


# **Self-organisation in Wireless Networks – Use Cases and their Interrelation**



**Dr. Werner Mohr**  
**Nokia Siemens Networks**  
**werner.mohr@nsn.com**  
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# Outline

- Introduction – Drivers for self-organisation
- The SOCRATES project
- Self-organisation use case examples
- Interrelation of use cases
- Conclusions

# Drivers for Self-organisation

## Technical:

- Increasing complexity and size of mobile networks
- Operation of several network generations in parallel
- Paradigm shift from telco specific towards IT networking technologies

## Market:

- Increasing diversity and complexity of offered services
- Reduced time-to-market and lifetime of services
- Enhanced requirements on service quality



**High efforts for radio Network planning and optimisation**



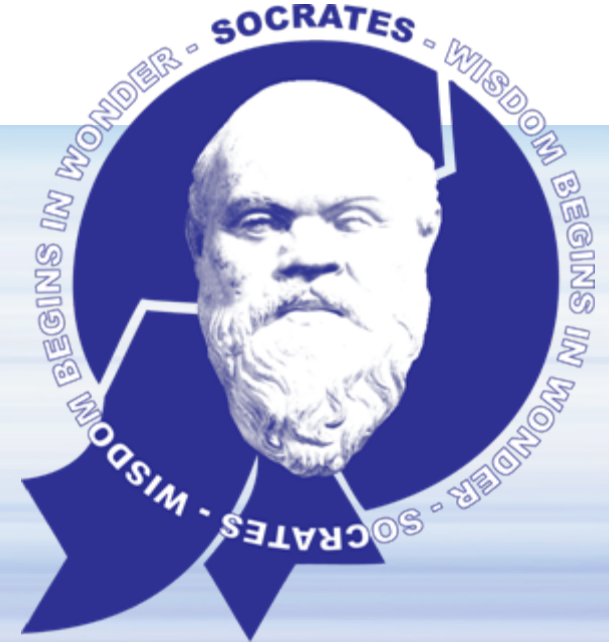
# The SOCRATES Project

## Self-Optimisation and self-ConfiguRATion in wireLESs networks

- STREP project within the EU FP #7
- Duration Jan. 2008 – Dec. 2010

### Goals:

- Development, Evaluation and Demonstration of methods and algorithms for self-configuration, self-optimisation and self-healing
- Improve network coverage, resource utilisation and service quality
- With a focus on 3GPP E-UTRAN, investigation of impact on standardisation, network operations and service provisioning



atesio ERICSSON



IBBT



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vodafone





# SOCRATES Approach

**Measurements:** continuous activity, collection of information from various sources (NE, UE, OAM)

**Parameter settings:** newly calculated / updated parameters are deployed to network elements

**Self-configuration:** for incidental events, e.g., deployment of new NEs or services



**Self-optimisation:** algorithms to intelligently process measurements and update configuration parameters

**Self-healing:** automated fault management to resolve incidental radio and networking errors

# SOCRATES Phases

## Requirements phase:

- Identification of use cases and requirements for self-organisation
- Definition of a self-organisation framework (architecture, assessment criteria for algorithm development, scenarios, operator policies etc.)

## Development phase:

- Detailed solutions (methods and algorithms) for selected self-organisation use cases
- Validation of solutions



Here we are

## Integration phase:

- Integration of solutions with framework
- Demonstration of benefits and implications of solutions
- Dissemination of solutions (standard contrib., workshops)

# SOCRATES Selected Use Cases

Use Case Title	Self-organisation Area
Self-optimisation of Home eNodeB	Self-optimisation
Load Balancing	Self-optimisation
Interference Coordination	Self-optimisation
Packet Scheduling	Self-optimisation
Handover optimisation	Self-optimisation
Admission & Congestion Control	Self-optimisation
Coverage Hole Detection & Compensation	Self-optimisation
Cell Outage Management	Self-healing
Management of Relays & Repeaters	Self-config./Self-opt.
Automatic Generation of Default Parameters	Self-configuration

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## Home eNodeB - Overview

- Home base stations are expected to be extensively used in 3G LTE
- Coverage / capacity extension in limited areas (office / in-house)
- Installed by end user and physically inaccessible for operator
- Characteristics:
  - Small coverage areas, probably few users per cell
  - May be turned on and off frequently, may be switched off and moved
  - Closed or open access
  - May operate on a separate frequency band as the macro eNodeBs (segregated spectrum) or in the same band (shared spectrum)



**Several self-organisation use cases apply for Home eNodeB, with different conditions than for macro network**

# Home eNodeB – Sub Use Cases

- Home eNodeB neighbour relations (including other HeNB and macro)
  - Detect neighbouring eNodeBs
  - Maintain and optimise neighbour cell list
- Home eNodeB handover optimisation (HeNB – macro, HeNB – HeNB)
  - Automatically decide if handover should take place
  - Optimise handover parameters to ensure seamless mobility
- Home eNodeB interference and coverage optimisation
  - Consider the compensation of coverage holes
  - Consider influence on macro network in case the same band is used
  - Consider tradeoff between interference and coverage
- Home eNodeB initialisation and configuration
  - Connection to operator network
  - Define appropriate settings for integration into running network



Selected



Selected

# Home eNodeB - Approach

## Measurements, e.g.

UE Reference Signal Received Power / Quality  
UE last visited cells (UE history), UE Packet loss / delay  
eNodeB Downlink Reference Signal Transmit Power, call drop ratio

## Operator Policies, e.g.

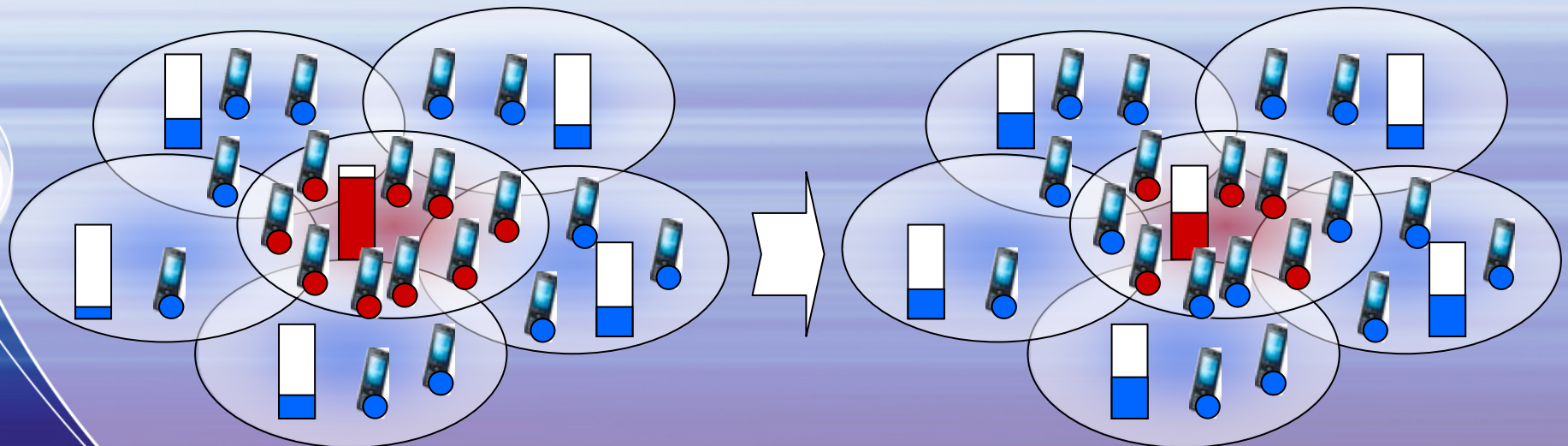
Provide coverage, provide a guaranteed service  
Relieve load from macro cells, with keeping impact on macro network performance low (e.g. handover ping-pong effects, interference)  
Commercial / marketing

## Configuration Parameters, e.g.

Uplink / downlink power settings  
Handover offsets, favouring / discriminating particular cells

# Load Balancing - Overview

- Problem: unequal user distribution, with heavily loaded cells in vicinity of lightly loaded cells
- Goal: detect and compensate load imbalance between cells to
  - Improve resource utilisation
  - Improve Quality / Grade of Service for end users

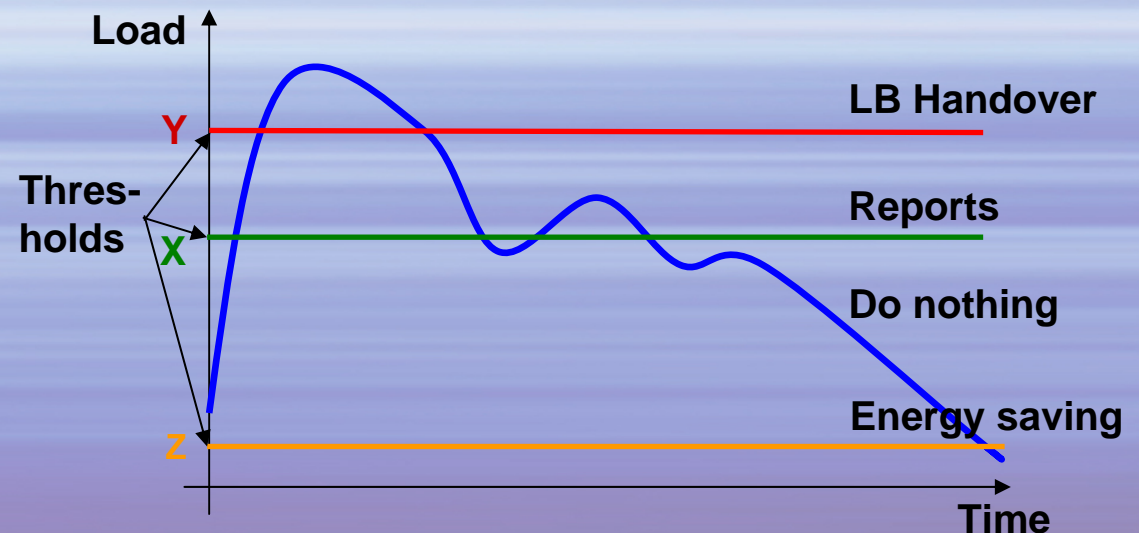




# Load Balancing - Status

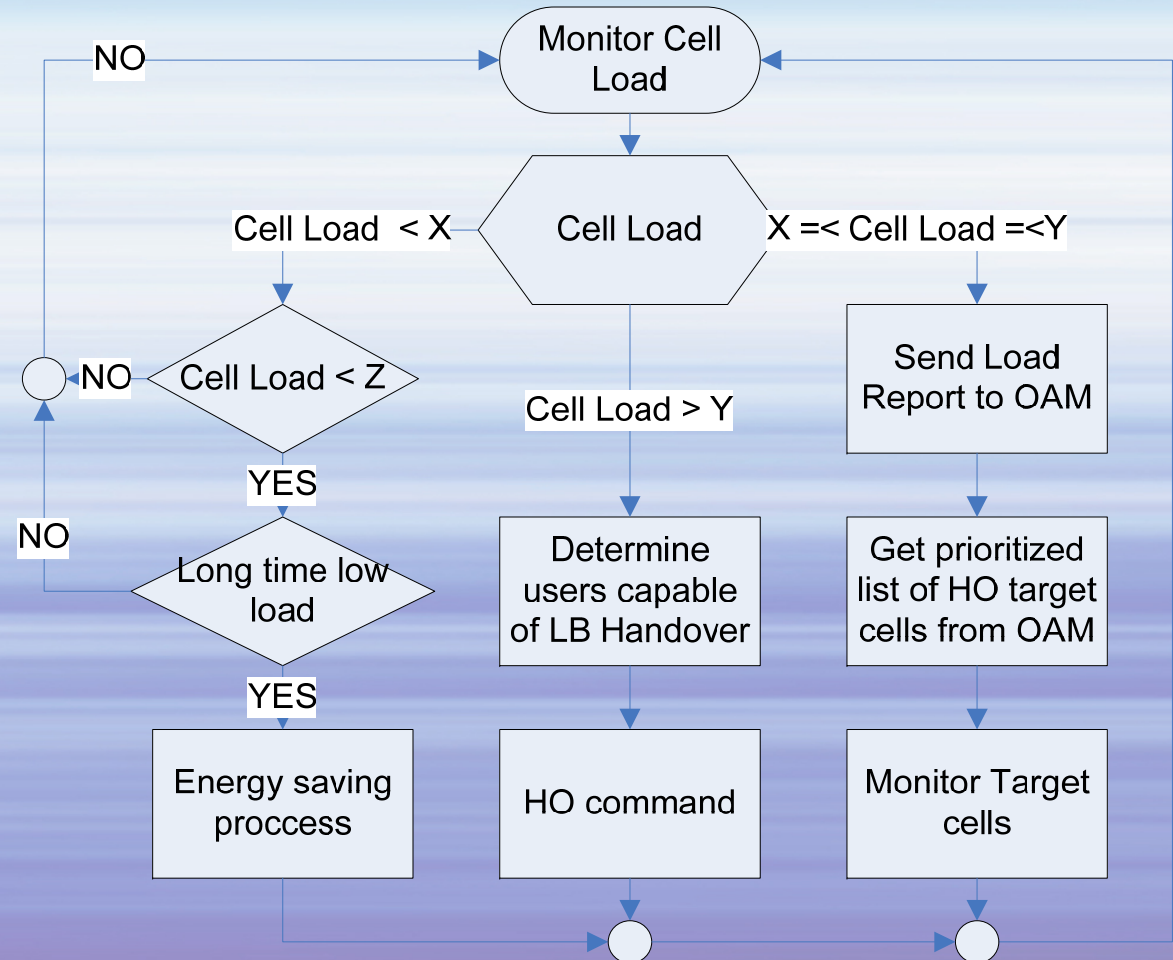
- Only load balancing within LTE system is regarded
- Triggers:
  - Overloaded cell      Load > Y (close to 100%)
  - QoS improvement      Load < Y but higher than in neighbour cells
  - Energy saving      Load << 1 (very low load)

- Thresholds:
  - Keep LB message size and frequency low
  - Set load thresholds to trigger LB functionalities



# Load Balancing – Solution Approach

- Load balancing only works for capacity driven networks with sufficient cell overlaying
- Besides HO of UEs to neighbouring cells, adjustment of cell size & coverage (transmitter power or antenna params.) are possible solutions



**Simplified Load Balancing algorithm**

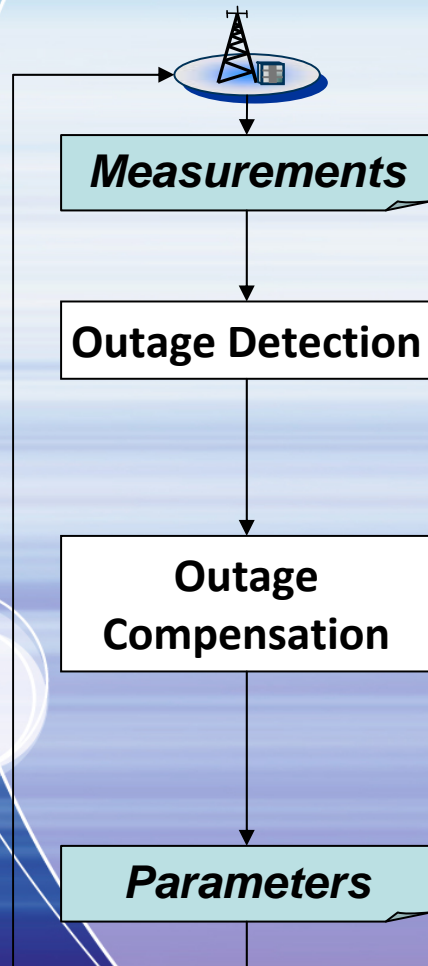
# Cell Outage Management – Overview

- Goal: minimise network performance degradation in case of outage
- Reasons for cell outage:
  - Hardware / software failures (e.g., radio board failure, channel processing implementation error, etc.)
  - External failures (e.g., power supply or network connectivity failures)
  - Erroneous Configuration
- Operator optimisation goals for outage compensation:
  - Achieve the best coverage possible
  - Provide the highest accessibility
  - Deliver the best possible quality in the outage area and surrounding cells



**Not all goals can be reached at the same time, they need to be weighted according to quality, coverage, or capacity policies**

# Cell Outage Management – Solution Approach



Continuous and event-triggered measurements (counters, timers, alarms, KPIs, radio measurements) from various sources (OAM, eNodeBs, UEs)

Outage scenarios: sleeping site / sector, site / sector failure, transport link failure

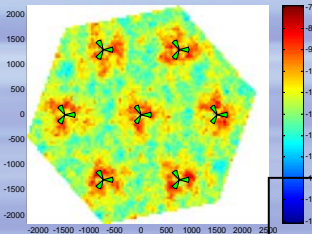
Which surrounding cells are to be taken into account  
 Compensation scenarios: large cells → coverage, high-capacity cells → accessibility, service quality  
 Estimation of compensation results using “X-map”, “X” = coverage, accessibility, packet loss, throughput etc.

Physical channel settings (e.g. power settings)  
 Antenna parameters (tilt, azimuth, multi-ant. techniques)  
 Home eNodeB for compensation or to reduce interference

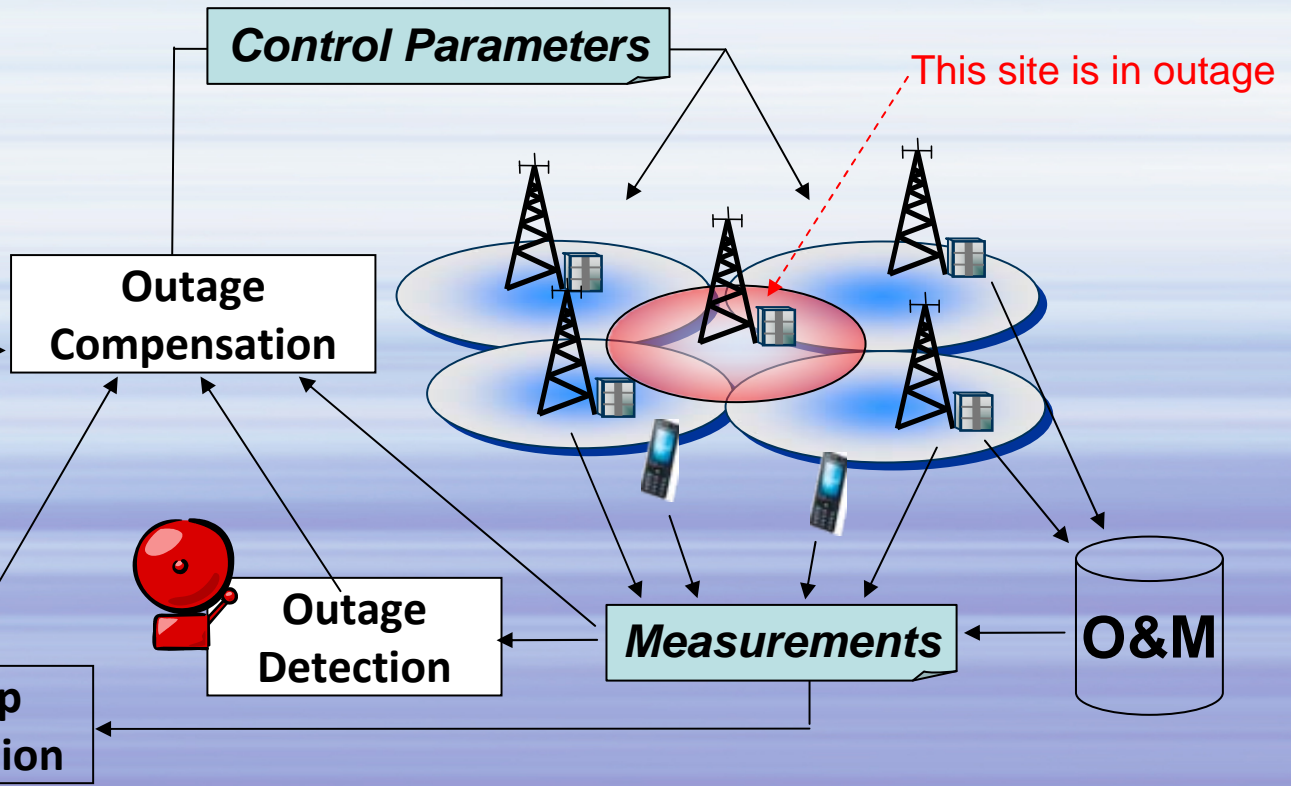


# Cell Outage Management – Solution Approach

**Operator policy:  
Coverage, QoS**



**X-map  
estimation**



This site is in outage

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## Interrelation of Use Cases

- Each self-organisation use case modifies a set of configuration *Parameters* (dedicated configuration setting) in the corresponding network elements to achieve the intended self-configuration, self-optimisation or self-healing *Goals* (high-level target of self-organisation)
- Several use cases are running in parallel, and therefore several self-optimisation functionalities may alter the same configuration parameters

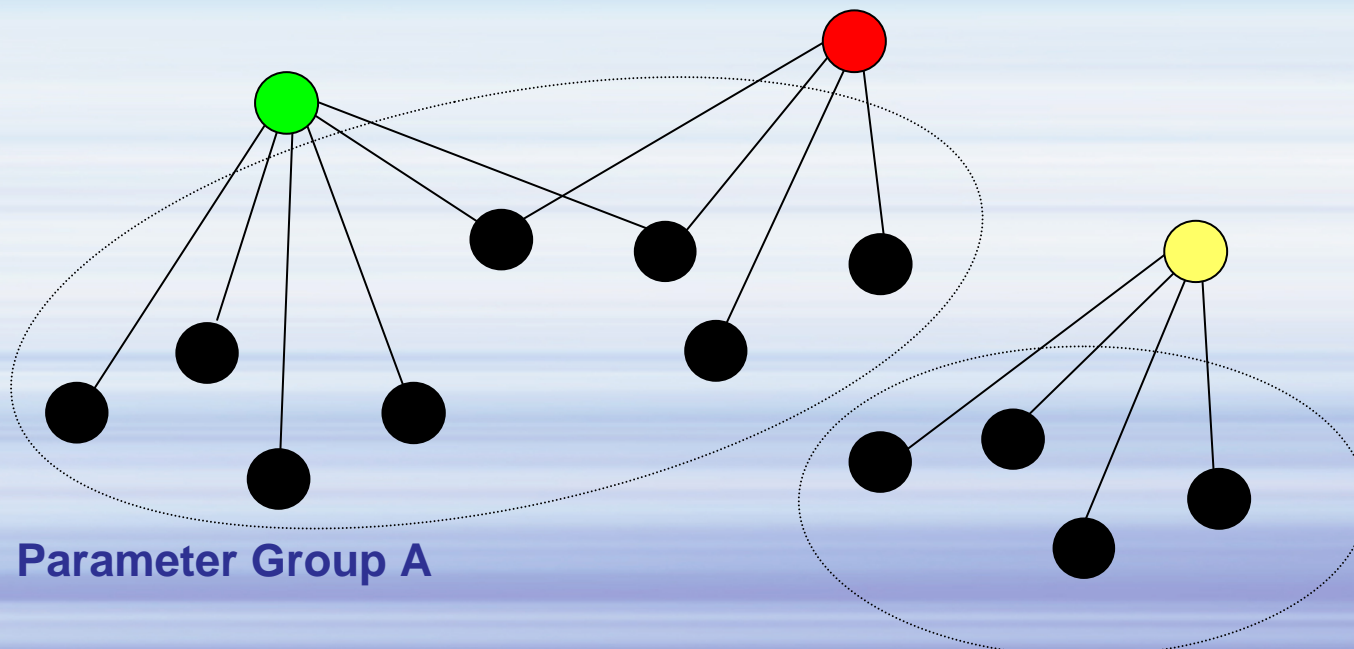


**All over system performance may depend on conflictive parameter adjustments**



**Interaction of self-organisation functionalities needs to be analysed, to identify functionalities that need to be coordinated**

# Configuration Parameter Grouping - Example



Parameter Group A

Parameter Group B

Goal A

Goal B

Goal C

Parameter

Contributor Relation (correlation between high-level goal and given parameter)



# Goals and Parameters - Examples

Goal	Parameters
Minimise interference	<ul style="list-style-type: none"><li>• <b>Radio bearer transmit power</b></li><li>• Radio bearer assignment</li><li>• <b>Antenna parameters</b></li><li>• Channel quality indicator thresholds for schemes switching</li></ul>
Balance load	<ul style="list-style-type: none"><li>• <b>Radio bearer transmit power</b></li><li>• <b>Antenna parameters</b></li><li>• Handover parameters</li><li>• Cell re-selection parameters</li></ul>
Maximise / Optimise coverage	<ul style="list-style-type: none"><li>• <b>Radio bearer transmit power</b></li><li>• <b>Antenna parameters</b></li></ul>

# Conclusions

- Each single use case requires considerable effort regarding
  - Analysis of input data, measurements, and configuration parameters
  - Development of solution algorithms and deployment scenarios
  - Evaluation of impact to OAM and RAN architecture
- Self-organisation is to be regarded as a whole
  - Use cases are not independent of each other regarding their influence on the system configuration and parameters
  - Self-organisation goals have to be defined as system goals, and these system goals have to be broken down to the single use case goals
  - For the development of self-organisation solutions, the solutions of single use-cases have to be coordinated and integrated

# Contact

SOCRATES Project Website: [www.fp7-socrates.org](http://www.fp7-socrates.org)

## Authors of WWRF 22 contribution:

L.C. SCHMELZ (Nokia Siemens Networks, Munich, Germany)  
J.L. VAN DEN BERG, R. LITJENS (TNO ICT, Delft, The Netherlands)  
M. AMIRIJOO, K. ZETTERBERG (Ericsson, Linköping, Sweden)  
K. SPAEY, I. BALAN (IBBT, Gent-Ledeberg, Belgium)  
N. SCULLY (Vodafone, Newbury, United Kingdom)  
S. STEFANSKI (Nokia Siemens Networks, Wroclaw, Poland)

## Contact:

Dr. Werner Mohr  
Nokia Siemens Networks GmbH & Co. KG  
80240 München Germany  
werner.mohr@nsn.com

Lars Christoph Schmelz  
Nokia Siemens Networks GmbH & Co. KG  
80240 München Germany  
lars.schmelz@nsn.com