Ad-Hoc Localization Infrastructure

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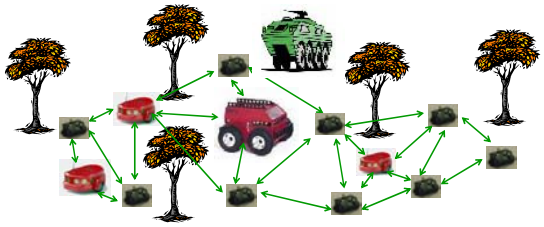
Introduction: Location Awareness is Fundamental to Sensor Networks

Node localization beyond GPS



Static sensor node and mobile sensor node can collaborate to find the locations

- **Static sensor nodes execute *Distributed* algorithms to localize themselves**
  - Less power consumption and signal interference.
  - Non light-of-sight (NLOS) errors exist for the nodes with surrounding obstacles.
- **Mobile sensor node helps to localize the static sensor nodes with NLOS errors**
  - Can be the ***Moving Beacon***, making these sensor nodes aware of their locations.
  - Have the potential of integrating services of localization, dumping data, and recharging for the static sensor nodes at the same time.

Problem Description: Ad-Hoc Localization in Mobile Sensor Networks

Solve a large non-linear optimization problem inside the network (Static)

- **Nodes collect a set of measurements/observations to each other.**
- **Nodes organize in *over-constrained groups* with rigid configurations inside the network.**
- **Derive a set of *initial estimates* based on geometric relationships.**
- **Refine estimates using *iterative least-squares* computation inside the network. All nodes share the cost of localization.**

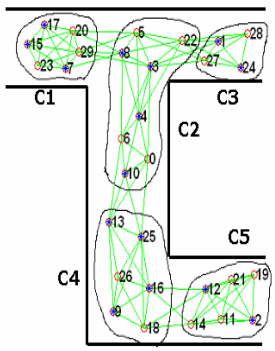
Explore the local area network while providing the location information (Mobile)

- **The mobile sensor node visits the static sensor nodes locally.**
- **Based on the *moving trajectory* of the mobile sensor node, the static sensor nodes can derive their locations.**
- **These static nodes then become the beacons, which can *calibrate* the locations of the network to alleviate the NLOS errors.**
- **The static and mobile sensor nodes update their locations *iteratively*.**

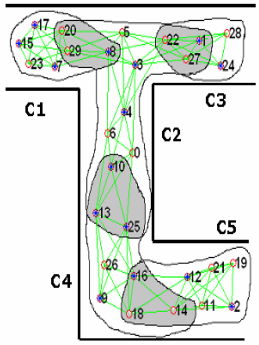
Proposed Solution: Infrastructure Supported Localization Algorithms

Beaconless Ad-Hoc *Distributed* Localization (A. Savvides)

Measurements are used to form isotropic local clusters and local coordinate systems

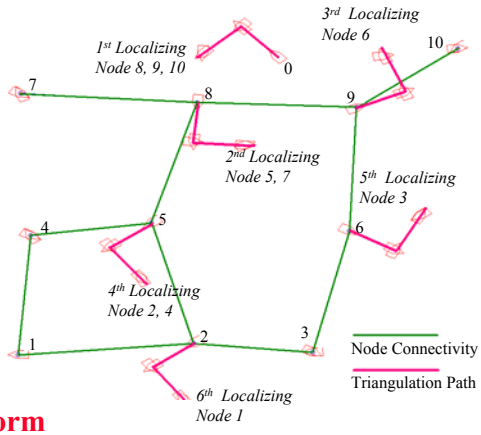


Clusters can then be merged to obtain a global coordinate system



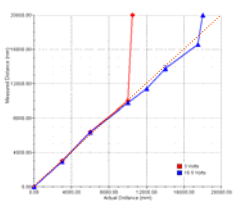
Mobile Beacon Training (Y.C. Kuan)

Breadth-First Search + Local Triangulation
= Explore and Localize the nodes at the same time.

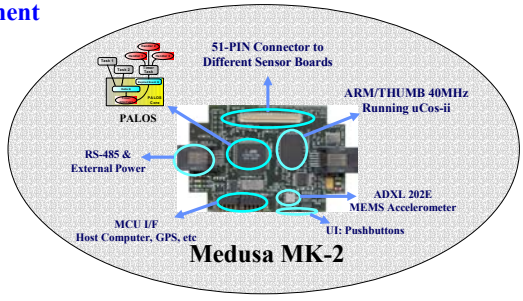


Visiting Seq. {0,8,9,10,5,7,6,2,4,3,1}
Localizing Seq. {(0),(8,9,10),(5,7),(6),(2,4),(3),(1)}

Outdoor Ultrasonic Distance Measurement



HW/SW Platform



- **Localization API**
- **Robot API**
- **Wireless MAC protocol - BMAC**