SON for LTE Networks

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Nokia Siemens Networks: A global company with a rich heritage

- Joint Venture of Nokia and Siemens, recently acquired Motorola’s wireless networks infrastructure business
- Started operations on April 1, 2007
- €12.7 bn net sales in 2010
- 120+ years of telecom experience
- ~73,000 employees
- ~46,000 service professionals (including externals)
- > 80 out of the top 100 operators worldwide
- 150+ countries
- 3 billion mobile subscribers and ¼ of world’s voice households served

2010 Wireless infrastructure revenues

Notes: Wireless networks revenues include Radio, Core and MWR
Source: NSN SBD IPS estimates; financial statements; Huawei revenue estimated based on its 2010 report
Load and Service Based HO within U900 & U2100

U900

PrxTarget = 8dB
Prxoffset = 2dB
PrxTargetPSMax = 8dB
PrxLoadMarginDCH = 4dB
PrxLoadMarginEDCH = 0dB
PrxMaxTargetBTS = 12dB
PtxTarget = 42dBm (20W LPA)

LHOResRateSC = 90%
LHWinSizeONResRateSC = 15s
LHOHystTimeResRateSC = 2s
LHOdelayOFFResRateSC = 30s
LHNumbUEInterFreq = 2
LHOMinNrtDchAllocTime = 20s

Example of manual parameter settings needed in establishing Base Station adjacencies.

Have you ever tried to manage 30,000 elements with hundreds of parameters each by hand?
Drivers for Self Organizing Networks

- Saturated markets, revenue per bit is dropping
- Parallel operation of LTE with 2G and 3G networks
- Large and complex number and structure of network parameters
- Expanding number of Base Stations (HetNet)

- OPEX reduction – reduce human interaction

- Configure & optimize the network automatically
- But allow the operator to be the final control instance
Operator Motivation for Self Organizing Networks (Source: Deutsche Telekom)

Have you ever tried to manage 30,000 elements with hundreds of parameters each by hand?

Question

Analysing cost drivers in site life cycle...

w/o SON

with SON

Potential savings

I&C

Operations

Optimisation

Planning
Drivers for SON are Quality and OPEX - decisive push through NGMN

“it is of vital interest to operators to minimize operational effort by introducing self-organizing mechanisms “
NGMN White Paper, Dec. 2006
Main Functionality of Self Organizing Networks

**Self-healing**: automatic detection, localization and removal of failures

**Self-optimisation**: auto-tune the network with the help of UE and eNB measurements on local eNB level and/or network management level

**Self-configuration**: automated network integration of new eNB by auto connection and auto configuration, core connectivity (S1) and automated neighbour site configuration (X2)

Configure & optimize the network automatically, **but** allow the operator to be the final control instance
LTE Network Management Architecture

The colour of a box denotes a vendor. Straight lines denote open interfaces.

Single vendor domain
Connected via open interfaces to systems from other vendors

de-centralized SON functionality
centralized SON functionality
Implementation challenge: Where to allocate SON functions best?

SON function execution:

- **Centralized**
  - large number of cells involved

- **Distributed**
  - ~ 2 cells involved

- **Local**
  - single cell scope

Function allocation?

- Son function execution:
  - (e.g., Hand Over optim.)

Reaction speed

- Fast

Optimization criteria

- Large
- High

Size of statistical database

- Decision complexity
NSN’s view on optimized function allocation

<table>
<thead>
<tr>
<th>Function Execution</th>
<th>pre-operational</th>
<th>in operation</th>
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<tr>
<td><strong>centralized</strong></td>
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<td>Automatic Neighbor Relations</td>
<td>Coverage and Capacity Optim.</td>
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<td>Cell Outage Compensation</td>
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<td>Energy Saving</td>
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<td><strong>distributed</strong></td>
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<td>Automatic Neighbor Relation</td>
<td>Phy. HO Optimization (Hyst.)</td>
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<td>Real-time Load Balancing</td>
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<tr>
<td><strong>local</strong></td>
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<td></td>
<td>Auto configuration</td>
<td>RACH optimization</td>
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<td></td>
<td>Node Authentication</td>
<td>CQI adaptation</td>
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<td>Auto connection</td>
<td>Load balancing</td>
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- **SON function execution**: pre-operational vs. in operation
- **Centralized**: phy. cell ID assignment, automatic neighbor relations
- **Distributed**: automatic neighbor relation
- **Local**: auto configuration, node authentication, auto connection
- **Pre-operational**: automatic neighbor relations
- **In operation**: phy. ho optimization (hyst.), real-time load balancing
SON Principle: From Observations to Root Cause

Detecting the Root Cause of a Problem

- from a large vector of input data
- while multiple changes impact the network concurrently
- ambiguity of observations
- trial-and-error in a live NW is prohibitive due to the risk of negative performance impact, effort and required time

![Diagram showing the relationship between observations, causes, and SON functions](image-url)
Nokia Siemens Networks enabled products ... it's about orchestration

**eNB**
Flexi Multimode BTS

**EMS/NMS**
NetAct OSS5.2 CD 2
NetAct Unify (E/2011)

Entry level configuration:
Rack mounted servers

Medium & large configuration:
Blade servers

**MME & SAE-GW**

Certification Authority
Nokia Siemens Networks entity
Management System for Public Key Infrastructure

Flexi Network Server
Flexi NS

Flexi Network Gateway
Flexi-NG
What’s next: … SON for LTE-A / Beyond 4G

Key ingredients

- Carrier Aggregation up to 100 MHz
- MIMO (8x4x)
- Cooperative Systems
- Relaying
- Heterogeneous Networks
- Smooth Migration to LTE-A
- Backward compatible to LTE

Carrier Aggregation up to 100 MHz
MIMO (8x4x)
Cooperative Systems
Relaying
Heterogeneous Networks
Smooth Migration to LTE-A
Backward compatible to LTE
SEASON
System Experience of Advanced SON

- **Realtime** multi user, multi-cell radio network emulator supporting **dozens of sites** and **more than 1000 terminals**
- System requirements: **Windows @ standard laptop**
- **Interactive control** via graphical I/F
- Timescale: **100 ms**
- Designed for evaluation and visualization of **SON features**: (Multi-RAT) ANR, LB, CoC, Tilt Opt., MRO, MDT, Energy Saving
- Traffic Steering: **Multi-RAT and Multi-Layer** scenarios
- **LTHE**: Multi-Flow Operation
- **Cognitive Radio**: Multi operator frequency sharing (‘licensing light’)
- Version 2: Support of **Real World deployments** (Munich City Center)
SEASON Demos
1. Tilt Optimization
2. Cell Outage Compensation (COC)
3. Load Balancing (LB)
4. Automatic Neighbor Relations (ANR)

rural area
inter site distance: 3.5 km

urban area
inter site distance: 1.2 km
Commercial Break

- NSN Editors & Authors
- Publication: 01/2012
- Hardback, ~448 pages
- Table of Contents:
  1. Introduction
  2. LTE Overview
  3. Self-Organizing Networks (SON)
  4. Self-Configuration ("Plug-and-Play")
  5. Self-Optimization
  6. Self-Healing
  7. Supporting function: Minimization of Drive Tests
  8. SON for Core Networks
  9. SON operation
  10. SON for Heterogeneous Networks (HetNet)
  11. Future Research Topics
Thank you