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Contents

Foreword

This Technical Report has been produced by the 3rd Generation Partnership Project (3GPP).

The contents of the present document are subject to continuing work within the TSG and may change following formal TSG approval. Should the TSG modify the contents of the present document, it will be re-released by the TSG with an identifying change of release date and an increase in version number as follows:

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Introduction

Reduction of operational efforts and complexity are key drivers for RAN Long Term Evolution. One of the important aspects to this is that the system operability is improved under multi vendor environment. It is of importance that measurements and performance data of different vendors share the same “language.” Such alignment is easing ease network performance analyses and problem finding, and reduces efforts in maintaining the network at a properly working state.

It is also of interest to minimise operational effort by introducing self configuring and self optimising mechanisms. A self optimising function shall increase network performance and quality reacting to dynamic processes in the network.

Especially in the early deployment phase, the efforts to set up and optimise are significant and traditionally lead to lengthy periods of getting an optimum and stable system setup. It is thus essential to have the necessary set of self configuration and self optimisation mechanisms already available when initial deployment starts.

As such, standardisation is asked to define the necessary measurements, procedures and open interfaces to support better operability under multi vendor environment. Such standardised functions shall also facilitate self configuration and self optimisation under multi vendor environment. Especially the interaction between self configuring/optimizing networks and O&M has to be considered.

1 Scope

The present document provides descriptions of agreed use cases and solutions with regards to self configuring and self optimizing networks.

The scope of the self configuring and self optimizing functionality is defined in [2].

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

[1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

[2] 3GPP TS 36.300: "Radio Access (E-UTRAN); Overall description; Stage 2".

[3] 3GPP TS 36.211: "Radio Access (E-UTRA); Physical Channels and Modulation"

[4] 3GPP TS 36.304: "Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) procedures in idle mode".

[5] 3GPP TS 36.331: "Evolved Universal Terrestrial Radio Access (E-UTRA); Radio Resource Control (RRC); Protocol specification".

[6] 3GPP TS 36.321: "Radio Access (E-UTRA); Medium Access Control (MAC) Protocol Specification".

[7] 3GPP TS 36.423: "X2 application protocol (X2AP) ".

[8] 3GPP TS 36.213: "Radio Access (E-UTRA); Physical Layer Procedures".

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in TR 21.905 [1] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in TR 21.905 [1].

3.2 Symbols

For the purposes of the present document, the following symbols apply:

<symbol> <Explanation>

3.3 Abbreviations

For the purposes of the present document, the abbreviations given in TR 21.905 [1] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in TR 21.905 [1].

DRX	Discontinuous Reception
ICIC	Inter-cell Interference Coordination
OFDM	Orthogonal Frequency Division Multiplexing
PRB	Physical Resource Block
RACH	Random Access CHannel
RAT	Radio Access Technology
RRM	Radio Resource Management
SC-FDMA	Single Carrier Frequency Division Multiple Access

4 Description of envisioned self configuring and self optimizing functionality, Use cases

4.1 Coverage and capacity optimization

A typical operational task is to optimize the network according to coverage and capacity. Planning tools support this task based on theoretical models but for both problems measurements must be derived in the network. Call drop rates give a first indication for areas with insufficient coverage, traffic counters identify capacity problems.

4.1.1 Use Case description

The use case will have two main objectives:

Providing optimal coverage

This objective requires that in the area, where LTE system is offered, users can establish and maintain connections with acceptable or default service quality, according to operator's requirements. It implies therefore that the coverage is continuous and users are unaware of cell borders. The coverage must be therefore provided in both, idle and active mode for both, UL and DL.

Providing optimal capacity

While coverage optimization has higher priority than capacity optimization in Rel-9, the coverage optimization algorithms must take the impact on capacity into account. Since coverage and capacity are linked, a trade-off between the two of them may also be a subject of optimisation.

This use case is not completed in rel-9.

4.2 Energy Savings

A typical critical cost for the operator is the energy expenses. Cuts on energy expenses could be realized if the capacity offered by the network would match the needed traffic demand at any point of time as close as possible.

4.2.1 Use Case description

Objective:

Energy savings based on enabling the possibility, for a cell providing additional capacity in a deployment where capacity boosters can be distinguished from cells providing basic coverage, to be switched off when its capacity is no longer needed and to be re-activated on a need basis.

Expected outcome:

Cuts on operational expenses through energy savings.

4.2.2 Solution Description

4.2.2.1 Input data, definition of Measurements or Performance data

See [2].

4.2.2.2 Output, influenced entities and parameter

See [2].

4.2.2.3 Impacted specifications, procedure interactions and interfaces

See [2].

4.3 Interference Reduction

Capacity could be improved through interference reduction by switching off those cells which are not needed for traffic at some point of time, in particular home eNodeBs when the user is not at home.

4.3.1 Use Case description

Objective:

Interference reduction based on cell switch on/off.

Expected outcome:

- Increased capacity through interference reduction.
- Increased quality through interference reduction.

This use case is not completed in rel-9.

4.4 Automated Configuration of Physical Cell Identity

4.4.1 Use Case description

Objective:

Automatic configuration of the Physical ID of an eNB’s radio cell

The proposed SON use case provides an automated configuration of a newly introduced cell’s physical ID (L1 cell identifier [2]).

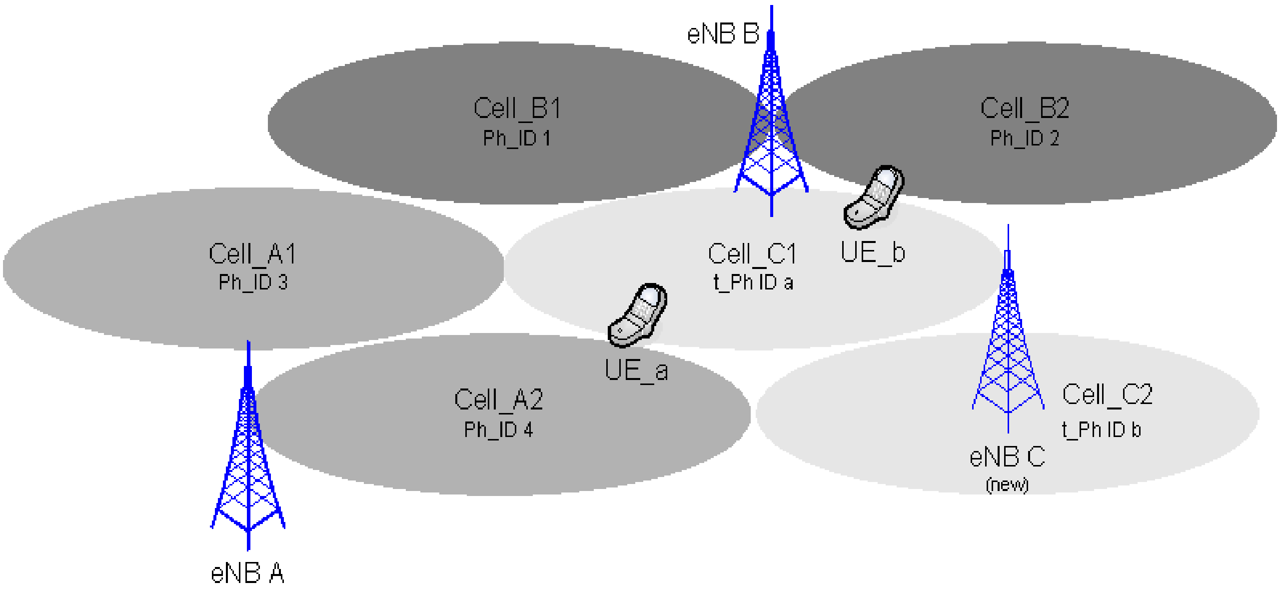

Figure 4.4.1: Deployment Illustration

The physical cell identity, or L1 identity (Phy_ID in this document), is an essential configuration parameter of a radio cell, it corresponds to a unique combination of one orthogonal sequence and one pseudo-random sequence, and 504 unique Phy_IDs are supported –leading to unavoidable reuse of the Phy_ID in different cells [3].

When a new eNodeB is brought into the field, a Phy_ID needs to be selected for each of its supported cells, avoiding collision with respective neighbouring cells (the use of identical Phy_ID by two cells results in interference conditions hindering the identification and use of any of them where otherwise both would have coverage). Traditionally, the proper Phy_ID is derived from radio network planning and is part of the initial configuration of the node. The Phy_ID assignment shall fulfil following conditions,

"collision-free": the Phy_ID is unique in the area that the cell covers

"confusion-free": a cell shall not have neighbouring cells with identical Phy_ID

4.4.2 Solution Description

Self-configuration case applied during initial cell configuration

Functionality: selection of a Physical ID for a newly deployed radio cell

Actions:

FFS

Expected outcome:

Selection of Phy_ID without conflicts.

4.4.2.1 Input data, definition of Measurements or Performance data

(FFS)

4.4.2.2 Output, influenced entities and parameter

Output parameters from the SON function are:

Self-configuration of Phy_ID

4.4.2.3 Impacted specifications and interfaces

There may be an impact related to the method to be used for obtaining existing configuration at neighbours that is FFS.

4.5. Mobility robustness optimisation

4.5.1 Use Case description

Manual setting of HO parameters in current 2G/3G systems is a time consuming task. In many cases, it is considered too costly to update the mobility parameters after the initial deployment.

For some cases, RRM in one eNB can detect problems and adjust the mobility parameters, but there are also examples where RRM in one eNB can not resolve problems:

Incorrect HO parameter settings can negatively affect user experience and wasted network resources by causing HO ping-pongs, HO failures and radio link failures (RLF). While HO failures that do not lead to RLFs are often recoverable and invisible to the user, RLFs caused by incorrect HO parameter settings have a combined impact on user experience and network resources. Therefore, the main objective of mobility robustness optimization should be reducing the number of HO-related radio link failures. Furthermore, non-optimal configuration of handover parameters, even if it does not result in RLFs, may lead to serious degradation of the service performance. Example of such a situation is incorrect setting of the HO hysteresis, which may be the reason for either ping-pong effect or prolonged connection to non-optimal cell. Thus the secondary objective will be reduction of the inefficient use of network resources due to unecessary or missed handovers.

HO-related failures can be categorized as follows:

- Failures due to too late HO triggering
- Failures due to too early HO triggering
- Failures due to HO to a wrong cell

Additionally cell-reselection parameters not aligned with HO parameters may result in unwanted handovers subsequent to connection setup, which should be avoided by parameter adjustments done by MRO function.

4.5.2 Required Functionality

4.5.2.1 Detection of Too Late HO

If the UE mobility is more aggressive than what the HO parameter settings allow for, handover can be triggered when the signal strength of the source cell is already too low – leading to a RLF; or handover may not be triggered at all if a RLF preempts it. Signature of Too Late HOs may be summarized by:

- RLF in the source cell before the HO was initiated or during HO procedure,
- UE re-establishes the connection in a cell different than the source cell.

4.5.2.2 Detection of Too Early HO

Too early HO can be triggered when the UE enters unintended island of coverage of another cell contained inside the coverage area of the serving cell. This is a typical scenario for areas where fragmented cell coverage is inherent to the radio propagation environment, such as dense urban areas. Signature of Too Early HO may be summarized by:

- RLF occurred short time after the UE successfully connected to the target cell
- UE re-establishes the connection in the source cell

4.5.2.3 Detection of HO to a Wrong Cell

If the Cell Individual Offset (CIO) [5] parameters are set incorrectly, the handover, albeit timed correctly, will be directed towards a wrong cell. Signature of HO to a wrong cell may be summarized by:

- RLF occurred short time after the UE succesfully connected to the target cell

- UE re-establishes the connection in a cell other than the source cell or the target cell

4.5.2.4 Reducing inefficient use of network resources due to unnecessary HOs

HO procedure is resource-consuming and therefore costly to the network operator. Moreover, its optimal settings depend on momentary radio conditions, which makes it difficult to control manually. Sometimes, the combination of user mobility patterns and cell coverage boundary layout can generate frequent unnecessary HOs that consume NW resources inefficiently. Alternatively, incorrect HO configuration (e.g. too big HO hysteresis) may result in missing handovers that should have been executed. HO parameter optimisation function should aim at detecting such scenarios. These scenarios sometimes can be remedied by HO parameter optimisation.

4.5.2.5 Optimization of cell reselection parameters

If cell reselection parameters are not aligned with handover parameter settings, unwanted handovers subsequent to connection setup may occur and should be avoided.

4.5.3 Evaluation scenarios and expected results

Expected results:

- Detect and minimize occurences of Too Late HOs
- Detect and minimize occurences of Too Early HOs
- Detect and minimize occurences of HO to a Wrong Cell
- Reduce inefficient use of network resources due to unnecessary HOs, e.g. “ping pong”
- Reduce unwanted handovers subsequent to connection setup

4.5.4 O&M requirements for radio related functions

While algorithms for mobility robustness optimisation should be located in the eNB SON entities, network operators should have the ability to provide their input reflecting their knowledge about the network and their network management policies,

In order to enable mobility robustness optimization:

- The relevant mobility robustness parameters should be autoconfigurable by the eNB SON entities.
- OAM should be able to configure a valid range of values for these parameters (list of parameters described in Section 4.5.5),
- eNB should pick a value from within this configured range, using proprietery algorithms for HO parameter optimisation.

Furthermore, in order to support the solutions for detection of Too Late and Too Early HO, it is required that parameter $T_{store\_UE\_cntxt}$ shall be configurable by the OAM system.

4.5.5 Solution Description

4.5.5.1 Input data, definition of Measurements or Performance data

It is proposed that certain information may be exchanged between neighboring eNBs, to facilitate optimization of mobility robustness parameters:

- Report of RLF failures: This report includes the following information elements:
    - Failure Cell ID: PCI of the cell in which the RLF occurred.
    - Reestablishment Cell ID: PCI and (optionally) ECGI of the cell where RL re-establishment attempt is made

- C-RNTI: C-RNTI of the UE in the cell where RLF occurred.

NOTE: Reporting both the PCI and ECGI helps to resolve confusion in the network, in case the RLF was due to PCI confusion in the first place.

4.5.5.1.1 Detection of Too Late HOs

The source cell is not always aware of a too late HO because the RLF can occur before the source cell is able to receive the HO-triggering measurement report message (MRM) from the UE. Therefore, a report of the RLF from the target cell in which the radio link is re-established to the source cell is necessary in order to allow the source cell to properly identify the RLF as related to incorrect HO parameter settings. The RLF report can be formalized as follows:

If the UE re-establishes the radio link at eNB B after a RLF at eNB A then eNB B shall report this RLF event to eNB A.

4.5.5.1.2 Detection of Too Early HO

In the event of a too early handover from cell A to cell B, an RLF event may get reported by cell A to cell B according to the mechanism described in Section 4.5.5.1.1, when the UE returns to cell A after RLF. In this case, the cell B will consider it as an indication of a too late HO. This case needs to be prevented in order to ensure the stability of the MRO function in the network. This following mechanism achieves this goal:

eNB B shall return an indication of a Too Early HO event to eNB A when eNB B receives an RLF report from eNB A and if eNB B has sent the UE Context Release message to eNB A related to the completion of an incoming HO for the same UE within the last $T_{store\_UE\_cntxt}$ *seconds.*

4.5.5.2 Output, influenced entities and parameter

The following mobility parameters may be optmized:

- Hysteresis,
- Time to Trigger,
- Cell Individual Offset
- Cell reselection parameters

The list of parameters to be optmized is FFS, depending on the solution adopted.

The parameters related to cell reselection are defined in [4] and those related to handover in [5].

4.5.5.3 Impacted specifications and interfaces

[7]

4.6 Mobility Load balancing optimisation

4.6.1 Use Case description

Objective:

Optimisation of cell reselection/handover parameters in order to cope with the unequal traffic load and to minimize the number of handovers and redirections needed to achieve the load balancing.

Self-optimisation of the intra-LTE and inter-RAT mobility parameters to the current load in the cell and in the adjacent cells can improve the system capacity compared to static/non-optimised cell reselection/handover parameters. Such optimisation can also minimize human intervention in the network management and optimization tasks.

The load balancing shall not affect the user QoS negatively beyond what a user would experience at normal mobility without load-balancing. Service capabilities of RATs must be taken into account, and solutions should take into account network deployments with overlay of high-capacity and low-capacity layers where high-capacity layer can have spotty coverage.

Load balancing can be done in following scenarios:

- Intra-LTE load balancing
- Inter-RAT load balancing

4.6.2 Required functionality

General features of the solution are as follows:

Functionality: An algorithm decides to distribute the UEs camping on or having a connection to a cell, in order to balance the traffic load. This may be achieved by delaying or advancing the handing over of the UEs between cells.

Actions:

- An eNB monitors the load in the controlled cell and exchanges related information over X2 or S1 with neighbouring node(s).
- An algorithm identifies the need to distribute the load of the cell towards either adjacent or co-located cells, including cells from other RATs, e.g. by comparing the load among the cells, the type of ongoing services, the cell configuration, etc.
- For the intra-LTE case, an algorithm estimates if the HO parameter settings need to be modified; if so, communication between involved eNBs (or towards O&M) takes place to propose changes of the neighbours HO trigger settings to the neighbour eNB.

4.6.3 Evaluation criteria and expected results

Expected results:

- According to handover mechanisms, some of the UEs at the cell border hand over to a less loaded cell;
- In the new situation the cell load is balanced.
- Increased capacity of the system.
- Minimized human intervention in network management and optimization tasks.

4.6.4 O&M requirements for radio related functions

(editor's note: in this section requirements on O&M respectively paramenters to be made configurable in a standardized way over the north bound interface in responsibility of SA5 shall be covered, once identified and agreed.

The text shall describe how these parameters are to be used by the respective node, the range, the type of the parameter and their granularity etc.

e.g

Boundary for **Qoffset$_{s,n}$ as** specified in TS 36.304 [4] for SON operation.

It shall be possible to set boundaries within SON algoritms are allowed to work (i.e. the implementation specific algorithm may take any value out of the allowed range within the specified boundary). The boundaries are enumerated values, in a maximum range of -10dB to +10dB. The envisioned granularity are steps of 0,2 dB. Furthermore if SON functionality is deactivated it shall be possible to set a distinct value for **Qoffset$_{s,n}$** the node has to apply in this case.

end of editors note:)

4.6.5 Solution description for Intra LTE load balancing

4.6.5.1 Input data, definition of Measurements or Performance data

It is proposed that load information is used for load balancing. Besides its own load, an eNB must know the load in the neighbouring cells to be able to decide on the appropriate candidate cell for LB action. The neighbour load can be provided with:

Intra-LTE load balancing (information exchanged over X2):

- the current radio resource usage (UL / DL GBR PRB usage, UL/DL non-GBR PRB usage, UL/DL total PRB usage), (further refinements of non-GBR load is FFS)
- the current HW load indicator (UL/DL HW load: low, mid, high, overload),
- the current TNL load indicator (UL/DL TNL load: low, mid, high, overload).
- a composite available capacity indicator (UL / DL).
- a cell capacity class indicator (UL / DL).

It is assumed the node indicating available capacity is ready to accept the corresponding traffic, but it is not mandatory.

It is also assumed that the algorithm to calculate the available capacity indicator is vendor-specific and runs in the eNB that provides the indicator.

4.6.5.2 Output, influenced entities and parameter

Intra-LTE load balancing:

- Handover parameters: HO trigger threshold.

The parameters related to handover are defined in [5]

4.6.5.3 Impacted specifications and interfaces

The signalling of composite available capacity impacts the X2AP protocol and the necessary support is introduced in the Resource Status Reporting procedures.

The negotiation of HO trigger thresholds is also defined in the X2AP protocol by means of the Mobility Settings Change procedure.

4.6.6 Solution description for Inter RAT load balancing

Need for inter RAT load exchange is confirmed. Inter-RAT load balancing and cell offload actions may be needed independently of existing or recent inter-RAT mobility events. However, in order to avoid ping-pong inter-RAT load balancing handovers (with associated waste of CN signalling resources and degradation of user experience), reported load should be assumed to have validity beyond immediate UE RRM purpose.

It is therefore proposed that the neighbouring load is provided on a low-frequency basis using a procedure separated from existing active mode mobility procedures.

4.6.6.1 Input data, definition of Measurements or Performance data

It is proposed that load information is used for inter-RAT load balancing. Besides its own load, an eNB can request the load of the neighbouring cell(s) belonging to the candidate RAT(s) to be able to decide on the appropriate candidate cell / RAT for LB action.

The neighbouring cell load is provided in the format used by the reporting RAT.

4.6.6.2 Output, influenced entities and parameter

4.6.6.3 Impacted specifications and interfaces

The need for inter-RAT parameter negotiation was not shown, and will not be standardised in Rel-9. Inter-RAT load balancing functionality may result in implementation dependent inter-RAT handover actions.

A dedicated procedure for inter-RAT cell load request / reporting is provided with minimal impact using a generic SON container extension of the RIM (RAN Information Management) mechanism.

Impacts mainly concern BSSGP specification where the cell load reporting has been specified as a new RIM application.

In order to introduce routing of RIM messages between UTRAN and E-UTRAN, alignment CRs concerning the following interfaces have been done.

- RANAP

- S1AP

- CN interfaces using GTPv2-C.

4.7 RACH Optimisation

4.7.1 Use Case description

The RACH configuration has critical impacts to system performance:

The RACH collision probability is significantly affected by the RACH settings, 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 has impacts on the system capacity.A poorly configured RACH may also result in low preamble detection probability and limited coverage. Therefore, RACH parameter optimisation provides significant benefits to the deployed network. The setting of RACH parameters depends on a multitude of factors, e.g.:

- the uplink inter-cell interference from the Physical Uplink Shared Channel (PUSCH),
- RACH load (call arrival rate, HO rate, tracking area update, traffic pattern and population under the cell coverage as it affects the UL synchronization states and hence the need to use random access),
- PUSCH load,
- the cubic metric of the preambles allocated to a cell,
- whether the cell is in high-speed mode or not,
- uplink (UL) and downlink (DL) imbalances.

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. Measurements on the RACH performance/usage are needed to be collected at a SON entity.

An automatic RACH optimization function monitors the prevailing conditions, e.g., a change on RACH load, uplink interference, and determines and updates the appropriate parameters.

4.7.2 Objective

The primary objectives of a RACH optimization function are:

a.) Minimize access delays for all UEs in the system

- Incoming probe must have sufficient power for the eNB to detect.

b.) Minimize UL interference due to RACH

- Too high power causes unnecessary interference to other eNBs.

Secondary objective is furthermore:

c.) Minimize interference among RACH attempts

- Configure neighbouring cells to minimize sequence/frequency overlaps.
- Choose call parameters to account for mobile velocity (high speed [$\geq$ 300kph] vs. Normal).

Consequently, the RACH optimization function will attempt to automatically set several parameters related to the performance of RACH, for example:

- PRACH configuration index (resource unit allocation and format) [3];
- RACH preamble split (among dedicated, random-high, random-low) [5];
- RACH backoff parameter value [6];
- PRACH transmission power control parameters [8].

The exact set of parameters to be optimized by the RACH Optimization function is outside the scope of this technical report.

4.7.3 Expected results

Reduction in access delay, which results into:

- short call setup delays
- short data resuming delays from UL unsynchronized state
- short 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.

4.7.4 Solution Description

4.7.4.1 Performance data, Input data and definition of Measurements

4.7.4.1.1 Performance Specification

The UE performs a power ramping procedure, where the UE increases its power for the subsequent preamble transmission if the UE is not granted access due to a preamble detection miss or contention, as described in [6].

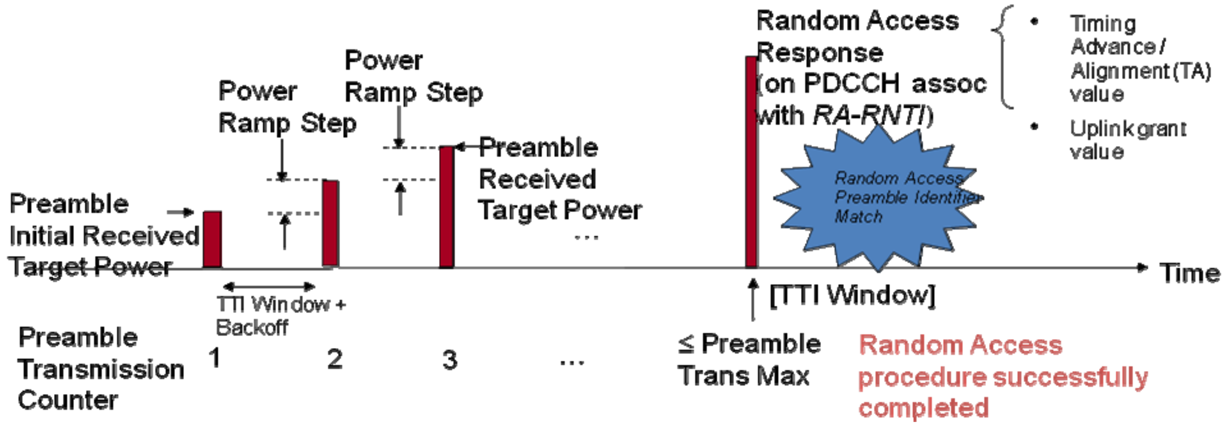

Figure 4.7.4.1.1-1: RACH Procedure

The desired performance of RACH may be expressed in terms of the access probability *AP(m)*, which is the probability that the UE has access after a certain random access attempt number m=1,2,3….

Alternatively, the desired performance may be expressed in terms of the *access delay*, which is the delay from the initial random access attempt until access is granted. Similar to above, the RACH performance may be expressed in terms of the access delay probability $ADP(\delta)$, which is the probability that the access delay is less than δ.

Various alternatives are possible, although it is noted that ADP is more appropriate since it explicitly takes into account the delay involved in the random access procedure as discussed in the objectives of RACH optimization (section 4.7.2).

4.7.4.1.2 Input Data

Potential input parameters to set the following RACH related parameters are as follows:

PRACH Configuration Index

Plausible input information for the automatic function may be estimates of access probability, access delay probability, and the PUSCH load.

PRACH Transmission Power Control Parameters

Relevant input information for the automatic function may include the access probability and/or access delay probability estimates, and uplink inter-cell interference. Further, since the uplink interference may change on a fast cycle it is beneficial for the automatic RACH optimization function to be responsive and act immediately to changes in interference.

RACH Backoff Parameter

Suitable input information for the automatic function may include the access probability and momentary RACH load.

RACH Preamble Split

Each cell can measure the incoming handover rate. Further, at handover the target cell also sets the "handover failure timer T304", which determines for how long dedicated pre-ambles are locked and this has an impact on the number of dedicated preambles needed.

Root Sequence Index

These indexes are used to choose the code sequences for the RACH attempts. These may be useful in avoiding RACH collisions when the same time and frequency resource gets reused in neighbouring cells, and for calculating the interference caused in the RACH area in an eNB. For the purpose of calculating interference, this may be also done using dedicated preambles as there is no need of reserving additional root sequences for this purpose.

An eNB may exchange information over the X2 interface with its neighbors for the purpose of RACH optimisation. An eNB may also communicate with the O&M in order to perform RACH optimization.

4.7.4.1.3 Definition of Measurements

Reporting Entities

RACH optimization functions need to estimate *AP*(*m*) or *ADP*(*m*), in order to set RACH parameters, e.g., configuration and transmission power control parameters. AP and ADP depend on CP and DMP. Although it may be possible to estimate the CP by, e.g., using the number of received preambles and number of UEs that have obtained access, it is not possible to estimate DMP using only measurements available at the eNodeB. An undetected preamble is simply a correlation peak below the detection threshold and is, therefore, classified as noise at the eNodeB detector. Hence, it is needed that UEs report necessary information needed to estimate AP and ADP.

To estimate AP, it is necessary that the UE reports the number of attempts needed to obtain access (see, PREAMBLE_TRANSMISSION_COUNTER in [6]). Note, that the UE ramps up its power (increments PREAMBLE_TRANSMISSION_COUNTER) also when the UE has not been granted access due to loosing the contention resolution process. In order to derive accurate estimates of DMP, it may be necessary to exclude random access procedures that have been subject to contention failures (i.e., reports where the transmission counter has been increased due to contention failure). This is indicated using a single bit, where the UE indicates whether it has been subject to contention during the random access procedure.

The details of the UE reporting procedure is captured in [5]. The network may poll for the UE report after a successful random access procedure (see *UEInformationRequest*) and the UE responds with the number of preambles sent by MAC for the last successfully completed random access procedure and whether contention is detected by MAC for at least one of the transmitted preambles for the last successfully completed random access procedure (see *UEInformationResponse*).

4.7.4.2 Output, influenced entities and parameters

Potential output parameters are:

- PRACH configuration index (resource unit allocation and format);
- RACH preamble split (among dedicated, random-high, random-low);
- RACH backoff timer parameter;
- PRACH transmission power control parameters;
- Root sequence index.

4.7.4.3 Impacted specifications, procedure interactions and interfaces

UE and eNB measurements are provided to the SON entity, which resides in the eNB. Details on UE measurements are specified in [5].

An eNB exchanges information over the X2 interface with its neighbors for the purpose of RACH optimisation. The PRACH Configuration is exchanged via the X2 Setup and eNB Configuration Update procedures.

An eNB may also need to communicate with the O&M in order to perform RACH optimization.

4.7.4.3.1 Stage 2 and stage 3 specifications

4.7.4.3.1.1 Stage 2 specification

The use case is described in [2].

4.7.4.3.1.2 Stage 3 specification

The necessary support is specified in [5] and [7].

4.7.5 O&M requirements

Operators may be able to configure the initial planned RACH configuration. The related parameters may be modified based on operator’s policies. The RACH performance target may also be set via O&M.

While algorithms for RACH optimization are located in the eNB, in order to enable RACH optimization:

- The relevant RACH parameters should be autoconfigurable by the eNB.
- OAM should be able to configure value ranges for these parameters,
- eNB should be able to operate within the configured ranges using proprietary algorithms for RACH optimisation.

While the exact list of parameters is FFS because it may be more optimal to keep certain entities within the eNB, the following are candidates for this set:

- preambleInitialReceivedTargetPower
- powerRampingStep
- preambleTransMax
- ContentionResolutionTimer

How eNB makes use of the list of values of the above parameters to affect the used value of these parameters will be subject to eNB implementation.

Any specified OAM mechanism shall make sure that the optimization function residing in the eNB is not constrained by the configured parameters in a way that performance of the SON mechanism is jeopardized or limited.

Note: Any specified OAM mechanism shall make sure that the range of values provided are adequate for the efficient performance of the optimization function residing in the eNB.

4.8 Automatic Neighbour Relation Function

This use case allows an eNB to build and maintain neighbour relationships as described in [2].

4.9 Inter-cell Interference Coordination

In reuse one cellular networks mutual interference between cells occurs. Within the OFDM and SC-FDMA based LTE system interference has to be coordinated on the basis of the physical resource blocks (PRBs). Such interference can be reduced or avoided in uplink and downlink by a coordinated usage of the available resources (PRBs) in the related cells which leads to improved SIR and corresponding throughput. This coordination is realized by restriction and preference for the resource usage in the different cells. This can be achieved by means of ICIC related RRM mechanisms employing signalling of e.g. HII, OI and DL TX Power indicator.

ICIC RRM might be configured by ICIC related configuration parameters like reporting thresholds/periods and preferred/prioritized resources. Then these have to be set by the operator for each cell. Setting and updating these parameters automatically is the task of a SON mechanism.

4.9.1 Use Case description

Objective:

The objective is the self-configuration and self-optimization of control parameters of RRM ICIC schemes for UL and DL. By means of ICIC related Performance Measurements (PM) analysis the SON function may properly tune ICIC configuration parameters like reporting thresholds/periods and resource preference configuration settings in order to make the ICIC schemes effective with respect to Operator's requirements.

This shall allow an advantageous RRM resource usage by means of preferences with respect to the e.g. available time/frequency resources, neighbourhood relations of the cells and QoS requirements targeted by the operator.

Expected results:

Automatic configuration or adaptation, with respect to cell topology, of

ICIC reporting thresholds/periods

resource preferences in eNBs

RSRP threshold for ICIC

Minimized human intervention in network management and optimization tasks

Optimised capacity in terms of satisfied users

This use case is not completed in rel-9.

Annex A: Change history

Change history					
TSG #	**TDoc**	**CR**	**Rev**	**Subject/Comment**	**Version**
RAN3#59	R3-080476			First Skeleton provided	0.0.1
02-2008				- text proposals included as agreed after e-mail discussion in RAN3#59: R3-080459 without section 4.x.2, R3-080566, R3-080557, R3-080526, R3-080525	0.0.2
RAN3#59bis				editorial changes, input in R3-080989 on RACH optimisation added	0.0.3
RAN3#60				editorial changes, input in R3-081096 & R3-081530 added	0.0.4
RAN#40				presented for information as V1.0.0.	1.0.0
RAN3#63bis	R3-091002			- text proposals included as agreed at RAN3#63bis: R3-090963, R3-090965, R3-090968, R3-090969 Specification date and REL. changed	1.1.0
RAN3#64				- text proposals included as agreed at RAN3#64: R3-091421, R3-091486, R3-091491, R3-091426, R3-091457, R3-091493 Editors notes included to capture some discussions during RAN3#64, and examples for content of O&M sections are added Some smaller editorials are done	1.2.0
RAN3#65				text proposals included as agreed at RAN3#65: R3-091538	2.0.0
RAN#45	RP-090788			Approved and placed under change control	9.0.0
RAN#47	RP-100228	0003		Finalization of Solution Description sub clause for MLB	9.1.0
RAN#48	RP-100598	0008	1	Finalization of sub clause for RACH optimization	9.2.0
RAN#48	RP-100598	0009	3	Finalization of sub clause for Energy Saving	9.2.0
RAN#48	RP-100598	0011		Finalisation of Solution Description sub-clause for inter-RAT MLB	9.2.0
RAN#48	RP-100598	0015		Removal of parts uncompleted in Rel-9	9.2.0

History

Document history		
V9.0.0	February 2010	Publication
V9.1.0	April 2010	Publication
V9.2.0	September 2010	Publication