Demonstrator for Objective Driven SON Operation

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***Abstract*—The demonstrator shows a self-management system for heterogeneous mobile wireless networks that uses context-specific and weighted Key Performance Indicator (KPI) target values defined by the operator to automatically and autonomously configure and control the operation of Self-Organising Network (SON) functions such that they contribute to achieving these KPI targets by appropriately optimising the network configuration. Changing KPI targets, context or weights leads to an automatic re-configuration of the SON functions by using a policy system, and the impact of the changes to the policy and the network configuration can be seen and traced in the demonstrator's realistic network scenario and KPI charts.**

Keywords—self-organising networks; network management; policy-based management

I. Introduction

The automation of the management of mobile radio networks is described through the Self-Organising Networks (SON) approach. An individual SON function is represented through a closed control loop that acts at network level, aiming at the autonomous configuration, optimisation and failure recovery of mobile network elements [1]. The closed control loop thereby includes the acquisition of measurement from the individual network elements or the user equipments, including for example performance counters and timers, alarms, or radio measurements. These measurements are analysed with respect to performance shortcomings or alarms, and new values for the network element configuration (e.g., time-to-trigger, handover hysteresis, or cell individual offset) are computed and deployed in order to overcome the identified performance shortcomings.

The overall goal of the mobile network operator is not to optimise a number of individual measurements in the network, but to achieve certain technical objectives, i.e., Key Performance Indicators (KPIs) that may depend on a certain operational context and be weighted or prioritised among each other. Examples for such KPIs are cell throughput, network capacity, or drop call rate (cf. [2]). The KPIs are influenced through the operation of the SON functions. SON functions in turn can be configured through their SON function Configuration Parameters (SCPs), where modifying the SCP Values (SCVs) changes the behaviour of the SON function with respect to the closed control loop's reaction when computing new network configuration values. With the typical approach to deploy and operate SON functions with default sets of SCVs only, the network performance may be lower compared to SCV sets being adapted to the current operator objectives. However, the SCV sets are usually not adapted due to the required manual effort.

Within the European funded project SEMAFOUR [6] solutions for a Policy-based SON Management (PBSM) are developed (see, e.g., [3]), which aim at closing the gap between the definition of the technical objectives at the operator side, and the configuration of the SON functions implemented in the network in such way that the SON functions contribute to achieving these objectives. The PBSM solution merges a model of the technical objectives with models of the SON functions (see [5]), and the resulting SON policy consists of a set of rules providing the appropriate SCV sets for the defined KPI targets, for all defined contexts and weights. A cornerstone of the SEMAFOUR development work is the early implementation of concepts and solutions into a common simulation environment in order to continuously prove and verify the conceptual work. The demonstrator described in this paper represents a visualisation of the simulation work, focusing on the applicability and practicability within the working environment of an operator's network management organisation.

II. Demonstrator Description

The demonstrator shows several components of the SEMAFOUR self-management system for heterogeneous mobile radio networks, including (i) an operator panel, representing the user interface for the human operator, which allows the composition of technical objectives, i.e., target values for the available KPIs, the context under which these target values shall apply, and the KPI weights; (ii) a policy panel showing the current composition and execution status of the SON policy; (iii) a KPI panel showing the available network KPIs with respect to the defined objectives; and (iv) a network panel showing the operation of the SON functions themselves, and their effect on the mobile radio network.

A. Simulator Foundation

The demonstrator builds upon a simulation environment consisting of a number of distributed operating clients (cf. [4]).

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The SEMAFOUR PBSM showcases use a system-level network simulator platform with a realistic network scenario in the city centre of Hannover, Germany, with 65 LTE-1800 radio base stations and a number of Wi-Fi hot-spots located in a 3km x 5km area The area covers several different cell types, including urban and dense urban cells, and a number of 2000 realistic users with different mobility patterns (vehicular, pedestrian, semi-static in-house). By using a high-resolution ray-tracing signal level prediction the radio propagation within the core simulation platform is calculated. The clients connected to the platform include a common handover algorithm, SON algorithms for Mobility Load Balancing (MLB), Mobility Robustness Optimisation (MRO) and LTE-Wi-Fi Traffic Steering (TS), a SON Objective Manager client (SOM) responsible for merging operator objectives and SON function models, and a Policy system client responsible for deciding and executing the policy rules.

B. Demonstration Setup

As introduced above, the demonstrator is split into four panels. The Network Panel as depicted in Fig. 1 shows the Hannover scenario with location and orientation of all radio base stations and their cells. A colour code indicates the cells' current load situation together with additional selectable information such as the cell configuration or handover events. Fig. 1 also depicts the Time Control Panel, which indicates the current date, time and demonstration speed.

Fig. 1. Network Panel

Fig. 2. Operator Panel

Fig. 2 depicts the Operator Panel which allows the human operator to set and weight the operator objectives, and to define the corresponding context information for the KPI targets to which these objectives shall be achieved. The demonstrator allows the user to interactively change the technical objectives at the Operator Panel by the end user. The KPI Panel as depicted in Fig. 3 (left side) displays a set of charts of the KPIs which are related to the operator objectives, for example, network load and service quality experienced by the active users.

In Fig. 3 (right side) the Policy Panel is depicted which shows the current composition of the SON policy, i.e. the set of rules. Those rules being active (e.g., due to the current context or KPI weight) are displayed in different colours, and corresponding colours show those cells in the Network Panel which are affected by the changes.

The client-based architecture of the simulation environment and the demonstrator allows showing each of the described panels on a separate screen, whereby resolutions up to full-HD are supported as well as handhelds or tablet PCs.

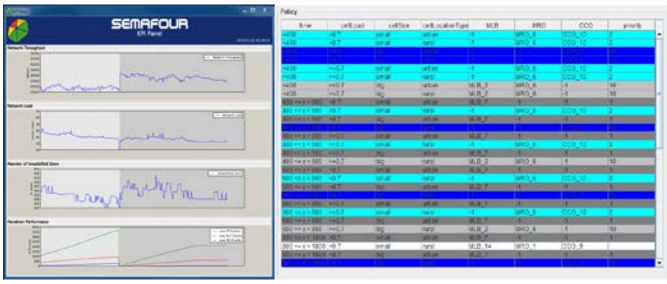

Fig. 3. KPI Panel (left) and Policy Panel (right)

III. Potential Impact on the Audience

The audience can experience the SEMAFOUR demonstrator as a step forward in operating a SON-enabled mobile radio network, where "black-box" SON functions autonomously adapt to the actual requirements of the mobile network operator: technical objectives, i.e., weighted and context-specific KPI targets, rather than a large number of individual network and SON function configuration parameters that need to be adapted. Thereby, the demonstrator provides some insight into the enormous hidden complexity of the heterogeneous network.

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