Self-configuration and Self-optimization of 4G Radio Access Networks
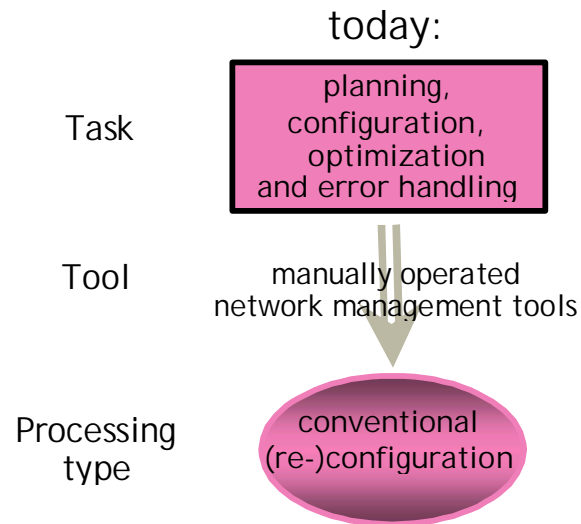
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Outline

1. Motivation

2. Solution Approach for self-x
   - RAN self-configuration
   - RAN self-optimization

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5. Self-optimization: Targets, Use Cases and Tasks

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Motivation

Current situation for radio network configuration and optimization:

deployment, maintenance, and optimization of radio networks become more and more complex and cost extensive

high manual intervention and high expertise required

several different tools for network planning and optimization involved
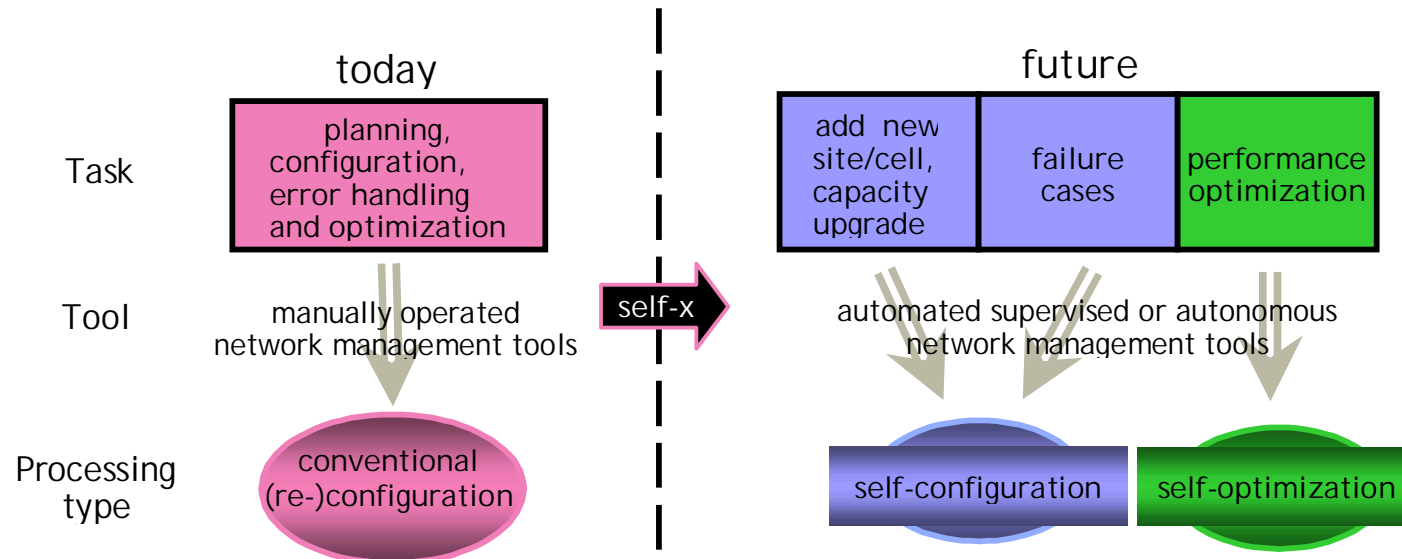
today:

Task — planning, configuration, optimization and error handling

Tool — manually operated network management tools

Processing type — conventional (re-)configuration

Main Targets: CAPEX and OPEX reduction

Solution Approach

Solution: introduction of self-x mechanisms — self-configuration and self-optimization

	today		future		
Task	planning, configuration, error handling and optimization		add new site/cell, capacity upgrade	failure cases	performance optimization
Tool	manually operated network management tools	self-x	automated supervised or autonomous network management tools		
Processing type	conventional (re-)configuration		self-configuration		self-optimization

significantly increased automation

simplified deployment procedures

faster recognition and reaction on fault situations

automatic and continuous radio access network optimization

adaptation to dynamic system behavior

Solution Approach: Self-Configuration and Self-Optimization

deployment
set of optimized
radio parameters

self-optimisation
function

system model
+ optimization
algorithms

model
adaptation

analysis system
performance

operational
mode

self-configuration
of radio and
RRM parameters
(pre-operational
mode)

deployment
of new
cells & nodes

performance monitoring,
measurements

algorithmic
description of
system behavior

topological info
(e.g. morphology
data, eNodeB and
UE based
measurements
with location info)

Architecture and Standardization Aspects

Relevant self-x scenarios:
  Public Access, Office and Home

Self-x Architecture

  self-x function required in OMC (network element manager) and base stations

  self-x support by MS (measurements and preferably MS location info) and by base stations (measurements, Key Performance Indicators (KPIs), alarms and status reports)

  self-x control and supervision via OMC

  to be adapted to scenario specific RAN architecture

  centralized vs. distributed self-x functional architecture is ffs.
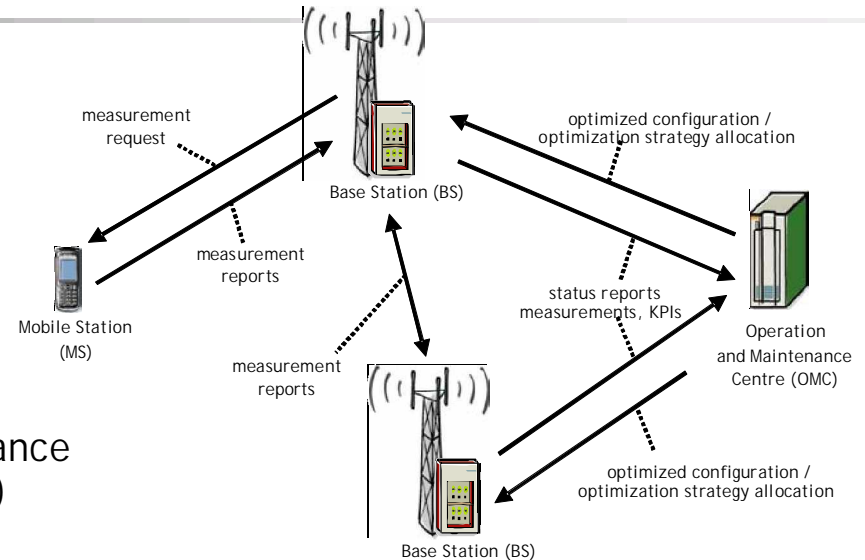
Required interfaces:

  interface between base station and OMC: tailored to specific network node implementation: to achieve maximum optimization efficiency

  multi vendor support vs. OMC northbound interfaces

Standardization relevance:

  configuration and reporting of MS based measurements and (if available) location info
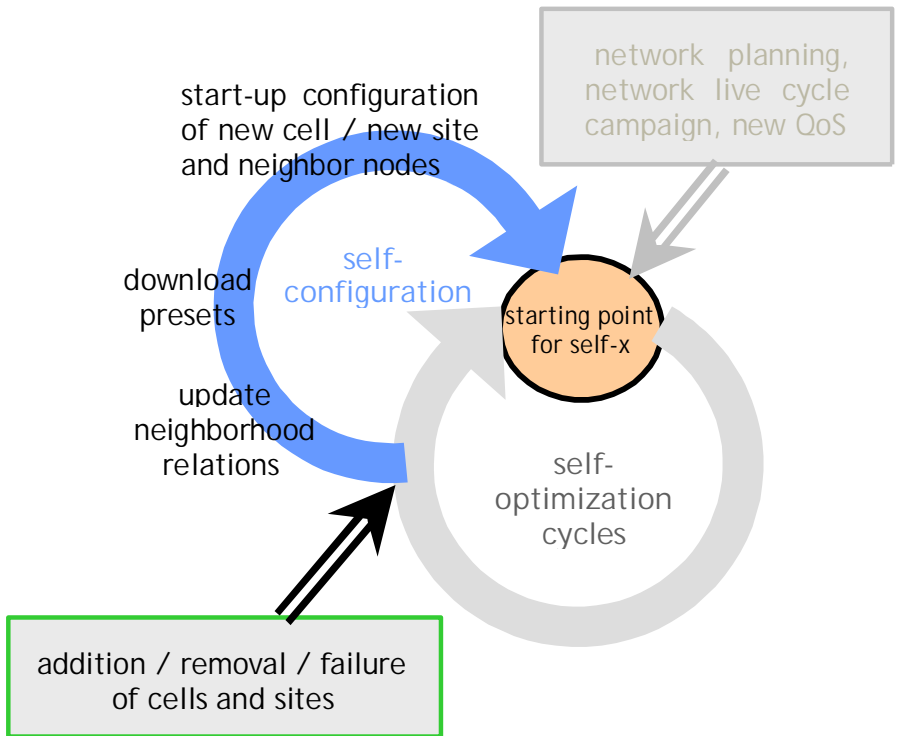
  multi vendor support

measurement request

Base Station (BS)

optimized configuration / optimization strategy allocation

measurement reports

Mobile Station (MS)

status reports measurements, KPIs

measurement reports

Operation and Maintenance Centre (OMC)

optimized configuration / optimization strategy allocation

Base Station (BS)

Self-Configuration Targets

Overall Targets:

real plug and play for installation
of new nodes and cells
guaranteeing acceptable QoS
when switching to operational
mode

fast re-configuration in failure cases

Configuration functions:

set-up of neighborhood
relations (cell, base station)
initial resource allocation
to cell and base station

set-up of (initial) base station radio
and RRM parameter configuration
neighbor re-configuration

start-up configuration
of new cell / new site
and neighbor nodes

network planning,
network live cycle
campaign, new QoS

self-
configuration

download
presets

starting point
for self-x

update
neighborhood
relations

self-
optimization
cycles

addition / removal / failure
of cells and sites

Self-configuration Use Cases and Tasks

Self-configuration Use Cases:

- Add cell / add site scenarios, removal of cells / sites
- capacity upgrade
- failure cases (cell/node)

Self-configuration tasks:

- automated initial configuration of cells and network nodes before entering operational mode (real plug & play) including reconfiguration of neighborhood nodes and cells:
  assignment of radio resources (frequency bands, interference coordination, physical channel parameters)
  - assignment of required identifiers (e.g. cell ID)
  - adaptation of predefined radio configuration parameter sets to actual location and environment, e.g.
    - radio parameters (e.g. power settings)
    - RRM parameters (e.g. handover parameters like thresholds, timers, hysteresis, ...)
  - reconfiguration of mutually depending parameters of neighbor nodes
- set-up of neighborhood relations
  - key function for RRM and self-x use cases (required e.g. for set-up of handover relations between cells, coverage optimization, interference coordination)
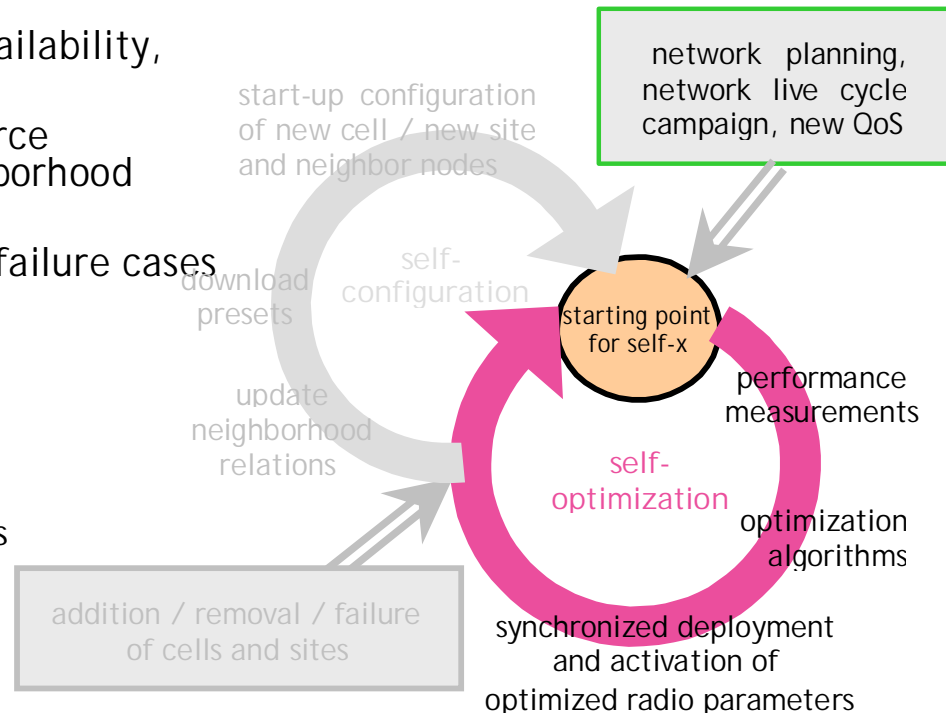 - neighborhood information required in base stations and OMC databases

Self-Optimization Targets

Overall Targets:

- continuous improvement of service availability, QoS and network efficiency
- optimization of radio and Radio Resource Management parameters and of neighborhood relation list
- fast reconfiguration/compensation in failure cases
- adaptation to short and long term dynamic system behavior

Optimization process:

- control of optimization process
  - interactive, supervised, up to autonomous
  - monitoring of optimization process
- optimization functions based on
  - system performance analysis and modeling of system behavior
  - topological info (e.g. morphology data, MS and base station based measurements)
- application of an optimization strategy
- optimization targets configurable application of predefined
  - parameter constraints
  - maintain stable system operation

network planning, network live cycle campaign, new QoS

start-up configuration of new cell / new site and neighbor nodes

self-configuration

download presets

update neighborhood relations

starting point for self-x

self-optimization

performance measurements

optimization algorithms

addition / removal / failure of cells and sites

synchronized deployment and activation of optimized radio parameters

Self-optimization Use Cases and Tasks

Optimization tasks (examples)
  Coverage optimization

  detection of areas with insufficient coverage by analysis of measurements and Key Performance Indicators (e.g. received power and call drop rates)

  corrective actions:

  – adaptation of transmit power settings
  – adaptation of antenna direction and tilt (if available by remote control)

  constraints given by the maximum tolerable interference to neighbor cells

  Interference coordination and optimization

  detection of cases with non acceptable high inter-cell interference and support of static and dynamic interference coordination schemes by analysis of measurements, Key Performance Indicators (e.g. interference level and call drop rates)

  corrective actions:

  – resource reassignment for interference coordination schemes
  – automatic assignment of re-use factors > 1
  – power setting modification
  – antenna tilt and direction modification (if available by remote control)

  constraints are to keep coverage in overlap areas of neighbor cells

Self-optimization Use Cases and Tasks

Handover optimization

minimizing handover failure rates and avoidance of so-called ping pong handovers. Problem detection by analysis of Key Performance Indicators (handover failure rates, number of discarded PDUs and received signal level during handover, visit time distribution of target cells, ...) corrective actions:

- adaptation of handover thresholds, hysteresis and timers

includes intra and also inter technology handover

Load balancing

increasing the overall throughput by avoiding overload situations with increased blocking rates and insufficient provisioning of ongoing services w.r.t. QoS. Detection of unbalanced load situations by measuring usage of radio resources (e.g. total transmit power, interference, throughput) and computational power of the base stations

corrective actions:

- modification of handover parameters to force handover to neighbor cells
- redistribution of radio resources

Updating neighborhood relations

correction of neighbor relations according to real environment (key function for self-x and RRM)

Conclusions

- Self-x reduces OPEX and CAPEX -- simplified processes for deployment, maintenance, and optimization

- Enabling real plug & play for new network nodes and cells

- Continuous optimization of network performance adaptation to short and long term dynamic system behavior

- Standardization required for self-x