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1 Introduction

This document describes Application Profiles and Function Modules in the scope of the TR Biometrics. For an overview of this guideline, consult TR-03121-1.

2 Application Profiles for Asylum Seeker Documents

2.1 Application Arrival Attestation Document

The following Application Profile describes the application for an Arrival Attestation Document. This profile is valid for the document application process as of November 2016. Function Modules may have additional transition rules for their requirements.

2.1.1 Introduction

The requirements for the application and issuance of an Arrival Attestation Document are determined by national law AsylVfG §63a (“Bescheinigung über die Meldung als Asylsuchender und die zugehörige Verordnung über die Bescheinigung über die Meldung als Asylsuchender“) according to Ankunftsnachweisverordnung (AKNV).

By legal requirements, the enrolment of the applicants facial image and fingerprints (only for applicants 14 years of age or older) is mandatory. In addition to the issued document, the recorded information must be transferred to the central register of foreigners (according to AZRG §3 und AZRGDV §5).

2.1.2 System Overview

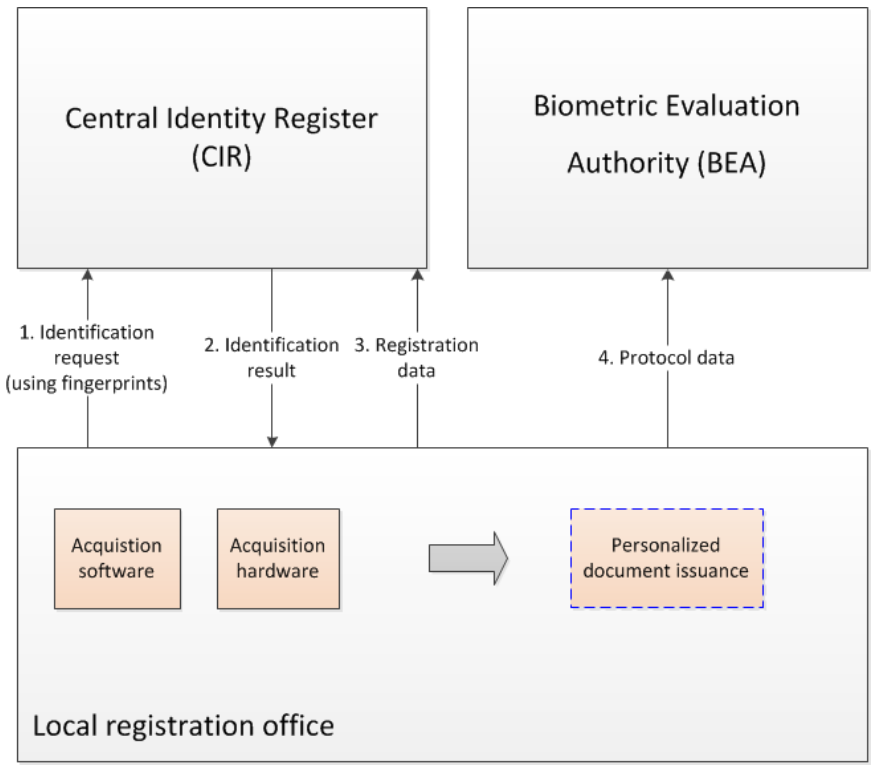

Figure 2-1: System Architecture Overview

The main components in this context consist of the Central Identity Register (CIR), the Biometric Evaluation Authority (BEA) and the local registration office as depicted in Figure 2-1. Any request for biometric and biographic data retrieval or storage is performed via the CIR, which connects and proxies further background systems. The BEA represents the destination for log files documenting the process in

detail. The applicant appears in person at the local registration office, where an official operates the live enrolment equipment and guides the process.

In the depicted architecture the CIR comprises of the central register of foreigners (operated by Federal Office of Administration) in conjunction with the Automated Fingerprint Identification System (operated by Federal Criminal Office). The BEA is also operated by the Federal Office of Administration.

2.1.3 Process Overview

In general, two different scenarios exist: One scenario is the pre-registration with storage of the applicants biographic and biometric data in the CIR. The issuance of the Arrival Attestation Document is performed at any registration office later on in a separate process by retrieving the already existing data from the CIR (see Figure 2-2). In the other scenario, the process consists of both biographic and biometric data assessment and the immediate subsequent issuance of the document.

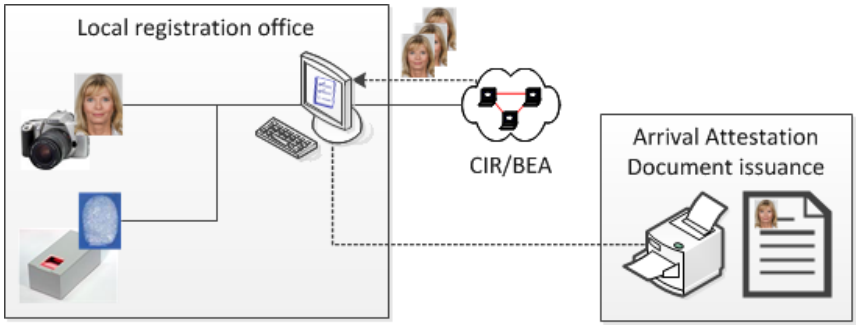

Figure 2-2: Process Overview

In any case, the main process begins with an initial identification request to the CIR. Up to ten fingerprints are captured from the applicant and sent to the CIR in order to perform a biometric identification and check whether the applicant has already been registered upfront. The returned result is either empty or contains a set of identification results.

In case the identification fails, i.e. no record is returned from the CIR, a new data record for the applicant is created and subsequently sent to the CIR for storage. Therefore, additionally rolled fingerprints are captured. A biometric cross-verification with the previously plain captured fingerprints (“control prints”) is used as QA in this process.

In case one or more facial images of the applicant are present in a retrieved record, they are assessed in regard to quality requirements and re-usability for the issuance of the Arrival Attestation Document. If no facial image is available from the CIR, a high quality image is captured live by the operating official using a digital camera with subsequently applied QA.

The applicants biographic and biometric data including process and quality information are coded and passed to the calling application, which directs the data to the back-end system for enrolment.

2.1.4 Target Audience

The Application Profile “Application Arrival Attestation Document” is relevant for the following instances.

- police authorities
- foreigner authorities
- suppliers of hardware and software components

2.1.5 Relevant Standards and Conditions

In addition to the legal requirements, further basic directives and standards are applicable.

— BKA GSAT XML
— ISO/IEC 19794-5

2.1.6 Information for Function Modules

All Function Modules necessary for the Application Profile “Application Arrival Attestation Document” are presented in Table 2-1.[1]

1 Slash separated entries denote alternative modules. Comma-separated entries denote requirements for all modules.

Module Category	Required Function Modules
Process	P-PH-AAD P-FP-PLAIN, P-FP-ROLL
Acquisition Hardware	AH-PH-DC AH-FP-OPT
Acquisition Software	AS-PH-DC AS-FP-MF, AS-FP-ROLL
Presentation Attack Detection	PAD-FP-APP
Biometric Image Processing	BIP-PH-DC-HQ BIP-FP-APP
Quality Assurance	QA-PH-SB, QA-PH-PG QA-FP-APP
Compression	COM-PH-JPG COM-FP-WSQ
Operation	O-PH-APP O-FP-ACQ
User Interface	UI-PH-APP UI-FP-APP
Reference Storage	REF-PH-AAD REF-FP-AAD
Biometric Comparison	CMP-FP-CC
Logging	LOG-ALL-GENERIC, LOG-ALL-AAD LOG-PH-GENERIC LOG-FP-GENERIC
Coding	COD-ALL-AAD COD-PH-GSAT3 COD-FP-GSAT3
Evaluation	EVA-ALL-AAD EVA-PH-AAD EVA-FP-AAD

Table 2-1: Application Profile Arrival Attestation Document

3 Function Modules

This chapter lists all the Function Modules for the defined Application Profiles.

3.1 Process

The module Process describes the modality of how the different Function Modules have to be called and combined in order to achieve the objective of the Application Profile. Any alternative call of modules (e.g. for conformance testing) is specified by additional information.

3.1.1 P-PH-AAD

This function block describes the overall process requirements for capturing facial images in the context of the Arrival Attestation Document.

3.1.1.1 Requirements

The Arrival Attestation Document shall contain images of the type „full frontal image" according to the standard [ISO_FACE].

Multiple lossy compressions of face image data are not allowed within the overall process (with the exception of the initial capture by a digital camera whenever that camera does not support uncompressed image capture[2]).

In order to obtain a facial image complying with all specified requirements, the following process has to be followed. In this context, several Function Modules and the according Function Blocks are involved and the respective requirements have to be fulfilled.

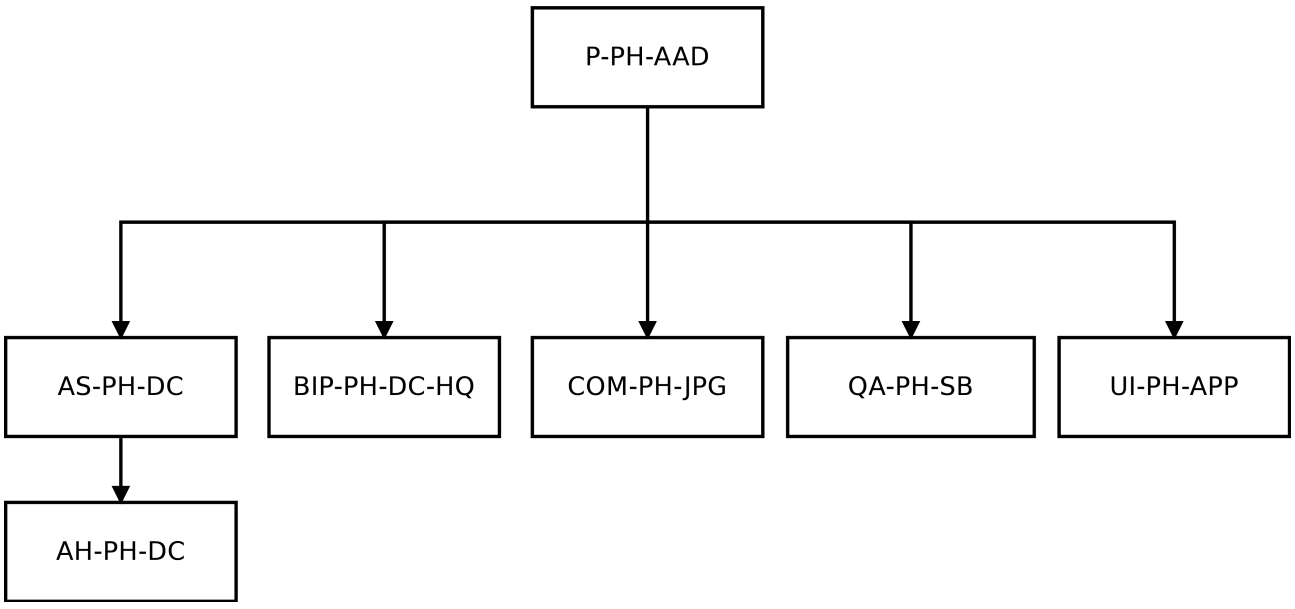

Figure 3-1: Relevant Function Blocks for the Facial Image Process

2 See detailed requirements on FM AH for further information

The following FMs apply for the technical process (see Figure 3-1):

— AH-PH-DC
— AS-PH-DC
— BIP-PH-DC-HQ
— COM-PH-JPG
— QA-PH-SB
— UI-PH-APP

Furthermore, the official has to take the modules QA-PH-PG and O-PH-APP into account. Logging and Coding of biometric data and quality data is conducted according to the given FM LOG and FM COD of the profile.

The facial image acquisition process offers two options of how an image can be obtained for the application (see Figure 3-2):

1. The applicant's photo is captured using live enrolment equipment (including a digital camera within a photo studio setup) operated by an official[3].
2. One or more photos of the applicant already exist in the Central Identity Register (CIR) and can be retrieved to be examined for re-use.

In the first case, a photo of the applicant is taken live by the official operator using a digital camera. An immediately performed software quality assessment (QA) for the captured photo ensures its biometric usability. If the quality assessment succeeds positively, the photo is released to the application software. If the quality is assessed as insufficient, the operator can recapture or has the option to put a veto in order to accept the captured photo despite the negative software decision. In case of a overruling veto, the photo is accepted and released to the application. In the negative case, the photo is discarded and a re-capture is performed.

3 See ISO/IEC 19794-5, Annex B for "Best practices for Face Images"

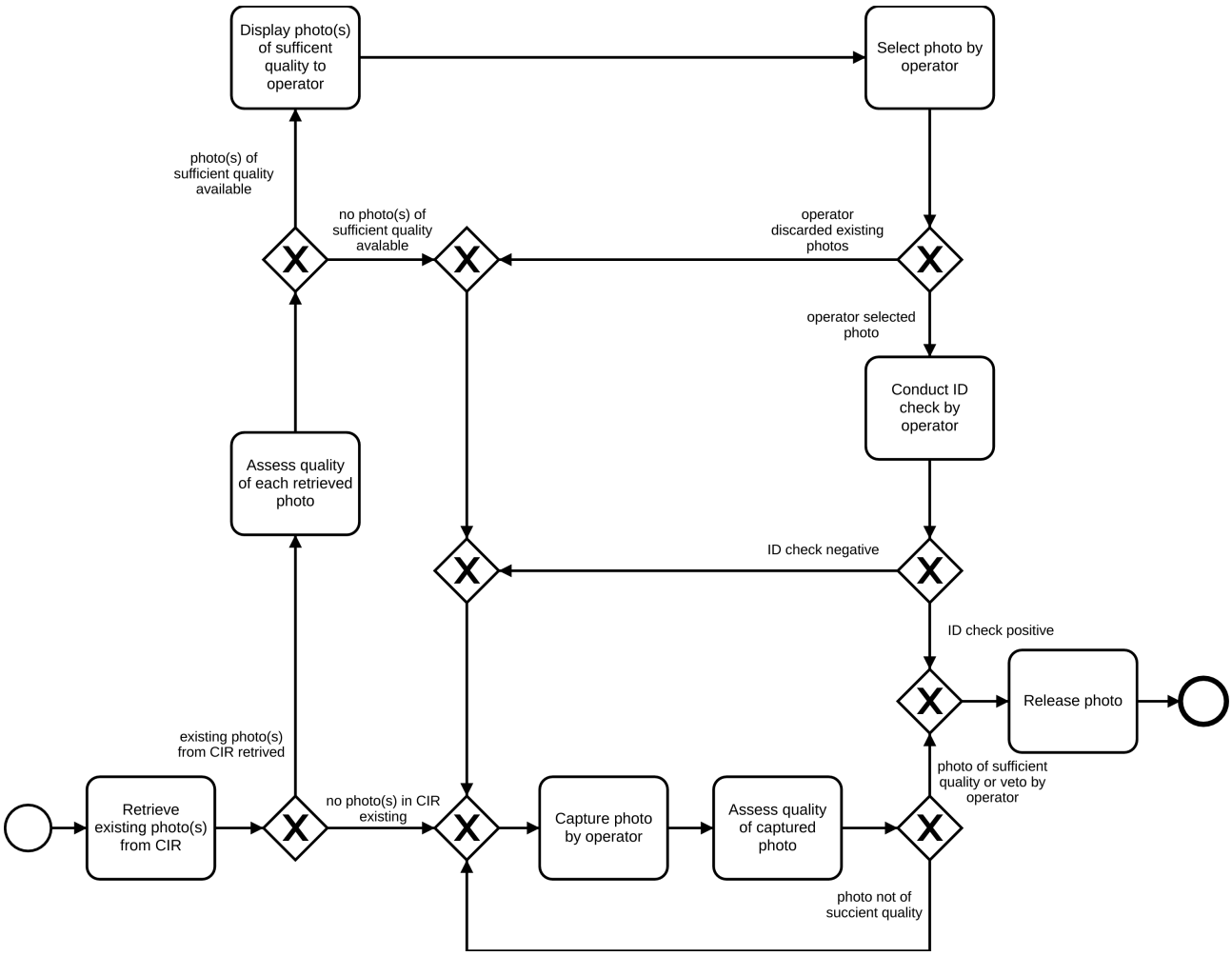

Figure 3-2: Facial Image Acquisition Process

In case one or more facial images of the applicant are available in the CIR, they can potentially be reused for the issuance of the document. In case the CIR does provide information about the capture date or date of storing the photo in the CIR, only photos must be retrieved not dated older than six months by capture date or date of storing the photo in the CIR. The quality of each retrieved photo must be assessed by the software in regard to quality requirements and usability for the issuance of the Arrival Attestation Document. After the images were processed by the software quality assessment (QA), they are displayed to the operating official for selection via the graphical user interface (GUI) of the software in order to be selected for release. Thereby, only those images are displayed which pass the quality assessment with a positive result. In case none of the retrieved images are considered to be of sufficient quality or the operator puts a veto to not select any of the retrieved photos of good quality, a live photo has to be captured (see first case). The final resulting photo and the defined log data are coded and returned.

3.1.2 P-FP-PLAIN

This function block describes the overall process requirements for capturing up to ten plain fingerprints.

3.1.2.1 Requirements

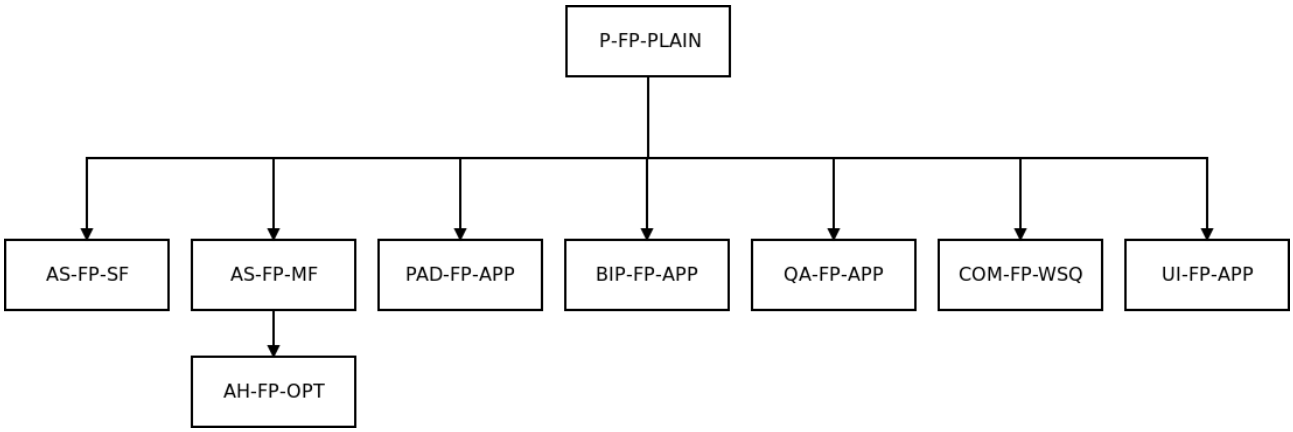

Figure 3-3: Relevant Function Blocks for Plain Fingerprint Acquisition Process

For fingerprint capture single-finger or multi-finger scanners can be used. Multiple lossy compressions on the fingerprint image data are not allowed during the process.

In the following, the process of capturing plain fingerprints for identification or enrolment purposes is described in detail. At the beginning of this section, an overview of the included Function Modules and the respective Function Blocks is given in advance.

The following FMs apply (see Figure 3-3).

— AH-FP-OPT
— AS-FP-MF
— AS-FP-SF
— PAD-FP-APP
— BIP-FP-APP
— QA-FP-APP
— COM-FP-WSQ
— UI-FP-APP

Furthermore, the official has to take the module O-FP-ACQ into account. Logging and coding of biometric data and quality data is conducted according to the given FM LOG and FM COD of the profile.

Acquire Plain Slap Task

Figure 3-4 depicts the basic capture sequence for a plain slap acquisition. A plain slap acquisition can be part of more complex acquisition processes, e.g. a ten finger acquisition by the 4-1-4-1 capture sequence for identification purposes. The plain slap capture acquisition is subsequently described in detail. The quality assessment is conducted according to the requirements of the applicable FM QA.

1. If the applicant is physically not capable to place all fingers of the slap on the acquisition hardware at the same time, the operator can decide to acquire each finger of the slap in single finger acquisition mode. Hereby, single finger acquisition mode refers to the “Acquire Plain Finger” task as described below.
2. The counter variable for the number of attempts for capturing the current slap is initialized as i = 1.
3. The slap image is acquired from hardware.
4. The fingerprints are segmented and each is assessed.
   a. In case the quality of the fingerprints meet the quality requirements defined in the corresponding QA Function Module, the captured slap and the set of segmented fingerprints and parameter data (e.g. quality values) are temporarily stored.
   b. In case the quality requirements for one or more fingerprints of the slap are not met, the capture is repeated up to two times (i.e. the acquisition of a single slap consists of a maximum of three capture attempts).
5. A sequence check shall be conducted for the acquired slap image to detect the acquisition of wrong fingers e.g. due to interchanged hands or multiple acquisition of the same hand or finger. Note, that it is recommended to conduct the sequence check as early as possible after a fingerprint image is available.
   a. In case the comparison of any finger of the current slap with any finger of a previous slap is successful, the sequence check shall throw an error.
   b. In case the comparisons of all fingers of the current slap with all fingers of previous slaps are not successful, the sequence check shall throw no error.

If the quality check of the third capture attempt fails, the best of the captured slaps is identified according to the corresponding QA Function Module and temporarily stored along with corresponding information. Note, that in verification scenarios no quality assessment is conducted by the QA module.

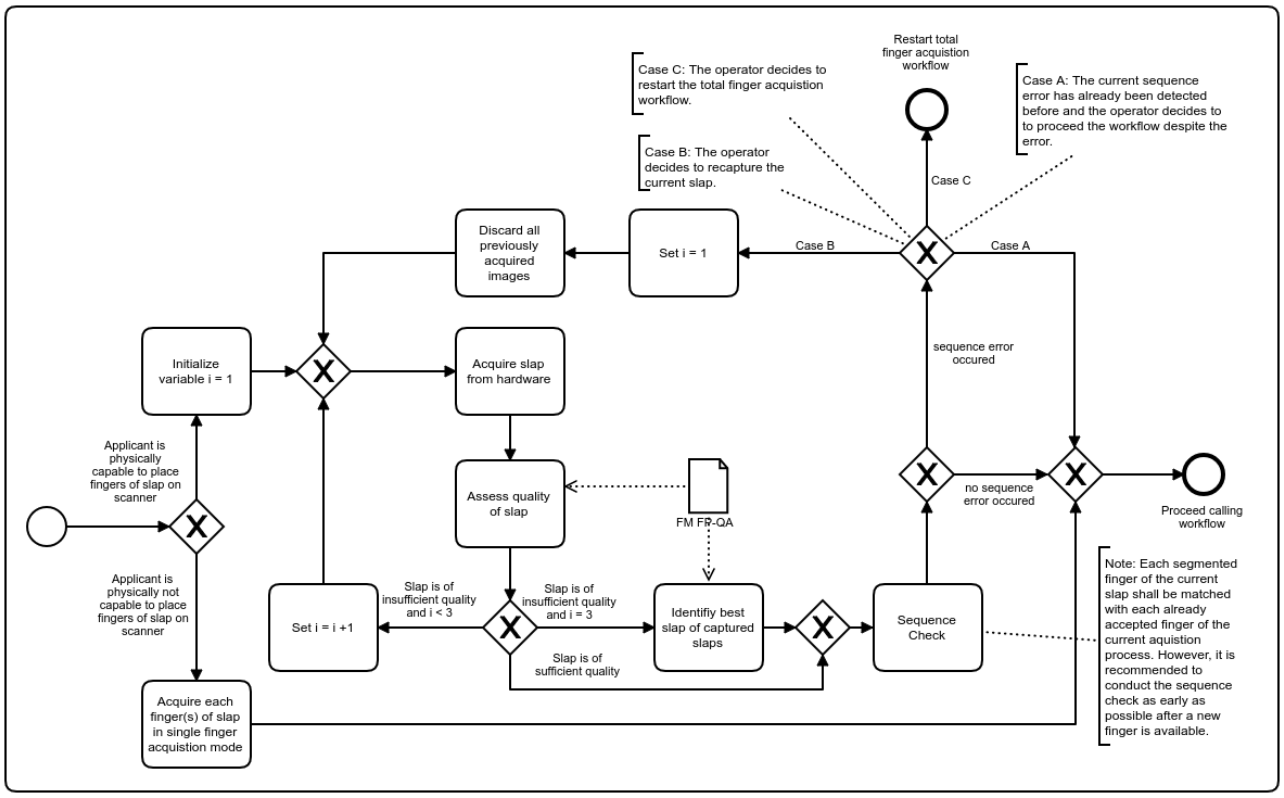

Figure 3-4: "Acquire Plain Slap" Task

“Capture Slap Unsupervised” Process

Figure 3-5 depicts the basic process for a plain unsupervised slap capture. A plain slap capture can be part of more complex acquisition processes, e.g. a ten finger acquisition by the 4-1-4-1 capture sequence. The plain unsupervised slap capture is subsequently described in detail. The quality assessment is conducted according to the requirements of the applicable FM QA.

1. The slap image is retrieved from hardware.
2. The fingerprints are segmented and each is assessed.
   a. The PAD is carried out.
   b. The sequence check is conducted.
      i. If the sequence check fails, the captured image is discarded and the capture repeated.
      ii. If the sequence check fails for the second time for the same finger, the process continues with the quality assessment.
   c. In case the quality of the fingerprints meet the quality requirements defined in the corresponding Functional Module QA-FP, the captured slap and the set of segmented fingerprints and parameter data (e.g. quality values) are temporarily stored.
   d. The quality assessment shall be conducted within 300ms.
   e. In case the timeout is reached and no slap image of sufficient quality was captured, the best slap image according to the corresponding QA Function Module is stored with the set of segmented fingerprints and parameter data (e.g. quality values).
   f. In case the quality requirements for one or more fingerprints of the slap are not met, the capture is repeated if the timeout is not reached. The timeout starts with the start of retrieval of the first slap image from hardware and shall be configurable.

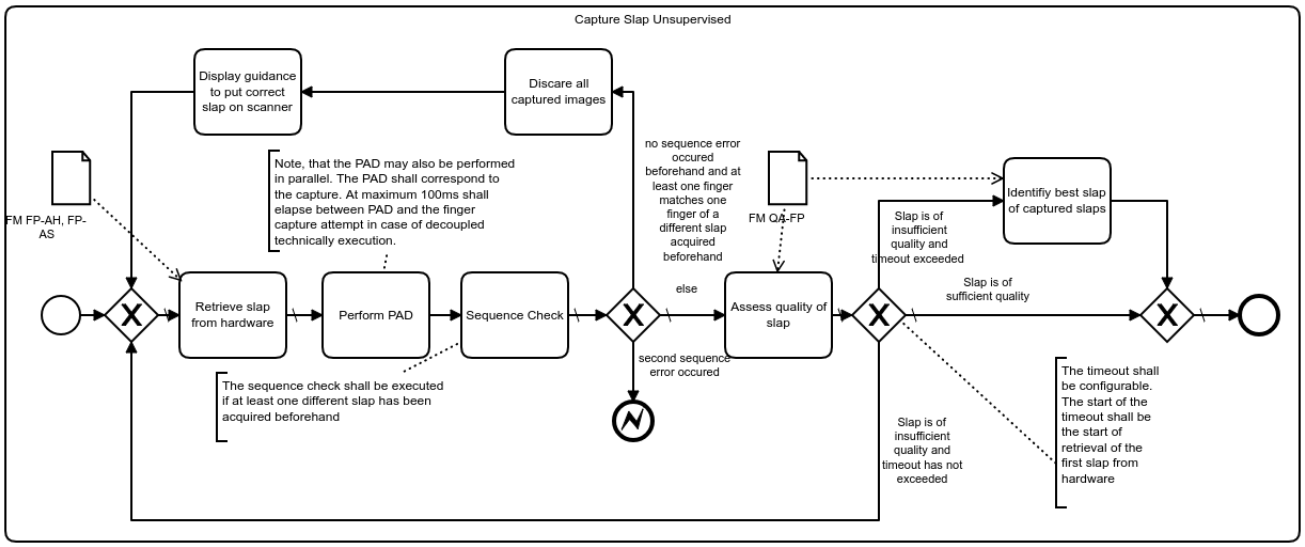

Figure 3-5: "Capture Slap Unsupervised" Task

“Capture Plain Finger Unsupervised” Process

Figure 3-6 depicts the basic process for a plain unsupervised finger capture. A plain finger capture can be part of more complex acquisition processes, e.g. a ten finger acquisition. The plain unsupervised finger capture is subsequently described in detail. The quality assessment is conducted according to the requirements of the applicable FM QA.

1. The finger image is retrieved from hardware.
2. The finger is assessed.
   a. The PAD is carried out.
   b. The sequence check is conducted.
      i. If the sequence check fails, the captured image is discarded and the capture repeated.
      ii. If the sequence check fails for the second time for the same finger, the process continues with the quality assessment.
   c. In case the quality of the fingerprint meets the quality requirements defined in the corresponding Functional Module QA-FP, the captured finger and parameter data (e.g. quality values) are temporarily stored.
   d. The quality assessment shall be conducted within 300ms.
   e. In case the timeout is reached and no finger image of sufficient quality was captured, the best finger image according to the corresponding QA Function Module is stored and parameter data (e.g. quality values).
   f. In case the quality requirements for the fingerprint is not met, the capture is repeated if the timeout is not reached. The timeout starts with the start of retrieval of the first finger image from hardware and shall be configurable.

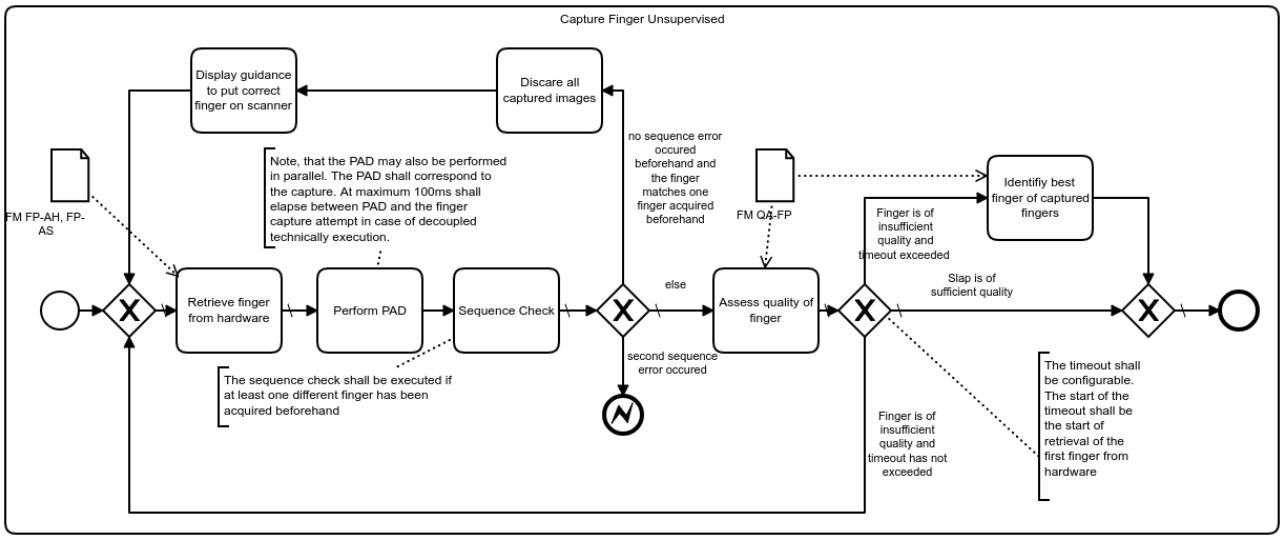

Figure 3-6: "Capture Plain Finger Unsupervised" Task

Acquire Plain Finger Task

Figure 3-7 depicts the basic capture sequence for a plain finger acquisition. A plain finger acquisition can be part of more complex acquisition processes e.g. a ten finger acquisition by the 4-1-4-1 capture sequence for identification purpose. The plain finger capture acquisition is described in detail subsequently. The quality assessment is conducted according to the requirements of the applicable FM QA.

1. The counter variable for the number of attempts for capturing the current slap is initialized as i = 1.
2. The finger image is acquired from hardware.
3. The fingerprint is assessed.
   a) In case the quality of the fingerprint meets the quality requirements defined in the corresponding QA Function Module, the captured fingerprint and parameter data (e.g. quality values) are temporarily stored.
   b) In case the quality requirements for the fingerprint is not met, the capture is repeated up to two times (i.e. the acquisition of a finger consists of a maximum of three capture attempts).
4. A sequence check shall be conducted for the acquired finger image to detect the acquisition of wrong fingers e.g. due to interchanged hands or multiple acquisition of the same hand or finger. Note: It is recommended to conduct the sequence check as early as possible after a fingerprint image is available.
   a) In case the comparison of the current finger with any previously captured finger is successful, the sequence check shall throw an error.
   b) In case the comparison of the current finger with any previously captured finger is not successful, the sequence check shall throw no error.

If the quality check of the third capture attempt fails, the best of the captured fingerprint images is identified according to the corresponding QA Function Module and temporarily stored along with corresponding information. Note, that in verification scenarios no quality assessment is conducted by the QA module.

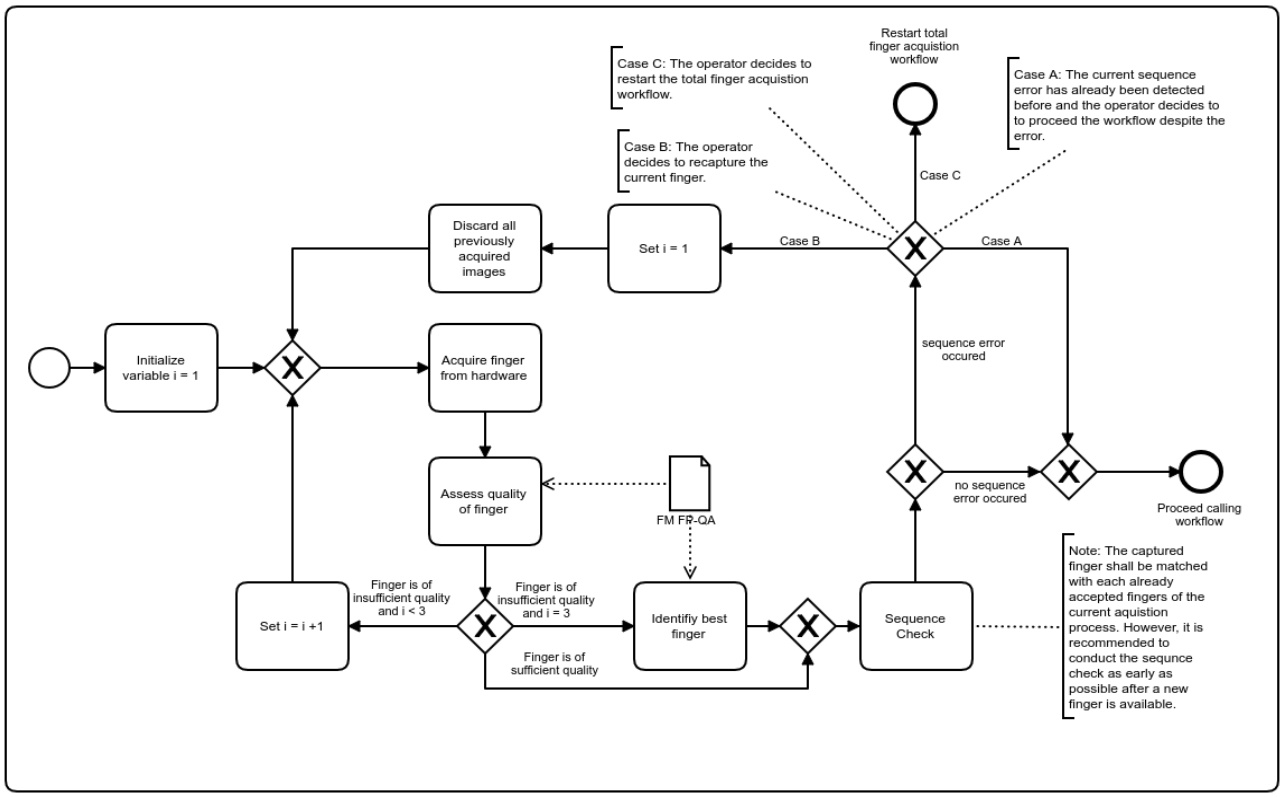

Figure 3-7: "Acquire Plain Finger" Task

Fingerprint Acquisition Processes

In the following fingerprint acquisition processes for enrolment, verification and identification processes are defined. Thereby, processes can be tailored to single-finger or multi-finger hardware. The processes use the acquisition process of plain slaps or fingers. The task “Acquire Plain Slap” refers to Figure 3-4 and the task “Acquire Plain Finger” refers to Figure 3-7. The remarks in brackets denote the fingers to capture by the individual capture process. It is recommended to select missing fingers for each slap right before the slap is captured. Selection of all missing fingers at the beginning of an acquisition process is also possible.

Figure 3-9 depicts the acquisition process for the 4-4-2 enrolment scenario and Figure 3-8 depicts the acquisition process for the 4-4-2 identification scenario. The 4-4-2 sequences are described in detail subsequently:

1. Acquire right hand: index finger, middle finger, ring finger, little finger
2. Acquire left hand: index finger, middle finger, ring finger, little finger
3. Thumbs of both hands (simultaneously)

In case of an enrolment scenario, additional single finger captures are possible for each slap capture after the slap capture itself. This variant is only recommended if a slap capture does not yield to sufficient quality.

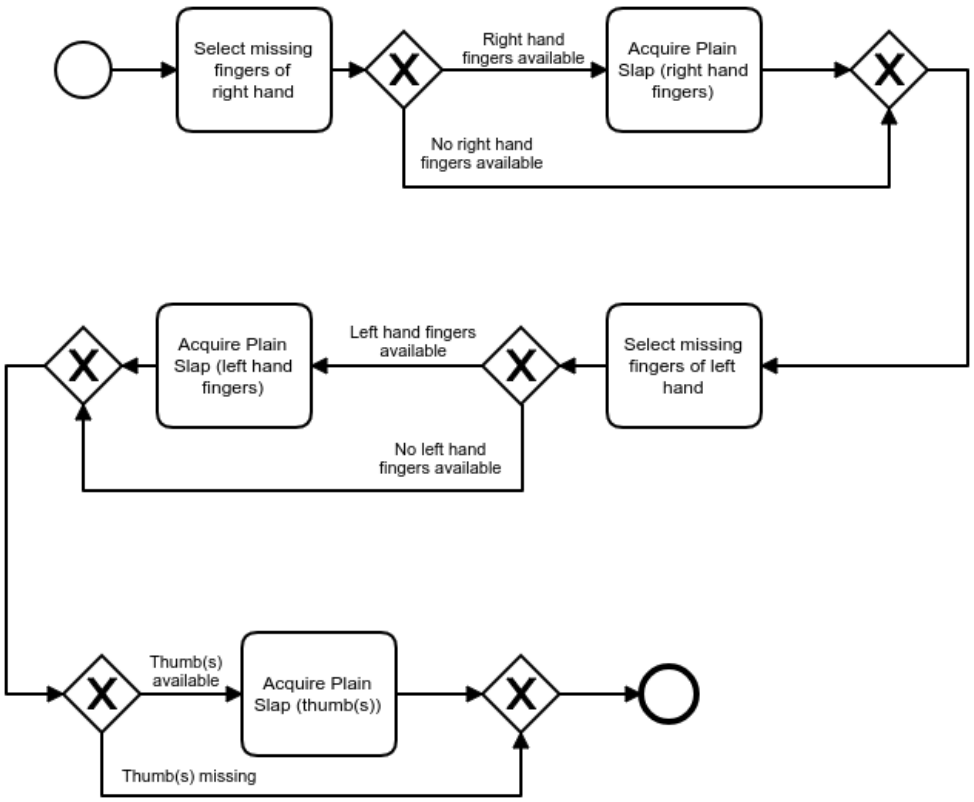

Figure 3-8: Acquisition Workflow for 4-4-2 Identification

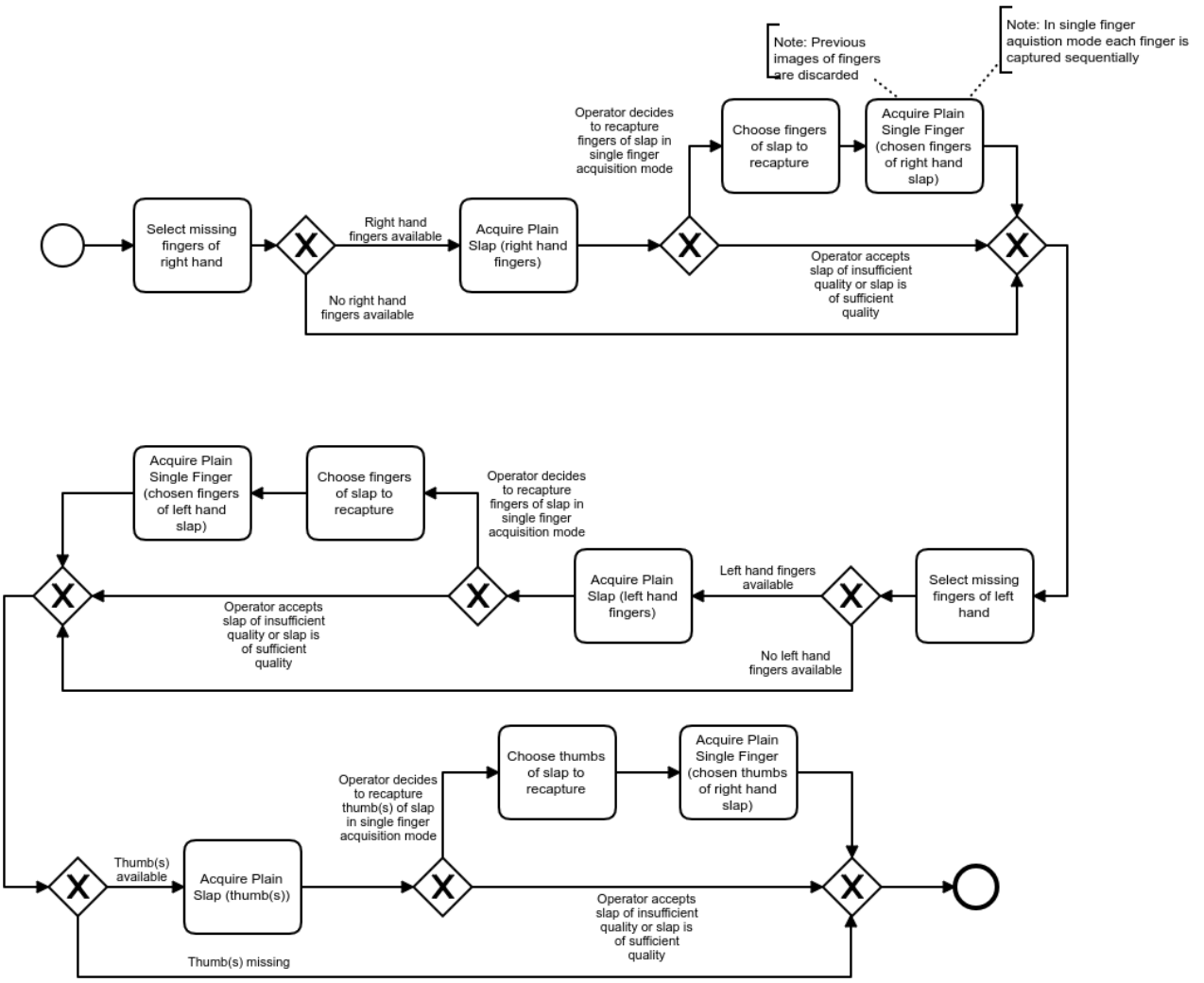

Figure 3-9: Acquisition Workflow for 4-4-2 Enrolment

Figure 3-10 depicts the acquisition process for 4-1-4-1 the enrolment scenarios and Figure 3-11 depicts the acquisition process for 4-1-4-1 the identification scenario. The 4-1-4-1 sequences are described in detail subsequently:

1. Acquire right hand: index finger, middle finger, ring finger, little finger
2. Acquire right hand: thumb
3. Acquire left hand: index finger, middle finger, ring finger, little finger
4. Acquire left hand: thumb

In case of a plain finger enrolment scenario, additional single finger captures are possible for the slaps. This variant is only recommended if a slap capture does not yield to sufficient quality.

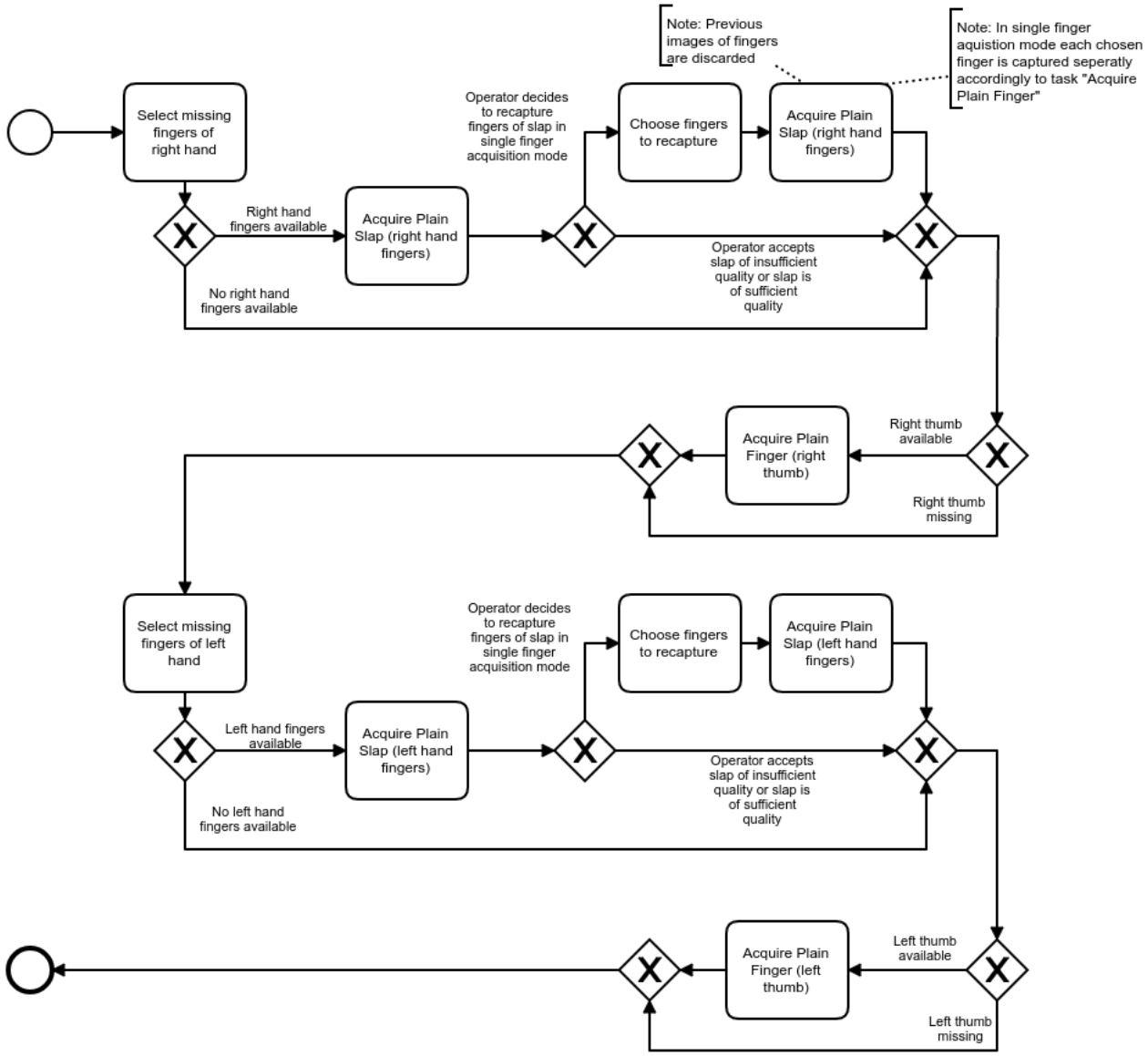

Figure 3-10: Acquisition Workflow for 4-1-4-1 Enrolment

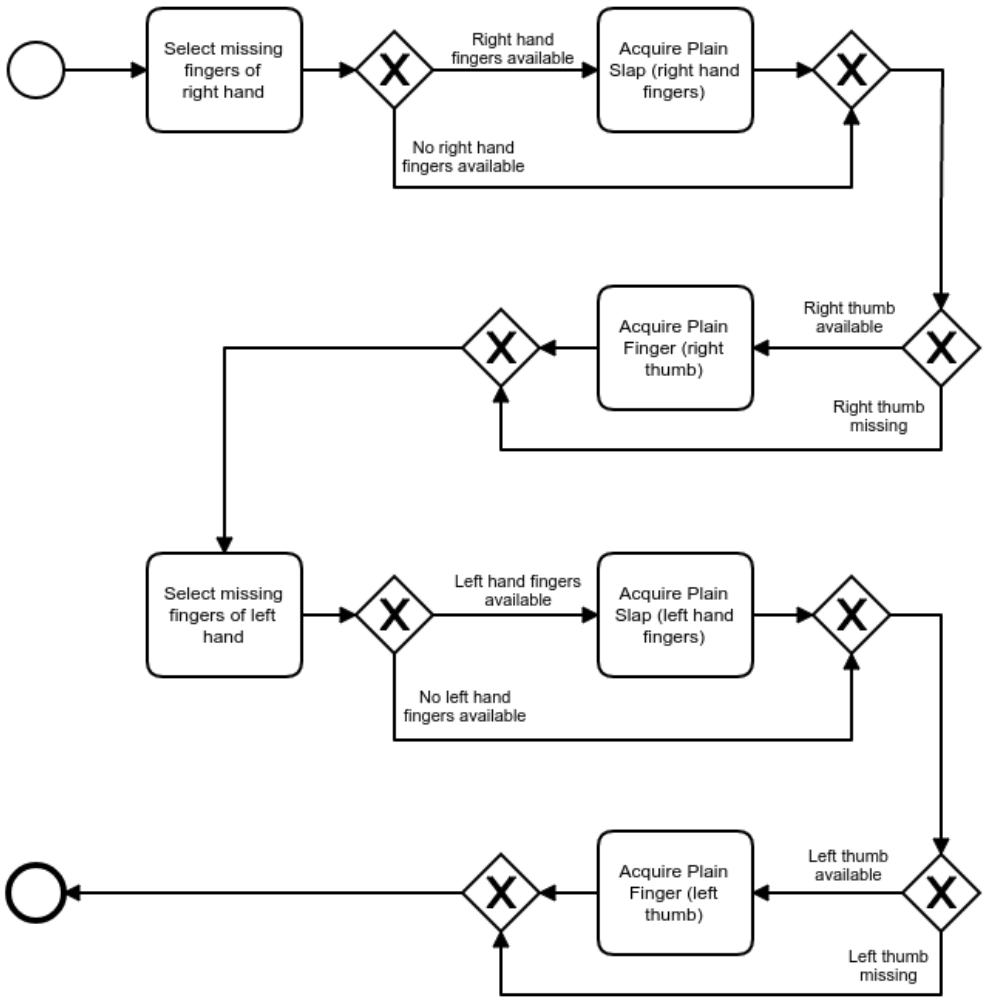

Figure 3-11: Acquisition Workflow for 4-1-4-1 Identification

Figure 3-12 depicts the acquisition process for two finger enrolment on single finger hardware, Figure 3-13 depicts the acquisition process for two finger enrolment on multi finger hardware. The two finger acquisition sequences are described in detail subsequently:

Sequence option for two finger enrolment capture with multi-finger acquisition hardware

1. Acquire right index finger, left index finger (as two-finger slap)
2. In case of insufficient index finger quality, alternative finger(s) should be acquire for each index finger of insufficient quality. First further fingers from the right hand are acquired in single-finger mode (if any available), then further fingers from the left hand. Further fingers are considered in the following order: thumb, middle finger, ring finger. The index fingers are not recaptured.
3. In any case, at least one further finger (if available) for each hand shall be acquired if the index finger does not fulfil the quality requirements.

Sequence option for two finger enrolment capture with single-finger acquisition hardware

1. Right index finger (followed by optional capture of thumb, middle finger, ring finger of the right hand)
2. Left index finger (followed by optional capture of thumb, middle finger, ring finger of the left hand)
3. In any case, at least one further finger (if available) for each hand shall be acquired if the index finger does not fulfil the quality requirements.

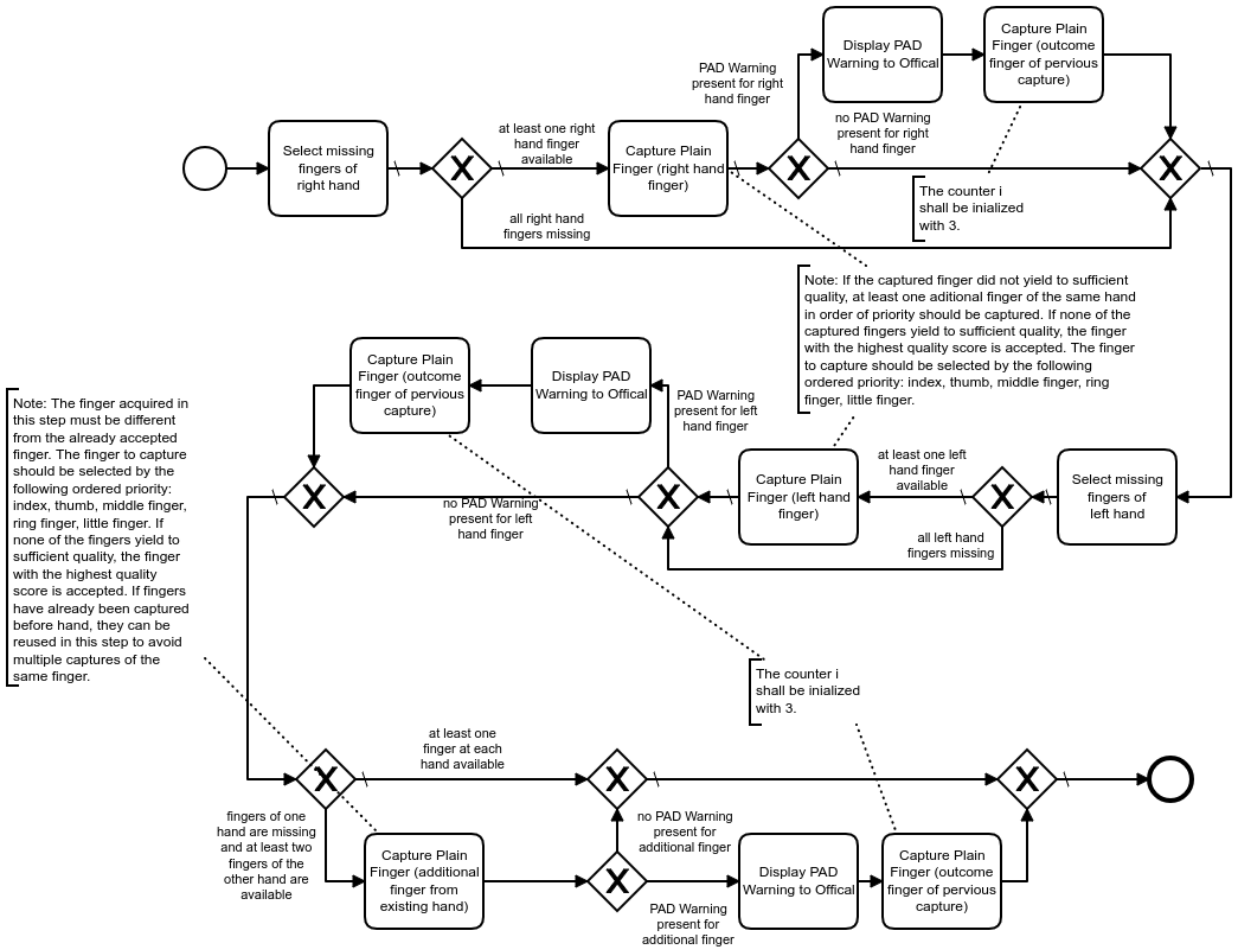

Figure 3-12: Acquisition Workflow for Two Finger Enrolment Single Finger Hardware

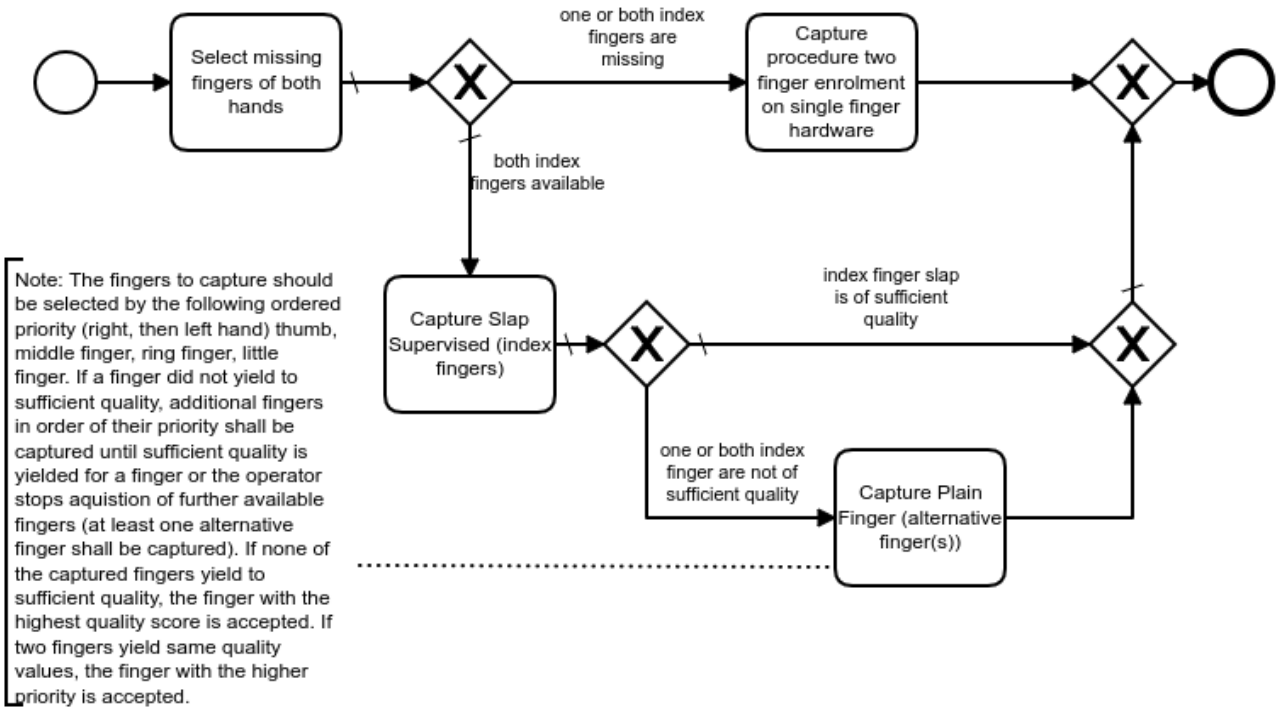

Figure 3-13: Acquisition Workflow for Two Finger Enrolment Multi Finger Hardware

Two Finger Plain Unsupervised Acquisition On Multi-Finger Hardware for Enrolment

Figure 3-14 depicts the unsupervised acquisition process for two finger enrolment on multi finger hardware. Note, that the “Capture Slap Supervised” process is used here. The sequence is described in detail subsequently:

1. Acquire right index finger, left index finger (as two-finger slap)
2. In case of insufficient index finger quality, alternative finger(s) should be acquire for each index finger of insufficient quality. First further fingers from the right hand are acquired in single-finger mode (if any available), then further fingers from the left hand. Further fingers are considered in the following order: thumb, middle finger, ring finger. The index fingers are not recaptured.
3. In any case, at least one further finger (if available) for each hand shall be acquired if the index finger does not fulfil the quality requirements.

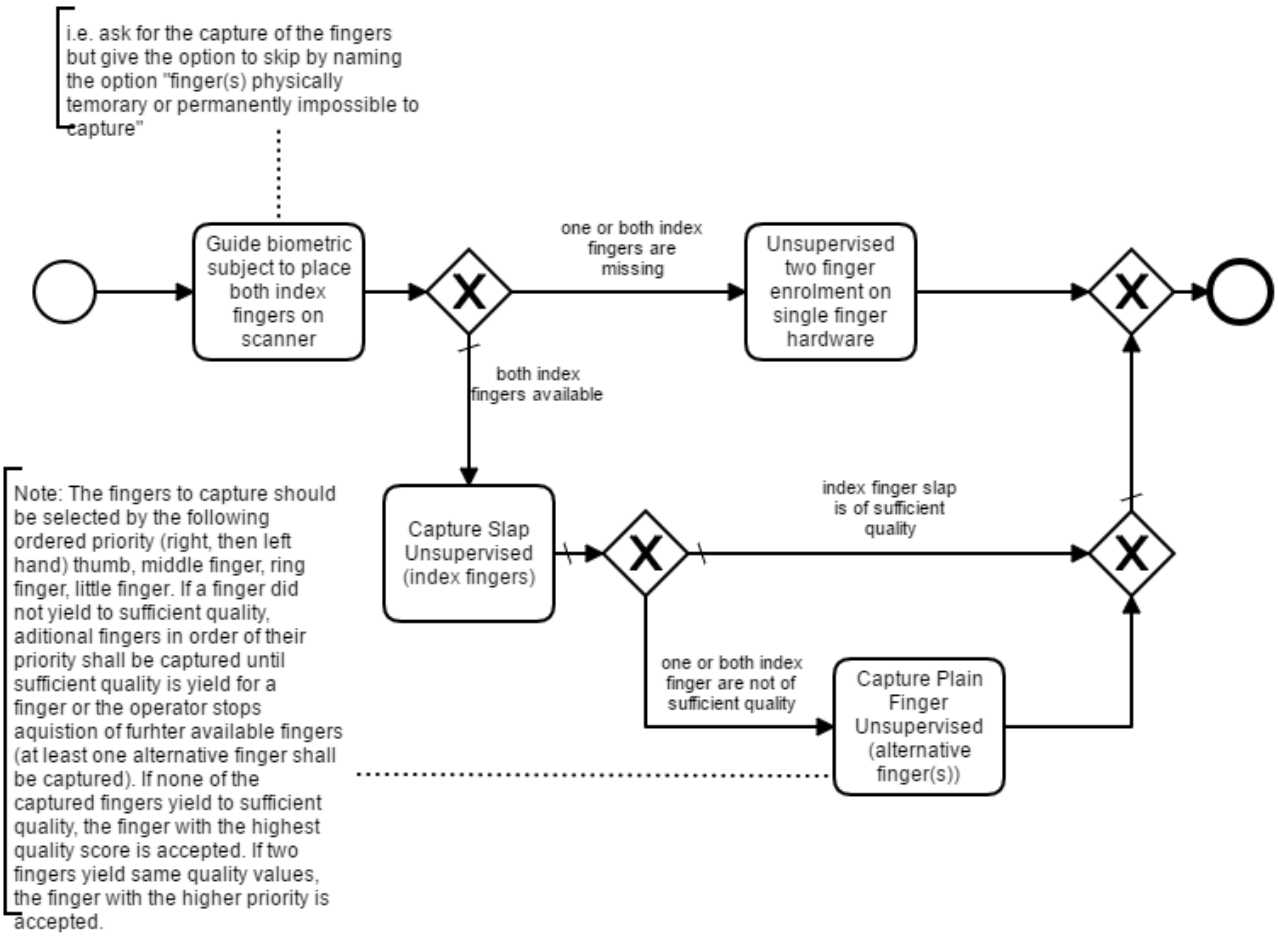

Figure 3-14: Unsupervised Acquisition Process for Two Plain Finger On Multi Finger Hardware for Enrolment

Two Finger Plain Unsupervised Acquisition On Single-Finger Hardware for Enrolment

Figure 3-15 depicts the unsupervised acquisition process for two finger enrolment on single finger hardware. Note, that the “Capture Plain Finger Unsupervised” process as defined is used here.

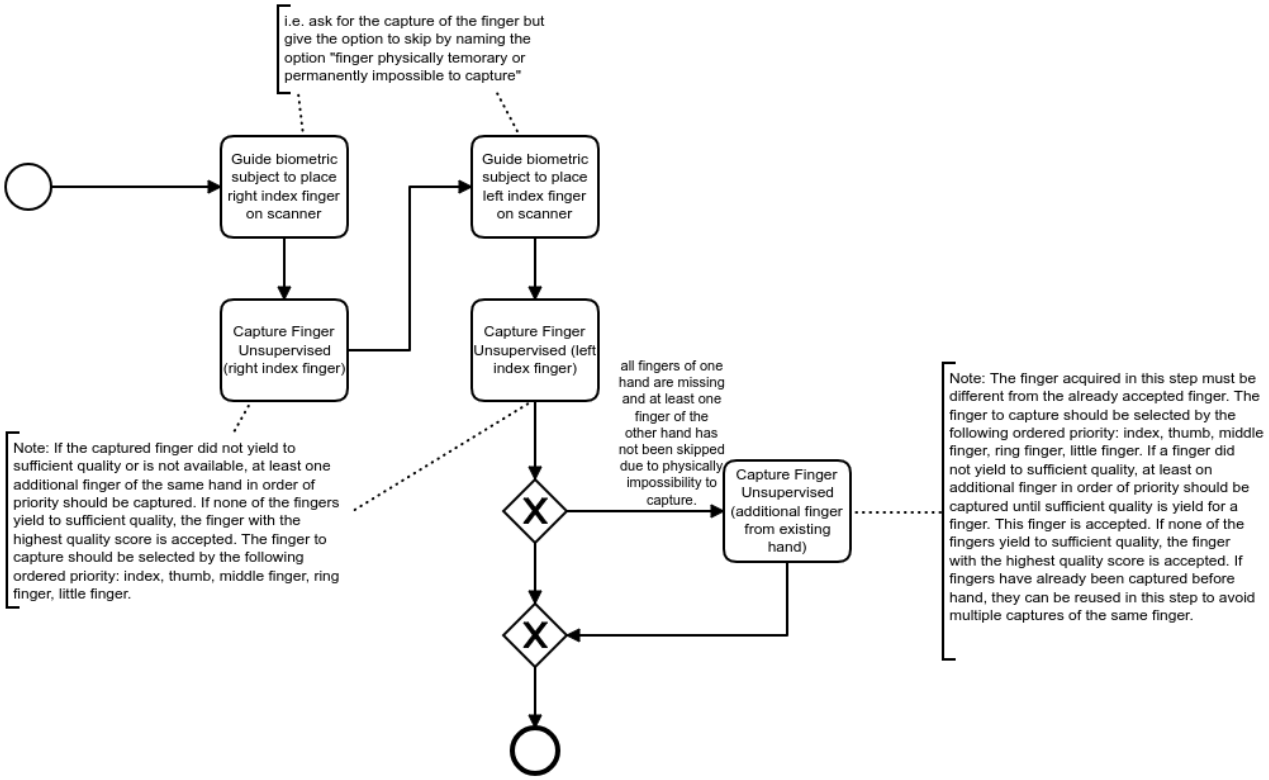

Figure 3-15: Unsupervised Acquisition Process for Two Plain Finger Single Finger Hardware for Enrolment

3.1.3 P-FP-ROLL

This function block describes the overall process requirements for capturing up to ten rolled fingerprints.

3.1.3.1 Requirements

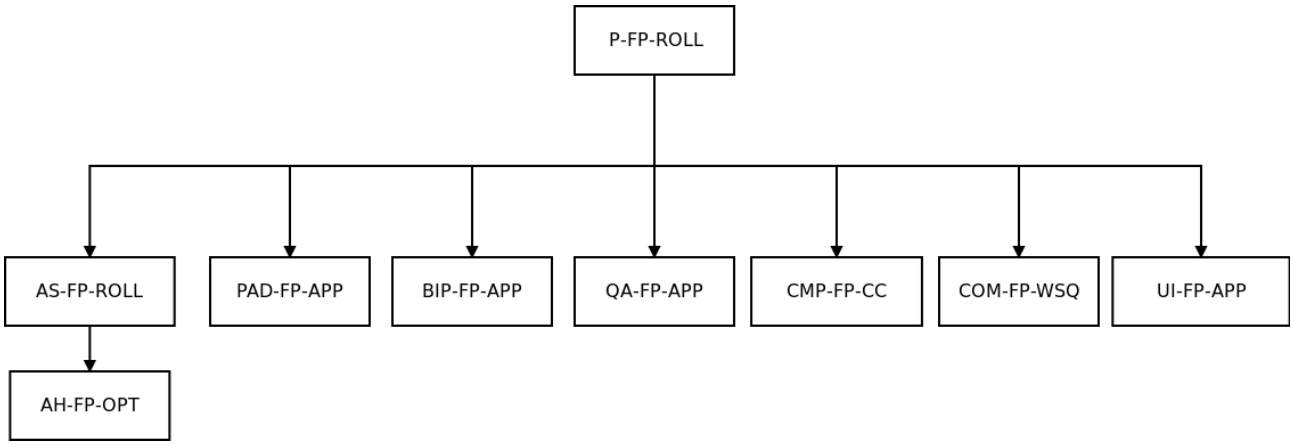

Figure 3-16: Relevant Function Blocks for Rolled Fingerprint Acquisition Process

Fingerprints scanners providing rolled fingerprints have to be used for the acquisition process. Multiple lossy compressions on the fingerprint image data are not allowed during the process.

In the following, the enrolment process of capturing rolled fingerprints is described in detail. At the beginning of this section, an overview of the included Function Modules and the respective Function Blocks is given in advance.

The following FMs apply (see Figure 3-16).

— AH-FP-OPT
— AS-FP-ROLL
— PAD-FP-APP
— BIP-FP-APP
— QA-FP-APP
— CMP-FP-CC
— COM-FP-WSQ
— UI-FP-APP

Furthermore, the official has to take the module O-FP-ACQ into account. Logging and coding of biometric data and quality data is conducted according to the given FM LOG and FM COD of the profile.

The quality requirements are defined by the profile in the corresponding module FM QA. For quality assurance, each captured fingerprint is compared with a plain captured print of the same finger segmented from the corresponding control print by means of a biometric comparison algorithm according to FM CMP.

Acquire Rolled Finger Task

Figure 3-17 defines the basic sequence for a rolled fingerprint image acquisition. The basic sequence for a rolled fingerprint image acquisition can be part of more complex acquisition processes e.g. a ten finger rolled acquisition for enrolment purpose. The basic sequence for a rolled fingerprint image acquisition is described in detail subsequently. The quality assessment is conducted according to the requirements of the applicable FM QA.

1. The counter variable for the number of attempts for capturing is initialized as $i = 1$.
2. The rolled fingerprint images is acquired from the acquisition hardware.
3. If the hardware reports an issue of the rolling process, the capture shall be repeated if $i < 3$ and i is increased by 1.
4. If no hardware reported issue was found, quality assurance shall ensure proper quality of the captured fingerprint.
   a) In case the quality of the fingerprint meets the quality requirements defined in the corresponding QA Function Module, the captured fingerprint and parameter data (e.g. quality values) are temporarily stored and the capture of the current finger finishes.
   b) In case the quality requirements of the rolled fingerprint is not met, the capture shall be repeated if $i < 3$ and i is increased by 1.
5. A control verification shall be conducted for each acquired rolled image. Therefore, plain control slaps have to be captured in a workflow upfront. Note, it is recommended to conduct the control verification as early as possible after a fingerprint image is available.
   a) In case the comparison of the rolled finger and its corresponding plain finger is successful, the control verification is considered successful.
   b) In case the comparison of the rolled finger and its plain finger is not successful and the rolled finger is successfully compared with any other plain finger, the control verification is considered not successful.
   c) In case no successful comparison of the rolled finger and any plain finger occurs, the control verification is considered undetermined.
6. The capture shall be repeated up to two times because of a hardware reported issues of the rolling process or quality issues. The operator shall be allowed to capture additional images if after the third attempt no fingerprint without hardware reported issue and sufficient quality was conducted.

If the quality check of the third capture attempt fails or the hardware reported an issue of the rolling process, the best of the previously captured images is identified according to the corresponding QA Function Module and temporarily stored along with corresponding information. Note, that in verification scenarios no quality assessment is conducted by the QA module.

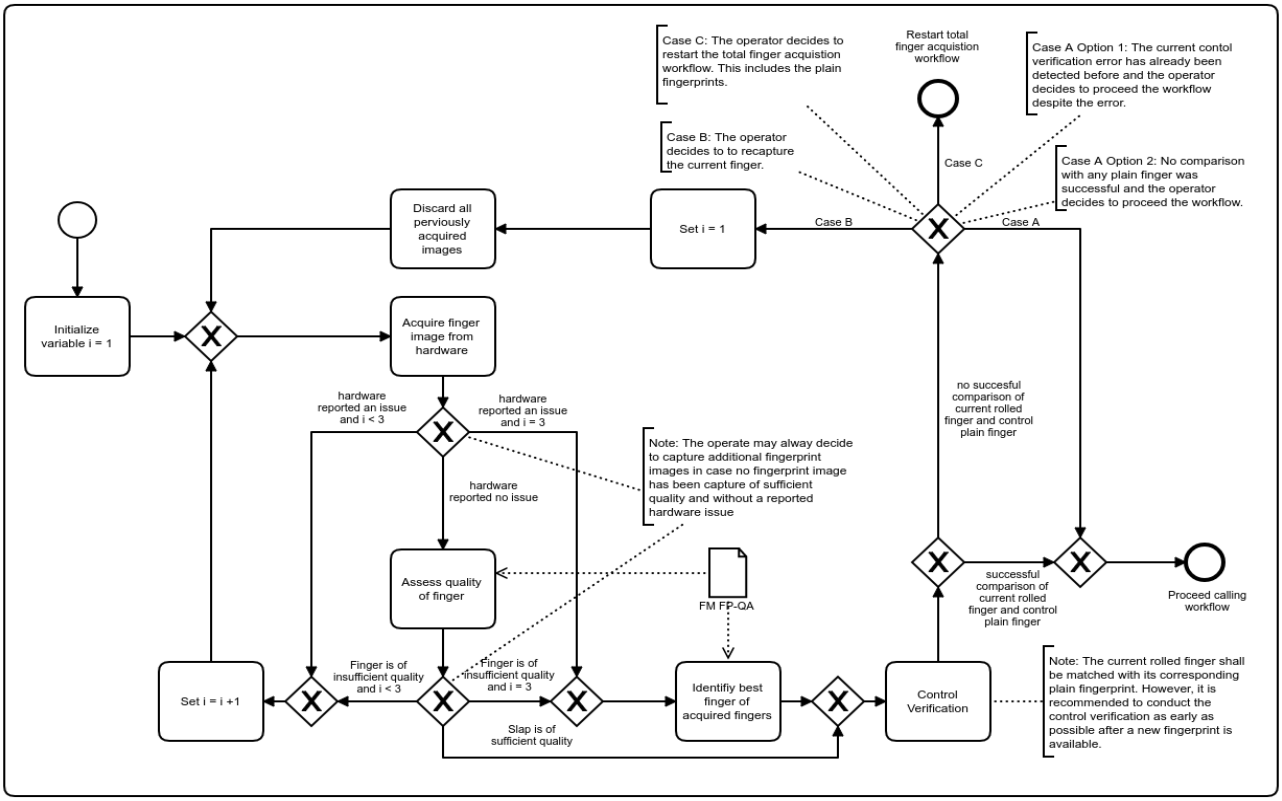

Figure 3-17: “Acquire Rolled Finger” Task

Ten Finger Rolled Acquisition

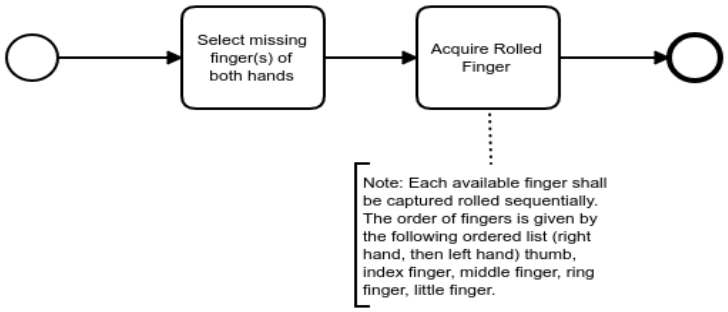

Figure 3-18: Acquisition Workflow for Enrolment of Ten Rolled Fingerprints

In case the finger to be captured is not available (e.g. due to injury), the current acquisition is skipped and the process continues with the next finger. When all available fingers have been captured, the process finishes. Note, that the “Acquire Rolled Finger” task is defined in more detail above.

3.2 Acquisition Hardware

Devices that are used for digitising physical, representable biometric characteristics are called acquisition hardware. Scanners for capturing photographs, digital cameras to capture images of the face, fingerprint sensors, or signature tablets can be named as examples.

3.2.1 AH-PH-DC

This function block describes the requirements and interfaces for digital cameras and physical setup that are used to obtain facial biometrics.

3.2.1.1 Requirements

For digital cameras the following requirements have to be met.

- physical resolution that allows a cropping of an image to 1600x1200 pixels without any upscaling
- adequate image quality to match requirements of [ISO_FACE]
- The physical and environmental conditions for capturing facial photos, such as the positioning of the camera, proper lighting of the face and a uniform background as described in Annex C of [ISO_FACE] have to be complied with.

3.2.2 AH-FP-OPT

This function block describes the requirements for high quality fingerprint scanners (single finger and multi finger).

3.2.2.1 Requirements

For the acquisition of the fingerprints, optical sensors using the principal of frustrated total reflection or direct contact (the imaging system is the sensor surface, typically separated by a transparent protection

layer) according to setting level 31 or 41 in table 1 of [ISO_FINGER] (especially this means a resolution of 500 ppi or 1000 ppi) shall be used exclusively.

For the acquisition of the fingerprints, only devices are permitted which meet the following requirements (in analogy to [EBTS/F]). Notwithstanding, a capturing area of at minimum 16 mm width and 20 mm height is required (deviating from table F 1 in [EBTS/F]) for single finger scanners.

3.2.2.1.1 Grayscale Linearity

When measuring a stepped series of uniform target reflectance patches (“step tablet”) that substantially covers the scanner’s gray range, the average value of each patch shall be within 7.65 gray-levels of a linear, least squares regression line fitted between target reflectance patch values (independent variable) and scanner output gray-levels of 8 bit resolution (dependent variable).

3.2.2.1.2 Resolution and Geometrical Accuracy

Resolution: The scanner’s final output fingerprint image shall have a resolution, in both sensor detector row and column directions, in the range: (R − 0.01R) to (R + 0.01R). The magnitude of R is either 500 ppi or 1000 ppi; a scanner may be certified at either one or both of these resolution levels. The scanner’s true optical resolution shall be greater than or equal to R.

Across-Bar geometric accuracy: When scanning a 1.0 cy/mm, multiple parallel bar target, in both vertical bar and horizontal bar orientations, the absolute value of the difference (D) between the actual distance across parallel target bars (X), and the corresponding distance measured in the image (Y) shall not exceed the following values for at least 99% of the tested cases in each print block measurement area and in each of the two directions

- for 500 ppi scanners:
  $D \leq 0.0007$, for $0.00 < X \leq 0.07$ and
  $D \leq 0.01X$, for $0.07 \leq X \leq 1.50$
- for 1000 ppi scanners:
  $D \leq 0.0005$, for $0.00 < X \leq 0.07$ and
  $D \leq 0.0071X$, for $0.07 \leq X \leq 1.50$

where $D = |Y-X|$, X = actual target distance, Y = measured image distance (D, X, Y are in inches).

Along-Bar geometric accuracy: When scanning a 1.0 cy/mm, multiple parallel bar target, in both vertical bar and horizontal bar orientations, the maximum difference in the horizontal or vertical direction, respectively, between the locations of any two points within a 1.5 inch segment of a given bar image, shall be less than 0.016 inches for at least 99% of the tested cases in each print block measurement area and in each of the two orthogonal directions.

3.2.2.1.3 Contrast Transfer Function

The spatial frequency response shall be measured using a binary grid target (Ronchi-Grating), denoted as contrast transfer function (CTF) measurement. When measuring the bar CTF, it shall meet or exceed the minimum modulation values defined by equation [EQ 1] or equation [EQ 2], in both the detector row and detector column directions, and over any region of the scanner's field of view. CTF values computed from equations [EQ 1] and [EQ 2] for nominal test frequencies are given in the following table. None of the CTF modulation values measured at specification spatial frequencies shall exceed 1.05. The output bar target image shall not exhibit any significant amount of aliasing.

Frequency [cy/mm]	Minimum Modulation for 500 ppi scanners	Minimum Modulation for 1000 ppi scanners	Maximum Modulation
1.0	0.948	0.957	1.05
2.0	0.869	0.904	1.05
3.0	0.791	0.854	1.05
4.0	0.713	0.805	1.05
5.0	0.636	0.760	1.05
6.0	0.559	0.716	1.05
7.0	0.483	0.675	1.05
8.0	0.408	0.636	1.05
9.0	0.333	0.598	1.05
10.0	0.259	0.563	1.05
12.0	---	0.497	1.05
14.0	---	0.437	1.05
16.0	---	0.382	1.05
18.0	---	0.332	1.05
20.0	---	0.284	1.05

Table 3-1: Minimum and Maximum Modulation

It is not required that the bar target contain the exact frequencies listed in Table 3-1, however, the target does need to cover the listed frequency range and contain bar patterns close to each of the listed frequencies. The following equations are used to obtain the minimum acceptable CTF modulation values when using bar targets that contain frequencies not listed in Table 3-1:

— 500 ppi scanner, for f = 1.0 to 10.0 cy/mm:
CTF = $3.04105 * 10^{-4} * f2 - 7.99095E-02 * f + 1.02774$ [EQ 1]

— 1000 ppi scanner, for f = 1.0 to 20.0 cy/mm:
CTF = $- 1.85487 * 10^{-5} * f3 + 1.41666E-03 * f2 - 5.73701E-02 * f + 1.01341$ [EQ 2]

For a given bar target, the specification frequencies include all of the bar frequencies which that target has in the range 1 to 10 cy/mm (500 ppi scanner) or 1 to 20 cy/mm (1000 ppi scanner).

3.2.2.1.4 Signal-to-Noise Ratio and the Gray–Level Uniformity

The white signal-to-noise ratio (SNR) and black SNR shall each be greater than or equal to 125.0, in at least 97% of respective cases, within each measurement area.

The gray level uniformity is defined for the three following cases:

— Adjacent row, column uniformity: At least 99% of the average gray-levels between every two adjacent quarter-inch long rows and 99% between every two adjacent quarter-inch long columns, within each imaged area, shall not differ by more than 1.0 gray-levels when scanning a uniform low reflectance target, and shall not differ by more than 2.0 gray-levels when scanning a uniform high reflectance target.
— Pixel to pixel uniformity: For at least 99.9% of all pixels within every independent 0.25 inch by 0.25 inch area located within each imaged area, no individual pixel's gray-level shall vary from the average by more than 22.0 gray-levels, when scanning a uniform high reflectance target, and shall not vary from the average by more than 8.0 gray-levels, when scanning a uniform low reflectance target.
— Small area uniformity: For every two independent 0.25 inch by 0.25 inch areas located within each imaged area, the average gray-levels of the two areas shall not differ by more than 12.0 graylevels when scanning a uniform high reflectance target, and shall not differ by more than 3.0 gray-levels when scanning a uniform low reflectance target.

3.2.2.1.5 Gray Scale Range of Fingerprint Images

A fingerprint scanner operating at 500ppi or 1000ppi, has to perform the following sets of live scans:

— For a standard roll and plain finger live scanner: capture a complete set of fingerprints from each of 10 subjects; i.e., 10 rolls (all 5 fingers from each hand), 2 plain thumb impressions, and 2 plain 4-finger impressions.
— For a palm scanner component of a live scan system: capture left and right palms from each of 10 subjects.
— For an identification flats live scanner: capture left and right 4-finger plain impressions and dual thumb plain impressions from each of 10 subjects.

Within the histogram of each image all gray values with at least 5 Pixels in this image are counted. The histogram has to show no break and no other artefact. At least 80% of the captured individual fingerprint images shall have a gray-scale dynamic range of at least 200 gray-levels, and at least 99% shall have a dynamic range of at least 128 gray-levels.

3.3 Acquisition Software

Acquisition Software contains all functionality regarding image processing except for biometric purposes. Therefore, this module usually contains device driver software for the Acquisition Hardware or, in general, software that is very close to the physical hardware such as firmware. Furthermore, colour management and image enhancement mechanisms are part of this software layer.

3.3.1 AS-PH-DC

This function block describes the requirements and interfaces for Acquisition Software used for digital cameras in order to obtain digitised images.

3.3.1.1 Requirements

The image data should to be provided without any compression in one of the following image formats: Windows Bitmap Format Version 3, JPEG Lossless, DNG (in combination with JPEG Lossless).

If the acquisition device does not support a lossless mode, the image can alternatively be provided in JPEG mode with the minimal level of compression possible. In normal mode of operation, no compression artefacts shall be detectable in the image.

3.3.1.2 Recommendations

Acquisition Software that supports calibration procedures for the respective digital camera should be used (in particular colour management).

3.3.2 AS-FP-MF

This function block describes the requirements and interfaces for Acquisition Software for multi finger scanners.

3.3.2.1 Requirements

The image provided by Acquisition Software has to meet the criteria of fingerprints as described in [ISO_FINGER] (particularly chapter 7 "Image acquisition requirements"). The requirements according to setting level 31 or 41 from table 1 in [ISO_FINGER] are mandatory.

For the acquisition process, a pre-qualification of the fingerprints to prefer high quality has to be used. The activation of the acquisition has to occur automatically. The capture should prefer the highest quality image of all images within the sequence, that present a quality above a to be defined scanner-specific threshold. In the case of a time-out, at least the last captured image is returned.

If the Acquisition Software allows multiple thresholds for pre-qualification, the thresholds shall be documented by the vendor and be configurable by the system administrator.

It is possible that this functionality is part of the hardware firmware and may not be available as separate software component.

If the sensor was not able to capture an image (e.g. because no finger was placed on it), it is not required to return an image after time-out. In this case, an adequate error code has to be returned.

3.3.3 AS-FP-ROLL

This function block describes the requirements and interfaces for Acquisition Software for scanners supporting rolled fingerprint capture.

3.3.3.1 Requirements

The acquisition software shall support the acquisition of rolled fingerprints. Therefore, the following requirements apply:

1 The captured fingerprint image shall depict the fingerprint from nail to nail.

2 The captured fingerprint image shall depict a faithful reproduction of the fingerprint, especially in the areas where the rolled fingerprint overlaps with the corresponding plain print.

3 Uniform Depiction

3.1 The captured fingerprint image shall not depict visible distortion or interruptions.

3.2 The captured fingerprint image shall not depict puzzle effects such that parts of the fingerprint image are displaced from their actual position.

4 Clear Depiction

4.1 The captured fingerprint image shall clearly depict friction ridges.

4.2 The captured fingerprint image shall not depict blurring and smearing.

4.3 The captured fingerprint image shall clearly depict ridge pattern.

4.4 If features exists for the given fingerprint:

4.4.1 The captured fingerprint image shall clearly depict features.

4.4.2 If loop features exists for the given fingerprint:

4.4.2.1 The captured fingerprint image shall clearly depict loop features (core and delta).

4.5 The captured fingerprint image shall clearly depict existing features at the border zone of the image.

5 Complete Fingerprint

5.1 The captured fingerprint image shall depict the fingerprint's upper part.

5.2 The captured fingerprint image shall depict the fingerprint’s core area with ridge lines.

5.3 If delta features exists for the given fingerprint:

5.3.1 The captured fingerprint image shall depict the fingerprints delta features.

5.4 The captured fingerprint image shall depict the fingerprint’s baseline (bottom area).

6 The captured fingerprint image shall be unrotated. Thus, the vertical axis of the fingerprint depicted in the captured image shall be in parallel with the fingerprint image’s vertical axis.

7 The captured fingerprint image provided by Acquisition Software shall meet the criteria of fingerprints as described in [ISO_FINGER] (particularly chapter 7 "Image acquisition requirements"). The requirements according to Table 3-2 are mandatory.

8 The acquisition software shall detect and provide information about issues while rolling a finger which affect the quality of the captured fingerprint. Those information shall be considered as hardware reported issues in the capture process, see relevant FM P-FP.

Setting Level	Scan Resolution Pixels/Centimeter (ppcm)	Scan Resolution Pixels/Inch (ppi)	Pixel Depth (bits)	Dynamic Range (Gray Levels)	Certification
31	197	500	8	200	EFTS/F
41	394	1000	8	200	EFTS/F

Table 3-2: Image Acquisition Settings Levels

3.4 Presentation Attack Detection

The objective of the module Presentation Attack Detection is to avoid presentations with the goal to subvert an enrolment, verification of identification process.

3.4.1 PAD-FP-APP

This function block describes requirements for presentation attack detection in the context of the acquisition of fingerprint biometrics. This function module is especially relevant for use cases where no direct observation of the acquisition process by an official is possible (e.g. in self-service scenarios).

3.4.1.1 Requirements

3.4.1.1.1 General Requirements

The capture system shall contain a presentation attack detection subsystem according to [ISO_PAD_1] detecting spoofing attempts using artefacts by which an attacker is trying to establish a different biometric characteristic as probe in the verification or identification process.

The presentation attack detection subsystem may consist of hardware and software (e.g. the used fingerprint scanner may have additional sensors designed for this purpose).

Typical artefacts consist of fake fingers (e.g. silicone, gelatine based). The presentation attack detection subsystem shall be able to detect all well-known attack types (refer to section Certification Requirements).

The presentation attack detection shall be conducted both in supervised acquisition scenarios, e.g. in a counter scenario, and in unsupervised acquisition scenarios, e.g. in self-service scenarios. Thereby, the presentation attack detection shall be conducted for all acquisition purposes e.g. enrolment, identification and verification.

Neither the presentation attack detection result nor presentation attack score shall be displayed to the person who's fingerprints are acquired.

3.4.1.1.2 Performance

The presentation attack system's usability in the field in terms of bona fide presentation classification error rate (BPCER) and bona fide presentation non-response rate (BPNRR) as defined by [ISO_PAD_3] should be compliant with the thresholds in Table 3-3.

Usability Metric	Threshold
BPCER	< 2%
BPNRR	< 1%

Table 3-3: Usability Metrics PAD

3.4.1.1.3 Self-Service Scenarios Requirements

In self-service scenarios where the person who's fingerprints shall be acquired uses an unsupervised fingerprint scanner, the presentation attack detection results from the unsupervised acquisition shall be displayed to a responsible process operator in case of a presentation attack detection and should be displayed to a responsible process operator in case of no presentation attack detection.

3.4.1.1.4 Integration Requirements

The presentation attack detection subsystem shall be independent of the regular capture subsystem, i.e. it shall not inhibit capturing image data in case of a suspected attack. It shall signal its detection in the form of

a presentation attack detection overall result to the calling application. It shall additionally provide detailed information about the scores of the presentation attack detection.

If the module is used within a comparison scenario, it is allowed to only signal the detection result in conjunction with a positive matching decision. In any case, the omission of the detection result shall be signalled.

3.4.1.1.5 Certification Requirements

To ensure comparable performance of presentation attack detection subsystems, single finger devices shall be certified under the Common Criteria Agreement according to the Protection Profiles stated below. The certification of multi finger devices under the stated Protection Profiles is recommended[4].

— BSI-CC-PP-0063-2010: Fingerprint Spoof Detection Protection Profile (FSDPP)
— BSI-CC-PP-0062-2010: Fingerprint Spoof Detection Protection Profile based on Organisational Security Policies (FSDPP_OSP)

3.4.1.1.6 Maintenance Requirements

As new technologies and new attack mechanisms are developed over time, it is required that the presentation attack detection subsystem is regularly updated and re-evaluated.

3.4.1.1.7 Transitional Rules

The requirements of this module only apply to devices and software put into operation after November 1, 2019.

After November 1, 2019, only software updates are allowed for non-certified PAD fingerprint scanners.

3.5 Biometric Image Processing

The module Biometric Image Processing provides the extraction of all relevant biometric information from the data which is provided by the Acquisition Hardware or the Acquisition Software layer. Thus, a proprietary data block is transformed to a digital image of a biometric characteristic. In general, specific image processing for biometrics is addressed here.

3.5.1 BIP-PH-DC-HQ

This function block describes requirements and interfaces for Biometric Image Processing with respect to the output of digital cameras to obtain a high quality facial image that fulfills the ISO requirements.

3.5.1.1 General Requirements

As a result of the image processing of this module, a facial image has to be generated that is compliant to the requirements of full frontal images specified in [ISO_FACE]. As a precondition, the person, a photograph is taken from, has to behave in a cooperative manner. The minimum distance between both eyes for capture positions of the applicant in the preferred area of the camera range shall be at last 120 pixel.

4 This is expected to be a mandatory requirement in a future version of this guideline.

Basically, the image processing encloses cropping the facial image, resulting in images with a height/width ratio of 4:3. The general requirements for the image cropping in Table 3-4 apply to all images if no dedicate requirements are defined for a given use case in this Functional Module.

Criterion	Value	Unit
Image height	1600	Pixel
Image width	1200	Pixel

Table 3-4: Requirements for the Size of Facial Images

Depending on the requirements of the COD modules, multiple differently cropped versions of the image might be created at this step of image processing.

3.5.1.2 Requirements GSAT Transactions

Requirements in Table 3-4 do not apply for GSAT transactions. The requirements in Table 3-5 apply to images used in GSAT transactions.

Criterion	Value	Unit
Image height	800	Pixel
Image width	600	Pixel

Table 3-5: Requirements for the Size of Facial Images in GSAT Transactions

3.5.1.3 Requirements on Printing

If the image is also used for printing to the target size of 45mm x 35mm, it shall be cropped equidistantly from the original 4:3 aspect ratio.[5]

3.5.2 BIP-FP-APP

This function block describes requirements and interfaces for the Biometric Image Processing to provide up to four single finger images for the subsequent reference storage or biometric comparison.

3.5.2.1 Requirements

The resolution of the fingerprint image has to be 500 ppi corresponding to table 1 in [ISO_FINGER] and, therefore, may differ from the scan resolution.

Depending on the call to capture one, two, three or four fingerprints, this number of individual fingerprints has to be extracted from the input image and provided as single fingerprints.

5 Note that for the purpose of biometric processing, the 45:35 image is not considered any further.

Note: Segmentation for single finger scanners is optional.

For this segmentation process, the following requirements have to be fulfilled.

- Ability to accept rotated fingerprints in the same direction up to 45°
- Rotated fingerprints in the same direction have to be corrected to be vertical
- Segment the first part of the finger (fingertip)
- Segmentation has to occur on uncompressed data

3.6 Quality Assurance

This module contains all kinds of mechanisms and procedures to check the quality of the biometric data or to select the best quality data out of multiple instances.

3.6.1 QA-PH-SB

This function block describes requirements and interfaces for software that is used for Quality Assurance of digital images to ensure compliance with [ISO_FACE].

3.6.1.1 Requirements

The Quality Assurance module is used for the software-based automatic check of the conformance of the picture to [ISO_FACE] after the digitisation. Thereby, the geometric properties of the picture as well as the digital parameters of the image are analysed and rated.

The standard which is relevant for the quality of facial images [ISO_FACE] hierarchically describes requirements to the facial images. In the following, full frontal images are expected.

The QA module has to analyse and to evaluate all of the quality criteria listed in Table 3-6. For the criteria marked with "M", the quality values must be provided while quality values for the criteria marked with "O" may be provided in the defined format according to the respective criteria.

A criterion is fulfilled if its calculated value is in the given threshold boundaries.

Based on the results of all provided quality criteria the QA module rejects or approves the picture. The total result is true if every single quality criteria is fulfilled.

A QA module shall provide an interface for conformance testing where a single image can be processed and the calculated values and configuration data are returned.

The QA module should operate on cropped images retrieved from the image processing according to FM BIP PH. Quality assurance must not happen on uncropped images.

ID	Criterion	ISO-Ref.[6]	M/O[7]	Unit/Range
Pose of the head				
1.1	Yaw, neck axis	7.2.2	O	Degrees
1.2	Pitch, ear axis	7.2.2	O	Degrees
1.3	Roll, nose axis	7.2.2	M	Degrees
Facial expression				
2.1	Neutral expression	7.2.3	O	Arbitrary units
2.2	Mouth closed	7.2.3	M	Arbitrary units
2.3	No raised eyebrows	7.2.3	O	Arbitrary units
Eyes				
3.1	Eyes open	7.2.3	O	Arbitrary units
3.2	No occlusion (glasses, hair, eye patch)	7.2.11 7.2.12	O	Arbitrary units
3.3	Eyes looking to the camera	7.2.3	O	Arbitrary units
Background				
4.1	Uniformity (plainness, no textures, colour)	7.2.6 A.2.4.3	O	Arbitrary units
4.2	No shadows	7.2.6 A.2.4.2	O	Arbitrary units
4.3	No further people / objects	7.2.4 A2.3	O	Arbitrary units
Geometry				
5.1	Image height	8.3.5 A.3.1.1 A.3.2.1	M	In pixel
5.2	Image width	8.3.4 A.3.1.1 A.3.2.1	M	In pixel
5.3	Ratio: Head width / image width	8.3.4	M	As ratio between 0 and 1
5.4	Ratio: Head height / image height	8.3.5	M	As ratio between 0 and 1
5.5	Vertical position of the face	8.3.3	M	As ratio between 0 and 1
5.6	Horizontally centred face	8.3.2	M	As ratio between 0 and 1

6 Compare [ISO_FACE]
7 Mandatory/Optional

ID	Criterion	ISO-Ref.	M/O	Unit/Range
5.7	Eye distance	8.4.1 A3.1.1	M	In pixel
Subject lighting				
6.1	Equally distributed lighting	7.2.7	O	Arbitrary units
6.2	No shadows over the face nor in the eye-sockets	7.2.8 7.2.9	O	Arbitrary units
6.3	No hot spots on skin	7.2.10	O	Arbitrary units
6.4	No effects on glasses	7.2.11	O	Arbitrary units
Image characteristics				
7.1	Proper exposure	7.3.2	M	Arbitrary units
7.2	Focus and depth of field	7.3.3	M	Arbitrary units
7.3	No unnatural colours	7.3.4	O	Arbitrary units
7.4	No red eyes	7.3.4	O	Arbitrary units
7.5	Colour space	7.4.2.3	M	RGB-24bit, YUV422, 8bit-grey scale
7.6	Grey scale density and colour saturation	7.4.2.1 7.4.2.2	M	Counted numbers of intensity values existing within the image

Table 3-6: Mapping of Relevant Quality Criteria

If defined, the thresholds for specific application profiles are detailed in Table 3-7.

ID	Criterion	Minimum	Maximum	Unit/Range
Image for passport chip (GID), ratio 45:35				
1.3	Roll, nose axis	-8	8	Degrees
5.1	Image height	403	423	In pixel
5.2	Image width	521	541	In pixel
5.3	Ratio: Head width / image width	0,5	0,75	As ratio between 0 and 1
5.4	Ratio: Head height / image height	0,6	0,9	As ratio between 0 and 1
5.5	Vertical position of the face	0,3	0,5	As ratio between 0 and 1
5.6	Horizontally centred face	0,45	0,55	As ratio between 0 and 1

ID	Criterion	Minimum	Maximum	Unit/Range
5.7	Eye distance	90	-	In pixel
Image for Central Identity Register (AAD), ratio 4:3				
1.3	Roll, nose axis	-8	8	Degrees
5.1	Image height	800	1600	In pixel
5.2	Image width	600	1200	In pixel
5.3	Ratio: Head width / image width	0,5	0,75	As ratio between 0 and 1
5.4	Ratio: Head height / image height	0,6	0,9	As ratio between 0 and 1
5.5	Vertical position of the face	0,3	0,5	As ratio between 0 and 1
5.6	Horizontally centred face	0,45	0,55	As ratio between 0 and 1
5.7	Eye distance	120	-	In pixel

Table 3-7: Application Specific Thresholds for Facial Images[8]

3.6.2 QA-PH-PG

This function block describes requirements for a photo guideline that is used for Quality Assurance.

3.6.2.1 Requirements

If the quality assurance is to be performed by a person, visual tools like a photo guideline [PhotoGuide] can be used for support.

The visual check with the photo guideline [PhotoGuide] must always be done even if the checks with the photo template and/or the QA software will be performed afterwards. A recent picture is required according to Annex A of [ISO_FACE].

If these basic criteria are not met, the image is rejected without any further checks by the software or the photo template.

In the case of the photo guideline, the following criteria have to be described, preferably using sample images for compliant and non compliant images (compare [ISO_FACE]):

— frontal pose

8 For quality criterion ID 5.5 “Vertical position of the face” the effective thresholds are [0,3; 0,5] according to the Technical Corrigenda of [ISO_FACE].

- neutral expression
- mouth closed
- eyes open
- no occlusion (glasses, hair, eye patch)
- eyes looking to the camera
- background uniformity (plainness, no textures, colour)
- no shadows
- no head coverings
- no further people / objects
- equally distributed lighting
- no shadows over the face
- no shadows in the eye-sockets
- no hot spots on skin
- no effects from glasses
- correct exposure
- correct contrast
- focus and depth of field
- no unnatural colours
- no red eyes

3.6.3 QA-FP-APP

This function block describes requirements for the Quality Assurance of plain or rolled fingerprints including quality assessment of single fingerprint, respectively slap and selection of the best quality image out of multiple instances.

3.6.3.1 Requirements

Quality Algorithm

As quality algorithm NFIQ 2.0 [NFIQ2.0] shall be used. As resulting quality value, the output value of NFIQ 2.0 in the integer range of $[0,100]$ shall be used. In the case of failure, the returned value 255 indicates that a computation was not successful, in this case, the value shall be returned as dedicated error code.

Quality Evaluation Process for a Slap or Single Fingerprint

In case a single captured fingerprint, respectively slap is passed, the quality assessment is performed as described in the following. Beforehand the fingerprints of the passed capture have to be segmented (considering missing fingers). Note, that in verification applications, a quality assessment is not conducted. Thus, every slap capture is considered sufficient and no thresholds are specified here.

1. For each segmented fingerprint $F_{A,j}$ of a passed capture A, a quality value $Q_{A,j}$ is calculated with $j \in \{1,..,10\}$ (up to 4 fingers in one slap) representing the specific finger code according to [ISO_FINGER].
2. The resulting quality value is compared with the defined threshold for this finger. The application specific thresholds TH_j as defined in the following section apply.
3. In case all of the fingerprint qualities reach the specified threshold (i.e. $\forall\, j, Q_{A,j} \geqslant TH_j$), the boolean information $b=1$ indicates a successful capture.
4. In case one or more fingerprints do no reach the threshold (i.e. $\exists\, j, Q_{A,j} < TH_j$), the boolean information $b=0$ indicates insufficient quality of the capture.

5. For the segmented fingerprint $F_{A,j}$ the corresponding parameter set $P_{A,j}$ is compiled and returned.
6. As a result of the quality assurance process, the following values are returned to the calling process:
   a. The boolean information b
   b. The parameter set $P_A = \{Q_{A,j}, \ldots, Q_{A,l}\}$ with $j, l \in \{1, \ldots, 10\}$ representing the specific finger code

Identification of the Best Capture out of Multiple Captures

When multiple captures $A_i, i \in \{1, .., n\}$ and their corresponding set of segmented fingerprints $F_{A_i,j}$ with $j \in \{1, .., 10\}$ representing the specific finger code according to [ISO_FINGER] are passed, the best of the captures is identified as described in the following section.

1. For each segmented fingerprint $F_{A_i,j}$ of a passed capture A_i, the quality value $Q_{A_i,j}$ is calculated with representing the specific finger code according to [ISO_FINGER].
2. The captures are ranked according to the quality values of the fingerprints according to the following (lexicographical) order. The highest ranked capture is considered as the capture yielding the best quality.
   a. for left/right four-finger slaps, the order is as follows:
      i. Index finger (highest priority)
      ii. Middle finger
      iii. Ring finger
      iv. Little finger (lowest priority)
   b. for thumb slaps, the order is as follows:
      i. Right thumb (highest priority)
      ii. Left thumb (lowest priority)
   c. for index finger slaps:
      i. In contrast to the other two slap types, the best capture of an index finger slap is a set of the best captures of each index finger as indicated by the following two options.
      ii. If each index finger yields sufficient quality in at least one of the already conducted captures, the index fingers of sufficient quality are accepted and the total index finger slap capture is considered as of sufficient quality.
      iii. If not both index fingers yield at least once sufficient quality in a capture, the best image for each index finger is returned as the best capture and the slap captured is considered as of insufficient quality.
   d. For rolled single finger captures:
      i. Of the set of captured images obtained in the process beforehand, which are not annotated by a hardware reported issue, the capture with the highest quality value is considered as the best image.
      ii. If the set of captured images obtained in the process beforehand on, does only contain images which are annotated by hardware reported issues, the capture with the highest quality value of the entire set is considered as the best image.
      iii. In case several captures yield to the same highest quality value, the last (temporal) of highest quality captures is considered as the best image.
3. As a result of the quality assurance process, the following values are returned:
   a. The identifier i representing the capture yielding the best quality
   b. The parameter set $P_A = \{Q_{A_i,j}, \ldots, Q_{A_i,l}\}$ with $j, l \in \{1, .., 10\}$

Thresholds for Plain Fingerprints for Enrolment Purposes

The following thresholds as indicated in Table 3-8 apply when fingerprints are captured plain for enrolment purposes. Note, the thresholds in Table 3-8 do not apply to plain captured fingerprint in enrolment

scenarios where the plain fingerprints are capture for control purpose of rolled fingerprints. In that case, thresholds as indicated in Table 3-9 apply for the plain fingerprints.

Finger Position	Finger Code	NFIQ 2.0 Threshold
Right thumb	1	30
Right index finger	2	30
Right middle finger	3	20
Right ring finger	4	10
Right little finger	5	10
Left thumb	6	30
Left index finger	7	30
Left middle finger	8	20
Left ring finger	9	10
Left little finger	10	10

Table 3-8: Thresholds for Plain Fingerprints for Enrolment Purposes

Thresholds for Plain Control Fingerprints and Fingerprints used for Identification Searches

The following thresholds as indicated in Table 3-9 apply when fingerprints are captured plain for the purpose of control slaps (used for comparison with rolled prints) or for use in identification searches. Note, the thresholds in Table 3-9 do apply to plain captured fingerprint in enrolment scenarios where the plain fingerprints are captured for control purpose of rolled fingerprints.

Finger Position	Finger Code	NFIQ 2.0 Threshold
Right thumb	1	20
Right index finger	2	20
Right middle finger	3	20
Right ring finger	4	10
Right little finger	5	10
Left thumb	6	20
Left index finger	7	20
Left middle finger	8	20
Left ring finger	9	10
Left little finger	10	10

Table 3-9: Thresholds for Plain Control /Identification Fingerprints

Thresholds for Rolled Fingerprints

The following thresholds as indicated in Table 3-10 apply when fingerprints are captured rolled for enrolment purposes.

Finger Position	Finger Code	NFIQ 2.0 Threshold
Right thumb	1	20
Right index finger	2	15
Right middle finger	3	15
Right ring finger	4	10
Right little finger	5	5
Left thumb	6	20
Left index finger	7	15
Left middle finger	8	15
Left ring finger	9	10
Left little finger	10	5

Table 3-10: Thresholds for Rolled Fingerprints

3.7 Compression

The objective of the module Compression is to keep the biometric data below a feasible size without losing too much quality for a biometric verification or identification.

3.7.1 COM-PH-JPG

This function block describes requirements and interfaces for the compression of photos using the JPEG format for reference storage.

3.7.1.1 Requirements

The compression method for facial images is JPEG (compare [ISO_10918-1]). The compression algorithm must parametrized that the application specific requirements as listed in Table 3-11 are met by the resulting compressed image. Within the Compression Module multiple lossy compressions are not allowed.

Minimum file size	Recommended compression ratio
Small size image (531x413 pixel)	
25 KiB	20:1
Medium size image (800x600 pixel)	
35 KiB	20:1
Standard size image (1600x1200 pixel)	
100 KiB	20:1

Table 3-11: Requirements to Compression Using JPEG Format

For conformance the implementation encapsulating the compression has to provide an interface that accepts predefined test data instead of performing the regular process.

3.7.2 COM-FP-WSQ

This function block describes requirements and interfaces for the compression of fingerprint images that are used for reference storage or identity checks.

3.7.2.1 Requirements

As compression method for fingerprint images WSQ is used. A bit rate of 0.75 must be used as compression parameter. This is equivalent to a compression factor of approximately 1:15[9] (according to [ISO_FINGER]).

The implementation of the used WSQ algorithm has to be certified by the FBI and has to be referenced by the respective certificate number (coded in the WSQ header). The certified WSQ implementation shall be version 3.1.

Within the Compression Module multiple lossy compressions are not allowed.

9 For estimation of compression factor it is allowed to crop to the minimum size containing the fingerprint defined in FM AH-FP- if a sensor is used with a larger capturing area than this minimum.

3.8 Operation

Within the module Operation, the working process is specified for the respective operator. All steps that have to be executed are described sequentially and in more detail. This also includes descriptions of how to proceed in error cases.

3.8.1 O-PH-ALL

This function block describes requirements to be observed by the official who handles the facial image acquisition process. This includes the full working process.

3.8.1.1 Requirements

3.8.1.1.1 Veto

If the Quality Assurance module rejects the image, the official can give a veto in order to release the image despite a negative software decision. Reasons for this can exist due to software failures or because the biometric requirements cannot be fulfilled for this individual. If an image is provided by a life enrolment station, the operator is allowed to reject the image regardless of the Quality Assurance decision (e.g. failures by the life enrolment station). Optionally, the official can use the photo guideline (see module QA).

3.8.1.1.2 ID Check

In case of scenarios where the facial image is not taken supervised by the official at his counter, e.g. in case of self-service systems, the official shall check that the digital image belongs to the biometric subject.

3.8.2 O-FP-ACQ

This function block describes requirements to be observed by the official who handles the acquisition of fingerprints independent of the purpose of the acquisition.

3.8.2.1 Requirements

3.8.2.1.1 Operation of Devices

It is important to specify requirements that guarantee the correct working process. A calibration of the system may be necessary because of ageing aspects of the components used or through fluctuations of temperature and humidity as well as through transport of the components.

The operator is responsible for an adequate cleanliness of the sensor surface.

3.8.2.1.2 Quality Assurance

The quality assurance for the acquisition of the fingerprints is essentially based on technical functions. However, the official has to consider the following issues. Please note that all figures used within this Function Module are valid for any kind of sensor (single and multi finger devices) which are allowed to be used as specified in the according Function Module.

— The official has to ensure that there is no permutation between the hands or in the following the fingers requested for the image acquisition and the finger actually placed on the sensor.
— The official must assure that the person acquiring fingerprints does not use any finger dummies, fakes or something similar. Therefore, a direct view to the scanner is necessary. It is recommended that the person shows his fingers before starting the acquisition process.
— When capturing flat fingers, the palm shall not be lifted (as shown in Figure 3-19).
— Very dry fingers which only produce poor lines, have to be moisturised (e.g. by breathing upon) and the pressure can be increased. Very wet fingers which produce very strong lines with sweat traces have to be dried.
— For specific environment and especially dry fingers the usage of specialised tools is recommended. With this tools the contrast can be improved by swiping the fingers on it.

Figure 3-19: Example for the Finger Position

— The finger shall be positioned centrally and straight on the fingerprint scanner. An example is given in Figure 3-20.

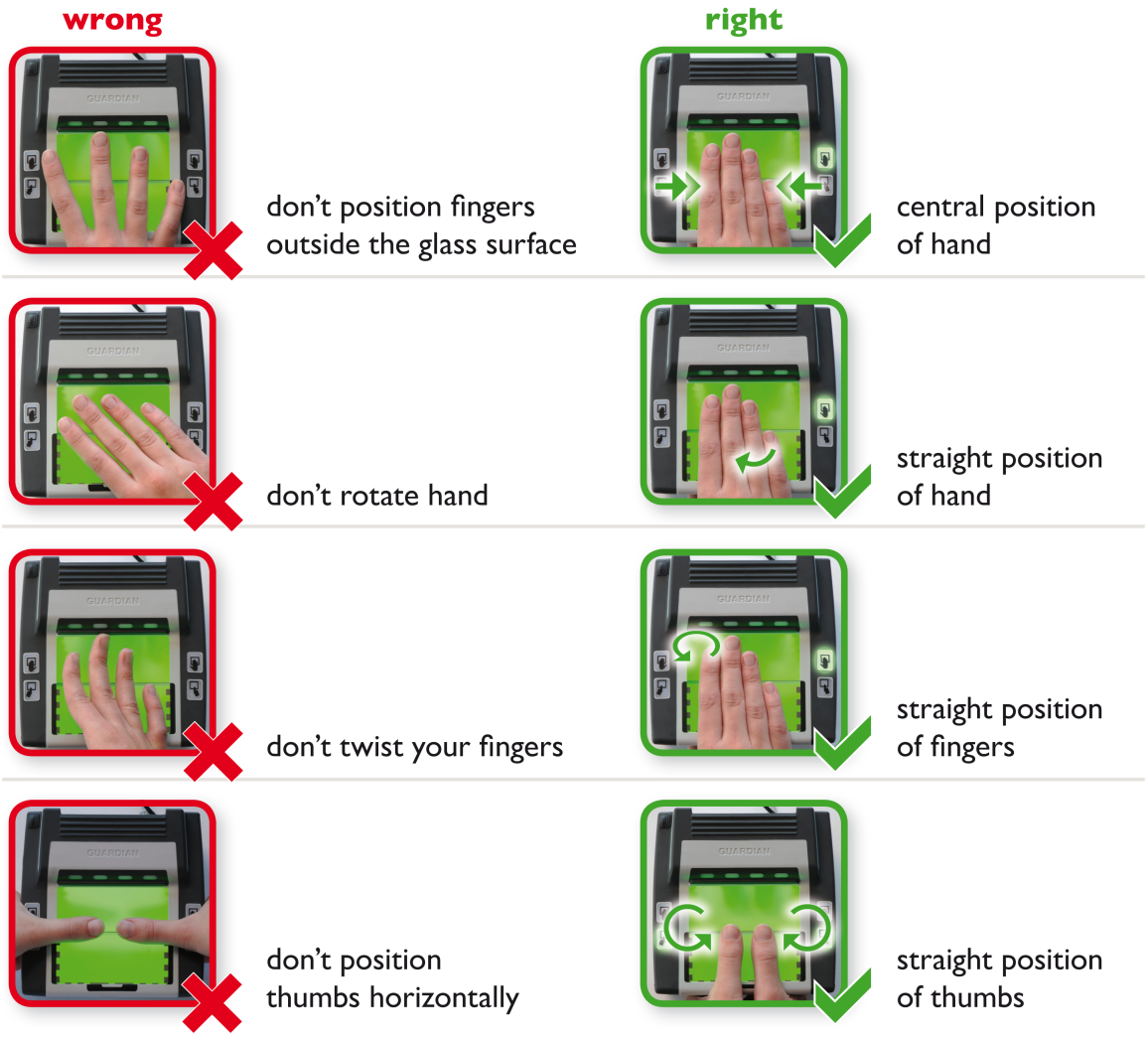

Figure 3-20: Example for the Position of the Hand

3.8.2.1.3 Process Requirements

The acquisition sequence for a fingerprint must be repeated completely, if operating errors have occurred by the official or the person acquiring fingerprints (e.g. if the wrong finger was placed on the sensor, incorrect identification by the official, or the finger was placed too late).

3.8.2.1.4 Process Requirements for Rolled Fingerprints

When rolling fingerprints, the conducting official has to ensure a steady rolling movement of each finger.

3.9 User Interface

It is the task of the User Interface to display and visualise the respective information that is obtained from the underlying Function Modules.

3.9.1 UI-PH-APP

This function block describes requirements for the user interface of the software displaying the result of the Quality Assurance of facial images.

3.9.1.1 Requirements

The module calling the QA module and respectively the graphical user interface (GUI) has to provide the following functions:

- displaying of the current evaluated picture
- displaying of all criteria evaluated with the current value and threshold as well as their relation: OK/NOK for every criterion
- displaying of the summarised result OK/NOK for the current picture
- provision of the veto power for the official
  - enforcement of OK for obvious reasons (e.g. disability)
  - enforcement of OK without obvious reasons

3.9.2 UI-FP-BSJ

This function block describes requirements for the user interface of the biometric subject for fingerprint acquisitions.

3.9.2.1 Requirements

Visual feedback of the acquisition process shall be provided for the biometric subject.

3.9.2.2 Recommendations

The following recommendations should be met for the user interface:

- a visualization which fingerprint / hand to place on the sensor,
- an indicator showing the capture status should be displayed to the biometric subject,
- an indication when the capture process has finished,
- graphics should avoid multiple colours or harsh contrast.
- The acquisition process should be displayed as real time feedback to the biometric subject (e.g. with the help of a feedback monitor).

3.9.3 UI-FP-OFF

This function block describes requirements for the user interface of the software displaying the result of the Quality Assurance of fingerprint images to the official.

3.9.3.1 Requirements

Visual feedback of the fingerprint acquisition at least displaying of the final images shall be provided to the official.

If a control verification or sequence check error occurs, the fingers involved in the unexpected successful comparisons shall be displayed to the official.

In case no successful comparison occurred during the control verification, a warning shall be displayed to the official, that the control verification could not be carried out.

3.9.3.2 Recommendations

The segmented single fingerprints shall be visualised to the official to identify potential failures in segmentation. This can be realised by displaying the result containing up to ten segmented single fingerprints.

The indication of the quality level should be displayed to the official.

3.10 Reference Storage

The objective of this module is to store biometric data in a way that it can be used for reference purposes later on.

3.10.1 REF-PH-AAD

This function block describes requirements how facial images are stored as reference data in the context of the Application Arrival Document.

3.10.1.1 Requirements

The facial image of an applicant is stored in the CIR and made available immediately for further identification requests.

3.10.2 REF-FP-AAD

This function block describes requirements how fingerprint images are stored as reference data within the context of the Application Arrival Document.

3.10.2.1 Requirements

The captured fingerprints of an applicant are stored in the CIR and made available immediately for further identification requests.

3.11 Biometric Comparison

The module Biometric Comparison encloses the mechanisms and algorithms to verify or identify an identity based on a 1:1 or 1:many biometric comparison between reference data and a current biometric sample (usually a live presented image) regardless of where the reference is stored (e.g. passport, identity card, AFIS, database, ...).

3.11.1 CMP-FP-CC

This function block contains requirements for the cross-comparison in order to match plain and rolled captured fingerprints used within the context of the Arrival Attestation Document.

3.11.1.1 Requirements

A fingerprint verification algorithm has to be used for cross-comparison of the plain and rolled captured fingerprints intended for enrolment in the CIR.

The used verification algorithm has to be configured at a security level (threshold) guaranteeing a maximum false match rate (FMR) of at least 0,1 % (1/1000) at a false non-match rate (FNMR) below 2 %. It is allowed to configure a threshold which allows stronger settings (lower FMR and/or FNMR).

Furthermore, the overall system has to be calibrated for the security level set within this specific scenario of verification. The vendor of the verification algorithm has to provide calibration data based on the actual system performance.

Input data of the verification are the segmented plain and rolled captured fingerprints from the applicant. Output of the algorithm is a comparison score for both prints of each captured finger and the result of the verification depending on the configured threshold of the algorithm.

3.12 Logging

The module Logging contains requirements as to which data has to be logged for a specific application.

3.12.1 LOG-ALL-GENERIC

This function block describes requirements and interfaces for the logging of process information for all profiles.

3.12.1.1 Requirements

A transaction shall cover all information concerning one single biometric subject. During the biometric process the following data shall be gathered / created by the application.

- generic process information
  - a globally unique Transaction ID conforming to RFC 4122 Version 1 UUID specification
  - global start time of the transaction (timestamp of the beginning of the biometric process as defined by the application profile)
  - global end time of the transaction (timestamp of the end of the biometric process as defined by the application profile)
  - fully qualified host name (or if not available any other locally unique identifier serving as host name) of the station
  - type of station (e.g. stationary/mobile)
  - location of station[10]
  - the software used in this transaction (biometric component), at least with the following identifiers
    - vendor name

10 The exact semantic of this value is profile-dependent. See the specific profile LOG module for a refined definition.

    - software name
    - version number[11]
    - optional configuration information
  - error code (optional) detailing any abnormal termination of the process
  - a transaction reference if this transaction is dependent or derived from another transaction
- information about any identification processes performed during this transaction
  - start time of the identification process (i.e. beginning of capturing biometric data)
  - submit time of the identification process (i.e. when the captured data is submitted to the backend system for identification)
  - end time of the identification process (i.e. when the results from the backend system are available or the process terminated with a timeout)
  - a list of modalities used for identification
  - the result of the identification
  - the count of candidates available
  - for each candidate
    - the rank of the candidate
    - score and threshold information
  - an error code in case of abnormal termination of the identification process
- information about any enrolment processes performed during this transaction
  - start time of the enrolment process (i.e. beginning of capturing biometric data)
  - optional submit time of the enrolment process (i.e. when the captured data is submitted to the backend for identification). This element shall be present in cases where the central system replies directly with enrolment status information.
  - end time of the enrolment process (i.e. when the process terminated with a timeout)
  - a list of modalities used for enrolment
  - the enrolment status (i.e. whether the subject was enrolled successfully)
  - an error code in case of abnormal termination of the enrolment process
- information about any control verifications performed during enrolment
  - information about any verification processes performed during this transaction
  - start time of the verification process (i.e. beginning of capturing biometric data)
  - end time of the verification process
  - information about the references used for this verification processes (image type, position codes)
  - the verification result
  - for each verification
    - the verification result
    - for each comparison
      - the result of the comparison
      - the duration of the comparison process
      - detailed scoring and threshold information
      - an error code in case of abnormal termination of the comparison process
    - an error code in case of abnormal termination of the verification process
- information about the records collected in this transaction
  - type of record (encoding format)
  - size of record
  - purpose of the record (enrolment, identification, verification)

11 Using a version numbering scheme which allows for proper lexicographic ordering is highly recommended.

The vendor shall provide a detailed list of error codes used with complete semantic descriptions.

3.12.2 LOG-ALL-AAD

This function block describes additional requirements and interfaces for the logging of process information for the application Arrival Attestation Document.

3.12.2.1 Requirements

The following additional data shall be gathered during the biometric process:

- Information about any existing facial images of the applicant in the CIR
  - number of images
  - whether an acceptable image is available and
  - whether any of the acceptable images was used.
- Issuance status of Arrival Attestation Document (i.e. document issued vs. issuance postponed)
- Information whether fingerprints are legally allowed to be captured

The location shall be logged by the name of the city or village where the biometric process takes place.

3.12.3 LOG-PH-GENERIC

This function block describes requirements and interfaces for the logging of information regarding facial images for all profiles.

3.12.3.1 Requirements

Within a transaction for each facial image used for enrolment / verification / identification, the following data items shall be collected:

- the purpose of the acquisition (enrolment, identification, verification)
- start time of the facial acquisition process
- end time of the facial acquisition process
- software components used in this facial acquisition process
- hardware components used in this facial acquisition process
- the source of the facial image under consideration
- the count of face captures performed
- for the best capture, detailed quality information about the result, detailing
  - information about the quality assessment software
  - duration of quality assessment
  - detailed quality values accompanied by
    - identifiers
    - upper and lower value bounds
    - upper and lower threshold bounds
  - any error code in case of abnormal termination of the quality assessment
- information about presentation attack detection (PAD) data during the capture
  - information about the PAD subsystem

  - the overall PAD assessment result
  - for each probe
    - the PAD result
  - detailed PAD quality values accompanied by
  - identifiers
  - upper and lower value bounds
  - upper and lower threshold bounds
- an error code in case of abnormal termination of the facial acquisition process.

The vendor shall provide a detailed list of error codes used with complete semantic descriptions.

3.12.4 LOG-FP-GENERIC

This function block describes requirements and interfaces for the logging of information regarding fingerprint images for all profiles.

3.12.4.1 Requirements

Within a transaction for each set of fingerprints used for enrolment / verification / identification, the following data items shall be collected:

- the purpose of the acquisition (enrolment, identification, verification)
- start time of the fingerprint acquisition process
- end time of the fingerprint acquisition process
- software components used in this fingerprint acquisition process
- hardware components used in this fingerprint acquisition process
- the finger capture mode (flat, rolled, contactless)
- information about missing fingers (in relation to the requirement of the profile)
- information for each capture process for a dedicated fingerprint of slap, detailing
  - fingerprint or slap code
  - duration of the capture
  - information whether this capture satisfies the quality requirements of the profile
  - count of single capture attempts performed for this fingerprint of slap
  - the capture number of the selected fingerprint or slap in case of multiple acquisitions
  - results from the control verification process for each finger (e.g. when comparing a rolled image against a finger extracted from a control slap)
  - for each capture attempt, detailing
    - whether this was an acceptable capture attempt (from the application software perspective, independent of the quality assessment)
    - the duration of the capture attempt
    - in case of an unacceptable capture attempt
      - the reason for rejection this capture attempt
      - an error code detailing the reason of rejection
- For the best capture attempt, detailed quality information about the result shall be logged. For all other capture attempts detailed quality information, if calculated during the process, should be logged:
  - information about the quality assessment software
  - duration of quality assessment
  - detailed quality values in the range 0-100

  - fingerprint or slap code
  - any error code in case of abnormal termination of the quality assessment
- uniqueness check information, detailing
  - information about the uniqueness check algorithm
  - the configured security level
  - information about potential duplicates including finger codes and detailed scoring information
  - any error code in case of abnormal termination of the uniqueness check
- information about presentation attack detection (PAD) data during the capture
  - information about the PAD subsystem
  - the overall PAD assessment result
  - for each probe
    - the PAD result
    - detailed PAD quality values accompanied by
    - identifiers
    - upper and lower value bounds
    - upper and lower threshold bounds
  - an error code in case of abnormal termination of the fingerprint acquisition process.

The vendor shall provide a detailed list of error codes used with complete semantic descriptions.

Within a transaction for each capture attempt acquired for enrolment / verification / identification, detailed information about the quality, if calculated during the process, should be logged:

- information about the quality assessment software
- duration of quality assessment
- detailed quality values in the range 0-100
- fingerprint or slap code
- any error code in case of abnormal termination of the quality assessment

3.13 Coding

This module contains the procedures to encode quality data as well as biometric data in defined formats. Interoperability is provided by means of standard compliant coding.

3.13.1 COD-ALL-GENERIC

This function block describes requirements and interfaces for the overall coding of biometric and biographic data used for all application profiles.

3.13.1.1 Requirements

The logging data as defined by the FM LOG is encoded in XML according to the schema definitions published alongside to this Technical Guideline.

3.13.2 COD-ALL-AAD

This function block describes requirements and interfaces for the overall coding of biometric and biographic data used within the context of the Arrival Attestation Document.

3.13.2.1 Requirements on Biometric and Biographic Data Encoding for the Central Foreigners Register

Biographic data and the facial image is delivered to the Central Foreigners Register in the compressed format as defined by FM COM with further encoding.

3.13.2.2 Requirements on Biometric and Biographic Data Encoding in GSAT 3

In general the XML-based standard [GSAT3] does apply for coding of both biometric and biographic data of an applicant and process related data. Depending on the biometric modality, the corresponding coding function module and the declared mandatory data fields have to be considered.

3.13.2.2.1 Requirements for the Package Information Record

The root element for the Package Information Record is defined as `itl:PackageInformationRecord` which includes the elements containing the relevant data.

Being part of the entire GSAT transaction message, this element is placed within the main root element `itl:NISTBiometricInformationExchangePackage`.

The following section addresses data coding for the Package Information Record. The elements listed in Table 3-12 are mandatory and have to be filled accordingly. For reference, the first column of the tables lists the specific mnemonic code.

Code	Relative XPath from root element	Description/Content
N/A	`ansi-nist:RecordCategoryCode`	Defines the type of this record (by default 1)
N/A	`int-i:Transaction`	The transaction element

Table 3-12: Mandatory Elements Included in Root Element `itl:PackageInformationRecord`

The mandatory elements containing the actual facial image data and corresponding information are included in the sub-element `int-i:Transaction` as listed in Table 3-13.

Code	Relative XPath from **`int-i:Transaction`**	Description/Content
DAT	`ansi-nist:TransactionDate/nc:Date`	Date of transaction

DAI	`ansi-nist:TransactionDestinationOrganization/`
	`nc:OrganizationIdentification/`
	`nc:IdentificationID`
	
	`ansi-nist:TransactionDestinationOrganization/`
	`nc:OrganizationLocation/`
	`nc:LocationAddress/`
	`nc:StructuredAddress/`
	`nc:LocationCountryISO3166Alpha3Code`
		Identification ID and country code of the destination organization

ORI	`ansi-nist:TransactionOriginatingOrganization/`
	`nc:OrganizationIdentification/`
	`nc:IdentificationID`
	
	`ansi-nist:TransactionOriginatingOrganization/`
		Identification ID and country code of the originating organization

Code	Relative XPath from `int-i:Transaction`	Description/Content

	`nc:OrganizationLocation/`
	`nc:LocationAddress/`
	`nc:StructuredAddress/`
	`nc:LocationCountryISO3166Alpha3Code`	

GMT	`ansi-nist:TransactionUTCDate/nc:DateTime`	Date and time of transaction in UTC
TCN	`ansi-nist:TransactionControlIdentification/` `nc:IdentificationID`	Transaction control number

DOM	`ansi-nist:TransactionDomain/`
	`ansi-nist:DomainVersionNumberIdentification/`
	`nc:IdentificationID`
	`ansi-nist:TransactionDomain/`
	`ansi-nist:DomainVersionNumberIdentification/`
	`ansi-nist:OrganizationName`
		Transaction domain version number and organization name

NSR	`ansi-nist:TransactionImageResolutionDetails/` `ansi-nist:NativeScanningResolutionValue`	The native scanning resolution value
NTR	`ansi-nist:TransactionImageResolutionDetails/` `ansi-nist:NominalTransmittingResolutionValue`	The native transmitting resolution value
VER	`ansi-nist:TransactionMajorVersionValue` `ansi-nist:TransactionMinorVersionValue`	Major and minor version value
PRY	`ansi-nist:TransactionPriorityValue`	The transaction priority
CNT	`ansi-nist:TransactionContentSummary/*`	The content summary of all records included in this transaction as defined by the schema
TOT	`int-i:TransactionAugmentation/` `int-i:TransactionCategoryCode`	Type of transaction

Table 3-13: Mandatory Elements Included in Element `int-i:Transaction`

3.13.2.2.2 Requirements for the Package Descriptive Text Record

The root element for the Package Descriptive Text Record is defined as `itl:PackageDescriptiveTextRecord` which includes the elements containing the relevant data.

Being part of the entire GSAT transaction message, this element is placed within the main root element `itl:NISTBiometricInformationExchangePackage`.

The following section addresses data coding for the Package Descriptive Text Record. The elements listed in Table 3-14 and Table 3-15 are mandatory and have to be filled accordingly. For reference, the first column of the tables lists the specific mnemonic code.

Code	Relative XPath from root element	Description/Content
N/A	`ansi-nist:RecordCategoryCode`	Defines the type of this record (by default 2)
IDC	`ansi-nist:ImageReferenceIdentification/`	Identifier for image reference

	nc:IdentificationID	
N/A	itl:UserDefinedDescriptiveText/ gsat:DomainDefinedDescriptiveFields	The domain defined descriptive fields as defined by the GSAT standard

Table 3-14: Mandatory Elements Included in Root Element `itl:PackageDescriptiveTextRecord`

The mandatory elements containing the actual facial image data and corresponding information are included in the sub-element `gsat:DomainDefinedDescriptiveFields` as listed in Table 3-15.

Code	Relative XPath from **gsat:DomainDefinedDescriptiveFields**	Description/Content
For identification and enrolment		
DPR	int-i:RecordActivity/ ansi-nist:CaptureDate/nc:Date	Date of capture
OBU	int-i:RecordActivity/ ansi-nist:CaptureOrganization/ nc:OrganizationName int-i:RecordActivity/ ansi-nist:CaptureOrganization/ nc:OrganizationLocation/ nc:LocationAddress/ nc:StructuredAddress/ nc:LocationCityName int-i:RecordActivity/ ansi-nist:CaptureOrganization/ nc:OrganizationLocation/ nc:LocationAddress/ nc:StructuredAddress/ nc:LocationCountryISO3166Alpha3Code	Owning bureau with organization name, city name and country code
SEX	gsat:RecordSubject/ int-i:PersonSexCode	Person sex code
PCN	gsat:TransactionMetadata/ gsat:PersonalControlNumber/ nc:IdentificationID	Personal control number
PTM	gsat:TransactionMetadata/ gsat:ProcessType/ gsat:SystemInformation/ gsat:System gsat:TransactionMetadata/ gsat:ProcessType/ gsat:SystemInformation/ gsat:Search/ gsat:Partition gsat:TransactionMetadata/ gsat:ProcessType/ gsat:SystemInformation/ gsat:Storage/ gsat:Partition	Process type matrix (for identification with search, for enrolment with storage)
For enrolment only		
RFP	int-i:RecordActivity/ nc:ActivityReasonText	Reason fingerprinted

Code	Relative XPath from `gsat:DomainDefinedDescriptiveFields`	Description/Content

DOB	`gsat:RecordSubject/`
	`nc:PersonBirthDate/`
	`nc:Date`
		Date of birth, if known

DBR	`gsat:RecordSubject/`
	`int-i:PersonBirthDateRange/`
	`nc:StartDate/`
	`nc:Date`
	
	`gsat:RecordSubject/`
	`int-i:PersonBirthDateRange/`
	`nc:EndDate/`
	`nc:Date`
		Date of birth range, this field shall only be used if and only if DOB is unknown

POB	`gsat:RecordSubject/`
	`nc:PersonBirthLocation/`
	`nc:LocationAddress/`
	`nc:StructuredAddress/`
	`nc:LocationCityName`
	
	`gsat:RecordSubject/`
	`nc:PersonBirthLocation/`
	`nc:LocationAddress/`
	`nc:StructuredAddress/`
	`nc:LocationCountryISO3166Alpha3Code`
		Place of birth with city name and country code

NAT	`gsat:RecordSubject/` `nc:PersonCitizenshipISO3166Alpha3Code`	Nationality of subject

NAM	`gsat:RecordSubject/int-i:PersonName/`
	`nc:PersonNamePrefixText`
	
	`gsat:RecordSubject/int-i:PersonName/`
	`nc:PersonGivenName`
	
	`gsat:RecordSubject/int-i:PersonName/`
	`nc:PersonMiddleName`
	
	`gsat:RecordSubject/int-i:PersonName/`
	`nc:PersonSurName`
	
	`gsat:RecordSubject/int-i:PersonName/`
	`nc:PersonNameSuffixText`
	
	`gsat:RecordSubject/int-i:PersonName/`
	`nc:PersonMaidenName`
	
	`gsat:RecordSubject/int-i:PersonName/`
	`int-i:PersonExtendedName`
		Name of subject

OTY	`int-i:RecordOffense/`
	`int-i:OffenseDescriptionText`
	
	`int-i:RecordOffense/`
	`int-i:OffenseLocation/`
	`nc:LocationAddress/`
	`nc:AddressFullText`
	
	`int-i:RecordOffense/`
	`int-i:OffenseDateTime/`
	`nc:DateTime`
		Offense type with description text, location with full address and date with time information

MN1	`gsat:RecordMetadata/`
	`gsat:MiscellaneousIdentification/`
	`gsat:EurodacNumber`
		The EURODAC number, if already present, at the time of enrolment for the CIR

Code	Relative XPath from **gsat:DomainDefinedDescriptiveFields**	Description/Content
PAA	gsat:TransactionMetadata/ gsat:PlaceOfApplication/ nc:LocationAddress/ nc:StructuredAddress/ nc:LocationStreet/ nc:StreetNumberText gsat:TransactionMetadata/ gsat:PlaceOfApplication/ nc:LocationAddress/ nc:StructuredAddress/ nc:LocationStreet/ nc:StreetName gsat:TransactionMetadata/ gsat:PlaceOfApplication/ nc:LocationAddress/ nc:StructuredAddress/ nc:LocationCityName gsat:TransactionMetadata/ gsat:PlaceOfApplication/ nc:LocationAddress/ nc:StructuredAddress/ nc:LocationPostalCode	Place of application with street, street number, city and postal code
DAA	gsat:TransactionMetadata/ gsat:DateOfApplication/ nc:DateTime	Date of application
NOO	gsat:TransactionMetadata/ gsat:OfficerInCharge/ nc:PersonGivenName gsat:TransactionMetadata/ gsat:OfficerInCharge/ nc:PersonSurName gsat:TransactionMetadata/ gsat:OfficerInCharge/ nc:ContactTelephoneNumber/ nc:FullTelephoneNumber/ nc:TelephoneNumberFullID	Officer in charge, with full name and telephone number

Table 3-15: Mandatory Elements Included in Element `int-i:Transaction`

3.13.2.3 Requirements on Encoding Logging Data

The logging data as defined by the FM LOG is encoded is XML according to the schema definition as `aad-app` element. The XML encoding is defined by the XML schema definition in the file „aad4v3.xsd“ and referenced schema files.

All log data has to be encoded as far as it is available throughout the acquisition process (e.g. fingerprint quality data is encoded if and only if fingerprint capture was performed).

The GSAT transaction container shall be embedded in the XML log (`XMLRecord` element) for conformance testing of the encoding.

3.13.3 COD-PH-GSAT3

This function block describes requirements and interfaces for the coding of facial images according to the German Standard for AFIS transactions in XML format.

3.13.3.1 Requirements on Encoding

For data format and encoding, the XML-based standard [GSAT3] does apply. The root element for facial image data is defined as `itl:PackageFacialAndSMTImageRecord` which includes the elements containing the relevant data.

Being part of the entire GSAT transaction message, this element is placed within the main root element `itl:NISTBiometricInformationExchangePackage`.

The following section addresses data coding for the purpose of storing facial images within the CIR. The elements listed in Table 3-16 and Table 3-17 are mandatory and have to be filled accordingly. For reference, the first column of the tables lists the specific mnemonic code.

Code	Relative XPath from root element	Description/Content
N/A	`ansi-nist:RecordCategoryCode`	Defines the type of this record (by default 10)
IDC	`ansi-nist:ImageReferenceIdentification/ nc:IdentificationID`	Identifier for image reference
N/A	`itl:FaceImage`	Sub-element containing data of the actual facial image (refer to Table 3-17)

Table 3-16: Mandatory Elements Included in Root Element `itl:PackageFacialAndSMTImageRecord`

The mandatory elements containing the actual facial image data and corresponding information are included in the sub-element `itl:FaceImage` as listed in Table 3-17.

Code	Relative XPath from sub-element `itl:FaceImage`	Description/Content
DAT	`nc:BinaryBase64Object`	The base64-coded facial image with a fixed size of 800x600 pixels
PHD	`ansi-nist:ImageCaptureDetail/ ansi-nist:CaptureDate/nc:Date`	Date of capture

SRC	`ansi-nist:ImageCaptureDetail/ ansi-nist:CaptureOrganization/ nc:OrganizationIdentification/ nc:IdentificationID`
	
	`ansi-nist:ImageCaptureDetail/ ansi-nist:CaptureOrganization/ nc:OrganizationLocation/ nc:LocationAddress/ nc:StructuredAddress/ nc:LocationCountryISO3166Alpha3Code`
		Identification ID and country code of the organization that captured the image

CSP	`ansi-nist:ImageColorSpaceCode`	Image color space code
CGA	`ansi-nist:ImageCompressionAlgorithmText`	Used compression algorithm

Code	Relative XPath from sub-element `itl:FaceImage`	Description/Content
HLL	`ansi-nist:ImageHorizontalLineLengthPixelQuantity`	Horizontal pixel count
HPS	`ansi-nist:ImageHorizontalPixelDensityValue`	Horizontal pixel density
SLC	`ansi-nist:ImageScaleUnitsCode`	Pixel density scale unit code
IMT	`ansi-nist:ImageCategoryCode`	Image category code
VLL	`ansi-nist:ImageVerticalLineLengthPixelQuantity`	Vertical pixel count
VPS	`ansi-nist:ImageVerticalPixelDensityValue`	Vertical pixel density
SAP	`ansi-nist:FaceImageAcquisitionProfileCode`	Subject acquisition profile

Table 3-17: Mandatory Elements Included in Sub-Element `itl:FaceImage`

3.13.4 COD-FP-GSAT3

This function block describes requirements and interfaces for the coding of fingerprint images according to the German Standard for AFIS transactions in XML format.

3.13.4.1 Requirements

For data format and encoding, the standard [GSAT3] does apply. The root element for fingerprint data is defined as `itl:PackageFingerprintImageRecord` which includes the elements containing the relevant data.

Being part of the entire GSAT transaction message, an element for each captured fingerprint is placed within the main root element `itl:NISTBiometricInformationExchangePackage`.

The following section illustrates the data coding for the purpose of fingerprint for both enrolment and identification within the CIR. For both purposes, the elements listed in Table 3-18 and Table 3-19 are mandatory and have to be filled accordingly.

Note, in enrolment scenarios missing fingers shall be indicated by special recode types indicating the missing fingers. In identification scenarios, missing should not be indicated by special recode types.

For enrolment transactions, the ten rolled fingerprints and plain control slaps shall be included in the GSAT transaction, except for cases where the acquisition of plain control slaps was conducted in single finger acquisition mode, e.g. if the person is physically not capable to place all fingers of the slap on the acquisition hardware. In this case, the single finger control images shall not be included in the enrolment transaction.

Code	Relative XPath from root element	Description/Content
N/A	`ansi-nist:RecordCategoryCode`	Defines the Type of this record (by default 14)
IDC	`ansi-nist:ImageReferenceIdentification/ nc:IdentificationID`	Identifier for image reference
N/A	`itl:FingerprintImage`	Sub-element containing data of the actual fingerprint image

Table 3-18: Mandatory Elements Included in Root Element `itl:PackageFingerprintImageRecord`

The mandatory elements containing the actual fingerprint image data and corresponding information are included in the sub-element `itl:FingerprintImage` as listed in Table 3-19.

Code	Relative XPath from root element	Description/Content
DAT	`nc:BinaryBase64Object`	Contains the base64-coded fingerprint image
BPX	`ansi-nist:ImageBitsPerPixelQuantity`	Bits per pixel ratio
FCD	`ansi-nist:ImageCaptureDetail/ ansi-nist:CaptureDate/nc:Date`	Date of capture

SRC	`ansi-nist:ImageCaptureDetail/ ansi-nist:CaptureOrganization/ nc:OrganizationIdentification/ nc:IdentificationID`
	
	`ansi-nist:ImageCaptureDetail/ ansi-nist:CaptureOrganization/ nc:OrganizationLocation/ nc:LocationAddress/ nc:StructuredAddress/ nc:LocationCountryISO3166Alpha3Code`
		Identifier and country code of the organization that captured the fingerprints

CGA	`ansi-nist:ImageCompressionAlgorithmText`	Used compression algorithm
HLL	`ansi-nist:ImageHorizontalLineLengthPixelQuantity`	Horizontal pixel count
HPS	`ansi-nist:ImageHorizontalPixelDensityValue`	Horizontal pixel density
SLC	`ansi-nist:ImageScaleUnitsCode`	Pixel density scale unit code
VLL	`ansi-nist:ImageVerticalLineLengthPixelQuantity`	Vertical pixel count
VPS	`ansi-nist:ImageVerticalPixelDensityValue`	Vertical pixel density
IMP	`ansi-nist:FingerprintImageImpressionCaptureCategoryCode`	Indicator of how the fingerprint was captured
FGP	`ansi-nist:FingerPositionCode`	Finger position code
AMP	`itl:FingerprintImageFingerMissing/ ansi-nist:FingerPositionCode>` `itl:FingerprintImageFingerMissing/ itl:FingerMissingCode`	Information about missing fingers. AMP blocks shall be present for all fingers that are marked missing by the application

Table 3-19: Mandatory Elements Included in Sub-Element itl:FingerprintImage

3.13.4.2 Example

The subsequent example illustrates the encoding of an amputated finger.

```
<itl:PackageFingerprintImageRecord>
       <ansi-nist:RecordCategoryCode>14</ansi-nist:RecordCategoryCode>
       <ansi-nist:ImageReferenceIdentification>
       <nc:IdentificationID>14</nc:IdentificationID>
       </ansi-nist:ImageReferenceIdentification>
       <itl:FingerprintImage>
              <ansi-nist:FingerprintImageImpressionCaptureCategoryCode>0</ansi-
nist:FingerprintImageImpressionCaptureCategoryCode>
              <ansi-nist:FingerPositionCode>10</ansi-nist:FingerPositionCode>
              <itl:FingerprintImageFingerMissing>
                     <ansi-nist:FingerPositionCode>10</ansi-nist:FingerPositionCode>
                     <itl:FingerMissingCode>XX</itl:FingerMissingCode>
              </itl:FingerprintImageFingerMissing>
       </itl:FingerprintImage>
</itl:PackageFingerprintImageRecord>
```

3.14 Evaluation

Methods and interfaces which are used in the scope of evaluation are the content of this Function Module.

3.14.1 EVA-ALL-GENERIC

This function module defines general requirements for evaluations realized by plots, graphics and tables.

3.14.1.1 Requirements

The general requirements for plots, graphics, tables etc. defined in this module shall apply for all evaluations if not overruled by evaluation specific requirements.

3.14.1.2 Representation of Component Information

If an evaluation specification requires to use information of an XML-element of type `type.component`, e.g. for a software or hardware, a string concatenation of its child elements `Vendor, Name, Version` and `FirmwareVersion` shall be used to represent the XML-element of type `type.component`. If a child element is empty, this child element shall be excluded from the string representation.

If the child element `ConfigurationInformation` is used for the application, the configuration information shall be added to the string representation if reasonable for the specific evaluation e.g. if the configuration parameter may influence the aspects addressed by the specific evaluation.

The elements of the string representation shall be separated by ",".

3.14.1.3 Number and Date Formatting

The following applies for all numbers in plots, graphics and tables:

- The "." or a blank shall be used as thousands separator.
- The "," shall be used as decimal separator.
- Small numerics, i.e. smaller than 10^{-4}, should be denoted in scientific notation e.g. $5{,}34*10^{-7}$.
- Large numerics, i.e. bigger than 10^{6}, should be denoted in scientific notation or by reasonable abbreviations e.g. "m" for million.
- Decimal fractions should be rounded to not more than two digits.
- Relative frequencies shall be noted as decimal.

The following applies for all numbers in tables:

- Leading zeros in the table body's cells should be omitted for decimal fractions e.g. ",34" instead of
- "0,34".

The following applies for all dates in plots, graphics and tables:

- The order of date components shall be (year, month, day). Note, that not all components are required.
- Day, month and year components shall be numeric.
- The "." shall be used as separator between numeric components.
- Leading zeros shall be used to fill up numeric months and days to two digits.
- Years shall be presented by four digits.

3.14.1.4 Use of Colours

Colours used in plots and graphics shall meet the following requirements:

- The used colours shall be consistent over all plots and graphics generated. Colours shall be consistent over variable types, i.e. the same colour schema shall be used for the same variable type in different plots and graphics.
- Colours commonly connoted with specific attributes shall be used only in coherence to the coloured object's meaning e.g. a plot or graphic object indicating an error fraction shall not be coloured green.
- If no need to use more than one colour in a plot or graphic, e.g. to distinguish different types of plot elements by colour or to emphasis the denotation of an element by colour, the default colour should be black.
- If more than one colour is used in a plot, a meaningful legend shall explain the applied colour schema.

Two recommanded colour palettes for e.g. line colours or stacked bar plot partitions are given in Table 3-20.

Palette 1 Hex Colour Codes	Palette 2 RGB Colour Codes
#3E647D	255, 200, 25
#7B92A8	242, 133, 2

Palette 1 Hex Colour Codes	Palette 2 RGB Colour Codes
#82C0E9	196, 0, 70
#2D6D66	137, 13, 72
#BFA19C	0, 184, 242
#008BBC	7, 120, 165
#97B6B0	0, 79,128
#D7D29E	116, 185, 23
#1A476F	35, 97, 78
#90353B	107, 117, 129
#9C8847	
#938DD2	
#6E8E84	
#C10534	
#CAC27E	

Table 3-20: Recommended Colour Palettes

3.14.1.5 Definitions of Terms

- The term “Geographic Region” shall be defined according to [UN REGIO].

3.14.1.6 Trimmed Values

For trimming of values the following applies:

- Trimming of values shall only be allowed for input variables of plots and graphics to e.g. remove outliers.
- Trimming of values shall not be allowed for any kind of variables in table presentation, especially in lookup tables.
- In case plot input variables have been trimmed, the trimming method and parameters as well as the number of excluded observation shall be denoted as remark at the resulting plot or graphic.
- Trimming in context of this document refers to omitting the visualisation of the trimmed data e.g. for a box plot, the median and quartiles of the box shall still be calculated based on the total data but not on the trimmed data. However, the trimmed data points shall not be depicted in the box plot as outliers.

3.14.1.7 Plots, Graphics and Tables in General

The following applies for all plots, graphics and tables:

- An explanatory description for each plot, graphic and table shall be given within a generated report.
- Every plot, graphic or table shall have a meaningful caption or heading.
- If finger codes are used, they shall be explained at the plot, graphic or table e.g. by a label or footnote.
- The units of axis, cell values and other metrics shall be denoted either at each value or annotated as e.g. footmark or label of axis, rows, columns.

3.14.1.8 Plots and Graphics in General

The following applies for all plots and graphics:

- Every axis of a plot or graphic shall have a meaningful labelling.
- If not specifically defined by the plot definition, plot axis and their labels shall be scaled and chosen meaningful.
- Every plot with multiple colours or other means of coding to distinguish elements shall have a meaningful legend explaining the coding.
- If an axis range is defined on an interval, e.g. [0,1] or [0,100], the respective axis shall be scaled for the full interval e.g. quality scores (0 to 100) or relative frequencies (0 to 1).

3.14.1.9 Plot and Graphic Types

The following plot and graphic types may be used by evaluation modules. The subsequent general plot and graphic requirement applies if not otherwise specified by the specific evaluation.

Pie Chart

It is recommended to use stacked bar plots instead of pie charts.

Heat Map

A heat map depicts the values of a matrix by colours. Thereby, the following applies:

The matrix cell values are mapped to a colour via two steps. Step 1 maps every cell value to a value in the range [0,1]. Step 2 maps every value within the range [0,1] to a heat colour. The exact computation shall be conducted in the following way:

- Step 0
  - If negative cell values are given in the relevant matrix, Step 0 shall be executed before the other Step 1 and 2.
  - Step 0 shall subtract from every cell value the minimum value of the column (case 1), the row (case 2) or of the whole matrix (case 3). In this way all values are mapped to non-negative numbers. Then all the other computations shall build on the non-negative cell values.
- Step 1
  - The matrix shall depict the values of the cells relatively to a given maximum value. Three types of modalities are possible: The cell values colours can orientate on

        - the maximum value in their column (case 1) or
        - the maximum value in their row (case 2) or
        - the maximum value of the entire matrix (case 3).
    - Which of the possible cases shall be considered is defined in the specifications of this Technical Guideline for the respective heat map by the “Colour” attribute. It shall be visible to the viewer of heat map if the maximum of the columns, the rows or the entire table is considered. This can be done by a legend to the plot or a footnote.
    - Every cell value shall be divided by …
        - the maximal value of the column (case 1)
        - the maximal value of the row (case 2)
        - the maximal value of the hole matrix (case 3)
    - In this way every cell is mapped to a value in the range [0,1]. Every maximal value is mapped to the value 1. Please note that this computation shall only be used to compute the heat map colour and shall not be used to label the cells itself (except for the case that it is the same value).
- Step 2
    - The values derived in Step 1 shall be mapped to a colour following the mapping defined in Table 3-21. Every maximal value of the column (case 1), of the row (case 2) or of the entire matrix (case 3) shall be coloured in #FF0000. Note, multiple maxima are possible.

ID	Value Interval	Corresponding colour of the Heat Map Cell
1	[0, 0.05]	#FFFFE6
2	(0.05, 0.1]	#FFFFB3
3	(0.1, 0.15]	#FFFF80
4	(0.15, 0.2]	#FFFF4D
5	(0.2, 0.25]	#FFFF19
6	(0.25, 0.3]	#FFFF00
7	(0.3, 0.35]	#FFED00
8	(0.35, 0.4]	#FFDB00
9	(0.4, 0.45]	#FFC800
10	(0.45, 0.5]	#FFB600
11	(0.5, 0.55]	#FFA400
12	(0.55, 0.6]	#FF9200
13	(0.6, 0.65]	#FF8000
14	(0.65, 0.7]	#FF6D00

ID	Value Interval	Corresponding colour of the Heat Map Cell
15	(0.7, 0.75]	#FF5B00
16	(0.75, 0.8]	#FF4900
17	(0.8, 0.85]	#FF3700
18	(0.85, 0.9]	#FF2400
19	(0.9, 0.95]	#FF1200
20	(0.95, 1]	#FF0000

Table 3-21: Heat Map Colours

An exemplary heat map is depicted in Figure 3-21. In this example the colours of the cells are derived relatively to the maximum value of the matrix (case 3) which occurs in the fourth row and the fourth column of the matrix.

Var2	Var1						
	val1	val2	val3	val4	val5	val6	val7
val1							
val2							
val3							
val4							
val5							
val6							
val7							

Figure 3-21: Example Heat Map

Box Plot

A box plot depicts distributions by central distribution metrics. Thereby, the following applies:

- The lower whisker shall be at maximum within a 1.5 inter quartile range from the lowest quartile and the higher whisker shall be within a 1.5 inter quartile range from the highest quartile.
- Outliers should be depicted as black filled dots with 33% transparency.

An exemplary box plot is depicted in Figure 3-22.

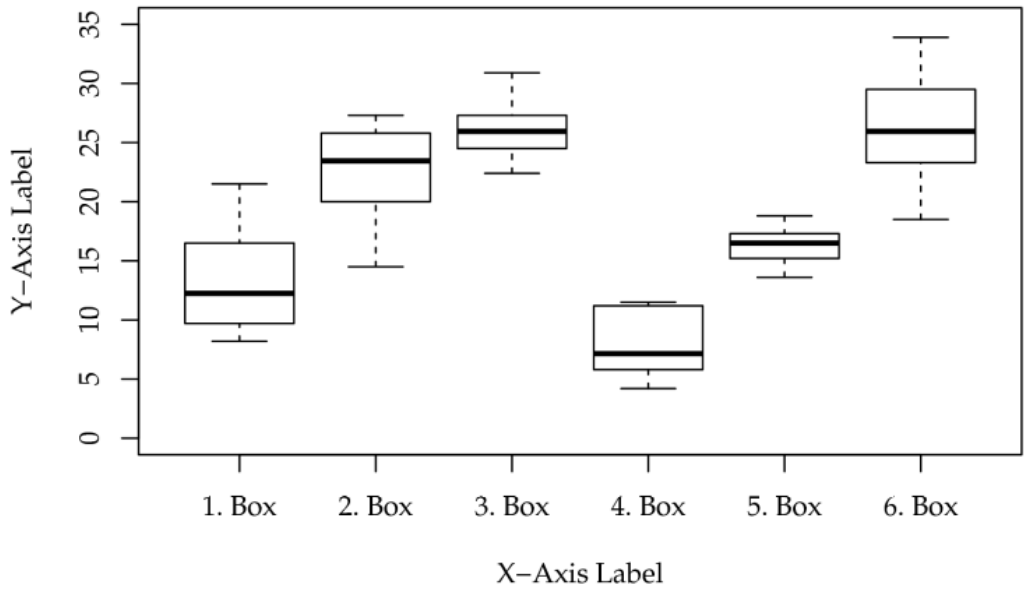

Figure 3-22: Example Box Plot

Scatter Plot

A scatter plot depicts two dimensional data points on an X- and Y-axis. Thereby, the following applies:

- Data points shall be depicted as filled dots with 33% transparency.

An exemplary scatter plot is depicted in Figure 3-23.

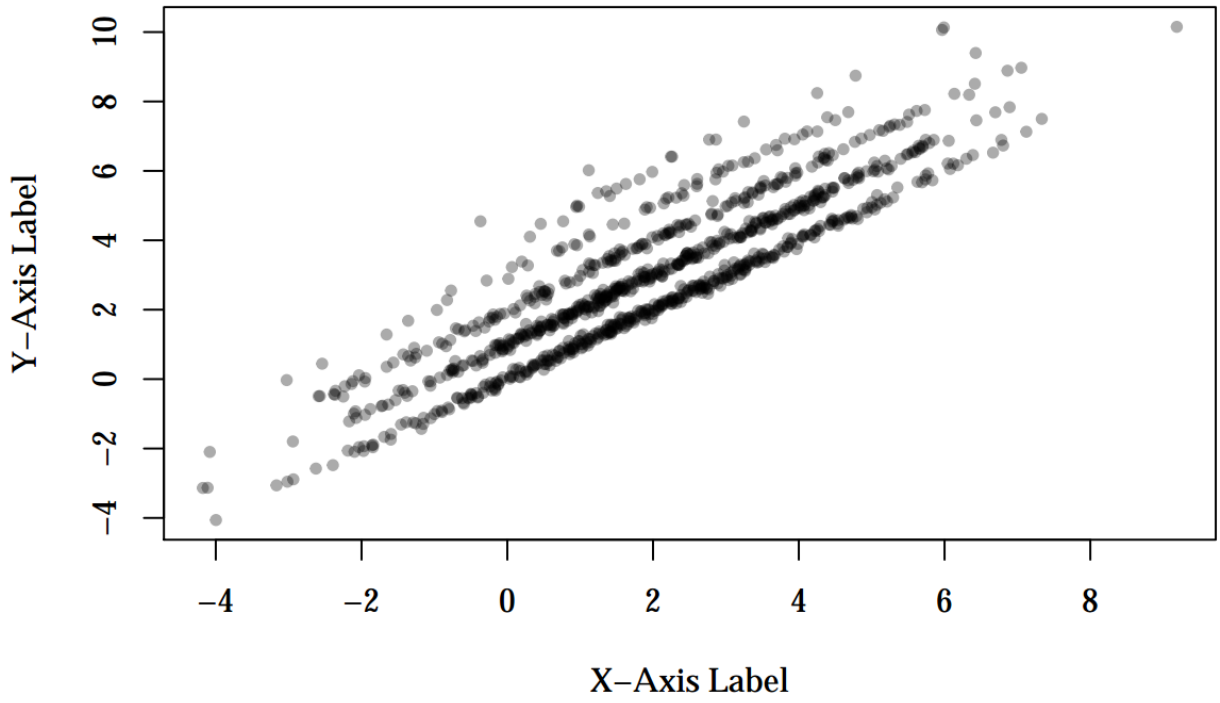

Figure 3-23: Example Scatter Plot

Line Plot

A line plot depicts two dimensional data points on an X- and Y-axis. Thereby, the following applies:

- Data points shall be connected by straight lines.
- Data points shall be visible i.e. not only the line shall be depicted.

An exemplary line plot is depicted in Figure 3-24.

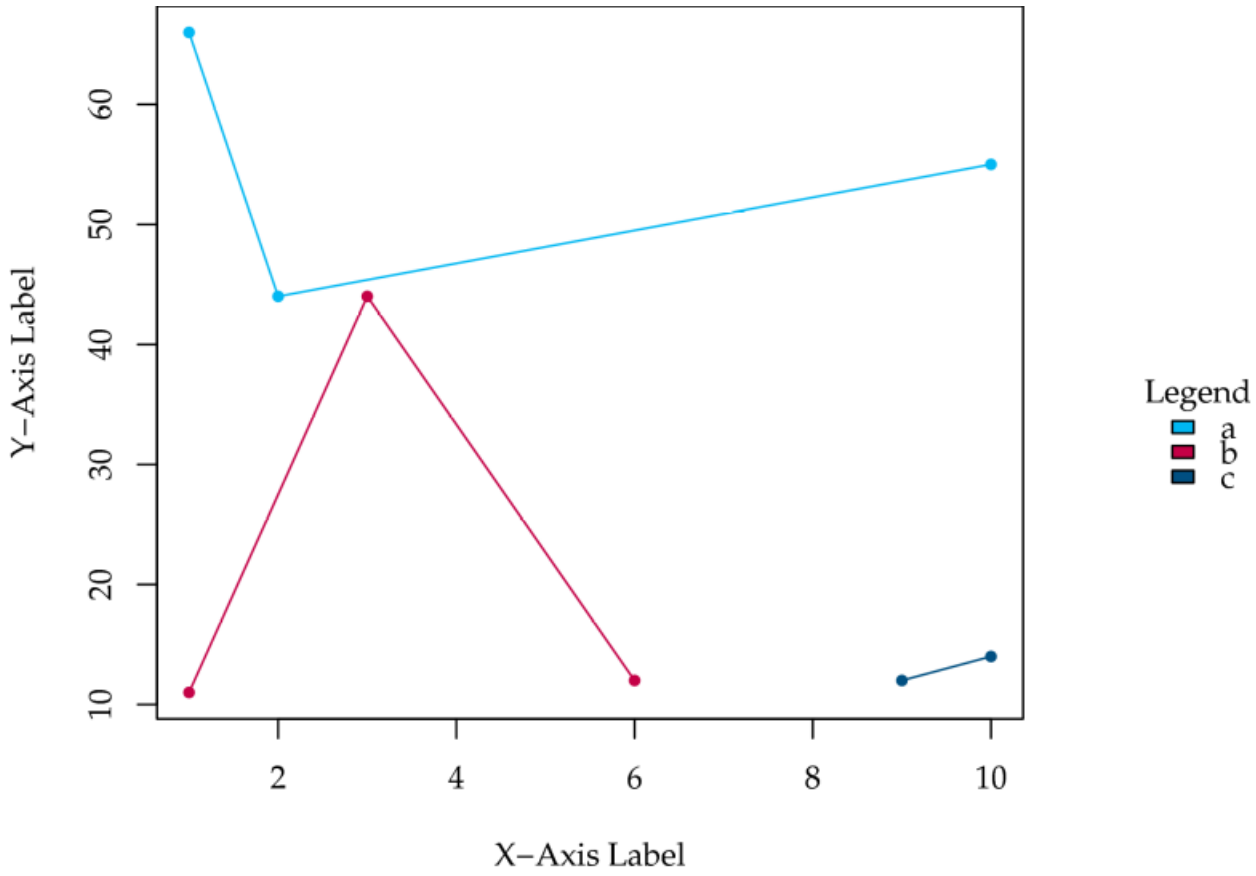

Figure 3-24: Example Line Plot

Histogram

A histogram is composed of vertical columns plotted on a graph for which the following applies:

- Histograms shall be based on continuous variables.
- It is recommended that there is no space between adjacent columns.
- The X-axis labels shall be single values or a range of value descriptions, i.e. bin names.
- The height of each individual column indicates the size of the group defined by the column bin.
- The Y-axis shall be located at the left hand side of the histogram.
- The median of the input variable shall be indicated by a red solid vertical line.
- The mean of the input variable shall be indicated by a red dashed vertical line.
- If the number of bins is not defined by the evaluation, the number of bins should be calculated by Scott's formula or Sturges' formula, whereby k denotes the number of bins, σ the standard deviation of the input data and n the number of data points.
- If the data is of type integer the number of bins *k* shall not be greater than the range of the data plus one e.g. the minimum data point is -5 and the maximum data point is 64, the number of bins shall not be greater than 70.

$$k = \frac{3{,}49 * \sigma}{\sqrt[3]{n}}$$

Figure 3-25: Scott's formula

$$k = 1 + \log_2 n$$

Figure 3-26: Sturges' formula

An exemplary histogram is depicted in Figure 3-27.

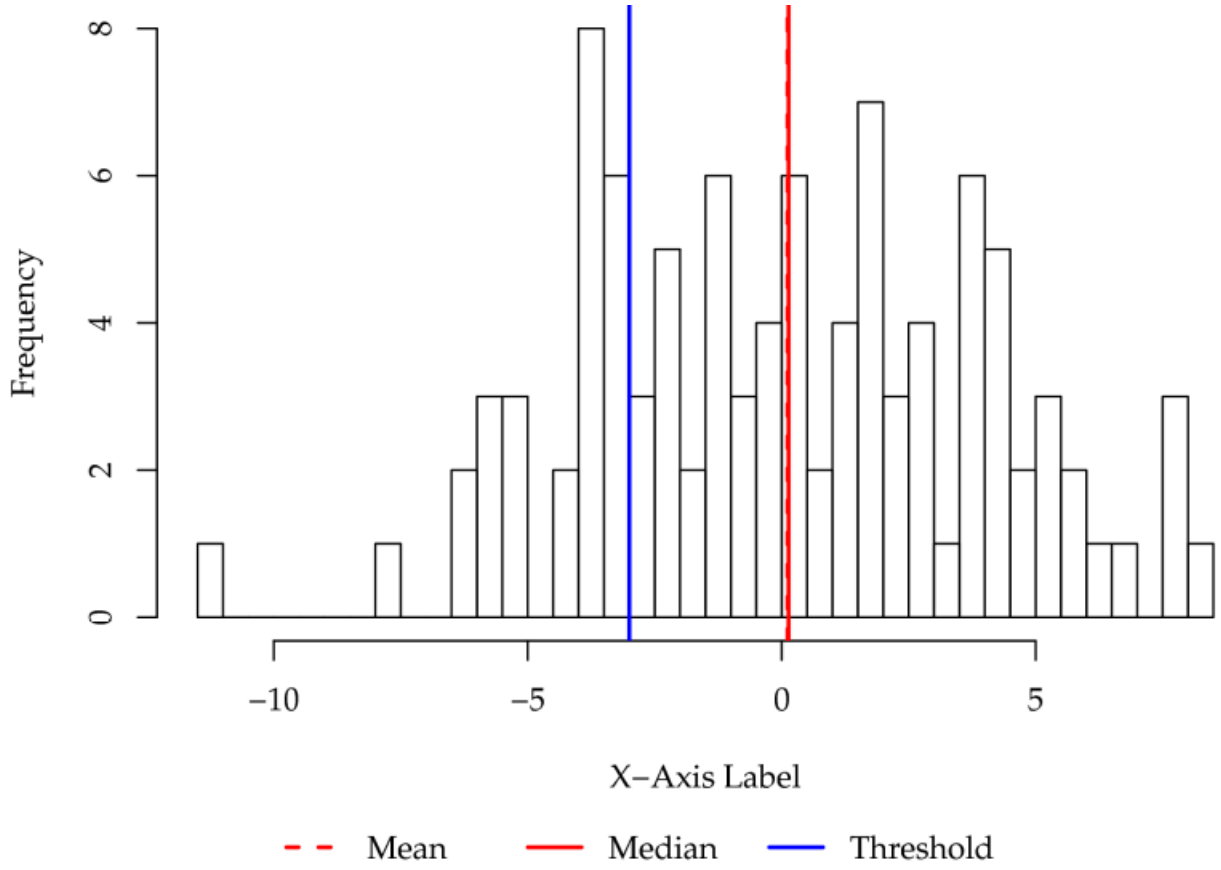

Figure 3-27: Example Histogram

Histogram with Empirical Cumulative Distribution Function

A histogram with empirical cumulative distribution function is a histogram with an empirical cumulative distribution function (CDF) added to the base histogram plot. All requirements for histograms apply. In addition, the following applies:

- The CDF shall be plotted as step function.
- No additional X-axis for the CDF shall be added to the base histogram.
- An additional Y-axis for the CDF shall be added to the base histogram on the right hand side, the histogram Y-axis shall be on the left hand side.
- The CDF Y-axis shall be scaled from 0 to 1 by 0.1 steps.

It is recommended to colour the CDF and its Y-axis in red.

An exemplary histogram with empirical CDF is depicted in Figure 3-28.

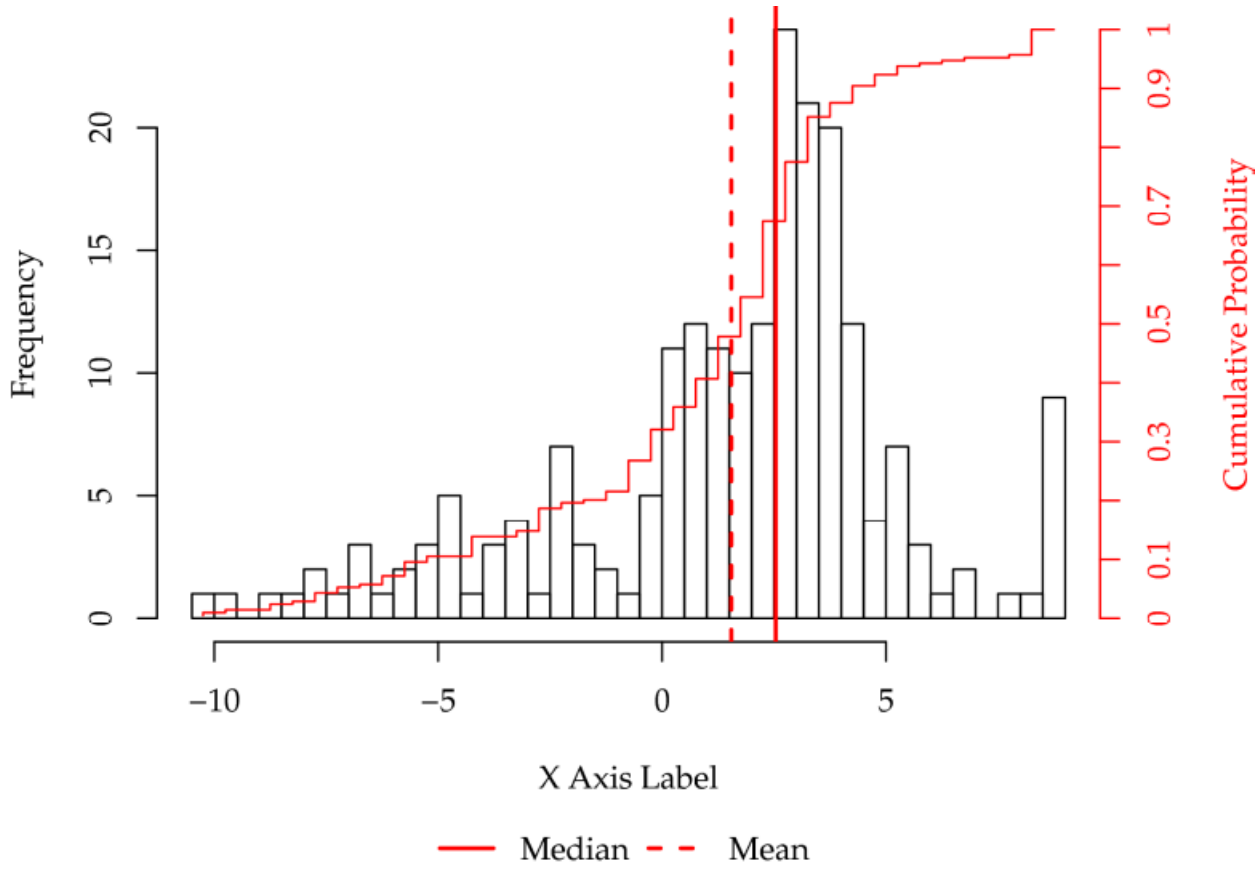

Figure 3-28: Example Histogram with Empirical Cumulative Distribution Function

Bar Plot

A bar plot is composed of vertical or horizontal bars plotted on a graph for which the following applies:

- The bars shall be labelled.
- A bar label shall represent a categorical variable.
- The height of a bar shall indicate the size of the group defined by the bar label.

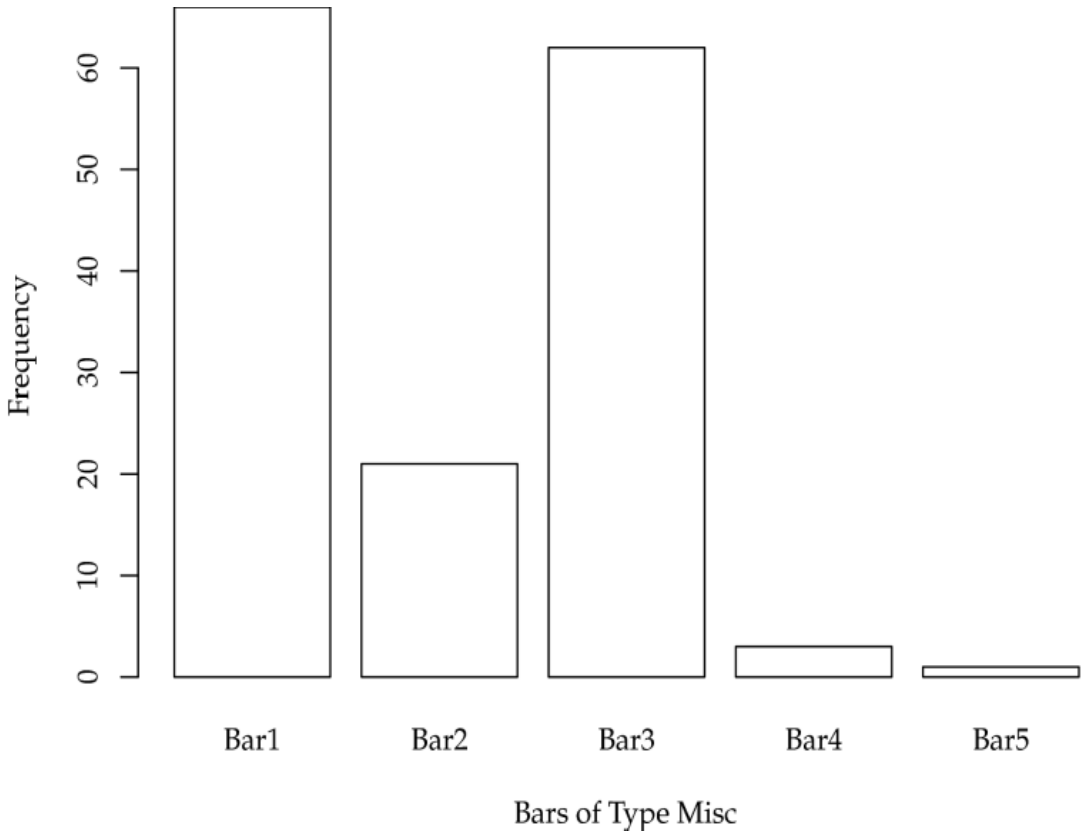

Figure 3-29: Example Vertical Bar Plot

Stacked Bar Plot

A stacked bar plot is a bar plot whose columns are partitioned by the relative frequencies of a variable. The following applies for stacked bar plots:

- Partitions shall be separated by different colours.
- If multiple bars are present, the order of partitions shall be consistent across all bars.

It is recommended to add an axis for both, relative frequencies and absolute frequencies.

An example horizontal stacked bar plot is depicted in Figure 3-30, an example vertical stacked bar plot is depicted in Figure 3-29.

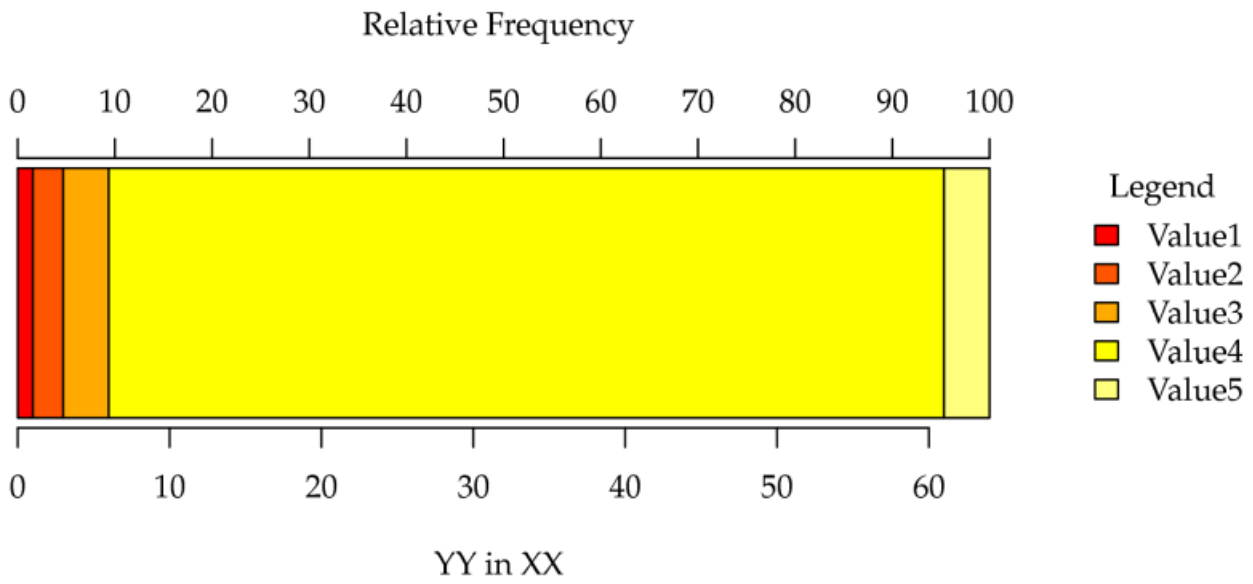

Figure 3-30: Example Horizontal Stacked Bar Plot

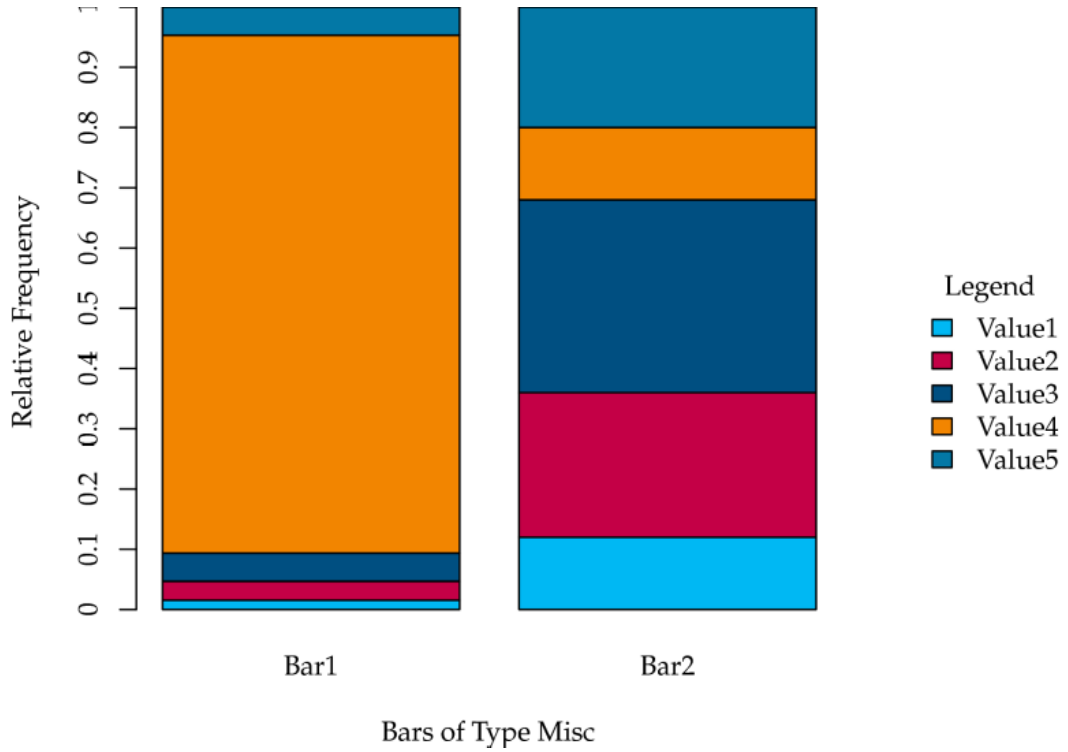

Figure 3-31: Example Vertical Stacked Bar Plot with Multiple Bars

3.14.1.10 Table Types

For all table types defined subsequently, the following applies:

- Input data for table representation shall never be trimmed by any means.
- Rows shall be visually separated, e.g. by alternating background colour.

An example table is depicted by Figure 3-32.

Figure 3-32: Example Table with Alternation Background Colour

Lookup Tables

A lookup table is designated to convey the exact values of a plot or graphic to the viewer. The following applies:

- Only the aggregated or processed absolute or relative data which is the direct input for a plot or graphic shall be present in the lookup table if not specified otherwise.
- A plot or graphic shall be reproducible, in terms of required data, only by using its corresponding lookup table.

Lookup Tables Heat Map

For lookup tables for heat maps the following applies:

- It is recommended to separate relative and absolute frequencies in separated lookup tables.
- Row and column sums, means and medians shall be present for the absolute frequency table.
- Total sum, mean and median shall be present for the absolute frequency table.

The lookup table for absolute frequencies is defined by the table definition in Table 3-22.

Attribute	Value
Name	Heat map absolute frequencies lookup table
Purpose	Presenting absolute frequencies and distribution summaries of the input data for a given heat map broken down by the heat map's dimensions.
Row Labelling	The row dimension of the heat map.
Column Labelling	The column dimension of the heat map.
Cell	The absolute frequency of the heat map's figure of interest.
Miscellaneous	The column and row sum, median and mean shall be present in the lookup table.

Table 3-22: Heat Map Absolute Frequency Lookup Table Definition

An exemplary heat map lookup table for absolute frequencies is depicted in Table 3-23.

		Var1					
		Val1.1	**Val1.2**	**Val1.3**	**Row Sum**	**Row Mean**	**Row Median**
Var2	**Val2.1**	Count 1	Count 2	Count 3	Sum Val2.1	Mean Val2.1	Median Val2.1
	Val2.2	Count 4	Count 5	Count 6	Sum Val2.2	Mean Val2.2	Median Val2.2
	Val2.3	Count 7	Count 8	Count 9	Sum Val2.3	Mean Val2.3	Median Val2.3
	Val2.4	Count 10	Count 11	Count 12	Sum Val2.4	Mean Val2.4	Median Val2.4
	Column Sum	Sum Val1.1	Sum Val1.2	Sum Val1.3	Total Sum		
	Column Mean	Mean Val1.1	Mean Val1.2	Mean Val1.3		Total Mean	
	Column Median	Median Val1.1	Median Val1.2	Median Val1.3			Total Median

Table 3-23: Example Heat Map Lookup Table Absolute Frequencies

The lookup table for relative frequencies is defined by the table definition in Table 3-24.

Attribute	Value
Name	Heat map absolute frequencies lookup table
Purpose	Presenting relative frequencies and distribution summaries of the input data for a given heat map broken down by the heat map's dimensions.
Row Labelling	The row dimension of the heat map.
Column Labelling	The column dimension of the heat map.
Cell	The relative frequency of the heat map's figure of interest.

Table 3-24: Heat Map Absolute Relative Lookup Table Definition

An exemplary heat map lookup table for relative frequency is depicted in Table 3-25.

		Var1		
		Val1.1	**Val1.2**	**Val1.3**
Var2	**Val2.1**	Share 1	Share 2	Share 3
	Val2.2	Share 4	Share 5	Share 6

Table 3-25: Example Heat Map Lookup Table for Relative Frequencies

Lookup Table Histogram

For lookup table for histograms the following applies:

- For every bin, its name, value and cumulative probability shall be present in the lookup table.
- Mean and median shall be listed in the lookup table.
- The sum of the input variable shall be listed at the end of the lookup table.

The lookup table for histograms is defined by the table definition in Table 3-26.

Attribute	Value
Name	Histogram lookup table
Purpose	Presenting relative frequencies and distribution summaries of the input data for a given histogram as well as cumulative probabilities.
Row Labelling	The bin variable of the histogram. Median and Mean shall be present.
Column Labelling	• a column representing the absolute frequencies of the bin • a column representing the relative frequencies of the bin

Attribute	Value
	• a column representing the empirical cumulative probability of the bin
Cell	The relative, absolute frequencies or cumulative probability of the histogram's figure of interest.
Miscellaneous	The absolute sum of the histogram's figure of interest shall be present in the lookup table.

Table 3-26: Histogram Lookup Table Definition

An exemplary histogram lookup table is depicted in Table 3-27.

Bin	**Absolute Bin Value**	**Relative Bin Value**	**Empirical Cumulative Probability**
Bin name 1	Bin value 1	Relative Bin value 1	Cumulative probability 1
Bin name 2	Bin value 2	Relative Bin value 2	Cumulative probability 2
...	...	...	...
Mean	Mean value		
...	...	...	...
Median	Median value		0.5
...	...	...	...
Bin name *n-1*	Bin value *n-1*	Relative Bin value n-1	Cumulative probability *n-1*
Bin name *n*	Bin value *n*	Relative Bin value n	Cumulative probability *n*
Sum	Sum value		

Table 3-27: Example Histogram Lookup Table

Lookup Tables Stacked Bar Plot

For lookup tables for stacked bar plots the following applies:

- For every bar, its absolute and relative frequencies shall be present.
- It is recommended to separate absolute and relative frequencies in separate lookup tables.

- The sum of the values of the intra and inter bar variables shall be present in the absolute count lookup table.
- The total sum of counts shall be present in the absolute count lookup table.

Note, a stacked bar plot may have only a single stacked bar. In this case, no inter bar variable exists and row and sum columns are to be omitted.

The lookup table for absolute frequency stacked bar plot lookup table is defined by the table definition in Table 3-28.

Attribute	**Value**
Name	Absolute frequency stacked bar plot lookup table
Purpose	Presenting absolute frequencies and sums of the input data for a given stacked bar plot.
Row Labelling	• The stacked bar plot's intra bar variable. • A column sum row.
Column Labelling	• The stacked bar plot's inter bar variable. • A row sum column.
Cell	The absolute frequencies of figure of interest for the stacked bar plot's partitions.
Miscellaneous	The absolute sum of the stacked bar plot's figure of interest shall be present in the lookup table.

Table 3-28: Absolute Frequency Stacked Bar Plot Lookup Table Definition

An exemplary absolute frequency stacked bar plot lookup table is depicted in Table 3-29.

		Inter Bar Variable				
		Val1.1	**Val1.2**	**Val1.3**	**Val1.4**	**Sum**
Intra Bar Variable	**Val2.1**	Count	Count	Count	Count	Sum Val2.1
	Val2.2	Count	Count	Count	Count	Sum Val2.2
	Val2.3	Count	Count	Count	Count	Sum Val2.3
	Val2.4	Count	Count	Count	Count	Sum Val2.4
	Val2.5	Count	Count	Count	Count	Sum Val2.1
	Sum	Sum Val1.1	Sum Val1.2	Sum Val1.3	Sum Val1.4	Total Sum

Table 3-29: Example Absolute Frequency Stacked Bar Plot Lookup Table

The lookup table for relative frequency stacked bar plot lookup table is defined by the table definition in Table 3-30.

Attribute	**Value**
Name	Relative frequency stacked bar plot lookup table
Purpose	Presenting relative frequencies of the input data for a given stacked bar plot.
Row Labelling	The stacked bar plot's intra bar variable.
Column Labelling	The stacked bar plot's inter bar variable.
Cell	The relative frequencies of figure of interest for the stacked bar plot's partitions.

Table 3-30: Relative Frequency Stacked Bar Plot Lookup Table Definition

An exemplary relative frequency stacked bar plot lookup table is depicted in Table 3-31.

		Inter Bar Variable		
		Val1.1	**Val1.2**	**Val1.3**
Intra Bar Variable	**Val2.1**	Share 1	Share 2	Share 3
	Val2.2	Share 4	Share 5	Share 6

Table 3-31: Example Relative Frequency Stacked Bar Plot Lookup Table

Lookup Table for Box Plots

For lookup table for box plots the following applies:

- For every box, its minimum, first and third quartile, median, mean and maximum shall be present.

The lookup table for box plots is defined by the table definition in Table 3-32.

Attribute	Value
Name	Box plots lookup table
Purpose	Presenting the distribution metrics for each box of the box plot.
Row Labelling	The box group variable.
Column Labelling	The distribution metrics.
Cell	The value of the distribution metric for the relevant box group.

Table 3-32: Box Plot Lookup Table Definition

An exemplary box plot lookup table is depicted in Table 3-33.

		Distribution Metric					
		Min.	**1. Qu.**	**Median**	**Mean**	**3. Qu.**	**Max.**
Box descriptor variable	**Box1 name**	val	val	val	val	val	val
	Box1 name	val	val	val	val	val	val

Table 3-33: Example Box Plot Lookup Table

Top and Bottom Tables

A top or bottom table is a table, ordered by a set of value columns. The following applies:

- “Value columns” shall be columns of the table which shall be considered and which are decisive for the ordering of the rows.
- A fixed number of rows shall be present. If the number of rows to display is not defined by the evaluation, the default number shall be 20 rows.
- In case of a top table, the table shall be ordered descending regarding the considered set of value columns and the row with the highest order shall be the first row of the table. In case of a bottom table, the table shall be ordered ascending by the set of value columns and the row with the lowest order shall be the first row of the table.
- The ordering shall be conducted in the order of the value columns defined in the respective evaluation. In case of ties, the next value column of the set shall be evaluated.
- If ties can not be resolved, the rank for same ranked rows shall be equal. The rank shall continue in the original order for following rows.
- In case relative frequencies are in the set of value columns, a goodness indicator shall be present to estimate the meaningfulness of the relative frequency i.e. the denominator of the relative frequency shall be the goodness estimator.
- A rank column shall be present giving the rank of the record according to the ordering by the value columns.
- The value columns shall be highlighted in the table header and a remark shall denote which columns are used for the ordering.
- The ordering shall be unambiguous so that it is clear in which ordering the different rows appear in the table. This can be realised by ordering the rows by a name column. If the rows differ only by the name the rank shall be equal for all of those rows.

The top and bottom table is defined by the table definition in Table 3-34.

Attribute	**Value**
Name	Top and bottom table
Purpose	Presenting records with lowest and highest rank according to a set of variables.
Row Labelling	The records.
Column Labelling	The records variables.
Cell	The value of the record variable for the given record.

Table 3-34: Top and Bottom Table Definition

An exemplary top table is depicted in Table 3-35.

Rank	Goodness Estimator	Value Column 1	Value Column 2	Value Column 3	Column 4	Column 5	Column 6
1	891	val	val	val	val	val	val

Rank	Goodness Estimator	Value Column 1	Value Column 2	Value Column 3	Column 4	Column 5	Column 6
2	753	val	val	val	val	val	val

Table 3-35: Example Top Table

An exemplary bottom table is depicted in Table 3-36.

Rank	Goodness Estimator	Value Column 1	Value Column 2	Value Column 3	Column 4	Column 5	Column 6
82	4	val	val	val	val	val	val
81	27	val	val	val	val	val	val

Table 3-36: Example Bottom Table

Component Usage Table

A component usage table presents the type and usage period of components of interest. Components can be hardware or software components. The following applies:

- The first and last day of operation in the reporting period shall be present.
- Component descriptors shall be present i.e. the triple vendor, name and version of the component.
- The number of occurrences and number of locations using the component in the reporting period shall be present.

The component usage table is defined by the table definition in Table 3-37.

Attribute	Value
Name	Component usage table
Purpose	Allowing to investigate the type and number of used components in the reporting period as well as investigating the first and last day of operation of the components in the report period.
Row Labelling	The components
Columns	• A consecutive numbering column, starting with 1 • Vendor, name, version and firmware version of the component • First day of operation in the reporting period • Last day of operation in the reporting period

Attribute	Value
	• Number of occurrences • Number of distinct locations with at last one occurrence of the component
Data Source	• The component usage table always refers to XML nodes of type `type.component` • An available location or host data field shall be used to calculate the number of distinct locations or hosts which used the component at least once in the reporting period. • An XML node `StartTime` must be used for period filtering and calculation of first and last day of operation
Miscellaneous	The table shall be ordered by the number of occurrences.

Table 3-37: Component Usage Table Definition

An exemplary component usage table is depicted in Table 3-38.

	Vendor	Name	Version	Firmware Version	First Day of Operation	Last Day of Operation	Number of Occurrences	Number of Locations
1.	XYZ	XYZ2	1.2	12 Test	03.01.1999	04.01.1999	744	32
2.	XYZ	XYZ1	3.2	6.4.2	01.01.1999	06.01.1999	345	12

Table 3-38: Example Component Usage Table

Threshold Configuration Table

A threshold configuration table presents the configured threshold of a component. The following applies:

- The first and last day of operation in the reporting period shall be present.
- Component descriptors shall be present i.e. the triple vendor, name and version of the component.
- The number of occurrences and number of locations using the component in the reporting period shall be present.

The component usage table is defined by the table definition in Table 3-39.

Attribute	Value
Name	Component usage table
Purpose	Allowing to investigate the type and number of used components in the reporting period as well as investigating the first and last day of operation of the components in the report period.

Attribute	Value
Row Labelling	The components
Columns	• A consecutive numbering column, starting with 1 • Vendor, name, version and firmware version of the component • The first day the configuration was logged in the reporting period • The last day the configuration was logged in the reporting period • The optional ID to note the ID of the corresponding measurement. • Configured lower bound of the possible range • Configured upper bound of the possible range • Number of occurrences • Number of distinct locations with at last one occurrence of the component
Data Source	• The threshold configuration table refers to XML nodes of type `type.configuration.parameters, type.value.with.threshold, type.finger.quality.integer` and a XML node of type `type.component` on the same hierarchy level or the first node of type `type.component` on a higher level. • The column “Lower Bound” refers to XML nodes `tmin` • The column “Upper Bound” refers to XML nodes `tmax` • An available location or host data field shall be used to calculate the number of distinct locations or hosts which used the component at least once in the reporting period. • An XML node `StartTime` must be used for period filtering and calculation of first and last day of operation • Note, that depending on the context a component may have several threshold for different measurements configured e.g. a face image quality component may evaluate a facial image on several different indicators or different thresholds are configured for different fingers. In those cases, an optional ID column shall be used to note the ID of the corresponding measurement, finger code etc. • Note, if only a threshold is specified and no upper and lower bounds, a single threshold column shall replace the lower and upper bound columns.
Miscellaneous	The table shall be ordered by the number of occurrences.

Table 3-39: Threshold Configuration Table Definition

An exemplary threshold configuration table is depicted in Table 3-40.

	Vendor	Name	Version	Firmware Version	First Day of Configuration	Last Day of Configuration	ID	Lower bound	Upper bound	Number of Occurrences	Number of Locations
1.	XYZ	XYZ2	1.2	12 Test	03.01.1999	04.01.1999	1.1	0	60	744	32
2.	XYZ	XYZ1	3.2	6.4.2	01.01.1999	06.01.1999	1.2	0.4	1	345	12

Table 3-40: Example Threshold Configuration Table

Lookup Table for Line Plots

For lookup tables for line plots the following applies:

- For every line, its absolute and relative frequencies shall be present. If there is only one line in the plot there shall be no relative frequencies.
- It is recommended to separate absolute and relative frequencies in separate lookup tables.
- The sum of the X-axis and Y-axis variable shall be present in the absolute count lookup table.
- The total sum of counts shall be present in the absolute count lookup table.

The absolute frequency line plot lookup table is defined by the table definition in Table 3-41.

Attribute	Value
Name	Absolute frequency line plot lookup table
Purpose	Presenting absolute frequencies and sums of the input data for a given line plot.
Row Labelling	• The stacked line plot's Y-axis variable. • A row called "Sum" which shows all the sums of the values of each column.
Column Labelling	• The stacked line plot's X-axis variable. • A column called "Sum" which shows all the sums of the values of each row.
Cell	The absolute frequencies of figure of interest for the line plots data points.
Miscellaneous	The absolute sum of the line plot's figure of interest shall be present in the lookup table.

Table 3-41: Absolute Frequency Line Bar Plot Lookup Table Definition

An exemplary absolute frequency line plot lookup table is depicted in Table 3-42.

		X-Axis Variable				
		Val1.1	Val1.2	Val1.3	Val1.4	Sum
Y-Axis Variable	Val2.1	Count	Count	Count	Count	Sum Val2.1

		X-Axis Variable				
	Val2.2	Count	Count	Count	Count	Sum Val2.2
	Val2.3	Count	Count	Count	Count	Sum Val2.3
	Val2.4	Count	Count	Count	Count	Sum Val2.4
	Val2.5	Count	Count	Count	Count	Sum Val2.1
	Sum	Sum Val1.1	Sum Val1.2	Sum Val1.3	Sum Val1.4	Total Sum

Table 3-42: Example Absolute Frequency Line Plot Lookup Table

The lookup table for relative frequency line plot lookup table is defined by the table definition in Table 3-43.

Attribute	**Value**
Name	Relative frequency stacked line plot lookup table
Purpose	Presenting relative frequencies of the input data for a given line plot.
Row Labelling	The line plot's X-axis variable.
Column Labelling	The line plot's Y-axis variable.
Cell	The relative frequencies of a figure of interest for the line plot's partitions.

Table 3-43: Relative Frequency Line Plot Lookup Table Definition

An exemplary relative frequency line plot lookup table is depicted in Table 3-44.

		X-Axis Variable		
		Val1.1	**Val1.2**	**Val1.3**
Y-Axis Variable	**Val2.1**	Share 1	Share 2	Share 3
	Val2.2	Share 4	Share 5	Share 6

Table 3-44: Example Relative Frequency Line Plot Lookup Table

3.14.2 EVA-ALL-PROCESS

This functional module defines general process evaluations which are not directly related to a biometric modality.

3.14.2.1 Requirements

The evaluations defined by this module shall be provided if the application specific EVA-ALL module requires them.

3.14.2.2 Number of Acquisition Processes

Attribute	Value
ID	ALL-PROCESS-1
Name	Number of acquisition processes
Purpose	This evaluation shall deliver insights into the number of acquisition processes.
Plots	Line Plot (Table 3-46)
Tables	Lookup table for line plot (Table 3-46)

Table 3-45: Evaluation Number of Acquisition Processes

Attribute	Value
Name	Line plot of number of acquisition processes
Purpose	This line plot depicts the number of acquisition processes by type.
Type	Line plot
X-Axis	Time, calendar weeks if yearly report, days if monthly report.
Y-Axis	Number of processes
Data Source	• The number of XML nodes `FingerAcquisition` for Y-axis if relevant for the application profile, if finger acquisition is conducted in the domain • The number of XML nodes `FaceAcquisition` for Y-axis if relevant for the application profile, if face acquisition is conducted in the domain • The number of XML nodes `IrisAcquisition` for Y-axis if relevant for the application profile, if iris acquisition is conducted in the domain • The XML node `FingerAcquisition/StartTime` for period filtering and X-axis, if finger acquisition is not conducted in the domain, face or iris element shall be used to extract the start time
Miscellaneous	The X-Axis shall span over the last six months if a monthly report is generated.

Attribute	Value
Example Visualisation	Will be amended in a future version of this guideline.

Table 3-46: Line Plot Number of Acquisition Processes

3.14.2.3 Identification Process Duration

Attribute	Value
ID	ALL-PROCESS-2
Name	Identification process duration
Purpose	This evaluation shall deliver insights into the duration of identification processes. Thereby, e.g. the detection of identifications with long duration is of interest.
Facet	• Modalities used for identification • identification System
Plots	• Histogram (Table 3-48)
Tables	• Lookup table for histogram (Table 3-48) • Top and bottom table (Table 3-49)

Table 3-47: Evaluation Identification Duration

Attribute	Value
Name	Histogram identification process duration
Purpose	This histogram depicts the distribution of the identification process duration. Thereby, e.g. the detection of outliers is of interest.
Type	Histogram with Cumulative Distribution Function

Attribute	Value
X-Axis	Identification duration
Y-Axis 1	Frequency of identification processes
Y-Axis 2	Axis for empirical cumulative distribution function scaled from 0 to 1.
Trimming	The input data of the histograms shall be trimmed by the respective 95% percentile.
Data Source	• distribution of time difference between XML-Nodes `/Identification/SubmitTime` and `Identification/EndTime` in XML-node • XML-node `Identification/StartTime` for period filtering • XML-attribute `Identification/@system` for facet • XML-node `Identification/Modalities` for facet
Example Visualisation	Will be amended in a future version of this guideline.

Table 3-48: Histogram Finger Identification Process Duration

Attribute	Value
Name	Top and bottom table locations by identification process duration median
Purpose	Presenting locations with lowest and highest rank according to the identification processes duration median
Row	The finger acquisition location.
Columns	• Median of identification process duration of the location (Valu (EndTime - SubmitTime) • Number of identification process at the location as goodness estimator
Miscellaneous	• value column for ordering is the median of identification duration median • ascending order (the lower, the better)

Attribute	Value
Data Source	• An XML-node with location or host information for location column. This data may also be located in sources external to this Technical Guideline. • XML-nodes `Identification/SubmitTime` and `Identification/EndTime` for the median duration calculation • XML-node `Identification/StartTime` for period filtering • XML-attribute `Identification/@system` for facet • XML-node `Identification/Modalities` for facet

Table 3-49: Top and Bottom Locations by Finger Identification Process Duration

3.14.2.4 Identification Candidate Count

Attribute	Value
ID	ALL-PROCESS-3
Name	Identification candidate count
Purpose	This evaluation shall deliver insights into the number of candidates of an identification processes.
Facet	• Modalities used for identification • Identification System
Plots	• Histogram (Table 3-51) per finger • Box plot (Table 3-50)
Tables	• Lookup table for histogram (Table 3-51) per finger • Lookup table for box plot (Table 3-50) • Top and bottom table (Table 3-52)

Table 3-50: Evaluation Identification Candidate Count

Attribute	Value
Name	Stacked bar plot relative frequencies of global identification candidate count
Purpose	This stacked bar plot shall deliver insights into how many candidates are returned on identifications.
Type	Stacked Bar Plot (horizontal)
X-Axis	Relative frequencies of candidate counts.
Data Source	• distribution XML-Nodes `Identification/CandidateCount` for X-axis.

Attribute	Value
	• XML-node `Identification/StartTime` for period filtering • XML-attribute `system` of XML-node `Identification` for facet • XML-node `Identification/Modalities` for facet
Example Visualisation	Will be amended in a future version of this guideline.

Table 3-51: Stacked Bar Plot Global Identification Candidate Count

Attribute	Value
Name	Top and bottom table locations by average candidate count.
Purpose	Presenting locations with lowest and highest rank according to the average identification candidate count.
Row	The identification location.
Columns	• Average candidate count of successful identification processes at the location (Value) • Number of successful identification process at the location as goodness estimator
Miscellaneous	• ascending order (the lower, the better)
Data Source	• An XML-node with location or host information for location column. This data may also be located in sources external to this Technical Guideline. • XML-nodes `Identification/Result` for filtering only successful identification processes • XML-nodes `Identification/CandidateCount` for calculation of average candidate count per location • XML-node `Identification/StartTime` for period filtering • XML-attribute `Identification/@system` for facet • XML-node `Identification/Modalities` for facet

Table 3-52: Top and Bottom Locations by Average Identification Candidate Count

3.14.2.5 Identification Process Result

Attribute	Value
ID	ALL-PROCESS-4
Name	Identification process result
Purpose	This evaluation shall deliver insights into the result of identification processes. Thereby, e.g. the detection of identifications with high number of hits is of interest.
Facet	• Modalities used for identification • Identification System
Plots	• Stacked Bar Plot (Table 3-54) • Histogram (Table 3-56)
Tables	• Lookup table for stacked bar plot (Table 3-54) • Lookup table for histogram (Table 3-56) • Top and bottom table for (Table 3-53)

	• Threshold Configuration Table ◦ use XML-node `Identification/System` for component information if present. If this information is not present or only part of the information is available for the table, omit the corresponding columns. ◦ use XML-node Verification `Identification/Candidates/Candidate/AchievedFMR` or if not existing `RawScore` for threshold information.

Table 3-53: Evaluation Identification Process Result

Attribute	Value
Name	Stacked bar plot global identification result
Purpose	This stacked bar plot shall deliver insights into how frequently an identification is successfully on a global scope.
Type	Stacked Bar Plot (horizontal)
X-Axis	Relative frequencies of identification results.
Data Source	• distribution XML-Nodes `Identification/Result` for X-axis. • XML-node `Identification/StartTime` for period filtering • XML-attribute `Identification/@system` for facet • XML-node `Identification/Modalities` for facet
Example Visualisation	Will be amended in a future version of this guideline.

Table 3-54: Stacked Bar Plot Global Identification Process Result

Attribute	Value
Name	Top and bottom table locations by successful identification result.

Attribute	Value
Purpose	Presenting locations with lowest and highest rank according to the identification processes result successful
Row	The finger acquisition location.
Columns	• Relative frequencies of successful identification processes at the location (Value) • Number of identification process at the location as goodness estimator
Miscellaneous	• ascending order (the lower, the better)
Data Source	• An XML-node with location or host information for location column. This data may also be located in sources external to this Technical Guideline. • XML-nodes `Identification/Result` for value column • XML-node `Identification/StartTime` for period filtering • XML-attribute `Identification/@system` for facet • XML-node `Identification/Modalities` for facet

Table 3-55: Top and Bottom Locations by Identification Process Result

Attribute	Value
Name	Histogram identification candidate's achieved FMR
Purpose	This histogram depicts the distribution of the identification candidate's achieved FMR. Thereby, e.g. the detection of unusual distribution characteristics is of interest.
Type	Histogram with Cumulative Distribution Function
X-Axis	Identification candidate's achieved FMR
Y-Axis 1	Frequency of identifications
Y-Axis 2	Axis for empirical cumulative distribution function scaled from 0 to 1.
Miscellaneous	If the applied threshold is equal over all candidates, the threshold shall be added as vertical line to the histogram.
Data Source	• XML-nodes `Identification/Candidates/Candidate/AchievedFMR` • XML-attribute `Identification/Candidates/Candidate/AchievedFMR/@threshold` • XML-node `Identification/StartTime` for period filtering • XML-attribute `Identification/@system` for facet • XML-node `Identification/Modalities` for facet
Example Visualisation	Will be amended in a future version of this guideline.

Table 3-56: Histogram Finger Identification Candidate's Achieved FMR

3.14.2.6 Applications by Time

Attribute	Value
ID	ALL-PROCESS-5
Name	Applications by time
Purpose	This evaluation shall deliver insights into the number of applications. Thereby, e.g. the detection of time periods with low and high number of applications is of interest and the distribution of application numbers over a given time frame.
Plots	Histogram (Table 3-58)
Tables	Lookup table for histogram (Table 3-58)

Table 3-57: Evaluation Application by Time

Attribute	Value
Name	Number of applications over time
Purpose	This histogram depicts the number of applications over a given time period to recognize e.g. periods of low and high number of applications.
Type	Histogram with Cumulative Distribution Function
X-Axis	Time, bin size shall be one calendar week for yearly report and one day for monthly report
Y-Axis 1	Number of applications
Y-Axis 2	Axis for empirical cumulative distribution function scaled from 0 to 1.
Data Source	• Count of applications with existing TR-03121 logging data in considered time frame • `/StartTime`
Miscellaneous	The mean shall not be indicated by a vertical line.

Attribute	Value
Example Visualisation	Will be amended in a future version of this guideline.

Table 3-58: Histogram Number of Applications

3.14.2.7 Single Verification Process Result

Attribute	Value
ID	ALL-PROCESS-6
Name	Verification process results
Purpose	This evaluation shall deliver insights into the result of verification processes. Thereby, e.g. the global relative frequency of failed verifications is of interest.
Facet	• Modalities used for verification • Identification System
Plots	• Stacked Bar Plot (Table 3-60) • Histogram (Table 3-61)
Tables	• Lookup table for stacked bar plot (Table 3-60) • Lookup table for histogram (Table 3-61) • Top and bottom table for (Table 3-59) • Threshold Configuration Table ◦ use XML-node Verification `Verification/Software` for component information ◦ use XML-node `Verification/SingleVerification/Comparison/AchievedFMR` or if not existing `RawScore` for threshold information.
Miscellaneous	

Table 3-59: Evaluation Single Verification Process Result

Attribute	Value
Name	Stacked bar plot global verification result
Purpose	This stacked bar plot shall deliver insights into how frequently a verification is successfully on a global scope.
Type	Stacked Bar Plot (horizontal)
X-Axis	Relative frequencies of verification results.
Data Source	• distribution XML attribute `Verification/@result` for X-axis. • XML-node `Verification/StartTime` for period filtering • XML-attribute `Verification/@system` for facet • XML-node `Verification/Modalities` for facet
Example Visualisation	Will be amended in a future version of this guideline.

Table 3-60: Stacked Bar Plot Global Single Verification Process Result

Attribute	Value
Name	Histogram verification achieved FMR
Purpose	This histogram depicts the distribution of the verification's achieved FMR. Thereby, e.g. the detection of unusual distribution characteristics is of interest.
Type	Histogram with Cumulative Distribution Function
X-Axis	Verification achieved FMR
Y-Axis 1	Frequency of verifications
Y-Axis 2	Axis for empirical cumulative distribution function scaled from 0 to 1.
Miscellaneous	If the applied threshold is equal over all comparisons, the threshold shall be added as vertical line to the histogram.

Attribute	Value
Data Source	• XML-nodes `Verification/SingleVerification/Comparison/AchievedFMR` • XML-attribute `Verification/SingleVerification/Comparison/AchievedFMR/@threshold` • XML-node `Verification/StartTime` for period filtering • XML-attribute `Verification/@system` for facet • XML-node `Verification/Modalities` for facet
Example Visualisation	Will be amended in a future version of this guideline.

Table 3-61: Histogram Single Verification Achieved FMR

3.14.2.8 Single Verification Process Duration

Attribute	Value
ID	ALL-PROCESS-7
Name	Verification process duration
Purpose	This evaluation shall deliver insights into the duration of verification processes. Thereby, e.g. the detection of verification with long duration is of interest.
Facet	• Modalities used for verification • Verification System
Plots	• Histogram (Table 3-63) per verification system and modalities used
Tables	• Lookup table for histogram (Table 3-63) per verification system and modalities used • Top and bottom table (Table 3-64) per verification system and modalities used.

Table 3-62: Evaluation Single Verification Process Duration

Attribute	Value
Name	Histogram verification process duration
Purpose	This histogram depicts the distribution of the verification process duration. Thereby, e.g. the detection of outliers is of interest.
Type	Histogram with Cumulative Distribution Function
X-Axis	Verification duration
Y-Axis 1	Frequency of verification processes
Y-Axis 2	Axis for empirical cumulative distribution function scaled from 0 to 1.
Trimming	The input data of the histograms shall be trimmed by the respective 95% percentile.
Data Source	• distribution of time difference between XML-Nodes `/Verification/StartTime` and `Verification/EndTime` in XML-node • XML-node Verification`/StartTime` for period filtering • XML-attribute `Verification/@system` for facet • XML-node `Verification/Modalities` for facet
Example Visualisation	Will be amended in a future version of this guideline.

Table 3-63: Histogram Single Verification Process Duration

Attribute	Value
Name	Top and bottom table locations by verification process duration median
Purpose	Presenting locations with lowest and highest rank according to the verification processes duration median
Row	The finger acquisition location.
Columns	• Median of verification process duration of the location (EndTime - StartTime) • Number of verification process at the location as goodness estimator
Miscellaneous	• value column for ordering is the median of verification duration median • ascending order (the lower, the better)
Data Source	• An XML-node with location or host information for location column. This data may also be located in sources external to this Technical Guideline. • XML-nodes `Verification/StartTime` and `Verification/EndTime` for the median duration calculation • XML-node `Verification/StartTime` for period filtering • XML-attribute `Verification/@system` for facet • XML-node `Verification/Modalities` for facet

Table 3-64: Top and Bottom Locations by Single Verification Process Duration

3.14.3 EVA-ALL-AAD

This functional module defines general evaluations for the Arrival Attestation Document application profiles.

3.14.3.1 Requirements

The evaluations specified by this module shall be provided for the Arrival Attestation Document application profiles. In addition all evaluation defined by Table 3-65 shall be provided. The requirements by EVA-ALL-GENERIC shall apply.

ID	Remark
ALL-PROCESS-1	
ALL-PROCESS-2	Identification by CIR.
ALL-PROCESS-3	Identification by CIR.
ALL-PROCESS-4	Identification by CIR.
ALL-PROCESS-5	

Table 3-65: Required Evaluations EVA-ALL-AAD

3.14.4 EVA-FP-GENERIC

This functional module defines requirements for the evaluation of fingerprint acquisitions.

3.14.4.1 Requirements

The evaluations defined by this module shall be provided if the application specific EVA-FP module requires them. The evaluations related to Finger Capture Attempts shall be provided if finger capture attempts occur in the relevant application profile.

3.14.4.2 Finger Capture Components

Attribute	Value
ID	FP-GENERIC-1
Name	Software and hardware version of finger capture
Purpose	This evaluation shall give insights in the used software and hardware for capturing fingers during the report period.
Plots	• Heat Map finger acquisition software usage (Table 3-67) • Heat Map finger hardware usage (Table 3-68)
Tables	• Lookup table for heat maps (Table 3-67 and Table 3-68) • Component Usage Tables for ◦ software of finger acquisition XML node `FingerAcquisition/Software/` ◦ hardware of finger acquisition XML node `FingerAcquisition/Hardware/`

Table 3-66: Evaluation Finger Capture Component

Attribute	Value
Name	Heat map of the number of finger acquisitions by software version
Purpose	This heat map depicts the distributions of the number of finger acquisitions by software version and time to recognize e.g. new software versions and their introduction phase.
Type	Heat Map
Row Labelling	The finger acquisition software version
Column Labelling	Time, calendar week if yearly report, day if monthly report
Cells	The frequency of finger acquisitions with the given software version
Data Source	• The number of XML nodes `FingerAcquisition` for the cell counts • The XML nodes `FingerAcquisition/Software` for the row dimension • XML node `FingerAcquisition/StartTime/` for period filtering and the column dimension
Colours	Maximum: “column wise” (case 1)
Example Visualisation	Will be amended in a future version of this guideline.

Table 3-67: Heat Map Finger Acquisitions by Software

Attribute	Value
Name	Heat map of the number of finger acquisitions by hardware version
Purpose	This heat map depicts the distributions of the number of finger acquisitions by hardware version over a given period to recognize e.g. detect new hardware versions and their introduction phase.
Type	Heat Map

Attribute	Value
Row Labelling	The finger acquisition hardware version
Column Labelling	Time, calendar week if yearly report, day if monthly report
Cells	The count of finger acquisitions with the relevant hardware version
Data Source	• The number of XML nodes `FingerAcquisition` for the cell counts • The XML nodes `FingerAcquisition/Hardware/Version` for the row dimension • XML node `FingerAcquisition/StartTime` for period filtering and the column dimension
Colours	Maximum: “column wise” (case 1)
Example Visualisation	Will be amended in a future version of this guideline.

Table 3-68: Heat Map Finger Acquisitions by Hardware

3.14.4.3 Number of Finger Captures

Attribute	Value
ID	FP-GENERIC-2
Name	Number of finger captures
Purpose	This evaluation shall give insights in the number of captures needed to digitise a finger. Thereby, e.g. the detection of digitization problems is of interest.
Plots	Stacked Bar Plot (Table 3-70)
Tables	• Lookup table for stacked bar plot (Table 3-70) • Top and bottom table (Table 3-71)
Facet	Finger capture mode

Table 3-69: Evaluation Number of Finger Captures

Attribute	Value
Name	Stacked bar plot for the number of necessary captures for finger digitalization
Purpose	This stacked bar plot depicts the number of finger captures needed to digitise a finger for a given period to recognize e.g. global high number of necessary attempts to capture a finger.
Type	Stacked Bar Plot (horizontal)
X-Axis	Relative frequencies of the observed counts of finger captures needed to digitise a finger.
Miscellaneous	At maximum a count of nine shall be depicted. All exceeding counts shall be summarised in a single category (only for plot, not for lookup table).
Data Source	• XML-attribute `FingerAcquisition/FingerCapture/@count` for the X-axis • XML node `FingerAcquisition/StartTime` for period filtering • XML node `FingerAcquisition/FingerCaptureMode` for facet

Attribute	Value
Example Visualisation	Will be amended in a future version of this guideline.

Table 3-70: Stacked Bar Plot Number of Finger Captures

Attribute	Value
Name	Top and bottom table locations with high number of finger captures
Purpose	Presenting locations with lowest and highest rank according to the mean of needed finger capture per finger.
Row Labelling	The finger acquisition location.
Columns	• Mean of number of captures per finger capture (Value) • Number of finger captures as goodness estimator
Miscellaneous	• value column for ordering is the mean of number of captures per finger capture • ascending order (the lower, the better)
Data Source	• XML-attribute `FingerAcquisition/FingerCapture/@count` for mean • number of `FingerAcquisition as` goodness estimator column • An XML-node with location or host information for location column. This data may also be located in sources external to this Technical Guideline. • XML node `FingerAcquisition/StartTime` for period filtering • XML node `FingerAcquisition/FingerCaptureMode` for facet

Table 3-71: Top and Bottom Locations by Finger Capture Count Mean

3.14.4.4 Number of Finger Captures by Time

Attribute	Value
ID	FP-GENERIC-3
Name	Number of finger captures by time
Purpose	This evaluation shall give insights in the number captures needed to digitise a finger over a period. Thereby, e.g. the detection of permanent or temporary shifts over time in the number of needed captures shall be detected.
Facet	Finger capture mode
Plots	Heat Map (Table 3-73)
Tables	Absolute and relative lookup tables for heat map (Table 3-73)

Table 3-72: Evaluation Number of Finger Captures by Time

Attribute	Value
Name	Heat map of the number of finger captures by time
Purpose	This heat map depicts the distributions of the number of finger captures needed over a given period to recognize e.g. permanent or temporary shifts in the needed number of finger captures over time.
Type	Heat map
Row Labelling	The observed counts of finger captures needed to digitise a finger.
Column Labelling	Time, calendar week if yearly report, day if monthly report
Data Source	• XML-attribute `FingerAcquisition/FingerCapture/@count` for the row dimension • XML node `FingerAcquisition/StartTime` for period filtering and the column dimension • XML node `FingerAcquisition/FingerCaptureMode` for facet
Colours	Maximum: “column wise” (case 1)
Miscellaneous	• At maximum a count of nine shall be depicted in the row dimension. All exceeding counts shall be summarised in a single category (only for plot, not for lookup table).
Example Visualisation	Will be amended in a future version of this guideline.

Table 3-73: Heat Map Number of Finger Captures by Time

3.14.4.5 Number of Finger Captures by Finger

Attribute	Value

ID	FP-GENERIC-4
Name	Number of finger captures by finger
Purpose	This evaluation shall give insights in the number of needed finger captures by finger. Thereby, e.g. the detection of fingers with low and high numbers of needed finger captures is of interest.
Facet	Finger capture mode
Plots	Stacked bar plot (Table 3-75)
Tables	Absolute and relative lookup table for stacked bar plot (Table 3-75)

Table 3-74: Evaluation Number of Finger Captures by Finger

Attribute	Value
Name	Stacked bar plot of the number of finger captures by finger
Purpose	This stacked bar plot depicts the number of finger captures by finger to e.g. identify fingers with low or high number of finger captures.
Type	Stacked Bar Plot (vertical)
X-Axis	Finger code
Y-Axis	Relative frequency of the number of captures scaled from 0 to 1.
Data Source	• XML-attribute `FingerAcquisition/FingerCapture/@count` for the Y-axis • XML-attribute `FingerAcquisition/FingerCapture/@fc` for the X-axis • XML node `FingerAcquisition/StartTime` for period filtering • XML node `FingerAcquisition/FingerCaptureMode` for facet
Example Visualisation	Will be amended in a future version of this guideline.

Table 3-75: Stacked Bar Plot Number of Finger Captures by Finger

3.14.4.6 Rejection Reasons of Finger Captures Attempts

Attribute	Value
ID	FP-GENERIC-5
Name	Rejection reasons of finger capture attempts
Purpose	This evaluation shall give insights in the rejection reasons of finger capture attempts needed to digitise a finger. Thereby, e.g. the detection of specific sensor problems is of interest.
Plots	Stacked Bar Plot (Table 3-77)
Tables	Lookup table for stacked bar plot (Table 3-77)
Facet	Finger capture mode

Table 3-76: Evaluation Rejection Reason of Finger Capture Attempts

Attribute	Value
Name	Stacked bar plot for the rejection reasons of finger capture attempts
Purpose	This stacked bar plot depicts the rejection reasons of finger capture attempts occurred for a given period to recognize e.g. globally unusual balances of sensor errors.
Type	Stacked Bar Plot (horizontal)
X-Axis	Relative frequencies of finger capture rejection reasons.
Miscellaneous	If the rejection reason is “other”, the error code shall be used as value in addition e.g. “other, Error Code 5”.
Data Source	• XML-attributes `FingerAcquisition/FingerCapture/FingerCaptureAttempt/@rejectionReason` and `FingerAcquisition/FingerCapture/FingerCaptureAttempt/@errorCode` for the X-axis • XML node `FingerAcquisition/StartTime` for period filtering • XML node `FingerAcquisition/FingerCaptureMode` for facet

Attribute	Value
Example Visualisation	Will be amended in a future version of this guideline.

Table 3-77: Stacked Bar Rejection Reasons of Finger Capture Attempts

3.14.4.7 Rejection Reasons of Finger Capture Attempts by Finger

Attribute	Value
ID	FP-GENERIC-6
Name	Rejection Reasons of finger capture attempts by finger
Purpose	This evaluation shall give insights in the rejection reasons of finger capture attempts by finger needed to digitise a finger. Thereby, e.g. the detection of fingers with specific sensor problems is of interest.
Plots	Stacked Bar Plot (Table 3-79)
Tables	Lookup table for stacked bar plot (Table 3-79)
Facet	Finger capture mode

Table 3-78: Evaluation Rejection Reason of Finger Capture Attempts by Finger

Attribute	Value
Name	Stacked bar plot for the rejection reasons of finger capture attempts by finger
Purpose	This stacked bar plot depicts the rejection reasons of finger capture attempts occurred for a given period to recognize e.g. globally unusual balances of sensor errors.
Type	Stacked Bar Plot (vertical)
X-Axis	Finger code

Attribute	Value
Y-Axis	Relative frequencies of finger capture rejection reasons. If the rejection reason is “other”, the error code shall be used as value in addition e.g. “other, Error Code 5”.
Miscellaneous	If the rejection reason is “other”, the error code shall be used as value in addition e.g. “other, Error Code 5”.
Data Source	• XML-attributes `FingerAcquisition/FingerCapture/FingerCaptureAttempt/@rejectionReason` and `FingerAcquisition/FingerCapture/FingerCaptureAttempt/@errorCode` for the X-axis • XML node `FingerAcquisition/StartTime` for period filtering • XML-attribute `FingerAcquisition/FingerCapture@fc` for the X-axis • XML node `FingerAcquisition/FingerCaptureMode` for facet
Example Visualisation	Will be amended in a future version of this guideline.

Table 3-79: Stacked Bar Rejection Reasons of Finger Capture Attempts by Finger

3.14.4.8 Success Rate of Finger Capture Attempts

Attribute	Value
ID	FP-GENERIC-7
Name	Success rate of finger capture attempts
Purpose	This evaluation shall give insights in the global success rate of finger capture attempts needed to digitise a finger. Thereby, the detection of global problems is of interest.
Plots	Stacked Bar Plot (Table 3-81)
Tables	• Lookup table for stacked bar plot (Table 3-81)

	• Top and bottom table (Table 3-82)
Facet	Finger capture mode

Table 3-80: Evaluation Rejection Reason of Finger Capture Attempts by Finger

Attribute	Value
Name	Stacked bar plot for the success rate of finger capture attempts
Purpose	This stacked bar plot depicts the global success rate of finger capture attempts occurred for a given period to recognize e.g. global high number of failed capture attempts.
Type	Stacked Bar Plot (horizontal)
X-Axis	Relative frequencies of successful and not successful finger captures.
Data Source	• XML-attribute `FingerAcquisition/FingerCapture/FingerCaptureAttempt/@acceptableCapture` for the X-axis • XML node `FingerAcquisition/StartTime` for period filtering • XML node `FingerAcquisition/FingerCaptureMode` for facet
Example Visualisation	Will be amended in a future version of this guideline.

Table 3-81: Stacked Bar Success Rate of Finger Capture Attempts

Attribute	Value
Name	Top and bottom table locations by success rate of finger capture attempts
Purpose	Presenting locations with lowest and highest rank according to the success rate of finger capture attempts.
Row Labelling	The finger acquisition location.
Columns	• Success rate of finger capture attempts of the location (Value)

Attribute	Value
	• Number of finger capture attempts of the location as goodness estimator
Miscellaneous	• value column for ordering is the success rate of finger capture attempts • descending order (the higher, the better)
Data Source	• An XML-node with location or host information for location column. This data may also be located in sources external to this Technical Guideline. • XML-attribute `FingerAcquisition/FingerCapture/FingerCaptureAttempt/@acceptableCapture` for the success rate • the number of XML nodes `FingerAcquisition/FingerCapture/FingerCaptureAttempt` for the success rate and goodness estimator column • XML node `FingerAcquisition/StartTime` for period filtering • XML node `FingerAcquisition/FingerCaptureMode` for facet

Table 3-82: Top and Bottom Locations by Success Rate of Finger Capture Attempts

3.14.4.9 Success Rate of Finger Capture Attempts by Finger

Attribute	Value
ID	FP-GENERIC-8
Name	Success rate of finger capture attempts by finger
Purpose	This evaluation shall give insights in the success rate by finger of finger capture attempts needed to digitise the specific finger. Thereby, the detection of specific fingers with digitisation problems is of interest.
Plots	Stacked Bar Plot (Table 3-84)
Tables	Lookup table for stacked bar plot (Table 3-84)
Facet	Finger capture mode

Table 3-83: Evaluation Rejection Reason of Finger Capture Attempts by Finger

Attribute	Value
Name	Stacked bar plot for the success rate of finger capture attempts by finger
Purpose	This stacked bar plot depicts the success rate by finger of finger capture attempts occurred for a given period to recognize e.g. fingers with high number of failed capture attempts.
Type	Stacked Bar Plot (vertical)
X-Axis	Finger code
Y-Axis	Relative frequencies of successful and not successful finger captures.
Data Source	• XML-attribute `FingerAcquisition/FingerCapture/FingerCaptureAttempt/@acceptableCapture` for the Y-axis • XML node `FingerAcquisition/StartTime` for period filtering • XML-attribute `FingerAcquisition/FingerCapture/@fc` for the X-axis • XML node `FingerAcquisition/FingerCaptureMode` for facet
Example Visualisation	Will be amended in a future version of this guideline.

Table 3-84: Stacked Bar Success Rate of Finger Capture Attempts by Finger

3.14.4.10 Number of Finger Captures per Applicant

Attribute	Value
ID	FP-GENERIC-9
Name	Number of finger capture per Applicant
Purpose	This evaluation shall give insights in the number finger captures per applicant. Thereby, e.g. the share of applicants with very high number of captures is of interest.
Plots	Histogram (Table 3-86)

Tables	Lookup table for histogram (Table 3-86)

Table 3-85: Number of Finger Captures per Applicant

Attribute	Value
Name	Histogram number of finger captures per applicant
Purpose	This histogram depicts the number of finger captures per applicant for a given time period to recognize e.g. groups of applicants with high number of finger captures.
Type	Histogram with Cumulative Distribution Function
X-Axis	Number of captures per applicant
Y-Axis 1	Number of applicants
Y-Axis 2	Axis for empirical cumulative distribution function scaled from 0 to 1.
Data Source	• distribution of the sum of the XML-attributes `FingerAcquisition/FingerCapture/@count` per applicant • XML node `FingerAcquisition/StartTime` for period filtering
Miscellaneous	The mean shall not be indicated by a vertical line.
Example Visualisation	Will be amended in a future version of this guideline.

Table 3-86: Histogram Number of Finger Capture Attempts per Applicant

3.14.4.11 NFIQ 2.0 Fingerprint Image Quality

Attribute	Value
ID	FP-GENERIC-10
Name	NFIQ 2.0 fingerprint image quality

Purpose	This evaluation shall give insights in the NFIQ 2.0 fingerprint image quality. Thereby, e.g. the detection of fingers with quality below defined thresholds is of interest.
Plots	• Histogram (Table 3-89) per finger • Box plot (Table 3-90)
Tables	• Lookup table for histogram (Table 3-89) per finger • Lookup table for box plot (Table 3-90) • Top and bottom table (Table 3-91) • Threshold Configuration Table ◦ `FingerAcquisition/FingerQuality/Software` for component information ◦ `FingerAcquisition/FingerQuality/fp` for threshold information.

Table 3-87: NFIQ 2.0 Fingerprint Image Quality

Attribute	Value
Name	Stacked bar plot finger quality errors
Purpose	This figure depicts a stacked bar plot of the relative frequencies of finger quality assessments with and without errors. Thereby, e.g. the detection of high numbers of fingers which no quality was measured for is of interest.
Type	Stacked bar plot (horizontal)
X-Axis	Relative frequencies of the finger quality assessments without error and with error (by error code).
Miscellaneous	Note, that the bar segment of fingers with error code shall be further segmented by the error code values itself. If the rejection reason is “other”, the error code shall be used as value in addition e.g. “other, Error Code 5”.
Data Source	• counts of XML nodes `FingerAcquisition/FingerQuality/` with and without `FingerAcquisition/FingerQuality/ErrorCodes` • XML-nodes `FingerAcquisition/FingerQuality/ErrorCode` • XML node `FingerAcquisition/StartTime` for period filtering

Attribute	Value
Example Visualisation	Will be amended in a future version of this guideline.

Table 3-88: Stacked Bar Plot Relative Finger Quality Assessment Errors

Attribute	Value
Name	Histogram NFIQ 2.0 fingerprint image quality per finger
Purpose	This histogram depicts the distribution of NFIQ 2.0 fingerprint image quality for a single finger. Thereby, e.g. the share of fingers below the finger's threshold is of interest.
Type	Histogram with Cumulative Distribution Function
X-Axis	NFIQ 2.0 score scaled from 0 to 100
Y-Axis 1	Number of fingers
Y-Axis 2	Axis for empirical cumulative distribution function scaled from 0 to 1.
Facet	Finger Code
Miscellaneous	• The histogram shall only depict the quality distribution for a single finger. No histogram without facet grouping. • A vertical line shall indicate the threshold for the finger. The line shall be annotated with the numeric threshold and the relative number of fingers below the threshold.
Data Source	• distribution of XML attribute `FingerAcquisition/FingerQuality/fp/@result` • XML-attribute `FingerAcquisition/FingerQuality/fp/@fc` for finger filtering • XML-attribute `FingerAcquisition/FingerQuality/fp/@threshold` for threshold of finger • XML node `FingerAcquisition/StartTime` for period filtering

Attribute	Value
Example Visualisation	Will be amended in a future version of this guideline.

Table 3-89: Histogram NFIQ 2.0 Fingerprint Image Quality

Attribute	Value
Name	Box plot NFIQ 2.0 fingerprint image quality comparison by finger
Purpose	This figure depicts box plots of the distributions of NFIQ 2.0 fingerprint image quality for multiple fingers. Thereby, e.g. the fingers with unusual distribution characteristics shall be identified.
Type	Box plot
X-Axis	Finger code
Y-Axis	NFIQ 2.0 score
Data Source	• distribution of XML-attribute `FingerAcquisition/FingerQuality/fp/@result` for Y-axis • XML-attribute `FingerAcquisition/FingerQuality/fp/@fc` for X-axis • XML node `FingerAcquisition/StartTime` for period filtering

Attribute	Value
Example Visualisation	Will be amended in a future version of this guideline.

Table 3-90: Box Plot NFIQ 2.0 Fingerprint Image Quality Finger Comparison

Attribute	Value
Name	Top and bottom table locations by NFIQ 2.0 result
Purpose	Presenting locations with lowest and highest rank according to the NFIQ 2.0 results
Row Labelling	The finger acquisition location.
Columns	• A column for the median of the NFIQ 2.0 results for each finger (value columns) • Number of total finger captures at the location as goodness estimator
Miscellaneous	• The value column for ordering are the median NFIQ 2.0 columns. The order priority is as follows: right index, left index, right thumb, left thumb, right middle, left middle, right ring, left ring, right little, left little. Note that some fingers may not be available in the application. • Rank: descending order (the higher, the better)
Data Source	• An XML-node with location or host information for location column. This data may also be located in sources external to this Technical Guideline. • distribution of XML-attribute `/FingerAcquisition/FingerQuality/fp/@result` for median • XML-attribute `/FingerAcquisition/FingerQuality/fp/@fc` for filtering the median columns • XML node `FingerAcquisition/StartTime` for period filtering

Table 3-91: Top and Bottom Locations by NFIQ 2.0 Result

3.14.4.12 Finger Capture Duration

Attribute	Value
ID	FP-GENERIC-11
Name	Finger capture duration
Purpose	This evaluation shall give insights in the duration of finger captures. Thereby, e.g. the detection of fingers with long capture duration is of interest.
Plots	• Histogram (Table 3-93) per finger • Box plot (Table 3-94)
Tables	• Lookup table for histogram (Table 3-93) per finger • Lookup table for box plot (Table 3-94) • Top and bottom table (Table 3-95)

Table 3-92: Evaluation Finger Capture Duration

Attribute	Value
Name	Histogram finger capture duration per finger
Purpose	This histogram depicts the distribution of the capture duration for a single finger. Thereby, e.g. the detection of outliers is of interest.
Type	Histogram with Cumulative Distribution Function
X-Axis	Finger capture duration
Y-Axis 1	Number of fingers
Y-Axis 2	Axis for empirical cumulative distribution function scaled from 0 to 1.
Facet	Finger Code
Trimming	The input data of the histograms shall be trimmed by the respective 95% percentile.
Data Source	• distribution of XML-attribute `/FingerAcquisition/FingerCapture/@duration` • XML-attribute `FingerAcquisition/FingerCapture/@fc` for finger filtering • XML node `FingerAcquisition/StartTime` for period filtering

Attribute	Value
Example Visualisation	Will be amended in a future version of this guideline.

Table 3-93: Histogram Finger Capture Duration per Finger

Attribute	Value
Name	Box Plot Finger capture duration comparison by finger
Purpose	This figure depicts box plots of the distributions of finger capture durations for multiple fingers. Thereby, e.g. fingers with unusual capture duration distribution characteristics shall be identified.
Type	Box plot (vertical)
X-Axis	Finger code
Y-Axis	Finger capture duration
Miscellaneous	The boxes shall be ordered by their finger code.
Trimming	The input data of the boxes shall be trimmed by the respective 95% percentile. The percentile shall be calculated for each box separately.
Data Source	• distribution of XML-attribute `/FingerAcquisition/FingerCapture/@duration` for Y-axis • XML-attribute `FingerAcquisition/FingerCapture/@fc` for X-axis • XML node `FingerAcquisition/StartTime` for period filtering

Attribute	Value
Example Visualisation	Will be amended in a future version of this guideline.

Table 3-94: Box Plot Finger Capture Duration Comparison

Attribute	Value
Name	Top and bottom table locations by finger acquisition duration
Purpose	Presenting locations with lowest and highest rank according to the finger acquisition duration
Row Labelling	The finger acquisition location.
Columns	• Median of finger acquisition duration at the location. The duration can be calculated by subtracting `StartTime from EndTime`. • Number of finger acquisitions at the location as goodness estimator
Miscellaneous	• value column for ordering is the median of finger acquisition duration • ascending order (the lower, the better)
Data Source	• An XML-node with location or host information for location column. This data may also be located in sources external to this Technical Guideline. • XML nodes `FingerAcquisition/StartTime` and `/FingerAcquisition/EndTime` for the median duration calculation • XML node `FingerAcquisition/StartTime` for period filtering

Table 3-95: Top and Bottom Locations by Finger Acquisition Duration

3.14.4.13 Missing Fingers

Attribute	Value

ID	FP-GENERIC-12
Name	Missing fingers
Purpose	This evaluation shall give insights in distribution of missing fingers.
Plots	• Stacked bar plot (Table 3-98) • Histograms (Table 3-99, facet) • Stacked bar plots (Table 3-100, facet)
Tables	• Lookup table for stacked bar plot (Table 3-98) • Lookup tables for histogram (Table 3-99) • Lookup tables for stacked bar plot (Table 3-100) • Top and bottom table (Table 3-101)

Table 3-96: Evaluation Missing Fingers

Attribute	Value
Name	Stacked bar plot relative frequencies of applicants with at least one missing finger
Purpose	This figure depicts a stacked bar plot of the relative frequencies of applicants with at least one missing finger. Thereby, e.g. globally unusually frequent numbers of applicants with missing fingers shall be detected.
Type	Stacked bar plot (horizontal)
X-Axis	Relative frequencies of applicants with at least on missing finger and no missing finger scaled from 0 to 1.
Data Source	• Number of processes with at least one and without any XML node `FingerAcquisition/FingerMissing` • XML node `FingerAcquisition/StartTime` for period filtering
Example Visualisation	Will be amended in a future version of this guideline.

Table 3-97: Stacked Bar Plot Relative Frequencies of Applicants with a Missing Finger

Attribute	Value
Name	Stacked bar plot reason for missing fingers
Purpose	This figure depicts a stacked bar plot of the relative frequencies of missing fingers by reason for finger missing. Thereby, e.g. the major reason for missing fingers shall be identified.
Type	Stacked bar plot (horizontal)
X-Axis	Relative frequencies of the number of missing fingers by reason for missing scaled from 0 to 1.
Data Source	• counts of XML nodes `FingerAcquisition/FingerMissing` • XML-attribute `FingerAcquisition/FingerMissing/@reason` for bar partitioning

Attribute	Value
	• XML node `FingerAcquisition/StartTime` for period filtering
Example Visualisation	Will be amended in a future version of this guideline.

Table 3-98: Stacked Bar Plot Relative Frequencies Missing Finger Reason

Attribute	Value
Name	Histogram missing fingers
Purpose	This histogram depicts the distribution of missing fingers. Thereby, e.g. the detection of unexpected high numbers of missing fingers is of interest.
Type	Histogram with Cumulative Distribution Function
X-Axis	Number of missing fingers per applicant
Y-Axis 1	Number of applicants
Y-Axis 2	Axis for empirical cumulative distribution function scaled from 0 to 1.
Facet	Reason for missing finger
Data Source	• distribution of the number of XML nodes `FingerAcquisition/FingerMissing` per applicant • XML node `FingerAcquisition/StartTime` for period filtering • XML-attribute `FingerAcquisition/FingerMissing/@reason` for facet

Attribute	Value
Example Visualisation	Will be amended in a future version of this guideline.

Table 3-99: Histogram Number of Missing Fingers

Attribute	Value
Name	Stacked bar plot missing finger relative frequencies by finger
Purpose	This figure depicts a stacked bar plot of the relative frequencies of missing fingers by finger. Thereby, e.g. fingers which are frequently missing shall be identified.
Type	Stacked bar plot (horizontal)
X-Axis	Finger Code
Y-Axis	Relative frequencies of the finger acquisitions with finger missing scaled from 0 to 1.
Facet	reason for missing finger
Data Source	• counts of XML nodes `FingerAcquisition/FingerMissing` relative to to counts of XML nodes `FingerAcquisition` • XML-attribute `FingerAcquisition/FingerMissing/@fc` for bar partitioning • XML node `FingerAcquisition/StartTime` for period filtering • XML-attribute `FingerAcquisition/FingerMissing/@reason` for facet

Attribute	Value
Example Visualisation	Will be amended in a future version of this guideline.

Table 3-100: Stacked Bar Plot Relative Frequencies Missing Fingers

Attribute	Value
Name	Top and bottom table locations by relative frequencies of at least on missing finger per process
Purpose	Presenting locations with lowest and highest rank according to the relative frequencies of process with at least one missing finger.
Row Labelling	The finger acquisition location.
Columns	• Relative frequencies of finger acquisition processes with at least on missing finger (Value) • Number of finger acquisitions at the location as goodness estimator
Miscellaneous	• ascending order (the lower, the better)
Data Source	• Number of processes with and without existing XML nodes `FingerAcquisition/FingerMissing`. If no XML node exists this process shall count for processes without missing fingers • XML node `FingerAcquisition/StartTime` for period filtering • An XML-node with location or host information for location column. This data may also be located in sources external to this Technical Guideline.

Table 3-101: Top and Bottom Locations by Relative Frequencies of at least one Missing Finger per Process

3.14.4.14 Sequence Errors

Attribute	Value
ID	FP-GENERIC-13
Name	Sequence Errors
Purpose	This evaluation shall give insights in the distribution of sequence errors.
Plots	• Histograms (Table 3-104) • Stacked Bar Plot (Table 3-103)
Tables	• Lookup table for histograms (Table 3-104) • Lookup table for stacked bar plot (Table 3-103)

Table 3-102: Evaluation Sequence Errors

Attribute	Value
Name	Stacked bar plot for proportion of finger acquisition with sequence errors
Purpose	This stacked bar plot depicts the relative frequencies of finger acquisitions with and without sequence errors to recognize e.g. globally unusual high number of acquisitions with sequence errors.
Type	Stacked Bar Plot (horizontal)
X-Axis	Relative frequencies of finger acquisitions with and without sequence errors.
Data Source	• Number of processes with and without existing XML node `FingerAcquisition/SequenceError` • XML node `FingerAcquisition/StartTime` for period filtering
Example Visualisation	Will be amended in a future version of this guideline.

Table 3-103: Stacked Bar Finger Acquisitions With Sequence Errors

Attribute	Value
Name	Histogram number of sequence errors
Purpose	This histogram depicts the distribution of the number of sequence errors. Thereby, e.g. the detection of unexpected high numbers of sequence errors shall be possible.
Type	Histogram with Cumulative Distribution Function
X-Axis	Number of finger acquisitions
Y-Axis 1	Number of sequence errors
Y-Axis 2	Axis for empirical cumulative distribution function scaled from 0 to 1.
Data Source	• XML node `FingerAcquisition/StartTime` for period filtering • distribution of XML nodes `FingerAcquisition/SequenceError`
Example Visualisation	Will be amended in a future version of this guideline.

Table 3-104: Histogram Number of Sequence Errors

3.14.4.15 Segmentation Errors

Attribute	Value
ID	FP-GENERIC-14
Name	Segmentation Errors
Purpose	This evaluation shall give insights in the distribution of segmentation errors.
Plots	• Stacked Bar Plot (Table 3-106)
Tables	Lookup table for stacked bar plot (Table 3-106)

Table 3-105: Evaluation Segmentation Errors

Attribute	Value
Name	Stacked bar plot for proportion of finger acquisition with segmentation errors
Purpose	This stacked bar plot depicts the relative frequencies of finger acquisitions with and without segmentation errors to recognize e.g. globally unusual high number of acquisitions with segmentation errors.
Type	Stacked Bar Plot (horizontal)
X-Axis	Relative frequencies of finger acquisitions with and without segmentation errors.
Data Source	• Number processes with and without existing XML node `FingerAcquisition/SegmentationError` • XML node `FingerAcquisition/StartTime` for period filtering
Example Visualisation	Will be amended in a future version of this guideline.

Table 3-106: Stacked Bar Finger Acquisitions With Segmentation Errors

3.14.4.16 Uniqueness Checks

Attribute	Value
ID	FP-GENERIC-15
Name	Uniqueness Checks
Purpose	This evaluation shall give insights in the distribution of uniqueness checks.
Plots	• Histograms (Table 3-109) • Stacked Bar Plot (Table 3-108)
Tables	• Lookup table for histograms (Table 3-109) • Lookup table for stacked bar plot (Table 3-108) • Top and bottom table (Table 3-110)

Table 3-107: Evaluation Uniqueness Checks

Attribute	Value
Name	Stacked bar plot for proportion of finger acquisition with uniqueness check errors
Purpose	This stacked bar plot depicts the relative frequencies of finger acquisitions with and without uniqueness errors to recognize e.g. globally unusual high number of acquisitions with uniqueness errors.
Type	Stacked Bar Plot (horizontal)
X-Axis	Relative frequencies of finger acquisitions with and without uniqueness errors.
Data Source	• Number of processes with and without existing XML node `FingerAcquisition/UniquenessCheck`. If no XML node exists or if it exists and its XML-attribute `result` is false, this process shall count for processes without uniqueness check errors. • XML node `FingerAcquisition/StartTime` for period filtering

Attribute	Value
Example Visualisation	Will be amended in a future version of this guideline.

Table 3-108: Stacked Bar Uniqueness Check Errors per Finger Acquisition

Attribute	Value
Name	Stacked bar plot of relative frequencies of finger duplicates
Purpose	This stacked bar plot depicts the relative frequencies of finger duplicates to recognize e.g. duplicates with unusual high number of occurrences.
Type	Stacked Bar Plot (horizontal)
X-Axis	Relative frequencies of duplicates
Data Source	• Distribution of XML node `FingerAcquisition/UniquenessCheck/Duplicates/Duplicate` • XML node `FingerAcquisition/StartTime` for period filtering
Example Visualisation	Will be amended in a future version of this guideline.

Table 3-109: Stacked Bar Finger Duplicates

Attribute	Value
Name	Top and bottom table locations by number of uniqueness check errors
Purpose	Presenting locations with lowest and highest rank according to the number of uniqueness
Row Labelling	The finger acquisition location.
Columns	• Relative frequencies of finger acquisition processes with uniqueness check errors of the location (Value) • Number of finger acquisitions at the location as goodness estimator
Miscellaneous	• value column for ordering is the relative frequencies of finger acquisitions with uniqueness check error • ascending order (the lower, the better)
Data Source	• Number of processes with and without existing XML node `FingerAcquisition/UniqunessCheck`. If no XML node exists or if it exists

Attribute	Value
	and its XML-attribute result is false, this process shall count for processes without uniqueness check errors. • XML node `FingerAcquisition/StartTime` for period filtering

Table 3-110: Top and Bottom Locations by Number of Uniqueness Check Errors

3.14.5 EVA-FP-CENTRAL

This functional module defines requirements for the evaluation of fingerprint images in central systems different from acquisition clients based on the XML-element “fp-gid-eval”.

3.14.5.1 Requirements

The evaluations defined by this module shall be provided if the application specific EVA-FP module requires them. For each quality algorithm deployed at the central side, the evaluations defined by this module shall be made provided.

3.14.5.2 NFIQ 2.0 Fingerprint Image Quality

Attribute	Value
ID	FP-CENTRAL-1
Name	NFIQ 2.0 fingerprint image quality
Purpose	This evaluation shall give insights in the NFIQ 2.0 fingerprint image quality. Thereby, e.g. the detection of fingers with quality below defined thresholds is of interest.
Plots	• Histogram (Table 3-113) per finger • Box plot (Table 3-114)
Tables	• Lookup table for histogram (Table 3-113) per finger • Lookup table for box plot (Table 3-114) • Threshold Configuration Table ◦ `FingerQualityAssurance/FingerQuality/Software` for component information ◦ `FingerQualityAssurance/FingerQuality/fp` for threshold information.

Table 3-111: NFIQ 2.0 Fingerprint Image Quality

Attribute	Value
Name	Stacked bar plot finger quality errors
Purpose	This figure depicts a stacked bar plot of the relative frequencies of finger quality

Attribute	Value
	assessments with and without errors. Thereby, e.g. the detection of high numbers of fingers which no quality was measured for is of interest.
Type	Stacked bar plot (horizontal)
X-Axis	Relative frequencies of the finger quality assessments without error and with error (by error code).
Miscellaneous	Note, that the bar segment of fingers with error code shall be further segmented by the error code values itself. If the rejection reason is “other”, the error code shall be used as value in addition e.g. “other, Error Code 5”.
Data Source	• counts of XML nodes `FingerQualityAssurance/FingerQuality/` with and without `FingerQualityAssurance/FingerQuality/ErrorCodes` • XML-nodes `FingerQualityAssurance/FingerQuality/ErrorCode` • XML node `StartTime` for period filtering
Example Visualisation	Will be amended in a future version of this guideline.

Table 3-112: Stacked Bar Plot Relative Finger Quality Assessment Errors

Attribute	Value
Name	Histogram NFIQ 2.0 fingerprint image quality per finger
Purpose	This histogram depicts the distribution of NFIQ 2.0 fingerprint image quality for a single finger. Thereby, e.g. the share of fingers below the finger’s threshold is of interest.
Type	Histogram with Cumulative Distribution Function
X-Axis	NFIQ 2.0 score scaled from 0 to 100
Y-Axis 1	Number of fingers
Y-Axis 2	Axis for empirical cumulative distribution function scaled from 0 to 1.
Facet	Finger Code

Attribute	Value
Miscellaneous	• The histogram shall only depict the quality distribution for a single finger. No histogram without facet grouping. • A vertical line shall indicate the threshold for the finger. The line shall be annotated with the numeric threshold and the relative number of fingers below the threshold.
Data Source	• distribution of XML attribute `FingerQualityAssurance/FingerQuality/fp/@result` • XML-attribute `FingerQualityAssurance/FingerQuality/fp/@fc` for finger filtering • XML-attribute `FingerQualityAssurance/FingerQuality/fp/@threshold` for threshold of finger • XML node `StartTime` for period filtering
Example Visualisation	Will be amended in a future version of this guideline.

Table 3-113: Histogram NFIQ 2.0 Fingerprint Image Quality

Attribute	Value
Name	Box plot NFIQ 2.0 fingerprint image quality comparison by finger
Purpose	This figure depicts box plots of the distributions of NFIQ 2.0 fingerprint image quality for multiple fingers. Thereby, e.g. the fingers with unusual distribution characteristics shall be identified.
Type	Box plot
X-Axis	Finger code
Y-Axis	NFIQ 2.0 score
Data Source	• distribution of XML-attribute

Attribute	Value
	`FingerQualityAssurance/FingerQuality/fp/@result` for Y-axis • XML-attribute `FingerQualityAssurance/FingerQuality/fp/@fc` for X-axis • XML node `StartTime` for period filtering
Example Visualisation	Will be amended in a future version of this guideline.

Table 3-114: Box Plot NFIQ 2.0 Fingerprint Image Quality Finger Comparison

3.14.6 EVA-FP-PAD

This functional module defines requirements for the evaluation of presentation attack detection at fingerprint acquisitions.

3.14.6.1 Requirements

The evaluations defined by this module shall be provided if the application specific EVA-FP module requires them.

3.14.6.2 Finger Presentation Attack Detection

Attribute	Value
ID	FP-PAD-1
Name	Presentation attack detection
Purpose	This evaluation shall give insights in the distribution of presentation attack detection results.
Plots	• Histograms (Table 3-119) • Stacked bar plot (Table 3-116)

Tables	• Lookup table for histograms (Table 3-119) • Top and bottom tables (Table 3-117, Table 3-118)

Table 3-115: Evaluation Finger Presentation Attack Detection

Attribute	Value
Name	Stacked bar plot activation of presentation attack detection
Purpose	This stacked bar plot depicts the relative frequencies of finger acquisition processes with and without activated presentation attack detection e.g. to detect misconfigured hosts.
Type	Stacked Bar Plot (horizontal)
X-Axis	Relative frequencies of finger acquisition processes with and without presentation detection enabled.
Data Source	• Number of processes with and without existing `FingerAcquisition/PADInformation` • XML node `FingerAcquisition/StartTime` for period filtering
Example Visualisation	Will be amended in a future version of this guideline.

Table 3-116: Stacked Bar Finger Acquisitions with Presentation Attack Detection

Attribute	Value
Name	Top and bottom table locations with low and high presentation attack detection activation quote.
Purpose	Presenting locations with high and low activation of presentation attack detection functionality.
Row Labelling	The finger acquisition location.
Columns	• Relative frequency of finger acquisition processes with a

Attribute	Value
	`FingerAcquisition/PADInformation` • Number of finger acquisitions as goodness estimator
Miscellaneous	• value column for ordering is relative frequency of finger acquisition processes with a `FingerAcquisition/PADInformation` • ascending order (the lower, the better)
Data Source	• count of XML-node `FingerAcquistion/PADInformation/ProbePADInfo/` • count of XML-node `FingerAcquistion` • An XML-node with location or host information. This data may also be located in sources external to this Technical Guideline. • XML node `FingerAcquisition/StartTime` for period filtering

Table 3-117: Top and Bottom Locations by Activation of Presentation Attack Detection

Attribute	Value
Name	Top and bottom table locations with low and high detected presentation attacks.
Purpose	Presenting locations with high and low relative numbers of detections of presentation attacks.
Row Labelling	The finger acquisition location.
Columns	• Share of presentation attack detection probes with “detected” presentation attack detection. • Number of presentation attack detection probes as goodness estimator
Miscellaneous	• value column for ordering is the share of “detected” results • ascending order (the lower, the better)
Data Source	• XML-attribute `FingerAcquistion/PADInformation/ProbePADInfo/@total` for share of PAD probes with “detected” result • An XML-node with location or host information. This data may also be located in sources external to this Technical Guideline. • XML node `FingerAcquisition/StartTime` for period filtering

Table 3-118: Top and Bottom Locations by Detected Presentation Attack Detection

Attribute	Value
Name	Histogram presentation attack detection scores

Attribute	Value
Purpose	This histogram depicts the distribution of presentation attack detection scores. Thereby, e.g. the detection of unexpected high numbers of low presentation attack detection results shall be possible.
Type	Histogram with Cumulative Distribution Function
X-Axis	Presentation attack detection score
Y-Axis 1	Number of probes
Y-Axis 2	Axis for empirical cumulative distribution function scaled from 0 to 1.
Facet	• Finger Code • PAD Subsystem Hardware • Finger Acquisition Software
Data Source	• XML node `FingerAcquisition/StartTime` for period filtering • distribution of XML-attribute `FingerAcquisition/PADInformation/ProbePADInfo/pad/@result` • XML-attribute `FingerAcquisition/FingerCapture/@fc` for facet • XML node `FingerAcquisition/PADInformation/PADSubsystem` for facet, child node values concatenated • XML node `FingerAcquisition/Hardware` for facet, child node values concatenated
Example Visualisation	Will be amended in a future version of this guideline.

Table 3-119: Histogram Number of Presentation Attack Detection Scores

3.14.7 EVA-FP-AAD

This functional module defines fingerprint evaluations for the arrival attestation document application profile.

3.14.7.1 Requirements

The evaluations specified by this module shall be provided. In addition all evaluation defined by Table 3-120 shall be provided.

ID	Remark
FP-CENTRAL-*	
FP-GENERIC-1	
FP-GENERIC-2	For rolled and flat acquisition separately.
FP-GENERIC-3	For rolled and flat acquisition separately.
FP-GENERIC-4	For rolled and flat acquisition separately.
FP-GENERIC-5	For rolled and flat acquisition separately.
FP-GENERIC-6	For rolled and flat acquisition separately.
FP-GENERIC-7	For rolled and flat acquisition separately.
FP-GENERIC-8	For rolled and flat acquisition separately.
FP-GENERIC-9	For rolled and flat acquisition separately.
FP-GENERIC-10	
FP-GENERIC-11	
FP-GENERIC-12	
FP-GENERIC-13	
FP-GENERIC-14	
FP-GENERIC-15	

Table 3-120: Required Evaluations FP-AAD

3.14.7.2 Fingerprint Capture Allowed

Attribute	Value
ID	FP-GID-1
Name	Fingerprint Capture Allowed
Purpose	This evaluation shall give insights in the distribution of applications regarding allowed fingerprint captures.
Plots	Stacked bar plot (Table 3-122)

Tables	• Absolute and relative lookup table for stacked bar plot (Table 3-122) • Top and bottom table (Table 3-123)

Table 3-121: Evaluation Fingerprint Capture Allowed

Attribute	Value
Name	Stacked bar plot share of applications where fingerprint capture is allowed
Purpose	This stacked bar plot depicts the share of applications where fingerprint capture is allowed and not allowed.
Type	Stacked Bar Plot (horizontal)
X-Axis	Relative frequency of fingerprint capture allowed logging field.
Data Source	• XML-nodes `FingerprintCaptureAllowed` for x axis shares • XML-node `StartTime` for period filtering
Example Visualisation	Will be amended in a future version of this guideline.

Table 3-122: Stacked Bar Plot Fingerprint Capture Allowed

Attribute	Value
Name	Top and bottom table locations by fingerprint capture allowed
Purpose	Presenting locations with lowest and highest rank according to the share of allowed fingerprint captures
Row	The finger acquisition location.
Columns	• Share of applications with TRUE FingerprintCaptureAllowed field • Number of applications process at the location as goodness estimator
Miscellaneous	• value column for ordering is the share of applications with TRUE

Attribute	Value
	FingerprintCaptureAllowed • descending order (the higher, the better)
Data Source	• An XML-node with location or host information for location column. This data my also be located in sources external to this Technical Guideline. • XML-node `FingerprintCaptureAllowed` • XML-node `StartTime` for period filtering

Table 3-123: Top and Bottom Locations by Fingerprint Capture Allowed

3.14.7.3 Fingerprint Exclude Option

Attribute	Value
ID	FP-GID-2
Name	Fingerprint Exclude Option
Purpose	This evaluation shall give insights in the distribution of applications regarding the fingerprint exclude option.
Plots	Stacked bar plot (Table 3-125)
Tables	• Absolute and relative lookup table for stacked bar plot (Table 3-125) • Top and bottom table (Table 3-126)

Table 3-124: Evaluation Fingerprint Exclude Option

Attribute	Value
Name	Stacked bar plot share of applications where fingerprint exclude option is TRUE
Purpose	This stacked bar plot depicts the share of applications where fingerprint exclude option is TRUE and not allowed.
Type	Stacked Bar Plot (horizontal)
X-Axis	Relative frequency of applications with fingerprint exclude option is TRUE
Data Source	• XML-nodes `FingerprintExcludeOption` for x axis shares • XML-node `StartTime` for period filtering

Attribute	Value
Example Visualisation	Will be amended in a future version of this guideline.

Table 3-125: Stacked Bar Plot Fingerprint Exclude Option

Attribute	Value
Name	Top and bottom table locations by fingerprint capture allowed
Purpose	Presenting locations with lowest and highest rank according to the share of TRUE fingerprint exclude option
Row	The finger acquisition location.
Columns	• Share of applications with TRUE FingerprintExcludeOption field • Number of applications process at the location as goodness estimator
Miscellaneous	• value column for ordering is the share of applications with TRUE FingerprintExcludeOption • ascending order (the lower, the better)
Data Source	• An XML-node with location or host information for location column. This data my also be located in sources external to this Technical Guideline. • XML-node `FingerprintExcludeOption` • XML-node `StartTime` for period filtering

Table 3-126: Top and Bottom Locations by Fingerprint Exclude Option

3.14.7.4 Fingerprint Exclude Option vs. Fingerprint Capture Allowed

Attribute	Value
ID	FP-GID-3

Name	Fingerprint Exclude Option vs. Fingerprint Capture Allowed
Purpose	This evaluation shall give insights in the combination of Fingerprint Capture Allowed vs. Fingerprint Exclude Option
Tables	• Absolute and relative contingency table (Table 3-128 and Table 3-129) • Top and bottom table (Table 3-130)

Table 3-127: Evaluation Fingerprint Exclude Option vs. Fingerprint Capture Allowed

Attribute	**Value**
Name	Absolute Contingency Table Fingerprint Exclude Option vs. Fingerprint Capture Allowed
Purpose	This table provides insights in the absolute frequencies of applications with different value combinations of Fingerprint Exclude Option and Fingerprint Capture Allowed.
Row Labelling	Value of Fingerprint Exclude Option
Column Labelling	Value of Fingerprint Capture Allowed
Cell	The cell shall be the absolute frequency of applications with the specific Fingerprint Exclude Option and Fingerprint Capture Allowed combination.
Data Source	• XML-node `FingerprintExcludeOption` • XML-node `FingerprintCaptureAllowed` • XML-node `StartTime` for period filtering

Table 3-128: Absolute Contingency Table Fingerprint Exclude Option vs. Fingerprint Capture Allowed

Attribute	Value
Name	Relative Contingency Table Fingerprint Exclude Option vs. Fingerprint Capture Allowed
Purpose	This table provides insights in the relative frequencies of applications with different value combinations of Fingerprint Exclude Option and Fingerprint Capture Allowed.
Row Labelling	Value of Fingerprint Exclude Option
Column Labelling	Value of Fingerprint Capture Allowed
Cell	The cell shall be the relative frequency of applications with the specific Fingerprint Exclude Option and Fingerprint Capture Allowed combination.
Data Source	• XML-node `FingerprintExcludeOption` • XML-node `FingerprintCaptureAllowed` • XML-node `StartTime` for period filtering

Table 3-129: Relative Contingency Table Fingerprint Exclude Option vs. Fingerprint Capture Allowed

Attribute	Value
Name	Top and bottom table locations by allowed but excluded fingerprints
Purpose	Presenting locations with lowest and highest rank according to the share of allowed but excluded fingerprints flags.
Row	The finger acquisition location.
Columns	• Share of applications with TRUE FingerprintExcludeOption field and TRUE FingerprintCaptureAllowed field • Number of applications process at the location as goodness estimator
Miscellaneous	• value column for ordering is the share of applications with TRUE FingerprintExcludeOption field and TRUE FingerprintCaptureAllowed field • ascending order (the lower, the better)
Data Source	• An XML-node with location or host information for location column. This data my also be located in sources external to this Technical Guideline. • XML-node `FingerprintExcludeOption` • XML-node `FingerprintCaptureAllowed` • XML-node `StartTime` for period filtering

Table 3-130: Top and Bottom Locations by Allowed but Excluded Fingerprints

3.14.8 EVA-PH-GENERIC

This functional module defines requirements for the evaluation of facial image acquisitions.

3.14.8.1 Requirements

The evaluations defined by this module shall be provided if the application specific EVA-PH module requires them.

3.14.8.2 Facial Image Capture Components

Attribute	Value
ID	PH-GENERIC-1
Name	Software version of facial image capture
Purpose	This evaluation shall give insights in the used software for capturing facial images during the report period.
Plots	• Heat Map facial image acquisition software usage (Table 3-132) • Heat Map facial image hardware usage (Table 3-133)
Tables	• Lookup table for heat maps (Table 3-132 and Table 3-133) • Component Usage Tables for ◦ software of facial image acquisition `FaceAcquisition/Software` ◦ hardware of facial image acquisition `FaceAcquisition/Hardware`

Table 3-131: Evaluation Facial Image Capture Component

Attribute	Value
Name	Heat map of the number of facial image acquisitions by software version
Purpose	This heat map depicts the distributions of the number of facial image acquisitions by software version over a given period to recognize e.g. new software versions and their introduction phase.
Type	Heat Map
Row Labelling	The facial image acquisition software version
Column Labelling	Time, calender week if yearly report, day if monthly report
Cells	The frequency of facial image acquisitions with the given software version
Data Source	• The number of XML nodes `FaceAcquisition` for the cell counts • The XML nodes `FaceAcquisition/Software` for the row dimension

Attribute	Value
	• XML node `FaceAcquisition/StartTime` for period filtering and the column dimension
Colours	Maximum: “column wise” (case 1)
Example Visualisation	Will be amended in a future version of this guideline.

Table 3-132: Heat Map Facial Image Acquisitions by Software

Attribute	Value
Name	Heat map of the number of facial image acquisitions by hardware version
Purpose	This heat map depicts the distributions of the number of facial image acquisitions by hardware version over a given period to recognize e.g. detect new hardware versions and their introduction phase.
Type	Heat Map
Row Labelling	The facial image acquisition hardware version
Column Labelling	Time, calendar week if yearly report, day if monthly report
Cells	The count of facial image acquisitions with the relevant hardware version
Data Source	• The number of XML nodes Face`Acquisition` for the cell counts • The XML nodes `FaceAcquisition/Hardware` for the row dimension • XML node `FaceAcquisition/StartTime` for period filtering and the column dimension
Colours	Maximum: “column wise” (case 1)
Example Visualisation	Will be amended in a future version of this guideline.

Attribute	Value

Table 3-133: Heat Map Facial Image Acquisitions by Hardware

3.14.8.3 Facial Image Acceptability

Attribute	Value
ID	PH-GENERIC-2
Name	Facial image acceptability
Purpose	This evaluation shall give insights in the acceptability of facial images. Thereby it can be measured if the percentage of acceptable images is reasonable.
Plots	• Stacked Bar Plot (Table 3-135) • Stacked Bar Plot (Table 3-136)
Tables	• Lookup table for stacked bar plot (Table 3-135) • Lookup table for stacked bar plot (Table 3-136) • Top and bottom table (Table 3-137) • Threshold Configuration Table ◦ `FaceAcquisition/FaceQuality/Software` for component information ◦ `FaceAcquisition/FaceQuality/qa` for threshold information.

Table 3-134: Evaluation Facial Image Acceptability

Attribute	Value
Name	Stacked bar plot of the total acceptability of facial images in the reporting period
Purpose	This stacked bar plot shall give insights in the total acceptability of the facial images. Thereby, it shall e.g. be measured if the total quality of the images is reasonable.
Type	Stacked Bar Plot (horizontal)

X-Axis	Relative percentage of acceptable and unacceptable facial images.
Miscellaneous	• An image is acceptable if it fulfils all mandatory quality criteria defined by the function module QA-PH-SB. • If any mandatory quality criteria is not fulfilled, the facial image's total acceptability shall be nominated as unacceptable.
Data Source	• XML-attributes `FaceAcquisition/FaceQuality/qa/@result, FaceAcquisition/FaceQuality/qa/@tmin, FaceAcquisition/FaceQuality/qa/@tmax` for the X-axis calculation • XML node `FaceAcquisition/StartTime` for period filtering
Example Visualisation	

Table 3-135: Stacked Bar Plot Total Facial Image Quality

Attribute	Value
Name	Stacked bar plot acceptability of facial images by quality criteria.
Purpose	This plot shall give insights in the distribution of results for different facial image quality criteria. This information can give insight in which aspects have to be addressed for future technology improvements.
Y-Axis	Relative frequencies of results of quality criteria.
X-Axis	The facial image quality criteria (QA-PH-SB)
Data Sources	• XML-attribute `FaceAcquisition/FaceQuality/qa/@result, FaceAcquisition/FaceQuality/qa/@tmin, FaceAcquisition/FaceQuality/qa/@tmax` for the Y-axis • XML-attribute `FaceAcquisition/FaceQuality/qa/@id` for the X-axis • XML node `FaceAcquisition/StartTime` for period filtering
Example	

Table 3-136: Stacked Bar Plot Acceptability of Facial Images by Quality Metrics

Attribute	Value
Name	Top and bottom table locations by total acceptability of facial images
Purpose	Presenting locations with lowest and highest rank according to total facial image quality
Row Labelling	The facial image acquisition location.
Columns	• Relative frequencies of results of facial image total acceptability

Attribute	Value
	• Number of facial image acquisitions at the location as goodness estimator
Miscellaneous	• ascending order (the lower, the better) • An image is acceptable if it fulfils all mandatory quality criteria defined by QA-PH-SB. • If any mandatory quality criteria is not fulfilled, the image's total acceptability is unacceptable.
Data Source	• XML-attributes `FaceAcquisition/FaceQuality/qa/@result`, `FaceAcquisition/FaceQuality/qa/@tmin`, `FaceAcquisition/FaceQuality/qa/@tmax` • XML-attribute `FaceAcquisition/FaceQuality/qa/@id` to determine whether criteria is mandatory • XML node `FaceAcquisition/StartTime` for period filtering • An XML-node with location or host information for location column. This data may also be located in sources external to this Technical Guideline.

Table 3-137: Top and Bottom Locations by Total Acceptability of Facial Images

3.14.9 EVA-PH-CENTRAL

This functional module defines requirements for the evaluation of facial image acquisitions on central systems different from acquisition clients based on the XML-element "ph-gid-eval".

3.14.9.1 Requirements

The evaluations defined by this module shall be provided if the application specific EVA-PH module requires them. For each quality algorithm deployed at the central side, the evaluations defined by this module shall be made provided.

3.14.9.2 Facial Image Acceptability

Attribute	Value
ID	PH-CENTRAL-1
Name	Facial image acceptability
Purpose	This evaluation shall give insights in the acceptability of facial images. Thereby it can be measured if the percentage of acceptable images is reasonable.
Plots	• Stacked Bar Plot (Table 3-139) • Stacked Bar Plot (Table 3-140)
Tables	• Lookup table for stacked bar plot (Table 3-139)

	• Lookup table for stacked bar plot (Table 3-140) • Threshold Configuration Table ◦ `FaceQualityAssurance/FaceQuality/Software` for component information ◦ `FaceQualityAssurance/FaceQuality/qa` for threshold information.

Table 3-138: Evaluation Facial Image Acceptability

Attribute	Value
Name	Stacked bar plot of the total acceptability of facial images in the reporting period
Purpose	This stacked bar plot shall give insights in the total acceptability of the facial images. Thereby, it shall e.g. be measured if the total quality of the images is reasonable.
Type	Stacked Bar Plot (horizontal)
X-Axis	Relative percentage of acceptable and unacceptable facial images.
Miscellaneous	• An image is acceptable if it fulfils all mandatory quality criteria defined by the function module QA-PH-SB. • If any mandatory quality criteria is not fulfilled, the facial image's total acceptability shall be nominated as unacceptable.
Data Source	• XML-attributes `FaceQualityAssurance/FaceQuality/qa/@result`, `FaceQualityAssurance/FaceQuality/qa/@tmin`, `FaceQualityAssurance/FaceQuality/qa/@tmax` for the X-axis calculation • XML node `StartTime` for period filtering
Example Visualisation	

Table 3-139: Stacked Bar Plot Total Facial Image Quality

Attribute	Value
Name	Stacked bar plot acceptability of facial images by quality criteria.
Purpose	This plot shall give insights in the distribution of results for different facial image quality criteria. This information can give insight in which aspects have to be addressed for future technology improvements.
Y-Axis	Relative frequencies of results of quality criteria.
X-Axis	The facial image quality criteria (QA-PH-SB)
Data Sources	• XML-attribute `FaceQualityAssurance/FaceQuality/qa/@result`, `FaceQualityAssurance/FaceQuality/qa/@tmin`,

	`FaceQualityAssurance/FaceQuality/qa/@tmax` for the Y-axis • XML-attribute `FaceAcquisition/FaceQuality/qa/@id` for the X-axis • XML node `StartTime` for period filtering
Example	

Table 3-140: Stacked Bar Plot Acceptability of Facial Images by Quality Metrics

3.14.10 EVA-PH-AAD

This functional module defines facial image evaluations for the arrival attestation document application profile.

3.14.10.1 Requirements

The evaluations specified by this module shall be provided. In addition all evaluation defined by Table 3-141 shall be provided.

ID	Remark
PH-CENTRAL-*	
PH-GENERIC-*	

Table 3-141: Required Evaluations EVA-PH-AAD

4 List of Abbreviations

Abbreviation	Description
AAD	Arrival Attestation Document
ACQ	Acquisition
AD	Acquisition Device
AFIS	Automated Fingerprint Identification System
AH	Acquisition Hardware
ANSI	American National Standards Institute
AP	Application Profile
APP	Application
AS	Acquisition Software
BEA	Biometric Evaluation Authority
BioAPI	Biometric Application Programming Interface
BioSFPI	Biometric Sensor Function Provider Interface
BioSPI	BioAPI Service Provider Interface
BIP	Biometric Image Processing
BMS	Biometric Matching System
BMP	Windows Bitmap version 3
BPCER	Bona fide presentation classification error rate
BFNRR	Bona fide presentation non-response rate
BSI	Bundesamt für Sicherheit in der Informationstechnik (Federal Office for Information Security)
BFP	Biometric Function Provider
BSFP	Biometric Sensor Function Provider
BSP	Biometric Service Provider
CDF	Cumulative Distribution Function
CMP	Biometric Comparison
COD	Coding

Abbreviation	Description
COM	Compression
CRM	Cross-matching
CTS	Conformance test suite
DC	Digital camera
DET	Detection error trade-off
eID	Electronic identity document
ePass	Electronic passport
EU	European Union
EVA	Evaluation
FAR	False accept rate
FBS	Flat bed scanner
FM	Function Module
FMR	False match rate
FNMR	False non-match rate
FOM	Freedom of Movement
FP	Fingerprint
FRR	False reject rate
FTR	Frustrated total reflection
GID	German Identity Document
ICAO	International Civil Aviation Organization
ID	Identity
IUT	Instance under test
JPG	JPEG
JP2	JPEG 2000
LOG	Logging
MF	Multi finger
MMI	Multimodal Identification

Abbreviation	Description
NCA	National Central Authority
NIST	National Institute of Standards and Technology
O	Operation
P	Process
PG	Photo Guideline ("Fotomustertafel”)
PH	Photo
PNG	Portable Network Graphics
PT	Photo Template ("Lichtbildschablone”)
QA	Quality Assurance
REF	Reference Storage
SB	Software based
SDK	Software Development Kit
SF	Single finger
STANAG	NATO Standardization Agreement
TC	Test Case
TR	Technische Richtlinie (Technical Guideline)
UI	User Interface
VAPP	Visa Application
VBIC	Visa Basic Identity Check
VEIC	Visa Extended Identity Check
VIC	Visa Identity Check
VID	Verification Identity Document
VIS	Visa Information System
WSQ	Wavelet Scalar Quantisation
WSQR	Wavelet Scalar Quantisation for reference storage

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[ISO_FINGER] ISO/IEC 19794-4:2005 “Information technology - Biometric data interchange formats – Part 4: Finger image data”

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