

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




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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**



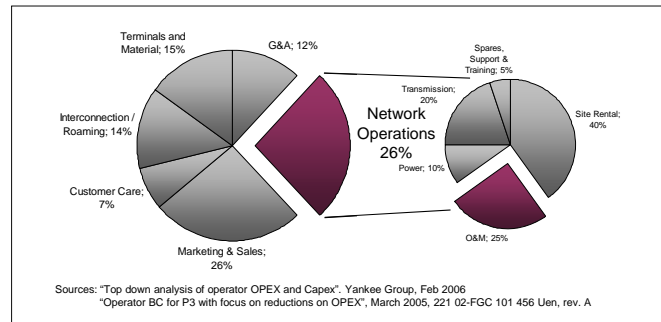
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Project overview: main drivers for self-organisation

- 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



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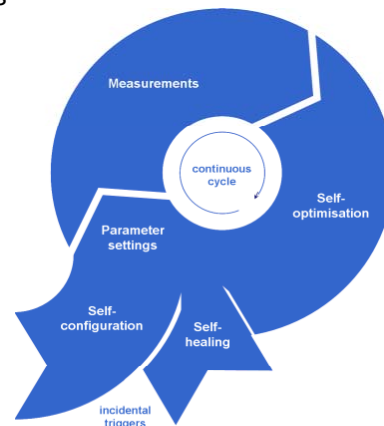
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Project overview: key issues

- 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



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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

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Next-Generation
Networks

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, ...)
-

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Next-Generation
Networks

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



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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



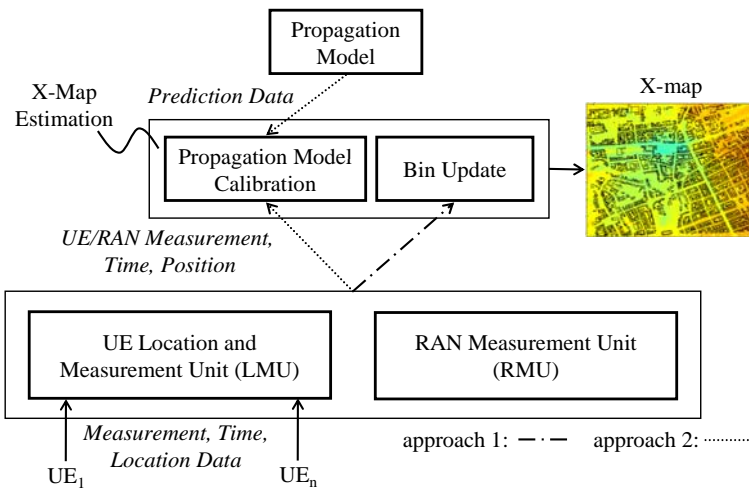
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X-map estimation approach



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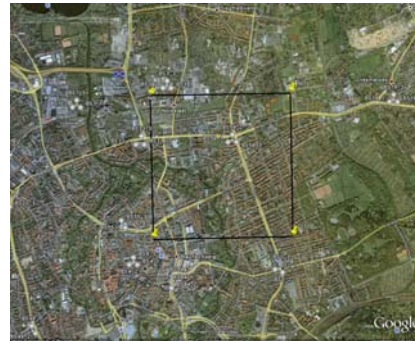
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Simulation scenario

- 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

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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

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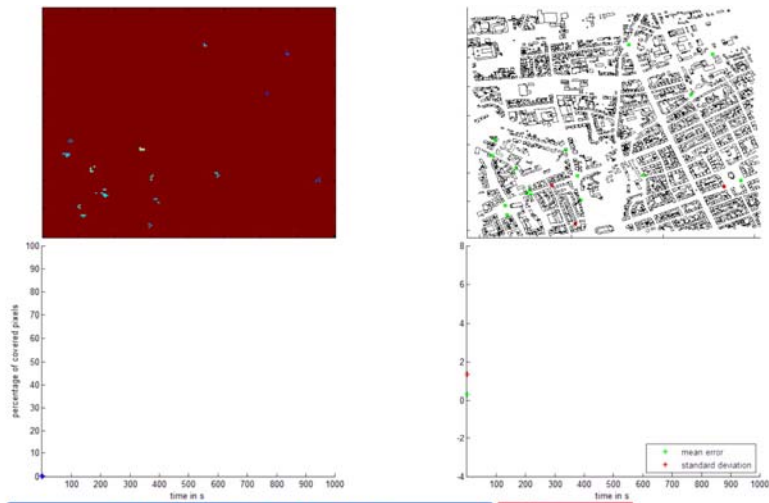
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Demonstration for approach 1



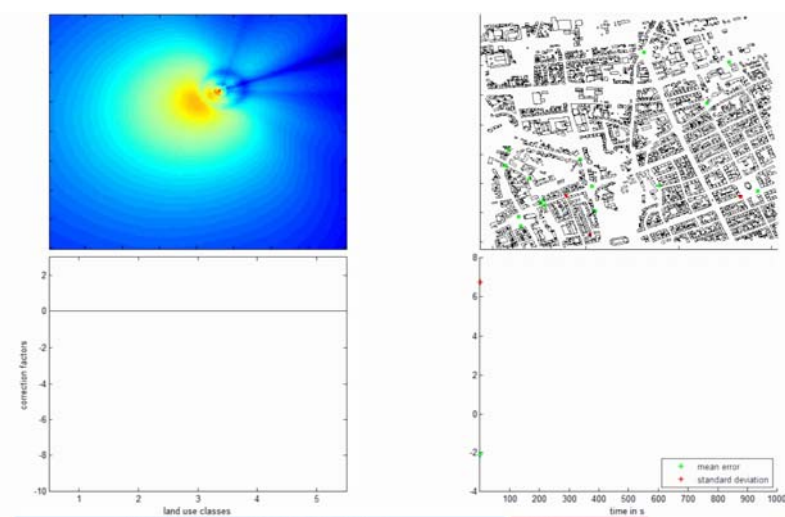
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Demonstration for approach 2

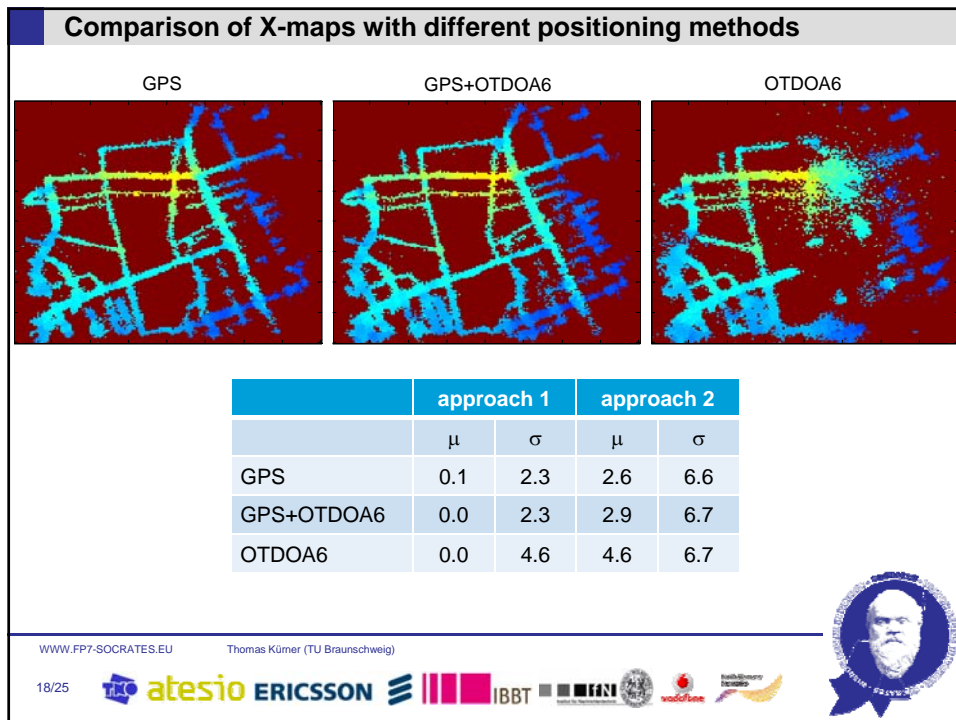
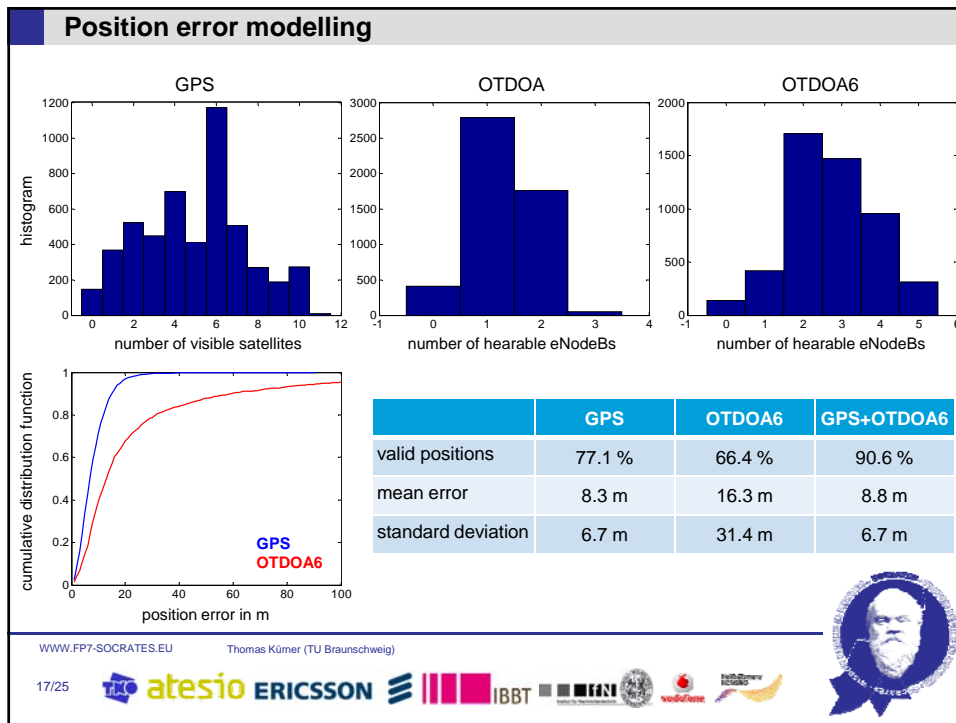


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Handover Optimisation



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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

Network monitoring

Handover statistics:
HO failure ratio
Call dropping ratio
Ping-pong HO ratio

➔


Performance Analysis

Optimisation Policy:
Weighting of the handover statistics

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Handover parameter adaptation

HO parameters:
Hysteresis
Time-to-Trigger



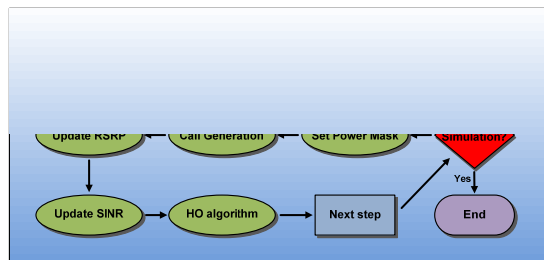
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Simulation set-up

- 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



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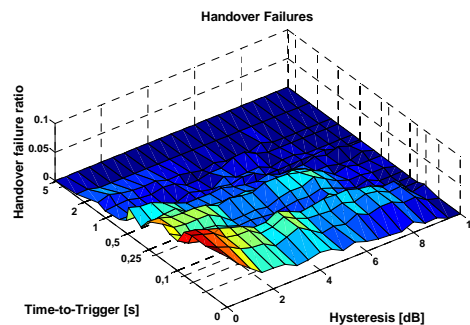
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Oberservability study

- 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:
 - $HP = w_1 \text{ HPIHOF} + w_2 \text{ HPIHPP} + w_3 \text{ HPIDC}$

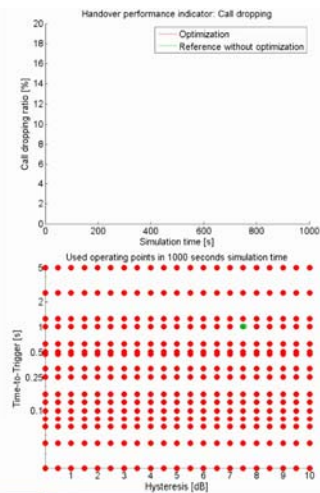
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Demonstration of HO optimisation



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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, ...):
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**Thank you very
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