

Self Organized Radio Access Wireless Networks

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Why Self Organization?

In early 2G networks, management of network elements was typically performed locally at each site. As networks expanded in size and complexity, remote management from central locations was incorporated and computer-aided tools were used extensively by operators.

Yet, in most currently deployed wireless networks, OAM activities require a substantial amount of human intervention for planning and deployment, analyzing reports systematically, identifying problem areas, deciding on optimization and improvement mechanisms, incorporating these into the deployed networks and ensuring their effectiveness. Further the optimization activities are iterative and need to be done continuously and constantly. It is evident that OAM activities contribute substantially (about 20%) to operational costs.

As technologies advance towards 3G and beyond, these issues are getting further compounded due to a number of reasons.

- Rising number and complexity of parameters in these networks means that even more effort is needed for the optimization processes. This translates into increased OPEX for operators, even as efficiency may be inadequate.
- In many regions, 2G, 3G and next generation technologies will be operated in parallel. Bringing in separate OAM systems to handle these is inefficient, while creating and setting up new integrated OAM systems as each new flavor of technology is incorporated implies long periods of system instability as well as huge additional costs.
- The recent advent of micro/pico/femto base stations heralds an explosion in the number of nodes in the network. Managing this unprecedented volume using traditional OAM techniques is very cumbersome. Further, new trends brought in by residential/enterprise femtocells, such as dynamic deployment of nodes coming from multiple vendors and restrictions on the user group, provide compelling reasons for bringing in changes in the current management methodology.

All these factors act as drivers for the necessity to evolve a new paradigm for making operations and management functions as autonomous/automatic as possible.



Figure 1: Drivers for Self Organization of Next Generation Networks

Self organization of wireless networks is slowly gaining ground as a promising technique that allows operators to simplify and optimize their networks, while saving on operational expenditures. In a Self Organized Network (SON), radio and network components interact among themselves dynamically to configure and tune the system automatically in real time.

Introduction to SON Concepts

What are the basic functionalities of a self organizing network and how does it help mitigate the problems of network management?

A self-organizing radio access wireless network continuously measures data such as network, traffic, user mobility and radio channel conditions. These raw measurements are processed to obtain a set of parameters (for example, antenna tilt or power settings) which are the inputs for self optimization. Base stations in the network constantly perform self-optimization by updating their parameters in accordance with this data. If there is a requirement for capacity expansion, timely notifications with accompanying recommendations for human intervention are delivered (for example, a location for a new cell site).

A newly added base station configures itself through a 'plug-and-play' approach. Even for existing base stations, an event such as a new neighbor being incorporated into the network, or a new service or feature being introduced, may require an initial re-configuration of certain parameters (for example, neighbor lists or power settings). Once this self configuration takes place, the parameters can be further optimized as part of the continuous self-optimization process.

In the event of any failures, the base stations try to rectify possible gaps in capacity or coverage by triggering self-healing methods. As an example, a base station might try to make up for the failure of a neighboring base station by adjusting certain parameters. However, once the actual failure has been repaired, all the parameters would get restored to their original settings.

Thus self-configuration, self-optimization and self-healing are the main functions of a self-organizing network. As explained, these are not independent approaches, but inter-related and overlapping elements that work together to provide an integrated methodology, as depicted in figure 2.

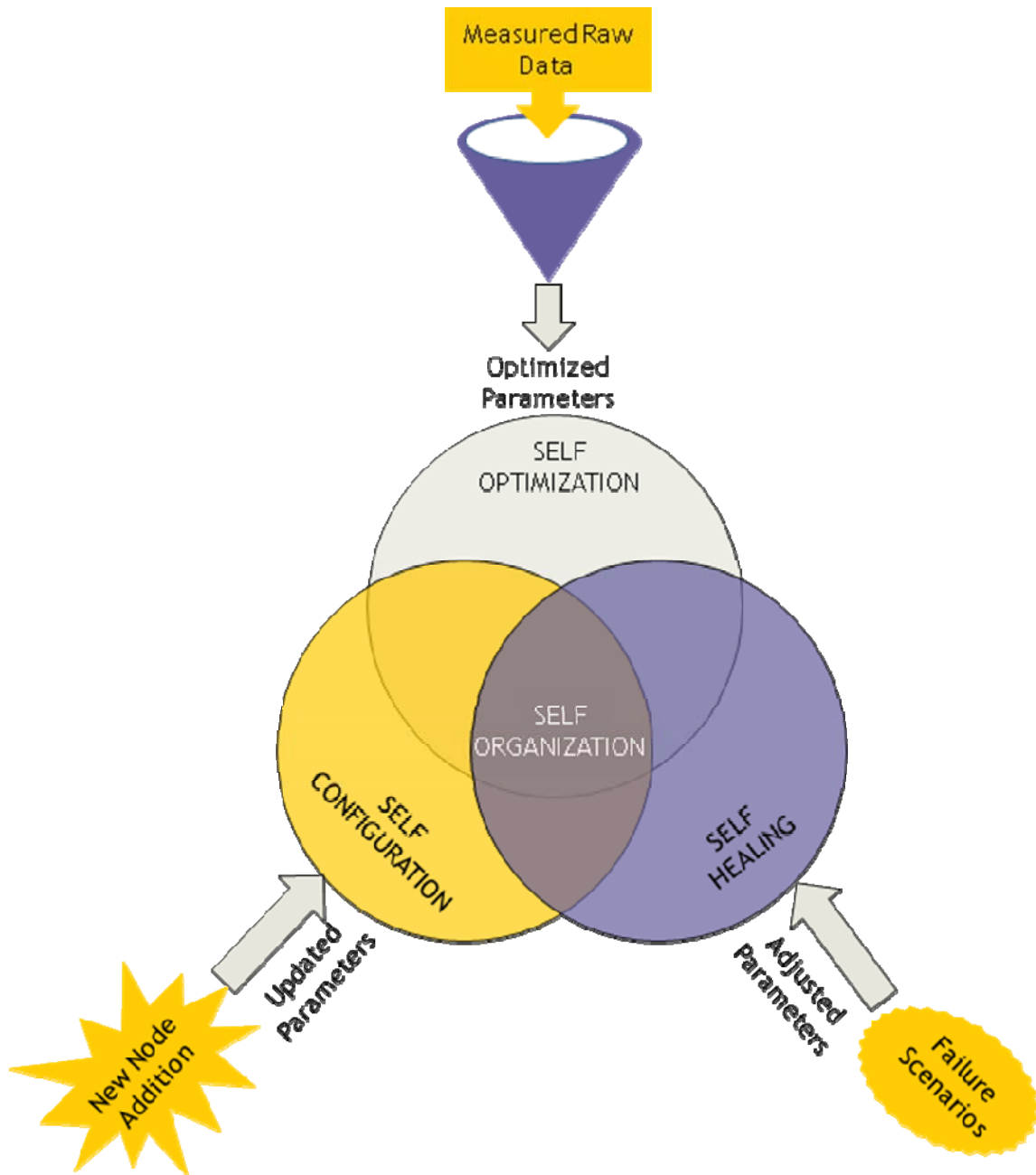


Figure 2: Inputs and Triggers to Self Organization

Advantages of Self Organization

The end goal of self organization is to achieve enhanced performance, increased service availability and quality and faster recovery of the network as a whole, while significantly decreasing operational expenditure through reduced operator intervention, as elucidated below.

Performance enhancements

- Self optimization and self healing decision mechanisms speed up the analysis and decision making required for maintaining and continuously improving network efficiency.
- Minimization of manual configuration also simplifies and hence accelerates the process of rolling out new base stations and technological upgrades, while continuing to ensure network reliability.
- Self configuration gives a definite impetus for rolling out femtocells, as end-users can easily install these with no manual support from operators/vendors. This in turn portends improved coverage and increased data throughput in indoor locations such as home and offices.

OPEX Reduction

- For operators, savings in operational expenditure can be expected through reduced human involvement in the areas of drive testing, network planning, monitoring and optimization.

Who Drives SON ?

Although self organization as a concept has been around for quite some time, primarily in ad-hoc and sensor networks, it has only recently become a focal point in wireless radio access networks.

SON is currently extensively discussed in 3GPP standardization, primarily for LTE. NGMN is playing a major role by collaborating with 3GPP to create SON based specifications for LTE network management.

The SOCRATES project, a consortium of companies and research organizations in Europe, is another player working towards development of self-organization methods in LTE.

Other standards bodies like the WiMAX forum are also making efforts to incorporate some form of self organization in their networks.

SON in LTE

The NGMN recommendation for SON in LTE details use cases related to self configuration, self optimization, as well as self healing (termed as fault management and fault correction). Further OAM related use cases as well as some SON enablers are also elaborated.

Specific use cases for self configuration of new base stations include

- Planning of location, capacity and coverage, radio and transport parameters
- Hardware installation
- Data alignment for neighbor nodes
- Set-up of transmission parameters for the new base station as well as its neighbors
- Authentication of base station, Secure access to the access gateways and OAM components
- Generation of automatic inventory, Automatic software download
- Self test by the base station, and self configuration in the network

The self-optimization use cases include

- Support to a central optimization entity
- Optimization of neighbor cell list, hand over parameters, QoS related parameters
- Interference control
- Load balancing
- Self optimization of different parameters

Self healing related use cases are

- Information correlation
- Cell/service outage detection and compensation
- Mitigation of unit outage

OAM related use cases include

- Minimization of operational effort in case of hardware capacity extensions
- Automatic NEM upgrade and enabling of fast recovery of unstable NEM system
- Minimization of impacts of outage of higher level network elements

Use cases pertaining to solutions that may enable certain SON functionality are

- Enabling of Performance Management in real time through NEM
- Enabling of definition of KPIs and reporting
- Support of interface for subscriber and equipment trace

SON @ L&T Infotech

L&T Infotech has always ensured that it is up to date on emerging technologies and paradigms, and SON is no exception.

L&T Infotech has been actively following and getting involved in the SON related activities in different standards bodies, apart from providing insight into the subject at various forums and conferences.

Further, L&T Infotech has been engaged in the implementation of commercial products incorporating SON mechanisms in radio access network base stations as well as network management entities.

We have worked on development of algorithms for distributed management of large heterogeneous networks, involving concepts such as self-organized grouping of network elements, automatic reconfiguration and dynamic software upgrade.

Our experience in advanced network management includes tools for analysis of various network parameters, with built-in logic to recognize trends, identify performance issues and re-configure the system for optimized performance.

Further, with LTE and WiMAX being the fore-runners for network management through self organization, we at L&T Infotech are well equipped to help customers in the SON domain by leveraging our extensive exposure to LTE and WiMAX domains as well as our rich experience in development of OAM and NMS systems.

Abbreviations and Acronyms

2G	Second Generation (Wireless communication system)
3G	Third Generation (Wireless communication system)
3GPP	3rd Generation Partnership Project
LTE	Long Term Evolution
NEM	Network Element Manager
NGMN	Next Generation Mobile Networks
NMS	Network Management System
OAM	Operations, Administration & Maintenance
OPEX	Operational Expenditure
SOCRATES	Self-Optimization and self-ConfigurATIOn in wirelEss networks
SON	Self Organizing Networks
WiMAX	Worldwide Interoperability for Microwave Access

References

3GPP standards	www.3gpp.org
NGMN Publications	www.ngmn.org
SOCRATES Project Publications	www.fp7-socrates.org

About the author



Renu Jagadish has an overall industry experience of over 12 years in the execution and management of software development projects in the wireless telecom infrastructure domain. One of her areas of technical interest is the management of wireless networks, especially through self organization. She has been associated with L&T Infotech since 2001.

About L&T Infotech

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