perfect localizations
- Error-prone localization algorithms

Problem Description: Pathologies of planarization

Asymmetric-links in PG

Disconnected-links in PG

Cross-links in PG

Basic CLDP Probing
- Whenever new link is established.
  CLDP probe (end points of link, probe_node_id, next_hop_id) is sent.
- It is traversed by right-handed rule.
- When a node, where the CLDP probe traverses, detects a cross-link,
  the node marks the CLDP probe with its node identifier.
- When CLDP probe returns to originator and it is marked,
  one among 4 removal cases is performed.

Multiple Probing & Concurrent Probing

Mutual Witness is not enough
- It can’t fix cross links in planarized sub-graph.
- It adds cross links instead of fixing asymmetric links.
- It adds cross links instead of fixing disconnected links.
- It creates asymmetric-links in PG if MW query/reply is lost.

Implementation on Mica2

Simulation Results

Planarization techniques don’t work in real deployments.
CLDP detects all cross-links in networks and removes removable-links among them.
CLDP guarantees 100% packet delivery of geographic routing.
Geographic routing with CLDP is practical and robust in wireless networks.

Conclusion