Self-Organisation in LTE - Results of the FP7 SOCRATES project

34. Treffen der VDE/ITG-Fachgruppe
Universität Stuttgart

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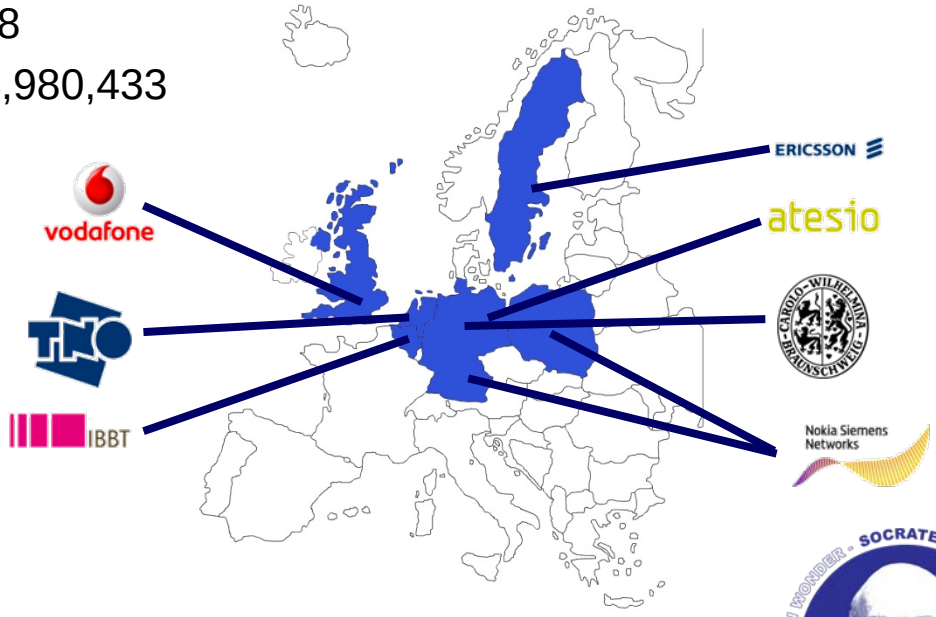
Outline

1. The SOCRATES Project
2. SON use cases
3. Realistic simulation scenario
4. Stand-alone use cases
5. Integration use cases
6. Summary

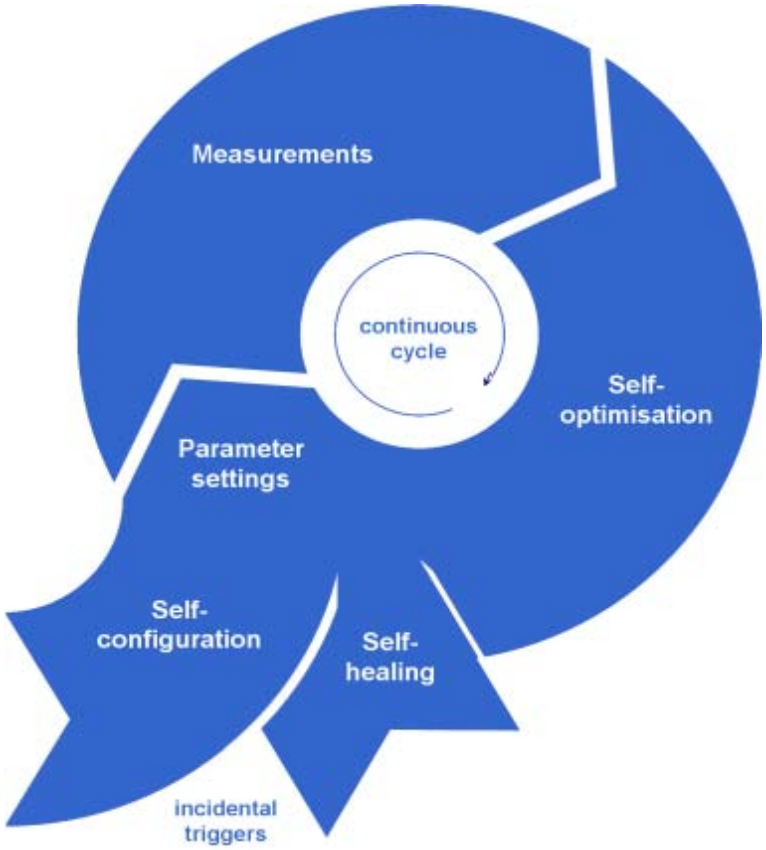
Project overview: facts and figures

- SOCRATES
  - Self-Optimisation and self-ConfiguRATion in wirelEss networkS
- Project period
  - 3-year duration: From 01/01/2008 until 31/12/2010
- Effort
  - Number of person months: 378
  - Total project costs: € 4,980,433
- Consortium



Project overview: key issues

- Self-organisation in wireless networks
  - Self-optimisation
    - measurements, processing, parameter adjustment, …
    - continuous loop
  - Self-healing
    - failure detection
    - automatic minimisation of coverage/capacity loss
  - Self-configuration
    - e.g. ‘plug-and-play’ of new base stations
- Focus on 3GPP LTE (E-UTRAN)



Use cases: self-optimisation

- Radio network optimisation
  - Interference coordination
  - Self-optimisation of physical channels
  - RACH optimisation
  - Self-optimisation of home eNodeB
- GOS/QoS related parameter optimisation
  - Admission control parameter optimisation
  - Congestion control parameter optimisation
  - Packet scheduling parameter optimisation
  - Link level retransmission scheme optimisation
  - Coverage hole detection
- Handover related optimisation
  - **Handover parameter optimisation**
  - **Load balancing**
  - Neighbour cell list
- Others
  - Reduction of energy consumption, Tracking areas, TDD UL/DL switching point, Management of relays and repeaters, Spectrum sharing, MIMO

For each use case:

- Description
- Objective
- Parameters
- Triggers
- Required measurements
- Architect. aspects
- Potential gain
- Related use cases
- References (NGMN, …)
- ….

Use cases: self-configuration and -healing

- Self-configuration
  - Intell. selecting site locations
  - Automatic generation of default parameters for NE insertion
  - Network authentication
  - Hardware/capacity extension
- Self-healing
  - Cell outage prediction
  - Cell outage detection
  - Cell outage compensation
- Supporting Function
  - X-Map-Estimation

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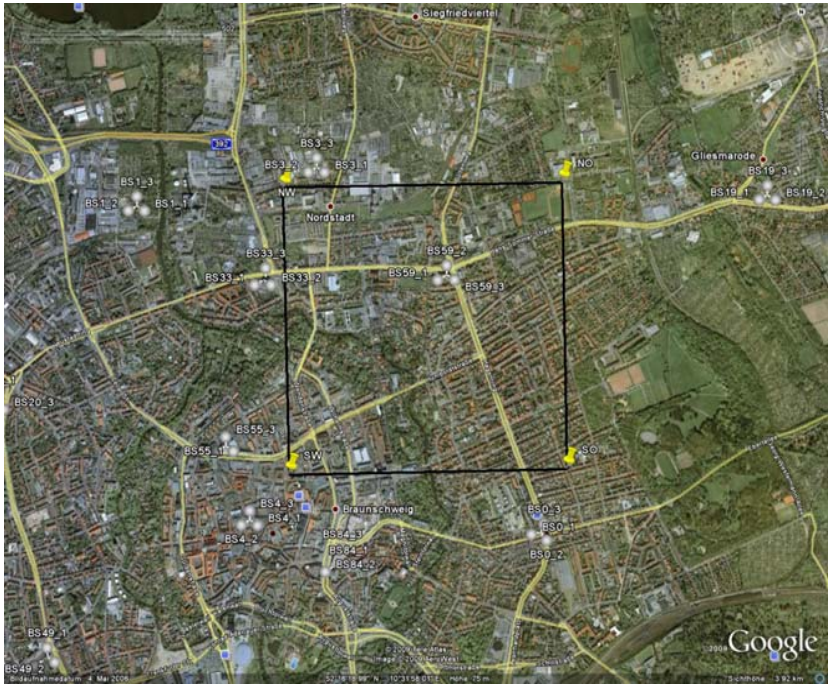
Realistic SOCRATES Scenario

- City area of 1.5 km x 1.5 km in Germany
- 50 mobile users traces derived with the help of a road traffic simulator (SUMO)
- Network information available (site location, sector orientation, tilt)
- Realistic path loss predictions at 2.6 GHz
  - used for determining 30 strongest cells for each user position
- Land-use classes converted from Openstreetmap



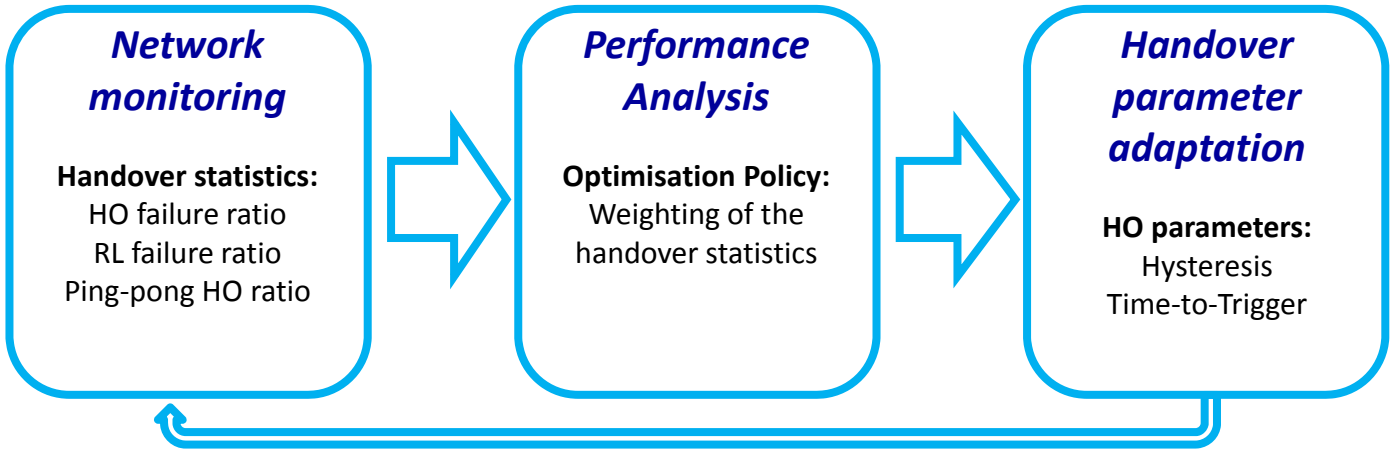
Source: Google Earth 5.0

Realistic SOCRATES Scenario

- Introducing mobility using SUMO (Simulation of Urban MObility)
  - microscopic road traffic simulator

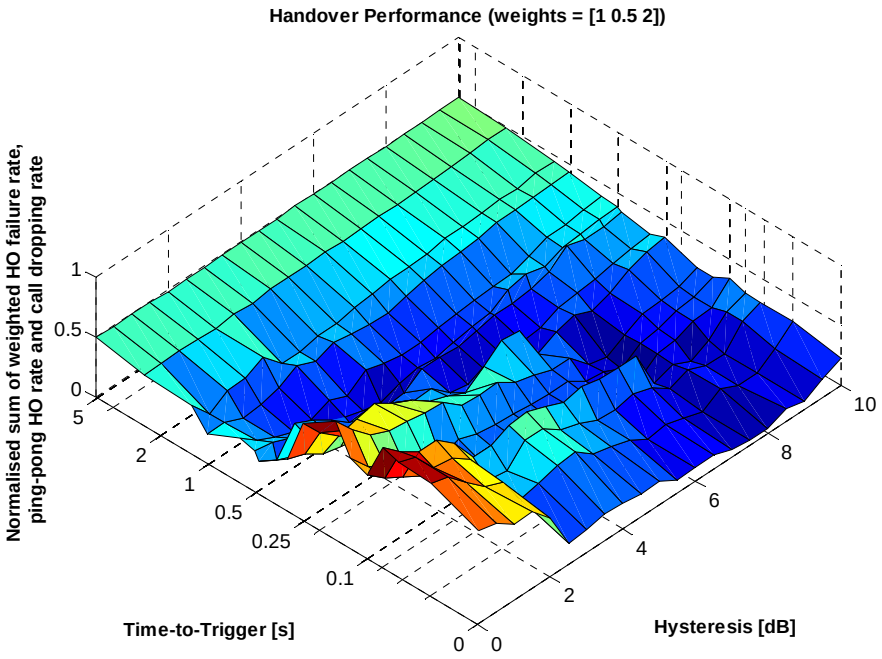
Handover parameter optimisation: Goal and Approach

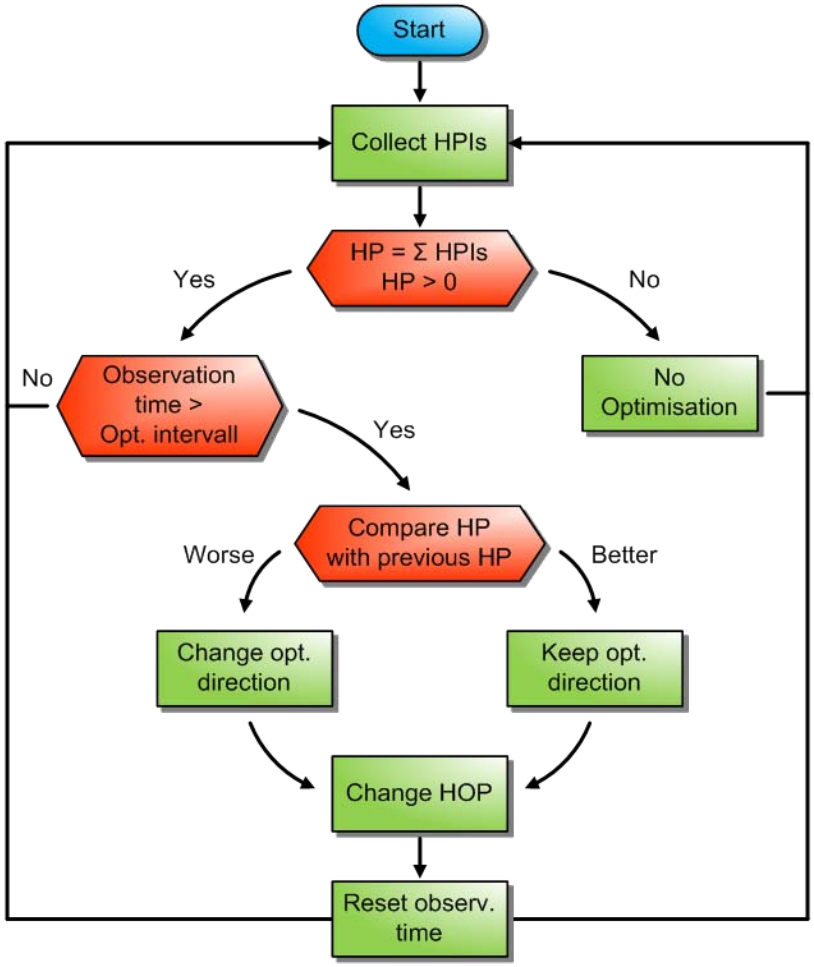
- Goal:
  - Improved handover performance
  - Reduced number of handover failures
  - Reduced number of “ping-pong” handovers
  - Reduced number of radio link failures
- Approach:
  - Optimisation based on handover performance indicators (HPIs)
  - Analysis of the current handover performance
  - Adaptation of handover control parameters



Handover parameter optimisation: HO Algorithm

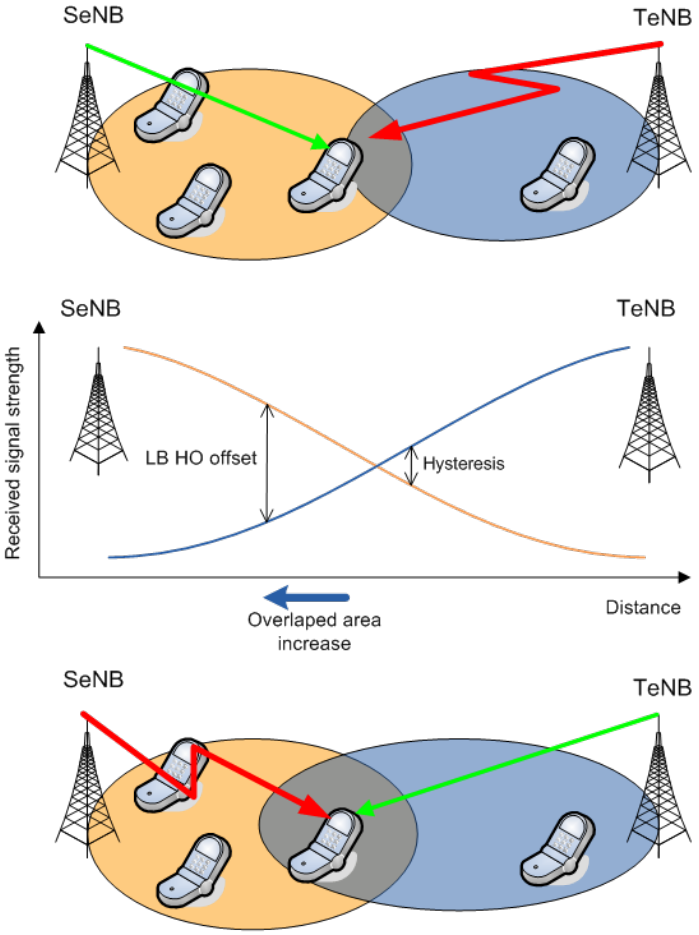
- **$HP = w_1 HPI_{HOF} + w_2 HPI_{HPP} + w_3 HPI_{RLF}$**
  - w_x is the weight of the individual HPI
- Handover operating points are chosen from a limited set





Load balancing: Goal and Approach

- Problem
  - Users concentrate in the area served by one cell
  - Unequal load distribution causes an overload
  - Users can not be served with required quality level due to lack of resources
- Main Idea
  - Reallocate some users from the overloaded cell to less loaded neighbour cell(s)
  - Overloaded (SeNB) cell must find neighbouring cell(s) (TeNB) which may accommodate additional load
  - SeNB adjusts the HO offset of the TeNB and forces users to HO to the TeNB
- Result
  - TeNB increases the overlapping area and takes over some users previously served by the SeNB
  - LB operation sets free resources at SeNB
  - SeNB is able to serve remaining users with the required QoS



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   - Load balancing and handover optimisation
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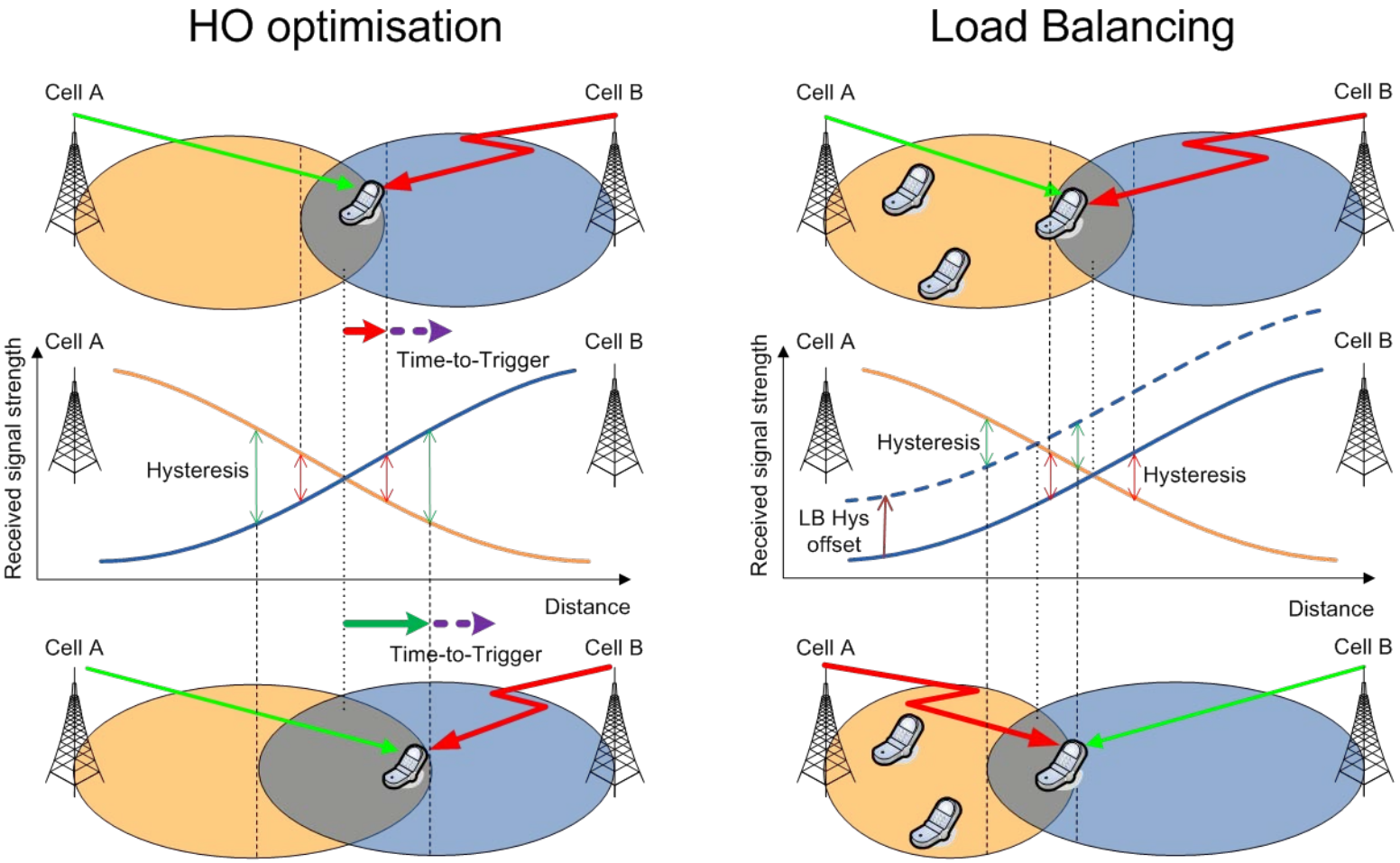
Integration use cases: Goals

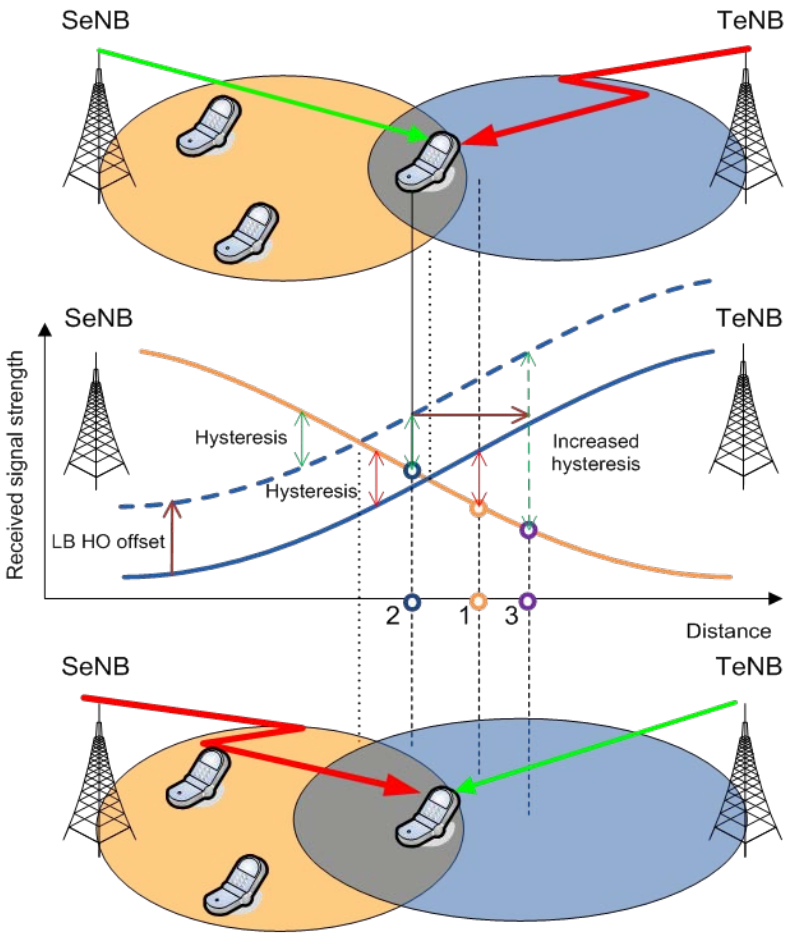
- 5 different integration use cases have been selected
  - Admission control and handover optimisation (AC & HO)
  - Handover optimisation and load balancing (HO & LB)
  - Interference coordination and packet scheduling (ICO & PS)
  - Macro and home eNodeB handover optimisation (Macro HO & HeNB HO)
  - Automatic generation of default parameters and handover optimisation (AGP & HO)
- Analyse the impact on and interaction between multiple use cases
- Develop concepts for coordination

Handover optimisation and load balancing: Interaction analysis



Handover optimisation and load balancing: Interaction analysis

- The SeNB is overloaded (1)
- The load balancing algorithms hands over users to the TeNB and increases the hysteresis offset of the TeNB (1->2)
- The HPI (radio link failure) of the TeNB increases
- The handover algorithm decreases the hysteresis of the TeNB (3)
- The users hand back to SeNB
- Overall situation is worse than before



Handover optimisation and load balancing: Simulation results

SON algorithm	Unsatisfied users	HO pp ratio	HO failure ratio	Radio Link Failure ratio
	#	%	%	%
Reference	12.76	0.43	1.66	13.62
HO optimisation	11.24	1.97	0.71	6.67
LB only	3.63	4.91	4.22	26.65
LB + HO opt.	2.84	5.11	1.87	16.62

- The handover optimisation and load balancing algorithms interact with each other
- Coordination between the algorithms is needed

Summary

- Stand-alone use case algorithms have been developed
- Significant gain in system performance can be achieved
- Use case algorithms interact with each other
- Two types of conflicts have been observed
  - Control parameter conflict
  - Observation parameter conflict
- Coordination between these algorithms is needed
- The results of the integration use cases are currently documented

Thank you very much for your attention

Call for Papers:
International Workshop on Self-Organizing Networks (IWSON)
at VTC2011-Spring BUDAPEST Beyond the Generations Game

May 15, 2011

- http://www.ieeevtc.org/vtc2011spring/workshops.php
- Scope:
  - SON for mobile networks (radio / core / transport) as enabler for efficient network operation
  - Focus on 3GPP technologies (LTE)
  - Results from industry and academia
  - Keynote, papers, posters & demonstrations
- Topics: self-configuration, -optimization, -healing, supporting SON functions and technologies
- **Submission deadline: November 15, 2010**
- Organizers: ERICSSON, Nokia Siemens Networks, Technische Universität Braunschweig