

White paper

# Towards Self-Organizing Networks

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## Ideas in brief

- Increasing complexity of networks and OPEX reduction pressures cause that operators are forced to change the way how they operate their networks
- Self-Organizing Networks (SON) promise to reduce manual effort needed for network operation by making networks capable to self-organize and manage its resources
- Comarch product portfolio supports SON use cases via automated process management and integration of planning and optimization, configuration management and network provisioning capabilities

**Current mobile market landscape with dropping revenues per bit and increasing demand for diversified service portfolio forces operators to reduce OPEX while investing in new technologies and solutions. Constantly growing multi-technology and multi-vendor networks become more complex than ever before and significant network planning and management effort is needed to ensure satisfactory end user experience. This effort can be minimized with implementation of Self-Organizing Networks (SON) which will enable operators to simplify network operation and extend their network in plug & play manner. Comarch considers network management automation as key requirement as well as a crucial factor for investments in next-generation wireless technologies such as LTE and supports SON use cases with its product portfolio.**

## Introduction

The ideas related to network automation and introduction of self-organized mechanisms have been always on operators' wish list. According to Yankee Group OPEX related to network operation constitute as much as 20% in the cost structure and tend to grow as networks mature. As the number of technologies, vendors and base stations in a network increases, so is the effort of network planning and management. Time-consuming manual work is still required in many workflows such as parameter planning, optimization and handling of site failures. On the other hand the technology and market dynamics put a pressure on faster rollouts and network upgrades to stay ahead of competition. New technologies such as LTE will increase the network complexity and parallel operation of 2G/3G/HSPA and LTE networks will be a must for some years ahead. Moreover, potential deployments of femto-cells on mass scale will significantly increase the number of base stations and will require a self-organized approach for integration of new cells with macro layer.

All above described factors indicate that we need to change the way how we operate networks. The required manual work needs to be significantly reduced and the network itself should be capable to self-configure and continuously self-optimize in response to network and traffic changes. Operators will define workflows and policies through which they will control the network but the hard work will be done by the network itself.

## Principles of Self-Organizing Networks

Self-Organizing Networks are defined as a set of use cases covering all aspects of network operation from network planning to maintenance activities. These use cases express high-level requirements for future networks and are based on the paradigm that network should self-organize and manage its resources so that optimal network quality and performance is achieved. SON use cases can be grouped into functional domains which are described in following paragraphs.

## Self-Planning

Achieved via self-configuration of initial parameters and re-computation of parameters during continuous self-optimization. The amount of manual pre-planning activities should be reduced to minimum and cover basic coverage and capacity planning. As a result, planning tool will deliver only few parameters such as location, number of sectors and other basic cell parameters while the rest will be derived automatically.

## Self-Optimization

The aim of self-optimization is to fine-tune initial parameters and dynamically re-calculate these parameters in case of network and traffic changes. Optimization of network shall be based on live measurement data. Self-optimization is an important improvement area due to the fact that current automatic optimization tools focus on small number of radio parameters and a lot of manual effort is required for optimization activities. The aim is to make following optimization activities automatic:

- neighbour cell list optimization
- interference control
- handover parameter optimization
- QoS related parameter optimization
- load balancing
- RACH load optimization
- optimization of home base stations

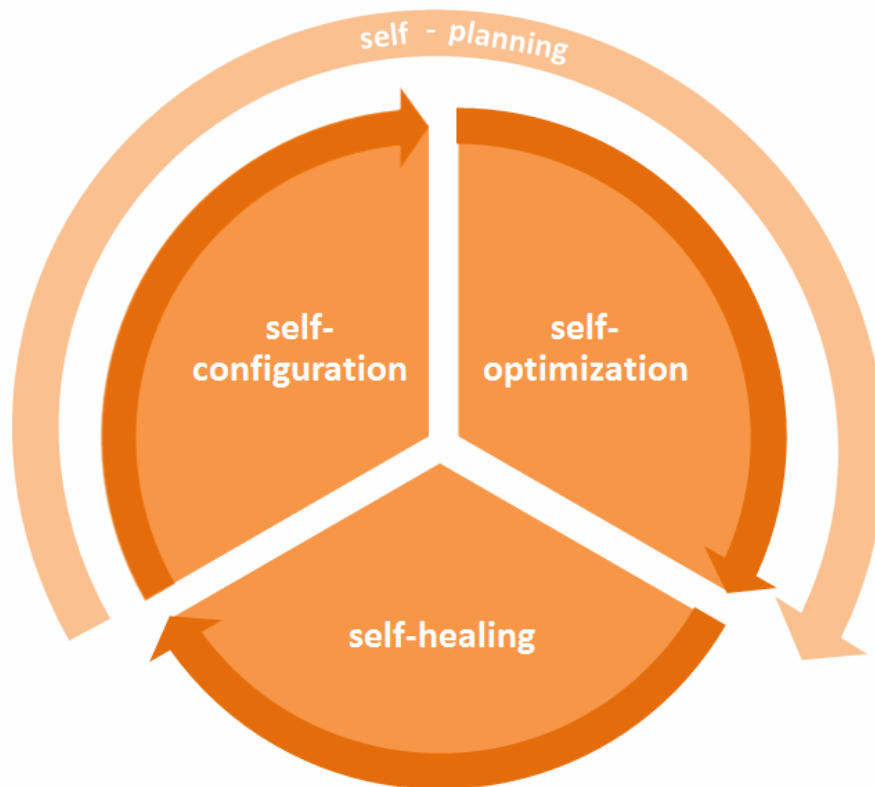
## Self-Configuration

Understood as the plug & play behavior of new network elements. The key areas is automated deployment of new base stations, which covers following activities:

- automatic configuration of initial radio/transport parameters
- automatic data alignment for neighbour nodes (realized for LTE via standardized Automatic Neighbour Relation (ANR) management)
- automatic connectivity establishment
- self-test
- automatic inventory
- automatic authentication and SW download

## Self-Healing

Fault management should be simplified and automated via information correlation mechanisms. Operators will be responsible for definition of correlation rules and corrective actions to specific faults but the fault correction itself will be autonomous. Self-healing covers use cases such as cell outage detection and compensation via automated root cause analysis and such corrective actions as routing traffic to nearby cells. Another example is migration of unit outage based on automatic mechanisms for adaptation and reconfiguration of hardware.



**Figure 1. Self-x capabilities of Self-Organizing Networks**

The key to understanding SON is that only part of SON use cases can be adopted while other remain manual. This enables gradual introduction of SON mechanisms and does not enforce 'big bang' approach.

In order to address inter-operability in multi-vendor scenarios SON solutions shall be based on standardized interfaces but the detailed implementation of SON functions is vendor specific. Depending on where SON algorithms will reside, different SON architectures can be distinguished:

- **distributed** – SON algorithm(s) will reside in one or more network elements
- **centralized** – SON algorithm(s) will reside in existing NMS or in an additional SON server
- **hybrid** – SON algorithm(s) will reside is partly in network elements and partly in the management system

Distributed and centralized SON architectures have been presented on Figure 2.

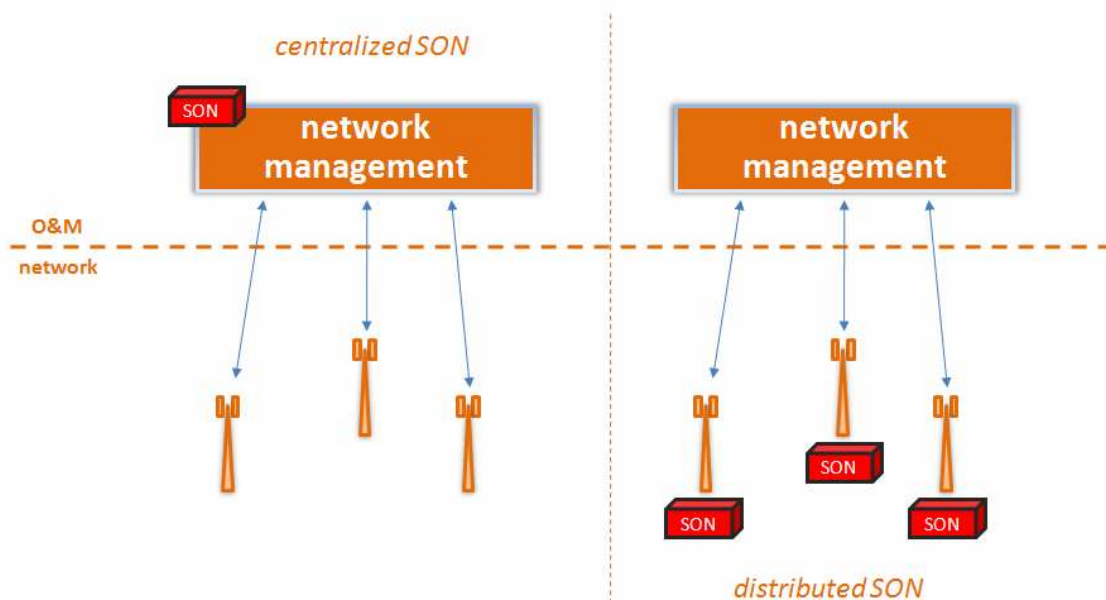


Figure 2. SON architectures

## Current Status of SON Activities

Concept of SON has been introduced in 3GPP Release 8 specification due to flattening architecture of E-UTRAN and resulting growth in number of nodes in the network. Main SON uses cases such as self-establishment of a new eNodeB and Automatic Neighbour Relation (ANR) management have been identified and described. Moreover, Release 8 standardizes important interfaces from SON point of view:

- X2 interface between eNodeBs
- S1 interface between eNodeBs and EPC

Strong motivation to increase operational efficiency caused that SON concepts are one of the key areas addressed by operators' lobby through Next Generation Mobile Networks (NGMN) initiative, which complements the work on future mobile broadband networks within standardization bodies.

There are many projects addressing self-organization issues. As an example, Socrates project concentrates on development of self-organization methods for wireless access networks, in particular related to LTE air interface. Gandalf project was defining solutions for self-diagnosis, self-testing and self-tuning in multi-system environment.

Vendors are also active in the field of SON. Recently Motorola has announced advanced SON solution which is a part of its LTE offering. Other vendors such as NSN, Ericsson and Huawei are also working intensively on their SON solutions.

## Our View on Self-Organizing Networks

As majority of operators and vendors we agree that network management automation is a key technology requirement and a crucial factor for investments in next-generation wireless technologies such as LTE. Therefore, we designed our products to support process management and task automation and we continuously seek for algorithms and solutions enabling self-organization.

When it comes to adoption of self-organization concepts in operational networks, we envision that this process will be gradual. Beside technical challenges related to algorithm implementation such as coping with ping-pong effects and algorithm convergence issues there is also a human factor which cannot be underestimated. For years networks have been operated in manual way and there is time needed for building trust in automatic network operation. Initially planners may want to view the results of self-x algorithms in order to be sure that network quality and performance will not be affected.

## Our Approach for Supporting SON Use Cases

High level definition of SON use cases enables to employ various implementation strategies ranging from centralized support of SON functions to fully decentralized solutions. Selection of implementation strategy shall depend on the problem to be solved. Centralized approach is suitable for SON use cases related to larger amount of cells such as coverage and capacity optimization. Decentralized solutions are better for solving localized problems such as neighbour list management and enable faster reaction times than centralized solutions.

We propose a universal approach to address particular SON use cases for various wireless access technologies rather than concentrating purely on such technologies as LTE. Although our portfolio enables centralized and hybrid approach depending on SON use cases to be supported, most of our efforts are concentrated on hybrid solutions in which SON logic is divided between network management system and network elements. Distributed part of use cases needs to be tackled by hardware vendors having a possibility to implement particular algorithms directly in the network elements.

The heart of our solution is a Process Driven Inventory with flexible Process Management and Automation Engine. With Auto-discovery & Reconciliation, Fault Management as well as advanced planning and optimization algorithms combined with powerful Network Provisioning module our product portfolio enables automation and self-organization of network operation activities.

## Process Management

Process Management engine allows fully managed and controlled execution of all operational processes. It can act as a SON coordinator and orchestrate various SON workflows and processes. Freedom of process definition is ensured via Process Designer, which provides GUI for process composition.

## Auto-discovery & Reconciliation

Advanced tools such as Auto-discovery and Reconciliation applied together enable to get information about current network status as well as SON functions configuration and act upon needs. Auto-discovery allows to collect data from network elements directly or via systems managing these elements. Reconciliation enables to import data from external systems having information about network configuration.

## Fault Management

Fault management is a complete solution to ongoing fault issues inside operators' networks. It monitors all important elements of the network, receives, displays and tracks alarms, allowing to manage potentially dangerous network problems. It provides root cause analysis based on correlation engine and combined with Process Management enables to automate fault corrections.

## Automation Engine

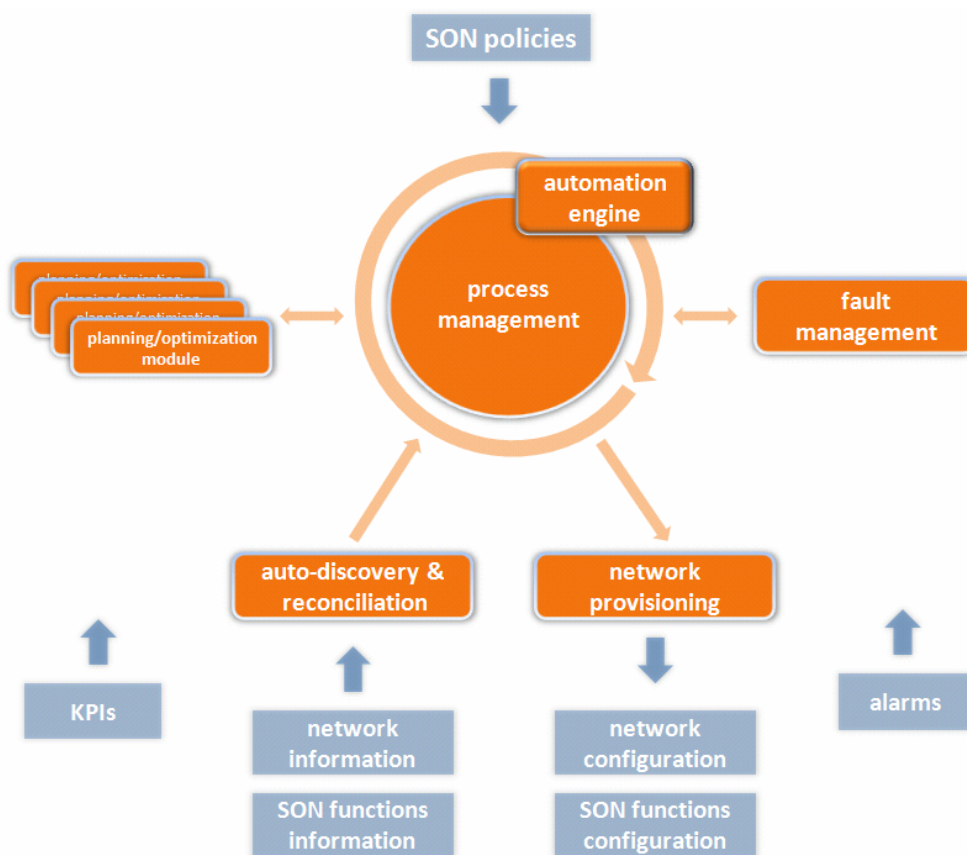
Enables to automate most of manual activities related to network operation. Flows of automated operations can be run by users, be part of processes controlled by Process Management module or can be provided as web service and triggered via external system.

## Planning & Optimization Modules

Beside very few parameters calculated in external planning tool, remaining parameters are calculated in self-organized manner by planning & optimization modules, which are pluggable pieces of logic utilizing prediction and OSS based data. External algorithms can be integrated with the solution to address operator specific needs.

## Network Provisioning

Network Provisioning is an Inventory-driven provisioning system capable to configure all network elements, while simultaneously reflecting all the changes in the inventory database. Comarch bi-directional OSS Mediation is used to easily integrate the Network Provisioning system with many network devices in the multi-vendor environment.

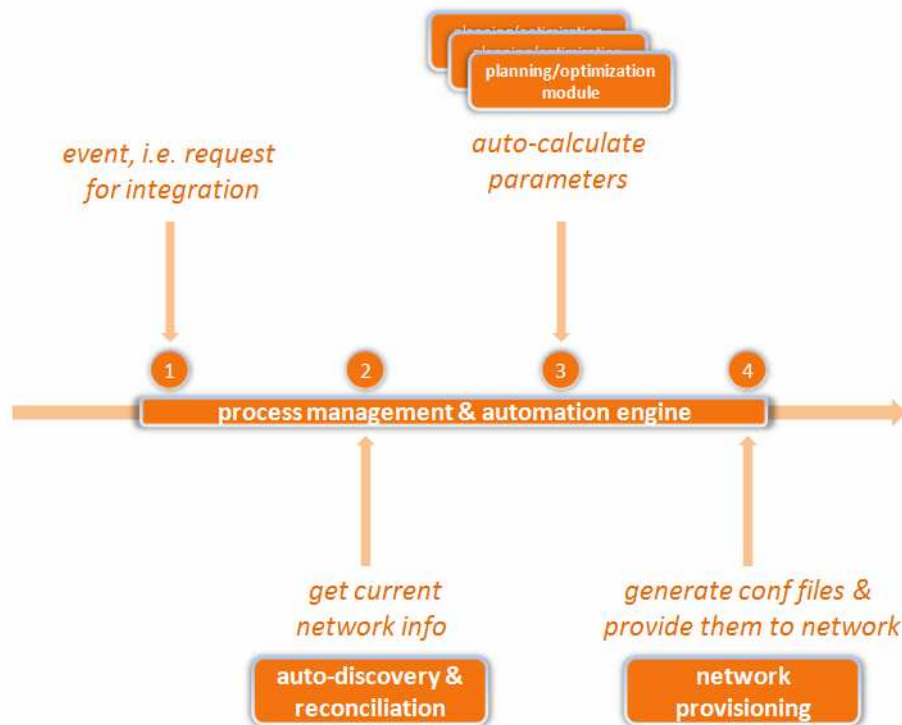


**Figure 3. SON use cases with Comarch product portfolio**

Figure 3 demonstrates how SON use cases can be achieved with our product portfolio. Operators will define SON policies and map them to corresponding processes which will be automated via Automation Engine. Execution of certain processes will be triggered dynamically based on information from the network (i.e. configuration changes, alarms, KPIs) or external events (i.e. request of site rollouts, customer complaints). Processes will orchestrate interaction of various modules such as Fault Management and Algorithm modules and as a result provide configuration changes or new settings for SON functions implemented in network elements via Network Provisioning module.

## Example Use Case: Self-Planning of Radio Parameters for a New Base Station

Installation of new base station requires definition of initial set of radio parameters such as power settings, frequencies, handover parameters and neighbour lists. This process should be as automated as possible and best practice rather than optimal parameters should be aimed for. Self-planning of initial radio parameters with Comarch modules has been depicted on Figure 4.



**Figure 4. Self-planning of initial radio parameters**

Parameter planning process is initiated with event, i.e. indicating request for integration of new base station. This event triggers reconciliation task which updates information about current network configuration. After that set of planning algorithms is launched in batch mode to calculate basic radio parameters for new cells. Depending on radio access technology appropriate algorithms are triggered and intra-/inter- layer parameter dependencies are resolved. Resulting basic parameter set is enriched based on predefined templates by configuration management logic and provided to network via Network Provisioning Module. In case of availability of ANR function neighbour planning can be realized at eNodeBs, otherwise planning modules will be responsible for neighbour list generation.

## Summary

As complexity of networks and OPEX reduction pressures grow, concepts related to Self-Organizing Networks are regarded by operators as the key technology requirement. The manual work associated with network operation needs to be significantly reduced and the network itself should be capable to self-configure and continuously self-optimize in response to network and traffic changes. In Comarch we designed our products to support automated process management and we continuously design algorithms and solutions enabling self-organization. With our clients we develop hybrid SON solutions and concentrate on integration of planning and optimization, configuration management and network provisioning capabilities. This allows our customers to quickly integrate new network elements and implement configuration changes to the network. By means of task automation many manual activities can be avoided and operational efficiency can be increased.

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