Emergent radio: Emergent strategies to optimise collaborative transmission schemes

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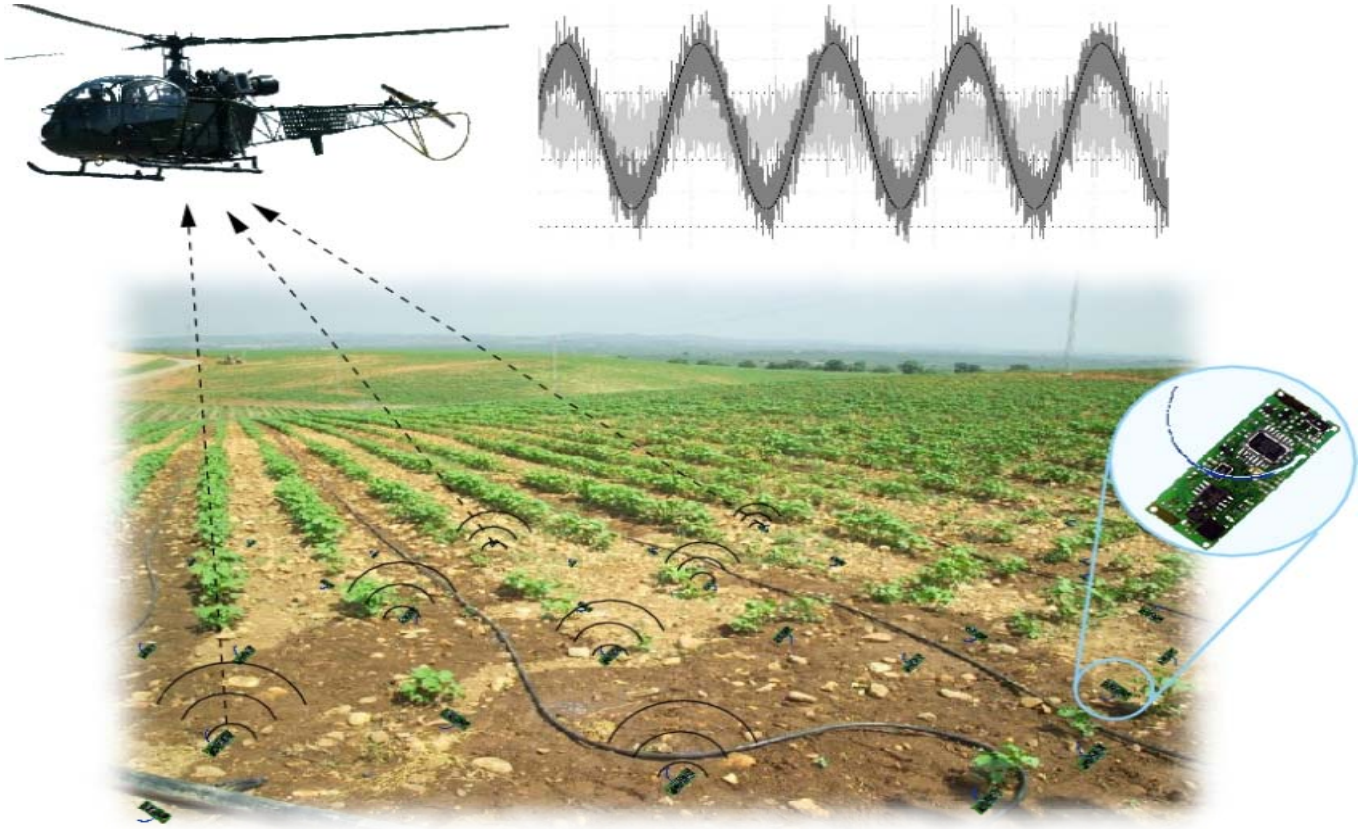
Introduction and motivation

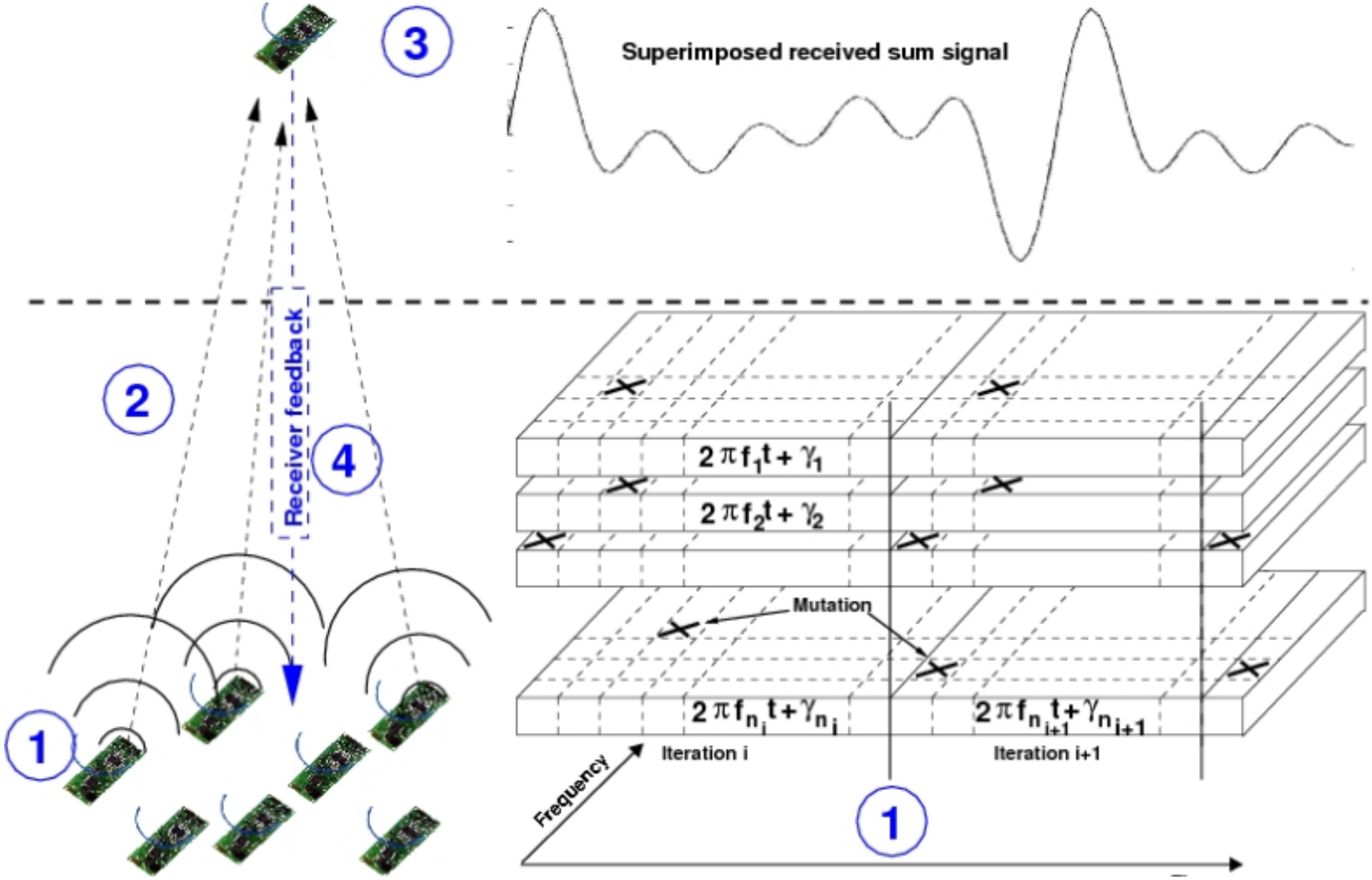
Scenario

- Cooperative transmission strategies for WSNs
- Transmission range restricted nodes reach distant receivers by superimposing transmission signals



Introduction and motivation

Feedback based distributed adaptive beamforming



Introduction and motivation

Feedback based distributed adaptive beamforming

Asymptotic synchronisation times

Evolutionary appproach:

$$\Theta\left(n \cdot k \cdot \log(n)\right)$$

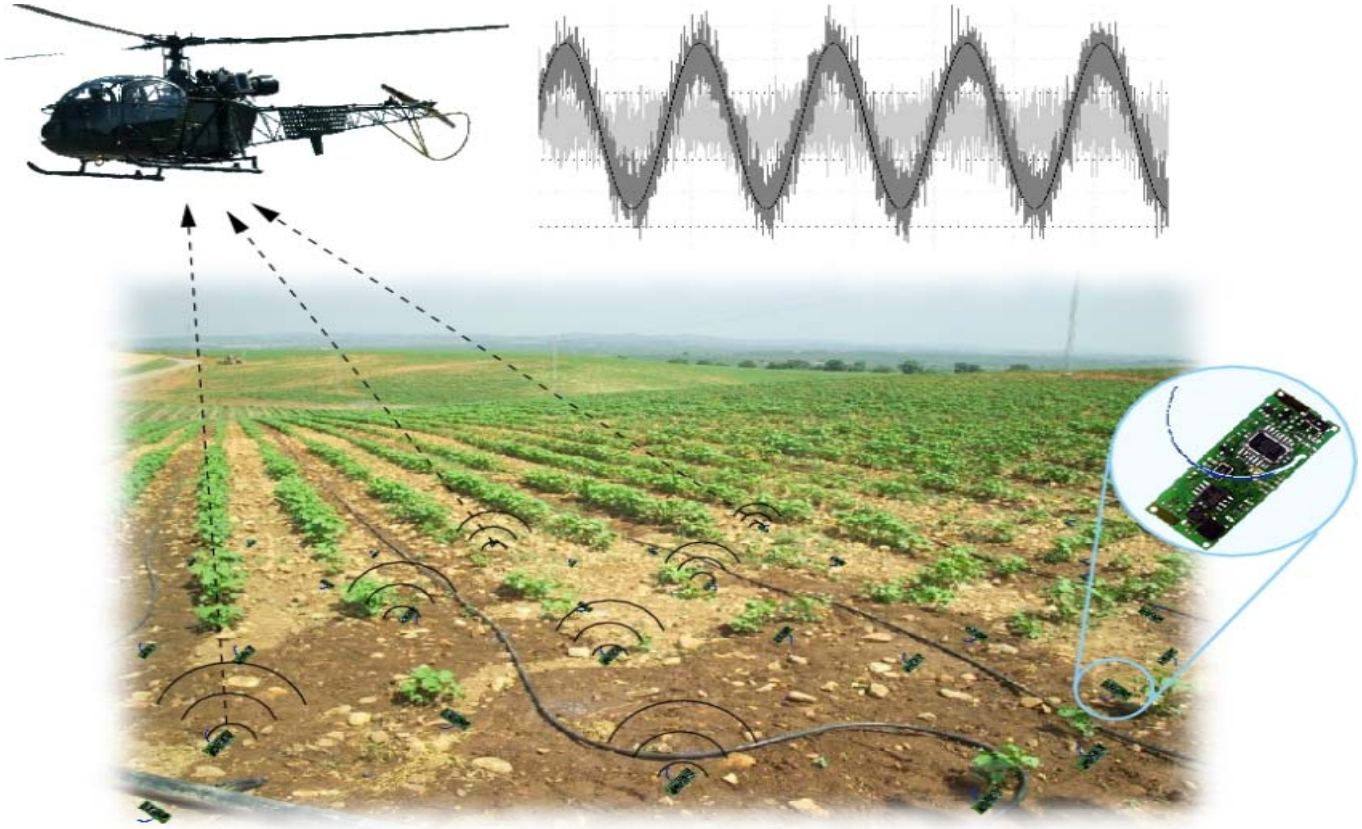
Multivariable equations:

$$\Theta(n)$$

Introduction and motivation

Environmental changes impact synch. performance

- Growth of plants drastically changes channel characteristics [Langendoen2005]
- Changing weather conditions



Motivation

Synchronisation performance dependent on environment

- Indoors/Outdoors
- Network size (count of nodes)
- Transmission distance
- Noise sources
- Reflections and signal damping

Adapt synchronisation parameters accordingly

- Probability to alter the phase of a carrier signal P[*mut*]
- Variance for the random phase adaptation
- Adaptive parameter setting over synchronisation
- Learn typical optimisation progress

Project aims

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- Develop environment-adaptive optimisation scheme
- Evaluate ways to minimise resource requirements of feedback based distributed adaptive beamforming

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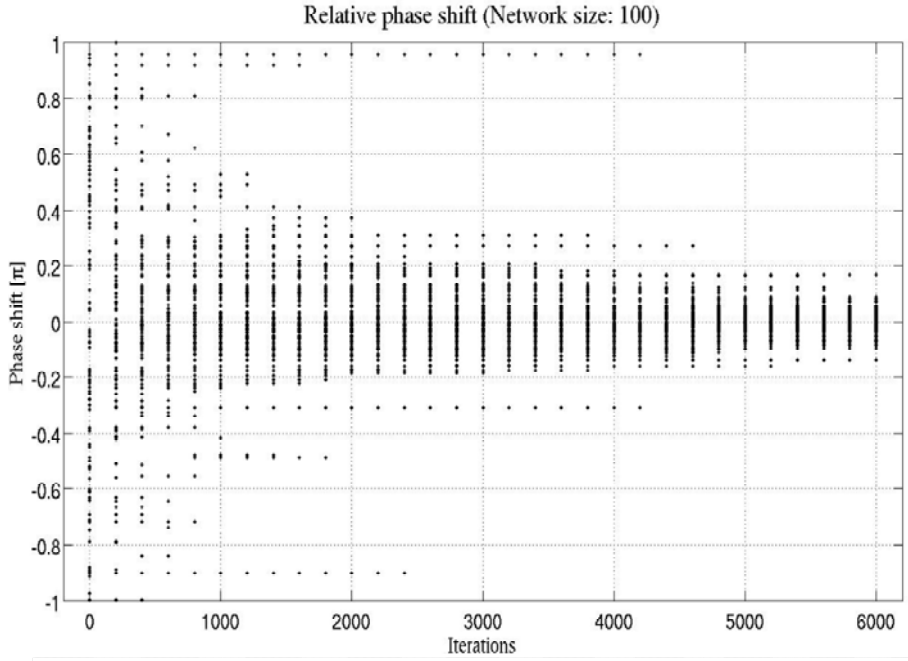


- *At increased noise level, synch. quality for identical P[mut] degrades*
- *With increased P[mut] it is improved*

Research questions

Emergent Radio:

- **Nodes Store progress and Synch. parameters**
  - Optimisation progress
    - Evolution of fitness scores
  - Design parameters
    - P[*mut*]
    - Variance
    - Transmission power
  - Environmental parameters
    - RSSI
    - Noise
    - Transmission distance
    - Node count
- **Learn optimum parameters for environmental setting**

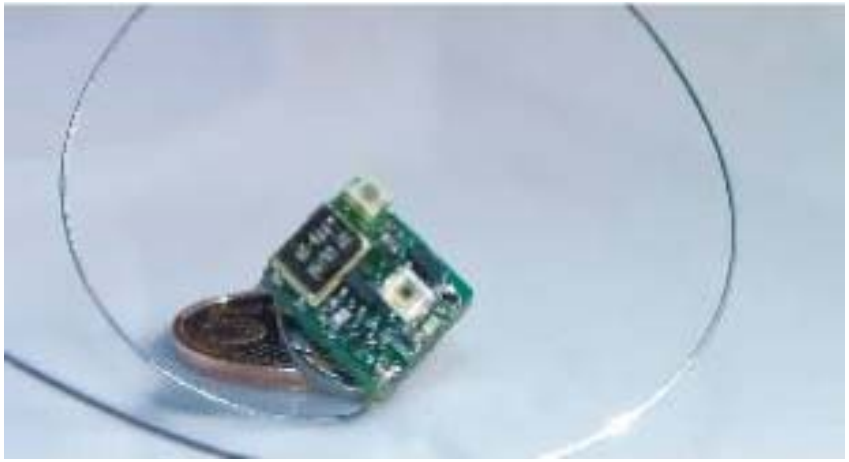
How to obtain these parameters

Some parameters are learned from previous synch.

- P[*mut*]
- Variance
- Synchronisation progress

Others need to be estimated to improve the synch.

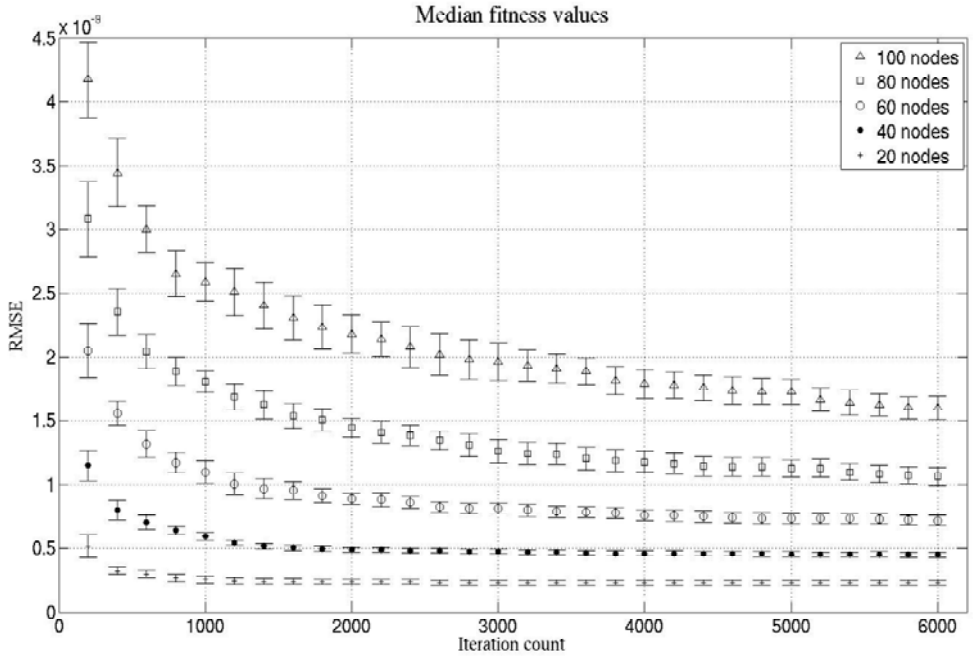
- Network size
  - Improve an approach detailed in [Krohn2007]
- Distance between network and receiver
  - E.g. by estimating the RTT



Research questions

Determine the optimum count of transmitting nodes

- **Tradeoff:**
  - Smaller network -> faster synchronisation
  - Larger network -> increased transmission range

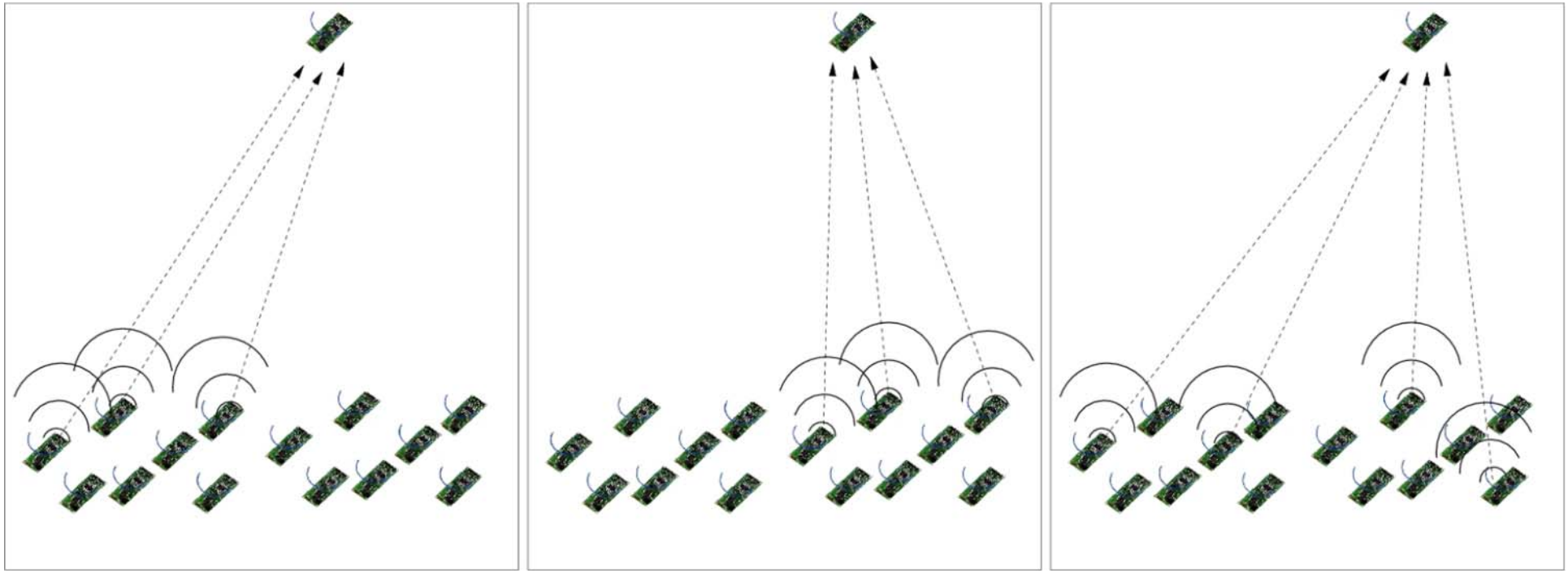


With reduced network size, optimum fitness value is reached earlier

Research questions

Determine optimum set of pre-synchronised nodes

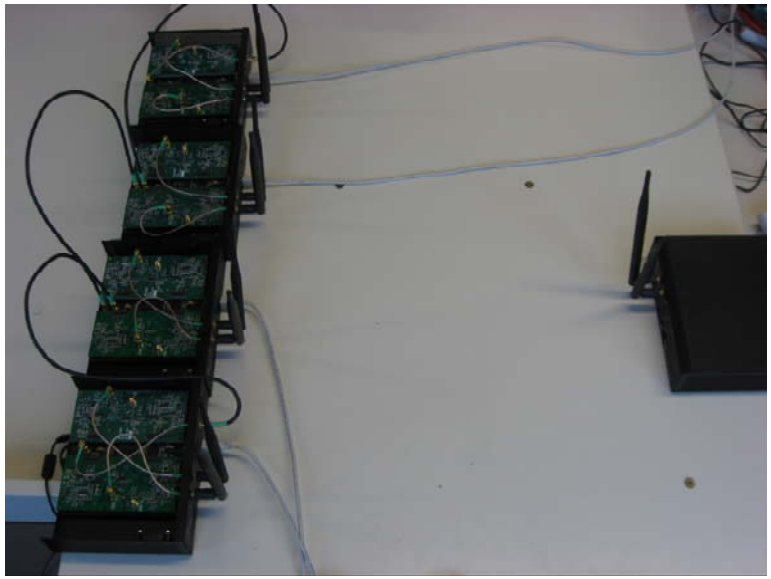
- **When nodes are well pre-synchronised**
  - Synchronisation performance is improved
- **When not all nodes are required**
  - Determine optimum pre-synchronised set of nodes



Investigation

Aspects are studied

- **Analytically**
  - Asymptotic runtime
- **In quantitative simulations**
  - Matlab-based simulation environment
- **In an experimental setup**
  - USRP software radios (9:1)



Questions?

Thank you for your attention.