

TS.11- Annex M

Detailed Test Procedures for 5G NR User Equipment

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# Annex M: Detailed Test Procedures for 5G NR User Equipment

This annex contains the detailed procedures that are recommended to be used for Field and Lab Tests for 3GPP 5G NR User Equipment.

Note (informative): Field tests are to be carried out on devices that are based on 3GPP Rel-15 or later core specifications. For SA the version of the 3GPP specification selected must be 15.3.x or later to avoid backward incompatibly problems.

Note: Definitions of 5G abbreviations are available in the Glossary, Annex H

**Applicability Table**

This table indicates the applicability of 5G implementation options of each test case of this Annex.



**100 Attach and Detach Related Test Cases**

## 100.1 Attach and Detach for EPS Services

### 100.1.1 EPS Attach and Detach for EPS Services

For 5G NR capable devices performing an EPS Attach/Detach for 5G NR Option 3, test cases in Annex C, Chapter 30.1.1 apply. This section therefore just references those test cases and only lists additional setup and execution steps that are required when an LTE eNB is complemented with a 5G NR gNB.

Note: Test cases that just contain a reference to Annex C may also be executed with an LTE eNB without a co-located 5G gNB and only need to be executed once for devices that are both LTE and 5G NR option 3 capable.

#### 100.1.1.1 EPS Attach / Detach

Description

The DUT shall successfully perform the “EPS Attach” and “Default EPS Bearer Context Activation” and “EPS Detach” procedures via an LTE eNB Master Node with a 5G NR gNB Secondary Node (5G NR EN-DC option 3).

Applicability

3GPP Rel. 15 or later

Non-SA Option 3

Related core specifications

3GPP TS 24.301, 5.5.1

3GPP TS 36.331, 5.3.3

3GPP TS 38.331, 6.3.3

Reason for test

To verify the 5G DUT can successfully establish a Default EPS bearer with EPS Attach in a 5G NR option 3 network configuration and, depending on network settings and manufacturer configuration, show an indication to the user that 5G service is available and to verfiy that the DUT successfully performs the EPS Detach procedure.

Initial configuration

DUT supports EN-DC option 3

A UICC with a subscription for 5G services is used

Network coverage is an EN-DC configuration with LTE eNB Master Node connected to an EPC and with a 5G NR gNB Secondary Node (i.e. non-standalone option 3).

DUT is powered off or in flight mode

Test procedure

| **-** | **Test procedure** | **Expected behaviour** |
| --- | --- | --- |
| 1 | Power on DUT / disable flight mode and confirm successful attach procedure. | Check in the trace if the network sets the upperLayerIndication-r15 flag in LTE SIB2 to indicate to the UE that a co-located 5G NR gNB is available at this location.  (Note: Depending on the network operator, this flag may or may not be set. If not set, either no 5G NR gNB is available at this location or the network operator does not want to indicate this. Therefore if the flag is not set, ensure that the LTE eNB used for this test is actually configured for 5G NR option 3 operation.)  DUT sends ATTACH REQUEST to the network with type EPS ATTACH (1).  Check that the UE informs the network that it is 5G NR option 3 capable by including the following IE’s:   * in the ATTACH REQUEST message:   + “UE Network Capability” with the DCNR bit set to 1 (dual connectivity with NR supported)   + “UE Additional Security Capability” indicating support for 5G encryption and integrity algorithms * UE-MRDC-Capability container in the ueCapabilityInformation message.   Network sends ATTACH ACCEPT and ACTIVATE DEFAULT EPS BEARER CONTEXT REQUEST containing the APN and PDN type.  DUT sends ACTIVATE DEFAULT EPS BEARER CONTEXT ACCEPT to the network. |
| 2 | Verify on the display that the DUT shows the proper radio network icon. | [If SIB2 indicates the presence of a 5G NR gNB, check that the UE displays a network icon that indicates that 5G coverage is available. How the icon looks like is implementation specific.  Note 1: If SIB2 does not contains this indication, the 5G icon might not be shown at all or only during times in which the DUT is in RRC Connected state and the network has configured the UE to use the co-located 5G gNB in addition to the LTE eNB.  Note 2: The device manufacturer could decide not to use the SIB2 information to show the 5G icon. If no 5G icon is shown, verify with the manufacturer if this is the intended configuration.] |
| 3 | Load a page on the embedded browser (or via a tethering connection if embedded browser is not supported). | Page is loaded successfully to confirm data connection. |
| 4 | Power off DUT / enable Flight Mode | DUT sends DETACH REQUEST to the network with type “EPS Detach (1)” and “Switch off (1)”. |

Example message flow:

| **Step** | **Direction DUT - NW** | **Message** | **Comments** |
| --- | --- | --- | --- |
| ATTACH | | | |
| 1 | --> | ATTACH REQUEST  (PDN CONNECTIVITY REQUEST) | EPS attach (1) |
| 2 | <-- | ATTACH ACCEPT  (ACTIVATE DEFAULT EPS BEARER CONTEXT REQUEST) |  |
| 3 | --> | ATTACH COMPLETE  (ACTIVATE DEFAULT EPS BEARER CONTEXT ACCEPT) |  |
| DETACH | | | |
| 4 | --> | DETACH REQUEST | EPS Detach (1) & Switch off (1) |

#### 100.1.1.2 Void

#### 100.1.1.3 Void

#### 100.1.1.4 Void

#### 100.1.1.5 Void

#### 100.1.1.6 Void

#### 100.1.1.7 Void

#### 100.1.1.8 Void

#### 100.1.1.9 Void

#### 100.1.1.10 EPS Attach unsuccessful for 5G services

Description

The DUT shall successfully perform the “EPS Attach” and “Default EPS Bearer Context Activation” procedures via an LTE eNB Master Node with a 5G NR gNB Secondary Node (5G EN-DC option 3) even in case if the UICC is not subscribed for 5G services

Applicability

3GPP Rel. 15 or later

Non-SA Option 3

Related core specifications

3GPP TS 24.301, 5.5.1

3GPP TS 36.331, 5.3.3

3GPP TS 38.331, 6.3.3

Reason for test

To verify the 5G DUT can successfully establish a Default EPS bearer with EPS Attach in a 5G NR option 3 network configuration and should not show an indication to the user that 5G service is available.

Initial configuration

DUT supports 5G EN-DC option 3

A UICC with a missing subscription for 5G services is used

Network coverage is an EN-DC configuration with LTE eNB Master Node connected to an EPC and with a 5G NR gNB Secondary Node (i.e. non-standalone option 3).

DUT is powered off or in flight mode

Test procedure

| **-** | **Test procedure** | **Expected behaviour** |
| --- | --- | --- |
| 1 | Power on DUT / disable flight mode and confirm successful attach procedure. | Check in the trace if the network sets the upperLayerIndication-r15 flag in LTE SIB2 to indicate to the UE that a 5G NR Secondary Node gNB is available at this location.  (Note: Depending on the network operator, this flag may or may not be set. If not set, either no 5G NR gNB is available at this location or the network operator does not want to indicate this. Therefore if the flag is not set, ensure that the LTE eNB used for this test is actually configured for 5G NR option 3 operation.)  DUT sends ATTACH REQUEST to the network with type EPS ATTACH (1).  Check that the UE informs the network that it is 5G NR option 3 capable by including following IE’s:   * in the ATTACH REQUEST message:   + “UE Network Capability” with the DCNR bit set to 1 (dual connectivity with NR supported)   + “UE Additional Security Capability” indicating support for 5G encryption and integrity algorithms * the UE-MRDC-Capability container in the ueCapabilityInformation message   Network includes following IE in ATTACH ACCEPT:   * RestrictDCNR = 1 (Use of dual connectivity with NR is restricted) |
| 2 | Verify on the display that the DUT shows the proper radio network icon. | Device shall show only 4G icon |
| 3 | Load a page on the embedded browser (or via a tethering connection if embedded browser is not supported). | Page is loaded successfully to confirm data connection. |

Example message flow:

| **Step** | **Direction DUT - NW** | **Message** | **Comments** |
| --- | --- | --- | --- |
| 1 | --> | ATTACH REQUEST  (PDN CONNECTIVITY REQUEST) | EPS attach (1) |
| 2 | <-- | ATTACH ACCEPT  (ACTIVATE DEFAULT EPS BEARER CONTEXT REQUEST) |  |
| 3 | --> | ATTACH COMPLETE  (ACTIVATE DEFAULT EPS BEARER CONTEXT ACCEPT) |  |

### 100.1.2 Combined Attach and Detach

#### 100.1.2.1 Combined Attach / Detach

Description

The DUT shall successfully perform the “Combined EPS/IMSI Attach”, “Default EPS Bearer Context Activation” and “Combined EPS/IMSI Detach” procedures via an LTE eNB Master Node with a 5G NR gNB Secondary Node (5G NR EN-DC option 3).

Applicability

3GPP Rel. 15 or later

Non-SA Option 3

Related core specifications

3GPP TS 24.301, 5.5.1

3GPP TS 36.331, 5.3.3

3GPP TS 38.331, 6.3.3

Reason for test

To verify the 5G DUT can successfully establish a Default EPS bearer with Combined EPS/IMSI Attach in a 5G NR option 3 network configuration and, depending on network settings and manufacturer configuration, show an indication to the user that 5G service is available and to verfiy that the DUT successfully performs the Detach procedure.

Initial configuration

DUT supports EN-DC option 3

A UICC with a subscription for 5G services is used

Network coverage is an EN-DC configuration with LTE eNB Master Node connected to an EPC and with a 5G NR gNB Secondary Node (i.e. non-standalone option 3).

DUT is powered off or in flight mode

Test procedure

| **-** | **Test procedure** | **Expected behaviour** |
| --- | --- | --- |
| 1 | Power on DUT / disable flight mode and confirm successful attach procedure. | Check in the trace if the network sets the upperLayerIndication-r15 flag in LTE SIB2 to indicate to the UE that a co-located 5G NR gNB is available at this location.  (Note: Depending on the network operator, this flag may or may not be set. If not set, either no 5G NR gNB is available at this location or the network operator does not want to indicate this. Therefore if the flag is not set, ensure that the LTE eNB used for this test is actually configured for 5G NR option 3 operation.)  DUT sends ATTACH REQUEST to the network with type COMBINED EPS/IMSI ATTACH (2).  Check that the UE informs the network that it is 5G NR option 3 capable by including the following IE’s:   * in the ATTACH REQUEST message:   + “UE Network Capability” with the DCNR bit set to 1 (dual connectivity with NR supported)   + “UE Additional Security Capability” indicating support for 5G encryption and integrity algorithms * UE-MRDC-Capability container in the ueCapabilityInformation message.   Network sends ATTACH ACCEPT and ACTIVATE DEFAULT EPS BEARER CONTEXT REQUEST containing the APN and PDN type.  DUT sends ACTIVATE DEFAULT EPS BEARER CONTEXT ACCEPT to the network. |
| 2 | Verify on the display that the DUT shows the proper radio network icon. | [If SIB2 indicates the presence of a 5G NR gNB, check that the UE displays a network icon that indicates that 5G coverage is available. How the icon looks like is implementation specific.  Note 1: If SIB2 does not contains this indication, the 5G icon might not be shown at all or only during times in which the DUT is in RRC Connected state and the network has configured the UE to use the co-located 5G gNB in addition to the LTE eNB.  Note 2: The device manufacturer could decide not to use the SIB2 information to show the 5G icon. If no 5G icon is shown, verify with the manufacturer if this is the intended configuration.] |
| 3 | Load a page on the embedded browser (or via a tethering connection if embedded browser is not supported). | Page is loaded successfully to confirm data connection. |
| 4 | Power off DUT / enable Flight Mode | DUT sends DETACH REQUEST to the network with type “COMBINED EPS/IMSI Detach (3)” and “Switch off (1)”. |

Example message flow:

| **Step** | **Direction DUT - NW** | **Message** | **Comments** |
| --- | --- | --- | --- |
| ATTACH | | | |
| 1 | --> | ATTACH REQUEST  (PDN CONNECTIVITY REQUEST) | Combined EPS/IMSI attach (2) |
| 2 | <-- | ATTACH ACCEPT  (ACTIVATE DEFAULT EPS BEARER CONTEXT REQUEST) |  |
| 3 | --> | ATTACH COMPLETE  (ACTIVATE DEFAULT EPS BEARER CONTEXT ACCEPT) |  |
| DETACH | | | |
| 4 | --> | DETACH REQUEST | Combined EPS/IMSI Detach (3) & Switch off (1) |

#### 100.1.2.2 Combined Attach – successful for EPS services only, cause #18 “CS Domain not available”

Applicability

3GPP Rel. 15 or later

Non-SA Option 3

Please refer to Annex C, 30.1.2.2 for general execution of the test case

Please refer to 100.1.1.1 for 5G NR option 3 specifics that have to be checked in this test case, particularly the signalling of 5G NR capabilities and indication of a 5G icon on the display of the DUT.

#### 100.1.2.3 Void

#### 100.1.2.4 Void

#### 100.1.2.5 Void

#### 100.1.2.6 Combined EPS Attach unsuccessful for 5G services

Description

The DUT shall successfully perform the “Combined EPS Attach” and “Default EPS Bearer Context Activation” procedures via an LTE eNB Master Node with 5G NR gNB Secondary Node (5G NR option 3) even in case if the UICC is not subscribed for 5G services.

Applicability

3GPP Rel. 15 or later

Non-SA Option 3

Related core specifications

3GPP TS 24.301, 5.5.1

3GPP TS 36.331, 5.3.3

3GPP TS 38.331, 6.3.3

Reason for test

To verify the 5G DUT can successfully establish a Default EPS bearer with Combined EPS Attach in a 5G NR option 3 network configuration and should not show an indication to the user that 5G service is available.

Initial configuration

DUT supports 5G EN-DC option 3

A UICC with a missing subscription for 5G services is used

Network coverage is an EN-DC configuration with LTE eNB Master Node connected to an EPC and with a 5G NR gNB Secondary Node (i.e. non-standalone option 3).

DUT is powered off or in flight mode

Test procedure

| **-** | **Test procedure** | **Expected behaviour** |
| --- | --- | --- |
| 1 | Power on DUT / disable flight mode and confirm successful attach procedure. | Check in the trace if the network sets the upperLayerIndication-r15 flag in LTE SIB2 to indicate to the UE that a 5G NR Secondary Node gNB is available at this location.  Note: Depending on the network operator, this flag may or may not be set. If not set, either no 5G NR gNB is available at this location or the network operator does not want to indicate this. Therefore if the flag is not set, ensure that the LTE eNB used for this test is actually configured for 5G NR option 3 operation.  DUT sends ATTACH REQUEST to the network with type COMBINED EPS/IMSI ATTACH (2).  Check that the UE informs the network that it is 5G NR option 3 capable by including following IE’s:   * in the ATTACH REQUEST message:   + “UE Network Capability” with the DCNR bit set to 1 (dual connectivity with NR supported)   + “UE Additional Security Capability” indicating support for 5G encryption and integrity algorithms * the UE-MRDC-Capability container in the ueCapabilityInformation message   Network includes following IE in ATTACH ACCEPT:   * RestrictDCNR = 1 (Use of dual connectivity with NR is restricted) |
| 2 | Verify on the display that the DUT shows the proper radio network icon. | Device shall show only 4G icon |
| 3 | Load a page on the embedded browser (or via a tethering connection if embedded browser is not supported). | Page is loaded successfully to confirm data connection. |

Example message flow:

| **Step** | **Direction DUT - NW** | **Message** | **Comments** |
| --- | --- | --- | --- |
| 1 | --> | ATTACH REQUEST  (PDN CONNECTIVITY REQUEST) | EPS attach (1) |
| 2 | <-- | ATTACH ACCEPT  (ACTIVATE DEFAULT EPS BEARER CONTEXT REQUEST) |  |
| 3 | --> | ATTACH COMPLETE  (ACTIVATE DEFAULT EPS BEARER CONTEXT ACCEPT) |  |

**100.1.2.7 EPS Attach – Dynamic Spectrum Sharing (DSS)**

**Description**

The DUT shall successfully perform the “EPS Attach” and “Default EPS Bearer Context Activation” procedures via an LTE eNB with a co-located NR gNB. The NR cell is configured for Dynamic Sprectrum Sharing (DSS). The DUT shall be able to decode SIB2 (upperLayerIndication-r15) and be able to indicate the relevant NR capabilites. The DUT shall set the the DCNR bit to "dual connectivity with NR supported"..

**Applicability**

3GPP Rel. 15 or later

Non-SA Option 3

**Related core specifications**

3GPP TS 24.301, 5.3.2

3GPP TS 36.331, 5.3.3

3GPP TS 38.331, 6.3.3

**Reason for test**

To verify the 5G DUT can successfully establish a Default EPS bearer with Combined EPS Attach in an 5G EN-DC combination with DSS.

**Initial configuration**

DUT supports 5G NR option 3

A UICC with a subscription for 5G services is used

Network coverage of an LTE gNB with a co-located 5G NR gNB (DSS) is available.

DUT is powered off or in flight mode

**Test procedure**

| **-** | **Test procedure** | **Expected behaviour** |
| --- | --- | --- |
| 1 | Power on DUT / disable flight mode and confirm successful attach procedure. | Check in the trace if the network sets the upperLayerIndication-r15 flag in LTE SIB2 to indicate to the UE that a co-located 5G NR gNB is available at this location.  Note: Depending on the Operator, this flag may or may not be set. If not set, either no 5G NR gNB is available at this location or the network operator does not want to indicate this. Therefore if the flag is not set, ensure that the LTE eNB used for this test is actually onfigured for 5G NR option 3 operation.  - DUT sends ATTACH REQUEST to the network with type EPS ATTACH. Check that the UE informs the network that it is 5G NR option 3 capable by including the UE-MRDC-Capability  container in the ueCapabilityInformation message.  - Network sends ATTACH ACCEPT and ACTIVATE DEFAULT EPS BEARER CONTEXT REQUEST containing the APN and PDN type.   * - DUT sends ACTIVATE DEFAULT EPS BEARER CONTEXT ACCEPT to the network. |
| 2 | Verify on the display that the DUT shows the proper radio network icon. | SIB2 indicates the presence of a 5G NR gNB, check that the UE displays a network icon that indicates that 5G coverage is available. How the icon looks like is implementation specific.  Note 1: If SIB2 does not contains this indication, the 5G icon shall not be shown during IDLE only during times in which the DUT is in RRC Connected state and the network has configured the UE to use the co-located 5G gNB in addition to the LTE eNB.  Note 2: The device manufacturer could decide not to use the SIB2 information to show the 5G icon. If no 5G icon is shown, verify with the manufacturer if this is the intended configuration. |
| 3 | Wait until the DUT enters IDLE mode and ensure the 5G Icon is displayed | The DUT enters IDLE mode, the 5G icon is displayed (if upperLayerIndication=true) |
| 4 | Load a page on the embedded browser (or via a tethering connection if embedded browser is not supported). | The Page is loaded successfully to confirm data connection. The 5G Icon shall be displayed also during connected mode |
| 5 | Set the DUT to "4G/3G/2G-only mode and repeat step 1-3. | The 5G-Icon shall NOT displayed in any step |
| 6 | Set the DUT to "2G-only" mode and repeat step 1-3. | No 5G icon & full detach/re-attach procedure |

**Example message flow:**

| **Step** | **Direction DUT - NW** | **Message** | **Comments** |
| --- | --- | --- | --- |
| 1 | --> | ATTACH REQUEST (incl. DCNR bit)  (PDN CONNECTIVITY REQUEST) | EPS attach (1) |
| 2 | <-- | ATTACH ACCEPT  (ACTIVATE DEFAULT EPS BEARER CONTEXT REQUEST) |  |
| 3 | --> | ATTACH COMPLETE  (ACTIVATE DEFAULT EPS BEARER CONTEXT ACCEPT) |  |

## 100.2 Registration and Deregistration for 5GC Services

### 100.2.1 5GC Registration

#### 100.2.1.1 5GC Registration – Option 2

Description

The DUT shall successfully perform the registration to the 5G system and establish PDU sessions as indicated.

Applicability

3GPP Rel.15 or later

SA Option 2

Related core specifications

3GPP TS 23.502

Reason for test

To verify the DUT can successfully perform the registration to the 5G system and establish PDU sessions as indicated.

Initial configuration

DUT and NW support 5G NR Option 2.

DUT is powered off or in flight mode

.

Test procedure

|  |  |  |
| --- | --- | --- |
| **-** | **Test procedure** | **Expected behaviour** |
| 1 | Power on DUT / disable flight mode and confirm successful registration procedure. | DUT sends REGISTRATION REQUEST to the network with Registration type set to “initial registration”.  Network sends REGISTRATION ACCEPT.  DUT sends REGISTRATION COMPLETE to the network. |
| 2 | Perform data transfer on the DUT (e,g, Load a page on the embedded browser). | Data transfer is successful. (e,g, Page is loaded successfully) |

Example message flow

| **Step** | **Direction UE - NW** | **Message** | **Comments** |
| --- | --- | --- | --- |
| 1 | --> | REGISTRATION REQUEST | Registration type “initial registration” |
| 2 | <-- | REGISTRATION ACCEPT |  |
| 3 | --> | REGISTRATION COMPLETE |  |

### 100.2.2 5GC Deregistration

#### 100.2.2.1 5GC Deregistration – Option 2

Description

The DUT shall successfully deregister from the registered 5G system.

Applicability

3GPP Rel.15 or later

SA Option 2

Related core specifications

3GPP TS 23.502

Reason for test

To verify the DUT successfully deregister from the registered 5G system.

Initial configuration

DUT and NW support 5G NR Option 2.

DUT is in RM-REGISTERED and CM-IDLE state.

Test procedure

|  |  |  |
| --- | --- | --- |
| - | Test procedure | Expected behaviour |
| 1 | Power off the DUT / Set the DUT to Flight Mode so that all radio transmitters are switched off. | DUT sends DEREGISTRATION REQUEST to the network with Deregistration type “Switch off”. |

Example message flow

| **Step** | **Direction UE - NW** | **Message** | **Comments** |
| --- | --- | --- | --- |
| 1 | --> | DEREGISTRATION REQUEST | Deregistration type “Switch off” |

### 100.2.3 Registration Reject, cause #27 " N1 mode not allowed "

Description

Check the DUT’s behaviour on the reject message with cause 27 “N1 mode not allowed”

Applicability

3GPP Rel. 15 or later

SA Option 2

Related core specifications

3GPP TS 24.501, 5.3.1

Reason for test

To verify that the DUT behaves correctly on a reject message “N1 mode not allowed”

Initial configuration

DUT and NW support 5G NR Option 2

DUT is not subscribed for 5GS services

5GS services and EPS services are available at the test location

DUT is powered off

Test procedure

| **-** | **Test procedure** | **Expected behaviour** |
| --- | --- | --- |
| 1 | Power on DUT and attempt registration procedure for 5GS services. | DUT sends REGISTRATION REQUEST to the network.  Network sends REGISTRATION REJECT with Reject Cause #27 “N1 mode not allowed”. |
| 2 | Verify DUT start the timer T3540 upon receiption of 5GMM cause value #27 | DUT locally release the established N1 NAS signalling connection upon expiry of T3540.  DUT set the 5GS update status to 5U3 ROAMING NOT ALLOWED and delete any 5G-GUTI, last visited registered TAI, TAI list and ngKSI.  Additionally,DUT reset the registration attempt counter and enter the 5GMM-NULL state. |
| 3 | Verify DUT attempt attach procedure for EPS services | DUT sends ATTACH REQUEST to the network and sets the N1 mode bit to "N1 mode not supported" in the UE network capability IE of the ATTACH REQUEST message.  Network sends ATTACH ACCEPT and ACTIVATE DEFAULT EPS BEARER CONTEXT REQUEST containing the APN and PDN type.  DUT sends ATTACH COMPLETE to the network andsuccessfully attach to an E-UTRA cell. |

### 100.2.4 Registration Reject, cause “#7 5GS services not allowed”

Description

Check that UE correctly starts timer T3247 upon reception of non-integrity protected message and restart the registration procedure

Related core specifications

3GPP TS 24.501, clause 5.3.20.2

Reason for test

To verify that the DUT behaves correctly after expiry of timer T3247.

Initial configuration

* DUT is powered off
* Network does not allow 5GS services (e.g. this particular SUPI is not provisioned for 5GS services)

|  |  |  |
| --- | --- | --- |
| - | **Test procedure** | Expected behaviour |
| 1 | Power on the DUT | The DUT attempts Registration procedure. |
| 2 | Network sends REGISTRATION REJECT with EMM cause #7, 5GS services not allowed. The NAS message is not integrity protected | DUT shall start T3247 timer with a random value uniformly drawn from the range between 30 minutes and 60 minutes |
| 3 | Check whether the DUT tries to initiate Registration procedure in 30-60 minutes range after DUT receives Attach Reject message. | DUT shall initiate Registration procedure after T3247 expires. |

## 100.4 Void

PLMN selection (EPC) test cases have been transitioned to Annex D, section 59

## 100.5 Void

PLMN selection (5GC) test cases have been transitioned to Annex D, section 59-1

## 100.6 Security Features

### 100.6.1 Advertisement of mandatory integrity and ciphering algorithms (5NR Option 3 – EN-DC)

Description

To verify that MS includes mandatory 5G integrity and ciphering algorithms in “UE additional security capability” IE

Reason for test

Several ciphering algorithms are supported by mobile stations and networks today. This test verifies that DUT complies with the mandatory requirements from 35.401 by advertising support of:

Integrity algorithms:

* 128-NIA1 128-bit SNOW 3G based algorithm.
* 128-NIA2 128-bit AES based algorithm

Ciphering algorithms:

* NEA0 Null ciphering algorithm.
* 128-NEA1 128-bit SNOW 3G based algorithm.
* 128-NEA2 128-bit AES based algorithm.

Note: UEs shall implement NIA0 for integrity protection of NAS and RRC signalling but is only allowed for unauthenticated emergency session and shall not be explicitly advertised.

Related 3GPP core specifications

3GPP TS 24.301, 3GPP TS 35.401, Chapter 5.2.2; Chapter 5.2.3

Initial configuration

DUT is Powered OFF (or Flight Mode enabled).

DUT supports 5G NR Option 3 – EN-DC

Test procedure

|  |  |  |
| --- | --- | --- |
| **-** | **Test procedure** | **Expected behaviour** |
| 1 | Power ON DUT (or disable Flight Mode). | DUT is successfully camping on the PLMN and starts regular registration procedure (attach for EPS services only or attach for both EPS and non-EPS services) |
|  | DUT sends an ATTACH REQUEST message to the network. | Within ATTACH REQUEST message, confirm the advertised integrity and ciphering algorithms included by the DUT in “**“**UE additional security capabilityIE”. Encoding example at the end.  The network shall respond to the DUT with an ATTACH ACCEPT message. |

Encoding example:

NAS EPS Mobility Management Message Type: Attach request (0x41)

...

UE additional security capability

Element ID: 0x6f

Length: 4

1... .... = 5G-EA0: Supported

.1.. .... = 128-5G-EA1: Supported

..1. .... = 128-5G-EA2: Supported

...1 .... = 128-5G-EA3: Supported

.... 0... = 5G-EA4: Not supported

.... .0.. = 5G-EA5: Not supported

.... ..0. = 5G-EA6: Not supported

.... ...0 = 5G-EA7: Not supported

0... .... = 5G-EA8: Not supported

.0.. .... = 5G-EA9: Not supported

..0. .... = 5G-EA10: Not supported

...0 .... = 5G-EA11: Not supported

.... 0... = 5G-EA12: Not supported

.... .0.. = 5G-EA13: Not supported

.... ..0. = 5G-EA14: Not supported

.... ...0 = 5G-EA15: Not supported

0... .... = 5G-IA0: Not supported

.1.. .... = 128-5G-IA1: Supported

..1. .... = 128-5G-IA2: Supported

...1 .... = 128-5G-IA3: Supported

.... 0... = 5G-IA4: Not supported

.... .0.. = 5G-IA5: Not supported

.... ..0. = 5G-IA6: Not supported

.... ...0 = 5G-IA7: Not supported

0... .... = 5G-IA8: Not supported

.0.. .... = 5G-IA9: Not supported

..0. .... = 5G-IA10: Not supported

...0 .... = 5G-IA11: Not supported

.... 0... = 5G-IA12: Not supported

.... .0.. = 5G-IA13: Not supported

.... ..0. = 5G-IA14: Not supported

.... ...0 = 5G-IA15: Not supported

### 100.6.2 Advertisement of mandatory integrity and ciphering algorithms (5NR Option 2)

Description

To verify that MS includes mandatory 5G integrity and ciphering algorithms in “UE security capability” IE

Reason for test

Several ciphering algorithms are supported by mobile stations and networks today. This test verifies that DUT complies with the mandatory requirements from 35.401 by advertising support of:

Integrity algorithms:

* 128-NIA1 128-bit SNOW 3G based algorithm.
* 128-NIA2 128-bit AES based algorithm

Ciphering algorithms:

* NEA0 Null ciphering algorithm.
* 128-NEA1 128-bit SNOW 3G based algorithm.
* 128-NEA2 128-bit AES based algorithm.

Note: UEs shall implement NIA0 for integrity protection of NAS and RRC signalling but is only allowed for unauthenticated emergency session and shall not be explicitly advertised.

Related 3GPP core specifications

3GPP TS 24.301, 3GPP TS 35.401, Chapter 5.2.2; Chapter 5.2.3

Initial configuration

DUT is Powered OFF (or Flight Mode enabled).

DUT supports 5G NR Option 2

Test procedure

|  |  |  |
| --- | --- | --- |
| **-** | **Test procedure** | **Expected behaviour** |
| 1 | Power ON DUT (or disable Flight Mode). | DUT is successfully camping on the PLMN and starts regular registration procedure (initial registration) |
|  | DUT sends an REGISTRATION REQUEST message to the network. | Within REGISTRATION REQUEST message, confirm the advertised integrity and ciphering algorithms included by the DUT in “**“**UE security capability IE”. Encoding example at the end.  The network shall respond to the DUT with an REGISTRATION ACCEPT message. |

Encoding example:

NAS EPS Mobility Management Message Type: Attach request (0x41)

...

UE security capability

Element ID: 0x2e

Length: 2

1... .... = 5G-EA0: Supported

.1.. .... = 128-5G-EA1: Supported

..1. .... = 128-5G-EA2: Supported

...0 .... = 128-5G-EA3: Not supported

.... 0... = 5G-EA4: Not supported

.... .0.. = 5G-EA5: Not supported

.... ..0. = 5G-EA6: Not supported

.... ...0 = 5G-EA7: Not supported

0... .... = 5G-IA0: Not supported

.1.. .... = 128-5G-IA1: Supported

..1. .... = 128-5G-IA2: Supported

...0 .... = 128-5G-IA3: Not supported

.... 0... = 5G-IA4: Not supported

.... .0.. = 5G-IA5: Not supported

.... ..0. = 5G-IA6: Not supported

.... ...0 = 5G-IA7: Not supported

### 100.6.3 Subscription concealed identifier generation by ME

Description

The Subscription Concealed Identifier, called SUCI, is a privacy preserving identifier containing the concealed SUPI (Subscription Permanent identifier).

A UE supporting N1 mode includes a SUCI:

* in the REGISTRATION REQUEST message when the UE is attempting initial registration procedure and a valid 5G-GUTI is not available.
* in the IDENTITY RESPONSE message, if the SUCI is requested by the network during the identification procedure

Reason for test

To verify that MS shall generate a SUCI using a protection scheme with the raw public key, i.e. the Home Network Public Key that was securely provisioned in control of the home network

Related 3GPP core specifications

3GPP TS 24.501, 3GPP TS 33.501, 3GPP TS 31.102

Initial configuration

* UICC contains configuration “SUCI calculation is to be performed by the ME”
  + service n°124 Subscription identifier privacy support is “available" in EFust and
  + service n°125 SUCI calculation by the USIM is not "available" in EFust
* EFSUCI\_Calc\_Info (Subscription Concealed Identifier Calculation Information EF) does not contain null protection scheme.
* DUT does not contain a valid 5G-GUTI:
  + EF5GS3GPPLOCI (5GS 3GPP location information) is empty
* DUT is Powered OFF (or Flight Mode enabled).
* DUT supports 5G NR Option 2

Test procedure

|  |  |  |
| --- | --- | --- |
| **-** | **Test procedure** | **Expected behaviour** |
| 1 | Power ON DUT (or disable Flight Mode). | DUT is successfully camping on the PLMN and starts regular registration procedure (initial registration) |
| 2 | DUT sends an REGISTRATION REQUEST message to the network | Within REGISTRATION REQUEST message, confirm the structure of 5GS Mobile identity included by DUT:   1. SUPI format = IMSI 2. Home network identifier contains MCC/MNC of the mobile subscription 3. Routing indicator 4. Protection scheme identifier being equal to the value being provided in EFsuci\_calc\_info 5. Home Network Public Key Identifier being equal to the value being provided in EFsuci\_calc\_info 6. Scheme Output, consisting of a string of characters with a variable length or hexadecimal digits, dependent on the used protection scheme   The network shall respond to the DUT with an REGISTRATION ACCEPT message. |

Note 1: Structure of the 5GS in accordance with 24.301

Table

Description automatically generated

Note 2: Encoding example using correct protection-scheme:

        5GS registration type

            .... .001 = 5GS registration type: initial registration (1)

        5GS mobile identity

            Length: 53

            0... .... = Spare: 0

            .000 .... = SUPI format: IMSI (0)

            .... 0... = Spare: 0

            .... .001 = Type of identity: SUCI (1)

            Mobile Country Code (MCC): 260

            Mobile Network Code (MNC): 02

            Routing indicator: 1

            .... 0001 = Protection scheme Id: ECIES scheme profile A (1)

            Home network public key identifier: 1

Scheme output: XXXXXX

Note 3: Encoding example with null-protection scheme (incorrect behaviour)

5GS mobile identity

Length: 13

0... .... = Spare: 0

.000 .... = SUPI format: IMSI (0)

.... 0... = Spare: 0

.... .001 = Type of identity: SUCI (1)

            Mobile Country Code (MCC): 260

            Mobile Network Code (MNC): 02

Routing indicator: 0

.... 0000 = Protection scheme Id: NULL scheme (0)

Home network public key identifier: 0

MSIN: 2608659739

# 101 PS Data / Services

## 101.1 PDN activation / deactivation (EPC)

### 101.1.1 Multiple PDN Connection Activation / Deactivation – Single PDN Connectivity over NR

Description

Verify that the DUT can successfully activate/deactivate a second PDN Connection via an LTE eNB only while it has already an active PDN connection via Master Node with a 5G NR gNB Secondary Node (5G EN-DC option 3)

Related core specifications

3GPP TS 24.301 (NAS specific procedures)

3GPP TS 36.331 (RRC specific procedures)

3GPP TS 37.340 (EN-DC specific parts. secondary node addition, chapter 10.2)

Initial configuration

DUT supports 5G NR EN-DC option 3

Network coverage of is an EN-DC configuration with LTE eNB Master Node connected to an EPC and LTE with a 5G NR gNB Secondary Node (i.e. non-standalone option 3).

Network supports only singel PDN (bearer) to be in use in EN-DC configuration

Setup and APN2 profile for Home operator services (e.g. MMS, XCAP)

DUT is Attached for EPS services: Default PDN connection and Bearer Context is active with APN1. Ensure that a dual-connectivity split bearer is established before the attempt for second PDN Connection

Test procedure

|  |  |  |
| --- | --- | --- |
| **-** | **Test procedure** | **Expected behaviour** |
| 1 | Open the embedded browser application and load a webpage. | Webpage is loaded successfully. |
| 2 | Use any operator services that requires APN2 (send an MMS or interrogate any supplementary service) | DUT sends a PDN CONNECTIVITY REQUEST message to the network using APN2.  DUT sends ACTIVATE DEFAULT EPS BEARER CONTEXT ACCEPT to the network  The transmission of MMS or supplementary service operation is successful |
| 3 | Wait for APN2 disconnection after the home operator service has been used | DUT sends a PDN DISCONNECT REQUEST message to the network.  Network sends DEACTIVATE EPS BEARER CONTEXT REQUEST.  DUT sends DEACTIVATE EPS BEARER CONTEXT ACCEPT to the network |
| 4 | Open the embedded browser application and load a webpage | Webpage is loaded successfully |

Note 1: If DUT is not supporting the setup of a separate APN for the operator services, the use of a different application provoking the establishment of a second PDN context is acceptable.

### 101.1.2 Multiple PDN Connection Activation / Deactivation - Multiple PDN Connectivity over NR

Description

Verify that the DUT can successfully activate/deactivate a second PDN Connection via an LTE eNB Master Node with a 5G NR gNB Secondary Node (5G EN-DC option 3)

Related core specifications

3GPP TS 24.301 (NAS specific procedures)

3GPP TS 36.331 (RRC specific procedures)

3GPP TS 37.340 (EN-DC specific parts. secondary node addition, chapter 10.2)

Initial configuration

DUT supports 5G NR EN-DC option 3

Network coverage of is an EN-DC configuration with LTE eNB Master Node connected to an EPC and LTE with a 5G NR gNB Secondary Node (i.e. non-standalone option 3).

Network supports multiple PDNs being in use in EN-DC configuration.

Setup an APN profile for a Mobile hotspot (Tethering / DUN) connection using APN2.

DUT is Attached for EPS services: Default PDN connection and Bearer Context is active with APN1.

Ensure that the tethering/DUN connection is as fast as the available cellular connection.

Testprocedure

|  |  |  |
| --- | --- | --- |
| - | Test procedure | Expected behaviour |
| 1 | Prepare the DUT with the method of measuring the throughput. | DUT is setup with the appropriate tool/method. |
| 2 | Perform  1 x throughput measurement using the appropriate method on DUT. | Measurement is taken and recorded. |
| 3 | Activate a Tethering / DUN connection. | DUT sends a PDN CONNECTIVITY REQUEST message to the network for APN2.  DUT sends ACTIVATE DEFAULT EPS BEARER CONTEXT ACCEPT to the network  The Tethering / DUN connection is established successfully. |
| 4 | Using an external device such as a PC, connect to the hotspot. |  |
| 5 | Prepare the external device with the method of measuring the throughput. | The external device is setup with the appropriate tool/method. |
| 6 | Perform  1 x throughput measurement using the appropriate method on the external device. | Measurement is taken and recorded. |
| 7 | Compare the test results | Ensure that the measurement obtained on the external device is no more than 10% worse than the measurement taken on DUT. |
| 8 | Deactivate the Tethering / DUN connection | DUT sends a PDN DISCONNECT REQUEST message to the network for APN2.  Network sends DEACTIVATE EPS BEARER CONTEXT REQUEST.  DUT sends DEACTIVATE EPS BEARER CONTEXT ACCEPT to the network  The Tethering / DUN connection is deactivated successfully. |

Note 1: If DUT is not supporting the setup of a separate APN for the Mobile hotspot (Tethering/DUN) connection, the use of a different application provoking the establishment of a second PDN context is acceptable.

## 101.2 PDU Session Establishment / Release (5GC)

### 101.2.1 Establishment of Multiple PDU Sessions

Description

Verify that the DUT can successfully establish multiple PDU sessions.

Applicability

3GPP Rel.15 or later

SA Option 2

Related core specifications

3GPP TS 23.502 (5GS procedures)

3GPP TS 24.501 (NAS specific procedures)

Initial configuration

DUT and NW support 5G NR Option 2

DUT is powered off or in flight mode

DNN1 is associated with a PDN session for data transfer

DNN2 is associated with a PDN session for IMS voice service

Test procedure

|  |  |  |
| --- | --- | --- |
| **-** | **Test procedure** | **Expected behaviour** |
| 1 | Power on DUT / disable flight mode. | DUT successfully register to the network. |
| 2 | Initiate a MO IMS voice call on DUT. | DUT establishes a PDU session for IMS voice using DNN2.  A IMS voice call is successfully established. |
| 3 | Open the embedded browser application and load a webpage | DUT establishes a second PDU session for data transfer using DNN1.  Webpage is loaded successfully while the call is ongoing. |
| 4 | End the call. | The call is successfully ended. |

Note: If DUT is not supporting the setup of a separate PDU sesion for the IMS voice service, the use of a different application provoking the establishment of a second PDU sesion is acceptable.

## 101.3 Multi RAT Dual Carrier - Option 3 (EPC)

#### 101.3.1.1 Establishment of Dual Connectivity - Downlink

Description

This test case verifies that the UE can establish connectivity to an Option 3 Non-Standalone 5G network by initially connecting to the 4G eNB and then being configured for downlink dual-connectivity operation.

Related core specifications

3GPP TS 24.301 (NAS specific procedures)

3GPP TS 36.331 (RRC specific procedures)

3GPP TS 37.340 (EN-DC specific parts. secondary node addition, chapter 10.2)

Initial configuration

DUT supports 5G NR option 3

Network coverage of an LTE eNB with a co-located 5G NR gNB is available.

5G NR frequency in use is not shared with LTE frequency.

Aggregated DL channel bandwidth in EN\_DC Mode is greater than in 4G only mode

DUT is powered off or in flight mode

Test procedure

|  |  |  |
| --- | --- | --- |
| **-** | **Test procedure** | **Expected behaviour** |
| 1 | Power on DUT / disable flight mode and confirm successful attach procedure. | DUT attaches successfully to the network.  DUT establishes a default bearer for Internet connectivity. |
| 2 | Prepare the DUT with the method of measuring the throughput. | DUT is setup with the appropriate tool/method. |
| 3 | Perform 1 x Downlink throughput measurement using the appropriate method on DUT. | Measurement is taken and recorded. |
| 4 | Configure DUT to 4G only mode. |  |
| 5 | Perform 1 x Downlink throughput measurement using the appropriate method on DUT. | Measurement is taken and recorded. |
| 6 | Compare the results obtained. | Confirm that the data rate in EN-DC mode is higher than what could be achieved over the 4G only bearer thus ensuring that the split bearer is properly used. |

#### 101.3.1.2 Establishment of Dual Connectivity – Uplink (via LTE Only)

Description

This test case verifies that the UE can establish connectivity to an Option 3 Non-Standalone 5G network by initially connecting to the 4G eNB and then being configured for uplink transmission via LTE only.

Related core specifications

3GPP TS 24.301 (NAS specific procedures)

3GPP TS 36.331 (RRC specific procedures)

3GPP TS 37.340 (EN-DC specific parts. secondary node addition, chapter 10.2)

**Initial configuration**

DUT supports 5G NR option 3.

Network coverage of an LTE eNB with a co-located 5G NR gNB is available.

Network supports UL transmission via LTE only.

DUT is powered off or in flight mode.

Test procedure

|  |  |  |
| --- | --- | --- |
| **-** | **Test procedure** | **Expected behaviour** |
| 1 | Power on DUT / disable flight mode and confirm successful attach procedure. | DUT attaches successfully to the network.  DUT establishes a default bearer for Internet connectivity. |
| 2 | Prepare the DUT with the method of measuring the throughput. | DUT is setup with the appropriate tool/method. |
| 3 | Perform  1 x Uplink throughput measurement using the appropriate method on DUT. | Measurement is taken and recorded. |
| 4 | Configure DUT to 4G only mode. |  |
| 5 | Perform  1 x Uplink throughput measurement using the appropriate method on DUT. | Measurement is taken and recorded. |
| 6 | Compare the results obtained. | Confirm that the data rates obtained are similar thus ensuring that the 4G only bearer is used. |

#### 101.3.1.3 Establishment of Dual Connectivity - Uplink (via NR only)

Description

This test case verifies that the UE can establish connectivity to an Option 3 Non-Standalone 5G network by initially connecting to the 4G eNB and then being configured for uplink transmission via NR only.

Related core specifications

3GPP TS 24.301 (NAS specific procedures)

3GPP TS 36.331 (RRC specific procedures)

3GPP TS 37.340 (EN-DC specific parts. secondary node addition, chapter 10.2)

Initial configuration

DUT supports 5G NR option 3.

Network coverage of an LTE eNB with a co-located 5G NR gNB is available.

Network supports UL transmission via NR only.

DUT is powered off or in flight mode.

Test procedure

|  |  |  |
| --- | --- | --- |
| **-** | **Test procedure** | **Expected behaviour** |
| 1 | Power on DUT / disable flight mode and confirm successful attach procedure. | DUT attaches successfully to the network.  DUT establishes a default bearer for Internet connectivity. |
| 2 | Prepare the DUT with the method of measuring the throughput. | DUT is setup with the appropriate tool/method. |
| 3 | Perform  1 x Uplink throughput measurement using the appropriate method on DUT. | Measurement is taken and recorded. |
| 4 | Record the result obtained. | Confirm that the data rate via NR is not lower than 60% of theoretical rate (Note 1) assuming a single user in the cell |

Note 1: Theoretical rate is dependent on bandwidth in use; FDD/TDD in use; Number of allocated UL slots thus cannot be explicitly provided in the test case description.

#### 101.3.1.4 Establishment of Dual Connectivity - Uplink (via Split DRB)

Description

This test case verifies that the UE can establish connectivity to an Option 3 Non-Standalone 5G network by initially connecting to the 4G eNB and then being configured for dual-connectivity operation with UL Split bearer functionality.

Related core specifications

3GPP TS 24.301 (NAS specific procedures)

3GPP TS 36.331 (RRC specific procedures)

3GPP TS 37.340 (EN-DC specific parts. secondary node addition, chapter 10.2)

Initial configuration

DUT supports 5G NR option 3.

Network coverage of an LTE eNB with a co-located 5G NR gNB is available.

DUT and network supports UL transmission via both MCG path and SCG path for the split DRB

Aggregated UL channel bandwidth in EN\_DC Mode is greater than in 4G only mode

DUT is powered off or in flight mode.

**Test procedure**

|  |  |  |
| --- | --- | --- |
| **-** | **Test procedure** | **Expected behaviour** |
| 1 | Power on DUT / disable flight mode and confirm successful attach procedure. | DUT attaches successfully to the network.  DUT establishes a default bearer for Internet connectivity. |
| 2 | Prepare the DUT with the method of measuring the throughput. | DUT is setup with the appropriate tool/method. |
| 3 | Perform  1 x Uplink throughput measurement using the appropriate method on DUT. | Measurement is taken and recorded. |
| 4 | Configure DUT to 4G only mode. |  |
| 5 | Perform  1 x Uplink throughput measurement using the appropriate method on DUT. | Measurement is taken and recorded. |
| 6 | Compare the results obtained. | Confirm that the data rate in EN-DC mode is higher than what could be achieved over the 4G only bearer thus ensuring that the split bearer is properly used, also taking in consideration that 2 ULCA could be in use in 4G Only mode |

**101.3.1.5 Establishment of Dual Connectivity - Through handover procedure - Downlink**

**Description**

This test case verifies that the UE can establish connectivity to an Option 3 Non-Standalone 5G network by initially connecting to the 4G eNB without NR coverage and then being configured for dual-connectivity operation after handover to a 4G eNB with NR coverage

**Related core specifications**

3GPP TS 24.301 (NAS specific procedures)

3GPP TS 36.331 (RRC specific procedures)

3GPP TS 37.340 (EN-DC, handover procedures, chapter 10.7)

**Initial configuration**

DUT supports 5G NR option 3

Network coverage is of an LTE configuration (Cell 1)

Network coverage is of an ENDC configuration (Cell 2)

5G NR frequency in use is not shared with LTE frequency.

Aggregated DL channel bandwidth in EN\_DC Mode is greater than in 4G only mode

DUT is powered off or in flight mode

**Test procedure**

|  |  |  |
| --- | --- | --- |
| **-** | **Test procedure** | **Expected behaviour** |
| 1 | Power on DUT / disable flight mode and confirm successful attach procedure in Cell 1 | DUT attaches successfully to the network.  DUT establishes a default bearer for Internet connectivity. |
| 2 | Transfer data in the **downlink** direction. | Data transfer is ongoing. |
| 3 | Move the UE from the Cell 1 to a combined LTE/5G NR Option 3 cell (Cell 2) while the data transfer is ongoing | The data transfer continues seamlessly.  Confirm that the data rate in EN-DC (Cell 2) is higher than what could be achieved over the LTE-Only cell (Cell 1) thus ensuring that the split bearer is properly used. |
| 4 | Move the UE to an LTE-only cell (Cell 1) while the data transfer is ongoing | The data transfer continues seamlessly. |

**101.3.1.6 Establishment of Dual Connectivity - Through handover procedure - Uplink**

**Description**

This test case verifies that the UE can establish connectivity to an Option 3 Non-Standalone 5G network by initially connecting to the 4G eNB without NR coverage and then being configured for dual-connectivity operation after handover to a 4G eNB with NR coverage

**Related core specifications**

3GPP TS 24.301 (NAS specific procedures)

3GPP TS 36.331 (RRC specific procedures)

3GPP TS 37.340 (EN-DC, handover procedures, chapter 10.7)

**Initial configuration**

DUT supports 5G NR option 3

DUT and network supports UL transmission via both MCG path and SCG path for the split DRB

Network coverage is of an LTE configuration (Cell 1)

Network coverage is of an ENDC configuration (Cell 2)

Aggregated DL/UL channel bandwidth in EN\_DC Mode is greater than in 4G only mode

DUT is powered off or in flight mode

**Test procedure**

|  |  |  |
| --- | --- | --- |
| **-** | **Test procedure** | **Expected behaviour** |
| 1 | Power on DUT / disable flight mode and confirm successful attach procedure in Cell 1 | DUT attaches successfully to the network.  DUT establishes a default bearer for Internet connectivity. |
| 2 | Transfer data in the **uplink** direction. | Data transfer is ongoing. |
| 3 | Move the UE from the Cell 1 to a combined LTE/5G NR Option 3 cell (Cell 2) while the data transfer is ongoing | The data transfer continues seamlessly.  Confirm that the data rate in EN-DC (Cell 2) is higher than what could be achieved over the LTE-Only cell (Cell 1) thus ensuring that the split bearer is properly used, taking in consideration that 2 ULCA could be in use in Cell 1 |
| 4 | Move the UE to an LTE-only cell (Cell 1) while the data transfer is ongoing | The data transfer continues seamlessly. |

#### 101.3.1.7 Use of VoLTE Services in EN-DC mode

Description

This test case verifies that the UE can establish a PDN connection for VoLTE services in a 5G Option 3 network environment and that voice calls and a simultaneous data transmission over the split bearer is possible.

Note: This test case does not validate VoLTE IMS functionality but particularly focuses on the following air interface aspects:

* VoLTE signalling over the IMS default bearer over the LTE cell
* VoLTE speech path over a dedicated bearer over the LTE cell
* Simultaneous data transfer over a split default bearer

Related core specifications

3GPP TS 24.301 (NAS specific procedures)

3GPP TS 36.331 (RRC specific procedures)

3GPP TS 37.340 (EN-DC, handover procedures, chapter 10.7)

Initial configuration

DUT supports 5G NR option 3

Network coverage of an LTE eNB **with** a co-located 5G NR gNB is available.

DUT is powered off or in flight mode

Network maintains the 5G bearer while the VoLTE Call is established.

Test procedure

|  |  |  |
| --- | --- | --- |
| **-** | **Test procedure** | **Expected behaviour** |
| 1 | Power on DUT / disable flight mode and confirm successful attach procedure. | DUT attaches successfully to the network.  DUT establishes a default bearer for Internet connectivity.  DUT establishes a default bearer for IMS/VoLTE connectivity. |
| 2 | Prepare the DUT with the method of measuring the throughput. | DUT is setup with the appropriate tool/method. |
| 3 | Perform 1 x Downlink throughput measurement using the appropriate method on DUT. | Measurement is taken and recorded. |
| 4 | Establish a VoLTE call | A VoLTE call is successfully established, including a dedicated bearer. Speech path is present in both directions. |
| 5 | Perform 1 x Downlink throughput measurement using the appropriate method on DUT. | Measurement is taken and recorded  Confirm that the audio call remains uninterrupted during the throughput measurement.  Ensure that the throughput measurement taken during the VoLTE call is no more than 10% worse than the measurement taken before the call. |

## 101.4 Multi-RAT Dual Carrier Option 7 (5GC)

## 101.5 Multi-RAT Dual Carrier Option 4 (5GC)

## 101.6 Basic Services (EPC)

### 101.6.1 Legacy: PING

Description

The 5G-NR capable DUT shall successfully ping a remote IP address

Applicability

3GPP Release 15 or later

5G Option 3 (EN-DC - EPC)

Related core specifications

3GPP TS 24.301, section 6.4 (ESM procedures), section 8.3.3.11 (max BR / GBR) and section 9.9.4 (QoS)

3GPP TS 38.331, section 5.3 (RRC Connection Control)

Reason for test

To verify that DUT successfully ping a remote IP address in a 5G EN-DC environment.

Initial configuration

DUT and Reference1 are switched ON

The DUT, Reference 1 and NW support 5G Option 3

Test procedure

| **-** | **Test procedure** | **Expected behaviour** |
| --- | --- | --- |
| 1 | On DUT and Reference 1: Start a ping procedure (ping –t [-l size] [-w timeout] destination, for e.g. ping –t –l 100 –w 1500 10.11.26.52) | - |
| 2 | On DUT and Reference 1: Verify that the replies from the ping commands are correctly received. | The DUT is able to ping the remote destination |
| 3 | Stop ping procedure | The DUT’s ´ping performance is comparable to the Reference 1 ping performance (no more than 10% worse |

### 101.6.2 Void

### 101.6.3 Performance (Good coverage - relative measurement)

It is essential for the tester to build up a knowledge base of the maximum throughput achievable in the test location and for the device capability. This can be done using different Reference devices with similar capabilities to the DUT. Once a maximum achievable throughput is known for the location then this can be used as a base figure to validate the test result. Please note, that with networks continuously improving, this maximum achievable figure shall be monitored regularly and updated with the latest known maximum achievable throughput. The model name(s) used to build up the knowledge base shall be noted in the test result.

Note: There are several ways to check the throughput:

* DUT tethered to a laptop (USB/Wi-Fi). A speedtest tool on the laptop can then be used to measure the throughput. Ensure that the tethering/DUN connection is as fast as the available cellular connection.
* A speedtest tool directly on the DUT can be used to measure the throughput.
* For modules or devices without a UI, a DUN connection to a laptop can be used along with a speedtest tool on the laptop to measure the throughput.Other valid methods are available such as an FTP client.

#### 101.6.3.1 Stationary Data Performance – Relative Downlink Throughput

Description

Measure the average downlink throughput for an ENDC Radio Access Bearer.

Applicability

3GPP Release 15 or later

5G Option 3 (EN-DC - EPC)

Related core specifications

3GPP TS 24.301, section 6.4 (ESM procedures)

3GPP TS 38.331, section 5.3 (RRC Connection Control)

Reason for test

Obtain a measure of average downlink throughput for ENDC Radio Access Bearer.

Initial configuration

Network coverage of an LTE eNB with a co-located 5G NR gNB is available.

Ensure optimal testing conditions (optimum RF signal, low traffic hours to avoid contention with other devices, etc.).

Knowledge base of the maximum throughput achievable in the test location and for the device capability is available.

DUT and Reference are in RRC Idle.

Test procedure

|  |  |  |
| --- | --- | --- |
| - | Test procedure | Expected behaviour |
| 1 | Prepare the DUT and Reference with the method of measuring the throughput. | DUT and Reference are setup with the appropriate tool/method. |
| 2 | Perform 1 x Downlink throughput measurement on DUT using the appropriate method. | Measurement is taken and recorded. |
| 3 | Perform 1 x Downlink throughput measurement on the Reference using the appropriate method. | Measurement is taken and recorded. |
| 4 | Ensure there is no further data traffic and wait for in-activity timer to expire. | Confirm with a trace tool / test monitor that DUT switches to RRC state IDLE |
| 5 | Repeat and perform at least 5 Downlink throughput measurements on DUT and Reference in alternating sequence.  Ensure DUT and Reference are in IDLE before performing the next throughput measurement. | Measurements are taken and recorded on DUT and Reference. |
| 6 | Calculate average Downlink throughput for DUT and reference. |  |
| 7 | Evaluate the data performance by comparing the DUT’s average throughput with the reference average throughput and the known maximum throughput for the test location and device capability from the knowledge base. | Ensure that the DUT’s data performance is no more than 10% worse than the reference device and that the DUT’s performance is no more than 20% worse than the known maximum throughput from the knowledge base. |

#### 101.6.3.2 Stationary Data Performance – Relative Uplink Throughput

Description

Measure the average uplink throughput for an ENDC Radio Access Bearer.

Applicability

3GPP Release 15 or later

5G Option 3 (EN-DC - EPC)

Related core specifications

3GPP TS 24.301, section 6.4 (ESM procedures)

3GPP TS 38.331, section 5.3 (RRC Connection Control)

Reason for test

Obtain a measure of average uplink throughput for ENDC Radio Access Bearer.

Initial configuration

Network coverage of an LTE eNB with a co-located 5G NR gNB is available.

DUT and network supports UL transmission via both MCG path and SCG path for the split DRB.

Ensure optimal testing conditions (optimum RF signal, low traffic hours to avoid contention with other devices, etc.).

Knowledge base of the maximum throughput achievable in the test location and for the device capability is available.

DUT and Reference are in RRC Idle.

Test procedure

|  |  |  |
| --- | --- | --- |
| - | Test procedure | Expected behaviour |
| 1 | Prepare the DUT and Reference with the method of measuring the throughput. | DUT and Reference are setup with the appropriate tool/method. |
| 2 | Perform 1 x Uplink throughput measurement on DUT using the appropriate method. | Measurement is taken and recorded. |
| 3 | Perform 1 x Uplink throughput measurement on the Reference using the appropriate method. | Measurement is taken and recorded. |
| 4 | Ensure there is no further data traffic and wait for in-activity timer to expire. | Confirm with a trace tool / test monitor that DUT switches to RRC state IDLE |
| 5 | Repeat and perform at least 5 Uplink throughput measurements on DUT and Reference in alternating sequence.  Ensure DUT and Reference are in IDLE before performing the next throughput measurement. | Measurements are taken and recorded on DUT and Reference. |
| 6 | Calculate average Uplink throughput for DUT and reference. |  |
| 7 | Evaluate the data performance by comparing the DUT’s average throughput with the reference average throughput and the known maximum throughput for the test location and device capability from the knowledge base. | Ensure that the DUT’s data performance is no more than 10% worse than the reference device and that the DUT’s performance is no more than 20% worse than the known maximum throughput from the knowledge base. |

**101.6.3.3 Stationary Data Performance – Relative UL-DL Throughput - DSS**

**Description**

The 5G-NR capable DUT shall successfully perform "TP UL/DL using embedded application in a NW with 5G EN-DC combinations. The DUT shall use the maximun available EN-DC combination. Additionally it also verifies EN-DC split bearer and the percentage of splitted data through the 4G and 5G legs. This requires a performance tool that is able to separate the 4G and 5G legs.

**Applicability**

3GPP Rel. 15 or later

NSA Option 3

**Related core specifications**

3GPP TS 24.301, section 6.4 (ESM procedures), section 8.3.3.11 (max BR / GBR) and section 9.9.4 (QoS)

3GPP TS 38.331, section 5.3 (RRC Connection Control)

**Reason for test**

Obtain a measure of average uplink and downlink throughput for EN-DC Radio Access Bearer with DSS configuration

**Initial configuration**

DUT and Reference 1 are in RRC Idle

The DUT, Reference 1 and NW supports 5G Option 3

FTP server with sufficient data and bandwidth available to transfer data in all possible EN-DC band combinations for a sufficient period of time.

**Test procedure**

| **-** | **Test procedure** | **Expected behaviour** |
| --- | --- | --- |
| 1 | On DUT and Reference 1: Open the FTP application and start DL of content.  Measure the downlink throughput for a sufficient amount of time to evaluate the throughput using a suitable application on 4G leg | The content is downloaded correctly within a reasonable time |
| 2 | On DUT and Reference 1: Repeat step 1 for the 5G leg. | The content is downloaded correctly within a reasonable time |
| 3 | On DUT and Reference 1: Start uploading of content to FTP server  Measure the uplink throughput for a sufficient amount of time to evaluate the throughput using a suitable application on 4G leg. | The content is downloaded correctly within a reasonable time |
| 4 | On DUT and Reference 1: Repeat step 3 for the 5G leg. | The content is downloaded correctly within a reasonable time |
| 5 | Repeat Step 1 to 4 until you have in total 5 measurements | The DUT’s data performance is comparable to the Reference 1 data performance (no more than 10% worse) |

## 101.7 Basic Services (5GC)

### 101.7.1 Legacy: Service and Performance (5GC)

Description

The 5G-NR capable DUT shall successfully A) ping a remote IP address, B) send SMS over NAS (SGs), C) send SMS over IMS, D) use IMS voice, E) perform IMS emergency services and F) make IMS video call in a NW with 5G combinations listed above.

Applicability

3GPP Release 15 or later

5G Option 2 (NB – 5GC)

5G Option 5 (eLTE – 5GC)

5G Option 7 (NGEN-DC – 5GC)

5G Option 4 (NE-DC – 5GC)

Related core specifications

3GPP TS 24.501, section 5 (service request procedure), 6 (5GSM procedures)

3GPP TS 38.331, section 5.3 (RRC Connection Control)

Reason for test

To verify that DUT successfully A) ping a remote IP address, B) send SMS over NAS, C) send SMS over IMS, D) use IMS voice, E) perform IMS emergency services and F) make IMS video call in a 5GC environment.

Initial configuration

DUT and Reference 1 is Switched ON

The DUT, Reference 1 and NW support 5G Architecture Options 2, 5, 7 or 4

Test procedure

#### 101.7.1.1 PING

|  |  |  |
| --- | --- | --- |
| **-** | **Test procedure** | **Expected behaviour** |
| 1 | On DUT and Reference 1: Start a ping procedure (ping –t [-l size] [-w timeout] destination, for e.g. ping –t –l 100 –w 1500 10.11.26.52) | - |
| 2 | On DUT and Reference 1: Verify that the replies from the ping commands are correctly received. | The DUT is able to ping the remote destination |
| 3 | Stop ping procedure | The DUT’s ´ping performance is comparable to the Reference 1 ping performance (no more than 10% worse |

#### 101.7.1.2 MO/MT SMS over NAS

|  |  |  |
| --- | --- | --- |
| **-** | **Test procedure** | **Expected behaviour** |
| 1 | Using the DUT messaging application, create a new SMS and enter the MSISDN of Client 1 as the recipient | The Messaging application is opened and the MSISDN of Client 1 is entered |
| 2 | Enter some text | The message is prepared |
| 3 | Send the SMS to Client 1 | SMS is successfully sent from DUT and received on Client 1. Ensure DUT stays in E-UTRA service the whole time |
| 4 | Open the SMS at Client 1 and check the contents | The message content is identical to the message prepared on DUT |
| 5 | At Client 1, create a new SMS and enter the MSISDN of DUT as the recipient | The Messaging application is opened and the MSISDN of DUT is entered |
| 6 | Enter some text | The message is prepared |
| 7 | Send the SMS to DUT | SMS is successfully sent from Client 1 and received on DUT. Ensure DUT stays in E-UTRA service the whole time |
| 8 | Open the SMS at DUT and check the contents | The message content is identical to the message prepared on Client 1 |

#### 101.7.1.3 Void

#### 101.7.1.4 Void

### 101.7.2 Void

### 101.7.3 URLLC: Service & Performance (5GC) –different DC combinations

Editor’s note: the test cases in this chapter are tbd as deployment details are not yet available. The current content gives an idea how the test cases could be structured.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Test Case Title** | **LTE 1 CC + NR 1 CC** | **LTE 2 CC + NR 1 CC** | **LTE 3 CC + NR 1 CC** | **LTE 4 CC + NR 1 CC** | **LTE 5 CC + NR 1 CC** | **eLTE 1CC** | **eLTE 2CC** | **NB 1CC** | **NB 2CC** | **SUL** |
| NGEN DC | | | | | eLTE | | NB | | SUL |
| 101.7.3.1 Industry Automation / MEC | X | X | X | X | X | X | X | X | X | X |
| 101.7.3.2 Intelligent Transport System / MEC | X | X |  |  |  | X |  | X |  |  |
| 101.7.3.3 Remote Control / MEC | X | X |  |  |  | X |  | X |  |  |
| 101.7.3.4 Augmented Reality | X | X | X | X | X | X | X | X | X | X |
| 101.7.3.5 Mission Critical Apps / MEC | X | X |  |  |  | X | X | X |  |  |
| 101.7.3.6 Mission Critical Data / UP Data | X | X | X | X | X | X | X | X | X | X |
| 101.7.3.7 Mission Critical Data / UP Voice | X | X |  |  |  | X | X | X |  |  |

Description

The 5G-NR capable DUT shall successfully perform the following in a NW with 5G combinations listed below:

- Packet Delay: 10 ms (Use-case: Industry Automation/MEC)

- Packet Delay: 5 ms (Use-case: IntelligentTransportSys/MEC),

- Packet Delay: 5 ms (Use-case: RemoteCtrl/MEC),

- Packet Delay: 10 ms (Use-case: Augmented Reality),

- Packet Delay: 10 ms (Use-case: Mission Critical Apps/MEC),

- Packet Delay: 200 ms (Use-case: Mission Critical Data, UP data)

- Packet Delay: 100 ms (Use-case: Mission Critical Data, UP voice)

It is essential for the tester to build up a knowledge base of the maximum throughput achievable in the test location and for the device capability. This can be done using different Reference devices with similar capabilities to the DUT. Once a maximum achievable throughput is known for the location then this can be used as a base figure to validate the test result. Please note, that with networks continuously improving, this maximum achievable figure shall be monitored regularly and updated with the latest known maximum achievable throughput. The model name(s) used to build up the knowledge base shall be noted in the test result.

Applicability

3GPP Release 15 or later

5G Option 2 (NB – 5GC)

5G Option 5 (eLTE – 5GC)

5G Option 7 (NGEN-DC – 5GC)

5G Option 4 (NE-DC – 5GC)

Related core specifications

3GPP TS 24.501, section 5 (service request procedure), 6 (5GSM procedures)

3GPP TR 37.872 (SUL)

3GPP TS 38.331, section 5.3 (RRC Connection Control)

3GPP TR 22.804

Reason for test

To verify that the DUT is able to perform Industry Automation, Mission Critical Apps, MEC Mobile Edge Computing Service and Augmented Reality in a NW with 5GC combinations. The data rates, response times and quality of services are excellent and are according to the Carrier combinations. The focus of the test cases is performance and service continuity.

Initial configuration

DUT and Reference 1 are in RRC Idle

The DUT, Reference 1 and NW support 5G Architecture Options 2, 5, 7 or 4

Ensure optimal testing conditions (optimum RF signal, low traffic hours to avoid contention with other devices, etc.)

#### 101.7.3.1 Packet delay 10 ms (use-case: Industry Automation / MEC)

Bearer with 5QI 16 or 17 (10 ms Packet Delay Budget, DelayCriticalGBR, Discrete Automation) available, or

Bearer with 5QI E or F (10 ms Packet Delay Budget, GBR, Discrete Automation) available

Test procedure

|  |  |  |
| --- | --- | --- |
| **-** | **Test procedure** | **Expected behaviour** |
| 1 | On DUT and Reference 1: Open the FTP application and start DL of content.  Measure the time the payload is transferred to the server using a suitable application | The content is downloaded correctly within swift time.  The throughput measurement is taken and recorded |
| 2 | On DUT and Reference 1: During data DL ping a remote location. (e.g. ping –t –l 100 –w 1500 10.11.26.52) | The ping response time does not exceed packet delay time according to test scenario (10 or 20 ms) |
| 3 | On DUT and Reference 1: Start uploading of content to FTP server.  PING  Measure the time the payload is transferred to the server using a suitable application | The content is uploaded correctly within swift time.  The throughput measurement is taken and recorded |
| 4 | On DUT and Reference 1: During data UL ping a remote location. (e.g. ping –t –l 100 –w 1500 10.11.26.52)) | The ping response time does not exceed packet delay time according to test scenario (10 or 20 ms) |
| 5 | Repeat Step 1 and Step 2 until you have in total 5 measurements | The DUT’s data performance is comparable to the Reference 1 data performance (no more than 10% worse) |

#### 101.7.3.2 Packet delay 5 ms (use-case: IntelligTranspSys / MEC (closed loop NW?))

Bearer with 5QI 11 (5 ms Packet Delay Budget, DelayCriticalGBR, IntelligTranspSys) available

|  |  |  |
| --- | --- | --- |
| **-** | **Test procedure** | **Expected behaviour** |
| 1 | On DUT and Reference 1: Open the FTP application and start DL of content.  Measure the time the payload is transferred to the server using a suitable application | The content is downloaded correctly within swift time.  The throughput measurement is taken and recorded |
| 2 | On DUT and Reference 1: During data DL ping a remote location. (e.g. ping –t –l 100 –w 1500 10.11.26.52) | The ping response time does not exceed packet delay time according to test scenario (10 or 20 ms) |
| 3 | On DUT and Reference 1: Start uploading of content to FTP server.  PING  Measure the time the payload is transferred to the server using a suitable application | The content is uploaded correctly within swift time.  The throughput measurement is taken and recorded |
| 4 | On DUT and Reference 1: During data UL ping a remote location. (e.g. ping –t –l 100 –w 1500 10.11.26.52)) | The ping response time does not exceed packet delay time according to test scenario (10 or 20 ms) |
| 5 | Repeat Step 1 and Step 2 until you have in total 5 measurements | The DUT’s data performance is comparable to the Reference 1 data performance (no more than 10% worse) |

#### 101.7.3.3 Packet delay 5 ms (use case: Remote Ctrl / MEC (closed loop NW?))

Bearer with 5QI 10 (5 ms Packet Delay Budget, GBR, DelayCriticalGBR, RemoteCTRL) available

|  |  |  |
| --- | --- | --- |
| **-** | **Test procedure** | **Expected behaviour** |
| 1 | On DUT and Reference 1: Open the FTP application and start DL of content.  Measure the time the payload is transferred to the server using a suitable application | The content is downloaded correctly within swift time.  The throughput measurement is taken and recorded |
| 2 | On DUT and Reference 1: During data DL ping a remote location. (e.g. ping –t –l 100 –w 1500 10.11.26.52) | The ping response time does not exceed packet delay time according to test scenario (10 or 20 ms) |
| 3 | On DUT and Reference 1: Start uploading of content to FTP server.  PING  Measure the time the payload is transferred to the server using a suitable application | The content is uploaded correctly within swift time.  The throughput measurement is taken and recorded |
| 4 | On DUT and Reference 1: During data UL ping a remote location. (e.g. ping –t –l 100 –w 1500 10.11.26.52)) | The ping response time does not exceed packet delay time according to test scenario (10 or 20 ms) |
| 5 | Repeat Step 1 and Step 2 until you have in total 5 measurements | The DUT’s data performance is comparable to the Reference 1 data performance (no more than 10% worse) |

#### 101.7.3.4 Packet delay 10 ms (use-case: Augmented Reality)

Bearer with 5QI 80 (10 ms Packet Delay Budget, nonGBR, AugmentedReality, LLCeMBB) available

Application available to deliver 3D models and data (to place life-size 3D models in their surroundings). This shall include a) smartphone with a camera (with a frame rate ≥ 60 Hz and at least HD (1280 x 720) or Full HD (1920 x 1080) resolution) to capture reality; b) connection to the Internet for receiving the layer of information and; c) software on phone to combine all functions. GPS and/or compass might be supported as well.

|  |  |  |
| --- | --- | --- |
| **-** | **Test procedure** | **Expected behaviour** |
| 1 | On DUT and Reference 1: Open the AR application and start exchanging content/data. | The content/data is exchanged correctly in real-time. “Reality” and augmented “3D object” are in synch.  The throughput measurement is taken and recorded |
| 2 | On DUT and Reference 1: During running application ping a remote location. | The ping response time does not exceed packet delay time 20 ms |
| 3 | Repeat Step 1 and Step 2 until you have in total 5 measurements | The DUT’s data performance is comparable to the Reference 1 data performance (no more than 10% worse) |

#### 101.7.3.5 Packet delay 60-75 ms (use-case: Mission Critical Apps / MEC)

Bearer with 5QI 65 (75 ms Packet Delay Budget, GBR, MC-PTT) available, or

Bearer with 5QI 69 (60 ms Packet Delay Budget, nonGBR, MC-PTT signalling) available

|  |  |  |
| --- | --- | --- |
| **-** | **Test procedure** | **Expected behaviour** |
| 1 | On DUT and Reference 1: Open the FTP application and start DL of content. TBD  Measure the downlink throughput for a sufficient amount of time to evaluate the throughput using a suitable application | The content is downloaded correctly within a reasonable time  The throughput measurement is taken and recorded |
| 2 | On DUT and Reference 1: Start uploading of content to FTP server.  Measure the uplink throughput for a sufficient amount of time to evaluate the throughput using a suitable application | The content is uploaded correctly within a reasonable time  The throughput measurement is taken and recorded |
| 3 | Repeat Step 1 and Step 2 until you have in total 5 measurements | The DUT’s data performance is comparable to the Reference 1 data performance (no more than 10% worse) |

#### 101.7.3.6 Packet delay 200 ms (use-case: Mission Critical Data UP data)

Bearer with 5QI 70 (200 ms Packet Delay Budget, nonGBR, MC-PTT Data) available

|  |  |  |
| --- | --- | --- |
| **-** | **Test procedure** | **Expected behaviour** |
| 1 | On DUT and Reference 1: Open the FTP application and start DL of content. TBD  Measure the downlink throughput for a sufficient amount of time to evaluate the throughput using a suitable application | The content is downloaded correctly within a reasonable time  The throughput measurement is taken and recorded |
| 2 | On DUT and Reference 1: Start uploading of content to FTP server.  Measure the uplink throughput for a sufficient amount of time to evaluate the throughput using a suitable application | The content is uploaded correctly within a reasonable time  The throughput measurement is taken and recorded |
| 3 | Repeat Step 1 and Step 2 until you have in total 5 measurements | The DUT’s data performance is comparable to the Reference 1 data performance (no more than 10% worse) |

#### 101.7.3.7 Packet delay 100 ms (use-case: Mission Critical Data UP voice)

Bearer with 5QI 66 (100 ms Packet Delay Budget, GBR, MC-PTT UP voice) available

|  |  |  |
| --- | --- | --- |
| **-** | **Test procedure** | **Expected behaviour** |
| 1 | On DUT and Reference 1: Initiate a voice call to the MCPTT service. TBD | The call is established and both parties are able to talk to each other. The voice quality is excellent an without any interruptions (TBD) |
| 2 | Repeat Step 1 until you have in total 5 measurements | The DUT’s voice performance is comparable to the Reference 1 data performance (no more than 10% worse) and all calls are successfully setup. |

### 101.7.4 eMBB Data Performance (5GC) (Good coverage - Relative Measurement)

It is essential for the tester to build up a knowledge base of the maximum throughput achievable in the test location and for the device capability. This can be done using different Reference devices with similar capabilities to the DUT. Once a maximum achievable throughput is known for the location then this can be used as a base figure to validate the test result. Please note, that with networks continuously improving, this maximum achievable figure shall be monitored regularly and updated with the latest known maximum achievable throughput. The model name(s) used to build up the knowledge base shall be noted in the test result.

Note: There are several ways to check the throughput:

* DUT tethered to a laptop (USB/Wi-Fi). A speedtest tool on the laptop can then be used to measure the throughput. Ensure that the tethering/DUN connection is as fast as the available cellular connection.
* A speedtest tool directly on the DUT can be used to measure the throughput.
* For modules or devices without a UI, a DUN connection to a laptop can be used along with a speedtest tool on the laptop to measure the throughput.Other valid methods are available such as an FTP client.

#### 101.7.4.1 Stationary Data Performance – Relative Downlink Throughput

Description

Measure the average downlink throughput for a 5G New Radio Access Bearer.

Applicability

3GPP Release 15 or later

5G Option 2 (NB – 5GC)

5G Option 5 (eLTE – 5GC)

5G Option 7 (NGEN-DC – 5GC)

5G Option 4 (NE-DC – 5GC)

Related core specifications

3GPP TS 24.501, section 5 (service request procedure), 6 (5GSM procedures)

3GPP TS 38.331, section 5.3 (RRC Connection Control)

Reason for test

Obtain a measure of average downlink throughput for 5G New Radio Access Bearer.

Initial configuration

DUT and Reference 1 are in RRC Idle

The DUT, Reference 1 and NW support 5G Architecture Option 2, 5, 7 or 4

Ensure optimal testing conditions (optimum RF signal, low traffic hours to avoid contention with other devices, etc.)

Knowledge base of the maximum throughput achievable in the test location and for the device capability is available.

Test procedure

|  |  |  |
| --- | --- | --- |
| - | **Test procedure** | **Expected behaviour** |
| 1 | Prepare the DUT and Reference with the method of measuring the throughput. | DUT and Reference are setup with the appropriate tool/method. |
| 2 | Perform 1 x Downlink throughput measurement on DUT using the appropriate method. | Measurement is taken and recorded. |
| 3 | Perform 1 x Downlink throughput measurement on the Reference 1 using the appropriate method. | Measurement is taken and recorded. |
| 4 | Ensure there is no further data traffic and wait for in-activity timer to expire. | Confirm with a trace tool / test monitor that DUT and Reference 1 return to RRC Idle. |
| 5 | Repeat and perform at least 5 Downlink throughput measurements on DUT and Reference in alternating sequence.  Ensure DUT and Reference 1 is in RRC Idle before performing the next throughput measurement. | Measurements are taken and recorded on DUT and Reference 1. |
| 6 | Calculate average downlink throughput for DUT and reference 1. |  |
| 7 | Evaluate the data performance by comparing the DUT’s average throughput with the reference 1’s average throughput and the known maximum throughput for the test location and device capability from the knowledge base. | Ensure that the DUT’s data performance is no more than 10% worse than the reference device and that the DUT’s performance is no more than 20% worse than the known maximum throughput from the knowledge base. |

#### 101.7.4.2 Stationary Data Performance – Relative Uplink Throughput

Description

Measure the average uplink throughput for a 5G New Radio Access Bearer.

Applicability

3GPP Release 15 or later

5G Option 2 (NB – 5GC)

5G Option 5 (eLTE – 5GC)

5G Option 7 (NGEN-DC – 5GC)

5G Option 4 (NE-DC – 5GC)

Related core specifications

3GPP TS 24.501, section 5 (service request procedure), 6 (5GSM procedures)

3GPP TS 38.331, section 5.3 (RRC Connection Control)

Reason for test

Obtain a measure of average uplink throughput for 5G New Radio Access Bearer.

Initial configuration

DUT and Reference 1 are in RRC Idle

The DUT, Reference 1 and NW support 5G Architecture Option 2, 5, 7 or 4

Ensure optimal testing conditions (optimum RF signal, low traffic hours to avoid contention with other devices, etc.)

Knowledge base of the maximum throughput achievable in the test location and for the device capability is available.

Test procedure

|  |  |  |
| --- | --- | --- |
| - | **Test procedure** | **Expected behaviour** |
| 1 | Prepare the DUT and Reference with the method of measuring the throughput. | DUT and Reference are setup with the appropriate tool/method. |
| 2 | Perform 1 x Uplink throughput measurement on DUT using the appropriate method. | Measurement is taken and recorded. |
| 3 | Perform 1 x Uplink throughput measurement on the Reference 1 using the appropriate method. | Measurement is taken and recorded. |
| 4 | Ensure there is no further data traffic and wait for in-activity timer to expire. | Confirm with a trace tool / test monitor that DUT and Reference 1 return to RRC Idle. |
| 5 | Repeat and perform at least 5 Uplink throughput measurements on DUT and Reference in alternating sequence.  Ensure DUT and Reference 1 is in RRC Idle before performing the next throughput measurement. | Measurements are taken and recorded on DUT and Reference 1. |
| 6 | Calculate average Uplink throughput for DUT and reference 1. |  |
| 7 | Evaluate the data performance by comparing the DUT’s average throughput with the reference 1’s average throughput and the known maximum throughput for the test location and device capability from the knowledge base. | Ensure that the DUT’s data performance is no more than 10% worse than the reference device and that the DUT’s performance is no more than 20% worse than the known maximum throughput from the knowledge base. |

#### 101.7.4.3 Stationary Data Performance during Active IMS Voice Call– Relative Throughput

Description

Measure the average data throughput during active IMS voice call for a 5G New Radio Access Bearer.

Applicability

3GPP Release 15 or later

5G Option 2 (NB – 5GC)

5G Option 5 (eLTE – 5GC)

5G Option 7 (NGEN-DC – 5GC)

5G Option 4 (NE-DC – 5GC)

Related core specifications

3GPP TS 24.501, section 5 (service request procedure), 6 (5GSM procedures)

3GPP TS 38.331, section 5.3 (RRC Connection Control)

Reason for test

Obtain a measure of average data throughput during active IMS voice call for 5G New Radio Access Bearer.

Initial configuration

DUT is in RRC Idle

The DUT and NW support 5G Architecture Option 2, 5, 7 or 4

Ensure optimal testing conditions (optimum RF signal, low traffic hours to avoid contention with other devices, etc.)

Test procedure

|  |  |  |
| --- | --- | --- |
| - | **Test procedure** | **Expected behaviour** |
| 1 | Prepare the DUT with the method of measuring the throughput. | DUT and Reference are setup with the appropriate tool/method. |
| 2 | Perform data throughput measurement on DUT using the appropriate method. | Measurement is taken and recorded. |
| 3 | Establish an IMS voice call on DUT. | An IMS voice call is successfully established, including a dedicated bearer. Speech path is present in both directions. |
| 4 | Perform data throughput measurement on DUT using the appropriate method. | Measurement is taken and recorded. |
| 5 | Compare the date throughput evaluated before and during the IMS voice call. | Confirm that the voice call remains uninterrupted during the throughput measurement.  Ensure that the throughput measurement taken during the IMS voice call is no more than 10% worse than the measurement taken before the call |

# 102 Mobility

## 102.1 Void

## 102.2 Registration/Notification Area Update (5GC)

### 102.2.1 Mobility Registration Area Update

Description

The DUT shall successfully perform Mobility Registration Update procedure after reselecting a cell in a new Tracking Area outside its Registration Area.

Applicability

3GPP Rel.15 or later

SA Option 2

Related core specifications

3GPP TS 23.502

Reason for test

To verify that the DUT successfully performs Mobility Registration Update procedure, after reselecting a cell in a new Tracking Area outside its Registration Area.

Initial configuration

DUT and NW support 5G NR Option 2.

DUT is in RM-REGISTERED and CM-IDLE state.

Test procedure

|  |  |  |
| --- | --- | --- |
| **-** | **Test procedure** | **Expected behaviour** |
| 1 | Move the DUT to a NR cell in a new Tracking Area. | DUT sends a REGISTRATION REQUEST message to the network with Registration type set to “Mobility Registration Update”.  The network shall respond with REGISTRATION ACCEPT to the DUT.  If the REGISTRATION ACCEPT messsage contains a new 5G-GUTI, the DUT shall send REGISTRATION COMPLETE to acknowledge the received 5G-GUTI. |
| 2 | Load a page on the embedded browser (or via a tethering connection if embedded browser is not supported). | Page is loaded successfully to confirm data connection. |

Example message flow:

| **Step** | **Direction UE - NW** | **Message** | **Comments** |
| --- | --- | --- | --- |
| 1 | --> | RRC: RRCConnectionRequest |  |
| 2 | <-- | RRC: RRCConnectionSetup |  |
| 3 | --> | RRC: RRCConnectionSetupComplete  NAS: REGISTRATION REQUEST | Registration type “Mobility Registration Update” |
| 4 | <-- | RRC: RRCConnectionReconfiguration  NAS: REGISTRATION ACCEPT |  |
| 5 | --> | RRC: RRCConnectionReconfiguration Complete  NAS: REGISTRATION COMPLETE | Conditional |
| 6 | <-- | RRC: RRCConnectionRelease |  |

### 102.2.2 Periodic Registration Area Update

Description

The DUT shall successfully perform Periodic Registration Update procedure after the expiry of the T3512 timer.

Applicability

3GPP Rel.15 or later

SA Option 2

Related core specifications

3GPP TS 23.502, TS 24.501

Reason for test

To verify that the DUT successfully performs Periodic Registration Update procedure after the expiry of the T3512 timer.

Initial configuration

DUT and NW support 5G NR Option 2.

DUT is in RM-REGISTERED and CM-IDLE state.

T3512 timer is configured.

Test procedure

|  |  |  |
| --- | --- | --- |
| **-** | **Test procedure** | **Expected behaviour** |
| 1 | Wait for the T3512 timer to expire and observe DUT | DUT sends a REGISTRATION REQUEST message to the network with Registration type set to “Periodic Registration Update”.  The network shall respond with REGISTRATION ACCEPT to the DUT.  If the REGISTRATION ACCEPT messsage contains a new 5G-GUTI, the DUT shall send REGISTRATION COMPLETE to acknowledge the received 5G-GUTI. |
| 2 | Load a page on the embedded browser (or via a tethering connection if embedded browser is not supported). | Page is loaded successfully to confirm data connection. |

Example message flow:

| **Step** | **Direction UE - NW** | **Message** | **Comments** |
| --- | --- | --- | --- |
| 1 | --> | RRC: RRCConnectionRequest |  |
| 2 | <-- | RRC: RRCConnectionSetup |  |
| 3 | --> | RRC: RRCConnectionSetupComplete  NAS: REGISTRATION REQUEST | Registration type “Periodic Registration Update” |
| 4 | <-- | RRC: RRCConnectionReconfiguration  NAS: REGISTRATION ACCEPT |  |
| 5 | --> | RRC: RRCConnectionReconfiguration Complete  NAS: REGISTRATION COMPLETE | Conditional |
| 6 | <-- | RRC: RRCConnectionRelease |  |

### 102.2.3 RAN-Based Notification Area Update During Mobility

Description

The DUT shall successfully perform RAN-Based Notification Area Update procedure after reselecting a cell in a new RAN-Based Notification Area (RNA).

Applicability

3GPP Rel.15 or later

SA Option 2

Related core specifications

3GPP TS 38.331

Reason for test

To verify that the DUT successfully performs RAN-Based Notification Area Update procedure upon changing to a new RNA.

Initial configuration

DUT and NW support 5G NR Option 2.

DUT is in RRC\_INACTIVE state.

Test procedure

|  |  |  |
| --- | --- | --- |
| **-** | **Test procedure** | **Expected behaviour** |
| 1 | Move the DUT to a NR cell in a new RAN\_Based Notification Area. | DUT sends a RRCResumeRequest message to the network with ResumeCause set to “rna-Update”.  The network shall respond with RRCResume to the DUT.  DUT sends RRCResumeComplete. |
| 2 | Load a page on the embedded browser (or via a tethering connection if embedded browser is not supported). | Page is loaded successfully to confirm data connection. |

Example message flow:

| **Step** | **Direction UE - NW** | **Message** | **Comments** |
| --- | --- | --- | --- |
| 1 | --> | RRCResumeRequest | ResumeCause “rna-Update” |
| 2 | <-- | RRCResume |  |
| 3 | --> | RRCResumeComplete |  |

### 102.2.4 Periodic RAN-Based Notification Area Update

Description

The DUT shall successfully perform RAN-Based Notification Area Update procedure after the expiry of the T380 timer.

Applicability

3GPP Rel.15 or later

SA Option 2

Related core specifications

3GPP TS 38.331

Reason for test

To verify that the DUT successfully performs RAN-Based Notification Area Update procedure after the expiry of the periodic RNA update timer.

Initial configuration

DUT and NW support 5G NR Option 2.

DUT is in RRC\_INACTIVE state.

Test procedure

|  |  |  |
| --- | --- | --- |
| **-** | **Test procedure** | **Expected behaviour** |
| 1 | Wait for the T380 timer to expire and observe DUT | DUT sends a RRCResumeRequest message to the network with ResumeCause set to “rna-Update”.  The network shall respond with RRCResume to the DUT.  DUT sends RRCResumeComplete. |
| 2 | Load a page on the embedded browser (or via a tethering connection if embedded browser is not supported). | Page is loaded successfully to confirm data connection. |

Example message flow:

| **Step** | **Direction UE - NW** | **Message** | **Comments** |
| --- | --- | --- | --- |
| 1 | --> | RRCResumeRequest | ResumeCause “rna-Update” |
| 2 | <-- | RRCResume |  |
| 3 | --> | RRCResumeComplete |  |

## 102.3 Mobility for 5G NR Option 3 (EN-DC)

This chapter contains the mobility test cases for 5G NR Option 3 (EN-DC).

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Test Case Title** | **INTRA-BAND** | **INTER-BAND**  **NR** | **INTER-BAND**  **eUTRAN** | **INTER-RAT** | | | **INTER-SYSTEM** | **INTER-RAT**  **DSS** | |
| A | B | C | D | E | F | G | H | I |
| EN-DC | | | EN-DC – 4G | EN-DC – 3G | EN-DC - 2G | EN-DC  5G FDD –  EN-DC  5G TDD | EN-DC (DSS) – 4G | EN-DC (DSS) – 2G |
| 102.3.1 Void |  |  |  |  |  |  |  |  |  |
| 102.3.2 Void |  |  |  |  |  |  |  |  |  |
| 102.3.3 PDN Activated - Data Transfer (CONNECTED) | X | X | X | X | X | X | X | X | X |
| 102.3.4 PDN Activated - VoLTE + Data Transfer (CONNECTED) | X | X | X | X | X | X | X | X | X |

This table shows which scenarios are applicable to each test in this section.

Applicability

3GPP Rel.15 or later

Non-Standalone Option 3

Related core specifications

3GPP TS 38.304, TS 38.331, TS 37.340

Reason for test

To ensure that the DUT performs handovers, release redirects and cell reselections correctly without losing service.

Initial configuration

There must be an appropriate number of EN-DC, EN-DC with Dynamic Spectrum Sharing (DSS), LTE (4G), UTRAN (3G) and GSM (2G) cells available of the same PLMN.

Test Scenario

Use an internal test monitor or protocol tool to confirm the scenario has been successfully performed.

Scenario A: Intra-Band (Long Route / Multiple Cells)

Test route should contain a substantial number of different Cell IDs.

The test route should contain as many of the scenarios as possible:

* Cells within the same Tracking Area.
* Cells in different Tracking Areas.
* Cells using the same frequency.
* Cells using different frequencies within the same band.

|  |  |  |
| --- | --- | --- |
| **-** | **Test procedure** | **Expected behaviour** |
| 1 | Move DUT along the route and ensure that a significant number of handovers / reselections are performed.  Check the Cell ID details as the DUT moves through the route. | The scenarios are successfully performed and DUT stays in service the whole time. |

Scenario B: Inter-Band NR

In this scenario the band used for the eUTRAN band remains the same but the band used for the NR part changes when moving from one cell to another.

|  |  |  |
| --- | --- | --- |
| **-** | **Test procedure** | **Expected behaviour** |
| 1 | Move DUT between two cells that use a different carrier frequency for the NR part.  Check the Cell ID details as the DUT moves through the route. | The scenarios are successfully performed and DUT stays in service the whole time. |

Scenario C: Inter-Band eUTRAN

In this scenario the band used for the eUTRAN band changes while the band used for the NR remains the same when moving from one cell to another.

|  |  |  |
| --- | --- | --- |
| **-** | **Test procedure** | **Expected behaviour** |
| 1 | Move DUT between two cells that use a different carrier frequency for the eUTRAN part.  Check the Cell ID details as the DUT moves through the route. | The scenarios are successfully performed and DUT stays in service the whole time. |

Scenario D: Inter-RAT (EN-DC – 4G)

In these scenarios the DUT moves from EN-DC to LTE (4G)

|  |  |  |
| --- | --- | --- |
| **-** | **Test procedure** | **Expected behaviour** |
| 1 | Move DUT from EN-DC to LTE (4G)  Check the Cell ID details as the DUT moves from one cell to the other | The scenarios are successfully performed and DUT stays in service the whole time. |

Scenario E and F: Inter-RAT (EN-DC – 3G and 2G)

In these scenarios the DUT moves from EN-DC to a different RAT (i.e. UMTS (3G) or GSM (2G)

|  |  |  |
| --- | --- | --- |
| **-** | **Test procedure** | **Expected behaviour** |
| 1 | Move DUT from EN-DC to the other RAT.  Check the Cell ID details as the DUT moves through the route. | The scenarios are successfully performed and DUT stays in service the whole time. |

Scenario G: Inter-system NR

In this scenario the band used for the eUTRAN band remains the same, but the NR system used for the NR part changes when moving from one cell to another.

Scenario H: Inter-RAT (EN-DC DSS – 4G)

In these scenarios the DUT moves from EN-DC with DSS to LTE (4G)

|  |  |  |
| --- | --- | --- |
| **-** | **Test procedure** | **Expected behaviour** |
| 1 | Move DUT from EN-DC to the other RAT.  Check the Cell ID details as the DUT moves through the route. | The scenarios are successfully performed and DUT stays in service the whole time. |

Scenario I: Inter-RAT (EN-DC DSS – 2G)

In these scenarios the DUT moves from EN-DC with DSS to GSM (2G)

|  |  |  |
| --- | --- | --- |
| **-** | **Test procedure** | **Expected behaviour** |
| 1 | Move DUT from EN-DC to the other RAT.  Check the Cell ID details as the DUT moves through the route. | The scenarios are successfully performed and DUT stays in service the whole time. |

|  |  |  |
| --- | --- | --- |
| **-** | **Test procedure** | **Expected behaviour** |
| 1 | Move DUT between two cells that use a different 5G technology – 5G FDD and 5G TDD.  Check the Cell ID details as the DUT moves through the route. | The scenarios are successfully performed and DUT stays in service the whole time. |

Test Procedures

102.3.1 Void

102.3.2 Void

102.3.3 PDN Activated - Data Transfer (CONNECTED

|  |  |  |
| --- | --- | --- |
| **-** | **Test procedure** | **Expected behaviour** |
| 1 | DUT is configured so that data is enabled. | Data connection is available according to the RAT connection. |
| 2 | Ensure a data transfer is ongoing. This can be via a tethered connection, DUN, an internal application on DUT or via continuous PINGs. | DUT is actively transferring data. |
| 3 | Follow the instruction of the desired scenario. | |
| 4 | Check data transfer continues after the scenario. | DUT is actively transferring data. |

102.3.4 PDN Activated – VoLTE + Data Transfer (CONNECTED)

|  |  |  |
| --- | --- | --- |
| **-** | **Test procedure** | **Expected behaviour** |
| 1 | DUT is configured so that data is enabled. | Data connection is available according to the RAT connection. |
| 2 | Establish a voice call | A voice call is successfully established, including a dedicated bearer. Speech path is present in both directions. |
| 3 | Ensure a data transfer is ongoing. This can be via a tethered connection, DUN, an internal application on DUT or via continuous PINGs. | DUT is actively transferring data. |
| 4 | Follow the instruction of the desired scenario. | |
| 5 | Check data transfer continues after the scenario. | DUT is actively transferring data. |
| 6 | Check that the voice call continues seamlessly | Check that audio quality during the data transfer remains excellent. |

## 102.4 Mobility for 5G NR - 5GC - Option 2 (NB)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Test Case Title** | **INTRA-RAT** | | **INTER-RAT** | | **INTER-SYSTEM** | |
| A | B | C | D | E | F |
| 5G Intra-Band | 5G Inter-Band | 5G to 4G | 4G to 5G | FDD to TDD | TDD to FDD |
| 102.4.1 Reselection (RRC Idle) (5GC) - UE initiated | X | X | X | X | X | X |
| 102.4.2 Handover (RRC Inactive) (5GC) - UE initiated | X | X | X |  | X | X |
| 102.4.3 Handover (RRC Active) (5GC) - NW initiated - Data Transfer | X | X | X | X | X | X |
| 102.4.4 Handover (RRC Active) (5GC) - NW initiated – IMS Voice Call | X | X | X | X | X | X |

Description

The DUT should perform reselections and handovers without losing service.

Applicability

3GPP Rel.15 or later

SA Option 2

Related core specifications

3GPP TS 38.304, TS 38.331

Reason for test

To ensure that the DUT performs reselections, handovers and release redirect correctly without losing service.

Initial configuration

There must be an appropriate number of NR and E-UTRA cells available on the same PLMN.

The above table shows the combinations of test cases that can be performed with each scenario.

Please see the test scenario and apply the required test procedure (below) as per the requirement in the table.

Use an internal test monitor or protocol tool to confirm the scenario has been successfully performed.

Scenario A: Intra-Band (Long Route / Multi Cell) (5G -> 5G)

Test route should contain a substantial number of different Cell ID’s.

The test route should contain as many of the scenarios as possible:

* Cells within the same Registration Area.
* Cells in different Registration Areas.
* Cells using the same frequency.
* Cells using different frequencies within the same band.
* Cells sharing the same gNodeB.
* Cells not sharing the same gNodeB.
* Cells using a different AMF.

|  |  |  |
| --- | --- | --- |
| **-** | **Test procedure** | **Expected behaviour** |
| 1 | Move DUT along the route, ensuring as many scenarios as possible are covered.  Check the Cell ID details as the DUT moves through the route. | The scenarios are successfully performed and DUT stays in service the whole time. |

Scenario B: Inter-Band (5G (Band A) -> 5G (Band B))

The test route should contain the following scenario:

* Cells operating on different frequency bands (Band A -> Band B).

|  |  |  |
| --- | --- | --- |
| **-** | **Test procedure** | **Expected behaviour** |
| 1 | DUT is at start location. | DUT is in a 5G cell (Band A). |
| 2 | Move DUT along the route.  Check the Cell ID details as the DUT moves through the route. | DUT is in a 5G cell (Band B). |

Scenario C: Inter-RAT (5G -> 4G)

The test route should contain the following scenario:

* 5G cells and 4G cells.

|  |  |  |
| --- | --- | --- |
| **-** | **Test procedure** | **Expected behaviour** |
| 1 | DUT has performed initial registration procedure in 5G  DUT has several active PDU sessions (e.g. IMS; Internet)  DUT is at start location. | DUT is in a 5G cell. |
| 2 | Move DUT along the route.  Check the Cell ID details as the DUT moves through the route. | Reselection, redirect or handover is successfully performed as per the network and DUT implementation.  DUT is in a 4G cell.  Verify that PDU sessions were transferred and active in 4G in case if the network supports session continuity between 5G and 4G |

Scenario D: Inter-RAT (4G -> 5G)

The test route should contain the following scenario:

* 5G cells and 4G cells.

|  |  |  |
| --- | --- | --- |
| **-** | **Test procedure** | **Expected behaviour** |
| 1 | DUT has performed initial registration procedure in 4G  DUT has several active PDN sessions  DUT is at start location. | DUT is in a 4G cell. |
| 2 | Move DUT along the route.  Check the Cell ID details as the DUT moves through the route. | Reselection, Redirect or Handover is successfully performed as per the network and DUT implementation.  DUT is in a 5G cell.  Verify that PDN sessions were transferred and active in 5G in case if the network supports session continuity between 4G and 5G |

Scenario E: Inter-Technology (5G (FDD) -> 5G (TDD))

The test route should contain the following scenario:

* 5G cells supporting FDD and 5G cells supporting TDD.

|  |  |  |
| --- | --- | --- |
| **-** | **Test procedure** | **Expected behaviour** |
| 1 | DUT is at start location. | DUT is in a 5G cell supporting FDD. |
| 2 | Move DUT along the route.  Check the Cell ID details as the DUT moves through the route. | DUT is in a 5G cell supporting TDD. |

Scenario F: Inter-Technology (5G (TDD) -> 5G (FDD))

The test route should contain the following scenario:

* 5G cells supporting TDD and 5G cells supporting FDD.

|  |  |  |
| --- | --- | --- |
| **-** | **Test procedure** | **Expected behaviour** |
| 1 | DUT is at start location. | DUT is in a 5G cell supporting TDD. |
| 2 | Move DUT along the route.  Check the Cell ID details as the DUT moves through the route. | DUT is in a 5G cell supporting FDD. |

Test Procedures

102.4.1 Reselection (RRC Idle) (5GC) - UE initiated

|  |  |  |
| --- | --- | --- |
| **-** | **Test procedure** | **Expected behaviour** |
| 1 | DUT is configured so that data is enabled. | Data connection is available according to the RAT connection. |
| 2 | DUT is in Idle state. | No data transfer is on-going. |
| 3 | Perform the instruction of the desired scenario. | |
| 4 | Page (SMS) the DUT after the scenario. | DUT can be successfully paged (SMS). |

102.4.2 Handover (RRC Inactive) (5GC)

|  |  |  |
| --- | --- | --- |
| **-** | **Test procedure** | **Expected behaviour** |
| 1 | DUT is configured so that data is enabled. | Data connection is available according to the RAT connection. |
| 2 | Ensure a data transfer is ongoing. This can be via a tethered connection, DUN, an internal application on DUT or via continuous PINGs. | DUT is actively transferring data. |
| 3 | Stop data transfer. | DUT enters in RRC Inactive state. |
| 4 | Perform the instruction of the desired scenario. | In Scenario A/B/E/F, DUT can successfully perform RAN Notification Area Updates.  In Scenario C, DUT can successfully perform TAU. |
| 5 | Page (SMS) the DUT after the scenario. | DUT can be successfully paged (SMS). |

102.4.3 Handover (RRC Active) (5GC) - Data Transfer

|  |  |  |
| --- | --- | --- |
| **-** | **Test procedure** | **Expected behaviour** |
| 1 | DUT is configured so that data is enabled. | Data connection is available according to the RAT connection. |
| 2 | Ensure a data transfer is ongoing. This can be via a tethered connection, DUN, an internal application on DUT or via continuous PINGs. | DUT is actively transferring data. |
| 3 | Follow the instruction of the desired scenario. | |
| 4 | Check data transfer continues after the scenario. | DUT is actively transferring data. |

102.4.4 Handover (RRC Active) (5GC) - IMS Voice Call

|  |  |  |
| --- | --- | --- |
| **-** | **Test procedure** | **Expected behaviour** |
| 1 | Set up MO IMS voice call to Client 1 in a static location. | IMS voice call set up successfully. |
| 2 | Follow the instruction of the desired scenario. | |
| 3 | Check the voice call is still active after the scenario. | Voice call is on-going. |

## 102.5 Handover (RRC Inactive) (5GC)

## 102.6 Handover and Release/Redirect (RRC Active) (EPC)

## 102.7 Handover (RRC Active) (5GC)

## 102.8 Multi-RAT Dual Carrier Mobility – Option 3 MR-DC with EN-DC

## 102.9 Multi-RAT Dual Carrier Mobility – Option 7 MR-DC with NGEN-DC

## 102.10 Multi-RAT Dual Carrier Mobility – Option 4 MR-DC with NE-DC

## 103 Performance

## 103.1 eMBB Performance (EPC)

## 103.2 PS Performance (5GC) QoS Related

## 104 DL Data Transfer

## 105 Interworking with Legacy Networks

# 5G Carrier Aggregation

It is essential for the tester to build up a knowledge base of the maximum throughput achievable in the test location and for the device capability. This can be done using different Reference devices with similar capabilities to the DUT. Once a maximum achievable throughput is known for the location then this can be used as a base figure to validate the test result. Please note, that with networks continuously improving, this maximum achievable figure shall be monitored regularly and updated with the latest known maximum achievable throughput. The model name(s) used to build up the knowledge base shall be noted in the test result.

Note: There are several ways to check the throughput:

* DUT tethered to a laptop (USB/Wi-Fi). A speedtest tool on the laptop can then be used to measure the throughput. Ensure that the tethering/DUN connection is as fast as the available cellular connection.
* A speedtest tool directly on the DUT can be used to measure the throughput.
* For modules or devices without a UI, a DUN connection to a laptop can be used along with a speedtest tool on the laptop to measure the throughput.Other valid methods are available such as an FTP client.

## Carrier Aggregation Stationary Data Performance for 5G NR Option 3 (EN-DC)

### Carrier Aggregation Stationary Data Performance – Relative Downlink Throughput

Description

To measure the average downlink throughput under static conditions using Carrier Aggregation as allocated by the network.

Related core specifications

3GPP TS 38.331

Reason for test

To obtain a measure of average downlink throughput for an 5G NR Option 3 (EN-DC) network using Carrier Aggregation as implemented in the network under test.

This test is applicable for devices supporting 5G NSA Carrier Aggregation regardless of the type of Carrier Aggregation (Contiguous, non-contiguous, inter band), technology (FDD, TDD) or number of components aggregated by the network.

Initial configuration

Network coverage of an LTE eNB with a co-located 5G NR gNB is available.

DUT and network under test are both supporting supporting multiple 5G Carrier Aggregation Bands and frequencies required to be tested.

Reference device(s) used to validate the result with similar Carrier Aggregation capabilities is/are available. The model name(s) shall be noted in the test result.

Ensure optimal testing conditions (low user traffic hours to avoid conflict with other devices for Radio resources and a stable RF environment).

|  |  |  |
| --- | --- | --- |
| - | Test procedure | Expected behaviour |
| 1 | Prepare the DUT and Reference with the method of measuring the throughput. | DUT and Reference are setup with the appropriate tool/method. |
| 2 | Perform 1 x Downlink throughput measurement on DUT using the appropriate method. | Measurement is taken and recorded.  Make a note of the Carrier Aggregation configuration being used (e.g. CA\_n1\_n78; CA\_n3\_n78) |
| 3 | Perform 1 x Downlink throughput measurement on the Reference using the appropriate method. | Measurement is taken and recorded.  Make a note of the Carrier Aggregation configuration being used (e.g. CA\_n1\_n78; CA\_n3\_n78) |
| 4 | Ensure there is no further data traffic and wait for in-activity timer to expire. | Confirm with a trace tool / test monitor that DUT switches to RRC state IDLE |
| 5 | Repeat and perform at least 5 Downlink throughput measurements on DUT and Reference in alternating sequence.  Ensure DUT and Reference are in IDLE before performing the next throughput measurement. | Measurements are taken and recorded on DUT and Reference. |
| 6 | Calculate average Downlink throughput for DUT and reference. |  |
| 7 | Evaluate the data performance by comparing the DUT’s average throughput with the reference average throughput and the known maximum throughput for the test location and device capability from the knowledge base. | Ensure that the DUT’s data performance is no more than 10% worse than the reference device and that the DUT’s performance is no more than 20% worse than the known maximum throughput from the knowledge base. |

## Carrier Aggregation Stationary Data Performance for 5G NR Option 2

### Carrier Aggregation Stationary Data Performance – Relative Downlink Throughput

Description

To measure the average downlink throughput under static conditions using Carrier Aggregation as allocated by the network.

Related core specifications

3GPP TS 38.331

Reason for test

To obtain a measure of average downlink throughput for an 5G NR Option 2 network using Carrier Aggregation as implemented in the network under test.

This test is applicable for devices supporting Carrier Aggregation regardless of the type of Carrier Aggregation (Contiguous, non-contiguous, inter band), technology (FDD, TDD) or number of components aggregated by the network.

Initial configuration

DUT and network under test are both supporting Carrier Aggregation in the downlink.

There must be an appropriate number of 5G SA cells available on the same PLMN, supporting the Carrier Aggregation Bands and frequencies required to be tested.

Reference device(s) used to validate the result with similar Carrier Aggregation capabilities is/are available. The model name(s) shall be noted in the test result.

Ensure optimal testing conditions (low user traffic hours to avoid conflict with other devices for Radio resources and a stable RF environment).

|  |  |  |
| --- | --- | --- |
| - | Test procedure | Expected behaviour |
| 1 | Prepare the DUT and Reference with the method of measuring the throughput. | DUT and Reference are setup with the appropriate tool/method. |
| 2 | Perform 1 x Downlink throughput measurement on DUT using the appropriate method. | Measurement is taken and recorded.  Make a note of the Carrier Aggregation configuration being used (e.g. CA\_n1\_n78; CA\_n3\_n78) |
| 3 | Perform 1 x Downlink throughput measurement on the Reference using the appropriate method. | Measurement is taken and recorded.  Make a note of the Carrier Aggregation configuration being used (e.g. CA\_n1\_n78; CA\_n3\_n78) |
| 4 | Ensure there is no further data traffic and wait for in-activity timer to expire. | Confirm with a trace tool / test monitor that DUT switches to RRC state IDLE |
| 5 | Repeat and perform at least 5 Downlink throughput measurements on DUT and Reference in alternating sequence.  Ensure DUT and Reference are in IDLE before performing the next throughput measurement. | Measurements are taken and recorded on DUT and Reference. |
| 6 | Calculate average Downlink throughput for DUT and reference. |  |
| 7 | Evaluate the data performance by comparing the DUT’s average throughput with the reference average throughput and the known maximum throughput for the test location and device capability from the knowledge base. | Ensure that the DUT’s data performance is no more than 10% worse than the reference device and that the DUT’s performance is no more than 20% worse than the known maximum throughput from the knowledge base. |

### Carrier Aggregation Stationary Data Performance – Relative Uplink Throughput

Description

To measure the average uplink throughput under static conditions using Carrier Aggregation as allocated by the network.

Related core specifications

3GPP TS 36.331

Reason for test

To obtain a measure of average uplink throughput for an 5G NR Option 2 network using Carrier Aggregation as implemented in the network under test.

This test is applicable for devices supporting Carrier Aggregation regardless of the type of Carrier Aggregation (Contiguous, non-contiguous, inter band), technology (FDD, TDD) or number of components aggregated by the network.

Initial configuration

DUT and network under test are both supporting Carrier Aggregation in the uplink.

There must be an appropriate number of 5G SA cells available on the same PLMN, supporting the Carrier Aggregation Bands and frequencies required to be tested.

Reference device(s) used to validate the result with similar Carrier Aggregation capabilities is/are available. The model name(s) shall be noted in the test result.

Ensure optimal testing conditions (low user traffic hours to avoid conflict with other devices for Radio resources and a stable RF environment).

|  |  |  |
| --- | --- | --- |
| - | Test procedure | Expected behaviour |
| 1 | Prepare the DUT and Reference with the method of measuring the throughput. | DUT and Reference are setup with the appropriate tool/method. |
| 2 | Perform 1 x Uplink throughput measurement on DUT using the appropriate method. | Measurement is taken and recorded.  Make a note of the Carrier Aggregation configuration being used (e.g. CA\_n1\_n78; CA\_n3\_n78) |
| 3 | Perform 1 x Uplink throughput measurement on the Reference using the appropriate method. | Measurement is taken and recorded.  Make a note of the Carrier Aggregation configuration being used (e.g. CA\_n1\_n78; CA\_n3\_n78) |
| 4 | Ensure there is no further data traffic and wait for in-activity timer to expire. | Confirm with a trace tool / test monitor that DUT switches to RRC state IDLE |
| 5 | Repeat and perform at least 5 Uplink throughput measurements on DUT and Reference in alternating sequence.  Ensure DUT and Reference are in IDLE before performing the next throughput measurement. | Measurements are taken and recorded on DUT and Reference. |
| 6 | Calculate average Uplink throughput for DUT and reference. |  |
| 7 | Evaluate the data performance by comparing the DUT’s average throughput with the reference average throughput and the known maximum throughput for the test location and device capability from the knowledge base. | Ensure that the DUT’s data performance is no more than 10% worse than the reference device and that the DUT’s performance is no more than 20% worse than the known maximum throughput from the knowledge base. |

## 106.3 Carrier Aggregation Mobility Test for 5G NR Option 3 (EN-DC)

## 106.4 Carrier Aggregation Mobility Test for 5G NR Option 2

### 106.4.1 Carrier Aggregation Mobility – Downlink

Description

The DUT shall perform Carrier Aggregation along the drive route as expected for the network under test.

Related core specifications

3GPP TS 38.331

Reason for test

To ensure the DUT can perform Carrier Aggregation under mobility conditions.

This test is applicable for devices supporting Carrier Aggregation regardless of the type of Carrier Aggregation (Contiguous, non-contiguous, inter band), technology (FDD, TDD) or number of components aggregated by the network.

Initial configuration

DUT and network under test are both supporting Carrier Aggregation in the downlink.

There must be an appropriate number of 5G SA cells available on the same PLMN, supporting the Carrier Aggregation Bands and frequencies required to be tested.

The test route should be sufficient enough to adequately test the Carrier Aggregation scenarios supported by the network and DUT.

Test procedure

1. Start a Data session. I.e. activate tethering (USB/Wi-Fi) / DUN / internal FTP client.
2. Download a large incompressible file from an external server.

Confirm Carrier Aggregation status is ACTIVATED using a trace tool or internal measuring application to ensure successful addition of the Scell(s) to the Pcell.

Confirm Data download has started, and the transfer is ongoing throughout the test.

1. Move along the test route ensuring the DUT moves between Pcells sharing the same gNodeB and Pcells not sharing the same gNodeB.

Ideally, as many of the below scenarios should be covered:

Scell(s) release by RRCReconfiguration (sCellToReleaseList):

1. Release to a reduced component Carrier Aggregation
2. Release to single carrier.

Scell(s) add by RRCReconfiguration (sCellToAddModList):

1. Adding to an active Carrier Aggregation.
2. Adding to a single carrier to activate Carrier Aggregation.

Scell(s) modify by RRCReconfiguration (sCellToReleaseList and sCellToAddModList):

1. Combination of release and adding to an already active Carrier Aggregation.
2. Stop the data download.

Expected behaviour

1. Data connection is successfully established.
2. Carrier Aggregation status is ACTIVATED as implemented and allocated by the network.

Data download is ongoing successfully.

1. The DUT performs Carrier Aggregation as expected along the drive route. Each handover is successfully performed and data download continues as expected after each handover and cell change.
2. Data download is successfully stopped.

### 106.4.2. Carrier Aggregation Mobility – Uplink

Description

The DUT shall perform Carrier Aggregation along the drive route as expected for the network under test.

Related core specifications

3GPP TS 38.331

Reason for test

To ensure the DUT can perform Carrier Aggregation under mobility conditions.

This test is applicable for devices supporting Carrier Aggregation regardless of the type of Carrier Aggregation (Contiguous, non-contiguous, inter band), technology (FDD, TDD) or number of components aggregated by the network.

Initial configuration

DUT and network under test are both supporting Carrier Aggregation in the uplink.

There must be an appropriate number of 5G SA cells available on the same PLMN, supporting the Carrier Aggregation Bands and frequencies required to be tested.

The test route should be sufficient enough to adequately test the Carrier Aggregation scenarios supported by the network and DUT.

Test procedure

1. Start a Data session. I.e. activate tethering (USB/Wi-Fi) / DUN / internal FTP client.
2. Upload a large incompressible file to an external server.

Confirm Carrier Aggregation status is ACTIVATED using a trace tool or internal measuring application to ensure successful addition of the Scell(s) to the Pcell.

Confirm Data upload has started, and the transfer is ongoing throughout the test.

1. Move along the test route ensuring the DUT moves between Pcells sharing the same gNodeB and Pcells not sharing the same gNodeB.

Ideally, as many of the below scenarios should be covered:

Scell(s) release by RRCReconfiguration (sCellToReleaseList):

1. Release to a reduced component Carrier Aggregation
2. Release to single carrier.

Scell(s) add by RRCReconfiguration (sCellToAddModList):

1. Adding to an active Carrier Aggregation.
2. Adding to a single carrier to activate Carrier Aggregation.

Scell(s) modify by RRCReconfiguration (sCellToReleaseList and sCellToAddModList):

1. Combination of release and adding to an already active Carrier Aggregation.
2. Stop the data upload.

Expected behaviour

1. Data connection is successfully established.
2. Carrier Aggregation status is ACTIVATED as implemented and allocated by the network.

Data upload is ongoing successfully.

1. The DUT performs Carrier Aggregation as expected along the drive route. Each handover is successfully performed, and data upload continues as expected after each handover and cell change.
2. Data upload is successfully stopped.

### 106.4.3. Carrier Aggregation Mobility – Downlink & Uplink

Description

The DUT shall perform Carrier Aggregation along the drive route as expected for the network under test.

Related core specifications

3GPP TS 38.331

Reason for test

To ensure the DUT can perform Carrier Aggregation under mobility conditions.

This test is applicable for devices supporting Carrier Aggregation regardless of the type of Carrier Aggregation (Contiguous, non-contiguous, inter band), technology (FDD, TDD) or number of components aggregated by the network.

Initial configuration

DUT and network under test are both supporting Carrier Aggregation in the downlink and uplink.

There must be an appropriate number of 5G SA cells available on the same PLMN, supporting the Carrier Aggregation Bands and frequencies required to be tested.

The test route should be sufficient enough to adequately test the Carrier Aggregation scenarios supported by the network and DUT.

Test procedure

1. Start a Data session. I.e. activate tethering (USB/Wi-Fi) / DUN / internal FTP client.
2. Download a large incompressible file from an external server.

Confirm Carrier Aggregation status is ACTIVATED using a trace tool or internal measuring application to ensure successful addition of the Scell(s) to the Pcell.

Confirm Data download has started, and the transfer is ongoing throughout the test.

1. Simultaneously upload a large incompressible file to an external server.
2. Move along the test route ensuring the DUT moves between Pcells sharing the same eNodeB and Pcells not sharing the same eNodeB.

Ideally, as many of the below scenarios should be covered:

Scell(s) release by RRCReconfiguration (sCellToReleaseList):

1. Release to a reduced component Carrier Aggregation
2. Release to single carrier.

Scell(s) add by RRCReconfiguration (sCellToAddModList):

1. Adding to an active Carrier Aggregation.
2. Adding to a single carrier to activate Carrier Aggregation.

Scell(s) modify by RRCReconfiguration (sCellToReleaseList and sCellToAddModList):

1. Combination of release and adding to an already active Carrier Aggregation.
2. Stop the data download & upload.

Expected behaviour

1. Data connection is successfully established.
2. Carrier Aggregation status is ACTIVATED as implemented and allocated by the network.

Data download is ongoing successfully.

1. Data upload is ongoing successfully.
2. The DUT performs Carrier Aggregation as expected along the drive route. Each handover is successfully performed and data download & upload continues as expected after each handover and cell change.
3. Data download and upload are successfully stopped.

# Document Management

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| Initial to 11.6 |  | ev. of this PRD as described in Annex J, approved at TSG FT#xx |  | Hajo Schulze / Vodafone |
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| 36 | 20/09/2021 | Rev. of this PRD as described in Annex J, approved at TSG FT#75 | TSG#45 | Momar Goumballe / Orange |
| 37 | 3/01/2022 | Rev. of this PRD as described in Annex J, approved at TSG FT#76 | TSG#46 | Momar Goumballe / Orange |
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| 39 | 18/07/2022 | Rev. of this PRD as described in Annex J, approved at TSG FT#78 | TSG#48 | Momar Goumballe / Orange |
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