

Optimization Techniques

Volatility of Communication Edge to the Robustness of Trusted Spanning Forest

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Background

What is this work based on ?

- Delay Tolerant Mobile Ad-Hoc Networks
- Simulating DTMs using different models
- Collecting metrics
- Optimizing the proposed algorithm

Delay Tolerant Mobile Ad-Hoc Network (DTM)

MANET

- Mobile Ad-Hoc Network
- Wireless Technology, oftenly WiFi (*IEEE802.11*) and Bluetooth (*IEEE 802.15.1*)
- Ad-Hoc operation mode
- No infrastructure

DTM

- Subclass of MANET
- Partitions
- Frequent reorganizations

MANETs / DTMNs

Properties

- Rely on cooperativeness of their nodes
- There **are** mis-behaving nodes
- Need a measure for judging behavior and reliability of nodes
- Measure used for deciding whether to connect to or not
- Further on referred to as “trust”^a

^aNot to be confused with Security & Trust

Mobility Models



Highway Model

- Nodes (“cars”) moving on different lanes, in opposite directions



Mall Model

- Nodes (“people / shoppers”) moving in virtual mall

How is this implemented ?

G-Trust[4]

- G-Trust introduces the notion of “trust” per node
- Used to construct backbone like network
- Avoids to have low trust nodes in important positions
- Constructs Spanning Forests

Robustness and Reorganization

Robustness and Reorganization[1] ?

- Don't break stable links even if higher “trusted” node in reach
- Need a measure to help decide on when to break connections
- A link-stability measure, similar to “trust”, is needed for **edges** as well

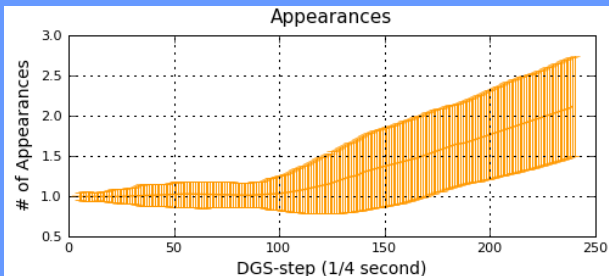
My Contribution

Think, Code & Evaluate

- Collect many different metrics
- Analyze, Plot, Evaluate those metrics
- Try to find stability threshold used as “trust” value for edges

Edge :: Metric

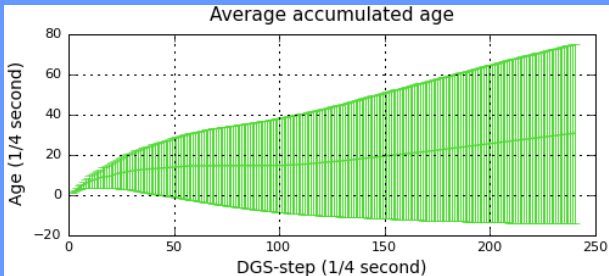
Appearances



- an element appears if it changes its state from disappeared to active
- lower is better
- higher means many state changes

Edge :: Metric

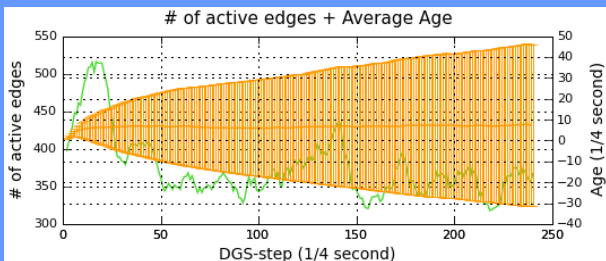
Average Accumulated Age



- $\sum_{i=0}^n t_{present_i}$, sum of time intervals an element is active
- higher is better, means edges longer active

Edge :: Metric

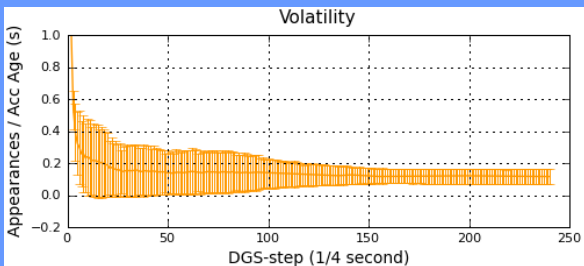
Active Edges + Average Age



- Average Age = $\frac{\text{Accumulated Age}}{\text{Appearances}}$
- higher is better, means edges longer active, more stable

Edge :: Metric

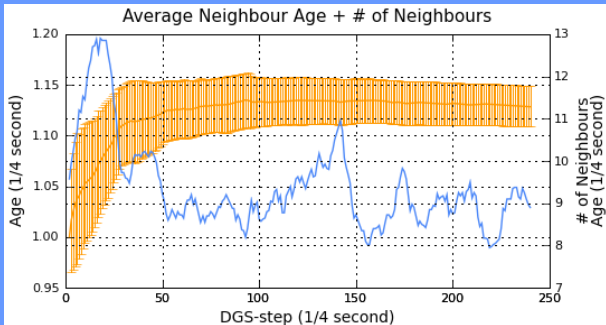
Volatility



- $\text{Volatility} = \frac{\text{Appearances}}{\text{Accumulated Age}}$
- lower is better
- gives a quality measure for the observed edges

Node :: Metric

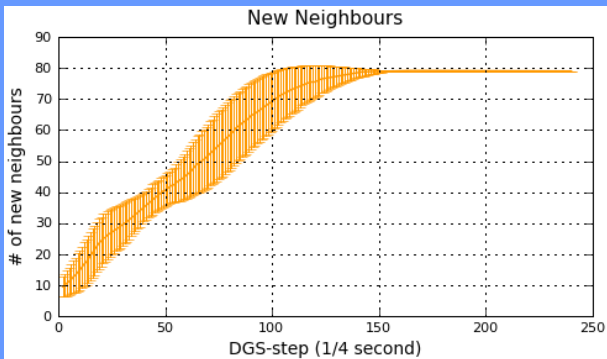
Average Neighbor Age + # of Neighbours



- orange: Average Age = $\frac{\text{Accumulated Age}}{\text{Appearances}}$
- blue: number of neighbours the nodes have on average
- the less it fluctuates, the better, the more stable it is

Node :: Metric

Number of new Neighbours



- number of new neighbours per simulation step each node sees on average

Node :: Metric

Cumulative distribution function (CDF)

- CDF: # of nodes with avg. age \leq a specific age
- gives us the distribution of nodes over the simulation
- used for determining threshold value for deciding whether to establish connection between 2 nodes

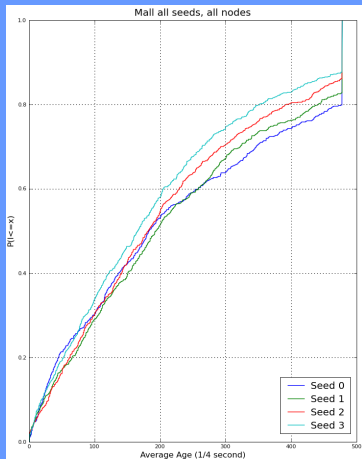
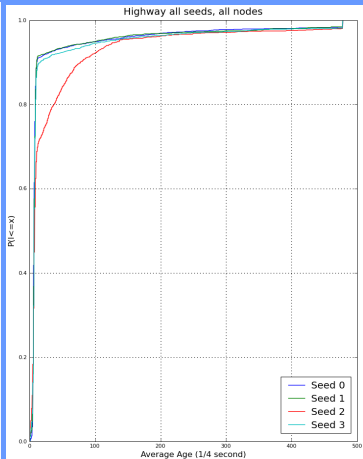
Node :: Metric

Threshold choosen here

Type	Percentage of average age	Threshold (1/4s)
highway	10%	5.1
highway	30%	6.1
highway	60%	7.77
mall	10%	23.5
mall	30%	97.35
mall	60%	237.85

Node :: Metric

Cumulative distribution function



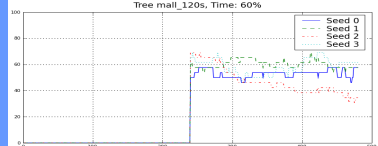
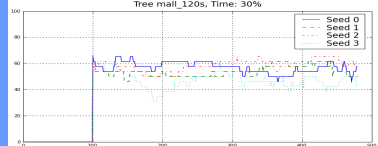
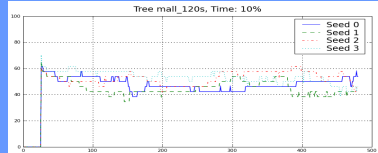
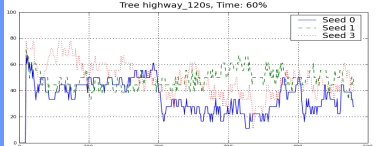
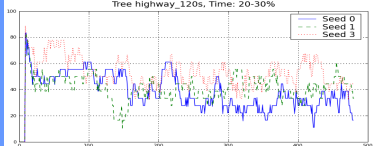
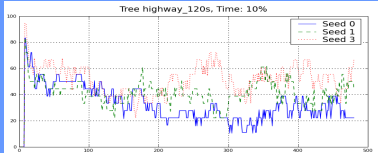
Evaluating the algorithm

Applying the threshold values for both models

- We assess the quality using 3 functions
 - $isolatingLowTrustedNode(\gamma) = \left(\frac{|\theta^*(\gamma)|}{|\theta(\gamma)|} \right) * 100$
 - $weight(\gamma) = \sum_{x \in V(\gamma)} trust(x) * tree_degree(x)$
 - $performanceRatio(G(t)) = \left(\frac{|\Gamma|}{m} \right)$

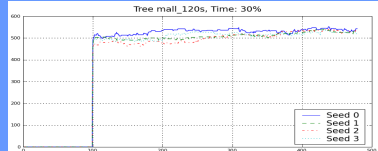
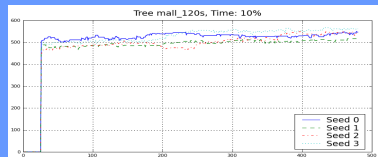
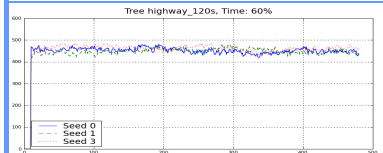
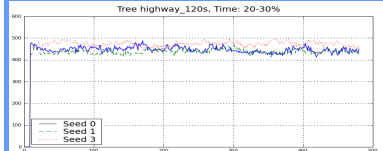
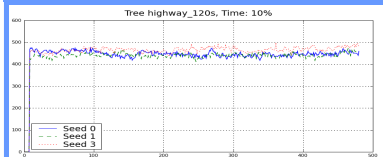
Evaluating the algorithm

isolateLowTrustedNode()



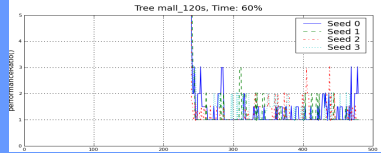
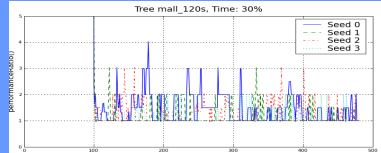
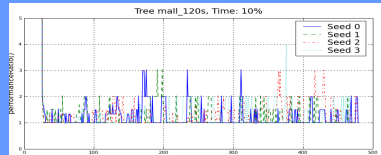
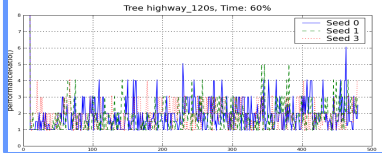
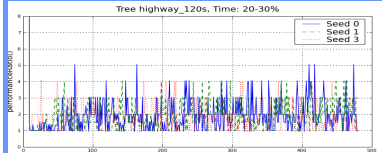
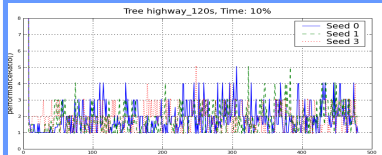
Evaluating the algorithm

weight()



Evaluating the algorithm

performanceRatio()



Evaluating the algorithm

Conclusion

- Results are inconclusive
- Barely any changes at all
- No clear improvement

Perspectives

- Currently duration of 120s, try much longer simulations
- Try other mobility models
- Introduce new parameters and new metrics, e.g.:
 - S/N ratio → distance of nodes, closer means higher throughput
 - Simulate battery level
 - Simulate packets → higher trust if more packets relayed



Adrian Andronache and Steffen Rothkugel.

Nlwca - node and link weighted clustering algorithm for backbone-assisted mobile ad hoc networks.

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Embedded and Ubiquitous Computing, IEEE/IFIP International Conference on, 2:293–299, 2008.



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The end

Thank you for listening !