



# Test Plan for LTE Carrier Aggregation Interoperability

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## Section 1 Introduction

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### 1.1 Purpose

This document lists the test cases for the interoperability testing of the Carrier Aggregation feature defined in 3GPP Rel. 10 and above. These tests cover the following broad areas:

- Basic Carrier Aggregation Configuration and Activation Functionality
- Connected Mode Mobility in Carrier Aggregation Enabled Cells
- Idle Mode Mobility in Carrier Aggregation Enabled Cells
- Data Throughput Performance in Carrier Aggregation Enabled Cells
- Carrier Aggregation Interaction with Legacy Network Features

### 1.2 Scope

This document is intended for use by LTE Device, Network and Equipment vendors and Wireless Operators to conduct device to network interoperability testing specifically related to LTE Carrier Aggregation (CA). The tests defined in this document contain recommended suite of test cases that apply to the CA features.

This test plan is to be executed in addition to the CTIA Test Plan for LTE Interoperability [1] for all Carrier Aggregation capable UEs.

This version of test plan specifies test instructions for two Component Carriers. Updates for two or more Component Carriers will be in new version in the future.

### 1.3 Applicable Documents

The following documents are referenced in this test plan:

#### CTIA Related References:

Note: All CTIA specifications can be found at the following location:

<http://www.ctia.org/policy-initiatives/certification/certification-test-plans>

[1] CTIA Test Plan for LTE Interoperability Ver. 3.1

#### 3GPP Related References:

[2] 3GPP TS 36.101 *E-UTRA UE Radio Transmission and Reception* (Release 13)

[3] 3GPP TS 36.331 *Radio Resource Control (RRC); Protocol Specification* (Release 13)

[4] 3GPP TS 36.523-1 *E-UTRA and EPC; UE Conformance Specification; Protocol Conformance Specification*

[5] 3GPP TS 24.301 *UMTS; LTE; NAS Protocol for EPS; Stage 3*

[6] 3GPP TS 36.321 *LTE; E-UTRA; MAC Protocol Specification*

### 1.4 Acronyms and Definitions

Acronym	Definition
1xCSFB	1x Circuit Switched Fallback
1xRTT	1x (single-carrier) Radio Transmission Technology
3GPP	3rd Generation Partnership Project
ANR	Automatic Neighbor Relation
CA	Carrier Aggregation
CDMA	Code Division Multiple Access
CQI	Channel Quality Indicator
CSI	Channel State Information
CSIM	CDMA Subscriber Identity Module
DL	Down Link
DRB	Data Radio Bearer
ECGI	EUTRAN Cell Global ID
eCSFB	Enhanced Circuit Switched Fallback
e1xCSFB	Enhanced 1x Circuit Switched Fallback
eHRPD	evolved High Rate Packet Data
eNB	Evolved Node B
eNBES	Evolved Packet System
E-UTRAN	Evolved-Universal Terrestrial Radio Access Network
EVDO	cdma2000 1xRTT Evolution – Data Only
FGI	Feature Group Indicator
FTP	File Transfer protocol
ICMP	Internet Control Message Protocol
IE	Information Element

Acronym	Definition
IOT	Interoperability Testing
IP	Internet Protocol
IPv4	Internet Protocol version 4 (32-bit address)
IPv6	Internet Protocol version 6 (128-bit address)
IRAT	Inter-Radio Access Technology
IWS	Interworking Solution
LCID	Logical Channel ID
LTE	Long-Term Evolution
MAC	Medium Access Control
MCC	Mobile Country Code
MIMO	Multiple Input - Multiple Output
MMSS	Multi-Mode System Selection
MO	Mobile-Originated
MT	Mobile-Terminated
NAS	Non-Access-Stratum
MNC	Mobile Network Code
OEM	Original Equipment Manufacturer
OS	Operation System
PCC	Primary Component Carrier
PCS	Personal Communications Service
PDCCH	Physical Downlink Control Channel
PDU	Protocol Data Unit
PLMN	Public Land Mobile Network
PMI	Precoding Matrix Indicator

Acronym	Definition
PRI	Program Release Instructions
PTI	Procedure Transaction Identity
QAM	Quadrature Amplitude Modulation
RAT	Radio Access Technology
RI	Rank Indicator
RLF	Radio Link Failure
RRC	Radio Resource Control
RSRP	Reference Signal Receive Power
SCC	Secondary Component Carrier
SIB	System Information Block
SMS	Short Message Services
SRB	Signaling Radio Bearer
TAU	Tracking Area Update
TCP	Transmission Control Protocol
TS	Technical Standard
UDP	User Datagram Protocol
UE	User Equipment
UHDM	Universal Handoff Direction Message
UICC	USIM Integrated Circuit Card
UL	Up Link
USIM	Universal Subscriber Identity Modules

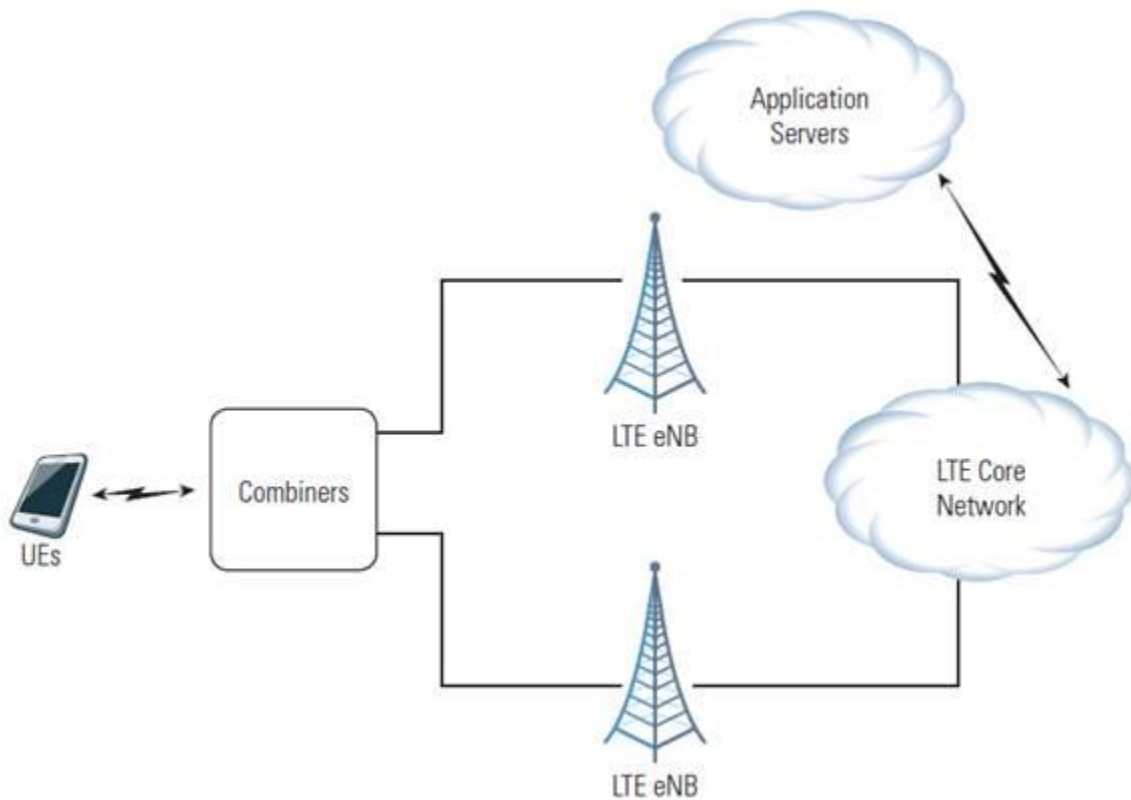
### 1.5 Terms and Definitions

Term	Definition
Average throughput	Calculated as number delivered units of total bits or bytes over total time. The total time is calculated from the start of the first bits or bytes to the end of the last bits or bytes received.
Operator Market Endorsement	Endorsement by MNO(s) to specify test or implementation configuration
Throughput	Rate of successful message delivery over a communication channel. In this test plan message throughput is used for measurement are delivered messages at the application layer using tools such as iperf or ftp to send and receive UDP or TCP frames. In this test plan throughput is the sum of the data rates that are delivered through all the component carriers specified in the test case. Test case may specify which tool to be used.

### 1.6 Basic Lab Configuration

Figure 1.6-1 below shows the basic lab configuration, which reflects the network implementation of the LTE Wireless 3GPP network deployment.

FIGURE 1.6-1 BASIC LAB CONFIGURATION



## 1.7 Network Requirements

The network shall provide the following key functions to execute all test cases listed in this document. If execution of only a subset of the test cases is planned, the network requirements should be adjusted accordingly.

The network must be able to support multiple carriers for Carrier Aggregation feature.

Unless otherwise noted, the following are default configuration:

- All eNBs must use Open Loop Spatial Multiplexing with a DL modulation of 64QAM.
- All signal level changes to the DUT shall be executed using attenuators.
- All downlink power adjustments shall be executed through the use of attenuators. Care must be taken to ensure that the attenuators for each downlink path provide a downlink power level that's balanced within +/- 2 dB. If possible, external RF components (such as duplexers or circulators) should be used on the DUT's conducted uplink antenna port to allow independent control of the uplink vs. the downlink path loss.

## 1.8 UE and UICC Setup Details

To execute this test plan, the UE must be configured for Carrier Aggregation – defined below in Section 1.11.

For data connectivity verification over LTE, Iperf or ICMP ping application can be used from the tethered equipment, or from the embedded application or OS.

### 1.8.1 Setup Details

UICC cards with the following setup and details need to be prepared for Carrier Aggregation IOT:

- UICC card with USIM application should be used.
- UICC card with both CSIM applications should be used for the test cases that require interaction with 1Xrtt system or 1x-eCSFB cases.
- RRC security settings
- NAS security settings
- MMSS provisioning such that LTE is the highest preferred RAT

### 1.8.2 UE Capabilities

UE Capabilities shall be set in the rf-Parameters-v1020 parameter found in the UE Capability Information message for the following parameters:

bandEUTRA-r10: to include the LTE Band(s) which will be used for CA cells as per CA configuration in [2].

ca-BandwidthClassUL-r10: to specify the UL bandwidth as per CA configuration in [2].

ca-BandwidthClassDL-r10: to specify the combined DL bandwidth as per CA configuration in [2].

supportedMIMO-CapabilityDL-r10→twoLayers

Also UE should include ue-CategoryDL parameter which will determine the expected throughput in DL direction as indicated in

value UE-EUTRA-Capability ::= { accessStratumRelease rel10,ue-Category <X>,}

The UE must support carrier aggregation for at least two downlink component carriers as stated in 3GPP Rel-10 or above.

## 1.9 E-UTRAN Diagnostic Logging Requirements

For debugging issues encountered in IOT, specific logging might be required.

### 1.10 UE Diagnostic Logging Requirements

E-UTRAN should have the capability to log and decode signaling messages from layers 1 to 3 between the UE and the network.

### 1.11 E-UTRAN Carrier Aggregation Configuration

For detailed information of the possible configuration of the following permutation, please see [Appendix B](#).

- Intra-band contiguous CA operating bands and channel bandwidths (e.g. 3GPP Class C, D, E or F)
- Inter-band CA operating bands (two bands) and channel bandwidths (e.g. 3GPP Class A)
- Intra-band, non-contiguous CA operating bands and channel bandwidths (e.g. 3GPP Class A)

### 1.12 E-UTRAN SIB8 Default Configuration

The following minimum fields in the SIB8 message must be configured and transmitted for eCSFB and 1X/LTE Hybrid related test cases.

- systemTimeInfo
- searchWindowSizecsfb-RegistrationParam1xRTT
- cellReselectionParametersCDMA2000
- longCodeState1XRTT
- csfb-RegistrationParam1xRTT-v920
- cellReselectionParametersCDMA2000-v920
- ac-BarringConfig1XRTT

### 1.13 Passing Throughput Criteria

Throughput of UE that is configured and activated for CA depends on UE Category, Band class and bandwidth. For calculated maximum throughput please check 3GPP TS 36.306 Section 4.1 and 3GPP TS 36.101 Annex A.3.



## 2 Basic Two Carrier Aggregation Functionality

---

### 2.1 Attach in CA Configured Cell

#### 2.1.1 Definition and Purpose

The purpose of this test is to verify that the UE can be successfully configured with RRC Connection Re-configuration procedure to a secondary component carrier (SCC) for carrier aggregation, during UE's initial access procedure to the primary component carrier (PCC).

#### 2.1.2 Initial Settings

- Configure the UE per Section 1.8.
- Configure PCC and SCC as defined in Appendix B or by operator endorsed combination.
- PCC is active.
- SCC is inactive.
- UE is powered off.

#### 2.1.3 Procedure

1. Power up the UE.
2. Wait for the UE to attach to the PCC, according to 3GPP TS 36.523-1 [4] clause 9.2.1.1.1.
3. Cause an SCC to be configured by sending an *RRCCConnectionReconfiguration* message containing *sCellToAddModList* with a SCC addition, according to 3GPP TS 36.523-1 [4] clause 8.2.2.3.1.

#### 2.1.4 Expected Results

After Step 1, verify that:

- The UE attaches to the PCC and receives an attach accept message from the network, as per 3GPP TS 24.301 [5], clauses 5.3.1.2 and 3GPP TS 36.331 [3] clauses 5.3.3.3 and 5.3.3.4.
- The UE has flags set to indicate support of CA and the band combinations enlisted in the contents of the *rf-Parameters-v1020* parameter found in the UE Capability Information message by Section 1.7.
- The UE has the correct setup as defined by Section 1.8.

After Step 3, verify that:

- The UE is successfully configured with SCC configuration through the contents of the *sCellToAddModListsCell-r10* parameter found in the *RRCCConnectionReconfiguration* message as per 3GPP TS 36.331 [3], clause 5.3.10.3b.
- The UE transmits an *RRCCConnectionReconfigurationComplete* message after the successful attachment to the SCC as per 3GPP TS 36.331 [3], clause 5.3.10.3b.

## 2.2 SCC Configuration after RRC IDLE to RRC CONNECTED Transition

### 2.2.1 Definition and Purpose

The purpose of this test is to verify that the UE can be successfully re-configured with RRC Connection Re-configuration procedure to an SCC for carrier aggregation, after the UE has transitioned from the RRC Idle state to the RRC connected state.

### 2.2.2 Initial Settings

- Test Case 2.1 has been successfully executed.
- Configure the UE per Section 1.8.
- Configure the PCC and SCC as defined in [Appendix B](#) or by operator endorsed combination.
- PCC is active.
- SCC is inactive.
- UE is idle camped on the PCC.

### 2.2.3 Procedure

1. Use ICMP to ping the UE from the network.
  - UE performs Service Request procedure, according to 3GPP TS 36.523-1 [4], clause 8.1.1.1.
2. Send an *RRCCONNECTIONRECONFIGURATION* message containing *sCellToAddModListsCell* with an SCC addition to the UE.
  - UE performs RRC Connection Reconfiguration according to 3GPP TS 36.523-1 [4], clause 8.2.2.3.1.

### 2.2.4 Expected Results

After Step 1, verify that:

- The UE transitions to RRC connected state by Service Request procedure and responds to the ping from the network, as defined by 3GPP TS 36.331 [3], 5.3.3.
- The UE has flags set to indicate support of carrier aggregation and the band combinations enlisted in the contents of the *rf-Parameters-v1020* parameter found in the UE Capability Information message.

After Step 2, verify that:

- The UE is successfully configured with SCC configuration through the contents of the *sCellToAddModList-r10* parameter found in the *RRCCONNECTIONRECONFIGURATION* message as per 3GPP TS 36.331 [3], clause 5.3.10.3b.
- The UE shall transmit an *RRCCONNECTIONRECONFIGURATIONCOMPLETE* message after the successful attachment to the SCC as per 3GPP TS 36.331 [3], clause 5.3.10.3b.

## 2.3 SCC De-Configuration after RRC CONNECTED to RRC IDLE transition

### 2.3.1 Definition and Purpose

The purpose of this test is to verify that the SCC can be successfully de-configured from the UE with *rrcConnectionRelease* for CA, after UE transitions from RRC Connected to RRC Idle state.

### 2.3.2 Initial Settings

- Configure the UE per Section 1.8.
- Configure PCC and SCC as defined in [Appendix B](#) or by operator endorsed combination.
- PCC is active.
- SCC is inactive.
- UE is attached to the PCC and SCC in the RRC Connected state.

### 2.3.3 Procedure

2. Send an *RRCCConnectionRelease* message with release cause 'other' to the UE.
  - UE shall begin the RRC Connection Release procedure, according to 3GPP TS 36.523-1 [\[4\]](#), clause 8.1.3.1.
3. Let the UE inactivity timer expire.
  - UE shall complete the RRC Connection Release procedure, according to 3GPP TS 36.523-1 [\[4\]](#), clause 8.1.3.1.

### 2.3.4 Expected Results

After Step 1, verify that:

- The eNB sends *rrcConnectionRelease* message.
- The inactivity timer starts as per 3GPP TS 36.331 [\[3\]](#), clause 5.3.8.3.

After Step 2, verify that:

- The UE connection has been released at the expiry of the inactivity timer.
- *RRCCConnectionRelease* procedure is completed as per 3GPP TS 36.331 [\[3\]](#), clause 5.3.8.3.
- All radio resources have been released.
- The UE is idle on the PCC.
- The SCC has been de-configured from the UE.

## 2.4 SCC Activation with Timer Deactivation

### 2.4.1 Definition and Purpose

The purpose of this test is to verify that the UE can successfully activate an SCC, using Activation MAC control element, and deactivate an SCC, due to timer expiry, for CA when instructed by eNB.

### 2.4.2 Initial Settings

- Configure the UE per Section 1.8.
- Configure PCC and SCC as defined in [Appendix B](#) or by operator endorsed combination.

- PCC is active.
- SCC is inactive.
- UE is attached to the PCC in the RRC Idle state.
- UE is in good radio conditions for both the PCC and SCC.
- Set *sCellDeactivationTimer* to rf4 (4 radio frames).

### 2.4.3 Procedure

1. Page the UE for RRC connection.
  - UE performs Service Request procedure, according to 3GPP TS 36.523-1 [4], clause 8.1.1.1.
2. Send an *RRCCONNECTIONRECONFIGURATION* message containing *sCellToAddModList* with a SCC addition to the UE.
  - UE performs RRC Connection Reconfiguration according to 3GPP TS 36.523-1 [4], clause 8.2.2.3.1.
3. Send the activation/deactivation MAC control element from the eNB to activate the configured SCC.
  - SCC is activated according to 3GPP TS 36.523-1 [4], clause 7.1.9.1.
4. Start *sCellDeactivationTimer*.
5. Let the *sCellDeactivationTimer* expire.
  - Deactivate SCC due to expired timer, according to 3GPP TS 36.523-1 [4], clause 7.1.9.1.

### 2.4.4 Expected Results

After Step 1, verify that:

- The UE transitions to RRC connected state by Service Request procedure and responds to the ping from the network, as per 3GPP TS 36.331 [3], clause 5.3.3.

After Step 2, verify that:

- The UE is successfully configured with SCC configuration through the contents of the *sCellToAddModList-r10* parameter found in the *RRCCONNECTIONRECONFIGURATION* message as per 3GPP TS 36.331 [3], clause 5.3.10.3b.
- The UE shall transmit an *RRCCONNECTIONRECONFIGURATIONCOMPLETE* message after the successful attachment to the SCC as per 3GPP TS 36.331 [3], clause 5.3.10.3b.

After Step 3, verify that:

- The eNB activates the configured SCC by sending the Activation MAC control element.
- When the UE received the MAC control element with LCID equal to 11011 (27), it started monitoring the SCC according to was configured in the *rrcReconfiguration* message, as per 3GPP TS 36.321 [6], clause 5.13.
- The UE sends CQI for both PCC and SCC after activation.

After Step 5, verify that:

- The UE de-activated the SCC and all SCC CSI reporting and monitoring has stopped, as per 3GPP TS 36.321 [6], clause 5.13.

## 2.5 SCC Activation/De-Activation

### 2.5.1 Definition and Purpose

The purpose of this test is to verify that the UE can successfully activate and then de-activate, by Activation/Deactivation MAC control element, an SCC for CA when instructed by eNB, that the UE can report periodic measurement for both of PCC and SCC after the SCC is configured, and that the UE can start and stop CSI reporting successfully after SCC is activated and de-activated.

### 2.5.2 Initial Settings

- Configure the UE per Section 1.8.
- Configure PCC and SCC as defined in Appendix B or by operator endorsed combination.
- Enable periodic measurements on the eNB.
- PCC is active.
- SCC is inactive.
- UE is attached to PCC and is RRC Idle.
- UE is in good radio conditions for both PCC and SCC.
- Ref\_link

### 2.5.3 Procedure

1. Send an *RRCCONNECTIONRECONFIGURATION* message containing *sCellToAddModList* with a SCC addition to the UE.
  - UE performs RRC Connection Reconfiguration according to 3GPP TS 36.523-1 [4], clause 8.2.2.3.1.
2. eNB to send activation MAC control element, to trigger the UE to activate the configured SCC.
  - SCC is activated according to 3GPP TS 36.523-1 [4], clause 7.1.9.1.
3. De-activate the SCC by sending the activation/deactivation MAC control element.
  - Deactivate SCC by MAC control element, according to 3GPP TS 36.523-1 [4], clause 7.1.9.1.

### 2.5.4 Expected Results

After Step 1, verify that:

- The UE is successfully configured with SCC configuration through the contents of the *sCellToAddModList-r10* parameter found in the *RRCCONNECTIONRECONFIGURATION* message as per 3GPP TS 36.331 [3], clause 5.3.10.3b.
- The UE shall transmit an *RRCCONNECTIONRECONFIGURATIONCOMPLETE* message after the successful attachment to the SCC as per 3GPP TS 36.331 [3], clause 5.3.10.3b.

After Step 2, verify that:

- The eNB activates the configured SCC by sending the Activation MAC control element with LCID equal to 11011 (27).
- The starts monitoring the SCC according to the configuration in the *rrcReconfiguration* message as per 3GPP TS 36.321 [6], clause 5.13.
- The UE sends CSI reporting (CQI, RI, PTI, and PMI) for both the PCC and SCC as per 3GPP TS 36.321 [6], clause 5.13.
- A periodic measurement report configuration is sent to UE by *RRCCONNECTIONRECONFIGURATION* message.
- The UE reports the periodic measurement for both the PCC and SCC by an RRC measurement report message containing the RSRP values.

After Step 3, verify that:

- The UE de-activated the SCC, stopped SCC CSI reporting, and stopped monitoring SCC as per 3GPP TS 36.321 [6], clause 5.13.

## 2.6 PCC Re-establishment and SCC Activation after RLF

### 2.6.1 Definition and Purpose

The purpose of this test is to verify that the UE can be successfully re-established and activate an SCC for CA after brief UE loss of the LTE system and radio link failure (RLF). All bearer timers do not expire in this test case.

### 2.6.2 Initial Settings

- Configure the UE per Section 1.8.
- Configure PCC and SCC as defined in Appendix B or by operator endorsed combination.
- PCC is active.
- SCC is inactive.
- UE is attached to the PCC and is RRC Connected.
- Timers T310 and T311 in the eNB are set to a minimum of two seconds.
- The eNB supports the RRC connection re-establishment procedure.

### 2.6.3 Procedure

1. Send an *RRCCONNECTIONRECONFIGURATION* message containing *sCellToAddModList* with a SCC addition to the UE.
  - UE performs RRC Connection Reconfiguration according to 3GPP TS 36.523-1 [4], clause 8.2.2.3.1.
2. Send the activation MAC control element to trigger the eNB to activate the configured SCC.
  - SCC is activated according to 3GPP TS 36.523-1 [4], clause 7.1.9.1.
3. Rapidly attenuate PCC and SCC signals until are both are completely non-accessible by the UE for the 3 seconds.
  - SCC is released, in accordance with 5.3.10.3a.

4. After 3 seconds, rapidly increase the PCC and SCC signals until the RSRP of both component carriers are -75 dB or stronger.
5. Allow UE to perform system selection and attach to PCC.
  - UE completes RRC connection reconfiguration Re-establishment according to 3GPP TS 36.523-1 [4], clause 8.2.4.7.
6. Send an *RRCCONNECTIONRECONFIGURATION* message containing *sCellToAddModList* with a SCC addition to the UE.
  - UE performs RRC Connection Reconfiguration according to 3GPP TS 36.523-1 [4] clause 8.2.2.3.1.
7. Cause UE to connect to and re-activate SCC by sending the activation MAC control element to trigger the eNB to activate the configured SCC.
  - SCC is activated according to 3GPP TS 36.523-1 [4], clause 7.1.9.1.

#### 2.6.4 Expected Results

After Step 1, verify that:

- The UE transmits an *RRCCONNECTIONRECONFIGURATIONCOMPLETE* message after the successful attachment to the SCC as per 3GPP TS 36.331 [3], clause 5.3.10.3b.

After Step 2, verify that:

- The eNB activates the configured SCC by sending the Activation MAC control element.
- When the UE received the MAC control element with LCID equal to 11011 (27), it started monitoring the SCC according to was configured in the *rrcReconfiguration* message, as per 3GPP TS 36.321 [6], clause 5.13.

After Step 3, verify that:

- After signal loss, the UE acquires the PCC and sends an *RRCCONNECTIONREESTABLISHMENTREQUEST* message to the cell.

Upon RRC connection re-establishment procedure initiation, verify that:

- The SCC is released as per 3GPP TS 36.331 [3], clause 5.3.7.2.

After Step 5, verify that:

- The PCC sends an *RRCCONNECTIONREESTABLISHMENT* message and the UE responds with *RRCCONNECTIONREESTABLISHMENTCOMPLETE* message.
- The RRC message exchange is successful and that the re-establishment cause is set the value "OtherFailure".

After Step 6, verify that:

- The UE is successfully configured with SCC configuration through the contents of the *sCellToAddModList-r10* parameter found in the *RRCCONNECTIONRECONFIGURATION* message.

- The UE shall transmit an *RRCCONNECTIONRECONFIGURATIONCOMPLETE* message after the successful attachment to the SCC.
- SRB1 has been reconfigured.

After Step 7, verify that:

- The eNB activates the configured SCC by sending the Activation MAC control element.
- When the UE received the MAC control element with LCID equal to 11011 (27), it started monitoring the SCC according to was configured in the *rrcReconfiguration* message, as per 3GPP TS 36.321 [6], clause 5.13.
- SRB1 has been reconfigured and data traffic is resumed on both cells after re-establishment completed.

## 2.7 PCC Re-Configuration and SCC Activation after System Loss

### 2.7.1 Definition and Purpose

The purpose of this test is to verify that the UE can be successfully re-configured and activate an SCC for CA after system loss. All bearer timers expire in this test case.

### 2.7.2 Initial Settings

- Configure the UE per Section 1.8.
- Configure PCC and SCC as defined in Appendix B or by operator endorsed combination.
- PCC is active.
- SCC is inactive.
- UE is attached to the PCC and is RRC Connected.
- Timers T310 and T311 in the eNB are set to a minimum of two seconds.
- The eNB supports the RRC connection re-configuration procedure.

### 2.7.3 Procedure

1. Send an *RRCCONNECTIONRECONFIGURATION* message containing *sCellToAddModList* with an SCC addition to the UE.
  - UE performs RRC Connection Reconfiguration according to 3GPP TS 36.523-1 [4], clause 8.2.2.3.1.
2. Initiate maximum data downlink throughput, by sending the activation MAC control element with LCID equal to 11011 (27), to trigger the eNB to activate the configured SCC.
  - SCC is activated according to 3GPP TS 36.523-1 [4], clause 7.1.9.1.
3. Rapidly attenuate PCC and SCC signals until are both are completely non-accessible by the UE for the 5 seconds.
4. After 5 seconds, rapidly increase the PCC and SCC signals until the RSRP of both component carriers are -75 dB or stronger.
5. Wait for the UE to trigger attach or service request to the PCC, according to 3GPP TS 36.523-1 [4], clause 9.2.1.1.1 or clause 9.3.1.1.1.
6. Send an *RRCCONNECTIONRECONFIGURATION* message containing *sCellToAddModList* with an SCC addition to the UE.



- UE performs RRC Connection Reconfiguration according to 3GPP TS 36.523-1, [4] clause 8.2.2.3.1.
- 7. Cause to reactivate SCC by sending the activation MAC control element to trigger the eNB.
  - SCC is activated according to 3GPP TS 36.523-1 [4], clause 7.1.9.1.

#### 2.7.4 Expected Results

After Step 1, verify that:

- The UE transmits an *RRCCConnectionReconfigurationComplete* message after the successful attachment to the SCC as per 3GPP TS 36.331 [3], clause 5.3.10.3b.

After Step 2, verify that:

- The eNB activates the configured SCC by sending the Activation MAC control element.
- When the UE received the MAC control element with LCID equal to 11011 (27), it started monitoring the SCC according to was configured in the *rrcReconfiguration* message, as per 3GPP TS 36.321 [6], clause 5.13.

After Step 3, verify that:

- After T311 expires the UE will go to idle mode and may perform RRC Connection Request.

After Step 5, verify that:

- The UE triggers attach request or service request to the PCC and receives an attach accept message or RRC E-RAB modification Request from the network, as per 3GPP TS 24.301 [5], clauses 5.3.1.2 and 3GPP TS 36.331 [3], clauses 5.3.3.3 and 5.3.3.4.
- The UE acquires the PCC and sends an *RRCCConnectionRequest* message to the cell.
- The PCC sends an *RRCCConnection* message and the UE responds with *RRCCConnectionSetupComplete* message as defined by 3GPP TS 36.331 [3], 5.3.3.

After Step 6, verify that:

- The UE is successfully configured with SCC configuration through the contents of the *sCellToAddModList-r10* parameter found in the *RRCCConnectionReconfiguration* message.
- The UE shall transmit an *RRCCConnectionReconfigurationComplete* message after the successful attachment to the SCC.
- SRB1 has been reconfigured.

After Step 7, verify that:

- The eNB activates the configured SCC by sending the Activation MAC control element.
- When the UE received the MAC control element with LCID equal to 11011 (27), it started monitoring the SCC according to was configured in the *rrcReconfiguration* message, as per 3GPP TS 36.321 [6], clause 5.13.
- SRB1 has been reconfigured and data traffic is resumed on both cells.

### 3 Connected Mode Mobility in CA Configured Cells

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#### 3.1 Intra-Band Intra-Frequency Handover between CA Cells

##### 3.1.1 Definition and Purpose

This test verifies that the UE can successfully handover based on PCC coverage and the previously configured SCC will be removed and de-configured. After successful handover to the target primary cell the UE will be verified to successfully configure and activate an SCC if the CA conditions are satisfied. The UE will be verified to successfully hand over and configure and activate an SCC with the *RRConnectionReconfiguration* message and MAC control element.

##### 3.1.2 Initial Conditions

- Configure the UE per Section 1.8.
- Configure two available eNBs: eNB1 and eNB2.
- Both eNBs are configured with PCCs and SCCs as defined in Appendix B or by operator endorsed combination.
- The two PCCs are configured as neighbor cells to one another.
- The eNBs have been configured with the appropriate measurement events, i.e. A3 events.
- PCC1 is the PCC of eNB1. SCC1 is the SCC of eNB1.
- PCC2 is the PCC of eNB2. SCC2 is the SCC of eNB2.
- PCC1 RSRP is stronger than PCC2 RSRP.
- PCC1 is inactive.
- SCC1 is inactive.

##### 3.1.3 Procedure

1. Attach the UE to the PCC1, according to 3GPP TS 36.523-1 [4] clause 9.2.1.1.1.
2. Initiate maximum UDP bidirectional traffic (Dependent upon BW combination used).
  - eNB1 sends an *RRConnectionReconfiguration* message containing *sCellToAddModList* with a SCC addition to the UE and the UE performs RRC Connection Reconfiguration according to 3GPP TS 36.523-1 [4] clause 8.2.2.3.1.
  - eNB1 sends the activation MAC control element to activate the configured SCC, according to 3GPP TS 36.523-1 [4] clause 7.1.9.1.
3. Attenuate the signal level of PCC1 and increase the signal level of PCC2.
  - UE successfully hands over from PCC1 to PCC2, according to 3GPP TS 36.523-1 [4], clause 8.2.4.19.
  - UE successfully hands over from SCC1 to SCC2, according to 3GPP TS 36.523-1 [4] clause 8.2.4.20.
4. Attenuate the signal level of PCC2 and increase the signal level of PCC1.
  - UE successfully hands over from SCC2 to SCC1, according to 3GPP TS 36.523-1 [4] clause 8.2.4.19.
  - UE successfully hands over from PCC2 to PCC1, according to 3GPP TS 36.523-1 [4] clause 8.2.4.20.
5. Repeat Steps 3 through 4 two more times.

### 3.1.4 Expected Results

After Step 1, verify that:

- The UE attaches to PCC1 and receives an attach accept message from the network, as per 3GPP TS 24.301 [5] clauses 5.3.1.2 and 3GPP TS 36.331 [4] clauses 5.3.3.3 and 5.3.3.4.

After Step 2, verify that:

- The PCC sends an *RRCCConnection* message and the UE responds with *RRCCConnectionSetupComplete* message as defined by 3GPP TS 36.331 [3], 5.3.3.
- The UE attaches and starts traffic with maximum throughput and SCC1 is activated.

After Step 3, verify that:

- SCC1 is deactivated and de-configured.
- The UE has been successfully handed over to the PCC2/eNB2 by the *RRCCConnectionReconfiguration* message containing the *mobilityControlInfo* IE sent from PCC1.
- The UE configured and activated SCC2 and all bearers are correctly reconfigured.
- The UE resumed the traffic with maximum throughput (dependent upon aggregated bandwidth).

After Step 4, verify that:

- SCC2 is deactivated and de-configured.
- The UE has been successfully handed over to the PCC1/eNB1 by the *RRCCConnectionReconfiguration* message containing the *mobilityControlInfo* IE sent from PCC2.
- The UE configured and activated SCC1 and all bearers are correctly reconfigured.
- The UE resumed the traffic with maximum throughput (dependent upon aggregated bandwidth).

When repeating Step 3 and Step 4, verify that:

- All subsequent handovers follow expected results described above.

## 3.2 Intra-Band Intra-Frequency Handover between CA to Non-CA Cells

### 3.2.1 Definition and Purpose

This test will verify that the UE can successfully handover based on PCC coverage and the previously configured SCC will be removed and de-configured. After the successful handover to the target PCC the UE will be verified to successfully configure and activate an SCC if the carrier aggregation conditions are satisfied. This test will verify that the UE can be successfully handed over, configure and activate carrier aggregation procedures with the *RRCCConnectionReconfiguration* messages and Activation/Deactivation MAC control element.

### 3.2.2 Initial Settings

- Configure the UE per Section 1.8.
- Configure two available eNBs: eNB1 and eNB2.
- eNB1 is configured with a PCC and SCC as defined in [Appendix B](#) or by operator endorsed combination.
- eNB2 has only one component carrier active.
- PCC1, the PCC of eNB1, is configured as a neighbor cell to eNB2.
- The eNBs have been configured with appropriate measurement event, i.e. A3 events.
- PCC1 RSRP is stronger than the RSRP of eNB2.

### 3.2.3 Procedure

1. Attach the UE to PCC1.
2. Initiate maximum UDP bidirectional traffic (Dependent upon BW combination used).
3. Attenuate the signal level of PCC1 and increase the signal level of eNB2.
4. Attenuate the signal level of eNB2 and increase the signal level of PCC1.
5. Repeat Steps 3 through 4 two more times.

### 3.2.4 Expected Results

After step 2, verify that:

- The UE attaches and starts traffic with maximum throughput and SCC1 is activated.

After step 3, verify that:

- SCC1 is deactivated and de-configured.
- The UE has been successfully handed over to eNB2 by the *RRConnectionReconfiguration* message containing the *mobilityControlInfo* IE sent from PCC1.
- All bearers are correctly reconfigured and the UE resumed the traffic with maximum throughput.
- The UE used “full reconfiguration” RRC signaling mechanism to release its current dedicated configuration and to re-configure with the full configuration of the eNB2 cell. The *RRConnectionReconfiguration* message sent to UE at handover execution contains the flag *fullConfig-r9* set to TRUE, and also includes complete configurations for SRBs, DRBs, MAC, and Physical layer for the UE in eNB2 cell.

After Step 4, verify that:

- eNB2 cell is de-configured.
- The UE has been successfully handed over to the PCC1/eNB1 by the *RRConnectionReconfiguration* message containing the *mobilityControlInfo* IE sent from the eNB2 cell.
- The UE configured and activated SCC1 and all bearers are correctly reconfigured.
- The UE resumed the traffic with maximum throughput (dependent upon aggregated bandwidth).

When repeating Step 3 and Step 4, verify that:

- All subsequent handovers follow expected results described above.

### 3.3 Intra-Band Inter-Frequency S1 handover within CA Cells

#### 3.3.1 Definition and Purpose

This test will verify that the UE can successfully handover based on PCC coverage and the previously configured SCC will be removed and de-configured. After successful handover to the target PCC, the UE will be verified to successfully configure and activate an SCC if CA conditions are satisfied. The UE will be verified to successfully handed over, configure and activate CA procedures with the *RRConnectionReconfiguration* messages and Activation/Deactivation MAC control element.

#### 3.3.2 Initial Settings

- Configure the UE per Section 1.8.
- Configure two available eNBs: eNB1 and eNB3.
- Both eNBs are configured with PCCs and SCCs as defined in [Appendix B](#) or by operator endorsed combination.
- The two PCCs are configured as neighbor cells to one another.
- The eNBs have been configured with the appropriate measurement events, i.e. A2 and A5 events.
- The eNBs are configured to use S1 for an inter-eNB handover.
- The RSRP of PCC1 is stronger than the RSRP of PCC2.
- Configure the PCCs to have two different frequencies in the same band.

#### 3.3.3 Procedure

1. Attach the UE to the PCC of eNB1.
2. Initiate maximum UDP bidirectional traffic (Dependent upon BW combination used).
3. Attenuate the signal level of PCC1 and increase the signal level of PCC2.
4. Attenuate the signal level of PCC2 and increase the signal level of PCC1.
5. Repeat Steps 3 through 4 two more times.

#### 3.3.4 Expected Results

After Step 2, verify that:

- The UE attaches and starts traffic with maximum throughput and the SCC1 is activated.

After Step 3, verify that:

- SCC1 is deactivated and de-configured.
- The UE has been successfully handed over to PCC2/eNB3 by the *RRConnectionReconfiguration* message containing the *mobilityControlInfo* IE sent from the PCC1.
- The UE configures and activates SCC2 and all bearers are correctly reconfigured.

- The UE has resumed the traffic with maximum throughput (dependent upon aggregated bandwidth).
- All subsequent handovers are following expected steps described above.

After Step 4, verify that:

- SCC2 is deactivated and de-configured.
- The UE has been successfully handed over to the PCC1/eNB1 by the *RRConnectionReconfiguration* message containing the *mobilityControlInfo* IE sent from PCC2.
- The UE configured and activated SCC1 and all bearers are correctly reconfigured.
- The UE resumed the traffic with maximum throughput (dependent upon aggregated bandwidth).

When repeating Step 3 and Step 4, verify that:

- All subsequent handovers follow expected results described above.

### 3.4 Intra-Band Inter-Frequency Handover between PCC and SCC

#### 3.4.1 Definition and Purpose

This test will verify that the UE can successfully handover based on PCC coverage and the previously configured SCC will be removed and de-configured. After successful handover to the target PCC the UE will be verified to successfully configure and activate a SCC if the CA conditions are satisfied. The UE will be verified to successfully handed over, configure and activate CA procedures with the *RRConnectionReconfiguration* messages and Activation/Deactivation MAC control element.

#### 3.4.2 Initial Settings

- Configure the UE per Section 1.8.
- Configure one available eNB configured with a PCC and SCC as defined in [Appendix B](#) or by operator endorsed combination.
- Carrier1 is configured as the PCC and Carrier2 is configured as SCC before step 1.
- Carrier1 cell is also configured as neighboring cell of Carrier2 and also Carrier2 cell is configured as a neighboring cell of Carrier1.
- Carrier1 and Carrier2 are on the same band but have two different frequencies.
- The eNB is configured with the appropriate measurement event, i.e. A2 or blind handover in this test.
- The RSRP of Carrier1 is stronger than the RSRP of Carrier2.

#### 3.4.3 Procedure

1. Attach the UE to the Carrier1 – Carrier1 is now the PCC.
2. Initiate maximum UDP bidirectional traffic (Dependent upon BW combination used).
3. Attenuate the signal level of Carrier1 and increase the signal level of Carrier2.
4. Attenuate the signal level of Carrier2 and increase the signal level of Carrier1.
5. Repeat Steps 3 through 4 two more times.

### 3.4.4 Expected Results

After Step 2, verify that:

- The UE attaches to Carrier1 and starts traffic with maximum throughput.
- Carrier2 is activated as the SCC.

After Step 3, verify that:

- Carrier2 is deactivated and de-configured as the SCC.
- The UE has successfully handed over to Carrier2 by the *RRCCONNECTIONRECONFIGURATION* message containing the *MOBILITYCONTROLLINFO* IE sent from Carrier1 or RRC Release with Redirection. The UE has configured and activated Carrier1 as the SCC all bearers correctly reconfigured.
- The UE has resumed the traffic with maximum throughput (dependent upon aggregated bandwidth).

After Step 4, verify that:

- Carrier1 is deactivated and de-configured as the SCC.
- The UE has been successfully handed over to the Carrier1 by the *RRCCONNECTIONRECONFIGURATION* message containing the *MOBILITYCONTROLLINFO* IE sent from Carrier2 or RRC Release with Redirection.
- The UE has configured and activated Carrier2 as the SCC and all bearers are correctly reconfigured.
- The UE resumed the traffic with maximum throughput (dependent upon aggregated bandwidth).

When repeating Step 3 and Step 4, verify that:

- All subsequent handovers follow expected results described above.

## 3.5 Intra-Band Intra-Frequency A6 Triggered Handover Between SCCs

### 3.5.1 Definition and Purpose

This test will verify that the UE can successfully handover based on reconfiguration message from network triggered by an A6 event. The UE will be verified to successfully hand back over to the source, configure and activate CA procedures with the *RRCCONNECTIONRECONFIGURATION* messages and Activation/Deactivation MAC control element.

### 3.5.2 Initial Settings

- Configure the UE per Section 1.8.
- eNB-eNB is configured with a PCC and two SCCs as defined in [Appendix B](#) or by operator endorsed combination.
- PCC1 is the PCC of the eNB-eNB.
- SCC1 and SCC2 are the SCCs of the eNB-eNB.
- SCC1 and SCC2 are configured as a neighbor cells.

- All carriers need to support A6 measurement event reporting.
- The RSRP of SCC1 is stronger than -75 dBm.
- The RSRP of SCC2 is weaker than -100 dBm.

### 3.5.3 Procedure

1. Attach the UE to PCC1.
2. Initiate maximum UDP bidirectional traffic (dependent upon BW combination used).
3. Attenuate the signal level of SCC1 so the RSRP is weaker than -100 dB and increase the signal level of SCC2 so the RSRP is stronger than -75 dBm.
4. Attenuate the signal level of SCC2 so the RSRP is weaker than -100 dB and increase the signal level of SCC1 so the RSRP is stronger than -75 dBm.

### 3.5.4 Expected Results

After Step 2, verify that:

- The UE attaches and starts traffic with maximum throughput and SCC1 is activated.

After Step 3, verify that:

- SCC1 is deactivated and de-configured.
- The SCC has been successfully handed over to SCC2 by the *RRCCConnectionReconfiguration* message containing the *mobilityControlInfo* IE sent from PCC1.
- The UE configured and activated SCC1 and all bearers are correctly reconfigured.
- The UE resumed the traffic with maximum throughput (dependent upon aggregated bandwidth).

After Step 4, verify that:

- SCC2 is de-configured.
- The SCC has been successfully handed over to SCC1 by the *RRCCConnectionReconfiguration* message containing the *mobilityControlInfo* IE sent from PCC1.
- The UE configured and activated SCC1 and all bearers are correctly reconfigured.
- The UE resumed the traffic with maximum throughput (dependent upon aggregated bandwidth).

## 3.6 CA Intra-Band Intra-Frequency Handover with ANR

### 3.6.1 Definition and Purpose

This test will verify that the UE can successfully handover based on PCC coverage and the configured SCC will be removed and de-configured. After successful handover to the target cell the UE will be verified to successfully configure an SCC.

### 3.6.2 Initial Settings

- Configure the UE per Section 1.8.
- Configure two available eNB eNBs: eNB eNB1 and eNB eNB2.



- eNB eNB1 and eNB eNB2 are configured with a PCC and SCC as defined in [Appendix B](#) or by operator endorsed combination.
- PCC1 is the PCC of eNB eNB1. SCC1 is the SCC of the eNB eNB1.
- PCC2 is the PCC of eNB eNB2. SCC2 is the SCC of the eNB eNB2.
- PCC1 is NOT configured as a neighbor cell to PCC2 or SCC2.
- The eNB eNBs have been configured with appropriate measurement events, i.e. A2/B2, A2/A3 or A5.
- PCC1 RSRP is stronger than the RSRP of PCC2.

### 3.6.3 Procedure

1. Attach the UE to PCC1.
2. Initiate maximum UDP bidirectional traffic (Dependent upon BW combination used).
3. Attenuate the signal level of PCC1 and SCC1 and increase the signal level of PCC2 and SCC2.

### 3.6.4 Expected Results

After Step 2, verify that:

- The UE attaches and starts traffic with maximum throughput and SCC1 is activated.

After Step 3, verify that:

- UE reports Event A2 based on PCC1 becoming worse than configured threshold.
- SCC1 is deactivated and de-configured.
- UE detects PCC2 and reports the unknown PCI to eNB eNB1 via RRC Measurement Report message.
- eNB eNB1 requests UE to report EUTRAN Cell Global ID (ECGI).
- UE reports ECGI by reading BCCH channel.
- eNB eNB1 retrieves the IP address from MME to further setup the x2 interface.
- The UE has been successfully handed over to PCC2 by the *RRConnectionReconfiguration* message containing the *mobilityControlInfo* IE sent from PCC1.
- All bearers are correctly reconfigured and the UE resumed the traffic with maximum throughput (dependent upon bandwidth configuration).

## 4 Performance in CA Configured Cells

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### 4.1 Open Loop Spatial Multiplexing Throughput using UDP and Downlink 64QAM

#### 4.1.1 Definition and Purpose

The purpose of this test is to verify that a downlink data transfer with maximum traffic can be successfully performed for both the PCC and SCC and the throughput is proportional to the aggregate bandwidth.

#### 4.1.2 Initial Conditions

- Configure the UE per Section 1.8.
- Configure PCC and SCC as defined in [Appendix B](#) or by operator endorsed combination.
- PCC and SCC are both available.
- RSRP of the PCC is -75 dBm or greater.
- SCC is attenuated to below  $Q_{rxlevmeas}$  (minimum required RX level in cell) threshold.

#### 4.1.3 Test Procedure

1. Attach the UE to the PCC.
2. Adjust the SCC RSRP so it is stronger than -75 dBm.
3. Using Iperf, initiate maximum IPv4 UDP downlink throughput (dependent upon the sum of the bandwidth combination tested) and ensure that the eNB activates the configured SCC by sending the activation MAC control element.
4. Record the two minute average DL throughput value of the aggregated cells.
5. Using Iperf, initiate maximum IPv6 UDP downlink throughput (dependent upon the sum of the bandwidth combination tested) and ensure that the eNB activates the configured SCC by sending the activation MAC control element.
6. Record the two minute average DL throughput value of the aggregated cells.

#### 4.1.4 Expected Results

After Step 3, verify that:

- The UE is successfully configured with the SCC according to the contents of the `sCellToAddModList-r10` parameter found in the `RRConnectionReconfiguration` message.
- UE listens for PDCCH and transmit data and activates CA when requested by the eNB.
- UE sends CQI for both the PCC and the SCC after activation.

After Step 4, verify that:

- Record average DL throughput value of the aggregated cells.
- Ensure average DL throughput value is greater than the corresponding required value in Table C-7 or operator endorsed values.

After Step 6, verify that:

- Record average DL throughput value of the aggregated cells.

- Ensure average DL throughput value is greater than the corresponding required value in Table C-7 or operator endorsed values.

## 4.2 Open Loop Spatial Multiplexing FTP Throughput with Downlink 64QAM

### 4.2.1 Definition and Purpose

The purpose of this test is to verify that a downlink data transfer with maximum traffic can be successfully performed for both primary cell and secondary cell and the throughput is proportional to the aggregate bandwidth.

### 4.2.2 Initial Conditions

- Configure the UE per Section 1.8.
- Configure PCC and SCC as defined in [Appendix B](#) or by operator endorsed combination.
- PCC and SCC are both available.
- RSRP of the PCC is -75 dBm or greater.
- SCC is completely attenuated and UE cannot read it.

### 4.2.3 Test Procedure

1. Attach the UE to the PCC.
2. Adjust the SCC RSRP so it is stronger than -75 dBm.
3. By starting DL FTP initiate maximum IPv4 TCP downlink throughput (dependent upon the sum of the bandwidth combination tested) and ensure that the eNB activates the configured SCC by sending the activation MAC control element.
4. Record the two minute average DL throughput value of the aggregated cells.
5. By starting DL FTP initiate maximum Ipv6 TCP downlink throughput (dependent upon the sum of the bandwidth combination tested) and ensure that the eNB activates the configured SCC by sending the activation MAC control element.
6. Record the two minute average DL throughput value of the aggregated cells.

### 4.2.4 Expected Results

After Step 3, verify that:

- The UE is successfully configured with the SCC according to the contents of the *sCellToAddModList-r10* parameter found in the *RRConnectionReconfiguration* message.
- UE activates CA when requested by the eNB.
- UE sends CQI for both the PCC and the SCC after activation.

After Step 4:

- Record the average DL throughput value of the aggregated.
- Ensure average DL throughput value is greater than the corresponding required value in Table C-7 or operator endorsed values.

After Step 6:

- Record the average DL throughput value of the aggregated.
- Ensure average DL throughput value is greater than the corresponding required value in Table C-7 or operator endorsed values.

### 4.3 Open Loop Spatial Multiplexing UDP Ipv4 Throughput with Downlink 64QAM and Uplink 16QAM

#### 4.3.1 Definition and Purpose

The purpose of this test is to verify that simultaneous downlink and uplink data transfer with maximum traffic can be successfully performed for both the PCC and the SCC and the throughput is proportional to the aggregate bandwidth. Also to verify that maximum downlink traffic is not affecting UE's maximum traffic.

#### 4.3.2 Initial Conditions

- Configure the UE per Section 1.8.
- Configure PCC and SCC as defined in [Appendix B](#) or by operator endorsed combination.
- PCC and SCC are both available.
- RSRP of the PCC is -75 dBm or greater.
- SCC is completely attenuated and UE cannot read it.

#### 4.3.3 Test Procedure

1. Attach the UE to the PCC.
2. Adjust the SCC RSRP so it is stronger than -75 dBm.
3. Using Iperf, initiate both maximum UDP uplink & downlink throughput (DL dependent upon the sum of the bandwidth combination tested) and ensure that the eNB activates the configured SCC by sending the activation MAC control element.
4. Record the two minute average UL&DL throughput values of the aggregated cells.

#### 4.3.4 Expected Results

After Step 3, verify that:

- The UE is successfully configured with the SCC according to the contents of the *sCellToAddModList-r10* parameter found in the *RRConnectionReconfiguration* message.
- UE listens for PDCCH and transmit data and activates CA when requested by the eNB.
- UE sends CQI for both the PCC and the SCC after activation.

After Step 4:

- Record the average DL throughput value of the aggregated cells.
- Record the UL throughput value.
- Ensure average throughput values are greater than the corresponding required values in Table C-7 or operator endorsed values.

## 4.4 Transmit Diversity UDP IPV4 Throughput with Downlink 64QAM

### 4.4.1 Definition and Purpose

The purpose of this test is to verify that a downlink data transfer with maximum traffic can be successfully performed for both the PCC and SCC and the throughput is proportional to the aggregate bandwidth.

### 4.4.2 Initial Conditions

- Configure the UE per Section 1.8.
- Configure PCC and SCC as defined in [Appendix B](#) or by operator endorsed combination.
- PCC and SCC are both available.
- RSRP of the PCC is -75 dBm or greater.
- SCC is completely attenuated and UE cannot read it.

### 4.4.3 Test Procedure

1. Attach the UE to the PCC.
2. Adjust the SCC RSRP so it is stronger than -75 dBm.
3. Using Iperf, initiate maximum UDP downlink throughput (dependent upon the sum of the bandwidth combination tested) and ensure that the eNB activates the configured SCC by sending the activation MAC control element.
4. Record the two minute average DL throughput value of the aggregated cells.

### 4.4.4 Expected Results

After Step 3, verify that:

- The UE is successfully configured with the SCC according to the contents of the *sCellToAddModList-r10* parameter found in the *RRConnectionReconfiguration* message.
- UE listens for PDCCH and transmit data and activates CA when requested by the eNB.
- UE sends CQI for both the PCC and the SCC after activation.

After Step 4:

- Record the average DL throughput value of the aggregated cells.
- Ensure average DL throughput value is greater than the corresponding required value in TableC-7 or operator endorsed values.

## 4.5 SIMO UDP IPV4 Throughput with Downlink 64QAM

### 4.5.1 Definition and Purpose

The purpose of this test is to verify that a downlink data transfer with maximum traffic can be successfully performed for both the PCC and the SCC and the throughput is proportional to the aggregated bandwidth.

#### 4.5.2 Initial Conditions

- Configure the UE per Section 1.8.
- Configure PCC and SCC as defined in [Appendix B](#) or by operator endorsed combination
- PCC and SCC are both available.
- RSRP of the PCC is -75 dBm or greater.
- SCC is completely attenuated and UE cannot read it.

#### 4.5.3 Test Procedure

1. Attach the UE to the PCC.
2. Adjust the SCC RSRP so it is stronger than -75 dBm.
3. Using Iperf, initiate maximum UDP downlink throughput (dependent upon the sum of the bandwidth combination tested) and ensure that the eNB activates the configured SCC by sending the activation MAC control element.
4. Record the two minute average DL throughput value of the aggregated cells.

#### 4.5.4 Expected Results

After Step 3, verify that:

- The UE is successfully configured with the SCC according to the contents of the *sCellToAddModList-r10* parameter found in the *RRConnectionReconfiguration* message.
- UE listens for PDCCH and transmit data and activates CA when requested by the eNB.
- UE sends CQI for both the PCC and the SCC after activation.

After Step 4:

- Record the average DL throughput value of the aggregated.
- Ensure average DL throughput value is greater than the corresponding required value in Table C-7 or operator endorsed values.

## 5 CA Interaction with Other Network Features

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### 5.1 Interaction with Basic LTE Features

#### 5.1.1 Definition and Purpose

TBD – the following two features (CDRX and SRS) are just as an example

This test verifies that the UE can successfully comply with basic LTE features while simultaneously has download traffic with acceptable CA throughput rates.

#### 5.1.2 Initial Conditions

- Configure the UE per Section 1.8.
- Configure two available eNBs: eNB1 and eNB2.
- eNB1 is configured with a PCC and SCC as defined in Appendix B or by operator endorsed combination.
- eNB1 has short and long DRX and SRS enabled as defined in Appendix B.
- eNB2 has only one component carrier active.
- PCC1, the PCC of eNB1, is configured as a neighbor cell to eNB2.
- The eNBs have been configured with appropriate measurement event, i.e. A3 events.
- PCC1 RSRP is stronger than the RSRP of eNB2.

#### 5.1.3 Test Procedure

1. Attach the UE to PCC1.
2. Initiate maximum UDP bidirectional traffic (Dependent upon BW combination used).
3. Attenuate the signal level of PCC1 and increase the signal level of eNB2.
4. Attenuate the signal level of eNB2 and increase the signal level of PCC1.
5. Repeat Steps 3 through 4 two more times.
6. Record the average DL throughput value of the aggregated.

#### 5.1.4 Expected Results

- The device is not impacted by the configuration of the features in the initial configuration on handover and performance in the CA activated cells.
- The device shall pass all the criteria as per Intra-Band Intra-Frequency Handover between CA to non-CA Cell found in Section 3.2.

### 5.2 Interaction with IRAT to eHRPD

#### 5.2.1 Definition and Purpose

This test verifies that the UE can successfully report HRPD measurements, maintain session continuity, and transition from LTE to eHRPD when instructed by NB with CA activated.

#### 5.2.2 Initial Conditions

- Configure the UE per Section 1.8.

- Configure the UE to make eHRPD power measurements during the measurement gaps while on the LTE network.
- Configure the LTE network so that the eNB transmits system information and schedules measurement gaps with SIB3/SIB8 pointing to an available eHRPD Cell.
- Configure PCC and SCC as defined in [Appendix B](#) or by operator endorsed combination
- PCC and SCC are both available.
- RSRP of the PCC is -75 dBm or greater.
- SCC is completely attenuated and UE cannot read it.

### 5.2.3 Test Procedure

1. Attach the UE to the PCC.
2. Adjust the SCC RSRP so it is stronger than -75 dBm.
3. Using Iperf, initiate both maximum UDP uplink & downlink throughput (DL dependent upon the sum of the bandwidth combination tested) and ensure that the eNB activates the configured SCC by sending the activation MAC control element.
4. While the UE is receiving down link UDP transfer, attenuate both LTE signals so the LTE network will request the UE to report the HRPD signal and then redirects the UE to the eHRPD Cell.

### 5.2.4 Expected Results

After Step 2, verify that:

- The device successfully starts UDP data transfer in CA configuration.

After Step 4, verify that:

- The device successfully reports the HRPD signal when requested by eNB during the measurement gap.
- The SCC is deactivated and de-configured.
- The device successfully transitions to eHRPD while maintaining session continuity.

## 5.3 MO 1x/LTE Hybrid Call while CA RRC\_Connected

### 5.3.1 Definition and Purpose

This test verifies that the UE can successfully perform a 1X/LTE Hybrid MO call from an RRC\_Connected with CA activated state.

### 5.3.2 Initial Conditions

- Configure the UE per Section [1.8](#).
- Configure two available eNBs: eNB1 and eNB2.
- Configure UE to support 1x/LTE Hybrid mode.
- Both eNBs are configured with PCCs and SCCs as defined in [Appendix B](#) or by operator endorsed combination.
- The two PCCs are configured as neighbor cells to one another.
- A single 1xRTT cell site is available.



### 5.3.3 Test Procedure

1. Ensure that the UE is Hybrid 1X/LTE capable and can register on the 1xRTT network (for voice services) and LTE network (for data services) prior to executing any steps beyond powering up the device.
2. Attach the UE to PCC1.
3. Initiate maximum UDP bidirectional traffic (Dependent upon BW combination used).
4. Make a MO voice call.
5. Attenuate the signal level of PCC1 and increase the signal level of PCC2.
6. Terminate the voice call after 30 seconds.
7. Attenuate the signal level of PCC2 and increase the signal level of PCC1.
8. Repeat Steps 4 and 6 one more time.

### 5.3.4 Expected Results

- Verify that the device maintains 1xRTT registration throughout the test case.

After Step 1, verify that:

- The UE attaches successfully registers on the 1x network.

After Step 2, verify that:

- The UE attaches and starts traffic with maximum throughput and SCC1 is activated.

After Step 4, verify that:

- E-UTRAN suspends the LTE data session.
- The voice call is not impacted by the configuration of CA.

After Step 6, verify that:

- The UE returns to LTE and successfully preforms TAU request to PCC2.
- Upon reattaching to the LTE network, the data session is restored.
- The UE configured and activated SCC2 and all bearers are correctly reconfigured.
- The UE resumed the traffic with maximum throughput (dependent upon aggregated bandwidth).

After Step 7, verify that:

- SCC2 is deactivated and de-configured.
- The UE has been successfully handed over to the PCC1/eNB1 by the *RRConnectionReconfiguration* message containing the *mobilityControlInfo* IE sent from PCC2.
- The UE configured and activated SCC1 and all bearers are correctly reconfigured.
- The UE resumed the traffic with maximum throughput (dependent upon aggregated bandwidth).

When repeating Step 4 and Step 6, verify that:

- All subsequent handovers follow expected results described above.

## 5.4 MT 1x/LTE Hybrid Call while CA RRC\_Connected

### 5.4.1 Definition and Purpose

This test verifies that the UE can successfully perform a 1X/LTE Hybrid MT call from an RRC\_Connected with CA activated state.

### 5.4.2 Initial Conditions

- Configure the UE per Section 1.8.
- Configure two available eNBs: eNB1 and eNB2.
- Configure UE to support 1x/LTE Hybrid mode.
- Both eNBs are configured with PCCs and SCCs as defined in [Appendix B](#) or by operator endorsed combination.
- The two PCCs are configured as neighbor cells to one another.
- A single 1xRTT cell site is available.

### 5.4.3 Test Procedure

1. Ensure that the UE is Hybrid 1X/LTE capable and can register on the 1xRTT network (for voice services) and LTE network (for data services) prior to executing any steps beyond powering up the device.
2. Attach the UE to PCC1.
3. Initiate maximum UDP bidirectional traffic (Dependent upon BW combination used).
4. Make a MT voice call.
5. The UE should receive a page for the 1x MT call.
6. Attenuate the signal level of PCC1 and increase the signal level of PCC2.
7. Terminate the voice call after 30 seconds.
8. Attenuate the signal level of PCC2 and increase the signal level of PCC1.
9. Repeat Steps 4 and 6 one more time.

### 5.4.4 Expected Results

- Verify that the device maintains 1xRTT registration throughout the test case.

After Step 1, verify that:

- The UE attaches successfully registers on the 1x network.

After Step 2, verify that:

- The UE attaches and starts traffic with maximum throughput and SCC1 is activated.

After Step 4, verify that:

- E-UTRAN suspends the LTE data session.
- The voice call is not impacted by the configuration of CA.

After Step 6, verify that:

- The UE returns to LTE and successfully performs TAU request to PCC2.
- Upon reattaching to the LTE network, the data session is restored.
- The UE configured and activated SCC2 and all bearers are correctly reconfigured.
- The UE resumed the traffic with maximum throughput (dependent upon aggregated bandwidth).

After Step 7, verify that:

- SCC2 is deactivated and de-configured.
- The UE has been successfully handed over to the PCC1/eNB1 by the *RRConnectionReconfiguration* message containing the *mobilityControlInfo* IE sent from PCC2.
- The UE configured and activated SCC1 and all bearers are correctly reconfigured.
- The UE resumed the traffic with maximum throughput (dependent upon aggregated bandwidth).

When repeating Step 4 and Step 6, verify that:

- All subsequent handovers follow expected results described above.

## 5.5 MO 1x/LTE Hybrid SMS while CA RRC\_Connected

### 5.5.1 Definition and Purpose

This test verifies that the UE can successfully receive a MO SMS over 1xRTT in RRC\_Connected with CA in activate state.

### 5.5.2 Initial Conditions

- Configure the UE per Section 1.8.
- Configure one available eNB with a PCC and SCC as defined in [Appendix B](#) or by operator endorsed combination.
- Configure UE to support 1x/LTE Hybrid

### 5.5.3 Test Procedure

1. Attach the UE to PCC1.
2. Initiate maximum UDP bidirectional traffic (Dependent upon BW combination used).
3. Make a MO SMS.

#### 5.5.4 Expected Results

After Step 2, verify that:

- The UE attaches and starts traffic with maximum throughput and SCC1 is activated.

After Step 3, verify that:

- The MO SMS is sent successfully.
- The CA data session is not impacted by the MO SMS.

### 5.6 MT 1x/LTE Hybrid SMS while CA RRC\_Connected

#### 5.6.1 Definition and Purpose

This test verifies that the UE can successfully receive a MT SMS over 1xRTT in RRC\_Connected with CA in activate state.

#### 5.6.2 Initial Conditions

- Configure the UE per Section 1.8.
- Configure one available eNB with a PCC and SCC as defined in [Appendix B](#) or by operator endorsed combination.
- Configure UE to support 1x/LTE Hybrid mode.

#### 5.6.3 Test Procedure

1. Attach the UE to PCC1.
2. Initiate maximum UDP bidirectional traffic (Dependent upon BW combination used).
3. Make a MT SMS.

#### 5.6.4 Expected Results

After Step 2, verify that:

- The UE attaches and starts traffic with maximum throughput and SCC1 is activated.

After Step 3, verify that:

- The MT SMS is received successfully.
- The CA data session is not impacted by the MT SMS.

## 6 Three Carrier Aggregation

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### 6.1 Basic Three Carrier Aggregation Functionality

#### 6.1.1 SCC Activation/De-Activation

##### 6.1.1.1 Test Case Reference

- SCC Activation/De-Activation Section [2.5](#).

##### 6.1.1.2 Definition and Purpose

The purpose of this test is to verify that the UE can successfully activate and then de-activate, by Activation/Deactivation MAC control element, SCC1 and SCC2 for CA when instructed by eNB, that the UE can report periodic measurement for PCC, SCC1 and SCC2 after the SCCs are configured, and that the UE can start and stop CSI reporting successfully after SCCs are activated and de-activated.

##### 6.1.1.3 Initial Settings

- Configure the UE per Section [1.8](#).
- Configure PCC, SCC1 and SCC2 as defined in [Appendix B](#) or by operator endorsed combination.
- Enable periodic measurements on the eNB.
- PCC is active.
- SCC1 is inactive.
- SCC2 is inactive.
- UE is attached to PCC and is RRC Idle.
- UE is in good (above  $-75$  dBm) radio conditions for PCC, SCC1 and SCC2.

##### 6.1.1.4 Procedure

1. Send an *RRCConnectionReconfiguration* message containing *sCellToAddModList* with a SCell(1) addition to the UE.
  - UE performs RRC Connection Reconfiguration according to 3GPP TS 36.523-1 [\[4\]](#), clause 8.2.2.3.1.
2. Send the activation MAC control element, to trigger the eNB to activate the configured SCC1.
  - SCC1 is activated according to 3GPP TS 36.523-1 [\[4\]](#), clause 7.1.9.1.
3. Send an *RRCConnectionReconfiguration* message containing *sCellToAddModList* with a SCell(2) addition to the UE.
  - UE performs RRC Connection Reconfiguration according to 3GPP TS 36.523-1 [\[4\]](#), clause 8.2.2.3.1.
4. Send the activation MAC control element, to trigger the eNB to activate the configured SCC2.
  - SCC2 is activated according to 3GPP TS 36.523-1 [\[4\]](#), clause 7.1.9.1.
5. De-activate the SCC2 by sending the activation/deactivation MAC control element.
  - Deactivate SCC2 by MAC control element, according to 3GPP TS 36.523-1 [\[4\]](#), clause 7.1.9.1.
6. De-activate the SCC1 by sending the activation/deactivation MAC control element.

- Deactivate SCC1 by MAC control element, according to 3GPP TS 36.523-1 [4], clause 7.1.9.1.

#### 6.1.1.5 Expected Results

After Step 1, verify that:

- The UE is successfully configured with SCC1 configuration through the contents of the *sCellToAddModList-r10* parameter found in the *RRConnectionReconfiguration* message as per 3GPP TS 36.331 [3], clause 5.3.10.3b.
- The UE shall transmit an *RRConnectionReconfigurationComplete* message after the successful attachment to the SCC1 as per 3GPP TS 36.331 [3], clause 5.3.10.3b.

After Step 2, verify that:

- The eNB activates the configured SCC1 by sending the Activation MAC control element with LCID equal to 11011 (27).
- The starts monitoring the SCC1 according to the configuration in the *rrcReconfiguration* message as per 3GPP TS 36.321 [6], clause 5.13.
- The UE sends CSI reporting (CQI, RI, PTI, and PMI) for both the PCC and SCC1 as per 3GPP TS 36.321 [6], clause 5.13.
- A periodic measurement report configuration is sent to UE by *RRConnectionReconfiguration* message.
- The UE reports the periodic measurement for both the PCC and SCC1 by an RRC measurement report message containing the RSRP values.

After Step 3, verify that:

- The UE is successfully configured with SCC2 configuration through the contents of the *sCellToAddModList-r10* parameter found in the *RRConnectionReconfiguration* message as per 3GPP TS 36.331 [3], clause 5.3.10.3b.
- The UE shall transmit an *RRConnectionReconfigurationComplete* message after the successful attachment to the SCC2 as per 3GPP TS 36.331 [3], clause 5.3.10.3b.

After Step 4, verify that:

- The eNB activates the configured SCC2 by sending the Activation MAC control element with LCID equal to 11011 (27).
- The starts monitoring the SCC1 and SCC2 according to the configuration in the *rrcReconfiguration* message as per 3GPP TS 36.321 [6], clause 5.13.
- The UE sends CSI reporting (CQI, RI, PTI, and PMI) for the PCC, SCC1 and SCC2 as per 3GPP TS 36.321 [6], clause 5.13.
- A periodic measurement report configuration is sent to UE by *RRConnectionReconfiguration* message.
- The UE reports the periodic measurement for the PCC, SCC1 and SCC2 by an RRC measurement report message containing the RSRP values.

After Step 5, verify that:

- The UE de-activated the SCC2, stopped SCC2 CSI reporting, and stopped monitoring SCC2 as per 3GPP TS 36.321 [6], clause 5.13.

After Step 6, verify that:

- The UE de-activated the SCC1, stopped SCC1 CSI reporting, and stopped monitoring SCC1 as per 3GPP TS 36.321 [6], clause 5.13.

## 6.2 Connected Mode Mobility in CA Configured Cells

### 6.2.1 Intra-Band Intra-Frequency Handover - 3xCA and Non-CA Cells

#### 6.2.1.1 Test Case Reference

- Intra-Band Intra-Frequency Handover between CA to Non-CA Section 3.2.

#### 6.2.1.2 Definition and Purpose

This test will verify that the UE can successfully handover based on PCC coverage and the previously configured SCCs will be removed and de-configured. After the successful handover to the target PCC the UE will be verified to successfully configure and activate SCCs if the carrier aggregation conditions are satisfied. This test will verify that the UE can be successfully handed over, configure and activate carrier aggregation procedures with the *RRConnectionReconfiguration* messages and Activation/Deactivation MAC control element.

#### 6.2.1.3 Initial Settings

- Configure the UE per Section 1.8.
- Configure two available eNBs: eNB1 and eNB2.
- eNB1 is configured with a PCC, SCC1 and SCC2 as defined in Appendix B or by operator endorsed combination.
- eNB2 has only one component carrier active.
- PCC1, the PCC of eNB1, is configured as a neighbor cell to eNB2.
- The eNBs have been configured with appropriate measurement event, i.e. A3 events.
- PCC1 RSRP is stronger than the RSRP of eNB2.

#### 6.2.1.4 Procedure

1. Attach the UE to PCC1.
2. Initiate maximum UDP bidirectional traffic (Dependent upon BW combination used).
3. Attenuate the signal level of PCC1 and increase the signal level of eNB2.
4. Attenuate the signal level of eNB2 and increase the signal level of PCC1.
5. Repeat Steps 3 through 4 two more times.

#### 6.2.1.5 Expected Results

After step 2, verify that:

- The UE attaches and starts traffic with maximum throughput. SCC1 and SCC2 are activated.

After step 3, verify that:

- SCC1 and SCC2 are deactivated and de-configured.
- The UE has been successfully handed over to eNB2 by the *RRConnectionReconfiguration* message containing the *mobilityControlInfo* IE sent from PCC1.
- All bearers are correctly reconfigured and the UE resumed the traffic with maximum throughput.
- The UE used “full reconfiguration” RRC signaling mechanism to release its current dedicated configuration and to re-configure with the full configuration of the eNB2 cell. The *RRConnectionReconfiguration* message sent to UE at handover execution contains the flag *fullConfig-r9* set to TRUE, and also includes complete configurations for SRBs, DRBs, MAC, and Physical layer for the UE in eNB2 cell.

After Step 4, verify that:

- eNB2 cell is de-configured.
- The UE has been successfully handed over to the PCC1/eNB1 by the *RRConnectionReconfiguration* message containing the *mobilityControlInfo* IE sent from the eNB2 cell.
- The UE configured and activated SCC1 and SCC2, and all bearers are correctly reconfigured.
- The UE resumed the traffic with maximum throughput (dependent upon aggregated bandwidth).

When repeating Step 3 and Step 4, verify that:

- All subsequent handovers follow expected results described above.

### 6.3 Performance in 3xCA Configured Cells

#### 6.3.1 Open Loop Spatial Multiplexing (TM3) Throughput using UDP and DL 64QAM (3DL CA)

##### 6.3.1.1 Test Case Reference

- Open Loop Spatial Multiplexing Throughput using UDP and Downlink 64QAM Section [4.1](#).

##### 6.3.1.2 Definition and Purpose

The purpose of this test is to verify that a downlink data transfer with maximum traffic can be successfully performed for PCC, SCC1 and SCC2, and the throughput is proportional to the aggregate bandwidth.

##### 6.3.1.3 Initial Conditions

- Configure the UE per Section [1.8](#).
- Configure PCC, SCC1 and SCC2 as defined in [Appendix B](#) or by operator endorsed combination.
- PCC, SCC1 and SCC2 are available.



- RSRP of the PCC is -75 dBm or greater.
- SCC1 and SCC2 are completely attenuated and UE cannot read it.

#### 6.3.1.4 Test Procedure

1. Attach the UE to the PCC.
2. Adjust the SCC1 and SCC2 RSRP so they are stronger than -75 dBm.
3. Using Iperf, initiate maximum IPv4 UDP downlink throughput (dependent upon the sum of the bandwidth combination tested) and ensure that the eNB activates the configured SCCs by sending the activation MAC control element.
4. Record the two minute average DL throughput value of the aggregated cells.
5. Using Iperf, initiate maximum IPv6 UDP downlink throughput (dependent upon the sum of the bandwidth combination tested) and ensure that the eNB activates the configured SCCs by sending the activation MAC control element.
6. Record the two minute average DL throughput value of the aggregated cells.

#### 6.3.1.5 Expected Results

After Step 3, verify that:

- The UE is successfully configured with the SCCs according to the contents of the *sCellToAddModList-r10* parameter found in the *RRConnectionReconfiguration* message.
- UE listens for PDCCH and transmit data and activates CA when requested by the eNB.
- UE sends CQI for the PCC, SCC1 and SCC2 after activation.

After Step 4, verify that:

- Record average DL throughput value of the aggregated cells.
- Ensure average DL throughput value is greater than the corresponding required value in Table C-7 or operator endorsed values.

After Step 6, verify that:

- Record average DL throughput value of the aggregated cells.
- Ensure average DL throughput value is greater than the corresponding required value in Table C-7 or operator endorsed values.

### 6.3.2 Open Loop Spatial Multiplexing (TM3) FTP Throughput with DL 64QAM in (3DL CA)

#### 6.3.2.1 Test Case Reference

- Open Loop Spatial Multiplexing FTP Throughput with Downlink 64QAM [4.2](#).

#### 6.3.2.2 Definition and Purpose

The purpose of this test is to verify that a downlink data transfer with maximum traffic can be successfully performed for primary cell and secondary cells and the throughput is proportional to the aggregate bandwidth.

### 6.3.2.3 Initial Conditions

- Configure the UE per Section 1.8.
- Configure PCC, SCC1 and SCC2 as defined in Appendix B or by operator endorsed combination.
- PCC, SCC1 and SCC2 are available.
- RSRP of the PCC is -75 dBm or greater.
- SCC1 and SCC2 are completely attenuated and UE cannot read it.

### 6.3.2.4 Test Procedure

1. Attach the UE to the PCC.
2. Adjust the SCC1 and SCC2 RSRP so they are stronger than -75 dBm.
3. By starting DL FTP initiate maximum IPv4 TCP downlink throughput (dependent upon the sum of the bandwidth combination tested) and ensure that the eNB activates the configured SCCs by sending the activation MAC control element.
4. Record the two minute average DL throughput value of the aggregated cells.
5. By starting DL FTP initiate maximum IPv6 TCP downlink throughput (dependent upon the sum of the bandwidth combination tested) and ensure that the eNB activates the configured SCCs by sending the activation MAC control element.
6. Record the two minute average DL throughput value of the aggregated cells.

### 6.3.2.5 Expected Results

After Step 3, verify that:

- The UE is successfully configured with the SCCs according to the contents of the *sCellToAddModList-r10* parameter found in the *RRConnectionReconfiguration* message.
- UE listens for PDCCH, transmit data and activates CA when requested by the eNB.
- UE sends CQI for the PCC, SCC1 and SCC2 after activation.

After Step 4:

- Record the average DL throughput value of the aggregated.
- Ensure average DL throughput value is greater than the corresponding required value in Table C-7 or operator endorsed values.

After Step 6:

- Record the average DL throughput value of the aggregated.
- Ensure average DL throughput value is greater than the corresponding required value in Table C-7 or operator endorsed values.

### 6.3.3 Open Loop Spatial Multiplexing (TM3) Bidirectional throughput using UDP IPv4 with DL 64QAM and UL 16QAM in (3DL CA)

#### 6.3.3.1 Test Case Reference

- Open Loop Spatial Multiplexing UDP IPv4 Throughput with Downlink 64QAM and Uplink 16QAM [4.3](#).

#### 6.3.3.2 Definition and Purpose

The purpose of this test is to verify that simultaneous downlink and uplink data transfer with maximum traffic can be successfully performed for the PCC, SCC1 and SCC2, and the throughput is proportional to the aggregate bandwidth. Also to verify that maximum downlink traffic is not affecting UE's maximum traffic.

#### 6.3.3.3 Initial Conditions

- Configure the UE per Section [1.8](#).
- Configure PCC, SCC1 and SCC2 as defined in [Appendix B](#) or by operator endorsed combination.
- PCC, SCC1 and SCC2 are available.
- RSRP of the PCC is -75 dBm or greater.
- SCC1 and SCC2 are completely attenuated and UE cannot read it.

#### 6.3.3.4 Test Procedure

1. Attach the UE to the PCC.
2. Adjust the SCC1 and SCC2 RSRP so they are stronger than -75 dBm.
3. Using Iperf, initiate both maximum UDP uplink & downlink throughput (DL dependent upon the sum of the bandwidth combination tested) and ensure that the eNB activates the configured SCCs by sending the activation MAC control element.
4. Record the two minute average UL&DL throughput values of the aggregated cells.

#### 6.3.3.5 Expected Results

After Step 3, verify that:

- The UE is successfully configured with the SCCs according to the contents of the *sCellToAddModList-r10* parameter found in the *RRConnectionReconfiguration* message.
- UE listens for PDCCH and transmit data and activates CA when requested by the eNB.
- UE sends CQI for the PCC, SCC1 and SCC2 after activation.

After Step 4:

- Record the average DL throughput value of the aggregated cells.
- Record the UL throughput value.
- Ensure average throughput values are greater than the corresponding required values in Table C-7 or operator endorsed values.

### 6.3.4 Open Loop Spatial Multiplexing Bidirectional Throughput Using UDP IPv4 with DL 256QAM and UL 64QAM in (3DL CA)

#### 6.3.4.1 Test Case Reference

- Open Loop Spatial Multiplexing UDP IPv4 Throughput with Downlink 64QAM and Uplink 16QAM Section 4.3.

#### 6.3.4.2 Definition and Purpose

The purpose of this test is to verify that simultaneous downlink and uplink data transfer with maximum traffic can be successfully performed for the PCC, SCC1 and SCC2, and the throughput is proportional to the aggregate bandwidth. In this case modulation is increased to 256/64QAM in DL/L directions.

#### 6.3.4.3 Initial Conditions

- Configure the UE per Section 1.8.
- Configure PCC, SCC1 and SCC2 as defined in Appendix B or by operator endorsed combination.
- PCC, SCC1 and SCC2 are available.
- RSRP of the PCC is -75 dBm or greater.

#### 6.3.4.4 Test Procedure

1. Attach the UE to the PCC.
2. Adjust the SCC1 and SCC2 RSRP so they are stronger than -75 dBm.
3. Using Iperf, initiate both maximum UDP uplink & downlink throughput (DL dependent upon the sum of the bandwidth combination tested) and ensure that the eNB activates the configured SCCs by sending the activation MAC control element.
4. Record the two minute average UL&DL throughput values of the aggregated cells.

#### 6.3.4.5 Expected Results

After Step 3, verify that:

- The UE is successfully configured with the SCCs according to the contents of the *sCellToAddModList-r10* parameter found in the *RRConnectionReconfiguration* message.
- UE listens for PDCCH and transmit data and activates CA when requested by the eNB.
- UE sends CQI for the PCC, SCC1 and SCC2 after activation.

After Step 4:

- Record the average DL throughput value of the aggregated cells.
- Record the UL throughput value.
- Ensure average throughput values are greater than the corresponding required values in Table C-7 or operator endorsed values.

## 6.4 Hybrid1X and 3DL CA Concurrency

### 6.4.1 Mobile Originated 1X Call in RRC\_Connected (3DL CA)

#### 6.4.1.1 Test Case Reference

- GCF TS35 H1xLTE 6.10

#### 6.4.1.2 Definition and Purpose

This test verifies that the UE can successfully perform a 1X/LTE Hybrid MO call from an RRC\_Connected with 3xCA activated state.

#### 6.4.1.3 Initial Conditions

- Configure the UE per Section 1.8.
- Configure two available eNBs: eNB1 and eNB2.
- Configure UE to support 1x/LTE Hybrid mode.
- Both eNBs are configured with PCCs, SCC1s and SCC2s as defined in [Appendix B](#) or by operator endorsed combination.
- The two PCCs are configured as neighbor cells to one another.
- SCC1 and SCC2 are available for PCC1 and PCC2.
- A single 1xRTT cell site is available.

#### 6.4.1.4 Test Procedure

1. Ensure that the UE is Hybrid 1X/LTE capable and can register on the 1xRTT network (for voice services) and LTE network (for data services) prior to executing any steps beyond powering up the device.
2. Attach the UE to PCC1.
3. Initiate maximum UDP bidirectional traffic (Dependent upon BW combination used).
4. Make a MO voice call.
5. Attenuate the signal level of PCC1, SCC1 and SCC2, and increase the signal level of PCC2.
6. Terminate the voice call after 30 seconds, then increase the signal level of SCC1 and SCC2
7. Attenuate the signal level of PCC2 and increase the signal level of PCC1.
8. Repeat Steps 4 and 7 one more time.

#### 6.4.1.5 Expected Results

- Verify that the device maintains 1xRTT registration throughout the test case.

After Step 1, verify that:

- The UE attaches successfully registers on the 1x network.

After Step 2, verify that:

- The UE attaches and starts traffic with maximum throughput, and PCC1/SCC1 and PCC1/SCC2 are activated.

After Step 4, verify that:

- E-UTRAN suspends the LTE data session.
- The voice call is not impacted by the configuration of CA.

After Step 6, verify that:

- The UE returns to LTE and successfully performs TAU request to PCC2.
- Upon reattaching to the LTE network, the data session is restored.
- The UE configured and activated PCC2/SCC1 and PCC2/SCC2, and all bearers are correctly reconfigured.
- The UE resumed the traffic with maximum throughput (dependent upon aggregated bandwidth).

After Step 7, verify that:

- PCC2/SCC1 and PCC2/SCC2 are deactivated and de-configured.
- The UE has been successfully handed over to the PCC1/eNB1 by the *RRConnectionReconfiguration* message containing the *mobilityControlInfo* IE sent from PCC2.
- The UE configured and activated PCC1/SCC1 and PCC1/SCC2, and all bearers are correctly reconfigured.
- The UE resumed the traffic with maximum throughput (dependent upon aggregated bandwidth).

When repeating Step 4 and Step 6, verify that:

- All subsequent handovers follow expected results described above.

## 6.4.2 Mobile Terminated 1X Call in RRC\_ Connected (3DL CA)

### 6.4.2.1 Test Case Reference

- GCF TS35 H1xLTE 6.11

### 6.4.2.2 Definition and Purpose

This test verifies that the UE can successfully perform a 1X/LTE Hybrid MT call from an RRC\_Connected with 3xCA activated state.

### 6.4.2.3 Initial Conditions

- Configure the UE per Section 1.8.
- Configure two available eNBs: eNB1 and eNB2.
- Configure UE to support 1x/LTE Hybrid mode.
- Both eNBs are configured with PCCs and SCCs as defined in [Appendix B](#) or by operator endorsed combination.
- The two PCCs are configured as neighbor cells to one another.

- SCC1 and SCC2 are available for PCC1 and PCC2.
- A single 1xRTT cell site is available.

#### 6.4.2.4 Test Procedure

1. Ensure that the UE is Hybrid 1X/LTE capable and can register on the 1xRTT network (for voice services) and LTE network (for data services) prior to executing any steps beyond powering up the device.
2. Attach the UE to PCC1.
3. Initiate maximum UDP bidirectional traffic (Dependent upon BW combination used).
4. Make a MT voice call.
5. The UE should receive a page for the 1x MT call.
6. Attenuate the signal level of PCC1, SCC1 and SCC2 and increase the signal level of PCC2.
7. Terminate the voice call after 30 seconds, then increase SCC1 and SCC2.
8. Attenuate the signal level of PCC2 and increase the signal level of PCC1.
9. Repeat Steps 4 and 8 one more time.

#### 6.4.2.5 Expected Results

- Verify that the device maintains 1xRTT registration throughout the test case.

After Step 1, verify that:

- The UE attaches successfully registers on the 1x network.

After Step 2, verify that:

- The UE attaches and starts traffic with maximum throughput and PCC1/SCC1 and PCC1/SCC2 are activated.

After Step 4, verify that:

- E-UTRAN suspends the LTE data session.
- The voice call is not impacted by the configuration of CA.

After Step 6, verify that:

- The UE returns to LTE and successfully performs TAU request to PCC2.
- Upon reattaching to the LTE network, the data session is restored.
- The UE configured and activated PCC2/SCC1 and PCC2/SCC2, and all bearers are correctly reconfigured.
- The UE resumed the traffic with maximum throughput (dependent upon aggregated bandwidth).

After Step 7, verify that:

- PCC2/SCC1 and PCC2/SCC2 are deactivated and de-configured.

- The UE has been successfully handed over to the PCC1/eNB1 by the *RRCConnectionReconfiguration* message containing the *mobilityControlInfo* IE sent from PCC2.
- The UE configured and activated PCC1/SCC1 and PCC1/SCC2, and all bearers are correctly reconfigured.
- The UE resumed the traffic with maximum throughput (dependent upon aggregated bandwidth).

When repeating Step 4 and Step 6, verify that:

- All subsequent handovers follow expected results described above.

### 6.4.3 Mobile Terminated 1X Call in RRC\_Connected with Quick Paging Disabled (3DL CA)

#### 6.4.3.1 Test Case Reference

- GCF TS35 H1xLTE 6.12

#### 6.4.3.2 Definition and Purpose

This test verifies that the UE can successfully perform a 1X/LTE Hybrid MT call from an RRC\_Connected with Quick Paging Disabled and 3xCA activated state.

#### 6.4.3.3 Initial Conditions

- Configure the UE per Section 1.8.
- Configure two available eNBs: eNB1 and eNB2.
- Configure UE to support 1x/LTE Hybrid mode.
- Both eNBs are configured with PCCs and SCCs as defined in [Appendix B](#) or by operator endorsed combination.
- The two PCCs are configured as neighbor cells to one another.
- SCC1 and SCC2 are available for PCC1 and PCC2.
- A single 1xRTT cell site is available.
- Disable Quick Paging on test network.

#### 6.4.3.4 Test Procedure

1. Ensure that the UE is Hybrid 1X/LTE capable and can register on the 1xRTT network (for voice services) and LTE network (for data services) prior to executing any steps beyond powering up the device.
2. Attach the UE to PCC1.
3. Initiate maximum UDP bidirectional traffic (Dependent upon BW combination used).
4. Make a MT voice call.
5. The UE should receive a page for the 1x MT call.
6. Attenuate the signal level of PCC1, SCC1 and SCC2 and increase the signal level of PCC2.
7. Terminate the voice call after 30 seconds, then increase SCC1 and SCC2.
8. Attenuate the signal level of PCC2 and increase the signal level of PCC1.
9. Repeat Steps 4 and 8 one more time.



### 6.4.3.5 Expected Results

- Verify that the device maintains 1xRTT registration throughout the test case.

After Step 1, verify that:

- The UE attaches successfully registers on the 1x network.

After Step 2, verify that:

- The UE attaches and starts traffic with maximum throughput and PCC1/SCC1 and PCC1/SCC2 are activated.

After Step 4, verify that:

- E-UTRAN suspends the LTE data session.
- The voice call is not impacted by the configuration of CA.

After Step 6, verify that:

- The UE returns to LTE and successfully performs TAU request to PCC2.
- Upon reattaching to the LTE network, the data session is restored.
- The UE configured and activated PCC2/SCC1 and PCC2/SCC2, and all bearers are correctly reconfigured.
- The UE resumed the traffic with maximum throughput (dependent upon aggregated bandwidth).

After Step 7, verify that:

- PCC2/SCC1 and PCC2/SCC2 are deactivated and de-configured.
- The UE has been successfully handed over to the PCC1/eNB1 by the *RRConnectionReconfiguration* message containing the *mobilityControlInfo* IE sent from PCC2.
- The UE configured and activated PCC1/SCC1 and PCC1/SCC2, and all bearers are correctly reconfigured.
- The UE resumed the traffic with maximum throughput (dependent upon aggregated bandwidth).

When repeating Step 4 and Step 6, verify that:

- All subsequent handovers follow expected results described above.

## 6.4.4 SMS Origination – Large SMS (Over 240 Characters) – RRC\_ Connected (3DL CA)

### 6.4.4.1 Test Case Reference

- GCF TS35 H1xLTE 6.18

#### 6.4.4.2 Definition and Purpose

This test verifies that the UE can successfully receive a MO SMS over 1xRTT in RRC\_Connected with 3xCA in activate state.

#### 6.4.4.3 Initial Conditions

- Configure the UE per Section 1.8.
- Configure one available eNB with a PCC, SCC1 and SCC2 as defined in [Appendix B](#) or by operator endorsed combination.
- Configure UE to support 1x/LTE Hybrid.

#### 6.4.4.4 Test Procedure

1. Attach the UE to PCC1.
2. Initiate maximum UDP bidirectional traffic (Dependent upon BW combination used).
3. Make a MO SMS with greater than 240 characters.

#### 6.4.5 Expected Results

After Step 2, verify that:

- The UE attaches and starts traffic with maximum throughput, and SCC1 and SCC2 are activated.

After Step 3, verify that:

- The UE attaches to the LTE network successfully.
- The MO SMS is sent successfully.
- The 3xCA data session is not halted by the MO SMS.

#### 6.4.6 SMS Termination – Large SMS (Over 240 Characters) – RRC\_Connected (3DL CA)

##### 6.4.6.1 Test Case Reference

- GCF TS35 H1xLTE 6.19

##### 6.4.6.2 Definition and Purpose

This test verifies that the UE can successfully receive a MT SMS over 1xRTT in RRC\_Connected with 3xCA in activate state.

##### 6.4.6.3 Initial Conditions

- Configure the UE per Section 1.8.
- Configure one available eNB with a PCC and SCC as defined in [Appendix B](#) or by operator endorsed combination.
- Configure UE to support 1x/LTE Hybrid mode.

#### 6.4.6.4 Test Procedure

1. Attach the UE to PCC1.
2. Initiate maximum UDP bidirectional traffic (Dependent upon BW combination used).
3. Make a MT SMS with greater than 240 characters.

#### 6.4.6.5 Expected Results

After Step 2, verify that:

- The UE attaches and starts traffic with maximum throughput, and SCC1 and SCC2 are activated.

After Step 3, verify that:

- The UE attaches to the LTE network successfully.
- The MT SMS is received successfully.
- The 3xCA data session is not halted by the MT SMS.

## 7 Basic Four Carrier Aggregation Functionality

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### 7.1 SCC Activation/De-Activation

#### 7.1.1 Test Case Reference

SCC Activation/De-Activation Section [2.5](#).

#### 7.1.2 Definition and Purpose

The purpose of this test is to verify that the UE can successfully activate and then de-activate, by Activation/Deactivation MAC control element, SCC1, SCC2, and SCC3 for CA when instructed by eNB, that the UE can report periodic measurement for PCC, SCC1, SCC2, and SCC3 after the SCCs are configured, and that the UE can start and stop CSI reporting successfully after SCCs are activated and de-activated.

#### 7.1.3 Initial Settings

- Configure the UE per Section [1.8](#).
- Configure PCC, SCC1, SCC2, and SCC3 as defined in [Appendix B](#) or by operator endorsed combination.
- Enable periodic measurements on the eNB.
- PCC is active.
- SCC1 is inactive.
- SCC2 is inactive.
- SCC3 is inactive.
- UE is attached to PCC and is RRC Idle.
- UE is in good radio conditions for PCC, SCC1, SCC2 and SCC3.

#### 7.1.4 Procedure

1. Send an RRCConnectionReconfiguration message containing *sCellToAddModList* with a SCell (1) addition to the UE.
  - UE performs RRC Connection Reconfiguration according to 3GPP TS 36.523-1 [\[4\]](#), clause 8.2.2.3.1.
2. Send the activation MAC control element, to trigger the eNB to activate the configured SCC1.
  - SCC1 is activated according to 3GPP TS 36.523-1 [\[4\]](#), clause 7.1.9.1.
3. Send an RRCConnectionReconfiguration message containing *sCellToAddModList* with a SCell (2) addition to the UE.
  - UE performs RRC Connection Reconfiguration according to 3GPP TS 36.523-1 [\[4\]](#), clause 8.2.2.3.1.
4. Send the activation MAC control element, to trigger the eNB to activate the configured SCC2.
  - SCC2 is activated according to 3GPP TS 36.523-1 [\[4\]](#), clause 7.1.9.1.
5. Send an RRCConnectionReconfiguration message containing *sCellToAddModList* with a SCell (3) addition to the UE.
  - UE performs RRC Connection Reconfiguration according to 3GPP TS 36.523-1 [\[4\]](#), clause 8.2.2.3.1.
6. Send the activation MAC control element, to trigger the eNB to activate the configured SCC3.
  - SCC3 is activated according to 3GPP TS 36.523-1 [\[4\]](#), clause 7.1.9.1.

7. De-activate the SCC3 by sending the activation/deactivation MAC control element.
  - Deactivate SCC3 by MAC control element, according to 3GPP TS 36.523-1 [4], clause 7.1.9.1.
8. De-activate the SCC2 by sending the activation/deactivation MAC control element.
  - Deactivate SCC2 by MAC control element, according to 3GPP TS 36.523-1 [4], clause 7.1.9.1.
9. De-activate the SCC1 by sending the activation/deactivation MAC control element.
  - Deactivate SCC1 by MAC control element, according to 3GPP TS 36.523-1 [4], clause 7.1.9.1.

### 7.1.5 Expected Results

After Step 1, verify that:

- The UE is successfully configured with SCC1 configuration through the contents of the *sCellToAddModList-r10* parameter found in the *RRConnectionReconfiguration* message as per 3GPP TS 36.331 [3], clause 5.3.10.3b.
- The UE shall transmit an *RRConnectionReconfigurationComplete* message after the successful attachment to the SCC1 as per 3GPP TS 36.331 [3], clause 5.3.10.3b.

After Step 2, verify that:

- The eNB activates the configured SCC1 by sending the Activation MAC control element with LCID equal to 11011 (27).
- The starts monitoring the SCC1 according to the configuration in the *rrcReconfiguration* message as per 3GPP TS 36.321 [6], clause 5.13.
- The UE sends CSI reporting (CQI, RI, PTI, and PMI) for both the PCC and SCC1 as per 3GPP TS 36.321 [6], clause 5.13.
- A periodic measurement report configuration is sent to UE by *RRConnectionReconfiguration* message.
- The UE reports the periodic measurement for both the PCC and SCC1 by an RRC measurement report message containing the RSRP values.

After Step 3, verify that:

- The UE is successfully configured with SCC2 configuration through the contents of the *sCellToAddModList-r10* parameter found in the *RRConnectionReconfiguration* message as per 3GPP TS 36.331 [3], clause 5.3.10.3b.
- The UE shall transmit an *RRConnectionReconfigurationComplete* message after the successful attachment to the SCC2 as per 3GPP TS 36.331 [3], clause 5.3.10.3b.

After Step 4, verify that:

- The eNB activates the configured SCC2 by sending the Activation MAC control element with LCID equal to 11011 (27).
- The starts monitoring the SCC1 and SCC2 according to the configuration in the *rrcReconfiguration* message as per 3GPP TS 36.321 [6], clause 5.13.

- The UE sends CSI reporting (CQI, RI, PTI, and PMI) for the PCC, SCC1 and SCC2 as per 3GPP TS 36.321 [6], clause 5.13.
- A periodic measurement report configuration is sent to UE by *RRCCONNECTIONRECONFIGURATION* message.
- The UE reports the periodic measurement for the PCC, SCC1, and SCC2 by an RRC measurement report message containing the RSRP values.

After Step 5, verify that:

- The UE is successfully configured with SCC3 configuration through the contents of the *sCellToAddModList-r10* parameter found in the *RRCCONNECTIONRECONFIGURATION* message as per 3GPP TS 36.331 [3], clause 5.3.10.3b.
- The UE shall transmit an *RRCCONNECTIONRECONFIGURATIONCOMPLETE* message after the successful attachment to the SCC3 as per 3GPP TS 36.331 [3], clause 5.3.10.3b.

After Step 6, verify that:

- The eNB activates the configured SCC3 by sending the Activation MAC control element with LCID equal to 11011 (27).
- The starts monitoring the SCC1, SCC2, and SCC3 according to the configuration in the *rrcReconfiguration* message as per 3GPP TS 36.321 [6], clause 5.13.
- The UE sends CSI reporting (CQI, RI, PTI, and PMI) for the PCC, SCC1, SCC2, and SCC3 as per 3GPP TS 36.321 [6], clause 5.13.
- A periodic measurement report configuration is sent to UE by *RRCCONNECTIONRECONFIGURATION* message.

The UE reports the periodic measurement for the PCC, SCC1, SCC2, and SCC3 by an RRC measurement report message containing the RSRP values.

After Step 7, verify that:

- The UE de-activated the SCC3, stopped SCC3 CSI reporting, and stopped monitoring SCC3 as per 3GPP TS 36.321 [6], clause 5.13.

After Step 8, verify that:

- The UE de-activated the SCC2, stopped SCC2 CSI reporting, and stopped monitoring SCC2 as per 3GPP TS 36.321 [6], clause 5.13.

After Step 9, verify that:

- The UE de-activated the SCC1, stopped SCC1 CSI reporting, and stopped monitoring SCC1 as per 3GPP TS 36.321 [6], clause 5.13.

## 7.2 Connected Mode Mobility in CA Configured Cells

### 7.2.1 Intra-Band Intra-Frequency Handover - 4xCA and Non-CA Cells

#### 7.2.1.1 Test Case Reference

Intra-Band Intra-Frequency Handover between CA Cells Section [3.2](#).

#### 7.2.1.2 Definition and Purpose

This test will verify that the UE can successfully handover based on PCC coverage and the previously configured SCCs will be removed and de-configured. After the successful handover to the target PCC the UE will be verified to successfully configure and activate SCCs if the carrier aggregation conditions are satisfied. This test will verify that the UE can be successfully handed over, configure and activate carrier aggregation procedures with the *RRConnectionReconfiguration* messages and Activation/Deactivation MAC control element.

#### 7.2.1.3 Initial Settings

- Configure the UE per Section [1.8](#).
- Configure two available eNBs: eNB1 and eNB2.
- eNB1 is configured with a PCC, SCC1, SCC2, and SCC3 as defined in [Appendix B](#) or by operator endorsed combination.
- eNB2 has only one component carrier active.
- PCC1, the PCC of eNB1, is configured as a neighbor cell to eNB2.
- The eNBs have been configured with appropriate measurement event, i.e. A3 events.
- PCC1 RSRP is stronger than the RSRP of eNB2.

#### 7.2.1.4 Procedure

1. Attach the UE to PCC1.
2. Initiate maximum UDP bidirectional traffic (Dependent upon BW combination used).
3. Attenuate the signal level of PCC1 and adjust the signal level of eNB2.
4. Attenuate the signal level of eNB2 and adjust the signal level of PCC1.
5. Repeat Steps 3 through 4 two more times.

#### 7.2.1.5 Expected Results

After step 2, verify that:

- The UE attaches and starts traffic with maximum throughput. SCC1, SCC2, and SCC3 are activated.

After step 3, verify that:

- SCC1, SCC2, and SCC3 are deactivated and de-configured.
- The UE has been successfully handed over to eNB2 by the *RRConnectionReconfiguration* message containing the *mobilityControlInfo* IE sent from PCC1.

- All bearers are correctly reconfigured and the UE resumed the traffic with maximum throughput.
- The UE used “full reconfiguration” RRC signaling mechanism to release its current dedicated configuration and to re-configure with the full configuration of the eNB2 cell. The *RRConnectionReconfiguration* message sent to UE at handover execution contains the flag *fullConfig-r9* set to TRUE, and also includes complete configurations for SRBs, DRBs, MAC, and Physical layer for the UE in eNB2 cell.

After Step 4, verify that:

- eNB2 cell is de-configured.
- The UE has been successfully handed over to the PCC1/eNB1 by the *RRConnectionReconfiguration* message containing the *mobilityControlInfo* IE sent from the eNB2 cell.
- The UE configured and activated SCC1 and SCC2, and all bearers are correctly reconfigured.
- The UE resumed the traffic with maximum throughput (dependent upon aggregated bandwidth).

When repeating Step 3 and Step 4, verify that:

- All subsequent handovers follow expected results described above.

### 7.3 Performance in 4xCA Configured Cells

#### 7.3.1 Bidirectional throughput using UDP IPv4 with DL 64QAM and UL 16QAM in (4DL CA)

##### 7.3.1.1 Test Cases

- 4CC CA Intra-band contiguous
- 4CC CA Intra-band non-contiguous
- 4CC CA Inter-band FDD-TDD
- 4CC CA with minimum of one CC with 4x4MiMO

##### 7.3.1.2 Test Case Reference

- Open Loop Spatial Multiplexing Throughput using UDP and Downlink 64QAM [4.1](#).

##### 7.3.1.3 Definition and Purpose

The purpose of this test is to verify that a downlink data transfer with maximum traffic can be successfully performed for PCC, SCC1 and SCC2, and the throughput is proportional to the aggregate bandwidth.

##### 7.3.1.4 Initial Conditions

- Configure the UE per Section [1.8](#).
- Configure PCC, SCC1, SCC2, and SCC3 as defined in [Appendix B](#) or by operator endorsed combination.
- PCC, SCC1, SCC2, and SCC3 are available.



- RSRP of the PCC is -75 dBm or greater.
- SCC1, SCC2, and SCC3 are completely attenuated and UE cannot read it.

### 7.3.1.5 Test Procedure

1. Attach the UE to the PCC.
2. Adjust the SCC1, SCC2, and SCC3 RSRP so they are stronger than -75 dBm.
3. Using Iperf, initiate maximum IPv4 UDP downlink throughput (dependent upon the sum of the bandwidth combination tested) and ensure that the eNB activates the configured SCCs by sending the activation MAC control element.
4. Record the two minute average DL throughput value of the aggregated cells.
5. Using Iperf, initiate maximum IPv6 UDP downlink throughput (dependent upon the sum of the bandwidth combination tested) and ensure that the eNB activates the configured SCCs by sending the activation MAC control element.
6. Record the two minute average DL throughput value of the aggregated cells.

### 7.3.1.6 Expected Results

After Step 3, verify that:

- The UE is successfully configured with the SCCs according to the contents of the *sCellToAddModList-r10* parameter found in the *RRConnectionReconfiguration* message.
- UE listens for PDCCH and transmit data and activates CA when requested by the eNB.
- UE sends CQI for the PCC, SCC1, SCC2, and SCC3 after activation.

After Step 4, verify that:

- Record average DL throughput value of the aggregated cells.
- Ensure average DL throughput value is greater than the corresponding required value in Table C-7 or operator endorsed values.

After Step 6, verify that:

- Record average DL throughput value of the aggregated cells.
- Ensure average DL throughput value is greater than the corresponding required value in Table C-7 or operator endorsed values.

## 7.3.2 Bidirectional Throughput Using UDP IPv4 with DL 256QAM and UL 64QAM in (4DL CA)

- 4CC CA Intra-band contiguous
- 4CC CA Intra-band non-contiguous
- 4CC CA Inter-band FDD-TDD
- 4CC CA with minimum of one CC with 4x4MiMO

### 7.3.2.1 Test Case Reference

- Open Loop Spatial Multiplexing FTP Throughput with Downlink 64QAM Section [4.2](#)

### 7.3.2.2 Definition and Purpose

The purpose of this test is to verify that a downlink data transfer with maximum traffic can be successfully performed for primary cell and secondary cells and the throughput is proportional to the aggregate bandwidth.

### 7.3.2.3 Initial Conditions

- Configure the UE per Section 1.8.
- Configure PCC, SCC1, SCC2, and SCC3 as defined in [Appendix B](#) or by operator endorsed combination.
- PCC, SCC1, SCC2, and SCC3 are available.
- RSRP of the PCC is -75 dBm or greater.
- SCC1, SCC2, and SCC3 are completely attenuated and UE cannot read it.

### 7.3.2.4 Test Procedure

1. Attach the UE to the PCC.
2. Adjust the SCC1, SCC2, and SCC3 RSRP so they are stronger than -75 dBm.
3. By starting DL FTP initiate maximum IPv4 TCP downlink throughput (dependent upon the sum of the bandwidth combination tested) and ensure that the eNB activates the configured SCCs by sending the activation MAC control element.
4. Record the two minute average DL throughput value of the aggregated cells.
5. By starting DL FTP initiate maximum IPv6 TCP downlink throughput (dependent upon the sum of the bandwidth combination tested) and ensure that the eNB activates the configured SCCs by sending the activation MAC control element.
6. Record the two minute average DL throughput value of the aggregated cells.

### 7.3.2.5 Expected Results

After Step 3, verify that:

- The UE is successfully configured with the SCCs according to the contents of the *sCellToAddModList-r10* parameter found in the *RRCCONNECTIONRECONFIGURATION* message.
- UE listens for PDCCH, transmit data and activates CA when requested by the eNB.
- UE sends CQI for the PCC, SCC1, SCC2, and SCC3 after activation.

After Step 4:

- Record the average DL throughput value of the aggregated.
- Ensure average DL throughput value is greater than the corresponding required value in Table C-7 or operator endorsed values.

After Step 6:

- Record the average DL throughput value of the aggregated.
- Ensure average DL throughput value is greater than the corresponding required value in Table C-7 or operator endorsed values.

### 7.3.3 Open Loop Spatial Multiplexing (TM3) Bidirectional throughput using UDP IPv4 with DL 64QAM and UL 16QAM in (4DL CA)

#### 7.3.3.1 Test Case Reference

- Open Loop Spatial Multiplexing UDP IPv4 Throughput with Downlink 64QAM and Uplink 16QAM Section [4.3](#).

#### 7.3.3.2 Definition and Purpose

The purpose of this test is to verify that simultaneous downlink and uplink data transfer with maximum traffic can be successfully performed for the PCC, SCC1 and SCC2, and the throughput is proportional to the aggregate bandwidth. Also to verify that maximum downlink traffic is not affecting UE's maximum traffic.

#### 7.3.3.3 Initial Conditions

- Configure the UE per Section [1.8](#).
- Configure PCC, SCC1, SCC2, and SCC3 as defined in [Appendix B](#) or by operator endorsed combination.
- PCC, SCC1, SCC2, and SCC3 are available.
- RSRP of the PCC is -75 dBm or greater.
- SCC1, SCC2, and SCC3 are completely attenuated and UE cannot read it.

#### 7.3.3.4 Test Procedure

1. Attach the UE to the PCC.
2. Adjust the SCC1, SCC2, and SCC3 RSRP so they are stronger than -75 dBm.
3. Using Iperf, initiate both maximum UDP uplink & downlink throughput (DL dependent upon the sum of the bandwidth combination tested) and ensure that the eNB activates the configured SCCs by sending the activation MAC control element.
4. Record the two minute average UL&DL throughput values of the aggregated cells.

#### 7.3.3.5 Expected Results

After Step 3, verify that:

- The UE is successfully configured with the SCCs according to the contents of the *sCellToAddModList-r10* parameter found in the *RRConnectionReconfiguration* message.
- UE listens for PDCCH and transmit data and activates CA when requested by the eNB.
- UE sends CQI for the PCC, SCC1, SCC2, and SCC3 after activation.

After Step 4:

- Record the average DL throughput value of the aggregated cells.
- Record the UL throughput value.
- Ensure average throughput values are greater than the corresponding required values in Table C-7 or operator endorsed values.

### 7.3.4 Open Loop Spatial Multiplexing Bidirectional Throughput Using UDP IPv4 with DL 256QAM and UL 64QAM in (4DL CA)

#### 7.3.4.1 Test Case Reference

- Open Loop Spatial Multiplexing UDP IPv4 Throughput with Downlink 64QAM and Uplink 16QAM Section 4.3.

#### 7.3.4.2 Definition and Purpose

The purpose of this test is to verify that simultaneous downlink and uplink data transfer with maximum traffic can be successfully performed for the PCC, SCC1 and SCC2, and the throughput is proportional to the aggregate bandwidth. In this case modulation is increased to 256/64QAM in DL/L directions.

#### 7.3.4.3 Initial Conditions

- Configure the UE per Section 1.8.
- Configure PCC, SCC1, SCC2, and SCC3 as defined in Appendix B or by operator endorsed combination.
- PCC, SCC1, SCC2, and SCC3 are available.
- RSRP of the PCC is -75 dBm or greater.

#### 7.3.4.4 Test Procedure

1. Attach the UE to the PCC.
2. Adjust the SCC1, SCC2, and SCC3 RSRP so they are stronger than -75 dBm.
3. Using Iperf, initiate both maximum UDP uplink & downlink throughput (DL dependent upon the sum of the bandwidth combination tested) and ensure that the eNB activates the configured SCCs by sending the activation MAC control element.
4. Record the two minute average UL&DL throughput values of the aggregated cells.

#### 7.3.4.5 Expected Results

After Step 3, verify that:

- The UE is successfully configured with the SCCs according to the contents of the *sCellToAddModList-r10* parameter found in the *RRConnectionReconfiguration* message.
- UE listens for PDCCH and transmit data and activates CA when requested by the eNB.
- UE sends CQI for the PCC, SCC1, SCC2, and SCC3 after activation.

After Step 4:

- Record the average DL throughput value of the aggregated cells.
- Record the UL throughput value.
- Ensure average throughput values are greater than the corresponding required values in Table C-7 or operator endorsed values.

## 7.4 Hybrid1X and 4DL CA Concurrency

### 7.4.1 Mobile Originated 1X Call in RRC\_Connected (4DL CA)

#### 7.4.1.1 Test Case Reference

- GCF TS35 H1xLTE 6.10

#### 7.4.1.2 Definition and Purpose

This test verifies that the UE can successfully perform a 1X/LTE Hybrid MO call from an RRC\_Connected with 4xCA activated state.

#### 7.4.1.3 Initial Conditions

- Configure the UE per Section 1.8.
- Configure two available eNBs: eNB1 and eNB2.
- Configure UE to support 1x/LTE Hybrid mode.
- Both eNBs are configured with PCCs, SCC1s and SCC2s as defined in [Appendix B](#) or by operator endorsed combination.
- The two PCCs are configured as neighbor cells to one another.
- SCC1, SCC2, and SCC3 are available for PCC1 and PCC2.
- A single 1xRTT cell site is available.

#### 7.4.1.4 Test Procedure

1. Ensure that the UE is Hybrid 1X/LTE capable and can register on the 1xRTT network (for voice services) and LTE network (for data services) prior to executing any steps beyond powering up the device.
2. Attach the UE to PCC1.
3. Initiate maximum UDP bidirectional traffic (Dependent upon BW combination used).
4. Make a MO voice call.
5. Attenuate the signal level of PCC1, SCC1 and SCC2, and increase the signal level of PCC2.
6. Terminate the voice call after 30 seconds, then increase the signal level of SCC1, SCC2, and SCC3.
7. Attenuate the signal level of PCC2 and increase the signal level of PCC1.
8. Repeat Steps 4 and 7 one more time.

#### 7.4.1.5 Expected Results

- Verify that the device maintains 1xRTT registration throughout the test case.

After Step 1, verify that:

- The UE attaches successfully registers on the 1x network.

After Step 2, verify that:

- The UE attaches and starts traffic with maximum throughput, and PCC1/SCC1, PCC1/SCC2 and PCC1/SCC3 are activated.

After Step 4, verify that:

- E-UTRAN suspends the LTE data session.
- The voice call is not impacted by the configuration of CA.

After Step 6, verify that:

- The UE returns to LTE and successfully performs TAU request to PCC2.
- Upon reattaching to the LTE network, the data session is restored.
- The UE configured and activated PCC2/SCC1 and PCC2/SCC2, and all bearers are correctly reconfigured.
- The UE resumed the traffic with maximum throughput (dependent upon aggregated bandwidth).

After Step 7, verify that:

- PCC2/SCC1 and PCC2/SCC2 are deactivated and de-configured.
- The UE has been successfully handed over to the PCC1/eNB1 by the *RRCConnectionReconfiguration* message containing the *mobilityControlInfo* IE sent from PCC2.
- The UE configured and activated PCC1/SCC1, PCC1/SCC2 and PCC1/SCC3, and all bearers are correctly reconfigured.
- The UE resumed the traffic with maximum throughput (dependent upon aggregated bandwidth).

When repeating Step 4 and Step 6, verify that:

- All subsequent handovers follow expected results described above.

## 7.4.2 Mobile Terminated 1X Call in RRC\_ Connected (4DL CA)

### 7.4.2.1 Test Case Reference

- GCF TS35 H1xLTE 6.11

### 7.4.2.2 Definition and Purpose

This test verifies that the UE can successfully perform a 1X/LTE Hybrid MT call from an RRC\_Connected with 4xCA activated state.

### 7.4.2.3 Initial Conditions

- Configure the UE per Section 1.8.
- Configure two available eNBs: eNB1 and eNB2.

- Configure UE to support 1x/LTE Hybrid mode.
- Both eNBs are configured with PCCs and SCCs as defined in [Appendix B](#) or by operator endorsed combination.
- The two PCCs are configured as neighbor cells to one another.
- SCC1, SCC2, and SCC3 are available for PCC1 and PCC2.
- A single 1xRTT cell site is available.

#### 7.4.2.4 Test Procedure

1. Ensure that the UE is Hybrid 1X/LTE capable and can register on the 1xRTT network (for voice services) and LTE network (for data services) prior to executing any steps beyond powering up the device.
2. Attach the UE to PCC1.
3. Initiate maximum UDP bidirectional traffic (Dependent upon BW combination used).
4. Make a MT voice call.
5. The UE should receive a page for the 1x MT call.
6. Attenuate the signal level of PCC1, SCC1, SCC2, and SCC3 and increase the signal level of PCC2.
7. Terminate the voice call after 30 seconds, then increase SCC1 and SCC2.
8. Attenuate the signal level of PCC2 and increase the signal level of PCC1.
9. Repeat Steps 4 and 8 one more time.

#### Expected Results

- Verify that the device maintains 1xRTT registration throughout the test case.

After Step 1, verify that:

- The UE attaches successfully registers on the 1x network.

After Step 2, verify that:

- The UE attaches and starts traffic with maximum throughput and PCC1/SCC1, PCC1/SCC2 and PCC1/SCC3 are activated.

After Step 4, verify that:

- E-UTRAN suspends the LTE data session.
- The voice call is not impacted by the configuration of CA.

After Step 6, verify that:

- The UE returns to LTE and successfully performs TAU request to PCC2.
- Upon reattaching to the LTE network, the data session is restored.
- The UE configured and activated PCC2/SCC1 and PCC2/SCC2, and all bearers are correctly reconfigured.
- The UE resumed the traffic with maximum throughput (dependent upon aggregated bandwidth).

After Step 7, verify that:

- PCC2/SCC1 and PCC2/SCC2 are deactivated and de-configured.
- The UE has been successfully handed over to the PCC1/eNB1 by the *RRCConnectionReconfiguration* message containing the *mobilityControlInfo* IE sent from PCC2.
- The UE configured and activated PCC1/SCC1, PCC1/SCC2 and PCC1/SCC3, and all bearers are correctly reconfigured.
- The UE resumed the traffic with maximum throughput (dependent upon aggregated bandwidth).

When repeating Step 4 and Step 6, verify that:

- All subsequent handovers follow expected results described above.

#### 7.4.3 SMS Origination – Large SMS (Over 240 Characters) – RRC\_Connected (4DL CA)

##### 7.4.3.1 Test Case Reference

- GCF TS35 H1xLTE 6.18

##### 7.4.3.2 Definition and Purpose

This test verifies that the UE can successfully receive a MO SMS over 1xRTT in RRC\_Connected with 4xCA in activate state.

##### 7.4.3.3 Initial Conditions

- Configure the UE per Section 1.8.
- Configure one available eNB with a PCC, SCC1, SCC2, and SCC3 as defined in [Appendix B](#) or by operator endorsed combination.
- Configure UE to support 1x/LTE Hybrid.

##### 7.4.3.4 Test Procedure

1. Attach the UE to PCC1.
2. Initiate maximum UDP bidirectional traffic (Dependent upon BW combination used).
3. Make a MO SMS with greater than 240 characters.

##### 7.4.3.5 Expected Results

After Step 2, verify that:

- The UE attaches and starts traffic with maximum throughput, and SCC1, SCC2, and SCC3 are activated.

After Step 3, verify that:

- The UE attaches to the LTE network successfully.



- The MO SMS is sent successfully.
- The 4xCA data session is not halted by the MO SMS.

#### **7.4.4 SMS Termination – Large SMS (Over 240 Characters) – RRC\_ Connected (4DL CA)**

##### **7.4.4.1 Test Case Reference**

- GCF TS35 H1xLTE 6.19

##### **7.4.4.2 Definition and Purpose**

This test verifies that the UE can successfully receive a MT SMS over 1xRTT in RRC\_Connected with 4xCA in activate state.

##### **7.4.4.3 Initial Conditions**

- Configure the UE per Section 1.8.
- Configure one available eNB with a PCC and SCC as defined in [Appendix B](#) or by operator endorsed combination.
- Configure UE to support 1x/LTE Hybrid mode.

##### **7.4.4.4 Test Procedure**

1. Attach the UE to PCC1.
2. Initiate maximum UDP bidirectional traffic (Dependent upon BW combination used).
3. Make a MT SMS with greater than 240 characters.

##### **7.4.4.5 Expected Results**

After Step 2, verify that:

- The UE attaches and starts traffic with maximum throughput, and SCC1, SCC2, and SCC3 are activated.

After Step 3, verify that:

- The UE attaches to the LTE network successfully.
- The MT SMS is received successfully.
- The 4xCA data session is not halted by the MT SMS.

## 8 Five Carrier Aggregation

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### 8.1 Basic Five Carrier Aggregation Functionality

#### 8.1.1 SCC Activation/De-Activation

##### 8.1.1.1 Test Case Reference

SCC Activation/De-Activation Section [2.5](#).

##### 8.1.1.2 Definition and Purpose

The purpose of this test is to verify that the UE can successfully activate and then de-activate, by Activation/Deactivation MAC control element, SCC1, SCC2, SCC3, and SCC4 for CA when instructed by eNB, that the UE can report periodic measurement for PCC, SCC1, SCC2, SCC3, and SCC4 after the SCCs are configured, and that the UE can start and stop CSI reporting successfully after SCCs are activated and de-activated.

##### 8.1.1.3 Initial Settings

- Configure the UE per Section [1.8](#).
- Configure PCC, SCC1, SCC2, SCC3, and SCC4 as defined in [Appendix B](#) or by operator endorsed combination.
- Enable periodic measurements on the eNB.
- PCC is active.
- SCC1 is inactive.
- SCC2 is inactive.
- SCC3 is inactive.
- SCC4 is inactive.
- UE is attached to PCC and is RRC Idle.
- UE is in good radio conditions for PCC, SCC1, SCC2, SCC3, and SCC4.

##### 8.1.1.4 Procedure

1. Send an *RRConnectionReconfiguration* message containing *sCellToAddModList* with a SCell(1) addition to the UE.
  - UE performs RRC Connection Reconfiguration according to 3GPP TS 36.523-1 [\[4\]](#), clause 8.2.2.3.1.
2. Send the activation MAC control element, to trigger the eNB to activate the configured SCC1.
  - SCC1 is activated according to 3GPP TS 36.523-1 [\[4\]](#), clause 7.1.9.1.
3. Send an *RRConnectionReconfiguration* message containing *sCellToAddModList* with a SCell(2) addition to the UE.
  - UE performs RRC Connection Reconfiguration according to 3GPP TS 36.523-1 [\[4\]](#), clause 8.2.2.3.1.
4. Send the activation MAC control element, to trigger the eNB to activate the configured SCC2.
  - SCC2 is activated according to 3GPP TS 36.523-1 [\[4\]](#), clause 7.1.9.1.
5. Send an *RRConnectionReconfiguration* message containing *sCellToAddModList* with a SCell(3) addition to the UE.

- UE performs RRC Connection Reconfiguration according to 3GPP TS 36.523-1 [4], clause 8.2.2.3.1.
- 6. Send the activation MAC control element, to trigger the eNB to activate the configured SCC3.
  - SCC3 is activated according to 3GPP TS 36.523-1 [4], clause 7.1.9.1.
- 7. Send an *RRCCConnectionReconfiguration* message containing *sCellToAddModList* with a SCell(4) addition to the UE.
  - UE performs RRC Connection Reconfiguration according to 3GPP TS 36.523-1 [4], clause 8.2.2.3.1.
- 8. Send the activation MAC control element, to trigger the eNB to activate the configured SCC4.
  - SCC4 is activated according to 3GPP TS 36.523-1 [4], clause 7.1.9.1.
- 9. De-activate the SCC4 by sending the activation/deactivation MAC control element.
  - Deactivate SCC4 by MAC control element, according to 3GPP TS 36.523-1 [4], clause 7.1.9.1.
- 10. De-activate the SCC3 by sending the activation/deactivation MAC control element.
  - Deactivate SCC3 by MAC control element, according to 3GPP TS 36.523-1 [4], clause 7.1.9.1.
- 11. De-activate the SCC2 by sending the activation/deactivation MAC control element.
  - Deactivate SCC2 by MAC control element, according to 3GPP TS 36.523-1 [4], clause 7.1.9.1.
- 12. De-activate the SCC1 by sending the activation/deactivation MAC control element.
  - Deactivate SCC1 by MAC control element, according to 3GPP TS 36.523-1 [4], clause 7.1.9.1.

#### 8.1.1.5 Expected Results

After Step 1, verify that:

- The UE is successfully configured with SCC1 configuration through the contents of the *sCellToAddModList-r10* parameter found in the *RRCCConnectionReconfiguration* message as per 3GPP TS 36.331 [3], clause 5.3.10.3b.
- The UE shall transmit an *RRCCConnectionReconfigurationComplete* message after the successful attachment to the SCC1 as per 3GPP TS 36.331 [3], clause 5.3.10.3b.

After Step 2, verify that:

- The eNB activates the configured SCC1 by sending the Activation MAC control element with LCID equal to 11011 (27).
- The starts monitoring the SCC1 according to the configuration in the *rrcReconfiguration* message as per 3GPP TS 36.321 [6], clause 5.13.
- The UE sends CSI reporting (CQI, RI, PTI, and PMI) for both the PCC and SCC1 as per 3GPP TS 36.321 [6], clause 5.13.
- A periodic measurement report configuration is sent to UE by *RRCCConnectionReconfiguration* message.
- The UE reports the periodic measurement for both the PCC and SCC1 by an RRC measurement report message containing the RSRP values.

After Step 3, verify that:

- The UE is successfully configured with SCC2 configuration through the contents of the *sCellToAddModList-r10* parameter found in the *RRCCONNECTIONRECONFIGURATION* message as per 3GPP TS 36.331 [3], clause 5.3.10.3b.
- The UE shall transmit an *RRCCONNECTIONRECONFIGURATIONCOMPLETE* message after the successful attachment to the SCC2 as per 3GPP TS 36.331 [3], clause 5.3.10.3b.

After Step 4, verify that:

- The eNB activates the configured SCC2 by sending the Activation MAC control element with LCID equal to 11011 (27).
- The starts monitoring the SCC1 and SCC2 according to the configuration in the *rrcReconfiguration* message as per 3GPP TS 36.321 [6], clause 5.13.
- The UE sends CSI reporting (CQI, RI, PTI, and PMI) for the PCC, SCC1 and SCC2 as per 3GPP TS 36.321 [6], clause 5.13.
- A periodic measurement report configuration is sent to UE by *RRCCONNECTIONRECONFIGURATION* message.
- The UE reports the periodic measurement for the PCC, SCC1 and SCC2 by an RRC measurement report message containing the RSRP values.

After Step 5, verify that:

- The UE is successfully configured with SCC3 configuration through the contents of the *sCellToAddModList-r10* parameter found in the *RRCCONNECTIONRECONFIGURATION* message as per 3GPP TS 36.331 [3], clause 5.3.10.3b.
- The UE shall transmit an *RRCCONNECTIONRECONFIGURATIONCOMPLETE* message after the successful attachment to the SCC3 as per 3GPP TS 36.331 [3], clause 5.3.10.3b.

After Step 6, verify that:

- The eNB activates the configured SCC3 by sending the Activation MAC control element with LCID equal to 11011 (27).
- The starts monitoring the SCC1, SCC2 and SCC3 according to the configuration in the *rrcReconfiguration* message as per 3GPP TS 36.321 [6], clause 5.13.
- The UE sends CSI reporting (CQI, RI, PTI, and PMI) for the PCC, SCC1, SCC2 and SCC3 as per 3GPP TS 36.321 [6], clause 5.13.
- A periodic measurement report configuration is sent to UE by *RRCCONNECTIONRECONFIGURATION* message.
- The UE reports the periodic measurement for the PCC, SCC1, SCC2 and SCC3 by an RRC measurement report message containing the RSRP values.

After Step 7, verify that:

- The UE is successfully configured with SCC4 configuration through the contents of the *sCellToAddModList-r10* parameter found in the *RRCCONNECTIONRECONFIGURATION* message as per 3GPP TS 36.331 [3], clause 5.3.10.3b.

- The UE shall transmit an *RRCConnectionReconfigurationComplete* message after the successful attachment to the SCC3 as per 3GPP TS 36.331 [3], clause 5.3.10.3b.

After Step 8, verify that:

- The eNB activates the configured SCC4 by sending the Activation MAC control element with LCID equal to 11011 (27).
- The starts monitoring the SCC1, SCC2, SCC3, and SCC4 according to the configuration in the *rrcReconfiguration* message as per 3GPP TS 36.321 [6], clause 5.13.
- The UE sends CSI reporting (CQI, RI, PTI, and PMI) for the PCC, SCC1, SCC2, SCC3, and SCC4 as per 3GPP TS 36.321 [6], clause 5.13.
- A periodic measurement report configuration is sent to UE by *RRCConnectionReconfiguration* message.
- The UE reports the periodic measurement for the PCC, SCC1, SCC2, SCC3, and SCC4 by an RRC measurement report message containing the RSRP values.

After Step 9, verify that:

- The UE de-activated the SCC4, stopped SCC4 CSI reporting, and stopped monitoring SCC4 as per 3GPP TS 36.321 [6], clause 5.13.

After Step 10, verify that:

- The UE de-activated the SCC3, stopped SCC3 CSI reporting, and stopped monitoring SCC3 as per 3GPP TS 36.321 [6], clause 5.13.

After Step 11, verify that:

- The UE de-activated the SCC2, stopped SCC2 CSI reporting, and stopped monitoring SCC2 as per 3GPP TS 36.321 [6], clause 5.13.

After Step 12, verify that:

- The UE de-activated the SCC1, stopped SCC1 CSI reporting, and stopped monitoring SCC1 as per 3GPP TS 36.321 [6], clause 5.13.

## 8.2 Connected Mode Mobility in CA Configured Cells

### 8.2.1 Intra-Band Intra-Frequency Handover - 5xCA and Non-CA Cells

#### 8.2.1.1 Test Case Reference

- Intra-Band Intra-Frequency Handover between CA to Non-CA Cells Section 3.2

#### 8.2.1.2 Definition and Purpose

This test will verify that the UE can successfully handover based on PCC coverage and the previously configured SCCs will be removed and de-configured. After the successful handover to the target PCC the UE will be verified to successfully configure and activate SCCs if the carrier aggregation

conditions are satisfied. This test will verify that the UE can be successfully handed over, configure and activate carrier aggregation procedures with the *RRConnectionReconfiguration* messages and Activation/Deactivation MAC control element.

### 8.2.1.3 Initial Settings

- Configure the UE per Section 1.8.
- Configure two available eNBs: eNB1 and eNB2.
- eNB1 is configured with a PCC, SCC1, SCC2, SCC3, and SCC4 as defined in [Appendix B](#) or by operator endorsed combination.
- eNB2 has only one component carrier active.
- PCC1, the PCC of eNB1, is configured as a neighbor cell to eNB2.
- The eNBs have been configured with appropriate measurement event, i.e. A3 events.
- PCC1 RSRP is stronger than the RSRP of eNB2.

### 8.2.1.4 Procedure

1. Attach the UE to PCC1.
2. Initiate maximum UDP bidirectional traffic (Dependent upon BW combination used).
3. Attenuate the signal level of PCC1 and increase the signal level of eNB2.
4. Attenuate the signal level of eNB2 and increase the signal level of PCC1.
5. Repeat Steps 3 through 4 two more times.

### 8.2.1.5 Expected Results

After step 2, verify that:

- The UE attaches and starts traffic with maximum throughput. SCC1, SCC2, SCC3, and SCC4 are activated.

After step 3, verify that:

- SCC1, SCC2, SCC3, and SCC4 are deactivated and de-configured.
- The UE has been successfully handed over to eNB2 by the *RRConnectionReconfiguration* message containing the *RRConnectionReconfiguration* IE sent from PCC1.
- All bearers are correctly reconfigured and the UE resumed the traffic with maximum throughput.
- The UE used “full reconfiguration” RRC signaling mechanism to release its current dedicated configuration and to re-configure with the full configuration of the eNB2 cell. The *RRConnectionReconfiguration* message sent to UE at handover execution contains the flag *fullConfig-r9* set to TRUE, and also includes complete configurations for SRBs, DRBs, MAC, and Physical layer for the UE in eNB2 cell.

After Step 4, verify that:

- eNB2 cell is de-configured.

- The UE has been successfully handed over to the PCC1/eNB1 by the *RRConnectionReconfiguration* message containing the *mobilityControlInfo* IE sent from the eNB2 cell.
- The UE configured and activated SCC1, SCC2, SCC3 and SCC4, and all bearers are correctly reconfigured.
- The UE resumed the traffic with maximum throughput (dependent upon aggregated bandwidth).

When repeating Step 3 and Step 4, verify that:

- All subsequent handovers follow expected results described above.

### 8.3 Performance in 5xCA Configured Cells

- 5CC CA Intra-band contiguous
- 5CC CA Intra-band non-contiguous
- 5CC CA Inter-band FDD-TDD
- 5CC CA with minimum of one CC with 4x4MiMO

#### 8.3.1 Bidirectional throughput using UDP IPv4 with DL 64QAM and UL 16QAM in (5DL CA)

##### 8.3.1.1 Test Case Reference

- Open Loop Spatial Multiplexing Throughput using UDP and Downlink 64QAM Section [4.1](#)

##### 8.3.1.2 Definition and Purpose

The purpose of this test is to verify that a downlink data transfer with maximum traffic can be successfully performed for PCC, SCC1, SCC2, SCC3 and SCC4, and the throughput is proportional to the aggregate bandwidth.

##### 8.3.1.3 Initial Conditions

- Configure the UE per Section [1.8](#).
- Configure PCC, SCC1, SCC2, SCC3, and SCC4 as defined in [Appendix B](#) or by operator endorsed combination.
- PCC, SCC1, SCC2, SCC3, and SCC4 are available.
- RSRP of the PCC is -75 dBm or greater.
- SCC1, SCC2, SCC3, and SCC4 are completely attenuated and UE cannot read it.

##### 8.3.1.4 Test Procedure

1. Attach the UE to the PCC.
2. Adjust the SCC1, SCC2, SCC3, and SCC4 RSRP so they are stronger than -75 dBm.
3. Using Iperf, initiate maximum IPv4 UDP downlink throughput (dependent upon the sum of the bandwidth combination tested) and ensure that the eNB activates the configured SCCs by sending the activation MAC control element.
4. Record the two minute average DL throughput value of the aggregated cells.

5. Using Iperf, initiate maximum IPv6 UDP downlink throughput (dependent upon the sum of the bandwidth combination tested) and ensure that the eNB activates the configured SCCs by sending the activation MAC control element.
6. Record the two minute average DL throughput value of the aggregated cells.

#### 8.3.1.5 Expected Results

After Step 3, verify that:

- The UE is successfully configured with the SCCs according to the contents of the *sCellToAddModList-r10* parameter found in the *RRCConnectionReconfiguration* message.
- UE listens for PDCCH and transmit data and activates CA when requested by the eNB.
- UE sends CQI for the PCC, SCC1, SCC2, SCC3, and SCC4 after activation.

After Step 4, verify that:

- Record average DL throughput value of the aggregated cells.
- Ensure average DL throughput value is greater than the corresponding required value in Table C-7 or operator endorsed values.

After Step 6, verify that:

- Record average DL throughput value of the aggregated cells.
- Ensure average DL throughput value is greater than the corresponding required value in Table C-7 or operator endorsed values.

### 8.4 Bidirectional Throughput Using UDP IPv4 with DL 256QAM and UL 64QAM in (5DL CA)

- 5CC CA Intra-band contiguous
- 5CC CA Intra-band non-contiguous
- 5CC CA Inter-band FDD-TDD
- 5CC CA with minimum of one CC with 4x4MiMO.

#### 8.4.1 Test Case Reference

- Open Loop Spatial Multiplexing FTP Throughput with Downlink 64QAM Section [4.2](#)

##### 8.4.1.1 Definition and Purpose

The purpose of this test is to verify that a downlink data transfer with maximum traffic can be successfully performed for primary cell and secondary cells and the throughput is proportional to the aggregate bandwidth.

##### 8.4.1.2 Initial Conditions

- Configure the UE per Section [1.8](#).
- Configure PCC, SCC1, SCC2, SCC3, and SCC4 as defined in [Appendix B](#) or by operator endorsed combination.
- PCC, SCC1, SCC2, SCC3, and SCC4 are available.



- RSRP of the PCC is -75 dBm or greater.
- SCC1, SCC2, SCC3, and SCC4 are completely attenuated and UE cannot read it.

### 8.4.1.3 Test Procedure

1. Attach the UE to the PCC.
2. Adjust the SCC1, SCC2, SCC3, and SCC4 RSRP so they are stronger than -75 dBm.
3. By starting DL FTP initiate maximum IPv4 TCP downlink throughput (dependent upon the sum of the bandwidth combination tested) and ensure that the eNB activates the configured SCCs by sending the activation MAC control element.
4. Record the two minute average DL throughput value of the aggregated cells.
5. By starting DL FTP initiate maximum IPv6 TCP downlink throughput (dependent upon the sum of the bandwidth combination tested) and ensure that the eNB activates the configured SCCs by sending the activation MAC control element.
6. Record the two minute average DL throughput value of the aggregated cells.

### 8.4.1.4 Expected Results

After Step 3, verify that:

- The UE is successfully configured with the SCCs according to the contents of the *sCellToAddModList-r10* parameter found in the *RRConnectionReconfiguration* message.
- UE listens for PDCCH, transmit data and activates CA when requested by the eNB.
- UE sends CQI for the PCC, SCC1, SCC2, SCC3, and SCC4 after activation.

After Step 4:

- Record the average DL throughput value of the aggregated.
- Ensure average DL throughput value is greater than the corresponding required value in Table C-7 or operator endorsed values.

After Step 6:

- Record the average DL throughput value of the aggregated.
- Ensure average DL throughput value is greater than the corresponding required value in Table C-7 or operator endorsed values.

## 8.4.2 Open Loop Spatial Multiplexing (TM3) Bidirectional throughput using UDP IPv4 with DL 64QAM and UL 16QAM in (5DL CA)

### 8.4.2.1 Test Case Reference

- Open Loop Spatial Multiplexing UDP IPv4 Throughput with Downlink 64QAM and Uplink 16QAM Section 4.3.

### 8.4.2.2 Definition and Purpose

The purpose of this test is to verify that simultaneous downlink and uplink data transfer with maximum traffic can be successfully performed for the PCC, SCC1, SCC2, SCC3 and SCC4, and the

throughput is proportional to the aggregate bandwidth. Also to verify that maximum downlink traffic is not affecting UE's maximum traffic.

#### 8.4.2.3 Initial Conditions

- Configure the UE per Section 1.8.
- Configure PCC, SCC1, SCC2, SCC3, and SCC4 as defined in Appendix B or by operator endorsed combination
- PCC, SCC1, SCC2, SCC3, and SCC4 are available.
- RSRP of the PCC is -75 dBm or greater.
- SCC1, SCC2, SCC3, and SCC4 are completely attenuated and UE cannot read it.

#### 8.4.2.4 Test Procedure

1. Attach the UE to the PCC.
2. Adjust the SCC1, SCC2, SCC3, and SCC4 RSRP so they are stronger than -75 dBm.
3. Using Iperf, initiate both maximum UDP uplink & downlink throughput (DL dependent upon the sum of the bandwidth combination tested) and ensure that the eNB activates the configured SCCs by sending the activation MAC control element.
4. Record the two minute average UL&DL throughput values of the aggregated cells.

#### 8.4.2.5 Expected Results

After Step 3, verify that:

- The UE is successfully configured with the SCCs according to the contents of the *sCellToAddModList-r10* parameter found in the *RRConnectionReconfiguration* message.
- UE listens for PDCCH and transmit data and activates CA when requested by the eNB.
- UE sends CQI for the PCC, SCC1, SCC2, SCC3, and SCC4 after activation.

After Step 4:

- Record the average DL throughput value of the aggregated cells.
- Record the UL throughput value.
- Ensure average throughput values are greater than the corresponding required values in Table C-7 or operator endorsed values.

### 8.4.3 Open Loop Spatial Multiplexing Bidirectional Throughput Using UDP IPv4 with DL 256QAM and UL 64QAM in (5DL CA)

#### 8.4.3.1 Test Case Reference

- Open Loop Spatial Multiplexing UDP IPv4 Throughput with Downlink 64QAM and Uplink 16QAM Section 4.3

#### 8.4.3.2 Definition and Purpose

The purpose of this test is to verify that simultaneous downlink and uplink data transfer with maximum traffic can be successfully performed for the PCC, SCC1, SCC2, SCC3 and SCC4, and the

throughput is proportional to the aggregate bandwidth. In this case modulation is increased to 256/64QAM in DL/L directions.

#### 8.4.3.3 Initial Conditions

- Configure the UE per Section 1.8.
- Configure PCC, SCC1, SCC2, SCC3, and SCC4 as defined in [Appendix B](#) or by operator endorsed combination.
- PCC, SCC1, SCC2, SCC3, and SCC4 are available.
- RSRP of the PCC is -75 dBm or greater.

#### 8.4.3.4 Test Procedure

1. Attach the UE to the PCC.
2. Adjust the SCC1, SCC2, SCC3, and SCC4 RSRP so they are stronger than -75 dBm.
3. Using Iperf, initiate both maximum UDP uplink & downlink throughput (DL dependent upon the sum of the bandwidth combination tested) and ensure that the eNB activates the configured SCCs by sending the activation MAC control element.
4. Record the two minute average UL&DL throughput values of the aggregated cells.

#### 8.4.3.5 Expected Results

After Step 3, verify that:

- The UE is successfully configured with the SCCs according to the contents of the *sCellToAddModList-r10* parameter found in the *RRConnectionReconfiguration* message.
- UE listens for PDCCH and transmit data and activates CA when requested by the eNB.
- UE sends CQI for the PCC, SCC1, SCC2, SCC3, and SCC4 after activation.

After Step 4:

- Record the average DL throughput value of the aggregated cells.
- Record the UL throughput value.
- Ensure average throughput values are greater than the corresponding required values in Table C-7 or operator endorsed values.

### 8.5 Hybrid1X and 5DL CA Concurrency

#### 8.5.1 Mobile Originated 1X Call in RRC\_Connected (5DL CA)

##### 8.5.1.1 Test Case Reference

- GCF TS35 H1xLTE 6.10

##### 8.5.1.2 Definition and Purpose

This test verifies that the UE can successfully perform a 1X/LTE Hybrid MO call from an RRC\_Connected with 5xCA activated state.

### 8.5.1.3 Initial Conditions

- Configure the UE per Section 1.8.
- Configure two available eNBs: eNB1 and eNB2.
- Configure UE to support 1x/LTE Hybrid mode.
- Both eNBs are configured with PCCs, SCC1s and SCC2s as defined in [Appendix B](#) or by operator endorsed combination.
- The two PCCs are configured as neighbor cells to one another.
- SCC1, SCC2, SCC3, and SCC4 are available for PCC1 and PCC2.
- A single 1xRTT cell site is available.

### 8.5.1.4 Test Procedure

1. Ensure that the UE is Hybrid 1X/LTE capable and can register on the 1xRTT network (for voice services) and LTE network (for data services) prior to executing any steps beyond powering up the device.
2. Attach the UE to PCC1.
3. Initiate maximum UDP bidirectional traffic (Dependent upon BW combination used).
4. Make a MO voice call.
5. Attenuate the signal level of PCC1, SCC1, SCC2, SCC3 and SCC4, and increase the signal level of PCC2.
6. Terminate the voice call after 30 seconds, then increase the signal level of SCC1, SCC2, SCC3, and SCC4.
7. Attenuate the signal level of PCC2 and increase the signal level of PCC1.
8. Repeat Steps 4 and 7 one more time.

### 8.5.1.5 Expected Results

- Verify that the device maintains 1xRTT registration throughout the test case.

After Step 1, verify that:

- The UE attaches successfully registers on the 1x network.

After Step 2, verify that:

- The UE attaches and starts traffic with maximum throughput, and PCC1/SCC1, PCC1/SCC2 and PCC1/SCC3 are activated.

After Step 4, verify that:

- E-UTRAN suspends the LTE data session.
- The voice call is not impacted by the configuration of CA.

After Step 6, verify that:

- The UE returns to LTE and successfully performs TAU request to PCC2.
- Upon reattaching to the LTE network, the data session is restored.

- The UE configured and activated PCC2/SCC1 and PCC2/SCC2, and all bearers are correctly reconfigured.
- The UE resumed the traffic with maximum throughput (dependent upon aggregated bandwidth).

After Step 7, verify that:

- PCC2/SCC1 and PCC2/SCC2 are deactivated and de-configured.
- The UE has been successfully handed over to the PCC1/eNB1 by the *RRCConnectionReconfiguration* message containing the *mobilityControlInfo* IE sent from PCC2.
- The UE configured and activated PCC1/SCC1, PCC1/SCC2 and PCC1/SCC3, and all bearers are correctly reconfigured.
- The UE resumed the traffic with maximum throughput (dependent upon aggregated bandwidth).

When repeating Step 4 and Step 6, verify that:

- All subsequent handovers follow expected results described above.

## 8.5.2 Mobile Terminated 1X Call in RRC\_Connected (5DL CA)

### 8.5.2.1 Test Case Reference

- GCF TS35 H1xLTE 6.11

### 8.5.2.2 Definition and Purpose

This test verifies that the UE can successfully perform a 1X/LTE Hybrid MT call from an RRC\_Connected with 5xCA activated state.

### 8.5.2.3 Initial Conditions

- Configure the UE per Section 1.8.
- Configure two available eNBs: eNB1 and eNB2.
- Configure UE to support 1x/LTE Hybrid mode.
- Both eNBs are configured with PCCs and SCCs as defined in [Appendix B](#) or by operator endorsed combination.
- The two PCCs are configured as neighbor cells to one another.
- SCC1, SCC2, SCC3, and SCC4 are available for PCC1 and PCC2.
- A single 1xRTT cell site is available.

### 8.5.2.4 Test Procedure

1. Ensure that the UE is Hybrid 1X/LTE capable and can register on the 1xRTT network (for voice services) and LTE network (for data services) prior to executing any steps beyond powering up the device.
2. Attach the UE to PCC1.

3. Initiate maximum UDP bidirectional traffic (Dependent upon BW combination used).
4. Make a MT voice call.
5. The UE should receive a page for the 1x MT call.
6. Attenuate the signal level of PCC1, SCC1, SCC2, SCC3, and SCC4 and adjust the signal level of PCC2.
7. Terminate the voice call after 30 seconds, then increase SCC1, SCC2, SCC3 and SCC4.
8. Attenuate the signal level of PCC2 and increase the signal level of PCC1.
9. Repeat Steps 4 and 8 one more time.

#### 8.5.2.5 Expected Results

- Verify that the device maintains 1xRTT registration throughout the test case.

After Step 1, verify that:

- The UE attaches successfully registers on the 1x network.

After Step 2, verify that:

- The UE attaches and starts traffic with maximum throughput and PCC1/SCC1, PCC1/SCC2 and PCC1/SCC3 are activated.

After Step 4, verify that:

- E-UTRAN suspends the LTE data session.
- The voice call is not impacted by the configuration of CA.

After Step 6, verify that:

- The UE returns to LTE and successfully performs TAU request to PCC2.
- Upon reattaching to the LTE network, the data session is restored.
- The UE configured and activated PCC2/SCC1 and PCC2/SCC2, and all bearers are correctly reconfigured.
- The UE resumed the traffic with maximum throughput (dependent upon aggregated bandwidth).

After Step 7, verify that:

- PCC2/SCC1 and PCC2/SCC2 are deactivated and de-configured.
- The UE has been successfully handed over to the PCC1/eNB1 by the *RRConnectionReconfiguration* message containing the *mobilityControlInfo* IE sent from PCC2.
- The UE configured and activated PCC1/SCC1, PCC1/SCC2 and PCC1/SCC3, and all bearers are correctly reconfigured.
- The UE resumed the traffic with maximum throughput (dependent upon aggregated bandwidth).

When repeating Step 4 and Step 6, verify that:

- All subsequent handovers follow expected results described above.

### 8.5.3 SMS Origination – Large SMS (Over 240 Characters) – RRC\_ Connected (5DL CA)

#### 8.5.3.1 Test Case Reference

- GCF TS35 H1xLTE 6.18

#### 8.5.3.2 Definition and Purpose

This test verifies that the UE can successfully receive a MO SMS over 1xRTT in RRC\_Connected with 5xCA in activate state.

#### 8.5.3.3 Initial Conditions

- Configure the UE per Section 1.8.
- Configure one available eNB with a PCC, SCC1, SCC2, SCC3, and SCC4 as defined in [Appendix B](#) or by operator endorsed combination.
- Configure UE to support 1x/LTE Hybrid.

#### 8.5.3.4 Test Procedure

1. Attach the UE to PCC1.
2. Initiate maximum UDP bidirectional traffic (Dependent upon BW combination used).
3. Make a MO SMS with greater than 240 characters.

#### 8.5.3.5 Expected Results

After Step 2, verify that:

- The UE attaches and starts traffic with maximum throughput, and SCC1, SCC2, SCC3, and SCC4 are activated.

After Step 3, verify that:

- The UE attaches to the LTE network successfully.
- The MO SMS is sent successfully.
- The 5xCA data session is not halted by the MO SMS.

### 8.5.4 SMS Termination – Large SMS (Over 240 Characters) – RRC\_ Connected (5DL CA)

#### 8.5.4.1 Test Case Reference

- GCF TS35 H1xLTE 6.19

#### 8.5.4.2 Definition and Purpose

This test verifies that the UE can successfully receive a MT SMS over 1xRTT in RRC\_Connected with 5xCA in activate state.

#### 8.5.4.3 Initial Conditions

- Configure the UE per Section 1.8.
- Configure one available eNB with a PCC and SCC as defined in [Appendix B](#) or by operator endorsed combination.
- Configure UE to support 1x/LTE Hybrid mode.

#### 8.5.4.4 Test Procedure

1. Attach the UE to PCC1.
2. Initiate maximum UDP bidirectional traffic (Dependent upon BW combination used).
3. Make a MT SMS with greater than 240 characters.

#### 8.5.4.5 Expected Results

After Step 2, verify that:

- The UE attaches and starts traffic with maximum throughput, and SCC1, SCC2, SCC3, and SCC4 are activated.

After Step 3, verify that:

- The UE attaches to the LTE network successfully.
- The MT SMS is received successfully.
- The 5xCA data session is not halted by the MT SMS.



## 9 LTE 2CC UL Carrier Aggregation

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### 9.1 Basic two UL Carrier Aggregation Functionality

#### 9.1.1 2CC UL & 2CC DL Carrier Aggregation Uplink/Downlink UDP data throughput on the default bearer with 64/16 QAM in DL/UL, UL enabled

##### 9.1.1.1 Reference

- 3GPP 36.331 chapter 5.3.5
- 3GPP 36.101 chapter 5.7.4

##### 9.1.1.2 Definition and Purpose

- Verify that a simultaneous uplink and downlink data transfer with maximum UDP traffic can be successfully performed for PCC and SCC(s).
- The purpose of RRC Connection Reconfiguration procedure in this test is to configure a SCC for carrier aggregation in both UL and DL.
- The network activates and deactivates a configured SCC(s) by sending the Activation/Deactivation MAC control element.

##### 9.1.1.3 Test case focus

- SCC configuration at initial access procedure.
- The SCC is configured/deconfigured for the UE by the *RRCCONNECTIONRECONFIGURATION* message and the UE responds with a *RRCCONNECTIONRECONFIGURATIONCOMPLETE* message.
- UE's signaling and eNB's handling of supportedBandwidthCombinationSet-r10
- The Activation is for both UL and DL CA. MAC control element is identified by a MAC PDU subheader with LCID equals to 11011.
- SCCs to be activated and throughput to be stable.

##### 9.1.1.4 UE capability check:

For inter-band CA or non-contiguous intra-band CA, UE is required to have CA bandwidth class A for each band or each block within the band if there are no carriers contiguously aggregated.

If it's a mixed CA deployment, i.e. there are carriers contiguously aggregated within one of the bands or the blocks, the UE is required to have CA bandwidth class B or even higher depending on the channel bandwidth of the contiguously aggregated carriers within a band or block.

IE: UE-EUTRA-Capability-v1020-IEs -> RF-Parameters-v1020 -> SupportedBandCombination-r10 -> BandParametersUL-r10 -> CA-BandwidthClass-r10

For the system setting of intra-band contiguous 20+20MHz frequencies; If BandParametersUL-r10 -> CA-BandwidthClass-r10 = C, it means UL CA is supported by UE in this SupportedBandCombination-r10.

Check on IE: UE-EUTRA-Capability-v1020-IEs → ue-Category-v1020

If ue-Category-v1020  $\geq 7$ , it means UE support peak UL CA throughput.

Check UE supports carrier aggregation and the band combinations as required by test case.

#### 9.1.1.5 Test Configuration

Following Features are ENABLED and ACTIVAED in eNB

- Two cells active (primary cell and secondary cell).
- Configure the primary cell and secondary cell in the eNB with instructed frequencies and bandwidths for this test as defined in Carrier Aggregation IOT Result Template.
- Both cells are configured to use Open Loop Spatial Multiplexing with DL modulation of 64QAM and UL modulation of 16QAM.
- Primary Cell is -75 dBm or greater.
- Secondary Cell is completely attenuated and UE cannot read it.
- UE is verified to support carrier aggregation and the band combinations for this test.

#### 9.1.1.6 Test Procedure

1. Attach the UE to the primary cell.
2. Make secondary cell -75 dBm or greater.
3. Using Iperf, initiate simultaneous maximum UDP downlink and uplink throughput (depending on the sum of the bandwidth combination you are using) and ensure that the eNB activates the configured secondary cell by sending the activation MAC control element.
4. Record the two minutes' average DL/UL throughput value in for aggregated cells.

#### 9.1.1.7 Expected Results:

- UE is configured by eNB with SCC by the *RRConnectionReconfiguration* message and the UE responds with a *RRConnectionReconfigurationComplete* message. Check sCellToAddModListsCell-r10 parameter.
- UE listens for PDCCH and transmit data and activates carrier aggregation when requested by the eNB.
- UE sends CQI for both primary cell and secondary cell after activation.
- Recorded average UL and DL throughput value. The throughput values of aggregated cells are within acceptable range. (depends on the aggregated bandwidth).

### 9.1.2 2CC UL & 2CC DL Carrier Aggregation Uplink/Downlink TCP data throughput on the default bearer with 64/16 QAM in DL/UL, UL enabled

#### 9.1.2.1 Reference

- 3GPP 36.331 chapter 5.3.5
- 3GPP 36.101 chapter 5.7.4

#### 9.1.2.2 Definition and Purpose

- Verify that a simultaneous uplink and downlink data transfer with maximum TCP traffic can be successfully performed for PCC and SCC(s).

- The purpose of RRC Connection Reconfiguration procedure in this test is to configure a SCC for carrier aggregation in both UL and DL.
- The network activates and deactivates a configured SCC(s) by sending the Activation/Deactivation MAC control element.

### 9.1.2.3 Test Case Focus

- SCC configuration at initial access procedure.
- The SCC is configured/deconfigured for the UE by the *RRCCONNECTIONRECONFIGURATION* message and the UE responds with a *RRCCONNECTIONRECONFIGURATIONCOMPLETE* message.
- UE's signaling and eNB's handling of supportedBandwidthCombinationSet-r10.
- The Activation is for both UL and DL CA. MAC control element is identified by a MAC PDU sub header with LCID equals to 11011.
- SCCs to be activated and throughput to be stable.

### 9.1.2.4 UE Capability Check

For inter-band CA or non-contiguous intra-band CA, UE is required to have CA bandwidth class A for each band or each block within the band if there are no carriers contiguously aggregated.

If it's a mixed CA deployment, i.e. there are carriers contiguously aggregated within one of the bands or the blocks, the UE is required to have CA bandwidth class B or even higher depending on the channel bandwidth of the contiguously aggregated carriers within a band or block.

IE: UE-EUTRA-Capability-v1020-IEs -> RF-Parameters-v1020 -> SupportedBandCombination-r10 -> BandParametersUL-r10 -> CA-BandwidthClass-r10.

For the system setting of intra-band contiguous 20+20MHz frequencies; If BandParametersUL-r10 -> CA-BandwidthClass-r10 = C, it means UL CA is supported by UE in this SupportedBandCombination-r10.

Check on IE: UE-EUTRA-Capability-v1020-IEs → ue-Category-v1020.

If ue-Category-v1020 ≥ 7, it means UE support peak UL CA throughput.

### 9.1.2.5 Test Configuration

Following Features are ENABLED and ACTIVAED in eNB

- Two cells active (primary cell and secondary cell).
- Configure the primary cell and secondary cell in the eNB with instructed frequencies and bandwidths for this test as defined in Carrier Aggregation IOT Result Template.
- Both cells are configured to use Open Loop Spatial Multiplexing with DL modulation of 64QAM and UL modulation of 16QAM.
- Primary Cell is -75 dBm or greater.
- Secondary Cell is completely attenuated and UE cannot read it.
- UE is verified to support carrier aggregation and the band combinations for this test.

### 9.1.2.6 Test Procedure

1. Attach the UE to the primary cell.
2. Make secondary cell -75 dBm or greater.
3. Using ftp or lperf, initiate simultaneous maximum TCP downlink and uplink throughput (depending on the sum of the bandwidth combination you are using) and ensure that the eNB activates the configured secondary cell by sending the activation MAC control element.
4. Record the two minutes' average DL/UL throughput value in for aggregated cells.

### 9.1.2.7 Expected Results

- UE is configured by eNB with SCC by the *RRConnectionReconfiguration* message and the UE responds with a *RRConnectionReconfigurationComplete* message. Check *sCellToAddModList-r10* parameter.
- UE listens for PDCCH and transmit data and activates carrier aggregation when requested by the eNB.
- UE sends CQI for both primary cell and secondary cell after activation.
- Recorded average UL and DL throughput value. The throughput values of aggregated cells are within acceptable range. (depends on the aggregated bandwidth).

## 9.1.3 2CC UL & 2CC DL Carrier Aggregation Uplink/Downlink UDP data throughput on the default bearer with 64QAM UL enabled on the PCC & SCC

### 9.1.3.1 Reference

- 3GPP 36.331 chapter 5.3.5
- 3GPP 36.101 chapter 5.7.4

### 9.1.3.2 Definition and Purpose

- Verify that a simultaneous uplink and downlink data transfer with maximum UDP traffic can be successfully performed for PCC with 64QAM UL and SCC(s) with 64QAM UL.
- The purpose of RRC Connection Reconfiguration procedure in this test is to configure a SCC for carrier aggregation in both UL and DL.
- The network activates and deactivates a configured SCC(s) by sending the Activation/Deactivation MAC control element.

### 9.1.3.3 Test Case Focus

- SCC configuration at initial access procedure.
- The SCC is configured/deconfigured for the UE by the *RRConnectionReconfiguration* message and the UE responds with a *RRConnectionReconfigurationComplete* message.
- UE's signaling and eNB's handling of supportedBandwidthCombinationSet-r10.
- The Activation is for both UL and DL CA. MAC control element is identified by a MAC PDU sub header with LCID equals to 11011.
- SCCs to be activated and throughput to be stable.

#### 9.1.3.4 UE Capability Check

For inter-band CA or non-contiguous intra-band CA, UE is required to have CA bandwidth class A for each band or each block within the band if there are no carriers contiguously aggregated.

If it's a mixed CA deployment, i.e. there are carriers contiguously aggregated within one of the bands or the blocks, the UE is required to have CA bandwidth class B or even higher depending on the channel bandwidth of the contiguously aggregated carriers within a band or block.

IE: UE-EUTRA-Capability-v1020-IEs -> RF-Parameters-v1020 -> SupportedBandCombination-r10 -> BandParametersUL-r10 -> CA-BandwidthClass-r10

For the system setting of intra-band contiguous 20+20MHz frequencies; If BandParametersUL-r10 -> CA-BandwidthClass-r10 = C, it means UL CA is supported by UE in this SupportedBandCombination-r10.

Check on IE: UE-EUTRA-Capability-v1020-IEs → ue-Category-v1020.

If ue-Category-v1020 ≥ 7, it means UE support peak UL CA throughput.

Check for UE-EUTRA-Capability dl-256QAM-r12 supported & ul-64QAM-r12 supported.

Check UE supports carrier aggregation and the band combinations as required by test case.

#### 9.1.3.5 Test Configuration

- Two cells active (primary cell and secondary cell).
- Configure the primary cell and secondary cell in the eNB with instructed frequencies and bandwidths for this test as defined in Carrier Aggregation IOT Result Template.
- PCCs is configured to use Open Loop Spatial Multiplexing with DL modulation of 256QAM and UL modulation of 64QAM.
- SCCs is configured to use Open Loop Spatial Multiplexing with DL modulation of 256QAM and UL modulation of 64QAM.
- Primary Cell is -75 dBm or greater.
- Secondary Cell is completely attenuated and UE cannot read it.
- UE is verified to support carrier aggregation and the band combinations for this test.

#### 9.1.3.6 Test Procedure

1. Attach the UE to the primary cell.
2. Make secondary cell -75 dBm or greater.
3. Using UDP with Iperf, initiate simultaneous maximum downlink and uplink throughput (depending on the sum of the bandwidth combination you are using) and ensure that the eNB activates the configured secondary cell by sending the activation MAC control element.
4. Record the two minutes' average DL/UL throughput value in for aggregated cells.

### 9.1.3.7 Expected Results:

- UE is configured by eNB with SCC by the *RRConnectionReconfiguration* message and the UE responds with a *RRConnectionReconfigurationComplete* message. Check *sCellToAddModList-r10* parameter.
- UE listens for PDCCH and transmit data and activates carrier aggregation when requested by the eNB.
- UE sends CQI for both primary cell and secondary cell after activation.
- Recorded average UL and DL throughput value. The throughput values of aggregated cells are within acceptable range. (depends on the aggregated bandwidth).

### 9.1.4 2CC UL & 2CC DL Carrier Aggregation Uplink/Downlink UDP data throughput on the default bearer with 16QAM UL on the PCC and 64QAM UL on SCC

#### 9.1.4.1 Reference

- 3GPP 36.331 chapter 5.3.5
- 3GPP 36.101 chapter 5.7.4

#### 9.1.4.2 Definition and Purpose

- Verify that a simultaneous uplink and downlink data transfer with maximum UDP traffic can be successfully performed for PCC with 16QAM UL and SCC(s) with 64QAM UL.
- The purpose of RRC Connection Reconfiguration procedure in this test is to configure a SCC for carrier aggregation in both UL and DL.
- The network activates and deactivates a configured SCC(s) by sending the Activation/Deactivation MAC control element.

#### 9.1.4.3 Test Case Focus

- SCC configuration at initial access procedure.
- The SCC is configured/deconfigured for the UE by the *RRConnectionReconfiguration* message and the UE responds with a *RRConnectionReconfigurationComplete* message.
- UE's signaling and eNB's handling of *supportedBandwidthCombinationSet-r10*.
- The Activation is for both UL and DL CA. MAC control element is identified by a MAC PDU sub header with LCID equals to 11011.
- SCCs to be activated and throughput to be stable.

#### 9.1.4.4 UE Capability Check

For inter-band CA or non-contiguous intra-band CA, UE is required to have CA bandwidth class A for each band or each block within the band if there are no carriers contiguously aggregated.

If it's a mixed CA deployment, i.e. there are carriers contiguously aggregated within one of the bands or the blocks, the UE is required to have CA bandwidth class B or even higher depending on the channel bandwidth of the contiguously aggregated carriers within a band or block.

IE: UE-EUTRA-Capability-v1020-IEs -> RF-Parameters-v1020 -> SupportedBandCombination-r10 -> BandParametersUL-r10 -> CA-BandwidthClass-r10.

For the system setting of intra-band contiguous 20+20MHz frequencies; If  $\text{BandParametersUL-r10} > \text{CA-BandwidthClass-r10} = \text{C}$ , it means UL CA is supported by UE in this  $\text{SupportedBandCombination-r10}$ .

Check on IE: UE-EUTRA-Capability-v1020-IEs → ue-Category-v1020

If ue-Category-v1020  $\geq 7$ , it means UE support peak UL CA throughput.

Check for UE-EUTRA-Capability dl-256QAM-r12 supported & ul-64QAM-r12 supported.

Check UE supports carrier aggregation and the band combinations as required by test case.

#### 9.1.4.5 Test Configuration

- Following Features are ENABLED and ACTIVATED in eNB.
- Two cells active (primary cell and secondary cell).
- Configure the primary cell and secondary cell in the eNB with instructed frequencies and bandwidths for this test as defined in Carrier Aggregation IOT Result Template.
- PCCs is configured to use Open Loop Spatial Multiplexing with DL modulation of 64QAM and UL modulation of 16QAM.
- SCCs is configured to use Open Loop Spatial Multiplexing with DL modulation of 64QAM and UL modulation of 64QAM.
- Primary Cell is -75 dBm or greater.
- Secondary Cell is completely attenuated and UE cannot read it.
- UE is verified to support carrier aggregation and the band combinations for this test.

#### 9.1.4.6 Test Procedure

1. Attach the UE to the primary cell.
2. Make secondary cell -75 dBm or greater.
3. Using UDP with Iperf, initiate simultaneous maximum downlink and uplink throughput (depending on the sum of the bandwidth combination you are using) and ensure that the eNB activates the configured secondary cell by sending the activation MAC control element.
4. Record the two minutes' average DL/UL throughput value in for aggregated cells.

#### Expected Results

- UE is configured by eNB with SCC by the *RRConnectionReconfiguration* message and the UE responds with a *RRConnectionReconfigurationComplete* message. Check *sCellToAddModList-r10* parameter.
- UE listens for PDCCH and transmit data and activates carrier aggregation when requested by the eNB.
- UE sends CQI for both primary cell and secondary cell after activation.
- Recorded average UL and DL throughput value. The throughput values of aggregated cells are within acceptable range. (depends on the aggregated bandwidth).



## 9.1.5 2CC UL & 2CC DL Carrier Aggregation Uplink/Downlink TCP data throughput on the default bearer with 64QAM UL enabled on the PCC & SCC

### 9.1.5.1 Reference

- 3GPP 36.331 chapter 5.3.5
- 3GPP 36.101 chapter 5.7.4

### 9.1.5.2 Definition and Purpose

- Verify that a simultaneous uplink and downlink data transfer with maximum TCP traffic can be successfully performed for PCC with 64QAM UL and SCC(s) with 64QAM UL.
- The purpose of RRC Connection Reconfiguration procedure in this test is to configure a SCC for carrier aggregation in both UL and DL.
- The network activates and deactivates a configured SCC(s) by sending the Activation/Deactivation MAC control element.

### 9.1.5.3 Test Case Focus

- SCC configuration at initial access procedure.
- The SCC is configured/deconfigured for the UE by the *RRCConnectionReconfiguration* message and the UE responds with a *RRCConnectionReconfigurationComplete* message.
- UE's signaling and eNB's handling of supportedBandwidthCombinationSet-r10.
- The Activation is for both UL and DL CA. MAC control element is identified by a MAC PDU sub header with LCID equals to 11011.
- SCCs to be activated and throughput to be stable.

### 9.1.5.4 UE Capability Check

For inter-band CA or non-contiguous intra-band CA, UE is required to have CA bandwidth class A for each band or each block within the band if there are no carriers contiguously aggregated.

If it's a mixed CA deployment, i.e. there are carriers contiguously aggregated within one of the bands or the blocks, the UE is required to have CA bandwidth class B or even higher depending on the channel bandwidth of the contiguously aggregated carriers within a band or block.

IE: UE-EUTRA-Capability-v1020-IEs -> RF-Parameters-v1020 -> SupportedBandCombination-r10 -> BandParametersUL-r10 -> CA-BandwidthClass-r10.

For the system setting of intra-band contiguous 20+20MHz frequencies; If BandParametersUL-r10 -> CA-BandwidthClass-r10 = C, it means UL CA is supported by UE in this SupportedBandCombination-r10.

Check on IE: UE-EUTRA-Capability-v1020-IEs → ue-Category-v1020.

If ue-Category-v1020 ≥ 7, it means UE support peak UL CA throughput.

Check for UE-EUTRA-Capability dl-256QAM-r12 supported & ul-64QAM-r12 supported.

Check UE supports carrier aggregation and the band combinations as required by test case.



### 9.1.5.5 Test Configuration

- Following Features are ENABLED and ACTIVAED in eNB.
- Two cells active (primary cell and secondary cell).
- Configure the primary cell and secondary cell in the eNB with instructed frequencies and bandwidths for this test as defined in Carrier Aggregation IOT Result Template.
- PCCs is configured to use Open Loop Spatial Multiplexing with DL modulation of 64QAM and UL modulation of 64QAM.
- SCCs is configured to use Open Loop Spatial Multiplexing with DL modulation of 64QAM and UL modulation of 64QAM.
- Primary Cell is -75 dBm or greater.
- Secondary Cell is completely attenuated and UE cannot read it.
- UE is verified to support carrier aggregation and the band combinations for this test.

### 9.1.5.6 Test Procedure

1. Attach the UE to the primary cell.
2. Make secondary cell -75 dBm or greater.
3. Using ftp or lperf, initiate simultaneous maximum TCP downlink and uplink throughput (depending on the sum of the bandwidth combination you are using) and ensure that the eNB activates the configured secondary cell by sending the activation MAC control element.
4. Record the two minutes' average DL/UL throughput value in for aggregated cells.

### 9.1.5.7 Expected Results:

- UE is configured by eNB with SCC by the *RRConnectionReconfiguration* message and the UE responds with a *RRConnectionReconfigurationComplete* message. Check *sCellToAddModList-r10* parameter.
- UE listens for PDCCH and transmit data and activates carrier aggregation when requested by the eNB.
- UE sends CQI for both primary cell and secondary cell after activation.
- Recorded average UL and DL throughput value. The throughput values of aggregated cells are within acceptable range. (depends on the aggregated bandwidth).

## 9.1.6 2CC UL & 2CC DL Carrier Aggregation Uplink/Downlink UDP data throughput on the default bearer with 64QAM UL and 256QAM DL enabled on the PCC & SCC

### 9.1.6.1 Reference

- 3GPP 36.331 chapter 5.3.5
- 3GPP 36.101 chapter 5.7.4

### 9.1.6.2 Definition and Purpose

Verify that a simultaneous uplink and downlink data transfer with maximum TCP traffic can be successfully performed for PCC with 256QAM DL/64QAM UL and SCC(s) with 256QAM DL/64QAM UL.

The purpose of RRC Connection Reconfiguration procedure in this test is to configure a SCC for carrier aggregation in both UL and DL.

The network activates and deactivates a configured SCC(s) by sending the Activation/Deactivation MAC control element.

### 9.1.6.3 Test Case Focus

- SCC configuration at initial access procedure.
- The SCC is configured/deconfigured for the UE by the *RRCConnectionReconfiguration* message and the UE responds with a *RRCConnectionReconfigurationComplete* message.
- UE's signaling and eNB's handling of supportedBandwidthCombinationSet-r10.
- The Activation is for both UL and DL CA. MAC control element is identified by a MAC PDU sub header with LCID equals to 11011.
- SCCs to be activated and throughput to be stable.

### 9.1.6.4 UE Capability Check

For inter-band CA or non-contiguous intra-band CA, UE is required to have CA bandwidth class A for each band or each block within the band if there are no carriers contiguously aggregated.

If it's a mixed CA deployment, i.e. there are carriers contiguously aggregated within one of the bands or the blocks, the UE is required to have CA bandwidth class B or even higher depending on the channel bandwidth of the contiguously aggregated carriers within a band or block.

IE: UE-EUTRA-Capability-v1020-IEs -> RF-Parameters-v1020 -> SupportedBandCombination-r10 -> BandParametersUL-r10 -> CA-BandwidthClass-r10.

For the system setting of intra-band contiguous 20+20MHz frequencies; If BandParametersUL-r10 -> CA-BandwidthClass-r10 = C, it means UL CA is supported by UE in this SupportedBandCombination-r10.

Check on IE: UE-EUTRA-Capability-v1020-IEs → ue-Category-v1020.

If ue-Category-v1020 ≥ 7, it means UE support peak UL CA throughput.

Check for UE-EUTRA-Capability dl-256QAM-r12 supported & ul-64QAM-r12 supported.

Check UE supports carrier aggregation and the band combinations as required by test case.

### 9.1.6.5 Test Configuration

Following Features are ENABLED and ACTIVATED in eNB

- Two cells active (primary cell and secondary cell).
- Configure the primary cell and secondary cell in the eNB with instructed frequencies and bandwidths for this test as defined in Carrier Aggregation IOT Result Template.
- PCCs is configured to use Open Loop Spatial Multiplexing with DL modulation of 256QAM and UL modulation of 64QAM.

- SCCs is configured to use Open Loop Spatial Multiplexing with DL modulation of 256QAM and UL modulation of 64QAM.
- Primary Cell is -75 dBm or greater.
- Secondary Cell is completely attenuated and UE cannot read it.
- UE is verified to support carrier aggregation and the band combinations for this test.

#### 9.1.6.6 Test Procedure

1. Attach the UE to the primary cell.
2. Make secondary cell -75 dBm or greater.
3. Using UDP with Iperf, initiate simultaneous maximum downlink and uplink throughput (depending on the sum of the bandwidth combination you are using) and ensure that the eNB activates the configured secondary cell by sending the activation MAC control element.
4. Record the two minutes' average DL/UL throughput value in for aggregated cells.

#### 9.1.6.7 Expected Results

- UE is configured by eNB with SCC by the *RRConnectionReconfiguration* message and the UE responds with a *RRConnectionReconfigurationComplete* message. Check *sCellToAddModList-r10* parameter.
- UE listens for PDCCH and transmit data and activates carrier aggregation when requested by the eNB.
- UE sends CQI for both primary cell and secondary cell after activation.
- Recorded average UL and DL throughput value. The throughput values of aggregated cells are within acceptable range. (depends on the aggregated bandwidth).

### 9.1.7 2CC UL & 2CC DL Carrier Aggregation Uplink/Downlink TCP data throughput on the default bearer with 64QAM UL and 256QAM DL enabled on the PCC & SCC

#### 9.1.7.1 Reference

- 3GPP 36.331 chapter 5.3.5
- 3GPP 36.101 chapter 5.7.4

#### 9.1.7.2 Definition and Purpose

- Verify that a simultaneous uplink and downlink data transfer with maximum TCP traffic can be successfully performed for PCC with 256QAM DL/64QAM UL and SCC(s) with 256QAM DL/64QAM UL.
- The purpose of RRC Connection Reconfiguration procedure in this test is to configure a SCC for carrier aggregation in both UL and DL.
- The network activates and deactivates a configured SCC(s) by sending the Activation/Deactivation MAC control element.

#### 9.1.7.3 Test Case Focus

- SCC configuration at initial access procedure.

- The SCC is configured/deconfigured for the UE by the *RRConnectionReconfiguration* message and the UE responds with a *RRConnectionReconfigurationComplete* message.
- UE's signaling and eNB's handling of *supportedBandwidthCombinationSet-r10*.
- The Activation is for both UL and DL CA. MAC control element is identified by a MAC PDU sub header with LCID equals to 11011.
- SCCs to be activated and throughput to be stable.

#### 9.1.7.4 UE Capability Check

- For inter-band CA or non-contiguous intra-band CA, UE is required to have CA bandwidth class A for each band or each block within the band if there are no carriers contiguously aggregated.
- If it's a mixed CA deployment, i.e. there are carriers contiguously aggregated within one of the bands or the blocks, the UE is required to have CA bandwidth class B or even higher depending on the channel bandwidth of the contiguously aggregated carriers within a band or block.
- IE:UE-EUTRA-Capability-v1020-IEs->RF-Parameters-v1020 -> SupportedBandCombination-r10 -> BandParametersUL-r10 -> CA-BandwidthClass-r10.
- For the system setting of intra-band contiguous 20+20MHz frequencies; If BandParametersUL-r10 -> CA-BandwidthClass-r10 = C, it means UL CA is supported by UE in this SupportedBandCombination-r10.

Check on IE: UE-EUTRA-Capability-v1020-IEs → ue-Category-v1020.

If ue-Category-v1020 ≥ 7, it means UE support peak UL CA throughput.

Check for UE-EUTRA-Capability dl-256QAM-r12 supported & ul-64QAM-r12 supported.

Check UE supports carrier aggregation and the band combinations as required by test case.

#### 9.1.7.5 Test Configuration

- Following Features are ENABLED and ACTIVATED in eNB.
- Two cells active (primary cell and secondary cell).
- Configure the primary cell and secondary cell in the eNB with instructed frequencies and bandwidths for this test as defined in Carrier Aggregation IOT Result Template.
- PCCs is configured to use Open Loop Spatial Multiplexing with DL modulation of 256QAM and UL modulation of 64QAM.
- SCCs is configured to use Open Loop Spatial Multiplexing with DL modulation of 256QAM and UL modulation of 64QAM.
- Primary Cell is -75 dBm or greater.
- Secondary Cell is completely attenuated and UE cannot read it.
- UE is verified to support carrier aggregation and the band combinations for this test.

#### 9.1.7.6 Test Procedure

1. Attach the UE to the primary cell.
2. Make secondary cell -75 dBm or greater.

3. Using ftp or lperf, initiate simultaneous maximum TCP downlink and uplink throughput (depending on the sum of the bandwidth combination you are using) and ensure that the eNB activates the configured secondary cell by sending the activation MAC control element.
4. Record the two minutes' average DL/UL throughput value in for aggregated cells.

#### 9.1.7.7 Expected Results

- UE is configured by eNB with SCC by the *RRConnectionReconfiguration* message and the UE responds with a *RRConnectionReconfigurationComplete* message. Check *sCellToAddModList-r10* parameter.
- UE listens for PDCCH and transmit data and activates carrier aggregation when requested by the eNB.
- UE sends CQI for both primary cell and secondary cell after activation.
- Recorded average UL and DL throughput value. The throughput values of aggregated cells are within acceptable range. (depends on the aggregated bandwidth).

## 9.2 CC UL & 3CC DL CA Throughput (UL CA is Enabled on Both Network & DUT)

### 9.2.1 2CC UL & 3CC DL Carrier Aggregation Uplink/Downlink UDP data throughput on the default bearer with 64/16 QAM in DL/UL enabled on the PCC and SCCs

#### 9.2.1.1 Reference

- 3GPP 36.331 chapter 5.3.5
- 3GPP 36.101 chapter 5.7.4

#### 9.2.1.2 Definition and Purpose

- Verify that a simultaneous uplink and downlink data transfer with maximum UCP traffic can be successfully performed for PCC with 64QAM UL and SCC(s) with 64QAM UL.
- The purpose of RRC Connection Reconfiguration procedure in this test is to configure the SCCs for carrier aggregation in both UL and DL.
- The network activates and deactivates a configured SCC(s) by sending the Activation/Deactivation MAC control element.

#### 9.2.1.3 Test Case Focus

- SCC configuration at initial access procedure in a 3CC DL and 2CC UL configuration.
- The SCC is configured/deconfigured for the UE by the *RRConnectionReconfiguration* message and the UE responds with a *RRConnectionReconfigurationComplete* message.
- UE's signaling and eNB's handling of supportedBandwidthCombinationSet-r10.
- The Activation is for both UL and DL CA. MAC control element is identified by a MAC PDU sub header with LCID equals to 11011.
- SCCs to be activated and throughput to be stable.

#### 9.2.1.4 UE Capability Check

- For inter-band CA or non-contiguous intra-band CA, UE is required to have CA bandwidth class A for each band or each block within the band if there are no carriers contiguously aggregated.
- If it's a mixed CA deployment, i.e. there are carriers contiguously aggregated within one of the bands or the blocks, the UE is required to have CA bandwidth class B or even higher depending on the channel bandwidth of the contiguously aggregated carriers within a band or block.
- IE:UE-EUTRA-Capability-v1020-IEs->RF-Parameters-v1020 -> SupportedBandCombination-r10 -> BandParametersUL-r10 -> CA-BandwidthClass-r10.
- For the system setting of intra-band contiguous 20+20MHz frequencies; If BandParametersUL-r10 -> CA-BandwidthClass-r10 = C, it means UL CA is supported by UE in this SupportedBandCombination-r10.

Check on IE: UE-EUTRA-Capability-v1020-IEs → ue-Category-v1020.

If ue-Category-v1020 ≥ 7, it means UE support peak UL CA throughput.

Check for UE-EUTRA-Capability dl-256QAM-r12 supported & ul-64QAM-r12 supported.

Check UE supports carrier aggregation and the band combinations as required by test case.

#### 9.2.1.5 Test Configuration

- Following Features are ENABLED and ACTIVATED in eNB.
- Three cells active (one primary cell and two secondary cell).
- Configure the primary cell and two secondary cell in the eNB with instructed frequencies and bandwidths for this test as defined in Carrier Aggregation IOT Result Template.
- PCCs is configured to use Open Loop Spatial Multiplexing with DL modulation of 64QAM and UL modulation of 16QAM.
- SCCs are configured to use Open Loop Spatial Multiplexing with DL modulation of 64QAM and UL modulation of 16QAM.
- Primary Cell is -75 dBm or greater.
- Secondary Cells are completely attenuated and UE cannot read it.
- UE is verified to support carrier aggregation and the band combinations for this test.

#### 9.2.1.6 Test Procedure

1. Attach the UE to the primary cell.
2. Make secondary cells -75 dBm or greater.
3. Using Iperf, initiate simultaneous maximum UDP downlink and uplink throughput (depending on the sum of the bandwidth combination you are using) and ensure that the eNB activates the configured secondary cell by sending the activation MAC control element.
4. Record the two minutes' average DL/UL throughput value with Iperf in for aggregated cells.

### 9.2.1.7 Expected Results

- UE is configured by eNB with SCC by the *RRConnectionReconfiguration* message and the UE responds with a *RRConnectionReconfigurationComplete* message. Check *sCellToAddModList-r10* parameter.
- UE listens for PDCCH and transmit data and activates carrier aggregation when requested by the eNB.
- UE sends CQI for both primary cell and secondary cell after activation.
- Recorded average UL and DL throughput value. The throughput values of aggregated cells are within acceptable range. (depends on the aggregated bandwidth).

## 9.3 CC UL & 2CC DL CA with Handover (UL CA is Enabled on Both Network & DUT)

### 9.3.1 Inter-eNB intra-band Handover from 2CC UL & 2CC DL Carrier Aggregation Uplink/Downlink (16QAM/64QAM) to 2CC UL & 2CC DL Carrier Aggregation Uplink/Downlink (16QAM/64QAM)

#### 9.3.1.1 Reference

- 3GPP 36.331 chapter 5.3.5
- 3GPP 36.101 chapter 5.7.4

#### 9.3.1.2 Definition and Purpose

- Verify Intra LTE intra-band handover procedure for a UL/DL Carrier Aggregation capable UE. Mobility is performed based on PCC coverage. During handover, any configured SCC will be removed/deconfigured. New SCC(s) will be configured during the handover preparation at the source PCC.

#### 9.3.1.3 Test Case Focus

- *RRConnectionReconfiguration* message containing the *mobilityControllInfo*.
- The *RRConnectionReconfiguration* message:
  - Deconfigure/remove the "old" SCC(s) belonging to the Source PCC
  - Configure the new SCC(s) belonging to the target PCC
- SCCs to be activated before and after handover and throughput to be stable.

#### 9.3.1.4 UE Capability Check

- For inter-band CA or non-contiguous intra-band CA, UE is required to have CA bandwidth class A for each band or each block within the band if there are no carriers contiguously aggregated.
- If it's a mixed CA deployment, i.e. there are carriers contiguously aggregated within one of the bands or the blocks, the UE is required to have CA bandwidth class B or even higher depending on the channel bandwidth of the contiguously aggregated carriers within a band or block.
- IE:UE-EUTRA-Capability-v1020-IEs->RF-Parameters-v1020 -> SupportedBandCombination-r10 -> BandParametersUL-r10 -> CA-BandwidthClass-r10.



- For the system setting of intra-band contiguous 20+20MHz frequencies; If BandParametersUL-r10 -> CA-BandwidthClass-r10 = C, it means UL CA is supported by UE in this SupportedBandCombination-r10.

Check on IE: UE-EUTRA-Capability-v1020-IEs → ue-Category-v1020.

If ue-Category-v1020 ≥7, it means UE support peak UL CA throughput.

Check for UE-EUTRA-Capability dl-256QAM-r12 supported & ul-64QAM-r12 supported.

Check UE supports carrier aggregation and the band combinations as required by test case.

#### 9.3.1.5 Test Configuration

- Following Features are ENABLED and ACTIVAED in eNB(s).
- On Two eNBs Configure the primary cell and one secondary cell in the eNB with instructed frequencies and bandwidths for this test as defined in Carrier Aggregation IOT Result Template.
- Two eNBs have 2 PCCs configured as neighbors to each other and both PCCs have SCCs configuration. Ensure that the eNB has been configured with appropriate measurement reporting triggers for Events A2, A3, and A5 for the PCC.
- On Both eNBs PCCs is configured to use Open Loop Spatial Multiplexing with DL modulation of 64QAM and UL modulation of 16QAM.
- On both eNBs SCCs are configured to use Open Loop Spatial Multiplexing with DL modulation of 64QAM and UL modulation of 16QAM.
- Primary Cell is -75 dBm or greater.
- Secondary Cell on Source eNB is completely attenuated and UE cannot read it.
- Target eNB PCC and SCC are completely attenuated and UE cannot read it.
- UE is verified to support carrier aggregation and the band combinations for this test.

#### 9.3.1.6 Test Procedure:

1. Attach the UE to the source eNB/PCC.
2. Make source eNB/SCC of -75 dBm or greater.
3. Using Iperf, initiate simultaneous maximum UDP downlink and uplink throughput (depending on the sum of the bandwidth combination you are using) and ensure that the eNB activates the configured secondary cell by sending the activation MAC control element.
4. Ensure DL/UL throughput is stable for aggregated cells.
5. Make the target eNB/PCC better terms of signal strength.
6. Degrade the downlink signal of source eNB/PCC. The target eNB/PCC becomes the preferred cell in terms of signal strength.
7. Reverse power signal in order to hand back to the opposite direction; and repeat this step for three more times.

#### 9.3.1.7 Expected Results

- UE is configured by eNB with SCC by the RRCConnectionReconfiguration message and the UE responds with a RRCConnectionReconfigurationComplete message. Check sCellToAddModList-r10 parameter.



- UE listens for PDCCH and transmit data and activates carrier aggregation when requested by the eNB. UE sends CQI for both primary cell and secondary cell after activation.
- The throughput values of aggregated cells is within acceptable range. (depends on the aggregated bandwidth).
- After the handover complete, verify that the new SCC(s) of the target PCC is activated. Throughput values of aggregated cells is within acceptable range.
- All subsequent handovers are following expected steps described above.

More detail verification checks could be found in [Appendix A](#) of this document.

## 9.4 Interaction with Hybrid 1X LTE

### 9.4.1 Interaction with Mobile Terminated (MT) Call

#### 9.4.1.1 Reference

- 3GPP 36.331 chapter 5.3.5
- 3GPP 36.101 chapter 5.7.4
- MDG 209 Voice Options Over LTE-CDMA Multimode Device Requirements
- GCF-TS35 Hybrid 1X & LTE Interoperability Test Specification
- 3GPP2 C.S0044 Interoperability Specification for cdma2000 Air Interface
- CTIA Test Plan for LTE Interoperability

#### 9.4.1.2 Definition and Purpose

- Verify that a simultaneous uplink and downlink data transfer with maximum TCP traffic can be successfully performed for PCC with 256QAM DL/64QAM UL and SCC(s) with 256QAM DL/64QAM UL during the MT hybrid call.
- The purpose of RRC Connection Reconfiguration procedure in this test is to configure a SCC for carrier aggregation in both UL and DL.
- The network activates and deactivates a configured SCC(s) by sending the Activation/Deactivation MAC control element.

#### 9.4.1.3 Test Case Focus

- SCC configuration at initial access procedure.
- The SCC is configured/deconfigured for the UE by the *RRCCConnectionReconfiguration* message and the UE responds with a *RRCCConnectionReconfigurationComplete* message.
- UE's signaling and eNB's handling of supportedBandwidthCombinationSet-r10.
- The Activation is for both UL and DL CA. MAC control element is identified by a MAC PDU sub header with LCID equals to 11011.
- SCCs to be activated and throughput to be stable.
- UE's supporting both eCSFB and Hybrid 1X & LTE modes.
- CDMA2000 1X-RTT support for CS Voice Calls and EVDO REV A Data for fall back to 1X & EVDO Hybrid Mode.

#### 9.4.1.4 UE Capability Check

- For inter-band CA or non-contiguous intra-band CA, UE is required to have CA bandwidth class A for each band or each block within the band if there are no carriers contiguously aggregated.
- If it's a mixed CA deployment, i.e. there are carriers contiguously aggregated within one of the bands or the blocks, the UE is required to have CA bandwidth class B or even higher depending on the channel bandwidth of the contiguously aggregated carriers within a band or block.
- IE:UE-EUTRA-Capability-v1020-IEs->RF-Parameters-v1020 -> SupportedBandCombination-r10 -> BandParametersUL-r10 -> CA-BandwidthClass-r10.
- For the system setting of intra-band contiguous 20+20MHz frequencies; If BandParametersUL-r10 -> CA-BandwidthClass-r10 = C, it means UL CA is supported by UE in this SupportedBandCombination-r10.

Check on IE: UE-EUTRA-Capability-v1020-IEs → ue-Category-v1020.

If ue-Category-v1020 ≥ 7, it means UE support peak UL CA throughput.

Check for UE-EUTRA-Capability dl-256QAM-r12 supported & ul-64QAM-r12 supported.

Check UE supports carrier aggregation and the band combinations as required by test case.

UE's supporting both eCSFB and Hybrid 1X & LTE modes.

#### 9.4.1.5 Test Configuration

Following Features are ENABLED and ACTIVAED in eNB

- Two cells active (primary cell and secondary cell).
- One CDMA cell active.
- Configure the primary cell and secondary cell in the eNB with instructed frequencies and bandwidths for this test as defined in Carrier Aggregation IOT Result Template.
- PCCs is configured to use Open Loop Spatial Multiplexing with DL modulation of 256QAM and UL modulation of 64QAM.
- SCCs is configured to use Open Loop Spatial Multiplexing with DL modulation of 256QAM and UL modulation of 64QAM.
- Primary Cell is -75 dBm or greater.
- Secondary Cell is completely attenuated and UE cannot read it.
- UE is verified to support carrier aggregation and the band combinations for this test.
- CDMA 1x-RTT signal is strong.

#### 9.4.1.6 Test Procedure

1. Attach the UE to the primary cell and register to CDMA 1x-RTT.
2. Make MT voice call from a landline or second CDMA mobile to UE (DUT).
3. Make secondary cell -75 dBm or greater.
4. End the Voice call.

5. Using ftp or lperf, initiate simultaneous maximum TCP downlink and uplink throughput (depending on the sum of the bandwidth combination you are using) and ensure that the eNB activates the configured secondary cell by sending the activation MAC control element.

#### 9.4.1.7 Expected Results

- UE is configured by eNB with SCC by the *RRConnectionReconfiguration* message and the UE responds with a *RRConnectionReconfigurationComplete* message. Check *sCellToAddModList-r10* parameter.
- Voice path for both directions is up and clear. Ensure UE sends ESR message for Hybrid11x UE.
- LTE data call is suspended when UE makes a 1xVoice call.
- UE listens for PDCCH and transmit data and activates carrier aggregation when requested by the eNB.
- UE sends CQI for both primary cell and secondary cell after activation.

#### 9.4.2 Interaction with Mobile Originated (MO) Call

##### 9.4.2.1 Reference

- 3GPP 36.331 chapter 5.3.5
- 3GPP 36.101 chapter 5.7.4
- MDG 209 Voice Options Over LTE-CDMA Multimode Device Requirements
- 3GPP2 C.S0044 Interoperability Specification for cdma2000 Air Interface
- CTIA Test Plan for LTE Interoperability

##### 9.4.2.2 Definition and Purpose

- Verify that a simultaneous uplink and downlink data transfer with maximum TCP traffic can be successfully performed for PCC with 256QAM DL/64QAM UL and SCC(s) with 256QAM DL/64QAM UL during the MO hybrid call.
- The purpose of RRC Connection Reconfiguration procedure in this test is to configure a SCC for carrier aggregation in both UL and DL.
- The network activates and deactivates a configured SCC(s) by sending the Activation/Deactivation MAC control element.

##### 9.4.2.3 Test Case Focus

- SCC configuration at initial access procedure.
- The SCC is configured/deconfigured for the UE by the *RRConnectionReconfiguration* message and the UE responds with a *RRConnectionReconfigurationComplete* message.
- UE's signaling and eNB's handling of *supportedBandwidthCombinationSet-r10*.
- The Activation is for both UL and DL CA. MAC control element is identified by a MAC PDU sub header with LCID equals to 11011.
- SCCs to be activated and throughput to be stable.
- UE's supporting both eCSFB and Hybrid 1X & LTE modes.

- CDMA2000 1X-RTT support for CS Voice Calls and EVDO REV A Data for fall back to 1X & EVDO Hybrid Mode.

#### 9.4.2.4 UE Capability Check

- For inter-band CA or non-contiguous intra-band CA, UE is required to have CA bandwidth class A for each band or each block within the band if there are no carriers contiguously aggregated.
- If it's a mixed CA deployment, i.e. there are carriers contiguously aggregated within one of the bands or the blocks, the UE is required to have CA bandwidth class B or even higher depending on the channel bandwidth of the contiguously aggregated carriers within a band or block.
- IE:UE-EUTRA-Capability-v1020-IEs->RF-Parameters-v1020 -> SupportedBandCombination-r10 -> BandParametersUL-r10 -> CA-BandwidthClass-r10.
- For the system setting of intra-band contiguous 20+20MHz frequencies; If BandParametersUL-r10 -> CA-BandwidthClass-r10 = C, it means UL CA is supported by UE in this SupportedBandCombination-r10.
- Check on IE: UE-EUTRA-Capability-v1020-IEs → ue-Category-v1020.
- If ue-Category-v1020 ≥ 7, it means UE support peak UL CA throughput.
- Check for UE-EUTRA-Capability dl-256QAM-r12 supported & ul-64QAM-r12 supported.
- Check UE supports carrier aggregation and the band combinations as required by test case.
- UE's supporting both eCSFB and Hybrid 1X & LTE modes.

#### 9.4.2.5 Test Configuration

Following Features are ENABLED and ACTIVAED in eNB

- Two cells active (primary cell and secondary cell).
- One CDMA cell active.
- Configure the primary cell and secondary cell in the eNB with instructed frequencies and bandwidths for this test as defined in Carrier Aggregation IOT Result Template.
- PCCs is configured to use Open Loop Spatial Multiplexing with DL modulation of 256QAM and UL modulation of 64QAM.
- SCCs is configured to use Open Loop Spatial Multiplexing with DL modulation of 256QAM and UL modulation of 64QAM.
- Primary Cell is -75 dBm or greater.
- Secondary Cell is completely attenuated and UE cannot read it.
- UE is verified to support carrier aggregation and the band combinations for this test.
- CDMA 1x-RTT signal is strong.

#### 9.4.2.6 Test Procedure

1. Attach the UE to the primary cell and register to CDMA 1x-RTT.
2. Make MO voice call to a landline or second CDMA mobile.
3. Make secondary cell -75 dBm or greater.
4. End the Voice call.

5. Using ftp or lperf, initiate simultaneous maximum TCP downlink and uplink throughput (depending on the sum of the bandwidth combination you are using) and ensure that the eNB activates the configured secondary cell by sending the activation MAC control element.

#### 9.4.2.7 Expected Results

- UE is configured by eNB with SCC by the *RRConnectionReconfiguration* message and the UE responds with a *RRConnectionReconfigurationComplete* message. Check *sCellToAddModList-r10* parameter.
- Voice path for both directions is up and clear Ensure UE sends ESR message for Hybrid1x UE. LTE data is suspended during the Voice call.
- UE listens for PDCCH and transmit data and activates carrier aggregation when requested by the eNB.
- UE sends CQI for both primary cell and secondary cell after activation.

#### 9.4.3 Interaction with Mobile Terminated SMS

##### 9.4.3.1 Reference

- 3GPP 36.331 chapter 5.3.5
- 3GPP 36.101 chapter 5.7.4
- MDG 209 Voice Options Over LTE-CDMA Multimode Device Requirements
- 3GPP2 C.S0044 Interoperability Specification for cdma2000 Air Interface
- CTIA Test Plan for LTE Interoperability

#### 9.4.4 Definition and Purpose

- Verify that a simultaneous uplink and downlink data transfer with maximum TCP traffic can be successfully performed for PCC with 256QAM DL/64QAM UL and SCC(s) with 256QAM DL/64QAM UL during the MT hybrid call.
- The purpose of RRC Connection Reconfiguration procedure in this test is to configure a SCC for carrier aggregation in both UL and DL.
- The network activates and deactivates a configured SCC(s) by sending the Activation/Deactivation MAC control element.

##### 9.4.4.1 Test Case Focus

- SCC configuration at initial access procedure.
- The SCC is configured/deconfigured for the UE by the *RRConnectionReconfiguration* message and the UE responds with a *RRConnectionReconfigurationComplete* message.
- UE's signaling and eNB's handling of *supportedBandwidthCombinationSet-r10*.
- The Activation is for both UL and DL CA. MAC control element is identified by a MAC PDU sub header with LCID equals to 11011.
- SCCs to be activated and throughput to be stable.
- UE's supporting both eCSFB and Hybrid 1X & LTE modes.
- CDMA2000 1X-RTT support for CS Voice Calls and EVDO REV A Data for fall back to 1X & EVDO Hybrid Mode.

#### 9.4.4.2 UE Capability Check

- For inter-band CA or non-contiguous intra-band CA, UE is required to have CA bandwidth class A for each band or each block within the band if there are no carriers contiguously aggregated.
- If it's a mixed CA deployment, i.e. there are carriers contiguously aggregated within one of the bands or the blocks, the UE is required to have CA bandwidth class B or even higher depending on the channel bandwidth of the contiguously aggregated carriers within a band or block.
- IE:UE-EUTRA-Capability-v1020-IEs->RF-Parameters-v1020 -> SupportedBandCombination-r10 -> BandParametersUL-r10 -> CA-BandwidthClass-r10
- For the system setting of intra-band contiguous 20+20MHz frequencies; If BandParametersUL-r10 -> CA-BandwidthClass-r10 = C, it means UL CA is supported by UE in this SupportedBandCombination-r10.

Check on IE: UE-EUTRA-Capability-v1020-IEs → ue-Category-v1020

If ue-Category-v1020 ≥ 7, it means UE support peak UL CA throughput.

Check for UE-EUTRA-Capability dl-256QAM-r12 supported & ul-64QAM-r12 supported

Check UE supports carrier aggregation and the band combinations as required by test case.

UE's supporting both eCSFB and Hybrid 1X & LTE modes.

#### 9.4.4.3 Test Configuration

Following Features are ENABLED and ACTIVAED in eNB

- Two cells active (primary cell and secondary cell).
- One CDMA cell active.
- Configure the primary cell and secondary cell in the eNB with instructed frequencies and bandwidths for this test as defined in Carrier Aggregation IOT Result Template
- PCCs is configured to use Open Loop Spatial Multiplexing with DL modulation of 256QAM and UL modulation of 64QAM.
- SCCs is configured to use Open Loop Spatial Multiplexing with DL modulation of 256QAM and UL modulation of 64QAM.
- Primary Cell is -75 dBm or greater.
- Secondary Cell is completely attenuated and UE cannot read it.
- UE is verified to support carrier aggregation and the band combinations for this test.
- CDMA 1x-RTT signal is strong.

#### 9.4.4.4 Test Procedure

1. Attach the UE to the primary cell and register to CDMA 1x-RTT.
2. Make secondary cell -75 dBm or greater.

3. Using ftp or lperf, initiate simultaneous maximum TCP downlink and uplink throughput (depending on the sum of the bandwidth combination you are using) and ensure that the eNB activates the configured secondary cell by sending the activation MAC control element.
4. While TCP downlink and uplink throughput ongoing, send a Mobile Terminated SMS between 12-160 characters to the UE (DUT).
5. Record the two minutes' average DL/UL throughput value in for aggregated cells.

#### 9.4.4.5 Expected Results

- UE is configured by eNB with SCC by the *RRCCONNECTIONRECONFIGURATION* message and the UE responds with a *RRCCONNECTIONRECONFIGURATIONCOMPLETE* message. Check *sCellToAddModList-r10* parameter.
- Verify the MTSMS is successfully received by the UE (DUT).
- UE listens for PDCCH and transmit data and activates carrier aggregation when requested by the eNB.
- UE sends CQI for both primary cell and secondary cell after activation.

#### 9.4.5 Interaction with Mobile Originated SMS

##### 9.4.5.1 Reference

- 3GPP 36.331 chapter 5.3.5
- 3GPP 36.101 chapter 5.7.4
- MDG 209 Voice Options Over LTE-CDMA Multimode Device Requirements
- 3GPP2 C.S0044 Interoperability Specification for cdma2000 Air Interface
- CTIA Test Plan for LTE Interoperability

##### 9.4.5.2 Definition and Purpose

- Verify that a simultaneous uplink and downlink data transfer with maximum TCP traffic can be successfully performed for PCC with 256QAM DL/64QAM UL and SCC(s) with 256QAM DL/64QAM UL during the MT hybrid call.
- The purpose of RRC Connection Reconfiguration procedure in this test is to configure a SCC for carrier aggregation in both UL and DL.
- The network activates and deactivates a configured SCC(s) by sending the Activation/Deactivation MAC control element.

##### 9.4.5.3 Test Case Focus

- SCC configuration at initial access procedure.
- The SCC is configured/deconfigured for the UE by the *RRCCONNECTIONRECONFIGURATION* message and the UE responds with a *RRCCONNECTIONRECONFIGURATIONCOMPLETE* message.
- UE's signaling and eNB's handling of supportedBandwidthCombinationSet-r10.
- The Activation is for both UL and DL CA. MAC control element is identified by a MAC PDU sub header with LCID equals to 11011.
- SCCs to be activated and throughput to be stable.
- UE's supporting both eCSFB and Hybrid 1X & LTE modes.



- CDMA2000 1X-RTT support for CS Voice Calls and EVDO REV A Data for fall back to 1X & EVDO Hybrid Mode.

#### 9.4.5.4 UE Capability Check

- For inter-band CA or non-contiguous intra-band CA, UE is required to have CA bandwidth class A for each band or each block within the band if there are no carriers contiguously aggregated.
- If it's a mixed CA deployment, i.e. there are carriers contiguously aggregated within one of the bands or the blocks, the UE is required to have CA bandwidth class B or even higher depending on the channel bandwidth of the contiguously aggregated carriers within a band or block.
- IE:UE-EUTRA-Capability-v1020-IEs->RF-Parameters-v1020 -> SupportedBandCombination-r10 -> BandParametersUL-r10 -> CA-BandwidthClass-r10.
- For the system setting of intra-band contiguous 20+20MHz frequencies; If BandParametersUL-r10 -> CA-BandwidthClass-r10 = C, it means UL CA is supported by UE in this SupportedBandCombination-r10.
- Check on IE: UE-EUTRA-Capability-v1020-IEs → ue-Category-v1020.
- If ue-Category-v1020 ≥7, it means UE support peak UL CA throughput.
- Check for UE-EUTRA-Capability dl-256QAM-r12 supported & ul-64QAM-r12 supported.
- Check UE supports carrier aggregation and the band combinations as required by test case.
- UE's supporting both eCSFB and Hybrid 1X & LTE modes.

#### 9.4.5.5 Test Configuration

- Two cells active (primary cell and secondary cell).
- One CDMA cell active.
- Configure the primary cell and secondary cell in the eNB with instructed frequencies and bandwidths for this test as defined in Carrier Aggregation IOT Result Template
- PCCs is configured to use Open Loop Spatial Multiplexing with DL modulation of 256QAM and UL modulation of 64QAM.
- SCCs is configured to use Open Loop Spatial Multiplexing with DL modulation of 256QAM and UL modulation of 64QAM.
- Primary Cell is -75 dBm or greater.
- Secondary Cell is completely attenuated and UE cannot read it.
- UE is verified to support carrier aggregation and the band combinations for this test.
- CDMA 1x-RTT signal is strong.

#### 9.4.5.6 Test Procedure

1. Attach the UE to the primary cell and register to CDMA 1x-RTT.
2. Make secondary cell -75 dBm or greater.
3. Using ftp or lperf, initiate simultaneous maximum TCP downlink and uplink throughput (depending on the sum of the bandwidth combination you are using) and ensure that the eNB activates the configured secondary cell by sending the activation MAC control element.
4. While TCP downlink and uplink throughput ongoing, send a Mobile Originated SMS between 12-160 characters from UE (DUT) to network SMS server or second mobile.



#### 9.4.5.7 Expected Results

- UE is configured by eNB with SCC by the *RRConnectionReconfiguration* message and the UE responds with a *RRConnectionReconfigurationComplete* message. Check *sCellToAddModList-r10* parameter.
- Verify the MOSMS is successfully sent to network SMS server or second mobile.
- UE listens for PDCCH and transmit data and activates carrier aggregation when requested by the eNB.
- UE sends CQI for both primary cell and secondary cell after activation.

**Appendix A Device Checklist and UE Information Summary**

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**General Information**

Item	Mnemonic	Vendor Provided Information	Comments
UE Manufacturer:	TBD		
UE Model:	TBD		
UE Software Version	TBD		
UE Hardware Version	TBD		
UE Protocol Version (if applicable)	TBD		
Chipset Manufacturer	TBD		
Chipset Number / Name	TBD		
Chipset Firmware Version	TBD		
UE Serial Number	TBD		
List the targeted Carrier(s)	TBD		
3GPP Release Level	TBD		

**Contact Information**

Item	Mnemonic	Vendor Provided Information	Comments
UE Vendor Representative	TBD		
Phone Number:	TBD		
Email Address:	TBD		

**Testing Requirements**

<p>Please indicate the testing required:</p>	<p>List the type of testing, test suites and/or specifications per testing should be executed.</p> <ul style="list-style-type: none"> <li><input type="checkbox"/> Full Testing</li> <li><input type="checkbox"/> Regression Testing</li> <li><input type="checkbox"/> Debug / Development Testing</li> <li><input type="checkbox"/> CTIA LTE INTEROPERABILITY TEST PLAN</li> <li><input type="checkbox"/> CTIA LTE CARRIER AGGREGATION INTEROPERABILITY - TEST PLAN</li> </ul>
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Item	Mnemonic	Vendor Provided Information
List all LTE bands supported by the UE (Comma-Delimited)	TBD	
Indicate the primary band class for testing	TBD	
Indicate the primary bandwidth for testing	TBD	
Please list other feature(s) applicable for the test (comma – delimited)	TBD	
RF Connection (e.g. SMA, MMCX, etc.	TBD	
External Power Supply Required (Default=No)	TBD	<input type="checkbox"/> Yes
External Power Supply Voltage (IF <i>ueextpwr</i> =Y, ELSE N/A)	TBD	Numeric field, one decimal place
External Power supply Current (IF <i>ueextpwr</i> =Y, ELSE N/A)	TBD	Numeric field, one decimal place
UICC or S/W USIM Interface	TBD	<input type="checkbox"/> Supports USIM on UICC
	TBD	<input type="checkbox"/> Supports CSIM on UICC

**UE Capabilities**

**Programming and Tool Requirements (Informative)**

Item	Vendor Provided Information	Comments
DM tools		
Programming tools		
UE USIM / UICC Card and programming instruction		

AT commands		List/provide tool required or AT commands necessary to program
USB Driver version (if supported)		
RF Cables supplied (minimum 4)		
Diagnostic monitor cables		

**Interoperability Lab Specific Requirements**

Contact the Interoperability Lab for specific requirements.

**Test Cases Not Supported**

Reference: CTIA Interoperability Test Plan	Please list all test cases not supported in the chapter	Comments

**Appendix B Network Configuration Recommendations per Operating Band**

**B.1 Band 41 Recommendations**

TDD subframe and special subframe configuration should mimic that of the deployed field network.

All SCCs should be directly configured unless otherwise stated by the test case.

The band combination used for testing must be supported by the UE and be comprised of a PCC and SCC defined in 3GPP 36.101 Section 5.

TABLE B.1-1 DEFAULT, BAND 41 ENB1, AND ENB2 CA CONFIGURATION

Band Combination	DL PCC (BW)	DL SCC (BW)	UL PCC (BW)	UL SCC (BW)
CA_41C	40056 (20 MHz)	40254 (20 MHz)	40056 (20 MHz)	No Uplink CA Supported
CA_41D	40056 (20 MHz)	40254 40437 (20 MHz)	40056 (20 MHz)	No Uplink CA Supported

TABLE B-2 ENB3 CA CONFIGURATION

Band Combination	DL PCC (BW)	DL SCC (BW)	UL PCC (BW)	UL SCC (BW)
CA_41C	40650 (20 MHz)	40452 (20 MHz)	40650 (20 MHz)	No Uplink CA Supported
CA_41D	40650 (20 MHz)	40848 41031 (20 MHz)	40650 (20 MHz)	No Uplink CA Supported

TABLE B-3 RECOMMENDED MINIMUM THROUGHPUT FOR THE FOLLOWING TEST CASES

Test Case Number	DL (Mbps)	UL (Mbps)
4.1	TBD	
4.2	TBD	
4.3	TBD	TBD
4.4	TBD	TBD
4.5	TBD	TBD

Refer to operator and / or operator market endorsement for pass / fail criteria.

**Appendix C Change History**

Date	Version	Description
August 2016	1.0	<ul style="list-style-type: none"> <li>• Initial Publication</li> </ul>
February 2017	1.1	<ul style="list-style-type: none"> <li>• Corrections and updates to indicate test scope for 2CC and higher CCs will be in future versions.</li> <li>• Corrections to test cases:               <ul style="list-style-type: none"> <li>○ 2.2, 2.5, 2.7, 3.6, 5.5, 5.7-5.10</li> </ul> </li> </ul>
August 2017	2.0	<ul style="list-style-type: none"> <li>• Insert 3DL CC CA to Section 6.</li> <li>• Remove eCSFB test cases in 5.2 to 5.5 due to no endorsement</li> <li>• Remove Appendix B as it is being updated and referenced in 3GPP TS 36.101 and 36.306</li> <li>• Editorial changes to reflect version change to 2.0</li> </ul>
February 2019	3.0	<ul style="list-style-type: none"> <li>• Added the following test cases:               <ul style="list-style-type: none"> <li>○ 7.1, 7.2, 7.3, 7.4, 8.1, 8.2, 8.3, 8.4, 8.5, 9.1, 9.2, 9.3, 9.4</li> </ul> </li> <li>• Modified Appendix A to include a mnemonic for each parameter and eliminated fields which are no longer required.</li> <li>• Expanded Appendix B to include configuration parameters for multiple bands.</li> </ul>