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| Document Summary | | | |
| **THIS CR IS USES TS.53 v0.4 AS THE BASELINE AND THIS BASELINE VERSION IS** [**HERE**](https://infocentre2.gsma.com/gp/wg/TS/WI/AIN/WorkingDocuments/TS.53v0.4%20Draft%20CTS%20for%20AI%20mobile%20device-20220121.docx)**.**  This CR proposes following changes:   1. Define separate test for int8 and float16 hardware performance. 2. Move how to implement TOPS performance test into appendix. 3. Separate tests for object identification, scene detection, camera setting optimisation and photo classification. 4. Separate tests for ASR, NLU and Text-to-Speech.   Note: This CR has not removed reference to TS.29. This will be remedied via CT CR or via separate CR in future. | | | |
| Document History | | | |
| Date | Version | Author / Comments | |
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# Introduction

## Overview

While more and more device manufacturers declare their products support AI, unfortunately there are obvious difference in the functionality and performance, which greatly impact the user’s experience and perception of AI. In order to guide the industry and align the performance of AI mobile device, GSMA has published TS.47 to set up the standard for AI mobile device. The purpose of this document is to define test cases to verify the compliance of a device to the requirements defined in GSMA PRD TS.47.

## Scope

This document defines the test cases to verify whether a device comply to GSMA PRD TS.47, including test set-up, test method, test procedure and expected results.

The devices covered by this document are mobile devices and tablets.

## Definition

| **Term** | **Description** |
| --- | --- |
| AI Mobile Device | Refer to the definition of AI Mobile Device in TS.47 AI Mobile Device Specification [1]. |
| Power Meter | Equipment that used for power measurement and can fulfil the following functions:  1. Provide power for DUT.  2. Display the current value in diagram. |
| VGG16\_notop | VGG16 without last three fully connected layers, in float32 format. |

## Abbreviations

| **Term** | **Description** |
| --- | --- |
| AI | Artificial Intelligence |
| OEM | Original Equipment Manufacturer |
| DUT | Device Under Test |
| SDO | Standard Developing Organisations |
| TOPS | Tera Operations Per Second |
| TOPS/w | Tera Operations Per Second / Per Watt |

## References

Requirements shall be based on the exact versions as indicated below. However if the manufacturers use a later release and/or version this should be indicated. The GSMA will continually align with other SDOs as appropriate.

| Ref | Doc Number | Title |
| --- | --- | --- |
|  | GSMA PRD TS.47 | AI Mobile Device Specification, Version 1.0, September 2019 |
| [2] | ISO-IEC-19795-1 | Information technology — Biometric performance testing and reporting —Part 1: Principles and framework |
| [3] |  | FIDO Biometrics Requirements (2020) |
| [4] | GSMA PRD TS.29 | Smartphone Performance Test Case Guideline Version 6.0 or later |
| [5] | RFC 2119 | “Key words for use in RFCs to Indicate Requirement Levels”, S. Bradner, March 1997. Available at <http://www.ietf.org/rfc/rfc2119.txt> |
| [6] | RFC8174 | Ambiguity of Uppercase vs Lowercase in RFC 2119 Key Words  <https://www.rfc-editor.org/info/rfc8174> |

## Modal verbs terminology

The key words “MUST”, “MUST NOT”, “REQUIRED”, “SHALL”, “SHALL NOT”, “SHOULD”, “SHOULD NOT”, “RECOMMENDED”, “MAY”, and “OPTIONAL” in this document are to be interpreted as described in RFC 2119 [5] (RFC8174) [6] when, and only when, they appear in all capitals, as shown here.

# Test Methodology

## Testing of optional requirements

Any requirement which is optional may be subject to a conformance test if it is supported by the DUT.

A declaration by the device manufacturer based on Applicability Table (Annex A), is used to determine whether an optional requirement is supported.

## Implicit testing

The conformance of some requirements may not verified explicitly in the present document. This does not imply that these requirements are not essential, but these are implicitly tested to a sufficient degree in other tests. For clarity these are marked out correspondingly below:

XX

## Repetition of tests

As a general rule, the test cases specified in the present document are highly reproducible and don't need to be repeated unless otherwise stated.

## Testing of cases that can leverage the existing certification scheme

For those test cases that can leverage the existing certification scheme, the corresponding conformance test here to will directly accept the results from the certification scheme.

## Testing methods

For guidance, some testing methods are provided in Annex D.

Unless stated otherwise, all the testing methods defined in Annex D can be used with all test cases defined in this specification.

For each test case, the DUT is configured as required by the test method.

# Hardware Performance

## Integer implementation performance

### Test purpose

To verify the DUT can meet the minimum requirements of int8 TOPS and int8 TOPS/w.

### Referenced requirements

|  |  |
| --- | --- |
|  | |
| TS47\_3.1\_REQ\_001 | An AI Mobile Device SHOULD have a minimum of (1) int8 TOPS. |
|  |  |
| TS47\_3.1\_REQ\_003 | An AI Mobile Device SHOULD have a minimum of (0.5) int8 TOPS/Watt. |
|  |  |

### Test Model Preparation

1. AI Application for TOPS testing shall have the following characteristics:
   1. Source code must be available for software auditing
   2. AI application shall support the NN baseline model used to evaluate TOPS performance
   3. AI application shall create a test report with TOPS configuration and performance

### Test Dataset

1. Test dataset shall be publicly available

### Initial configuration

DUT is configured for int8 TOPS and TOPS/watt measurement.

DUT is Switched OFF.

Power meter is Switched ON and connected to the DUT.

### Test procedure

|  |  |  |
| --- | --- | --- |
| Step | Test procedure | Expected result |
| 1 | Review AI Application source code to ensure unbiased implementation of int8 TOPS testing. | Software source code audit report for int8 TOPS testing. |
| 2 | Switch DUT on, adjust the screen brightness to the lowest level, , mute the DUT and turn on the flight mode. | DUT is on and is in flight mode with all radios (e.g., cellular radio, BT, WiFi etc) turned off. |
| 3 | Record the current and voltage. | The current curve and the voltage are displayed. |
| 4 | Wait until the current is stable, i.e. the current curve is stable [+/-5%]. | The current is stable. |
| 5 | Record the background current and the voltage for 60 seconds, compute the average value. | The value of average background current and average voltage are obtained. |
| 6 | Run the test scripts for int8 Test Model, record the inference time and compute the average inference current. | The inference time and the average inference current value are obtained. |
| 7 | Compute int8 TOPS and compare the result with the value specified in the requirement TS.47\_3.1\_REQ\_001. | The int8 TOPS result meets requirement TS.47\_3.1\_REQ\_001. |
| 8 | Compute int8 TOPS/Watt and compare the result with the value specified in the requirement TS.47\_3.1\_REQ\_003. | The int8 TOPS/Watt result meets requirement TS.47\_3.1\_REQ\_003. |
|  |  |  |
|  |  |  |

## Testing floating point implementation

### Test purpose

To verify the DUT can meet the minimum requirements of float16 TOPS and float16 TOPS/w.

### Referenced requirements

|  |  |
| --- | --- |
| TS47\_3.1\_REQ\_002 | An AI Mobile Device SHOULD have a minimum of (0.5) float16 TOPS. |
| TS47\_3.1\_REQ\_004 | An AI Mobile Device SHOULD have a minimum of (0.3) float16 TOPS/Watt. |

### Test Model Preparation

1. AI Application for TOPS testing shall have the following characteristics:
   1. Source code must be available for software auditing
   2. AI application shall support the NN baseline model used to evaluate TOPS performance
   3. AI application shall create a test report with TOPS configuration and performance

### Test Dataset

1. Test dataset shall be publicly available

### Initial configuration

DUT is configured for float16 TOPS and float16 TOPS/watt measurement.

DUT is Switched OFF.

Power meter is Switched ON and connected to the DUT.

### Test procedure

|  |  |  |
| --- | --- | --- |
| Step | Test procedure | Expected result |
| 1 | Review AI Application source code to ensure unbiased implementation of float32 TOPS testing. | Software source code audit report for float32 TOPS testing. |
| 2 | Switch DUT on, adjust the screen brightness to the lowest level, mute the DUT and turn on the flight mode. | DUT is on and is in flight mode with all radios (e.g., cellular radio, BT, WiFi) turned off. |
| 3 | Record the current and voltage. | The current curve and the voltage are displayed. |
| 4 | Wait until the current is stable, i.e., the current curve is stable [+/-5%]. | The current is stable. |
| 5 | Record the background current and the voltage for 60 seconds, compute the average value. | The value of average background current and average voltage are obtained. |
| 6 | Run the test scripts for float16 Test Model, record the inference time and compute the average inference current. | The inference time and the average inference current value are obtained. |
| 7 | Compute float16 TOPS and compare the result with the value specified in the requirement TS.47\_3.1\_REQ\_002. | The float16 TOPS result meets requirement TS.47\_3.1\_REQ\_002. |
| 8 | Compute float16 TOPS/Watt and compare the result with the value specified in the requirement TS.47\_3.1\_REQ\_004. | The float16 TOPS/Watt result meets requirement TS.47\_3.1\_REQ\_004. |

# Software Functions

## Deep learning model update

### Test purpose

To verify that the DUT can support deep learning model update.

### Referenced Requirements

|  |  |
| --- | --- |
| TS47\_3.2\_REQ\_001 | An AI Mobile Device SHALL support on-device model updates of an existing deep learning network. |

### Preconditions

Updated Model preparation:

1. Select an AI Application for the DUT that has the Source Code available for review.
2. Select a specific Neural Network Model supported by the application
3. Select a baseline NN Model and an Updated NN Model.

Dataset preparation:

1. Prepare a dataset that matches the selected model for inferencing usage.

### Initial configuration

DUT is Switched OFF.

### Test procedure

| Step | Test procedure | Expected result |
| --- | --- | --- |
| 1 | Review source code of the AI Application to ensure NN model update is supported. | Source code review confirms proper support for AI NN model updates. |
| 2 | Switch DUT on. | DUT is in idle mode. |
| 3 | Load AI Application onto the DUT | DUT loads AI Application |
| 4 | Load baseline Neural Network Model into AI Application | AI Application loads baseline NN Model |
| 5 | Process dataset with the baseline NN Model and record accuracy of the result. | DUT reports accuracy of baselined NN |
| 6 | Load the updated model into AI Application. | The updated model is successfully loaded with no exception. |
| 7 | Process the dataset using the updated model. | The updated model can be run on the device successfully. |
| 8 | Record the accuracy of the result | DUT reports accuracy of Modified NN Model |
| 9 | Compare accuracy of baseline and updated NN models. | Model accuracy of the Updated NN Model should be within [TBD %] of the Baseline NN Model. |

## Native API requirements

### Test purpose

To verify that the DUT has native APIs to expose AI hardware functions.

### Referenced Requirements

|  |  |
| --- | --- |
| TS47\_3.2\_REQ\_002 | An AI Mobile Device SHALL support native APIs to expose the AI hardware functions. |

### Preconditions

Check what native APIs are supported:

1. Select an AI Application for the DUT that has the following characteristics:
   1. Source Code available for review
   2. Supports internal test report generation to exercise native APIs described above

### Initial configuration

DUT is Switched OFF.

DUT is loaded with native API test scripts.

### Test procedure

| Step | Test procedure | Expected result | |
| --- | --- | --- | --- |
| 1 | Review AI Application source code to ensure proper support for Native APIs that expose AI hardware functions | Software source code audit report for Native API support. | |
| 2 | Switch DUT on. | DUT is in idle mode. | |
| 3 | Load AI Application with Native API Support | AI Application is loaded | |
| 4 | Run the native API to generate out API test report. | AI Application generates API report. | |
| 5 | Review API report and compare to source code audit expectations | Comparison report to indicate compliance. |

## Application APIs requirements

### Test purpose

1. To verify that DUT provides application APIs for the following commonly used AI models:
   1. Computer Vision (CV),
   2. Automatic Speech Recognition (ASR),
   3. Natural Language Understanding (NLU) models.

### Referenced Requirements

|  |  |
| --- | --- |
| TS47\_3.2\_REQ\_003 | An AI Mobile Device SHALL support application APIs (See Appendix A) for native and third-party applications to access Computer Vision (CV), Automatic Speech Recognition (ASR), Natural Language Understanding (NLU) models. |

### Preconditions

1. Select appropriate AI Device Application
2. Select an AI Device Application for the DUT that has the following characteristics:
   1. Source Code available for review
   2. Support for an APIs that supports
      1. Computer Vision (CV)
      2. Automatic Speech Recognition (ASR)
      3. Natural Language Understanding (NLU) models.
   3. Supports internal test report generation to exercise native APIs described above
3. Prepare the input data set and the reference output data set for each of the application APIs.

### Initial configuration

DUT is Switched OFF.

DUT is loaded with application API test script.

### Test procedure

| Step | Test procedure | Expected result |
| --- | --- | --- |
| 1 | Review Application API source code to ensure support for:   1. Computer Vision (CV) 2. Automatic Speech Recognition (ASR) 3. Natural Language Understanding (NLU) models. | Source code audit report with API support results. |
| 1 | Switch DUT on. | DUT is in idle mode. |
| 2 | Run application internal API test script for the validation that DUT has the API to access CV model. | The related APIs are invoked successfully and the expected output is obtained from the model in a report. |
| 3 | Run application internal API test script for the validation that DUT has the API to access ASR model. | The related APIs are invoked successfully and the expected output is obtained from the model in a report. |
| 4 | Run application internal API test script for the validation that DUT has the API to access NLU model. | The related APIs are invoked successfully and the expected output is obtained from the model in a report. |

## Model Format conversion

### Test purpose

To verify that DUT has the SDK to convert model format to its native format so that the model can be run successfully on the DUT.

### Referenced Requirements

|  |  |
| --- | --- |
| TS47\_3.2\_REQ\_004 | An AI Mobile Device SHOULD provide an SDK to convert DNN models from an existing format to the native format of the AI mobile device. Non-exhaustive examples of DNN model file format are: \*.ckpt or \*.pb, \*.tflite, \*.prototxt, \*.pb or \*.pth or \*.pt, \*.json and \*.onnx. |

### Preconditions

1. Use AI Application that runs on DUT with the following characteristics:
   1. AI application source code shall be available for review
   2. AI application can support the baseline and modified NN Models listed below
   3. AI application can generate an accurate report for the models
2. Prepare NN Models with the supported formats for testing.
3. Prepare baseline dataset for use in NN model calibration
4. An OEM provided SDK to convert the format of the test model to native format shall be available with the following characteristics:
   1. OEM SDK shall be available in either open source or closed source format
   2. OEM SDK shall be available to the general public for use and technical evaluation
   3. OEM SDK shall support conversion of the model format to the Native format of the DUT

### Initial configuration

DUT is Switched OFF.

### Test procedure

| Step | Test procedure | Expected result |
| --- | --- | --- |
|  |  |  |
| 1 | Review AI Application source code to ensure it supports both original and native NN Model formats. | Software source code audit report showing full support. |
| 2 | Switch DUT on. | DUT is in idle mode. |
| 3 | Load AI Application with original baseline NN model format. | Application NN model loads |
| 4 | Run baseline NN model with test dataset and record output model accuracy | Output report with test data set accuracy for baseline model |
| 5 | Use OEM SDK to convert model format to Native Format | Output report from SDK indicating successful model conversion. Report should indicate what parameters have changed. |
| 6 | Run native NN model with test dataset and record output model accuracy. | Output report with test data set accuracy base native model |
| 7 | Compare original and native NN model accuracy results | Report comparing baseline and native accuracies. Accuracy results should be [TBD %] compared to baseline. |
|  |  |  |

## Customized Operator

### Test purpose

To verify that DUT support new operator customization.

### Referenced Requirements

|  |  |
| --- | --- |
| TS47\_3.2\_REQ\_005 | An AI Mobile Device SHOULD provide an SDK to support definition of new customized Deep Learning operators. |

### Preconditions

* **Check what operators are supported by DUT**

1. Use AI Application that runs on DUT with the following characteristics:
   1. Source code shall be available for review
   2. Supports the definition of new customized Deep Learning operators
   3. Supports baseline NN models and new NN models using new DL operators
   4. Generates an accurate report for the baseline and custom models

* **Operator Customization**

OEM supplied SDK that defines and creates new custom operators.

* **Create a model as test model with the new defined operator**

Create a model that utilizes the new operator.

* **Test dataset for use with baseline and custom operator models**

### Initial configuration

DUT is Switched OFF.

Covert the test model to native format of DUT if necessary.

### Test procedure

| Step | Test procedure | Expected result |
| --- | --- | --- |
|  |  |  |
|  |  |  |
| 1 | Review AI Application source code to ensure it supports both original and customized operator NN Model formats. | Software source code audit report showing full support. |
| 2 | Switch DUT on. | DUT is in idle mode. |
| 3 | Load AI Application with original baseline NN model format. | Application NN model loads |
| 4 | Run baseline NN model with test dataset and record output model accuracy | Output report with test data set accuracy for baseline model |
| 5 | Use OEM SDK to convert model format to custom operator Format | Output report from SDK indicating successful model conversion. Report should indicate what parameters have changed. |
| 6 | Run native NN model with test dataset and record output model accuracy. | Output report with test data set accuracy base native model |
| 7 | Compare original and custom operator NN model accuracy results | Report comparing baseline and native accuracies. Accuracy results should be [TBD %] compared to baseline. |

# Inference Performance

## Test purpose

To generate a report on inferencing performance of DUT.

## Referenced Requirements

|  |  |
| --- | --- |
| TS47\_3.3\_REQ\_001 | The device SHALL use a benchmark system to generate an inferencing performance report. |

## Preconditions

1. The AI Benchmark application shall have the following characteristics:
   1. Source code shall be available for auditing purposes
   2. Support a variety of applicable mobile NN models (see Appendix)
   3. Report benchmark inferencing and accuracy results
   4. Support for Single Stream and Offline processing reporting

## Neural Network Data and Model Configuration

1. Dataset shall be publicly available
2. Model shall be applicable to the DUT general usage
3. Model shall be publicly available

## Initial Configuration

As required by the benchmark system

## Test Procedure

| Step | Test procedure | Expected result |
| --- | --- | --- |
| 1 | Review AI Application source code to ensure it supports selected models and datasets correctly | Software source code audit report showing full support. |
| 2 | Switch DUT on. | DUT is in idle mode. |
| 3 | Load AI Application benchmark application | Application loads |
| 4 | Run AI benchmark tests | Tests complete without failure |
| 5 | Reports AI benchmark performance results | A report with inferences per second, and accuracy for each model for each stream and offline use-case shall be generated in a table. |

# AI Application Requirements

## Biometric Performance – without FIDO certification

### Common Test Procedures for Biometric Performance

This section defines a common procedure to perform Biometric performance testing for 2D, 3D and fingerprint recognition when an OEM intends to carry out these tests instead of providing FIDO certification.

#### Preconditions

As required by FIDO Biometrics Requirements (2020) [3], chapter 5.

#### Initial configuration

As required by FIDO Biometrics Requirements (2020), chapter 5.

#### Test procedure

| Step | Test procedure | Expected result |
| --- | --- | --- |
| 1 | Switch the DUT on and lock the screen. | The screen is locked. |
| 2 | FAR and FRR test procedure for Device Unlock refer to FIDO Biometrics Requirements (2020), 5.1.3. | Mean of FAR and FRR are obtained. |
| 3 | Check the result. | Both FAR and FRR results meet the relevant requirement. |

### 2D facial biometric system performance

#### Test purpose

To verify that DUT meets the 2D facial biometric performance requirements.

#### Referenced requirements

|  |  |
| --- | --- |
| TS47\_3.4.1\_REQ\_001 | An AI Mobile Device SHOULD support a 2D facial biometric system. |
| TS47\_3.4.1\_REQ\_004 | An AI Mobile Device supporting 2D facial biometric system SHALL support the biometric KPI requirement TS47\_3.4.1\_REQ\_004.1 for each of the use cases: Device Unlock, Application Login and Payment Authorization. |
| TS47\_3.4.1\_REQ\_004.1 | 2D Facial FAR <= (0.002)% and FRR <= (3)% simultaneously |

#### Preconditions

As defined in 6.1.1.1.

#### Initial configuration

As defined in 6.1.1.2.

#### Test procedure

|  |  |  |
| --- | --- | --- |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |

As defined in 6.1.3.5, with FAR and FRR performance as defined for 2D facial biometric.

### 3D facial biometric system performance

#### Test purpose

To verify that DUT meets the 3D facial biometric performance requirements.

#### Referenced requirements

|  |  |
| --- | --- |
| TS47\_3.4.1\_REQ\_002 | An AI Mobile Device SHOULD support a 3D facial biometric system. |
| TS47\_3.4.1\_REQ\_005 | An AI Mobile Device supporting 3D facial biometric system SHALL support the biometric KPI requirement TS47\_3.4.1\_REQ\_005.1 for each of the use cases: Device Unlock, Application Login and Payment Authorization. |
| TS47\_3.4.1\_REQ\_005.1 | 3D Facial FAR <= (0.001)% and FRR <= (3)% simultaneously. |

#### Preconditions

As defined in 6.1.1.1.

#### Initial configuration

As defined in 6.1.1.2.

#### Test procedure

As defined in 6.1.3.5, with FAR and FRR performance as defined for 3D facial biometric.

### Fingerprint biometric system performance

#### Test purpose

To verify that DUT meets the fingerprint biometric performance requirements.

#### Referenced requirements

|  |  |
| --- | --- |
| TS47\_3.4.1\_REQ\_003 | An AI Mobile Device SHOULD support a fingerprint biometric system. |
| TS47\_3.4.1\_REQ\_006 | An AI Mobile Device supporting fingerprint biometric system SHALL support the biometric KPI requirement TS47\_3.4.1\_REQ\_006.1 for each of the use cases: Device Unlock, Application Login and Payment Authorization. |
| TS47\_3.4.1\_REQ\_006.1 | Fingerprint FAR <= (0.002)% and FRR <= (3)% simultaneously. |

#### Preconditions

As defined in 6.1.1.1.

#### Initial configuration

As defined in 6.1.1.2.

#### Test procedure

As defined in 6.1.3.5, with FAR and FRR performance as defined for fingerprint biometric.

## Biometric Performance – with FIDO/IFAA certification

### 2D facial biometric system performance

#### Referenced requirements

|  |  |
| --- | --- |
| TS47\_3.4.1\_REQ\_001 | An AI Mobile Device SHOULD support a 2D facial biometric system. |
| TS47\_3.4.1\_REQ\_004 | An AI Mobile Device supporting 2D facial biometric system SHALL support the biometric KPI requirement TS47\_3.4.1\_REQ\_004.1 for each of the use cases: Device Unlock, Application Login and Payment Authorization. |
| TS47\_3.4.1\_REQ\_004.1 | 2D Facial FAR <= (0.002)% and FRR <= (3)% simultaneously |
| TS47\_3.4.1\_REQ\_007 | The biometric key performance indicators (KPIs) for the supported biometric system SHOULD be certified by one or more of the following programs:  Fast IDentity Online (FIDO) Alliance Biometric Component Certification Program.  Internet Finance Authentication Alliance (IFAA) biometric Certification Program. |

#### Test purpose

To verify that DUT meets the 2D facial biometric performance requirements.

#### Preconditions

OEM provided FIDO/IFAA certification for 2D facial biometric performance.

#### Initial configuration

None.

#### Test procedure

| Step | Test procedure | Expected result |
| --- | --- | --- |
| 1 | Check FIDO/IFFA certification for 2D facial recognition. | OEM provided FIDO/IFAA certification for 2D facial recognition. |

### 3D facial biometric system performance

#### Test purpose

To verify that DUT meets the 3D facial biometric performance requirements.

#### Referenced requirements

|  |  |
| --- | --- |
| TS47\_3.4.1\_REQ\_002 | An AI Mobile Device SHOULD support a 3D facial biometric system. |
| TS47\_3.4.1\_REQ\_005 | An AI Mobile Device supporting 3D facial biometric system SHALL support the biometric KPI requirement TS47\_3.4.1\_REQ\_005.1 for each of the use cases: Device Unlock, Application Login and Payment Authorization. |
| TS47\_3.4.1\_REQ\_005.1 | 3D Facial FAR <= (0.001)% and FRR <= (3)% simultaneously. |
| TS47\_3.4.1\_REQ\_007 | The biometric key performance indicators (KPIs) for the supported biometric system SHOULD be certified by one or more of the following programs:  Fast IDentity Online (FIDO) Alliance Biometric Component Certification Program.  Internet Finance Authentication Alliance (IFAA) biometric Certification Program. |

#### Preconditions

OEM provided FIDO/IFAA certification for 2D facial biometric performance.

#### Initial configuration

None.

#### Test procedure

| Step | Test procedure | Expected result |
| --- | --- | --- |
| 1 | Check FIDO/IFAA certification for 3D facial recognition. | OEM provided FIDO/IFAA certification for 3D facial recognition. |

### Fingerprint biometric system performance

#### Test purpose

To verify that DUT meets the fingerprint biometric performance requirements.

#### Referenced requirements

|  |  |
| --- | --- |
| TS47\_3.4.1\_REQ\_003 | An AI Mobile Device SHOULD support a fingerprint biometric system. |
| TS47\_3.4.1\_REQ\_006 | An AI Mobile Device supporting fingerprint biometric system SHALL support the biometric KPI requirement TS47\_3.4.1\_REQ\_006.1 for each of the use cases: Device Unlock, Application Login and Payment Authorization. |
| TS47\_3.4.1\_REQ\_006.1 | Fingerprint FAR <= (0.002)% and FRR <= (3)% simultaneously. |
| TS47\_3.4.1\_REQ\_007 | The biometric key performance indicators (KPIs) for the supported biometric system SHOULD be certified by one or more of the following programs:  Fast IDentity Online (FIDO) Alliance Biometric Component Certification Program.  Internet Finance Authentication Alliance (IFAA) biometric Certification Program. |

#### Preconditions

OEM provided FIDO/IFAA certification for fingerprint performance.

#### Initial configuration

None.

#### Test procedure

| Step | Test procedure | Expected result |
| --- | --- | --- |
| 1 | Check FIDO/IFAA certification for fingerprint recognition. | OEM provided FIDO/IFAA certification for fingerprint recognition. |

## On-device Image Processing

### Photo scene detection

#### Test purpose

To verify that DUT meets the photo scene detection and recognition requirements.

#### Referenced requirements

|  |  |
| --- | --- |
| TS47\_3.4.2.1\_REQ\_001 | The AI Mobile Device SHOULD support photo scene detection and recognition where the User has the ability to consent to their use. |
| TS47\_3.4.2.1\_REQ\_001.1 | If REQ\_001 is supported then the AI Mobile Device SHALL support  Identification of one or more objects in different scenes such as portraits, landscapes, foods, night scenes and texts, etc. |
|  |  |
|  |  |

#### Preconditions

Prepare the Test Dataset:

Images that are evenly categorized as portrait, landscape, food, night scene and text.

Test Scripts:

Develop Scripts to get the camera setting.

#### Initial configuration

DUT Switched ON.

The photo scene detection and recognition function on DUT is enabled with user consent.

#### Test procedure

| Step | Test procedure | Expected result |
| --- | --- | --- |
| 1 | Switch the DUT rear camera on. | The DUT’s rear camera is on. |
| 2 | Take photos of the portrait images in Test Dataset by using DUT and check whether the screen shows the category correctly on DUT. | The photos are saved in an album on the DUT.  DUT’s screen correctly shows each photo a portrait. |
| 3 | Repeat step 2 for landscapes, foods, night scenes and texts images. | The photos are saved in an album on the DUT.  DUT’s screen correctly shows each photo as a landscape, as a food, as a night scene or as a text. |
|  |  |  |
|  |  |  |
|  |  |  |

### Camera settings optimisation based on detected scene

#### Test purpose

To verify that DUT can optimise camera settings suitable for the detected scene.

#### Referenced requirements

|  |  |
| --- | --- |
| TS47\_3.4.2.1\_REQ\_001 | The AI Mobile Device SHOULD support photo scene detection and recognition where the User has the ability to consent to their use. |
| TS47\_3.4.2.1\_REQ\_001.2 | If REQ\_001 is supported then the AI Mobile Device SHALL support  Scene detection capabilities to optimize camera settings for image capture based on scene content. |

#### Preconditions

Prepare the Test Dataset:

1. Images that are evenly categorized as portrait, landscape, food, night scene and text.

Test Scripts:

1. Develop Scripts to get the camera setting.

#### Initial configuration

DUT Switched ON.

DUT loaded with test scripts.

The photo scene detection and recognition function on DUT is enabled with user consent.

#### Test procedure

| Step | Test procedure | Expected result |
| --- | --- | --- |
| 1 | Switch the DUT rear camera on. | The DUT’s rear camera is on. |
| 2 | Using DUT, take photos of different scenes that include portraits, landscapes, foods, night scene, test images. | The photos are saved in album and DUT’s screen show it is portrait. |
| 3 | Obtain camera setting for each photo. | Check that camera settings are different for the photos in each scene from the photos of the other scenes e.g., a portrait photo has different aperture setting from that of a landscape photo, or a daylight photo has smaller aperture than the same photo take at night. |

### Photo categorisation

#### Test purpose

To verify that DUT meets the photo scene detection and recognition requirements.

#### Referenced requirements

|  |  |
| --- | --- |
| TS47\_3.4.2.1\_REQ\_007 | The AI Mobile Device SHOULD support automatic classification of photos in an album by different categories. |

#### Preconditions

Prepare the Test Dataset:

1. Images that are evenly categorized as portrait, landscape, food, night scene and text.

#### Initial configuration

DUT Switched ON.

The photo scene detection and recognition function on DUT is enabled with user consent.

#### Test procedure

| Step | Test procedure | Expected result |
| --- | --- | --- |
| 1 | Switch the DUT rear camera on. | The DUT’s rear camera is on. |
| 2 | Using DUT, take photos of different scenes that include portraits, landscapes, foods, night scene, test images. | The photos are saved in an album on the DUT according to the defined categories. |

### Text detection and recognition

#### Test purpose

To verify that DUT supports automatic language detection, text detection and recognition.

#### Referenced requirements

|  |  |
| --- | --- |
| TS47\_3.4.2.1\_REQ\_002 | The AI Mobile Device SHOULD support text detection and recognition of installed language packages, where the User has the ability to consent to the text detection and recognition use. |
| TS47\_3.4.2.1\_REQ\_003 | The AI Mobile Device SHOULD support automatic language detection. |

#### Preconditions

Prepare Text Image Dataset:

1. Images containing text in languages which are supported by DUT.

#### Initial configuration

DUT is Switched ON.

Put DUT into flight mode.

The rear camera of DUT is available.

Text detection, text recognition and language determination functions enabled with user consent.

#### Test procedure

| Step | Test procedure | Expected result |
| --- | --- | --- |
| 1 | Apply text detection on text image dataset. | Text in the picture identified.  Language of the text in the picture identified. |
|  |  |  |
|  |  |  |
|  |  |  |

### Facial photo enhancement (FPE)







## Voice Processing

### Automatic Speech Recognition

#### Test Purpose

To verify that DUT meets the Automatic Speech Recognition requirements.

#### Referenced Requirements

|  |  |
| --- | --- |
| TS47\_3.4.3\_REQ\_001 | The AI Mobile Device SHOULD have speech ability. |
| TS47\_3.4.3\_REQ\_002 | The AI Mobile Device SHOULD support Automatic speech recognition (ASR) capabilities where the User has the ability to consent to ASR. |
|  |  |
|  |  |
|  |  |

#### Preconditions (TBD)

#### Initial Configurations (TBD)

#### Test Procedure (TBD)

### Natural Language Understanding

#### Test Purpose

To verify that DUT meets the requirement for Natural Language Understanding.

#### Referenced Requirements

|  |  |
| --- | --- |
| TS47\_3.4.3\_REQ\_001 | The AI Mobile Device SHOULD have speech ability. |
| TS47\_3.4.3\_REQ\_003 | The AI Mobile Device SHOULD support Natural Language Understanding (NLU) capabilities where the User has the ability to consent to NLU. |

#### Preconditions (TBD)

#### Initial Configurations (TBD)

#### Test Procedure (TBD)

### Text to Speech

#### Test Purpose

To verify that DUT can meet the text-to-speech requirement.

#### Referenced Requirements

|  |  |
| --- | --- |
| TS47\_3.4.3\_REQ\_001 | The AI Mobile Device SHOULD have speech ability. |
| TS47\_3.4.3\_REQ\_004 | The AI Mobile Device SHOULD support Synthesized Voice (Text-To-Speech (TTS) capabilities where the User has the ability to consent to TTS. |

#### Preconditions (TBD)

#### Initial Configurations (TBD)

#### Test Procedure (TBD)

### Voice Assistant

#### Voiceprint recognition performance - quiet environment

##### Test purpose

To verify that DUT meets the voice trigger performance requirements.

##### Referenced requirements

|  |  |
| --- | --- |
| TS47\_3.4.3.1\_REQ\_002 | The AI Mobile Device SHALL support voice trigger, and its specific requirements are listed in the following sub requirements: TS47\_3.4.3.1\_REQ\_002.1, 002.2 and\_002.3 |
| TS47\_3.4.3.1\_REQ\_002.1 | The AI Mobile Device SHOULD support voiceprint recognition for preventing people other than the device’s owner from triggering voice assistant. |
| TS47\_3.4.3.1\_REQ\_002.2 | In a quiet environment, the following SHALL be required:  The true acceptance rate (TAR) >= (90)%, and the false acceptance rate (FAR) of voiceprint recognition <= (20)%. |
|  |  |

##### Preconditions

Test Environment and Test subject preparation:

1. Refer to TS.29 Smartphone Performance Test Case Guideline [4], section 6.1.2.Note: For Quiet Environment refer to the background noise scenarios as defined in TS.29, 6.1.2.1, of which the noise level is less than 40dB.

For Noisy Environment refer to TS.29, 6.1.2.2 and 6.1.2.3, of which the noise level is 40-70dB.

* **Test Dataset**

Refer to TS.29, 6.1.3.1

##### Initial configuration

DUT is Switched ON.

Voice assistant is enabled with user’s consent.

DUT is configured to support at least LTE network.

##### Test procedure

| Step | Test procedure | Expected result |
| --- | --- | --- |
| 1 | Enroll wake-up word according to the system prompts. | Wake-up word setting is successful. |
| 2 | TAR test procedure refer to TS.29, 6.3.1.  Conduct the test in quiet environment. | Mean of TAR is obtained. |
| 3 | FAR of voiceprint recognition test procedure refer to TS.29, 6.4.1.  Conduct the test in quiet environment. | Mean of FAR of voiceprint recognition is obtained. |
| 4 | Check the result. | TAR >= (90)% and FAR of voiceprint recognition <= (20)% |
|  |  |  |

#### Voiceprint recognition performance – noisy environment

##### Test purpose

To verify that DUT meets the voice trigger performance requirements.

##### Referenced requirements

|  |  |
| --- | --- |
| TS47\_3.4.3.1\_REQ\_002 | The AI Mobile Device SHALL support voice trigger, and its specific requirements are listed in the following sub requirements: TS47\_3.4.3.1\_REQ\_002.1, 002.2 and\_002.3 |
| TS47\_3.4.3.1\_REQ\_002.1 | The AI Mobile Device SHOULD support voiceprint recognition for preventing people other than the device’s owner from triggering voice assistant. |
| TS47\_3.4.3.1\_REQ\_002.3 | In a noisy environment, the following SHALL be required:  TAR >=(80)%, and FAR of voiceprint recognition <= (20)%. |

##### Preconditions

TBD

Test Dataset:

TBD

##### Initial configuration

DUT is Switched ON.

Voice assistant is enabled with user’s consent.

DUT is configured to support at least LTE network.

##### Test procedure

| Step | Test procedure | Expected result |
| --- | --- | --- |
| 1 | Enrol wake-up word according to the system prompts. | Wake-up word setting is successful. |
| 2 | TAR test procedure refer to TS.29, 6.3.1.  Conduct the test in a noisy environment. | Mean of TAR is obtained. |
| 3 | FAR of voiceprint recognition test procedure refer to TS.29, 6.4.1. | Mean of FAR of voiceprint recognition is obtained. |
| 5 | Check the results for noisy environment. | TAR >= (80)% and FAR of voiceprint recognition <= (20)% |

#### On-device speech recognition

##### Test purpose

To verify that the voice assistant of DUT has the local capability to change system setting even in the case that without network connection and invoke native application.

##### Referenced requirements

|  |  |
| --- | --- |
| TS47\_3.4.3.1\_REQ\_003 | The AI Mobile Device SHALL have on-device speech recognition library (i.e. with no access to the Internet) for changing the system setting (e.g. Turn Bluetooth on/off via voice assistant) and invoking the native applications (e.g. send SMS via voice assistant). |

##### Preconditions

Test Environment and Test subject preparation:

TBD

##### Initial configuration

DUT is Switched On.

Voice assistant is enabled with user’s consent.

Put DUT into flight mode.

##### Test procedure

| Step | Test procedure | Expected result |
| --- | --- | --- |
| 1 | On-device speech recognition capability test procedure refer to TS.29, 6.8.4. | The voice assistant can response or execute correctly for all the test samples in the local test dataset. |

#### Interaction with third-party applications

##### Test purpose

To verify that voice assistant on DUT supports interaction with third-party applications.

##### Referenced requirements

|  |  |
| --- | --- |
| TS47\_3.4.3.1\_REQ\_004 | The AI Mobile Device SHOULD have access to different categories of applications and invoke these applications’ services and functions via voice assistant. |

##### Preconditions

Test Environment and Test subject preparation: TBD

##### Test Dataset

1. Third-party application test dataset is based on what third-party applications the DUT supports.

##### Initial configuration

DUT is Switched ON.

Voice assistant is enabled with user’s consent.

DUT is configured to support at least LTE network.

##### Test procedure

| Step | Test procedure | Expected result |
| --- | --- | --- |
| 1 | Third-party application invoking test procedure refer to TS.29, 6.8.5. | The voice assistant executes correctly for all the test samples in the third-party application test dataset. |

#### Information search

##### Test purpose

To verify that voice assistant on DUT supports information search.

##### Referenced requirements

|  |  |
| --- | --- |
| TS47\_3.4.3.1\_REQ\_005 | The AI Mobile Device SHALL support information search by on-device voice assistant. |

##### Preconditions

TBD

##### Test Environment and Test subject preparation

TBD

##### Test Dataset

TBD

##### Initial configuration

DUT is Switched On.

Voice assistant is enabled with user’s consent.

DUT is configured to support at least LTE network.

##### Test procedure

| Step | Test procedure | Expected result |
| --- | --- | --- |
| 1 | Information search test procedure refer to TS.29, 6.8.1 and 6.8.2. | The voice assistant can response correctly for all the information search that DUT supports. |

#### Interaction with smart devices

##### Test purpose

To verify that voice assistant on DUT supports interaction with smart devices.

##### Referenced requirements

|  |  |
| --- | --- |
| TS47\_3.4.3.1\_REQ\_006 | The AI Mobile Device SHOULD support interaction with smart devices (e.g. home appliances) via voice assistant. |

##### Preconditions

TBD

##### Test Environment and Test subject preparation

TBD

##### Test Dataset

Smart device test dataset will base on what smart devices that DUT supports.

##### Initial configuration

DUT is Switched ON.

Voice assistant is enabled with user’s consent.

DUT is configured to support at least LTE network.

##### Test procedure

| Step | Test procedure | Expected result |
| --- | --- | --- |
| 1 | Interaction with smart devices test procedure refer to TS.29, 6.8.2. | The voice assistant can interact with smart devices successfully. |

## Augmented Reality (AR)

### AI capabilities for AR applications

#### Test Purpose

To verify that DUT provides AI capabilities for AR native and third-party applications.

#### Referenced Requirements

|  |  |
| --- | --- |
| TS47\_3.4.4\_REQ\_001 | The AI Mobile Device SHOULD provide the following AI capabilities for AR native and third-party applications:   1. Hand gesture recognition. 2. Hand skeleton tracking. 3. Human body pose recognition. 4. Human body skeleton tracking. |

#### Preconditions

Check what AI capabilities are supported by AR applications on DUT

#### Test Dataset

TBD

#### Initial Configuration

DUT is Switched ON.

The setting for camera access for DUT is turned on.

#### Test procedure

| Step | Test procedure | Expected result |
| --- | --- | --- |
| 1 | Open the AR application that support hand gesture recognition function, do the hand gesture that DUT supports. Check whether the hand gesture can be recognized.  Note: All hand gesture should be done in front of the DUT’s camera. | The hand gesture can be recognized successfully. |
| 2 | Open the AR application that support hand skeleton tracking function. Move the hand, and check whether the hand can be tracked. | The hand movement can be tracked. |
| 3 | Open the AR application that support human body recognition function, do the pose that DUT supports. Check whether the human body pose can be recognized. | The human body pose can be recognized successfully. |
| 4 | Change to another human body pose, check whether the pose can be tracked and recognized. | The human body pose can be tracked and recognized successfully. |

### AR application

#### Test purpose

To verify that DUT supports AR emoji and AR video functions.

#### Referenced requirements

|  |  |
| --- | --- |
| TS47\_3.4.4\_REQ\_002 | The AI Mobile Device SHOULD support the following applications:   1. AR Emoji    1. Creating customized AR-based Emoji.    2. Tracking User’s facial movement and expression and render these on the AR-based Emoji. 2. AR video    1. Compositing real objects with virtual objects and/or virtual background.    2. Minimum (30) fps frame rate.    3. AR shadow effect and occlusion handling.    4. AR enhanced information text labels should not deviate or disappear from the actual target scene when the AI Mobile Device moves. |

#### Preconditions

* **FPS Test Script preparation**

Test script for Frames Per Second measurement.

#### Initial configuration

DUT is Switched ON.

DUT is loaded with FPS Test Script.

The DUT is configured to support at least LTE network.

#### Test procedure

| Step | Test procedure | Expected result |
| --- | --- | --- |
| 1 | Switch the camera on DUT, turn on the AR emoji function.  Note: If there are other entrances to AR, DUT should declare. | The AR emoji function is enabled. |
| 2 | Create an AR emoji and move test subject’s head to left, then blink eyes and open mouth to check whether the emoji do the same actions. | The AR emoji does the same actions with the test subject. |
| 3 | Switch to AR video function. |  |
| 4 | Scan the ground. | Virtual plane appears. |
| 5 | Select an AR object and place it on the virtual plane. | AR object appears on the virtual plane and has a well interaction/combination with real environment. |
| 6 | Select another AR object with shadow, move the DUT to weak light place, check the shadow effect. | The shadow is darken in the weak light place. |
| 7 | Move the AR object behind one real object | The occlusion reflects the real situation. |
| 8 | Apply AR video for 60 seconds and run the FPS Test Program. | The measured FPS is greater than 30. |
| 9 | Switch to the scene that can show AR enhanced information text label, move the DUT horizontal and vertical, check whether the label deviates or disappears during the moving. | The label is not deviate or disappear during the moving. |

# Privacy and Security

## Privacy

### Compliance with privacy laws

#### Test Purpose

To verify that DUT complies with the privacy laws.

#### Referenced Requirements

|  |  |
| --- | --- |
| TS47\_4.1\_REQ\_001 | AI on mobile device SHOULD comply with the privacy laws in the country where the device is commercially retailed. |

#### Preconditions

None.

#### Initial Configuration

None.

#### Test procedure

| Step | Test procedure | Expected result |
| --- | --- | --- |
| 1 | Check letter of commitment provided by OEM. | OEM provides a letter of commitment that declares DUT complies with the requirement TS47\_4.1\_REQ\_001. |

### Personal data protection by default

#### Test Purpose

To verify that DUT protects personal data by default.

#### Referenced Requirements

|  |  |
| --- | --- |
| TS47\_4.1\_REQ\_002 | Appropriate technical and organisational safeguards SHOULD be implemented to ensure that, by default, only the personal data reasonably necessary for a specific purpose are processed. |

#### Preconditions

None.

#### Initial Configuration

None.

#### Test procedure

| Step | Test procedure | Expected result |
| --- | --- | --- |
| 1 | Check letter of commitment provided by OEM. | OEM provides a letter of commitment that declares DUT complies with the requirement TS47\_4.1\_REQ\_002. |

### Check default AI Applications status

#### Test Purpose

To verify that

1. AI Applications which process Personal Data are switched off by default unless processing exclusively takes place locally on the device

#### Referenced Requirements

|  |  |
| --- | --- |
| TS47\_4.1\_REQ\_003 | AI Applications that process Personal Data SHALL be off by default unless processing exclusively takes place locally on the device. |
|  |  |
|  |  |

#### Preconditions

DUT reset to factory default state

#### Initial Configuration

DUT is Switched ON and registered with the network.

OEM provides the AI applications list the DUT supports.

#### Test procedure

| Step | Test procedure | Expected result |
| --- | --- | --- |
| 1 | Use each AI application that is enabled on the device. | Device performs the AI function as expected from the application.  Device does not exchange any AI application data with the network. |
|  |  |  |

### AI Applications on-off

#### Test Purpose

To verify that

1. User can control the AI applications on-off

#### Referenced Requirements

|  |  |
| --- | --- |
| TS47\_4.1\_REQ\_003.1 | The User SHOULD be allowed to control whether individual AI applications are switched on. |
| TS47\_4.1\_REQ\_003.2 | The User SHOULD be allowed to control whether individual AI applications are switched off. |

#### Preconditions

DUT reset to factory default state

#### Initial Configuration

DUT is Switched ON and registered with the network.

OEM provides the AI applications list the DUT supports.

#### Test procedure

| Step | Test procedure | Expected result |
| --- | --- | --- |
| 2 | Check whether every individual AI application can be switched on/off. | All the individual AI applications can be switched on/off . |

### Responsibility of a Data Processor related to AI applications

#### Test Purpose

To verify that a Data Processor related to AI applications has the responsibility to

1) Be transparent with the User on the nature of the input data used in the AI processing (e.g. personal files, biometrics, …).

2)  Forbid transferring personal data processing off the device except if the User has explicitly agreed or other legal basis has been satisfied in accordance with the law.

3)  Forbid transferring results of on-device AI processing containing personal data off the device except if the User has explicitly agreed or other legal basis has been satisfied in accordance with the law.

#### Referenced Requirements

|  |  |
| --- | --- |
| TS47\_4.1\_REQ\_004 | The AI Application on the AI Mobile Device SHALL be designed in such a way that a Data Processor will have the responsibility to:  1) Be transparent with the User on the nature of the input data used in the AI processing (e.g. personal files, biometrics, …).  2) Forbid transferring personal data processing off the device except if the User has explicitly agreed or other legal basis has been satisfied in accordance with the law.  3)  Forbid transferring results of on-device AI processing containing personal data off the device except if the User has explicitly agreed or other legal basis has been satisfied in accordance with the law. |

#### Preconditions

None.

#### Initial Configuration

None.

#### Test procedure

| Step | Test procedure | Expected result |
| --- | --- | --- |
| 1 | Check letter of commitment provided by OEM. | OEM provides a letter of commitment that declares the DUT complies with the requirement TS47\_4.1\_REQ\_004 . |

## Security

### Requirement of information protection

#### Test purpose

To verify whether DUT has reasonable safeguards for information protection.

#### Referenced requirements

|  |  |
| --- | --- |
| TS47\_4.2\_REQ\_001 | The AI Mobile Device SHALL use reasonable safeguards appropriate to the sensitivity, confidentiality and integrity of the information. |

#### Preconditions

None.

#### Initial configuration

None.

#### Test procedure

| Step | Test procedure | Expected result |
| --- | --- | --- |
| 1 | Check the letter of commitment provided by OEM. | OEM provides a letter of commitment that declares DUT complies with the requirement TS47\_4.2\_REQ\_001. |

### Requirement of personal data collection control

#### Test purpose

To verify that the user is in control of the collection of their personal data and its usage.

#### Referenced requirements

|  |  |
| --- | --- |
| TS47\_4.2\_REQ\_002 | Except as required or permitted by applicable law, the User SHALL always remain in control of the collection of their personal data and its usage, in order to minimise the risk of malicious usage or data leakage. |

#### Preconditions

None.

#### Initial configuration

None.

#### Test procedure

| Step | Test procedure | Expected result |
| --- | --- | --- |
| 1 | Check the letter of commitment provided by OEM. | OEM provides a letter of commitment that declares the DUT complies with the requirement TS47\_4.2\_REQ\_002. |

### Requirement of Off toggle switches

#### Test purpose

To verify whether there are Off ‘toggle’ switches that can be used to turn off the functionality, except as permitted or required by applicable law.

#### Referenced requirements

|  |  |
| --- | --- |
| TS47\_4.2\_REQ\_003 | Off ‘toggle’ switches SHALL turn off the functionality, except as permitted or required by applicable law. |

#### Preconditions

DUT reset to factory default state.

OEM provides list of all the Off ‘toggle’ switches.

#### Initial configuration

None.

#### Test procedure

| Step | Test procedure | Expected result |
| --- | --- | --- |
| 1 | Check the letter of commitment provided by OEM. | OEM provides a letter of commitment that declares DUT complies with the requirement TS47\_4.2\_REQ\_003. |
| 2 | Check Off ‘toggle’ switches listed by OEM are in Off state. | All the Off ‘toggle’ switches are set to off. |

### Requirement of manipulation techniques

#### Test purpose

To verify that the techniques (such as ‘Dark Pattern’) that manipulate the user’s choice are not used.

#### Referenced requirements

|  |  |
| --- | --- |
| TS47\_4.2\_REQ\_004 | Techniques, such as ‘Dark Patterns’, that manipulate the User’s choice SHALL NOT be used. |

#### Preconditions

None.

#### Initial configuration

None.

#### Test procedure

| Step | Test procedure | Expected result |
| --- | --- | --- |
| 1 | Check the letter of commitment provided by OEM. | OEM provides a letter of commitment that declares DUT complies with the requirement TS47\_4.2\_REQ\_004. |

### Security for AI applications

#### Requirement of AI models

##### Test purpose

To verify that the AI models used by an AI Mobile Device meet the secure requirements.

##### Referenced requirements

|  |  |
| --- | --- |
| TS47\_4.2.1\_REQ\_001 | The AI models used by an AI Mobile Device SHOULD be secure and robust, and be protected with appropriate safeguards to prevent and to mitigate attacks. |

##### Preconditions

None.

##### Initial configuration

None.

##### Test procedure

| Step | Test procedure | Expected result |
| --- | --- | --- |
| 1 | Check the letter of commitment provided by OEM. | OEM provides a letter of commitment that declares DUT complies with the requirement TS47\_4.2.1\_REQ\_001. |

#### Requirement of training data protection

##### Test purpose

To verify that defence techniques are deployed to protect the training data for protecting models.

##### Referenced requirements

|  |  |
| --- | --- |
| TS47\_4.2.1\_REQ\_002 | Defence techniques SHOULD be employed to protect the training data for protecting models. For example, in evasion attacks, data can be manipulated to mislead AI models |

##### Preconditions

None.

##### Initial configuration

None.

##### Test procedure

| Step | Test procedure | Expected result |
| --- | --- | --- |
| 1 | Check the letter of commitment provided by OEM. | OEM provides a letter of commitment that declares DUT complies with the requirement TS47\_4.2.1\_REQ\_001. |

#### Requirement of autonomous AI Mobile Device operations

##### Test purpose

To verify that Autonomous AI Mobile Device operations meet the secure requirements.

##### Referenced requirements

|  |  |
| --- | --- |
| TS47\_4.2.1\_REQ\_003 | Autonomous AI Mobile Device operations SHALL be controlled, and/or authorized by the authenticated User. |

##### Preconditions

None.

##### Initial configuration

None.

##### Test procedure

| Step | Test procedure | Expected result |
| --- | --- | --- |
| 1 | Check the letter of commitment provided by OEM. | OEM provides a letter of commitment declares DUT complies with the requirement TS47\_4.2.1\_REQ\_003. |

#### Requirements of Secured Environment

##### Test purpose

To verify that AI mobile device operations are performed in the secured environment.

To verify that Data and metadata are stored with encryption, and keys are stored in the Secured Environment.

##### Referenced requirements

|  |  |
| --- | --- |
| TS47\_4.2.1\_REQ\_004 | AI Mobile Device operations SHOULD be performed in the Secured Environment [4], e.g. a secure boot and upgrade is enforced, and the system integrity is protected. |
| TS47\_4.2.1\_REQ\_005 | Data and metadata for AI Mobile Device SHALL be stored with encryption with keys that are stored securely in a Secured Environment, e.g. Trusted Execution Environment (TEE). |

##### Preconditions

None.

##### Initial configuration

None.

##### Test procedure

| Step | Test procedure | Expected result |
| --- | --- | --- |
| 1 | Check the letter of commitment provided by OEM. | OEM provides a letter of commitment that declares DUT complies with the requirements TS47\_4.2.1\_REQ\_004 and TS47\_4.2.1\_REQ\_005. |

#### Requirement of Biometric Data for authentication

##### Test purpose

To verify that Biometric Data processed by an AI Application used for authentication within the AI Mobile Device are not transferred off the device.

##### Referenced requirements

|  |  |
| --- | --- |
| TS47\_4.2.1\_REQ\_006 | Biometric Data, which are processed by an AI Application (e.g. templates) used for authentication within the AI Mobile Device, SHALL NOT be transferred off the device. |

##### Preconditions

None.

##### Initial configuration

None.

##### Test procedure

| Step | Test procedure | Expected result |
| --- | --- | --- |
| 1 | Check the letter of commitment provided by OEM. | OEM provides a letter of commitment that declares DUT complies with the requirements TS47\_4.2.1\_REQ\_006. |

#### Requirements of Biometric Data

##### Test purpose

To verify that:

1. Users' Biometric Data are encrypted when at rest on the device.
2. Encryption/decryption of this data is performed in a Secured Environment.
3. Biometric Data are stored in the Secured Environment.

##### Referenced requirements

|  |  |
| --- | --- |
| TS47\_4.2.1\_REQ\_007 | Users' Biometric Data (such as facial data, fingerprint data, etc.) SHALL be encrypted when at rest on the device. Encryption/decryption of this data SHALL be performed in a Secured Environment. |
| TS47\_4.2.1\_REQ\_007.1 | Biometric Data SHALL also be stored in the Secured Environment. |
| TS47\_4.2.1\_REQ\_011 | Voiceprint Data SHOULD be stored on the device with encryption. |

##### Preconditions

None.

##### Initial configuration

None.

##### Test procedure

| Step | Test procedure | Expected result |
| --- | --- | --- |
| 1 | Check the letter of commitment provided by OEM. | OEM provides a letter of commitment that declares DUT complies with the requirements TS47\_4.2.1\_REQ\_007, TS47\_4.2.1\_REQ\_007.1 and TS47\_4.2.1\_REQ\_011. |

#### Requirement of biometric algorithms

##### Test purpose

To verify that biometric algorithms are run in a private and Secure Environment.

##### Referenced requirements

|  |  |
| --- | --- |
| TS47\_4.2.1\_REQ\_008 | Biometric algorithms (such as face recognition algorithms, fingerprint algorithms, etc.) SHOULD run in a private and Secure Environment such as a Trusted Execution Environment (TEE). |

##### Preconditions

None.

##### Initial configuration

None.

##### Test procedure

| Step | Test procedure | Expected result |
| --- | --- | --- |
| 1 | Check the letter of commitment provided by OEM. | OEM provides a letter of commitment that declares DUT complies with the requirement TS47\_4.2.1\_REQ\_008. |

#### Requirement of Biometric Data replacement

##### Test purpose

To verify that Biometric Data replacement meets the secure requirements.

##### Referenced requirements

|  |  |
| --- | --- |
| TS47\_4.2.1\_REQ\_009 | If Users' Biometric Data is replaced, the previous Biometric Data before the replacement SHALL be deleted completely and permanently and not be recoverable by data rollback. |
| TS47\_4.2.1\_REQ\_013 | When the Voiceprint Data is permanently and completely deleted, it SHALL NOT be recoverable by data rollback |

##### Preconditions

Select Biometric data to use i.e., fingerprint, 2D facial, 3D facial or voice print

Prepare selected Biometric Data 1 for User1.

Prepare selected Biometric Data 2 for User2 .

##### Initial configuration

Biometric Data 1 is pre-stored on DUT with user’s consent.

DUT is Switched Off.

##### Test procedure

| Step | Test procedure | Expected result |
| --- | --- | --- |
| 1 | Switch DUT on. | DUT is in idle mode. |
| 2 | Use User1 and selected Biometric to login/unlock AI applications. | AI applications can execute with Biometric from person 1. |
| 3 | Replace Biometric Data 1 with Biometric Data 2. | Users' Biometric Data is updated and Biometric Data 1 is deleted. |
| 4 | Use User1 and selected Biometric to login/unlock AI applications | AI applications cannot be executed. |
| 5 | Use User2 and selected Biometric to login/unlock AI applications | AI applications can be executed. |
| 6 | Execute data rollback operation. |  |
| 7 | Use User1 and selected Biometric to login/unlock AI applications | AI applications cannot be executed. |
| 8 | Use User2 and selected Biometric to login/unlock AI applications | AI applications can execute with Biometric Data 2. |
| 9 | Delete all the Biometric Data on DUT. | Users’ Biometric Data is wiped out and cannot be found on DUT. |
| 10 | Use User1 and selected Biometric to Execute AI applications. | AI applications cannot be executed. |
| 11 | Use User 2 and selected Biometric to Execute AI applications respectively. | AI applications cannot be executed. |

#### Requirement of device factory reset

##### Test purpose

To verify that the Biometric Data are wiped out and made unrecoverable by a device factory reset.

##### Referenced requirements

|  |  |
| --- | --- |
| TS47\_4.2.1\_REQ\_010 | The Biometric Data SHALL be wiped and made unrecoverable by a device factory reset. |
| TS47\_4.2.1\_REQ\_014 | The Voiceprint Data SHALL be wiped and made unrecoverable by a device factory reset. |

##### Preconditions

Select Biometric data to use i.e., fingerprint, 2D facial, 3D facial or voice print

Prepare User1’s biometric data as Biometric Data 1.

##### Initial configuration

DUT is Switched OFF.

Biometric Data 1 is pre-stored on DUT with user’s consent.

##### Test procedure

| Step | Test procedure | Expected result |
| --- | --- | --- |
| 1 | Switch DUT on. | DUT is in idle mode. |
| 2 | Execute AI applications with User1 and selected Biometric. | AI applications can be executed with Biometric Data 1. |
| 3 | Execute factory reset on DUT |  |
| 4 | Check the information of Biometric Data on DUT. | Biometric Data 1 is wiped out. |
| 5 | Execute AI applications with User1 and selected Biometric. | AI applications cannot be executed. |

#### Requirement of temporary Voiceprint Data

##### Test purpose

To verify that the temporary Voiceprint Data do not remain in the memory after processing.

##### Referenced requirements

|  |  |
| --- | --- |
| TS47\_4.2.1\_REQ\_012 | The temporary Voiceprint Data SHALL NOT remain in the memory after processing. |

##### Preconditions

None.

##### Initial configuration

None.

##### Test procedure

| Step | Test procedure | Expected result |
| --- | --- | --- |
| 1 | Check the letter of commitment provided by OEM. | OEM provides a letter of commitment that declares DUT complies with the requirement TS47\_4.2.1\_REQ\_012. |

#### Requirement for Voice replay attack defence

##### Test purpose

To verify that the device can be resistant to voice replay attacks.

##### Referenced requirements

|  |  |
| --- | --- |
| TS47\_4.2.1\_REQ\_015 | The device SHOULD be resistant to voice replay attacks. |

##### Preconditions

Prepare voice replay samples.

* **Test Environment preparation**

TBD

* **Test Dataset**

Voice replay test dataset should be prepared by recording the user’s wake-up words for the AI application that support voice recognition.

* **Initial configuration**

DUT is Switched OFF.

##### Test procedure

| Step | Test procedure | Expected result |
| --- | --- | --- |
| 1 | Switch DUT on. | DUT is in idle mode. |
| 2 | Open the AI applications that support voice recognition and use voice replay test dataset to perform voice replay attacks under different background noise. | AI applications cannot execute with voice replay test dataset under all background noise. |

#### Requirement of AR applications

##### Test purpose

To verify that appropriate safeguards are used to protect AR applications from malicious application attacks.

##### Referenced requirements

|  |  |
| --- | --- |
| TS47\_4.2.1\_REQ\_016 | Appropriate safeguards SHOULD be used to protect AR applications from malicious application attacks, such as spoofing a User with information about the real and/or virtual world, sensory overload attacks, hijacking the User's clicks, etc. |

##### Preconditions

None.

##### Initial configuration

None.

##### Test procedure

| Step | Test procedure | Expected result |
| --- | --- | --- |
| 1 | Check the letter of commitment provided by OEM. | OEM provides a letter of commitment that declares DUT complies with the requirement TS47\_4.2.1\_REQ\_016. |

1. Applicability Table

Applicability Table : A document, in the form of a questionnaire , which requires the device manufacturer to declare which requirement the device meets and to provide the necessary information for conducting tests.

| **TS.47 Requirement Number** | **Requirement** | **TS.53 Test Cases Number** | **Test Case Applicability**  **M = Mandatory**  **O = Optional**  **C = Conditional** | **Is this requirement supported?**  **Yes / No** | **Is this requirement tested?**  **Yes / No** | **If the requirement is supported, but not tested give reasons and confirm compliance.** | **Self-Declaration Requirement**  **(Questions)** | **Self-Declaration**  **(Answers)** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| TS47\_3.1\_REQ\_001 | An AI Mobile Device SHOULD have a minimum of (1) int8 TOPS. |  | **O** |  |  |  |  |  |
| TS47\_3.1\_REQ\_002 | An AI Mobile Device SHOULD have a minimum of (0.5) float16 TOPS. |  | **O** |  |  |  |  |  |
| TS47\_3.1\_REQ\_003 | An AI Mobile Device SHOULD have a minimum of (0.5) int8 TOPS/Watt. |  | **O** |  |  |  |  |  |
| TS47\_3.1\_REQ\_004 | An AI Mobile Device SHOULD have a minimum of (0.3) float16 TOPS/Watt. |  | **O** |  |  |  |  |  |
| TS47\_3.2\_REQ\_001 | An AI Mobile Device SHALL support on-device model updates of an existing deep learning network. |  | **M** |  |  |  | What are the AI models supported by the device?  At least provide one. |  |
| TS47\_3.2\_REQ\_002 | An AI Mobile Device SHALL support native APIs to expose the AI hardware functions. |  | **M** |  |  |  | Please list the native APIs |  |
| TS47\_3.2\_REQ\_003 | An AI Mobile Device SHALL support application APIs (See Appendix A in TS.47) for native and third-party applications to access Computer Vision (CV), Automatic Speech Recognition (ASR), Natural Language Understanding (NLU) models. |  | **M** |  |  |  | Please list the application APIs |  |
| TS47\_3.2\_REQ\_004 | An AI Mobile Device SHOULD provide an SDK to convert DNN models from an existing format to the native format of the AI mobile device. Non-exhaustive examples of DNN model file format are: \*.ckpt or \*.pb, \*.tflite, \*.prototxt, \*.pb or \*.pth or \*.pt, \*.json and \*.onnx. |  | **O** |  |  |  | Please list the file formats that can be converted to native one by the SDK |  |
| TS47\_3.2\_REQ\_005 | An AI Mobile Device SHOULD provide an SDK to support definition of new customized Deep Learning operators. |  | **O** |  |  |  | Please list all the operators that have been already supported. |  |
| TS47\_3.4.1\_REQ\_001 | An AI Mobile Device SHOULD support a 2D facial biometric system. |  | **O** |  |  |  |  |  |
| TS47\_3.4.1\_REQ\_002 | An AI Mobile Device SHOULD support a 3D facial biometric system. |  | **O** |  |  |  |  |  |
| TS47\_3.4.1\_REQ\_003 | An AI Mobile Device SHOULD support a fingerprint biometric system. |  | **O** |  |  |  |  |  |
| TS47\_3.4.1\_REQ\_004 | An AI Mobile Device supporting 2D facial biometric system SHALL support the biometric KPI requirement TS47\_3.4.1\_REQ\_004.1 for each of the use cases: Device Unlock, Application Login and Payment Authorization. |  | **M** |  |  |  |  |  |
| TS47\_3.4.1\_REQ\_004.1 | 2D Facial FAR <= (0.002)% and FRR <= (3)% simultaneously |  | **M** |  |  |  |  |  |
| TS47\_3.4.1\_REQ\_005 | An AI Mobile Device supporting 3D facial biometric system SHALL support the biometric KPI requirement TS47\_3.4.1\_REQ\_005.1 for each of the use cases: Device Unlock, Application Login and Payment Authorization. |  | **M** |  |  |  |  |  |
| TS47\_3.4.1\_REQ\_005.1 | 3D Facial FAR <= (0.001)% and FRR <= (3)% simultaneously. |  | **M** |  |  |  |  |  |
| TS47\_3.4.1\_REQ\_006 | An AI Mobile Device supporting fingerprint biometric system SHALL support the biometric KPI requirement TS47\_3.4.1\_REQ\_006.1 for each of the use cases: Device Unlock, Application Login and Payment Authorization. |  | **M** |  |  |  |  |  |
| TS47\_3.4.1\_REQ\_006.1 | Fingerprint FAR <= (0.002)% and FRR <= (3)% simultaneously. |  | **M** |  |  |  |  |  |
| TS47\_3.4.1\_REQ\_007 | The biometric key performance indicators (KPIs) for the supported biometric system SHOULD be certified by one or more of the following programs:  Fast IDentity Online (FIDO) Alliance Biometric Component Certification Program.  Internet Finance Authentication Alliance (IFAA) biometric Certification Program. |  | **O** |  |  |  |  |  |
| TS47\_3.4.2\_REQ\_001 | An AI Mobile Device SHOULD have optical character recognition (OCR) capability on the device. |  | **O** |  |  |  |  |  |
| TS47\_3.4.2\_REQ\_002 | An AI Mobile Device SHOULD have image detection, image classification and image segmentation capabilities on the device. |  | **O** |  |  |  |  |  |
| TS47\_3.4.2\_REQ\_003 | An AI Mobile Device SHOULD have face detection and face clustering capabilities within a group of photos on the device. |  | **O** |  |  |  |  |  |
| TS47\_3.4.2\_REQ\_004 | An AI Mobile Device SHOULD have video super-resolution capabilities on the device. |  | **O** |  |  |  |  |  |
| TS47\_3.4.2\_REQ\_005 | An AI Mobile Device SHOULD have video classification capabilities on the device. |  | **O** |  |  |  |  |  |
| TS47\_3.4.2.1\_REQ\_001 | The AI Mobile Device SHOULD support photo scene detection and recognition where the User has the ability to consent to their use. |  | **O** |  |  |  |  |  |
| TS47\_3.4.2.1\_REQ\_001.1 | If REQ\_001 is supported then the AI Mobile Device SHALL support  Identification of one or more objects in different scenes such as portraits, landscapes, foods, night scenes and texts, etc. |  | **M** |  |  |  |  |  |
| TS47\_3.4.2.1\_REQ\_001.2 | If REQ\_001 is supported then the AI Mobile Device SHALL support  Scene detection capabilities to optimize camera settings for image capture based on scene content. |  | **M** |  |  |  |  |  |
| TS47\_3.4.2.1\_REQ\_002 | The AI Mobile Device SHOULD support text detection and recognition of installed language packages, where the User has the ability to consent to the text detection and recognition use. |  | **O** |  |  |  |  |  |
| TS47\_3.4.2.1\_REQ\_003 | The AI Mobile Device SHOULD support automatic language detection. |  | **O** |  |  |  | Please list all the languages that the device supports |  |
| TS47\_3.4.2.1\_REQ\_004 | The AI Mobile Device SHOULD provide personalized FPE for Users based on gender, age, and skin tone. |  | **O** |  |  |  |  |  |
| TS47\_3.4.2.1\_REQ\_005 | The AI Mobile Device SHOULD support FPE of multiple people in a single photo. |  |  |  |  |  |  |  |
| TS47\_3.4.2.1\_REQ\_006 | The FPE functionality SHOULD be switched off by default and the AI Mobile Device SHOULD support User adjustment of the FPE level from no enhancement to the max FPE. |  |  |  |  |  |  |  |
| TS47\_3.4.2.1\_REQ\_007 | The AI Mobile Device SHOULD support automatic classification of photos in an album by different categories. |  | **O** |  |  |  |  |  |
| TS47\_3.4.3\_REQ\_001 | The AI Mobile Device SHOULD have speech ability. |  | **O** |  |  |  |  |  |
| TS47\_3.4.3\_REQ\_002 | The AI Mobile Device SHOULD support Automatic speech recognition (ASR) capabilities where the User has the ability to consent to ASR. |  | **O** |  |  |  |  |  |
| TS47\_3.4.3\_REQ\_003 | The AI Mobile Device SHOULD support Natural Language Understanding (NLU) capabilities where the User has the ability to consent to NLU. |  | **O** |  |  |  |  |  |
| TS47\_3.4.3\_REQ\_004 | The AI Mobile Device SHOULD support Synthesized Voice (Text-To-Speech (TTS) capabilities where the User has the ability to consent to TTS. |  | **O** |  |  |  |  |  |
| TS47\_3.4.3\_REQ\_005 | If the AI Mobile Device supports Voice Assistant then the requirements in section 3.4.3.1 SHALL apply. |  | **M** |  |  |  |  |  |
| TS47\_3.4.3.1\_REQ\_001 | AI Mobile Device SHALL support the following functions.  Automatic speech recognition (ASR) capabilities.  Natural Language Understanding (NLU) capabilities.  Synthesized Voice (Text-To-Speech (TTS)) capabilities. |  | **M** |  |  |  |  |  |
| TS47\_3.4.3.1\_REQ\_002 | The AI Mobile Device SHALL support voice trigger, and its specific requirements are listed in the following sub requirements: TS47\_3.4.3.1\_REQ\_002.1, 002.2 and\_002.3 |  | **M** |  |  |  |  |  |
| TS47\_3.4.3.1\_REQ\_002.1 | The AI Mobile Device SHOULD support voiceprint recognition for preventing people other than the device’s owner from triggering voice assistant. |  | **O** |  |  |  |  |  |
| TS47\_3.4.3.1\_REQ\_002.2 | In a quiet environment, the following SHALL be required:  The true acceptance rate (TAR) >= (90)%, and the false acceptance rate (FAR) of voiceprint recognition <= (20)%. |  | **M** |  |  |  |  |  |
| TS47\_3.4.3.1\_REQ\_002.3 | In a noisy environment, the following SHALL be required:  TAR >=(80)%, and FAR of voiceprint recognition <= (20)%. |  | **M** |  |  |  |  |  |
| TS47\_3.4.3.1\_REQ\_003 | The AI Mobile Device SHALL have on-device speech recognition library (i.e. with no access to the Internet) for changing the system setting (e.g. Turn Bluetooth on/off via voice assistant) and invoking the native applications (e.g. send SMS via voice assistant). |  | **M** |  |  |  |  |  |
| TS47\_3.4.3.1\_REQ\_004 | The AI Mobile Device SHOULD have access to different categories of applications and invoke these applications’ services and functions via voice assistant. |  | **O** |  |  |  |  |  |
| TS47\_3.4.3.1\_REQ\_005 | The AI Mobile Device SHALL support information search by on-device voice assistant. |  | **M** |  |  |  |  |  |
| TS47\_3.4.3.1\_REQ\_006 | The AI Mobile Device SHOULD support interaction with smart devices (e.g. home appliances) via voice assistant. |  | **O** |  |  |  |  |  |
| TS47\_3.4.4\_REQ\_001 | The AI Mobile Device SHOULD provide the following AI capabilities for AR native and third-party applications:   1. Hand gesture recognition. 2. Hand skeleton tracking. 3. Human body pose recognition. 4. Human body skeleton tracking. |  | **O** |  |  |  |  |  |
| TS47\_3.4.4\_REQ\_002 | The AI Mobile Device SHOULD support the following applications:   1. AR Emoji    1. Creating customized AR-based Emoji.    2. Tracking User’s facial movement and expression and render these on the AR-based Emoji. 2. AR video    1. Compositing real objects with virtual objects and/or virtual background.    2. Minimum (30) fps frame rate.    3. AR shadow effect and occlusion handling.    4. AR enhanced information text labels should not deviate or disappear from the actual target scene when the AI Mobile Device moves. |  | **O** |  |  |  |  |  |
| TS47\_3.4.5\_REQ\_001 | Only with the explicit permission of the User in order to respect the User’s right to privacy around their habits: the AI Mobile Device SHOULD support dynamic system resource allocation and optimization based on feedback provided by on-device sensors measuring environmental conditions combined with continuous learning of User habits and behaviours or device or network usage or performance indicators:  1. Dynamic application management (e.g. pre-loading, closing, put to sleep, control network access) based on User’s habits (e.g. usage duration, frequency).  2. Dynamic application management based on abnormal behaviour detection (e.g. increased memory usage, abnormal power consumption, self-starting in the background).  3. Dynamic system resource management based on continuous learning of system performance (e.g. memory and storage defragmentation, off-line storage during off-peak periods).  4. Dynamic system resource allocation for high performance applications (e.g., gaming and video). |  | **O** |  |  |  |  |  |
| TS47\_4.1\_REQ\_001 | AI on mobile device SHOULD comply with the privacy laws in the country where the device is commercially retailed. |  | **O** |  |  |  |  |  |
| TS47\_4.1\_REQ\_002 | Appropriate technical and organisational safeguards SHOULD be implemented to ensure that, by default, only the personal data reasonably necessary for a specific purpose are processed. |  | **O** |  |  |  |  |  |
| TS47\_4.1\_REQ\_003 | AI Applications that process Personal Data SHALL be off by default unless processing exclusively takes place locally on the device. |  | **M** |  |  |  |  |  |
| TS47\_4.1\_REQ\_003.1 | The User SHOULD be allowed to control whether individual AI applications are switched on. |  | **O** |  |  |  |  |  |
| TS47\_4.1\_REQ\_003.2 | The User SHOULD be allowed to control whether individual AI applications are switched off. |  | **O** |  |  |  |  |  |
| TS47\_4.1\_REQ\_004 | The AI Application on the AI Mobile Device SHALL be designed in such a way that a Data Processor will have the responsibility to:  1) Be transparent with the User on the nature of the input data used in the AI processing (e.g. personal files, biometrics, …).  2)     Forbid transferring personal data processing off the device except if the User has explicitly agreed or other legal basis has been satisfied in accordance with the law.  3)     Forbid transferring results of on-device AI processing containing personal data off the device except if the User has explicitly agreed or other legal basis has been satisfied in accordance with the law. |  | **M** |  |  |  |  |  |
| TS47\_4.2\_REQ\_001 | The AI Mobile Device SHALL use reasonable safeguards appropriate to the sensitivity, confidentiality and integrity of the information. |  | **M** |  |  |  |  |  |
| TS47\_4.2\_REQ\_002 | Except as required or permitted by applicable law, the User SHALL always remain in control of the collection of their personal data and its usage, in order to minimise the risk of malicious usage or data leakage. |  | **M** |  |  |  |  |  |
| TS47\_4.2\_REQ\_003 | Off ‘toggle’ switches SHALL turn off the functionality, except as permitted or required by applicable law. |  | **M** |  |  |  |  |  |
| TS47\_4.2\_REQ\_004 | Techniques, such as ‘Dark Patterns’, that manipulate the User’s choice SHALL NOT be used. |  | **M** |  |  |  |  |  |
| TS47\_4.2.1\_REQ\_001 | The AI models used by an AI Mobile Device SHOULD be secure and robust, and be protected with appropriate safeguards to prevent and to mitigate attacks. |  | **O** |  |  |  |  |  |
| TS47\_4.2.1\_REQ\_002 | Defence techniques SHOULD be employed to protect the training data for protecting models. For example, in evasion attacks, data can be manipulated to mislead AI models. |  | **O** |  |  |  |  |  |
| TS47\_4.2.1\_REQ\_003 | Autonomous AI Mobile Device operations SHALL be controlled, and/or authorized by the authenticated User. |  | **M** |  |  |  |  |  |
| TS47\_4.2.1\_REQ\_004 | AI Mobile Device operations SHOULD be performed in the Secured Environment [4], e.g. a secure boot and upgrade is enforced, and the system integrity is protected. |  | **O** |  |  |  |  |  |
| TS47\_4.2.1\_REQ\_005 | Data and metadata for AI Mobile Device SHALL be stored with encryption with keys that are stored securely in a Secured Environment, e.g. Trusted Execution Environment (TEE) [4]. |  | **M** |  |  |  |  |  |
| TS47\_4.2.1\_REQ\_006 | Biometric Data, which are processed by an AI Application (e.g. templates) used for authentication within the AI Mobile Device, SHALL NOT be transferred off the device. |  | **M** |  |  |  |  |  |
| TS47\_4.2.1\_REQ\_007 | Users' Biometric Data (such as facial data, fingerprint data, etc.) SHALL be encrypted when at rest on the device. Encryption/decryption of this data SHALL be performed in a Secured Environment [4]. |  | **M** |  |  |  |  |  |
| TS47\_3.2.1\_REQ\_007.1 | Biometric Data SHALL also be stored in the Secured Environment. |  | **M** |  |  |  |  |  |
| TS47\_4.2.1\_REQ\_008 | Biometric algorithms (such as face recognition algorithms, fingerprint algorithms, etc.) SHOULD run in a private and Secure Environment such as a Trusted Execution Environment (TEE) [4]. |  | **O** |  |  |  |  |  |
| TS47\_4.2.1\_REQ\_009 | If Users' Biometric Data is replaced, the previous Biometric Data before the replacement SHALL be deleted completely and permanently and not be recoverable by data rollback. |  | **M** |  |  |  |  |  |
| TS47\_4.2.1\_REQ\_010 | The Biometric Data SHALL be wiped and made unrecoverable by a device factory reset. |  | **M** |  |  |  |  |  |
| TS47\_4.2.1\_REQ\_011 | Voiceprint Data SHOULD be stored on the device with encryption. |  | **O** |  |  |  |  |  |
| TS47\_4.2.1\_REQ\_012 | The temporary Voiceprint Data SHALL NOT remain in the memory after processing. |  | **M** |  |  |  |  |  |
| TS47\_4.2.1\_REQ\_013 | When the Voiceprint Data is permanently and completely deleted, it SHALL NOT be recoverable by data rollback. |  | **M** |  |  |  |  |  |
| TS47\_4.2.1\_REQ\_014 | The Voiceprint Data SHALL be wiped and made unrecoverable by a device factory reset. |  | **M** |  |  |  |  |  |
| TS47\_4.2.1\_REQ\_015 | The device SHOULD be resistant to voice replay attacks. |  | **O** |  |  |  |  |  |
| TS47\_4.2.1\_REQ\_016 | Appropriate safeguards SHOULD be used to protect AR applications from malicious application attacks, such as spoofing a User with information about the real and/or virtual world, sensory overload attacks, hijacking the User's clicks, etc. |  | **O** |  |  |  |  |  |

1. Letter of commitment template

\_\_\_\_\_(Company name) \_\_\_\_\_\_\_\_(DUT model) complies with these privacy requirements

| **TS.47 Requirement Number** | **Requirement** | **Is this requirement supported?**  **Yes / No** |
| --- | --- | --- |
| TS47\_4.1\_REQ\_001 | AI on mobile device SHOULD comply with the privacy laws in the country where the device is commercially retailed. |  |
| TS47\_4.1\_REQ\_002 | Appropriate technical and organisational safeguards SHOULD be implemented to ensure that, by default, only the personal data reasonably necessary for a specific purpose are processed. |  |
| TS47\_4.1\_REQ\_003 | AI Applications that process Personal Data SHALL be off by default unless processing exclusively takes place locally on the device. |  |
| TS47\_4.1\_REQ\_004 | The AI Application on the AI Mobile Device SHALL be designed in such a way that a Data Processor will have the responsibility to:  1) Be transparent with the User on the nature of the input data used in the AI processing (e.g. personal files, biometrics, …).  2)     Forbid transferring personal data processing off the device except if the User has explicitly agreed or other legal basis has been satisfied in accordance with the law.  3)     Forbid transferring results of on-device AI processing containing personal data off the device except if the User has explicitly agreed or other legal basis has been satisfied in accordance with the law. |  |

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_(Company Signature & Stamp)

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_(Data)

Note: Requirements for TS.47\_4.1\_REQ\_001 and TS.47\_4.1\_REQ\_002 are not mandatory.

1. Letter of commitment template

\_\_\_\_\_(Company name)\_\_\_\_\_\_\_\_(DUT model)complies with these privacy requirements

| **TS.47 Requirement Number** | **Requirement** | **Is this requirement supported?**  **Yes / No** |
| --- | --- | --- |
| TS47\_4.2\_REQ\_001 | The AI Mobile Device SHALL use reasonable safeguards appropriate to the sensitivity, confidentiality and integrity of the information. |  |
| TS47\_4.2\_REQ\_002 | Except as required or permitted by applicable law, the User SHALL always remain in control of the collection of their personal data and its usage, in order to minimise the risk of malicious usage or data leakage. |  |
| TS47\_4.2\_REQ\_003 | Off ‘toggle’ switches SHALL turn off the functionality, except as permitted or required by applicable law. |  |
| TS47\_4.2\_REQ\_004 | Techniques, such as ‘Dark Patterns’, that manipulate the User’s choice SHALL NOT be used. |  |
| TS47\_4.2.1\_REQ\_001 | The AI models used by an AI Mobile Device SHOULD be secure and robust, and be protected with appropriate safeguards to prevent and to mitigate attacks. |  |
| TS47\_4.2.1\_REQ\_002 | Defence techniques SHOULD be employed to protect the training data for protecting models. For example, in evasion attacks, data can be manipulated to mislead AI models. |  |
| TS47\_4.2.1\_REQ\_003 | Autonomous AI Mobile Device operations SHALL be controlled, and/or authorized by the authenticated User. |  |
| TS47\_4.2.1\_REQ\_004 | AI Mobile Device operations SHOULD be performed in the Secured Environment [4], e.g. a secure boot and upgrade is enforced, and the system integrity is protected. |  |
| TS47\_4.2.1\_REQ\_005 | Data and metadata for AI Mobile Device SHALL be stored with encryption with keys that are stored securely in a Secured Environment, e.g. Trusted Execution Environment (TEE). |  |
| TS47\_4.2.1\_REQ\_006 | Biometric Data, which are processed by an AI Application (e.g. templates) used for authentication within the AI Mobile Device, SHALL NOT be transferred off the device. |  |
| TS47\_4.2.1\_REQ\_007 | Users' Biometric Data (such as facial data, fingerprint data, etc.) SHALL be encrypted when at rest on the device. Encryption/decryption of this data SHALL be performed in a Secured Environment. |  |
| TS47\_4.2.1\_REQ\_007.1 | Biometric Data SHALL also be stored in the Secured Environment. |  |
| TS47\_4.2.1\_REQ\_008 | Biometric algorithms (such as face recognition algorithms, fingerprint algorithms, etc.) SHOULD run in a private and Secure Environment such as a Trusted Execution Environment (TEE). |  |
| TS47\_4.2.1\_REQ\_011 | Voiceprint Data SHOULD be stored on the device with encryption. |  |
| TS47\_4.2.1\_REQ\_012 | The temporary Voiceprint Data SHALL NOT remain in the memory after processing. |  |
| TS47\_4.2.1\_REQ\_016 | Appropriate safeguards SHOULD be used to protect AR applications from malicious application attacks, such as spoofing a User with information about the real and/or virtual world, sensory overload attacks, hijacking the User's clicks, etc. |  |

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_(Company Signature & Stamp)

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_(Date)

1. Testing Methods
   1. Hardware performance testing
      1. Testing Method 1

* **Test Model preparation**

1. Take VGG16\_notop as the Reference Model.

2. Use the Model Conversion tool provided by the chipset vendor to convert the Reference Model to an int8 or/and a float16 model that can be run on the DUT, take this converted model as Model\_t.

3. Validate Model\_t can be used as the Test Model. (TBD)

* **Test Scripts preparation**

Scripts to pre-process the test dataset, run the test model and measure TOPS.

* **Test Dataset**

1000 images of size 224\*224\*3.

* + 1. Testing Method 2
* **MLCommons GSMA application has been properly compiled from Open and Closed source for each device.**
* **All models have been agreed upon and integrated into the application to support all requirements above.**
* **Proper report formatting has been agreement upon between MLC and GSMA.**
* **The datasets and models shown in the following table shall be used from MLC.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| ***Task*** | Image classification | Object detection | Image segmentation | Natural Language Processing |
| ***Data*** | ImageNet | COCO | ADE20K | SQuAD v1.1 |
| ***Model*** | MobileNetEdge | MobileDET\_SSD | Deeplabv3+ - MobileNetv2 | MobileBERT |
| ***Scenario*** | Single Stream / Offline | Single Stream | Single Stream | Single Stream |

1. Document Management
   1. Document History

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Version | Date | Brief Description of Change | Approval Authority | Editor / Company |
| 0.3 | Oct 2021 | The following CRs have been included:   * TSGAI#21 Doc 003 TS.53 CR Section 6 Biometric Performance test cases * TSGAI#21 Doc 004 TS.53 CR Section 6 Voice assistant test cases * TSGAI#21 Doc 005 TS.53 CR Section 7 privacy test cases * TSGAI#20 Doc 004 TS.53 AI Mobile Device Requirements Specification Test Book 0921 * TSGAI#19 Doc 004 - Draft CTS for AI mobile device V0.2-China Telecom 0816 (partly approved) * TSGAI#19 Doc 003 - Fido biometric requirements Introduction (For discussion) * TSGAI#19 Doc 005 - Dataset for TS.53 CTS (For discussion) * TSGAI#18 Doc 003 TS.53 Section 4 Updated FPE test case * TSGAI#18 Doc 004 TS.53 Section 6 Updated privacy requirements * TSGAI#16 Doc 003 TS53 CR001 v0.3 Section 2-3 China Telecom ( **updated one based on TSGAI#15 Doc 004**) * TSGAI#15 Doc 004 TS53 CR001 Section 2-3 Updated hardware and software test cases China Telecom * TSGAI#15 Doc 005 TS53 CR002 Section 6 Updated security requirements test cases China Telecom * TSGAI#13 Doc 001 TS.53 CTS for AI mobile device China Telecom CR0001 v1 (partly approved) | TSGAI | Di Zhang China Telecom |
| 0.4 |  | The following CRs have been included:   * TSGAI#22 Doc 005 - CR Section 6.4.1 AI capabilities for AR application test cases-CT * TSGAI#22 Doc 007 CR for Security test cases-CT(open) | TSGAI | Di Zhang China Telecom |
|  |  |  |  |  |

* 1. Other Information

|  |  |
| --- | --- |
| Type | Description |
| Document Owner | Terminal Steering Group AI |
| Editor / Company |  |

It is our intention to provide a quality product for your use. If you find any errors or omissions, please contact us with your comments. You may notify us at [prd@gsma.com](mailto:prd@gsma.com)

Your comments or suggestions & questions are always welcome.