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Technical Report

3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Study on next generation Self-Optimizing Network (SON) for UTRAN and E-UTRAN; (Release 12)

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Postal address

3GPP support office address
650 Route des Lucioles - Sophia Antipolis
Valbonne - FRANCE
Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Internet
http://www.3gpp.org

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Foreword

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

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where:

- x the first digit:
  - 1 presented to TSG for information;
  - 2 presented to TSG for approval;
  - 3 or greater indicates TSG approved document under change control.
- y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.
- z the third digit is incremented when editorial only changes have been incorporated in the document.

Introduction

SON enhancements may be necessary for the interoperability of the existing features as well as for the new features and new deployments considered in Rel.12.

In Rel.11 Mobility Robustness Optimisation (MRO) has been enhanced so that identification of the UE type, for which a failure has occurred may be possible. Other SON use cases may benefit from similar differentiation in handling. Active antennas allow the creation of multiple vertical and horizontal beams making the deployment dynamic. SON may enhance network deployment based on active antennas. Finally, review of SON techniques and verification of any enhancements with regard to existing pre-Rel.12 small cells are part of the study item.

1 Scope

The present document provides descriptions and possible solutions of use cases and analysis of these solutions. Considerations with regards to requested functionality in scope of other 3GPP groups if any, may be captured in this document as well.

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".

3 Definitions 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 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].

SON Self-Organizing Network

4 Description of addressed problems and solutions

4.1 SON for UE types

According to current specifications, differentiation of mobility settings is possible. The objective of the “SON for UE types” task should be to evaluate if differentiation of mobility settings mechanisms can cause interoperability issues and if yes, to evaluate solutions for them.

Any solution should bring sufficient improvements to inter vendor interoperability and it should be robust and future proof. Such solutions should not unnecessarily limit the flexibility available in current systems for assigning different policies to UEs or UE groups.

4.1.1 Ping-pong event

Problem description:

Enabling wider differentiation of mobility setting may be needed in the system (homogeneous and heterogeneous scenarios), but may create issues, such as ping-pongs. Example scenarios are presented below (further scenarios are FFS).

Scenario 1:

When load balancing is used to resolve congestion in the source cell, and the Mobility Settings Change procedure is used to adapt the handover trigger point to the target cell, some UE categories may be subject to ping-pong depending on how the UE category is handled in the target cell. A UE belonging to such UE category is handed over from the congested source cell to the target cell while located far out in the edge of the target cell. While the eNB serving the target cell is aware that handing over the UE back to the congested cell within a certain time window is a ping pong event it is FFS whether the eNB serving the target cell needs additional information for further handover decisions. These decisions are typically based on a trade off between the risk for failure and ping pong.

Solutions:

The following solutions have been identified:

1. Solution without additional information
   The existing information such as load information, measurement configuration, QoS parameters and UE capabilities can be used to assess the offset used for a handover and likelihood of connection failure of the served UE. Therefore, current specifications enable an eNB to have information for avoiding unnecessary handovers back to the source cell.

2. Solution with additional information but without pre-defined UE groups.
   In this solution the source eNB sends an indication in the handover request to the target eNB to give additional information about each handover.

   a. Signal the offset from the agreed handover trigger used for this handover.

   b. Signal a timer to inform the target that it should not hand over the UE back to source within the given time.

   c. Signal a group identity (defined at source as a bit string) in the Mobility Setting Change procedure; later, the target, if it accepted the new mobility settings, applies the new settings to the UEs handed over successfully with the same group identity signaled in the HO preparations.

3. Solution with pre-defined UE groups
   In this solution, the groups are defined in the standard. The mobility settings change procedure is extended to include negotiation of the predefined groups.

   a. The eNB exchange the group ID in the handover request.

   b. The groups are based on commonly known parameters, like UE capabilities or release or bearer class.

4.1.2 Mobility Settings Change interpretation

Problem description:

The way the Mobility Setting Change procedure is defined allows for very different implementations, also such that may reduce the available range for the negotiation. To depict it, the following example may be considered:

There are two eNBs, eNB A, whose vendor considers the procedure as “advisory” and relies on its implementation, and eNB B where the procedure is considered binding and where the mobility decisions are made according to the agreed mobility settings. If the two eNBs are to negotiate the mobility setting, the eNB A may propose rather big changes, assuming that if there is a UE that can not handle such a big extensions, the mobility implementation will hand over the UE sooner. Despite the fact that the specifications do not mandate to apply the negotiated handover to all UEs, the eNB B may reject such a request because some UEs (e.g. legacy UEs) may not be able to handle it. And since the standard states that eNB A should consider the response before executing the planned change, the available range for the load balancing may be reduced.

Solutions:

The problem can be solved in different ways:

1. Clarify that the negotiation is for the least sensitive UE (typically legacy UEs).

2. Clarify that the negotiation is for the most sensitive UEs.

The clarification can be added as a specification or as an information element in the Mobility Setting Change procedure.

Alternatively, the problem may be considered as irrelevant, because the ambiguity was present in the procedure since the Rel.9, when it was first specified. Then, the handover trigger points established via Mobility Setting Change procedures should be interpreted as a recommendation that, whenever possible, the negotiated handover trigger point shall be respected.

4.2 SON for AAS-based deployments

The objective of SON for AAS task should be to evaluate whether SON mechanism could be beneficial to optimize inter-operability of AAS operations. Also, as part of the task, an evaluation should be performed of whether existing SON features need to be enhanced to handle the dynamic changes due to AAS activities.

The scenarios assumes high traffic demand from high density of UEs. The UEs may be concentrated temporarily or permanently in space; the AAS-based deployment is used to optimise capacity.

Three AAS techniques have been considered:

1) Beam forming

- The solution introduces adaptive or reconfigurable antenna systems, where the coverage of each cell is maintained unchanged.
- The same PCI is used in all the cell coverage.
- These adjustments are considered to be on fast time scale (following RRM).
- The control unit may be the base station (implementation based).
- Problems related to existing SON features or enhancements needed: none (intra-cell activity)

2) Cell Shaping

- The solution introduces adaptive or reconfigurable antenna systems, where the main coverage of each cell is maintained unchanged but the cell edge can be adapted to load demand.
- The same PCI is used in all the cell coverage.
- These adjustments are considered to be on medium time scale (every 1h or more seldom).
- The trigger for the change may be OAM reconfiguration (e.g. based on collected KPIs) or the control unit may be the base station (implementation based).
- Problems related to existing SON features or enhancements needed: FFS

3) Cell splitting

- The solution adopts higher order sectorisation (vertical, horizontal or a combination) to selected base stations by changing an antenna system to include more antenna beams, each covering a smaller area than before the change – however, the main coverage of the combined beams correspond to the main cell coverage before the split.
- Each of the beams broadcasts different PCI.
- Cell splitting / merging procedures is considered on a long term time scale (every 1h or more seldom – few times a day).
- The trigger for the change may be OAM reconfiguration (e.g. based on collected KPIs) or, if the cell coverage is not affected and the split is pre-planned, the control unit is the base station (implementation based). Indication of the cell splitting may be needed at OAM and neighbour eNBs.
- Problems related to existing SON features or enhancements needed: FFS

A centralized (in OAM) controlled solution is already possible today, since OAM is able to send any configuration to the involved eNBs. It is also capable of monitoring an extensive range of measurements. Therefore, the solutions for cell splitting operate on a discreet set of configurations provided from OAM.

Scenario descriptions involving cell splitting should provide answers to the following questions:

1. Should cell splitting occur in zones freely defined by the eNB, or only according to OAM preconfigured geographical information?

   Answer: The cell splitting should occur according to OAM preconfigured geographical information.

   The process of cell splitting should be carried out in a controlled and preconfigured way, i.e. by selecting splitting configurations that have been validated in terms of coverage at OAM level. According to network load and users service type and requirements in the considered geographic areas, OAM can define whether a cell splitting is necessary or not.

2. Should the RAN provide particular information to OAM in order to help configuration of geographical or other information related to cell splitting?

   Answer: Information such as MDT measurement data or statistics can be provided to OAM to help further optimisation of configuration related to cell splitting.

   RAN can provide statistics and/or MDT data to OAM, for example, OAM can consider statistics and/or configure MDT measurements before or after cell splitting in the concerned zones, and the statistics and/or MDT measurements data collected from eNBs and UEs may help operators get knowledge of the real coverage and capacity conditions under the two different antenna configurations within the concerned geographical area. Operators can make further optimisation on the setting of AAS antenna and geographical zones.

3. Should the cell splitting, once defined by OAM, be permanently activated?

   Answer: The cell splitting can be activated and merged back.

   In a situation where the hot spots of traffic demand are consistently localised in space and are present for most of the time, or appear/disappear with a relatively short time period, it would be plausible to permanently adopt the cell splitting configuration.

   On the other end, if the traffic hotspots are not consistently localised in space and appear in time with rather long periods, it may be plausible to allow the merge back, from the splitting configuration to a merged one.

4. Should the OAM system be able to activate/de-activate the cell splitting (cell merging)?

   Answer: The OAM system should be able to activate/de-activate the cell splitting/merging, which allows operators to control the cell splitting/merging functionality at their needs.

5. Should the eNB be able to autonomously activate (the possibly OAM preconfigured) cell splitting? If so which kind of information is needed?

6. Should the eNB be able to autonomously de-activate cell splitting (cell merging)? If so which kind of information is needed?

   Answer5/6: The eNB should be able to activate/de-activate the cell splitting using splitting configurations preconfigured by OAM. Under the supervision and validation of OAM (e.g. validation that the configuration is compatible with the neighboring eNB status), the eNB may be able to trigger activation/de-activation of the cell splitting when certain conditions are met.

7. Should intra-frequency scenarios be considered?

8. Should inter-frequency scenarios be considered?

   Answer7/8: Both, intra-frequency and inter-frequency scenarios should be considered, which may satisfy different operators demands.

4.2.1 Connection failures due to cell splitting/merging

Problem description:

a) Radio link failures in the splitting/merging cell

Once the cell splitting is triggered, the eNB controlling the cell to be split may not yet know exactly which UEs will be impacted. Therefore, it may not be able to initiate a handover for some UEs accordingly before the cell splitting action. Even though such UEs could be identified and assuming that these UEs are in active mode while the cell splitting occurs, it is not guaranteed that a suitable target cell for handover is available. Consequently, these UEs may experience an RLF.

In addition, some UEs served by the cell for which the PCI is unchanged before and after a splitting/merging action, they may also experience an RLF if the interruption time due to cell splitting/merging is too long (e.g., longer than the RLF detection related timer T310).

Moreover, once the cell splitting is triggered a large number of UEs may have to be in handover procedures. Therefore, this solution may result in high handover failure cases because of the inter-cell interference in the intra-frequency deployment.

b) Incoming handover failure and consequent re-establishment failure

Handover preparation may be triggered by a neighboring eNB to the cell to be split/merged before the cell splitting/merging action. When the UE tries to access the target cell, the target cell may have changed due to cell splitting/merging. This handover may fail due to unsuccessful access. Soon the UE attempts to re-establish the connection in the best cell, it would fail due to lack of re-establishment information for this cell.

Solutions:

4.3 SON for pre-Rel.12 small cells

4.3.1 Taking the outcome of the RRC re-establishment into account for MRO

Problem description:

The UE is currently only reporting which cell it will attempt to re-establish after a failure in the RLF report. The actual outcome of the re-establishment is currently not available for the MRO analysis. The reported re-establishment cell is used to diagnose the failure by MRO and may lead to a corrective action by MRO. It is FFS whether the appropriate corrective actions may differ depending on the actual outcome of the RRC re-establishment.

Solutions:

4.3.2 RLF reporting in LTE island coverage scenarios

Problem description:

In LTE deployments where small LTE cells are used to provide capacity in areas with high capacity requirements, the LTE coverage may be limited to islands. In the edge of these islands it is very important to set the correct inter RAT mobility parameters to balance the amount of measurements and avoid call drops. Inter RAT MRO provides the support for this, but requires an X2 connection in order to report the failures. At the same time, the reporting solution for inter RAT MRO is that the UE reports when connecting to LTE again after the failure. If the coverage is not mature (islands) the UE may travel quite far before reaching LTE coverage again. Enabling these reports would require an extensive setup of X2 connections.

Solutions:

One solution is to use proprietary methods (e.g. OAM) to forward the information in the RLF report to the eNB handling the last serving cell.

Another solution is to forward the information in the RLF report over S1 to the eNB handling the last serving cell. For this solution, there are two options. The first option is to only support sending this to an eNB belonging to the same

MME pool. The second option is to support sending this to an eNB belonging to any MME pool. The latter requires that the TAI of the last serving LTE cell is known. It is FFS whether it is feasible (pending a discussion with RAN2) to include the TAI in the RLF report from the UE.

5 Conclusions

Annex A (informative): Change history

Change history					
Date	WG #	WG Doc.	Subject/Comment	Old	New
2013-04	R3#79bis	R3-130742	Skeleton TR agreed		0.1.0
2013-04	R3#79bis	R3-130743	Objective for SON for UE types added	0.1.0	0.2.0
2013-04	R3#79bis	R3-130746	Objective for SON for AAS-based deployments added	0.1.0	0.2.0
2013-05	R3#80	R3-131162	Two problem cases added in “SON for UE types” added	0.1.0	0.2.0
2013-05	R3#80	R3-131092	Questions concerning cell splitting added in the “SON for AAS-based deployments” section	0.1.0	0.2.0
2013-05	R3#80	R3-131094	Capacity optimisation scenario added to the “SON for AAS-based deployments” section	0.1.0	0.2.0
2013-05	R3#80	R3-131095	A scenario related to using of the result of the RRC re-establishment in the MRO added to the “SON for pre-Rel.12 small cells” section	0.1.0	0.2.0
2013-05	R3#80	R3-131096	A scenario related to RLF reporting in islands deployments added to the “SON for pre-Rel.12 small cells” section	0.1.0	0.2.0
2013-08	R3#81	R3-131548	Added solutions for the ping-pong problem	0.2.0	0.3.0
2013-08	R3#81	R3-131552	Added answers to the questions on cell splitting	0.2.0	0.3.0
2013-08	R3#81	R3-131553	The description of the AAS techniques clarified and moved to the introduction to the clause 4.2, before the questions on the cell splitting.	0.2.0	0.3.0
2013-08	R3#81	R3-131563	A problem scenario concerning continuity of a connection in case of cell splitting added to clause 4.2	0.2.0	0.3.0

Change history							
Date	TSG #	TSG Doc.	CR	Rev	Subject/Comment	Old	New
2013-09	61	RP-131147	—	—	TR 37.822 is submitted for information	0.3.0	1.0.0
2013-09					MCC clean up	1.0.0	1.0.1