GeoLANMAR Routing: Asymptotic Analysis in Large and Dense Networks

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Outline

• Scenario, Motivation, and Goals
• Scalable ad hoc routing protocols
• Geo-LANMAR routing
• Asymptotic Analysis
• Simulation Results
• Conclusions
The scenario

- Large ad hoc network
  - Civilian search/rescue (tsunami, hurricane, jungle, etc)
  - Tactical battlefield (Iraq, Afghanistan, etc)
- Only ground ad hoc communications (uniform radio range)
- Node population: in the thousands
- Motion pattern:
  - Static nodes (say 50%)
  - Moving teams (say 40%)
  - Isolated roaming nodes (say 10%)
- Communications requirements
  - Unicast (data + real time)
  - Multicast (geo-cast, team-cast)
  - Local broadcast
Goal of this study

• Develop a robust routing scheme that:
  – provides reasonably low latency
  – leads to efficient network utilization
  – scales up to 10,000 nodes
**Option 1: Geo Routing (GPSR)**

- **Problem:**
  - “Holes”; heavy O/H to overcome them with GPSR

- **Existing solutions:**
  - Fixed anchors and detours
  - Source routing trajectories
  (Not effective if nodes move)

- **A second problem:**
  need Geo Location Service to learn Destination Coordinates
Option 2: LANMAR Routing

- Local Routing (within k-hop): Optimal Link State Routing (OLSR),
- Remote Routing: Distance Vector (DSDV) used for landmark advertising
- Exploits Group Motion (only the Landmarks need to advertise)

Problems with LANMAR:

Landmark advertising O/H increases with network size and mobility
If advertised rate is too low, path to Landmark is stale and breaks
**Key idea:** GeoLANMAR = Geo + LANMAR

1. **LANMAR advertising:**
   - traces feasible path to Landmark.
   - piggybacks destination Landmark coordinates;

2. **Georouting** (instead of DSDV) is used to route packets to remote Landmarks
   1. more robust to mobility than DSDV table forwarding
   2. When Georouting gets stuck in a hole, it is rescued by Landmark path
If Euclidian distance to destination is **shorter** than the advertised path length (Effective Traveled Distance - ETD):

- presence of “void” (ie hole) is suspected
- packet is geo routed **via next Landmark** on the path
More on GeoLandmark advertising

- Flat advertisements (LANMAR)
  - Route to destination Landmark points to next node on the path
  - Shortest path, but..
  - Vulnerable to node motion

- Hierarchical advertisements (Geo LANMAR)
  - Route to destination Landmark points to next Landmark on the path
  - Not always shortest path, but
  - More robust to motion (by virtue of Georouting)
Scalability and Robustness

Scalability and Robustness is achieved through:

1. Georouting (robust to mobility)
2. LANMAR paths eliminate “perimeter routing” O/H
3. Landmark coordinates come directly from advertisements
4. Only Lanmarks advertise (not regular nodes)
5. Advertisements update frequency decreases with distance (as in Fisheye Routing or Hazy Sighted Link State Routing)
6. If GPS fails (eg, jamming, indoor ops, etc), the scheme safely falls back to LANMAR
Another example of GeoLANMAR detour
Asymptotic Analysis

• Goal:
  – Find the “local scope” $K$ that minimizes the cost of GeoLANMAR
    • $K =$ cluster diameter
    • Cost = control traffic overhead
  – Optimize routing parameters based on $K$
O/H cost vs Number of Nodes

Parameter A (~ Number of Nodes)
K = Cluster Size
Simulation Experiments

- 500 nodes (20 groups with 25 nodes each)
- 2500m x 2500m (grid with obstacles)
- Radio range 250m
- CBR traffic (medium load)
- Variable speed (up to 20m/s)
- Evaluate:
  - Delivery ratio
  - Delay
- Two options for GOAL (GeO Assisted Lanmar):
  - Use LANMAR advertised route only when “hole” detected
  - Use LANMAR advertised route using Effective Trav Distance (ETD) criterion
Grid with obstacles
Delivery ratio vs speed
Delay vs speed

Note: Goal is GeoLANMAR.
Conclusions

- GeoLANMAR scales better than LANMAR and GPSR
- Robust to mobility and to GPS failure
- Increases data throughput at high mobility (around 10% more than LANMAR, 20% more than GPSR, 40% more than AODV).
- Major reduction in average end-to-end delay through a better route recovery procedure
- Additional costs wrt LANMAR:
  1. GPS
  2. ETD (Effective Travelled Distance): computation and header O/H
The End
Thank You