Technical Guideline TR-03121-3

Biometrics for Public Sector Applications

Part 3: Function Modules

Version 2.3
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1 Introduction

This document describes Function Modules (FMs) in the scope of the TR Biometrics. Within this document all relevant Function Modules for the Application Profiles are explained. An overview of this document is given in chapter 3 of TR-03121-1. Furthermore, the mapping between Application Profiles and Function Modules can be found in TR-03121-2. This document provides binding information, in particular of technical requirements and respective interfaces.
2 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 is specified with additional information.

2.1 P-FP-GID

This function block describes the overall process requirements for capturing two fingerprints for enrolment purposes for identity documents.

Requirements

Multiple lossy compressions on image data are not allowed within the overall process.

In the following, the process of capturing 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:

- FM Acquisition Hardware (FM AH)
- FM Acquisition Software (FM AS)
- FM Biometric Image Processing (FM BIP)
- FM Quality Assurance (FM QA)
- FM Compression (FM COM)
- FM Coding (FM COD)
- FM Operation (FM O)

The full process is illustrated by three figures. Within the scope of the first figure, the overall process of the acquisition of fingers of both hands is described (figure 2-2). Starting from this process, the acquisition of one finger of one hand is examined in more detail (figure 2-3).
Afterwards, the capturing of an individual finger is presented (figure 2-4). Finally, a detailed technical description of the process is given.

Figure 2-2 presents an overview of how two fingerprints are captured. At first, a selection of available fingers is created. By this means, fingers that are not applicable or missing for acquisition can be excluded. Based on this selection, the standard sequence or an alternative application process can be applied. In the case of the standard sequence, the acquisition of one finger of the right hand and, afterwards, the acquisition of one finger of the left hand are performed (compare figure 2-3).

The process of the acquisition of one finger of one hand is presented in figure 2-3:

1. The acquisition of the fingerprints starts with the acquisition of the print of the index finger.
2. If the print of the index finger is captured successfully, the image of the fingerprint as well as additional information (e.g. quality values) are returned as a result.
3. If the index finger cannot be captured successfully, one proceeds with the acquisition of the thumb. In the case of a successful capture of the thumb, the values are returned according to 2).
4. If the thumb cannot be captured either, the option either to abort the acquisition of the fingers of this hand (after at least two unsuccessfully tried fingers) or to continue with the capture of the middle finger must be given to the official (compare FM O-FP-GID).

5. If the middle finger cannot be captured either, the option either to abort the acquisition of the fingers of this hand or to continue with the capture of the ring finger must be given to the official (compare FM O-FP-GID). In the case of a successful capture of the middle finger, the values are returned according to 2). This is also valid if the ring finger was captured successfully.

6. If no finger of this hand can be captured successfully, the image of the fingerprint with the highest quality among the rejected ones (low quality) and the corresponding additional information are returned as a result.
*Simplified: As far as the finger is available, otherwise the next finger is tried to be captured. At least two different available finger have to be tried.
The acquisition of an individual finger is described in figure 2-4. During the capture of an individual finger, the following steps are executed:

1. Three independent images are taken from each individual finger (by placing the finger on the sensor three times, with respect to the Function Modules Acquisition Hardware (FM AH-FP-FTR), Acquisition Software (FM AS-FP-SF) and Biometric Image Processing (FM BIP-FP-APP), and are handed over to the Function Module Quality Assurance (FM QA-FP-APPD).

2. The Function Module QA-FP-APPD delivers the index of the best of these three fingerprints based on quality evaluation and additional information.

3. If the necessary quality is met, this sequence ends with successful acquisition of an individual finger.

4. In case the quality is not reached: if the quality of this rejected fingerprint is better than the maximum quality of the previously rejected fingerprints for all fingers of the same hand, the current fingerprint is considered as the best but rejected fingerprint until now.

5. If the acquisition of one finger is not successful, the acquisition of this finger may be repeated (continuing at 1) or the acquisition of this finger may be quit by the official (compare FM O-FP-GID).

6. After quitting the acquisition of this finger, the best of the rejected fingerprints is returned to the calling process.

Detailed information for the processing for the operator can be found in FM O-FP-GID.
Allowed exceptions from the regular process

In general, the image acquisition of the fingers of both hands is processed sequentially. Notwithstanding, in case a multi finger sensor is used, the simultaneous capturing of two fingers is allowed. The processing of the individual fingers segmented from the multi finger captures has to occur in analogy to the process described in the following, especially concerning the quality requirements.

As an exception the selection of available fingers at the beginning can be skipped if this is done during the acquisition process.
Detailed technical description

In the following, the process of how the fingerprints are captured is described in more detail. While the requirements in the following subsection are valid for single and multi finger acquisition hardware, a separate section presents the extended process needed for multi finger acquisition hardware.

Process for Single Finger Acquisition Hardware

The acquisition of the fingerprints starts with the check of the availability of the fingers and hands respectively (compare figure 2-5).

Before starting the actual acquisition of the fingerprints, it has to be defined which fingers are not available for the acquisition (e.g. because of injuries or disabilities). The fingers which are available for acquisition are enumerated in a finger list.

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<td>Right index finger</td>
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<td>Right middle finger</td>
<td>3</td>
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<td>Right ring finger</td>
<td>4</td>
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<td>Left thumb</td>
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<tr>
<td>Left index finger</td>
<td>7</td>
</tr>
<tr>
<td>Left middle finger</td>
<td>8</td>
</tr>
<tr>
<td>Left ring finger</td>
<td>9</td>
</tr>
</tbody>
</table>

Table 2-1: Finger position codes according to [ISO_FINGER]

If fingers are available on both hands, the acquisition of the fingerprints consists of the acquisition of one finger of the right hand and the acquisition of one finger of the left hand.

If no fingers are available at all, no fingerprints are actually captured (note the coding requirements for missing fingers in FM COD-FP-GID).

If only one hand is available for the acquisition of fingerprints, two fingers of this hand are captured. If only one finger is available, only this finger is captured (compare figure 2-5).

1 The conclusion which fingers are not available for the image acquisition may also occur during the image acquisition process.

2 The numbers represent the finger codes according to [ISO_FINGER].
The following results are produced:

1. One image of a fingerprint:
   - $A_i$ if the image of the fingerprint is of adequate quality according to the quality criteria.
   - $A_{i_{LQ}}$ if the image of the fingerprint does not meet the quality criteria (low quality). $A_{i_{LQ}}$ is therefore the image of the fingerprint with the highest quality below the quality threshold (defined in FM QA-FP-APPD).

2. A parameter set for this image:
   - $P_{A_i}$ if the image of the fingerprint meets the quality criteria as defined in Function Module Quality Assurance (FM QA-FP-APPD).
   - $P_{A_{i_{LQ}}}$ if the image of the fingerprint does not meet the quality criteria (low quality) as defined above for $P_{A_i}$.

3. The finger code (as defined in [ISO_FINGER]) for the relevant finger, for which the image and the parameter set were captured:
   - $FC(A_i)$ if the image of the fingerprint meets the quality criteria, otherwise $FC_{i_{LQ}} = FC(A_{i_{LQ}})$.
Figure 2-5: Full sequence acquisition of fingerprints
Acquisition of one finger of one hand

The process of the acquisition of a finger of one hand (compare figure 2-6) starts with the right hand (if fingers of the right hand are included in the finger list).

1. The storage for the following values is initialised:
   - \( A_{iQ} = \text{NULL} \) (currently the best, but rejected capture of a fingerprint)
   - \( R_{A_{iQ}} = 0 \) (quality rating for the currently best, but rejected capture of a fingerprint)
   - \( P_{A_{iQ}} = \text{NULL} \) (parameter set for the currently best, but rejected capture of a fingerprint)
   - \( k = 0 \) (counter for the number of attempts for capturing fingers on one hand)

2. The acquisition of the fingerprints starts with the acquisition of the index finger, as far as it is included in the finger list. Otherwise (throughout the process), the next available finger in the finger list is chosen.

3. After the acquisition of a finger, the counter \( k \) is increased by one, irrespective of whether the acquisition was successful or not.

4. If the acquisition of the index finger is successful, the image of the fingerprint \( A_i \), the parameter set \( P_i \), as well as the finger code \( FC \) necessary to identify the individual finger are transferred to the calling process. The acquired finger is deleted from the finger list. Afterwards the process ends.

5. If the acquisition of the index finger is not successful or the index finger was not included in the finger list, the thumb is acquired (as far as the thumb is included in the finger list). Irrespective of whether the acquisition was successful or not, the counter \( k \) is increased by one. If the acquisition of the thumb is successful, the values according to step 4 are transferred and the acquired finger is deleted from the finger list.

6. If the acquisition of the thumb is not successful either, the acquisition of the fingers of this hand (if \( k \geq 2 \)) can either be aborted by the official and one can switch to the other hand, or one can continue with the acquisition of the middle finger, as far as it is included in the finger list. Irrespective of whether the acquisition was successful or not, the counter \( k \) is increased by one. If the acquisition of the middle finger is successful, the values according to step 4 are transferred and this finger is deleted from the finger list.

7. If the acquisition of the middle finger is not successful either, the acquisition of the fingers of this hand (if \( k \geq 2 \)) can either be aborted by the official and one can switch to the other hand, or the official can continue with the acquisition of the ring finger, as far as it is included in the finger list. Irrespective of whether the acquisition was successful or not, the counter \( k \) is increased by one. If the acquisition of the ring finger is successful, the values according to step 4 are transferred and this finger is deleted from the finger list.

8. If none of the fingers can be acquired successfully, the image \( A_{iQ} \) of the best but refused fingerprint (low quality), the corresponding parameter set \( P_{A_{iQ}} \), as well as the corresponding finger code \( FC_{iQ} = FC(A_{iQ}) \) are transferred to the calling process. The acquired finger (low quality) is deleted from the finger list.
2 Process

The sequence 1-8 is repeated for the left hand (as far as a finger of the left hand is included in the finger list).
*Simplified: As far as the finger is available, otherwise the next finger is tried to be captured.
Acquisition of an individual finger (compare figure 2-7)

Within the acquisition of an individual finger the following steps are executed:

1. Of every single finger three independent images (by placing the finger on the sensor three times) $A_1, A_2, A_3$ are captured. This acquisition has to follow the requirements given for the Function Modules Acquisition Hardware (FM AH-FP-FTR), Acquisition Software (FM AS-FP-SF) and Biometric Image Processing (FM BIP-FP-APP). The images have to be handed over to the Function Module Quality Assurance (FM QA-FP-APPD).

2. The Function Module Quality Assurance delivers the index $i, i \in \{1, 2, 3\}$, of the best of these three fingerprints based on quality evaluation. $i$ is part of a parameter set $P_A$ containing quality information (compare FM QA-FP-APPD). Furthermore, a boolean information $b$ (whether the threshold was achieved) is set.

3. If the quality threshold is achieved ($b = true$), this sequence ends with successful acquisition of an individual finger. The fingerprint image $A_i$ and the related parameter set $P_A[i]$ are returned to the calling process.

4. In case the quality threshold is not achieved ($b = false$): if this rating $R_{AQ}$ is higher than the so far stored maximum rating $R_{AQ}$ of the captured fingerprints previously refused for all fingers of the same hand, the following steps are performed:
   - the storage for the best but refused captured fingerprint $A_{LQ}$ is replaced by the current fingerprint image $A_i$;
   - the storage for the maximum rating of the previously rejected fingerprint images $R_{AQ}$ is replaced by the value $R_A$;
   - the storage of the finger code for the finger with the best so far appeared rating $FC_{LQ}$ is replaced by the finger code of the current finger $FC(A_i)$;
   - the storage for the parameter set of the finger with the best so far appeared rating $P_{AQ}$ is replaced by the parameter set of the current finger $P_A$.

5. If the acquisition of a fingerprint is unsuccessful, the acquisition of the same finger can be repeated arbitrarily (continuing at 1).

After the abort of the acquisition attempts of one finger, the values recorded in the storage for capturing of the fingerprint $A_{AQ}$, rating $R_{AQ}$, finger code $FC_{LQ}$ and parameter set $P_{AQ}$ are transferred to the superior process.
Figure 2-7: Sequence of the capture of an individual finger

Legend:
- $A_i$: regular fingerprint image
- $A_{10}$: best of the rejected fingerprint images
- $i$: indices $i \in \{1, 2, 3\}$
- $PC$: finger code according to ISO 19794-4
- $PC_{10}$: $PC$ for $A_{10}$
- $R_A$: rating acquisition fingerprint
- $P_A$: parameter set for capture of finger
- $b$: boolean information if the quality threshold is achieved

Process 2:
1. Start acquisition of an individual finger
2. Acquisition $A_1$
3. Acquisition $A_2$
4. Acquisition $A_3$
5. Quality assurance, selection of the best image, and provision of the boolean information $b$ if the quality threshold is achieved
6. Quality threshold achieved? $b = true$?
   - yes: FP image, Parameter $A_i$, Successful acquisition of an individual finger
   - no: $R_A > R_{A_{10}}$?
     - yes: $A_{10} = A_i$, $R_{A_{10}} = R_A$, $PC_{10} = PC$, $P_{A_{10}} = P_A$
     - no: Further attempt reasonable?
       - yes: FP image, Rating $A_{10}$, Finger code $PC_{10}$, Parameter $P_{A_{10}}$
       - no: Non-successful acquisition of an individual finger

Standard sequence
Process for Multi Finger Acquisition Hardware

Within this process, two fingerprints are captured at the same time (compare figure 2-9). In the following, the full process is presented on the basis of diagrams. In order to get an overview of the different sub-processes, figure 2-8 illustrates the connections between the diagrams.

The process begins with a selection of available fingers. If fingers are available on both hands, one can choose to start a single or multi-finger acquisition (compare figure 2-9).

In case of the multi-finger acquisition, fingers are captured from both hands at the same time. The captured images, the parameter sets as well as the finger codes are returned. Figure 2-10 describes the process for multiple finger acquisition, if fingers from both hands are available. In the standard sequence, the index fingers of a person is captured three times.

In case of the single finger acquisition, the fingers of the hand are captured separately. The captured images, the parameter sets as well as the finger codes are returned in this process, too. In the first diagram (compare figure 2-9) it has been shown that either two fingers can be captured within one acquisition (compare figure 2-10) or two fingerprints can be captured within two sequential acquisition processes. The second case is displayed in figure 2-11.

Within the acquisition of fingers of both hands (compare figure 2-10) and acquisition of fingers of one hand (compare figure 2-11), it can become necessary to capture further fingers of one hand. This is shown in figure 2-12.

In the case that fingerprints of both hands have been chosen (compare figure 2-10) and fingers have been available on both hands, one proceeds with the acquisition of two fingerprints. This is presented in figure 2-13.

If the threshold for two fingers in figure 2-13 has not been achieved, one continues in the following with the acquisition of a single finger. Furthermore, in the case that the acquisition of fingerprints of both hands has returned that fingers are not available on both hands, one also continues (if possible)
with the acquisition of a single finger. The process of capturing a single finger is presented in figure 2-14.

If no finger is available on one hand, one or two fingers are tried to be captured of the other hand. It can also happen that the threshold for the right and left hand cannot be achieved and, therefore, in this case, the operator can decide if a further attempt is reasonable. If a further attempt has been taken for one hand, one continues with the acquisition of a single finger without a question. This situation is described in figure 2-15.

Afterwards, the single finger acquisition ends.

If fingers are not available on either hand, no fingerprints can be captured and the acquisition process ends.
Figure 2-9: Overview process acquisition multiple fingerprints
Figure 2-10: Acquisition fingerprints both hands
Figure 2-11: Acquisition finger of one hand

Legend:
- $H$: right or left hand
- $F_L$: still for acquisition available finger
- $A_F$: list of fingers to capture
- $i$: number of already captured finger of this hand
- $PC_{11}, PC_{10}^g$: finger code according to ISO19794-4
- $A$: finger image
- $A_{1b}$: so far best of the bad finger images
- $R, R_{1b}$: rating of the finger image $A$ respectively $A_{1b}$
- $P, P_{1b}$: parameter set for finger image $A$ respectively $A_{1b}$
- $E, E_{1b}$: Result of the acquisition ("good" or "bad")

Legend:
- Return of an image that was rated with "good" or "bad"
Figure 2-12: Acquisition further finger of one hand
Figure 2-13: Acquisition of two fingerprints
Process 2

Figure 2-14: Acquisition single finger

Legend

\( A_i, A \) finger images

\( i \) index of the best image \( i \in \{1, 2, 3\} \)

\( FC \) finger code according to ISO 19794-4

\( E \) result of the acquisition ("good" or "bad")

\( R \) rating of the finger image \( A_i \) resp. \( A \)

\( P \) parameter set for the finger image \( A_i \) resp. \( A \)

\( b \) boolean information if the threshold is achieved

Legend

- Return of a "good" rated image
- Return of a "good" or "bad" rated image

Information:

Quality assurance, selection of the best image, and provision of the boolean information \( b \) if the threshold is achieved (right finger images)

Simple process

Start acquisition single finger

Finger code \( FC \)

Information:
Acquisition of which finger

\( FC \) Acquisition \( A_1 \)

\( FC \) Acquisition \( A_2 \)

\( FC \) Acquisition \( A_3 \)

Quality threshold achieved ?

\( b = \) true

Result: "good" Image Rating Parameter set

End acquisition single finger

Continue acquisition single finger

Input Output
\( FC, A, R, P \)
\( E, A, R, P \)

Result Image Rating Parameter set

End acquisition single finger
Figure 2-15: Continue acquisition single finger (without question)
2.2 P-FP-VAPP

This function block describes the overall process requirements for capturing a set of fingerprints for enrolment purposes for visa. In the following, the standard mechanisms for quality assurance are introduced while the process for acquisition of fingerprints based on these standard mechanisms is described afterwards.

Requirements

Multiple lossy compressions on image data are not allowed within the overall process.

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

- FM Acquisition Hardware (FM AH)
- FM Acquisition Software (FM AS)
- FM Biometric Image Processing (FM BIP)
- FM Quality Assurance (FM QA)
- FM Compression (FM COM)
- FM Coding (FM COD)
- FM Operation (FM O)

The provision of fingerprints for VIS/BMS with preferably best achievable quality is based on the concept of composite records. In order to build composite records adequate analysis methods need to be applied. Here, fingerprints can be selected out of multiple captures. Fingers that are not applicable or missing for acquisition can be excluded.
A proven way to build composite records is to use cross matching. Thereby, multiple captures (3 times) are performed. As a result for every single finger out of the set, the three fingerprints are matched against each other and the one that matches best against the other two is chosen for the composite record.

Depending on the results of the acquisition, the process of capturing multiple fingerprints at once (i.e. right slap, left slap and thumbs) can be abandoned in order to switch to the acquisition of single fingers if the acquisition of individual fingers turns out to be difficult.

In the case of acquisition of fingerprints with less good quality at least one repetition shall be enforced.
Composite records based on cross matching (n=3):

The process begins with the acquisition of fingerprints of the right hand. In the standard process (compare figure 2-18) multi finger acquisition is applied. Therefore, multiple fingerprints are captured at once while the sequence of fingerprint acquisition is repeated three times.

The activation of the acquisition has to occur automatically by hardware or software. As a recommendation manual capturing shall be possible, but not immediately but after a short delay.

The capture shall prefer the highest quality image per finger of the sequence. All fingerprints of this hand that have been achieved with the highest quality are combined to a composite record. After the acquisition of fingerprints from the slap of the right hand, the fingerprints from the slap of the left hand and finally the thumbs are captured.

If adequate quality cannot be achieved for all fingerprints within a composite record, there exist two alternatives to try to advance the quality for these fingerprints. If a composite record contains fingerprints with insufficient quality, the acquisition of fingerprints of this composite record can either be restarted directly or can be tried to be improved after all three slaps of fingerprints have been captured. In the second case it can be switched directly to the according slap with fingerprints of insufficient quality.
Beside the standard process, the acquisition of fingerprints by using a single finger scanner may be needed in exceptional cases. Here, the composite record containing the set of fingerprints is combined by the acquisition of sequences of single finger acquisition. Nevertheless, the matrix of figure 2-18 can be used in this case, too.

Note: due to the fact that single finger acquisition has to be performed three times for all ten fingers, the enrolment will take a long time. Therefore, this alternative is highly discouraged and should not be considered in practice except for rare cases.

2.3 P-FP-VBIC

This function block describes the overall process requirements of using fingerprint recognition for basic identity check purposes in the context of biometric visa. Note that the actual biometric comparison is done by the VIS BMS.

Requirements

For fingerprint capture, single- as well as multi-finger capture devices adhering to AH-FP modules may be used.

By using multi-finger capture devices fingerprints shall be tried to be captured in the following order. By default, the right slap is captured. Only if handicaps are available other fingerprints shall be used.

- Right slap
- Right index and middle finger
- Right index finger
- Right thumb
- Left slap
- Left index and middle finger
- Left index finger
- Left thumb

By using single-finger capture devices a single fingerprint is used for verification. Depending on the availability of the passengers' fingers, one of the following fingers has to be used in the given order:

- Right index finger
- Right thumb
- Left index finger
- Left thumb

Multiple lossy compressions on the fingerprint image data are not allowed during the process.
In the following, the process of verifying the identity of the corresponding person 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:

- FM Acquisition Hardware (FM AH)
- FM Acquisition Software (FM AS)
- FM Biometric Image Processing (FM BIP)
- FM Compression (FM COM)
- FM Coding (FM COD)
- FM Operation (FM O)
- FM Biometric Comparison (FM CMP)

For the verification, fingerprints are captured according to the Function Modules described in figure 2-19.

In general, the overall process is divided into two separate workflows (see figure 2-20). The authentication workflow contains the actual verification of the document holder against the VIS BMS. Furthermore, evaluation data is collected within the evaluation workflow.
2 Process

In the first step, an existence check is performed based on the visa Machine Readable Zone (MRZ) to identify if biometric data exists for this specific visa. Depending on the results from the previous step a BioAPI 2.0 compliant Capture BSP is used to acquire the live fingerprint data (FM AH-FP, FM AS-FP-MF or FM AS-FP-SF, FM BIP-FP-VIS). Afterwards the captured biometric data is compressed (FM COM-FP-WSQ) and coded according to the VIS-ANSI/NIST specification [VIS-ANSI_NIST]. No quality checks are conducted for performance reasons within this process step. Basic identity check is intended to be used for fast access and high throughput at the border control post. Results of the capture process are logged according to FM LOG-FP-VIC. Captured and already encoded live image(s) are then verified against the VIS. Through the National Central Authority (NCA) the verification request is sent to the BMS and results are returned. Information about the verification process is then logged into a separate log file according to the structure defined in FM COD-FP-VIS (fp-visa).

In parallel, the captured live images are evaluated in terms of fingerprint quality. Quality assurance is conducted by a QA module provider which implements the quality assessment algorithm for fingerprint images. Via the QA module interface - defined in the Application Profile of this technical guideline (TR-03121-2) – the QA module provider is selected and executed for returning the quality assessment results to the application. All obtained results within the evaluation workflow are logged to another log file according to FM COD-FP-VIS (fp-visa-eval).

Figure 2-20: Overall process flow of basic identity check for biometric visa
2.4 P-FP-VEIC

This function block describes the overall process requirements of fingerprint recognition for extended identity check purposes in the context of biometric visa. Note that the actual biometric identity comparison is done by the VIS BMS.

Requirements

For fingerprint capture, multi-finger capture devices adhering to AH-FP modules are required. All available fingers of the passenger crossing the border (usually 10) are required to be captured for the extended identity check. Multiple lossy compressions on the fingerprint image data are not allowed during the process.

In the following, the process of checking the identity of the corresponding person 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:

- FM Acquisition Hardware (FM AH)
- FM Acquisition Software (FM AS)
- FM Biometric Image Processing (FM BIP)
- FM Quality Assurance (FM QA)
- FM Compression (FM COM)
- FM Coding (FM COD)
- FM Operation (FM O)
- FM Biometric Comparison (FM CMP)

In general, the overall process is divided into two separate workflows (see figure 2-22). The authentication workflow contains the actual identity check of the document holder against the VIS BMS. Furthermore, evaluation data is collected within the evaluation workflow.
2 Process

If not yet conducted, an existence check is performed in a first step based on the visa Machine Readable Zone (MRZ) to identify if biometric data exists for this specific visa. Depending on the results from the previous step a BioAPI 2.0 compliant Capture BSP is used to acquire the live fingerprint data (FM AH-FP, FM AS-FP-MF, FM BIP-FP-VIS, FM QA-FP-CRM). Within this Capture BSP quality assurance is conducted in order achieved best possible fingerprint image quality. Afterwards the captured and quality-rated biometric data is compressed (FM COM-FP-WSQ) and coded according to the VIS-ANSI/NIST specification [VIS-ANSI_NIST]. Results of the capture process are logged according to FM LOG-FP-VIC. Captured and already encoded live images are then verified and/or identified against the VIS. Through the National Central Authority (NCA) the identity check request is sent to the BMS and results are returned. Using the same captured fingerprint data it is also possible to conduct verification and identification within the same process. Certain situations might require this opportunity to get verification and identification information of the person crossing the border. Several information about the authentication process is then logged in a separate log file according to the structure defined in FM COD-FP-VIS (fp-visa).

In parallel, the captured live images are evaluated in terms of fingerprint quality. Quality assurance is conducted by a QA module provider which implements the quality assessment algorithm for fingerprint images. Via the QA module interface - defined in the Application Profile of this technical guideline (TR-03121-2) – the QA module provider is selected and executed for returning the quality assessment results to the application. All obtained results within the evaluation workflow are logged to a separate log file according to FM COD-FP-VIS (fp-visa-eval).

![Figure 2-22: Overall process flow of extended identity check for biometric visa](image-url)
2.5 P-PH-APP

This function block describes the alternatives and the overall process requirements for the provisioning of facial images for enrolment purposes.

Requirements

German identity documents and biometric visa\(^3\) 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.

In order to obtain a facial image that complies 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:

- FM Acquisition Hardware (FM AH)
- FM Acquisition Software (FM AS)
- FM Biometric Image Processing (FM BIP)
- FM Compression (FMCOM)
- FM Quality Assurance (visual and software based) (FM QA)
- FM Coding (FM COD)
- FM Operation (FM O)

\(^3\) According to requirements of the VIS, for biometric visa it is possible to use other types of images (e.g. “token frontal”) as well.

*Figure 2-23: Relevant Function Blocks for the facial image process*
In the case of application for German Identity Documents the following FMs apply (compare figure 2-23):

- COM-PH-JP2
- QA-PH-SB
- QA-PH-PG
- QA-PH-PT
- COD-PH-GID

In the case of application for a biometric visa the following FMs apply (compare figure 2-23):

- COM-PH-JPG or alternative COM-PH-JP2
- QA-PH-SB
- QA-PH-PG
- QA-PH-PT
- COD-PH-VAPP

The process of the acquisition of a facial image offers three options of how an image can be provided for the application (compare figure 2-24):

1. The applicant's photo which was taken and printed by a photographer is brought into the office.
2. A life enrolment station is used that contains no Quality Assurance module.
3. A life enrolment station is used that contains a Quality Assurance module.

In the first case, a photo taken and printed by a photographer is provided for the application. At first, a visual check is performed by the official at the application counter (FM O-PH-APP, FM QA-PH-PG, FM QA-PH-PT). Depending on the result of the visual inspection, the photo is rejected or accepted for further processing. In the successful case, the image is digitised at the application counter with a scanner (compare FM AH-PH-FBS, FM AS-PH-FBS, FM BIP-PH-FBS) and compressed (compare FM COM-PH-JP2). Afterwards, the scanned image is subject to Quality Assurance (compare FM QA-PH-SB). Finally, the operator can give a veto in order to accept the image despite a negative software decision. In the positive case, the image is accepted and finally released. In the negative case, the use of this facial image is rejected.

In the case that a life enrolment station is used that does not contain a Quality Assurance module, an image is captured (compare FM AH-PH-VID, FM AS-PH-DC, FM BIP-PH-DC) and compressed (compare FM COM-PH-JP2). An image is provided for the further use at the application counter. In order to guarantee the connection between the facial image and the respective person, an identification check has to be made by the operator (compare FM O-PH-APP). In the successful case, the image is checked by the software (FM QA-PH-SB). Finally, the official can give a veto in order to accept the image despite a negative software decision.

As a third option, a life enrolment station can be used that works with an integrated Quality Assurance module (FM QA-PH-SB). In this case, the general requirements of FM AH-PH-VID and all requirements of FM AS-PH-DC and FM BIP-PH-DC apply. The quality is checked directly while the image is taken. If the quality is not suitable, the acquisition can be started again.
quality is sufficient, the image can be released for the application counter. For security reasons it has to be checked that applicant and facial image fit together. Therefore, the FM O-PH-APP has to be observed. If the identification check within the application counter is successful and the official accepts the image for further use, the image is used for the further processing, otherwise the official gives a veto.

Note: Usage of Live Enrolment Stations – Due to less manageable environment conditions stronger requirements (AH-PH-VID) are needed for Live Enrolment Stations as compared to facial images taken by photographers.

Note: Check with photo template - In addition to the check by QA software the official can verify the geometric features of the image using a photo template (one for adults and one for children) (compare FM QA-PH-PT).

---

Figure 2-24: Digital provision of a facial image
2 Process

Note: If the operator gives a veto (veto equals yes) a negative software decision of the quality assurance can be overruled and the facial image is released. In case of a positive software decision of the quality assurance, the operator may reject the facial image (e.g. if the facial image is not from the person applying for the document).
2.6 P-PH-VID

This function block describes the overall acquisition software process for verification of an identity based on the comparison of a live captured facial image and a stored reference.

Requirements

Multiple lossy compressions on image data are not allowed within the overall process.

In order to verify a live captured facial image with a stored reference image, all specified requirements which are described in the following have to be fulfilled. In this context, several Function Modules and the according Function Blocks are involved and the respective requirements have to be fulfilled:

▸ FM Acquisition Hardware (FM AH)
▸ FM Acquisition Software (FM AS)
▸ FM Biometric Image Processing (FM BIP)
▸ FM Compression (FM COM)
▸ FM Quality Assurance (FM QA)
▸ FM Coding (FM COD)
▸ FM Operation (FM O)
▸ FM Biometric Comparison (FM CMP)

Note: A biometric verification result is of no use, if the reference is not authenticated. Thus, the biometric verification process has to be performed in combination with appropriate optical and electronic checks of the identity document to ensure the link between stored reference image and the document itself.

The full process of provision of the reference image, acquisition of the facial image with verification afterwards is presented in figure 2-26.

Figure 2-25: Relevant Function Blocks for the verification of facial images

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1. The reference (DG2) stored in the electronic document is read out by considering the corresponding security mechanisms. A facial image can be stored as an image with the type “full frontal image” or “token image” whereas the information regarding the type is coded within the data group.

Furthermore, a live image is captured with respect to the Function Modules Acquisition Hardware (FM AH-PH-VID), Acquisition Software (FM AS-PH-VID) and Biometric Image Processing (FM BIP-PH-VID). Prequalification (compare FM QA-PH-VID) ensures that only images of sufficient quality are taken.

Note: It is recommended to load the reference and to conduct the acquisition of a live image in parallel in order to reduce the processing time. Using compression of live image data is optional. If compression is used it has to be conducted according to COM-PH-VID.

2. If the reference image as well as the live image are available a verification according to FM CMP-PH-VID can be performed.

3. If the comparison process described in step 2 is successful the process ends with a successful verification. In the unsuccessful case an exit condition is checked. If the specified timeout is
not reached a new live image is captured and again the verification is started. If the timeout is
reached the process ends with an unsuccessful match. All gathered information is then coded
and logged according to FM COD-PH-VID and FM LOG-PH-VID.

During the complete transaction of acquisition and verification the border control officer has to
ensure that the document holder does not try to illegally bypass the border control by using fake
biometrics or other mechanisms.

In detail, the whole process consists of two separate workflows:

▸ the verification and
▸ the evaluation workflow.

Figure 2-27 shows an overview of the whole system. After the start, the stored reference image is
loaded. In parallel, the verification workflow is triggered. The verification workflow represents the
whole process of capturing live images and verifying them against the reference image.

For further evaluation purposes, the reference image is added to a temporary list of reference
images. This is needed for an evaluation workflow which is conducted to get information about the
quality and security level of the overall verification process. The live image and the last few
reference images shall be used for quality assurance checks and cross-comparison tasks within the
evaluation workflow only. Temporarily stored images shall be deleted safely after evaluation of
these images is finished.

Both workflows return separate logging data according to FM COD-PH-VID. As the evaluation
workflow might need longer time due to cross-comparisons and multiple quality checks both
workflows are independent. The verification workflow is not blocked until all results of the
evaluation workflow are available. Evaluation is conducted in the background. Thus, it is possible
to perform verifications in a short time while not needing to wait for the evaluation workflow to
finish. Linking verification and evaluation logging data is up to the implementer of the application.
This overall workflow might be implemented as a superior process which waits for both workflows
to finish. Another option for implementing the overall workflow is to follow a sequential approach
where the evaluation workflow is triggered right after the verification workflow returns results.

The verification workflow can be found in figure 2-29.

As already mentioned in the Software Architecture description of this Application Profile (see TR-
03121-2), the verification workflow consists of two main BioAPI Biometric Service Providers
(BSPs). A BioAPI compliant Capture BSP is capable of accessing hardware and software (FM AH-
PH-VID, FM AS-PH-VID, FM BIP-PH-VID, FM QA-PH-VID) to capture and deliver the live
image. For evaluation and monitoring purposes logging (as specified in FM LOG-PH-VID) is
performed.
Inputs to the second component, the Verification Engine BSP, are the previously captured live image and the reference image loaded from the identity document. Within the Verification Engine (see FM CMP-PH-VID) the verification is performed. Similar to the Capture BSP, the Verification Engine also produces some logging data for evaluation purposes. In conjunction with the verification result all produced logging data within the verification workflow is merged in the Function Module COD-PH-VID. A separate XML log of the verification workflow is created. The verification result is also returned to the calling application (see workflow of figure 2-26).

The evaluation consists of two main processes: Quality assurance and cross-comparison. Quality assurance is conducted for both the live and the reference image. Besides the quality assurance described in FM QA-PH-VID it is intended to get quality information about face images enrolled by document issuing authorities as well as quality information of captured live data. Thus, quality assurance for evaluation purposes shall be conducted according to FM QA-PH-SB. This Function Module is also used for acquisition of face data for ePassports and identity cards. Hence, results of this quality assurance are comparable to results retrieved during the acquisition for ePassport and identity cards.

Results of this quality assurance do not influence the acquisition process of the live image within the verification workflow. Outcomes of quality assurance shall be logged to be evaluated later, too.
Quality assurance is conducted by a QA module provider which implements the quality assessment algorithm for faces. Via the QA module interface - defined in the Application Profile of this technical guideline (TR-03121-2) – the QA module provider is selected and executed for returning the quality assessment results to the application.

Cross-comparison is conducted for the live image and the last few reference images of the temporary image list. It is intended to produce lots of impostor comparison scores and results for evaluating and determining the biometric performance of the used (or even more) verification algorithms. Furthermore, at least one genuine comparison of the live and the according reference image is made. In accordance with the verification within the verification workflow, a BioAPI compliant Verification Engine BSP is used for comparing live and reference images. Thus, cross-comparison shall be conducted according to Function Module CMP-PH-VID which is also used for verifying the identity of the document holder. Results of cross-comparison are logged and finally combined with all other logging data of the evaluation workflow within the Function Module Coding (FM COD-PH-VID). A separate XML log of the evaluation workflow is created.

In detail, the following approach has to be followed for cross-comparison. For the assessment of the potential capability of the complete biometric system genuine comparisons of the image from the document and the captured live image as well as comparisons of faces of not identical people are calculated. For that purpose, the following procedure has to be applied by the border control process:

1. The reference face images of the last 10 passport verifications are saved anonymously in a dynamic list.
2. The live face image from the verification process is compared against the other faces in the list and the comparison score is saved (impostor comparison).
3. The live face image is compared against the reference face image (genuine comparison).
4. The reference face image is added to the dynamic list.
5. The oldest face image in the list and the live face image are discarded and deleted safely. Finally, it has to be ensured that during the process a comparison of identical face images is avoided. This might happen due to multiple verification tries of the same person.
3 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.

3.1 AH-FP-FTR

This function block describes the requirements for high quality fingerprint scanners (single finger and multi finger) as used in particular for enrolment purposes.

Requirements

For the acquisition of the fingerprints, optical sensors using the principle of frustrated total reflection (FTR live scanner) according to setting level 31 or 41 in table 1 in [ISO_FINGER] (especially this means a resolution of 500 ppi or 1000 ppi) have to 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.

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).

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:
  
  \[ D \leq 0.0007, \text{ for } 0.00 < X \leq 0.07 \]  
  \[ D \leq 0.01X, \text{ for } 0.07 \leq X \leq 1.50 \]
3 Acquisition Hardware

- for 1000 ppi scanners:
  \[ D \leq 0.0005, \text{ for } 0.00 < X \leq 0.07 \text{ and} \]
  \[ D \leq 0.0071X, \text{ for } 0.07 \leq X \leq 1.50 \]

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 cpi/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.

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

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:
  \[
  CTF = 3.04105E-04 * f^2 - 7.99095E-02 * f + 1.02774 \quad [EQ 1]
  \]

- 1000 ppi scanner, for f = 1.0 to 20.0 cy/mm:
  \[
  CTF = -1.85487E-05*f^3 +1.41666E-03*f^2 - 5.73701E-02*f +1.01341 \quad [EQ 2]
  \]

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).
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 gray-levels 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.

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.

3.2 AH-PH-FBS

This function block describes the requirements and interfaces in particular for flat bed scanners that are used to scan photos for enrolment purposes.
Requirements

For flat bed scanners the following requirements have to be met:

▸ physical resolution of at least 300ppi
▸ adequate image quality to match requirements of [ISO_FACE]

3.3 AH-PH-DC

This function block describes the requirements and interfaces for digital cameras that are used to obtain digitised photos for enrolment purposes.

Requirements

For digital cameras the following requirements have to be met:

▸ physical resolution that allows a cropping of an image without upscaling to an image size specified in (FM BIP-PH-DC)
▸ adequate image quality to match requirements of [ISO_FACE]

3.4 AH-PH-VID

This function block describes the requirements and interfaces for integrated camera systems that are used to obtain digitised face images.

Requirements

General requirements

For integrated camera systems the following general requirements have to be met:

▸ minimum physical resolution of the camera video stream of 640 x 480 pixels
▸ adequate image quality to match requirements of [ISO_FACE]
▸ the possibility to automatically adjust the camera to the height of the person standing in front of the camera
▸ the possibility to adapt the camera for the application scenario (e.g. automatic adjustment, appropriate installation)
▸ functionality to capture adequate frontal image of the person if the person is looking straight to the camera (compare figure 3-1 for an example of a frontal image: yaw, roll and pitch are close to 0)
3 Acquisition Hardware

▸ using active diffuse lighting of the camera unit to ensure an uniform lighting of the captured face image (see also FM O-PH-VID) and to be independent of external lighting; mirroring effects of glasses have to be avoided

▸ guaranteeing the sharpness of the captured image within the range of possible capture distance by minimising the distortion depending on the camera optics

Specific requirements for eGate scenarios

For the usage in eGate scenarios the following requirements have to be met:

▸ cameras shall be designed to be placed in the moving direction of the person (sideways attached camera units which require a rotation of the moving passenger are not allowed)

▸ passengers have to be captured within a typical range of at least 2 meters to ensure sufficient depth of sharpness

▸ the camera needs to have high resolution and a short release time for fast capturing

▸ a feedback screen for displaying the camera live stream (mirrored image) has to be provided to the passenger; if the passenger is looking straight to the feedback screen the viewing direction of the passenger has to be frontal (which means that the feedback screen needs to be attached directly next to the camera)

Figure 3-1: Example of frontal image
4 Acquisition Software

Acquisition Software contains all functionality regarding image processing except for biometric purposes. Therefore, this module usually contains 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.

4.1 AS-FP-SF

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

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 in force.

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 a sequence, at least the last captured image (after time-out) of a sequence. 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.

4.2 AS-FP-MF

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

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 in force.

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 a sequence, at least the last captured image (after time-out) of a sequence. 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.

4.3 AS-PH-FBS

This function block describes the requirements and interfaces of Acquisition Software in particular 
for flat bed scanners that are used for the provisioning of digitised application form for the 
application of a German Identity Document.

Requirements

The image data has to be provided without any compression in Windows Bitmap Format Version 3.

Recommendations

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

4.4 AS-PH-DC

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

Requirements

The image data has to be provided without any compression in Windows Bitmap Format Version 3.

Recommendations

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

4.5 AS-PH-VID

This function block describes the requirements and interfaces for Acquisition Software used for 
integrated camera systems in order to obtain digitised face images.

Requirements

The uncompressed image data has to be provided in either Windows Bitmap Format Version 3 
(BMP) or Tagged Image File Format (TIFF) which can be used for further processing.
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 e.g. provision of full frontal images or segmentation of fingerprints.

5.1 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.

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 have to be extracted from the input image and provided as single fingerprints.

Note: Segmentation for single finger scanner 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 over the finger (fingertip)
- Segmentation has to occur on uncompressed data

5.2 BIP-FP-VIS

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 in conjunction with the Biometric Matching System (BMS) of the European Visa Information System (VIS).

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 have to be extracted from the input image and provided as single fingerprints.
5 Biometric Image Processing

Note: Segmentation for single finger scanner 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 over the finger (fingertip)
▸ Segmentation has to occur on uncompressed data

Furthermore, according to field 4.006 of the VIS-ANSI/NIST specification (cf. section 3.5.3 of [VIS-ANSI_NIST]) the width of the fingerprint image has to be between 400 and 900 pixels for flat and rolled fingerprints. The height of the fingerprint image (cf. field 4.007 of VIS-ANSI/NIST specification), indeed, has to be between 400 and 800 pixels for flat and rolled fingerprints.

Following the VIS-ANSI/NIST specification, single fingerprint images of width and/or height smaller than 400 pixels have to be filled with white space around the fingerprint image to reach the required minimum size of 400 pixels in each dimension.

Fingerprint images of width greater than 900 pixels have to be cropped to the maximum width of 900 pixels. Additionally, images of height greater than 800 pixels have to be cropped to the maximum height of 800 pixels.

5.3 BIP-PH-FBS

This function block describes requirements and interfaces for Biometric Image Processing with respect to the output of flat bed scanners to obtain a facial image for enrolment purposes.

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 input image has to fulfil the requirements of [ISO_FACE] as well and the photograph must be positioned on the application form in a correct manner.

Basically, the image processing encloses the cropping to the facial image. In the following, the requirements for the image cropping are specified:

▸ size of the image 3.5 cm x 4.5 cm (width x height) with an image resolution of 300 ppi i.e. 413 pixels width, 531 pixels height and with a tolerance of +/- 10 pixels.
▸ colour depth 24 bit RGB (for colour and black-and-white pictures) or 8 bit grey scale (just for black-and-white-pictures).

5.4 BIP-PH-DC

This function block describes requirements and interfaces for Biometric Image Processing with respect to the output of digital cameras to obtain a facial image that fulfils the ICAO requirements for travel documents.
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.

Basically, the image processing encloses the cropping to the facial image. In the following the requirements for the image cropping are specified:

▸ size of the image 3.5 cm x 4.5 cm (width x height) with an image resolution of 300 ppi i.e. 413 pixels width, 531 pixels height and with a tolerance of +/- 10 pixels.

▸ colour depth 24 bit RGB (for colour and black-and-white pictures) or 8 bit grey scale (just for black-and-white pictures).

5.5 BIP-PH-VID

This function block describes requirements and interfaces for Biometric Image Processing with respect to the output of integrated camera systems to obtain a facial image that fulfils the requirements for being used within automated face recognition.

Requirements

In the following, the requirements for the image processing are specified:

▸ colour depth 24 bit RGB (for colour and black-and-white pictures) or 8 bit grey scale (just for black-and-white pictures)

▸ the face of the person to be authenticated has to be fully visible in the foreground of the provided image

▸ minimum distance of 120 pixels between both eye centres for capture positions of the passenger in the preferred area of the camera range

Note: For the usage in eGate scenarios it is allowed to have a lower distance between both eye centres (e.g. if the passenger is moving towards the eGate). Nevertheless, this will probably result in much lower biometric performance.

Recommendations

It is recommended to crop and de-rotate the face of the passenger from the overall scene in the captured image so that only the frontal face of the passenger is visible.
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.

6.1 QA-FP-APPD

This function block describes requirements and interfaces for the Quality Assurance of fingerprints including quality measurement and selection of the best quality image out of multiple instances.

Requirements

Regardless of the success of the quality evaluation and the test verification of the finger acquisition, three images have to be taken. As a result, there are three independent fingerprint images of which the best one is chosen. This quality assurance process and selection is described in the following.

1. For all three images \( A_i \) of a fingerprint, the quality value \( Q_{A_i} \) is calculated. As evaluation algorithm NFIQ from the NIST NFIS2 [NFIS] or NIST NBIS release 3.2.0 package [NBIS] has to be taken for uncompressed images. Differing from NFIQ standard values the NFIQ quality results are coded with the following steps 100 (NFIQ-1), 75 (NFIQ-2), 50 (NFIQ-3), 25 (NFIQ-4) and 0 (NFIQ-5).

2. Three verifications between the individual images \( A_i \) are executed. As a result, three comparison scores are obtained as minimum of both directions comparisons:

\[
S_{A_i,A_j} := \min \{ S_{A_i,A_j}, S_{A_j,A_i} \}, \quad S_{A_i,A_j} := \min \{ S_{A_i,A_j}, S_{A_j,A_i} \}, \quad S_{A_i,A_j} := \min \{ S_{A_i,A_j}, S_{A_j,A_i} \}.
\]

As verification algorithm Bozorth3 from the NIST NFIS2 [NFIS] or NIST NBIS release 3.2.0 package [NBIS] has to be used.

3. A rating is performed to provide the comparison of quality of the captured fingerprints as the average of the comparison scores to the other prints of the same finger. For every captured image of a fingerprint the rating \( R_{A_i} \) is calculated according to the following formulas:

\[
R_{A_i} = (S_{A_i,A_j} + S_{A_j,A_i}) / 2
\]

4. From the captured images of the fingerprint the one with the maximum rating is chosen.

5. The rating is compared with the quality threshold \( R_i \geq TH_R \). The result is a boolean information \( b \) ( \( b = \text{true} \) if \( R_i \geq TH_R \) and \( b = \text{false} \) if \( R_i < TH_R \)). The threshold for the rating has to be 50.

6. For the chosen fingerprint image \( A_i \), the parameter set \( P_{A_i} \) is compiled.

7. As a result of the quality assurance process, the following values are returned:

- The parameter set \( P_{A_i} \) for the selected image (see table 6-1):
  - \( P_{A_i} \) includes the quality values for the three images of the finger as well as the comparison
scores of the verifications between these images. The index \( i, i \in \{1, 2, 3\} \) marks the selected i.e. the best quality image. \( P_{A_i} = \{ i, Q_{A_i}, Q_{A_{i-1}}, Q_{A_{i+1}}, S_{A_i A_j} \} \).

- The rating \( R_{A_i} \) of the selected finger.
- The boolean information \( b \) if the quality threshold is achieved.

The results of the quality evaluation of the fingerprints selected in the capturing process are shown in table 6-1.

<table>
<thead>
<tr>
<th>ID</th>
<th>Criterion</th>
<th>M/O</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>Index</td>
<td>M</td>
<td>Index of the selected image</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>Quality values</strong></td>
</tr>
<tr>
<td>2.1</td>
<td>( Q(A_1) )</td>
<td>M</td>
<td>NFIQ value of image ( A_1 )</td>
</tr>
<tr>
<td>2.2</td>
<td>( Q(A_2) )</td>
<td>M</td>
<td>NFIQ value of image ( A_2 )</td>
</tr>
<tr>
<td>2.3</td>
<td>( Q(A_3) )</td>
<td>M</td>
<td>NFIQ value of image ( A_3 )</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>Comparison scores</strong></td>
</tr>
<tr>
<td>3.1</td>
<td>( S(A_1, A_2) )</td>
<td>M</td>
<td>Comparison score of images ( A_1 ) and ( A_2 )</td>
</tr>
<tr>
<td>3.2</td>
<td>( S(A_1, A_3) )</td>
<td>M</td>
<td>Comparison score of images ( A_1 ) and ( A_3 )</td>
</tr>
<tr>
<td>3.3</td>
<td>( S(A_2, A_3) )</td>
<td>M</td>
<td>Comparison score of images ( A_2 ) and ( A_3 )</td>
</tr>
</tbody>
</table>

Table 6-1: Quality criteria to be submitted

For conformance testing the BSP encapsulating the quality assurance module has to provide an interface that accepts predefined test data instead of performing the regular process.

### 6.2 QA-FP-CRM

This function block describes requirements and interfaces for the Quality Assurance of fingerprints including quality measurement and selection of the best quality image out of multiple instances using cross-matching.

#### Requirements

Three images of every available finger have to be taken. Please note that multi finger sensors may be used for faster capturing and thus segmentation of fingerprint slaps may be conducted in advance. After quality assurance there are independent fingerprint images of every finger of which the best one is chosen. Finally, of all selected fingerprint instances a composite record containing all fingerprints is generated. This quality assurance process and selection for every single finger is described in the following.

1. Three verifications between the individual fingerprint images \( A_i \) are executed. As a result, three comparison scores are obtained as minimum of both directions comparisons

\[
S_{A_i A_j} := \min \{ S_{A_i A_j}, S_{A_j A_i} \}, S_{A_i A_j} := \min \{ S_{A_i A_j}, S_{A_j A_i} \}, S_{A_i A_j} := \min \{ S_{A_i A_j}, S_{A_j A_i} \}.
\]
As verification algorithm Bozorth3 from the NIST NFIS2 [NFIS] or NIST NBIS release 3.2.0 package [NBIS] has to be used.

2. A rating is performed to provide the comparison of quality of the captured fingerprints as the average of the comparison scores to the other prints of the same finger. For every captured image of a fingerprint the rating $R_{A_i}$ is calculated according to the following formulas:

$$R_{A_1} = \frac{S_{A_1,A_1} + S_{A_1,A_2}}{2}$$

$$R_{A_2} = \frac{S_{A_2,A_1} + S_{A_2,A_2}}{2}$$

$$R_{A_3} = \frac{S_{A_3,A_1} + S_{A_3,A_2}}{2}$$

3. From the captured images of the fingerprint the one with the maximum rating is chosen.

4. The rating is compared with the quality threshold $R_{A_i} \geq TH_{R}$. The result is a boolean information $b$ ( $b = true$ if $R_{A_i} \geq TH_{R}$ and $b = false$ if $R_{A_i} < TH_{R}$ ). The threshold for the rating has to be 50.

5. If $b$ is true for the chosen fingerprint image $A_i$ the fingerprint image is used for being added to the composite record.

   If $b$ is false for the chosen fingerprint image $A_i$ another two instances of this finger are captured. Rating is then conducted according to steps 1 to 4 of the newly captured fingerprint instances and the chosen fingerprint from step 3 (the one with the maximum rating).

6. If the best rating of the newly captured fingerprints exceeds the threshold as specified in step 4 this instance of the finger is used for being added to the composite record.

   If the best rating of the newly captured fingerprints does not exceed the specified threshold the instance with the best rating of all captured instances is added to the composite record.

For conformance testing the BSP encapsulating the quality assurance module has to provide an interface that accepts predefined test data instead of performing the regular process.

6.3 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].

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 as shown in figure 6-1. 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 6-2. 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.

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.
<table>
<thead>
<tr>
<th>ID</th>
<th>Criterion</th>
<th>ISO-Ref.</th>
<th>M/O</th>
<th>Unit/Range</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Pose of the head</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.1</td>
<td>Yaw, neck axis</td>
<td>7.2.2</td>
<td>O</td>
<td>Degrees</td>
</tr>
<tr>
<td>1.2</td>
<td>Pitch, ear axis</td>
<td>7.2.2</td>
<td>O</td>
<td>Degrees</td>
</tr>
<tr>
<td>1.3</td>
<td>Roll, nose axis</td>
<td>7.2.2</td>
<td>M</td>
<td>Degrees</td>
</tr>
<tr>
<td></td>
<td><strong>Facial expression</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.1</td>
<td>Neutral expression</td>
<td>7.2.3</td>
<td>O</td>
<td>Arbitrary units</td>
</tr>
<tr>
<td>2.2</td>
<td>Mouth closed</td>
<td>7.2.3</td>
<td>M</td>
<td>Arbitrary units</td>
</tr>
<tr>
<td>2.3</td>
<td>No raised eyebrows</td>
<td>7.2.3</td>
<td>O</td>
<td>Arbitrary units</td>
</tr>
<tr>
<td></td>
<td><strong>Eyes</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.1</td>
<td>Eyes open</td>
<td>7.2.3</td>
<td>O</td>
<td>Arbitrary units</td>
</tr>
<tr>
<td>3.2</td>
<td>No occlusion (glasses, hair, eye patch)</td>
<td>7.2.11</td>
<td>O</td>
<td>Arbitrary units</td>
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<tr>
<td></td>
<td></td>
<td>7.2.12</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>7.2.3</td>
<td>O</td>
<td>Arbitrary units</td>
</tr>
<tr>
<td></td>
<td><strong>Background</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.1</td>
<td>Uniformity (plainness, no textures, colour)</td>
<td>7.2.6</td>
<td>O</td>
<td>Arbitrary units</td>
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<tr>
<td></td>
<td></td>
<td>A.2.4.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.2</td>
<td>No shadows</td>
<td>7.2.6</td>
<td>O</td>
<td>Arbitrary units</td>
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<td></td>
<td>A.2.4.2</td>
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<td></td>
</tr>
<tr>
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<td>O</td>
<td>Arbitrary units</td>
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<tr>
<td></td>
<td></td>
<td>A.2.3</td>
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<td></td>
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<td>5.1</td>
<td>Image height</td>
<td>8.3.5</td>
<td>M</td>
<td>In pixel</td>
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<td>A.3.1.1</td>
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<td>A.3.2.1</td>
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</tr>
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<td>5.2</td>
<td>Image width</td>
<td>8.3.4</td>
<td>M</td>
<td>In pixel</td>
</tr>
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<td></td>
<td>A.3.1.1</td>
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<td>A.3.2.1</td>
<td></td>
<td></td>
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<tr>
<td>5.3</td>
<td>Ratio: Head width / image width</td>
<td>8.3.4</td>
<td>M</td>
<td>As ratio between 0 and 1</td>
</tr>
<tr>
<td>5.4</td>
<td>Ratio: Head height / image height</td>
<td>8.3.5</td>
<td>M</td>
<td>As ratio between 0 and 1</td>
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</table>

4 Compare [ISO_FACE]
<table>
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<th>Unit/Range</th>
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<td>5.5</td>
<td>Vertical position of the face</td>
<td>8.3.3</td>
<td>M</td>
<td>As ratio between 0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>and 1</td>
</tr>
<tr>
<td>5.6</td>
<td>Horizontally centred face</td>
<td>8.3.2</td>
<td>M</td>
<td>As ratio between 0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>and 1</td>
</tr>
<tr>
<td>5.7</td>
<td>Eye distance</td>
<td>8.4.1</td>
<td>M</td>
<td>In Pixel</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A3.1.1</td>
<td></td>
<td></td>
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**Subject lighting**

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<th>Unit/Range</th>
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<td>Equally distributed lighting</td>
<td>7.2.7</td>
<td>O</td>
<td>Arbitrary units</td>
</tr>
<tr>
<td>6.2</td>
<td>No shadows over the face nor in the eye-</td>
<td>7.2.8</td>
<td>O</td>
<td>Arbitrary units</td>
</tr>
<tr>
<td></td>
<td>sockets</td>
<td>7.2.9</td>
<td></td>
<td></td>
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<tr>
<td>6.3</td>
<td>No hot spots on skin</td>
<td>7.2.10</td>
<td>O</td>
<td>Arbitrary units</td>
</tr>
<tr>
<td>6.4</td>
<td>No effects on glasses</td>
<td>7.2.11</td>
<td>O</td>
<td>Arbitrary units</td>
</tr>
</tbody>
</table>

**Image characteristics**

<table>
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<th>Unit/Range</th>
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<td>Proper exposure</td>
<td>7.3.2</td>
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<td>Arbitrary units</td>
</tr>
<tr>
<td>7.2</td>
<td>Focus and depth of field</td>
<td>7.3.3</td>
<td>M</td>
<td>Arbitrary units</td>
</tr>
<tr>
<td>7.3</td>
<td>No unnatural colours</td>
<td>7.3.4</td>
<td>O</td>
<td>Arbitrary units</td>
</tr>
<tr>
<td>7.4</td>
<td>No red eyes</td>
<td>7.3.4</td>
<td>O</td>
<td>Arbitrary units</td>
</tr>
<tr>
<td>7.5</td>
<td>Colour space</td>
<td>7.4.2.3</td>
<td>M</td>
<td>RGB-24-Bit, YUV422,</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>8-Bit-Greyscale</td>
</tr>
<tr>
<td>7.6</td>
<td>Greyscale density and colour saturation</td>
<td>7.4.2.1</td>
<td>M</td>
<td>Counted numbers of</td>
</tr>
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<td>7.4.2.2</td>
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<td></td>
<td>existing within the</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>image</td>
</tr>
<tr>
<td>7.7</td>
<td>Compression artefacts</td>
<td></td>
<td>O</td>
<td>Arbitrary units</td>
</tr>
<tr>
<td>7.8</td>
<td>Compression level</td>
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<td>M</td>
<td>As ratio between 0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>and 1</td>
</tr>
</tbody>
</table>

*Table 6-2: Mapping of relevant quality criteria*
6.4 QA-PH-PG

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

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
▸ 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
6.5 QA-PH-PT

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

Requirements

The photo template [Template] is used to determine if the geometric requirements of [ISO_FACE] are fulfilled (e.g. format, the height of the face and the centred alignment of the face). For this purpose, the photo template is placed on the image by the official.

For the photo template at least the following criteria out of [ISO_FACE] have to be supported:

▸ Image height
▸ Image width
▸ Head height
▸ Eye positions
▸ Centred horizontally

For images of children under the age of 10, different requirements for the height of the head and the area of the eyes are allowed. That is why a special photo template for children has to exist to check the acceptability of the image.

For the images of infants and babies younger than 6 years, additional tolerances concerning the pose of the head, the facial expression and the line of sight are allowed, compared to those already described by the photo template for children.

The current photo template is available at [Template].

6.6 QA-PH-VID

This function block describes quality requirements for a digital live face image that is used for automated face recognition.

Requirements

It is required to use a prequalification of captured live face images instead of using every captured image for verification. When the verification algorithm requests a face image, the best image according to the conducted prequalification shall be used. Prequalification shall be conducted according to several criteria defined in [ISO_FACE]:

▸ Head pose
▸ Subject lighting
▸ Facial expression
▸ Position of eyes
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.

7.1 COM-FP-WSQR

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

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\(^5\) (according to [ISO_FINGER]). The resulting image file of a fingerprint must not exceed the maximum size of 18 kB\(^6\).

If the resulting image file compressed with the above-named bit rate is larger than the defined maximum size, for this particular case a stronger compression has to be used. Therefore, an iterative process has to be applied, which results in an image file smaller or equal to the maximum size, yet differs at least 1 kB from the maximum size. Therefore the result is between or equal 17 and 18 kB.

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).

Within the Compression Module multiple lossy compressions are not allowed.

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.

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\(^7\) (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).

---

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

6 1 kB equals 1024 bytes.

7 For estimation of compression factor it is allowed to crop to the minimum size containing the fingerprint defined in FM AH-FP-FTR if a sensor is used with a larger capturing area than this minimum.
Within the Compression Module multiple lossy compressions are not allowed.

### 7.3 COM-PH-JPG

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

#### Requirements

The compression method for facial images is JPEG (compare [ISO_10918-1]). The compression must result in a constant file size not smaller than 25 kB\(^8\). Within the Compression Module multiple lossy compressions are not allowed. For conformance testing the BSP encapsulating the compression has to provide an interface that accepts predefined test data instead of performing the regular process.

### 7.4 COM-PH-JP2

This function block describes requirements and interfaces for the compression of photos using the JPEG 2000 format for reference storage usable for enrolment, verification, and identification purposes.

#### Requirements

The compression method for facial images is JPEG 2000 (compare [ISO_15444]). The compression must result in a constant file size of 15 kB\(^9\). An approved implementation of JPEG 2000 (for example JASPER, LuraWave, Aware) must be used. Within the Compression Module multiple lossy compressions are not allowed. For conformance testing the BSP encapsulating the compression has to provide an interface that accepts predefined test data instead of performing the regular process.

### 7.5 COM-PH-VID

This function block describes requirements and interfaces for the compression of live images used for face recognition.

---

8 1 kB equals 1024 bytes.

9 1 kB equals 1024 bytes.


7 Compression

Requirements

Depending on the implementation, compression may be used or not. If compression is used, the compression method for facial images may be either JPEG 2000 (compare [ISO_15444]) or JPEG (compare [ISO_10918-1]).

Using JPEG2000, the compression must result in a minimum file size of 75 kB\(^{10}\) to ensure proper quality of images.

Using JPEG, the compression must result in a minimum file size not smaller than 75 kB, too.

Within the Compression Module multiple lossy compressions are not allowed.

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

\(^{10}\) 1 kB equals 1024 bytes.
8 Coding

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

8.1 COD-FP-GID

This function block describes requirements and interfaces for the coding of fingerprint images used for application of German Identity Documents.

Requirements

In the following, requirements are defined for coding of biometric data as well as corresponding additional quality information.

As described in the Software Architecture (compare TR-03121-2 section 2) the result data is encoded in a Biometric Information Record (BIR) returned by the respective BSP enclosing a header and a Biometric Data Block (BDB).

In the BIR header an output format according to CBEFF is specified which is published by the Federal Office for Information Security. It includes the format owner and type used by the coding function module. For the coding of fingerprints the structure is as following:

Figure 8-1: BioAPI BIR FP
The BDB of the BIR is encoded in XML format according to the schema “fp-gid” defined in table 8-2. This XML data contains the biometric data of zero, one or two fingers (record), the quality information (xinfo-fp-gid), and if needed auxiliary information (aux).

The biometric data (zero, one or two fingers) is coded as a Biometric Information Template (BIT) according to [ISO_19785-3]. The BIT has to contain at least the fields header version, BDB Format Owner, BDB Format Type, Purpose, BDB Biometric Type, and BDB Biometric Subtype in the header and BDB data according to [ISO_FINGER] containing a WSQ image. The field for finger image quality information defined in [ISO_FINGER] has to be occupied with the result of the quality evaluation algorithm (specified in FM QA-FP-GID) of the selected fingerprint. The BIT is encoded Base64 and stored in the output XML data.

Optionally, a MD5 checksum can be calculated over the BIT and be stored in the XML.

The input information is obtained from several Function Modules:

- FM Acquisition Hardware (FM AH)
- FM Acquisition Software (FM AS)
- FM Biometric Image Processing (FM BIP)
- FM Quality Assurance (FM QA)
- FM Compression (FM COM)
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Type</th>
<th>Status</th>
<th>Number</th>
<th>Comment</th>
<th>XML Types</th>
</tr>
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<tbody>
<tr>
<td>fp-gid</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>record</td>
<td>type.data.record</td>
<td>M</td>
<td>0..2</td>
<td>Encapsulates the BIT with a fingerprint and the corresponding hash value of the BIT.</td>
<td>type.data.record</td>
</tr>
<tr>
<td>data</td>
<td>base64Binary</td>
<td>M</td>
<td>1</td>
<td>Contains the BIT (Biometric Information Template) encoded in Base64.</td>
<td>type.data</td>
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<tr>
<td>md5</td>
<td>hexBinary</td>
<td>O</td>
<td>0..1</td>
<td>Hash value calculated over the binary BIT.</td>
<td>type.hash.value</td>
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<td>type.additional.information.finger</td>
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<td>Encapsulates the additional quality information for the respective fingerprints.</td>
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</table>
### Parameter Types

<table>
<thead>
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**Moduleinfo**

Type: `M` Status: `1..*` Comment: Encapsulates the Function Module information.
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<td>Describes the type of the Function Module. Possible values are:</td>
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<td></td>
<td>TRBIO_ModuleType_AH,</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>TRBIO_ModuleType_AS,</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>TRBIO_ModuleType_BIP,</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>TRBIO_ModuleType_QA,</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>TRBIO_ModuleType_COM,</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>TRBIO_ModuleType_COD</td>
<td></td>
</tr>
<tr>
<td>vendorinfo</td>
<td>M</td>
<td>1</td>
<td></td>
<td>Encapsulates all necessary information regarding the vendor of the</td>
<td>type.vendor.info</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Function Module.</td>
<td></td>
</tr>
<tr>
<td>type.vendor.info</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>vendor-name</td>
<td>String</td>
<td>M</td>
<td>1</td>
<td>Description of the vendor of the Function Module.</td>
<td>type.vendor.name</td>
</tr>
<tr>
<td>product-name</td>
<td>String</td>
<td>M</td>
<td>1</td>
<td>Specification of the product name.</td>
<td>type.product.name</td>
</tr>
<tr>
<td>version</td>
<td>String</td>
<td>M</td>
<td>1</td>
<td>Specification of the version number is always included.</td>
<td>type.version</td>
</tr>
<tr>
<td>firmware-version</td>
<td>String</td>
<td>M</td>
<td>0..1</td>
<td>Specification of the firmware version is an additional information</td>
<td>type.firmware.version</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>that is entered if it is available.</td>
<td></td>
</tr>
<tr>
<td>qa_config</td>
<td>String</td>
<td>M</td>
<td>0..1</td>
<td>Config version number for the quality configuration.</td>
<td>type.version</td>
</tr>
</tbody>
</table>

Federal Office for Information Security
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Type</th>
<th>Status</th>
<th>Number</th>
<th>Comment</th>
<th>XML Types</th>
</tr>
</thead>
<tbody>
<tr>
<td>aux</td>
<td>any</td>
<td>O</td>
<td>0..1</td>
<td>Additional auxiliary information of the software.</td>
<td>type.aux.information</td>
</tr>
<tr>
<td>comp</td>
<td></td>
<td>O</td>
<td>0..*</td>
<td>Components that are used within the Function Module.</td>
<td>type.subcomponent</td>
</tr>
</tbody>
</table>

**type.subcomponent**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Type</th>
<th>Status</th>
<th>Number</th>
<th>Comment</th>
<th>XML Types</th>
</tr>
</thead>
<tbody>
<tr>
<td>name</td>
<td>String</td>
<td>M</td>
<td>1</td>
<td>Describes the name of the component.</td>
<td>type.subcomponent.name</td>
</tr>
<tr>
<td>version</td>
<td>String</td>
<td>M</td>
<td>1</td>
<td>Contains the version number of the component.</td>
<td>type.version</td>
</tr>
<tr>
<td>algorithm</td>
<td>M</td>
<td>0..*</td>
<td></td>
<td>Description of the algorithm used within the Function Module.</td>
<td>type.algorithm</td>
</tr>
</tbody>
</table>

**type.algorithm**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Type</th>
<th>Status</th>
<th>Number</th>
<th>Comment</th>
<th>XML Types</th>
</tr>
</thead>
<tbody>
<tr>
<td>type</td>
<td>String</td>
<td>M</td>
<td>1</td>
<td>Describes the type (resp. the functionality) of the algorithm. Possible values are: TRBIO_AlgoType_Matcher, TRBIO_AlgoType_QA, TRBIO_AlgoType_Segment</td>
<td>type.algorithm.type</td>
</tr>
<tr>
<td>name</td>
<td>String</td>
<td>M</td>
<td>1</td>
<td>Name of the used algorithm.</td>
<td>type.algorithm.name</td>
</tr>
<tr>
<td>Parameter</td>
<td>Type</td>
<td>Status</td>
<td>Number</td>
<td>Comment</td>
<td>XML Types</td>
</tr>
<tr>
<td>-------------</td>
<td>----------</td>
<td>--------</td>
<td>--------</td>
<td>-------------------------------------------------------------------------</td>
<td>----------------------------------</td>
</tr>
<tr>
<td>version</td>
<td>String</td>
<td>M</td>
<td>1</td>
<td>Version of the according algorithm.</td>
<td>type.version</td>
</tr>
<tr>
<td>qa_finger</td>
<td>M</td>
<td>0..2</td>
<td></td>
<td>Describes the quality information of the captured fingerprints</td>
<td>type.qa.finger</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(compare section 6.1 output parameters)</td>
<td></td>
</tr>
<tr>
<td>total</td>
<td>boolean</td>
<td>M</td>
<td>1</td>
<td>Total result true/false for the fingerprint quality analysis.</td>
<td>type.total.qa.result</td>
</tr>
<tr>
<td>fc</td>
<td>integer</td>
<td>M</td>
<td>1</td>
<td>Characteristic for the captured finger as defined in [ISO_FINGER].</td>
<td>type.registered.finger</td>
</tr>
<tr>
<td>qa</td>
<td>double</td>
<td>M</td>
<td>1..*</td>
<td>Identified quality values. For every quality value this element is repeated.</td>
<td>type.quality.assurance</td>
</tr>
</tbody>
</table>
### type.quality.assurance

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Type</th>
<th>Status</th>
<th>Number</th>
<th>Comment</th>
<th>XML Types</th>
</tr>
</thead>
<tbody>
<tr>
<td>id</td>
<td>String</td>
<td>M</td>
<td>1</td>
<td>This attribute specifies which quality criterion (compare table 6-1) is described by this tag.</td>
<td>type.identifier.criterion</td>
</tr>
<tr>
<td>m</td>
<td>double</td>
<td>O</td>
<td>1</td>
<td>Minimum value from the range of this criterion. If the range of possible values does not have a lower bound this attribute has to be left out. Otherwise the attribute has to be specified.</td>
<td>type.result.qa</td>
</tr>
<tr>
<td>M</td>
<td>double</td>
<td>O</td>
<td>1</td>
<td>Maximum value from the range of this criterion. If the range of possible values does not have an upper bound this attribute has to be left out. Otherwise the attribute has to be specified.</td>
<td>type.result.qa</td>
</tr>
<tr>
<td>t</td>
<td>double</td>
<td>O</td>
<td>1</td>
<td>Minimum value of the allowed tolerance range of this criterion. If the range of valid values does not have a lower bound this attribute has to be left out. Otherwise the attribute has to be specified.</td>
<td>type.result.qa</td>
</tr>
<tr>
<td>Parameter</td>
<td>Type</td>
<td>Status</td>
<td>Number</td>
<td>Comment</td>
<td>XML Types</td>
</tr>
<tr>
<td>-----------</td>
<td>----------</td>
<td>--------</td>
<td>--------</td>
<td>-------------------------------------------------------------------------</td>
<td>--------------------</td>
</tr>
<tr>
<td>T</td>
<td>double</td>
<td>O</td>
<td>1</td>
<td>Maximum value of the allowed tolerance range of this criterion. If the range of valid values does not have an upper bound this attribute has to be left out. Otherwise the attribute has to be specified.</td>
<td>type.result.qa</td>
</tr>
<tr>
<td>time</td>
<td>dateTime</td>
<td>M</td>
<td>1</td>
<td>Time stamp of the coding.</td>
<td>type.time.coding</td>
</tr>
<tr>
<td>note</td>
<td>String</td>
<td>O</td>
<td>0..*</td>
<td>Free field for optional comments and extensions.</td>
<td>type.note</td>
</tr>
<tr>
<td>aux</td>
<td>any</td>
<td>O</td>
<td>0..1</td>
<td>Additional auxiliary information of the software.</td>
<td>type.aux.information</td>
</tr>
</tbody>
</table>

Table 8-2: Representation for the coding of fingerprints (fp-gid)

The XML representation of the afore described coding can be found in Annex A: XML-Schema in section bio_finger and bioqa.

**XML example coding**

```xml
<?xml version="1.0" encoding="UTF-8"?>
<bio_finger:fp-gid xmlns:bio_finger="http://trbio.bsi.bund.de/1.0/bio_finger"
 xmlns:bioqa="http://trbio.bsi.bund.de/1.0/bioqa"
 xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
 xsi:schemaLocation="http://trbio.bsi.bund.de/bio_finger bio_finger.xsd">
 <bio_finger:record>
  <bioqa:data>VGhpcyBmaWVsZCBjb250YyB0aGUgQmlvQmVjaW5hdGlvbi1JIEJJUg==</bioqa:data>
  <bioqa:md5>201D8105B4DF914D0074E41B4EDDE3B8</bioqa:md5>
 </bio_finger:record>
 <bio_finger:record>
  <bioqa:data>VGhpcyBmaWVsZCBjb250YyB0aGUgQmlvQmVjaW5hdGlvbi1JIEJJUg==</bioqa:data>
  <bioqa:md5>201D8105B4DF914D0074E41B4EDDE3B8</bioqa:md5>
 </bio_finger:record>
 <bio_finger:xinfo-fp-gid>
  <bio_finger:moduleinfo>
   <bioqa:moduletype>TRBIO_ModuleType_AH</bioqa:moduletype>
   <bioqa:vendorinfo>
    <bioqa:vendorname>exampleVendorname</bioqa:vendorname>
    <bioqa:productname>exampleProductname</bioqa:productname>
    <bioqa:version>0.7</bioqa:version>
    <bioqa:firmwareversion>11E.7ZH.112</bioqa:firmwareversion>
    <bioqa:qa_config>1.0</bioqa:qa_config>
   </bioqa:vendorinfo>
  </bio_finger:moduleinfo>
  <bio_finger:moduleinfo>
   <bioqa:moduletype>TRBIO_ModuleType_AS</bioqa:moduletype>
 </bio_finger:xinfo-fp-gid>
</bio_finger:fp-gid>
Working Example: Provision of fingerprint images (WSQ)

In the technical guideline TR-03121-2 the Software Architecture based on BioAPI 2.0 [ISO_19784-1] was introduced. The application on the top layer of the architecture model calls for every biometric feature a separate Biometric Service Provider (BSP) that can be addressed through a standardised BioAPI_* interface according to [ISO_19784-1]. As a response the BSP returns a Biometric Information Record (BIR) that contains the respective biometric data. The structure of the BIR is shown in figure 8-2.
This working example gives an overview how a WSQ image (containing the finger images) can be extracted by the application from the BIT. Within the working example Enrolment in TR-03121-2 it was already shown how the outer BDB can be retrieved from the BIR. More detailed information about the inner Biometric Data Block (BDB) is given in figure 8-3.

BDB

The two finger images are enclosed in the data elements of the fp-gid element. According to [ISO_19784-1] the BIT is composed of the Biometric Header Template (BHT) and the CBEFF BDB containing the general record header, the finger image header record, and the finger image data.

More information about the structure of the BIT according to [ISO_19785-3] can be obtained from table 6-2.
<table>
<thead>
<tr>
<th>Tag</th>
<th>Length</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>7F60</td>
<td>var.</td>
<td>Biometric Information Template (BIT)</td>
</tr>
<tr>
<td>80</td>
<td>02</td>
<td>0101 CBEFF_patron_header_version</td>
</tr>
<tr>
<td>81</td>
<td>01</td>
<td>08 CBEFF_BDB_biometric_type</td>
</tr>
<tr>
<td>82</td>
<td>01</td>
<td>?? CBEFF_BDB_biometric_subtype</td>
</tr>
<tr>
<td>87</td>
<td>02</td>
<td>0101 CBEFF_BDB_format_owner (ISO/IEC JTC 1 SC 37-Biometrics)</td>
</tr>
<tr>
<td>88</td>
<td>02</td>
<td>0007 CBEFF_BDB_format_type (ISO/IEC JTC 1 SC 37-Biometrics)</td>
</tr>
<tr>
<td>5F2E</td>
<td>var.</td>
<td>CBEFF BDB</td>
</tr>
<tr>
<td></td>
<td></td>
<td>General record header</td>
</tr>
<tr>
<td></td>
<td></td>
<td>46495200 Format Identifier (&quot;FIR&quot; - Finger Image Record)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>30313000 Version Number (&quot;010&quot;)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>32+ 1 * (14 bytes + Data length)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Record Length (6 bytes)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>?? ?? Capture device ID (2 bytes, Vendor specified)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>001F (Level 31) or 0029 (Level 41) Image Acquisition Level</td>
</tr>
<tr>
<td></td>
<td></td>
<td>01 Number of fingers</td>
</tr>
<tr>
<td></td>
<td>01</td>
<td>Scale units</td>
</tr>
<tr>
<td></td>
<td>01F4</td>
<td>Scan resolution (horiz) (500ppi)</td>
</tr>
<tr>
<td></td>
<td>01F4</td>
<td>Scan resolution (vert) (500ppi)</td>
</tr>
<tr>
<td></td>
<td>01F4</td>
<td>Image resolution (horiz)</td>
</tr>
<tr>
<td></td>
<td>01F4</td>
<td>Image resolution (vert)</td>
</tr>
<tr>
<td></td>
<td>08</td>
<td>Pixel depth</td>
</tr>
</tbody>
</table>
### 8 Coding

<table>
<thead>
<tr>
<th>02</th>
<th>Image compression algorithm (WSQ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0000</td>
<td>Reserved</td>
</tr>
<tr>
<td></td>
<td>Finger image header record</td>
</tr>
<tr>
<td>?? ?? ?? ??</td>
<td>Length of finger data block</td>
</tr>
<tr>
<td>07</td>
<td>Finger position (e.g. left index finger)</td>
</tr>
<tr>
<td>01</td>
<td>Count of views</td>
</tr>
<tr>
<td>01</td>
<td>View number</td>
</tr>
<tr>
<td>??</td>
<td>Finger image quality</td>
</tr>
<tr>
<td>00</td>
<td>Impression type</td>
</tr>
<tr>
<td>?? ??</td>
<td>Horizontal line length</td>
</tr>
<tr>
<td>?? ??</td>
<td>Vertical line length</td>
</tr>
<tr>
<td>00</td>
<td>Reserved</td>
</tr>
<tr>
<td></td>
<td>Finger image data</td>
</tr>
<tr>
<td>8F 60 $$ A1 $$ 80 02 01 01 81 01 08 82 01 ?? 87 02 01 01 88 02 00 07 5F 2E 46 49 52 00 30 31 30 00 ?? ?? ?? ?? ?? ?? ?? ?? ?? ?? ?? 00 1F 01 01 01 F4 01 F4 01 F4 01 F4 01 F4 08 02 00 00 ?? ?? ?? ?? 07 01 01 ?? 00 ?? ?? ?? ?? ?? 00 WSQ</td>
<td></td>
</tr>
</tbody>
</table>

*Table 8-3: Example for a data element containing a WSQ image*

The hexadecimal representation of the BIT ($$ representing a placeholder with variable length, ?? representing a placeholder for a byte, and WSQ representing a placeholder for the actual fingerprint image) is then coded in base64 and included in the data element as shown in figure 8-3. As an example the following BIT in hexadecimal representation is presumed:

8.2 **COD-FP-VIS**

This function block describes requirements and interfaces for the coding of fingerprint images used for application and border control of biometric visas.

**Requirements**

In the following, requirements are defined for coding of biometric data as well as corresponding additional quality information.
As described in the Software Architecture (compare TR-03121-2 section 2) the result data is encoded in a Biometric Information Record (BIR) returned by the respective BSP enclosing a header and a Biometric Data Block (BDB).

In the BIR header, which has to be encoded according to the ISO/IEC 19784-1:2006 standard [BioAPI], output formats according to CBEFF are specified which are published by the Federal Office for Information Security. It includes the format owner and type used by the coding function module. For the coding of fingerprints the structure is as following:

```
<table>
<thead>
<tr>
<th>Organisation Name</th>
<th>Organisation Identifier</th>
<th>BDB Format</th>
<th>Format Short Name</th>
<th>Specification Name, Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Federal Office for Information Security (BSI)</td>
<td>00 4B</td>
<td>00 03</td>
<td>TR Biometrics XML-FP-Visa Application 1.0</td>
<td>TR-03121-3 (TR-Biometrics)</td>
</tr>
<tr>
<td>Federal Office for Information Security (BSI)</td>
<td>00 4B</td>
<td>00 05</td>
<td>TR Biometrics XML-FP-Visa Basic Identity Check 1.0</td>
<td>TR-03121-3 (TR-Biometrics)</td>
</tr>
<tr>
<td>Federal Office for Information Security (BSI)</td>
<td>00 4B</td>
<td>00 06</td>
<td>TR Biometrics XML-FP-Visa Extended Identity Check 1.0</td>
<td>TR-03121-3 (TR-Biometrics)</td>
</tr>
</tbody>
</table>
```

Table 8-4: COD-FP-VIS Output Format
The fingerprint images are included in a VIS-ANSI/NIST message [VIS-ANSI_NIST] that is coded in a record element while additional quality information is encoded in a xinfo-fp-visa element (compare figure 8-4).

It is possible to add several record elements due to the fact that the captured fingerprint images in the workflow might be used for several operations (e.g. application for visa, identification of visa holder). Although the fingerprint images themselves remain the same, the coding of Type-1 and Type-2 records of the VIS-ANSI/NIST message have different requirements depending on the chosen operation (e.g. Type of Transaction field). Thus, separate record elements may be encoded in the BSP and added to the BDB of the BIR. The data in the xinfo-fp-visa element remains the same for every record element as the fingerprint capture process itself does not change with regard to the chosen VIS operation.

Optionally, a MD5 checksum can be calculated over the data element and be stored in the XML.

Several sub-elements in the xinfo-fp-visa element are optional. Their existence depends on the chosen VIS operation. In the following detailed description of each element it will be stated in which situations such optional elements have to be available.

**Special requirements for identity check workflows**

As mentioned in the Software Architecture of this Application Profile (compare TR-03121-2 section 2) and Function Modules P-FP-VBIC and P-FP-VEIC, the result data in terms of basic and extended identity check is collected from different components. Both specified workflows, authentication and evaluation, from FMs P-FP-VBIC and P-FP-VEIC return separate logging data:

- All results of the authentication workflow are encoded in XML format according to the schema defined in table 8-5. General and acquisition data of the authentication workflow data is also gathered and stored in the acquisition process when applying for a biometric visa.

- All results of the evaluation workflow are encoded in XML format according to the schema defined in table 8-8.
An overview of the main information which is logged within this Function Module is given in figure 8-5.

The input information is obtained from several Function Modules:

- FM Acquisition Hardware (FM AH)
- FM Acquisition Software (FM AS)
- FM Biometric Image Processing (FM BIP)
- FM Quality Assurance (FM QA)
- FM Compression (FM COM)
- Only in case of identity checks: FM Biometric Comparison (FM CMP)

**Specification of the general (capture and authentication) workflow structure**

The following table encloses the XML data for the general workflow structure. This includes the description for all information gathered in the capture processes (including fingerprint data) and results of the identity checks (e.g. verification and/or identification).

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Type</th>
<th>Status</th>
<th>Number</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>fp-visa</td>
<td><img src="image" alt="Image" /></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### 8 Coding

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Type</th>
<th>Status</th>
<th>Number</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>type.function.module.fp-visa</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>record</td>
<td>M</td>
<td>1..*</td>
<td>Encapsulates the VIS-ANSI/NIST message with the enclosed fingerprint images and the optional corresponding hash value of the data field. Depending on the set purpose attribute, the message is encoded to the given operation of the VIS and purpose of use. Several elements with different VIS-ANSI/NIST encoding of the same fingerprint data may be available.</td>
<td></td>
</tr>
<tr>
<td>type.data.record</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Diagram:**
- **type.function.module.fp-visa**
  - record [1..*] type.data.record
  - info-fp-visa type.additional_information.fp.visa
  - aux [0..1] type.aux_information
- **type.data.record**
  - purpose type.purpose
  - data type.data
  - md5 [0..1] type.hash.value
- **type.additional_information.fp.visa**
  - transaction type.transaction
  - date type.date
  - capture type.function.module.fp.capture
  - verification [0..1] type.function.module.fpverification
  - identification [0..1] type.function.module.fp.identification
  - comment [0..1] type.note
  - test type.test
  - error code type.error.code
  - ori type.ori.code
  - software type.software.general
  - demographic data type.demographic.data
  - aux [0..1] type.aux_information

**Diagram:**
- **type.aux_information**
  - any
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Type</th>
<th>Status</th>
<th>Number</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>purpose</td>
<td>string</td>
<td>O</td>
<td>0..1</td>
<td>Represents the purpose of the operation for which the data in the record element will be used. Enumeration with possible values of “enrolment”, “verification”, “identification”.</td>
</tr>
<tr>
<td>data</td>
<td>base64Binary</td>
<td>M</td>
<td>1</td>
<td>Contains the VIS-ANSI/NIST message according to [VIS-ANSI_NIST].</td>
</tr>
<tr>
<td>md5</td>
<td>hexBinary</td>
<td>O</td>
<td>0..1</td>
<td>Hash value calculated over the base64Binary data field.</td>
</tr>
<tr>
<td>xinfo-fp-visa</td>
<td></td>
<td>M</td>
<td>1</td>
<td>Encapsulates the additional quality information for the respective fingerprints.</td>
</tr>
<tr>
<td>type.additional.information.fp.visa</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parameter</td>
<td>Type</td>
<td>Status</td>
<td>Number</td>
<td>Comment</td>
</tr>
<tr>
<td>--------------</td>
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<td>-----------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Transaction</td>
<td></td>
<td>M</td>
<td>1</td>
<td>Element for representing an unique transaction of the message. For some scenarios only the TransactionID might be enough (e.g. application for visa). Other scenarios, like border control, might require the Counter element as well. An example for the latter case: Two verification tries of the same person are needed to pass the border control. Thus, two separate XMLs for every process are the result. TransactionID remains the same for both XMLs while Counter is 1 for the first try and 2 for the second try. Note: This Transaction element must be equal to the Transaction element of the evaluation workflow to ensure the possibility to link the results of both workflows.</td>
</tr>
<tr>
<td>TransactionID</td>
<td>string</td>
<td>M</td>
<td>1</td>
<td>Unique identifier of the current identity check transaction (e.g. visa sticker number, UUID, ...)</td>
</tr>
<tr>
<td>Counter</td>
<td>integer</td>
<td>O</td>
<td>0..1</td>
<td>Usually only necessary for identity checks. Index of the current identity check try within the same authentication process (should start with 1).</td>
</tr>
<tr>
<td>Date</td>
<td>date</td>
<td>M</td>
<td>1</td>
<td>Describes the day of the acquisition process.</td>
</tr>
</tbody>
</table>
This field describes the capture process of acquiring live image data.

If basic capture is conducted (e.g. for basic identity check), the sub-element BasicCapture has to be selected. Otherwise, if extended capture (e.g. for enrolment or extended identity check) is conducted, the sub-element ExtendedCapture has to be selected. One of both sub-elements needs to be available.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Type</th>
<th>Status</th>
<th>Number</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capture</td>
<td>M</td>
<td>1</td>
<td></td>
<td>This field describes the capture process of acquiring live image data. If basic capture is conducted (e.g. for basic identity check), the sub-element BasicCapture has to be selected. Otherwise, if extended capture (e.g. for enrolment or extended identity check) is conducted, the sub-element ExtendedCapture has to be selected. One of both sub-elements needs to be available.</td>
</tr>
<tr>
<td>type.function.module.fp.capture</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BasicCapture</td>
<td>M</td>
<td>1</td>
<td></td>
<td>If basic capture is conducted, this element has to be present. It encloses all necessary information of the basic capture process of fingerprint data and represents a capture workflow without quality assurance.</td>
</tr>
<tr>
<td>Parameter</td>
<td>Type</td>
<td>Status</td>
<td>Number</td>
<td>Comment</td>
</tr>
<tr>
<td>-----------</td>
<td>------</td>
<td>--------</td>
<td>--------</td>
<td>---------</td>
</tr>
<tr>
<td>type.function.module.fp.basic.capture</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Duration</td>
<td>duration</td>
<td>O</td>
<td>0..1</td>
<td>Describes the duration of the acquisition process whereas the end is characterised by the time where all results for the VIS-ANSI/NIST fingerprint coding are available.</td>
</tr>
<tr>
<td>CapturedFingers</td>
<td>M</td>
<td>1</td>
<td></td>
<td>This field encloses the information of all captured fingers within the capture process.</td>
</tr>
<tr>
<td>Parameter</td>
<td>Type</td>
<td>Status</td>
<td>Number</td>
<td>Comment</td>
</tr>
<tr>
<td>---------------------------</td>
<td>---------------</td>
<td>--------</td>
<td>--------</td>
<td>-------------------------------------------------------------------------</td>
</tr>
<tr>
<td>type.captured.fingers</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FingerCode</td>
<td>M 1..10</td>
<td>For every captured finger an element containing the information about the captured finger code has to be added.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>type.finger.code</td>
<td>integer M 1</td>
<td></td>
<td></td>
<td>Describes the ISO finger code of the finger. Possible values: 1 – 10.</td>
</tr>
<tr>
<td>SoftwareType</td>
<td>M 1</td>
<td></td>
<td></td>
<td>Specification of the software type used for capturing live images.</td>
</tr>
<tr>
<td>type.software.general</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>identifier</td>
<td>string M 1</td>
<td></td>
<td></td>
<td>Specification of the vendor of the software.</td>
</tr>
<tr>
<td>name</td>
<td>string M 1</td>
<td></td>
<td></td>
<td>Specification of the software name.</td>
</tr>
<tr>
<td>Parameter</td>
<td>Type</td>
<td>Status</td>
<td>Number</td>
<td>Comment</td>
</tr>
<tr>
<td>---------------</td>
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<td>--------</td>
<td>--------------------------------------------------------------</td>
</tr>
<tr>
<td>version</td>
<td>string</td>
<td>M</td>
<td>1</td>
<td>Specification of the software version.</td>
</tr>
<tr>
<td>note</td>
<td>string</td>
<td>O</td>
<td>0..1</td>
<td>Specification of the software type or other specific software information.</td>
</tr>
<tr>
<td>HardwareType</td>
<td></td>
<td>M</td>
<td>1</td>
<td>Specification of the hardware type used for capturing live images.</td>
</tr>
<tr>
<td>type.hardware</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>identifier</td>
<td>string</td>
<td>M</td>
<td>1</td>
<td>Specification of the vendor of the hardware.</td>
</tr>
<tr>
<td>name</td>
<td>string</td>
<td>M</td>
<td>1</td>
<td>Specification of the hardware name.</td>
</tr>
<tr>
<td>version</td>
<td>string</td>
<td>M</td>
<td>1</td>
<td>Specification of the hardware version.</td>
</tr>
<tr>
<td>Parameter</td>
<td>Type</td>
<td>Status</td>
<td>Number</td>
<td>Comment</td>
</tr>
<tr>
<td>-----------------</td>
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<td>--------</td>
<td>-------------------------------------------------------------------------</td>
</tr>
<tr>
<td>firmwareversion</td>
<td>string</td>
<td>O</td>
<td>0..1</td>
<td>Specification of the firmware version</td>
</tr>
<tr>
<td>note</td>
<td>string</td>
<td>O</td>
<td>0..1</td>
<td>Specification of the hardware type or other specific hardware information.</td>
</tr>
<tr>
<td>ContainerSize</td>
<td>integer</td>
<td>M</td>
<td>1..*</td>
<td>Represents the size of the container in bytes. The amount of ContainerSize elements corresponds to the amount of record elements.</td>
</tr>
<tr>
<td>purpose</td>
<td>string</td>
<td>O</td>
<td>0..1</td>
<td>Represents the purpose for which the container was required. Enumeration with following possible values: “enrolment”, “verification”, “identification”.</td>
</tr>
<tr>
<td>ErrorCode</td>
<td>integer</td>
<td>O</td>
<td>0..1</td>
<td>This optional field allows the communication of error messages of the capture process.</td>
</tr>
<tr>
<td>aux</td>
<td>any</td>
<td>O</td>
<td>0..1</td>
<td>Optional field for additional information.</td>
</tr>
<tr>
<td>ExtendedCapture</td>
<td>M</td>
<td>1</td>
<td></td>
<td>If extended capture is conducted, this element has to be present. It encloses all necessary information of the extended capture process of fingerprint data. This process is usually used if quality assurance is applied during the capture process.</td>
</tr>
<tr>
<td>Parameter</td>
<td>Type</td>
<td>Status</td>
<td>Number</td>
<td>Comment</td>
</tr>
<tr>
<td>------------------------------------------------</td>
<td>---------------------------</td>
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</tr>
<tr>
<td>type.function.module.fp.extended.capture</td>
<td>type.function.module.fp.extended.capture</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Duration</td>
<td>type.duration</td>
<td></td>
<td>[0..1]</td>
<td></td>
</tr>
<tr>
<td>CaptureCounts</td>
<td>type.capture.counts</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CaptureSuccess</td>
<td>type.capture.success</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LocalQualityValue</td>
<td>type.local.quality.value</td>
<td>[1..*]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CentralQualityValue</td>
<td>type.central.quality.value</td>
<td>[0..*]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>UniquenessCheck</td>
<td>type.uniqueness.check</td>
<td>[0..*]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SegmentationError</td>
<td>type.segmentation.error</td>
<td>[0..1]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SequenceError</td>
<td>type.sequence.error</td>
<td>[0..1]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SoftwareType</td>
<td>type.software.general</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HardwareType</td>
<td>type.hardware</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ContainerSize</td>
<td>type.container.size</td>
<td>[1..*]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ErrorCode</td>
<td>type.error.code</td>
<td>[0..1]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>aux</td>
<td>type.aux.information</td>
<td>[0..1]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

...
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Type</th>
<th>Status</th>
<th>Number</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duration</td>
<td>duration</td>
<td>O</td>
<td>0..1</td>
<td>Describes the duration of the biometric acquisition process whereas the end is characterised by time where all results for the VIS-ANSI/NIST fingerprint coding are available.</td>
</tr>
<tr>
<td>CaptureCounts</td>
<td></td>
<td>M</td>
<td>1</td>
<td>This field describes the number of capture attempts made within acquisition of the fingerprints.</td>
</tr>
<tr>
<td>type.capture.counts</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Right</td>
<td>integer</td>
<td>M</td>
<td>1</td>
<td>Number of capture attempts for right slap</td>
</tr>
<tr>
<td>Left</td>
<td>integer</td>
<td>M</td>
<td>1</td>
<td>Number of capture attempts for left slap</td>
</tr>
<tr>
<td>Thumbs</td>
<td>integer</td>
<td>M</td>
<td>1</td>
<td>Number of capture attempts for both thumbs</td>
</tr>
<tr>
<td>SingleFinger</td>
<td>O</td>
<td>0..1</td>
<td></td>
<td>Encapsulates the capture attempts information regarding the single fingerprints.</td>
</tr>
<tr>
<td>Parameter</td>
<td>Type</td>
<td>Status</td>
<td>Number</td>
<td>Comment</td>
</tr>
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<td>----------------------</td>
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<td>--------------------------------------------------------------</td>
</tr>
<tr>
<td><code>type.single.finger</code></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>fp1</td>
<td>integer</td>
<td>O</td>
<td>0..1</td>
<td>Number of capture attempts for right thumb. If this finger is not available this element is left out.</td>
</tr>
<tr>
<td>fp2</td>
<td>integer</td>
<td>O</td>
<td>0..1</td>
<td>Number of capture attempts for right index finger. If this finger is not available this element is left out.</td>
</tr>
<tr>
<td>fp3</td>
<td>integer</td>
<td>O</td>
<td>0..1</td>
<td>Number of capture attempts for right middle finger. If this finger is not available this element is left out.</td>
</tr>
<tr>
<td>fp4</td>
<td>integer</td>
<td>O</td>
<td>0..1</td>
<td>Number of capture attempts for right ring finger. If this finger is not available this element is left out.</td>
</tr>
<tr>
<td>fp5</td>
<td>integer</td>
<td>O</td>
<td>0..1</td>
<td>Number of capture attempts for right little finger. If this finger is not available this element is left out.</td>
</tr>
<tr>
<td>fp6</td>
<td>integer</td>
<td>O</td>
<td>0..1</td>
<td>Number of capture attempts for left thumb. If this finger is not available this element is left out.</td>
</tr>
<tr>
<td>fp7</td>
<td>integer</td>
<td>O</td>
<td>0..1</td>
<td>Number of capture attempts for left index finger. If this finger is not available this element is left out.</td>
</tr>
<tr>
<td>fp8</td>
<td>integer</td>
<td>O</td>
<td>0..1</td>
<td>Number of capture attempts for left middle finger. If this finger is not available this element is left out.</td>
</tr>
<tr>
<td>Parameter</td>
<td>Type</td>
<td>Status</td>
<td>Number</td>
<td>Comment</td>
</tr>
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<td>--------------------</td>
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</tr>
<tr>
<td>fp9</td>
<td>integer</td>
<td>O</td>
<td>0..1</td>
<td>Number of capture attempts for left ring finger. If this finger is not available this element is left out.</td>
</tr>
<tr>
<td>fp10</td>
<td>integer</td>
<td>O</td>
<td>0..1</td>
<td>Number of capture attempts for left ring finger. If this finger is not available this element is left out.</td>
</tr>
<tr>
<td>CaptureSuccess</td>
<td></td>
<td>M</td>
<td>1</td>
<td>Within this element the success of the acquisition process for each slap is enclosed. An estimation of the local slap shall be given according to the defined local quality metric.</td>
</tr>
<tr>
<td>type.capture.success</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Right</td>
<td>boolean</td>
<td>M</td>
<td>1</td>
<td>Representation of the successful or unsuccessful acquisition of the right slap.</td>
</tr>
<tr>
<td>Left</td>
<td>boolean</td>
<td>M</td>
<td>1</td>
<td>Representation of the successful or unsuccessful acquisition of the left slap.</td>
</tr>
<tr>
<td>Thumbs</td>
<td>boolean</td>
<td>M</td>
<td>1</td>
<td>Representation of the successful or unsuccessful acquisition of the thumbs.</td>
</tr>
<tr>
<td>LocalQualityValue</td>
<td></td>
<td>M</td>
<td>1..*</td>
<td>Element that encloses the local quality values for all captured fingerprints retrieved at the acquisition office or at the border control desk.</td>
</tr>
<tr>
<td>Parameter</td>
<td>Type</td>
<td>Status</td>
<td>Number</td>
<td>Comment</td>
</tr>
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<td>----------------------------</td>
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<td>--------</td>
<td>--------------------------------------------------</td>
</tr>
<tr>
<td>type.local.quality.value</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>software</td>
<td>M</td>
<td>1</td>
<td></td>
<td>Specification of the used software.</td>
</tr>
<tr>
<td>type.software</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>identifier</td>
<td>string</td>
<td>M</td>
<td>1</td>
<td>Specification of the vendor of the software.</td>
</tr>
<tr>
<td>name</td>
<td>string</td>
<td>M</td>
<td>1</td>
<td>Specification of the software name.</td>
</tr>
<tr>
<td>version</td>
<td>string</td>
<td>M</td>
<td>1</td>
<td>Specification of the software version.</td>
</tr>
<tr>
<td>note</td>
<td>string</td>
<td>O</td>
<td>0..1</td>
<td>Specification of the software type or other</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>specific software information.</td>
</tr>
<tr>
<td>configuration</td>
<td>O</td>
<td>0..1</td>
<td></td>
<td>Additional configuration information of the used</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>software.</td>
</tr>
<tr>
<td>Parameter</td>
<td>Type</td>
<td>Status</td>
<td>Number</td>
<td>Comment</td>
</tr>
<tr>
<td>--------------------</td>
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<td>-------------------------------------------------------------------------</td>
</tr>
<tr>
<td>type.configuration</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>criterion</td>
<td>string</td>
<td>M</td>
<td>1..*</td>
<td>Specifies a specific criterion that can be configured within the software.</td>
</tr>
<tr>
<td>m</td>
<td>double</td>
<td>O</td>
<td>1</td>
<td>Minimum value of the range of this criterion. If the range of possible values does not have a lower bound this attribute has to be left out. Otherwise, the attribute has to be specified.</td>
</tr>
<tr>
<td>M</td>
<td>double</td>
<td>O</td>
<td>1</td>
<td>Maximum value of the range of this criterion. If the range of possible values does not have a upper bound this attribute has to be left out. Otherwise, the attribute has to be specified.</td>
</tr>
<tr>
<td>t</td>
<td>double</td>
<td>O</td>
<td>1</td>
<td>Minimum of the tolerance range of this criterion. If the range of valid values does not have a lower bound this attribute has to be left out. Otherwise, the attribute has to be specified.</td>
</tr>
<tr>
<td>T</td>
<td>double</td>
<td>O</td>
<td>1</td>
<td>Maximum of the tolerance range of this criterion. If the range of valid values does not have an upper bound this attribute has to be left out. Otherwise, the attribute has to be specified.</td>
</tr>
<tr>
<td>OverallQualityValue</td>
<td>double</td>
<td>O</td>
<td>0..1</td>
<td>Specifies the resulting quality value for all enclosed fingerprints i.e. fp1 to fp10. It is up to the implementer depending on the local quality value to specify the OverallQualityValue. If the value is available this field shall be present.</td>
</tr>
<tr>
<td>fp1</td>
<td>double</td>
<td>O</td>
<td>0..1</td>
<td>Declaration of the local quality value for the right thumb. If this finger is not available this element is left out.</td>
</tr>
<tr>
<td>Parameter</td>
<td>Type</td>
<td>Status</td>
<td>Number</td>
<td>Comment</td>
</tr>
<tr>
<td>-----------------</td>
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<td>--------</td>
<td>--------</td>
<td>--------------------------------------------------------------------------</td>
</tr>
<tr>
<td>fp2</td>
<td>double</td>
<td>O</td>
<td>0..1</td>
<td>Declaration of the local quality value for the right index finger. If this finger is not available this element is left out.</td>
</tr>
<tr>
<td>fp3</td>
<td>double</td>
<td>O</td>
<td>0..1</td>
<td>Declaration of the local quality value for the right middle finger. If this finger is not available this element is left out.</td>
</tr>
<tr>
<td>fp4</td>
<td>double</td>
<td>O</td>
<td>0..1</td>
<td>Declaration of the local quality value for the right ring finger. If this finger is not available this element is left out.</td>
</tr>
<tr>
<td>fp5</td>
<td>double</td>
<td>O</td>
<td>0..1</td>
<td>Declaration of the local quality value for the right little finger. If this finger is not available this element is left out.</td>
</tr>
<tr>
<td>fp6</td>
<td>double</td>
<td>O</td>
<td>0..1</td>
<td>Declaration of the local quality value for the left thumb. If this finger is not available this element is left out.</td>
</tr>
<tr>
<td>fp7</td>
<td>double</td>
<td>O</td>
<td>0..1</td>
<td>Declaration of the local quality value for the left index finger. If this finger is not available this element is left out.</td>
</tr>
<tr>
<td>fp8</td>
<td>double</td>
<td>O</td>
<td>0..1</td>
<td>Declaration of the local quality value for the left middle finger. If this finger is not available this element is left out.</td>
</tr>
<tr>
<td>fp9</td>
<td>double</td>
<td>O</td>
<td>0..1</td>
<td>Declaration of the local quality value for the left ring finger. If this finger is not available this element is left out.</td>
</tr>
<tr>
<td>fp10</td>
<td>double</td>
<td>O</td>
<td>0..1</td>
<td>Declaration of the central quality value for the left little finger. If this finger is not available this element is left out.</td>
</tr>
<tr>
<td>CentralQualityValue</td>
<td></td>
<td>O</td>
<td>0..*</td>
<td>Element that encloses the central quality values for all captured fingerprints.</td>
</tr>
<tr>
<td>Parameter</td>
<td>Type</td>
<td>Status</td>
<td>Number</td>
<td>Comment</td>
</tr>
<tr>
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<td>------</td>
<td>--------</td>
<td>--------</td>
<td>---------</td>
</tr>
<tr>
<td>type.central.quality.value</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>software</td>
<td>type.software</td>
<td>M</td>
<td>1</td>
<td>Specification of the used software.</td>
</tr>
<tr>
<td>identifier</td>
<td>type.identifier</td>
<td>M</td>
<td>1</td>
<td>Specification of the vendor of the software.</td>
</tr>
<tr>
<td>name</td>
<td>type.identifier</td>
<td>M</td>
<td>1</td>
<td>Specification of the software name.</td>
</tr>
<tr>
<td>version</td>
<td>type.version</td>
<td>M</td>
<td>1</td>
<td>Specification of the software version.</td>
</tr>
<tr>
<td>note</td>
<td>type.identifier</td>
<td>O</td>
<td>0..1</td>
<td>Specification of the software type or other specific software information.</td>
</tr>
<tr>
<td>configuration</td>
<td>type.configuration</td>
<td>O</td>
<td>0..1</td>
<td>Additional configuration information of the used software.</td>
</tr>
</tbody>
</table>
### Parameter Type Status Number Comment

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Type</th>
<th>Status</th>
<th>Number</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>type.configuration</td>
<td>string</td>
<td>M</td>
<td>1..*</td>
<td></td>
</tr>
<tr>
<td>criterion</td>
<td>string</td>
<td>M</td>
<td>1..*</td>
<td>Specifies a specific criterion that can be configured within the software.</td>
</tr>
<tr>
<td>m</td>
<td>double</td>
<td>O</td>
<td>1</td>
<td>Minimum value of the range of this criterion. If the range of possible values does not have a lower bound this attribute has to be left out. Otherwise, the attribute has to be specified.</td>
</tr>
<tr>
<td>M</td>
<td>double</td>
<td>O</td>
<td>1</td>
<td>Maximum value of the range of this criterion. If the range of possible values does not have an upper bound this attribute has to be left out. Otherwise, the attribute has to be specified.</td>
</tr>
<tr>
<td>t</td>
<td>double</td>
<td>O</td>
<td>1</td>
<td>Minimum of the tolerance range of this criterion. If the range of valid values does not have a lower bound this attribute has to be left out. Otherwise, the attribute has to be specified.</td>
</tr>
<tr>
<td>T</td>
<td>double</td>
<td>O</td>
<td>1</td>
<td>Maximum of the tolerance range of this criterion. If the range of valid values does not have an upper bound this attribute has to be left out. Otherwise, the attribute has to be specified.</td>
</tr>
<tr>
<td>OverallQualityValue</td>
<td>float</td>
<td>O</td>
<td>0..1</td>
<td>Specifies the resulting quality value for all enclosed fingerprints i.e. fp1 till fp10. It is up to the implementer depending on the central quality value to specify the OverallQualityValue. If the value is available this field shall be present.</td>
</tr>
<tr>
<td>Parameter</td>
<td>Type</td>
<td>Status</td>
<td>Number</td>
<td>Comment</td>
</tr>
<tr>
<td>-----------</td>
<td>--------</td>
<td>--------</td>
<td>--------</td>
<td>-------------------------------------------------------------------------</td>
</tr>
<tr>
<td>fp1</td>
<td>double</td>
<td>O</td>
<td>0..1</td>
<td>Declaration of the central quality value for the right thumb which is achieved at the visa application office. If this finger is not available this element is left out.</td>
</tr>
<tr>
<td>fp2</td>
<td>double</td>
<td>O</td>
<td>0..1</td>
<td>Declaration of the central quality value for the right index finger which is achieved at the visa application office. If this finger is not available this element is left out.</td>
</tr>
<tr>
<td>fp3</td>
<td>double</td>
<td>O</td>
<td>0..1</td>
<td>Declaration of the central quality value for the right middle finger which is achieved at the visa application office. If this finger is not available this element is left out.</td>
</tr>
<tr>
<td>fp4</td>
<td>double</td>
<td>O</td>
<td>0..1</td>
<td>Declaration of the central quality value for the right ring finger which is achieved at the visa application office. If this finger is not available this element is left out.</td>
</tr>
<tr>
<td>fp5</td>
<td>double</td>
<td>O</td>
<td>0..1</td>
<td>Declaration of the central quality value for the right little finger which is achieved at the visa application office. If this finger is not available this element is left out.</td>
</tr>
<tr>
<td>fp6</td>
<td>double</td>
<td>O</td>
<td>0..1</td>
<td>Declaration of the central quality value for the left thumb which is achieved at the visa application office. If this finger is not available this element is left out.</td>
</tr>
<tr>
<td>fp7</td>
<td>double</td>
<td>O</td>
<td>0..1</td>
<td>Declaration of the central quality value for the left index finger which is achieved at the visa application office. If this finger is not available this element is left out.</td>
</tr>
<tr>
<td>fp8</td>
<td>double</td>
<td>O</td>
<td>0..1</td>
<td>Declaration of the local quality value for the left middle finger which is achieved at the visa application office. If this finger is not available this element is left out.</td>
</tr>
<tr>
<td>fp9</td>
<td>double</td>
<td>O</td>
<td>0..1</td>
<td>Declaration of the central quality value for the left ring finger which is achieved at the visa application office. If this finger is not available this element is left out.</td>
</tr>
<tr>
<td>Parameter</td>
<td>Type</td>
<td>Status</td>
<td>Number</td>
<td>Comment</td>
</tr>
<tr>
<td>-------------------</td>
<td>---------</td>
<td>--------</td>
<td>--------</td>
<td>-------------------------------------------------------------------------</td>
</tr>
<tr>
<td>fp10</td>
<td>double</td>
<td>O</td>
<td>0..1</td>
<td>Declaration of the central quality value for the left little finger which is achieved at the visa application counter. If this finger is not available this element is left out.</td>
</tr>
<tr>
<td>UniquenessCheck</td>
<td></td>
<td>O</td>
<td>0..*</td>
<td>Element that encloses the results of a performed uniqueness check of the fingerprints of the final VIS-ANSI/NIST container.</td>
</tr>
</tbody>
</table>

**type.uniqueness.check**

- SoftwareType
  - SecurityLevel
  - Unique
  - Duplicates
- type.uniqueness.check

**type.software**

- SoftwareType
  - SecurityLevel
  - Unique
  - Duplicates
- type.software

**software**

- M 1 Specification of the used software.

- identifier string M 1 Specification of the vendor of the software.
- name string M 1 Specification of the software name.
- version string M 1 Specification of the software version.
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Type</th>
<th>Status</th>
<th>Number</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>note</td>
<td>string</td>
<td>O</td>
<td>0..1</td>
<td>Specification of the software type or other specific software information.</td>
</tr>
<tr>
<td>configuration</td>
<td></td>
<td>O</td>
<td>0..1</td>
<td>Additional configuration information of the used software.</td>
</tr>
<tr>
<td>criterion</td>
<td>string</td>
<td>M</td>
<td>1..*</td>
<td>Specifies a specific criterion that can be configured within the software.</td>
</tr>
<tr>
<td>m</td>
<td>double</td>
<td>O</td>
<td>1</td>
<td>Minimum value of the range of this criterion. If the range of possible values does not have a lower bound this attribute has to be left out. Otherwise, the attribute has to be specified.</td>
</tr>
<tr>
<td>M</td>
<td>double</td>
<td>O</td>
<td>1</td>
<td>Maximum value of the range of this criterion. If the range of possible values does not have a upper bound this attribute has to be left out. Otherwise, the attribute has to be specified.</td>
</tr>
<tr>
<td>t</td>
<td>double</td>
<td>O</td>
<td>1</td>
<td>Minimum of the tolerance range of this criterion. If the range of valid values does not have a lower bound this attribute has to be left out. Otherwise, the attribute has to be specified.</td>
</tr>
<tr>
<td>T</td>
<td>double</td>
<td>O</td>
<td>1</td>
<td>Maximum of the tolerance range of this criterion. If the range of valid values does not have an upper bound this attribute has to be left out. Otherwise, the attribute has to be specified.</td>
</tr>
<tr>
<td>SecurityLevel</td>
<td>float</td>
<td>O</td>
<td>0..1</td>
<td>Describes the security level for the uniqueness check expressed as False Match Rate (FMR) (only if known).</td>
</tr>
<tr>
<td>Parameter</td>
<td>Type</td>
<td>Status</td>
<td>Number</td>
<td>Comment</td>
</tr>
<tr>
<td>-----------------</td>
<td>---------</td>
<td>--------</td>
<td>--------</td>
<td>-------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Unique</td>
<td>boolean</td>
<td>M</td>
<td>1</td>
<td>Specifies the uniqueness of the corresponding container. If Unique equals true all fingerprints have been recognised as different fingerprints while Unique equals false means that duplicate fingerprints have occurred.</td>
</tr>
<tr>
<td>Duplicates</td>
<td>O</td>
<td>0..1</td>
<td></td>
<td>Element that encloses the detected duplicate fingers of the performed uniqueness check. This can be either candidates (DuplicateFingerCandidate) or real duplicates.</td>
</tr>
</tbody>
</table>

**type.duplicates**

- **DuplicateFingerCandidate**
  - Integer M 2..10
  - Detected duplicate finger for which it is not known which is the corresponding second duplicate finger (i.e. this might happen when having more than two possible duplicate fingers).

- **Duplicate**
  - Integer M 1..45
  - Detected duplicate finger pair for which it is known which is the corresponding second duplicate finger.

**type.duplicate**

- **FingerCode**
  - Integer M 2..2
  - Specifies the finger code regarding the identified duplicate fingerprints.

- **SegmentationError**
  - Integer O 0..1
  - Within this optional element the number of occurred segmentation errors is describes. If no segmentation error has occurred the field can be left out.
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Type</th>
<th>Status</th>
<th>Number</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>SequenceError</td>
<td>integer</td>
<td>O</td>
<td>0..1</td>
<td>Within this optional element the number of sequence errors is described independent of the slap. If no sequence error occurred the field can be be left out.</td>
</tr>
<tr>
<td>SoftwareType</td>
<td></td>
<td>M</td>
<td>1</td>
<td>Specification of the software type used for capturing live images.</td>
</tr>
<tr>
<td>type.software.general</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>identifier</td>
<td>string</td>
<td>M</td>
<td>1</td>
<td>Specification of the vendor of the software.</td>
</tr>
<tr>
<td>name</td>
<td>string</td>
<td>M</td>
<td>1</td>
<td>Specification of the software name.</td>
</tr>
<tr>
<td>version</td>
<td>string</td>
<td>M</td>
<td>1</td>
<td>Specification of the software version.</td>
</tr>
<tr>
<td>note</td>
<td>string</td>
<td>O</td>
<td>0..1</td>
<td>Specification of the software type or other specific software information.</td>
</tr>
<tr>
<td>HardwareType</td>
<td></td>
<td>M</td>
<td>1</td>
<td>Specification of the hardware type used for capturing live images.</td>
</tr>
<tr>
<td>type.hardware</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>identifier</td>
<td>string</td>
<td>M</td>
<td>1</td>
<td>Specification of the vendor of the hardware.</td>
</tr>
<tr>
<td>name</td>
<td>string</td>
<td>M</td>
<td>1</td>
<td>Specification of the hardware name.</td>
</tr>
<tr>
<td>Parameter</td>
<td>Type</td>
<td>Status</td>
<td>Number</td>
<td>Comment</td>
</tr>
<tr>
<td>-----------------</td>
<td>-----------</td>
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<td>--------</td>
<td>--------------------------------------------------------------------------</td>
</tr>
<tr>
<td>version</td>
<td>string</td>
<td>M</td>
<td>1</td>
<td>Specification of the hardware version.</td>
</tr>
<tr>
<td>firmwareversion</td>
<td>string</td>
<td>O</td>
<td>0..1</td>
<td>Specification of the firmware version</td>
</tr>
<tr>
<td>note</td>
<td>string</td>
<td>O</td>
<td>0..1</td>
<td>Specification of the hardware type or other specific hardware information.</td>
</tr>
<tr>
<td>ContainerSize</td>
<td>integer</td>
<td>M</td>
<td>1..*</td>
<td>This field contains the size of the VIS-ANSI/NIST message. Depending on the amount of available record elements, this element has to be available accordingly.</td>
</tr>
<tr>
<td>purpose</td>
<td>string</td>
<td>O</td>
<td>0..1</td>
<td>This attribute represents the purpose of the operation the fingerprint data was captured for. Enumeration of following possible values: “enrolment”, “identification”, “verification”.</td>
</tr>
<tr>
<td>ErrorCode</td>
<td>integer</td>
<td>O</td>
<td>0..1</td>
<td>This optional field allows the communication of error messages of the capture process.</td>
</tr>
<tr>
<td>aux</td>
<td>any</td>
<td>O</td>
<td>0..1</td>
<td>Optional field for additional information of the capture process.</td>
</tr>
<tr>
<td>Verification</td>
<td></td>
<td>O</td>
<td>0..1</td>
<td>This field describes information about the verification conducted against the BMS. If no verification was conducted (e.g. application for biometric visa, extended identity check) this element can be left out.</td>
</tr>
</tbody>
</table>

**Diagram:**

```
+-----------------+-----------------+-----------------+-----------------+-----------------+
|                  | type.function   | type.function   | type.function   | type.function   |
|                  | module.fp       | module.fp       | module.fp       | module.fp       |
|                  | verification    | verification    | verification    | verification    |
| Duration         | duration        | duration        | duration        | duration        |
| VerificationResult | type.result.vis | type.result.vis | type.result.vis | type.result.vis |
| ErrorCode        | type.error.code | type.error.code | type.error.code | type.error.code |
| aux              | type.aux.info   | type.aux.info   | type.aux.info   | type.aux.info   |
| any              |                  |                  |                  |                  |
```

**Comment:**

- **Duration**: Describes the duration of the verification process against the BMS.
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Type</th>
<th>Status</th>
<th>Number</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>VerificationResult</td>
<td>string</td>
<td>O</td>
<td>0..1</td>
<td>Describes the verification result retrieved from the BMS. Enumeration: “true”, “false”, “undetermined”.</td>
</tr>
<tr>
<td>ErrorCode</td>
<td>integer</td>
<td>O</td>
<td>0..1</td>
<td>This optional field allows the communication of error messages.</td>
</tr>
<tr>
<td>aux</td>
<td>any</td>
<td>O</td>
<td>0..1</td>
<td>Optional field for additional information.</td>
</tr>
<tr>
<td>Identification</td>
<td></td>
<td>O</td>
<td>0..1</td>
<td>This field describes information about the identification conducted against the BMS. If no identification was conducted (e.g. application for biometric visa, basic identity check) this element can be left out.</td>
</tr>
</tbody>
</table>

**type.function.module.fp.identification**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Type</th>
<th>Status</th>
<th>Number</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duration</td>
<td>duration</td>
<td>O</td>
<td>0..1</td>
<td>Describes the duration of the identification process against the BMS.</td>
</tr>
<tr>
<td>IdentificationPossible</td>
<td>boolean</td>
<td>M</td>
<td>1</td>
<td>This element encloses the information if identification against the BMS was possible. Reasons for not being able to conduct an identification might by a rejection of the VIS BMS due to insufficient fingerprint quality of the live data.</td>
</tr>
<tr>
<td>Parameter</td>
<td>Type</td>
<td>Status</td>
<td>Number</td>
<td>Comment</td>
</tr>
<tr>
<td>----------------------------</td>
<td>-----------</td>
<td>--------</td>
<td>--------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>NumberOfCandidates</td>
<td>integer</td>
<td>O</td>
<td>0..1</td>
<td>If identification was possible, the number of returned candidates are enclosed within this element.</td>
</tr>
<tr>
<td>IdentificationResult</td>
<td>boolean</td>
<td>O</td>
<td>0..1</td>
<td>If a result of the performed identification is available at this stage of the identity check, it shall be represented within this element.</td>
</tr>
<tr>
<td>ErrorCode</td>
<td>integer</td>
<td>O</td>
<td>0..1</td>
<td>This optional field allows the communication of error messages.</td>
</tr>
<tr>
<td>aux</td>
<td>any</td>
<td>O</td>
<td>0..1</td>
<td>Optional field for additional information.</td>
</tr>
<tr>
<td>Comment</td>
<td>string</td>
<td>O</td>
<td>0..1</td>
<td>This optional field allows to log additional proprietary information or individual notes.</td>
</tr>
<tr>
<td>Test</td>
<td>boolean</td>
<td>M</td>
<td>1</td>
<td>This field shall be used to mark test data against real application data.</td>
</tr>
<tr>
<td>ErrorCode</td>
<td>integer</td>
<td>O</td>
<td>0..1</td>
<td>This optional field allows the communication of error messages of the whole process.</td>
</tr>
<tr>
<td>ORI</td>
<td>string</td>
<td>M</td>
<td>1</td>
<td>Specification of the Originating Agency Identifier (Country and City of the Agency e.g. DE/ULAN for a German consular post in Ulan Bator). As the ORI information might not be available while encoding the data an external call to set this information shall be provided by the implemented BSP (cf. tables 8-6 and 8-7).</td>
</tr>
<tr>
<td>SoftwareType</td>
<td></td>
<td>O</td>
<td>0..1</td>
<td>Specification of the software used for the whole process of acquisition for biometric visa, basic or extended identity check.</td>
</tr>
<tr>
<td>type.software.general</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Coding 8

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Type</th>
<th>Status</th>
<th>Number</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>identifier</td>
<td>string</td>
<td>M</td>
<td>1</td>
<td>Specification of the vendor of the software.</td>
</tr>
<tr>
<td>name</td>
<td>string</td>
<td>M</td>
<td>1</td>
<td>Specification of the software name.</td>
</tr>
<tr>
<td>version</td>
<td>string</td>
<td>M</td>
<td>1</td>
<td>Specification of the software version.</td>
</tr>
<tr>
<td>note</td>
<td>string</td>
<td>O</td>
<td>0..1</td>
<td>Specification of the software type or other specific software information.</td>
</tr>
<tr>
<td>DemographicData</td>
<td></td>
<td>O</td>
<td>0..1</td>
<td>Optional element that contains demographic data. As demographic data might not be available while encoding the data an external call to set this information shall be provided by the implemented BSP (cf. tables 8-6 and 8-7).</td>
</tr>
</tbody>
</table>

**type.demographic.data**

- **Gender**
  - string
  - M
  - 1
  - Description of the gender of the applicant or visa holder.

- **AgeClass**
  - string
  - M
  - 1
  - Specification of the age class shall be given as a range … “20-29”, “30-39”, ...

- **Nationality**
  - string
  - O
  - 0..1
  - Nationality of the visa applicant or visa holder.

- **aux**
  - any
  - O
  - 0..1
  - Optional field for additional information.

Table 8-5: Representation for the coding of fingerprints (fp-visa)

The XML representation of the afore described coding can be found in Annex A: XML-Schema in sections visa_finger and bio_common.

**XML example coding for acquisition of fingerprints (enrolment)**

```xml
<?xml version="1.0" encoding="UTF-8"?>
<bio_fp_visa:fp-visa
xmlns:bio_fp_visa="http://trbio.bsi.bund.de/1.0/bio_fp_visa"
xmlns:bio_common="http://trbio.bsi.bund.de/1.0/bio_common">`
<bio_fp_visa:record>
  <bio_common:data>VGhpcyBpcyBiaW5hcnkgZGF0YSBmb3IgZW5yb2xtZWR5Lg==</bio_common:data>
  <bio_common:md5>fb52276858686f9a5fbbc8528688ca1f</bio_common:md5>
</bio_fp_visa:record>

<bio_fp_visa:xinfo-fp-visa>
  <bio_fp_visa:Transaction>
    <bio_common:TransactionID>identifierTransaction</bio_common:TransactionID>
  </bio_fp_visa:Transaction>
  <bio_fp_visa:Date>2009-10-23</bio_fp_visa:Date>
  <bio_fp_visa:Capture>
    <bio_fp_visa:ExtendedCapture>
      <bio_fp_visa:Duration>P0Y0M0DT0H3M15S</bio_fp_visa:Duration>
      <bio_fp_visa:CaptureCounts>
        <bio_common:Right>3</bio_common:Right>
        <bio_common:Left>3</bio_common:Left>
        <bio_common:Thumbs>3</bio_common:Thumbs>
        <bio_common:SingleFinger>
          <bio_common:fp1>0</bio_common:fp1>
          <bio_common:fp2>2</bio_common:fp2>
          <bio_common:fp3>0</bio_common:fp3>
          <bio_common:fp4>0</bio_common:fp4>
          <bio_common:fp5>0</bio_common:fp5>
          <bio_common:fp6>0</bio_common:fp6>
          <bio_common:fp7>0</bio_common:fp7>
          <bio_common:fp8>3</bio_common:fp8>
          <bio_common:fp9>0</bio_common:fp9>
          <bio_common:fp10>0</bio_common:fp10>
        </bio_common:SingleFinger>
      </bio_fp_visa:CaptureCounts>
      <bio_fp_visa:CaptureSuccess>
        <bio_common:Right>true</bio_common:Right>
        <bio_common:Left>true</bio_common:Left>
        <bio_common:Thumbs>true</bio_common:Thumbs>
      </bio_fp_visa:CaptureSuccess>
    </bio_fp_visa:ExtendedCapture>
    <bio_fp_visa:LocalQualityValue>
      <bio_common:software>
        <bio_common:identifier>id_Company_A</bio_common:identifier>
        <bio_common:name>FingerQA_Algo_Company_A</bio_common:name>
        <bio_common:version>3.1.0.1</bio_common:version>
      </bio_common:software>
      <bio_common:OverallQualityValue>1</bio_common:OverallQualityValue>
      <bio_common:fp1>0.85</bio_common:fp1>
      <bio_common:fp2>0.60</bio_common:fp2>
      <bio_common:fp3>0.71</bio_common:fp3>
      <bio_common:fp4>0.72</bio_common:fp4>
      <bio_common:fp5>0.70</bio_common:fp5>
      <bio_common:fp6>0.65</bio_common:fp6>
      <bio_common:fp7>0.68</bio_common:fp7>
      <bio_common:fp8>0.70</bio_common:fp8>
      <bio_common:fp9>0.72</bio_common:fp9>
    </bio_fp_visa:LocalQualityValue>
  </bio_fp_visa:Capture>
</bio_fp_visa:xinfo-fp-visa>
<bio_common:fp10>0.02</bio_common:fp10>
</bio_fp_visa:LocalQualityValue>
<bio_common:software>
  <bio_common:identifier>id_CentralAuthority_B</bio_common:identifier>
  <bio_common:name>FingerQA_Algo_Company_C</bio_common:name>
  <bio_common:version>4.0.2</bio_common:version>
  <bio_common:note>Default configuration was used.</bio_common:note>
</bio_common:software>
</bio_common:OverallQualityValue>
</bio_common:CentralQualityValue>
</bio_fp_visa:UniquenessCheck>
</bio_common:SoftwareType>
</bio_common:SecurityLevel>
</bio_common:Unique>false</bio_common:Unique>
</bio_common:Duplicates>
</bio_common:Duplicate>
</bio_common:Duplicates>
</bio_fp_visa:UniquenessCheck>
</bio_common:SegmentationError>0</bio_common:SegmentationError>
</bio_common:SequenceError>0</bio_common:SequenceError>
</bio_common:SoftwareType>
</bio_common:identifier>id_Company_A</bio_common:identifier>
</bio_common:name>SW_Capture_BSP</bio_common:name>
</bio_common:version>1.5</bio_common:version>
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</bio_fp_visa:SoftwareType>
</bio_fp_visa:HardwareType>
</bio_common:identifier>id_Company_B
</bio_common:identifier>
</bio_common:name>HW_Scanner_1</bio_common:name>
</bio_common:version>1.0.2.1</bio_common:version>
</bio_common:firmwareversion>2.2
</bio_common:firmwareversion>
</bio_fp_visa:HardwareType>
</bio_fp_visa:ContainerSize>110080</bio_fp_visa:ContainerSize>
</bio_fp_visa:ExtendedCapture>
</bio_fp_visa:Capture>
</bio_fp_visa:Test>false</bio_fp_visa:Test>
</bio_fp_visa:ORI>DE/ULAN</bio_fp_visa:ORI>
</bio_fp_visa:DemosraphicData>
</bio_common:Gender>female</bio_common:Gender>
</bio_common:AgeClass>30-39</bio_common:AgeClass>
</bio_fp_visa:DemosphericData>
</bio_fp_visa:xinfo-fp-visa>
</bio_fp_visa:fp-visa>

XML example coding for basic identity check

<?xml version="1.0" encoding="UTF-8"?>
<bio_fp_visa:fp-visa
xmlns:bio_fp_visa="http://trbio.bsi.bund.de/1.0/bio_fp_visa"
xmlns:bio_common="http://trbio.bsi.bund.de/1.0/bio_common"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://trbio.bsi.bund.de/1.0/bio_fp_visa visa_finger.xsd">
<bio_fp_visa:record>
</bio_common:gender>female</bio_common:Gender>
</bio_common:ageClass>30-39</bio_common:ageClass>
</bio_fp_visa:record>
</bio_fp_visa:xinfo-fp-visa>
</bio_fp_visa:fp-visa>
<bio_fp_visa:HardwareType>
  <bio_common:identifier>id_Company_B</bio_common:identifier>
  <bio_common:name>HW_Scanner_1</bio_common:name>
  <bio_common:version>1.0.2.1</bio_common:version>
  <bio_common:firmwareversion>2.2</bio_common:firmwareversion>
</bio_fp_visa:HardwareType>
<bio_fp_visa:ContainerSize>29085</bio_fp_visa:ContainerSize>
</bio_fp_visa:BasicCapture>
</bio_fp_visa:Capture>
</bio_fp_visa:Verification>
</bio_fp_visa:VerificationResult>
</bio_fp_visa:Test>
</bio_fp_visa:ErrorCode>
</bio_fp_visa:ORI>
</bio_fp_visa:SoftwareType>
</bio_fp_visa:BasicCapture>
</bio_fp_visa:Capture>
</bio_fp_visa:VerificationResult>
</bio_fp_visa:Test>
</bio_fp_visa:ErrorCode>
</bio_fp_visa:ORI>
</bio_fp_visa:SoftwareType>
</bio_fp_visa:DemographicData>
</bio_fp_visa:Gender>
</bio_fp_visa:AgeClass>30-39</bio_common:AgeClass>
</bio_fp_visa:Nationality>JPN</bio_common:Nationality>
</bio_fp_visa:DemographicData>
</bio_fp_visa:xinfo-fp-visa>
</bio_fp_visa:fp-visa>

XML example coding for extended identity check

```xml
<?xml version="1.0" encoding="UTF-8"?>
<bio_fp_visa:fp-visa
xmlns:bio_fp_visa="http://trbio.bsi.bund.de/1.0/bio_fp_visa"
xmlns:bio_common="http://trbio.bsi.bund.de/1.0/bio_common"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://trbio.bsi.bund.de/1.0/bio_fp_visa visa_finger.xsd">
  <bio_fp_visa:record purpose="enrolment">
    <bio_common:data>VGhpcyBpcyBiaW5hcnkgZGF0YSBmb3IgZW5yb2xtZW50Lg==</bio_common:data>
    <bio_common:md5>fb52276858686f9a5fbbbc8528688calf</bio_common:md5>
  </bio_fp_visa:record>
  <bio_fp_visa:record purpose="verification">
    <bio_common:data>VGhpcyBpcyBiaW5hcnkgZGF0YSBmb3IgZW5yb2xtZW50Lg==</bio_common:data>
    <bio_common:md5>3b83e5d53e335cde7a8e3bb4e426b2cc</bio_common:md5>
  </bio_fp_visa:record>
  <bio_fp_visa:record purpose="identification">
    <bio_common:data>VGhpcyBpcyBiaW5hcnkgZGF0YSBmb3IgZW5yb2xtZW50Lg==</bio_common:data>
    <bio_common:md5>89a986758ab7006c29cb3b4a23ce07</bio_common:md5>
  </bio_fp_visa:record>
  <bio_fp_visa:xinfo-fp-visa>
```

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<bio_fp_visa:Transaction>
  <bio_common:TransactionID>identifierTransaction</bio_common:TransactionID>
  <bio_common:Counter>1</bio_common:Counter>
</bio_fp_visa:Transaction>
<bio_fp_visa:Date>2010-03-30</bio_fp_visa:Date>
<bio_fp_visa:Capture>
  <bio_fp_visa:ExtendedCapture>
    <bio_fp_visa:Duration>P0Y0M0DT0H0M41S</bio_fp_visa:Duration>
    <bio_fp_visa:CaptureCounts>
      <bio_common:Right>3</bio_common:Right>
      <bio_common:Left>3</bio_common:Left>
      <bio_common:Thumbs>3</bio_common:Thumbs>
      <bio_common:SingleFinger>
        <bio_common:fp1>0</bio_common:fp1>
        <bio_common:fp2>2</bio_common:fp2>
        <bio_common:fp3>0</bio_common:fp3>
        <bio_common:fp4>0</bio_common:fp4>
        <bio_common:fp5>0</bio_common:fp5>
        <bio_common:fp6>0</bio_common:fp6>
        <bio_common:fp7>0</bio_common:fp7>
        <bio_common:fp8>1</bio_common:fp8>
        <bio_common:fp9>0</bio_common:fp9>
        <bio_common:fp10>0</bio_common:fp10>
      </bio_common:SingleFinger>
    </bio_fp_visa:CaptureCounts>
    <bio_fp_visa:CaptureSuccess>
      <bio_common:Right>true</bio_common:Right>
      <bio_common:Left>true</bio_common:Left>
      <bio_common:Thumbs>true</bio_common:Thumbs>
    </bio_fp_visa:CaptureSuccess>
  </bio_fp_visa:ExtendedCapture>
</bio_fp_visa:Capture>
<bio_fp_visa:LocalQualityValue>
  <bio_common:software>
    <bio_common:identifier>id_Company_A</bio_common:identifier>
    <bio_common:name>FingerQA_Algo_Company_A</bio_common:name>
    <bio_common:version>3.1.0.1</bio_common:version>
  </bio_common:software>
  <bio_common:OverallQualityValue>1</bio_common:OverallQualityValue>
</bio_fp_visa:LocalQualityValue>
</bio_fp_visa:Transaction>

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</bio_common:SoftwareType>
</bio_common:SecurityLevel>
</bio_common:Unique>
</bio_fp_visa:UniquenessCheck>
</bio_fp_visa:SegmentationError>
</bio_fp_visa:SequenceError>
</bio_fp_visa:SoftwareType>
</bio_common:identifier>
</bio_common:name>SW_Capture_BSP</bio_common:name>
</bio_common:version>1.6</bio_common:version>
</bio_fp_visa:SoftwareType>
</bio_common:identifier>
</bio_common:name>HW_Scanner_1</bio_common:name>
</bio_common:version>1.0.2.1</bio_common:version>
</bio_common:firmwareversion>2.2
</bio_common:firmwareversion>
</bio_fp_visa:HardwareType>
</bio_fp_visa:ContainerSize purpose="enrolment">100333
</bio_fp_visa:ContainerSize>
</bio_fp_visa:ContainerSize purpose="verification">100253
</bio_fp_visa:ContainerSize>
</bio_fp_visa:ContainerSize purpose="identification">100408
</bio_fp_visa:ContainerSize>
</bio_fp_visa:ExtendedCapture>
</bio_fp_visa:Capture>
</bio_fp_visa:Verification>
</bio_fp_visa:Duration>P0Y0M0DT0H0M5S</bio_fp_visa:Duration>
</bio_fp_visa:VerificationResult>true
</bio_fp_visa:Verification>
</bio_fp_visa:Identification>
</bio_fp_visa:Duration>P0Y0M0DT0H0M18S</bio_fp_visa:Duration>
</bio_fp_visa:IdentificationPossible>true
</bio_fp_visa:IdentificationPossible>
</bio_fp_visa:NumberOfCandidates>1
</bio_fp_visa:NumberOfCandidates>
</bio_fp_visa:IdentificationResult>true
</bio_fp_visa:IdentificationResult>
</bio_fp_visa:Identification>
</bio_fp_visa:Test>false</bio_fp_visa:Test>
</bio_fp_visa:ORI>DE/FRA</bio_fp_visa:ORI>
</bio_fp_visa:SoftwareType>
</bio_common:identifier>
</bio_common:name>SW_Extended_IDC_Visa</bio_common:name>
</bio_common:version>1.3</bio_common:version>
</bio_fp_visa:SoftwareType>
</bio_common:Gender>female</bio_common:Gender>
</bio_common:AgeClass>30-39</bio_common:AgeClass>
</bio_common:Nationality>ITA</bio_common:Nationality>
</bio_fp_visa:DemographicData>
</bio_fp_visa:xinfo-fp-visa>

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Specification of setting additional coding information

Setting additional coding information requires a BioSPI_ControlUnit call in advance to the BioSPI_Capture call described above (described in the Software Architecture part of TR-03121-2 section 2). Table 8-6 defines the ControlCode and table 8-7 the according XML-InputData structure for this BioSPI_ControlUnit call.

<table>
<thead>
<tr>
<th>Organisation Name</th>
<th>ControlCode</th>
<th>InputData Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Federal Office for Information Security (BSI)</td>
<td>0x584D4C10</td>
<td>fp-visa-inputdata</td>
</tr>
</tbody>
</table>

Table 8-6: COD-FP-VIS ControlCode specification

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Type</th>
<th>Status</th>
<th>Number</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>fp-visa-inputdata</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ORI</td>
<td>string</td>
<td>M</td>
<td>1</td>
<td>Specification of the Originating Agency Identifier (Country and City of the Agency e.g. DE/ULAN for a German consular post in Ulan Bator).</td>
</tr>
<tr>
<td>DemographicData</td>
<td></td>
<td>O</td>
<td>0..1</td>
<td>Optional element that contains demographic data.</td>
</tr>
<tr>
<td>type.demographic.data</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td>string</td>
<td>M</td>
<td>1</td>
<td>Description of the gender of the applicant or visa holder.</td>
</tr>
<tr>
<td>AgeClass</td>
<td>string</td>
<td>M</td>
<td>1</td>
<td>Specification of the age class shall be given as a range … “20-29”, “30-39”, …</td>
</tr>
</tbody>
</table>
Table 8-7: COD-FP-VIS InputData specification

The XML representation of the afore described coding can be found in Annex A: XML-Schema in sections visa_finger_inputdata and bio_common.

XML example coding of InputData structure

```xml
<?xml version="1.0" encoding="UTF-8"?>
<bio_common:fp-visa-inputdata
xmlns:bio_common="http://trbio.bsi.bund.de/1.0/bio_common"
xlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://trbio.bsi.bund.de/1.0/bio_common
visa_finger_enrol_inputdata.xsd">
  <bio_common:ORI>DE/ULAN</bio_common:ORI>
  <bio_common:DemographicData>
    <bio_common:Gender>female</bio_common:Gender>
    <bio_common:AgeClass>30-39</bio_common:AgeClass>
  </bio_common:DemographicData>
</bio_common:fp-visa-inputdata>
```

Specification of the evaluation workflow structure

The following table describes all single elements of the information obtained within the evaluation workflow.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Type</th>
<th>Status</th>
<th>Number</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>fp-visa-eval</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Transaction: type.transaction
- Date: type.date
- Quality Assurance: type_function.module.fp.visa.quality.assurance
- Comment: type.note
- Test: type.test
- ErrorCode: type.error.code
- aux: type.aux_information

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<table>
<thead>
<tr>
<th>Parameter</th>
<th>Type</th>
<th>Status</th>
<th>Number</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>type.function.module.fp.visa.eval</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Transaction**
  - **M 1**
  - Element for representing a unique transaction within the identity check process. Example: Two verification tries of the same person are needed to pass the border control. Thus, two separate XMLs for every process are the result. TransactionID remains the same for both XMLs while Counter is 1 for the first try and 2 for the second try.
  - Note: This Transaction element must be equal to the Transaction element of the authentication workflow to ensure the possibility to link the results of both workflows.

| type.transaction |  |  |  | |

- **TransactionID**
- **Counter**

---

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<table>
<thead>
<tr>
<th>Parameter</th>
<th>Type</th>
<th>Status</th>
<th>Number</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>TransactionID</td>
<td>string</td>
<td>M</td>
<td>1</td>
<td>Unique identifier of the current identity check transaction.</td>
</tr>
<tr>
<td>Counter</td>
<td>integer</td>
<td>M</td>
<td>1</td>
<td>Index of the current identity check try within the same authentication process (should start with 1).</td>
</tr>
<tr>
<td>Date</td>
<td>date</td>
<td>M</td>
<td>1</td>
<td>Date of the acquisition of the fingerprint data. Please note that if the evaluation was conducted later than the actual acquisition, it is important that the date of the acquisition is saved in order to guarantee distinctiveness in the evaluation process (TransactionID might be the same for multiple identity checks on different days, e.g. multiple border crossings with the same issued visa).</td>
</tr>
<tr>
<td>QualityAssurance</td>
<td>M</td>
<td>1..*</td>
<td></td>
<td>This field describes information about further conducted quality assurance of the captured live fingerprint data. For every single quality assurance software used one element shall be present.</td>
</tr>
</tbody>
</table>

**QualityAssurance**

- **Type**: `type.function.module.fp.visa.quality.assurance`
- **Duration**: `duration` O 0..1 Describes the duration of the conducted quality assurance.
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Type</th>
<th>Status</th>
<th>Number</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>SoftwareType</td>
<td>M</td>
<td>1</td>
<td></td>
<td>Specification of the software type used for quality assurance.</td>
</tr>
<tr>
<td>type.software</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>identifier</td>
<td>string</td>
<td>M</td>
<td>1</td>
<td>Specification of the vendor of the software.</td>
</tr>
<tr>
<td>name</td>
<td>string</td>
<td>M</td>
<td>1</td>
<td>Specification of the software name.</td>
</tr>
<tr>
<td>version</td>
<td>string</td>
<td>M</td>
<td>1</td>
<td>Specification of the software version.</td>
</tr>
<tr>
<td>note</td>
<td>string</td>
<td>O</td>
<td>0..1</td>
<td>Specification of the software type or other specific software information.</td>
</tr>
<tr>
<td>configuration</td>
<td>O</td>
<td>0..1</td>
<td></td>
<td>Additional configuration information of the used software.</td>
</tr>
<tr>
<td>type.configuration</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>criterion</td>
<td>string</td>
<td>M</td>
<td>1..*</td>
<td>Specifies a specific criterion that can be configured within the software.</td>
</tr>
<tr>
<td>m</td>
<td>double</td>
<td>O</td>
<td>1</td>
<td>Minimum value of the range of this criterion. If the range of possible values does not have a lower bound this attribute has to be left out. Otherwise, the attribute has to be specified.</td>
</tr>
<tr>
<td>M</td>
<td>double</td>
<td>O</td>
<td>1</td>
<td>Maximum value of the range of this criterion. If the range of possible values does not have a upper bound this attribute has to be left out. Otherwise, the attribute has to be specified.</td>
</tr>
<tr>
<td>Parameter</td>
<td>Type</td>
<td>Status</td>
<td>Number</td>
<td>Comment</td>
</tr>
<tr>
<td>-----------------</td>
<td>------------</td>
<td>--------</td>
<td>--------</td>
<td>-------------------------------------------------------------------------</td>
</tr>
<tr>
<td>t</td>
<td>double</td>
<td>O</td>
<td>1</td>
<td>Minimum of the tolerance range of this criterion. If the range of valid values does not have a lower bound this attribute has to be left out. Otherwise, the attribute has to be specified.</td>
</tr>
<tr>
<td>T</td>
<td>double</td>
<td>O</td>
<td>1</td>
<td>Maximum of the tolerance range of this criterion. If the range of valid values does not have a upper bound this attribute has to be left out. Otherwise, the attribute has to be specified.</td>
</tr>
<tr>
<td>QualityResult</td>
<td>O</td>
<td>0..*</td>
<td></td>
<td>Describes the results of the conducted quality assurance.</td>
</tr>
</tbody>
</table>

**type.qa.finger.visa**

| OverallQualityValue | double | O   | 0..1 | Specifies the resulting overall quality value for all enclosed fingerprints. It is up to the implementer depending on the quality assurance results to specify the OverallQualityValue. If the value is available this field shall be present. |
| qa                | double | M   | 1..10| Describes the quality result value for every assessed fingerprint. One entry for every processed fingerprint is expected. |

**type.quality.assurance.finger.visa**

<p>| fc               | integer  | M   | 1    | Specifies the finger code of the processed fingerprint.               |</p>
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Type</th>
<th>Status</th>
<th>Number</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>ErrorCode</td>
<td>integer</td>
<td>O</td>
<td>0..1</td>
<td>This optional field allows the communication of error messages.</td>
</tr>
<tr>
<td>aux</td>
<td>any</td>
<td>O</td>
<td>0..1</td>
<td>Optional field for additional information.</td>
</tr>
<tr>
<td>Comment</td>
<td>string</td>
<td>O</td>
<td>0..1</td>
<td>Describes additional comments about the process which can be added to the logging data.</td>
</tr>
<tr>
<td>Test</td>
<td>boolean</td>
<td>M</td>
<td>1</td>
<td>Specifies if conducted identity check was used for testing or not.</td>
</tr>
<tr>
<td>ErrorCode</td>
<td>integer</td>
<td>O</td>
<td>0..1</td>
<td>This optional field allows the communication of error messages of the evaluation workflow.</td>
</tr>
<tr>
<td>aux</td>
<td>any</td>
<td>O</td>
<td>0..1</td>
<td>Optional field for additional information of the evaluation workflow.</td>
</tr>
</tbody>
</table>

Table 8-8: Representation for the coding of results of the evaluation workflow (fp-visa-eval)

The XML representation of the afore described coding can be found in Annex A: XML-Schema in sections visa_finger_eval and bio_common. A mapping of all XSDs and XMLs is added to Annex B: XSD and XML mapping.

XML example coding of evaluation workflow:
```xml
<?xml version="1.0" encoding="UTF-8"?>
<bio_fp_visa:fp-visa-eval
 xmlns:bio_fp_visa="http://trbio.bsi.bund.de/1.0/bio_fp_visa"
 xmlns:bio_common="http://trbio.bsi.bund.de/1.0/bio_common"
 xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
 xsi:schemaLocation="http://trbio.bsi.bund.de/1.0/bio_fp_visa visa_finger_eval.xsd">
  <bio_fp_visa:Transaction>
    <bio_common:TransactionID>identifierTransaction</bio_common:TransactionID>
    <bio_common:Counter>1</bio_common:Counter>
  </bio_fp_visa:Transaction>
  <bio_fp_visa:Date>2010-03-30</bio_fp_visa:Date>
  <bio_fp_visa:QualityAssurance>
    <bio_fp_visa:Duration>P0Y0M0DT0H0M09S</bio_fp_visa:Duration>
    <bio_fp_visa:SoftwareType>
      <Bio_common:identifier>id_Company_C</Bio_common:identifier>
      <bio_common:name>SW_Quality_Assurance</bio_common:name>
      <bio_common:version>1.1</bio_common:version>
    </bio_fp_visa:SoftwareType>
    <bio_fp_visa:QualityResult>
      <Bio_common:OverallQualityValue>1</Bio_common:OverallQualityValue>
      <bio_common:qa fc="1">1</bio_common:qa>
      <bio_common:qa fc="2">2</bio_common:qa>
      <bio_common:qa fc="3">1</bio_common:qa>
      <bio_common:qa fc="4">1</bio_common:qa>
    </bio_fp_visa:QualityResult>
  </bio_fp_visa:QualityAssurance>
</bio_fp_visa:fp-visa-eval>
```
8.3 COD-PH-GID

This function block describes requirements and interfaces for the coding of facial images used for application of German Identity Documents.

Requirements

In the following, requirements are defined for coding of biometric data as well as corresponding additional quality information.

As described in the Software Architecture (compare TR-03121-2 section 2) the result data is encoded in a Biometric Information Record (BIR) returned by the respective BSP enclosing a header and a Biometric Data Block (BDB).

In the BIR header an output format according to CBEFF is specified which is published by the Federal Office for Information Security. It includes the format owner and type used by the coding function module. For the coding of the facial image the structure is as following:

![Figure 8-6: BioAPI BIR PH](image-url)
The BDB of the BIR is encoded in XML format according to the schema defined in table 8-10. This XML data contains the biometric data of the facial image (record), the quality information (xinfo-ph-gid), and if needed auxiliary information (aux).

The biometric data (face) is coded as a Biometric Information Template (BIT) according to [ISO_19785-3]. The BIT has to contain at least the fields header version, BDB Format Owner, BDB Format Type, Purpose, BDB Biometric Type, and BDB data according to [ISO_FACE] containing a Full Frontal JPEG 2000 image. The BIT is encoded Base64 and stored in the output XML data.

Optionally an MD5 checksum can be calculated over the BIT and be stored in the XML.

The input information is obtained from several Function Modules:

- FM Acquisition Hardware (FM AH)
- FM Acquisition Software (FM AS)
- FM Biometric Image Processing (FM BIP)
- FM Quality Assurance (FM QA)
- FM Compression (FM COM)
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Type</th>
<th>Status</th>
<th>Number</th>
<th>Comment</th>
<th>XML Types</th>
</tr>
</thead>
<tbody>
<tr>
<td>ph-gid</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Encapsulates the data group and the hash value of the facial image.</td>
<td>type.data.record</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**type.function.module.ph-gid**

- record: type.data.record
- xinfo-ph-gid: type.additional.information.face
- aux: [0..1] type.aux.information

**type.data.record**

- data: type.data
- md5: [0..1] type.hash.value

**data**

- base64Binary: M 1 Contains the BIT (Biometric Information Template) encoded in Base64. type.data

**md5**

- hexBinary: O 0..1 Hash value calculated over the binary BIT type.hash.value
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Type</th>
<th>Status</th>
<th>Number</th>
<th>Comment</th>
<th>XML Types</th>
</tr>
</thead>
<tbody>
<tr>
<td>xinfo-phgid</td>
<td>M</td>
<td>1</td>
<td></td>
<td>Encapsulates the additional quality information for the respective facial image.</td>
<td>type.additional.information.face</td>
</tr>
</tbody>
</table>

**type.additional.information.face**

```xml
<type:additional_information_face>
  <moduleinfo minOccurs="1..*">
    <moduleinfo/>
    <ca_face minOccurs="0..1">
      <ca_face/>
    </ca_face>
    <time>
      <time>
    </time>
    <note minOccurs="0..*">
      <note/>
    </note>
  </moduleinfo>
</type:additional_information_face>
```

**moduleinfo**

```xml
<moduleinfo minOccurs="1..*">
  <moduleinfo/>
  <ca_face minOccurs="0..1">
    <ca_face/>
  </ca_face>
  <time>
    <time>
  </time>
  <note minOccurs="0..*">
    <note/>
  </note>
</moduleinfo>
```

Encapsulates the Function Module information. type.module.info
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Type</th>
<th>Status</th>
<th>Number</th>
<th>Comment</th>
<th>XML Types</th>
</tr>
</thead>
<tbody>
<tr>
<td>module-type</td>
<td>String</td>
<td>M</td>
<td>1</td>
<td>Describes the type of the Function Module. Possible values are:</td>
<td>type.module.type</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>TRBIO_ModuleType_AH, TRBIO_ModuleType_AS, TRBIO_ModuleType_BIP,</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>TRBIO_ModuleType_COM, TRBIO_ModuleType_QA, TRBIO_ModuleType_COD</td>
<td></td>
</tr>
<tr>
<td>vendorinfo</td>
<td></td>
<td>M</td>
<td>1</td>
<td>Encapsulates all necessary information regarding the vendor of the</td>
<td>type.vendor.info</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Function Module.</td>
<td></td>
</tr>
<tr>
<td>Parameter</td>
<td>Type</td>
<td>Status</td>
<td>Number</td>
<td>Comment</td>
<td>XML Types</td>
</tr>
<tr>
<td>--------------------</td>
<td>-------</td>
<td>--------</td>
<td>--------</td>
<td>--------------------------------------------------------------------------</td>
<td>-------------------------</td>
</tr>
<tr>
<td>type.vendor.info</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>vendor-name</td>
<td>String</td>
<td>M</td>
<td>1</td>
<td>Description of the vendor of the Function Module.</td>
<td>type.vendor.name</td>
</tr>
<tr>
<td>product-name</td>
<td>String</td>
<td>M</td>
<td>1</td>
<td>Specification of the product name.</td>
<td>type.product.name</td>
</tr>
<tr>
<td>version</td>
<td>String</td>
<td>M</td>
<td>1</td>
<td>Specification of the version number is always included.</td>
<td>type.version</td>
</tr>
<tr>
<td>firmware-version</td>
<td>String</td>
<td>M</td>
<td>0..1</td>
<td>Specification of the firmware version is an additional information that is entered if it is available.</td>
<td>type.firmware.version</td>
</tr>
<tr>
<td>qa_config</td>
<td>String</td>
<td>M</td>
<td>0..1</td>
<td>Config version number for the quality configuration.</td>
<td>type.version</td>
</tr>
<tr>
<td>aux</td>
<td>any</td>
<td>O</td>
<td>0..1</td>
<td>Additional auxiliary information of the software.</td>
<td>type.aux.information</td>
</tr>
<tr>
<td>comp</td>
<td>O</td>
<td>0..*</td>
<td></td>
<td>Components that are used within the Function Module.</td>
<td>type.subcomponent</td>
</tr>
<tr>
<td>type.subcomponent</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>name</td>
<td>String</td>
<td>M</td>
<td>1</td>
<td>Describes the name of the component.</td>
<td>type.subcomponent.name</td>
</tr>
<tr>
<td>Parameter</td>
<td>Type</td>
<td>Status</td>
<td>Number</td>
<td>Comment</td>
<td>XML Types</td>
</tr>
<tr>
<td>------------</td>
<td>------------</td>
<td>--------</td>
<td>--------</td>
<td>-------------------------------------------------------------------------</td>
<td>-----------------</td>
</tr>
<tr>
<td>version</td>
<td>String</td>
<td>M</td>
<td>1</td>
<td>Contains the version number of the component.</td>
<td>type.version</td>
</tr>
<tr>
<td>algorithm</td>
<td></td>
<td>M</td>
<td>0..*</td>
<td>Description of the algorithm used within the Function Module.</td>
<td>type.algorithm</td>
</tr>
<tr>
<td>type</td>
<td></td>
<td>M</td>
<td>1</td>
<td>Describes the type (resp. the functionality) of the algorithm. Possible values are: TRBIO_AlgoType_Annotation, TRBIO_AlgoType_Registration, TRBIO_AlgoType_Recognition, TRBIO_AlgoType_Validation, TRBIO_AlgoType_ValidationQA, TRBIO_AlgoType_ValidationMCS, TRBIO_AlgoType_ValidationMCSQA</td>
<td>type.algorithm.type</td>
</tr>
<tr>
<td>name</td>
<td>String</td>
<td>M</td>
<td>1</td>
<td>Name of the used algorithm.</td>
<td>type.algorithm.name</td>
</tr>
<tr>
<td>version</td>
<td>String</td>
<td>M</td>
<td>1</td>
<td>Version of the according algorithm.</td>
<td>type.version</td>
</tr>
<tr>
<td>qa_face</td>
<td></td>
<td>M</td>
<td>0..1</td>
<td>Describes the quality information for the captured facial image.</td>
<td>type.qa.face</td>
</tr>
<tr>
<td>Parameter</td>
<td>Type</td>
<td>Status</td>
<td>Number</td>
<td>Comment</td>
<td>XML Types</td>
</tr>
<tr>
<td>---------------------------------</td>
<td>--------</td>
<td>--------</td>
<td>--------</td>
<td>-------------------------------------------------------------------------</td>
<td>------------------------------------</td>
</tr>
<tr>
<td>type.qa.face</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>total</td>
<td>boolean</td>
<td>M</td>
<td>1</td>
<td>Total result true/false for the facial image quality analysis.</td>
<td>type.total.qa.result</td>
</tr>
<tr>
<td>qa</td>
<td>double</td>
<td>M</td>
<td>1..*</td>
<td>Identified quality values. For every quality value this element is repeated.</td>
<td>type.quality.assurance</td>
</tr>
<tr>
<td>type.quality.assurance</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>id</td>
<td>String</td>
<td>M</td>
<td>1</td>
<td>This attribute specifies which quality criterion (compare table 6-2) is described by this tag.</td>
<td>type.identifier.criterion</td>
</tr>
<tr>
<td>m</td>
<td>double</td>
<td>O</td>
<td>1</td>
<td>Minimum value from the range of this criterion. If the range of possible values does not have a lower bound this attribute has to be left out. Otherwise the attribute has to be specified.</td>
<td>type.result.qa</td>
</tr>
<tr>
<td>Parameter</td>
<td>Type</td>
<td>Status</td>
<td>Number</td>
<td>Comment</td>
<td>XML Types</td>
</tr>
<tr>
<td>-----------</td>
<td>--------</td>
<td>--------</td>
<td>--------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>----------------------------</td>
</tr>
<tr>
<td>M</td>
<td>double</td>
<td>O</td>
<td>1</td>
<td>Maximum value from the range of this criterion. If the range of possible values does not have an upper bound this attribute has to be left out. Otherwise the attribute has to be specified.</td>
<td>type.result.qa</td>
</tr>
<tr>
<td>t</td>
<td>double</td>
<td>O</td>
<td>1</td>
<td>Minimum value of the allowed tolerance range of this criterion. If the range of valid values does not have a lower bound this attribute has to be left out. Otherwise the attribute has to be specified.</td>
<td>type.result.qa</td>
</tr>
<tr>
<td>T</td>
<td>double</td>
<td>O</td>
<td>1</td>
<td>Maximum value of the allowed tolerance range of this criterion. If the range of valid values does not have an upper bound this attribute has to be left out. Otherwise the attribute has to be specified.</td>
<td>type.result.qa</td>
</tr>
<tr>
<td>time</td>
<td>dateTime</td>
<td>M</td>
<td>1</td>
<td>Time stamp of the coding.</td>
<td>type.time.coding</td>
</tr>
<tr>
<td>note</td>
<td>String</td>
<td>O</td>
<td>0..*</td>
<td>Free field for optional comments and extensions.</td>
<td>type.note</td>
</tr>
<tr>
<td>aux</td>
<td>any</td>
<td>O</td>
<td>0..1</td>
<td>Additional auxiliary information of the software.</td>
<td>type.aux.information</td>
</tr>
</tbody>
</table>

Table 8-10: Representation for the coding of facial images (ph-gid)

The XML representation of the afore described coding can be found in Annex A: XML-Schema in section bio_face.

**XML example coding**

```xml
<?xml version="1.0" encoding="UTF-8"?>
<bio_face:ph-gid xmlns:bio_face="http://trbio.bsi.bund.de/1.0/bio_face"
    xmlns:bioqa="http://trbio.bsi.bund.de/1.0/bioqa"
```
8 Coding

xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://trbio.bsi.bund.de/1.0/bio_face bio_face.xsd">
  <bio_face:record>
    <bioqa:data>VGhpcyBmaWVsZCBjb250YWlucyB0aGUgQmlvQVBJIEJJUg==</bioqa:data>
    <bioqa:md5>201D8105B4DF914D0074E41B4EDDE3B8</bioqa:md5>
  </bio_face:record>
  <bio_face:xinfo-ph-gid>
    <bio_face:moduleinfo>
      <bioqa:moduletype>TRBIO_ModuleType_AH</bioqa:moduletype>
      <bioqa:vendorinfo>
        <bioqa:vendorname>exampleVendorname</bioqa:vendorname>
        <bioqa:productname>exampleProductname</bioqa:productname>
        <bioqa:version>1.28</bioqa:version>
        <bioqa:firmwareversion>88HE-975dz</bioqa:firmwareversion>
        <bioqa:qa_config>1.0</bioqa:qa_config>
      </bioqa:vendorinfo>
    </bio_face:moduleinfo>
    <bio_face:moduleinfo>
      <bioqa:moduletype>TRBIO_ModuleType_AS</bioqa:moduletype>
      <bioqa:vendorinfo>
        <bioqa:vendorname>exampleVendorname</bioqa:vendorname>
        <bioqa:productname>exampleProductname</bioqa:productname>
        <bioqa:version>1.28</bioqa:version>
        <bioqa:firmwareversion>00158741</bioqa:firmwareversion>
        <bioqa:qa_config>1.0</bioqa:qa_config>
      </bioqa:vendorinfo>
    </bio_face:moduleinfo>
    <bio_face:moduleinfo>
      <bioqa:moduletype>TRBIO_ModuleType_BIP</bioqa:moduletype>
      <bioqa:vendorinfo>
        <bioqa:vendorname>exampleVendorname</bioqa:vendorname>
        <bioqa:productname>exampleProductname</bioqa:productname>
        <bioqa:version>1.28</bioqa:version>
        <bioqa:firmwareversion>00158741</bioqa:firmwareversion>
        <bioqa:qa_config>1.0</bioqa:qa_config>
      </bioqa:vendorinfo>
    </bio_face:moduleinfo>
    <bio_face:moduleinfo>
      <bioqa:moduletype>TRBIO_ModuleType_QA</bioqa:moduletype>
      <bioqa:vendorinfo>
        <bioqa:vendorname>exampleVendorname</bioqa:vendorname>
        <bioqa:productname>exampleProductname</bioqa:productname>
        <bioqa:version>1.28</bioqa:version>
        <bioqa:firmwareversion>00158741</bioqa:firmwareversion>
        <bioqa:qa_config>1.0</bioqa:qa_config>
      </bioqa:vendorinfo>
    </bio_face:moduleinfo>
    <bio_face:moduleinfo>
      <bioqa:moduletype>TRBIO_ModuleType_COM</bioqa:moduletype>
      <bioqa:vendorinfo>
        <bioqa:vendorname>exampleVendorname</bioqa:vendorname>
        <bioqa:productname>exampleProductname</bioqa:productname>
        <bioqa:version>0.88</bioqa:version>
        <bioqa:firmwareversion>1.11</bioqa:firmwareversion>
        <bioqa:qa_config>1.0</bioqa:qa_config>
      </bioqa:vendorinfo>
    </bio_face:moduleinfo>
  </bio_face:xinfo-ph-gid>
</bio_face:record>
This function block describes requirements and interfaces for the coding of facial images used for application of biometric visas.

**Requirements**

In the following, requirements are defined for coding of biometric data as well as corresponding additional quality information.

![Figure 8-7: BioAPI BIR PH-Visa](image)

**8.4 COD-PH-VAPP**

This function block describes requirements and interfaces for the coding of facial images used for application of biometric visas.
As described in the Software Architecture (compare TR-03121-2 section 2) the result data is encoded in a Biometric Information Record (BIR) returned by the respective BSP enclosing a header and a Biometric Data Block (BDB).

In the BIR header an output format according to CBEFF is specified which is published by the Federal Office for Information Security. It includes the format owner and type used by the coding function module. For the coding of facial images the structure is as following:

<table>
<thead>
<tr>
<th>Organisation Name</th>
<th>Organisation Identifier</th>
<th>BDB Format</th>
<th>Format Short Name</th>
<th>Specification Name, Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Federal Office for Information Security (BSI)</td>
<td>00 4B</td>
<td>00 04</td>
<td>TR Biometrics XML-PH-Visa Application 1.0</td>
<td>TR-03121-3 (TR-Biometrics)</td>
</tr>
</tbody>
</table>

Table 8-11: COD-PH-VAPP Output Format

In the following the facial image is included in a data element while additional quality information is encoded in a xinfo-ph-visa element (compare figure 8-7).

The input information is obtained from several Function Modules:

- FM Process (FM P)
- FM Acquisition Hardware (FM AH)
- FM Acquisition Software (FM AS)
- FM Biometric Image Processing (FM BIP)
- FM Quality Assurance (FM QA)
- FM Compression (FM COM)
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Type</th>
<th>Status</th>
<th>Number</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>type.function.module.ph.visa</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>record</td>
<td></td>
<td>M</td>
<td>1</td>
<td>Encapsulates the data group and the hash value of the facial image.</td>
</tr>
<tr>
<td>type.data.record</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>data</td>
<td>base64Binary</td>
<td>M</td>
<td>1</td>
<td>Contains the facial image encoded in Base64.</td>
</tr>
<tr>
<td>md5</td>
<td>hexBinary</td>
<td>O</td>
<td>0..1</td>
<td>Hash value calculated over the data element.</td>
</tr>
<tr>
<td>xinfo-ph-visa</td>
<td></td>
<td>M</td>
<td>1</td>
<td>Encapsulates the additional quality information for the respective facial image.</td>
</tr>
</tbody>
</table>
8 Coding

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Type</th>
<th>Status</th>
<th>Number</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>type.additional.information.ph.visa</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transaction</td>
<td>type.transaction</td>
<td>M</td>
<td>1</td>
<td>Assigns an unique identifier to the application transaction.</td>
</tr>
<tr>
<td>type.transaction</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Transaction | M | 1 | Assigns an unique identifier to the application transaction.
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Type</th>
<th>Status</th>
<th>Number</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>TransactionID</td>
<td>string</td>
<td>M</td>
<td>1</td>
<td>Unique identifier of the current acquisition transaction (e.g. visa sticker number, UUID, ...)</td>
</tr>
<tr>
<td>Counter</td>
<td>integer</td>
<td>O</td>
<td>0..1</td>
<td>Index of the current transaction (should start with 1). Probably not needed in this context.</td>
</tr>
<tr>
<td>Date</td>
<td>date</td>
<td>M</td>
<td>1</td>
<td>Describes the day of the acquisition process.</td>
</tr>
<tr>
<td>Duration</td>
<td>duration</td>
<td>O</td>
<td>0..1</td>
<td>Describes the duration of the whole face acquisition process.</td>
</tr>
<tr>
<td>moduleinfo</td>
<td>M</td>
<td></td>
<td>1..*</td>
<td>Encapsulates the Function Module information.</td>
</tr>
</tbody>
</table>

**type.module.info**

- **moduletype**
  - **String**
  - M
  - 1
  - Describes the type of the Function Module. Possible values are:
    - TRBIO_ModuleType_AH,
    - TRBIO_ModuleType_AS,
    - TRBIO_ModuleType_BIP,
    - TRBIO_ModuleType_COM,
### Parameter Type Status Number Comment

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Type</th>
<th>Status</th>
<th>Number</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>vendorinfo</td>
<td>M</td>
<td>1</td>
<td></td>
<td>Encapsulates all necessary information regarding the vendor of the Function Module.</td>
</tr>
</tbody>
</table>

**type.vendor.info**

- **vendorname**: String M 1 Description of the vendor of the Function Module.
- **productname**: String M 1 Specification of the product name.
- **version**: String M 1 Specification of the version number is always included.
- **firmwareversion**: String M 0..1 Specification of the firmware version is an additional information that is entered if it is available.
- **qa_config**: String M 0..1 Config version number for the quality configuration.
- **aux**: any O 0..1 Additional auxiliary information of the software.
- **comp**: O 0..* Components that are used within the Function Module.

**type.subcomponent**

- **name**: type.subcomponent.name
- **version**: type.version
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Type</th>
<th>Status</th>
<th>Number</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>name</td>
<td>String</td>
<td>M</td>
<td>1</td>
<td>Describes the name of the component.</td>
</tr>
<tr>
<td>version</td>
<td>String</td>
<td>M</td>
<td>1</td>
<td>Contains the version number of the component.</td>
</tr>
<tr>
<td>algorithm</td>
<td></td>
<td>M</td>
<td>0..*</td>
<td>Description of the algorithm used within the Function Module.</td>
</tr>
<tr>
<td>type.algorithm</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>type</td>
<td>String</td>
<td>M</td>
<td>1</td>
<td>Describes the type (resp. the functionality) of the algorithm. Possible values are: TRBIO_AlgoType_Matcher, TRBIO_AlgoType_QA</td>
</tr>
<tr>
<td>name</td>
<td>String</td>
<td>M</td>
<td>1</td>
<td>Name of the used algorithm.</td>
</tr>
<tr>
<td>version</td>
<td>String</td>
<td>M</td>
<td>1</td>
<td>Version of the according algorithm.</td>
</tr>
<tr>
<td>qa_face</td>
<td></td>
<td>M</td>
<td>0..1</td>
<td>Describes the quality information for the captured facial image.</td>
</tr>
<tr>
<td>type.qa.face</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>total</td>
<td>boolean</td>
<td>M</td>
<td>1</td>
<td>Total result true/false for the facial image quality analysis.</td>
</tr>
<tr>
<td>Parameter</td>
<td>Type</td>
<td>Status</td>
<td>Number</td>
<td>Comment</td>
</tr>
<tr>
<td>--------------------</td>
<td>---------------</td>
<td>--------</td>
<td>--------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>qa</td>
<td>M</td>
<td>1..*</td>
<td></td>
<td>Identified quality values. For every quality value this element is repeated.</td>
</tr>
<tr>
<td>type.quality.assurance</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>id</td>
<td>String</td>
<td>M</td>
<td>1</td>
<td>This attribute specifies which quality criterion (compare table 6-2) is described by this tag.</td>
</tr>
<tr>
<td>m</td>
<td>double</td>
<td>O</td>
<td>1</td>
<td>Minimum value from the range of this criterion. If the range of possible values does not have a lower bound this attribute has to be left out. Otherwise the attribute has to be specified.</td>
</tr>
<tr>
<td>M</td>
<td>double</td>
<td>O</td>
<td>1</td>
<td>Maximum value from the range of this criterion. If the range of possible values does not have an upper bound this attribute has to be left out. Otherwise the attribute has to be specified.</td>
</tr>
<tr>
<td>t</td>
<td>double</td>
<td>O</td>
<td>1</td>
<td>Minimum value of the allowed tolerance range of this criterion. If the range of valid values does not have a lower bound this attribute has to be left out. Otherwise the attribute has to be specified.</td>
</tr>
<tr>
<td>T</td>
<td>double</td>
<td>O</td>
<td>1</td>
<td>Maximum value of the allowed tolerance range of this criterion. If the range of valid values does not have an upper bound this attribute has to be left out. Otherwise the attribute has to be specified.</td>
</tr>
<tr>
<td>note</td>
<td>string</td>
<td>O</td>
<td>0..*</td>
<td>Free field for optional comments and extensions.</td>
</tr>
<tr>
<td>Parameter</td>
<td>Type</td>
<td>Status</td>
<td>Number</td>
<td>Comment</td>
</tr>
<tr>
<td>-----------</td>
<td>------------</td>
<td>--------</td>
<td>--------</td>
<td>-------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Test</td>
<td>boolean</td>
<td>M</td>
<td>1</td>
<td>Indicates if the acquisition process was only conducted for testing or not.</td>
</tr>
<tr>
<td>ErrorCode</td>
<td>integer</td>
<td>O</td>
<td>0..1</td>
<td>Represents the error code of the occurred error (if an error has occurred).</td>
</tr>
<tr>
<td>ORI</td>
<td>string</td>
<td>M</td>
<td>1</td>
<td>Saves the Originating Agency Identifier of the visa application office (e.g. DE/ULAN). As the ORI information might not be available while encoding the data an external call to set this information shall be provided by the implemented BSP (cf. tables 8-13 and 8-14).</td>
</tr>
<tr>
<td>ImageFormat</td>
<td>string</td>
<td>M</td>
<td>1</td>
<td>Specifies the image format of the stored facial image in the record element. Enumeration with possible values: “jpeg”, “jpeg2000”.</td>
</tr>
<tr>
<td>aux</td>
<td>any</td>
<td>O</td>
<td>0..1</td>
<td>Additional auxiliary information of the software.</td>
</tr>
</tbody>
</table>

Table 8-12: Representation for the coding of facial images (ph-visa)

The XML representation of the afore described coding can be found in Annex A: XML-Schema in sections visa_face, bio_common and bioqa.

**XML example coding**

```xml
<?xml version="1.0" encoding="UTF-8"?>
<bio_ph_visa:ph-visa
xmlns:bio_ph_visa="http://trbio.bsi.bund.de/1.0/bio_ph_visa"
xmlns:bioqa="http://trbio.bsi.bund.de/1.0/bioqa"
xmlns:bio_common="http://trbio.bsi.bund.de/1.0/bio_common"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://trbio.bsi.bund.de/1.0/bio_ph_visa visa_face.xsd">
    <bio_ph_visa:record>
        <bioqa:data>VGhpcyBpcyBiaW5hcnkgZGF0YSBmb3IgZW5yb2xtZW50Lg==</bioqa:data>
        <bioqa:md5>fb5227685866f9a5fbbc8528688ca1f</bioqa:md5>
    </bio_ph_visa:record>
    <bio_ph_visa:xinfo-ph-visa>
        <bio_ph_visa:Transaction>
            <bio_common:TransactionID>identifierTransaction</bio_common:TransactionID>
        </bio_ph_visa:Transaction>
        <bio_ph_visa:Date>2009-10-23</bio_ph_visa:Date>
        <bio_ph_visa:Duration>P0Y0M0DT0H1M46S</bio_ph_visa:Duration>
        <bio_ph_visa:moduleinfo>
            <bioqa:moduletype>TRBIO_ModuleType_AH</bioqa:moduletype>
            <bioqa:vendorinfo>
                <bioqa:vendorname>AH_HW_Vendor_A</bioqa:vendorname>
            </bioqa:vendorinfo>
        </bio_ph_visa:moduleinfo>
    </bio_ph_visa:xinfo-ph-visa>
</bio_ph_visa:ph-visa>
```
<bioqa:productname>HW_Photo_camera_X</bioqa:productname>
<bioqa:version>3.9.0.0</bioqa:version>
</bioqa:vendorinfo>
</bio_ph_visa:moduleinfo>
<bioqa:moduletype>TRBIO_ModuleType_AS</bioqa:moduletype>
<bioqa:vendorinfo>
  <bioqa:vendorname>AS_SW_Vendor_B</bioqa:vendorname>
  <bioqa:productname>SW_Component_Y</bioqa:productname>
  <bioqa:version>2.4.0</bioqa:version>
</bioqa:vendorinfo>
</bio_ph_visa:moduleinfo>
<bioqa:moduletype>TRBIO_ModuleType_BIP</bioqa:moduletype>
<bioqa:vendorinfo>
  <bioqa:vendorname>BIP_SW_Vendor_C</bioqa:vendorname>
  <bioqa:productname>Eyefinder_Algz_Z</bioqa:productname>
  <bioqa:version>0.9</bioqa:version>
</bioqa:vendorinfo>
</bio_ph_visa:moduleinfo>
<bioqa:moduletype>TRBIO_ModuleType_COM</bioqa:moduletype>
<bioqa:vendorinfo>
  <bioqa:vendorname>COM_SW_Vendor_F</bioqa:vendorname>
  <bioqa:productname>JPGCompressor</bioqa:productname>
  <bioqa:version>1.2</bioqa:version>
</bioqa:vendorinfo>
</bio_ph_visa:moduleinfo>
<bioqa:moduletype>TRBIO_ModuleType_QA</bioqa:moduletype>
<bioqa:vendorinfo>
  <bioqa:vendorname>QA_SW_Vendor_E</bioqa:vendorname>
  <bioqa:productname>QASW_Ensurer</bioqa:productname>
  <bioqa:version>5.0.0.1</bioqa:version>
</bioqa:vendorinfo>
</bio_ph_visa:moduleinfo>
<bioqa:moduletype>TRBIO_ModuleType_COD</bioqa:moduletype>
<bioqa:vendorinfo>
  <bioqa:vendorname>COD_SW_Vendor_B</bioqa:vendorname>
  <bioqa:productname>SW_Component_YX</bioqa:productname>
  <bioqa:version>3.0</bioqa:version>
</bioqa:vendorinfo>
</bio_ph_visa:moduleinfo>
<bio_ph_visa:qa face total="true">
  <bio_ph_visa:qa id="1.1" m="-30" M="30" t="-8" T="8">-0.313132</bio_ph_visa:qa>
  <bio_ph_visa:qa id="2.2" t="0.5">2.19658</bio_ph_visa:qa>
  <bio_ph_visa:qa id="5.1" m="0" t="531" T="531">531</bio_ph_visa:qa>
  <bio_ph_visa:qa id="5.2" m="0" t="413" T="413">413</bio_ph_visa:qa>
  <bio_ph_visa:qa id="5.3" m="0" M="1" t="0.5" T="0.75">0.530699</bio_ph_visa:qa>
  <bio_ph_visa:qa id="5.4" m="0" M="1" t="0.6" T="0.9">0.638858</bio_ph_visa:qa>
</bio_ph_visa:qa>
Specification of setting additional coding information

Setting additional coding information requires a BioSPI_ControlUnit call in advance to the BioSPI_Capture call described above (described in the Software Architecture part of TR-03121-2). Table 8-13 defines the ControlCode and table 8-14 the according XML-InputData structure for this BioSPI_ControlUnit call.

<table>
<thead>
<tr>
<th>Organisation Name</th>
<th>ControlCode</th>
<th>InputData Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Federal Office for Information Security (BSI)</td>
<td>0x584D4C20</td>
<td>ph-visa-inputdata</td>
</tr>
</tbody>
</table>

Table 8-13: COD-PH-VAPP ControlCode specification

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Type</th>
<th>Status</th>
<th>Number</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>ph-visa-inputdata</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ORI</td>
<td>string</td>
<td>M</td>
<td>1</td>
<td>Specification of the Originating Agency Identifier (Country and City of the Agency e.g. DE/ULAN for a German consular post in Ulan Bator).</td>
</tr>
</tbody>
</table>

Table 8-14: COD-PH-VAPP InputData specification
8 Coding

The XML representation of the afore described coding can be found in Annex A: XML-Schema in sections visa_face_inputdata and bio_common.

XML example coding of InputData structure

```xml
<?xml version="1.0" encoding="UTF-8"?>
<bio_common:ph-visa-inputdata
xmlns:bio_common="http://trbio.bsi.bund.de/1.0/bio_common"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://trbio.bsi.bund.de/1.0/bio_common visa_face_inputdata.xsd">
  <bio_common:ORI>DE/ULAN</bio_common:ORI>
</bio_common:ph-visa-inputdata>
```

8.5 COD-PH-VID

This function block describes requirements for the coding used during the verification process of facial images.

Requirements

As mentioned in the Software Architecture of this Application Profile (compare TR-03121-2 section 2) and Function Module P-PH-VID the result data is collected from different components. Function Module LOG-PH-VID describes which components log what kind of information. Both specified workflows from FM P-PH-VID return separate logging data:

- All results of the verification workflow are encoded in XML format according to the schema defined in table 8-15.
- All results of the evaluation workflow are encoded in XML format according to the schema defined in table 8-16.

An overview of the main information which is logged within this Function Module is given in figure 8-8.

![Figure 8-8: Overview of main logging data](image-url)
The input information is obtained from several Function Modules:

▸ FM Acquisition Hardware (FM AH)
▸ FM Acquisition Software (FM AS)
▸ FM Biometric Image Processing (FM BIP)
▸ FM Quality Assurance (FM QA)
▸ FM Biometric Comparison (FM CMP)
▸ FM Logging (FM LOG)

In the following table all single elements of the information obtained within the verification workflow are described.
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Type</th>
<th>Status</th>
<th>Number</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>ph-vid-verify</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

![Diagram](image-url)
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Type</th>
<th>Status</th>
<th>Number</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>type.function.module.ph.vid.verify</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transaction</td>
<td>type.transaction</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Date</td>
<td>type.date</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capture</td>
<td>type.function.module.ph.vid.capture</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Verification</td>
<td>type.function.module.ph.vid.verification</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SoftwareType</td>
<td>[1..*] type.software.general</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ReferenceImage</td>
<td>type.image.information</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DocumentInformation</td>
<td>type.document.information</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DemographicData</td>
<td>[0..1] type démographic.data</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comment</td>
<td>[0..1] type.note</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ErrorCode</td>
<td>[0..1] type.error.code</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>aux</td>
<td>[0..1] type.aux.information</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Parameter Type

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Type</th>
<th>Status</th>
<th>Number</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transaction</td>
<td>M</td>
<td>1</td>
<td></td>
<td>Element for representing a unique transaction within the verification process. Example: Two verification tries of the same person are needed to pass the border control. Thus, two separate XMLs for every process are the result. TransactionID remains the same for both XMLs while Counter is 1 for the first try and 2 for the second try. Note: This Transaction element must be equal to the Transaction element of the evaluation workflow to ensure the possibility to link the results of both workflows.</td>
</tr>
<tr>
<td>type.transaction</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TransactionID</td>
<td>string</td>
<td>M</td>
<td>1</td>
<td>Unique identifier of the current verification transaction.</td>
</tr>
<tr>
<td>Counter</td>
<td>integer</td>
<td>M</td>
<td>1</td>
<td>Index of the current verification try within the same verification process (should start with 1).</td>
</tr>
<tr>
<td>Date</td>
<td>date</td>
<td>M</td>
<td>1</td>
<td>Describes the day of the verification process.</td>
</tr>
<tr>
<td>Capture</td>
<td>M</td>
<td>1</td>
<td></td>
<td>Within this element the whole process of capturing live face images is enclosed.</td>
</tr>
<tr>
<td>Parameter</td>
<td>Type</td>
<td>Status</td>
<td>Number</td>
<td>Comment</td>
</tr>
<tr>
<td>-----------</td>
<td>------</td>
<td>--------</td>
<td>--------</td>
<td>---------</td>
</tr>
<tr>
<td>type.function.module.ph.vid.capture</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Duration</td>
<td>duration</td>
<td>O</td>
<td>0..1</td>
<td>Describes the duration of the whole process of capturing live images during the current transaction.</td>
</tr>
<tr>
<td>SoftwareType</td>
<td>M</td>
<td>1</td>
<td></td>
<td>Specification of the software type used for capturing live images.</td>
</tr>
<tr>
<td>type.software.general</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>identifier</td>
<td>string</td>
<td>M</td>
<td>1</td>
<td>Specification of the vendor of the software.</td>
</tr>
<tr>
<td>name</td>
<td>string</td>
<td>M</td>
<td>1</td>
<td>Specification of the software name.</td>
</tr>
<tr>
<td>version</td>
<td>string</td>
<td>M</td>
<td>1</td>
<td>Specification of the software version.</td>
</tr>
<tr>
<td>Parameter</td>
<td>Type</td>
<td>Status</td>
<td>Number</td>
<td>Comment</td>
</tr>
<tr>
<td>---------------</td>
<td>------------</td>
<td>--------</td>
<td>--------</td>
<td>-------------------------------------------------------------------------</td>
</tr>
<tr>
<td>note</td>
<td>string</td>
<td>O</td>
<td>0..1</td>
<td>Specification of the software type or other specific software information.</td>
</tr>
<tr>
<td>HardwareType</td>
<td>M</td>
<td>1</td>
<td></td>
<td>Specification of the hardware type used for capturing live images.</td>
</tr>
<tr>
<td>type.hardware</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>identifier</td>
<td>string</td>
<td>M</td>
<td>1</td>
<td>Specification of the vendor of the hardware.</td>
</tr>
<tr>
<td>name</td>
<td>string</td>
<td>M</td>
<td>1</td>
<td>Specification of the hardware name.</td>
</tr>
<tr>
<td>version</td>
<td>string</td>
<td>M</td>
<td>1</td>
<td>Specification of the hardware version.</td>
</tr>
<tr>
<td>firmwareversion</td>
<td>string</td>
<td>O</td>
<td>0..1</td>
<td>Specification of the firmware version.</td>
</tr>
<tr>
<td>note</td>
<td>string</td>
<td>O</td>
<td>0..1</td>
<td>Specification of the hardware type or other specific hardware information.</td>
</tr>
<tr>
<td>ErrorCode</td>
<td>integer</td>
<td>O</td>
<td>0..1</td>
<td>This optional field allows the communication of error messages.</td>
</tr>
<tr>
<td>aux</td>
<td>any</td>
<td>O</td>
<td>0..1</td>
<td>Optional field for additional information.</td>
</tr>
<tr>
<td>Verification</td>
<td>M</td>
<td>1</td>
<td></td>
<td>Within this element the whole process of verifying a live face image is enclosed.</td>
</tr>
<tr>
<td>Parameter</td>
<td>Type</td>
<td>Status</td>
<td>Number</td>
<td>Comment</td>
</tr>
<tr>
<td>-----------</td>
<td>------</td>
<td>--------</td>
<td>--------</td>
<td>---------</td>
</tr>
<tr>
<td>type.function.module.ph.vid.verification</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Duration</td>
<td>duration</td>
<td>O</td>
<td>0..1</td>
<td>Describes the duration of a single verification attempt.</td>
</tr>
<tr>
<td>SoftwareType</td>
<td></td>
<td>M</td>
<td>1</td>
<td>Specification of the software type used for verification.</td>
</tr>
</tbody>
</table>

**type.software.general**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Type</th>
<th>Status</th>
<th>Number</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>identifier</td>
<td>string</td>
<td>M</td>
<td>1</td>
<td>Specification of the vendor of the software.</td>
</tr>
<tr>
<td>name</td>
<td>string</td>
<td>M</td>
<td>1</td>
<td>Specification of the software name.</td>
</tr>
<tr>
<td>version</td>
<td>string</td>
<td>M</td>
<td>1</td>
<td>Specification of the software version.</td>
</tr>
<tr>
<td>note</td>
<td>string</td>
<td>O</td>
<td>0..1</td>
<td>Specification of the software type or other specific software information.</td>
</tr>
<tr>
<td>Parameter</td>
<td>Type</td>
<td>Status</td>
<td>Number</td>
<td>Comment</td>
</tr>
<tr>
<td>----------------------------</td>
<td>----------</td>
<td>--------</td>
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</tr>
<tr>
<td>Threshold</td>
<td>float</td>
<td>M</td>
<td>1</td>
<td>Specified threshold used for genuine comparison of used software type.</td>
</tr>
<tr>
<td>GenuineComparison</td>
<td>O</td>
<td>0..1</td>
<td></td>
<td>Describes the result of the genuine verification performed by the configured software type and set threshold. If any result is returned by the configured software type this element needs to be existing.</td>
</tr>
<tr>
<td>type.comparison</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ComparisonScore</td>
<td>float</td>
<td>M</td>
<td>1</td>
<td>Comparison score returned by the software used for verification.</td>
</tr>
<tr>
<td>ComparisonResult</td>
<td>boolean</td>
<td>M</td>
<td>1</td>
<td>Result of comparison returned by the software used for verification.</td>
</tr>
<tr>
<td>ErrorCode</td>
<td>integer</td>
<td>O</td>
<td>0..1</td>
<td>This optional field allows the communication of error messages.</td>
</tr>
<tr>
<td>aux</td>
<td>any</td>
<td>O</td>
<td>0..1</td>
<td>Optional field for additional information.</td>
</tr>
<tr>
<td>SoftwareType</td>
<td>M</td>
<td>1..*</td>
<td></td>
<td>Specification of the software type used for the whole verification and evaluation workflow. Due to different options of implementing this process multiple software types may be used for processing.</td>
</tr>
<tr>
<td>type.software.general</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>identifier</td>
<td>string</td>
<td>M</td>
<td>1</td>
<td>Specification of the vendor of the software.</td>
</tr>
<tr>
<td>name</td>
<td>string</td>
<td>M</td>
<td>1</td>
<td>Specification of the software name.</td>
</tr>
<tr>
<td>Parameter</td>
<td>Type</td>
<td>Status</td>
<td>Number</td>
<td>Comment</td>
</tr>
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<td>--------------------------------------------------------------------------</td>
</tr>
<tr>
<td>version</td>
<td>string</td>
<td>M</td>
<td>1</td>
<td>Specification of the software version.</td>
</tr>
<tr>
<td>note</td>
<td>string</td>
<td>O</td>
<td>0..1</td>
<td>Specification of the software type or other specific software information.</td>
</tr>
<tr>
<td>ReferenceImage</td>
<td></td>
<td>M</td>
<td>1</td>
<td>Within this element information about the reference image read from the document is enclosed.</td>
</tr>
</tbody>
</table>

**type.image.information**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Type</th>
<th>Status</th>
<th>Number</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>ImageType</td>
<td>string</td>
<td>M</td>
<td>1</td>
<td>Describes the image type of the reference image. Enumeration: “full_frontal”, “token_frontal”, “unspecified”.</td>
</tr>
<tr>
<td>ImageFormat</td>
<td>string</td>
<td>M</td>
<td>1</td>
<td>Describes the image format of the reference image. Enumeration: “jpeg”, “jpeg2000”.</td>
</tr>
</tbody>
</table>

**type.document.information**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Type</th>
<th>Status</th>
<th>Number</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>DocumentType</td>
<td>string</td>
<td>M</td>
<td>1</td>
<td>Describes the type of the document used for verification. Enumeration: “passport”, “identity_card”, “visa”, “residence_permit”, “other”.</td>
</tr>
<tr>
<td>IssuingState</td>
<td>string</td>
<td>M</td>
<td>1</td>
<td>Describes the issuing state of the document.</td>
</tr>
<tr>
<td>DemographicData</td>
<td></td>
<td>O</td>
<td>0..1</td>
<td>Within this element demographic data of the holder of the document may be enclosed.</td>
</tr>
</tbody>
</table>
The following table describes all single elements of the information obtained within the evaluation workflow.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Type</th>
<th>Status</th>
<th>Number</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>type.demographic.data</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td>string</td>
<td>M</td>
<td>1</td>
<td>Describes the gender of the document holder. Enumeration: “male”, “female”, “unknown”.</td>
</tr>
<tr>
<td>AgeClass</td>
<td>string</td>
<td>M</td>
<td>1</td>
<td>Specification of the age class shall be given as a range ... “20-29”, “30-39”, ...</td>
</tr>
<tr>
<td>Nationality</td>
<td>string</td>
<td>O</td>
<td>0..1</td>
<td>Describes the nationality of the document holder.</td>
</tr>
<tr>
<td>Comment</td>
<td>string</td>
<td>O</td>
<td>0..1</td>
<td>This optional field allows to log additional proprietary information or individual notes.</td>
</tr>
<tr>
<td>ErrorCode</td>
<td>integer</td>
<td>O</td>
<td>0..1</td>
<td>This optional field allows the communication of error messages.</td>
</tr>
<tr>
<td>aux</td>
<td>any</td>
<td>O</td>
<td>0..1</td>
<td>Optional field for additional information.</td>
</tr>
<tr>
<td>Parameter</td>
<td>Type</td>
<td>Status</td>
<td>Number</td>
<td>Comment</td>
</tr>
<tr>
<td>---------------------</td>
<td>--------------------------</td>
<td>--------</td>
<td>--------</td>
<td>----------------------------------------------</td>
</tr>
<tr>
<td>ph-vid-eval</td>
<td>type.function.module.ph.vid.eval</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transaction</td>
<td>type.transaction</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>QualityAssurance</td>
<td>type.function.module.ph.vid.quality.assurance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CrossComparison</td>
<td>type.function.module.ph.vid.cross.comparison</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comment</td>
<td>type.note</td>
<td>[0..1]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ErrorCode</td>
<td>type.error.code</td>
<td>[0..1]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>aux</td>
<td>type.aux.information</td>
<td>[0..1]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>type.function.module.ph.vid.eval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transaction</td>
</tr>
<tr>
<td>QualityAssurance</td>
</tr>
<tr>
<td>CrossComparison</td>
</tr>
<tr>
<td>Comment</td>
</tr>
<tr>
<td>ErrorCode</td>
</tr>
<tr>
<td>aux</td>
</tr>
</tbody>
</table>

Federal Office for Information Security
### Parameter Type Status Number Comment

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Type</th>
<th>Status</th>
<th>Number</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transaction</td>
<td>M</td>
<td>1</td>
<td></td>
<td>Element for representing a unique transaction within the verification process. Example: Two verification tries of the same person are needed to pass the border control. Thus, two separate XMLs for every process are the result. TransactionID remains the same for both XMLs while Counter is 1 for the first try and 2 for the second try. Note: This Transaction element must be equal to the Transaction element of the verification workflow to ensure the possibility to link the results of both workflows.</td>
</tr>
<tr>
<td>type.transaction</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TransactionID</td>
<td>string</td>
<td>M</td>
<td>1</td>
<td>Unique identifier of the current verification transaction.</td>
</tr>
<tr>
<td>Counter</td>
<td>integer</td>
<td>M</td>
<td>1</td>
<td>Index of the current verification try within the same verification process (should start with 1).</td>
</tr>
<tr>
<td>QualityAssurance</td>
<td>I</td>
<td>1</td>
<td>1..*</td>
<td>Within this element information about results of the quality check of live and reference images are enclosed. For every single quality assurance software used to check the quality one element shall be present.</td>
</tr>
<tr>
<td>Parameter</td>
<td>Type</td>
<td>Status</td>
<td>Number</td>
<td>Comment</td>
</tr>
<tr>
<td>-----------</td>
<td>------</td>
<td>--------</td>
<td>--------</td>
<td>---------</td>
</tr>
<tr>
<td>type.function.module.ph.vid.quality.assurance</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Duration</td>
<td>duration</td>
<td>O</td>
<td>0..1</td>
<td>Describes the duration of the quality assurance process.</td>
</tr>
<tr>
<td>SoftwareType</td>
<td>M</td>
<td>1</td>
<td></td>
<td>Specification of the software type used for quality assurance.</td>
</tr>
<tr>
<td>type.software</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>identifier</td>
<td>string</td>
<td>M</td>
<td>1</td>
<td>Specification of the vendor of the software.</td>
</tr>
<tr>
<td>name</td>
<td>string</td>
<td>M</td>
<td>1</td>
<td>Specification of the software name.</td>
</tr>
<tr>
<td>Parameter</td>
<td>Type</td>
<td>Status</td>
<td>Number</td>
<td>Comment</td>
</tr>
<tr>
<td>--------------</td>
<td>----------</td>
<td>--------</td>
<td>--------</td>
<td>--------------------------------------------------------------------------</td>
</tr>
<tr>
<td>version</td>
<td>string</td>
<td>M</td>
<td>1</td>
<td>Specification of the software version.</td>
</tr>
<tr>
<td>note</td>
<td>string</td>
<td>O</td>
<td>0..1</td>
<td>Specification of the software type or other specific software information.</td>
</tr>
<tr>
<td>configuration</td>
<td>O</td>
<td>0..1</td>
<td></td>
<td>Additional configuration information of the used software.</td>
</tr>
</tbody>
</table>

**type.configuration**

<p>| criterion    | string   | M      | 1..*   | Specifies a specific criterion that can be configured within the software.|
| m            | double   | O      | 1      | Minimum value of the range of this criterion. If the range of possible values does not have a lower bound this attribute has to be left out. Otherwise, the attribute has to be specified. |
| M            | double   | O      | 1      | Maximum value of the range of this criterion. If the range of possible values does not have an upper bound this attribute has to be left out. Otherwise, the attribute has to be specified. |
| t            | double   | O      | 1      | Minimum of the tolerance range of this criterion. If the range of valid values does not have a lower bound this attribute has to be left out. Otherwise, the attribute has to be specified. |
| T            | double   | O      | 1      | Maximum of the tolerance range of this criterion. If the range of valid values does not have an upper bound this attribute has to be left out. Otherwise, the attribute has to be specified. |
| QualityResult| O        | 0..*   |        | Describes the results of the conducted quality assurance.               |</p>
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Type</th>
<th>Status</th>
<th>Number</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>type.qa.face</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>total</td>
<td>boolean</td>
<td>M</td>
<td>1</td>
<td>Total result for facial image quality analysis (true/false).</td>
</tr>
<tr>
<td>ImageSource</td>
<td>string</td>
<td>M</td>
<td>1</td>
<td>Describes the type of image used for quality analysis. Enumeration: “live”, “reference”.</td>
</tr>
<tr>
<td>qa</td>
<td>double</td>
<td>M</td>
<td>1..*</td>
<td>Identified quality values. For every quality value this element is repeated.</td>
</tr>
<tr>
<td>type.quality.assurance</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>id</td>
<td>string</td>
<td>M</td>
<td>1</td>
<td>This attribute specifies which quality criterion is described by this tag.</td>
</tr>
<tr>
<td>Parameter</td>
<td>Type</td>
<td>Status</td>
<td>Number</td>
<td>Comment</td>
</tr>
<tr>
<td>-----------------</td>
<td>--------</td>
<td>--------</td>
<td>--------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>m</td>
<td>double</td>
<td>O</td>
<td>1</td>
<td>Minimum value from the range of this criterion. If the range of possible values does not have a lower bound this attribute has to be left out. Otherwise the attribute has to be specified.</td>
</tr>
<tr>
<td>M</td>
<td>double</td>
<td>O</td>
<td>1</td>
<td>Maximum value from the range of this criterion. If the range of possible values does not have an upper bound this attribute has to be left out. Otherwise the attribute has to be specified.</td>
</tr>
<tr>
<td>t</td>
<td>double</td>
<td>O</td>
<td>1</td>
<td>Minimum value of the allowed tolerance range of this criterion. If the range of valid values does not have a lower bound this attribute has to be left out. Otherwise the attribute has to be specified.</td>
</tr>
<tr>
<td>T</td>
<td>double</td>
<td>O</td>
<td>1</td>
<td>Maximum value of the allowed tolerance range of this criterion. If the range of valid values does not have an upper bound this attribute has to be left out. Otherwise the attribute has to be specified.</td>
</tr>
<tr>
<td>ErrorCode</td>
<td>integer</td>
<td>O</td>
<td>0..1</td>
<td>This optional field allows the communication of error messages.</td>
</tr>
<tr>
<td>aux</td>
<td>any</td>
<td>O</td>
<td>0..1</td>
<td>Optional field for additional information.</td>
</tr>
<tr>
<td>CrossComparison</td>
<td>M</td>
<td>1..*</td>
<td></td>
<td>Within this element results of conducted cross-comparisons (consisting of genuine and impostor comparisons) are enclosed. For every comparison algorithm used a separate element shall be present.</td>
</tr>
<tr>
<td>Parameter</td>
<td>Type</td>
<td>Status</td>
<td>Number</td>
<td>Comment</td>
</tr>
<tr>
<td>-----------</td>
<td>------</td>
<td>--------</td>
<td>--------</td>
<td>---------</td>
</tr>
<tr>
<td>type.function.module.ph.vid.cross.comparison</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Duration</td>
<td>duration</td>
<td>O</td>
<td>0..1</td>
<td>Describes the duration of the cross-comparison process.</td>
</tr>
<tr>
<td>SoftwareType</td>
<td>M</td>
<td>1</td>
<td></td>
<td>Specification of the software type used for cross-comparison.</td>
</tr>
<tr>
<td>type.software.general</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>identifier</td>
<td>string</td>
<td>M</td>
<td>1</td>
<td>Specification of the vendor of the software.</td>
</tr>
<tr>
<td>name</td>
<td>string</td>
<td>M</td>
<td>1</td>
<td>Specification of the software name.</td>
</tr>
<tr>
<td>version</td>
<td>string</td>
<td>M</td>
<td>1</td>
<td>Specification of the software version.</td>
</tr>
<tr>
<td>note</td>
<td>string</td>
<td>O</td>
<td>0..1</td>
<td>Specification of the software type or other specific software information.</td>
</tr>
<tr>
<td>Parameter</td>
<td>Type</td>
<td>Status</td>
<td>Number</td>
<td>Comment</td>
</tr>
<tr>
<td>-------------------------</td>
<td>----------</td>
<td>--------</td>
<td>--------</td>
<td>------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Threshold</td>
<td>float</td>
<td>M</td>
<td>1</td>
<td>Specified threshold used for genuine and impostor comparisons of used software type.</td>
</tr>
<tr>
<td>GenuineComparison</td>
<td>O</td>
<td>0..1</td>
<td></td>
<td>Describes the result of the genuine verification performed by the configured software type and set threshold. If any result is returned by the configured software type this element needs to be existing.</td>
</tr>
<tr>
<td>ComparisonScore</td>
<td>float</td>
<td>M</td>
<td>1</td>
<td>Genuine comparison score returned by the software used for verification.</td>
</tr>
<tr>
<td>ComparisonResult</td>
<td>boolean</td>
<td>M</td>
<td>1</td>
<td>Result of genuine comparison returned by the software used for comparison.</td>
</tr>
<tr>
<td>ImpostorComparison</td>
<td>O</td>
<td>0..*</td>
<td></td>
<td>Describes the results of the impostor verification performed by the configured software type and set threshold. If any result is returned by the configured software type this element needs to be existing. Multiple impostor comparisons are possible for generating error rates of the used software type.</td>
</tr>
<tr>
<td>ErrorCode</td>
<td>integer</td>
<td>O</td>
<td>0..1</td>
<td>This optional field allows the communication of error messages.</td>
</tr>
</tbody>
</table>

**type.comparison**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Type</th>
<th>Status</th>
<th>Number</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>ComparisonScore</td>
<td>float</td>
<td>M</td>
<td>1</td>
<td>Impostor comparison score returned by the software used for verification.</td>
</tr>
<tr>
<td>ComparisonResult</td>
<td>boolean</td>
<td>M</td>
<td>1</td>
<td>Result of impostor comparison returned by the software used for comparison.</td>
</tr>
<tr>
<td>ErrorCode</td>
<td>integer</td>
<td>O</td>
<td>0..1</td>
<td>This optional field allows the communication of error messages.</td>
</tr>
<tr>
<td>Parameter</td>
<td>Type</td>
<td>Status</td>
<td>Number</td>
<td>Comment</td>
</tr>
<tr>
<td>-----------</td>
<td>------</td>
<td>--------</td>
<td>--------</td>
<td>---------</td>
</tr>
<tr>
<td>aux</td>
<td>any</td>
<td>O</td>
<td>0..1</td>
<td>Optional field for additional information.</td>
</tr>
<tr>
<td>Comment</td>
<td>string</td>
<td>O</td>
<td>0..1</td>
<td>This optional field allows to log additional proprietary information or individual notes.</td>
</tr>
<tr>
<td>ErrorCode</td>
<td>integer</td>
<td>O</td>
<td>0..1</td>
<td>This optional field allows the communication of error messages of the overall evaluation workflow.</td>
</tr>
<tr>
<td>aux</td>
<td>any</td>
<td>O</td>
<td>0..1</td>
<td>Optional field for additional information of the overall evaluation workflow.</td>
</tr>
</tbody>
</table>

Table 8-16: Representation for the coding of facial verification (ph-vid-eval)

The XML representation of the afore described coding can be found in Annex A: XML-Schema in sections vid_verify_face, vid_eval_face and bio_common. A mapping of all XSDs and XMLs is added to Annex B: XSD and XML mapping.

XML example coding of verification workflow

```xml
<?xml version="1.0" encoding="UTF-8"?>
<bio_ph_vid:ph-vid-verify
xmlns:bio_ph_vid="http://trbio.bsi.bund.de/1.0/bio_ph_vid"
xmlns:bio_common="http://trbio.bsi.bund.de/1.0/bio_common"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://trbio.bsi.bund.de/1.0/bio_ph_vid
vid_verify_face.xsd">
  <bio_ph_vid:Transaction>
    <bio_common:TransactionID>identifierTransaction</bio_common:TransactionID>
    <bio_common:Counter>1</bio_common:Counter>
  </bio_ph_vid:Transaction>
  <bio_ph_vid:Date>2010-01-15</bio_ph_vid:Date>
  <bio_ph_vid:Capture>
    <bio_ph_vid:Duration>P0Y0M0DT0H0M8S</bio_ph_vid:Duration>
    <bio_ph_vid:SoftwareType>
      <bio_common:identifier>id_Company_A</bio_common:identifier>
      <bio_common:name>SW_Capture_BSP</bio_common:name>
      <bio_common:version>1.5</bio_common:version>
    </bio_ph_vid:SoftwareType>
    <bio_ph_vid:HardwareType>
      <bio_common:identifier>id_Company_B</bio_common:identifier>
      <bio_common:name>HW_Scanner_1</bio_common:name>
      <bio_common:version>1.0.1</bio_common:version>
      <bio_common:firmwareversion>2.1</bio_common:firmwareversion>
    </bio_ph_vid:HardwareType>
  </bio_ph_vid:Capture>
  <bio_ph_vid:Verification>
    <bio_ph_vid:Duration>P0Y0M0DT0H0M2S</bio_ph_vid:Duration>
    <bio_ph_vid:SoftwareType>
```

Federal Office for Information Security
<bio_common:identifier>id_Company_C</bio_common:identifier>
<bio_common:name>SW_Verification_Engine</bio_common:name>
<bio_common:version>2.0</bio_common:version></bio_ph_vid:SoftwareType>
<bio_ph_vid:Threshold>25</bio_ph_vid:Threshold>
<bio_ph_vid:GenuineComparison>
  <bio_common:ComparisonScore>31</bio_common:ComparisonScore>
  <bio_common:ComparisonResult>true</bio_common:ComparisonResult>
</bio_ph_vid:GenuineComparison>
</bio_ph_vid:Verification>
<bio_ph_vid:SoftwareType>
  <bio_common:identifier>id_Company_A</bio_common:identifier>
  <bio_common:name>SW_Verification_ePass</bio_common:name>
  <bio_common:version>1.0.1</bio_common:version>
</bio_ph_vid:SoftwareType>
<bio_ph_vid:ReferenceImage>
  <bio_common:ImageType>full_frontal</bio_common:ImageType>
</bio_ph_vid:ReferenceImage>
<bio_ph_vid:DocumentInformation>
  <bio_common:DocumentType>passport</bio_common:DocumentType>
  <bio_common:IssuingState>D</bio_common:IssuingState>
</bio_ph_vid:DocumentInformation>
<bio_ph_vid:DemographicData>
  <bio_common:Gender>male</bio_common:Gender>
  <bio_common:AgeClass>30-39</bio_common:AgeClass>
  <bio_common:Nationality>D</bio_common:Nationality>
</bio_ph_vid:DemographicData>
<bio_ph_vid:ErrorCode>0</bio_ph_vid:ErrorCode>
</bio_ph_vid:ph-vid-verify>

XML example coding of evaluation workflow

<?xml version="1.0" encoding="UTF-8"?>
<bio_ph_vid:ph-vid-eval xmlns:bio_ph_vid="http://trbio.bsi.bund.de/1.0/bio_ph_vid"
xmlns:bio_common="http://trbio.bsi.bund.de/1.0/bio_common"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://trbio.bsi.bund.de/1.0/bio_ph_vid_vid_eval_face.xsd">
  <bio_ph_vid:Transaction>
    <bio_common:TransactionID>identifierTransaction</bio_common:TransactionID>
    <bio_common:Counter>1</bio_common:Counter>
  </bio_ph_vid:Transaction>
  <bio_ph_vid:QualityAssurance>
    <bio_ph_vid:Duration>P0Y0M0DT0H0M6S</bio_ph_vid:Duration>
    <bio_ph_vid:SoftwareType>
      <bio_common:identifier>id_Company_D</bio_common:identifier>
      <bio_common:name>SW_Quality_Assurance</bio_common:name>
      <bio_common:version>1.3</bio_common:version>
    </bio_ph_vid:SoftwareType>
    <bio_ph_vid:QualityResult total="false">
    </bio_ph_vid:QualityResult>
  </bio_ph_vid:QualityAssurance>
</bio_ph_vid:ph-vid-eval>
<bio_common:ComparisonResult>false</bio_common:ComparisonResult>
</bio_ph_vid:ImpostorComparison>
<bio_ph_vid:ImpostorComparison>
<Bio_common:ComparisonScore>29</Bio_common:ComparisonScore>
</bio_common:ComparisonResult>
</bio_common:ComparisonResult>
</bio_ph_vid:ImpostorComparison>
</bio_ph_vid:CrossComparison>
</bio_ph_vid:ErrorCode>0</bio_ph_vid:ErrorCode>
</bio_ph_vid:ph-vid-eval>
9 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.

9.1 O-FP-GID

This function block describes requirements to be observed by the official who handles the applicants for German identity documents in the scope of fingerprint acquisition. This includes the full working process.

Requirements

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.

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:

- The official has to ensure that there is no permutation between the finger requested for the image acquisition and the finger actually placed on the sensor.

- The official must assure that the applicant does not use any finger dummies, fakes or something similar.

- The fingers are captured flat not rolled. The official has to ensure that the core is in the centre of the capture of the fingerprint (see figure 9-1).
Operation 9

Very dry fingers which only produce poor lines, have to be moisturised (e.g. by breathing upon). Very wet fingers which produce very strong lines with sweat traces have to be dried.

Process requirements

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

The following exceptions from the regular process are allowed to the official:

▸ After an unsuccessful acquisition of a finger it is allowed to try again or to finish the process of capturing this individual fingerprint.

▸ After trying to capture two different fingers of one hand unsuccessfully it is allowed to try again or to finish the process of capturing fingerprints for this hand (compare FM P-FP-GID).

9.2 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. This includes the overall working process.

Requirements

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.
9 Operation

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

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 optical FTR fingerprint sensors (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.

▸ The fingers are captured flat not rolled. The palm shall not be lifted (as shown in figure 9-2)

▸ 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.
The finger shall be positioned centrally and straight on the fingerprint scanner. An example is given in figure 9-3.

**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).

**Process Recommendation**

A guidance poster with example images can be used for information of the person acquiring fingerprints beforehand.

**Operator training**

The operator shall be taught how to handle the acquisition and further connected processes e.g. with the help of a training video.
9 Operation

9.3 O-PH-APP

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

Requirements

Operation of Devices in case of photo taken by a photographer

When a desired scanner is put into operation, it is the operator who is responsible for a clean scanning surface so that adequate image results can be obtained in the following.

Visual Check in case of photo taken by a photographer

The applicant appears with an image that was taken by a photographer:

For the visual check the official has to consider the photo guideline (compare FM QA-PH-PG). Optionally, the official can use the photo template (compare FM QA-PH-PT).

The person on the photo has to be doubtlessly identified.

Scanning in case of photo taken by a photographer

The official should place the picture carefully and with the correct orientation into the intended place.

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 (compare FM QA-PH-PG) or photo template (compare FM QA-PH-PT).

ID Check in case of live enrolment stations

The official checks that the digital image belongs to the applicant.
9.4 O-PH-VID

This function block describes requirements to be observed by the official who handles the border control process using facial images.

Requirements

Administration and Configuration

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.

Operation of Devices

The operator is responsible for an adequate cleanliness of all capture hardware components.

Organisational Requirements

The following requirements have to be met to ensure the proper operation of the border control process:

▸ The official must assure that only one person at the time is entering the eGate for border control.

▸ The official must assure that the applicant does not use any face dummies, fakes or something similar (e.g. printed face image) for authentication.

▸ Video surveillance of the eGates has to be conducted in order to give the official the possibility to react on special incidents (e.g. passenger tries to use fakes for verification, emergency cases, ...).

Environment

The following measures of infrastructure and environment are necessary for proper operation:

▸ Capturing of face images has to be independent of external lighting sources. Different environmental lighting conditions caused by direct or indirect sunlight and different seasons of the year shall not influence the proper and uniform lighting of the captured face image.

▸ Direct and cross irradiation of lighting has to be avoided.

▸ An adequate and sufficient illumination level of the captured face image has to be guaranteed.
10 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. This encloses, among other things, functionality, quality assurance information, and veto messages.

10.1 UI-FP-APP

This function block describes requirements for the user interface for fingerprint acquisition for reference storage (e.g. in the scope of application for an Identity Document).

Requirements

Visual feedback of the fingerprint acquisition at least displaying of the final images must be provided.
If the BSP is applied in conformance test mode the normally called graphical user interface is not displayed.

Recommendations

The segmented single fingerprints shall be visualised to the operator 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.
The acquisition process can be displayed as real time feedback to the applicant (e.g. with the help of a feedback monitor).

10.2 UI-FP-VBIC

This function block describes requirements for the user interface for basic identity check of biometric visas.

Requirements

An indication of the returned verification result (e.g. green and red ticks/signs) and a live stream of the fingerprint acquisition shall be displayed to the operator.
Furthermore, the returned face image from the VIS as well as main personal data like names, date of birth, nationality and gender shall be displayed to the operator.
Recommendations

The acquisition process can be displayed as real time feedback to the person crossing the border (e.g. with the help of a feedback monitor).

10.3 UI-FP-VEIC

This function block describes requirements for the user interface for extended identity check of biometric visas.

Requirements

Visual feedback of the fingerprint acquisition, at least displaying of the final images, must be provided to the operator.

If verification is conducted, an indication of the returned verification result (e.g. green and red ticks/signs) shall be displayed to the operator.

If identification is conducted, returned information of all identified candidates shall be displayed.

Recommendations

The segmented single fingerprints shall be visualised to the operator 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.

The returned face image from the VIS as well as main personal data like names, date of birth, nationality and gender shall be displayed to the operator.

The acquisition process can be displayed as real time feedback to the applicant (e.g. with the help of a feedback monitor).

10.4 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.

Requirements

The module (Facial Image Enrolment BSP) calling the QA module and respectively the graphical user interface (GUI) have 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; in the case of NOK: declaration of rejection arguments (as line of reasoning for the official in the case of rejection)
► provision of the veto power for the official:
  a) enforcement of OK for obvious reasons (e.g. disability)
  b) enforcement of OK without obvious reasons
  option: in both cases annotation by the official and labelling in the encoded data.

If the BSP is applied in conformance test mode the normally called graphical user interface is not displayed.

### 10.5 UI-PH-VID

This function block describes requirements for the user interface for verification of facial images.

#### Requirements

Visual feedback of the verification process must be provided for the operator. At least both used images (live and reference) and the result of the verification have to be displayed to the operator.

#### Recommendations

A mirrored image of the captured live image shall be displayed to the travelling passenger. An indicator showing the result (good/bad) of the prequalification check shall be shown to the passenger, too.

Furthermore, information about the successful or failed verification process should be displayed in appropriate manner. Green ticks or green frames around the captured live image could mark a successful verification whereas red ticks or red frames could mark a failed verification.
11 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.

11.1 REF-FP-GID

This function block describes requirements how fingerprint images are stored as reference data.

Requirements

According to the ICAO document Doc 9303 the data is put on the chip.

11.2 REF-FP-VAPP

This function block describes requirements how fingerprint images are stored as reference data.

Requirements

According to VIS specification the fingerprint data is stored respectively.

11.3 REF-PH-GID

This function block describes requirements how facial images are stored as reference data.

Requirements

According to the ICAO document Doc 9303 the data is put on the chip.

11.4 REF-PH-VAPP

This function block describes requirements how facial images are stored as reference data.

Requirements

According to VIS specification the facial image data is stored respectively.
12 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, ...).

12.1 CMP-FP-VIC

This function block contains requirements for the verification and identification used within identity checks against the European BMS VIS.

Requirements

Verification and/or identification is conducted by the BMS of the European VIS.

12.2 CMP-PH-VID

This function block contains requirements for the verification of an identity in relation to a stored reference facial image.

Requirements

A face recognition algorithm has to be used to verify the identity of the document holder by comparing the captured live face image with the reference image loaded from the identity document.

The face recognition algorithm has to be configured at a security level (threshold) guaranteeing a maximum false match rate (FMR) of at least 0.1 % (1:1000) and a false non-match rate (FNMR) below 5 %. 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 captured live image and the reference image loaded from the identity document. Output of the algorithm are a comparison score and the result of the verification depending on the chosen security level (threshold) of the algorithm.
13 Logging

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

13.1 LOG-FP-GID

This function block describes the requirements for the logging of fingerprint quality information data used within application for German Identity Documents.

Requirements

Central reference algorithms

For the assessment of the potential capability of the complete biometric system comparison scores based on the biometric data are generated with a reference matching algorithm. Comparisons of fingerprints of not identical fingers are calculated. For that purpose, the following procedure has to be applied by the document producer:

1. The fingerprint images of the last 10 passport applications are saved anonymously in a dynamic list.
2. A fingerprint from the next new application is compared against the other fingerprints in the list and the comparison score is saved.
3. The fingerprint is added to the dynamic list.
4. The oldest fingerprint in the list is discarded.

As the reference comparison algorithm Bozorth3 from the NIST NFIS2 [NFIS]or NIST NBIS release 3.2.0 package [NBIS] shall be used. Alternative or additional reference algorithms (comparators or quality algorithms) may be defined by the technical responsible authority.

The identifiers according to table 13-1 shall be used for the acquired data (in analogy to table 8-11).
## 13 Logging

<table>
<thead>
<tr>
<th>ID</th>
<th>Criterion</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.1</td>
<td>First comparison score against the list</td>
</tr>
<tr>
<td>9.2</td>
<td>Second comparison score against the list</td>
</tr>
<tr>
<td>9.3</td>
<td>Third comparison score against the list</td>
</tr>
<tr>
<td>9.4</td>
<td>Fourth comparison score against the list</td>
</tr>
<tr>
<td>9.5</td>
<td>Fifth comparison score against the list</td>
</tr>
<tr>
<td>9.6</td>
<td>Sixth comparison score against the list</td>
</tr>
<tr>
<td>9.7</td>
<td>Seventh comparison score against the list</td>
</tr>
<tr>
<td>9.8</td>
<td>Eighth comparison score against the list</td>
</tr>
<tr>
<td>9.9</td>
<td>Ninth comparison score against the list</td>
</tr>
<tr>
<td>9.10</td>
<td>Tenth comparison score against the list</td>
</tr>
</tbody>
</table>

**Table 13-1: Identifiers for the reference quality data**

The following data has to be collected and added to the central statistics as described below:

- Authority identification number (corresponding to the new fingerprint record)
- Default quality information, which means results from the reference comparison algorithm with identifiers and bounds, corresponding version and component information as described above
- Additional quality information from additional / alternative quality or comparison algorithms if applicable

**Collection of data for the central statistics**

The document producer is responsible for the data collection for the central statistics.

The following data has to be collected from each application:

- Authority identification number
- All quality information from the application according to FM COD-FP-GID, in particular
  - Summarised result of the quality evaluation
  - Quality values with identifiers and upper/lower maximal bounds and threshold bounds
  - Vendor / component information and version numbers
  - Hardware information
  - Time stamps
  - Notes

Additionally, the data of the reference algorithms, as described above, shall be stored in the central statistics.
The storage scheme shall be devised by the given types of the corresponding XML encoding, it shall be able to reproduce the complete content of the originally received „xinfo-fp-gid“.

Export of data from the central statistics

As an export format, the given „xinfo-fp-gid“ record structure, according to FM COD-FP-GID, sorted by authority identification number, shall be used.

Omission of person-related data

No person-related data is saved for QA statistics, this means the biometric data itself and the optional hashes as described in FM COD-FP-GID.

Storage duration and deletion of data from the central statistics

The data of the central statistics have to be stored for a duration of 36 months. Data of the central statistics, which are older than 36 months, have to be deleted monthly.

13.2 LOG-FP-VAPP

This function block describes requirements and interfaces for the logging of additional (quality) information regarding fingerprints in conjunction with application for biometric visas.

Requirements

The Biometric Evaluation Authority is responsible for the collection of data for the central statistics. The application office is responsible for one part of the data collection for later central statistics:

- Quality information from the application according to FM COD-FP-VIS
  - Transaction ID
  - Date of acquisition
  - Duration of biometric acquisition process (optional)
  - Number of capture counts (optional)
  - Number of successful captures
  - Local quality values for all captured fingerprints including information about the vendor, the software name, the version and an overall quality value
  - Uniqueness check results (if check was performed) including information about the used software and the uniqueness information of the captured data (optional)
  - Information about segmentation errors (optional)
  - Size of the VIS-ANSI/NIST message
13 Logging

- Comments given by the application office (optional)
- Status of the enrolment (i.e. test mode or real operation)
- Error code (optional)
- Information about the Originating Agency Identifier (ORI)
- Hardware type of enrolment hardware
- Software type of enrolment software
- Demographic data (optional specification of gender and age class)
- Auxiliary information (optional)

If possible, the National Central Authority shall compute values which are forwarded to the Biometric Evaluation Authority:

- Values computed by a central authority regarding quality information from the application according to FM COD-FP-VIS (optional)

13.3 LOG-FP-VIC

This function block contains requirements for the logging of quality information regarding the identity check process of biometric visas.

Requirements

The border control office is responsible for data collection for later central statistics. Each workflow of the overall border control process creates its own log file whereas the components of each workflow are responsible for gathering the required information. Function Module COD-FP-VIS describes how logging data is encoded.

Authentication workflow logging data

General logging data

Within the authentication workflow following data needs to be collected for evaluation and monitoring purposes:

- An unique transaction identifier of the current authentication process (distinguishable for every authentication try during the whole border control process)
- Date of the authentication process
- Information about the software used
- Test flag indicating if border control try was a test or not
- Originating Agency Identifier (ORI) representing the location of the border control process
- Demographic data of the document holder (gender, age class and nationality)
- Error code (optional)
 Auxiliary information or data (optional)

**Logging data of the capture process**

If basic identity check is conducted, within the Capture BSP of the authentication workflow (see Function Module P-FP-VBIC) the following information has to be collected:

- Duration of capturing live images (optional)
- Information about the software used for capturing
- Information about the hardware used for capturing
- Information about all captured fingers used for verification
- Size of the encoded container which is sent to the VIS for verification
- Error code of the capture process (optional)
- Auxiliary information or data of the capture process (optional)

If extended identity check is conducted, within the Capture BSP of the authentication workflow (see Function Module P-FP-VEIC) the following information has to be collected:

- Duration of capturing live images (optional)
- Information about the software used for capturing
- Information about the hardware used for capturing
- Amount of slaps and single fingers captured during the acquisition process
- Capture success indicating the successful capturing depending on local quality assurance
- Local quality information of all captured live fingers
- Size of the encoded container which is sent to the VIS for verification/identification
- Error code of the capture process (optional)
- Auxiliary information or data of the capture process (optional)

**Logging data of the verification process**

Within the authentication workflow (see Function Modules P-FP-VBIC and P-FP-VEIC) following information has to be collected for verification, if conducted:

- Duration of the verification (optional)
- Result of the verification
- Error code of the verification process (optional)
- Auxiliary information or data of the verification process (optional)

**Logging data of the identification process**

Within the authentication workflow (see Function Module P-FP-VEIC) following information has to be collected for identification, if conducted:

- Duration of the identification (optional)
- Result of the identification (found candidates)
13 Logging

- Error code of the identification process (optional)
- Auxiliary information or data of the identification process (optional)

**Evaluation workflow logging data**

**General logging data**

Within the evaluation workflow following data needs to be collected:

- An unique transaction identifier of the current authentication process (distinguishable for every authentication try during the whole border control process)\(^{11}\)
- Date of the acquisition
- Error code (optional)
- Auxiliary information or data (optional)

**Quality analysis results**

The following information has to be logged for evaluation purposes:

- Duration of the quality assurance check (optional)
- Information about the software used for quality analysis
- Obtained results of the quality check
- Error code of the quality assurance process (optional)
- Auxiliary information or data of the quality assurance process (optional)

**13.4 LOG-PH-GID**

This function block describes the best practice for the logging of photo quality information data used during application for German Identity Documents.

**Requirements**

**Central reference algorithms**

For the assessment of the photo quality information data, the document producer shall apply a central reference quality algorithm to all incoming photos (as described in FM QA-PH-SB). Alternative or additional reference algorithms (comparators or quality algorithms) may be defined by the technical responsible authority.

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\(^{11}\) This unique transaction identifier has to be equal to the unique transaction identifier of the authentication workflow. Later linking of results of the authentication and evaluation workflow for evaluation is ensured by this common unique transaction identifier.
The output of the quality algorithm shall be encoded in XML according to the „xinfo-ph-gid“ record structure as defined in FM COD-PH-GID.

The following data has to be collected and added to the central statistics as described below:

▸ Authority identification number (corresponding to the new photo record)
▸ quality information, which means results from the quality algorithm with identifiers and bounds, corresponding version and component information
▸ additional quality information from additional / alternative quality algorithms if applicable

### Collection of data for the central statistics

The document producer is responsible for the data collection for the central statistics.

The following data has to be collected from each application:

▸ Authority identification number
▸ all quality information from the application according to FM COD-PH-GID, in particular
   ▸ summarised result of the quality evaluation
   ▸ quality values with identifiers and upper/lower maximal bounds and threshold bounds
   ▸ vendor / component information and version numbers
   ▸ hardware information
   ▸ time stamps
   ▸ notes

Additionally, the data of the reference algorithms, as described above, shall be stored in the central statistics.

The storage scheme shall be devised by the given types of the corresponding XML encoding, it shall be able to reproduce the complete content of the originally received „xinfo-ph-gid“.

### Export of data from the central statistics

As an export format, the given „xinfo-ph-gid“ record structure, according to FM COD-PH-GID, sorted by authority identification number, shall be used.

### Omission of person-related data

No person-related data is saved for QA statistics, this means the biometric data itself and the optional hashes as described in FM COD-PH-GID.
Storage duration and deletion of data from the central statistics

The data of the central statistics have to be stored for a duration of 36 months. Data of the central statistics, which are older than 36 months, have to be deleted monthly.

13.5 LOG-PH-VAPP

This function block describes requirements and interfaces for the logging of additional (quality) information regarding facial images in conjunction with application for biometric visas.

Requirements
Biometric Evaluation Authority is responsible for the collection of data for the central statistics.
The application office is responsible for data collection for later central statistics:

▸ quality information from the application according to FM COD-PH-VAPP
  ▶ transaction ID
  ▶ summarised result of the quality evaluation
  ▶ quality values with identifiers and upper/lower maximal bounds and thresholds bounds
  ▶ vendor / component information and version numbers
  ▶ hardware information
  ▶ date of acquisition
  ▶ duration of acquisition process
  ▶ Orignating Agency Identifier (ORI)
  ▶ image format of stored face image
  ▶ error codes (if errors occurred)
  ▶ notes
  ▶ auxiliary data (optional)

13.6 LOG-PH-VID

This function block contains requirements for the logging of information regarding the verification process.

Requirements

The border control office is responsible for data collection for later central statistics. Each workflow of the overall border control process creates its own log file whereas the components of each workflow are responsible for gathering the required information. Function Module COD-PH-VID describes how logging data is encoded.
Verification workflow logging data

General logging data
Within the verification workflow following data needs to be collected for evaluation and monitoring purposes:

▸ An unique transaction identifier of the current verification process (distinguishable for every verification try during the whole border control process)
▸ Date of the verification process
▸ Information about the software used
▸ Information about the loaded reference image (image type and image format)
▸ Information about the read document (document type and issuing state)
▸ Demographic data of the document holder (gender, age class and nationality)
▸ Error code (optional)
▸ Auxiliary information or data (optional)

Logging data of the capture process
Within the Capture BSP of the verification workflow (see Function Module P-PH-VID) following information has to be collected:

▸ Duration of capturing live images (optional)
▸ Information about the software used for capturing
▸ Information about the hardware used for capturing
▸ Error code of the capture process (optional)
▸ Auxiliary information or data of the capture process (optional)

Logging data of the verification process
Within the Verification Engine BSP of the verification workflow (see Function Module P-PH-VID) following information has to be collected:

▸ Duration of the verification (optional)
▸ Information about the software used for verification
▸ Configured threshold of the verification software
▸ Results of the genuine comparison (result and score)
▸ Error code of the verification process (optional)
▸ Auxiliary information or data of the verification process (optional)
Evaluation workflow logging data

General logging data
Within the evaluation workflow following data needs to be collected:

▸ An unique transaction identifier of the current verification process (distinguishable for every verification try during the whole border control process)\(^\text{12}\)
▸ Error code (optional)
▸ Auxiliary information or data (optional)

Quality analysis results
The following information has to be logged for evaluation purposes:

▸ Duration of the quality assurance check (optional)
▸ Information about the software used for quality analysis
▸ Obtained results of the quality check
▸ Information of the image source used for quality assurance (live or reference image)
▸ Error code of the quality assurance process (optional)
▸ Auxiliary information or data of the quality assurance process (optional)

Cross-comparison results
Following information has to be logged during cross-comparison:

▸ Duration of the cross-comparison process (optional)
▸ Information about the software used for cross-comparison
▸ Configured threshold of the verification software
▸ Results and scores obtained from genuine and impostor comparisons
▸ Error code of the cross-comparison process (optional)
▸ Auxiliary information or data of the cross-comparison process (optional)

\(^\text{12}\) This unique transaction identifier has to be equal to the unique transaction identifier of the verification workflow. Later linking of results of the verification and evaluation workflow for evaluation is ensured by this common unique transaction identifier.
14 Evaluation

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

14.1 EVA-FP-GID

This Function Module describes requirements on evaluation of fingerprint quality in conjunction with the application for German Identity Documents.

Requirements

The document producer shall run the following evaluations on the data collected in the central statistics according to LOG-FP-GID. All evaluations have to be executed separately for each document type. All evaluations shall show the results numerically and graphically, if applicable.

Based on the collected data for following evaluations it shall be possible to perform each evaluation based on applied filtering. Filtering shall be possible at least with regard to a selected time-frame (e.g. only applications from year 2009) of the acquisition process.

Quality evaluations

**EVA-FP-GID.1: Finger records in applications**

All results of the quality assurance software according to QA-FP-GID from all applications shall be used to show the percentage of

- number for records containing quality data of two fingerprints
- number for records containing quality data of one fingerprint
- number for records containing quality data of zero fingerprints

Table 14-1: Evaluation EVA-FP-GID.1

**EVA-FP-GID.2: Total fingerprint quality**

All total results of the quality assurance software according to QA-FP-GID from all applications shall be used to show the percentage of records of combinations of total results (for two finger records respectively one finger record):

(true/true), (true/false), (false/false), (true), (false)

Table 14-2: Evaluation EVA-FP-GID.2

**EVA-FP-GID.3: NFIQ quality distribution**

All results of the quality assurance software according to QA-FP-GID from all applications shall be used to show the distribution of quality values for all chosen fingerprints (which means the
result value $Q(A_i)$ of criterion 2.X where X is the result value of criterion 1.1, compare QA-FP-GID for details).

Table 14-3: Evaluation EVA-FP-GID.3

**EVA-FP-GID.4: Standard enrolment case**

All results of the quality assurance software according to QA-FP-GID from all applications shall be used to show the percentage of applications where the left and right index finger were chosen in the enrolment process (finger codes 2 and 7) and the percentage of the other cases.

Table 14-4: Evaluation EVA-FP-GID.4

**EVA-FP-GID.5: Distribution in capture series**

All results of the quality assurance software according to QA-FP-GID from all applications shall be used to show the percentage of applications where the

- the first
- the second
- the third

image in the capture series was chosen (as given in criterion 1.1).

Table 14-5: Evaluation EVA-FP-GID.5

### 14.2 EVA-FP-VAPP

This Function Module describes requirements on evaluation of fingerprint quality in conjunction with application for biometric visas.

#### Requirements

Evaluations can be accomplished based on the logging data that is collected at the Application Offices and furthermore logging data that is collected in the central statistics according to FM LOG-FP-VAPP. All evaluations shall show the results numerically and graphically, if applicable.

Based on the data that is collected within the Application Offices for following evaluations it shall be possible to perform each evaluation based on applied filtering. Filtering shall be possible with regard to a selected time-frame (e.g. only applications from year 2009) and/or ORI values (e.g. only applications issued in Ulan Bator if ORI is DE/ULAN) of the acquisition process.

#### Local quality evaluations

**EVA-FP-VAPP.1: Local quality value distribution**

All results of the locally performed quality assurance using the applied local quality mechanism should be used to show a distribution of all available single finger quality values. Optionally, if
available the same distribution shall be conducted for the overall quality value.

Table 14-6: Evaluation EVA-FP-VAPP.1

### Error code evaluations

The following evaluations can only be conducted if error code information is available.

**EVA-FP-VAPP.2: Error reasons from the local acquisition process**

This evaluation shows the percentage of all error codes that have occurred during the local acquisition process and have been encoded and logged according to FM COD-FP-VIS and FM LOG-FP-VAPP.

Table 14-7: Evaluation EVA-FP-VAPP.2

### Timing evaluations

The following evaluations can only be conducted if timing information is available.

**EVA-FP-VAPP.3: Average enrolment duration**

The evaluation shows the average time in seconds needed to enrol applicants. This information can be obtained from the encoded and logged duration according to FM COD-FP-VIS and FM LOG-FP-VAPP.

Table 14-8: Evaluation EVA-FP-VAPP.3

**EVA-FP-VAPP.4: Distribution of enrolment duration**

The evaluation shows the percentage of enrolments that were completed within a given time frame of 1, 2, 3, 4, 5, or more minutes.

Table 14-9: Evaluation EVA-FP-VAPP.4

**EVA-FP-VAPP.5: Cumulative representation of enrolment duration**

The evaluation shows a cumulative representation of enrolments that were completed within a given time frame of at least 5 minutes. Cumulative values should be calculated in an interval of 10 seconds.

Table 14-10: Evaluation EVA-FP-VAPP.5

**EVA-FP-VAPP.6: Developments of average enrolment duration over time**

The evaluation shows developments of the average enrolment duration over time. For every month, the average enrolment duration shall be obtained from logged information according to FM COD-FP-VIS and FM LOG-FP-VAPP.
Uniqueness check evaluations

The following evaluations can only be conducted if uniqueness check information is available.

**EVA-FP-VAPP.7: Distribution of uniqueness check results**

The evaluation shows the percentage of unique and non-unique containers according to logged information of FM COD-FP-VIS and FM LOG-FP-VAPP.

Central quality evaluations

Based on the central quality values described in FM LOG-FP-VAPP the following evaluations can be performed if logging information is available.

**EVA-FP-VAPP.8: Central quality value distribution**

All results of the central quality assurance should be used to show a distribution of all available single finger quality values. Additionally, if available the same distribution shall be conducted for the overall quality value. This evaluation shows the percentage of fingerprint records rejected by the central quality check as well as distribution of rejection rate of all single fingers.

**EVA-FP-VAPP.9: Correlation between local and central quality of fingerprints**

The evaluation shows the correlation between the results of the local and central quality values in percentage. Additionally, for every possible local quality value (or local quality value groups if too much values are available) the central rejection rate can be computed to show the rejection rate in dependency of the local quality assurance.

**EVA-FP-VAPP.10: Developments of central rejection rate over time**

The evaluation shows developments of the central rejection rate over time. For every month, the central rejection rate shall be obtained from logged information according to FM COD-FP-VIS and FM LOG-FP-VAPP.

Demographic data evaluations

The following evaluations can only be conducted if demographic data is available.
**EVA-FP-VAPP.11: Distribution of gender**

The evaluation shows the percentage of male, female and unknown gender.

*Table 14-16: Evaluation EVA-FP-VAPP.11*

**EVA-FP-VAPP.12: Distribution of age group**

The evaluation shows the percentage of all age groups (0-9, 10-19, 20-20, ...) that have occurred within the acquisition process.

*Table 14-17: Evaluation EVA-FP-VAPP.12*

**Capture counts evaluations**

The following evaluations can only be conducted if capture counts information is available.

**EVA-FP-VAPP.13: Distribution of slap capture counts**

The evaluation shows the distribution of the amount of slaps captured during the acquisition process. Separate statistics for right slap, left slap and thumbs slap shall be made.

*Table 14-18: Evaluation EVA-FP-VAPP.13*

**EVA-FP-VAPP.14: Distribution of single finger capture counts**

The evaluation shows the distribution of the amount of single fingers captured during the acquisition process.

*Table 14-19: Evaluation EVA-FP-VAPP.14*

### 14.3 EVA-FP-VIC

This function block contains requirements for the evaluation of quality information regarding the identity check of biometric visas.

**Requirements**

Evaluations can be accomplished based on the logging data that is collected at the Border Control Stations and furthermore logging data that is collected during the evaluation workflow according to Function Modules P-FP-VBIC, P-FP-VEIC, COD-FP-VIS and LOG-FP-VIC. All evaluations shall show the results numerically and graphically, if applicable.

Based on the data that is collected for following evaluations it shall be possible to perform each evaluation based on applied filtering. Filtering shall be possible with regard to a selected time-frame (e.g. only verifications from year 2009) and/or the Originating Agency Identifier (ORI) of the border control location (e.g. all verifications that were conducted at Frankfurt airport in Germany).
Biometric performance

**EVA-FP-VIC.1: Verification results**

All results of the verification process shall be used to calculate the percentage of verified and non-verified passengers. Differences between verifications conducted during basic identity check and extended identity check shall be evaluated and displayed, too.

*Table 14-20: Evaluation EVA-FP-VIC.1*

**EVA-FP-VIC.2: Correlation between live fingers and verification rate**

All results of the verification process shall be used to calculate the verification rate in dependency of the used fingers for verification. It is also possible to calculate and display the verification rate depending on the quality value of the live fingerprint data (only possible if results of the evaluation process are already available). Displaying the verification rate of more than 10 different quality values shall be avoided by forming groups of quality intervals for better structure of diagrams.

*Table 14-21: Evaluation EVA-FP-VIC.2*

The following evaluation can only be conducted for data gathered during extended identity check.

**EVA-FP-VIC.3: Identification results**

Identification tries might be rejected due to lack of fingerprint quality. The percentage of all rejected and accepted identification tries shall be calculated and displayed. Furthermore, the distribution of the number of candidates returned by the BMS shall be evaluated.

*Table 14-22: Evaluation EVA-FP-VIC.3*

**Error code evaluations**

The following evaluations can only be conducted if error code information is available.

**EVA-FP-VIC.4: Error reasons from the verification process**

This evaluation shows the percentage of all error codes that have occurred during the authentication processes and have been encoded and logged.

*Table 14-23: Evaluation EVA-FP-VIC.4*

**Quality evaluations**

The following evaluation can only be conducted if results of the evaluation process are already available.

**EVA-FP-VIC.5: Distribution of quality values**

All results of the performed quality assurance within the evaluation process should be used to
show a distribution of all obtained and available quality values.

Table 14-24: Evaluation EVA-FP-VIC.5

The following evaluation can only be conducted for data gathered during extended identity check.

**EVA-FP-VIC.6: Local quality value distribution**

All results of the locally performed quality assurance of the extended identity check using the applied local quality mechanism should be used to show a distribution of all available single finger quality values. Optionally, if available the same distribution shall be conducted for the overall quality value.

Table 14-25: Evaluation EVA-FP-VIC.6

**Timing evaluations**

The following evaluations can only be conducted if timing information is available.

**EVA-FP-VIC.7: Average authentication process duration**

The evaluation shows the average time in seconds needed to authenticate a holder of an identity document. Furthermore, it is interesting to show the differences in average capture, net verification time and net identification time. Differences between basic and extended identity check shall be obtained, too.

Table 14-26: Evaluation EVA-FP-VIC.7

**EVA-FP-VIC.8: Distribution of authentication attempts per transaction**

The evaluation shows the distribution of authentication attempts needed to pass the border control.

Table 14-27: Evaluation EVA-FP-VIC.8

**EVA-FP-VIC.9: Cumulative representation of basic identity check duration**

The evaluation shows a cumulative representation of verifications that were completed within a given time frame of at least 30 seconds. A cumulative representation of the complete basic identity check duration shall be added, too.

Table 14-28: Evaluation EVA-FP-VIC.9

**EVA-FP-VIC.10: Developments of average basic identity check duration over time**

The evaluation shows developments of the average verification duration over time. For every month, the average verification duration shall be obtained from logged information. An evaluation of the development of the average basic identity check duration shall be added, too.

Table 14-29: Evaluation EVA-FP-VIC.10

The following evaluations can only be conducted for data gathered during extended identity check.
**EVA-FP-VIC.11: Cumulative representation of extended identity check duration**

The evaluation shows a cumulative representation of identifications that were completed within a given time frame of at least 5 minutes. A cumulative representation of the complete extended identity check duration shall be added, too.

*Table 14-30: Evaluation EVA-FP-VIC.11*

**EVA-FP-VIC.12: Developments of average extended identity check duration over time**

The evaluation shows developments of the average identification duration over time. For every month, the average identification duration shall be obtained from logged information. Additionally, an evaluation of the development of the average extended identity check duration shall be added.

*Table 14-31: Evaluation EVA-FP-VIC.12*

### Demographic data evaluations

The following evaluations can only be conducted if demographic data is available.

**EVA-FP-VIC.13: Distribution of gender**

The evaluation shows the percentage of male, female and unknown gender.

*Table 14-32: Evaluation EVA-FP-VIC.13*

**EVA-FP-VIC.14: Distribution of age group**

The evaluation shows the percentage of all age groups (0-9, 10-19, 20-20, ...) that have occurred within the authentication process.

*Table 14-33: Evaluation EVA-FP-VIC.14*

The following evaluation can only be conducted if information about the nationality is available.

**EVA-FP-VIC.15: Distribution of nationalities**

The evaluation shows the percentage of all appeared nationalities.

*Table 14-34: Evaluation EVA-FP-VIC.15*

### 14.4 EVA-PH-GID

This Function Module describes the requirements on evaluations of photo quality in conjunction with application for German Identity Documents.
Requirements

The document producer shall run the following evaluations on the data collected in the central statistics according to FM LOG-PH-GID. All evaluations have to be executed separately for each document type. All evaluations shall show the results numerically and graphically, if applicable.

Based on the collected data for following evaluations it shall be possible to perform each evaluation based on applied filtering. Filtering shall be possible at least with regard to a selected time-frame (e.g. only applications from year 2009) of the acquisition process.

Quality evaluations

**EVA-PH-GID.1: Total results of the decentral quality assurance software**

This evaluation shows the percentage of all total results of the decentral quality assurance software according to FM QA-PH-SB (consisting of „true“/„false“ for each application).

Table 14-35: Evaluation EVA-PH-GID.1

**EVA-PH-GID.2-0\(^\text{13}\): Total results of the central reference quality assurance algorithm**

All total results of the central reference quality assurance algorithm according to LOG-PH-GID (consisting of „true“/„false“ for each application) shall be used to show the percentage of the different results from the central reference quality assurance software from all applications.

Table 14-36: Evaluation EVA-PH-GID.2-0

**EVA-PH-GID.3: Highest percentage of images of insufficient quality**

All total results of the quality assurance software according to FM QA-PH-SB (consisting of „true“/„false“ for each application) shall be used to show the highest percentage of images of insufficient quality. This includes

- the authority key identifier (with corresponding name)
- the number of images from this authority
- the percentage of images with total result „false“

where this percentage is maximal. The topmost three authorities fulfilling these criteria shall be listed. Authorities with a number of images less than 20 shall not be considered.

Table 14-37: Evaluation EVA-PH-GID.3

**EVA-PH-GID.4: Error reasons from decentral quality assurance software**

All results of the quality assurance software according to FM QA-PH-SB from all applications

\(^\text{13}\) If additional reference quality assurance algorithms are in use, corresponding evaluations (named EVA-PH-GID.2-1 etc.) shall be performed.
14 Evaluation

(consisting of quintuples \((id,m,M,t,T)\) and the corresponding value \(x\) for each application) shall be used to show for each id:

- \(id\) (and textual representation)
- percentage of images where the relation \(t \leq x \leq T\) does not hold

Table 14-38: Evaluation EVA-PH-GID.4

\textbf{EVA-PH-GID.5-0}^{14}: Error reasons from central reference quality assurance software

All results of the central reference assurance software according to FM QA-PH-SB from all applications (consisting of quintuples \((id,m,M,t,T)\) and the corresponding value \(x\) for each application) shall be used to show for each id:

- \(id\) (and textual representation)
- percentage of images where the relation \(t \leq x \leq T\) does not hold

Table 14-39: Evaluation EVA-PH-GID.5-0

14.5 EVA-PH-VAPP

This Function Module describes the requirements on evaluations of photo quality in conjunction with application for biometric visas.

Requirements

The Biometric Evaluation Authority shall run the following evaluations on the data collected within FM LOG-PH-VAPP. All evaluations shall show the results numerically and graphically, if applicable.

Based on the data that is collected within the Application Offices for following evaluations it shall be possible to perform each evaluation based on applied filtering. Filtering shall be possible at least with regard to a selected time-frame (e.g. only applications from year 2009) of the acquisition process.

Quality evaluations

The following evaluations can only be conducted if a QA tool is present.

\textbf{EVA-PH-VAPP.1}: Total results of the decentral quality assurance software

This evaluation shows the percentage of all total results of the decentral quality assurance software according to FM QA-PH-SB(consisting of „true“, „false“ for each application).

Table 14-40: Evaluation EVA-PH-VAPP.1

\footnote{14 If additional reference quality assurance algorithms are in use, corresponding evaluations (named EVA-PH-GID.5-1 etc.) shall be performed.}
**EVA-PH-VAPP.2: Highest percentage of images of insufficient quality**

All total results of the quality assurance software according to FM QA-PH-SB (consisting of „true“/„false“ for each application) shall be used to show the highest percentage of images of insufficient quality. This includes

▸ the Originating Agency Identifier (Country and City of the Agency)
▸ the number of images from this agency
▸ the percentage of images with total result „false“

where this percentage is maximal. The topmost three agencies fulfilling these criteria shall be listed. Agencies with a number of images less than 20 shall not be considered.

*Table 14-41: Evaluation EVA-PH-VAPP.2*

**EVA-PH-VAPP.3: Error reasons from decentral quality assurance software**

All results of the quality assurance software according to FM QA-PH-SB from all applications (consisting of quintuples (id,m,M,t,T) and the corresponding value x for each application) shall be used to show for each id:

▸ id (and textual representation)
▸ percentage of images where the relation $t \leq x \leq T$ does not hold

*Table 14-42: Evaluation EVA-PH-VAPP.3*

### 14.6 EVA-PH-VID

This function block contains requirements for the evaluation of information regarding the verification process of facial images.

**Requirements**

Evaluations can be accomplished based on the logging data that is collected at the Border Control Stations and furthermore logging data that is collected during the evaluation workflow according to Function Modules P-PH-VID and LOG-PH-VID. All evaluations shall show the results numerically and graphically, if applicable.

Based on the data that is collected for following evaluations it shall be possible to perform each evaluation based on applied filtering. Filtering shall be possible with regard to a selected time-frame (e.g. only verifications from year 2009) and/or the issuing state of the ePassport or identity card (e.g. only verifications of German passports).
Biometric performance

**EVA-PH-VID.1: Detection error trade-off (DET) curve**

All results of the cross-comparison conducted within the evaluation workflow may be used for generating False Accept Rates (FAR) and False Reject Rates (FRR). It has to be noted that due to the fact of multiple possible verifications within the whole verification process not all live images have to be used for calculating error rates. The FAR and FRR have to be calculated by using the best result within in the verification process (transactions).

*Table 14-43: Evaluation EVA-PH-VID.1*

**EVA-PH-VID.2: Influence of image quality on biometric performance**

All results of the quality assurance and cross-comparison conducted within the evaluation workflow may be used for generating False Accept Rates (FAR) and False Reject Rates (FRR). Two different sets of images shall be generated. Set one consists of images with good quality, set two consists of images of bad quality. Afterwards, the biometric performance is calculated for both sets. Results may then be used to determine the influence of image quality on biometric performance.

*Table 14-44: Evaluation EVA-PH-VID.2*

Error code evaluations

The following evaluations can only be conducted if error code information is available.

**EVA-PH-VID.3: Error reasons from the local acquisition process**

This evaluation shows the percentage of all error codes that have occurred during the local acquisition process and have been encoded and logged.

*Table 14-45: Evaluation EVA-PH-VID.3*

Quality evaluations

**EVA-PH-VID.4: Distribution of quality values**

All results of the performed quality assurance should be used to show a distribution of all available criterion and quality factors.

*Table 14-46: Evaluation EVA-PH-VID.4*

Timing evaluations

The following evaluations can only be conducted if timing information is available.
**EVA-PH-VID.5: Average verification process duration**

The evaluation shows the average time in seconds needed to verify a holder of an identity document. Furthermore, it is interesting to show the differences in average capture and verification time.

Table 14-47: Evaluation EVA-PH-VID.5

**EVA-PH-VID.6: Distribution of verification attempts per transaction**

The evaluation shows the distribution of verification attempts needed to pass the border control successfully or until the timeout is reached. In this context, it also interesting to see the number of verification attempts needed for successful and failed verification. Optionally, this evaluation can be displayed as a cumulative representation of verification attempts needed per transaction.

Table 14-48: Evaluation EVA-PH-VID.6

**EVA-PH-VID.7: Cumulative representation of verification duration**

The evaluation shows a cumulative representation of verifications that were completed within a given time frame of at least 15 seconds. Cumulative values should be calculated in an interval of one second.

Table 14-49: Evaluation EVA-PH-VID.7

**EVA-PH-VID.8: Developments of average verification duration over time**

The evaluation shows developments of the average verification duration over time. For every month, the average verification duration shall be obtained from logged information.

Table 14-50: Evaluation EVA-PH-VID.8

**Issuing states evaluations**

The following evaluations can only be conducted if information about issuing states is available.

**EVA-PH-VID.9: Distribution of issuing states**

The evaluation shows the distribution of all issuing states occurred during verification of ePassports and identity cards.

Table 14-51: Evaluation EVA-PH-VID.9

**Demographic data evaluations**

The following evaluations can only be conducted if demographic data is available.

**EVA-PH-VID.10: Distribution of gender**
The evaluation shows the percentage of male, female and unknown gender.

Table 14-52: Evaluation EVA-PH-VID.10

**EVA-PH-VID.11: Distribution of age group**

The evaluation shows the percentage of all age groups (0-9, 10-19, 20-29, ...) that have occurred within the verification process.

Table 14-53: Evaluation EVA-PH-VID.11
# List of Abbreviations

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<th>Abbreviation</th>
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<td>ACQ</td>
<td>Acquisition</td>
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<tr>
<td>AD</td>
<td>Acquisition Device</td>
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<td>AFIS</td>
<td>Automated Fingerprint Identification System</td>
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<td>Application</td>
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</tr>
<tr>
<td>FBS</td>
<td>Flat bed scanner</td>
</tr>
<tr>
<td>FM</td>
<td>Function Module</td>
</tr>
<tr>
<td>FP</td>
<td>Fingerprint</td>
</tr>
<tr>
<td>FTR</td>
<td>Frustrated total reflection</td>
</tr>
<tr>
<td>GID</td>
<td>German Identity Document</td>
</tr>
<tr>
<td>ID</td>
<td>Identity</td>
</tr>
<tr>
<td>JPG</td>
<td>JPEG</td>
</tr>
<tr>
<td>JP2</td>
<td>JPEG 2000</td>
</tr>
<tr>
<td>LOG</td>
<td>Logging</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Description</td>
</tr>
<tr>
<td>--------------</td>
<td>-------------</td>
</tr>
<tr>
<td>O</td>
<td>Operation</td>
</tr>
<tr>
<td>P</td>
<td>Process</td>
</tr>
<tr>
<td>PG</td>
<td>Photo Guideline (&quot;Fotomustertafel&quot;)</td>
</tr>
<tr>
<td>PH</td>
<td>Photo</td>
</tr>
<tr>
<td>PT</td>
<td>Photo Template (&quot;Lichtbildschablone&quot;)</td>
</tr>
<tr>
<td>QA</td>
<td>Quality Assurance</td>
</tr>
<tr>
<td>REF</td>
<td>Reference Storage</td>
</tr>
<tr>
<td>SB</td>
<td>Software based</td>
</tr>
<tr>
<td>UI</td>
<td>User Interface</td>
</tr>
<tr>
<td>VAPP</td>
<td>Visa Application</td>
</tr>
<tr>
<td>VBIC</td>
<td>Visa Basic Identity Check</td>
</tr>
<tr>
<td>VEIC</td>
<td>Visa Extended Identity Check</td>
</tr>
<tr>
<td>VIC</td>
<td>Visa Identity Check</td>
</tr>
<tr>
<td>VID</td>
<td>Verification Identity Document</td>
</tr>
<tr>
<td>VIS</td>
<td>Visualisation or Visa Information System</td>
</tr>
<tr>
<td>WSQ</td>
<td>Wavelet Scalar Quantisation</td>
</tr>
<tr>
<td>WSQR</td>
<td>Wavelet Scalar Quantisation for reference storage</td>
</tr>
</tbody>
</table>
16 Bibliography


[PhotoGuide] Photo guideline ("Fotomustertafel") available at www.epass.de

[Template] Photo template ("Lichtbildschablone") available at http://www.epass.de

17 Annex A: XML-Schema

The additional quality information as well as the data element are coded based in the requirements of the respective function blocks as described afore. This is represented within the following files. As far as crossovers exist the data is encapsulated in a further XML schema files: bioqa.xsd and bio_common.xsd. The mapping to the Function Modules can be found in Annex B: XSD and XML mapping.

17.1 bio_finger.xsd

```xml
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema"
        xmlns:bio_finger="http://trbio.bsi.bund.de/1.0/bio_finger"
        xmlns:bioqa="http://trbio.bsi.bund.de/1.0/bioqa"
        targetNamespace="http://trbio.bsi.bund.de/1.0/bio_finger"
        elementFormDefault="qualified" attributeFormDefault="unqualified">
  <xs:annotation>
    <xs:documentation>
      Contains all necessary additional information for fingerprints
    </xs:documentation>
  </xs:annotation>
  <!-- Includes/Imports -->
  <xs:import namespace="http://trbio.bsi.bund.de/1.0/bioqa"
              schemaLocation="bioqa.xsd"/>
  <xs:element name="fp-gid" type="bio_finger:type.function.module.fp-gid">
    <xs:annotation>
      Contents all necessary additional information for fingerprints
    </xs:annotation>
  </xs:element>
  <xs:complexType name="type.function.module.fp-gid">
    <xs:sequence>
      <xs:element name="record" type="bioqa:type.data.record"
                  minOccurs="0" maxOccurs="2"/>
      <xs:element name="xinfo-fp-gid" type="bio_finger:type.additonal.information.finger"/>
      <xs:element name="aux" type="bioqa:type.aux.information"
                  minOccurs="0" maxOccurs="unbounded"/>
      <xs:element name="time" type="bioqa:type.time.coding"></xs:element>
      <xs:element name="note" type="bioqa:type.note" minOccurs="0" maxOccurs="unbounded"/>
    </xs:sequence>
  </xs:complexType>
  <xs:complexType name="type.additonal.information.finger">
    <xs:sequence>
      <xs:element name="moduleinfo" type="bioqa:type.module.info"
                  minOccurs="1" maxOccurs="unbounded"/>
      <xs:element name="qa_finger" type="bio_finger:type.qa.finger"
                  minOccurs="0" maxOccurs="2"/>
      <xs:element name="time" type="bioqa:type.time.coding"></xs:element>
      <xs:element name="note" type="bioqa:type.note" minOccurs="0" maxOccurs="unbounded"/>
    </xs:sequence>
  </xs:complexType>
</xs:schema>
```
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```xml
<xs:complexType name="type.qa.finger">
  <xs:sequence>
    <xs:element name="qa" type="bioqa:type.quality.assurance"
      minOccurs="1" maxOccurs="unbounded">
    </xs:element>
  </xs:sequence>
  <xs:attribute name="total" type="bioqa:type.total.qa.result"
    use="required">
  </xs:attribute>
  <xs:attribute name="fc" type="bio_finger:type.registered.finger"
    use="required">
  </xs:attribute>
</xs:complexType>

<xs:simpleType name="type.registered.finger">
  <xs:annotation>
    <xs:documentation>Finger code</xs:documentation>
  </xs:annotation>
  <xs:restriction base="xs:integer">
    <xs:enumeration value="1"/>
    <xs:enumeration value="2"/>
    <xs:enumeration value="3"/>
    <xs:enumeration value="4"/>
    <xs:enumeration value="6"/>
    <xs:enumeration value="7"/>
    <xs:enumeration value="8"/>
    <xs:enumeration value="9"/>
  </xs:restriction>
</xs:simpleType>
```

17.2 visa_finger.xsd

```xml
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema"
  xmlns:bio_fp_visa="http://trbio.bsi.bund.de/1.0/bio_fp_visa"
  xmlns:bio_common="http://trbio.bsi.bund.de/1.0/bio_common"
  targetNamespace="http://trbio.bsi.bund.de/1.0/bio_fp_visa"
  elementFormDefault="qualified" attributeFormDefault="unqualified">
  <xs:annotation>
    <xs:documentation>Contains all necessary additional information for the acquisition,
      verification and identification using fingerprints in the context of
      visa issuance and border control checks.</xs:documentation>
  </xs:annotation>
  <!-- Includes/Imports -->
  <xs:import namespace="http://trbio.bsi.bund.de/1.0/bio_common"
    schemaLocation="bio_common.xsd"/>
  <xs:element name="fp-visa"
    type="bio_fp_visa:type.function.module.fp-visa">
  </xs:element>
</xs:schema>
```
<xs:complexType name="type.function.module.fp-visa">
  <xs:sequence>
    <xs:element name="record" type="bio_common:type.data.record"
      minOccurs="1" maxOccurs="unbounded"/>
    <xs:element name="xinfo-fp-visa" type="bio_fp_visa:type.additional.information.fp.visa"/>
    <xs:element name="aux" type="bio_common:type.aux.information"
      minOccurs="0"/>
  </xs:sequence>
</xs:complexType>

<xs:complexType name="type.additional.information.fp.visa">
  <xs:sequence>
    <xs:element name="Transaction" type="bio_common:type.transaction"/>
    <xs:element name="Date" type="bio_common:type.date"/>
    <xs:element name="Capture" type="bio_fp_visa:type.function.module.fp.capture"/>
    <xs:element name="Verification" type="bio_fp_visa:type.function.module.fp.verification"
      minOccurs="0"/>
    <xs:element name="Identification" type="bio_fp_visa:type.function.module.fp.identification"
      minOccurs="0"/>
    <xs:element name="Comment" type="bio_common:type.note" minOccurs="0"/>
    <xs:element name="ErrorCode" type="bio_common:type.error.code" minOccurs="0"/>
    <xs:element name="ORI" type="bio_common:type.ori.code"/>
    <xs:element name="SoftwareType" type="bio_common:type.software.general" minOccurs="0"/>
    <xs:element name="DemographicData" type="bio_common:type.demographic.data" minOccurs="0"/>
    <xs:element name="aux" type="bio_common:type.aux.information"
      minOccurs="0"/>
  </xs:sequence>
</xs:complexType>

<xs:complexType name="type.function.module.fp.capture">
  <xs:choice>
    <xs:element name="BasicCapture" type="bio_fp_visa:type.function.module.fp.basic.capture"
      minOccurs="1" maxOccurs="1"/>
    <xs:element name="ExtendedCapture" type="bio_fp_visa:type.function.module.fp.extended.capture"
      minOccurs="1" maxOccurs="1"/>
  </xs:choice>
</xs:complexType>

<xs:complexType name="type.function.module.fp.basic.capture">
  <xs:sequence>
    <xs:element name="Duration" type="bio_common:type.duration" minOccurs="0"/>
    <xs:element name="CapturedFingers" type="bio_common:type.captured.fingers"/>
  </xs:sequence>
</xs:complexType>
<xs:element name="SoftwareType" type="bio_common:type.software.general" />
<xs:element name="HardwareType" type="bio_common:type.hardware" />
<xs:element name="ContainerSize" type="bio_common:type.container.size" minOccurs="1" maxOccurs="unbounded" />
<xs:element name="ErrorCode" type="bio_common:type.error.code" minOccurs="0" />
<xs:element name="aux" type="bio_common:type.aux.information" minOccurs="0" />
</xs:sequence>
</xs:complexType>

<xs:complexType name="type.function.module.fp.extended.capture">
  <xs:sequence>
    <xs:element name="Duration" type="bio_common:type.duration" minOccurs="0" />
    <xs:element name="CaptureCounts" type="bio_common:type.capture.counts" />
    <xs:element name="CaptureSuccess" type="bio_common:type.capture.success" />
    <xs:element name="LocalQualityValue" type="bio_common:type.local.quality.value" minOccurs="1" maxOccurs="unbounded" />
    <xs:element name="CentralQualityValue" type="bio_common:type.central.quality.value" minOccurs="0" maxOccurs="unbounded" />
    <xs:element name="UniquenessCheck" type="bio_common:type.uniqueness.check" minOccurs="0" maxOccurs="unbounded" />
    <xs:element name="SegmentationError" type="bio_common:type.segmentation.error" minOccurs="0" />
    <xs:element name="SequenceError" type="bio_common:type.sequence.error" minOccurs="0" />
    <xs:element name="SoftwareType" type="bio_common:type.software.general" />
    <xs:element name="HardwareType" type="bio_common:type.hardware" />
    <xs:element name="ContainerSize" type="bio_common:type.container.size" minOccurs="1" maxOccurs="unbounded" />
    <xs:element name="ErrorCode" type="bio_common:type.error.code" minOccurs="0" />
    <xs:element name="aux" type="bio_common:type.aux.information" minOccurs="0" />
  </xs:sequence>
</xs:complexType>

<xs:complexType name="type.function.module.fp.verification">
  <xs:sequence>
    <xs:element name="Duration" type="bio_common:type.duration" minOccurs="0" />
  </xs:sequence>
</xs:complexType>
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```xml
<xs:element name="VerificationResult"
    type="bio_common:type.result.vis" minOccurs="0"/>
<xs:element name="ErrorCode" type="bio_common:type.error.code"
    minOccurs="0"/>
<xs:element name="aux" type="bio_common:type.aux.information"
    minOccurs="0"/>
</xs:sequence>
</xs:complexType>

<xs:complexType name="type.function.module.fp.identification">
    <xs:sequence>
        <xs:element name="Duration" type="bio_common:type.duration"
            minOccurs="0"/>
        <xs:element name="IdentificationPossible"
            type="bio_common:type.identification.possible"/>
        <xs:element name="NumberOfCandidates"
            type="bio_common:type.number.of.candidates"
            minOccurs="0"
            maxOccurs="1"/>
        <xs:element name="IdentificationResult"
            type="bio_common:type.identification.result"
            minOccurs="0"
            maxOccurs="1"/>
        <xs:element name="ErrorCode" type="bio_common:type.error.code"
            minOccurs="0"/>
        <xs:element name="aux" type="bio_common:type.aux.information"
            minOccurs="0"/>
    </xs:sequence>
</xs:complexType>
</xs:schema>

17.3  bio_face.xsd

```xml
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema"
    xmlns:bio_face="http://trbio.bsi.bund.de/1.0/bio_face"
    xmlns:bioqa="http://trbio.bsi.bund.de/1.0/bioqa"
    targetNamespace="http://trbio.bsi.bund.de/1.0/bio_face"
    elementFormDefault="qualified" attributeFormDefault="unqualified">
    <xs:annotation>
        <xs:documentation>
            Contains all necessary additional information for facial images
        </xs:documentation>
    </xs:annotation>
    <!-- Includes/Imports -->
    <xs:import namespace="http://trbio.bsi.bund.de/1.0/bioqa"
        schemaLocation="bioqa.xsd"/>
    <xs:element name="ph-gid" type="bio_face:type.function.module.ph-gid"/>
    <xs:complexType name="type.function.module.ph-gid">
        <xs:sequence>
            <xs:element name="record" type="bioqa:type.data.record"/>
            <xs:element name="xinfo-ph-gid"
                type="bio_face:type.additonal.information.face"/>
            <xs:element name="aux" type="bioqa:type.aux.information"
                minOccurs="0"/>
        </xs:sequence>
    </xs:complexType>
</xs:schema>
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17.4 visa_face.xsd

```xml
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema"
  xmlns:bio_ph_visa="http://trbio.bsi.bund.de/1.0/bio_ph_visa"
  xmlns:bioqa="http://trbio.bsi.bund.de/1.0/bioqa"
  xmlns:bio_common="http://trbio.bsi.bund.de/1.0/bio_common"
  targetNamespace="http://trbio.bsi.bund.de/1.0/bio_ph_visa"
  elementFormDefault="qualified"
  attributeFormDefault="unqualified">
  <xs:annotation>
    <xs:documentation>
      Contains all necessary additional information for facial images
    </xs:documentation>
  </xs:annotation>
  <!-- Includes/Imports -->
  <xs:import namespace="http://trbio.bsi.bund.de/1.0/bio_common"
    schemaLocation="bio_common.xsd"/>
  <xs:import namespace="http://trbio.bsi.bund.de/1.0/bioqa"
    schemaLocation="bioqa.xsd"/>
  <xs:element name="ph-visa"
    type="bio_ph_visa:type.function.module.ph.visa">
  </xs:element>
</xs:schema>
```

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<xs:element name="record" type="bioqa:type.data.record"/>
<xs:element name="xinfo-ph-visa" type="bio_ph_visa:type.additonal.information.ph.visa"/>
<xs:element name="aux" type="bioqa:type.aux.information" minOccurs="0"/>
</xs:element>
</xs:complexType>
<xs:complexType name="type.additonal.information.ph.visa">
<xs:sequence>
<xs:element name="Transaction" type="bio_common:type.transaction"/>
<xs:element name="Date" type="bio_common:type.date" minOccurs="0"/>
<xs:element name="Duration" type="bio_common:type.duration" minOccurs="1" maxOccurs="unbounded"/>
<xs:element name="moduleinfo" type="bioqa:type.module.info" minOccurs="0" maxOccurs="1"></xs:element>
<xs:element name="qa_face" type="bio_ph_visa:type.qa.face" minOccurs="0" maxOccurs="1"></xs:element>
<xs:element name="note" type="bioqa:type.note" minOccurs="0" maxOccurs="unbounded"></xs:element>
<xs:element name="Test" type="bio_common:type.test" minOccurs="0"/>
<xs:element name="ErrorCode" type="bio_common:type.error.code" minOccurs="0"/>
<xs:element name="ORI" type="bio_common:type.ori.code"></xs:element>
<xs:element name="ImageFormat" type="bio_common:type.ph.image.format"></xs:element>
</xs:sequence>
</xs:complexType>
<xs:complexType name="type.qa.face">
<xs:sequence>
<xs:element name="qa" type="bioqa:type.quality.assurance" minOccurs="1" maxOccurs="unbounded"></xs:element>
</xs:sequence>
<xs:attribute name="total" type="bioqa:type.total.qa.result" use="required"></xs:attribute>
</xs:complexType>
</xs:schema>
<xs:simpleType name="type.data">
    <xs:restriction base="xs:base64Binary"></xs:restriction>
</xs:simpleType>

<xs:simpleType name="type.hash.value">
    <xs:restriction base="xs:hexBinary"></xs:restriction>
</xs:simpleType>

<xs:simpleType name="type.module.type">
    <xs:restriction base="xs:string"></xs:restriction>
</xs:simpleType>

<xs:complexType name="type.module.info">
    <xs:sequence>
        <xs:element name="moduletype" type="bioqa:type.module.type"></xs:element>
        <xs:element name="vendorinfo" type="bioqa:type.vendor.info"></xs:element>
        <xs:element name="comp" type="bioqa:type.subcomponent" minOccurs="0" maxOccurs="unbounded"></xs:element>
        <xs:element name="algorithm" type="bioqa:type.algorithm" minOccurs="0" maxOccurs="unbounded"></xs:element>
    </xs:sequence>
</xs:complexType>

<xs:complexType name="type.vendor.info">
    <xs:sequence>
        <xs:element name="vendorname" type="bioqa:type.vendor.name"></xs:element>
        <xs:element name="productname" type="bioqa:type.product.name"></xs:element>
        <xs:element name="version" type="bioqa:type.version"></xs:element>
        <xs:element name="firmwareversion" type="bioqa:type.version" minOccurs="0"></xs:element>
        <xs:element name="qa_config" type="bioqa:type.version" minOccurs="0"></xs:element>
        <xs:element name="aux" type="bioqa:type.aux.information" minOccurs="0"></xs:element>
    </xs:sequence>
</xs:complexType>

<xs:complexType name="type.aux.information">
    <xs:sequence>
        <xs:any/>
    </xs:sequence>
</xs:complexType>

<xs:complexType name="type.subcomponent.name">
    <xs:restriction base="xs:string"></xs:restriction>
</xs:complexType>
<xs:simpleType name="type.algorithm.type">
    <xs:restriction base="xs:string"></xs:restriction>
</xs:simpleType>
<xs:simpleType name="type.algorithm.name">
    <xs:restriction base="xs:string"></xs:restriction>
</xs:simpleType>
<xs:simpleType name="type.time.coding">
    <xs:restriction base="xs:dateTime"></xs:restriction>
</xs:simpleType>
<xs:simpleType name="type.note">
    <xs:restriction base="xs:string"></xs:restriction>
</xs:simpleType>
<xs:complexType name="type.subcomponent">
    <xs:attribute name="name" type="bioqa:type.subcomponent.name">
        <xs:annotation>
            <xs:documentation>Not all components provide information about the version, in this case the attribute is missing</xs:documentation>
        </xs:annotation>
    </xs:attribute>
</xs:complexType>
<xs:complexType name="type.algorithm">
    <xs:attribute name="type" type="bioqa:type.algorithm.type">
    </xs:attribute>
    <xs:attribute name="name" type="bioqa:type.algorithm.name">
    </xs:attribute>
    <xs:attribute name="version" type="bioqa:type.version" use="optional">
        <xs:annotation>
            <xs:documentation>Not all components provide information about the version, in this case the attribute is missing</xs:documentation>
        </xs:annotation>
    </xs:attribute>
</xs:complexType>
<xs:simpleType name="type.total.qa.result">
    <xs:restriction base="xs:boolean"></xs:restriction>
</xs:simpleType>
<xs:simpleType name="type.result.qa">
    <xs:restriction base="xs:double"></xs:restriction>
</xs:simpleType>
<xs:simpleType name="type.identifier.criterion">
    <xs:restriction base="xs:string"></xs:restriction>
</xs:simpleType>
<xs:complexType name="type.quality.assurance">
    <xs:simpleContent>
        <xs:extension base="bioqa:type.result.qa">
            <xs:attribute name="id" type="bioqa:type.identifier.criterion" use="required">
            </xs:attribute>
            <xs:attribute name="m" type="bioqa:type.result.qa" use="optional">
            </xs:attribute>
            <xs:attribute name="M" type="bioqa:type.result.qa" use="optional">
            </xs:attribute>
        </xs:extension>
    </xs:simpleContent>
</xs:complexType>
17.6   visa_finger_inputdata.xsd

<?xml version="1.0" encoding="UTF-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema"
xmlns:bio_common="http://trbio.bsi.bund.de/1.0/bio_common"
targetNamespace="http://trbio.bsi.bund.de/1.0/bio_common"
elementFormDefault="qualified" attributeFormDefault="unqualified">
  <xs:annotation>
    <xs:documentation>
      Contains all necessary additional information for the coding of fingerprints in the context of visa enrolment and border control.
    </xs:documentation>
  </xs:annotation>
  <!-- Includes/Imports -->
  <xs:include schemaLocation="bio_common.xsd"/>
  <xs:element name="fp-visa-inputdata" type="bio_common:type.fp-visa-additional-inputdata.data"/>
  <xs:complexType name="type.fp-visa-additional-inputdata.data">
    <xs:sequence>
      <xs:element name="ORI" type="bio_common:type.ori.code" minOccurs="1" maxOccurs="1"/>
      <xs:element name="DemographicData" type="bio_common:type.demographic.data" minOccurs="0" maxOccurs="1"/>
    </xs:sequence>
  </xs:complexType>
</xs:schema>

17.7   visa_face_inputdata.xsd

<?xml version="1.0" encoding="UTF-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema"
xmlns:bio_common="http://trbio.bsi.bund.de/1.0/bio_common"
targetNamespace="http://trbio.bsi.bund.de/1.0/bio_common"
elementFormDefault="qualified" attributeFormDefault="unqualified">
  <xs:annotation>
    <xs:documentation>
    </xs:documentation>
  </xs:annotation>
</xs:schema>
Contains all necessary additional information for the coding of facial images in the context of visa enrolment and border control.
</xs:documentation>
</xs:annotation>

<!-- Includes/Imports -->
<xs:include schemaLocation="bio_common.xsd"/>

<xs:element name="ph-visa-inputdata"
    type="bio_common:type.ph-visa-additional-inputdata.data">
</xs:element>

<xs:complexType name="type.ph-visa-additional-inputdata.data">
    <xs:sequence>
        <xs:element name="ORI"
            type="bio_common:type.ori.code"/>
    </xs:sequence>
</xs:complexType>

17.8  bio_common.xsd

<?xml version="1.0" encoding="UTF-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema"
    xmlns:bio_common="http://trbio.bsi.bund.de/1.0/bio_common"
    targetNamespace="http://trbio.bsi.bund.de/1.0/bio_common"
    elementFormDefault="qualified" attributeFormDefault="unqualified">
    <xs:annotation>
        <xs:documentation>
            Contains all necessary common information for verification, identification and enrolment of biometric features
        </xs:documentation>
    </xs:annotation>

    <xs:simpleType name="type.transaction.id">
        <xs:restriction base="xs:string"/>
    </xs:simpleType>

    <xs:complexType name="type.transaction">
        <xs:sequence>
            <xs:element name="TransactionID"
                type="bio_common:type.transaction.id"/>
            <xs:element name="Counter" type="bio_common:type.counter"
                minOccurs="0"/>
        </xs:sequence>
    </xs:complexType>

    <xs:simpleType name="type.counter">
        <xs:restriction base="xs:integer"/>
    </xs:simpleType>

    <xs:simpleType name="type.error.code">
        <xs:restriction base="xs:integer"/>
    </xs:simpleType>

    <xs:complexType name="type.aux.information">
        <xs:annotation>
            <xs:documentation>
                Contains all necessary common information for verification, identification and enrolment of biometric features
            </xs:documentation>
        </xs:annotation>
    </xs:complexType>
</xs:schema>
<xs:sequence>
  <xs:any/>
</xs:sequence>
</xs:complexType>

<xs:complexType name="type.capture.counts">
  <xs:sequence>
    <xs:element name="Right"
      type="bio_common:type.slaps">
    </xs:element>
    <xs:element name="Left"
      type="bio_common:type.slaps">
    </xs:element>
    <xs:element name="Thumbs"
      type="bio_common:type.slaps">
    </xs:element>
    <xs:element name="SingleFinger"
      type="bio_common:type.single.finger" minOccurs="0" maxOccurs="1">
    </xs:element>
  </xs:sequence>
</xs:complexType>

<xs:simpleType name="type.result.single.finger.capture.count">
  <xs:restriction base="xs:integer"/>
</xs:simpleType>

<xs:complexType name="type.single.finger">
  <xs:sequence>
    <xs:element name="fp1"
      type="bio_common:type.result.single.finger.capture.count"
      minOccurs="0" maxOccurs="1">
    </xs:element>
    <xs:element name="fp2"
      type="bio_common:type.result.single.finger.capture.count"
      minOccurs="0" maxOccurs="1">
    </xs:element>
    <xs:element name="fp3"
      type="bio_common:type.result.single.finger.capture.count"
      minOccurs="0" maxOccurs="1">
    </xs:element>
    <xs:element name="fp4"
      type="bio_common:type.result.single.finger.capture.count"
      minOccurs="0" maxOccurs="1">
    </xs:element>
    <xs:element name="fp5"
      type="bio_common:type.result.single.finger.capture.count"
      minOccurs="0" maxOccurs="1">
    </xs:element>
    <xs:element name="fp6"
      type="bio_common:type.result.single.finger.capture.count"
      minOccurs="0" maxOccurs="1">
    </xs:element>
    <xs:element name="fp7"
      type="bio_common:type.result.single.finger.capture.count"
      minOccurs="0" maxOccurs="1">
    </xs:element>
    <xs:element name="fp8"
      type="bio_common:type.result.single.finger.capture.count"
      minOccurs="0" maxOccurs="1">
    </xs:element>
  </xs:sequence>
</xs:complexType>
<xs:element name="fp9"
type="bio_common:type.result.single.finger.capture.count"
minOccurs="0" maxOccurs="1">
</xs:element>
<xs:element name="fp10"
type="bio_common:type.result.single.finger.capture.count"
minOccurs="0" maxOccurs="1">
</xs:element>
</xs:sequence>
</xs:complexType>

<xs:complexType name="type.local.quality.value">
<xs:sequence>
  <xs:element name="software"
type="bio_common:type.software"></xs:element>
  <xs:element name="OverallQualityValue"
type="bio_common:type.overall.quality.value"
minOccurs="0" maxOccurs="1"></xs:element>
  <xs:element name="fp1" type="bio_common:type.result.qa"
minOccurs="0" maxOccurs="1"></xs:element>
  <xs:element name="fp2" type="bio_common:type.result.qa"
minOccurs="0" maxOccurs="1"></xs:element>
  <xs:element name="fp3" type="bio_common:type.result.qa"
minOccurs="0" maxOccurs="1"></xs:element>
  <xs:element name="fp4" type="bio_common:type.result.qa"
minOccurs="0" maxOccurs="1"></xs:element>
  <xs:element name="fp5" type="bio_common:type.result.qa"
minOccurs="0" maxOccurs="1"></xs:element>
  <xs:element name="fp6" type="bio_common:type.result.qa"
minOccurs="0" maxOccurs="1"></xs:element>
  <xs:element name="fp7" type="bio_common:type.result.qa"
minOccurs="0" maxOccurs="1"></xs:element>
  <xs:element name="fp8" type="bio_common:type.result.qa"
minOccurs="0" maxOccurs="1"></xs:element>
  <xs:element name="fp9" type="bio_common:type.result.qa"
minOccurs="0" maxOccurs="1"></xs:element>
  <xs:element name="fp10" type="bio_common:type.result.qa"
minOccurs="0" maxOccurs="1"></xs:element>
</xs:sequence>
</xs:complexType>

<xs:simpleType name="type.slaps">
  <xs:restriction base="xs:integer"></xs:restriction>
</xs:simpleType>

<xs:complexType name="type.capture.success">
<xs:sequence>
  <xs:element name="Right"
type="bio_common:type.success"></xs:element>
  <xs:element name="Left"
type="bio_common:type.success"></xs:element>
  <xs:element name="Thumbs"
type="bio_common:type.success"></xs:element>
</xs:sequence>
</xs:complexType>

<xs:simpleType name="type.success">
  <xs:restriction base="xs:boolean"></xs:restriction>
</xs:simpleType>
<xs:simpleType>
    <xs:restriction base="xs:string"></xs:restriction>
</xs:simpleType>

<xs:simpleType name="type.ori.code">
    <xs:restriction base="xs:string"></xs:restriction>
</xs:simpleType>

<xs:simpleType name="type.verification.threshold">
    <xs:restriction base="xs:float"></xs:restriction>
</xs:simpleType>

<xs:simpleType name="type.comparison.score">
    <xs:restriction base="xs:float"></xs:restriction>
</xs:simpleType>

<xs:simpleType name="type.comparison.result">
    <xs:restriction base="xs:boolean"></xs:restriction>
</xs:simpleType>

<xs:simpleType name="type.result.vis">
    <xs:restriction base="xs:string">
        <xs:enumeration value="true"/>
        <xs:enumeration value="false"/>
        <xs:enumeration value="undetermined"/>
    </xs:restriction>
</xs:simpleType>

<xs:simpleType name="type.version">
    <xs:restriction base="xs:string"></xs:restriction>
</xs:simpleType>

<xs:simpleType name="type.identifier">
    <xs:restriction base="xs:string"></xs:restriction>
</xs:simpleType>

<xs:complexType name="type.configuration">
    <xs:sequence>
        <xs:element name="criterion" type="bio_common:type.conf.values" minOccurs="1" maxOccurs="unbounded"></xs:element>
    </xs:sequence>
</xs:complexType>

<xs:complexType name="type.conf.values">
    <xs:simpleContent>
        <xs:extension base="bio_common:type.identifier">
            <xs:attribute name="M" type="bio_common:type.result.value" use="optional"></xs:attribute>
            <xs:attribute name="m" type="bio_common:type.result.value" use="optional"></xs:attribute>
            <xs:attribute name="T" type="bio_common:type.result.value" use="optional"></xs:attribute>
            <xs:attribute name="t" type="bio_common:type.result.value" use="optional"></xs:attribute>
        </xs:extension>
    </xs:simpleContent>
</xs:complexType>
<xs:complexType name="type.software.general">
  <xs:sequence>
    <xs:element name="identifier" type="bio_common:type.identifier"/>
    <xs:element name="name" type="bio_common:type.identifier"/>
    <xs:element name="version" type="bio_common:type.version" minOccurs="0"/>
    <xs:element name="note" type="bio_common:type.identifier" minOccurs="0"/>
  </xs:sequence>
</xs:complexType>

<xs:complexType name="type.software">
  <xs:sequence>
    <xs:element name="identifier" type="bio_common:type.identifier"/>
    <xs:element name="name" type="bio_common:type.identifier"/>
    <xs:element name="version" type="bio_common:type.version" minOccurs="0"/>
    <xs:element name="firmwareversion" type="bio_common:type.version" minOccurs="0"/>
    <xs:element name="note" type="bio_common:type.identifier" minOccurs="0" maxOccurs="1"/>
  </xs:sequence>
</xs:complexType>

<xs:complexType name="type.hardware">
  <xs:sequence>
    <xs:element name="identifier" type="bio_common:type.identifier"/>
    <xs:element name="name" type="bio_common:type.identifier"/>
    <xs:element name="version" type="bio_common:type.version"/>
    <xs:element name="firmwareversion" type="bio_common:type.version" minOccurs="0"/>
    <xs:element name="note" type="bio_common:type.identifier" minOccurs="0"/>
  </xs:sequence>
</xs:complexType>

<xs:complexType name="type.comparison">
  <xs:sequence>
    <xs:element name="ComparisonScore" type="bio_common:type.comparison.score"/>
  </xs:sequence>
</xs:complexType>
<xs:element name="ComparisonResult" type="bio_common:type.comparison.result"/>
</xs:sequence>
</xs:complexType>

<xs:simpleType name="type.date">
    <xs:restriction base="xs:date"></xs:restriction>
</xs:simpleType>

<xs:simpleType name="type.duration">
    <xs:restriction base="xs:duration"></xs:restriction>
</xs:simpleType>

<xs:simpleType name="type.segmentation.error">
    <xs:restriction base="xs:integer"></xs:restriction>
</xs:simpleType>

<xs:simpleType name="type.test">
    <xs:restriction base="xs:boolean"></xs:restriction>
</xs:simpleType>

<xs:simpleType name="type.note">
    <xs:restriction base="xs:string"></xs:restriction>
</xs:simpleType>

<xs:complexType name="type.container.size">
    <xs:simpleContent>
        <xs:extension base="xs:integer">
            <xs:attribute name="purpose" type="bio_common:type.purpose" use="optional"></xs:attribute>
        </xs:extension>
    </xs:simpleContent>
</xs:complexType>

<xs:complexType name="type.demographic.data">
    <xs:sequence>
        <xs:element name="Gender" type="bio_common:type.gender"></xs:element>
        <xs:element name="AgeClass" type="bio_common:type.age.class"></xs:element>
        <xs:element name="Nationality" type="bio_common:type.nationality" minOccurs="0"></xs:element>
    </xs:sequence>
</xs:complexType>

<xs:complexType name="type.document.information">
    <xs:sequence>
        <xs:element name="DocumentType" type="bio_common:type.document.type"></xs:element>
        <xs:element name="IssuingState" type="bio_common:type.issuing.state"></xs:element>
    </xs:sequence>
</xs:complexType>

<xs:complexType name="type.image.information">
    <xs:sequence>
        
</xs:sequence>
</xs:complexType>
<xs:element name="ImageType" type="bio_common:type.ph.image.type"></xs:element>
<xs:element name="ImageFormat" type="bio_common:type.ph.image.format"></xs:element>
</xs:sequence>
</xs:complexType>
<xs:simpleType name="type.nationality">
  <xs:restriction base="xs:string"></xs:restriction>
</xs:simpleType>
<xs:simpleType name="type.document.type">
  <xs:restriction base="xs:string">
    <xs:enumeration value="passport"/>
    <xs:enumeration value="identity_card"/>
    <xs:enumeration value="visa"/>
    <xs:enumeration value="residence_permit"/>
    <xs:enumeration value="other"/>
  </xs:restriction>
</xs:simpleType>
<xs:simpleType name="type.gender">
  <xs:restriction base="xs:string">
    <xs:enumeration value="male"/>
    <xs:enumeration value="female"/>
    <xs:enumeration value="unknown"/>
  </xs:restriction>
</xs:simpleType>
<xs:simpleType name="type.age.class">
  <xs:restriction base="xs:string"></xs:restriction>
</xs:simpleType>
<xs:simpleType name="type.issuing.state">
  <xs:restriction base="xs:string"></xs:restriction>
</xs:simpleType>
<xs:simpleType name="type.finger.code">
  <xs:restriction base="xs:integer">
    <xs:enumeration value="1"/>
    <xs:enumeration value="2"/>
    <xs:enumeration value="3"/>
    <xs:enumeration value="4"/>
    <xs:enumeration value="5"/>
    <xs:enumeration value="6"/>
    <xs:enumeration value="7"/>
    <xs:enumeration value="8"/>
    <xs:enumeration value="9"/>
    <xs:enumeration value="10"/>
  </xs:restriction>
</xs:simpleType>
<xs:complexType name="type.captured.fingers">
  <xs:sequence>
    <xs:element name="FingerCode" type="bio_common:type.finger.code" minOccurs="1" maxOccurs="10"></xs:element>
  </xs:sequence>
</xs:complexType>
<xs:complexType name="type.qa.face">
  <xs:sequence>
    <xs:element name="ImageSource" type="bio_common:type.ph.image.source"/>
    <xs:element name="qa" type="bio_common:type.quality.assurance" minOccurs="0" maxOccurs="unbounded"/>
  </xs:sequence>
  <xs:attribute name="total" type="bio_common:type.total.qa.result" use="required"/>
</xs:complexType>

<xs:complexType name="type.qa.finger.visa">
  <xs:sequence>
    <xs:element name="OverallQualityValue" type="bio_common:type.overall.quality.value" minOccurs="0"/>
    <xs:element name="qa" type="bio_common:type.quality.assurance.finger.visa" minOccurs="1" maxOccurs="10"/>
  </xs:sequence>
</xs:complexType>

<xs:simpleType name="type.overall.quality.value">
  <xs:restriction base="xs:double"/>
</xs:simpleType>

<xs:simpleType name="type.total.qa.result">
  <xs:restriction base="xs:boolean"/>
</xs:simpleType>

<xs:simpleType name="type.result.qa">
  <xs:restriction base="xs:double"/>
</xs:simpleType>
<xs:simpleType name="type.hash.value">
  <xs:restriction base="xs:hexBinary"></xs:restriction>
</xs:simpleType>

<xs:simpleType name="type.number.of.candidates">
  <xs:restriction base="xs:integer"></xs:restriction>
</xs:simpleType>

<xs:simpleType name="type.identification.possible">
  <xs:restriction base="xs:boolean"></xs:restriction>
</xs:simpleType>

<xs:simpleType name="type.identification.result">
  <xs:restriction base="xs:boolean"></xs:restriction>
</xs:simpleType>

<xs:simpleType name="type.subtype.mask">
  <xs:restriction base="xs:string">
    <xs:enumeration value="left"/>
    <xs:enumeration value="right"/>
    <xs:enumeration value="thumb"/>
    <xs:enumeration value="pointerfinger"/>
    <xs:enumeration value="middlefinger"/>
    <xs:enumeration value="ringfinger"/>
    <xs:enumeration value="littlefinger"/>
    <xs:enumeration value="multiple"/>
  </xs:restriction>
</xs:simpleType>

<xs:complexType name="type.uniqueness.check">
  <xs:sequence>
    <xs:element name="SoftwareType" type="bio_common:type.software" minOccurs="1" maxOccurs="1"/>
    <xs:element name="SecurityLevel" type="bio_common:type.security.level" minOccurs="0" maxOccurs="1"/>
    <xs:element name="Unique" type="bio_common:type.unique" minOccurs="0" maxOccurs="1"/>
    <xs:element name="Duplicates" type="bio_common:type.duplicates" minOccurs="0" maxOccurs="1"/>
  </xs:sequence>
</xs:complexType>

<xs:simpleType name="type.security.level">
  <xs:restriction base="xs:float"></xs:restriction>
</xs:simpleType>

<xs:simpleType name="type.unique">
  <xs:restriction base="xs:boolean"></xs:restriction>
</xs:simpleType>

<xs:complexType name="type.duplicate">
  <xs:sequence>
  </xs:sequence>
</xs:complexType>
<xs:element name="FingerCode"
type="bio_common:type.finger.code" minOccurs="2" maxOccurs="2"></xs:element>
</xs:complexType>

<xs:complexType name="type.duplicates">
<xs:choice>
<xs:element name="DuplicateFingerCandidate"
type="bio_common:type.finger.code" minOccurs="2" maxOccurs="10">
</xs:element>
<xs:element name="Duplicate" type="bio_common:type.duplicate"
minOccurs="1" maxOccurs="45">
</xs:element>
</xs:choice>
</xs:complexType>

<xs:complexType name="type.central.quality.value">
<xs:sequence>
<xs:element name="software"
type="bio_common:type.software"></xs:element>
<xs:element name="OverallQualityValue"
type="bio_common:type.overall.quality.value"
minOccurs="0" maxOccurs="1"></xs:element>
<xs:element name="fp1" type="bio_common:type.result.qa"
minOccurs="0" maxOccurs="1"></xs:element>
<xs:element name="fp2" type="bio_common:type.result.qa"
minOccurs="0" maxOccurs="1"></xs:element>
<xs:element name="fp3" type="bio_common:type.result.qa"
minOccurs="0" maxOccurs="1"></xs:element>
<xs:element name="fp4" type="bio_common:type.result.qa"
minOccurs="0" maxOccurs="1"></xs:element>
<xs:element name="fp5" type="bio_common:type.result.qa"
minOccurs="0" maxOccurs="1"></xs:element>
<xs:element name="fp6" type="bio_common:type.result.qa"
minOccurs="0" maxOccurs="1"></xs:element>
<xs:element name="fp7" type="bio_common:type.result.qa"
minOccurs="0" maxOccurs="1"></xs:element>
<xs:element name="fp8" type="bio_common:type.result.qa"
minOccurs="0" maxOccurs="1"></xs:element>
<xs:element name="fp9" type="bio_common:type.result.qa"
minOccurs="0" maxOccurs="1"></xs:element>
<xs:element name="fp10" type="bio_common:type.result.qa"
minOccurs="0" maxOccurs="1"></xs:element>
</xs:sequence>
</xs:complexType>

<xs:simpleType name="type.error">
<xs:restriction base="xs:integer"></xs:restriction>
</xs:simpleType>

<xs:simpleType name="type.sequence.error">
<xs:restriction base="xs:integer"></xs:restriction>
</xs:simpleType>

</xs:schema>
17.9 vid_verify_face.xsd

```xml
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema"
  xmlns:bio_ph_vid="http://trbio.bsi.bund.de/1.0/bio_ph_vid"
  xmlns:bio_common="http://trbio.bsi.bund.de/1.0/bio_common"
  targetNamespace="http://trbio.bsi.bund.de/1.0/bio_ph_vid"
  elementFormDefault="qualified" attributeFormDefault="unqualified">
  <xs:import schemaLocation="bio_common.xsd"
    namespace="http://trbio.bsi.bund.de/1.0/bio_common"></xs:import>
  <xs:annotation>
    <xs:documentation>
      Contains all necessary information for verification of facial images of german identity documents - verification workflow
    </xs:documentation>
  </xs:annotation>
  <!-- Includes/Imports -->
  <xs:import namespace="http://trbio.bsi.bund.de/1.0/bio_common"
    schemaLocation="bio_common.xsd"/>

  <xs:element name="ph-vid-verify" type="bio_ph_vid:type.function.module.ph.vid.verify">
    <xs:complexType name="type.function.module.ph.vid.verify">
      <xs:sequence>
        <xs:element name="Transaction" type="bio_common:type.transaction"/>
        <xs:element name="Date" type="bio_common:type.date"/>
        <xs:element name="Capture" type="bio_ph_vid:type.function.module.ph.vid.capture"/>
        <xs:element name="Verification" type="bio_ph_vid:type.function.module.ph.vid.verification"/>
        <xs:element name="SoftwareType" type="bio_common:type.software.general" minOccurs="1" maxOccurs="unbounded"/>
        <xs:element name="ReferenceImage" type="bio_common:type.image.information"/>
        <xs:element name="DocumentInformation" type="bio_common:type.document.information"/>
        <xs:element name="DemographicData" type="bio_common:type.demographic.data" minOccurs="0"/>
        <xs:element name="Comment" type="bio_common:type.note" minOccurs="0"/>
        <xs:element name="ErrorCode" type="bio_common:type.error.code" minOccurs="0"/>
        <xs:element name="aux" type="bio_common:type.aux.information" minOccurs="0"/>
      </xs:sequence>
    </xs:complexType>
  </xs:element>

  <xs:complexType name="type.function.module.ph.vid.capture">
    <xs:sequence>
      <xs:element name="Duration" type="bio_common:type.duration" minOccurs="0"/>
    </xs:sequence>
  </xs:complexType>
</xs:schema>
```
17 Annex A: XML-Schema

```xml
<xs:element name="SoftwareType" type="bio_common:type.software.general"/>
<xs:element name="HardwareType" type="bio_common:type.hardware"/>
<xs:element name="ErrorCode" type="bio_common:type.error.code" minOccurs="0"/>
<xs:element name="aux" type="bio_common:type.aux.information" minOccurs="0"/>
</xs:sequence>
</xs:complexType>

<xs:complexType name="type.function.module.ph.vidverification">
    <xs:sequence>
        <xs:element name="Duration" type="bio_common:type.duration" minOccurs="0"/>
        <xs:element name="SoftwareType" type="bio_common:type.software.general"/>
        <xs:element name="Threshold" type="bio_common:type.verification.threshold"/>
        <xs:element name="GenuineComparison" type="bio_common:type.comparison" minOccurs="0"/>
        <xs:element name="ErrorCode" type="bio_common:type.error.code" minOccurs="0"/>
        <xs:element name="aux" type="bio_common:type.aux.information" minOccurs="0"/>
    </xs:sequence>
</xs:complexType>
</xs:schema>

17.10  vid_eval_face.xsd

<?xml version="1.0" encoding="UTF-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema"
    xmlns:bio_ph_vid="http://trbio.bsi.bund.de/1.0/bio_ph_vid"
    xmlns:bio_common="http://trbio.bsi.bund.de/1.0/bio_common"
    targetNamespace="http://trbio.bsi.bund.de/1.0/bio_ph_vid"
    elementFormDefault="qualified" attributeFormDefault="unqualified">
    <xs:import schemaLocation="bio_common.xsd" namespace="http://trbio.bsi.bund.de/1.0/bio_common"/>
    <xs:element name="ph-vid-eval" type="bio_ph_vid:type.function.module.ph.vid.eval"/>
</xs:schema>

Contains all necessary information for verification of facial images of german identity documents - evaluation workflow
```
Annex A: XML-Schema 17

<xs:element name="Transaction"
    type="bio_common:type.transaction"/>
<xs:element name="QualityAssurance"
    type="bio_ph_vid:type.function.module.ph.vid.quality.assurance" minOccurs="1" maxOccurs="unbounded"/>
<xs:element name="CrossComparison"
    type="bio_ph_vid:type.function.module.ph.vid.cross.comparison" minOccurs="1" maxOccurs="unbounded"/>
<xs:element name="Comment" type="bio_common:type.note"
    minOccurs="0"/>
<xs:element name="ErrorCode" type="bio_common:type.error.code"
    minOccurs="0"/>
<xs:element name="aux" type="bio_common:type.aux.information"
    minOccurs="0"/>
</xs:sequence>
</xs:complexType>

<xs:complexType name="type.function.module.ph.vid.quality.assurance">
    <xs:sequence>
        <xs:element name="Duration" type="bio_common:type.duration"
            minOccurs="0"/>
        <xs:element name="SoftwareType"
            type="bio_common:type.software"/>
        <xs:element name="QualityResult"
            type="bio_common:type.qa.face"
            minOccurs="0" maxOccurs="unbounded"/>
        <xs:element name="ErrorCode" type="bio_common:type.error.code"
            minOccurs="0"/>
        <xs:element name="aux" type="bio_common:type.aux.information"
            minOccurs="0"/>
    </xs:sequence>
</xs:complexType>

<xs:complexType name="type.function.module.ph.vid.cross.comparison">
    <xs:sequence>
        <xs:element name="Duration" type="bio_common:type.duration"
            minOccurs="0"/>
        <xs:element name="SoftwareType"
            type="bio_common:type.software.general"/>
        <xs:element name="Threshold"
            type="bio_common:type.verification.threshold"/>
        <xs:element name="GenuineComparison"
            type="bio_common:type.comparison"
            minOccurs="0"/>
        <xs:element name="ImpostorComparison"
            type="bio_common:type.comparison" minOccurs="0" maxOccurs="unbounded"/>
        <xs:element name="ErrorCode" type="bio_common:type.error.code"
            minOccurs="0"/>
        <xs:element name="aux" type="bio_common:type.aux.information"
            minOccurs="0"/>
    </xs:sequence>
</xs:complexType>
17.11  visa_finger_eval.xsd

<?xml version="1.0" encoding="UTF-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema"
xmlns:bio_fp_visa="http://trbio.bsi.bund.de/1.0/bio_fp_visa"
xmlns:bio_common="http://trbio.bsi.bund.de/1.0/bio_common"
targetNamespace="http://trbio.bsi.bund.de/1.0/bio_fp_visa"
elementFormDefault="qualified" attributeFormDefault="unqualified">
  <xs:import schemaLocation="bio_common.xsd"
    namespace="http://trbio.bsi.bund.de/1.0/bio_common"></xs:import>
  <xs:annotation>
    <xs:documentation>
      Contains all necessary information for identity check of
      biometric visa - evaluation workflow
    </xs:documentation>
  </xs:annotation>
  <!-- Includes/Imports -->
  <xs:import namespace="http://trbio.bsi.bund.de/1.0/bio_common"
schemaLocation="bio_common.xsd"/>

  <xs:element name="fp-visa-eval"
type="bio_fp_visa:type.function.module.fp.visa.eval">
  </xs:element>

  <xs:complexType name="type.function.module.fp.visa.eval">
    <xs:sequence>
      <xs:element name="Transaction"
type="bio_common:type.transaction"/>
      <xs:element name="Date" type="bio_common:type.date"/>
      <xs:element name="QualityAssurance"
type="bio_fp_visa:type.function.module.fp.visa.
      quality.assurance" minOccurs="1" maxOccurs="unbounded"/>
      <xs:element name="Comment" type="bio_common:type.note"
minOccurs="0"/>
      <xs:element name="Test" type="bio_common:type.test"/>
      <xs:element name="ErrorCode" type="bio_common:type.error.code"
minOccurs="0"/>
      <xs:element name="aux" type="bio_common:type.aux.information"
minOccurs="0"/>
    </xs:sequence>
  </xs:complexType>

  <xs:complexType name="type.function.module.fp.visa.quality.assurance">
    <xs:sequence>
      <xs:element name="Duration" type="bio_common:type.duration"
      minOccurs="0"/>
      <xs:element name="SoftwareType"
type="bio_common:type.software"/>
      <xs:element name="QualityResult"
type="bio_common:type.qa.finger.visa" minOccurs="0"
maxOccurs="unbounded"/>
      <xs:element name="ErrorCode" type="bio_common:type.error.code"
minOccurs="0"/>
      <xs:element name="aux" type="bio_common:type.aux.information"
minOccurs="0"/>
    </xs:sequence>
  </xs:complexType>
</xs:schema>
</xs:complexType>
</xs:schema>
18 Annex B: XSD and XML mapping

Following figure shows the mapping of all available XML schema definitions to the according Function Modules. Furthermore, information about XML examples and the defined namespaces are added to the figure.

Figure 18-1: Mapping of XSDs to Function Modules