

# Research Overview

Matthias

# Research Interests

- Ad hoc and wireless sensor networks
  - Localization and local approaches
- Flying ad hoc networks
  - Swarming and clustering
- Privacy and security
  - Privacy: OSN and participatory sensing
  - Security: DDoS (target area link flooding attacks)
- Complex and adaptive networks
  - Network scientific approaches
  - E.g. temporal networks

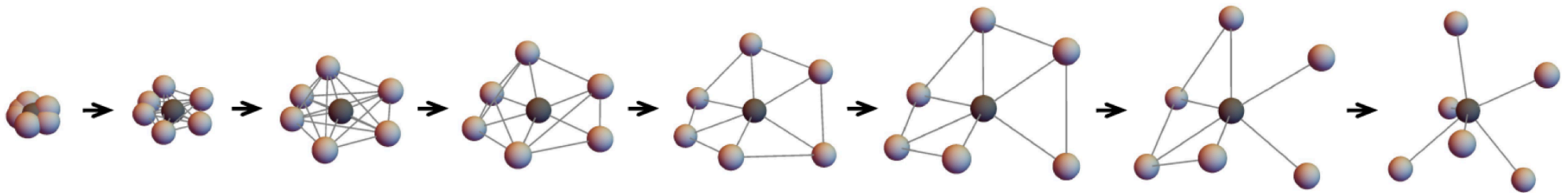
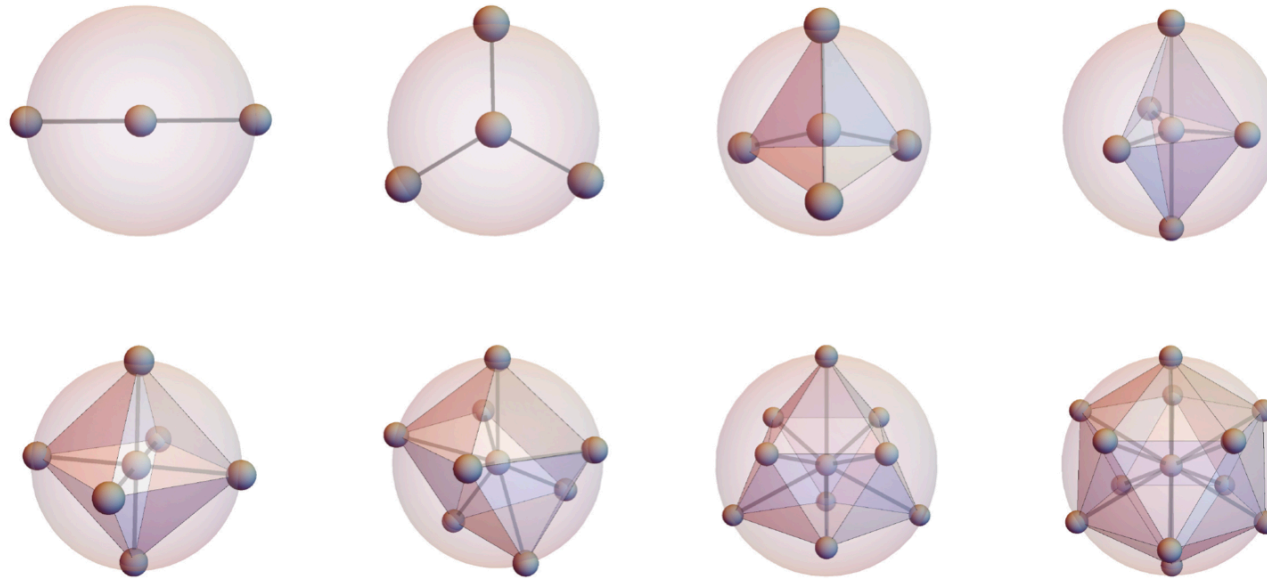
# Clustering

- Local Clustering Algorithms
  - Real-world systems, e.g. UAV swarms, army of robots
  - Data, e.g. participatory sensing

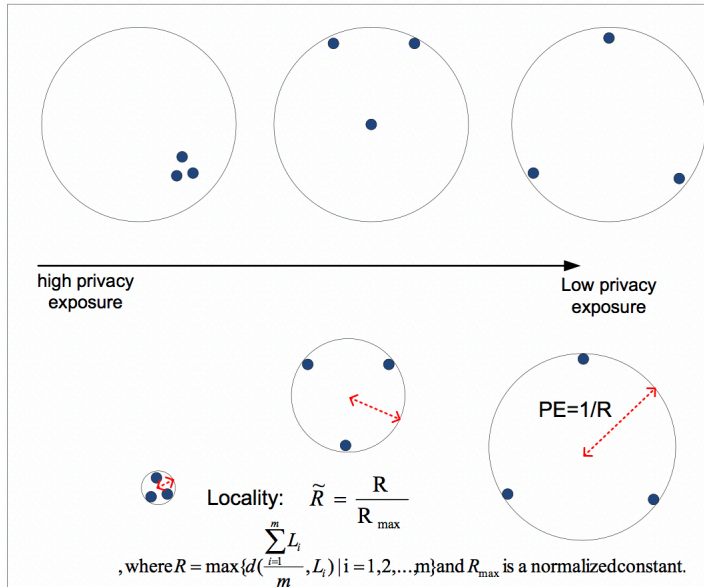
# Clustering (UAVs)

- VBCA: A Virtual Forces Clustering Algorithm for Autonomous Aerial Drone Systems
  - Flying Ad hoc Networks (FANETs)
  - Efficient and effective positioning of UAVs
  - Objective:
    - Dynamic positioning of the drones in three dimensional space with **local communication**
  - Approach:
    - VSEPR (Valence Shell Electron Pair Repulsion) model is the most successful model for the molecular geometry description
    - Arrangement of electron pairs in valence shell of the central atom are due to the repulsion between them
    - VSEPR theory is adopted to build a self-configuring dynamic network architecture

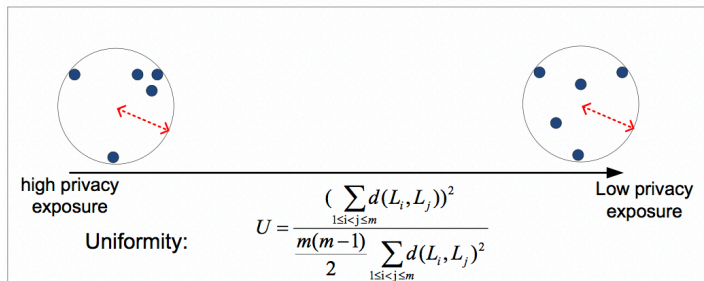
# Reproducing VSEPR-Geometries



# Clustering (Participatory Sensing)



Example 1: k-anonymity submissions with k=3.



Example 2: k-anonymity submissions with k=5.

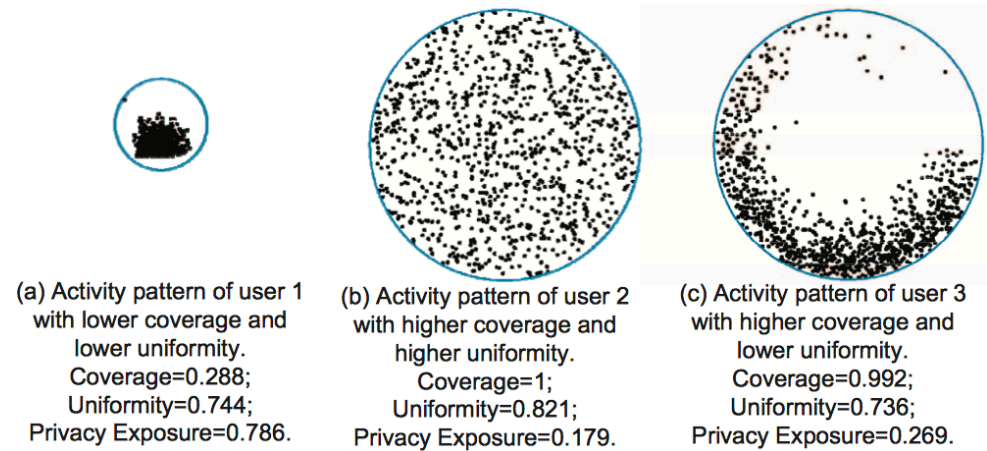


Fig. 8. Experimental results: (a) 34 real reports submitted by user 1's smartphone 1 running the *naive* sensing algorithm, where coverage=0.184, uniformity=0.515, and privacy exposure=0.905; (b) 60 reports inclusive of 2 real reports ( $k=30$ ) submitted by user 1's smartphone 2 running our sensing algorithm, where coverage=1.0, uniformity=0.745, and privacy exposure=0.255; (c) 240 reports inclusive of 8 real reports submitted by user 2's smartphone running our sensing algorithm, where coverage=1.0, uniformity=0.759, and privacy exposure=0.241; (d) 240 reports inclusive of 8 real reports submitted by user 3's smartphone running our sensing algorithm, where coverage=0.729, uniformity=0.787, and privacy exposure=0.426.

# Ongoing research

## 1. Networked Swarming

- Swarmed signaling networks (SSN)
- “Soft” Formation Control

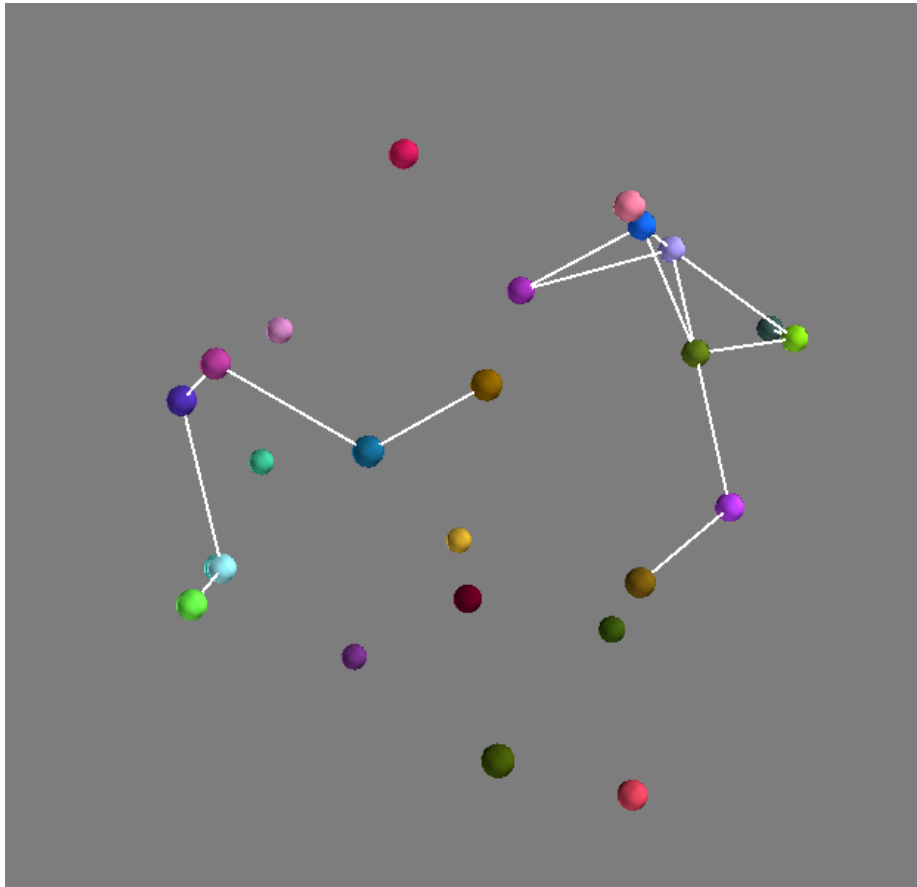
## 2. Fractal Clustering

- More natural clusters
- E.g. realization of swarm-intrinsic no-flight zones
  - exhibit no-flight zones out from the dynamics of the swarm

## 3. Relative Localization in Swarmed Systems

- Swarm as temporal network
- Two main concerns
  - Reconstruct entire network at given instant
  - Infer from the dynamics of the topology of the SSN over a certain time window, what the dynamical update rule is

# Simulator



- Implementation of swarming models
- Clustering
  - KHOPCA
  - Fractal clustering