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7. GI/ITG KuVS Fachgespräch „Drahtlose Sensornetze“
September 25–26, 2008 — Berlin, Germany
Motivation

Many algorithms depend on neighborhood knowledge

What is a “neighbor”? 

Neighborhood management protocols should be concerned about:

- Agility
- Stability
- Symmetry
- Connectivity
Link Estimator

- Links are not known a priori
- Behavior of the past is used for prediction
- Commonly used metric: packet reception rate (PRR)
- Estimated by receiving periodical broadcast packets
- Using exponentially weighted moving average (EWMA)
- Woo and Culler (2003) introduced agile and stable EWMA
  - Agile: low crossing time and high mean square error
  - Stable: high crossing time and low mean square error
Adaptive Link Estimator (ALE)

- Combines strength from agile and stable EWMA
- Low raising time and low mean square error
- Raising mechanism
  - New links are estimated agilely
  - When link reaches good quality switch to stable mode
- Dropping mechanism
  - Trust good links even if consecutive packets are lost for a short time
  - If link quality drops below a threshold switch back to agile mode
Comparison between EWMA and ALE
Mahalle – Neighborhood Management Protocol

- Node table contains neighbors and preparation list
- Periodical broadcasts
  - Neighbor identifiers and inbound PRR
- Each entry has information about
  - In- and outbound PRR (→ ALE)
  - Number of neighbors and overlapping neighbors
  - Time stamp and symmetry flag
- Eviction scheme if new “good neighbor” available
- Scoring model to choose a “bad neighbor”
Scoring Model: Criteria

- **Criteria:**
  - Neighboring node regards local node as neighbor
  - Neighboring node does not own bidirectional links
  - Number of bidirectional links of neighboring node
  - New in local neighborhood
  - Number of overlapping neighbors
  - Relative number of unknown neighbors
  - Inverse age
  - Product of in- and outbound PRR

- Scoring model adaptable to applications
- Example: minimum hop-count or disjunct neighborhood
Simulation Environment

- ns-2 simulation
- Random topologies with given density
- Irregular propagation model
- 15% asymmetrical links

Compared with:
- Basic approach
- TinyOS LEEP
Comparison of Neighborhood Protocols

Stable Estimator (density 24)

Adaptive Estimator (density 24)
9 nodes within communication radius
Node 4 starts after short delay
Mahalle uses 1 entry for preparation list
Only Mahalle achieves connectivity
Conclusion

- Mahalle & ALE show good performance
  - Low link detection delay
  - Decrease number of link changes
  - Ensure fast connectivity
- Real deployments
  - Testing estimator with 25 nodes over 3 month
  - Porting Mahalle to TinyOS
- Integration of physical metrics, e.g., LQI or RSSI
- Improve stability by decreasing link changes
- Integrate “snapshot” mechanism

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