Title
Design and Deployment of Services in Tiered Sensor Networks

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Design and deployment of tiered sensor networks

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Hierarchical Overlapped Coordination

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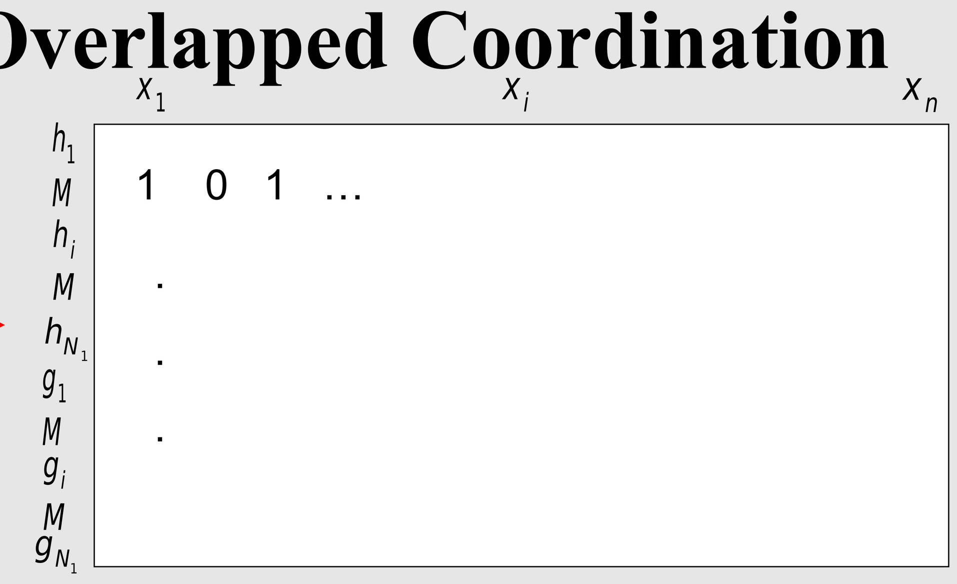
$$\min f(X)$$

subject to $h(X)=0$

$$g(X)\leq 0$$

Where h and g are matrices and X



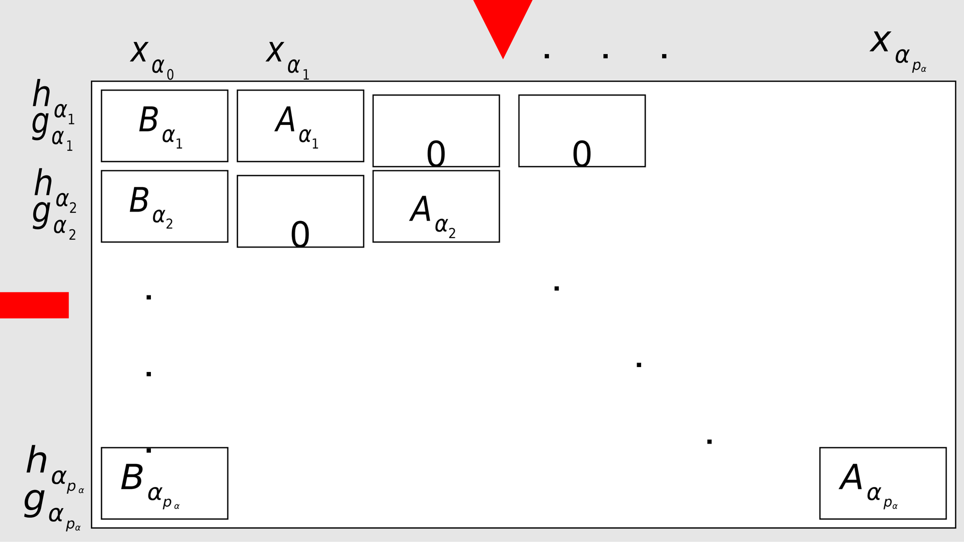
For each $i=1,\ldots,p_\alpha$

$$\min f_{\alpha_i}(d_\alpha, X_{\alpha_i})$$

subject to $h_{\alpha_i}(d_\alpha, X_{\alpha_i})=0$

$$g_{\alpha_i}(d_\alpha, X_{\alpha_i})\leq 0$$

$$X_{\alpha_0}=d_\alpha$$



HOC Algorithm

STEP 1: Fix linking variables X_{α_0} and solve problem α by solving p_α independent sub problems

STEP 2: Fix linking variables X_{β_0} to their values determined in step 1 and solve problem β by solving p_β sub problems

STEP 3: Go to step 1 with fixed values of α-linking variables determined by step 2

Repeat until convergence is achieved

Localization and Routing

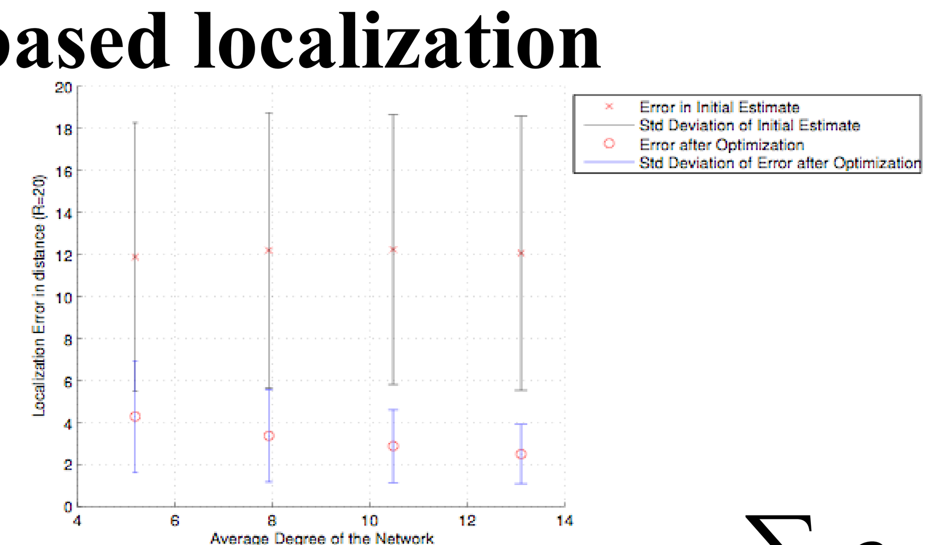
Proximity based localization

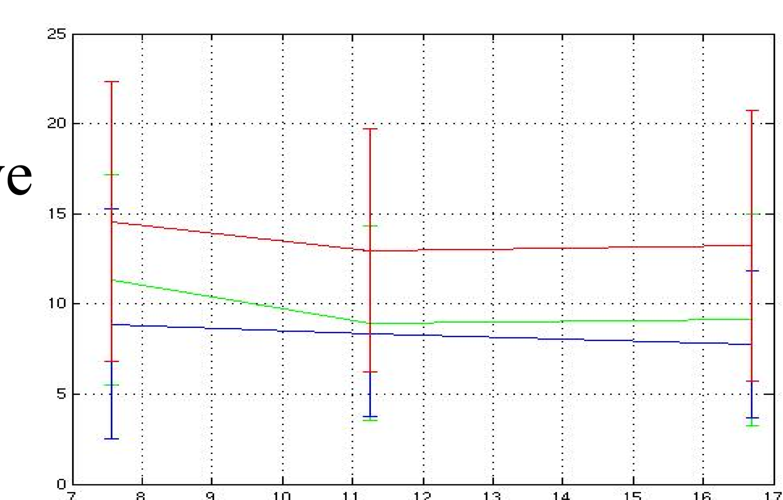
- Let d_i be the degree of node i
- Let (x_i, y_i) be the initial location of node i
- Let R be the radius of communication
- For every neighbor node j, we formulate a constraint

$$(x_i - x_j)^2 + (y_i - y_j)^2 \leq R^2$$

- For every non-neighbor node k, we formulate a constraint

$$(x_i - x_k)^2 + (y_i - y_k)^2 > R^2$$





Routing

For $\alpha = 1, \ldots, k$

$\max T^\alpha_{system}$ such that

$$q^\alpha_{(i,j)} + q^\alpha_{(j,i)} = Q \vee (i,j) \in A \text{ and } \vee i \in (S_\alpha - M)$$

$$q^\alpha(k,i) = 0 \vee k \in M$$

$$\sum_{j\in B_i} e_t \cdot q^\alpha_{(i,j)} + \sum_{j\in B_i} e_r \cdot q^\alpha_{(j,i)} \leq E_i \,\forall (i,j) \in A \text{ and } \forall i \in (S_\alpha - M)$$

$$q^\alpha_{(j,i)} \leq 0 \,\forall (i,j) \in A \text{ and } \forall i \in (S_\alpha - M)$$

e_r, e_t → energy to receive and and transmit a packet

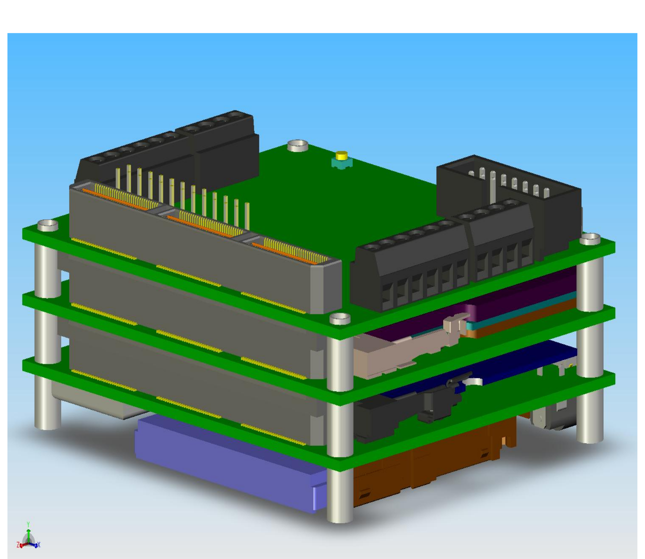
E_i → Total energy at node i

$q_{(i,j)}$ → Data flow from node i to node j

Q → total data produced at a node in time period T

Deployment

LEAP2 Platform



- Fine-grained energy measurement support
- Main board with Xscale processor
- MSP430-based addon board
- Capability to switch between mote and master functionality

Setup

- Network of LEAP2 Nodes
- Ability to measure total available battery at each node
- Dynamic reconfiguration of the network to maximize network lifetime

Formulation

- Similar to facility location problem
- K-median formulation
- Distance metric key to a good solution
- Other formulations exist – Minimum Dominating set, Maximum Independent set etc.

K-Median Problem

- NP-Hard in the centralized case
- Approximation algorithms exist for centralized case
- Distributed energy efficient solution needed

Distance Metric

- Node residual energy
- Number of hops (more hops implies more wireless loss)
- Data rate (Proportional to event occurance and pattern)