A Survey on Position-Based Routing in Mobile Ad hoc networks

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The ad-hoc network; Self-organization, infra-less networks

Ad-Hoc Networks

- Static
- Mobile

Approach:

- Topology-based
- Position-based
  - Proactive
  - Reactive
  - Hybrid

For Power-efficiency, Scalability
- Physical Position (GPS, etc)
- Location Service
Location service

- Learn the current position of a specific node
- Cellular network
  - Dedicated position servers that maintain position information about the nodes in the network
- In mobile ad hoc networks
  - A centralized approach is viable only as an external service that can be reached via non ad hoc means
    - Difficult to obtain the position of a position server
    - Difficult to guarantee that at least one position server will be present in a given ad hoc networks
Forwarding strategy

- How do we send a packet??
  - The position of a packet’s destination
  - The position of the node’s intermediate 1-hop neighbors

<table>
<thead>
<tr>
<th>Location service</th>
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<tbody>
<tr>
<td>Some-for-some</td>
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<td>Some-for-all</td>
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<tr>
<td>All-for-some</td>
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<td>All-for-all</td>
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+ Forwarding strategy

- Restricted directional flooding
- Greedy forwarding
  - Next-hop selection
  - Recovery strategy
- Hierarchical approaches
Distance Routing Effect Algorithm for Mobility (DREAM)

- All-for-All approach (Each node maintains a position DB)
- Each node flood packets to update the position information regularly.
  - Temporal resolution
    - Mobility rate of a node. (Higher Sp. -> more frequent the updates)
  - Spatial resolution
    - Different information with distance (Accurate or Not)
Quorum-Based Location Service

- Information updates/requests is a Subset (Quorum)

Quorum’s Intersection is nonempty

- Update D
- Query D

- : host position DB
- .......... : Virtual Backbone
Grid Location Service (GLS)

- n-order squares contain exactly four \((n-1)\)-order squares.
- Each node maintains a table of all other nodes within the local first-order square.
- Periodic position broadcast in the first-order square’s area.
Location Services (4/4)

- **Homezone**
  - A virtual homezone where position information for a node is stored
Forwarding Strategies (1/8)

- **Greedy Packet Forwarding**
  - The sender of a packet includes the approximate position of recipient in the packet.
  - When an intermediate node receives a packet, it forwards the packet to a neighbor lying in the general direction of the recipient.

- **Restricted Directional Flooding**
  - A node forward a given packet to more one-hop neighbors that are located closer to the destination than the forwarding node itself.

- **Hierarchical Routing**
  - In large scale networks.
Forwarding Strategies (2/8)

- **Greedy Packet Forwarding**
  - MFR (Most Forward within R)
  - NFP (Nearest with Forwarding Progress)
  - Compass routing

- **Restricted Directional Flooding**
  - DREAM
  - LAR (Location Aided Routing)

- **Hierarchical Routing**
  - Terminodes routing
  - Grid routing
Greedy Packet Forwarding (1/2)

- **MFR**
  - Minimizing the number of hops a packet has to traverse in order to reach D

- **NFP**
  - The packet is transmitted to the nearest neighbor of the sender which is closer to the destination
  - Better than MFR

- **Compass routing**
  - It selects the neighbor closest to the straight line between sender and destination
**Greedy Packet Forwarding (2/2)**

- **Greedy routing failure**
  - \( x \) is a local maximum to \( D \)
  - \( w \) & \( y \) are far from \( D \)

- **GPSR (Greedy Perimeter Stateless Routing)**
  - Each node does greedy forwarding
  - If stuck (no neighbor is closer to the destination), then switch to face-routing.
  - Face routing
    - Extract a planar graph
    - Using right hand rule, face-changes
**Restricted Directional Flooding**

- **DREAM**
  - Sender will forward the packet to all one-hop neighbors that lie in the direction of Destination.
  - A node calculates the expected radius: \( r = (t_1 - t_0) \cdot V_{\text{max}} \)
    - \( t_1 \): Current time
    - \( t_0 \): Timestamp of the position information
    - \( V_{\text{max}} \): Node's Max Sp.
  - The direction toward D is defined by the line between S and D and angle \( \phi \).
**Restricted Directional Flooding (2/2)**

- **LAR (Location Aided Routing)**
  - Nodes have information about other nodes’ positions
  - This position information can be used by LAR to restrict the flooding to a certain area

- **Expected Zone**
  - S knows the location L of D in t0
  - Current time t1
  - The location of D in t1 is the expected zone

- **Request Zone**
  - Flood with a modification
  - Node S defines a request zone for the route request
Hierarchical Routing (1/2)

Terminodes Routing

- TLR (Terminode Local Routing)
  - When the destination is in the local routing table...
  - It uses a proactive routing scheme if the destination is close to the source node.

- TRR (Terminode Remote Routing)
  - It uses mainly the locations of Source and Destination to discover a path from S to D.
  - TRR allows data to be sent to non-TLR-reachable destination by a greedy position-based approach
  - Position-based source routing to prevent greedy forwarding
Hierarchical Routing (2/2)

Grid Routing

- It is similar to Terminodes Routing
- A proactive distance vector routing is used at local level
- Intermediate Node Forwarding (INF) is used for long-distance routing

Difference with Terminodes Routing

- Allow nodes that do not know their own position to participate in the ad hoc networks
- Proxy based
Future Research

- **issues**
  - **The problem of ensuring anonymity**
    - When a persistent node identifier can be readily associated with its position, location privacy is hard to achieve.
  - **The strategy employed to choose the next hop to which a packet is forwarded.**
    - How to prevent very long “detours”
  - **The repair mechanism used when greedy packet forwarding fails.**
  - **How to make greedy routing more tolerant of inaccurate position information.**
Summary

- Discovering the position of the destination
  - DREAM
  - GLS
  - Homezone
  - Quorum

- Forwarding packets based on position information
  - Greedy routing: MFR, NFP, Compass routing
  - Restricted directional flooding: DREAM, LAR
  - Hierarchical routing: Terminodes, Grid