Geographical Clustering with Coarse-Grained Localization

Jakob Salzmann, Ralf Behnke, Dirk Timmermann

Initial Situation

- Sensor network - Hundreds of tiny and partly redundant nodes
- Deployed randomly in the area to observe
- Surveillement of environment by sensors and transmission of data to a central station
- Limited resources
- Imprecise information about their local position
- Coarse-grained localization by support of nodes with known position, called beacons

Challenge

Increase network's lifetime by

- Avoidance of redundant transmission and sensing events
- Simple and efficient clustering strategy

Traditional Approach

- Dividing the surveillance area into regular square cells
- Cell length depends on transmission- and sensing range

Advantages:

- Only one active node per cell guarantees full coverage and connectivity
- Switch-off remaining nodes to conserve energy

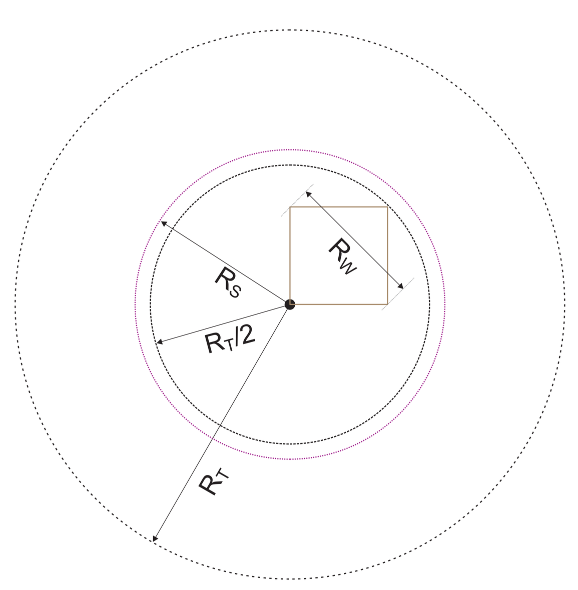
Disadvantage:

- Exact information about nodes' position has to be available to estimate cell membership

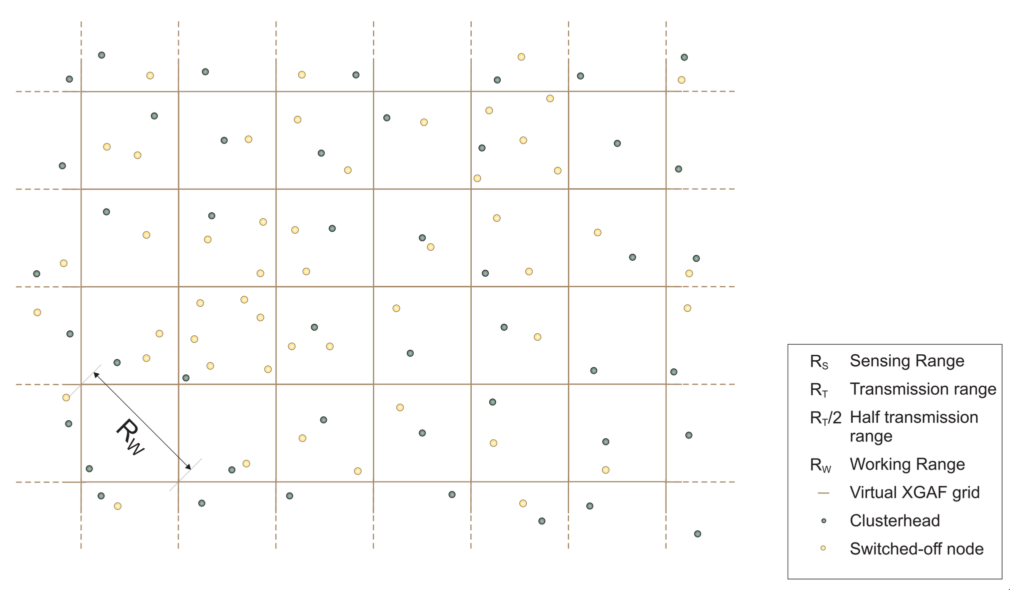
New Approach

- Exchange the regular cells by emerging cells of a regular beacon structure
- Cells with similar areas similar longest distances important
- Combination of adjacent cells possible

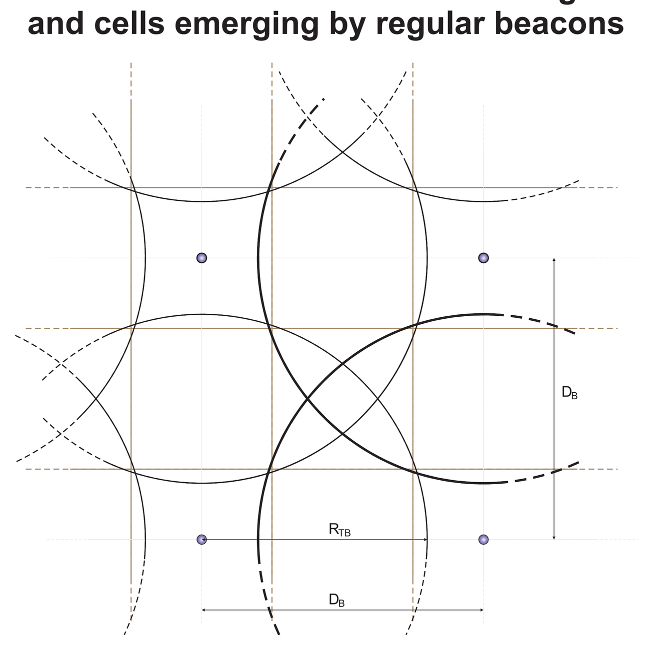
Estimation of the Working Range and the Maximum Cell Dimensions



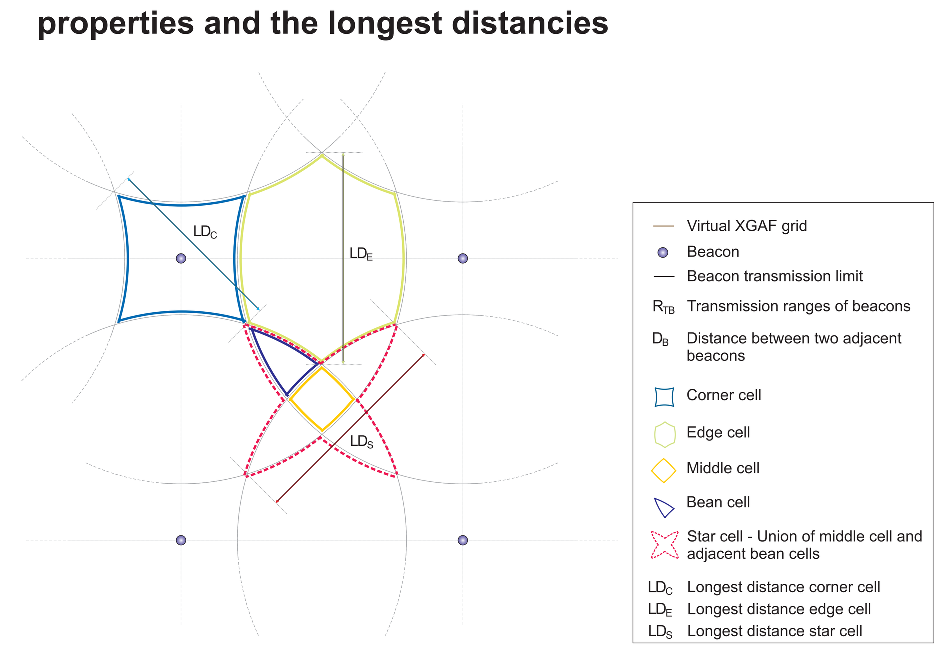
Applying the XGAF-algorithm to a Sensor Network



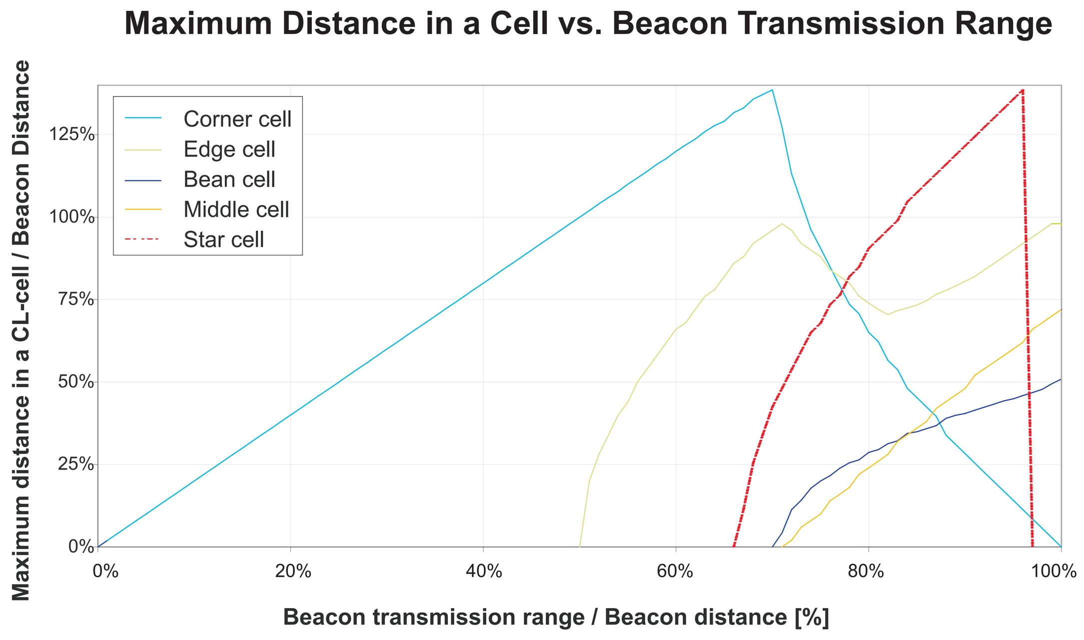
Similarities between virtual XGAF grid and cells emerging by regular beacons



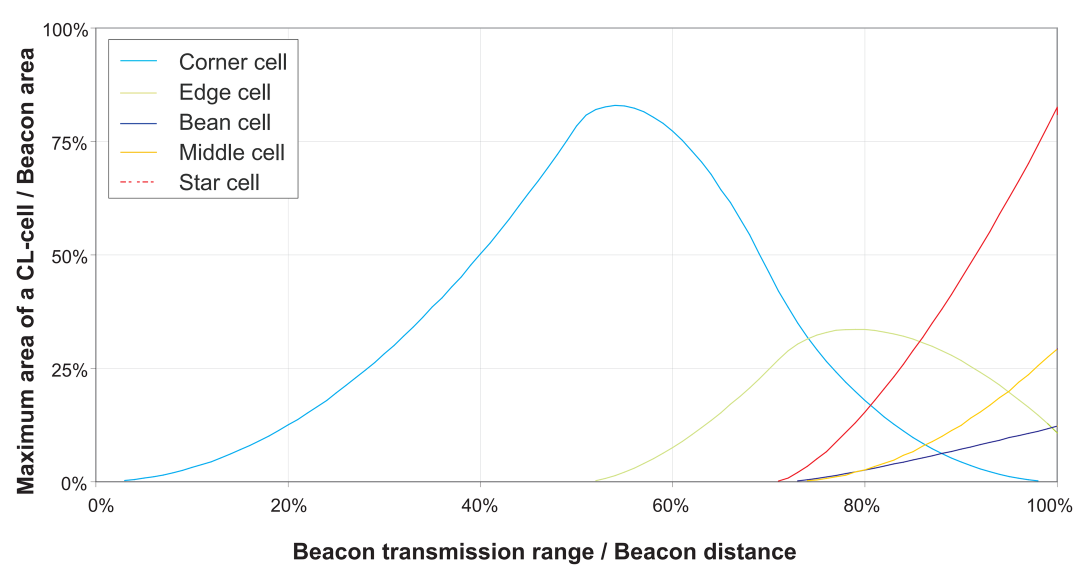
Estimation of cells with similar properties and the longest distances



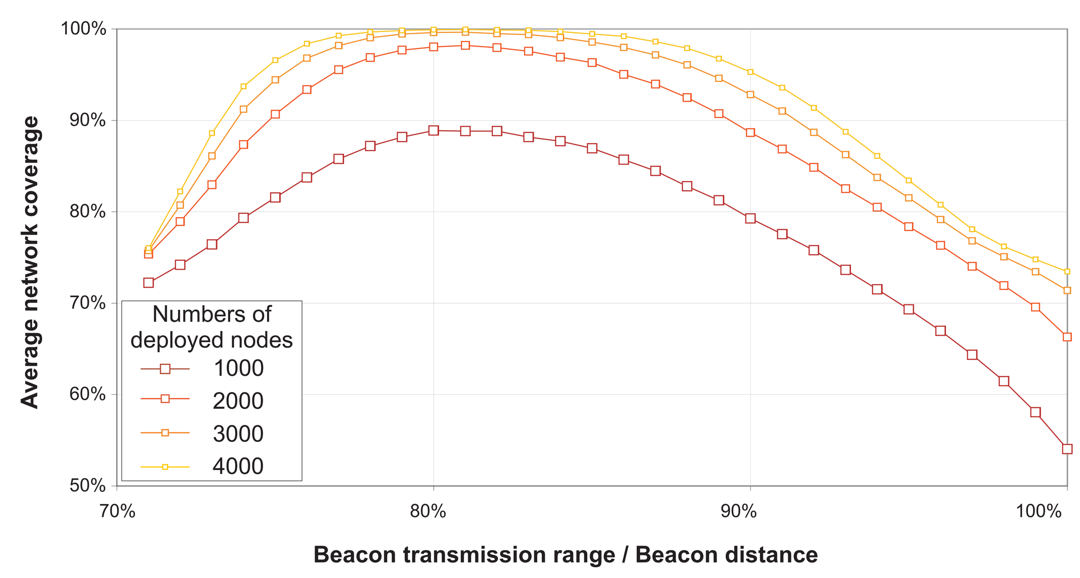
Maximum Distance in a Cell vs. Beacon Transmission Range



Cell Areas vs. Beacon Transmission Range



Cell Coverage vs. Beacon Transmission Range



Simulation Environment

- Using Matlab®

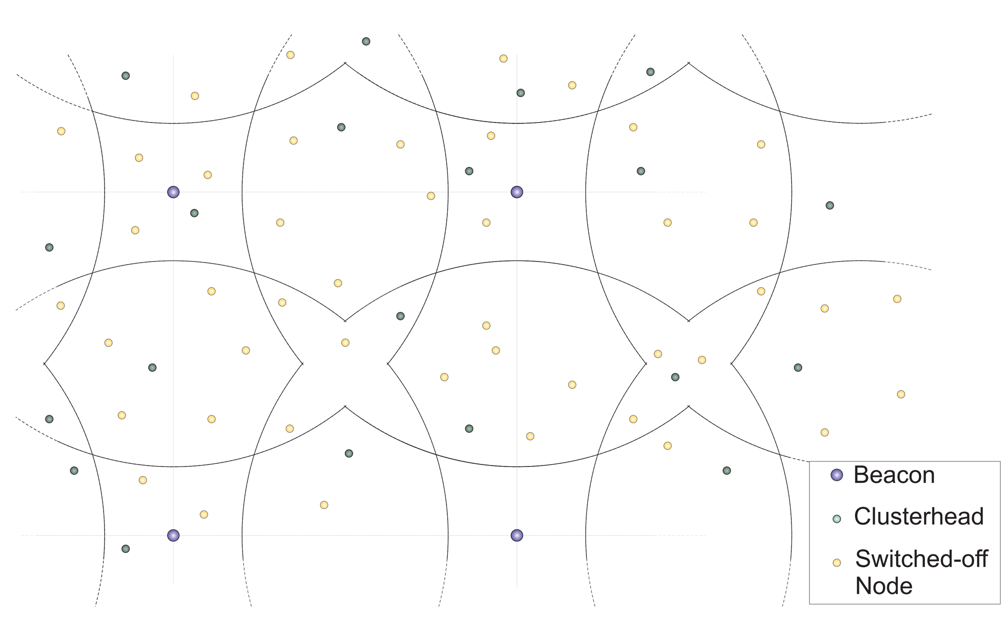
Regular beacon structure

- Vary transmission range/beacon distance between 0% and 100%

Network coverage

- Sensor field with 10*10 beacons
- No edge or corner effects by using a "Donut-world" simulation environment
- 100 Monte-Carlo simulations

Emerging Grid Structure and applied Clustering Algorithm



Results

- Successfull applied XGAF algorithm to realistic cellforms
- Optimal beacon transmission range/beacon distance: ~80%
- Combining "Middle Cell" and adjacent "Bean Cells" to a "Star cell" for more balanced areas and more balanced longest distances

Future Work

- Beacons with multiple transmission ranges
- Determine cells with unregular beacon distribution

CENTER FOR LIFE SCIENCE AUTOMATION

University of Rostock, Germany

Institute of Applied Microelectronics and Computer Engineering