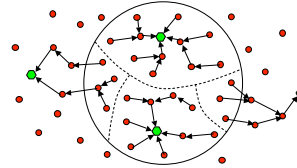


Anycasting, multicasting for sensor-actuator networks

Ivan Stojmenovic

Anycasting



Routing from a sensor to one of sinks/actuators

Position of sinks/actuators known

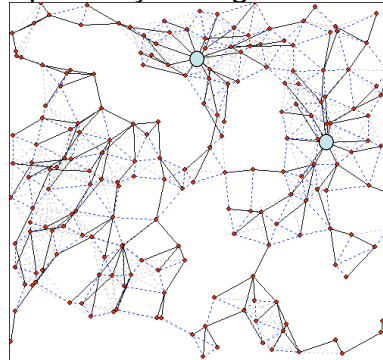
Anycasting may advance toward one sink but could eventually reach a different one

Mitton, Simplot-Ryl, Stojmenovic 2008

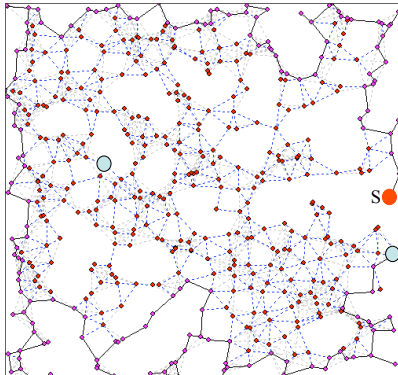
Algorithm - one variant

- Modified GFG approach
- In greedy mode, select neighbor providing best cost/progress ratio toward any actuator
- to preserve a single path, select only the closest sink node D for face routing toward it.
- The distance to D is recorded and forwarded with the message. Recovery mode stops when a node has a neighbor that is at shorter distance to one of sinks (not necessarily D) than recorded distance.

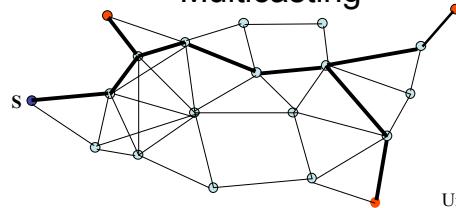
Example - anycasting from each sensor



A worst case scenario for the variant



Multicasting

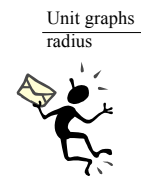


•source → several destinations

Position information

•Sanchez, Ruiz, Liu, Stojmenovic 2006

•Stojmenovic IEEE Network Jan. 2006

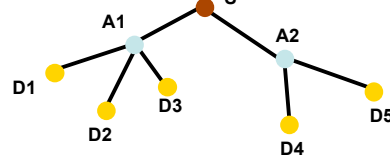


Classification of Multicast Protocols

- | | |
|--|--|
| <ul style="list-style-type: none"> • Stateful protocols <ul style="list-style-type: none"> - ODMRP, MAODV, ADMR - Traditional approach - Topology-based - Maintain distributed state <ul style="list-style-type: none"> • Membership, mesh/tree information - Routing table-based forwarding | <ul style="list-style-type: none"> • Stateless protocols <ul style="list-style-type: none"> - DSM, LGT, SPBM - More recent - Location-based - Carry in each packet • Membership, tree information, location - Use geographic forwarding |
|--|--|

Location-based protocols more robust, efficient than stateful protocols

Cost over Progress Ratio – Example



$$T_1 = \sqrt{SD_1} + \sqrt{SD_2} + \sqrt{SD_3} + \sqrt{SD_4} + \sqrt{SD_5}$$

$$T_2 = \sqrt{A_1D_1} + \sqrt{A_1D_2} + \sqrt{A_1D_3} + \sqrt{A_2D_4} + \sqrt{A_2D_5}$$

$$\text{cost over progress ratio} = \frac{2}{T_1 - T_2}$$

GMR: Multicasting algorithm

- Greedy advance toward each group of destinations, with or without splitting
- If no greedy advance toward any destination, follow face routing toward it
- Several destinations could be followed by same faces for a while
- Continue greedy advance after recovery
- Power instead of hop count as a metric ?

Multicasting to many destinations

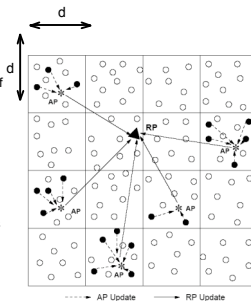
- Das, Pucha, Hu 2006
- Destinations are locally grouped
- Group leaders report to source
- Source constructs Minimal Spanning Tree of group leaders, and
- Initiates greedy routing between edges in MST (face routing added to recover)
- MST can be replaced by cost-to-progress ratio framework

HGMR: Hierarchical multicasting

- Hierarchical Geographic Multicast Routing for Wireless Sensor Networks
- Dimitrios Koutsonikolas, Saumitra Das, Y. Charlie Hu, and Ivan Stojmenovic SENSORCOMM 2007
- starts with a hierarchical decomposition of a multicast group into subgroups of manageable size using HRPM's key concept *mobile geographic hashing*.
- Within each subgroup, HGMR uses GMR's *local multicast scheme* to forward a data packet along multiple branches of the multicast tree in one transmission.

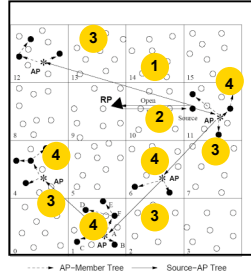
HGMR tree construction

- **Hierarchical decomposition**
 - Region divided into hierarchy of cells
 - Cells managed by APs
 - APs managed by RP
- **Geographic hashing**
 - APs/RP mapped to geographic locations
 - Node closest to location serves role of AP/RP
 - Routing to APs/RP via geographic forwarding



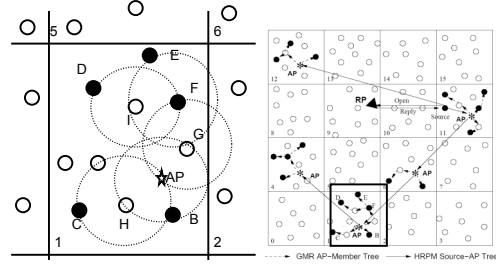
HGMR data delivery

- Source contacts RP
- OPEN
- RP sends group membership
- REPLY
- Source → APs tree
- Overlay tree (HRPM)
- Unicast-based
- AP → Members tree
- Localized neighbor selection algorithm (GMR)
- Broadcast-based



HGMR – AP → Members tree

HGMR



MSTEAM

- Frey, Ingelrest, Simplot-Ryl 2008
- Message replication occurs when MST of current node and multiple destinations has multiple edges originating at current node
- Group, best neighbor, cost/progress ratio..
- Progress= difference in MSTs to the group
- Multicast generalization of face recovery:
- Face (over GG) stops when MST of current node and 'face' destinations is shorter than MST of starting node and destinations
- Matches centralized algorithm for high densities