

Tutorial Proposal for MONAMI 2012

“Operating Heterogeneous Wireless Networks with SON (Self-Organizing Networks)”

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Objectives

- Providing a comprehensive introduction to Self-Organizing Networks (SON) applied to 3GPP mobile radio networks
- Addressing both network optimization and operation (configuration, troubleshooting, coordination) processes and how they can be improved with SON functions
- Giving the latest state-of-the-art in applying SON concepts to “Heterogeneous Networks” (multi-RAT, multi-cell layer, multi-vendor) contributing to address the “traffic explosion” challenge in mobile networks

Intended Audience

- Researchers in mobile network management automation, Future Internet management, autonomic networking, cognitive radio / cognitive networks
- Engineers working in network operation and optimization at operators and network equipment manufacturers
- PhD and master students in the area of communication networks

Why the proposed topic is interesting and timely:

Self-Organizing Networks represent a paradigm shift in the Operation, Administration and Management of large mobile radio networks. While the classical OAM approach incorporates configuration, performance and fault management with the human operator “in-the-loop”, SON aims at closed control loops for these management processes. This leads to changes in the way how a mobile network is operated: from a manual, rather long-term analysis of network status and performance (and the subsequent determination of corresponding configuration changes) towards the definition of how the individual closed control loops and their aggregation shall operate. This allows to reflect the current network setup and status as well as the operators’ requirements on network performance, robustness and resilience, and (last but not least) the operation and implementation costs.

Prerequisite Knowledge of Audience

Basic knowledge on mobile networks, in particular 3GPP, and network management concepts.

Abstract

Due to the decreasing revenue per user, mobile network operators are keen to reduce operational expenses in network deployment and operation. However, at the same time the dramatic increase of traffic in their networks requires new radio access technologies (RAT) like LTE to be deployed, in addition to existing 2G and 3G networks. To extend capacity as well as coverage (incl. indoor), traditional macro networks are complemented by smaller cell layers (micro, pico) down to femto cells, where basestations are even deployed to user's premises. LTE relays as a new type of network elements complement this infrastructure enabling more flexibility in providing the required backhaul.

All these measures result in on one hand efficiently addressing the bandwidth challenge, while on the other hand increasing network complexity counter-acting the initial desire to cut costs. Complexity comes simply from the increased number of network elements, but also from the requirement to combine different networks (2G/3G/LTE, femto), including legacy ones.

Self-Organizing Networks (SON) concepts have been proposed already for 3G and LTE macro networks to facilitate deployment (self-configuration), optimization and troubleshooting (self-healing). To cope with the effects of the "Heterogeneous Networks" (HetNet) scenario described above, SON mechanisms are required to automate the network operation, thereby improving the operator's cost position.

After introducing some basics on HetNet and SON respectively, the tutorial describes SON functions for network implementation and ongoing automatic configuration. While often SON is limited to optimization concepts, the tutorial specifically also addresses operational concepts like SON-supported troubleshooting and coordinating different SON function instances in a system.

Across those topics, the specific challenges of *multi-vendor* HetNets, and how those challenges are addressed by 3GPP standardization, are explained.

Outline

- LTE / HetNet / Network Management Basics
- Introduction to Self-Organising Networks
- Self-Configuration:
 - Auto-connectivity and –commissioning (incl. multi-vendor and LTE-A relay, *with demo*)
 - Dynamic Radio Configuration: (Multi-vendor) Physical Cell ID (PCI) and Automatic Neighbour Relationship (ANR) setup
- Self-Optimization: Mobility Robustness Optimization
- Self-Healing: Cell Degradation Detection and Diagnosis (*incl. demo*)
- SON Coordination
- *Integrated SON demo: LTE radio network simulation, centralized self-optimization, SON coordination*

Resume of Presenters

Henning Sanneck

Dr. Henning Sanneck studied Electrical Engineering at the University of Erlangen-Nuremberg, Germany. After receiving his Diploma in 1995, he joined GMD Fokus (now part of Fraunhofer) in Berlin. At Fokus, he worked as a Researcher in the area of Quality-of-Service (QoS) support for Real-Time Services in IP-based networks. He received his Dr.-Ing. (PhD) degree in Electrical Engineering from the Technical University of Berlin with a thesis on Voice over IP QoS in 2000.

In 2001 he joined Siemens - Mobile Networks in Munich, working as a Senior Research Engineer on cross-layer design for IP-based Radio Access Networks (RANs), Software Technologies for Mobile Networks and Technology Management. He became a Project Manager for technology innovation projects in the area of Network Management for 3G and beyond RANs in 2003, working on Basestation Auto-Configuration and Real-Time Performance Management concepts and their realisation as product features. Since the formation of Nokia Siemens Networks in 2007 he is a Research Manager heading the "Network Management Automation" team.

Dr. Sanneck has published 40 papers in refereed conferences and journals and has more than 15 patents granted or pending. He has co-edited and –authored the book “LTE Self-Organising Networks” published by Wiley in 2011.

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Lars Christoph Schmelz

Lars Christoph Schmelz received his Dipl.-Ing. degree in Electrical Engineering from the Technische Universität München in 2000, with specialization in Communications Engineering and Information Technology. He started working as research engineer for Siemens Information & Communication Mobile Networks in 2001, working on concepts and demonstrator implementations for radio access networks, namely on 3G radio resource management and SIP / Mobile IP-based service architectures for radio access. In 2003, Lars Christoph started to establish OAM as key research topic, working in the following years on various projects with a focus on wireless networks self-management and management automation. He participated in the EU FP7 project SOCRATES, leading the work package on self-configuration and self-healing. The current work focus within Nokia Siemens Networks Research is on end-to-end traffic steering in 3G and LTE networks, and on SON coordination. He has been involved of the successful preparation of the forthcoming FP7 call 8 project SEMAFOR on advanced SON concepts.

Lars Christoph has contributed to the books “LTE Self-Organising Networks (SON)” and “Self-Organizing Networks: Self-Planning, Self-Optimization and Self-Healing for GSM, UMTS and LTE” both published by Wiley in 2011.

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Recent Tutorials, Presentations, co-organized Events on the topic:

- Panel participation on “future SON” at Informa’s SON conference, London, 2011
- Keynote on “Self-Organizing Heterogeneous Wireless Networks” at Broadband Convergence Networks Workshop / IEEE IM, Dublin, 2011
- Co-organization of the 1st “International Workshop on Self-Organizing Networks” co-located with IEEE VTC Spring, Budapest, 2011
- Co-organization of the final dissemination workshop for the FP7 EU project SOCRATES, Karlsruhe, 2011
- Invited talk on “Dynamic Radio Configuration of Self-Organizing Base Stations“ for Special Session on SON at the 7th International Symposium on Wireless Communication Systems, York, 2010.
- Instructor for “SON masterclass” workshop at Informa’s 3G network optimization conference, Frankfurt 2010
- Invited talk on “Mobile Network Management” at TU Munich, 2010

Recent Publications on the topic:

- **S. Hämmäläinen, H. Sanneck, C. Sartori (eds.), LTE Self-Organizing Networks (SON) - Network Management Automation for Operational Efficiency, Wiley, ISBN 978-1-119-97067-5, December 2011.**
- P. Szilágyi, T. Bandh, H. Sanneck, Multi-vendor Physical Cell ID allocation, submitted to MONAMI 2012, Hamburg, September 2012.
- R. Romeikat, B. Bauer, H. Sanneck, Automated Refinement of Policies for Network Management. Asia-Pacific Conference on Communications, October 2011
- R. Romeikat, B. Bauer, H. Sanneck, Modeling of Domain-Specific ECA Policies, in International Conference on Software Engineering and Knowledge Engineering, Miami Beach, USA, July 2011.

- C. Schmelz et al., A Coordination Framework for Self-organisation in LTE Networks, in IFIP / IEEE Symposium on Integrated Management, Dublin, Ireland, May 2011.
- T. Bandh, R. Romeikat, H. Sanneck, H. Tang, Policy-based coordination and management of Self-Organizing-Network (SON) Functions, in IFIP / IEEE Symposium on Integrated Management, Dublin, Ireland, May 2011.
- P. Szilágyi, H. Sanneck, LTE Relay Self-Configuration, in IFIP / IEEE Symposium on Integrated Management, Dublin, Ireland, May 2011.
- T. Bandh, H. Sanneck, Automatic Site Identification and Hardware-to-Site-Mapping for Base Station Self-configuration, in IEEE International Workshop on Self-Organizing Networks, Budapest, Hungary, May 2011.
- T. Bandh, H. Sanneck, R. Romeikat, An Experimental System for SON Function Coordination, in IEEE International Workshop on Self-Organizing Networks, Budapest, Hungary, May 2011.
- H. Sanneck, C. Schmelz, T. Bandh, R. Romeikat, G. Carle, B. Bauer, Policy-driven Workflows for Mobile Network Management Automation, in 6th International Wireless Communications and Mobile Computing Conference, Caen, France, June 2010.
- H. Sanneck, Y. Bouwen, E. Troch, Context based Configuration Management of Plug & Play LTE Base Stations, in IEEE/IFIP Network Operations and Management Symposium, Osaka, Japan, April 2010.
- T. Bandh, R. Romeikat, H. Sanneck, C. Schmelz, B. Bauer, G. Carle, Optimized Network Configuration Parameter Assignment Based on Graph Coloring, in IEEE/IFIP Network Operations and Management Symposium, Osaka, Japan, April 2010.