SON: the Natural Evolution of Mobile Network Optimization

White Paper

Introduction

Automation of engineering processes has long been on the agendas of mobile telecom executives. Today, a combination of factors is creating a perfect storm, driving the development and future adoption of Self Optimizing Networks (SON). Standard bodies, mobile operator and equipment representatives have been busy hashing out SON requirements in the last two years as part of the more general LTE standardization effort. Now that LTE networks are on the event horizon and could potentially offer some much needed relief to the strained business models of all-you-can-eat mobile broadband service, understanding SON and its impact on the network operation and cost is becoming more important to industry decision makers.

In this whitepaper, Actix presents the key drivers behind SON, the required capabilities and systems, some of the typical use cases, and Actix' own readiness to provide SON.

1 What are the Key Drivers behind SON?

When LTE networks begin going live in 2009-2010, it is expected that the typical situation will be that of 2G, 3G and LTE technologies coexisting for some time. This implies that the incremental cost of delivering LTE will have to be low given that 2G and 3G have already been cost optimized and operators' EBITDA headroom is tight.

Second, there will be a large number of new engineering parameters in LTE, the optimization of which will require much effort and will lead to instability in the network, particularly in the early deployment phases. Therefore, there is a need to have the necessary self-optimizing processes in place before these deployments go live.

Finally, to enable fixed-mobile converged services as well as to dampen the drain on capacity created by mobile broadband, the deployment of home zone eNodeB's is likely to be necessary. There will be not only a large number of such eNodeBs but also a high degree of freedom in their manufacturer type, location and usage. This variety in turn will drive the need for plug and play aspects of SON functionality.

Leading industry watchers and commentators have been following SON drivers. According to Gabriel Brown, Senior Analyst at online wireless magazine Unstrung, July 08 2008:

> *"The idea of self-configuring, self-optimizing wireless networks is not a new one, but as the mobile industry moves toward commercialization of next-generation "4G" systems, the ability to automate the management processes has emerged as a key technology requirement. The idea is to minimize the lifecycle cost of running a network by eliminating manual configuration of equipment at the time of deployment, right through to dynamically optimizing radio network performance during operation. The ultimate aim is to reduce the unit cost and retail price of wireless data service."*

Crucially, the need for SON has also been recognized by 3G Partnership Project (3GPP) and the Next Generation Mobile Network (NGMN) alliance – both see in SON a key functionality in Next Generation Networks. NGMN board members include senior technical staff from leading operators such as T-Mobile International, France Telecom, NTT DoCoMo and SK and others. Interface specifications and use cases for SON have been defined and are part of 3GPP Specifications 32.500 in Release 8 with the first use cases of SON expected to appear in the first deployments of LTE in late 2009, early 2010.

Several leading operators are strong supporters of SON. Public statements in favor of SON include comments from the following:

- Kenny Graham, head of new technologies and innovation at Vodafone, highlighting the crucial role of SONs for home zone LTE deployments on June 25th 2008, online magazine Unstrung.
- Emin Gurdenli, T-Mobile UK's director of technology, who recently described network automation as critical to investment in next-generation wireless technologies.
- Frank Meywerk, Senior Vice President Radio Networks at T-Mobile International, London Conference on LTE on November 22 2008, online magazine Unstrung.

However, decision makers and Industry watchers alike are making critical assumptions on the existence of capabilities that are key components of SON systems. These capabilities are non-trivial to obtain organically for many industry players and require years of multi-faceted industry experience.

2 What are the Components of a SON System?

To begin with, an accurate, integrated and up to date view of RAN Status is necessary otherwise self optimizing a network would be a akin to flying a plane on autopilot with delayed altimeter readings in heavy fog – a stab in the dark at best. Therefore and referring to Figure 1, a scalable, multivendor Network Status Management data platform is required to consolidate data from Performance, Fault, Configuration, Planning and Call trace systems and present this data both for human and machine processing.

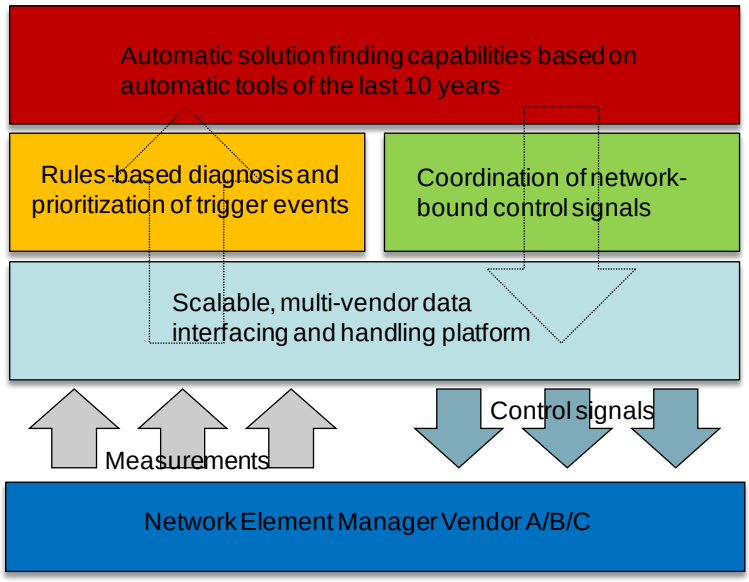

Figure 1 Key Components of a SON

Secondly, a system to apply rules-based diagnosis and prioritization is required. Such systems run in the background monitoring every aspect of the network using dozens of data sources – constantly sampling and analyzing live data to identify pre-defined events, such as for instance a dropped call rate crossing a predefined threshold. Events are prioritized according to their urgency and impact on the network while rules encapsulate the team's location specific RF Engineering knowledge. Once a problem has been classified, a solution-finding component is triggered.

Actions should then be taken to affect network conditions, which in turn require a solution finding capability. The solution finding capability can be either autonomous (no human intervention required) or automatic (some human intervention required). It is important to note that while SON use cases have been defined as part of the NGMN Group 12 work [1,2] , the specific algorithms or solution finding functions have not. Thus, experience developing Automatic Optimization algorithms for use in the field will be a critical component of a live SON system and will be a capability of great practical importance.

Finally, coordination of control signals and execution of the network orders by a control module will be necessary to ensure signals to the network do not conflict with each other.

To summarize, the key capabilities required for a successful SON deployment are:

- Network Status Visibility
- Expert Diagnostics and Prioritization
- Automatic Solution Finding
- Control Signal Coordination

Interestingly, with the exception of control signal coordination, these capabilities are not the preserve of base station infrastructure manufacturers. As counter-intuitive as it may seem, these vendors have not been traditionally strong in these areas. This has been the case for two main reasons. First, infrastructure vendors have generally focused on manufacturing base station hardware, deploying and operating networks but not in designing commercial grade RF software tools, which they often consider a distraction to their core business. The second reason rests on their customers, mobile operators' desire to keep their suppliers in check with independent third party tools used for configuration, testing and troubleshooting. Therefore, general-purpose optimization tools provided by infrastructure vendors have never been truly embraced by those mobile operators who have some level of bargaining power in their tools decisions. These vendor/customer dynamics will be present when SON systems start coming to market this year.

3 What are the stages of a SON lifecycle?

SON, as indicated in Figure 2, has three modes of operation: Self Configuration, Self Optimization and Self Healing.

In Self Configuration mode, when a new NodeB is "plugged in" it downloads the latest software release from the operations and maintenance system via the backhaul network. The NodeB then scans the radio environment and adjust its physical or soft parameters accordingly.

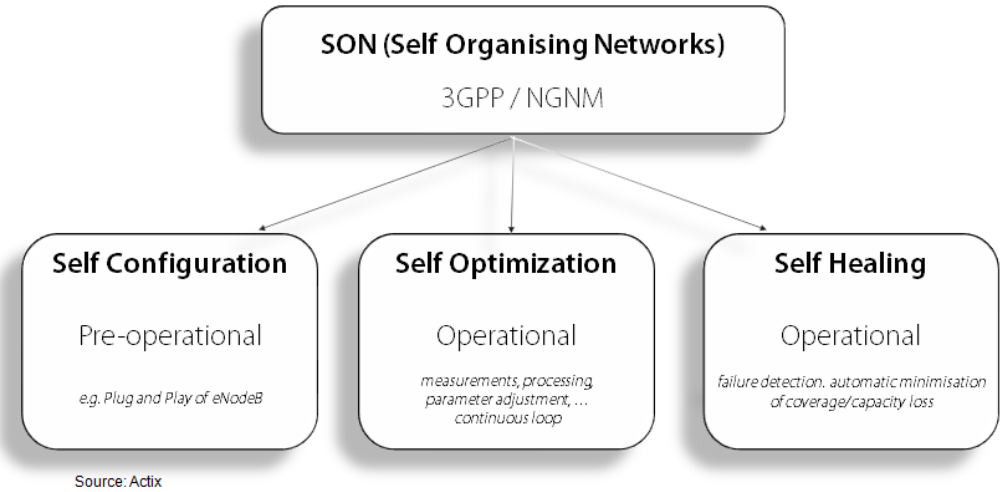

Figure 2 SON Modes

Once self-configuration is complete, the NodeB enters the operational state. In this mode the purpose of the Self Optimization functionality it to maintain and improve service quality and performance of the network, taking into account performance indicators sent by the mobile terminals.

Finally, in Self Healing mode, the NodeB can detect network failures and take remedial action to minimize coverage or capacity loss.

4 What are the Primary Architectures of SON?

3GPP standard 32.500 Release 2008-12 defines 3 types of SON systems:

- Centralized SON – Solutions where SON algorithms are executed in the Operations and Maintenance System (OAM). In such solutions, SON functionality resides in a small number of locations, at a high level in the architecture.
- Distributed SON – Solutions where SON algorithms are executed at the Network Element level. In such solutions SON functionality resides in many locations at a relatively low level in the architecture
- Hybrid SON – Solutions where a part of the SON algorithms are executed in the OAM system, while others are executed at the Network Element level.

Considering the large number of cells that will be typical of next generation deployments and the complexity of the multivendor environment, the centralized SON architecture appears to be the most comprehensive to manage variability and scope. Mobile operators will also require openness and visibility into SON systems, which tends to favor centralized SON systems. However, the centralized SON architecture - while likely to deliver the full complement of SON functionality - is likely to be more costly than the more distributed SON variants.

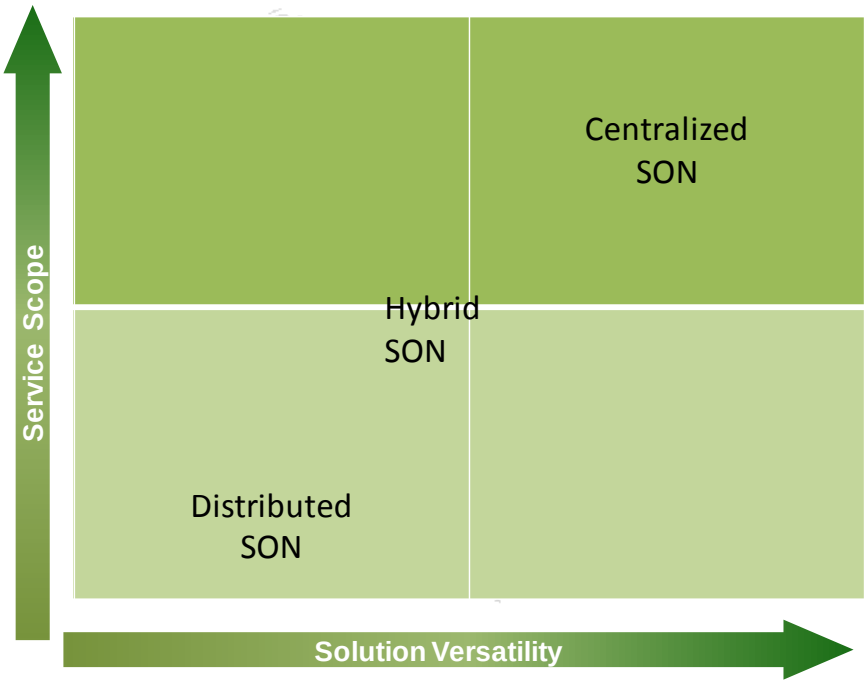

Figure 3 SON Service Scope versus Versatility

5 What are the main SON Use Cases?

Operator expectations are high for what LTE and SON should deliver with many keen on a step change in production costs. To provide more clarity to vendors, the NGMN alliance has identified typical use cases although the alliance points out that this list is meant to be indicative and non exhaustive. As indicated in Figure 4, SON use cases are categorized into the following groups: Planning, Deployment, Optimization and Maintenance.

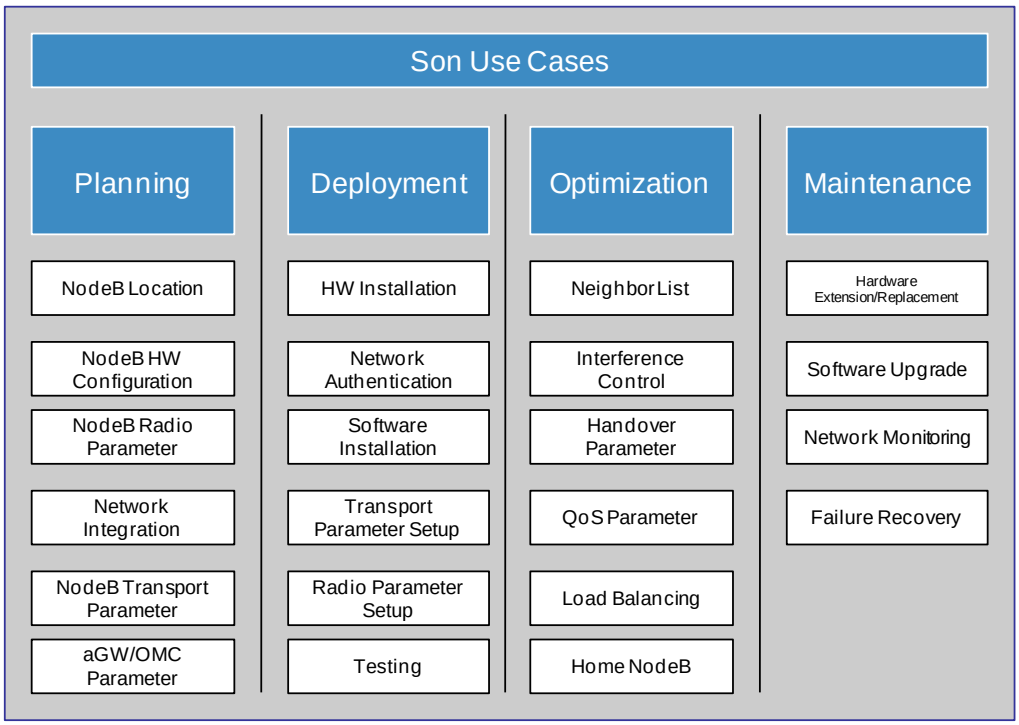

Figure 4 SON Use Cases as Defined by the NGMN

The following activity definitions are taken from the NGMN, NGMN Project 12, Use Cases related to Self Organizing Network 16-April-2007 [2]:

Planning Planning includes preparing the necessary parameters and settings that are needed before deploying a new enhanced NodeB (eNB). After planning all necessary parameters and settings, the new eNB can be placed and attached to the network.

Deployment The deployment of a new eNB consists in installing the eNB hardware at the designated site, and to set up the necessary configurations preceding commercial operation. Although this would be mainly a manual process, effort can be reduced by having a self-configuring functionality in the new eNB. This may entail relevant updates also in the neighbor eNBs as well as associated aGWs.

Optimization Optimization is a closed loop process of parameter deployment, performance evaluation, parameter optimization, and redeployment of

optimized parameters to the network. The optimization algorithm would depend on the operator policy, and would be implementation specific. It is however essential to identify all the necessary "hooks" to realize self-optimization, such as UE/eNB measurements and interfaces, and to standardize these hooks particularly to cope with multivendor scenarios. Optimization functions can then be accessed either by human operators or by automatic processes of machines.

The radio optimization process can be capacity-driven, coverage-driven, or performance-driven:

- Coverage-driven optimization means that parameters are changed to increase cell coverage.
- Capacity-driven optimization means that parameters are changed to increase the network or cell capacity
- Performance-driven optimization means that parameters are changed to increase user performance e.g. the throughput per user, user plane latency.

Maintenance

The aim of SON is to allow smarter operation and maintenance in LTE compared to the 2G and 3G Networks today. Many of the use cases are based on direct inputs from operations and planning departments and consequently, these use cases are more related to daily operations and the most annoying problems there.

6 What is Actix' role in the industry and in SON?

Actix has been bringing industry leading RAN deployment and automatic optimization products to market since the very early days of GSM – in the early nineties. Recognizing changing industry dynamics, Actix launched in February 2008 a carrier grade, enterprise platform, NSM, which aimed at reducing operator opex and the essential building block of SON. Actix' natural continuation of its product strategy is to build SON with NSM and Automatic Optimization component parts, which are available today. Actix is building up critical operational experience in managing large volumes of data for tier 1 customers as well as in improving its customers' operational efficiency.

Specifically, Actix supports today:

- A scalable, multi-vendor, data interfacing and handling platform, *Actix One*, which has been proven in over 20 live deployments, supporting each 400 engineering and management users with network processing demands of up to 1TB per day.

- Network Status Management rules-based diagnosis and prioritization of trigger events. NSM processes and correlates network data to allow detection of issues. Automatic diagnosis of root causes are performed using encapsulated knowledge. Automatic prioritization of each issue is based on KPI impact to the network such as calls or on revenue.
- Automatic solution finding capabilities are based on automatic tools of the last 10 years. These tools include Automatic cell planning, Automatic Frequency Planning, Automatic Neighbor Planning and Automated Radio Parameter Planning. These tools have been able to help operators with their capacity, coverage, performance and cost issues.

During 2009, Actix will be deploying the world's first SON system, comprising a full network model that will understand the macro context across several vendors, which will be able to manage heavy loads in real time and will integrate new use cases easily and quickly.

REFERENCES

[1] Informative List of SON Use Cases, NGMN Project 12 Version 1.53 17-April-2007

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[3] Self-Organizing Networks (SON); Concepts and requirements 3GPP TS 32.500 V8.0.0 2008-12

[4] NGMN Recommendations on SON & O&M Requirements, NGMN Project 12 1.23 – 5-December-2008

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