Landmark-based routing
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[Fonseca05] Rodrigo Fonseca, Sylvia Ratnasamy, Jerry Zhao, Cheng Tien Ee and David Culler, Scott Shenker, Ion Stoica, Beacon Vector Routing: Scalable Point-to-Point Routing in Wireless Sensornets, NSDI’05. Landmark-based routing scheme.

Landmark-based schemes

- $k$ nodes are selected as landmarks (beacons) that flood the network. Each node records hop distances to these landmarks.
  - estimate pair-wise distances,
  - point-to-point routing.

- Pros:
  - simplicity,
  - location-free,
  - independent of dimensionality (works for 3D networks).
  - No unit disk graph assumption
Use landmarks to estimate pair-wise distances

- Triangulation: estimate via triangle inequality
  - \((u,v),\) beacon \(b: |d(u,b)-d(v,b)| \leq d(u,v) \leq d(u,b)+d(v,b)\)
  - lower bound: \(d^-(u,v) = \max_b |d(u,b)-d(v,b)|\)
  - upper bound: \(d^+(u,v) = \min_b d(u,b)+d(v,b)\)
- Internet setting, IDMaps [Francis+ ’01], etc

- magic: relative error <1 on 90% node pairs
  - 900 random nodes, 15 beacons
  - relative error\((x,y) = |x-y| / \min(x,y)\)
A simple case

- With $O(1)$ random landmarks, $d^+(u,v) \leq 3d(u,v)$ for all but $\varepsilon$ fraction of pairs with prob $1-\gamma$.
  - At least one beacon inside $B(u)$.
  - For any point $v$ outside $B(u)$,
    - $d(v,b) \leq d(u,b)+d(u,v) \leq 2d(u,v)$
    - $d^+(u,v) \leq d(u,b)+d(v,b) \leq 3d(u,v)$