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Simulating an Efficient Geographic Routing Protocol for Large Wireless MANET Networks

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Problem Statement:

- Mobile ad hoc networks (MANET), by their ad hoc nature, lack permanent infrastructures (base stations, massive storage for routing tables) for routing data. In such networks, routing can be constructed on an as-needed basis.
- For large MANETs, existing routing schemes (AODV, OLSR) are usually ineffective:
  - Constantly changing network can lead to stale routing information.
    - Node mobility, loss and additions
- If the objective is to route to a particular location then Geographic routing is better suited than other protocols
  - Node IP addresses are irrelevant
  - What matters are node locations
- The performance of such routing schemes can only be practically evaluated via simulations due to the size of the MANET and the time scale of evaluation.

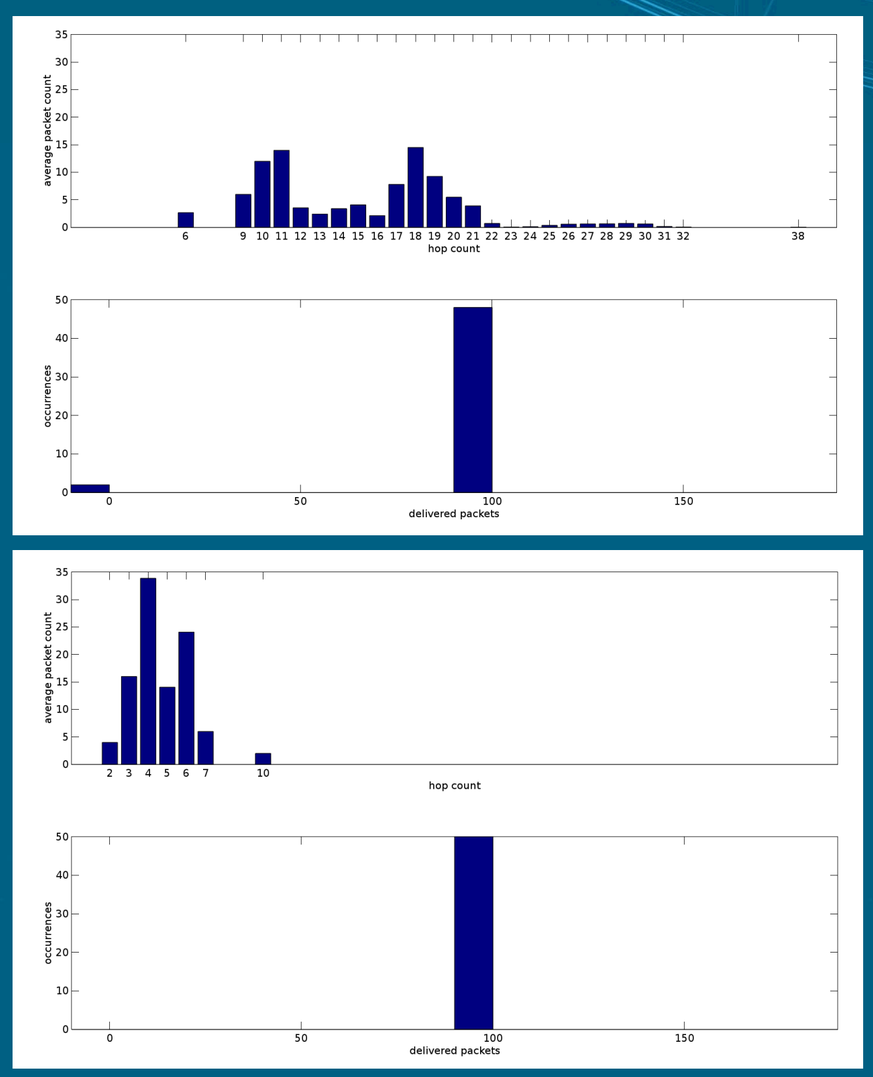
Objective and Approach:

- Improve a custom geographic, delay-tolerant routing protocol, called *Efficient Spreading Protocol with Backtracking* (ESB). ESB routing defines four phases for data delivery:
  - **Spreading** (utilizes diversity for better guarantee);
  - **Forwarding** (probabilistic selection of "best" hopping neighbor);
  - **Choking** (data deemed undeliverable and deleted);
  - **Backtracking** (attempt to escape from dead ends).
- A unique feature for ESB is the notion of *Delivery Advantage* (DA). DA is a custom metric that defines the utility of a node for delivering a packet to its final destination. Choosing the best choice for ESB's DA is a core focus area for this research work, which we evaluate via simulations. Parameters considered for DA include:
  - (Simple) greedy technique using distance away from destination;
  - (Predictable) mobility pattern;
  - Neighbors over a period of time; etc.

Evaluation:

- Network simulations done with the Rensselaer's Optimistic Simulation System (ROSS) simulator. ROSS is better tailored for large network simulations (parallel engine exists) than other better known network simulators (ns-3, OPNET).
- Model Instances
  - Number of MANET nodes simulated: ~1,000-10,000
  - World Size: 25KM x 25KM
  - Time Scale: 1-2 days
- Markov chain-driven mobility model
- We evaluated two implementations of DA computation:
  - Original `computeDA()`: uses the distance between the current node and the final destination (*greedy*);
  - Modified `computeDA()`: uses historical location information to determine a node's minimum distance reachable to the final destination (*mobility pattern*).

Results:



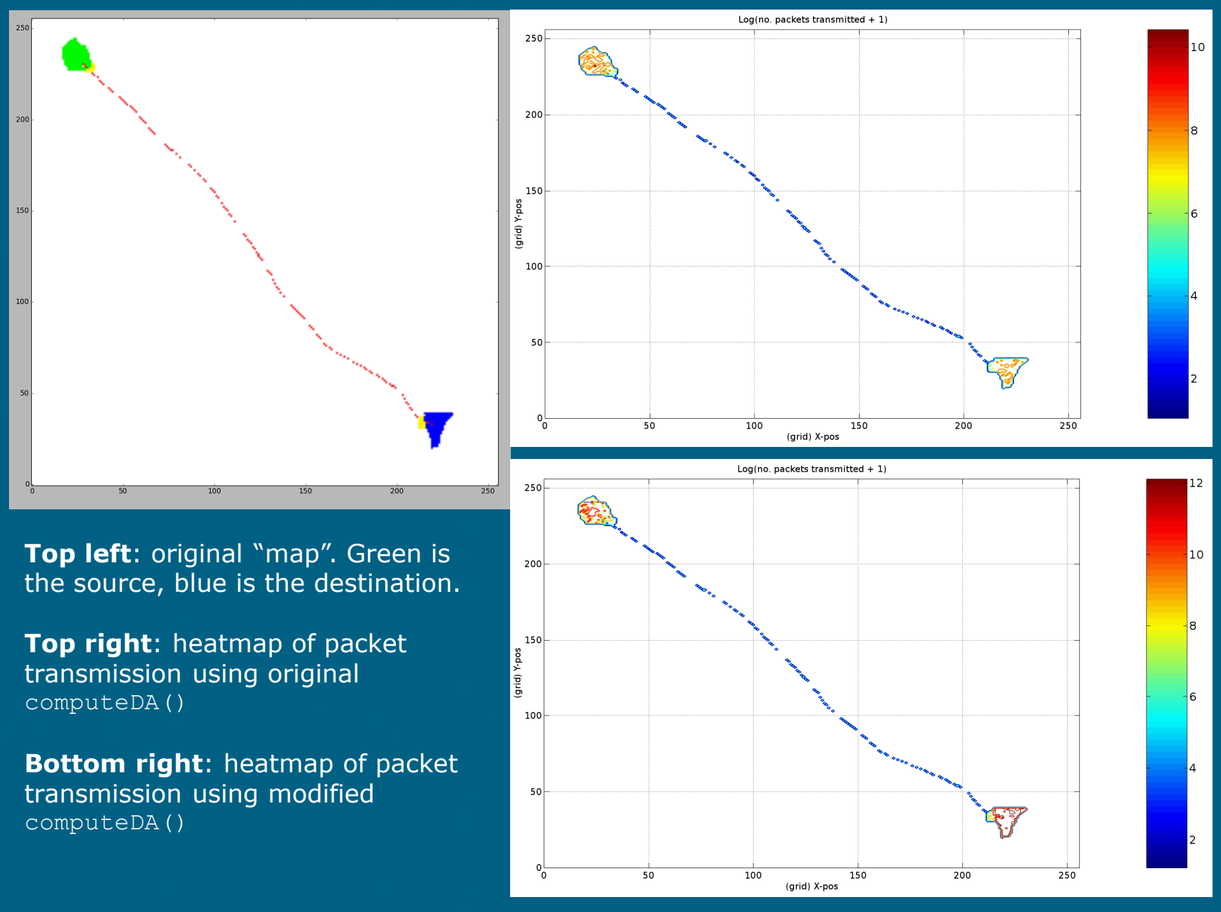
Top: original `computeDA()`

Bottom: modified `computeDA()`

These graphs were generated from 50 simulations of 5000 nodes each.

The top graph in each image is a bar chart showing the average number of packets that made it to the destination in the given number of hops.

The bottom graph in each image is a histogram of the total number of packets that reached its final destination.



Top left: original "map". Green is the source, blue is the destination.

Top right: heatmap of packet transmission using original `computeDA()`

Bottom right: heatmap of packet transmission using modified `computeDA()`

Conclusion and Future Work:

- The performance of our efficient routing protocol (ESB) strongly depends on the choice of DA.
- In the future, we will like to minimize unnecessary packet transmissions (saves battery life and reduces network congestion). Considerations include:
  - Spreading at the *k* closest locations as opposed to every visited location.
  - Spreading at the *k* "best" (based on neighbors' DA) locations.
- For performance evaluation, we could also keep track of time taken to delivery as a function of packet generation time for the purpose of evaluating DA computation schemes.

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