RaWMS – Random Walk based Lightweight Membership Service for Wireless Ad Hoc Networks

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Motivation

- How do I know who there are in MANET?
- Closed system: everyone knows everyone
- Open system: membership changes
- Small system: everyone can keeps track of the entire membership
- Large system: hard to keep the entire membership
- Static system: negligible mobility
- Dynamic system: significant mobility

System Model: Open and Dynamic

- Openness: any one can join and leave the system at any time
- Dynamic: random movement within the system
- High mobility may make it hard to keep track of the entire membership at any moment

Application?: Geographic Routing

- Once the location of the destination (x1, y1) is known, the routing will be trivial or easy
- Keeping tracking of all locations for each node may be impractical due to possible message explosion or even unnecessary
- Can make it scalable by keeping a node's location to a small subset of the entire nodes
- How to pick up a small subset?

Locations of the small subset

- One approach: uniformly randomized locations
- Otherwise, may be clustered to some degree
- Why better with uniformly randomized?
- Geographic routing: one can find a node who has the location information of the destination by using expanding ring of flooding. Uniform random distribution will bound the cost of flooding to 1/k with k = number of regions
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Location entries at each node

- Inversely, uniformly randomized locations mean that a node needs to keep several number of locations.
- For the size of a small set m, each node needs to keep m entries of location
- How to design this idea?

Random Walk

- Basic idea
  - Node u starts a random walk of length l
  - It finishes the random walk of length l, at node v
  - The random walk gives information of node u to v
  - Node v keeps the location of u
- Question:
  - How do we know that the location information is uniformly randomly distributed?

Theoretical Work

- With regular random graph, the view size (entires of location at each node) converges. Randomized knowledge graph!
- Two key parameters:
  - Length of random walk
  - Mixing time
- Random MANET topology: make it regular first
- Assumption: each node knows the system size!

Modification for Practicality

- Heart beat at every cycle to collect neighbor information
- Limit the view size
- Limit the lifetime of a location entry
- Results in periodic launching of random walk!
- Still claims it is scalable

Interesting Properties

- Strong connectivity: hard to partition the knowledge graph
- System converges to a steady state