LTE3230 UL Interference offsets

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LTE3230 UL Interference offsets
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Introduction

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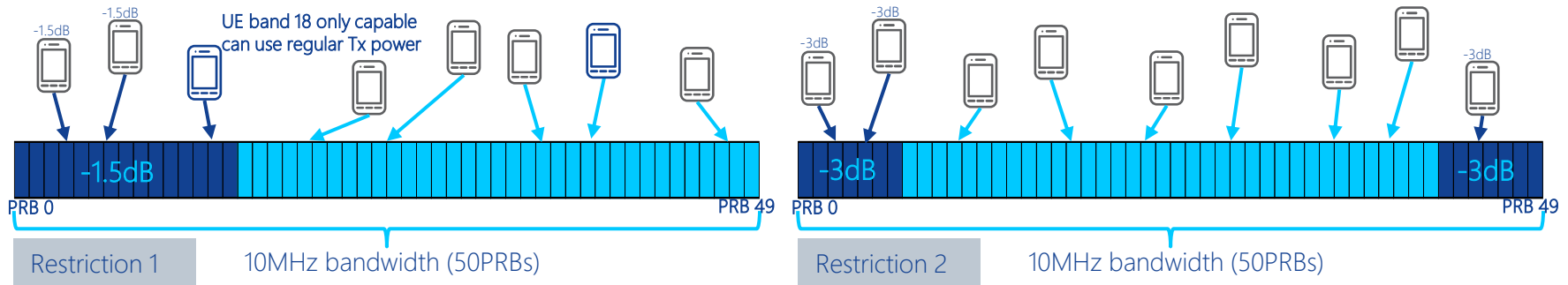
Introduction
3GPP UE transmit power restrictions

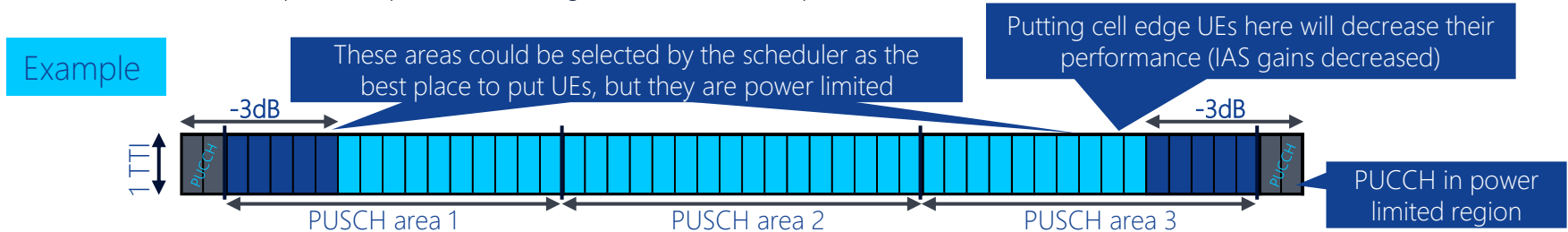- 3GPP has defined several **restrictions to UE's maximum transmission power** (3GPP TS36.101).

- Restrictions **depend on cell's frequency range**, **PRB locations** or **size of the allocation** given to UE

- Reason for such restrictions is to **protect other services** from spurious emissions, intermodulation products etc. Restriction 1 also allow for cheaper UE manufacturing due to less stringent requirments on RF filters

- Feature LTE3230 introduces **solution to decrease effect of two of such limitations**:

  1. On band 18 if UE has dual band capability (for band 18 and 26) then its maximum transmit power on first 15PRBs could be **decreased by 1.5dB**

  2. On band 30 all UEs maximum transmit power on first and last 7PRBs is **decreased by 3dB**

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Introduction
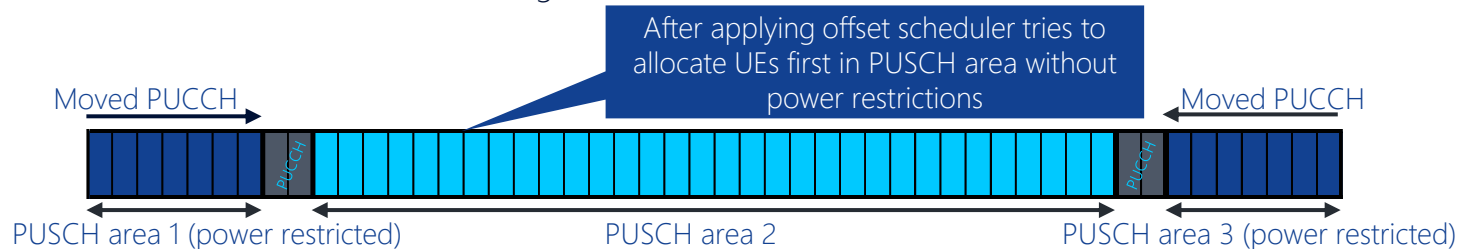## Restriction drawbacks on scheduling behavior

- Both **interference aware** and **channel aware schedulers** are affected by 3GPP Tx power restrictions on band 18/26 and 30
- Those types of schedulers **divide PUSCH area** into configured number of sub-areas (configured by *ulsNumSchedAreaUl* parameter)
- Interference aware and channel aware schedulers **measure interference level** in each of created **PUSCH sub-areas** and **start allocation in area with lowest interference level**, but:
  - Interference aware scheduler puts there cell edge users
  - Channel aware scheduler puts there users in best channel conditions
- This could lead in the situation where **scheduling areas with power restrictions will be chosen by the scheduler as the best areas for scheduling**, which could **cause cell throughput/cell edge throughput to decrease** and it puts traffic (UL interferences from our cell) right where some other service needs to be protected.
- PUCCH channel is placed on the edges of spectrum, therefore it also will be in place with power restriction which could deteriorate its performance (ACK/NACK feedback, CQI, SR)
- If PRACH channel is placed in power limited region, it also will be impacted

Example

These areas could be selected by the scheduler as the best place to put UEs, but they are power limited

Putting cell edge UEs here will decrease their performance (IAS gains decreased)

-3dB

1 TTI

PUCCH

-3dB

PUCCH

PUCCH in power limited region

PUSCH area 1   PUSCH area 2   PUSCH area 3

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Introduction
LTE3230 UL interference offsets in nutshell

- **LTE3230 UL interference offsets** feature was created **to overcome drawbacks of presented 3GPP restrictions** on band 18/26 and 30

- There are two settings possible during feature activation (*actUlPwrRestrScn* parameter):
  - Feature activation for restriction on band 18/26 (*band18_26* option)
  - Feature activation for restriction on band 30 (*band30_NS21* option)

- LTE3230 **moves PUCCH to the center of spectrum** (similarly to LTE786 feature) and therefore creates two outer regions (size of those regions depends on setting selected during feature activation)

- Schedulers **add to the interference calculation** in regions with power restriction a **fixed compensation value** (1.5dB for 18/26 band and 3dB for band 30) to compensate lower power which is used by UEs there.

- **Additional offset** can be configured using *ulInterferenceOffset* parameter to even **prohibit scheduler for selection those regions** from selection as the best scheduling area.

After applying offset scheduler tries to allocate UEs first in PUSCH area without power restrictions

Moved PUCCH

Moved PUCCH

PUSCH area 1 (power restricted)

PUSCH area 2

PUSCH area 3 (power restricted)

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Introduction
Before & after

Before

- If operator have a network on band 18 or 30 there are power restrictions (UE maximum power is decreased by 1.5 or 3dB) for UEs which have resources allocated on one or two the edges of spectrum

- PUCCH channel is also affected and its performance can be deteriorated.

- With those requirements less interference will be seen in some parts of the spectrum which can cause not optimal PUSCH scheduling areas selection by interference aware and channel aware schedulers and could lead to decreased cell throughput

After

- LTE3230 moves PUCCH from power restricted region, therefore impact of those restrictions (on band 18 and 30) on PUCCH is no more valid

- Shift of PUCCH towards center of spectrum creates PUSCH areas which are fully power restricted. UL schedulers add there special offsets during interference calculation which will bring again the balance and optimal PUSCH areas selection by interference aware and channel aware schedulers

- Optionally additional offset (default = 0) can be add to interference level calculation on those areas which will even prevent schedulers from selecting power restricted areas

- Influence of power restrictions on bands 18 and 30 is minimized

- Major drawback is decreased peak throughput due to fragmented PUSCH channel

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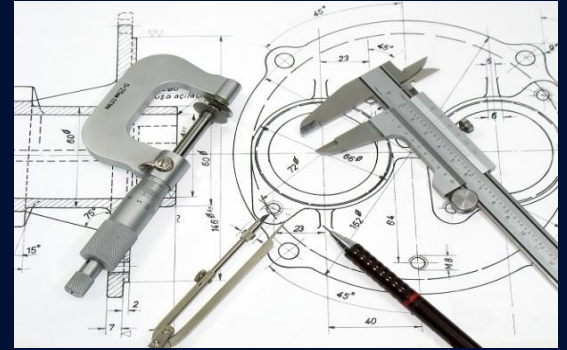
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Technical Details

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Technical Details
Dependency Table (LTE)

Release information

Release/version	RL release	eNodeB	NetAct
FDD LTE	FDD-LTE 17	FL17	NetAct 17.2
TDD LTE	-	-	-
Flexi Zone Micro (FZM/FZP)	FDD-LTE 17	FLF17	NetAct 17.2
Flexi Zone Controller (FZC)	FDD-LTE 17	FLC17	NetAct 17.2
Single RAN	-	-	-

Release information – general

HW & IOT	HW requirements	MME	SAE GW	UE	Specified by 3GPP
	FSMF, AirScale System Module	-	-	Rel. 8	36.101

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Technical Details
Basic information

- LTE3230 works **only with 10MHz bandwidth** and **Interference Aware** or **Channel Aware Scheduler**

- There are **two options** possible during feature activation using *actUlPwrRestrScn* parameter:

Band18_26

- Activation of feature for 3GPP **restriction on band 18** for **UEs which supports both bands 18 and 26**
- It can be chosen only when *earfcnUl* parameter is set to *23900*

815MHz   830MHz

Band30_NS21

- Activation of feature for 3GPP **restriction on band 30** (restriction 21 from 3GPP 36.101) for **all UEs**
- *addSpectrEmi* parameter must be set to *21*
- It can be chosen only when *earfcnUl* parameter is set to *27710*

2305MHz   2315MHz

- LTE3230 introduces **additional offset** configured by *ulInterferenceOffset* parameter which is added to interference measurements of **power restricted areas to pull UEs away from scheduling there**

- Depending on **which option** (*actUlPwrRestrScn*) is selected during feature activation **PUSCH channel will be divided in different way** to adapt to selected restrictions (more details on next slides)

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Technical Details
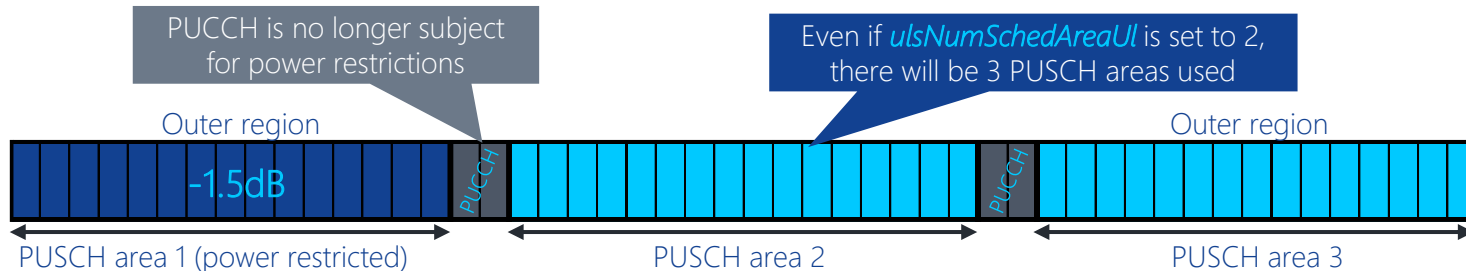## Band18_26 setting details

- When the feature is activated with *band18_26* setting, countermeasures for following restriction are applied:

> UEs which support **both bands 18 and 26** can have their **maximum transmit power restricted by 1.5dB** on **first 15PRBs** (PRB0 – PRB14) when **cell operates on band 18**
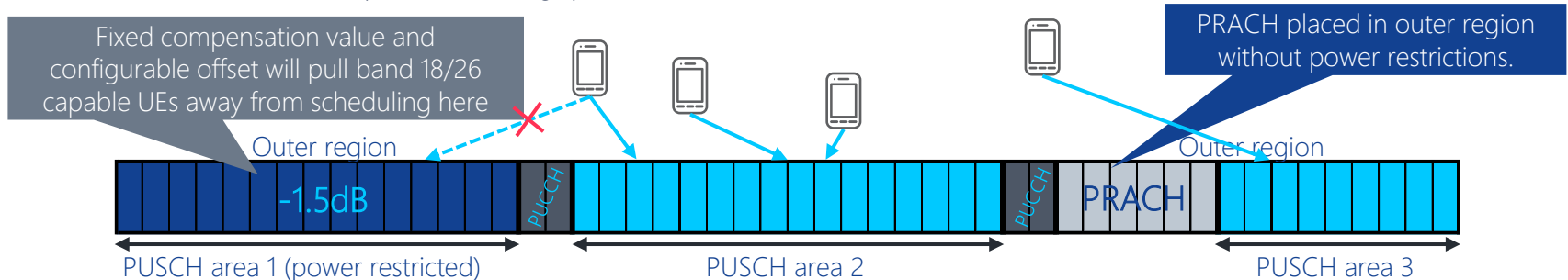
- **PUCCH is shifted 15PRBs** towards center of spectrum, which **creates two outer regions** at the borders
- Scheduler reconfigures location of scheduling areas such as **each outer region is a separate scheduling area** and central region is divided into **max(1, *ulsNumSchedAreaUl* -2)** areas

PUCCH is no longer subject for power restrictions

Even if *ulsNumSchedAreaUl* is set to 2, there will be 3 PUSCH areas used

Outer region

-1.5dB

PUCCH

PUCCH

Outer region

PUSCH area 1 (power restricted)

PUSCH area 2

PUSCH area 3

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Technical Details
Band18_26 setting details

- Uplink scheduler **adds fixed compensation value of 1.5dB** to **interference measurements on first 15 PRBs** if there is UE which supports both band 18 and 26 allocated on those PRBs. This mechanism will **prevent uplink scheduler** from **promoting power restricted PUSCH area** as the **best one for allocating cell edge UEs.**

- Additionally a **configurable offset can be set** (*ulInterferenceOffset* parameter) which also **will be added to interference measurements on first 15PRBs,** and this will make power restricted area unattractive and **pull away UEs from scheduling there.** UEs will be allocated there only when there will be no more place in other scheduling areas.

- When band18_26 option is chosen, **PRACH have to be placed in the outer region without power restrictions.** Parameter *selectPrachRegion* needs to be set to *OuterUpperEdge*. Such setting **will prevent PRACH from being power restricted** and also will not further decrease peak UE throughput.

Fixed compensation value and configurable offset will pull band 18/26 capable UEs away from scheduling here

PRACH placed in outer region without power restrictions.

Outer region

-1.5dB

PUSCH

PUSCH

PRACH

Outer region

PUSCH area 1 (power restricted)

PUSCH area 2

PUSCH area 3

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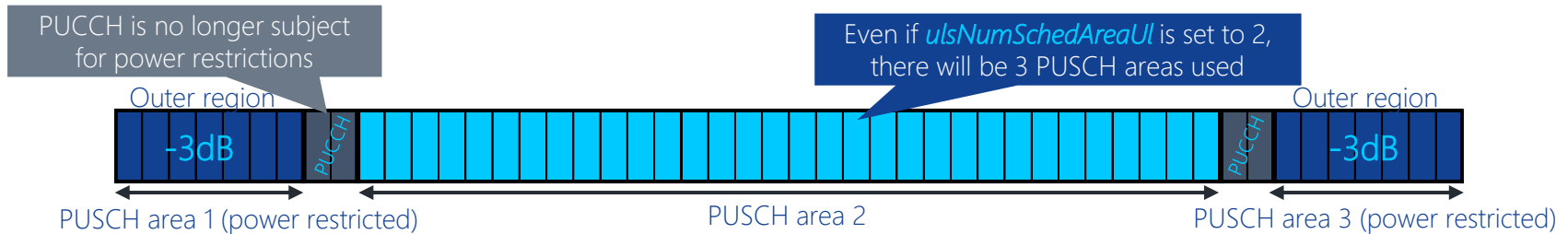# Technical Details
Band30_ns21 setting details

- When the feature is activated with *band30_NS21* setting, countermeasures for following restriction is applied:

> All UEs have their **maximum transmit power restricted by 3dB** on **first 7PRBs** (PRB0 – PRB14) and **last 7PRBs** (PRB43 – PRB49) when **cell operates on band 30.** Also small allocations (1 or 2 PRBs) in restricted regions have power restricted by 4dB.
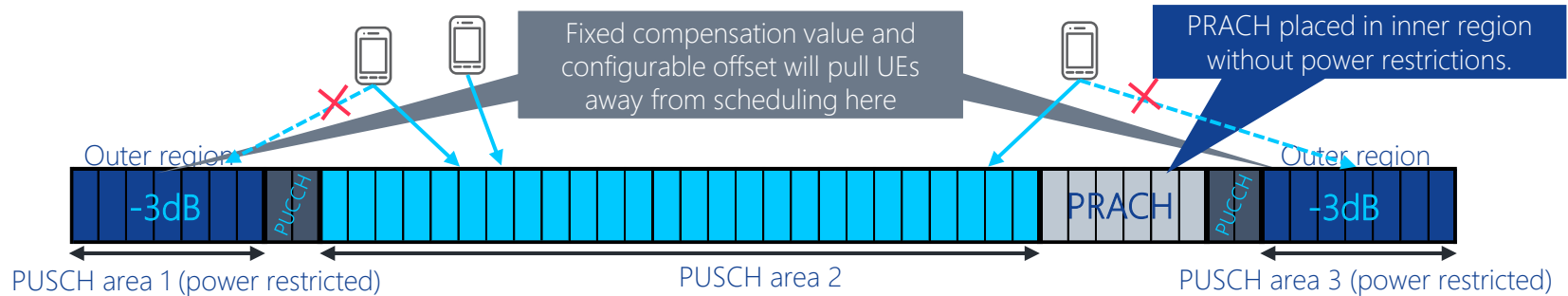
- **PUCCH is shifted 7PRBs** towards center of spectrum, which **creates two power restricted outer regions** at the borders

- Scheduler reconfigures location of scheduling areas such as **each outer region is a separate scheduling area** and central region is divided into **max(1,** *ulsNumSchedAreaUl* **-2)** areas

PUCCH is no longer subject for power restrictions

Even if *ulsNumSchedAreaUl* is set to 2, there will be 3 PUSCH areas used

Outer region

-3dB

PUCCH

PUCCH

Outer region

-3dB

PUSCH area 1 (power restricted)

PUSCH area 2

PUSCH area 3 (power restricted)

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Technical Details
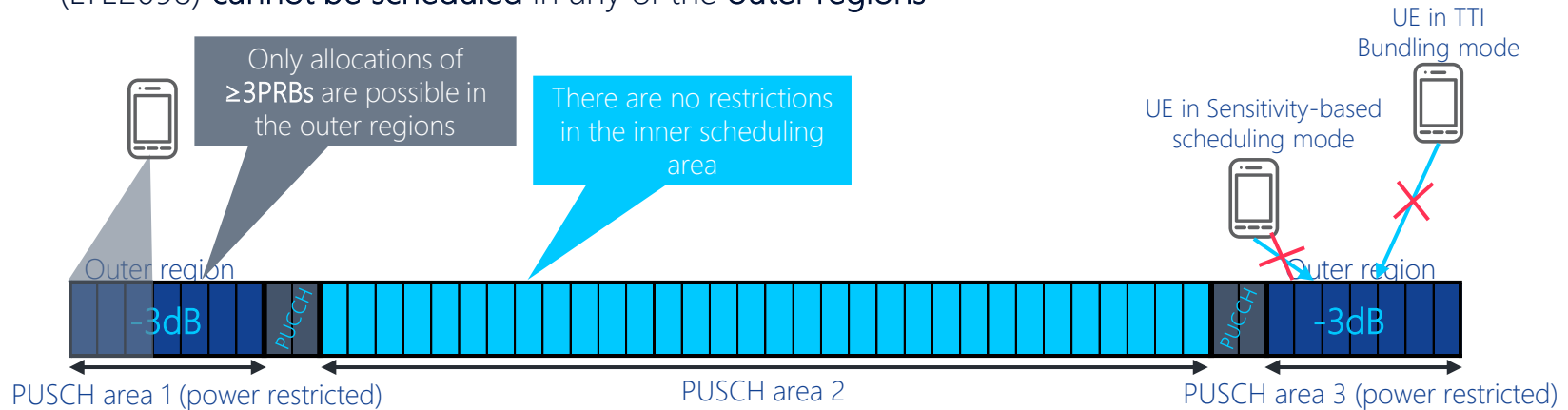## Band30_ns21 setting details

- Uplink scheduler **adds fixed compensation value of 3dB** to **interference measurements on first and last 7 PRBs** if there are UEs allocated on those PRBs. This mechanism will **prevent uplink scheduler** from **promoting power restricted PUSCH areas** as the **best one for allocating UEs**.

- Additionally a **configurable offset can be set** (*ulInterferenceOffset* parameter) which also **will be added to interference measurements on first and last 7PRBs**, and this will **make power restricted area unattractive** and **pull away UEs from scheduling there**. UEs will be allocated there only when there will be no more place in other scheduling areas.

- When *band30_NS21* option is chosen, **PRACH has to be placed in the inner region**. Parameter *selectPrachRegion* needs to be set to *InnerUpperEdge*. Such setting **will prevent PRACH from being power restricted**.

Fixed compensation value and configurable offset will pull UEs away from scheduling here

PRACH placed in inner region without power restrictions.

Outer region

-3dB   PUCCH   PRACH   PUCCH   -3dB

Outer region

PUSCH area 1 (power restricted)   PUSCH area 2   PUSCH area 3 (power restricted)

Technical Details
Band30_ns21 setting details

- There are **further restrictions** related to allocations on PUSCH when band30_NS21 option is chosen:
  - UL scheduler **cannot allocate 1 and 2PRBs** in any of the **outer regions**
  - UEs which are in **TTI Bundling mode** (LTE907 or LTE2098) or in **Sensitivity-based scheduling mode** (LTE2098) **cannot be scheduled** in any of the **outer regions**

Only allocations of ≥3PRBs are possible in the outer regions

There are no restrictions in the inner scheduling area

UE in Sensitivity-based scheduling mode

UE in TTI Bundling mode

Outer region

-3dB

PUSCH

-3dB

PUSCH

Outer region

-3dB

PUSCH area 1 (power restricted)

PUSCH area 2

PUSCH area 3 (power restricted)

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Technical Details
Further details related to both settings

- Uplink scheduler **normalizes Power Headroom Reports (PHR)** of UEs to have **all values like as for no power restrictions,** therefore it **will not interfere with scheduler decisions.**

- PHR normalization is done as follows:

  - **When band18_26 option is chosen:** 1.5dB is added to reported PHR if:

    - UE supports band 18 and 26

    - PRBs to which PHR belongs was allocated in the lower outer region (first 15PRBs)

  - **When band30_ns21 option is chosen:** 3dB is added to reported PHR if:

    - PRBs to which PHR belongs was allocated in any of the outer regions (first or last 7 PRBs)

- There is **new SRS configuration** (Configuration 8) added to the possible for 10MHz and it will be used in case SRS are activated together with LTE3230.

10 MHz	Hopping SRS bandwidth	SRS bandwidth wide	Full report time [ms]	Capacity (number of UEs)	SRS bandwidth narrow	Full report time [ms]	Capacity (number of UEs)
Configuration 8	48	16 PRBs	30	24	4 PRBs	120	96

All possible SRS configurations can be found in LTE825 NEI:
https://nokia.sharepoint.com/:p:/s/NetEng/EbbT2ezT_MlPotcVRyeGbZUBkfsvnloV6Ua3MYQME5f1FA

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Interdependencies

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Interdependencies

LTE1130 Dynamic PUCCH:

LTE1130 brings automatic PRACH configuration by selection scheduling are to which allocate the PRACH (introduction of *selectPrachRegion* parameter), LTE3230 uses this functionality to properly place PRACH

LTE46 Channel-aware Scheduler

LTE619 Interference-aware UL scheduling

These both types of scheduler divides PUSCH into scheduling areas and LTE3230 was created to help those two types of scheduler to cope with additional power restrictions

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Interdependencies

extensions

LTE2664 Load Based PUCCH Region:

LTE2664 can change the number of PRBs allocated for PUCCH. LTE3230 has to adjust scheduling areas accordingly.

LTE3128 LTE-M:

It is recommended to configure LTE-M narrowbands such that they are located in the central PUSCH region

LTE2205 Configurable uplink interference regions

LTE2205 introduces configured number of UL scheduling areas. When LTE3230 is activated even when number of areas is set to 2, there will be 3 areas used.

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Interdependencies

LTE1336 Interference-aware UL power control

Feature use measurements of uplink power and uplink interferences to determine commands for UL power control. With power restrictions in some parts of the bandwidth those measurements will not reflect the true situation

LTE1709 Liquid Cell

LTE1542 FDD Supercell

LTE2445 Combined Supercell

LTE3268 Combined Supercell for HetNet

All these features use measurements of uplink power and uplink interferences to determine the UEs location. With power restrictions in some parts of the bandwidth those measurements will not reflect the true situation

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Interdependencies

limitations

LTE1092 UL carrier aggregation

LTE944 PUSCH masking

Performing UL carrier aggregation, or PUSCH masking on top of power restrictions would cause too small gain

LTE1059 Uplink multi-cluster scheduling

To perform multi-cluster scheduling additional power back-off is needed and when it would be added on top of existing power restrictions feature gain would be too small ## LTE825 Outer region scheduling

LTE825 configures only one outer region while LTE3230 configures two of them

LTE786 Flexible uplink bandwidth

LTE3230 uses PUCCH blanking functionality to move PUCCH to center of spectrum and then configures two outer regions. Feature overrides the *blankedPucch* parameter setting.

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Benefits and Gains

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Benefits and Gains
Reduced impact of power restrictions

- Main benefit of LTE3230 is **reduced impact on cell throughput and cell edge throughput** of power restrictions on bands 18 and 30.
    - PUCCH is **no more in power restricted** region
    - **Interference aware** and **channel aware schedulers try not to allocate** UEs in **power restricted regions**, when without the feature they would allocate UEs there in first place

Areas with power restrictions can frequently be categorized as those with less interference, therefore resource allocation will start there

Example: **band 30**

-3dB

LTE3230

-3dB

In case Interference aware scheduler is selected cell edge UEs will not be allocated to power restricted regions

By applying offsets to interference calculations on power restricted regions now the scheduling of UEs will start with area without power restrictions

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Benefits and Gains
Feature drawbacks

- Due to the fact that **LTE3230 moved PUCCH towards the center** of bandwidth it **creates physically separated scheduling areas**.

- In uplink **allocations have to be continuous** therefore such **separation** of scheduling areas **will cause a UE peak throughput degradation**

- The actual **degradation depends on chosen activation option.** Below theoretical calculations are presented (4 PRBs for PUCCH is assumed)

Band18_26

- Before LTE3230:
    - Maximum available PRBs in single TTI: **45** (due to $2^i 3^j 5^k$ rule)
    - Maximum TBS (using MCS24 and 45PRBs): **24495 bits**
    - Maximum peak throughput: <u>24.495 Mbit/s</u>
- After LTE3230:
    - Maximum available PRBs in single TTI: **16**
    - Maximum TBS (using MCS24 and 16PRBs): **8504 bits**
    - Maximum peak throughput: <u>8.504 Mbit/s</u>

Band30_ns21

- Before LTE3230:
    - Maximum available PRBs in single TTI: **45** (due to $2^i 3^j 5^k$ rule)
    - Maximum TBS (using MCS24 and 45PRBs): **24495 bits**
    - Maximum peak throughput: <u>24.495 Mbit/s</u>
- After LTE3230:
    - Maximum available PRBs in single TTI: **32**
    - Maximum TBS (using MCS24 and 32PRBs): **16992 bits**
    - Maximum peak throughput: <u>16.992 Mbit/s</u>

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Configuration Management

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Configuration Management

Definition of terms and rules for parameter classification*

The 'Basic Parameters' category contains primary parameters which should be considered during cell deployment and must be adjusted to a particular scenario:

- Network Element (NE) identifiers
- Planning parameters, e.g. neighbour definitions, frequency, scrambling codes, PCI, RA preambles
- Parameters that are the outcome from dimensioning, i.e. basic parameters defining amount of resources
- Basic parameters activating basic functionalities, e.g. power control, admission control, handovers
- Parameters defining operators' strategy, e.g. traffic steering, thresholds for power control, handovers, cell reselections, basic parameters defining feature behaviour

The 'Advanced Parameters' category contains the parameters for network optimisation and fine tuning:

- Decent network performance should be achieved without tuning these parameters
- Universal defaults ensuring decent network performance need to be defined for all parameters of this category. If this is not possible for a given parameter it must be put to the 'Basic Parameters' category
- Parameters requiring detailed system knowledge and broad experience unless rules for the 'Basic Parameters' category are violated
- All parameters (even without defaults, e.g. optional structures) related to advanced and very complex features

The 'Obsolete parameters' category is intended for parameters that are candidates to be removed from the product in a future release:

- Parameters always used with default value
- Parameters that are not used by operators
- Parameters that are not relevant anymore

* - purpose: Categories of parameters have been defined to simplify network parametrization. Parameterization effort shall be focused mainly on Basic ones. Categorization is reflected in a 'view' definition in NetAct CM Editor.

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Configuration Management

New parameters

Abbreviated name	Full name	PKDB link
LNCEL_FDD:actUlPwrRestrScn	Activate UL Power Restriction Scenario	Parameter Knowledge Database
LNCEL_FDD:ulInterferenceOffset	UL interference offset	Parameter Knowledge Database

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Configuration Management
Related parameters

Abbreviated name	Full name	PKDB link
LNCEL_FDD:earfcnUL	EARFCN uplink	Parameter Knowledge Database
LNCEL_FDD:ulChBw	Uplink channel bandwidth	Parameter Knowledge Database
LNCEL:addSpectrEmi	Additional spectrum emission mask	Parameter Knowledge Database
LNCEL_FDD:actAutoPucchAlloc	Activation of automatic PUCCH allocation	Parameter Knowledge Database
LNCEL:ulsSchedMethod	Scheduling method of the UL scheduler	Parameter Knowledge Database

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Configuration Management
Related parameters

Abbreviated name	Full name	PKDB link
LNCEL_FDD:selectOuterPuschRegion	Target UL outer scheduling region	Parameter Knowledge Database
LNCEL:actUlPcMethod	Method for UL power control	Parameter Knowledge Database
LNCEL_FDD:actSuperCell	Activate supercell configuration	Parameter Knowledge Database
LNCEL_FDD:actCombSuperCell	Activate combined supercell configuration	Parameter Knowledge Database
LNCEL_FDD:actPuschMask	Activate PUSCH masking	Parameter Knowledge Database

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Configuration Management
Related parameters

Abbreviated name	Full name	PKDB link
LNCEL_FDD:actLiquidCell	Activate liquid cell configuration	Parameter Knowledge Database
LNBTS:actULCAggr	Activation of uplink carrier aggregation	Parameter Knowledge Database
LNCEL_FDD:actUlMultiCluster	Activate UL multi-cluster Scheduling	Parameter Knowledge Database

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Configuration Management
Related parameters

Abbreviated name	Full name	PKDB link
LNCEL_FDD:blankedPucch	Blanked PUCCH resources	☰ Parameter Knowledge Database
APUCCH_FDD:selectPrachRegion	Selection of PRACH region in automatic PUCCH allocation	☰ Parameter Knowledge Database

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Deployment Aspects

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Deployment Aspects
Area of application

- Feature is applicable **only for cells which are using band 18 or band 30** as their frequency, as feature aims to reduce influence of power restrictions which are defined by 3GPP on these bands

- Cells have to be also configured with **10MHz bandwidth**

FDD LTE Bands & Frequencies		
LTE Band Number	Uplink (MHz)	Downlink (MHz)
1	1920 - 1980	2110 - 2170
2	1850 - 1910	1930 - 1990
3	1710 - 1785	1805 -1880
4	1710 - 1755	2110 - 2155
5	824 - 849	869 - 894
6	830 - 840	875 - 885
7	2500 - 2570	2620 - 2690
8	880 - 915	925 - 960
9	1749.9 - 1784.9	1844.9 - 1879.9
10	1710 - 1770	2110 - 2170
11	1427.9 - 1452.9	1475.9 - 1500.9
12	698 - 716	728 - 746
13	777 - 787	746 - 756
14	788 - 798	758 - 768
15	1900 - 1920	2600 - 2620
16	2010 - 2025	2585 - 2600
17	704 - 716	734 - 746
18	**815 - 830**	**860 - 875**
19	830 - 845	875 - 890
20	832 - 862	791 - 821
21	1447.9 - 1462.9	1495.5 - 1510.9
22	3410 - 3500	3510 - 3600
23	2000 - 2020	2180 - 2200
24	1625.5 - 1660.5	1525 - 1559
25	1850 - 1915	1930 - 1995
26	814 - 849	859 - 894
27	807 - 824	852 - 869
28	703 - 748	758 - 803
29	n/a	717 - 728
30	**2305 - 2315**	**2350 - 2360**
31	452.5 - 457.5	462.5 - 467.5

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Deployment Aspects
Feature configuration in BTS Site Manager

- To be able to activate the feature specific cell configuration has to be performed first as feature works only for 10MHz bandwidth and on band 18 or 30.

- If **band18_26** option is going to be selected the cell has to be configured with cell **bandwidth of 10MHz** and **uplink earfcn 23900**

- If **band30_ns21** option is going to be selected the cell has to be configured with cell **bandwidth of 10MHz** and **uplink earfcn 27710**

Downlink (TX) carriers

Local cell	Frequency band	Bandwidth	EARFCN	Frequency (MHz)
0	850MHz (E-UTRA 18)	10 MHz	5900	865.0

Allowed EARFCN values

850MHz (E-UTRA 18, FHPC): [5850...5999]
700MHz (E-UTRA 28, FHPC): [9360...9459]
The EARFCN value must be at a bandwidth-dependent distance from the lower and upper limits of the allowed range.

Uplink (RX) carriers

Local cell	Frequency band	Bandwidth	EARFCN	Frequency (MHz)
0	850MHz (E-UTRA 18)	10 MHz	23900	820.0

Downlink (TX) carriers

Local cell	Frequency band	Bandwidth	EARFCN	Frequency (MHz)
1	2300MHz (E-UTRA 30)	10 MHz	9820	2355.0

Allowed EARFCN values

2300MHz (E-UTRA 30, FRNC): [9770...9869]
The EARFCN value must be at a bandwidth-dependent distance from the lower and upper limits of the allowed range.

Uplink (RX) carriers

Local cell	Frequency band	Bandwidth	EARFCN	Frequency (MHz)
1	2300MHz (E-UTRA 30)	10 MHz	27710	2310.0

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Deployment Aspects
Feature configuration in BTS Site Manager

- **Activation flag** for the feature can be found under LNCEL_FDD (two options can be chosen):

Activate UL Power Restriction Scenario:	band30_NS21 ▼
Activated MIMO transmission mode:	none
Activation of automatic PUCCH allocation:	band18_26
Add number DRB radioReasHo:	band30_NS21 [0...4500]

Two options depending on cell frequency

- **Additional interference offset** can be set and it is also located under LNCEL_FDD

UL interference offset:	0 % [-100, -95, ...100]

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Deployment Aspects
Feature configuration in BTS Site Manager

- When feature is activated following parameters needs to be configured:

Additional spectrum emission needs to be set to 21 when band30_NS21 option is chosen. This can be found under LNCEL

Automatic PUCCH allocation needs to be activated with LTE3230

- For band18_26 option PRACH placement need to be set to *OuterUpperEdge*
- For band30_ns21 option PRACH placement need to be set to *InnerUpperEdge*

When LTE3230 is activated, scheduler type needs to be set to *channel aware* or *interference aware*

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fALU equivalents

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ALU equivalents
Feature release, number and name

- The equivalent feature in the fALU portfolio is:

Release	Feature ID	Title
LR16.2	199783	B30 A-MPR and OP-PUCCH Support

- This fALU feature addresses the use case "restriction on band 30" ("NS_21 " use case).

- There is no fALU feature to address the use case "restriction on band 18/26".

                Nokia Internal Use

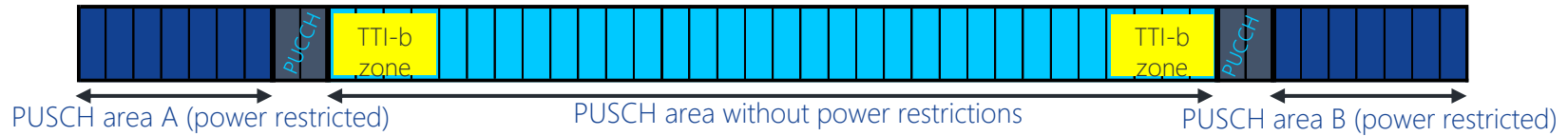**NOKIA**

fALU vs Nokia solution
Positions in the Frequency Domain

- The **fALU equivalent feature is applicable to FDD 10MHz in B30**. This is activated at cell level (*CellActivationService::booleanSpare01 (isBand30AMPREnabled)* parameter). **fALU does not have specific feature for the power restriction on B18/26.**

- Similarly to LTE3230, PUCCH regions are moved away from the band edges towards the center of the band, to protect PUCCH from A-MPR; to do so fALU re-uses the framework of the fALU OP-PUCCH feature (*isGeneralizedOPPUCCHEnabled* parameter). PUCCH PRBs are PRBs 7,8 and 41,42 (for 400AU capacity) or 7,8,9 and 40, 41,42 (for 500AU capacity).

- Similarly to LTE3230, because of PUCCH shift, the SRS has a specific configuration. For fALU, the Cell SRS bandwidth is reduced from 48 PRBs to 32 PRBs (through *srsBandwidthConfiguration* parameter). This SRS configuration, specific to the B30 "NS_21" use case, is not the same for Nokia, as per different legacy SRS management strategies.

- PRACH is placed in the inner region accordingly to the *prachFrequencyOffset* parameter. fALU can shift it either by +7 PRB (if it is usually placed in the lower half of the band) or by -7 PRB (if it is usually placed in the upper half of the band). Note: Nokia places it in the upper half of the band.

- The RACH Message3 is shifted accordingly to the *rACHMessage3StartingPRBIndex* parameter.

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fALU vs Nokia solution
Positions in the Frequency Domain

- Similarly to LTE3230, the outer regions (subject to the AMPR) are forbidden for the TTI-Bundling PRB allocations. This is achieved through the proper setting of *ttiBundlingPrbPriorityOrder* parameter.

PUSCH area A (power restricted)   PUSCH area without power restrictions   PUSCH area B (power restricted)

- The choice of PUSCH PRB for SPS scheduling are prioritized through the *sPSprioMetricTableUl* parameter. The PUCCH PRBs should have a SPS priority metric set to -1 (forbidden to be used) and the PUSCH PRB SPS priority metric should increase as the PUSCH PRBs are near PUCCH.

SPS priority metric

PRB index
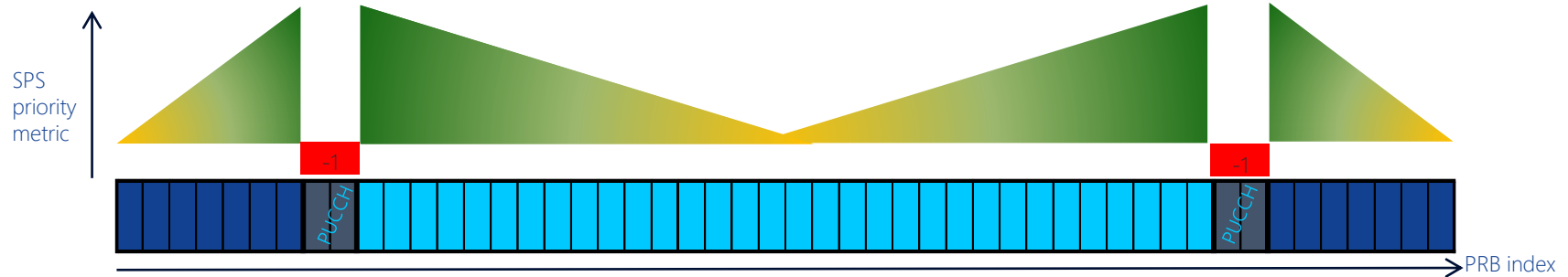
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fALU vs Nokia solution
AMPR

- fALU considers that the UEs applies the "NS_21" Power Reduction as specified by 3GPP 36.101 Table 6.2.4-16.

Table 6.2.4-16: A-MPR for "NS_21"

Channel Bandwidth [MHz]	Parameters	Region A		Region B	
10	RB_{start}	0 – 6	0 – 6	N/A	N/A
	RB_{end}	N/A	N/A	43 – 49	43 – 49
	L_{CRB} [RBs]	1 – 2	3 – 12, 32 - 50	1 – 2	3 – 12, 32 - 50
	A-MPR [dB]	≤ 4	≤ 3	≤ 4	≤ 3

UEs **decrease** their maximum transmit power on first and last 7PRBs **by 3dB if the scheduled number of PRB is [3..7].**

UEs **decrease** their maximum transmit power on first and last 7PRBs **by 4dB if the scheduled number of PRB is [1..2]**

- There is a difference with LTE3230 : LTE3230 considers that on band 30 all UEs maximum transmit power on first and last 7PRBs is **decreased by 3dB. UL scheduler cannot allocate 1 and 2PRBs** in any of the **outer regions**. -> the AMPR **4dB** use case will not happen.

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fALU vs Nokia solution
UL Scheduling Impact

- In similar way than LTE3230, fALU internally compensates the power reduction applied by the UEs, such that the UL scheduler algorithms take the proper decisions :

  - The AMPR specified by the parameter *aMPRappliedToSRS* is assumed to impact the wideband SRS transmission and hence is compensated for when processing per PRB SRS SINR reports.

  - The Power Headroom reports are compensated for when processing the PHR.

- To discourage scheduling in the regions subject to the power restriction, it is optionally possible to enforce an additional check, activated by setting the parameter *isMaxPHREnforcementEnabled* to True.

- If this is set to True, fALU will compare the normalized Power Headroom with a threshold, configured by the parameter *maxPHRthresholdTable*. The PRB index N will be declared unavailable for dynamic scheduling to user k if the corresponding normalized PHR is below the threshold:

> If Normalized PHR (user k) <= *maxPHRthresholdTable[N]*
>
> Then PRB N is declared unavailable for UL dynamic scheduling

- fALU « Max PHR enforcement » and LTE3230 « UL interference offset » both have the same goal : Make the PUSCH power restricted area unattractive for UL scheduling. However the mean to achieve this goal is different by design choice.

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fALU vs Nokia solution
Feature Interaction

- **Carrier Aggregation** : fALU recommends to restrict B30 from being assigned as a PCell during CA. The concern is that when NS21/AMPR is applied to B30, the B30 UL is likely to be compromised and hence eNB should avoid using it as a PCell. This is simply achieved by proper configuration (do not create object CarrierAggregation under B30 cells). Nokia can also avoid assign B30 as PCELL by configuration, if the same concern is foreseen.

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fALU vs Nokia solution
Parameters mapping

| Nokia Parameter	fALU equivalent	Mapping Rule Nokia / fALU
LNCEL_FDD:actUlPwrRestrScn	CellActivationService::booleanSpare01 (isBand30AMPREnabled) CellActivationService:isGeneralizedOPPUCCHEnabled	If (isBand30AMPREnabled = TRUE) then If (isGeneralizedOPPUCCHEnabled = TRUE and additionalSpectrumEmission = 21) then actUlPwrRestrScn = Band30_ns21
LNCEL:addSpectrEmi	LteCell:additionalSpectrumEmission	addSpectrEmi = additionalSpectrumEmission
LNCEL_FDD:ulInterferenceOffset	CellActivationService:isMaxPHREnforcementEnabled CellL2ULConf:maxPHRthresholdTable	Due to different implementation choices, the mapping is not straight forward. It can be based on traces (compare the UL PRB usage on the PUSCH power-restricted areas between fALU and Nokia and adjust ulInterferenceOffset accordingly)

- Other fALU parameters : *isGeneralizedOPPUCCHEnabled* , *srsBandwidthConfiguration* , *prachFrequencyOffset* , *rACHMessage3StartingPRBIndex, ttiBundlingPrbPriorityOrder* , *sPSprioMetricTableUl , aMPRappliedToSRS* discussed here do no require a specific mapping exercice. Nokia deployment guidelines, as described in "Deployement Aspects" shall be followed.

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SURVEY IN THE WEBEX PANEL
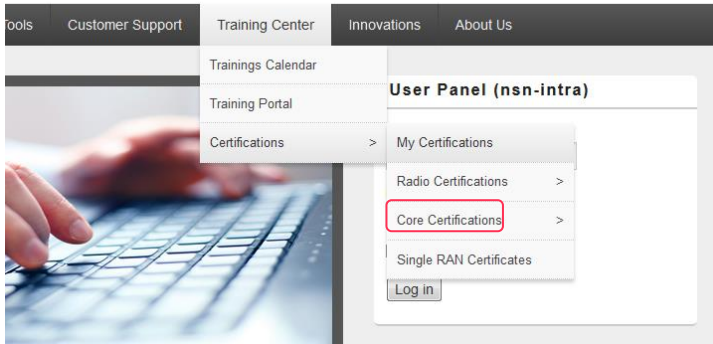
To get the certificate proving participation in the training please login to NEDC with your Nokia credentials and download the certificate after completing the training.

Nokia Internal Use

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Performance Aspects

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Nokia Internal Use

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Performance Aspects
Feature impact

Feature impact	How to measure?
Feature activation verification After feature is activated, PUCCH is moved from power limited region to the center of spectrum, therefore mean RSSI on PUCCH should go a bit up	KPIs: - E-UTRAN Average RSSI for PUCCH (LTE_5441b) Counters: - RSSI_CELL_PUCCH_MEAN (M8005C208)
Decreased UL peak UE throughput When PUSCH is physically divided into several scheduling areas peak UE throughput will be decreased as one user can be scheduled in only one scheduling area at the same time	As there are no available counters or KPIs to check UE peak throughput, TTI traces need to be checked.

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Compliance Aspects

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Compliance Aspects

- LTE3230 reduces impact of UE power restrictions on band 18 and 30 which are specified in 3GPP. (for more details please check 3GPP TS 36.101)

  - Specific requirements are in section 6.2.4

- All UEs starting from release 8 support this featu...

     Nokia Internal Use