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‘Designing a unified self-management system for the efficient and holistic operations of a heterogeneous mobile network’
Challenge: managing future network complexity

- **Heterogeneous access networks** to be cooperatively managed: multi-RAT, multi-layer, multi-vendor
- **Network ‘dynamicity’** ~ energy savings, femtocells
- **Operational complexity:** multitude of tunable radio parameters with intricate dependencies, effective on different time scales
Challenge: *market pressure*

- Increasing demand for ubiquitous mobile broadband access
  - Growing suite of services with distinct characteristics & requirements

- Pressure to remain competitive
  - Decreasing revenues
  - Reduce time to market of innovative services
  - Reduce costs (OPEX/CAPEX)
  - Enhance QoE

- Mobile communications becomes more and more a critical infrastructure
  - Need for network robustness/resilience
Solution

- Self-management for unified heterogeneous radio access networks

- Key benefits: enhanced ...
  - Operability (OPEX ↓)
    - Less human involvement in network planning, optimisation, monitoring, drive testing, troubleshooting, ...
  - Operational efficiency (CAPEX ↓)
    - Via ‘fine-grained’ tuning
    - Delayed capacity expansions
  - Customer satisfaction ↑
    - Service availability
    - Quality of Experience

![Impact of ‘Self-Optimisation’](image1.png)

![Impact of ‘Self-Healing’](image2.png)
Solution

• NGMN/3GPP have kicked off the development of initial SON solutions
  – Mobility robustness optimization, coverage/capacity optimization, interference management, energy savings, …
  – *Typically target single-RAT/layer solutions*

• Open issues
  – Integrated SON management to ensure conflict-free coordination of SON functions towards a set of common high-level objectives
    • Likelihood of (performance or parameter) conflicts increases in the number of operational SON functions concurrently active in overlapping areas, at different layers/RATs, considering HW from different vendors
      – Development of multi-layer/RAT SON functions
      – Automated support of residual operational tasks
Vision

- Self-Management for Unified Heterogeneous Radio Access Networks
  - Service provider
  - Network operator
  - Self-management system
  - Network resources
Vision

• Self-Management for Unified Heterogeneous Radio Access Networks
  – Integrated SON Management
    • Policy transformation
    • SON coordination
    • Monitoring
  – SON functions
    • Single/multi-RAT/layer
    • Self-configuration, -optimization, -healing
  – Decision support system
    • Spectrum refarming
    • Technology upgrades
    • Site deployment
    • SLA management
Vision: *Integrated SON Management*

- Management interface between the network operator and the SON functions
  - Policy transformation and supervision
    - *Heading harmonization*
    - Transform operator’s general network-oriented objectives to specific policies/execution rules for individual SON functions
      - Business-/strategic level, e.g. capacity targets
      - System objectives, e.g. max 10% LTE throughput
      - SON policies, if condition A then choose SON function configuration B
    - Automates operator’s expert knowledge

**OBJECTIVES**
- Coverage
- Resource/energy efficiency
- QoE
- Service continuity

**MLB**
- SETTINGS, e.g. load thresholds, step sizes
- ALGORITHM

**MRO**
- SETTINGS, e.g. $w_{\text{DROPPING}}$, $w_{\text{RLF}}$, $w_{\text{PING PONG}}$
- ALGORITHM

**SON COORDINATOR**
- SETTINGS
- ALGORITHM

2 x POLICY TRANSFORMATION & ENFORCEMENT
Vision: *Integrated SON Management*

- Management interface between the network operator and the SON functions
  - Policy transformation and supervision
    - *Heading harmonization*
  - Operational SON coordination
    - *Tailing harmonization*
    - Detect/resolve conflicts between SON functions, instabilities, …
    - Conflicting actions, conflicting performance effects, …
    - Temporary SON function locks, effectuation of priorities
  - Monitoring
    - Collection/processing of performance data for SON functions, SON coordination and for reporting purposes to the operator comparing realizations with objectives
  - *Work in progress: SON management for MLB, MRO, CovOpt*
Vision: Multi-layer/RAT Functions

- Dynamic Spectrum Allocation & Interference Mgmt
  - Automated assignment of spectrum to cells based on spatio-temporal traffic load fluctuations
  - Shift of resources to traffic demand
    - Across RATs (2G/3G/LTE)
    - Across layers (macro/micro/pico/femto)
  - Adjustment of carrier frequency, bandwidth, tx power
Vision: *Multi-layer/RAT Functions*

- **Active Antenna Systems**
  - Dynamic vertical sectorization
    - Automated on/off switching (splitting vs merging)
    - Automated optimisation of inner/outer cell-specific downtilts
    - Consideration of spatio-temporal traffic load fluctuations
  - Adaptation of resources to traffic demand
  - Tradeoff of increased capacity vs interference vs handovers
Vision: **Multi-layer/RAT Functions**

- Multi-layer LTE/Wi-Fi Traffic Steering
  - ‘Choose WiFi when available’ may offload cellular network but degrade effectiveness of WiFi and provide worse QoE
    - Poor WiFi coverage
    - WiFi overload
    - High mobility scenarios
  - Shift of traffic demand to resources
  - Development of adaptive traffic steering solutions to optimize resource efficiency and user experience
  - Consideration of spatio-temporal traffic load fluctuations and user mobility
Vision: *Multi-layer/RAT Functions*

- Work in progress
  - Definition of realistic scenarios
  - Development of simulators
  - Calibration of simulators
  - Controllability study
  - Observability study
  - Algorithm development
    - Assessment of SON functions
      - From single- to multi-RAT/layer
      - From stand-alone to integrated
    - Demonstration
Vision: Decision Support System

• Aiding operators with residual tasks fed by advanced network intelligence
  – Recommendations to swap base stations to other RATs
    • Once capacity increase is worth the investment & terminals are supportive
  – Recommendations to swap base station to other frequency bands
  – Recommendations to deploy new sites (macro, micro, pico, femto)
    • If the traffic growth can no longer be supported by the self-optimized network
  – Insight in the ‘resource cost of performance’
    • For SLA (re)negotiations
    • Promises to service providers vs network cost to deliver
    • Relation between performance targets, e.g. 10\textsuperscript{th} percentile vs average
Concluding remarks

- **Key drivers for self-management**
  - Complexity of future multi-layer/RAT technologies and pressure to be competitive are key drivers for self-management

- **SEMAFOUR develops solutions for ‘Self-Management for Unified Heterogeneous Radio Access Networks’**
  - Integrated SON management
  - Multi-layer/RAT SON functions
  - Decision Support Systems

- **Project focus**
  - Development, assessment and demonstration of concepts and algorithms
  - Embedding in standardisation: architectures, protocols, measurements
More information

- www.fp7-semafour.eu
- SEMAFOUR demonstration
  - General project information
  - SON MGMT based on operator objectives
- I hope you attended Workshop 10c
  - Management Frameworks for Future Mobile Communication Networks
  - C. Willcock, ‘Challenges for SON Functions and SON Management’
  - N. Scully, ‘The Development of SON for Future Mobile Networks’
  - Discussion panel on next steps
Questions?

It is a bit freaky with this wireless technology.