ERICSSON

Dynamic SCell Selection for Carrier Aggregation

Feature Description

56/221 04-LZA 701 6014/1 Uen AK4D

Contents

1 Dynamic SCell Selection for Carrier Aggregation Overview

Access Type:	LTE
Feature Identity:	FAJ 121 3063
Value Package Name:	Advanced Carrier Aggregation, Carrier Aggregation
Value Package Identity:	FAJ 801 0564, FAJ 801 0405
Node Type:	Baseband Radio Node DU Radio Node
Licensing:	Licensed feature. Once license per radio.

Summary

The Dynamic SCell Selection for Carrier Aggregation feature is based on the Carrier Aggregation feature and offers the following functions:

— A cell used as a PCell can have more than one SCell candidate.

— An SCell candidate of a cell can be added or deleted without the need to lock and unlock the cell for the change to take effect.

— Based on L3 measurements and by the SCell selection algorithm, the SCell of a UE is dynamically configured or deconfigured.

— When the number of component carriers is decided, it is not considered whether the UE can support lower subset band combinations. Hence, there is more opportunity for a configuration with higher number of component carriers.

— After successful SCell configuration, any SCell deconfiguration attempt is prevented if it leads to an unsupported UE capability or non-standard Carrier Aggregation band combination.

Additional Information

Find additional information about Dynamic SCell Selection for Carrier Aggregation:

— 3GPP TS 36.331 v 10.5.0

— 3GPP TS 36.306 v 10.9.0

— 3GPP TS 36.133 v 10.11.0

- Carrier Aggregation
- Uplink Carrier Aggregation

2 Dependencies of Dynamic SCell Selection for Carrier Aggregation

Features

Table 1 Feature Dependencies

Feature	Relationship	Description
Carrier Aggregation(FAJ 801 0405)	Prerequisite	The feature Dynamic Scell Selection for Carrier Aggregation requires the feature Carrier Aggregation to be activated.
3CC DL Carrier Aggregation Extension(FAJ 121 3084)	Related	The UE is configured to use three carrier components. One carrier component is PCell and the other two are SCells. The PCell is the cell where the UE is connected and established the RRC connection, and operating on the primary frequency. The SCells operate on secondary frequencies and are configured once the RRC connection is established.
4CC DL Carrier Aggregation Extension(FAJ 121 4466)	Related	The UE is configured to use four carrier components. One carrier component is a PCell and the other three are SCells. The PCell is the cell where the UE is connected and established the RRC connection, and operating on the primary frequency. The SCells operate on secondary frequencies and are configured once the RRC connection is established.
5CC DL Carrier Aggregation Extension(FAJ 121 4467)	Related	The UE is configured to use 5 component carriers.The Dynamic SCell Selection selects from the configured and allowed SCell candidates, the SCells are configured at initial selection and at re-selection. The initial selection is a blind selection. The re-selection is based on L3 UE measurements.
Configurable SCell Priority(FAJ 121 4701)	Related	Configurable SCell Priority provides a flexible means to perform dynamic SCell selection by supporting configurable priorities for frequency and cell relations.
High Power UE(FAJ 121 4762)	Related	When Dynamic SCell Selection for Carrier Aggregation or Configurable SCell Priority is used with the High Power UE feature, the SCell selection mechanism is affected. When the MOM attribute `EUtranCellTDD.prioHpueCapability` is set to `PRIORITIZE_IN_CA`, no uplink SCell component is considered for high power UEs not capable of simultaneous high power and uplink carrier aggregation. Also, only such downlink SCell combinations are selected that allow the preservation of high power capability. If attribute `EUtranCellTDD.prioHpueCapability` is set to `NO_PRIORITIZATION`, the node dynamically switches between carrier aggregation and high power UE support. Dynamic switching is based on time normalized filtered uplink SINR measurements for DMRS, and controlled by the following attributes: —`EUtranCellTDD.hpueCaSwitchThres` —`EUtranCellTDD.hpueCaSwitchHyst` —`EUtranCellTDD.hpueCaSwitchTimeToTrigger`

Feature	Relationship	Description
Multiple Frequency Band Indicators(FAJ 121 3054)	Prerequisite	Since the Multiple Frequency Band Indicators additional frequency bands are considered at every step of the SCell candidate selection algorithm so that higher order Carrier Aggregation band combinations of component carriers can be configured, this feature is a prerequisite. The Dynamic SCell Selection for Carrier Aggregation feature is also affected by the Multiple Frequency Band Indicators feature. For more information, see Multiple Frequency Band Indicators.
Shared LTE RAN(FAJ 121 0860)	Related	When the Dynamic SCell Selection for Carrier Aggregation feature or the Configurable SCell Priority feature is used together with the Shared LTE RAN, the SCell selection takes into account the list of allowed PLMNs for each frequency relation. Only UEs with PLMN Ids included in the relevant frequency relation allowed PLMN list (parameter `EUtranFreqRelation.allowedPlmnList`) are configured with an SCell in that frequency. This prevents UEs capable of Carrier Aggregation that belong to one operator PLMN to be configured with SCells that are not allowed from another operator network.
Supplemental Downlink for Carrier Aggregation(FAJ 121 3068)	Related	FDD only: The feature Supplemental Downlink for Carrier Aggregation uses downlink only cells as SCell. When working with Dynamic SCell Selection for the Carrier Aggregation feature, the downlink only cell SCell candidates are given higher priority during initial SCell selection.
Uplink Carrier Aggregation(FAJ 121 4425)	Related	The Uplink Carrier Aggregation feature makes it possible for a UE to transmit data on more than one carrier simultaneously. Activation and deactivation of an SCell in the UE is done at the same time for DL and UL.
Carrier Aggregation-Aware IFLB(FAJ 121 3075)	Related	The source eNB can trigger unexpected handover and this can lead to a lower number of component carriers.
VoLTE Optimized Carrier Aggregation(FAJ 121 4884)	Related	When Dynamic SCell Selection for Carrier Aggregation is used with the VoLTE Optimized Carrier Aggregation feature, the SCell handling is affected during an active voice bearer service. Effects of the Enum values of the MOM attribute `EUtranCellFDD.sCellHandlingAtVolteCall` and `TDD.sCellHandlingAtVolteCall` that manage SCell handling during VoLTE calls are the following: **Value 1: `DECONF_SCELLS`** All SCell candidates evaluated during Initial SCell selection are removed when a voice bearer is established and SCell selection procedure is triggered again when the voice bearer is released. **Value 2: `DECONF_UL_SUPPRESS_DL_SCELLS`** UL SCells are deconfigured and Dynamic SCell Selection is suppressed during an active voice bearer service. **Value 3: `DECONF_UL_SCELLS`** Disables activities related to UL SCell selection during an active voice bearer service.

Hardware

No special hardware requirement is expected for this feature.

Limitations

No limitations for this feature.

Network Requirements

No Network Requirements for this feature.

3 Feature Operation

This section contains network requirements and feature operation process steps for Dynamic SCell Selection for Carrier Aggregation.

Network Requirements

— The cell is an SCell candidate for downlink only if attribute `EUtranCellRelation.sCellCandidate` is set to `ONLY_ALLOWED_FOR_DL`.

— A UE capable of Carrier Aggregation must support at least one of the configured SCell bands on the node in its supported band combinations, otherwise the UE cannot be configured with Carrier Aggregation.

— The attribute `CarrierAggregationFunction.sCellSelectionMode` must be set to a value that corresponds to the desired SCell selection mode.

Feature Operation Sequence Diagram

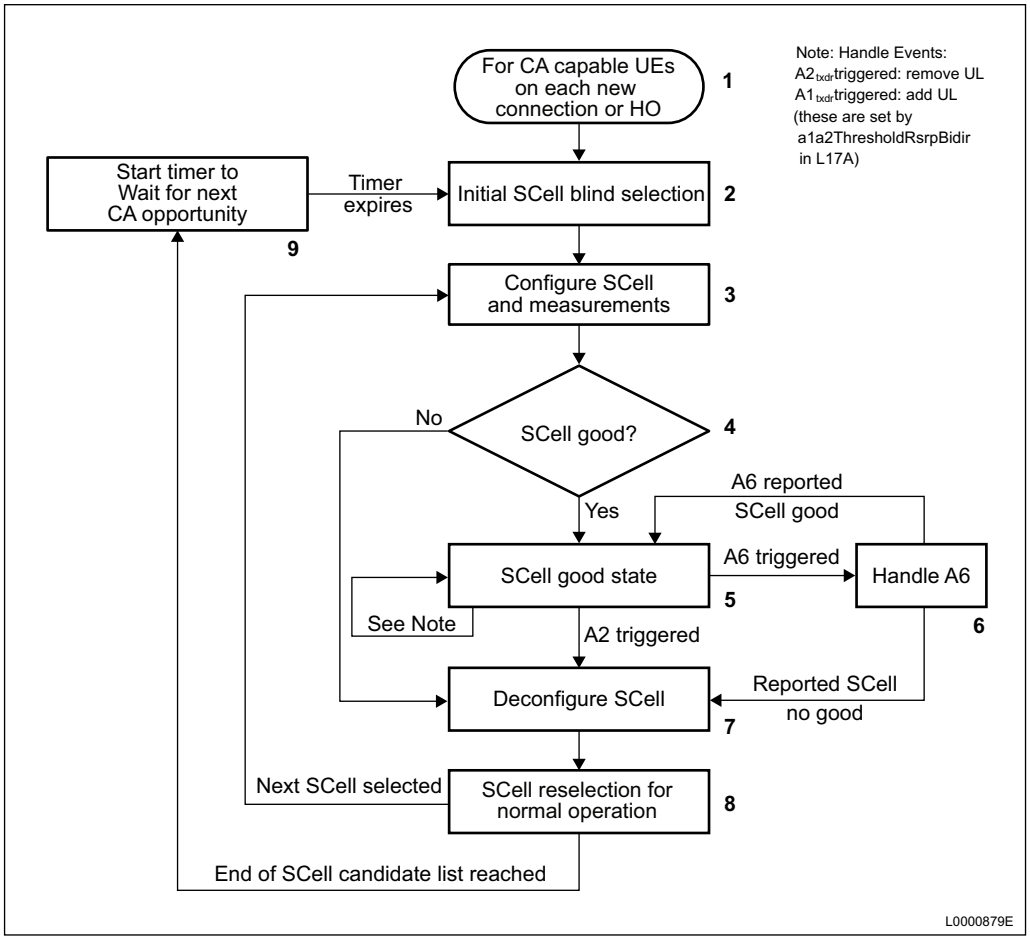

Figure 1 Sequence Diagram of Dynamic SCell Selection

Process Steps

1. Capabilities and any supported Carrier Aggregation band and bandwidth combinations are reported in recently connected UEs and those handed over from other cells. Only UEs capable of Carrier Aggregation are considered for SCell selection for Carrier Aggregation.

2. Initial SCell blind selection is handled.

    a. The UE-specific SCell candidate list is built. The list contains the intersection of the node cells configured as SCell candidates and the UE supported Carrier Aggregation band combinations. If the list is empty, no Carrier Aggregation is attempted for this UE until the next connection occurs.

Note: If Shared LTE RAN is enabled, `EUtranFreqRelation.allowedPlmnList` is checked before considering adding SCell candidates on that frequency relation. Only UEs with PLMN Ids included in the relevant frequency relation allowed PLMN list are configured with an SCell in that frequency.

If the relevant `EUtranFreqRelation.allowedPlmnList` is empty, the frequency relation and its respective cell relations are all allowed, and therefore considered as possible SCell candidates for UEs belonging to any PLMN. If the `EUtranFreqRelation.allowedPlmnList` contains at least one PLMN, the frequency relation and its respective cell relations are allowed and considered as possible SCell candidates only for UEs that have at least one of the listed PLMN Ids, if HRL is available. In this case the node also checks the UE equivalent PLMN Ids.

When HRL is not present, there are no restrictions on the SCell selection.

b. If the High Power UE feature is enabled, and attribute `EUtranCellTDD.prioHpueCapability` is set to `PRIORITIZE_IN_CA`, the SCell candidate list for high power UEs is modified in the following way:

   — If the UE is not capable of simultaneous high power and uplink carrier aggregation, the uplink component carrier is removed from SCell candidates.

   — Only such downlink SCell combinations are selected that allow the preservation of high power capability.

   — When the UE operates on band 41 in the PCell, inter-band SCells are excluded from the initial UE-specific SCell candidate list, to preserve high power UE capability while providing sufficient downlink throughput for the UE on band 41.

   If attribute `EUtranCellTDD.prioHpueCapability` is set to `NO_PRIORITIZATION`, the node dynamically switches between carrier aggregation and high power UE support. Dynamic switching is based on time normalized filtered uplink SINR measurements for DMRS, and controlled by the following MOs:

   — `EUtranCellTDD.hpueCaSwitchThres`

   — `EUtranCellTDD.hpueCaSwitchHyst`

   — `EUtranCellTDD.hpueCaSwitchTimeToTrigger`

   In bad radio conditions—when the uplink SINR is lower than `EUtranCellTDD.hpueCaSwitchThres` - `EUtranCellTDD.hpueCaSwitchHyst` for at least a time of `EUtranCellTDD.hpueCaSwitchTimeToTrigger`—the node switches to

support high power UE capability. The process is the same as when attribute EUtranCellTDD.prioHpueCapability is set to PRIORITIZE_IN_CA.

In good radio conditions—when the uplink SINR is higher than EUtranCellTDD.hpueCaSwitchThres + EUtranCellTDD.hpueCaSwitchHyst + the power value determined by the power class of the UE for at least a time of EUtranCellTDD.hpueCaSwitchTimeToTrigger—the node switches to uplink carrier aggregation mode. All component carriers are deconfigured and the SCell selection process is started without supporting high power UE capabilities.

c. If the VoLTE Optimized Carrier Aggregation feature is enabled and a voice bearer request is received over the S1 or X2 interface at Initial Context Setup, Incoming Handover, or RRC Connection Re-establishment with serviceType=VOIP, the SCell candidate list for the UE is removed or modified depending on the following values of the attribute EUtranCellFDD.sCellHandlingAtVolteCall or TDD.sCellHandlingAtVolteCall:

   — If the attribute EUtranCellFDD.sCellHandlingAtVolteCall or EUtranCellTDD.sCellHandlingAtVolteCall is set to DECONF_SCELLS, all SCell candidates are removed during a VoLTE call.

   — If the attribute EUtranCellFDD.sCellHandlingAtVolteCall or EUtranCellTDD.sCellHandlingAtVolteCall is set to DECONF_UL_SUPPRESS_DL_SCELLS, the following apply during a VoLTE call:

      • SCell selection does not start at VoIP bearer setup.

      • Measurement events of SCell are deleted to avoid later SCell configuration or deconfiguration.

      • UL component carriers are deconfigured.

   — If the attribute EUtranCellFDD.sCellHandlingAtVolteCall or EUtranCellTDD.sCellHandlingAtVolteCall is set to DECONF_UL_SCELLS, UL SCell candidate is changed to DL SCell and the SCells with DL only and no UL for the UE are configured.

d. If attribute CarrierAggregationFunction.sCellSelectionMode is set to either UN_ACK_SIMUTANEOUS_SCELL_SELECTION or ACK_SIMULTANEOUS_SCELL_SELECTION is set to, the MFBI additional bands are considered at every step of the SCell candidate selection algorithm. This means that SCell evaluation continues until the most preferable SCell candidate is found using all possible band combinations including MFBI additional bands. This provides more opportunity to configure higher order Carrier Aggregation component carrier.

e. One or more SCell candidates enabled from the SCell candidate list are selected in a sequence.

   — Only one SCell can be selected if `CarrierAggregationFunction.sCellSelectionMode` is set to `ACK_SEQUENTIAL_SCELL_SELECTION`.

   — Multiple SCells can be selected if `CarrierAggregationFunction.sCellSelectionMode` is set to `ACK_SIMULTANEOUS_SCELL_SELECTION` or `UN_ACK_SIMUTANEOUS_SCELL_SELECTION`.

   — If the node receives a frequency in the `MBMSInterestIndication` message from an MBMS on SCell capable UE (mbms-SCell-r11 = 1, 3GPP 36.331) and no SCell has already been configured with that frequency, SCells with the `MBMSInterestIndication` frequency (if any) are prioritized when selecting from the candidate list.

   While the selection is done, the node does not consider if lower subsets of carrier band combinations is supported by the UE. For example, when the UE is capable of 3CC Carrier Aggregation with P as PCell, S1 and S2 as SCells, but it does not support the combination P and S1, or P and S2, the UE is still configured for 3CC Carrier Aggregation with P, S1 and S2.

f. SCell selection priority can be used to determine which SCell is preferred when selecting an SCell to be configured. The prioritization is enabled by setting the `EUtranCellRelation.coverageIndicator` attribute to indicate cell overlap. The SCell priority is based on what type of overlap the cells have. The priority order is as follows where the default value `0` means that no prioritization applies:

   — 1 (COVERS)

   — 2 (OVERLAP)

   — 3 (CONTAINED_IN)

   — `0` (NONE)

   To use the attribute `EUtranCellRelation.coverageIndicator` with value 1 (COVERS) for SCell selection prioritization without also enabling blind handover, blind handover must be manually disabled. Otherwise blind handover becomes enabled for the cells where attribute `EUtranCellRelation.coverageIndicator` is set to value 1 (COVERS). This is done by setting the attribute `EUtranCellFDD.covTriggerdBlindHoAllowed` or `EUtranCellTDD.covTriggerdBlindHoAllowed` to false.

Note:

— If initial SCell blind selection runs after the timer `CarrierAggregationFunction.waitForCaOpportunity` has expired, it functions as if `CarrierAggregationFunction.sCellSelectionMode` is set to `ACK_SEQUENTIAL_SCELL_SELECTION`. No other setting of `CarrierAggregationFunction.sCellSelectionMode` takes effect in that case.

— In case all SCells candidates are removed by the VoLTE Optimized Carrier Aggregation feature during an active voice bearer service, the SCell blind selection to configure SCell is triggered again when the voice bearer is released.

3. The selected SCells and the following event measurements are configured.

   — Whether configure A1 or not depends on the attribute `CarrierAggregationFunction.sCellSelectionMode`.

   • `CarrierAggregationFunction.sCellSelectionMode` is set to A1 is configured for each SCell when `ACK_SEQUENTIAL_SCELL_SELECTION` or `ACK_SIMULTANEOUS_SCELL_SELECTION`

   • A1 is configured for each SCell whenA1 is not configured when `CarrierAggregationFunction.sCellSelectionMode` is set to `UN_ACK_SIMUTANEOUS_SCELL_SELECTION`. Since this mode assumes that SCells are in good coverage, avoiding the configuration of A1 helps to reduce RRC overhead.

   — A2 is always configured for each SCell.

   — If there is more than one SCell candidate on the same frequency for this UE, A6 is configured for each SCell.

   SCells are allowed to be configured only if the number of UEs capable of Carrier Aggregation does not exceed `CarrierAggregationFunction.caUsageLimit` and the number of connected users does not exceed a predetermined threshold based on `CarrierAggregationFunction.caPreemptionThreshold`. Otherwise Carrier Aggregation for this UE is terminated until the next connection occurs.

4. UE coverage is checked in the configured SCells. If coverage is good, go to Step 5. If coverage is poor, go to Step 7.

   An SCell is considered to have good coverage if any of the following conditions apply:

   • The attribute `CarrierAggregationFunction.sCellSelectionMode` is set to `UN_ACK_SIMULTANEOUS_SCELL_SELECTION`.

   • If the attribute `CarrierAggregationFunction.sCellSelectionMode` is set to `ACK_SEQUENTIAL_SCELL_SELECTION` or

ACK_SIMULTANEOUS_SCELL_SELECTION, the UE reports A1 event measurement on the SCell.

- The UE reports A6 event on the SCell, where the reported L3 measurements meet the A1 trigger parameter condition.

If the timer CarrierAggregationFunction.waitForBlindSelSCellRep expires without reception of a message indicating good coverage (A1 or A6), the SCell is considered to be out of coverage. Go to Step 7.

Note: The timer CarrierAggregationFunction.waitForBlindSelSCellRep that is the timer value while waiting for a confirmation of a blind SCell selection is calculated by the following formula:

CarrierAggregationFunction.waitForBlindSelSCellRep = CarrierAggregationFunction.waitForBlindSelSCellRepLessTtt + timeToTrigger

where:

— timeToTrigger = max (timeToTriggerA1, timeToTriggerA6)

— : The CarrierAggregationFunction.waitForBlindSelSCellRepLessTtt attribute is used to determine the value of timer CarrierAggregationFunction.waitForBlindSelSCellRep.

5. For each configured SCell, it is checked whether the SCell is good. It is checked how the SCell entered this state. The node handles the SCell depending on what type of event triggered its state.

Table 2

Triggering Condition	Description
A1 triggered	The current SCell is kept and the A1 event is removed.
A6 triggered	Go to Step 6.
A1 from ReportConfigSCellA1A2.a1a2ThresholdRsrpBidir is triggered	The SCell is deconfigured, and configured again with uplink Carrier Aggregation added, return to Step 5.
A2 from ReportConfigSCellA1A2.a1a2ThresholdRsrpBidir is triggered	The SCell is deconfigured, and configured again without uplink Carrier Aggregation, return to Step 5. **Note:** The uplink component carrier can be deconfigured without the possibility of unsupported Carrier Aggregation band combinations. Because the

Triggering Condition	Description
	maximum component carriers in uplink are two, so any deconfiguration of one component carrier cannot lead to unsupoprted or non-standard Carrier Aggregation band combination.

6. A6 event is handled.

   a. If A6 is triggered with its reported L3 measurements that meet the trigger condition of A1, the current SCell is deconfigured, and the SCell reported by the A6 event is configured. A2 and A6 are configured. Go to Step 5.

   b. If A6 is triggered, but its reported L3 measurements are below the threshold to trigger A1, or the reported cell is not an SCell candidate, go to Step 7.

7. The current SCell is deconfigured if any of the following applies:

   - The SCell is not good from Step 4.
   - The SCell is A2 triggered while in Step 5, and the deconfiguration of the SCell does not lead to unsupported UE capability or non-standard Carrier Aggregation band combination.
   - The SCell is A6 triggered without replacement of new SCell, so considered not good in Step 6, and the deconfiguration of the SCell does not lead to unsupported UE capability or non-standard Carrier Aggregation band combination.
   - The SCell is disabled while in Step 5. No measurement report (A2 or A6) is received. (LAA SCell is not applicable.)
   - If the VoLTE Optimized Carrier Aggregation feature is enabled and a voice bearer request is received at E-RAB Setup with `serviceType=VOIP`, the SCell is deconfigured depending on the following values of the attribute `EUtranCellFDD.sCellHandlingAtVolteCall` or `EUtranCellTDD.sCellHandlingAtVolteCall`:

     — If the attribute `EUtranCellFDD.sCellHandlingAtVolteCall` or `EUtranCellTDD.sCellHandlingAtVolteCall` is set to `DECONF_SCELLS`, all SCells which have been configured for the UE and measurements related to CA and SCells are deconfigured during a VoLTE call.

     — If the attribute `EUtranCellFDD.sCellHandlingAtVolteCall` or `EUtranCellTDD.sCellHandlingAtVolteCall` is set to `DECONF_UL_SUPPRESS_DL_SCELLS`, SCell selection does not start at VoIP bearer setup, Measurement events of SCell are deleted to avoid

later SCell configuration or deconfiguration, UL component carriers are deconfigured.

— If the attribute `EUtranCellFDD.sCellHandlingAtVolteCall` or `EUtranCellTDD.sCellHandlingAtVolteCall` is set to `DECONF_UL_SCELLS`, UL SCell which has been configured for the UE and measurement related to UL CA and SCell are deconfigured. In this case, DL in the SCell is kept.

In case the SCell is configured with missing subset of band combinations that leads to unsupported UE capability or non-standard Carrier Aggregation band combination, the SCell has an opportunity to be deconfigured in the following cases:

- When the UE connection is released.
- When the node receives a repeated A2 or A6 message, if deconfiguring the SCell does not lead to unsupported UE capability or non-standard Carrier Aggregation band combination any more, the SCell can be deconfigured. This happens, for example, when another SCell has been normally deconfigured before this repeated A2 or A6 event.

  Note: If the timer `CarrierAggregationFunction.waitForBlindSelSCellRep` is running, it is not stopped for the SCell when the node receives the A2 or A6 message.

- When the SCell is considered to be out of coverage because the timer `CarrierAggregationFunction.waitForBlindSelSCellRep` expires without reception of a message indicating good coverage (A1 or A6), and deconfiguring the SCell is prevented to avoid unsupported UE capability or non-standard Carrier Aggregation band combination, the timer is started again. At the next timer expiration, if deconfiguring the SCell does not lead to an unsupported UE capability or non-standard Carrier Aggregation band combination any more, the SCell can be deconfigured. This happens, for example, when another SCell has been normally deconfigured before this next timer expiration.

8. SCell re-selection during normal operation.

   The SCell candidate list is built in the same way as in Step 2. If the list is empty, no Carrier Aggregation is attempted for this UE until next connection. Otherwise it is checked if all the SCell candidates on the list have been configured once in the current iteration of SCell selection.

   a. If not, the next SCell candidate not configured is selected. Go to Step 3.

   b. If yes, go to Step 9.

9. The `CarrierAggregationFunction.waitForCaOpportunity` timer is started to wait for the next Carrier Aggregation opportunity.

4 Parameters

Feature Configuration Parameters

- CarrierAggregationFunction.sCellSelectionMode
- CarrierAggregationFunction.caPreemptionThreshold
- CarrierAggregationFunction.caUsageLimit
- CarrierAggregationFunction.waitForCaOpportunity
- ReportConfigSCellA1A2.a1a2ThresholdRsrp
- ReportConfigSCellA1A2.a1a2ThresholdRsrq
- ReportConfigSCellA1A2.hysteresisA1A2Rsrp
- ReportConfigSCellA1A2.hysteresisA1A2Rsrq
- ReportConfigSCellA1A2.timeToTriggerA1
- ReportConfigSCellA1A2.timeToTriggerA2
- ReportConfigSCellA1A2.triggerQuantityA1A2
- ReportConfigSCellA1A2.a1a2ThresholdRsrpBidir
- ReportConfigSCellA1A2.hysteresisA1A2RsrpBidirectional
- ReportConfigSCellA1A2.waitForBlindSelSCellRepLessTtt
- ReportConfigSCellA6.a6offset
- ReportConfigSCellA6.hysteresisA6
- ReportConfigSCellA6.timeToTriggerA6
- ReportConfigSCellA6.triggerQuantityA6

Affected Parameters

Table 3 Affected Parameters

Parameter	Description
UeMeasControl.sMeasure	sMeasure should be disabled for a PCell which has multiple SCell candidates with the same frequency.

Parameter	Description
	The benefit is quicker selection of a proper SCell and with fewer RRC messages.
ExternalEUtranCellFDD.isRemoveAllowed ExternalEUtranCellTDD.isRemoveAllowed	Parameter isRemoveAllowed (ExternalEUtranCellFDD.isRemoveAllowed, ExternalEUtranCellTDD.isRemoveAllowed) must be set to FALSE for those EUtranCellRelation MO instances whose sCellCandidate is set to ALLOWED. This ensures that these relation MOs used for specifying SCell candidates are not automatically removed by the Automated Neighbor Relations feature.
EUtranCellRelation.sCellCandidate	SCell candidate status. The value indicates whether the cell indicated by parameter cell relation can be used as SCell for UEs using this cell as their PCell. Changed value will take effect in relation to the next SCell configuration during the ongoing connection.

Parameters Affecting the Feature

Table 4 Parameters Affecting the Feature

Parameter	Description
EUtranCellFDD.sCellHandlingAtVolteCall EUtranCellTDD.sCellHandlingAtVolteCall	If VoLTE Optimized Carrier Aggregation feature is activated, SCell handling is based on the following Enum values of the MOM attribute sCellHandlingAtVolteCall that manages SCell handling during VoLTE calls: **Value 0** KEEP_SCELLS, is the default value. No changes in SCell handling. **Value 1** DECONF_SCELLS, deconfigures SCells during VoLTE calls. **Value 2** DECONF_UL_SUPPRESS_DL_SCELLS, deconfigures UL SCells and suppresses DL SCell selection during VoLTE calls. **Value 3** DECONF_UL_SCELLS, deconfigures UL SCells during VoLTE calls. No changes in DL SCell handling.
EUtranCellTDD.prioHpueCapability EUtranCellTDD.hpueCaSwitchThres EUtranCellTDD.hpueCaSwitchHyst EUtranCellTDD.hpueCaSwitchTimeToTrigger	When the MOM attribute EUtranCellTDD.prioHpueCapability is set to PRIORITIZE_IN_CA, no uplink SCell component is considered for high power UEs not capable of simultaneous high power and uplink carrier aggregation. Also, only such downlink SCell combinations are selected that allow the preservation of high power capability. If attribute EUtranCellTDD.prioHpueCapability is set to NO_PRIORITIZATION, the node dynamically switches between carrier aggregation and high power UE support. Dynamic switching is based on time normalized filtered uplink SINR measurements for DMRS, and controlled by the following attributes: —EUtranCellTDD.hpueCaSwitchThres —EUtranCellTDD.hpueCaSwitchHyst —EUtranCellTDD.hpueCaSwitchTimeToTrigger

5 Network Impact

Capacity and Performance

The Main Processor loading can be increased due to an RRC message load increase introduced in this feature. In particular, when a cell abruptly loses its RF power, either due to cell lock, or antenna failure, or both, an RRC message storm can occur if the cell is configured as an SCell that serves many UEs.

This feature is expected to improve network coverage. The Carrier Aggregation coverage area is expected to be improved for multiple SCell candidates in comparison with network coverage for a single SCell candidate.

Interfaces

No impact is expected from this feature.

Other Network Elements

No impact is expected from this feature.

6 Performance

KPIs

The following Key Performance Indicators (KPI) are associated with this feature:

— Downlink Latency, Downlink Latency per QC

— Average DL PDCP UE Throughput for Carrier Aggregation

— Average UL PDCP UE Throughput for Carrier Aggregation

— DL PDCP UE Throughput Distribution

— UL PDCP UE Throughput Distribution

— Mean DL UE PDCP Throughput

— Mean UL UE PDCP Throughput

Counters

The following counters in MO Classes `EUtranCellFDD` and `EUtranCellTDD` are associated with this feature:

— `pmCaConfiguredNoMeasAtt`

— `pmCaConfiguredMeasAtt`

— `pmCaConfiguredNoMeasSucc`

— `pmCaConfiguredMeasSucc`

— `pmCaConfiguredSamp`

— `pmCaDeconfigured`

— `pmCaDeconfiguredLostCoverage`

— `pmCaDeconfiguredSCellChange`

— `pmCaConfiguredDlSum`

— `pmCaConfiguredUlSum`

— `pmCaConfiguredSucc`

- pmPdcpVolDlDrb
- pmPdcpVolDlDrbCa
- pmPdcpVolUlDrb
- pmUeThpVolUl
- pmUeThpVolUlCa

Events

Table 5 Events

Event	Event Parameter	Description
INTERNAL_EVENT_UETR_MEASUREMENT_REPORT_RECEIVED	— EVENT_PARAM_MEASUREMENT_ID — EVENT_PARAM_MEAS_REQUESTER — EVENT_PARAM_NEIGHBOR_CGI — EVENT_PARAM_AFFECTED_MEAS_TYPE — EVENT_PARAM_RAT_TYPE	— The measurement ID for this UE measurement. — Indicates the function that requested the UE measurement. — Global Cell ID of the neighbor cell. — Reported RSRQ of the serving cell. — The measurement type that triggers the report.
INTERNAL_EVENT_MEAS_CONFIG_A6	EVENT_PARAM_EVENT_A6_OFFSET	The offset value for eventA6.
INTERNAL_PROC_UETR_RRC_SCELL_CONFIGURED	— EVENT_PARAM_GLOBAL_SCELL_ID — EVENT_PARAM_SCELL_SELECTION_METHOD — EVENT_PARAM_SERVING_RSRP — EVENT_PARAM_SERVING_RSRQ — EVENT_PARAM_SCELL_CONFIG_RESULT	— Identity of the cell used as SCell, defined in MOM, where eNB ID (20 bits) + Cell ID (8 bits) . — Method used to select SCell. — Reported RSRP of the serving cell. — Reported RSRQ of the serving cell. — Result code for SCell configuration attempt.
INTERNAL_EVENT_UETR_RRC_SCELL_DECONFIGURED	— EVENT_PARAM_GLOBAL_SCELL_ID — EVENT_PARAM_DESELECTION_REASON — EVENT_PARAM_SERVING_RSRP — EVENT_PARAM_SERVING_RSRQ	— Identity of the cell used as SCell, defined in MOM, where eNB ID (20 bits) + Cell ID (8 bits). — Reason for deconfiguring SCell. — Reported RSRP of the serving cell. — Reported RSRQ of the serving cell.

7 Activate Dynamic SCell Selection for Carrier Aggregation

Prerequisites

— The license key is installed in the node.

— Continuous Cell Trace Recording (CCTR) is activated since at least one week. This ensures there is troubleshooting data 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 Radio Node	`OptionalFeatureLicense=` DynamicScellSelection
Baseband-based Node	`FeatureState=CXC4011559`

After This Task

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

8 Deactivate Dynamic SCell Selection for Carrier Aggregation

Prerequisites

Continuous Cell Trace Recording (CCTR) is activated since at least one week. This ensures there is troubleshooting data 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 Radio Node	`OptionalFeatureLicense=` DynamicScellSelection
Baseband-based	`FeatureState=CXC4011559`

After This Task

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

9 Engineering Guidelines for Dynamic SCell Selection for Carrier Aggregation

caUsageLimit

It is recommended not to limit SCell connections using the attribute `CarrierAggregationFunction.caUsageLimit`, so that it is set to the largest permitted value. Instead, resources can be controlled using `caPreemptionThreshold`.

caPreemptionThreshold

The attribute `CarrierAggregationFunction.caPreemptionThreshold` configures the resource consumption margin in percentage, beyond which SCells should not be configured. If any increase in `pmCaConfiguredNoMeasAtt – pmCaConfiguredNoMeasSucc` is observed, the value of `caPreemptionThreshold` can be reduced from the default 50%, while monitoring for a decrease in accessibility and handover success.

sCellSelectionMode

The attribute `CarrierAggregationFunction.sCellSelectionMode` is recommended to be configured considering the PCell-SCell coverage relationship in different Carrier Aggregation deployment scenarios (see 3GPP 36.300 J.1 for typical Carrier Aggregation deployment scenarios).

Table 6 Configuration Guidelines for sCellSelectionMode

Mode	sCellSelectionMode	Description	Recommendation
ACK mode	`ACK_SEQUENTIAL_SCELL_SELECTION`	This mode only considers if the SCell has good coverage after an A1 measurement report is received from the UE. The SCell is deconfigured upon any A2 or A6 measurement report is received or an internal timer expired before receiving any A1, A2, or A6 measurement report. **Note:** Any deconfiguration attempt is prevented that leads to an unsupported UE capability or non-standard Carrier Aggregation band combination. Both downlink and uplink band combinations are considered.	This mode is safe for all Carrier Aggregation deployment scenarios, but increases RRC signaling overhead.
	`ACK_SIMULTANEOUS_SCELL_SELECTION`		
UN_ACK mode	`UN_ACK_SIMULTANEOUS_SCELL_SELECTION`	This mode assumes the SCell has good coverage as long as no A2 or A6 measurement report is received from the UE. **Note:**	This mode is recommended only for the Carrier Aggregation deployment scenarios where the SCell has same or larger coverage than the PCell. Because, if the

Mode	sCellSelectionMode	Description	Recommendation
		Any deconfiguration attempt is prevented that leads to an unsupported UE capability or non-standard Carrier Aggregation band combination. Both downlink and uplink band combinations are considered.	configured SCell has no radio coverage, and hence no A2 or A6 is reported, the node does not deconfigure this SCell, and the UE gets stuck.

For more information about `sCellSelectionMode` configuration in 3CC Carrier Aggregation, 4CC Carrier Aggregation, 5CC Carrier Aggregation, see 3CC DL Carrier Aggregation Extension, 4CC DL Carrier Aggregation Extension, and 5CC DL Carrier Aggregation Extension respectively.

waitForCaOpportunity

The value of the timer `CarrierAggregationFunction.waitForCaOpportunity` can be tuned to achieve a compromise between RRC overhead and how fast a UE is configured with a proper SCell. A larger value reduces the RRC messages generated by UEs which are out of coverage of any SCell candidates. A smaller value ensures that a UE that moves into the coverage of an SCell is configured with the SCell faster.

a1a2ThresholdRsrpBidir

The `ReportConfigSCellA1A2.a1a2ThresholdRsrpBidir` threshold is used to trigger the removal or configuration of the uplink aspect of an SCell. When the RSRP falls below the configured value `a1a2ThresholdRsrpBidir` - `hysteresisA1A2RsrpBidir`, the uplink aspect is removed. When the RSRP is above the configured value `a1a2ThresholdRsrpBidir` + `hysteresisA1A2Rsrp`, the uplink aspect is configured in addition to the downlink direction.

For guidelines, see Uplink Carrier Aggregation.

a1a2ThresholdRsrp

The `ReportConfigSCellA1A2.a1a2ThresholdRsrp` threshold is closely related to the activation and deactivation threshold `CarrierAggregationFunction.sCellScheduleSinrThres`. For example, for 2Tx rank 2 with noise only scenario, the `a1a2ThresholdRsrp` is set to `sCellScheduleSinrThres` − 126 or lower, to avoid deconfiguring the SCell while it is still activated.

The guidelines for setting `a1a2ThresholdRsrp` is based on the following principles:

— An SCell should not be deconfigured while it is still activated.

— When an SCell is deactivated due to poor channel conditions, the SCell should be deconfigured to free up resources.

There are, however, situations that warrant setting the threshold a1a2ThresholdRsrp differently. For example, if there is only one SCell candidate in the deployment and the cell load is low, then an SCell should not be deconfigured while it is still activated. So a1a2ThresholdRsrp can be set to a very low value to avoid deconfiguring the SCell when the UE is out of coverage. This reduces RRC signalling and the SCell can quickly be reactivated when the RF condition is improved.

waitForBlindSelSCellRepLessTtt

The attribute CarrierAggregationFunction.waitForBlindSelSCellRepLessTtt is used to determine the timer value while waiting for a confirmation of a blind SCell selection and can be configured in a way to prevent the unnecessary deconfiguration of a good SCell.

9.1 Configuring Dynamic Switching Between Carrier Aggregation and High Power UE Capability

If attribute EUtranCellTDD.prioHpueCapability is set to NO_PRIORITIZATION, the node dynamically switches between carrier aggregation and high power UE support. Dynamic switching is based on time normalized filtered uplink SINR measurements for DMRS, and controlled by the following attributes:

— EUtranCellTDD.hpueCaSwitchThres

— EUtranCellTDD.hpueCaSwitchHyst

— EUtranCellTDD.hpueCaSwitchTimeToTrigger

Table 7 Recommended Configuration for Dynamic Switching between Carrier Aggregation and High Power UE

MO Attribute	Recommended Value	Description
EUtranCellTDD.hpueCaSwitchThres	More than 50	To prevent UplinkTriggered Inter-Frequency Mobility to move the UE out of the cell, it is recommended that EUtranCellTDD.hpueCaSwitchThres - EUtranCellTDD.hpueCaSwitchHyst is higher than the uplink search threshold ReportConfigSearch.a1a2UlSearchThreshold.
EUtranCellTDD.hpueCaSwitchHyst	20	
EUtranCellTDD.hpueCaSwitchTimeToTrigger	40	

Appendix A: Feature Change History

This section lists changes that affected this feature and the impact it had on network.

Appendix A.a: Waiting Timer Control for SCell Good Coverage Measurement Report

Access Type:	LTE
Hardware Platform:	All
Licensing:	Dynamic SCell Selection for Carrier Aggregation, FAJ 121 3063

This enhancement to the Dynamic SCell Selection for Carrier Aggregation feature provides the possibility to configure the timer value while waiting for a confirmation of a blind SCell selection. It is possible to configure the timer value to wait for SCell good coverage measurement report. The timer can be configured in a way to prevent the unnecessary deconfiguration of a good SCell. As a result, this offers a positive impact on UE throughput.

The timer waitForBlindSelSCellRep to wait for SCell good coverage measurement report can be configured by the operator using the `waitForBlindSelSCellRepLessTtt` attribute in the MO class `CarrierAggregationFunction`.

Note: The operator who sets the system constant using the non-default values have to rewrite the setting value using the MOM attribute `waitForBlindSelSCellRepLessTtt`.

Capacity and Performance

No impact.

Operation

The following new MOM attribute is introduced:

Table 8 New MO Attributes

MO Class	Attribute	Description
`CarrierAggregationFunction`	`waitForBlindSelSCellRepLessTtt`	Amount of time to wait for blind SCell selection to return a measurement report, excluding the time to trigger. After waitForBlindSelSCellRep =

MO Class	Attribute	Description
		waitForBlindSelSCellRepLessTtt + max(timeToTriggerA1, timeToTriggerA6), if no report is received, this SCell is deemed not to have coverage.

Interfaces

No impact.

Other Network Elements

No impact.

Appendix A.b: 18.Q3: SCell Candidate Enhancements

This enhancement to the Dynamic SCell Selection for Carrier Aggregation feature provides more opportunity to configure higher order Carrier Aggregation band combinations of component carriers with searching Multiple Frequency Band Indicators for additional bands.

Feature Name:	Dynamic SCell Selection for Carrier Aggregation,
Feature Identity:	FAJ 121 3063 R4
Value Package Name:	Carrier Aggregation
Value Package Identity:	FAJ 801 0405 R11
Node Type:	DU Radio Node, Baseband Radio Node
Access Type:	LTE

This enhancement to the Dynamic SCell Selection for Carrier Aggregation feature provides more opportunity to configure higher order Carrier Aggregation band combinations of component carriers with searching Multiple Frequency Band Indicators for additional bands. Therefore, higher throughput can be achieved.

Capacity and Performance

No impact.

Operation

This enhancement is activated when attribute `sCellSelectionMode` is set to either `UN_ACK_SIMUTANEOUS_SCELL_SELECTION` or `ACK_SIMULTANEOUS_SCELL_SELECTION`.

Table 9 Feature Dependencies

Feature	Relationship	Description
Multiple Frequency Band Indicators	Prerequisite	Since the Multiple Frequency Band Indicators additional frequency bands are considered at every step of the SCell candidate selection algorithm so that higher order Carrier Aggregation band combinations of component carriers can be configured, this feature is a prerequisite.
Carrier Aggregation-Aware IFLB	Related	The source eNB can trigger unexpected handover and this can lead to a lower number of component carriers.

Interfaces

No impact.

Hardware

No special hardware requirements.

Other Network Elements

No impact.

Appendix A.c: CA Performance Optimization

Access Type: LTE

Hardware Platform: All DU products

Licensing: Carrier Aggregation
FAJ 121 3046
Dynamic SCell Selection
FAJ 121 3063

This enhancement provides carrier aggregation performance optimization, and enhances Carrier Aggregation related features and Dynamic SCell Selection feature. Internal parameters related to the Dynamic SCell Selection feature are set to enabled by default.

Capacity and Performance

No impact.

Operation

New pmCounters

— pmPdcpVolDlDrbCa: The total volume (PDCP SDU) on Data Radio Bearers. For KPI CA DL PDCP UE Throughput

— pmPdcpVolDlDrbLastTTICa: The total volume (PDCP SDU) on Data Radio Bearers of carrier aggregation UE. For KPI CA DL PDCP UE Throughput

— pmUeThpTimeDlCa: The effective DL transport time of carrier aggregation UE comprises those periods from when the first part of the PDCP SDU of the DL buffer was transmitted on Uu until the buffer is emptied, excluding the TTI emptying the buffer. For KPI CA DL PDCP UE Throughput.

— pmUeThpVolUlCa: The UL DRB volume used for UL carrier aggregation UE throughput. For KPI CA UL PDCP UE Throughput.

— pmUeThpTimeUlCa: The UL volume transfer time used for UL carrier aggregation UE Throughput. For KPI CA UL PDCP UE Throughput.

— pmUeThp2DlDistr: Distribution of the DL UE throughput. As KPI Downlink UE PDCP Throughput Distribution.

— pmUeThp2UlDistr: Distribution of the UL UE throughput. As KPI Uplink UE PDCP Throughput Distribution.

Interfaces

No impact.

Other Network Elements

No impact.

Appendix A.d: 18.Q3: Improved Handling of Carrier Aggregation When Subset of SCells Is Missing

Access Type:	LTE
Hardware Platform:	All
Licensing:	Dynamic SCell Selection for Carrier Aggregation, FAJ 121 3063 R4

With the enhancement there is more opportunity for Carrier Aggregation configuration with higher number of component carriers.

When the number of component carriers is decided, it is not considered whether the UE can support lower subset band combinations.

After successful SCell configuration, any SCell deconfiguration attempt is prevented if it leads to an unsupported UE capability or non-standard Carrier Aggregation band combination.

Capacity and Performance

No impact.

Operation

No impact.

Interfaces

No impact.

Other Network Elements

No impact.

Appendix A.e: 17.Q4: Dynamic SCell Selection for Carrier Aggregation Enhancements

This feature enhancement handles the shutting down of capacity cells triggered by Cell Sleep Mode (CSM) or any system-initiated soft lock functionality. This feature triggers SCell deconfiguration on CA stuck UEs which do not report any configured measurement report when SCell is disabled. This improves Carrier Aggregation (CA).

Feature Name:	Dynamic SCell Selection for Carrier Aggregation
Feature Identity:	FAJ 121 3063 R4
Value Package Name:	Carrier Aggregation
Value Package Identity:	FAJ 801 0405 R9
Node Type:	Baseband Radio Node, DU Radio Node
Access Type:	LTE

This feature enhancement handles the shutting down of capacity cells triggered by Cell Sleep Mode (CSM) or any system-initiated soft lock functionality. This feature triggers SCell deconfiguration on CA stuck UEs which do not report any configured measurement report when SCell is disabled. This improves Carrier Aggregation (CA).

Capacity and Performance

No impact.

Operation

The following pmCounter is updated:

Table 10 Updated pmCounters

pmCounter	Description
pmCaDeconfiguredOoc	Accumulated when the SCell deconfiguration is initiated because of poor coverage in the SCell. It includes either receiving A2 measurement or time-out for no measurement report.

The following pmEvents are updated:

Table 11 Updated pmEvents

pmEvent	Description
INTERNAL_EVENT_UETR_RRC_SCELL_DECONFIGURED	Generated when the SCell is deconfigured because no measurement report is received from the UE when the SCell is disabled.
INTERNAL_EVENT_RRC_SCELL_DECONFIGURED	

Interfaces

No impact.

Hardware

No special hardware requirements.

Other Network Elements

No impact.