



A Requirement Specification by the NGMN Alliance

**NGMN Recommendation on
SON and O&M Requirements**

next generation mobile networks



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Abstract

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1 INTRODUCTION

In [1] NGMN outlines the SON use cases which are foreseen by operators. The main purpose of this document is to provide vendors with operator recommendations and guidelines on requirements for implementation of solutions to support SON use cases in future. The formulation of the recommendations on requirements is done in a way that they are generic and would also align with future 3GPP features and enhancements as far as possible. It is foreseen that this document may be updated in the future based on progress on SON in 3GPP.

Most of the use cases considered in the present document have been described in [1]. However, a few additional use cases are also considered. These use cases were identified as important to the operators after the finalization of [1].

Generally, all solutions shall cover multi vendor scenarios and therefore shall be based on available standardised features and interfaces. In this document, descriptions on standardised SON features shall be considered as requirements rather than recommendations. These are clearly indicated where described, with further recommendations for the implementation provided where necessary. However, the detailed summary of 3GPP features may be done in other documents and by 3GPP technical specifications and requirements.



For each use case, the following sections are included, (although some use cases do not include all these sections):

- Abstract: Provides a brief description of the use case and states the main objective. Further description of the use case can be found in [1].
- Input Parameters/Pre-requisites (optional): Describes what inputs are required before the use case can be applied.
- Process (optional): Describes the actions that will be applied by the use case.
- Outcome (optional): The desired results and output of the process.

- **Basic requirement:** Describes a solution that is deemed to be practically feasible, and is a minimum requirement. This includes:
 - High level requirements, e.g. “number of parameter shall be minimised”
 - If appropriate, more concrete, e.g. request for standardised features or hint on proprietary solutions as examples.
 - For deployment use cases: definition of an abstract deployment process as basis for tailoring solutions.
- **Enhanced solution (optional):** Describes the solution that ideally should be achieved. Included as outlook towards more visionary solutions. It is acknowledged that it may only be possible to satisfy the basic requirement.
- **Dependencies (optional):** here dependencies with other use cases shall be included as applicable

The first four points provide background information, whereas the actual requirements are specified in the ‘Basic requirement’ and ‘Enhanced solution’ sections. These are numbered sequentially so that each requirement is unique for easy tracking adoption.

In the following recommendations are given on requirements describing solutions for the appropriate use case. Dependent on the different status of discussion on the certain use cases the requirement statements maybe differ respective detail level and standardisation references.

2 SELF-CONFIGURATION USE CASE SPECIFIC REQUIREMENTS

2.1 PLANNING OF ENB LOCATION, CAPACITY AND COVERAGE

Abstract:

The planning of a new network is based on capacity and coverage maps following operator specific deployment strategy and requirements on traffic model. These maps indicate how a target and / or ideal deployment should be achieved in a certain timeframe. In a first step a grid for a cost optimised deployment gets determined. This grid will be in later stages refined taking into account the requirement to use existing sites or the availability of new sites.

The planning process is based on planning tools in order to design radio network and provide the network nodes (namely eNBs) with configuration parameters.

This process requires huge effort for the operator in order to collect configuration parameters, performance measurements and to integrate planning tool, data base and configuration server, especially in a multi-vendor scenario.

In order to reduce the operational effort the following shall be supported:

1. The planning of self-configuration processes shall be aligned so that operational activities are minimized.
2. The self-configuration processes shall be integrated in the planning tools with Network Management functions in a modular manner

Input Parameter/Pre-requisites:

From operator's data bases: candidates for site locations, maps, coverage maps, results of drive tests, signalling data.

From Network Management: Measurements in form of PM, handover statistics, deep level traces; eNB specific parameter (from the Inventory Management).

Process:

The location of new eNB and their basic characteristics is derived based on the deployment grid input parameters.

Outcome:

The result is the location of new eNB type site having indication on:

- HW characteristics and transmission,
- number of sectors, and
- basic parameter per cell (e.g. antenna azimuth, antenna tilt, maximum power).

The output is provided to the Network Configuration function.

Note: the Configuration server is used as an abstract functional entity, which contains all necessary information to configure the eNB to bring into commercial use. This entity and the functionality behind shall be standardized to support multi vendor scenarios.

R1: Basic requirement on planning eNB location, capacity & coverage:

1. The following interfaces shall be supported:
 - Interface between the Planning Function and the Performance Monitoring function to transport measurements and counters
 - Interface between Planning Function and Inventory Management function to collect configuration data
 - Interface between Planning Function and Configuration Management function to provide network configuration
2. The above required interfaces shall be standardized or the vendor shall support third-party specific adaptations of Performance Monitoring, Configuration Management and Inventory Management to the Planning Function in a multi-vendor scenario.

R2: Enhanced solution on planning eNB location, capacity & coverage:

In general, the number of planning parameter needed by the centralized planning tool shall be minimized and derived automatically by the system based on the operator's deployment data and Self-Configuration information.

Dependencies:

This use case is related to a generic optimisation use case, because a centralised data on network status may be part of the basis for planning decisions. Furthermore, this use case also impacts the "Planning radio parameters of a new eNB" use case.

2.2 PLANNING RADIO PARAMETERS OF A NEW ENB

Abstract:

When installing a new eNB, the operator needs to define an initial set of radio parameters. In this phase, a best practice automatic radio parameter set should be provided, while the optimal setting may be defined at a later stage. In fact the Optimisation itself may require some traffic which cannot be guaranteed to be present in the initial deployment phase. The radio parameters include e.g. cell identities, RRM parameter like Handover thresholds, power settings, trigger points, neighbourhood lists, etc. depending on the detailed solution and later Self-Optimisation functionality.

Input Parameter/Pre-requisites:

They include: Location of new cells, basic parameter per cell, (e.g. antenna azimuth, antenna tilt, maximum power, and eNB type giving indication on HW characteristics and transmission). The configuration server is prepared and has got eNB basic characteristics and essential parameter. The eNB specific default parameter settings are available in a vendor's specific entity.

Process:

The radio parameters are derived based on input parameters available in the configuration server and the vendor's specific entity.

Outcome:

The initial set of radio parameters is available. It is accepted that not all radio parameters are set in optimal manner, since it is assumed that these parameter are optimised during active phase in an automatic way. Examples of radio parameters set in this process are:

- Cell Identifier and related identifiers, like PLMN id list, physical cell identity (in case that there is no active SON mechanism for automated configuration of PCI), eNB id, etc.
- Pilot Hopping sequences
- HO and cell selection thresholds
- Power Settings
- RACH related parameter
- PCH resource settings
- Generally parameter impacting RRM processes

R3: Basic requirement on planning radio parameters of new eNB:

Planning of parameter shall be substituted by a self-planning function with the following features:

- Cell specific parameter like global cell identifier, physical cell identifier, pilot hopping sequences and similar ones are generated by the system autonomously. On requirement of operator parameter can optionally be planned and configured by operator.
- For systems with re-use factor one it is assumed that no frequency related planning is needed. For re-use > 1 a self-configuration functionality to allocate frequencies and power is required to minimise planning efforts onto a minimum.
- Neighbour planning can be substituted by ANR, or alternatively the neighbour list is delivered by the planning tool.

- Neighbour list planning can be in theory fully exploited by the ANR function (see 1.2.2.2), nevertheless an initial neighbour list with control rules defined by O&M, could be self configured at the eNB, as part of initial parameters configuration. A parameter controlling RRM processes, which cannot be defined as default shall be derived by the system itself.

For most of the parameter default values are defined based on experiences in lab and field tests (examples: admission, congestion and load control related parameter, HO & cell selection parameter and other RRM parameter). These default values are configured for new planned cell automatically by the system.

For the remaining parameters, which are to be planned by the operator, the following requirements apply:

- Planning support by appropriate tools like “expert tools,” giving suggestions or recommendations.
 - Aim: The planning tool will implement the highest feasible abstraction level to hide the system complexity.
- If the planning tool gets integrated within in O&M system like the configuration management tools:
 - The interface shall be defined proprietary or standardized. The proprietary parts shall be transparent for the buyer.
- Measurements shall be standardised to support the centralised automatic planning approach.

R4: Enhanced solution on planning radio parameters of new eNB:

Generally, the number of parameter needed to be planned by centralized planning tool, shall be minimized and derived automatically by the system. The ideal solution would be that only location and very basic parameter are planned and all other parameter are configured and optimised during Self-Configuration and Self-Optimisation processes.

Dependencies:

This use case is also related to optimisation use cases like Interference Control, Load Balancing and others, because automatic/autonomous solutions to optimise parameter may substitute planning activities for certain parameters.

No dedicated optimisation use case is mentioned for this use case but cell specific parameter like physical cell identifier, pilot related parameter can be optimised by the system autonomously (e.g. in case of cell identifier conflicts).

2.3 PLANNING TRANSPORT PARAMETERS OF A NEW ENB

Abstract:

In the use case "Transmission Setup" (see 1.2.1.6) it is ensured that between eNB and a backhaul node a first transport tunnel is established as a basis for higher layer transport protocols like O&M link, S1 and X2 interfaces. But before this step the inserting of a new eNB requires the configuration of new transport resources and for this transport parameter are required (e.g. IP addresses, VLAN partition, QoS classes, bandwidth, triggers, ...). Some of this data have to be planned very early (3-6 month in advance) to prepare the right backhaul capability, others might be required at the time the eNodeB is installed (Security & Authentication, QoS parameters ...).

Input Parameter/Pre-requisites:

Location of new cells, cell specific parameter (like eNB type (e.g. high capacity Macro eNB in a hot spot or a Macro eNB for achieving coverage) giving indication on cell specific bandwidth and transmission). Configuration server is prepared: planned parameters are available for eNB's cells in configuration server. The eNB and cell specific default parameter settings are derived based on planned operator's input available in a vendor's specific entity.

Process:

Generally the eNB specific default parameters are derived during the Self-Configuration process: for this use case transmission parameter are derived based on input parameter available in configuration server and vendor's specific entity. The eNB detects the transport type and configure the appropriate parameter autonomously.

Outcome:

The initial set of transport parameter is available. As a prerequisite for use case "Transmission Setup" all parameter are available to establish a transport tunnel to network nodes and receive further settings. Based on this transport tunnel O&M link, S1 and X2 interface can be setup during the self-configuration process.

R5: Basic requirement of planning transport of new eNB:

There is no planning of specific layer1/2 parameter of dedicated transmission line connecting eNB and network backhaul. The parameter will be derived by the system during connection phase or are based on standard default values. Standardisation shall be considered respectively.

Dependencies:

Use Case Transmission Setup

2.4 PLANNING DATA ALIGNMENT FOR ALL NEIGHBOUR NODES

Abstract:

Inserting and deploying a new node will have impact on existing neighbour nodes. This Use Case describes how their data bases should be aligned and how the existence of the new node can be announced.

Input Parameter/Pre-requisites:

They include: Location of new cells, basic parameter per cell, (e.g. antenna azimuth, antenna tilt, maximum power, eNB type giving indication on HW characteristics and transmission). The configuration server is prepared and contains default eNB system parameters and essential deployment parameters. The eNB specific default parameter settings are available in the vendor's specific entity. White and Black lists are prepared based on the operator's input supported by planning tool.

Process:

If ANR is enabled, neighbour relationship, is derived based on input parameter available in the configuration server and the vendor's specific entity. White and black lists are available based on operator input or automatic processes. White list includes neighbour cells, which shall be configured as neighbours. Black list includes cells, which are forbidden to be configured as neighbours during configuration and later optimisation phase.

Outcome:

Neighbour relationship is configured in eNB considering White/Black lists. It is accepted that the cell starts with a non optimal neighbour list if it is ensured that this list can be derived during time of active phase.

R6: Basic requirement on planning data alignment neighbour nodes:

The data alignment of neighbour nodes shall be done automatically, upon insertion of the new eNB. For LTE: The standardized ANR function must be a full substitute for neighbour-cell topography planning. White and black list shall be supported in network management system.

Dependencies:

Use Case Neighbour Cell List Optimisation

2.5 HW INSTALLATION OF ENB

Abstract:

The HW installation shall include all tasks for the installation of a new eNB, like support of mounting, connecting with physical connections and first configuration. Even if these activities are not in the scope of self configuration, as usually intended in this document, they are considered as fundamental in order to reduce the effort in eNB installation and maintenance. The target for this use case is to minimize installation and maintenance time and effort at eNB site.

Input Parameter/Pre-requisites:

Planning data are available. eNB is ordered and delivered in the agreed configuration at the site.

Process:

The eNB is physically installed.

Outcome:

The eNB is physically installed and all physical connectors are plugged in.

The Automatic Inventory function inclusive self-discovery capabilities will be invoked to record the HW change.

R7: Basic requirement on eNB HW installation:

- The time at site for installation shall be minimized.
- The physical positioning of the eNB within racks, or relevant back-planes shall be refined to absolute simplicity. Insertion time, INCLUDING CONNECTION should not be more than 10-20 minutes. Example: 19 inch Rack-mounting servers, routers and IP switches.
- Connection of physical lines shall be supported by appropriate measures like e.g. colour and form coded plugs preventing wrong cabling.
- Specific configuration shall be substituted by vendor specific standardization of solutions to avoid variety of solutions. Vendor shall have a single form factor for the whole product range. Multi-form factor may be possible at operators request on bilateral basis.
- Detection and configuration of connected equipment in an automatic way: e.g. detection of TMA, antenna, antenna cable length and auto-adjustment of receiver-path, alarm connections etc.
- LMT usage shall be restricted on an absolute minimum. Necessary configuration shall be done via configuration management function in the network to avoid manual intervention by site personal.
- Number of parameter which must be transferred into eNB during installation shall be minimized on an absolute minimum.

R8: Enhanced solution on eNB HW installation:

Standard form factor with standard Itf-N interface (e.g. N-Itf.) allowing insertion of any eNB to any network.

Dependencies:

All deployment use cases. This use case shall be considered in the overall deployment process with target of minimised operational effort.

2.6 TRANSMISSION SETUP

Abstract:

Connecting the new node to the transmission network requires some configuration work. The main parameter settings shall be defined in use case 2.3. Here, it shall be described how the new node and the neighbour nodes get the correct transmission parameters.

The HW installation shall include all tasks for the installation of a new Node.

Input Parameter/Pre-requisites:

The eNB is physically installed and all physical connectors are plugged in.

Process:

A first transmission tunnel is established to a network node (like DHCP server or Security Gateway).

Outcome:

The eNB has got access into the network and can get detailed configuration data.

R9: Basic requirement on transmission setup:

1. Under the assumption that the transmission solution at site (e.g. Micro wave, E1, STM1, DSL) would provide an Ethernet connection with IP/TCP protocol layer the eNB can access a configuration server providing eNB IP address and other necessary basic parameter. This would require additional effort for deployment of transmission HW at the site and therefore is not assessed as an ideal solution.

2. The eNB provides physical connectors for all (operator specific) relevant transmission solutions and basic parameter settings to establish a restricted tunnel towards configuration server. It is not assumed that an Ethernet connection with IP/TCP protocol layer is already established – only physical layer connection is needed. Based on configuration by configuration server the eNB receives all necessary parameter to establish full tunnel to O&M and access nodes.

R10: Enhanced solution on transmission setup:

Guided by examples like the TR-069 (a configuration protocol between DSL modem and auto-configuration server) the best technical solution is standardization of Self-Configuration protocols for the common transmission solutions in 3GPP systems. The standardization must be driven by vendors and operators.

Dependencies:

All deployment use cases. This use case shall be considered in the overall deployment process with target of minimised operational effort.

2.7 NODE AUTHENTICATION

Abstract:

To ensure the right level of security and to have also an alignment of the correct planning parameter a node authentication is required.

Input Parameter/Pre-requisites:

The eNB has got access into the network and can get detailed configuration data. The eNB is configured basically to get permission into the network.

Process:

The eNB gets necessary information to get access to a Security Gateway. Based on pre-configured information and delivered information by DHCP server/configuration server the eNB gets permission to access the inner network and nodes like the network element manager and other management nodes.

Outcome:

The eNB has got access into the network and is allowed to connect with network management nodes.

R11: Basic requirement on node authentication:

The eNB can be authenticated and set up a secure tunnel to security gateway based on factory settings (unique identifier, general keys) and parameter received from configuration server. The eNB specific configuration is minimised especially configuration activities at the site shall be avoided.

R12: Enhanced solution on node authentication:

The best technical solution is standardization of security related protocols for the authentication and ciphering in 3GPP systems. The standardization must be driven by vendors and operators.

Dependencies:

All deployment use cases. This use case shall be considered in the overall deployment process with target of minimised operational effort.

2.8 SETUP OF SECURE TUNNEL TO O&M AND ACCESS GATEWAYS

Abstract:

After authentication the tunnel to O&M and access gateways is established. Optionally this tunnel can be ciphered.

Input Parameter/Pre-requisites:

The eNB has access into the network and can obtain network addresses that enable secure download of detailed configuration data. The eNB is configured basically to connect to the network nodes like O&M system and access gateways (MME, SAE GW). The network nodes are configured or will be configured during the establishment process appropriately to establish a bidirectional, stable and secure end-to-end connection.

Process:

The eNB and network nodes get necessary information to get connect the nodes. Based on pre-configured information and delivered information by DHCP server/configuration server the eNB and network nodes establish a bidirectional, stable and secure end-to-end connection.

Outcome:

The eNB has achieved a secure access into the network and is connected to network.

R13: Basic requirement on secure tunnel to O&M and access gateway setup:

Between eNB and network nodes a connection can be established. The eNB and network node specific manual operator driven configurations are minimised especially configuration activities at the eNB site shall be avoided.

R14: Enhanced solution on secure tunnel to O&M and access gateway setup:

The best technical solution is standardization of a connection establishment process in 3GPP systems. The standardization must be driven by vendors and operators.

Dependencies:

All deployment use cases. This use case shall be considered in the overall deployment process with target of minimised operational effort.

2.9 AUTOMATIC INVENTORY

Abstract:

The operator needs a full overview about the network status including the HW configuration of the eNB means installed units and their status.

Input Parameter/Pre-requisites:

The eNB has got access into the network and has a connection with network management nodes.

Process:

The eNB delivers to network nodes the configuration and status of all installed HW units.

Outcome:

In network management nodes a complete picture is available on the configuration and status of installed HW.

R15: Basic requirement on automatic inventory:

- Every unit that can be installed in the eNB shall carry a unique hardware identifier / label that can be used for inventory purposes.
Note: A unit is a replaceable part of the eNB which performs a specific function.
- Commissioning data; information about connected equipment.
- The actual inventory information is available on the NEM. No manual intervention is needed to update this information.
 - The inventory information is also being forwarded via standardised interface to Network Management. Hardware information shall be synchronized with Network Management after every change

Dependencies:

All deployment use cases. This use case shall be considered in the overall deployment process with target of minimised operational effort.

2.10 AUTOMATIC SW DOWNLOAD TO ENB

Abstract:

When the eNB is inserted into the network an O&M link to a dedicated Management entity has to be established. Via this O&M link the complete SW is downloaded to the network element and updates are initiated.

Input Parameter/Pre-requisites:

The eNB has got access into the network and has a connection with network management nodes.

Process:

The network management node gets the status on SW and configuration data in the eNB and delivers appropriate SW version and configuration file to the eNB.

Outcome:

The eNB has got newest SW version and configuration file and activate this.

Note: this process can also be started in operational state after the deployment of a new eNB.

R16: Basic requirement on automatic SW download to eNB:

Software deployment to eNB shall be autonomously managed from O&M system or an independent Software deployment application. It shall not need major attention from the operator.

- The software of the eNB can be made available on a centralized Software Deployment Server.
- The Software Deployment Server can also manage eNB from a different supplier / third party based on standardised SW management procedure and file format.
- A Software Deployment Server from a different supplier / third party can be used.
- The Software Deployment Server owns a list of all managed eNB. This list is updated autonomously. In this list the software levels of the eNB are displayed.
- If new software is to be installed a single eNB, a group of eNB or all eNB can be marked for software deployment.

The eNB checks in regular intervals and after reboot if there is a newer software version to be downloaded.

- Beside the eNB based “pull” approach the Software Deployment Server can actively push software versions to eNB following operator’s policy.
- The eNB downloads latest software versions as background activity without influencing bandwidth for customer.
- The eNB switches to the new software version with minimum customer impact:
 - at a dedicated time configured by the operator in the Software Deployment Application, or
 - in a low traffic period, or
 - as soon as possible (directly after download is finished)
- Requirement on minimal downtime [ffs]
- In case of unsuccessful software update the eNB autonomously falls back to the latest working software version (without additional SW download) and sends an appropriate message to the software deployment server.
- Firmware can also be managed the same way as software.

Dependencies:

All deployment use cases. This use case shall be considered in the overall deployment process with target of minimised operational effort.

2.11 SELF TEST

Abstract:

At the end of installation of an eNB there shall be a clear indication if the eNB is in the expected state and well prepared to go on air. It is required that only one site visit will be required to install a new eNB.

Input Parameter/Pre-requisites:

The eNB has activated newest SW version and configuration file.

Process:

The eNB checks itself in matter of SW and HW status.

Outcome:

The eNB delivers an unambiguous status report to the network management node. The eNB is ready for commercial usage and a test call is possible.

Note: this process can also be started in operational state after the deployment of a new eNB.

R17: Basic requirement on self test:

- Clear indication about eNB status is available, from eNB on-board internal test program, supporting result file output to LMT.
- If problems on external equipment occur indications are available to identify and to analyze the problem.
- This process can be initiated anytime by network management node during operational state of eNB.

Dependencies:

All deployment use cases. This use case shall be considered in the overall deployment process with target of minimised operational effort. No 3GPP related dependencies are expected here.

2.12 CONFIGURATION OF HOME ENB

Abstract:

HeNB self-configuration is an essential requirement to reduce the OPEX of HeNB deployment in the operator network. The installation of a HeNB should be a 'Plug & Play' experience with minimum user intervention. The self-configuration process works in a pre-operational state i.e. from the moment when the HeNB is powered up until the radio parameters are configured for the first time. The self configuration function related to the transport connection setup will vary depending on whether the router resides in the HeNB or not.

The main self configuration functions for HeNB are as follows:

- Auto-configuration as a part of home network to obtain its IP address, relevant DHCP options and establish the connection to IP broadband network.
- Configuration of a secure connection to mobile core network via an available backhaul and mutual authentication between the HeNB and the mobile network via secure VPN.
- Download of the relevant information and software/firmware updates from the mobile core network.
- Initial radio parameters configuration.

Input Parameter/Pre-requisites

An active backhaul connection to ISP. Two options are seen for HeNB:

1. with an internal router to realise the transport connection via the IP broadband network
2. without such a router

It is expected that the operator network can provide the software/firmware updates and the relevant information for the HeNB configuration.

The HeNB has a downlink receiver to detect basic parameters of the radio environment where it is located (e.g. identity and signal strength of neighbour cells).

The HeNB have means to provide support for detecting the basic location of the radio transmitter (e.g. Country, State, x,y) as appropriate of the operators and governing bodies licensing requirements.

Process

Self configuration up on connection with the home gateway to obtain IP address and relevant DHCP options. Establish the IP broadband connection through ISP network.

Self configuration of a secure connection to mobile core network via backhaul

The HeNB is able to negotiate a set of transport parameters via ISP network (e.g. IP addresses, QoS classes and security) to set up a secure connection with the mobile core network over the available backhaul.

Download of the software/firmware and information for configuration.

It is expected that the HeNB can setup the necessary connections with the network to have downloaded the updated software/firmware (if necessary), and the relevant information for operation.

Initial radio parameters configuration

The HeNB has to scan its neighbourhood to assess the interference situation from different carriers it may be allowed to use and the allocation of physical layer cell identities in use by surrounding HeNB and macro base stations.

- The HeNB selects the allowed RF carrier experiencing the least interference based on the received interfering carrier signal strength indicator and sets the transmit power level according to the target signal to noise ratio.
- The HeNB should choose a PCI which is not in use by its detected neighbours (macro or femto) in the selected carrier.

Outcome

Self configuration of transport connection to operator network via backhaul (should be standardised)

The HeNB can automatically set up a secure connection to the secure gateway in mobile core network which can be used to support signalling and data transfer from the HeNB to the target node in the mobile core network.

The logical separation between user/signalling data and O&M data shall be possible. It shall be possible to send user/signalling data to a different end location than the O&M data and transactions. It shall be possible to have multiple connections from the HeNB to the multiple endpoints simultaneously (e.g. O&M, Access Controller, Provisioning Servers, etc..) via one or more security methods dependent on traffic type.

Download of the software/firmware

After setting up the necessary connections with the network using a default configuration, the HeNB may download the updated software/firmware (if necessary).

Download default parameter configuration

The default parameters (e.g. PLMN-ID, TAI, CSG-ID) for the HeNB can be provided in a centralized network location with the help of one template. It is expected that the HeNB can setup the necessary connections with the network to download the default parameter setting.

Initial radio parameters configuration

At start up, the HeNB is able to choose a physical layer identity which ideally is not used by any neighbour HeNB in the same carrier detected in its neighbourhood.

At start up, if the interference on an HeNB carrier is too high, the HeNB should choose a less interfered carrier (if one is available for HeNB use). Potential impact to macro cells should be avoided when the chosen carrier and the physical cell identifiers are shared with macro layer.

The operator can define the maximum transmission power of the HeNB. The HeNB can further adjust its maximum transmission power for operation, reducing as much as possible the amount of interference over the network. The maximum reduction level and generally the enabling of this adjustment functionality can be controlled by operator.

The HeNB shall be able to store the appropriate HeNB parameter(s) that are specific to the HeNB in either volatile or non volatile memory dependent on the sensitivity of the information.

R18: Basic requirement on home eNB configuration

Self configuration of transport connection to mobile core network via backhaul

- The HeNB supports the automatic detection of core network and OAM nodes.
- The HeNB should support different set of QoS parameters on the transport connections that are consistent with IP broadband network QoS marking policies.
- The transport connection should be secure. Authentication between HeNB and mobile core network is supported.
- The authentication and availability of a stable secure connection to the network is a pre-requisite to activate RF.
- The HeNB should have automated setup of general and specific information pertaining to the HeNB and pass that information to the network as appropriate for storage, reprovisioning and verification of the HeNB.

Download of the software/firmware and information for configuration

- The HeNB can setup the necessary connections with the network to have downloaded the updated software/firmware (if necessary), and the relevant information for operation.

Initial radio parameters configuration

- The HeNB should be able to set automatically initial radio parameters minimising the interference.
- The HeNB can send information related to the neighbour cells to the network pertaining to its specific location in the network.
- The HeNB shall send the pertinent information to the network needed to detect the basic location of the radio transmitter as appropriate of the operators and governing bodies licensing requirements.

3 SELF-OPTIMISATION USE CASE SPECIFIC REQUIREMENTS

In this section, requirements for Self-Optimisation are given. However, it is also expected that further insight into these requirements will be obtained from LTE trials. Trials will help determine the top parameter settings responsible for system performance. In addition, it will be possible to get feedback from the manual optimisation work in the trial.

3.1 OVERALL OPTIMISATION REQUIREMENTS: SUPPORT OF CENTRALIZED OPTIMISATION ENTITY

Abstract:

The support of self-optimisation functions in the operator network can be provided with different architectural options, depending on the specific use cases. The operator needs to monitor the performance of the SON functions in order to take decisions accordingly.

Moreover the adoption of SON may be related to only a part of the use cases, while other activities are managed with manual procedures, also depending on the different phases of the network deployment. In some cases also the complete manual optimisation could be adopted.

In order to cope with all the scenarios above, the operator requires the support of a centralised management function that ensures:

- Manual optimisation
- Monitoring and control of distributed and hybrid SON functions
- Introduction of centralised SON functions

R19: Basic requirements on support of centralized optimisation entity:

The system shall support a centralised entity in network management level via appropriate measurements, performance indicators and configuration messages in standardized form.

- Provision of network state messaging (Alarms, Events) AND network performance (HW and Traffic measurements, KPIs) towards NMS level.
 - Standardised state messages (preferred)
 - For proprietary state messages: flexible specification of measurements is open for the operator and any third party OSS supplier.
 - It is ensured that essential measurements are available:
 - Average cell throughput per QoS class
 - Maximum cell throughput per QoS class
 - Percentage of UEs whose average throughput are unsatisfactory
 - Average packet delay per QoS class
 - Average packet drop rate per QoS class

- Average cell throughput
- Maximum cell throughput
- Average throughput per UE
- UL/DL throughput per QoS class
- Drop rates per QoS class
- Packet delay per QoS class
- Packet drop rate per QoS class
- Number of Connection Requests
- Number of rejected Connection Requests per QoS class
- Number of times congestion control is triggered in a given period
- Time of the day congestion control is triggered
- Duration of congestion situation once triggered
- Number of admitted connections of a given QoS class dropped as a result of congestion control
- Number of triggered intra-system handovers (source cells)
- Number of successful intra-system handovers (target cells)
- Number of successful inter-RAT handovers
- UL received interference power per PRB
- DL relative transmitted power per PRB
- Others [ffs]
- Provision of network Events and Radio Data for Localization of Faults (e.g. call drops, handover, ...)
 - Identification of Events
 - Identification of radio data (e.g. distance, RSCP, ...)
 - Standardized or proprietary identification e.g. via time stamp
- Providing configuration management in NMS level via Communication/Configuration/Policy Server
 - In a standardised way
 - In proprietary way; specification of configuration management is open for operator and it's chosen third party supplier
 - It is ensured that essential configuration messages are available via N-Interface:
 - Reset of eNB
 - Setting HO parameter (HO offsets)
 - Setting power values of cells
 - Others [ffs]
 - Providing a bi-directional exchange of configuration data (read & write). Audit facility to Standardised CMDB
 - Provision of tools at the NMS level to support processing network status data and event localization and derived configuration based on these data in multi vendor environment.
 - Provisions of tools support the statistical analysis of network status data, identifying of problem patterns and the linkage with appropriate automatic actions to solve the problem.

- The interfaces for measurement and configuration management shall be implemented such that a fast integration of other supplier's implementation is enabled. Standardised protocols shall be used (XML??). Third Party Management tooling (e.g. applications to use the measurements) shall be always open to integration to the suppliers' management interfaces.
 - Expected are tools to support assessment of measurements and performance indicators
 - Deliver statistical views
 - Deliver recommendations on optimised configuration
 - Correlate fault events from drive test with PM results (and enabling interfaces to feed in drive test outcome)

R20: Enhanced solution on support of centralized optimisation entity:

All measurement and configuration management and event localization functions shall be supported with standard solutions (e.g. N-Itf), not only for SON purpose but also for normal monitoring and maintenance purpose.

Dependencies:

This use case is related to planning and optimisation use cases because a centralised network view can be used as general basis for decisions in the field of planning and optimisation.

3.2 NEIGHBOR CELL LIST OPTIMISATION

Abstract:

Optimisation of existing neighbour cell list of a cell with all relevant neighbours and the associated parameterisation in the neighbouring cells. This is also related to the configuration of an initial neighbour cell list for a new cell.

R21: Basic requirements on neighbor cell list optimisation:

In order to reach a good network KPI level it is one of the basic and important requirements to have the optimal neighbour cell list available. A complete neighbour cell list will have direct impact on the network performance. A complete list will not only improve the site/cell base performance but also the area or the cluster of the site/cell will improve.

Another achievement will be the customer perception in terms of quality, service and availability of the network. This will increase the customer satisfaction.

SON features need to have the capability to use the following 3 evaluations to perform on a given configuration but using diverse methods. The results should be calculations of the following proposals or alternative configurations, with or without implementation in the network.

- Evaluation of the existing neighbour cell list
- Additional neighbour cells list
- Deletion neighbour cells list

Different Neighbour cell list Optimisation shall be considered:

- Intra frequency neighbour cell list Optimisation
- Inter frequency neighbour cell list Optimisation
- Inter system neighbour cell list Optimisation

Neighbour cell list configuration & Optimisation based on;

1. UE measurements (e.g. following the approaches specified for ANR in 3GPP (to be detailed when finally standardized))
2. Statistically derived data, using network statistics with the following elements,
 - Number of handover attempts
 - Handover Success Rate
 - Number of HO attempts due to quality and signal levels
 - Quality levels per cell per class
 - ISHO attempts and success
3. Measurement evaluation including the simulation of formulated proposals.
 - Number of measurements per cell
 - Levels per cell during the measurement reports
 - Sample distributions over the measurement reports
4. Field measurement data statistics.
 - Quality evaluation on the route of serving cell
 - Missing or wrong neighbour cell status evaluation
 - Interference level measurement results evaluation

Benefits of the Neighbor cell list Optimisation are

- Minimize unnecessary handovers
- Reducing the network failures due to missing or wrong neighbour definition
- Better quality and throughput distribution
- Better balancing the traffic level
- Improve the measurement quality

These requirements are e.g. covered in LTE by the features:

- ANR support for Intra LTE based on UE supported cell detection and request of global cell identifier
- ANR solutions for Inter LTE and Inter RAT scenarios according to 3GPP specification (ongoing)
- Standardized ANR specific O&M handling (White/Black list handling)
- Vendor specific implementation of algorithm to decide on new neighbours and to deal with not unique physical cell identifier (Requirement: physical cell identity shall not be planned, as SON mechanisms for automated configuration of PCI are being discussed in 3GPP. Nevertheless, automatic planning of PCI might be needed if such a SON mechanism is not finally agreed.)
- Support of standardized measurements and statistics to monitor the SON function and to Optimise neighbour related parameter (e.g. HO parameter) in NMS. It must be ensured that new neighbours configured by ANR are reported in less than a few seconds towards the NMS.
- Support of basic standardized configuration management to set essential parameter (like HO offset) in NMS as part of a centralised optimisation architecture.
- Support of vendor specific measurements and statistics and basic configuration management in NMS
- Opening vendor specification of specific measurements, statistics and configuration management to operator's favourite tool supplier

Dependencies

Use Case Planning data alignment for all neighbour nodes

3.3 INTERFERENCE CONTROL

Abstract:

In the LTE radio technology interference has to be coordinated on the basis uplink and downlink i.e. in a coordinated usage of the UL resources (Physical Resource Blocks, PRBs) and DL Transmitted Power, which lead to improve SIR and corresponding throughput. These are achieved by means of mechanisms employing X2 signalling of UL HII and OI and DL TX Power indicator, (Inter-cell Interference Coordination - ICIC) in support of scheduling/radio resource allocation functions.

These RRM functions in the eNB require the setting of frequency / power restrictions and preferences for the resource usage in the different cells. Moreover, ICIC functions also require configuration of parameters like reporting thresholds/periods. Setting and updating these parameters automatically is the task of a SON mechanism.

Input Parameter/Pre-requisites:

The SON function may properly tune configuration parameters in order to improve Interference Control and make the RRM/ICIC scheme more effective, while reducing the effort of the Operator for manual configuration/optimisation. Then, expected results are:

- Automatic configuration or adaptation, with respect to cell topology, of
 - Resource preferences in eNBs
 - ICIC reporting thresholds/periods
 - RSRP threshold for ICIC
- Minimized human intervention in network management and optimisation tasks
- Optimised capacity and radio network performance

The process of Interference Management Self Configuration/Optimisation may be organised in three phases and is described in Figure 1.1:

1. The analysis of ICIC related Performance Measurements (PM), based on e.g. ICIC signalling over X2 and/or other radio PM (e.g. throughput at cell edge), provides to the SON function an indication of the level of interference in the radio network and of the effectiveness of ICIC RRM algorithm.
2. Then the Self configuration/optimisation of ICIC configurations parameters provides tuning of RRM into two main areas:
 - ICIC algorithm in terms of reporting thresholds/period for HII, OI and DL TX Power
 - Radio planning, in terms of power restrictions and preferred/restricted PRBs.
3. The parameters tuning affects the Scheduler decision process

Self Optimisation of ICIC control parameters is required since they may need to be adapted over time based on ICIC related PM, according to the same phases described above.

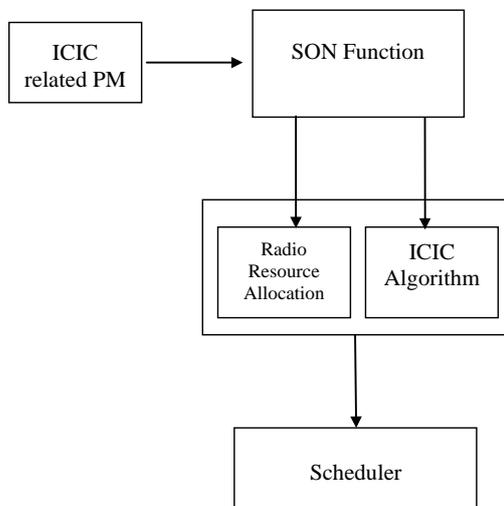


Figure 1.1 Process of Self Optimisation of ICIC related parameters

Input parameters to the SON algorithm are ICIC related Performance Measurement (PM). Details regarding the specific involved PM to be defined in a later stage, also based on completion of 3GPP activities on this topic.

Output parameters:

Configurations parameters are set up in eNBs in the pre-operational state at the download of the overall set of configuration parameters. Configurations parameters may be adapted over time as the output of the SON algorithm

Configuration parameters are (the list is not exhaustive and other output parameters could be included, also based on completion of 3GPP activities on this topic):

- ICIC reporting thresholds/periods
- Resource preferences in eNBs
- RSRP threshold for ICIC

R22: Basic requirements on interference control:

The SON function shall run in a multivendor environment. In order to fit this requirement, a coordination entity shall be introduced. The coordination entity may be deployed in the O&M that:

- either hosts the SON function itself (centralized approach); or
- coordinates the SON functions implemented in the eNBs (distributed approach).

In both cases the N interface is the multivendor interface for the proper interworking with eNBs and either it is an open interface or the vendor shall support specific adaptations to integrate eNBs and the SON function in a multi vendor scenario.

The centralized approach is taken as current working assumption. In this case the N interface shall:

- transport input data (measurements, PM) from the eNB to the SON function
- transport ICIC configuration parameters in the reverse direction

Distributed solutions are not precluded. Detailed characteristic of distributed architectures are FFS.

Dependencies:

The output parameters of this SON functions are related with input/output parameters of:

- Automatic Neighbourhood Relation function
- Coverage and Capacity optimisation

3.4 HANDOVER PARAMETER OPTIMISATION

Abstract:

Optimise handover parameters with minimal operational effort (related to neighbour cell list optimisation). The handover procedure has a direct impact on the following factors:

- Network Performance due to user mobility (Intra-Frequency, Inter-Technology, etc.)
- Network capacity

Therefore handover parameter optimisation should work towards these objectives

R23: Basic Requirements on HO parameter optimisation:

1. Minimise the handover failures – The SON feature should have the capability to detect the HO failures, identify the reason, the impact on the overall network performance and take remedial action.
 2. Reduce the unnecessary handovers (Ping-Pong effect) – The SON feature needs to understand the situation, identify the highly influencing parameters and decide the optimal values for those parameters
 3. Increase the load balancing capability of the network – SON feature should regularly monitor the congestion situation in all the cells and dynamically change the HO parameters of the particular cell as well as neighbour cells to ease the congestion without compromising other cells' performance.
- Recommendation on LTE: As defined in 3GPP HO history information in HO request messages can be basis for optimisation: Implementation of HO history information elements in HO request message and transport to network management entity. Analysis of HO Performance measurements and HO history by SON algorithm and optimisation of HO parameter.
 - HO history information and HO performance measurements can be gathered by centralized data entity in network management system as basis for SON algorithm
 - Algorithms are asked to process HO related data and derive optimised HO parameter.

Relevant data for optimisation, for both the basic and enhanced solution, are:

- Ue local distribution; measured localization data
- Bit error rates
- Radio power receiving levels (UL)
- Radio power receiving levels (DL)
- Traffic load of cells
- Time duration in cells with histogram analyzing
- Radio drops in relation to location

- Radio bad quality in relation to location

R24: Enhanced solutions on HO parameter optimisation:

1. Predict the possible handover failures in advance and take action pro-actively to avoid any failures – SON features need to have the capability to gather the user distribution and mobility information. Based on this data, it should predict the possible failures and take evasive actions without causing service deterioration
2. Predict the traffic requirements of cells and adjust the parameters according to the requirements – SON features need to have the capability to predict the near future capacity requirement of cells and determine the possible actions.

The HO Optimisation feature has to provide functionalities to improve the HO parameter settings regarding following detailed requirements:

- Perform best radio quality for up and downlink for real-time and non real-time traffic in the overlapping area of cells to the UE
- Perform the best effort of UE power consumption
- Avoid any bearer drop in the overlapping area of intra-system cells
- At Radio systems edge, perform a HO to other inter radio access technologies, with an optimum time setting before the radio quality or radio power link degradation, leading to interference or perceived customer quality.
- Minimize signalling load with Optimising/minimising ping pong HO
- HO decision should be dependent on the QoS profile of users
- Consider the load situation
- Consider service class and parameterization

Dependencies:

Related to Interference Control, Load Balancing, and Support of centralised Optimisation Use Case.

3.5 QOS RELATED PARAMETER OPTIMISATION

Abstract:

The following description is based on today's QoS definitions and may be updated according to LTE specific standardization. Therefore the chapter is under review and is just to inform on general trends.

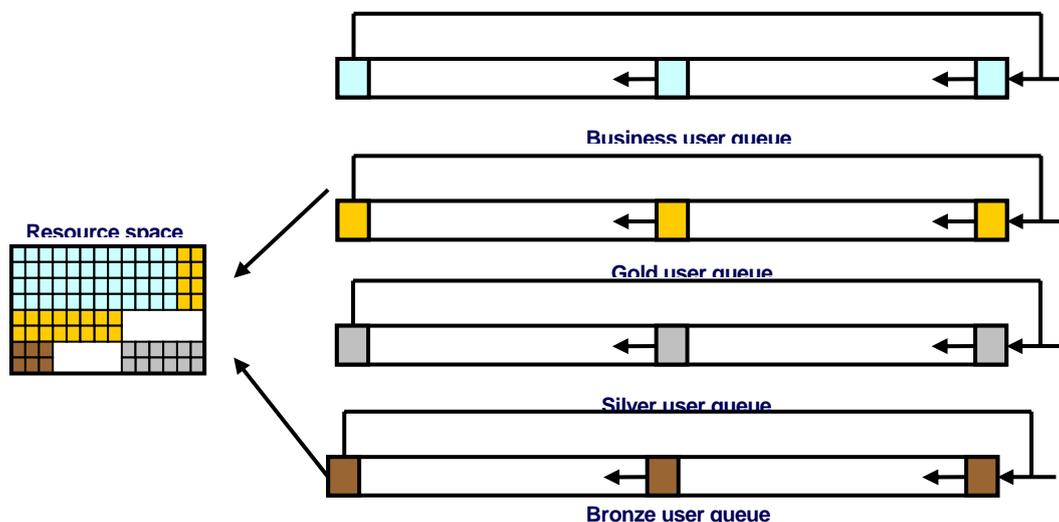
QoS related parameter optimisation relates to a number of different aspects of LTE functionality:

- Admission control parameter optimisation
- Congestion control parameter optimisation
- Packet scheduling parameter optimisation
- Link level retransmission scheme optimisation
- Coverage hole detection

Traffic class	Conversational class Real Time	Streaming class Real Time	Interactive class Best Effort	Background class Best Effort
Fundamental characteristics	<ul style="list-style-type: none"> ▪ Preserve time relation (variation) between information entities of the stream ▪ Conversational pattern (stringent and low delay) 	<ul style="list-style-type: none"> ▪ Preserve time relation (variation) between information entities of the stream 	<ul style="list-style-type: none"> ▪ Request response pattern ▪ Preserve payload content 	<ul style="list-style-type: none"> ▪ Destination is not expecting the data within a certain time ▪ Preserve payload content
Example of the application	Voice	streaming video	web browsing	telemetry, emails

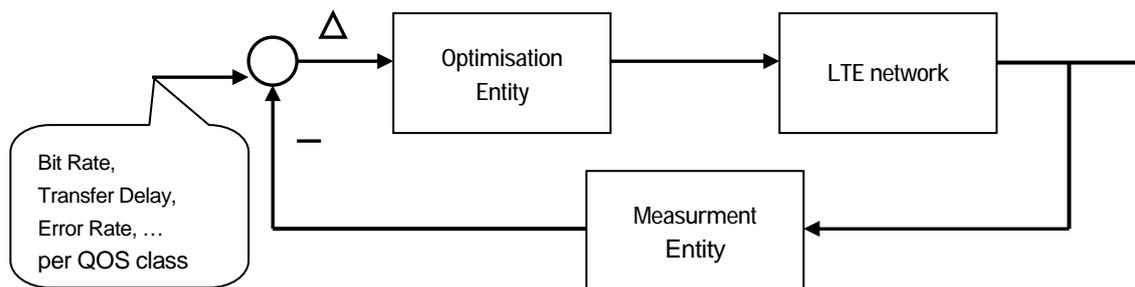
Note: the table above is based on UMTS QoS terminology as an example. For LTE the equivalent QoS classes and mechanisms shall be applicable.

Tier of Service (TOS):



Pre-Condition: The operator can configure QoS parameters in the Core Network (HLR/HSS) per QoS class as a network default or per user (service based QoS and user based TOS – Tier of Service).

Model:



R25: Basic Requirements on optimisation QoS related parameters:

LTE network: The QoS concept specified in 3GPP (36.300) shall be implemented. LTE RRM layer has to provide a set of QoS related parameters. That for example means, that the parameters of the Packet Scheduler are separately available for each QoS class [conv, str, int, backgr] and user profile (Tier of Service weights) including GBR/MBR approach. Other RRM functionalities like Handover, Power Control. ... shall be treated accordingly.

The LTE RRM layer must be able to deal with some Intelligence used in Evolved Packet Core network (service based packet labelling) and provide also a subset of relevant scheduler parameters per each DSCP label class.

Measurement Entity: QoS related measurements have to be available from the LTE system. That means that performance indicators like Throughput (min/max/avg), Transfer Delay (min/ max/avg), SDU error ratio, Bit error ratio, a.s.o. are measured by the eNB and signalled to the NEM- and NM level.

In the first step these measurements shall be available for every LTE radio cell but separated by QoS classes [conv, str, int, backgr] and user profile weighting (TOS).

E.g. the minimum throughput for all conversational users in a cell is 600 kbps; the minimum throughput for all streaming users in the cell is 400 kbps; the minimum throughput for all interactive and background users in the same cell is 250 kbps.

Optimisation Entity: The Optimisation and configuration of the QoS related to RRM parameters are done by the eNB and/or on NEM-level and the measures are reported to the NM-level. This means an Optimisation algorithm, which is located in the eNB at the NEM-I and NM- level that performs the QoS related Optimisation for all the cells of the eNB, and all cells of the specific Network Element Manager.

The kind of approval for the Optimisation measures must be operator configurable, whether the Optimisation staff gives the approval manually or it is done automatically and afterwards reported.

R26: Enhanced Solution on optimisation QoS related parameters:

LTE network: The LTE/SAE network shall support packet based QoS, which embraces both service based QoS and user profile TOS concept in one robust solution. Packet based QoS combines QoS/TOS approach based on each individual packet and gives him individual weighting based on QoS/TOS matrix. The LTE RRM layer has to provide set of packet based QoS parameters.

Measurement Entity: The measured values like Throughput, Transfer Delay and others are available for every user, and not just for every cell, separated by the QoS class and user profile TOS. This would give the basis for a user depended QoS related Optimisation (statistical approach or user specific with smart antennas).

Optimisation Entity: The QoS related Optimisation is done at the NM level. The information that is transferred via the N-Interface, (i.e. measurement data (read), configuration data (read/write)), is done in a standardized way, which is clearly preferred. By this implementation the operator has the chance to optimise in a multi-vendor network supported by 3rd party tools.

3.6 LOAD BALANCING

Abstract:

When a large number of idle and active UEs are present in a given cell, available resources may not be sufficient to meet the guaranteed quality of service for GBR services or/and offer decent performance for non-GBR services. A low cost method of coping with congestion of a cell is to balance the traffic with less-loaded adjacent cells. This is achieved by optimising cell reselection/handover parameters depending on the cell load. This reconfiguration of parameters is not supposed to be applied in a real-time manner. Such a mechanism implies the accurate definition of the cell load information to comply with a multi-vendor scenario. Load balancing mechanism also implies the exchange of the cell load information between eNBs over the X2 interface. Configuring the cell reselection and handover parameters values depending on the load information of the loaded cell and of its neighbouring cells is the task of a SON mechanism. Lastly, the updated values of cell reselection and handover parameters need to be exchanged between eNBs after each reconfiguration in order to ensure the stability of the load balancing function in a multi-vendor case.

R27: Basic Requirement on load balancing:

Load definition: The load balancing function has to rely on specified load information for the resources that can be limiting in the access network, namely:

- Radio resource,
- eNB hardware resource,
- Transport network resource.

The measurements envisaged to assess the load for the radio resource are:

- M1: DL PRB usage per QCI (including data and associated L2 control elements)
- M2: UL PRB usage per QCI (including data and associated L2 control elements)
- M3: DL PRB usage for SRBs
- M4: UL PRB usage for SRBs
- M5: DL PRB usage for common control channels (sum of usage for BCCH and PCCH)
- M6: UL PRB usage for common control channels (sum of usage for PRACH and PUCCH)
- M7: DL PRB usage for SC-PTM MBMS channels
- M8: DL PRB usage for MBSFN channels

These measurements could be possibly refined, completed or simplified especially to assess the load for non-GBR applications.

The measurement envisaged to assess the load for the eNB hardware resource is:

- a generic indicator (No Load/Loaded/Heavy Loaded/ Overloaded)

This measurement could be eventually refined, completed or simplified.

The measurement envisaged to assess the load for the transport network resource is:

- The percentage of occupation of the transport link supporting the S1 interface

The capacity of the transport link supporting the S1 interface is supposed to be exchanged between eNBs as part of the X2 setup procedure.

Load reporting: One eNB can request to another neighbouring eNB the reporting of load measurements when the load of the former eNB will exceed a threshold value(s). This value will be configurable by the operator via the O&M. In its request, the eNB will notify to the neighbouring eNB the value of the period at which it needs to receive load measurements values. Upon receipt, the neighbouring eNB shall initiate the requested measurement according to the parameters given in the request (especially the reporting periodicity).

SON function: Based on the measurements received by the eNB, the SON function may properly tune cell reselection and handover parameters, leading to network capacity increase. The parameters to be optimised for the idle mode are:

- Qhyst (Qhyst works to increase the measured link level in the serving cell, which has common impacts on evaluating the neighbouring cells during cell reselection),
- Qoffsets,n. (Qoffsets, n decides the relative link level offset between the serving cell "s" and a given neighbouring cell "n").

The parameter to be optimised for the active mode is:

- Cell Individual Offset (Cell Individual Offset is added by the UE to the measurement it performs in active mode on the associated neighbour cell)

To avoid any side effects (e.g. ping-pong) especially in a multi-vendor scenario, it is needed to make the adjustment of cell reselection and handovers parameters visible to the corresponding neighbouring cells so that the load could be balanced without degrading UEs' performance. The new values of these parameters shall also be reported to the O&M entity. A multi-vendor interface between eNB and O&M shall be supported.

The SON function may be implemented in a distributed way (i.e. within the eNB).

R28: Enhanced Solution on load balancing:

An enhanced solution for the load balancing use case could be to perform self-optimisation of inter-RAT mobility parameters depending on the current load in the cell and in the adjacent cells.

Dependencies:

The output parameters of this SON functions are related with input/output parameters of:

- Automatic Neighbour Relation function
- Coverage and Capacity optimisation

3.7 OPTIMISATION OF HOME ENB

Abstract:

HeNB is expected to be deployed in a wide variety of scenarios. In many of these deployment scenarios the radio environment may change continuously due to frequent on/off of HeNBs, location change of the device by the user, etc. A dynamic adaptation of the HeNB parameters to the specific radio situation is required to ensure that HeNBs limit the level of interference they experience and also limit the amount of interference they introduce in the network.

Input Parameter/Pre-requisites

The HeNB has a range of physical cell identities to choose from and there is possibility to choose a different carrier if the interference on the preferred carrier is too high.

The HeNB has an active backhaul connection.

The HeNB has a downlink receiver to detect basic parameters of the radio environment where it is located. Collection of UE measurements may also be used.

Process

Radio parameters optimisation

The HeNB regularly scans its neighbourhood to assess the interference situation from different carriers it may be allowed to use and the allocation of physical layer cell identities in use by surrounding HeNB and macro base stations. The operator shall be able to configure the repetition period of the scanning.

The HeNB should autonomously adapt its transmission power and maybe the physical cell identity to the scanned environment in order to provide the expected service while minimizing the interference over the network and avoiding collision/confusion with the neighbour identities.

Although a change of the HeNB carrier frequency during operation is expected to be infrequent, it may be required if excessive interference is experienced by the HeNB. This situation would lead to the reconfiguration of the HeNB. It is for further study whether the change of carrier frequency will be performed with all active calls maintained or whether the radio portion of HeNB has to be rebooted in order to select a less interfered RF carrier.

The HeNB and associated Network shall have the ability to trace a single UE, AP or group of UE or AP's for signalling and air interface. The HeNB shall be able to be traced realtime (e.g. immediately to the screen) and also to a file for post processing of the data.

Outcome

Radio parameters optimisation

If the interference on a HeNB carrier is too high, the HeNB should choose a less interfered carrier (if one is available for HeNB to use) or another physical cell identity not used by any neighbour cell in the same carrier. Potential impact to macro cells should be avoided when the chosen carrier is shared with macro layer.

The HeNB can adjust its transmission power, reducing as much as possible the amount of interference it introduces in the network.

R29: Basic requirement on optimisation home eNB

The HeNB should be able to automatically optimise its radio parameters to improve the interference situation and adapt to the dynamic environment.

The automatic mechanism shall ensure stable interference situation. Generally the behaviour of these automatic adaptation functionalities can be controlled by operator (so the operator can configure e.g. the allowed frequency ranges and maximum power adaptation).

The HeNB can deliver on demand or regularly indication about interference situation to a centralised management system. It shall be possible to setup an OAM link to configure all HeNB/cell specific parameter on operator's demand.

R30: Enhanced solution on optimisation home eNB

Dynamic configuration of home base station parameters would allow effective interference coordination between home base station and overlaying macro base station. For example home base station transmitting on resource blocks not used by macrocell or coordination among neighbour home base stations via virtual interface between home base stations.

Dependencies

This use case is related to the Interference Management use case especially for supporting an enhanced solution with dynamic configuration of HeNB parameters.

3.8 RACH LOAD OPTIMISATION

Abstract:

The RACH configuration has critical impacts to system performance:

- The RACH collision probability is significantly affected by the RACH configuration, making this a critical factor for call setup delays, data resuming delays from the UL unsynchronized state, and handover delays. It also affects the call setup success rate and handover success rate;
- Since UL resource units need to be reserved exclusively for RACH, the amount of reserved resources have impacts on the system capacity.

The optimum RACH configuration of a cell depends on a number of factors, including at least:

- Population under the cell coverage;
- Call arrival rate;
- Incoming handover rate;
- Whether the cell is at the edge of a tracking area;
- Traffic pattern, as it affects the DRX and UL synchronization states, and hence the need to use RACH.

Since these are affected by network configuration (e.g., antenna tilting, transmission power settings and handover thresholds), any change in these configurations would also affect the optimum RACH configuration. For example, if the antenna tilting of a cell is changed, the coverage of cells in the vicinity will be changed, consequently affecting the call arrival rate and handover rate at each cell. This will affect the amount of RACHs in each cell, including the usage per range of preambles. Then, the operator will have to check the RACH performance/usage in each cell and detect any problems on RACH associated with the applied changes. If required, it may further trigger some adjustments in RACH configuration.

The measurements on the RACH performance/usage are needed to be collected at a SON entity, and the parameter for RACH configuration regarding RACH capacity shall be configured automatically by the SON function following operator's policy.

The objective of this use case is to optimise the RACH configuration, including:

- RACH resource unit allocation;
- RACH preamble split (among dedicated, random-high, random-low);
- RACH persistence level and backoff control;
- RACH transmission power control.

Expected results:

- Reduction on RACH collision probability, which results into:
 - small call setup delays
 - small data resuming delays from UL unsynchronized state
 - small handover delays
 - high call setup success rate
 - high handover success rate
- Optimisation on the amount of UL resource unit reserved for RACH which brings a positive System Capacity impact.

R31: Basic requirement on RACH load optimisation:

eNB Measurement:

The following input data is to be measured at the eNB

- Number of received RACH preambles

The definition of [Number of received RACH preambles]:

- The number of received RACH preambles in a cell in a time interval. It is measured per preamble range (dedicated, random-low, random-high), and averaged over the PRACHs configured in a cell.

SON function:

The SON entity collects the input measurements to estimate RACH load and possible capacity problems of RACH.

The output parameters are:

- RACH resource unit allocation;
- RACH preamble split (among dedicated, random-high, random-low);
- RACH persistence level and backoff control parameters;
- RACH transmission power control parameters.

The SON entity delivers the result of optimised RACH configuration parameter towards each concerning eNBs to ensure optimal usage of system resources based on operator’s policy.

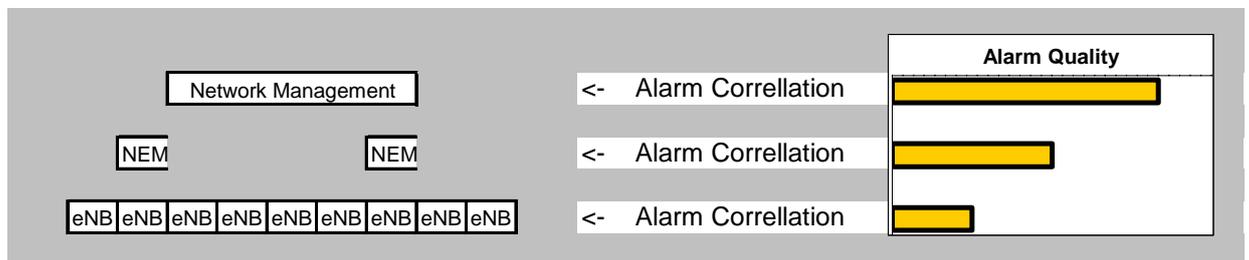
4 FAULT MANAGEMENT AND FAULT CORRECTION USE CASE SPECIFIC REQUIREMENTS

4.1 INFORMATION CORRELATION

Fault management shall be simplified and partly automated with the help of an information correlation functionality. Input values and output activities shall be configurable by the operator.

R32: Basic requirements on information correlation:

In order to support SON function for fault management and fault correction, the network shall provide mechanism for information collection and correlation with the following characteristics:



- Advanced alarm correlation is used to increase alarm quality with the help of several data sources (e.g. alarm , measurements, traces, UE information, neighbour cell information, configuration item information, loss of redundancy indication, eNB heartbeat).
- Alarm correlation is done on all layers preferably on the lowest possible layer.

- Aim: The alarm information is unambiguous for the alarm root cause (as far as possible from perspective of the node; in some cases the higher network view may be necessary and the alarm correlation must be done on this higher level) and the location where the alarm is generated.
- Important alarm information (root cause, location, threshold violations) can be easily accessed. Secondary and related information is suppressed but available for user inspection by a right click function to view the suppressed information.. This information is logged and available through a reporting system.
- In the FM application on the NEM fault specific corrective actions are proposed to the operator. The operator needs to confirm execution with one mouse click, however, the operator's management shall have the opportunity to accept or reject the corrective action being implemented in the production environment. If all proposed corrective actions presented by the NEM have been pre-approved for implementation prior to Operator viewing then the action can be taken. This information is logged and available through a reporting system.
- The NEM provides a user friendly interface to enable the operator to define his own correlation rules and corrective actions to be carried out as reaction to a specific fault. The NEM provides a user friendly interface for management to approve or reject the implementation of the correlation rules and corrective actions if this is being performed in real time. This is also logged and available through a reporting system.
- The operator can choose to allow this corrective action by default / for limited number of occurrences / only once or if approved by management. This is logged and reportable thru a reporting system.
- Default corrective actions (autonomous fault correction) is done on lowest possible layer – as soon as the alarm information is of sufficient quality. The time associated with corrective action tasks is captured and these actions are logged and available through a reporting system.
- The operators is being notified accordingly when an autonomous fault correction has been carried out and this is maintained in a log and is available through a reporting system.
- The FM application that carries out automatic / autonomous actions can also be located in Network Management. This will use more information e.g. from other eUTRAN areas or from ePC.
- An automated / autonomous FM application on NM level that can gather the required information from other vendor systems through standards-based bidirectional interfaces (manager of managers functionality)..
- It needs to have interconnection with the Trouble Ticketing systems via the Northbound interfaces.

4.2 CELL /SERVICE OUTAGE DETECTION & COMPENSATION

Abstract:

Detection and compensation of outage of services and cells are a main task in a mobile network. The outage covers for instance sleeping cells or poor performing service in a cell. If the outage of a cell or specific service is detected the system supports the solution or mitigation of this outage.

Input Parameter/Pre-requisites:

- The eNB can on lowest layer consolidate all available information (alarms, measurements, traces, UE information neighbour cell information, threshold violations, etc) and create a meaningful alarm that indicates a service affecting problem.

Process:

The SON entity shall:

- gather all necessary information from the networks (e.g. alarms, measurements, traces, PM data, probes, neighbour cells, threshold, UE, eNB heartbeat)
- consolidate this information to receive a proper information on the service state in each individual cell
- Detect and alarm service related problems in the network.
- Automated fault correction (if possible for known cases and allows automated fault corrections to be added as more is information is learned after implementation). This information shall be logged and automatically provided to the ticketing system.
- If automated fault correction was not successful the network compensates the problem in one cell by appropriate activities (see outcome) This shall automatically spawn a trouble ticket and record all actions taken and their results.
- Provide a means of near-real time reporting, standard or “canned” reports, and interface to a long-term reporting system.
- Interface with testing systems for automated fault correction verification that also passes information to the ticketing system for recordkeeping.

Outcome:

The network compensates the problem by appropriate actions such as routing traffic to nearby cells, call blocking, or automated root cause analysis then automated fault correction, then validation of service restoration.

R33: Basic Requirements on cell/service outage and compensation:

- The above process is supported by e.g. following actions if applicable:
 - P2P or a similar interface between 2G, 3G and LTE network for automatic Inter-RAT (I-RAT) neighbour configuration is in place.
 - Handover (intra-RAT and inter-RAT) into the affected LTE cell(or handover for the affected service) is forbidden.
 - Handover (Inter-RAT) into the affected 2G or 3G cell(or handover for the affected service) is forbidden.

- If not already configured, introduce new handover relations to move traffic to not affected layers.
- Power down affected cell. Neighbour cells e.g.
 - Increase transmission power
 - Change antenna tilt to cover the affected area.
 - Other mechanisms as part of self optimisation are started
- Provide a centralized entity that
 - gathers all necessary information from the networks (e.g. alarms, measurements, traces, PM data, probes, neighbour cells, UE, eNB heartbeat)
 - consolidates this information to receive a proper information on the service state in each individual cell
 - detects and alarms service related problems in the network.
 - Logs and reports on all activities associated with the alarm surveillance, incident and problem and change management.
 - the centralized entity is multi vendor capable.

4.3 MITIGATION OF UNIT OUTAGE

Abstract:

A unit is a replaceable part of the eNB which perform a specific function and its failure will not cause the whole eNB to fail. An eNB is made up of several units which have their specific function. When a unit outage is detected in a network node, functional and performance degradation should be minimised. In order to achieve this goal, in addition to the activation of the backup units, actions to reconfigure and optimise the usage of working units are required.

Automatic mechanisms for adaptation and reconfiguration of the equipment would increase the level of network performance until the node is restored to its original units configuration. All activities would include updating the Configuration Management Data Base to reflect real-time status of the replaceable unit.

R34: Basic requirements on mitigation unit outage:

SON functions shall be provided in the network nodes so that:

- the SON entity shall be able to detect the unit outage (e.g. by means of alarm signalling), and provided with all the information related the functional characteristics of the unit;
- if available, backup units are activated and configured (or redundant resources anyhow available due to license system)

- in case only a subset of functions can be restored, the SON entity shall reconfigure and optimise the usage of the node resources (e.g. reduced or balancing load, reduced number of carriers, reduced TRX power, etc.) and / or compensate with resources available in other equipment (e.g. coverage provided by neighbour eNBs).
- In order to reduce outage probability, operating conditions (e.g. load) and critical parameters (e.g. temperature) shall be monitored and reconfiguration shall be performed (e.g. preventive load reduction). This information shall be recorded and available for reporting in near real time. Any changes made shall be reflected in activities that update the configuration management database.
- SON function itself shall be protected in order to properly run also in case of unit outage.

5 O&M RELATED SON USE CASES

5.1 HARDWARE / CAPACITY EXTENSIONS

Abstract:

Minimise operational effort in case of hardware extension for capacity reasons.

R35: Basic requirements on HW / capacity extensions:

1. The system shall continuously survey hardware capacity and provide reaction and warning mechanism in case of possible capacity problems
2. The system can autonomously make use of the available spectrum and other air interface settings to adapt to changes in cell capacity.
3. A license concept for a flexible capacity management is available
4. A license based capacity management system is available and can be run in autonomous mode
5. Any hardware extension for capacity reason can be done with minimum operational effort:
 - Hot plug'n play
 - Immediate self test of new HW to ensure 1 site visit concept
 - No reboot of the site
 - No manual editing of databases
 - Automatic SW/firmware control
 - Automatic inventory update
 - Automatic logging of all threshold violations and notifications

5.2 AUTOMATED NEM UPGRADE

Abstract:

Minimise operational effort for NEM upgrade.

R36: Basic requirements on automated NEM upgrade:

The upgrade of the NEM shall be done with least impact on daily operational work.

NEM upgrade project				Guard Period (Pilot)
Preparation and data collection	OSS upgrade	NEM SW upgrade	Customization	

- All operator specific data is automatically gathered, stored and redistributed after the upgrade. No further user adaptations are necessary. This includes :
- Customer specific settings (configured by the supplier to adapt the product to the operator needs)
 - Operator specific settings (configured by the Operator for further adaptation to its own infrastructure)
 - Northbound Interfaces
 - Bidirectional Interfaces
 - Applications, Process, and Systems Adapters
 - Security Settings
 - User specific data and user specific adaptations.
- There is no or only minimum network configuration freeze necessary.
- There is no or only minimum surveillance outage.
- It is possible to fall back to the previous software release and previously stored configuration any time during the upgrade and for the guard period.
- There are no limitations to system redundancy during the guard period.
- The overall time of the NEM upgrade is kept to absolute minimum

5.3 COMPENSATION FOR OUTAGE OF HIGHER LEVEL NETWORK ELEMENTS

Abstract:

Minimise impacts of outage of higher level network elements.

R37: Basic requirements on outage compensation:

- Connection to MME / UPE is continuously monitored.
- Non-Pooled MME:: a primary and secondary MME IP address shall be provisioned to the eNB.
- The secondary is only used in the event that the primary is unreachable.
 - eNB will automatically connect to backup MME/UPE
- MME Pooling (as known as S1 flex) is supported. Load sharing between several MME s is possible.
 - As part of load sharing new calls will only be established on working links.

5.4 FAST RECOVERY OF INSTABLE NEM SYSTEM

Abstract:

Enable fast recovery of instable NEM system.

R38: Basic requirements on fast recovery NEM:

- a. A backup concept is available for the NEM that saves in regular intervals all important data should the failover capabilities fail.
- b. Failover automatically takes place when subcomponents of the system fails.
- c. The backup can be done in autonomous mode.
- d. Recovering the NEM from a taken backup is a straight forward and fast procedure and shall not take longer than 30 Minutes.
- e. In case the NEM fails the Northbound data and all Bidirectional data shall be re-routed such that all information reach the NMS.
- f. Limited configuration management for fault management (e.g. site reset) on eNB of the affected nodes shall be available.
- g. This (d, e) can be realized by intelligent load sharing in case more than one operational NEM is deployed. The remaining NEM shall than be run in some disaster mode with limited functionality (e.g. no real time PM, no KPIs, no software management,...)
- h. This (d, e) can be realized by providing additional hardware for a high availability solution.

6 SON ENABLER

In this chapter special use case and related solutions are mentioned which may enable certain SON functionality but cannot really be seen as an own SON function.

6.1 PERFORMANCE MANAGEMENT IN REAL TIME

Abstract:

Enable performance management in real to support network monitoring and SON.

R39: Basic requirements on performance management:

In addition to regular provisioning of PM data in 15 to 30 Minutes interval it shall be possible to monitor a limited number of active alarm counters quasi real time (~ 1 Min delay) after activating this functionality in a limited number of cells.

- It is possible in the NEM to activate 'real time PM' for one cell or a group of cells for one measurement or a group of measurements.
- It is possible from the northbound system to activate 'real time PM' for one cell or a group of cells for one measurement or a group of measurements. Measurements are being forwarded to the PM northbound interface.
- It is possible to select data gathering intervals for this activity from 10 seconds to 5 minutes.

6.2 DIRECT KPI REPORTING IN REAL TIME

Abstract:

Enable definition of KPI reporting to tailor operator optimal specific network monitoring solutions.

R40: Basic requirements on direct KPI reporting:

A number of standardized KPIs shall be configurable in the NEM to be continuously measured on all eNB's. If KPI's exceed their threshold an alarm shall be raised for the affected eNB.

- It is possible in the NEM to define KPIs on base of the existing PM counters for one cell, a group of cells or the whole network. This is supported by appropriate applications in an user friendly way.
- It is possible from the northbound system as part of CM to define KPIs on base of the existing PM counters for one cell, a group of cells or the whole network.
- What are the limitations for the number of KPIs and the number of used Measurements.
- The KPIs are treated like usual measurements after creation. It is possible:
 - To define individual thresholds to trigger alarms
 - To activate real time PM on KPIs
- KPIs are available via northbound interface to Network Management.

6.3 SUBSCRIBER AND EQUIPMENT TRACE

Abstract:

A powerful trace interface is supported to enable the operator to gather all relevant traces.

R41: Basic requirements on subscriber and equipment trace:

- The 3GPP eUTRAN System supports the respective Specification for Subscriber and equipment trace 32.421, 32.422, 32.423. In particular for eUTRAN Traces the following Network Elements and the Traceable interfaces in the NEs are supported
 - e-NB: S1-MME, X2, Uu (see 32.421)
- In addition to ‘Chapter 5.5 Trace data reporting’ the operator shall be able to
 - apply powerful filters to select certain information very specifically (e.g. a certain information element in a signalling message)
 - choose to store trace data locally on the eNB in a limited storage area (FIFO principle). Data can be uploaded upon request using the specified file formats.
- The NEM (if existing) can send trace results directly to a third party application.
- The NE (eNB) can send Trace data directly to a third party application based on standardised trace format and content.
- The locally stored trace information can be accessed directly from the eNB from a third party application.

7 REFERENCES

“Use_Cases_Related_to_SON_2.02.pdf”

„Annex A Informative list of SON_Use_Cases_1.53.pdf“

SA5-80800: “High level requirements for eUTRAN performance counters”

8 ABBREVIATIONS

3GPP	3rd Generation Partnership Project
ANR	Automatic Neighbour Relation
CM	Configuration Management
DHCP	Dynamic Host Configuration Protocol
eNB	LTE Base Station
FM	Fault Management
HeNB	Home Base Station

HII	High Interference Indicator
HLR	Home Location Register
HO	Handover
HSS	Home Subscriber Service
HW	Hardware
ICIC	Inter Cell Interference Coordination
KPI	Key Performance Indicator
LMT	Local Maintenance Terminal (to access directly eNB locally at the site)
LTE	Long Term Evolution
MME	Mobility Management Entity
NE	Network Elements (unspecific, depends on context: in most cases eNB)
NEM	Network Element Manager
NGMN	Next Generation Mobile Networks
NMS	Network Management System
O&M	Operation and Maintenance
OI	Overload Indicator
OSS	Operation Support System
PLMN	Public Land Mobile Network
PM	Performance Management
PRB	Physical Resource Block
QoS	Quality of Service
RACH	Random Access Channel
RRM	Radio Resource Management
S1	Interface between eNB and Core network
SON	Self Organising Network
SW	Software
UE	User Equipment
UPE	User Plane Entity
Uu	Air Interface



X2 Interface between two adjacent eNB