SON Management Demonstrator

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***Abstract*—The demonstrator shows a self-management system for heterogeneous mobile radio communication networks as developed in the European FP7 SEMAFOUR project. The self-management system uses operator-defined objectives regarding, e.g., network capacity, network load, or network robustness, to automatically configure and control the operation of Self-Organising Network (SON) Functions. The SON Functions are instrumented as to contribute to the operator objectives. Changing objectives or their priorities leads to a reconfiguration of the SON Functions. The demonstration uses three SON Functions, namely, Mobility Load Balancing, Mobility Robustness Optimisation and Coverage and Capacity Optimisation, and the impact of changing objectives can be traced in the demonstrator's realistic network scenario and the network's Key Performance Indicators.**

Keywords—self-organising networks; policy-based management

I. INTRODUCTION

Self-Organizing Networks (SON) describe an approach for the management and operation of mobile radio networks. A set of SON Functions acting at the network level aim at the automation of dedicated tasks in the scope of network configuration, network optimisation and failure recovery [1]. Each SON Function represents a closed control loop, acquiring measurements (e.g., radio measurements, performance counters, and timers) from the network or the user equipment, analysing these measurements with respect to performance deficiencies, computing new values for the network configuration (e.g., cell individual offset, handover hysteresis, time-to-trigger) in order to individually overcome the identified deficiencies, and deploying these network configuration values to the network.

However, the mobile network operator aims at optimising certain objectives, i.e., prioritised Key Performance Indicators (KPIs) of the network rather than single measurements. Examples for such KPIs are network capacity, network coverage, or call drop rate (cf. [2]). The SON Functions influence these KPIs through their operation by modifying the network configuration values. The SON Functions themselves can be configured by means of SON Function Configuration Parameters (SCPs). With modifying the SCP Values (SCVs) the behaviour of a SON Function changes, i.e., its closed control loop reacts differently when computing new network configuration values. SON Functions are, however, often deployed and operated with default SCVs only. This may lead to a lower network performance compared with SCVs that can be adapted to changing operator objectives. The reason for not changing SCVs during operation is that such changes and the analysis of the resulting effects are to be done manually.

The SEMAFOUR project [6] aims at developing Policy-based SON Management (PBSM) (see, e.g., [3]). With this solution, the gap between objective definition on the one hand and an automated and appropriate configuration of the SON Functions according to these objectives on the other hand shall be closed. The solution foresees an automated transformation from objectives to the SON Function configuration. A major component of this development within SEMAFOUR is an early implementation of the concepts and approaches in a simulation environment. The goal is to continuously verify the concepts and build up experience. This applies, in particular, to the verification of the effects of changing SON Function configurations on the mobile radio network and the practicability of the transformation concepts.

The demonstrator described in this paper represents the visualisation of the simulation environment, with a clear focus on the needs of the operational personnel that manages and operates a mobile radio network.

II. DEMONSTRATOR DESCRIPTION

The demonstrator shows key elements of the SEMAFOUR self-management system for heterogeneous mobile radio networks. These are (i) the transformation of operator objectives into SCV Sets for the different SON Functions; (ii) the operation of the SON Functions themselves; (iii) the combined effect they have on the mobile radio network; and (iv) the network KPIs with respect to the defined objectives.

A. Demonstrator Basics

The demonstrator builds upon a distributed, client-based simulation environment (cf. [4]). For the showcase visualising the SEMAFOUR PBSM solution, the system-level network simulator platform employs a realistic network scenario, with 65 LTE-1800 radio base stations located in a 3km x 5km area

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in the city centre of Hannover, Germany. The radio propagation is calculated using a high-resolution ray-tracing signal level prediction. 2000 realistic users in 3 different user classes (vehicular, pedestrian, semi-static in-house) are inserted. In a first stage, three clients have been attached to the platform: a control entity providing timing information and synchronization, a handover algorithm, and a Mobility Load Balancing (MLB) SON algorithm. In a second stage, a Mobility Robustness Optimisation (MRO) and a Coverage and Capacity Optimisation (CCO) SON algorithm client have been added. In a third stage, a SON Objective Manager client implementing the concept described in [5] has been added.

B. Demonstration Setup

The demonstrator is split into three panels. At first, in the Network Panel (see Fig. 1), the Hannover scenario as described above is shown, including the location and orientation of all radio base stations and their cells. For each cell, a colour code is used indicating the current load situation of the cell or other relevant information like cell configurations, handover events, etc. The Network Panel allows zooming into specific network areas to enable a detailed view on the local network performance and user movements. As shown in Fig. 1, a Time Control Panel indicates the current date and time and allows displaying the demonstration speed.

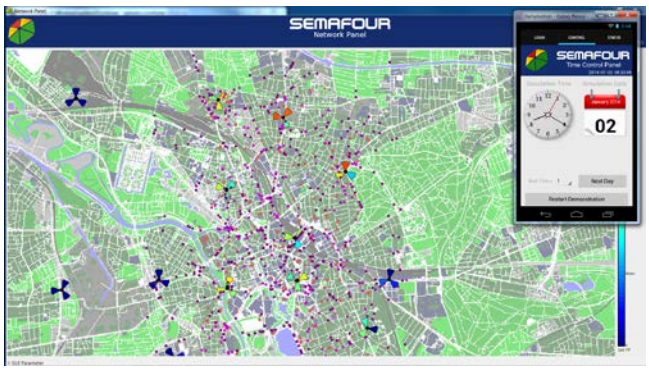

Fig. 1. Network Panel

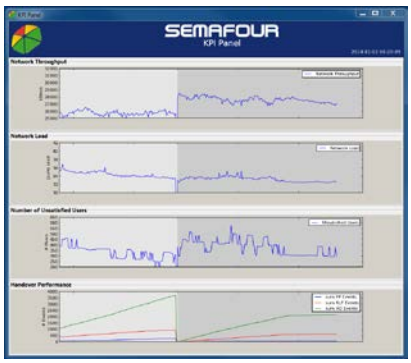

Fig. 2. KPI Panel

Second, the KPI Panel (see Fig. 2) shows charts of the KPIs related to network load and the service quality experienced by the active users. Third, the Operator Panel (see Fig. 3) allows to set and prioritise the operator objectives, and to define context information (e.g., the current time or the base station location) according to which these objectives shall be activated. Not visualised in the demonstrator is the policy environment, which automatically activates the appropriate SCV Sets for the implemented SON Functions according to the current context.

Fig. 3. Operator Panel

The demonstrator supports interactive changes to the objectives at the Operator Panel. The effects on the network and the KPIs can directly be seen in the Network and the KPI Panel. Each panel is shown on a separate screen, which can be full-HD monitors / projectors or handhelds / tablets.

III. Potential Impact on the Audience

The audience can experience the SON system as a "black box" means to manage a heterogeneous mobile radio network through objectives, i.e., prioritised and context specific KPI targets. It is no longer necessary to operate and optimise the network by changing the network configuration or the configuration of the SON Functions, but simply by defining the objectives – this is actually the targeted solution to be offered to network operators. The demonstrator exhibits the considerable hidden complexity of the heterogeneous network and of the underlying SON system in particular.

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