

IDC for Uplink Carrier Aggregation

Feature Description

Copyright

© Ericsson AB 2018. All rights reserved. No part of this document may be reproduced in any form without the written permission of the copyright owner.

Disclaimer

The contents of this document are subject to revision without notice due to continued progress in methodology, design and manufacturing. Ericsson shall have no liability for any error or damage of any kind resulting from the use of this document.

Trademark List

All trademarks mentioned herein are the property of their respective owners. These are shown in the document [Trademark Information](#).



Contents

1	Overview	1
2	Dependencies	4
3	Feature Operation	5
4	Network Impact	8
5	Parameters	9
6	Performance	10
7	Activate the Feature	12
8	Deactivate the Feature	13





1 IDC for Uplink Carrier Aggregation Overview

IDC for Uplink Carrier Aggregation makes it possible for IDC-capable UEs to host multiple radio transceivers in a way that prevents interference between those transceivers.

Feature Identity:	FAJ 121 4894
Value Package Name:	Carrier Aggregation
Value Package Identity:	FAJ 801 0405 R12
Node Type:	Baseband Radio Node, DU Radio Node
Licensing:	Licensed feature. One license per node.

Summary

IDC is the ability to host multiple radio transceivers in the same UE in a way that prevents interference between those transceivers. The UE informs the eNodeB that it experiences radio interference. This makes it possible for the eNodeB to prevent Carrier Aggregation from using SCells on problematic frequencies.

UEs capable of reporting IDC indications addressing Uplink Carrier Aggregation interference declare this capability by the RRC IE `inDeviceCoexInd-UL-CA-r11`, and report detected interference problems using the RRC IEs `VictimSystemType-r11` and `AffectedCarrierFreqCombList-r11`. The eNodeB then remedies the interference problem by disabling inter-band and intra-band uplink grants for the reported problematic combinations of UL frequencies.

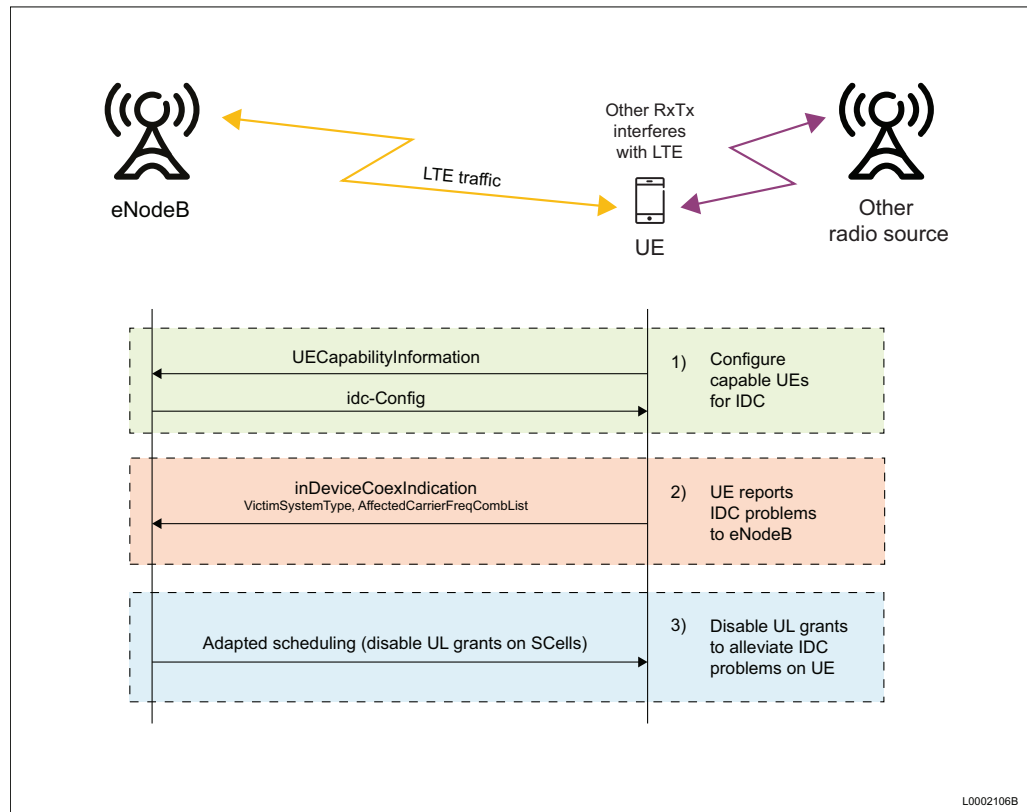


Figure 1 IDC for Uplink Carrier Aggregation Overview

IDC for Uplink Carrier Aggregation has the following main benefits:

- IDC for Uplink Carrier Aggregation capable UEs experience that uplink radio interference from SCells during Uplink Carrier Aggregation operation is significantly reduced.

Note: The benefit only affects the UEs.

- It prevents possible UE malfunction caused by radio interference between transceivers in live networks which can happen when the UE uses Carrier Aggregation to carry uplink data.
- Operators do not need to deactivate the Uplink Carrier Aggregation feature because in some UE devices, harmonic with multiple Uplink Carrier Aggregation transmission causes interference in other device components like GNSS.

Additional Information

More information about this feature and related topics can be found in the following documentation:

- *3GPP TS 36.331, Evolved Universal Terrestrial Radio Access (E-UTRA); Radio Resource Control (RRC); Protocol specification*



- *3GPP TS 36.101, Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) radio transmission and reception; Protocol specification*
- *3GPP TS 36.413, Evolved Universal Terrestrial Radio Access Network (E-UTRAN); S1 Application Protocol (S1AP); Protocol specification*
- *3GPP TS 36.423, Evolved Universal Terrestrial Radio Access Network (E-UTRAN); X2 Application Protocol (X2AP); Protocol specification*



2 Dependencies of IDC for Uplink Carrier Aggregation

The feature has dependencies with other features related to uplink carrier aggregation.

Table 1 Feature Dependencies

Feature	Relationship	Description
Carrier Aggregation (FAJ 121 3046)	Prerequisite	IDC for Uplink Carrier Aggregation requires the Carrier Aggregation feature to be active.
Uplink Carrier Aggregation (FAJ 121 4425)	Prerequisite	IDC for Uplink Carrier Aggregation requires the Uplink Carrier Aggregation feature to be active.
Dynamic SCell Selection for Carrier Aggregation (FAJ 121 3063)	Related	The Dynamic SCell Selection for Carrier Aggregation feature is based on the Carrier Aggregation feature and offers the following additional functions: <ul style="list-style-type: none">—A cell used as a PCell can have multiple cells as SCell candidates.—Based on UE measurements and the SCell selection algorithm, the SCell of a UE is dynamically configured or deconfigured.

Hardware

No special hardware requirement is expected for this feature.



3 Feature Operation of IDC for Uplink Carrier Aggregation

Operational Process

1. A UE that supports IDC functionality indicates related UE capabilities to the eNodeB through IE `inDeviceCoexInd-UL-CA-r11`.
2. The eNodeB can configure Uplink Carrier Aggregation related IDC capable UEs to provide IDC indications in order to initiate transmission of the `InDeviceCoexIndication` message through IE `idc-Config`.
3. The UE reports its IDC issues to the eNodeB using the RRC message `InDeviceCoexIndication` with the following IEs:

Information Element	Implementation Rules and Limitations
<code>victimSystemType-r11</code>	Provides detailed victim system related control input to the feature IDC for Uplink Carrier Aggregation.
<code>AffectedCarrierFreqComb-r11</code>	Provides detailed control input regarding one frequency combination to the feature IDC for Uplink Carrier Aggregation. It is processed either as a stand-alone parameter list or in combination with IEs <code>wlan-r11</code> and/or <code>Bluetooth-r11</code> .
<code>AffectedCarrierFreqCombList-r11</code>	Lists frequency combinations which can cause IDC issues for the reporting UE if present.
<code>gps-r11</code>	Turns on handling for GPS related IDC if set to TRUE. Turns off handling for GPS related IDC if there is no value associated.
<code>glonass-r11</code>	Turns on handling for GLONASS related IDC if set to TRUE. Turns off handling for GLONASS related IDC if there is no value associated.
<code>bds-r11</code>	Turns on handling for BDS related IDC if set to TRUE. Turns off handling for BDS related IDC if there is no value associated.



Information Element	Implementation Rules and Limitations
galileo-r11	Turns on handling for Galileo related IDC if set to TRUE. Turns off handling for Galileo related IDC if there is no value associated.
wlan-r11	Turns on handling for WLAN related IDC if set to TRUE. Turns off handling for WLAN related IDC if there is no value associated. Presence of IE <code>affectedCarrierFreqCombList-r11</code> is also required.
bluetooth-r11	Turns on handling for Bluetooth related IDC if set to TRUE. Turns off handling for Bluetooth related IDC if there is no value associated. Presence of IE <code>affectedCarrierFreqCombList-r11</code> is also required.

4. The UE that has IDC problems does not receive uplink grants from the eNodeB on the affected SCells.
- If the IE `AffectedCarrierFreqCombList-r11` is included in the IDC indication, then uplink grants are disabled on SCells with the least anticipated impact on uplink throughput.
 - For victim systems referenced by the IE `VictimSystemType-r11`, uplink grants are disabled on SCells with bands causing interference on frequencies used by the victim systems.
 - If a previously received IDC indication identified a selected SCell as a cell that impacts IDC, then uplink grants are disabled when the SCell selection is made.
 - If an SCell is already configured, and it is known to be a cell that impacts IDC because of a received IDC indication, then uplink grants are disabled as a result.

The UE receives the uplink grants again from the eNodeB on the SCells once it is free from IDC issues. For this to happen, the UE must send a new `InDeviceCoexIndication`, where the information which originally triggered the disabling of the uplink grants are now removed. This can happen if the user turns off GPS on the UE.



Handover

When initiating a handover, the source eNodeB sends the required IEs in IE `HandoverPreparationInformation`. The target eNodeB uses the IDC parameters that it received from the source eNodeBs over S1AP and X2AP.



4 Network Impact of IDC for Uplink Carrier Aggregation

This feature has impact on IDC-capable UEs.

Capacity and Performance

When the UE sends an IDC indication by the dedicated RRC signalling to the eNodeB, and the eNodeB disables uplink grants on one or several carriers for the affected UE, then the uplink capacity of the UE is reduced.

Interfaces

No impact is expected from this feature.

Other Network Elements

UE must support Carrier Aggregation as specified in 3GPP Release 10 and it must also be IDC-capable.



5 Parameters for IDC for Uplink Carrier Aggregation

IDC for Uplink Carrier Aggregation introduces no new parameters and affects no legacy parameters. Three parameters connected to SCell selection, the channel number for the central downlink frequency, and the uplink channel bandwidth in the cell can affect the feature.

Table 2 Parameters

Parameter	Type	Description
EUtranCellRelation.s CellCandidate	Affecting	The value indicates whether the cell indicated by parameter cellrelation can be used as SCell for UEs using this cell as their PCell.
EUtranCellFDD.earfcn ul	Affecting	The channel number for the central downlink frequency. The mapping from channel number to physical frequency for specified EUTRA bands is described in 3GPP TS 36.104. The values that can be used depend on national, operator-specific frequency allocation as well as on the supported frequency bands in the RBS.
EUtranCellFDD.ulChan nelBandwidth	Affecting	The uplink channel bandwidth in the cell.



6 Performance of IDC for Uplink Carrier Aggregation

This section describes performance indicators, counters, and events associated with the IDC for Uplink Carrier Aggregation feature.

KPIs

Table 3 Key Performance Indicators

KPI	Description
Average UL PDCP UE Throughput for Carrier Aggregation	Values for this KPI are reduced, because when IDC for Uplink Carrier Aggregation is indicated and disables uplink grants on one or several carriers for the affected UE, then its uplink capacity is reduced.
UL PDCP UE Throughput Distribution	Values for this KPI are reduced, because when IDC for Uplink Carrier Aggregation is indicated and disables uplink grants on one or several carriers for the affected UE, then its uplink capacity is reduced.
Mean UL PDCP UE Throughput	Values for this KPI are reduced, because when IDC for Uplink Carrier Aggregation is indicated and disables uplink grants on one or several carriers for the affected UE, then its uplink capacity is reduced.
Average UL PDCP Cell Throughput	Values for this KPI can be reduced because of secondary impact from the cell not being able to fully use all uplink resources.
Average UL MAC Cell Throughput	Values for this KPI can be reduced because of secondary impact from the cell not being able to fully use all uplink resources.

Counters

The following new counters are introduced with this feature in MO Classes EUTRANCellFDD and EUTRANCellTDD:

- pmIdcSamp



- pmIdcCapableSum
- pmIdcCapableMax
- pmIdcUlCaCapableSum
- pmIdcUlCaCapableMax
- pmIdcUlCaSum
- pmIdcUlCaMax
- pmIdcUlCaVictimOnDistr
- pmIdcUlCaVictimOffDistr

Events

Table 4 Events

Event	Event Parameter	Description
LOCAL_PER_IDC_USERS	EVENT_PARAM_IDC_CAPABLE_USERS	Number of UEs that are IDC-capable.
	EVENT_PARAM_IDC_UL_CA_CAPABLE_USERS	Number of UEs that are IDC for Uplink Carrier Aggregation-capable.
	EVENT_PARAM_IDC_UL_CA_ACTIVE_USERS	Number of UEs with disabled uplink caused by IDC issues.
LOCAL_EVENT_IDC_INDICATION	EVENT_PARAM_IDC_VICTIM_SYSTEM	Number of times when UL CA is turned on and turned off for each victim system type reason.
	EVENT_PARAM_IDC_INDICATION_DIRECTION	This parameter determines if IDC for each victim system type is active or inactive.
LOCAL_RRC_IN_DEVICE_COEX_INDICATION	EVENT_PARAM_CRNTI	CRNTI value.
LOCAL_EVENT_IDC_ACTIVE_USERS_CHANGE	EVENT_PARAM_IDC_INDICATION_DIRECTION	This parameter determined if In-Device Coexistence is active or inactive for UE.

For a full list with detailed information about PM events, see the list files in the *List Files* library folder.



7 Activate IDC for Uplink Carrier Aggregation

To use IDC for Uplink Carrier Aggregation, it must be activated following the usual feature activation procedure.

Prerequisites

The license key is installed in the node.

CCTR is activated at least for a week. This ensures that troubleshooting data is available if something goes wrong.

Steps

1. Set the attribute `featureState` to `ACTIVATED` in the applicable MO instance, depending on node type:

Node Type	License Control MO
DU-based	<code>OptionalFeatureLicense=IdcForUplinkCarrierAggregation</code>
Baseband-based	<code>FeatureState=CXC4012264</code>

After This Task

Let the CCTR be active for one week, for continued collection of troubleshooting data.



8 Deactivate IDC for Uplink Carrier Aggregation

If IDC for Uplink Carrier Aggregation is no longer needed, it can be deactivated following the usual feature deactivation procedure.

Prerequisites

CCTR is activated at least for a week. This ensures that troubleshooting data is available if something goes wrong.

Steps

1. Set the attribute `featureState` to `DEACTIVATED` in the applicable MO instance, depending on node type:

Node Type	License Control MO
DU-based	<code>OptionalFeatureLicense=IdcForUplinkCarrierAggregation</code>
Baseband-based	<code>FeatureState=CXC4012264</code>

After This Task

Let the CCTR be active for one week, for continued collection of troubleshooting data.