

Location Discovery in Ad Hoc Networks

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Special Course in Mobility Management: Ad hoc networks

Agenda

- Introduction to location discovery
- Localization techniques
- Beacon-based solutions
- Beacon-less solutions
- Mobility in localization
- Security in localization
- Sensor Exposure
- Applications

Introduction to location discovery

- Reference Points (RP)
- Spatial relationship between sensors and RPs
- Centralized Localization
- Distributed Localization
 - Range-based: distance or angle estimates, active
 - Range-free: relies on the contents of received messages (connectivity), passive (e.g. flooding hop counts, neighbors hearing)

Localization techniques

- Received Signal Strength Indicator (RSSI)
- Time of Arrival (ToA) and Time Difference of Arrival (TDoA)
- Angle of Arrival (AoA)
- RF and Ultrasound

Beacon-based solutions

- Beacon Node (BN)
 - Location known
 - Sensor detection
 - Consistent communication
- Pros and Cons
 - Easy to manage and maintain
 - Single point of failure, expensive setup

Beacon-less solutions

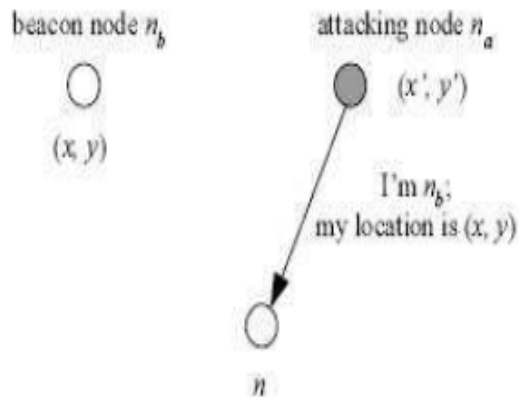
- Positioning Model
 - Pre-knowledge of deployment
 - Neighbor discovery
- Pros and Cons
 - Self-organize, fully distributed
 - Hard to manage and impossible to make changes

Mobility in localization

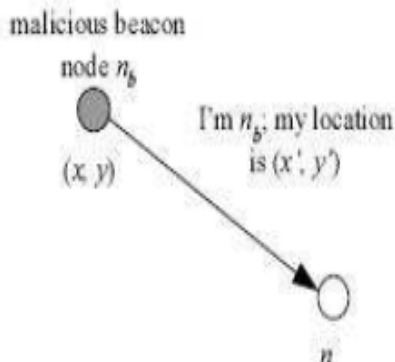
- Nodes (sensors) and Seeds (Beacons)
 - Nodes are static, seeds are moving
 - Nodes are moving, seeds are static
 - Both are moving
- Sequential Monte Carlo (SMC) algorithm
 - Represent the posterior distribution of possible locations using a set of weighted samples
- Prediction + revise
 - Sampling and re-sampling
- Resolution limit
 - Moving path and predicted circle

Security in Localization

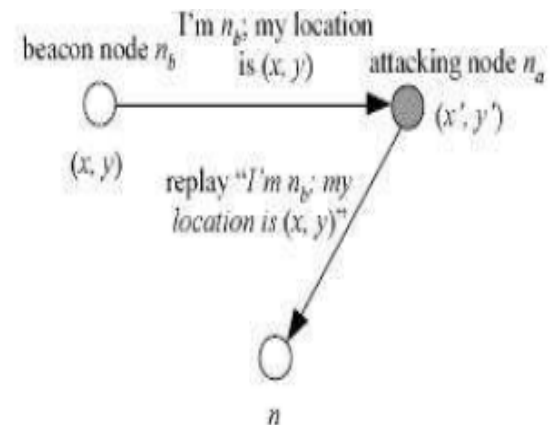
- Detection of Malicious Nodes
- Attack-Resistant Minimum Mean Square Estimation
- Voting-based location estimation



(a) Masquerade beacon nodes



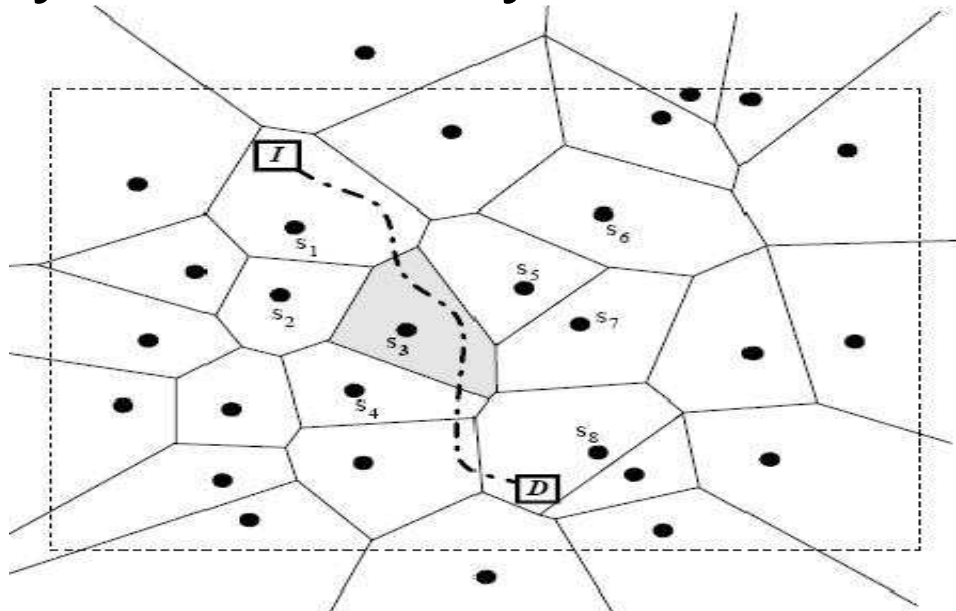
(b) Compromised beacon nodes



(c) Replay attack

Sensor Exposure

- Search expansion
 - Voronoi Diagram (polygon) and Delaunay Triangulation (neighbors)
- Security and Privacy



Applications

- Positioning System
- Ad hoc routing
- Collaborative signal processing
 - Data dissemination and gathering
- Optimization of communication tasks
 - Emergency reaction, fault tolerance system

Resources

- *Ad Hoc Wireless Networks: Architectures and Protocols*, C. Siva Ram Murthy and B. S. Manoj
- *A Directionality based Location Discovery Scheme for Wireless Sensor Network*, Asis Nasipuri and Kai Li
- *Localized Algorithms In Wireless Ad-Hoc Network: Location Discovery And Sensor Exposure*, Seapahn Meguerdichian, Sasa Slijepcevic, Vahag Karayan and Miodrag Potkonjak
- *Attack-Resistant Location Estimation in Sensor Network*, Donggang Liu, Peng Ning and Wenliang Kevin Du
- *A Beacon-Less Location Discovery Scheme for Wireless Sensor Networks*, Lei Fang, Wenliang Du and Peng Ning
- *Localization for Mobile Sensor Network*, Lingxuan Hu and David Evans
- *Detecting Malicious Beacon Nodes for Secure Location Discovery in Wireless Sensor Network*, Donggang Liu, Peng Ning and Wenliang Du

Questions

