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TECHNICAL REPORT

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Evolved Universal Terrestrial Radio Access (E-UTRA);
Potential solutions for energy saving for E-UTRAN
(3GPP TR 36.927 version 16.0.0 Release 16)

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Contents

Foreword

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Introduction

At present, sustainable development is a long-term commitment for all people in the world. This means not only development but also innovation. People should do their best to handle the resource shortage and environment deterioration. Therefore, how to improve the power efficiency and realize the power saving becomes a significant issue.

In the telecom area, most mobile network operators aim at decreasing the power consumption without too much impact on their network. In this case, the greenhouse emissions are reduced, while the OPEX of operators is saved.

Thus, the power efficiency in the infrastructure and terminal becomes an essential part of the cost-related requirements in network, and there is a strong need to investigate possible network energy saving solutions.

1 Scope

The present document is the technical report for the study item on Network Energy Saving for E-UTRAN, which was approved at TSG RAN#47. The objective of the SI is to first identify the relevant scenarios and then study and present the solutions that are applicable to EUTRAN energy saving. Furthermore, initial evaluation should be performed for each solution.

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] RP-100674: "Network Energy Saving for E-UTRAN ", CMCC.

[3] 3GPP TS 36.214: "Physical layer; Measurements ".

[4] 3GPP TS 36.300: "Evolved Universal Terrestrial Radio Access (E-UTRA) and Evolved Universal Terrestrial Radio Access (E-UTRAN); Overall description; Stage 2".

[5] 3GPP TS 36.331: "E-UTRA; RRC; Protocol specification Release 10".

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:

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].

eNB	enhanced NodeB
EPC	Evolved Packet Core
E-UTRAN	Evolved UTRAN
ES	Energy Savings
ESM	Energy Savings Management
FFS	For Further Specification
IoT	Interference over Thermal
LTE	Long Term Evolution
OAM	Operations, Administration, Maintenance
OPEX	Operating Expenses
RAN	Radio Access Network
SON	Self-Organizing Networks
TRX	Transceiver
UMTS	Universal Mobile Telecommunications System
UTRAN	Universal Terrestrial Radio Access Network

4 General

The objective of this study item is to identify potential solutions for energy saving in E-UTRAN and perform initial evaluation of the proposed solutions, so that a subset of them can be used as the basis for further investigation and standardization.

The following use cases will be considered in this study item as defined in RP-100674 [2]:

- Intra-eNB energy saving
- Inter-eNB energy saving
- Inter-RAT energy saving

Energy saving solutions identified in this study item should be justified by valid scenario(s), and based on cell/network load situation. Impacts on legacy and new terminals when introducing an energy saving solution should be carefully considered. The scope of the study item shall be as follows:

- User accessibility should be guaranteed when a cell transfers to energy saving mode
- Backward compatibility and the ability to provide energy saving for Rel-10 network deployment that serves a number of legacy UEs
- Solutions shall not impact the Uu physical layer
- The solutions should not impact negatively the UE power consumption

Note that energy saving for HeNB is out of the scope of this study item.

5 Inter-RAT energy saving

5.1 Study on inter-RAT scenario 1

5.1.1 Description of scenario 1

Networks may consist of LTE cells deployed as capacity enhancement, overlaying existing and optimized 2G/3G network.

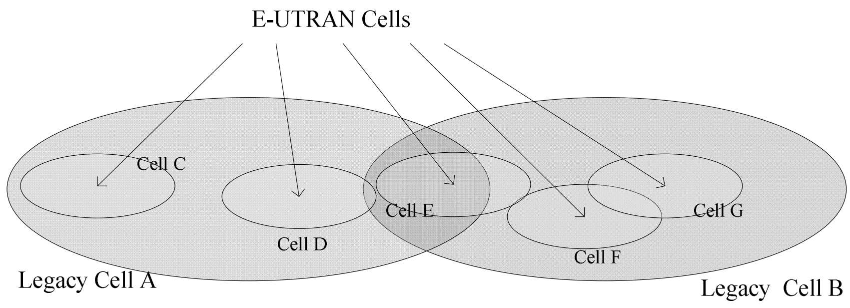

Figure 5.1.1-1. Inter-RAT energy saving scenario 1

Figure 5.1.1.1 shows scenario 1 in which E-UTRAN Cell C, D, E, F and G are totally covered by the same legacy RAT Cell A and B (e.g. UMTS or GSM). Cell A/B has been deployed to provide basic coverage of the services in the area, while other E-UTRAN cells boost the capacity.

The E-UTRAN cells are only deployed for capacity enhancement at some hot spots, therefore, the continuity of LTE coverage could not be guaranteed. The legacy network provides the basic coverage, for UEs with multi-mode capability.

The energy saving solutions for this scenario should only be considered in case the E-UTRAN is jointly deployed with legacy RAT (e.g. UMTS or GSM). It is up to operator's policy whether service for LTE-only capable devices needs to be maintained.

If all cells have the same multiple PLMNs in a network sharing scenario, there are no issues with the solutions to scenario 1. Limitations related to other network sharing scenarios are not included within this Study Item.

5.1.2 Energy saving procedures

To achieve energy savings in this inter-RAT energy savings scenario, two fundamental approaches, which differ in how capacity-booster E-UTRAN cells enter or wake up from dormant mode, can be used. These approaches are:

1. OAM-based approach
2. Signalling-based approach

Furthermore, the energy saving policy may prefer not to switch off the E-UTRAN cells that are in an overlapping area between two or more basic coverage cells (handover region).

5.1.2.1 OAM-based solution for E-UTRAN cell entering or waking up from dormant mode

The approach is based on the complete set or a subset of following principles:

- E-UTRAN cells enters or leaves dormant mode based on centralized OAM decisions, which are made based on statistical information obtained from coverage and/or GERAN/UTRAN/E-UTRAN cells, e.g. load information, traffic QCI, etc The OAM decisions can be pre-configured or directly signalled to the EUTRAN cells.

- If an E-UTRAN cell enters or leaves dormant mode, its intra/inter-RAT neighbour nodes should be informed either via OAM or signalling.

5.1.2.2 Signalling based solution for E-UTRAN cell entering or waking up from dormant mode

The approach is based on the complete set or a subset of following principles:

- E-UTRAN cells may decide to enter dormant mode autonomously or based on information exchanging with the UTRAN/GERAN coverage cell.
- Switch off decisions/requests will be based on information locally available in the EUTRAN node, including load information of both the coverage and E-UTRAN cells.
- Switch-on may be performed based upon requests from one or more neighbour inter-RAT nodes, or based on internal EUTRAN node policies (periodic switch on, max switch off time, etc,).
- Intra-RAT and Inter-RAT neighbour nodes should be informed after on/off decision is made.
- To perform energy saving more efficiently, some energy saving parameters may be exchanged between inter-RAT neighbour cells if required, e.g. traffic thresholds, time duration, power consumption and so on.

5.1.2.3 How to exit dormant mode efficiently?

Solution A: No assistance

When some E-UTRAN cells are in dormant mode and the load increases on the UTRAN/GERAN coverage cells, the UTRAN/GERAN coverage cells may not know the most appropriate E-UTRAN cells to wake-up. The overloaded coverage cells may request wake-up of one or more of the neighbouring dormant E-UTRAN cells. The final decision to leave dormant mode is however taken by the E-UTRAN cell based on information locally available.

Some possible enhancements to optimize switch on decisions are reported below, whereby the actual “switch on” decision algorithm implementation could be based on one or several of these enhancements:

Solution B: OAM predefined ‘low-load periods’ policies

When the coverage UTRAN/GERAN cell detects high load, it uses a proprietary algorithm to decide which E-UTRAN cells should be activated.

The algorithm could rely on pre-defined ‘low-load periods’ policies for each neighbour E-UTRAN cell. The ‘low-load periods’ information can first be derived from OAM based performance counters, and then the decision implemented in the coverage cell.

Solution C: IoT measurements

When the coverage UTRAN/GERAN cell detects high load, it can request some dormant E-UTRAN cells to switch on their listening capability to perform and report Interference over Thermal (IoT) measurements as defined in TS 36.214 [3].

Solution D: UEs measurements

When the coverage UTRAN/GERAN cell detects high load, it can request some dormant E-UTRAN cells to transmit the pilot signal (e.g. reference signal in LTE) for at least a short time interval i.e. the so-called ‘probing’ interval. After this interval, all or some E-UTRAN cells will return to dormant mode. The UEs covered by the coverage cell will be configured to perform Reference Signal (RS) measurements from the E-UTRAN cells during this interval and send feedback (the same approach as defined for mobility purposes in TS 36.331 [5] could be used). Based on the measurement results, the UTRAN/GERAN coverage cell will then determine which E-UTRAN cells should be switched on.

Solution E: Positioning information

When the coverage UTRAN/GERAN cell detects high load, it can use a combination of UEs locations, cell locations, and cell radii/transmit powers in deciding which E-UTRAN cells should be switched on (e.g. cells that cover the UEs).

Furthermore, a timer value can be included in the activation request message sent from the UTRAN/GERAN coverage cell to the selected E-UTRAN cells. At the expiry of this timer, each cell verifies if the condition required for staying on has been met, and if not, it autonomously switches off again.

5.1.3 Evaluations and comparisons

In this section of the TR, the described cell switching procedures for Energy Saving are evaluated and compared. In addition, all enhancements for signalling-based cell switching approach are also evaluated.

Criteria	Cell switch on/off based on centralized OAM decisions	Cell switch on/off based on signalling across RATs; assistance for switch on decisions base on:				
		No assistance	OAM Predefined ‘low load periods’ policies	IoT measurements	UE measurements	Positioning information
Feasibility	Feasible	Feasible	Feasible	Feasible	Feasible.	Feasible
Applicability	Applicable	Applicable	Applicable	Applicable	Applicable	Applicable
Backward compatibility	Yes	Yes	Yes	Yes	Yes	Yes
Complexity (*Note 1)	Medium: - Common O&M or synchronised O&M between RATs is required. - complexity also depends on the requested level of information to be provided from the RAN to O&M.	Medium: – Additional network signalling is needed for activate and deactivate unnecessary cells.	Medium: - OAM sync is not needed. - Statistics information is needed.	High: - IoT measurements of legacy RAT is needed in the hotspot cell in ES mode.	High: - Creation of a new cell state (probing phase) for neighbour relation handling	Medium: - need to collect position information for significant number of UEs.
Potential ES gain	OAM based solution is relatively static	In the worst case some neighbouring sleeping eNBs may be turned on even if these eNBs are not useful.	It has the risk of statistic information is unable to reflect the real conditions.	Possibly limited accuracy of IoT measurement and thresholds may reduce the efficiency of the method. Accuracy could be increased at the cost of complexity	The most useful cells could be selected, at the cost of introduction of an intermediate probing state where the cell is not fully functioning and cannot accept handover. Energy consumption during the probing phase may reduce its gain.	Since UE positions and link budgets are not fully correlated, the method may therefore have a limited efficiency. Additional gain could be obtained at the cost of complexity
Specification impact	No impact on RAN specifications.	Inter-RAT signalling for cell switching on/off	Inter-RAT signalling for cell switching on/off	-Inter-RAT signalling for cell switching on/off	Inter-RAT signalling for cell switching	Inter-RAT signalling for cell switching on/off

				- IoT measurements reporting may be added for accuracy.	on/off and probing trigger	
OAM impact	High	Low	Medium	Low	Low	Medium because location and coverage information is needed.
eNB impact	Not foreseen	Low	Low	High, because additional UL receiver	Medium, new "probing" cell state.	Low
UE impact	Not foreseen.	Not foreseen.	Not foreseen.	Not foreseen.	Negligible, additional measurements will be required during probing phase.	None to low depending on the positioning mechanism

*Note1: OAM Sync means OAM for different RAT should be synchronized.

5.1.4 Conclusions

Both OAM-based approach and Signalling-based approach are feasible, applicable and backward compatible for improving energy efficiency in inter-RAT scenario.

Enhancement solutions on how to exit dormant mode efficiently are feasible, applicable and backward compatible.

6 Inter-eNB energy saving

6.1 Study on inter-eNB scenario 1

6.1.1 Description of scenario 1

When operators deploy the LTE network, one possible application scenario of energy saving is described hereafter.

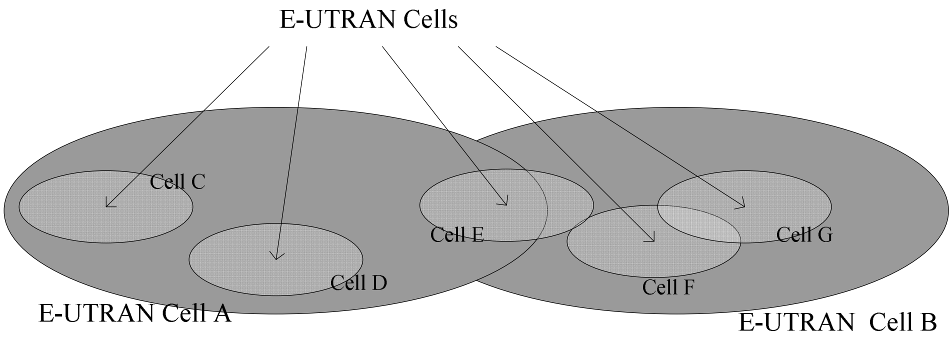

Figure 6.1.1-1. Inter-eNB scenario 1 for energy saving

Figure 6.1.1-1 shows scenario1 in which E-UTRAN Cell C, D, E, F and G are covered by the E-UTRAN Cell A and B. Here, Cell A and B have been deployed to provide basic coverage, while the other E-UTRAN cells boost the capacity. When some cells providing additional capacity are no longer needed, they may be switched off for energy optimization. In this case, both the continuity of LTE coverage and service QoS is guaranteed.

If all cells have the same multiple PLMNs in a network sharing scenario, there are no issues with the solutions to scenario 1. Limitations related to other network sharing scenarios are not included within this Study Item.

In general, inter-eNB energy saving mechanisms should preserve the basic coverage in the network.

6.1.2 Energy Saving Procedures

6.1.2.1 Baseline Rel-9 mechanisms

A signalling-based mechanism to achieve energy savings in the inter-eNB scenario 1 has already been specified in Rel-9 as captured in TS 36.300 [4].

In the following some proposed enhancements to the Rel-9 solution are discussed.

6.1.2.2 How to exit dormant mode efficiently

When some E-UTRAN hotspot cells are not active and the load increases on the E-UTRAN, the E-UTRAN coverage cells may not know the most appropriate E-UTRAN cells to wake-up. The overloaded coverage cells may request wake-up of one or more of the neighbouring dormant E-UTRAN cells. The final decision to leave dormant mode is however taken by the E-UTRAN cell based on information locally available.

Some possible enhancements to optimize switch on decisions are reported below, whereby the actual "switch on" decision algorithm implementation could be based on one or several of these enhancements:

Solution A: OAM predefined 'low-load periods' policy

When the coverage cell detects high load, it uses a proprietary algorithm to decide which hotspot cells should be activated. The algorithm could rely on pre-defined ‘low-load periods’ for each neighbour hotspot cell. The ‘low-load periods’ information can first be derived from OAM based performance counters, and then configured in the coverage cell.

Solution B: IoT measurement

When the coverage cell detects high load, it can request some dormant hotspot cells to switch on their listening capability to perform and report Interference over Thermal (IoT) measurements as defined in TS 36.214 [3].

Solution C: UEs measurement

When the Coverage cell detects high load, it can request some dormant hotspot cells to transmit the pilot signal (e.g. reference signal in LTE) for at least a short time interval i.e. the so-called ‘probing’ interval. After this interval, all or some hotspot cells will return to dormant mode. The UEs covered by the coverage cell will be configured to perform Reference Signal (RS) measurements from the hotspot cells during this interval and send the feedback (the same approach as defined for mobility purposes in TS 36.331 [5] could be reused). Based on the measurement results, the coverage cell will then determine which hotspot cells should be switched on.

Solution D: Positioning information

When the coverage cell detects high load, it can use a combination of UE locations, cell locations, and cell radii/transmit powers in deciding which hotspot cells should be switched on (e.g. cells that cover the UEs). Furthermore, a timer value can be included in the activation request message sent from the coverage cell to the selected hotspot cells. At the expiry of this timer, each cell verifies if the condition required for staying on has been met, and if not, it autonomously turn off cells again.

6.1.3 Evaluations and comparisons

In this part, all enhancements for cell exiting dormant mode will be evaluated here. Information beneficial for energy saving, e.g. traffic thresholds, time duration, power consumption, may be used if available.

Criteria	Baseline Rel-9	Switching on based on predefined low-load periods	Switching on based on IoT measurement	Switching on based on UE measurement	Switching on based on positioning
Feasibility	Feasible	Feasible	Feasible	Feasible	Feasible
Applicability	Applicable	Applicable	Applicable	Applicable	Applicable
Backward compatibility	Yes	Yes	Yes	Yes	Yes
Complexity	Low: – Additional network signalling is needed for activate and deactivate unnecessary cells.	Low: - Specific configuration information is required and will need to be updated.	Medium: - IoT measurements and signalling is needed between hotspot cells in energy saving mode and coverage cell.	Medium: - interference issue during probing phase for intra frequency case- Creation of a new cell state (probing phase) for neighbour relation handling	Medium: - need to collect position information for significant number of UEs.
Potential ES gain	In the worst case some neighbouring sleeping eNBs may be turned on even if these eNBs are not useful.	It has the risk of statistic information is unable to reflect the real conditions.	Possibly limited accuracy of IoT measurement and thresholds may reduce the efficiency of the method. Accuracy could be increased at the cost of complexity	The most useful cells could be selected, at the cost of introduction of an intermediate probing state where the cell is not fully functioning and cannot accept handover.	Since UE positions and link budgets are not fully correlated, the method may therefore have a limited efficiency. Additional gain could be obtained at

				Energy consumption during the probing phase may reduce its gain.	the cost of complexity
Specification impact	Covered by R9 solution.	None	X2 signalling for reporting IoT measurements	X2 signalling for probing trigger messages	S1 signalling for UE positioning retrieval
OAM impact	Covered by R9 solution.	Low	Low	Low	Medium (need for detailed coverage information).
eNB impact	Covered by R9 solution.	Low	Medium, additional UL receiver for inter-frequencies	Medium, new "probing" cell state.	Medium, location client in the eNB
UE impact	Not foreseen.	Not foreseen.	Not foreseen.	Not foreseen for intra-frequency case, Negligible for inter-frequency case	None to low depending on the positioning mechanism

6.1.4 Conclusions

Release 9 inter-eNB energy saving solution is feasible, applicable and backward compatible for improving energy efficiency.

Enhancement solutions on how to exit dormant mode efficiently are feasible, applicable and backward compatible.

6.2 Study on inter-eNB scenario 2

6.2.1 Description of scenario 2

When operators deploy the LTE network, one possible application scenario for energy saving is described hereafter.

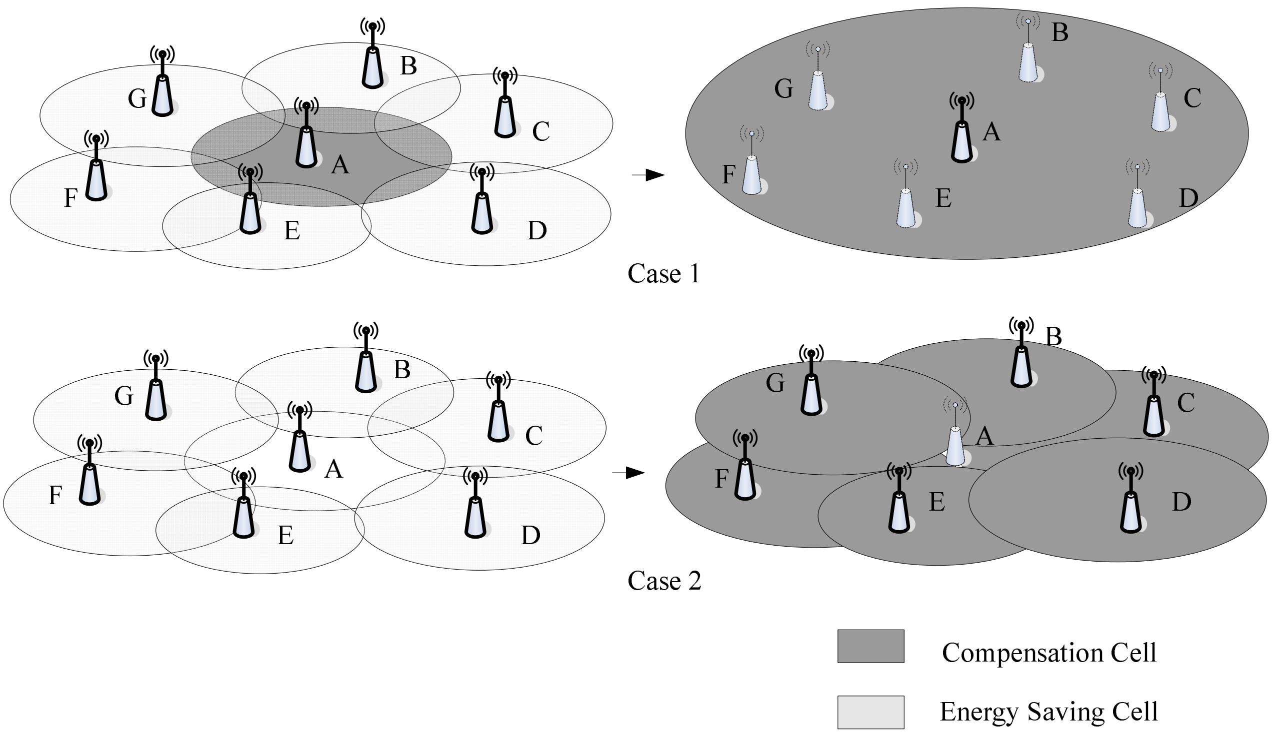

Figure 6.2.1-1. Inter-eNB scenario 2 for energy saving

As shown in Figure 6.2.1-1, this scenario involves two cases. For both cases, single layer coverage of E-UTRAN cells is deployed. At off-peak time, energy saving cells may enter dormant mode, while the basic coverage is provided by one cell (case 1) or by several compensation cells (case 2). In general, the continuity of LTE coverage is guaranteed while the QoS of some services may be impacted.

6.2.2 Energy saving procedures

When load level and distribution fluctuates some cells may be switched off, but in order to guarantee continuous coverage, others must be kept on or even reconfigured to cover up for those that are in dormant mode. To achieve energy savings in this inter-eNB scenario, two fundamental approaches differing in how hotspots E-UTRAN cells enters or leaves dormant mode can be used. These approaches are:

1. OAM-based approach
2. Signalling-based approach
3. Hybrid OAM and signalling-based approach

6.2.2.1 OAM-based solution for E-UTRAN cell entering or waking up from dormant mode

In this existing solution, all cells are preconfigured as potential compensation cells and energy saving cells. The decision to enter or leave dormant mode is made based on the proprietary algorithm in each cell configured by OAM. The neighbour nodes should be informed either by the OAM or by the signalling.

6.2.2.2 Signalling based solution for E-UTRAN cell entering or waking up from dormant mode

In this method, the cells are aware of whether they are compensation cell or energy saving cell based on OAM or proprietary information which is knowledge by itself, e.g. UE measurements, interference status, load information etc. When the energy saving cell decides to enter dormant mode autonomously or based on information exchanged with the compensation cell, it will initialise communication with the corresponding compensation cells, and the coverage related information may be included into the request message. The final decision is made at the compensation cell and the feedback may be needed. Furthermore, similar cell switching on procedure specified in Rel-9 as captured in TS 36.300 [4] could be reused.

6.2.2.3 Hybrid O&M and signalling based solution for E-UTRAN cell entering or waking up from dormant mode

In this solution, the cells are preconfigured as potential compensation cells or energy saving cells by OAM, and also OAM communicates to all cells, the values of some parameters that determine the behaviour of switching on/off mechanisms.

Note: Hybrid approach behavior depends entirely on the combination of OAM-based and Signaling-based solution and the parameters applied, being the behavior of cell switching on/off for OAM controlled and signaling exchange mechanisms shown in the evaluation table. Therefore Hybrid mode will not be compared against OAM or signaling based solution in the evaluation table.

6.2.3 Evaluations and comparisons

Rel-9 solution is not applicable in this scenario.

Criteria	Cell switching on/off based on OAM decisions (existing)	Cell switching on/off based on signalling exchange
Feasibility	Feasible	Feasible
Applicability	Applicable	Applicable
Backward compatibility	Yes	ES-capable cells don't use Rel.9 autonomous switch off to avoid coverage holes Impact on ANR/HO parameter setting
Complexity	High, because the OAM should coordinate the cell switching on/off	High. A certain coordination and synchronization of cell reconfigurations is needed to avoid creating coverage holes, or excessive interference levels during transitions
Potential ES gain	Long term statistics may lead to a conservative approach	More flexible compensation schemes. In addition the mechanism could improve network robustness by permitting compensation in case of cell outage.
Specification impact	None	Signalling between multiple cells is needed, as well as definition of compensation mechanisms providing interoperability. Enhancement on ANR/HO parameter setting
OAM impact	High. OAM has to define compensation cell and its candidate energy saving cells, and how to switch on/off	Low
eNB impact	Low, some functionalities are required for guarantee UE's coverage, e.g. ICIC	High, eNB must be able to adapt coverage (power / tilt / azimuth).

		Compensation coordination function has to be implemented in compensation nodes. More limited impact on ES-capable cells.
UE impact	Not foreseen.	Not foreseen.

6.2.4 Conclusions

Both OAM-based approach and Signalling-based approach, as well as hybrid approaches, are feasible, applicable and backward compatible for improving energy efficiency in inter-eNB scenario 2.

7 Intra-eNB energy saving

7.1 Intra-eNB Scenario

A single cell can operate in energy saving mode when the resource utilization is sufficiently low. In this case, the reduction of energy consumption will be mainly based on traffic monitoring with regard to QoS and coverage assurance. Since a large part of power of eNB is consumed by the power amplifier, energy saving solutions for a single cell mainly aim at reducing power consumption of the power amplifier.

7.2 Potential solutions and Evaluations

7.2.1 Configuring MBSFN subframes within the range supported according to current specification limitation

MBSFN subframes have less common reference signals (CRS) than normal subframes, and hence configuring as much as possible MBSFN subframes allows reduced eNB transmission time. According to current specification, at most 5 and 6 MBSFN subframes can be configured per radio frame for TDD and FDD, respectively.

1) Potential gain

To utilize the currently possible MBFSN subframes is an efficient way for energy efficient network operation in LTE and has potential to give energy savings in the order of 30-50% in typical traffic scenarios compared to operation without MBSFN subframes.

2) Potential risk

There is no impact on coverage and backward compatibility identified.

3) Possible impact on the specification

This solution already can be supported without any further impact on the specification.

7.2.2 Configuring DwPTS in subframe 1 and 6 to the minimum length

For TDD, the special subframe consists of three parts, i.e. DwPTS, Guard Period and UpPTS. The length of each part is configurable. Subframe 1 and 6 are configured as the special subframes for downlink-to-uplink switch-point periodicity of 5ms, and subframe 1 is configured as the special subframe for downlink-to-uplink switch-point periodicity of 10ms. To configure the DwPTS of subframe 1 and 6 (if applicable) to the minimum length (3 OFDM symbols) can result in a subframe similar to an MBSFN subframe.

1) Potential gain

From eNB transmission time point of view, the difference between MBSFN subframe and the special subframe with minimum length of DwPTS only lies in that for the latter, one more OFDM symbol (the 3rd one) is used to transmit primary synchronization signal. Hence, the energy saving gains achieved by this solution is very similar to configuring subframe 1/6 as MBSFN subframes.

2) Potential risk

From coverage and backward compatibility aspects, there is no risk identified.

3) Possible impact on the specification

This solution belongs to an implementation issue and no impact on the specification is foreseen.

Annex A (informative): Evaluation Criteria

Criteria	Description
Feasibility	Candidate solutions should be easily implemented with existing technology and/or realistic changes to the standards. If the solution breaks this criterion, it is out of the scope of the energy saving discussion.
Applicability	Verification against the scope of the SI as added in the TR (see section 4). If the solution breaks this criterion, it is out of the scope of the energy saving discussion.
Backward compatibility	In Release-9, RAN3 has already specified an inter-eNB energy saving for E-UTRAN based on the cross-eNB signalling exchange. New solutions should be backward compatible with Release-9 energy saving solution in TS 36.300 [4]. If the solution breaks this criterion, it is out of the scope of the energy saving discussion.
Complexity	Candidate solutions should not be too complex when implemented in practice. This criterion evaluates on how many messages exchanging or calculation is needed for the solutions. The frequency of appliance could be considered here.
Potential ES gain	The potential gain of candidate solutions for saving the energy should be evaluated. Qualitative indication of ES gain may be added relative to the following possible reference points : a) Current options for Inter-RAT/eNB ES solutions b) Other proposed ES solutions in the TR (Inter-RAT or Inter-eNB)
Specification impact	The specification impact should be evaluated. The description of the impact could be added.
OAM impact	The OAM impact should be evaluated. The description of the impact could be added. The operation effort could be considered.
eNB impact	The impact on eNB implementation should be evaluated. The description of the impact could be added.
UE impact	The UE impact and requirement of optional UE feature should be evaluated. The description of the impact could be added.

Annex B (informative): Change History

Change history						
Date	**TSG #**	**TSG Doc.**	**CR**	**Rev**	**Subject/Comment**	**New**
2010-09-03	RAN3	R3-102526			R3-102526 includes the inter-RAT energy saving scenario and potential solutions; includes one rule for inter-eNB solutions; updates the TR skeleton with adding the intra-eNB part.	
2010-10-25	RAN3	R3-103106			R3-103106 includes Introduction, Reference and Definitions, symbols and abbreviations part; includes the sentence “The solutions for this scenario should only be considered in case there are no LTE-only capable devices”; includes further description for solution 3; includes further enhancement for issues addressed.	
2010-11-22	RAN3	R3-103779			R3-103779 includes network sharing consideration; includes some solutions for correct cell to be switched on; includes some solutions for deactivation request and coordination; furthermore, the intra-eNB energy saving solutions proposed by RAN2 are included.	
2011-01-23	RAN3	R3-110389			R3-110389 includes the inter-eNB solutions for inter-eNB scenario 2; includes the evaluation table for all solutions for different scenarios respectively.	
2011-02-25	RAN3	R3-111057 R3-111069			R3-111069 includes restructured TR and some updated description on scenarios and solutions. R3-111057 includes the initial evaluation table in the TR.	
2011-05-13	RAN3	R3-111753			R3-111753 modifications: (1) Applied all chances in R3-111342 (2) Resolved FFS on inter-PLMN issue in section 5.1.1 and 6.1.1. (3) Removed *note 2 in Inter-RAT evaluation table, removed *note 1 in inter-eNB evaluation tables (both cases). (4) Applied conclusion 1~6 to the places they should be. “applicable” and “Backward compatible” are added. (5) Removed “high”, “medium” or “low” in the ES gain row in all 3 tables, with some rewording and update. (6) Added “Hybrid” approach to inter-eNB case 2.	
2011-06	52	RP-110720			Approved at RAN#52	10.0.0
2011-09	53	RP-111194	0001		Removal of UE capability restriction for inter-RAT energy saving following SA1's decision	10.1.0
2012-09					Update to Rel-11 version (MCC)	11.0.0
2014-09					Update to Rel-12 version (MCC)	12.0.0
2015-12					Update to Rel-13 version (MCC)	13.0.0

Change history							
Date	**Meeting**	**TDoc**	**CR**	**Rev**	**Cat**	**Subject/Comment**	**New version**
2017-03	SA#75					Promotion to Release 14 without technical change	14.0.0
2018-07	SA#80	-	-	-	-	Promotion to Release 15 without technical change	15.0.0
2020-07	SA#88-e	-	-	-	-	Update to Rel-16 version (MCC)	16.0.0

History

Document history		
V16.0.0	July 2020	Publication