FP7 ICT-SOCRATES

Self-Organisation in LTE Networks

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Outline

- Introduction
  - Motivation for Self-Organisation
  - FP7-ICT-SOCRATES
- Exemplary Description of SON-functionalities
  - X-Map-Estimation
  - Handover Optimisation
- Concluding Remarks

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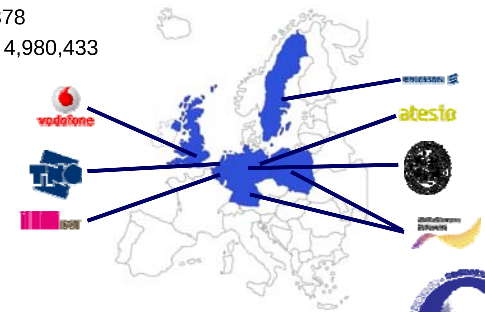
Introduction

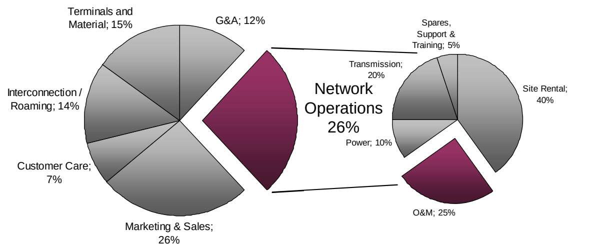
Project overview: facts and figures

- 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: main drivers for self-organisation

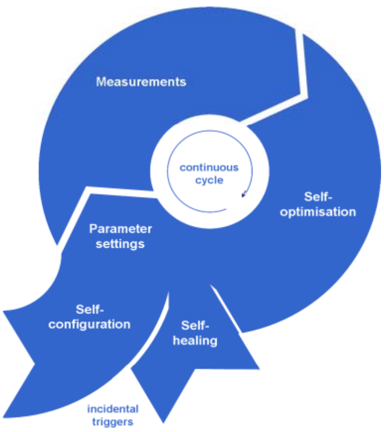
- Increasing network complexity requires increasing operational effort
  - new technologies, multi RAT; advanced services, high demand
- Effectuate substantial OPEX reductions
  - minimise human involvement
- Optimise network efficiency and service quality
  - CAPEX reduction
- Enhance robustness/resilience in case of failures



Sources: "Top down analysis of operator OPEX and Capex". Yankee Group, Feb 2006
"Operator BC for P3 with focus on reductions on OPEX", March 2005, 221 02-FGC 101 456 Uen, rev. A

Project overview: key issues

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



Project overview: objectives

Main Objectives

- Development of concepts**,** methods and algorithms for self-organisation
  - e.g. handover parameters, antenna parameters, admission control parameters, …
- Specification of the required measurements
  - statistical accuracy, methods of retrieval, needed protocol interfaces
- Validation and demonstration of the solutions
  - using simulation tools
- Assessment of the operational impact
  - e.g. radio network planning and capacity management processes
- Influence on 3GPP standardisation and NGMN activities

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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X-Map-Estimation

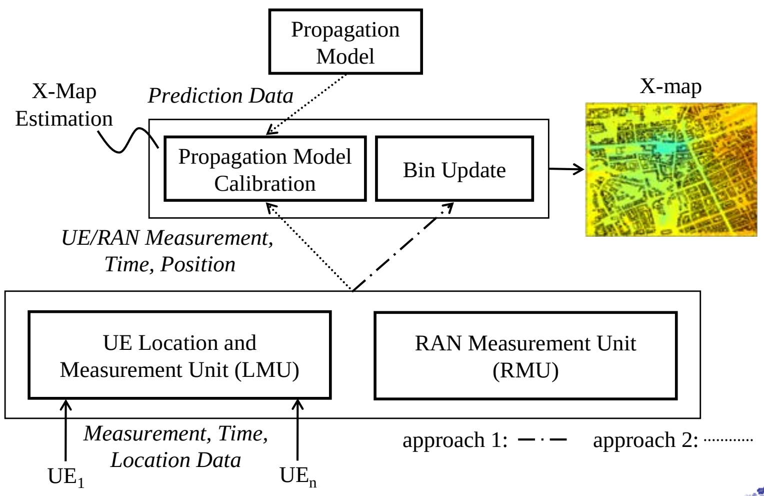
Motivation

- Drive/walk tests are used for radio network planning and optimisation today
  - expensive
  - cover only a limited part of the network
  - capture only a snapshot in time

⇒ use mobiles as probes for the service quality

- X-map estimation function
  - continuously monitors the network
  - estimates the spatial characteristics of the network, e.g., coverage or throughput
  - connects the UE measurements to an estimated geographic position
  - may use other sources of information, e.g. prediction data
- X-map is a geographic map with overlay performance information depending on
  - the positioning accuracy
  - the UE measurement accuracy
  - the number of measurements taken

X-map estimation approach



Simulation scenario

- city area of 1.5 km x 1.5 km in Germany
- 20 mobile users traces derived with the help of 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
  - reference for determining accuracy of the X-maps
- satellite orbits for a specific day and time

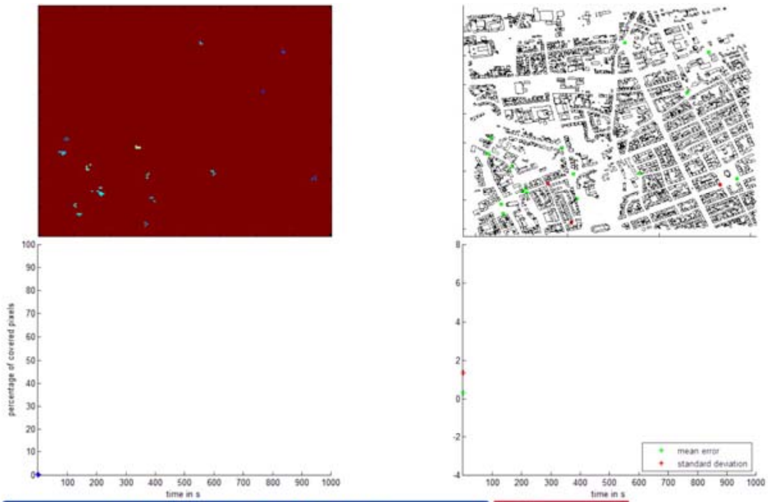
Source: Google Earth 5.0

Position Error Modelling

- For LTE, three different localisation methods are foreseen
  - Assisted Global Positioning System (A-GPS)
  - Observed Time Difference of Arrival (OTDOA)
  - Enhanced cell ID positioning method
- Model for the minimum mean square position error based on the Cramér-Rao lower bound found in the literature*
- This model is based on the
  - geometry of eNodeBs / satellites and the UE
  - number of measured signals
  - standard deviation of the measurement error

* C. Fritsche and A. Klein, “Cramér-Rao Lower Bounds for Hybrid Localization of Mobile Terminals”, 5th Workshop on Positioning, Navigation and Communication (WPNC ‘08), March 2008

Demonstration for approach 1



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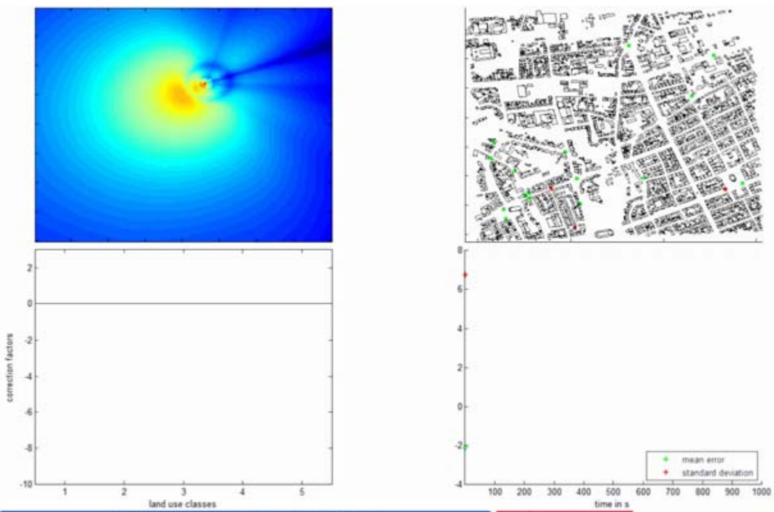
Demonstration for approach 2



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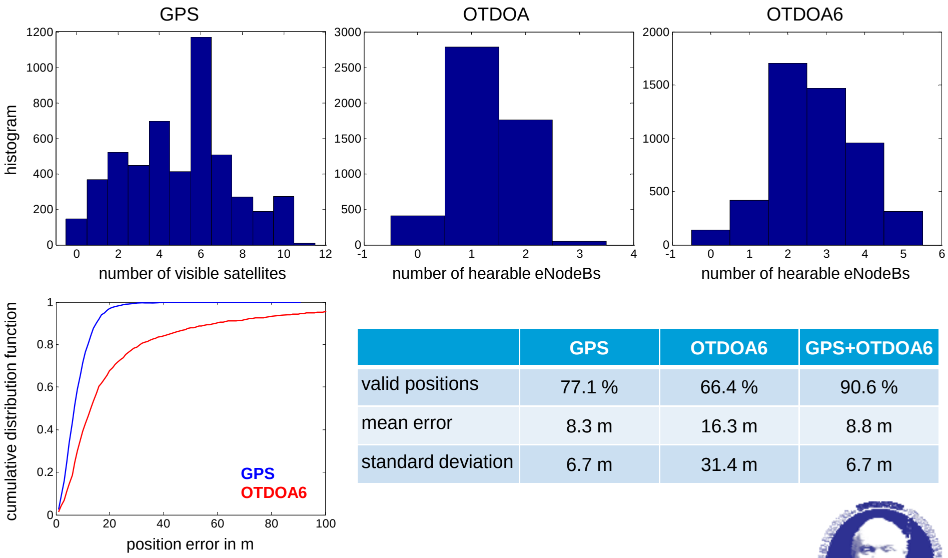
Position error modelling



	GPS	OTDOA6	GPS+OTDOA6
valid positions	77.1 %	66.4 %	90.6 %
mean error	8.3 m	16.3 m	8.8 m
standard deviation	6.7 m	31.4 m	6.7 m

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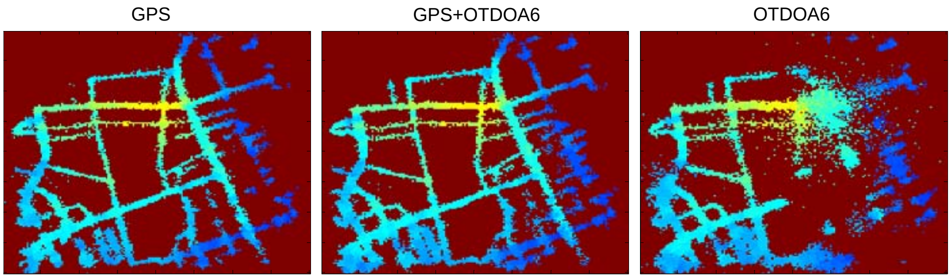
Comparison of X-maps with different positioning methods



	approach 1		approach 2	
	μ	σ	μ	σ
GPS	0.1	2.3	2.6	6.6
GPS+OTDOA6	0.0	2.3	2.9	6.7
OTDOA6	0.0	4.6	4.6	6.7

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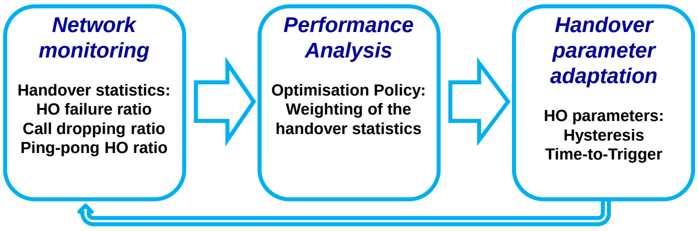
Handover Optimisation

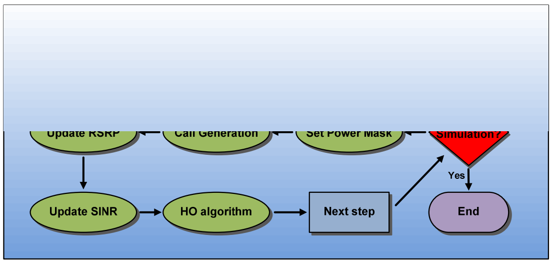
Goal and Approach

- Goal:
  - Improved handover performance
  - Reduced number of handover failures
  - Reduced number of “ping-pong” handovers
  - Reduced number of call drops
- Approach:
  - Optimisation based on handover statistics
  - Analysis of the current handover performance
  - Adaptation of handover control parameters



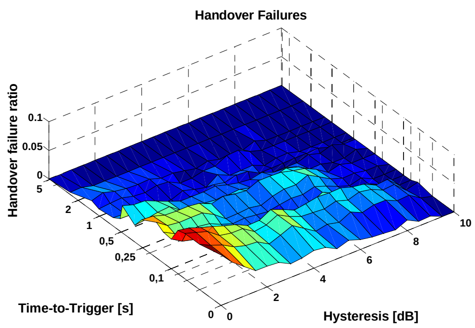
Simulation set-up

- Network
  - LTE FDD, 2.6 GHz, 10 MHz bandwidth
  - Realistic network layout:
  - Realistic pathloss data (10m/100m resolution)
- User mobility
  - Microscopic road traffic simulator (SUMO)
  - Detailed model (traffic lights, diff. speed, …)
- LTE System-level simulator



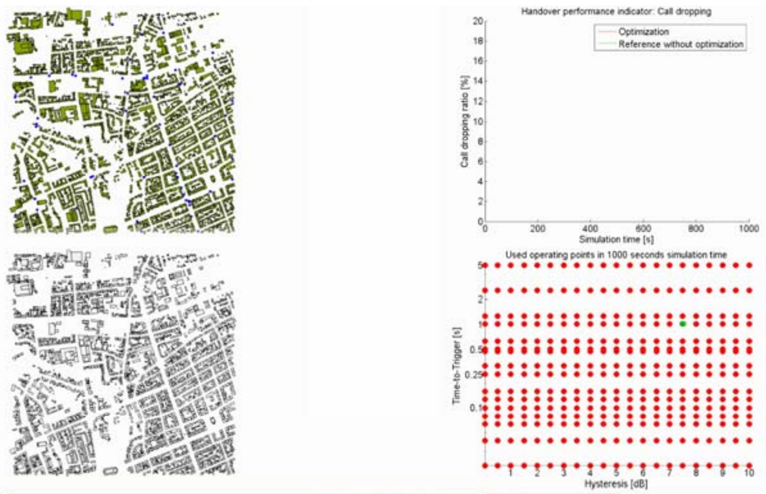
Oberservability study

- Analysis of the handover performance in all handover operating points
  - Hysteresis: 0 – 10 dB (0.5 dB steps)
  - Time-to-Trigger : 0 – 5.12 s (18 steps 3GPP)



- Weighting function for all handover performance indicators:
  - HP = w1 HPIHOF + w2 HPIHPP + w3 HPIDC

Demonstration of HO optimisation



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Concluding remarks

- Concept of SON in LTE networks
  - Use cases defined in 3GPP and NGNM
  - Use cases considered in SOCRATES
- First (exemplary) results based on simulations in realistic scenarios
  - X-Map-Estimation
  - Handover Optimisation
- For more information (deliverables, papers, events, …): WWW.FP7-SOCRATES.EU

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Thank you very much for your attention

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