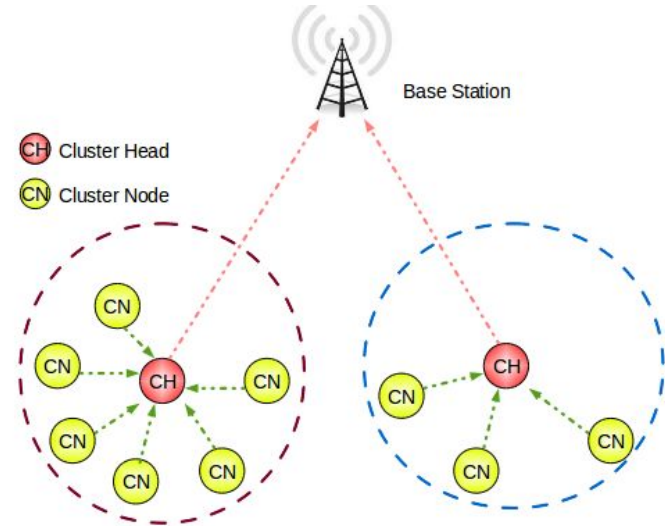


LEACH simulation & controlled CH selection strategies

Mauro Belgiovine
Wireless Sensor Networks

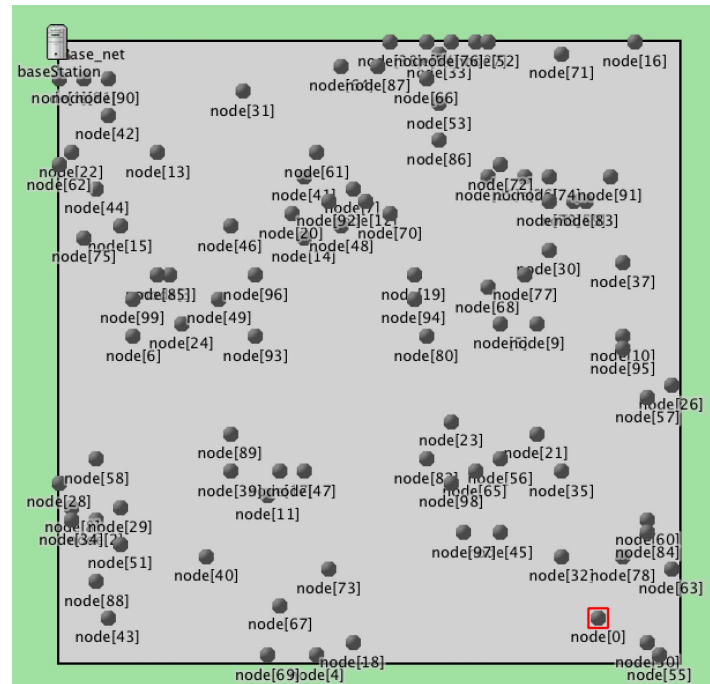
LEACH (Low-energy Adaptive Clustering Hierarchy)

- Localized coordination and control for cluster set-up and operation;
- Randomized rotation of Cluster Heads (CH) and corresponding clusters
 - **Low power** transmission within cluster
 - **High power** transmission to BS
- Local compression of data collected to reduce communications with a Base Station (BS)

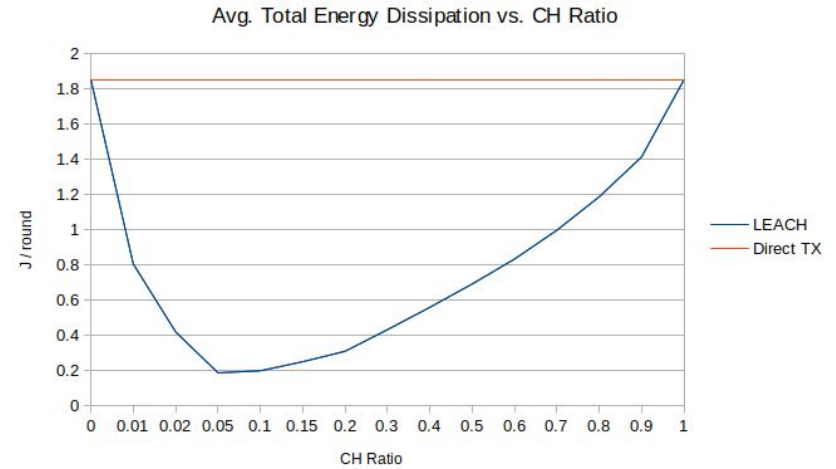
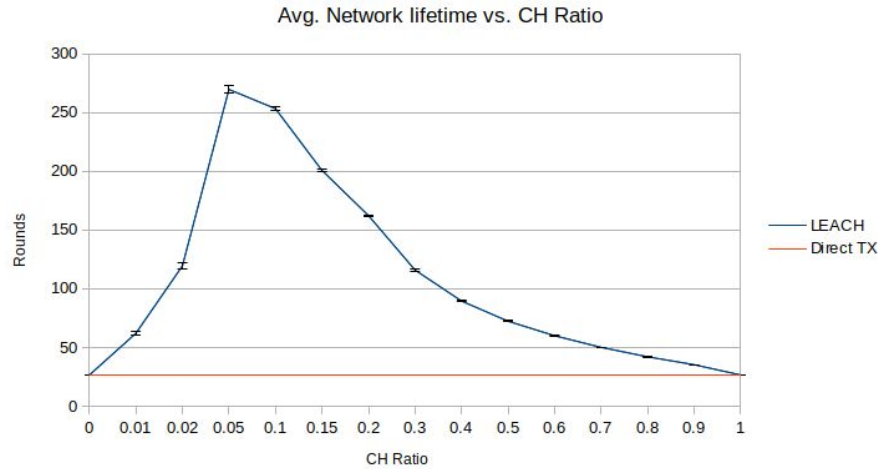


Simulation of LEACH

- LEACH protocol implemented in Omnet++ 5.6.1
- Performance comparison with Direct Transmission scheme
 - TDMA based with BS as “cluster” at each round



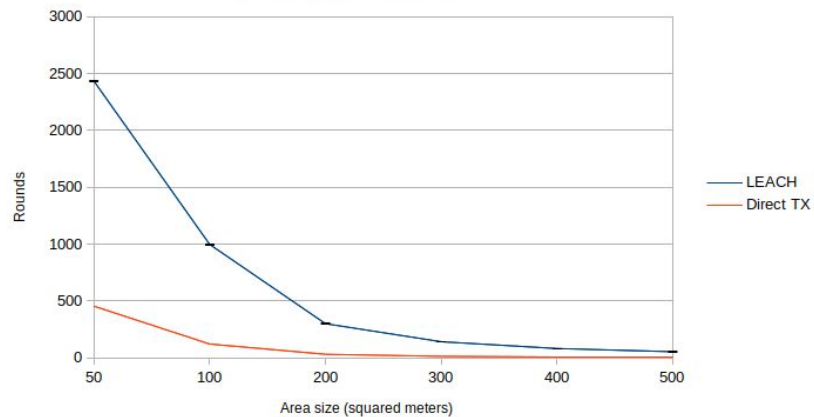
Simulation results



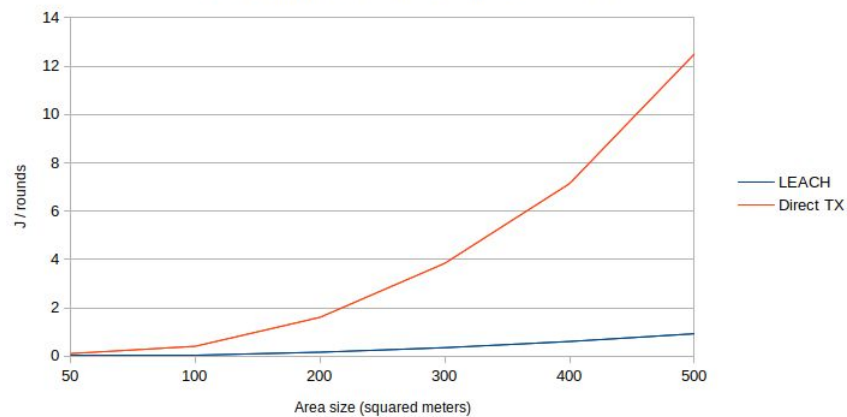


Simulation results

Avg. Network lifetime vs. Size of sensed area



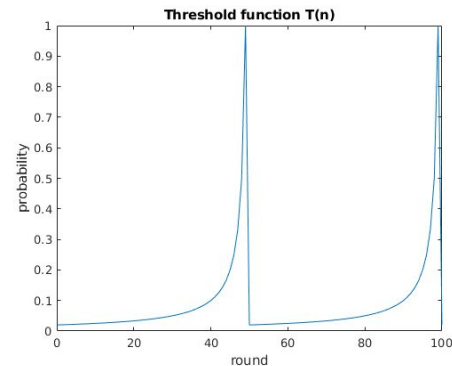
Avg. Energy Dissipation vs. Size of sensed area



A controlled CH selection scheme

- CH selection is based on a probability given by $T(n)$
- PROBLEM: Poor control on how nodes are selected
 - No energy awareness → energy consumption is assumed to be evenly distributed
 - No location awareness → when two or more CHs are too close to each other, creates imbalance in transmission distance
 - (No guarantee of CH selection)
- IDEA: try to improve network performances with a more accurate CH selection, based on some user-defined strategy (it depends on the application)

$$T(n) = \begin{cases} \frac{P}{1 - P(r \bmod \frac{1}{P})}, & \text{if } n \in G \\ 0, & \text{if } n \notin G \end{cases}$$



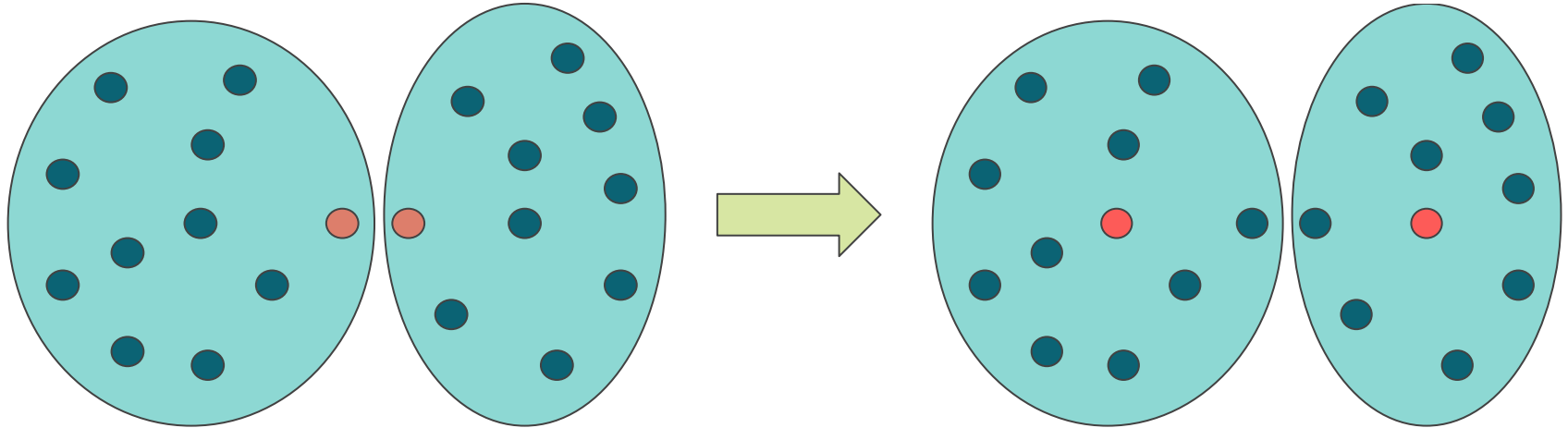
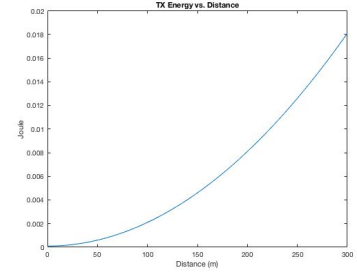


A controlled CH selection scheme

- Normal cluster setup → guarantees efficient dynamic clusters formation
- When CH has been selected, it receives **additional informations** from nodes in JOIN message
- CH will **sort nodes** based on the informations received and a given sorting strategy
- If a better suitable node is identified, it will **advertise the new CH_ID in SCHED** message
- Nodes receive SCHED information and compare their ID to the one of the newly advertised CH
 - if $myID == CH_ID$ → start listening for DATA messages
 - otherwise, send DATA messages following the TDMA schedule to the advertised CH

PRO: computationally efficient (sort), low payload overhead, no additional messages, localized

Strategy: choose CH as the node closer to the centroid of the cluster





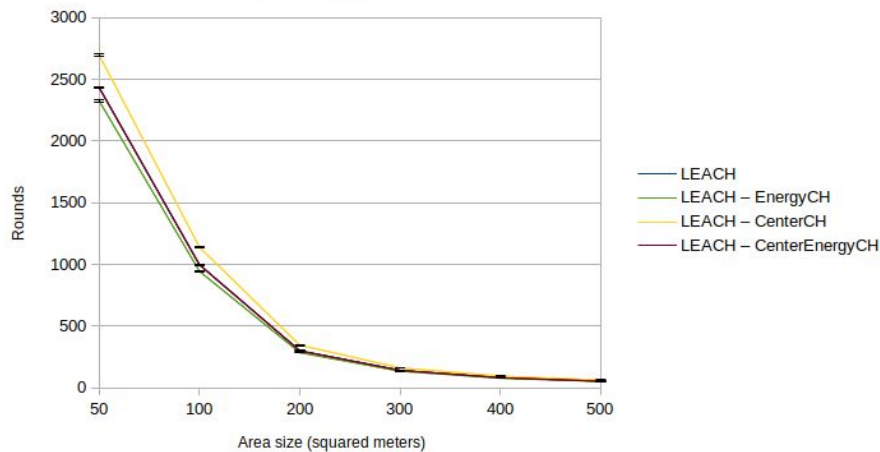
Other strategies/sorting criteria

- Choose the node *in the cluster closer to the centroid* → requires node position in JOIN message payload
- Choose the node *in the cluster with higher energy* → requires node battery level in JOIN message payload
- Choose the node *in the cluster closer to the centroid **and** with higher energy* → requires both node position and node battery level

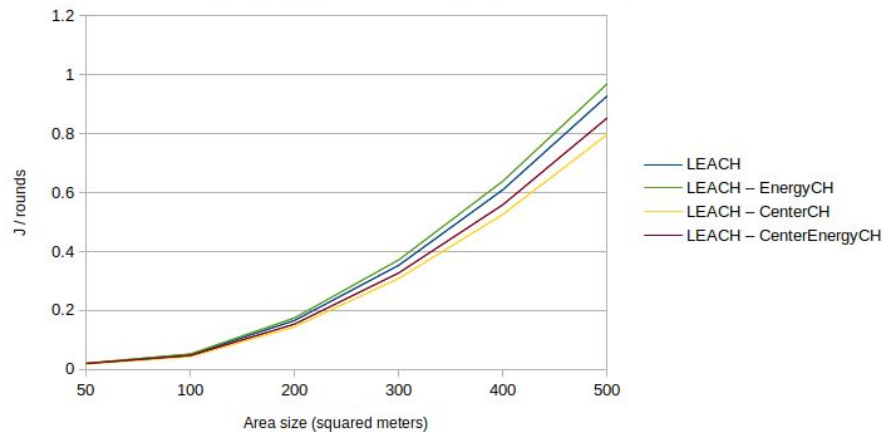


Experimental results

Avg. Network lifetime vs. Size of sensed area

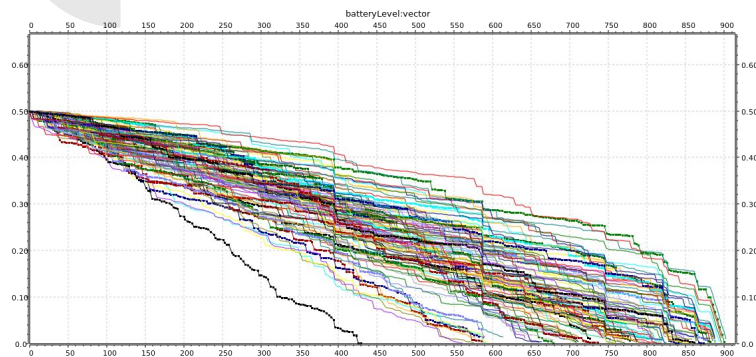


Avg. Energy Dissipation vs. Size of sensed area

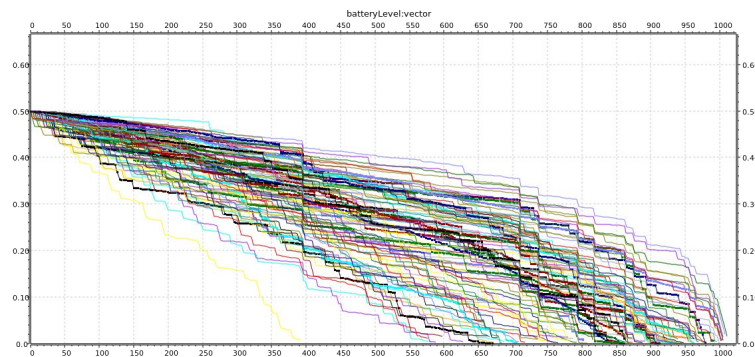


For network lifetime (last node dead) sensitive applications, **centroid** strategy is better!

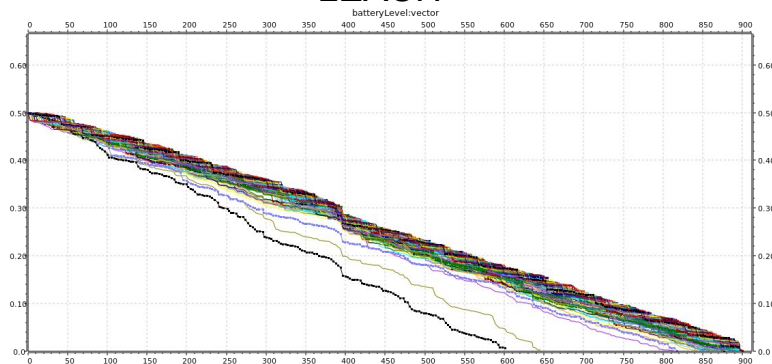
Impact of selection strategy



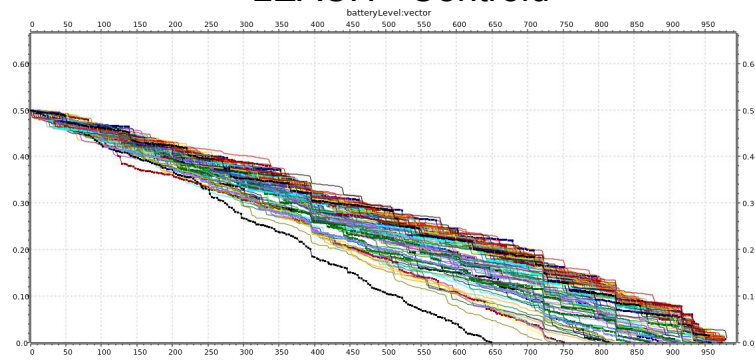
LEACH



LEACH - Centroid



LEACH - Energy aware



LEACH - Centroid + Energy



Problems/challenges

- Few simulation details in the original paper
 - Assumed fallback to Direct Transmission when no CH are selected or *isolated CH* case
 - No explicit explanation of Direct Transmission scheme
 - No explicit position of BS (assumed “far away” \rightarrow max)
- Original content required close analysis of mathematical properties of the CH selection scheme (different strategies tried/tested)
- Advanced Omnet++ features used for data collection



Q&A

Thank you!

Questions?