Dynamic Spectrum Allocation & Interference Management Use Case

Thomas Kürner, Hendrik Hoffmann

(TU Braunschweig, Germany)

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Outline

- Introduction to the SEMAFOUR project
- Introduction of DSA & IM
- Simulation approach for DSA
- Current status / time plan

Introduction to the SEMAFOUR project

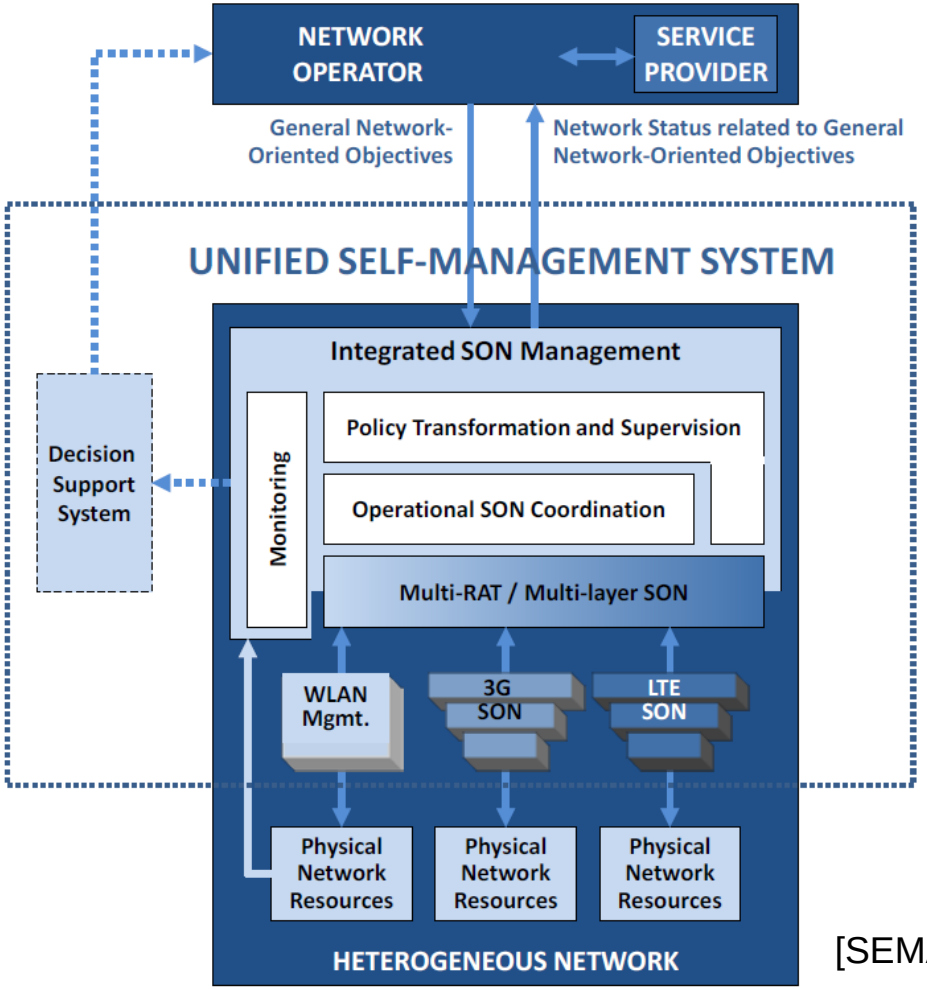
- **Se**lf-**Ma**nagement **fo**r **U**nified Heterogeneous **R**adio Access Networks
- FP7 EU Project
- Aim: Design, develop and evaluate a unified self-management system for heterogeneous radio access networks
- Duration: 09/2012 – 08/2015
- Partners
  - Atesio (Germany)
  - Ericsson (Sweden)
  - iMinds (Belgium)
  - Nokia Siemens Networks (Germany, Denmark)
  - France Télécom - Orange Labs (France)
  - Telefonica (Spain)
  - TNO (Netherlands)
  - TU Braunschweig (Germany)
- Total budget
  - Total cost: 6.12 million euro
  - EC contribution: 3.82 million euro

Introduction to the SEMAFOUR project

- Inner circles
  - SON functions
    - Automatic LTE / Wifi traffic steering
    - Adaptive Antenna Systems
    - Dynamic Spectrum Allocation / Interference Management
  - Closed loop of
    - Measurement acquisition
    - SON algorithm computing
    - Setting of new parameter values
- Multiple SON algorithms run in parallel
  - SON Management
  - Coordination of SON algorithms

SEMAFOUR High-Level Vision
[SEMAFOUR Deliverable 2.1, p.10]

- **Self-Management for Unified Heterogeneous Radio Access Networks**



[SEMAFOUR Deliverable 2.1, p.11]

Introduction: DSA & IM

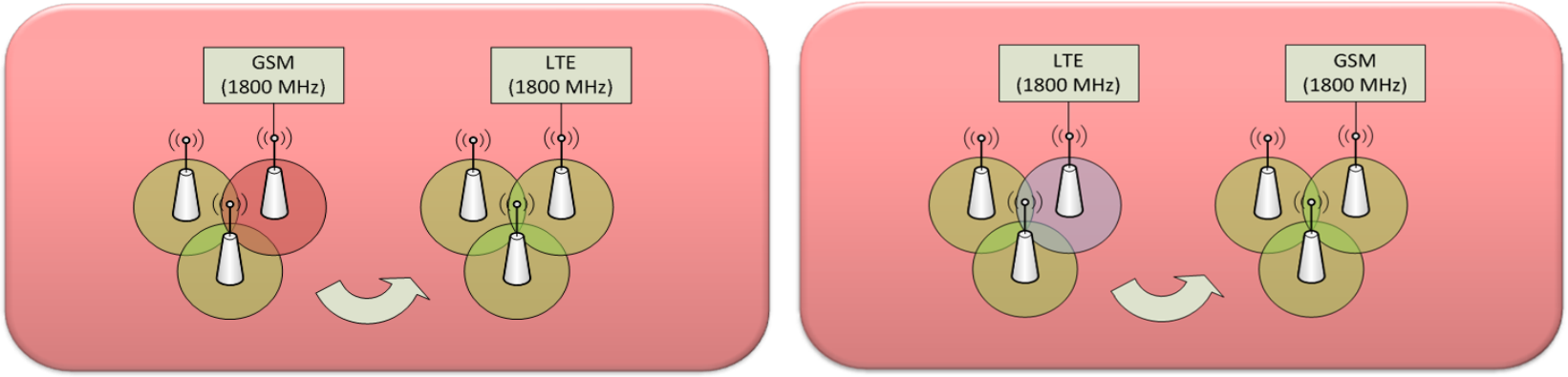
- **Goal**: Joint dynamic spectrum allocation and interference management in multi-layer and in multi-RAT environments

  - **Dynamic spectrum allocation**
    - Based on temporal and spatial usage of spectrum and / or cell load
    - (Re-)Assignment of carriers between different layers or RATs
    - Assignment of new carriers

  - **Interference management**
    - Assignment of bandwidth within one carrier
    - (Re-)Assignment of carriers between different LTE frequency layers
    - Adjustment of the transmitting power of the base station (for small cells only)
    - Switching UE to another technology (UMTS, GSM)
      - UE needs to support technology / frequency band

Three step approach for DSA

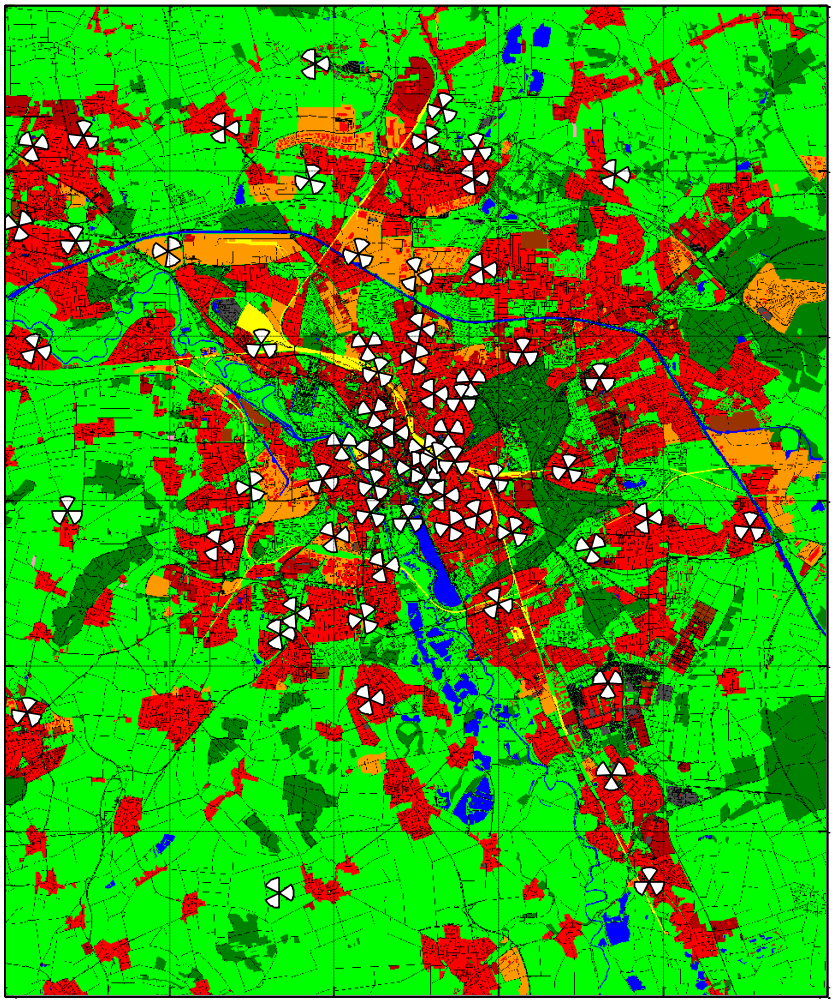
- **Step1: Intra-RAT Case A**
  - ***Controllability & Observability study (that is done right now)***
  - Dynamic spectrum allocation within an LTE network across different frequency layers. Only eNodeBs fully under control of the network operator are considered, e. g. no femto cells.
- **Step2: Intra-RAT Case B**
  - Same as Intra-RAT case A but with femto cells
- **Step3: Inter-RAT Case**
  - Dynamic spectrum allocation for the multi-layer LTE network including bandwidth re-farming across different 3GPP technologies (UMTS, GSM)



12:00 – 13:00 [SEMAFOUR Deliverable 2.1, p.21] 18:00 – 19:00

Simulation approach for DSA&IM

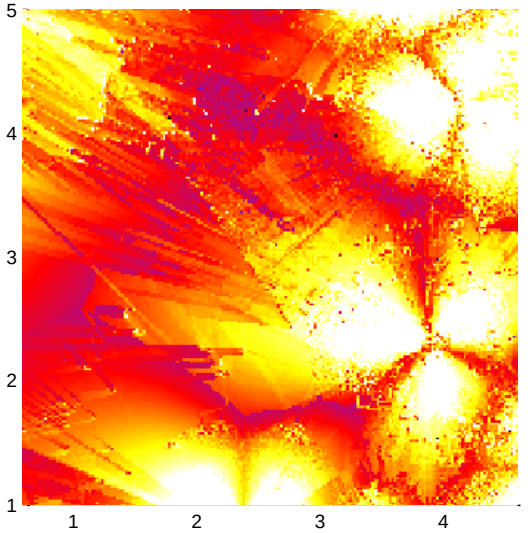
- Simulation of real networks
  - Real building data
  - Realistic mobility
  - Raytracing based pathloss prediction
- Frequency layer
  - LTE Macro 800 / 1800
  - LTE Micro 1800 */ 2600*
  - *LTE Pico 2600*
  - *LTE Femto 2600*
  - *UMTS (2100)*
  - *GSM (900 / 1800)*



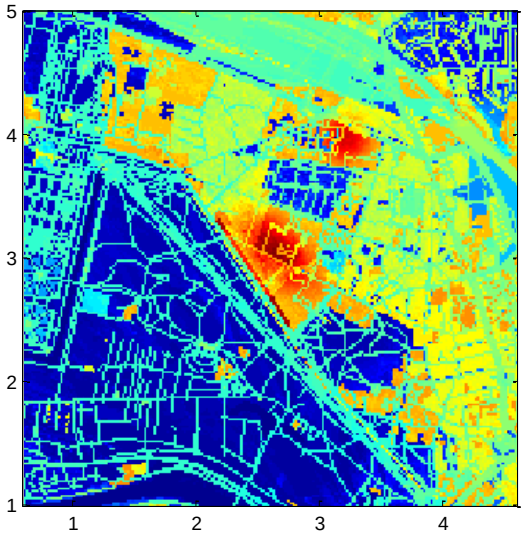
[SEMAFOUR Deliverable 2.4]

Simulation approach for DSA

- Macroscopic approach for **DSA**
- No single UEs modelled
- Input values
  - RSRP maps
    - Spatial resolution 10x10m
  - SINR maps (load dependent)
    - Spatial resolution 10x10m
  - Traffic intensity maps
    - Time resolution: 15min - 1 hour
    - Definition of hot spots
- Output values
  - Cell load, cell throughput
  - Average UE throughput
  - Spectral efficiency map
  - ...



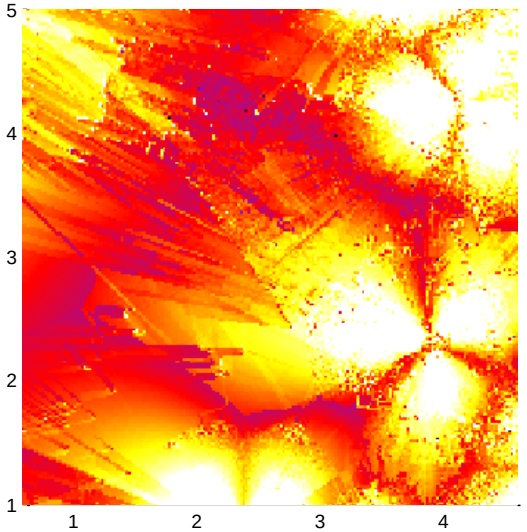
SINR map



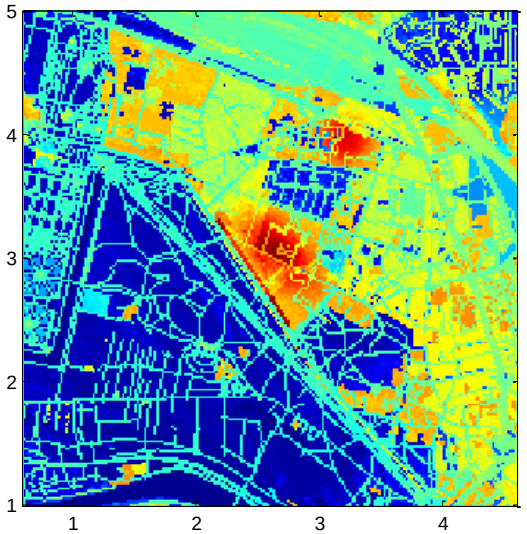
Traffic intensity map

Simulation approach for DSA&IM

- Two-Step approach for **DSA&IM**
- Plan: Do macroscopic DSA step, zoom in, run microscopic simulations
- Macroscopic simulations for DSA
  - Large area
    - E.g. 10 x 10 km
  - Based on RSRP/SINR/Traffic maps
  - No single UEs modelled
  - Time granularity: > 15 min
  - Simulated time: hours / days
- Microscopic approach for IM
  - Small area
    - E.g. 500 x 500 m
  - Modelling of single UEs
  - Time granularity: < 100 ms
  - Simulated time: minutes



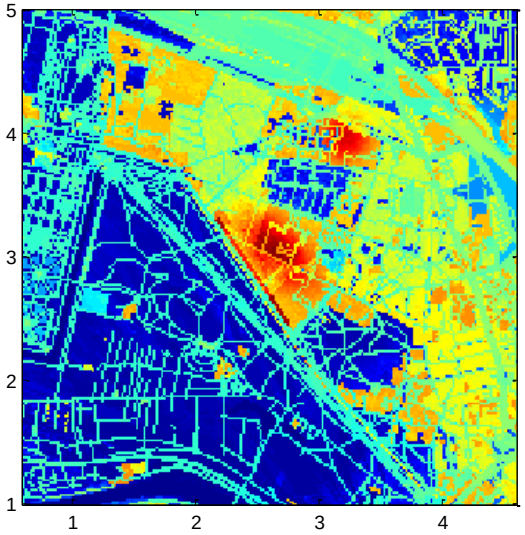
SINR map



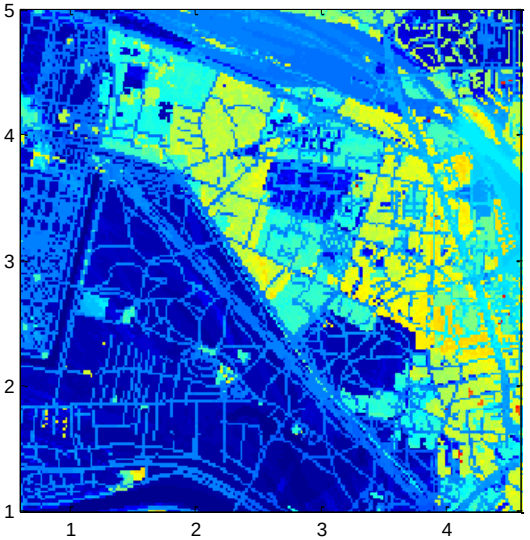
Traffic intensity map

Controllability & Observability study (for DSA)

- Simulated area
  - Campus area in a big city in Germany
- Temporal variation of traffic
  - Modelling students (hot spots)
    - Entering / leaving the university
    - Surfing during lectures
    - Just few traffic in university buildings after 17:00
  - Modelling environment
    - In the evening most of the traffic is offered in buildings in residential area
- Manual DSA steps
  - Manually assign carriers to different frequency layers, investigate KPIs



Traffic intensity map (10:00-11:00)



Traffic intensity map (18:00-19:00)

Current status / time plan

- Intra-RAT case A
  - (macro, micro layer)
  - C&O study finished
    End of July
  - First DSA algorithms
    End of August
- *Intra-RAT case B*
  - *(Intra-RAT case A + femto layer)*
  - ***Starting: 1st quarter 2014***
- *Inter-RAT*
  - *(LTE, UMTS, GSM)*
  - ***Starting: 3rd quarter 2014***
- *DSS-STM*
  - *Decision Support System / Spectrum & Technology Management*
  - ***Starting: 1st quarter 2015***
- End of project
  August 2015