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Background

- Black box testing is necessary for testing devices with different type of SIMs (removable, embedded or integrated).
- Some of the Test Cases in current 31.121 and 31.124 specifications support devices with removable SIMs only.
- Test Cases in the following sections need new TC variants for Black Box testing.
 - 31.121 5.3
 - 31.121 5.5
 - 31.121 15
 - 31.124
- Only some of the TCs in above sections need new TC variant. Some of TCs can be used as it is in Black Box testing.
- Very minimum change is required for the TCs in 31.124.
 - Minor change in initial conditions is sufficient for all most all the TCs and TC changes are needed only for Event Download TCs
- Having the test environment and the practical environment same is an advantage with Black Box testing. But Test System shall make sure to verify **all** the existing test requirements and acceptance criteria.
- New TCs shall introduce new methods to verify all the existing test requirements and acceptance criteria.

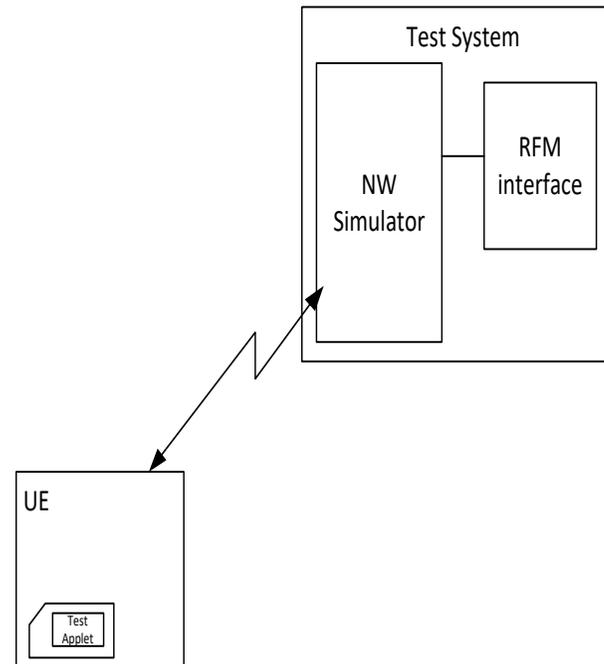
Black Box testing

- Black Box testing may be performed on an ME with UICC inserted or embedded or integrated where the physical interface between the ME and the UICC is not exposed to a SIM Simulator for monitoring the APDUs or for triggering any command.
- Test System shall update Elementary Files in the UICC to set up the Initial conditions for each Test Case.
- If Black Box testing is performed,
 - Acceptance Criterias of a test case related to Elementary Files read shall be verified without monitoring the structure and content of the APDUs send to the UICC.
 - Triggering of toolkit commands if needed shall be performed from the UICC itself.
 - UICC files shall be reset back to the original default contents for the test cases if needed.

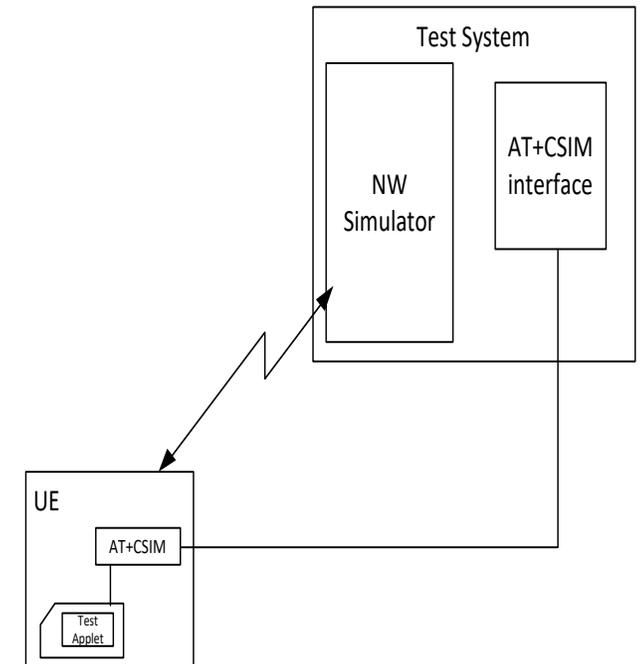
Black Box test setup examples

- Black Box testing may use AT interface or RFM interface for the Test System to update files or trigger commands from UICC.
- AT interface may not be supported in all the UEs.
- RFM can be used for such UEs but it shall be camped on to NW simulator for sending the RFM commands.
- It would be an advantage if Test Systems can support both interfaces and select the interface depend on the UE capabilities.
- Test Applets in the UICC can be used to trigger proactive commands from the card.
 - RFM (ETSI 102.226) or AT commands can be sent for Test System to trigger proactive commands.
 - Test Applet can be used for file updates as well. It can be loaded using RAM (ETSI 102.226) or any other tools.

Black Box testing with RFM interface



Black Box testing with AT interface



Removable, Embedded or Integrated eSIM

Challenges to meet Acceptance Criteria

31.121

- Some of the TCs need to verify ME has read certain EFs from the UICC.
- SUCI calculation by USIM TCs need to verify if ME has sent correct GET IDENTITY command to the UICC.
- Authentication TCs need to verify that ME forwards the RAND and AUTN received in EAP message IE with EAP-request/AKA'-challenge message to the USIM.
- Some of the files in the USIM are not accessible in all the cards.
 - Eg: EFs under DF-SAIP, EF-SQN

31.124

- Need to verify TERMINAL RESPONSE and ENVELOP commands send by the ME
 - No TC changes in the specification is required except to allow using any type of SIM with standard GSMA TS.48 eUICC Generic Test Profile loaded.
 - How test system verify TERMINAL RESPONSE and ENVELOP commands is implementation specific. Using a Test Applet may be an option for that purpose.
- Since SET UP EVENT LIST proactive command is handled by the CAT Runtime Environment TERMINAL RESPONSE for this command can't be accessed by Toolkit Applets.
 - Configuring EVENT LIST in SET UP EVENT LIST proactive command is required for verifying LOCATION STATUS EVENT or any other EVENT.
 - Though the required EVENT LIST configured in SET UP EVENT LIST is an initial condition and not in the Test Purpose current TCs consider it as a test step.

Requirements for APDUs in SIM-ME interface

- Black Box implementation is vendor specific, but it shall make sure APDU structure and the contents in SIM-ME interface adhere to relevant specifications.
- Following specifications can be considered for Black Box implementation:
 - GSMA TS.48 Generic Test Profile (GTP) v3.0 or higher can be used as the default UICC profile and Test System shall update the EFs as needed for the Test Cases.
 - This profile can be pre-loaded on to a removable/embedded eSIM or integrated iSIM whatever available in the ME.
 - Removable/embedded eSIM or iSIM and TS.48 GTP should be compliant with
 - ETSI 102.221 and 3GPP 31.122 (Test spec) with respect to EF referencing and APDU command structures.
 - Trusted Connectivity Alliance eUICC Profile Package Interoperable Format (TCA PP IF) Technical Specification v2.3 or higher.
 - Having compliance with TCA PP IF v2.3 or higher and with ETSI 102.221 (test spec 31.122) is important for SUCI calculation and processing of GET IDENTITY APDU or any other APDU (READ BINARY or READ RECORD).
 - Eg: If Test System guarantees only the data related to SUCI calculation by USIM is available and expected data for SUCI is received OTA by NG-SS, it implicitly proves ME has sent GET IDENTITY to the TCA PP IF v2.3 and ETSI 102.221 compliant eSIM/iSIM correctly.
 - The same logic applies to READ BINARY and READ RECORD if Test System guarantees data to be read is only available in the eSIM/iSIM.

List of EF Reads to be verified for 31.121 5G TCs

- 3GPP 31.121 5G TCs include verification of READ commands for the following EFs.
 - EF-IMSI,
 - EF-UST,
 - EF-SUCI_Cal_info,
 - EF-Routing_Indicator,
 - EF-5GS3GPPNSC,
 - EF-5GAUTHKEYs,
 - EF-5GS3GPPLOCI.
- Test case procedure and acceptance criteria shall make sure the source of file content read is from the relevant EF in USIM.
- If the Test UICC used in the ME is a standard UICC (eg: compliant with ETSI 102.121 Rel 15 or higher and TCA PP IF v2.3 or higher) APDU structure and the content send by the ME shall be compliant with specifications.
- All the EFs above should be verified but not necessary to verify the same EF in all the TCs.
 - All those EFs are read at the device power up initialization and that procedure is same for all the TCs and it is not necessary to verify reading of the same file during power up initialization in all the TCs.
 - Hence new TC variants may not include verification of the same EF read in all the TCs.

Verification of EF read (1)

EF-IMSI, EF-SUCI_Calc_Info, EF-Routing_Indicator

- Test System shall update EF-IMSI, EF-Routing_Indicator and EF-SUCI_Calc_Info with different / random values as the last digit of the IMSI (x), RI (y) and HN Public Key Identifier (z) every time the TC is initialized.
- Also Test System shall delete the data required for SUCI calculation by USIM to avoid any possible SUCI calculation by USIM.
- NG-SS shall compare x, y, z extracted from SUCI against what Test System updated in the USIM and confirm if matches.
- If for example, removable / embedded eSIM or iSIM is compliant with TCA-PP-IF and ETSI 102.221 specifications, APDU structure for the READ command should be correct.
- Considering all the above, Acceptance Criteria that ME read EF-IMSI, EF-Routing_Indicator and EF-SUCI_Calc_Info can be verified by comparing the random x, y and z values updated by the Test System and values received from SUCI.

Verification of EF read (2)

EF-5GS3GPPNSC, EF-5GAUTHKEYS

- TC shall use valid 5G NAS Security Context and valid 5G Keys instead of using no valid security context (ngKSI=7) as the initial context, for the TCs need verification of reading EF-5GS3GPPNSC and EF-5GAUTHKEYS.
 - The condition with no initial 5G NAS Security Context shall be verified with TCs do not need verification of reading of those EFs.
 - This will provide an additional verification compared to what we have in current 31.121.
- NG-SS generates Authentication vectors using the RAND send to the ME and the K used in the USIM and uses the CK/IK to derive the 5G Authentication Keys and the NAS security context .
- Test System shall update EF-5GS3GPPNSC file with the NAS Security Context and EF-5GAUTHKEYS with the K_{AUSF} and K_{SEAF} already generated.
 - Since RAND is a random number 5G Keys and NAS Security Context will be different each time the TC is initialized
 - If RFM is used for the file update NG-SS shall send AUTHENTICATION REJECT before powering down the ME at TC initialization to avoid the security EFs being overwritten by the ME.
- ME shall use protected NAS messages to send REGISTRATION REQUEST since card has valid NAS security context.
- If NS-SS can decode the REGISTRATION REQUEST that proves ME has read the files EF-5GS3GPPNSC and EF-5GAUTHKEYS.
- If for example, removable / embedded eSIM or iSIM is compliant with TCA-PP-IF and ETSI 102.221 specifications, APDU structure for the READ command send by the ME should be as per the specifications.
- Considering all the above, Acceptance Criteria for read EF-5GS3GPPNSC and EF-5GAUTHKEYS can be verified by using NAS protected messages and ability for decoding the REGISTRATION REQUEST correctly.

Verification of EF read (3)

EF-UST

- EF-UST verification can be done by using Service n° 124. Test System shall update service n° 124 randomly.
- NS-SS to verify that ME uses Null scheme or scheme B/A at power up correctly to confirm that ME read the UST file.
 - If Test system has chosen to make service n° 124 not available at powerup verify that ME uses NULL scheme. Otherwise, verify that ME uses protection scheme B/A.
 - For some TCs Test System can toggle the service n° 124 and verify the change in the Protection Scheme by resetting the device (Eg. 15.1.1)
- If for example, removable / embedded eSIM or iSIM is compliant with TCA-PP-IF and ETSI 102.221 specifications, APDU structure for the READ command should be correct.
- Considering all the above, Acceptance Criteria for read EF-UST can be verified by verifying the protection schemes used at power up REGISTRATION.

Verification of GET IDENTITY command

- Test System updates EF-IMSI, EF-Routing_Indicator and data for SUCI calculation by USIM with different / random values as the last digit of the IMSI (x), RI (y) and HN Public Key Identifier (z) every time the TC is initialized.
 - A Test Profile with access to files under DF-SAIP shall be loaded on to the UICC (eg: GSMA TS.48 Generic Test Profile).
- Also Test System shall delete the data required for SUCI calculation by ME (EF-SUCI_Calc_Info) to avoid any possible SUCI calculation by ME.
- NG-SS shall verify if x, y, z extracted from SUCI against what Test System updated in the USIM.
- If for example, removable / embedded eSIM or iSIM is compliant with TCA-PP-IF v2.3 or higher and ETSI 102.221, SUCI calculation should have been done by the USIM and the APDU structure for the GET IDENTITY command sent by the ME should be correct.
- Considering all the above, Acceptance Criteria if ME has sent the correct GET IDENTITY can be verified by comparing the random x, y and z values updated by the NS-SS and received from SUCI.

Verification of AUTHENTICATE command

- Some of the TCs need to verify ME forwards the RAND and AUTN received in EAP message IE with EAP-request/AKA'-challenge message to the USIM.
- For such TCs, Test System shall choose a different / random SQN value (SQN_{HE}) every time the TC is initialized and update EF-SQN in the USIM with SQN_{MS} (highest received SQN, $SEQ_{MS} - SEQ < L$. Ref Annex C.2.2 in 3GPP 33.102).
 - Make sure SEQ received is accepted by the USIM and not generate a sequence numbers sync failure.
 - A Test Profile with access to EF-SQN file shall be loaded no to the UICC (eg: GSMA TS.48 Generic Test Profile).
- NG-SS to use same SQN when generating the AUTN.
- If Authentication procedure initiated by the NG-SS is successful, that implicitly verifies that ME forwards the RAND and AUTN received in OTA message to the USIM.
 - SQN received in AUTN is acceptable and does not generate a Sync Failure by the USIM.
 - Successful Authentication Response with RES* at NG-SS.
- If for example, removable / embedded eSIM or iSIM is compliant with ETSI 102.221 and 3GPP 31.122 the APDU structure for the AUTHENTICATE command with RAND and AUTN sent by the ME should be correct.
- Considering all the above, Acceptance Criteria that ME forwards the RAND and AUTN received in EAP message IE with EAP-request/AKA'-challenge message to the USIM can be verified by updating the EF-SQN in the USIM to match with the SQN used by NS-SS for computing AUTN.
 - TCs that do not verify this requirements can have the default SQNs (all zeros) without any change.

Changes for 31.124

Verify TERMINAL RESPONSE and ENVELOP commands send by the ME

- No TC changes in the specification are required except to allow using any type of SIM with a Test Profile loaded (eg: GSMA TS.48 eUICC Generic Test Profile).
- How Test System verify TERMINAL RESPONSE and ENVELOP commands is implementation specific.
- Using a Test Applet may be an option for that purpose.

TCs with LOCATION STATUS ENVELOP

- Since SET UP EVENT LIST proactive command is handled by the CAT Runtime Environment TERMINAL RESPONSE for this command can't be accessed by Toolkit Applets.
- Configuring EVENT LIST in SET UP EVENT LIST proactive command is required for verifying LOCATION STATUS EVENT or any other EVENT.
- Though the required EVENT LIST configured in SET UP EVENT LIST is an initial condition and not in the Test Purpose current TCs consider it as a test step and not an initial condition.
- Therefore, TCs verifying LOCATION STATUS events shall be modified to include EVENTS to be registered as initial conditions
- If Test Applets are used it can call ***reg.setEvent()*** with required EVENTS during TC initialization to register for required EVENT LIST.

Summary

- As per reply LS C6-200618 for the GSMA LS (TSG eSIMTest meeting #29) a new version of TCs will be required for Black Box testing.
- Black Box testing may be performed on an ME with UICC inserted or embedded or integrated where the physical interface between the ME and the UICC is not exposed to a SIM Simulator.
- TC modifications suggested shall be done so that the new variant of the TCs meet **all** the test requirements and acceptance criteria to ensure black box testing can be used with both removable/non-removable eSIM and iSIMs.
- There are several challenges to handle all the test requirements and acceptance criteria for those TCs and each case shall be handled separately (eg: Read EFs, GET IDENTITY, AUTHENTICATE, SET UP EVENT LIST proactive command etc.) as described in this discussion paper.
 - EF read happens during power up initialization. Devices shall pass all the TCs applicable to the device.
 - Hence it is not necessary to verify reading of the same EF in all the TCs.
- Test systems shall update certain EFs with random data to mitigate the challenges.
 - Test Profile loaded on to the UICC shall provide access to all the needed EFs. Eg: EF under DF-SAIP for SUCI calculation by USIM, EF-SQN.

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Back Up slides

List of 5G 31.121 TCs need changes for Black Box testing

TC #	TC changes required?	Change required for verifying
5.3.1	Y	Read EF _{IMSI} , EF _{Routing_Indicator} and EF _{SUCI_Calc_Info}
5.3.2	Y	Read EF _{IMSI} , EF _{Routing_Indicator} and EF _{SUCI_Calc_Info}
5.3.3	Y	GET IDENTITY command
5.3.4	N	
5.3.5	N	
5.3.6	N	
5.3.7	Y	Read EF _{IMSI} , EF _{UST} , EF _{SUCI_Calc_Info} and EF _{Routing_Indicator}
5.3.8	Y	Read EF _{IMSI} and EF _{5GS3GPPLOCI}
5.3.9	Y	Read EF _{IMSI}
5.3.10	Y	Read EF _{IMSI}
5.3.11	Y	Read EF _{IMSI} , EF _{UST} , EF _{SUCI_Calc_Info} and EF _{Routing_Indicator}
5.3.12	Y	GET IDENTITY command
5.3.13	Y	Read EF _{IMSI} , EF _{Routing_Indicator} and EF _{SUCI_Calc_Info}
5.3.14	Y	Read EF _{IMSI} , EF _{Routing_Indicator} and EF _{SUCI_Calc_Info}
5.3.15	Y	Read EF _{IMSI}
5.3.16	Y	Read EF _{IMSI} , EF _{UST} , EF _{SUCI_Calc_Info} and EF _{Routing_Indicator}
5.3.17	Y	Read EF _{IMSI} , EF _{Routing_Indicator} and EF _{SUCI_Calc_Info}
	.	
5.4.x	N	
	.	
5.5.x	N	
	.	
15.1.1	Y	Read EF _{UST} , EF _{5GS3GPPNSC} and EF _{5GAUTHKEYS} , AUTHENTICATE command
15.1.2	Y	Read EF _{UST} , EF _{5GS3GPPNSC} and EF _{5GAUTHKEYS} , AUTHENTICATE command
15.1.3	N	AUTHENTICATE command (Response AUTS)
15.1.4	N	
15.2.1	Y	Read EF _{UST} , EF _{5GS3GPPNSC} and EF _{5GAUTHKEYS} , AUTHENTICATE command
15.2.2	Y	Read EF _{UST} , AUTHENTICATE command
15.2.3	N	AUTHENTICATE command (Response AUTS)
15.2.4	N	