



LTE1336 Interference-aware UL Power Control

LTE1336 – Interference-aware Uplink Power Control

- Table of Contents

 Main Menu

 Key Functionality

 Configuration and Deployment Aspects

 Simulation and Test Results

 Operational Hints and Guidelines


 Hints for Troubleshooting

LTE1336 – Interference-aware Uplink Power Control

- Table of Contents

 Main Menu

 Key Functionality

 Configuration and Deployment Aspects

 Simulation and Test Results

 Operational Hints and Guidelines

 Hints for Troubleshooting

Key Functionality

- Interference characteristics in LTE UL

Interference in LTE UL plays critical role determining the throughput

- UL interference is coming from neighboring cell UEs
 - It cannot be predicted since we do not know how the UEs will be distributed
 - Contributions to interference are most prominent from cell-border UEs
- As a result the **role of PC is to provide the required SINR while controlling at the same time the interference** caused to neighboring cells
- Looking at the UL SINR formula...

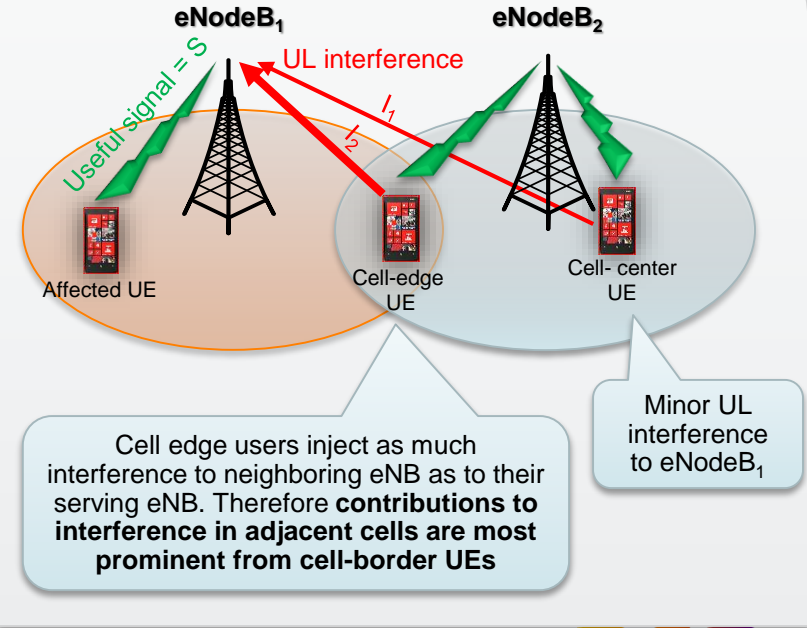
$$SINR = \frac{S}{I+N} = \frac{S}{\sum(I_1, I_2, \dots, I_n)}$$

Useful signal is already close to maximum

Noise N is negligible in interference limited scenarios: $I \gg N$

... it is clearly visible that **it's better to minimize the interference** than improve the useful signal if we want to get better SINR

UL Power control illustration



Key Functionality

- Interference-aware UL Power Control motivation

LTE1336 optimizes tradeoff between the throughput achieved in the own cell and the uplink interference injected to neighbor cells

- UL power control is **trade-off** between **inter-cell interference** and **own cell throughput**
 - Increase of UL power brings additional useful signal for own cell UEs, but adds additional interference for neighboring cells
 - Reduction of UL power decrease useful signal but also lowers the interference
- NSN research invented the algorithm which** achieves higher throughput in a whole range of cells, at reduced UL power settings (especially for cell-edge UEs)
- Interference-aware ULPC (IAwPC)** or so called **Interference Penalty Algorithm (IPA)** feature exploits that concept by implementation of new UL closed-loop power control

LTE1336

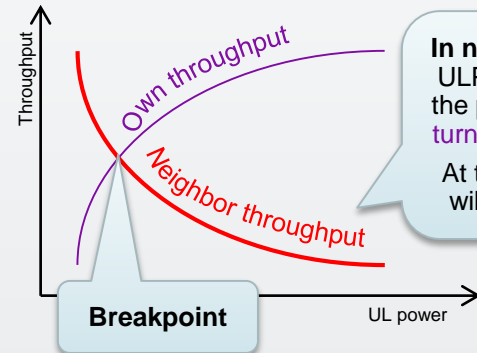
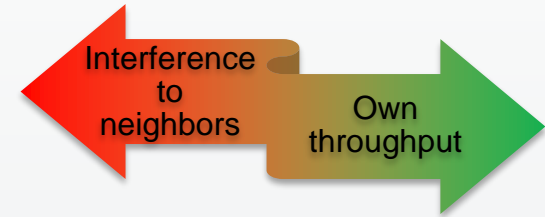


Maximized UE throughput with proportional fair scheduler



Improved average and cell-edge throughput

UL power-control dilemma



In neighboring cell ULPC will increase the power which will **turn back the effect**.
At the end all cells will be "shouting"

Key Functionality

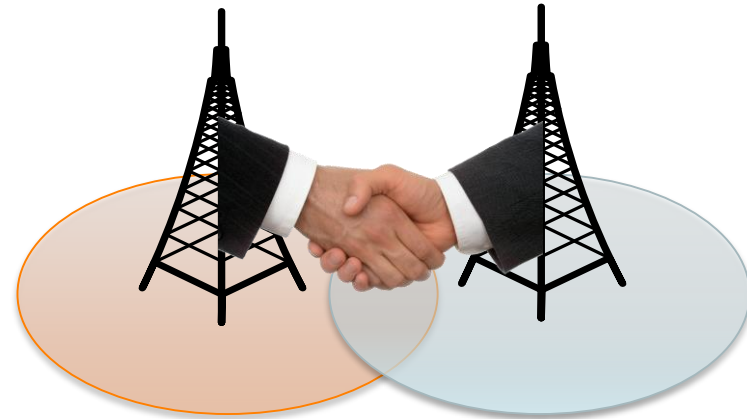
- Feature delimitations
- The mechanism is kind of a **deal** between neighboring eNBs:
 - This means: the feature only works (has benefit) with a multitude of eNBs with feature being activated
 - Conversely: LTE1336 can give no gain over OL-PC if cells are not coupled (without coverage overlap)
- More details in the deployment aspects section

"Dear neighbors, if I reduce your interference (at a loss of my own throughput), and if you then do the same (i.e. not use all of your improved link budget for higher throughput), there will be benefit for all of us.,,

Throughput improvement is higher than reduction due to power decrease

Cell border UEs
power decreased
• Throughput reduced

Interference
Limited
• Throughput improved



Key Functionality

- SINR definitions in IAwPC

Interference-aware UL-PC deals with various SINR values which might easily be confused

UL SINR

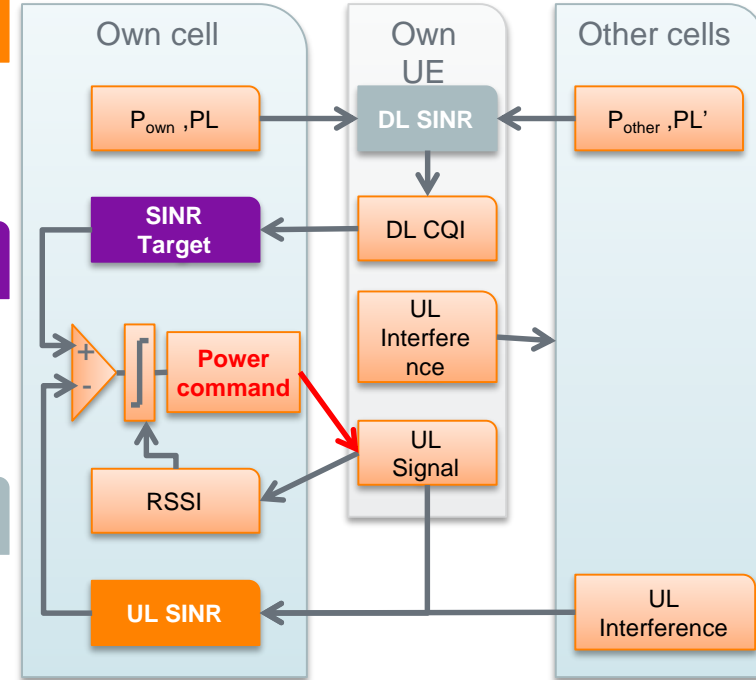
- UE-specific SINR of the UL transmission, **received at the eNB**
- UL SINR is one of the inputs into the control loop, and is compared to a variable threshold, SINR_Target

SINR Target

- UE-specific **target value for the UL SINR** calculated by LTE1336
- IAwPC calculates the transmit power-up/down commands to its UEs such that **UL SINR is kept as close as possible to SINR_Target**
- Depends (among other data) on a ratio PL'/PL of pathlosses at the UE's location, which the eNB derives from DL SINR (CQI)

DL SINR

- DL SINR **received at the UE's location**
- It is a measure of the **ratio of the pathloss from the UE towards the eNB** representing the **most prominent DL interference source**, and the pathloss towards the own eNB
- Reflected in the UE's CQI reports which are used in **SINR_Target** calculation



Key Functionality

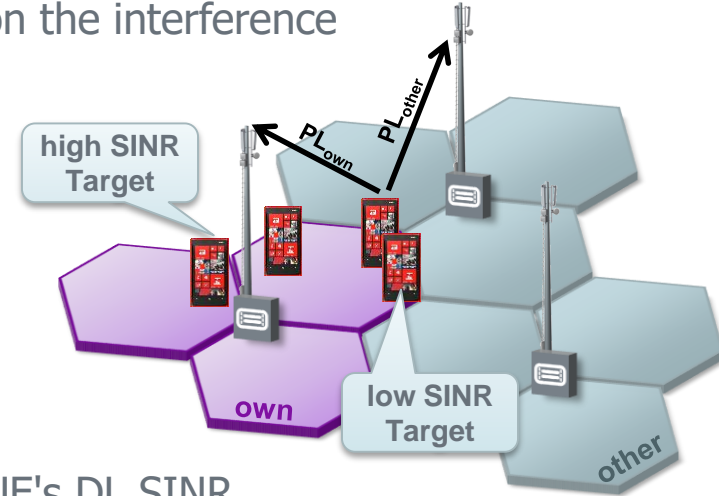
- SINR target idea
- **SINR Target is compared against measured UL SINR**
 - difference values are time-filtered and then taken to determine the power commands
- Target SINR is chosen such that an upper limit is placed on the interference that the UE injects into its next neighboring eNB
 - This is done on the basis of UE's pathloss ratio, eg. :

$$\frac{PL_{other}}{PL_{own}} \gg 1$$

UE is far away from other eNB/close own eNB cell center, so give it **high SINR_Target**

$$\frac{PL_{other}}{PL_{own}} \sim 1$$

UE is near the cell border interfering the neighbor significantly, so give it **low SINR_Target**



- Pathloss ratio is not directly available but is contained in UE's DL SINR
- A measure of DL SINR is contained in **DL CQI**. DL CQI is reported to eNB
 - eNB takes as input the UE's DL CQI and computes a UE-specific **target SINR**.

Key Functionality

- LTE1336 calculation of the SINR target

The $\text{SINR}_{\text{Target}}$ formula takes following input:

$$\text{sinr}_{\text{Target}} = \min \left\{ \text{sinr}_{\text{max}}, \frac{p_{0, \text{IAw}}}{i + n_T} * \max \left[(\text{sinr}_{\text{DL}})^{\text{ceBalance}}, Q_{\min} \right] \right\}$$

Diagram showing parameter mappings for the SINR target formula:

- $\text{LNCEL:ulpcRefPwrIAw}$ points to $p_{0, \text{IAw}}$
- $\text{LNCEL:ulpcCEBalanceIAw}$ points to ceBalance
- $\text{LNCEL:ulpcMinQualIAw}$ points to Q_{\min}

- **ceBalance**: cell-center to cell-edge balancing, similar to **ulpcAlpha**
 - Parameter **LNCEL:ulpcCEBalanceIAw**
- **p_{0,IAw}**: reference power value for interference-aware UL-PC, per used PRB, linear
 - Calculated from **LNCEL:ulpcRefPwrIAw** parameter as $p_{0, \text{IAw}} = 10^{(\text{ulpcRefPwrIAw}/10)}$
 - Should not be mistaken for **p0NomPuschIAw**, which is related to OLPC part, not to SINR target calculation !
- **Q_{min}**: Minimum quality
 - parameter **LNCEL:ulpcMinQualIAw**
- **sinr_{max}**: UL SINR which corresponds to the maximum MCS allowed in the cell, per used PRB
 - Based on Link Level simulations (SINR → MCS mapping table, slide 22) and max MCS configuration
- **sinr_{DL}**: DL SINR in linear terms, per used PRB, experienced by the UE under the condition that neighbor cells are fully loaded in DL direction.
 - Derived from DL CQI reports
- **i+n_T**: interference and thermal noise power per PRB
 - Filtered I + N from UL PHY measurements

Key Functionality

- SINR Target boundaries

SINR target is calculated per UE basis and it has predefined boundaries

- Cell-edge UEs are allowed a **minimum SINR** even if they create excessive interference (more that would be allowed by pathloss ratio)
 - Defined by $Q_{min} = \text{LNCEL:ulpcMinQualIAw}$, determines the lower limit for SINR_Target in linear scale
- **Maximum SINR** (sinr_{max}) is the upper limit for SINR_Target and indicates the SINR required to achieve the highest allowed MCS in UL
 - Its value depends on the eNB configuration (see next slide)
- These settings should not be mixed with CLPC SINR window, since they set bounds for entire SINR range rather than small SINR window



Key Functionality

- Maximum SINR (sinr_{max}) calculation
- **SINR_target** calculation considers additional margin so that UEs can successfully transmit with this **highest allowed MCS** (maxAllowedMcs)
 - The highest allowed MCS in Uplink, can be found from the parameter $\text{LNCEL:actModulationSchemeUL}$, which restricts it to either **MCS10**, **MCS20**, or **MCS24**
 - With *LTE44 64 QAM in UL*, maxAllowedMcs is **MCS28** for TDD
- eNB keeps a static table (from real channel estimates) of MCS vs. required SINR mapping, called 'ideal SINR', for MCS > 5
 - SINRMaxMcs is the SINR that corresponds to maxAllowedMcs in this table
 - The table of is based on a least-square linear fit performed on the simulation result for an ETU70 cell, at 25 PRB allocation size, 2 antennas, $\text{SINR} = 0.915 * \text{MCS} - 5.909$
- **Deviations between the “ideal SINR” table and field performance** (due to e.g. different configuration, #of antennas or channel characteristics) are covered during **SINRdelta** calculation
- SINRMaxMcs is calculated for each PUSCH transmission that uses an MCS in the **available range** ($5 < \text{MCS} \leq \text{maxAllowedMcs} - 1$)
- Please note that due to some problems in the field Max MCS calculation could be changed

MCS	SINR
6	-0.42
7	0.50
8	1.41
9	2.33
10	3.24
11	4.16
12	5.07
13	5.99
14	6.90
15	7.82
16	8.73
17	9.65
18	10.56
maxAllowedMcs SINRMaxMcs	
20	12.40
21	13.31
22	14.23
23	15.14
24	16.06
25	16.97
26	17.89
27	18.80
28	19.72

Key Functionality

★ Animated slide

- Maximum SINR (sinr_{max}) calculation
- Deviations between the “ideal SINR” table and field performance (due to e.g. different configuration, #of antennas or channel characteristics) are covered by **SINRdelta**
- The exemplary **SINRmax** calculation with current UE MCS = MCS15, and **maxAllowedMcs** = MCS24, would look as follows:

Get current SINR

- look up the 'ideal' SINR in the table, using the UE's MCS as index. **MCS15 → SINR 7.82**

Calculate a SINRDelta

- SINRDelta** = UE's SINR (from the PHY M4 measurement) – 'ideal' SINR from the table

Feed SINRDelta into averaging exponential filter

- SINRDeltaAvg** (t) = $\text{SINRDelta}(t) \times 1/\text{TavgSdelta} + (1-1/\text{TavgSdelta}) \times \text{SINRDeltaAvg}(t-1)$

Calculate SINRmax

- SINRmax** = **SINRMaxMcs** + **SINRDeltaAvg** + **rdTopMargin** → e.g.

Note
TavgSdelta and *rdTopMargin* are R&D parameters

Lookup range

Measured SINR

MCS	SINR
6	-0.42
7	0.50
8	1.41
9	2.33
10	3.24
11	4.16
12	5.07
13	5.99
14	6.90
15	7.82
16	8.73
17	9.65
18	10.56
19	11.48
20	12.40
21	13.31
22	14.23
23	15.14
24	16.06
25	16.97
26	17.89
27	18.80
28	19.72

SINRDelta
→ SINRDeltaAvg

SINRmax =
SINRMaxMcs +
SINRDeltaAvg

maxAllowedMcs SINRMaxMcs

LTE1336 – Interference-aware Uplink Power Control

 Main Menu

- Table of Contents

 Key Functionality

 Configuration and Deployment Aspects

 Simulation and Test Results

 Operational Hints and Guidelines

 Hints for Troubleshooting

Configuration and Deployment Aspects

- LTE1336

- Affected parameter

<u>ulpcAlpha</u>		Alpha
Object:	LNCEL	Used as a fractional path loss compensation factor. It controls received SNR variance (fairness) for user data and sounding reference symbol. In principle this parameter controls power trade-off between cell edge and cell center UEs
Range:	alpha 0 (0), alpha 0.4 (1), alpha 0.5 (2), alpha 0.6 (3), alpha 0.7 (4), alpha 0.8 (5), alpha 0.9 (6), alpha 1 (7)	
Step:		<u>Rule:</u> With LTE1336 activated, the <i>ulpcAlpha</i> needs to be set to value 1
Unit:		
Default:	alpha 1 (7)	
Multiplicity:	1	
Modification:	On-line	
Category:	basic	
Hidden:	No	

Configuration and Deployment Aspects

- LTE1336

- Affected parameter

<u>dlamcEnable</u>	Enable DL AMC
<p>Object: LNCEL</p> <p>Range: false; true</p> <p>Step:</p> <p>Unit:</p> <p>Default: true</p> <p>Multiplicity: 1</p> <p>Modification: On-line</p> <p>Category: advanced</p> <p>Hidden: No</p>	<p>This parameter switches on/off dynamic radio channel adaptation by MCS.</p> <p><u>Rule:</u> With LTE1336 DL link adaptation needs to be activated (parameter set to <u>value true</u>)</p>

Configuration and Deployment Aspects

- LTE1336

- Affected parameter

<u>dlOlqcEnable</u>	Enable OLQC
<p>Object: LNCEL</p> <p>Range: true, false</p> <p>Step:</p> <p>Unit:</p> <p>Default: true</p> <p>Multiplicity: 1</p> <p>Modification: On-line</p> <p>Category: advanced</p> <p>Hidden: No</p>	<p>This parameter controls the activation of the Open Loop Quality Control for the DL link adaptation</p> <p>The purpose of OLQC is to adapt/correct CQI values, delivered by UE and later on used by DL link adaptation (DL LA) and DL scheduler (DL SCH),</p> <p>The target of this adaptation is certain target block error ratio (BLER) of the first HARQ transmission</p> <p><u>Rule:</u></p> <p>With LTE1336 OLQC needs to be activated (parameter set to <u>value true</u>)</p>

Configuration and Deployment Aspects

- LTE1336

- Affected parameter

<u>deltaTfEnabled</u>		Enabled TB size impact to UE PUSCH power calculation
Object:	LNCEL	This parameter switches on/off ULPC formula addon from UL AMC. Parameter activates Transport Block size impact switch for UE PUSCH power calculation. <u>Rule:</u> With LTE1336 deltaTF needs to be deactivated(parameter set to <u>value false</u>)
Range:	true, false	
Step:		
Unit:		
Default:	false	
Multiplicity:	1	
Modification:	On-line	
Category:	advanced	
Hidden:	No	

- New parameter structure

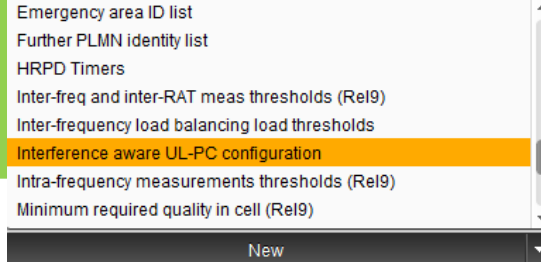
ulpclawConfig

Object: LNCEL
Range: structure
Step:
Unit:
Default:
Multiplicity: 1
Modification: On-line
Category: Basic
Hidden: No

Interference-aware UL-PC configuration

Configures interference-aware uplink power control

This is basic structure under LNCEL, which contains all majority of LTE1336-related parameters



- New parameter

<u>p0NomPuschIAw</u> (ulpclawConfig)	Nominal PUSCH P0 for interference-aware UL-PC
<p>Object: LNCEL</p> <p>Range: -110, -109, ... -70,</p> <p>Step: 1</p> <p>Unit: dBm</p> <p>Default: -100</p> <p>Multiplicity: 1</p> <p>Modification: On-line</p> <p>Category: basic</p> <p>Hidden: No</p>	<p>P0 setting that is broadcast in SIB2 if interference-aware UL-PC is activated</p> <p>Rule: To limit the confusion the LTE1336 introduces its own P0 parameter for PUSCH. However the rules for it's setting remain the same as for LNCEL:p0NomPusch. Due to fact that LNCEL:ulpcAlpha is set to value 1, the P0 should have the value around the -100.</p>

- New parameter

<u>ulpcCEBalanceAw</u> (ulpclawConfig)	Cell-center/edge balancing for interference-aware UL-PC
<p>Object: LNCEL</p> <p>Range: 0.5, 0.6, ..., 1.4,</p> <p>Step: 0.1</p> <p>Unit:</p> <p>Default: 1</p> <p>Multiplicity: 1</p> <p>Modification: On-line</p> <p>Category: advanced</p> <p>Hidden: No</p>	<p>Controls Target SINR in interference-aware UL-PC: provides a tilt in the balancing between Target SINR in cell-center and Target SINR at cell-edge.</p> <p>Target SINR determines the max. throughput, therefore higher values increase cell-center throughput at the cost of cell-edge throughput, and vice versa.</p> <p><u>Rule:</u></p> <ul style="list-style-type: none"> •The value 1 provides equal balance between cell-edge and cell-center •The value higher than 1, promote the cell-center UEs cannibalizing the cell-edge throughput

- New parameter

<u>ulpcMinWaitForPc</u> (ulpclawConfig)	Minimum waiting time for next UL-PC decision
Object: LNCEL Range: 6, 7, 8, ... 80 Step: 1 Unit: ms Default: 25 Multiplicity: 1 Modification: On-line Category: advanced Hidden: No	<p>Minimum number of TTIs (ms) that must pass before another UL power decision is made for a UE.</p> <p>Together with the number of PUSCH reception (UL SINR samples), the parameter defines the TPC command periodicity</p> <p>Note: All the simulations have been taken with value 50 (similar to LNCEL:ulpcReadPeriod)</p> <p>Rule:</p> <ul style="list-style-type: none"> •Power control should work with slower pace than Link Adaptation •Lower value → higher control of the LTE1336 over the UE transmission power •High value → low TPC command periodicity, and smaller impact of the LTE1336 algorithm over the UE Tx power

- New parameter

ulpcMinQuallAw (ulpclawConfig)	Minimum UL quality for interference-aware UL-PC
<p>Object: LNCEL</p> <p>Range: 0, 0.2, ... 5,</p> <p>Step: 0.2</p> <p>Unit:</p> <p>Default: 1</p> <p>Multiplicity: 1</p> <p>Modification: On-line</p> <p>Category: advanced</p> <p>Hidden: No</p>	<p>Minimum quality measure for interference-aware UL-PC. Target SINR for UEs in poor conditions cannot go below a limit defined by this parameter even if they generate higher UL interference.</p> <p><u>Rule:</u></p> <ul style="list-style-type: none"> •Capacity decreases with higher values for parameter •The smaller <i>ulpcMinQuallAw</i>, the larger the peak performance •Too high values of the parameter shall be avoided ! •During the simulation campaigns the optimum value has been found to be 2 (3 dB)

- New parameter

ulpcRefPwrIAw (ulpclawConfig)	Reference UL power value for interference-aware UL-PC
<p>Object: LNCEL</p> <p>Range: -110..-70,</p> <p>Step: 0.5</p> <p>Unit: dBm</p> <p>Default: -90</p> <p>Multiplicity: 1</p> <p>Modification: On-line</p> <p>Category: basic</p> <p>Hidden: No</p>	<p>Controls Target SINR in interference-aware UL-PC: provides an equal shift of Target SINR for all UEs in the cell, regardless of their pathloss ratios.</p> <p>Rule:</p> <ul style="list-style-type: none">•Capacity increases with higher value of Reference Power•The coverage drops significantly when choosing a high value ($\geq -100\text{dBm}$)•The Reference power has a strong influence on the lower ($<10\%$) end throughput figures<ul style="list-style-type: none">•The higher ulpcRefPwrIAw, the smaller the cell edge TP. <p>Similar to P0 setting for OLPC</p>

- New parameter

ulpcRssiMaxIAw	Maximum RSSI for interference-aware UL-PC
<p>Object: LNBTS</p> <p>Range: -90, -85, ... -60</p> <p>Step: 5</p> <p>Unit: dBm</p> <p>Default: -70</p> <p>Multiplicity: 1</p> <p>Modification: On-line</p> <p>Category: advanced</p> <p>Hidden: No</p>	<p>Sets an upper limit for RSSI received from a UE. If exceeded, the next power command indicates -1 dB UL power change even if the current UL power is insufficient for reaching Target SINR.</p> <p>The parameter is introduced as protection for receiver inputs (with a view on particular operators using LTE repeaters)</p> <p>Rule:</p> <p>Too low value of this parameter can lead to decreased UL power (consecutive -1 dB TPC commands). The parameter shall be optimized for the repeater sensitivity level.</p>

- New parameter

actUlpMethod	Method for UL power control
<p>Object: LNCEL</p> <p>Range: PuschOLPucchOL, PuschOLPucchCL, PuschCLPucchOL, PuschCLPucchCL, PuschCLSrsPucchOL, PuschCLSrsPucchCL, PuschIAwPucchOL, PuschIAwPucchCL</p> <p>Step:</p> <p>Unit:</p> <p>Default: PuschOLPucchOL</p> <p>Multiplicity: 1</p> <p>Modification: On-line</p> <p>Category: basic</p> <p>Hidden: No</p>	<p>Selects a working mode for UL power control. Offers various combinations between open-loop and closed-loop control for PUCCH and PUSCH/SRS power.</p> <p>This parameter replaces previously used UL PC activation parameters (see next slide)</p> <p>Rule:</p> <ul style="list-style-type: none"> • If the PUCCH CLPC algorithm is to be used (ulpcPucchEn was set to true), then the PuschIAwPucchCL value should be used to activate the LTE1336 • Otherwise the PuschIAwPucchOL will set the OL mode in the PUCCH along with the New IAwPC in the PUSCH Closed Loop <p>Note:</p> <ul style="list-style-type: none"> • Interference-aware UL PC provides the highest gains in the conditions in the presence of UL interference. Therefore joint activation with Interference-aware Scheduler (ulsSchedMethod) will result in lower gains for LTE1336.

LTE1336 – Interference-aware Uplink Power Control

- Table of Contents

 Main Menu

 Key Functionality

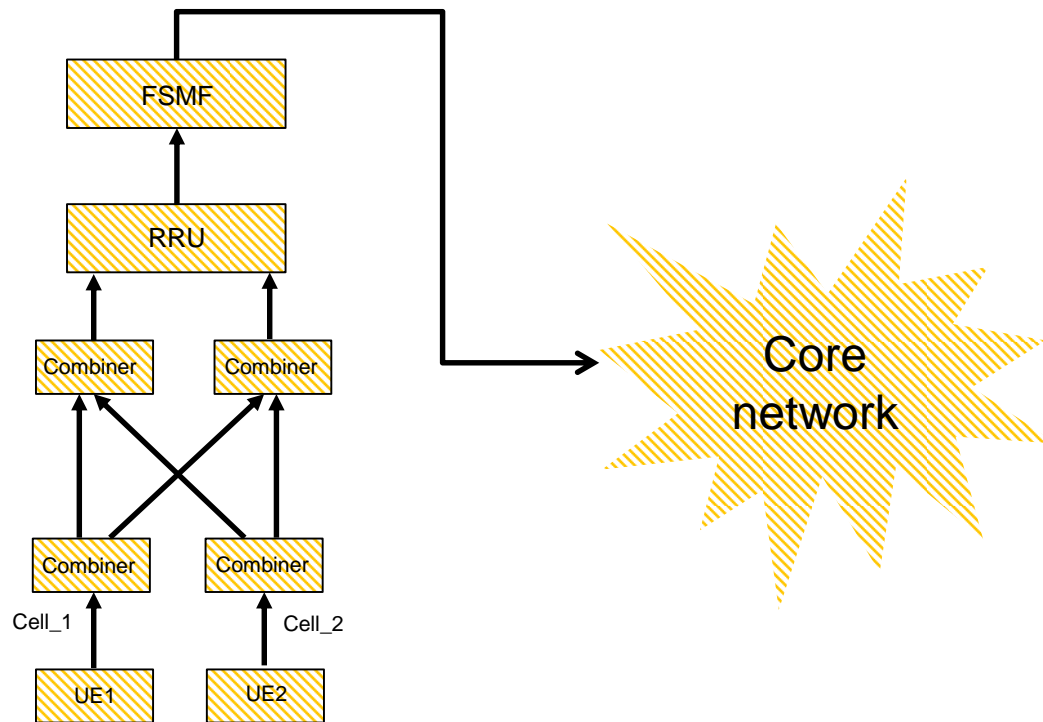
 Configuration and Deployment Aspects

 Simulation and Test Results

 Operational Hints and Guidelines

 Hints for Troubleshooting

Topology of operational lab test



Operational Hints and Guidelines

LTE1336

Interference-aware UL-PC provides an own P_0 parameter

- The P_0 value for a cell is broadcast on SIB2 (subtable 5) and together with *LNCEL:ulpcAlpha* it forms the base values for UE's open loop UL power control
 - If LTE1336 is activated (at cell startup or during runtime), SIB2 is sent with the *LNCEL:p0NomPuschIAw* value as P_0
 - When LTE1336 is deactivated, SIB2 shall be updated with the P_0 setting from OLPC: *LNCEL:p0NomPusch*

RadioResourceConfigCommon

```
RadioResourceConfigCommon ::= SEQUENCE {
    pdsch-ConfigCommon          PDSCH-ConfigCommon,
    pusch-ConfigCommon          PUSCH-ConfigCommon,
    phich-Config                PHICH-Config,
    pucch-ConfigCommon          PUCCH-ConfigCommon,
    soundingRS-UL-ConfigCommon  SoundingRS-UL-ConfigCommon,
    uplinkPowerControlCommon    UplinkPowerControlCommon,
    antennaInfoCommon           AntennaInfoCommon,
    p-Max                       P-Max,
    tdd-Config                  TDD-Config,
    ul-CyclicPrefixLength       UL-CyclicPrefixLength,
    ...
}
-- ASN1toTextFormat2
-- AdditionalSpectrumEmission
-- AdditionalSpectrumEmission
```

```
UplinkPowerControlCommon ::= SEQUENCE {
    p0-NominalPUSCH            INTEGER (-126..24),
    alpha                     ENUMERATED {a10, a104, a105, a106, a107, a108, a109,
    all},
    p0-NominalPUCCH            INTEGER (-127..-96),
    deltaFList-PUCCH           DeltaFList-PUCCH,
    deltaPreambleMsg3          INTEGER (-1..6)
}
```

- Activation/deactivation of LTE1336 and also modifications to the *p0NomPuschIAw* and *ulpcAlpha* parameters lead to SIB modifications
 - After 31 SIB occurrences within 3 hours, the SIB valueTag rolls over the 0
 - If a UE leaves the cell but stores the SIB value tag, comes back later and finds it unchanged and therefore has no trigger to re-read SIB.

Note

It takes some time until all UEs have taken notice of a change in SIB. The worst case is defined by maximum DRX off-time and the number of SIB repetitions required for the UE to correctly decode the SIB information. Therefore, changes to SIB values do not take immediate effect.

No interference

Ciperf Messages									
File									
[1932]	63.0-64.0	sec	1840	KBytes	15072	Kbits/sec	0.400	ms	606/ 2490 (24%)
[1932]	64.0-65.0	sec	1797	KBytes	14720	Kbits/sec	1.367	ms	624/ 2464 (25%)
[1932]	65.0-66.0	sec	1770	KBytes	14496	Kbits/sec	0.458	ms	630/ 2442 (26%)
[1932]	66.0-67.0	sec	1746	KBytes	14304	Kbits/sec	0.978	ms	659/ 2447 (27%)
[1932]	67.0-68.0	sec	1755	KBytes	14376	Kbits/sec	0.537	ms	718/ 2515 (29%)
[1932]	68.0-69.0	sec	1796	KBytes	14712	Kbits/sec	1.170	ms	645/ 2484 (26%)
[1932]	69.0-70.0	sec	1776	KBytes	14552	Kbits/sec	0.102	ms	622/ 2441 (25%)
[1932]	70.0-71.0	sec	1778	KBytes	14568	Kbits/sec	0.886	ms	632/ 2453 (26%)
[1932]	71.0-72.0	sec	1805	KBytes	14784	Kbits/sec	0.529	ms	657/ 2505 (26%)
[1932]	72.0-73.0	sec	1784	KBytes	14616	Kbits/sec	0.297	ms	609/ 2436 (25%)
[1932]	73.0-74.0	sec	1817	KBytes	14880	Kbits/sec	0.292	ms	684/ 2545 (27%)
[1932]	74.0-75.0	sec	1751	KBytes	14344	Kbits/sec	0.663	ms	606/ 2399 (25%)
[1932]	75.0-76.0	sec	1800	KBytes	14744	Kbits/sec	0.356	ms	671/ 2514 (27%)
[1932]	76.0-77.0	sec	1813	KBytes	14848	Kbits/sec	0.952	ms	548/ 2404 (23%)
[1932]	77.0-78.0	sec	1795	KBytes	14704	Kbits/sec	0.281	ms	648/ 2486 (26%)
[1932]	78.0-79.0	sec	1805	KBytes	14784	Kbits/sec	0.559	ms	676/ 2524 (27%)
[1932]	79.0-80.0	sec	1813	KBytes	14856	Kbits/sec	0.746	ms	678/ 2535 (27%)

Ciperf Messages									
File									
[1932]	68.0-69.0	sec	1711	KBytes	14016	Kbits/sec	0.548	ms	643/ 2395 (27%)
[1932]	69.0-70.0	sec	1700	KBytes	13920	Kbits/sec	0.680	ms	627/ 2368 (26%)
[1932]	70.0-71.0	sec	1723	KBytes	14112	Kbits/sec	0.820	ms	732/ 2496 (29%)
[1932]	71.0-72.0	sec	1719	KBytes	14080	Kbits/sec	0.998	ms	700/ 2460 (28%)
[1932]	72.0-73.0	sec	1702	KBytes	13944	Kbits/sec	0.084	ms	699/ 2442 (29%)
[1932]	73.0-74.0	sec	1693	KBytes	13872	Kbits/sec	0.745	ms	679/ 2413 (28%)
[1932]	74.0-75.0	sec	1721	KBytes	14096	Kbits/sec	0.985	ms	580/ 2342 (25%)
[1932]	75.0-76.0	sec	1697	KBytes	13904	Kbits/sec	0.433	ms	662/ 2400 (28%)
[1932]	76.0-77.0	sec	1702	KBytes	13944	Kbits/sec	0.515	ms	617/ 2360 (26%)
[1932]	77.0-78.0	sec	1697	KBytes	13904	Kbits/sec	0.912	ms	735/ 2473 (30%)
[1932]	78.0-79.0	sec	1712	KBytes	14024	Kbits/sec	0.445	ms	681/ 2434 (28%)
[1932]	79.0-80.0	sec	1708	KBytes	13992	Kbits/sec	0.535	ms	599/ 2348 (26%)

Ciperf Messages									
File									
[1932]	80.0-81.0	sec	1702	KBytes	13944	Kbits/sec	0.758	ms	597/ 2340 (26%)
[1932]	81.0-82.0	sec	1694	KBytes	13880	Kbits/sec	0.847	ms	686/ 2423 (28%)
[1932]	82.0-83.0	sec	1717	KBytes	14064	Kbits/sec	0.875	ms	595/ 2353 (25%)
[1932]	83.0-84.0	sec	1706	KBytes	13976	Kbits/sec	0.669	ms	677/ 2424 (28%)
[1932]	84.0-85.0	sec	1716	KBytes	14056	Kbits/sec	0.416	ms	653/ 2410 (27%)
[1932]	85.0-86.0	sec	1708	KBytes	13992	Kbits/sec	0.080	ms	713/ 2467 (29%)

For internal use

Document ID / Version number / Life cycle status / Department / Author

Close loop

CIperf Messages									
File									
[1932]	287.0-288.0 sec	177 KBytes	1448 Kbits/sec	8.362 ms	2280/	2461	(93%)		
[1932]	288.0-289.0 sec	184 KBytes	1504 Kbits/sec	9.748 ms	2238/	2426	(92%)		
[1932]	289.0-290.0 sec	191 KBytes	1568 Kbits/sec	5.986 ms	2225/	2421	(92%)		
[1932]	290.0-291.0 sec	180 KBytes	1472 Kbits/sec	10.134 ms	2242/	2426	(92%)		
[1932]	291.0-292.0 sec	180 KBytes	1472 Kbits/sec	8.513 ms	2276/	2460	(93%)		
[1932]	292.0-293.0 sec	184 KBytes	1504 Kbits/sec	9.962 ms	2274/	2462	(92%)		
[1932]	293.0-294.0 sec	179 KBytes	1464 Kbits/sec	9.357 ms	2279/	2462	(93%)		
[1932]	294.0-295.0 sec	213 KBytes	1744 Kbits/sec	5.533 ms	2275/	2493	(91%)		
[1932]	295.0-296.0 sec	210 KBytes	1720 Kbits/sec	9.678 ms	2216/	2431	(91%)		
[1932]	296.0-297.0 sec	191 KBytes	1568 Kbits/sec	9.959 ms	2267/	2463	(92%)		
[1932]	297.0-298.0 sec	189 KBytes	1552 Kbits/sec	7.737 ms	2343/	2537	(92%)		
[1932]	298.0-299.0 sec	194 KBytes	1592 Kbits/sec	8.632 ms	2243/	2442	(92%)		
[1932]	299.0-300.0 sec	185 KBytes	1512 Kbits/sec	7.757 ms	2258/	2447	(92%)		
[ID]	Interval	Transfer	Bandwidth	Jitter	Lost/Total Datagrams				
[1932]	300.0-301.0 sec	170 KBytes	1392 Kbits/sec	8.947 ms	2324/	2498	(93%)		
[1932]	301.0-302.0 sec	188 KBytes	1536 Kbits/sec	9.401 ms	2345/	2537	(92%)		
[1932]	302.0-303.0 sec	178 KBytes	1456 Kbits/sec	9.454 ms	2244/	2426	(92%)		
CIperf Messages									
File									
[1932]	293.0-294.0 sec	660 KBytes	5408 Kbits/sec	2.738 ms	1755/	2431	(72%)		
[1932]	294.0-295.0 sec	668 KBytes	5472 Kbits/sec	2.863 ms	1819/	2503	(73%)		
[1932]	295.0-296.0 sec	664 KBytes	5440 Kbits/sec	2.708 ms	1785/	2465	(72%)		
[1932]	296.0-297.0 sec	667 KBytes	5464 Kbits/sec	2.380 ms	1705/	2388	(71%)		
[1932]	297.0-298.0 sec	659 KBytes	5400 Kbits/sec	2.277 ms	1810/	2485	(73%)		
[1932]	298.0-299.0 sec	670 KBytes	5488 Kbits/sec	2.252 ms	1716/	2402	(71%)		
[1932]	299.0-300.0 sec	662 KBytes	5424 Kbits/sec	2.003 ms	1717/	2395	(72%)		
[ID]	Interval	Transfer	Bandwidth	Jitter	Lost/Total Datagrams				
[1932]	300.0-301.0 sec	663 KBytes	5432 Kbits/sec	2.320 ms	1774/	2453	(72%)		
[1932]	301.0-302.0 sec	665 KBytes	5448 Kbits/sec	2.100 ms	1667/	2348	(71%)		
[1932]	302.0-303.0 sec	657 KBytes	5384 Kbits/sec	2.502 ms	1750/	2423	(72%)		
[1932]	303.0-304.0 sec	657 KBytes	5384 Kbits/sec	2.903 ms	1780/	2453	(73%)		
[1932]	304.0-305.0 sec	656 KBytes	5376 Kbits/sec	3.027 ms	1830/	2502	(73%)		
[1932]	305.0-306.0 sec	670 KBytes	5488 Kbits/sec	1.139 ms	1788/	2474	(72%)		
[1932]	306.0-307.0 sec	667 KBytes	5464 Kbits/sec	2.210 ms	1806/	2489	(73%)		
[1932]	307.0-308.0 sec	660 KBytes	5408 Kbits/sec	2.232 ms	1791/	2467	(73%)		
[1932]	308.0-309.0 sec	660 KBytes	5408 Kbits/sec	3.301 ms	1778/	2454	(72%)		
[1932]	309.0-310.0 sec	675 KBytes	5528 Kbits/sec	2.076 ms	1667/	2358	(71%)		

Interference aware in PUSCH open loop in PUCCH

CIperf Messages

File

ID	Interval	Transfer	Bandwidth	Jitter	Lost/Total Dataframes
[1932]	41.0-42.0 sec	29.3 KBytes	240 Kbits/sec	45.015 ms	2299/ 2329 (99%)
[1932]	42.0-43.0 sec	33.2 KBytes	272 Kbits/sec	33.770 ms	2309/ 2343 (99%)
[1932]	43.0-44.0 sec	27.3 KBytes	224 Kbits/sec	44.400 ms	2471/ 2499 (99%)
[1932]	44.0-45.0 sec	30.3 KBytes	248 Kbits/sec	48.670 ms	2860/ 2891 (99%)
[1932]	45.0-46.0 sec	20.5 KBytes	168 Kbits/sec	56.833 ms	2248/ 2269 (99%)
[1932]	46.0-47.0 sec	25.4 KBytes	208 Kbits/sec	48.585 ms	2391/ 2417 (99%)
[1932]	47.0-48.0 sec	13.7 KBytes	112 Kbits/sec	66.367 ms	2219/ 2233 (99%)
[1932]	48.0-49.0 sec	25.4 KBytes	208 Kbits/sec	47.391 ms	2631/ 2657 (99%)
[1932]	49.0-50.0 sec	16.6 KBytes	136 Kbits/sec	63.657 ms	2170/ 2187 (99%)
[1932]	50.0-51.0 sec	14.6 KBytes	120 Kbits/sec	61.784 ms	2406/ 2421 (99%)
[1932]	51.0-52.0 sec	22.5 KBytes	184 Kbits/sec	61.076 ms	2674/ 2697 (99%)
[1932]	52.0-53.0 sec	21.5 KBytes	176 Kbits/sec	44.718 ms	2402/ 2424 (99%)
[1932]	53.0-54.0 sec	22.5 KBytes	184 Kbits/sec	47.572 ms	2672/ 2695 (99%)
[1932]	54.0-55.0 sec	19.5 KBytes	160 Kbits/sec	52.204 ms	2333/ 2353 (99%)
[1932]	55.0-56.0 sec	17.6 KBytes	144 Kbits/sec	49.852 ms	2592/ 2610 (99%)
[1932]	56.0-57.0 sec	21.5 KBytes	176 Kbits/sec	46.420 ms	2517/ 2539 (99%)
[1932]	57.0-58.0 sec	21.5 KBytes	176 Kbits/sec	42.978 ms	2263/ 2305 (99%)

CIperf Messages

File

ID	Interval	Transfer	Bandwidth	Jitter	Lost/Total Dataframes
[1932]	31.0-32.0 sec	1477 KBytes	12096 Kbits/sec	1.513 ms	941/ 2453 (38%)
[1932]	32.0-33.0 sec	1373 KBytes	11248 Kbits/sec	0.625 ms	860/ 2266 (38%)
[1932]	33.0-34.0 sec	1487 KBytes	12184 Kbits/sec	1.565 ms	1066/ 2589 (41%)
[1932]	34.0-35.0 sec	1516 KBytes	12416 Kbits/sec	0.983 ms	682/ 2234 (31%)
[1932]	35.0-36.0 sec	1522 KBytes	12472 Kbits/sec	0.929 ms	905/ 2464 (37%)
[1932]	36.0-37.0 sec	1492 KBytes	12224 Kbits/sec	0.858 ms	933/ 2461 (38%)
[1932]	37.0-38.0 sec	1565 KBytes	12824 Kbits/sec	0.990 ms	744/ 2347 (32%)
[1932]	38.0-39.0 sec	1518 KBytes	12432 Kbits/sec	1.017 ms	769/ 2343 (34%)
[1932]	39.0-40.0 sec	1552 KBytes	12712 Kbits/sec	1.116 ms	877/ 2466 (36%)

32.7,cmbi:42724,rssi:-90.2658,interPower:-92.7195,pre-snr:2.4537,fo:2161664,tA:-69.9336).

32.8,cmbi:42724,rssi:-91.3175,interPower:-118.5714,pre-snr:27.2539,fo:916480,tA:-171.0821).

32.2,cmbi:42724,rssi:-91.5161,interPower:-93.7839,pre-snr:2.2678,fo:1113088,tA:-159.2909).

32.3,cmbi:42724,rssi:-91.2282,interPower:-93.3617,pre-snr:2.1335,fo:982016,tA:-145.0303).

32.7,cmbi:42724,rssi:-91.3207,interPower:-93.7834,pre-snr:2.4627,fo:1573888,tA:-87.3458).

32.8,cmbi:42724,rssi:-91.0840,interPower:-92.9058,pre-snr:1.8258,fo:1375232,tA:-173.6087).

32.2,cmbi:42724,rssi:-90.5419,interPower:-92.7318,pre-snr:2.1899,fo:2685952,tA:-135.7627).

32.3,cmbi:42724,rssi:-90.1416,interPower:-92.3062,pre-snr:2.1666,fo:3013632,tA:-156.0254).

32.7,cmbi:42724,rssi:-90.3983,interPower:-92.7302,pre-snr:2.3319,fo:1770496,tA:-111.2731).

32.8,cmbi:42724,rssi:-90.2805,interPower:-92.9060,pre-snr:2.6254,fo:1178624,tA:-167.2761).

32.2,cmbi:42724,rssi:-89.8797,interPower:-91.4849,pre-snr:1.6052,fo:2360320,tA:-71.9623).

32.3,cmbi:42724,rssi:-89.8927,interPower:-90.9710,pre-snr:1.0783,fo:2096128,tA:-122.2852).

32.7,cmbi:42724,rssi:-89.9808,interPower:-91.6460,pre-snr:1.6652,fo:328704,tA:-71.7215).

32.7,cmbi:39897,rssi:-90.0918,interPower:-117.6035,pre-snr:27.5116,fo:916480,tA:-145.2568).

32.8,cmbi:39897,rssi:-89.6603,interPower:-117.5328,pre-snr:27.8725,fo:523264,tA:-145.2709).

32.2,cmbi:39897,rssi:-90.1076,interPower:-117.6696,pre-snr:27.5620,fo:2096128,tA:-144.8599).

32.3,cmbi:39897,rssi:-90.4458,interPower:-117.7260,pre-snr:27.2802,fo:1113088,tA:-143.0127).

32.7,cmbi:39897,rssi:-91.1529,interPower:-117.6324,pre-snr:26.4795,fo:1244160,tA:-144.7857).

32.8,cmbi:39897,rssi:-90.6977,interPower:-117.5271,pre-snr:26.8295,fo:1113088,tA:-145.2713).

32.2,cmbi:39897,rssi:-91.1628,interPower:-117.6145,pre-snr:26.4517,fo:1899520,tA:-144.8397).

32.3,cmbi:39897,rssi:-128.7263,interPower:-118.1546,pre-snr:-10.5714,fo:-2147483648,tA:0.000...

32.7,cmbi:39897,rssi:-90.1116,interPower:-117.8610,pre-snr:27.7494,fo:326656,tA:-144.6073).

32.8,cmbi:39897,rssi:-89.6725,interPower:-117.7473,pre-snr:28.0747,fo:457728,tA:-146.1523).

32.2,cmbi:39897,rssi:-90.1142,interPower:-117.8451,pre-snr:27.7309,fo:1440768,tA:-144.8680).

32.3,cmbi:39897,rssi:-130.6207,interPower:-118.2051,pre-snr:-12.4156,fo:-2147483648,tA:0.000...

32.7,cmbi:39897,rssi:-89.0331,interPower:-117.9433,pre-snr:28.9103,fo:1113088,tA:-145.5690).

32.8,cmbi:39897,rssi:-88.5872,interPower:-117.8773,pre-snr:29.2901,fo:1244160,tA:-145.2642).

32.2,cmbi:39897,rssi:-89.0423,interPower:-118.0247,pre-snr:28.9824,fo:1899520,tA:-144.9516).

32.3,cmbi:39897,rssi:-129.9344,interPower:-118.3510,pre-snr:-11.5834,fo:-2147483648,tA:0.000...

32.7,cmbi:39897,rssi:-90.1180,interPower:-118.0955,pre-snr:27.9776,fo:523264,tA:-144.2946).

32.8,cmbi:39897,rssi:-89.6733,interPower:-117.9904,pre-snr:28.3170,fo:705408,tA:-144.8256).

LTE1336 – Interference-aware Uplink Power Control

 Main Menu

- Table of Contents

 Key Functionality

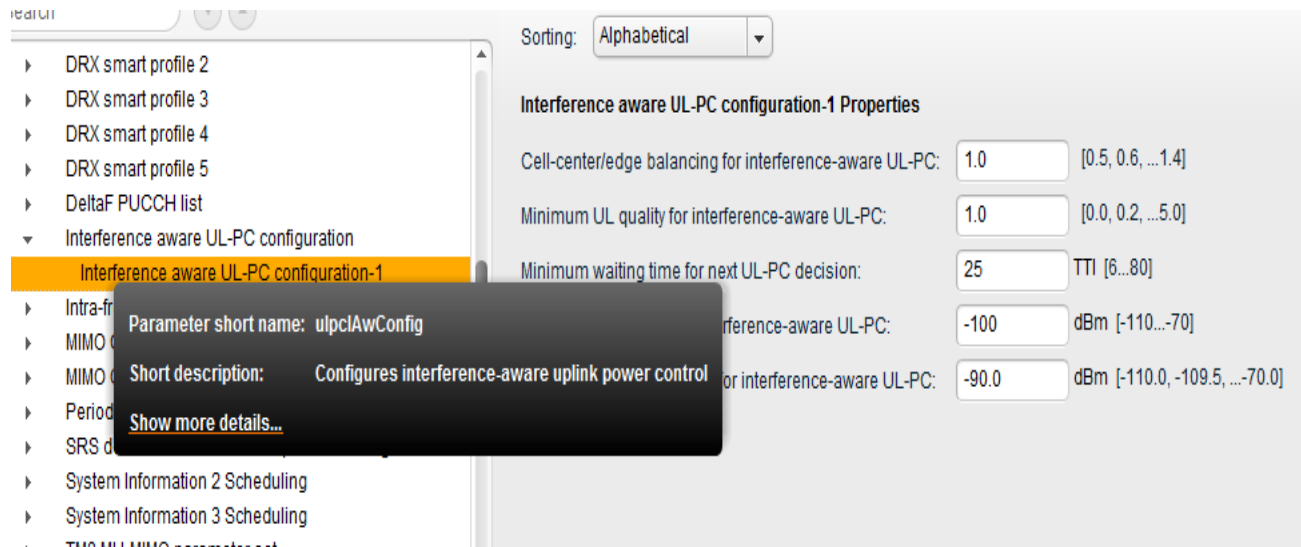
 Configuration and Deployment Aspects

 Simulation and Test Results

 Operational Hints and Guidelines

 Hints for Troubleshooting

New object of ulpclAwConfig needs to be created under LNCEL
Relevant parameters setting list on the right side



The screenshot displays the configuration interface for the 'Interference aware UL-PC configuration-1' object. On the left, a tree view shows the hierarchy of configuration objects, with 'Interference aware UL-PC configuration-1' selected. On the right, the 'Interference aware UL-PC configuration-1 Properties' section lists several parameters with their current values and ranges. A tooltip is visible over the 'Interference aware UL-PC configuration-1' entry in the tree view, providing additional information about the object.

Interference aware UL-PC configuration-1 Properties

Parameter	Value	Range
Cell-center/edge balancing for interference-aware UL-PC:	1.0	[0.5, 0.6, ...1.4]
Minimum UL quality for interference-aware UL-PC:	1.0	[0.0, 0.2, ...5.0]
Minimum waiting time for next UL-PC decision:	25	TTI [6...80]
Interference-aware UL-PC:	-100	dBm [-110...-70]
Interference-aware UL-PC:	-90.0	dBm [-110.0, -109.5, ...-70.0]

Parameter short name: ulpclAwConfig

Short description: Configures interference-aware uplink power control

[Show more details...](#)

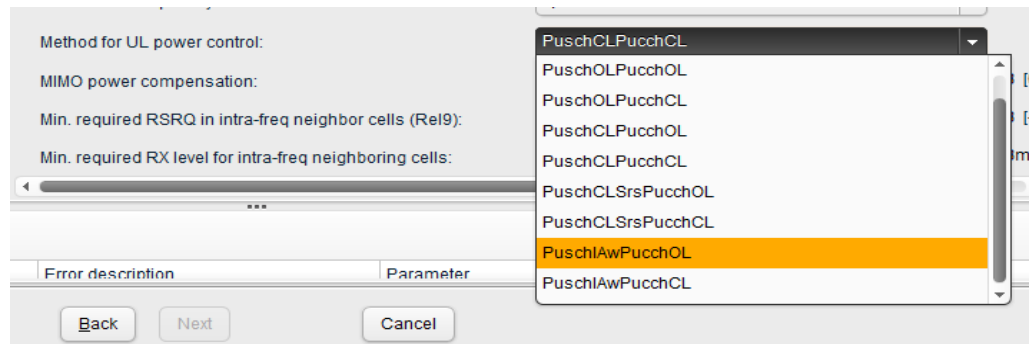
Two different method of IAW control mode can be used base on the requirement under LNCEL

PuschIAwPucchOL → PUCCH controlled by OLPC (LTE27)

PuschIAwPucchCL → PUCCH controlled by CLPC (LTE28)

The *LNCEL:ulpcAlpha* needs to be set to value 1

The *LNBTs:ulpcRssiMaxIAw* needs to configured



Method for UL power control:

MIMO power compensation:

Min. required RSRQ in intra-freq neighbor cells (Rel9):

Min. required RX level for intra-freq neighboring cells:

...

Error description	Parameter
	Back
	Next
	Cancel

Dropdown menu options:

- PuschCLPucchCL
- PuschOLPucchOL
- PuschOLPucchCL
- PuschCLPucchOL
- PuschCLPucchCL
- PuschCLSrsPucchOL
- PuschCLSrsPucchCL
- PuschIAwPucchOL**
- PuschIAwPucchCL

Alpha:

Maximum RSSI for interference-aware UL-PC: dBm [-90, -85, ..., -60]

LTE1336 – Interference-aware Uplink Power Control

- Table of Contents

 Main Menu

 Key Functionality

 Configuration and Deployment Aspects

 Simulation and Test Results

 Operational Hints and Guidelines

 Hints for Troubleshooting

Hints for Troubleshooting

- To check RSSI, Power and SNR, debug flags need to be enabled in swconfig which related to ULPHY
- If UPIAW doesn't work as expected, check the parameters setting in configuration file.
- Benefit gain could be observed in lab, in the field testing with multiple UE, gain was not so impressive as still on the correcting.