

# Face Recognition Vendor Test Ongoing

## Still Face 1:N Identification Application Programming Interface VERSION 1.0.3

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November 3, 2021

**Revision History**

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| Date              | Version | Description   |
|-------------------|---------|---|
| April 1, 2019     | 1.0     | Initial document  |
| September 9, 2020 | 1.0.1   | - Update link to General Evaluation Specifications document<br>- Adjust the legal similarity score range  |
| August 16, 2021   | 1.0.2   | Removed FRVT 1:1 pre-requisite. Developers may now participate in FRVT 1:N without having to participate in FRVT 1:1  |
| November 3, 2021  | 1.0.3   | - Added clarification that multi-threading is allowed in the finalizeEnrollment() function<br>- Removed holdover text from 2018<br>- Added clarification on function time limits to be based on a single core |

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## 38 1. FRVT 1:N

### 39 1.1. Scope

40 This document establishes a concept of operations and an application programming interface (API) for evaluation of one-  
 41 to-many face recognition algorithms applied to faces appearing in 2D still photographs. The test will include cooperative  
 42 portrait images, e.g. mugshots<sup>1</sup> as well as non-cooperative images<sup>2</sup>. The API communicates the type of image to the  
 43 algorithm, so that feature extraction may be tailored.

## 44 2. Rules for participation

### 45 2.1. Relation to the FRVT Ongoing 1:1 Evaluation

46 Since February 2017, NIST has been running an ongoing evaluation of one-to-one face verification algorithms, FRVT 1:1.  
 47 This allows any developer to submit algorithms at any time, once every few months, thereby better aligning development  
 48 and evaluation schedules. It will benefit developers to submit their core 1:1 recognition algorithms to the FRVT 1:1  
 49 process.

50 ~~**IMPORTANT:** Participation in the FRVT Ongoing 1:1 is required for participation in FRVT Ongoing 1:N. Participants must~~  
 51 ~~meet minimum accuracy requirements in the 1:1 test in order to submit to the 1:N.~~

## 52 3. General FRVT Evaluation Specifications

53 General and common information shared between all Ongoing FRVT tracks are documented in the FRVT General  
 54 Evaluation Specifications document - [https://pages.nist.gov/frvt/api/FRVT\\_common.pdf](https://pages.nist.gov/frvt/api/FRVT_common.pdf). This includes rules for  
 55 participation, hardware and operating system environment, software requirements, reporting, and common data  
 56 structures that support the APIs.

## 57 4. Core accuracy metrics

58 This test will execute open-universe searches. That is, some proportion of searches will not have an enrolled mate. From  
 59 the candidate lists returned by algorithms, NIST will compute and report accuracy metrics, primarily:

- 60 — False negative identification rate (FNIR) – the proportion of mated searches which do not yield a mate within the top  
 61 R ranks and at or above threshold, T.
- 62 — False positive identification rate (FPIR) – the proportion of non-mated searches returning any (1 or more) candidates  
 63 at or above a threshold, T.
- 64 — Selectivity – the number of non-mated candidates returned at or above a threshold, T. This quantity has a value  
 65 running from 0 to L, the number of candidates requested. It may be fractional, as it is estimated as a count divided by  
 66 the number of non-mate searches.

67 These quantities are estimated from candidate lists produced by requesting the top L most similar candidates to the  
 68 search. We do not intend to execute searches requesting only those candidates above a specified input threshold.

69 We will report FNIR, FPIR and selectivity by sweeping the threshold over the interval [0, infinity). Error tradeoff plots (FNIR  
 70 vs. FPIR, parametric on threshold) will be the primary reporting mechanism.

71 We will also report FNIR by sweeping a rank R over the interval [1, L] to produce (the complement of) the cumulative  
 72 match characteristic (CMC).

73 We will report proportions of attempted template generations that fail to produce a viable template – i.e failure to enroll  
 74 rate (FTE).

<sup>1</sup> The [MEDS](#) database includes sample mugshots.

<sup>2</sup> The [IJB-C](#) database includes non-cooperative, in-the-wild images.

## 5. Application relevance

NIST anticipates reporting FNIR in two FPIR / Selectivity regimes:

- Investigation mode: Given candidate lists and a threshold of zero, the CMC metric is relevant to investigational applications where human examiners will adjudicate candidates in decreasing order of similarity. This is common in law enforcement “lead generation”.
- Identification mode: We will apply (high) thresholds to candidate lists and report FNIR values relevant to identification applications where human labor is matched to the tolerable number of false positives per unit time. This is used in duplicate-ID detection searches for credential issuance and, more so, in surveillance applications.

Developers are encouraged to submit variants tailored to minimize FNIR in the two FPIR regimes, and to explore the speed-accuracy trade space.

## 6. Limits

### 6.1. Time limits

The elemental functions of the implementations shall execute under the time constraints of Table 1. These time limits apply to the function call invocations defined in section 9. Assuming the times are random variables, NIST cannot regulate the maximum value, so the time limits are median values. This means that the median of all operations should take less than the identified duration. Timing will be estimated from at least 1000 separate invocations of each elemental function. Timing will be measured on Xeon R CPU E5-2630 v4 @ 2.20GHz processors.

**Table 1 – Processing time limits in seconds, per 640 x 480 color image**

| Function  | 1:N             |
|---|-----------------|
| Template Generation: One image to one template                | 1 sec (1 core)  |
| 1:N finalization (on gallery of 1 million enrolled templates) | 40000 sec       |
| 1:N search for:   | 10 sec (1 core) |
| – N = 1 million enrolled templates                            |                 |
| – L = 100 returned candidates                                 |                 |

### 6.2. Template size limits

NIST anticipates evaluating performance with N well in excess of  $10^7$ . For implementations that represent a gallery in memory with a linear data structure, the memory of our machines implies a limit on template sizes. Thus, for a template size B, the total memory requirement would be about NB. NIST anticipates running the largest N values on machines equipped with 768GB of memory. With N = 25 million, templates should not exceed 32KB.

The API, however, supports multi-stage searches and read access of the disk during the 1:N search. Disk access would likely be very slow. In all cases, algorithms shall conform to the search duration limits given in Table 1, with linear scaling.

## 7. Implementation Library Filename

The core library shall be named as `libfrvt_1N_<provider>_<sequence>.so`, with

- provider: single word, non-infringing name of the main provider. Example: acme
- sequence: a three digit decimal identifier to start at 000 and incremented by 1 every time a library is sent to NIST. Example: 007

Example core library names: `libfrvt_1N_acme_000.so`, `libfrvt_1N_mycompany_006.so`.

Important: Public results will be attributed with the provider name and the 3-digit sequence number in the submitted library name.

## 8. Data structures supporting the API

The general data structures supporting this API are documented in the FRVT - General Evaluation Specifications document available at [https://pages.nist.gov/frvt/api/FRVT\\_common.pdf](https://pages.nist.gov/frvt/api/FRVT_common.pdf). The data structures specific to this particular test are described within this document. The header files are published at <https://github.com/usnistgov/frvt>.

### 8.1. File structure for enrolled template collection

To support this 1:N test, NIST will concatenate enrollment templates into a single large file, the EDB (for enrollment database). The EDB is a simple binary concatenation of proprietary templates. There is no header. There are no delimiters. The EDB may be many gigabytes in length.

This file will be accompanied by a manifest; this is an ASCII text file documenting the contents of the EDB. The manifest has the format shown as an example in Table 2. If the EDB contains N templates, the manifest will contain N lines. The fields are space (ASCII decimal 32) delimited. There are three fields. Strictly speaking, the third column is redundant.

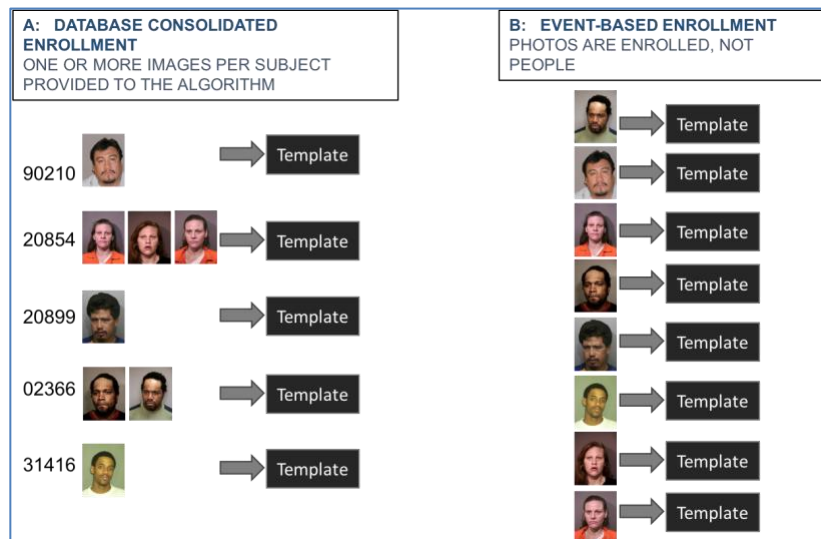
Important: If a call to the template generation function fails, or does not return a template, NIST will include the Template ID in the manifest with size 0. Implementations must handle this appropriately.

**Table 2 – Enrollment dataset template manifest**

| Field name  | Template ID | Template Length | Position of first byte in EDB |
|---|-------------|-----------------|-------------------------------|
| Datatype required   | std::string | uint64_t        | uint64_t                      |
| Example lines of a manifest file appear to the right. Lines 1, 2, 3 and N appear. | 90201744    | 1024            | 0                             |
|   | person01    | 1536            | 1024                          |
|   | 7456433     | 512             | 2560                          |
|   | ...         |                 |                               |
|   | subject12   | 1024            | 307200000                     |

The EDB scheme avoids the file system overhead associated with storing millions of small individual files.

#### 8.1.1. Gallery Type



**Figure 1 – Illustration of consolidated versus unconsolidated enrollment database<sup>3</sup>**

Figure 1 illustrates two types of galleries:

<sup>3</sup> The face images contained in this figure are from the publicly available Special Database 32 - Multiple Encounter Dataset (MEDS). <https://www.nist.gov/itl/iad/image-group/special-database-32-multiple-encounter-dataset-meds>

- 129 — **Consolidated:** The database is formed by enrolling all images of a subject under a common identity label. The result  
 130 is a gallery with N identities and N templates. This type of gallery presents us with the cleanest experimental design,  
 131 “one needle in a haystack” scenario. It allows algorithms to perform image and feature level fusion. Operationally it  
 132 requires high integrity biographical information to maintain.
- 133 — **Unconsolidated:** The database is formed by enrolling photographs without regard to whether the subject already has  
 134 already been enrolled or not. Under this scheme, different images of the same person can exist in the gallery under  
 135 different subject identifiers, that is, there are N identities, and  $M > N$  database entries.
- 136 During gallery finalization, algorithms will be provided with an enumerated label from Table 3 which specifies the type of  
 137 gallery being processed.

Table 3 – Labels describing gallery composition

| Label as C++ enumeration | Meaning   |
|--------------------------|---|
| enum class GalleryType { |   |
| Consolidated,            | Consolidated, subject-based enrollment                |
| Unconsolidated           | Unconsolidated, event-based or photo-based enrollment |
| };                       |   |

### 139 8.1.2. Data structure for result of an identification search

140 All identification searches shall return a candidate list of a NIST-specified length. The list shall be sorted with the most  
 141 similar matching entries list first with lowest rank. The data structure shall be that of Table 4.

Table 4 – Structure for a candidate

|    | C++ code fragment        | Remarks   |
|----|--------------------------|---|
| 1. | typedef struct Candidate |   |
| 2. | {                        |   |
| 3. | bool isAssigned;         | If the candidate computation succeeded, this value is set to true. False otherwise.<br>If value is set to false, similarityScore and templateId will be ignored entirely.   |
| 4. | std::string templateId;  | The Template ID from the enrollment database manifest defined in clause 8.1.  |
| 5. | double similarityScore;  | Measure of similarity between the identification template and the enrolled candidate.<br>Higher scores mean more likelihood that the samples are of the same person.<br><br>An algorithm is free to assign any value to a candidate. The distribution of values will have<br>an impact on the false-negative and false-positive identification rates.<br><br>The similarity score values should be reported on the range that is used in the developer’s<br>software products. Larger values indicate more likelihood that the two samples are from<br>the same person. However, we require scores to be non-negative. Developers often use<br>[0,1], for example. Our test reports include various plots with threshold values e.g.<br>FMR(T), to allow end-users to set thresholds in operations. These plots may become<br>difficult to interpret if scores span many orders of magnitude. |
| 6. | } Candidate;             |   |

143

## 144 9. API specification

145 FRVT 1:N participants shall implement the relevant C++ prototyped interfaces of section 9. C++ was chosen in order to  
 146 make use of some object-oriented features.

147

148 Please note that included with the FRVT 1:N validation package (available at <https://github.com/usnistgov/frvt>) is a “null”  
 149 implementation of this API. The null implementation has no real functionality but demonstrates mechanically how one  
 150 could go about implementing this API.

## 151 9.1. Header File

152 The prototypes from this document will be written to a file named **frvt1N.h** and will be available to implementers at  
 153 <https://github.com/usnistgov/frvt>.

## 154 9.2. Namespace

155 All supporting data structures will be declared in the `FRVT` namespace. All API interfaces/function calls for this track will  
 156 be declared in the `FRVT_1N` namespace.

## 157 9.3. Overview

158 The 1:N identification application proceeds in three phases: enrollment, finalization and identification. The identification  
 159 phase includes separate probe feature extraction and search stages.

160 The design reflects the following *testing* objectives for 1:N implementations.

- support distributed enrollment on multiple machines, with multiple processes running in parallel
- allow recovery after a fatal exception, and measure the number of occurrences
- allow NIST to copy enrollment data onto many machines to support parallel testing
- respect the black-box nature of biometric templates
- extend complete freedom to the provider to use arbitrary algorithms
- support measurement of duration of core function calls
- support measurement of template size
- support measurement of template insertion and removal times into an enrollment database

161 **Table 5 – Procedural overview of the 1:N test**

| Phase                | #  | Name                | Description   | Performance Metrics to be reported by NIST   |
|----------------------|----|---------------------|---|--|
| Enrollment           | E1 | Initialization      | <b>initializeTemplateCreation(TemplateRole=Enrollment_1N)</b><br>Give the implementation the name of a directory where any provider-supplied configuration data will have been placed by NIST. This location will otherwise be empty.<br>The implementation is permitted <b>read-only</b> access to the configuration directory.  |  |
|                      | E2 | Parallel Enrollment | <b>createTemplate(TemplateRole=Enrollment_1N)</b><br>For each of N individuals, pass $K \geq 1$ images of the individual to the implementation for conversion to a template. The implementation will return a template to the calling application.<br>NIST's calling application will be responsible for storing all templates as binary files. These will not be available to the implementation during this enrollment phase.<br>Multiple instances of the calling application may run simultaneously or sequentially. These may be executing on different computers.                               | Statistics of the times needed to enroll an individual.<br>Statistics of the sizes of created templates.<br>The incidence of failed template creations.  |
| Gallery Finalization | F1 | Finalization        | <b>finalizeEnrollment()</b><br>Permanently finalize the enrollment directory. This supports, for example, adaptation of the image-processing functions, adaptation of the representation, writing of a manifest, indexing, and computation of statistical information over the enrollment dataset.<br>The implementation is permitted <b>read-write-delete access</b> to the enrollment directory and <b>read-only access</b> to the configuration directory during this phase.<br><b>Note:</b> <code>finalizeEnrollment()</code> will be called in a separate process than the enrollment functions. | Size of the enrollment database as a function of population size N.<br>Duration of this operation. The time needed to execute this function shall be reported with the preceding enrollment times. |



|                         |    |                                 |  |  |
|-------------------------|----|---------------------------------|--|--|
| Probe Template Creation | S1 | Initialization                  | <b>initializeTemplateCreation(TemplateRole=Search_1N)</b><br>Give the implementation the name of a directory where any provider-supplied configuration data will have been placed by NIST. This location will otherwise be empty.<br>The implementation is permitted <b>read-only</b> access to the configuration directory.   | Statistics of the time needed for this operation.  |
|                         | S2 | Template preparation            | <b>createTemplate(TemplateRole=Search_1N)</b><br>For each probe, create a template from $K \geq 1$ images.<br>The result of this step is a search template.<br>Multiple instances of the calling application may run simultaneously or sequentially. These may be executing on different computers.  | Statistics of the time needed for this operation.<br>Statistics of the size of the search template.                |
| Search                  | S3 | Initialization                  | <b>initializeIdentification()</b><br>Tell the implementation the location of an enrollment directory that contains the gallery files produced from the <b>finalize()</b> function. The enrollment directory will always contain a successfully finalized gallery (i.e. will never be empty). The implementation should read all or some of the enrolled data into main memory, so that searches can commence.<br>The implementation is permitted <b>read-only access</b> to the enrollment directory during this phase.<br><b>Note:</b> The search functions ( <code>initializeIdentification()</code> , <code>identifyTemplate()</code> ) will be called in a separate process from the enrollment functions, therefore, you <u>cannot</u> assume that <code>initializeTemplateCreation()</code> is called by the test harness prior to the search functions. | Statistics of the time needed for this operation.  |
|                         | S4 | Search                          | <b>identifyTemplate()</b><br>A template is searched against the enrollment database.<br>Developers shall not attempt to improve the duration of the <code>identifyTemplate()</code> function by offloading any of its processing into the <code>createTemplate()</code> function.  | Statistics of the time needed for this operation.<br>Accuracy metrics - Type I + II error rates.<br>Failure rates. |
| Gallery Insert          | G1 | Initialization                  | <b>initializeIdentification()</b><br>Tell the implementation the location of an enrollment directory. The implementation should read all or some of the enrolled data into main memory, so that searches can commence.<br>The implementation is permitted <b>read-only access</b> to the enrollment directory during this phase.   | Statistics of the duration of the operation.   |
|                         | G2 | Template insertion into gallery | <b>galleryInsertID()</b><br><code>galleryInsertID()</code> is executed one or more times to insert a template created with <code>createTemplate(TemplateRole=Enrollment_1N)</code> into the gallery.   | Statistics of the duration of the operation.   |
|                         | G3 | Search                          | <b>identifyTemplate()</b><br>A template is searched against the enrollment database.   | Statistics of the duration of the operation.<br>Accuracy metrics - Type I + II error rates.                        |

## 162 9.4. API

### 163 9.4.1. Interface

164 The software under test must implement the interface `Interface` by subclassing this class and implementing each  
 165 method specified therein.

|    | C++ code fragment                                      | Remarks  |
|----|--|--|
| 1. | Class Interface  |  |
| 2. | {  |  |
| 3. | public:  |  |
|    | static std::shared_ptr<Interface> getImplementation(); | Factory method to return a managed pointer to the <code>Interface</code> object. This function is implemented by the submitted library and must return a managed pointer to the <code>Interface</code> object. |
| 4. | // Other functions to implement                        |  |
| 5. | };   |  |

166 There is one class (static) method declared in `Interface.getImplementation()` which must also be  
167 implemented. This method returns a shared pointer to the object of the interface type, an instantiation of the  
168 implementation class. A typical implementation of this method is also shown below as an example.

|  | C++ code fragment   | Remarks |
|--|---|---------|
|  | <pre>#include "frvt1N.h"  using namespace FRVT_1N;  NullImpl:: NullImpl () { }  NullImpl::~ NullImpl () { }  std::shared_ptr&lt;Interface&gt; Interface::getImplementation() {     return std::make_shared&lt;NullImpl&gt;(); }  // Other implemented functions</pre> |         |

#### 169 9.4.2. Initialization of template creation

170 Before any feature extraction/template creation calls are made, the NIST test harness will call the initialization function of  
171 Table 6. This function will be called BEFORE any calls to `fork()` are made.

172 **Table 6 – Template creation initialization**

|                   |  |   |
|-------------------|--|---|
| Prototype         | ReturnStatus initializeTemplateCreation(   |   |
|                   | const std::string &configDir,  | Input   |
|                   | TemplateRole role);  | Input   |
| Description       | <p>This function initializes the implementation under test and sets all needed parameters in preparation for template creation. This function will be called N=1 times by the NIST application, prior to parallelizing M &gt;= 1 calls to <code>createTemplate()</code> via <code>fork()</code>.</p> <p>This function will be called from a single process/thread.</p> |   |
| Input Parameters  | configDir  | A read-only directory containing any developer-supplied configuration parameters or run-time data files.  |
|                   | role   | A value from the <code>TemplateRole</code> enumeration that indicates the intended usage of the template to be generated. In this case, either <code>Enrollment_1N</code> or <code>Search_1N</code> . |
| Output Parameters | None   |   |
| Return Value      | See <a href="#">General Evaluation Specifications</a> document for all valid return code values.   |   |

#### 173 9.4.3. Template Creation

174 A Multiface is converted to a single template using the function of Table 7.

175 Some of the proposed datasets include K > 2 images per person for some persons. This affords the possibility to model a  
176 recognition scenario in which a new image of a person is compared against all prior images. Use of multiple images per  
177 person has been shown to elevate accuracy over a single image.

For this test, NIST will enroll  $K \geq 1$  images under each identity. Normally the probe will consist of a single image, but NIST may examine the case that it could consist of multiple images. Ordinarily, the probe images will be captured after the enrolled images of a person. The method by which the face recognition implementation exploits multiple images is not regulated. The test seeks to evaluate developer provided technology for multi-presentation fusion.

This document defines a template to be the result of applying feature extraction to a set of  $K \geq 1$  images. An algorithm might internally fuse  $K$  feature sets into a single model or maintain them separately - in any case the resulting proprietary template is contained in a contiguous block of data. All identification functions operate on such multi-image templates.

**Table 7 – Template Creation/Feature Extraction**

|                   |   |   |        |
|-------------------|---|---|--------|
| Prototypes        | ReturnStatus createTemplate(<br>const Multiface &faces,<br>TemplateRole role,<br>std::vector<uint8_t> &templ,<br>std::vector<EyePair> &eyeCoordinates);   |   |        |
|                   |   |   | Input  |
|                   |   |   | Input  |
|                   |   |   | Output |
|                   |   |   | Output |
| Description       | <p>Takes a Multiface and outputs a proprietary template and associated eye coordinates. The vector to store the template will be initially empty, and it is up to the implementation to populate it with the appropriate data.</p> <p>Note: In the event that more than one face is detected in an image, features should be extracted from the foreground face, that is, the largest face in the image.</p> <p><i>For enrollment templates (TemplateRole=Enrollment_1N):</i> If the function executes correctly (i.e. returns a successful return code), the template will be enrolled into a gallery. The NIST calling application may store the resulting template, concatenate many templates, and pass the result to the enrollment finalization function (see section 9.4.4). The resulting template may also be inserted immediately into previously finalized gallery. When the implementation fails to produce a template (i.e. returns a non-successful return code), it shall still return a blank template (which can be zero bytes in length). The template will be included in the enrollment database/manifest like all other enrollment templates, but is not expected to contain any feature information.</p> <p>IMPORTANT: NIST's application writes the template to disk. Any data needed during subsequent searches should be included in the template, or created from the templates during the enrollment finalization function of section 9.4.4.</p> <p><i>For identification/probe templates (TemplateRole=Search_1N):</i> The NIST calling application may commit the template to permanent storage, or may keep it only in memory (the developer implementation does not need to know). If the function returns a non-successful return status, the output template will not be used in subsequent search operations.</p> |   |        |
| Input             | face  | Input Multiface   |        |
| Parameters        | role  | Label describing the type/role of the template to be generated. In this case, it will either be Enrollment_1N or Search_1N.   |        |
| Output Parameters | templ   | The output template. The format is entirely unregulated. This will be an empty vector when passed into the function, and the implementation can resize and populate it with the appropriate data. |        |
|                   | eyeCoordinates  | The function shall return the estimated eye centers for the input face image.   |        |
| Return Value      | See <a href="#">General Evaluation Specifications</a> document for all valid return code values.  |   |        |

#### 9.4.4. Finalization

After all templates have been created, the function of Table 8 will be called. This freezes the enrollment data. After this call the enrollment dataset will be forever read-only.

The function allows the implementation to conduct, for example, statistical processing of the feature data, indexing and data re-organization. The function may alter the file structure. It may increase or decrease the size of the stored data. No output is expected from this function, except a return code.

**Implementations shall not move the input data. Implementations shall not point to the input data. Implementations should not assume the input data will be readable after the call. Implementations must, at a minimum, copy the input data or otherwise extract what is needed for search.**

**Table 8 – Enrollment finalization**

|                   |  |  |       |
|-------------------|--|--|-------|
| Prototypes        | ReturnStatus finalizeEnrollment(<br>const std::string &configDir,<br>const std::string &enrollmentDir,<br>const std::string &edbName,<br>const std::string &edbManifestName,<br>GalleryType galleryType);  |  |       |
|                   |  |  | Input |
|                   |  |  | Input |
|                   |  |  | Input |
|                   |  |  | Input |
|                   |  |  | Input |
| Description       | <p>This function takes the name of the top-level directory where the enrollment database (EDB) and its manifest have been stored. These are described in section 8.1. The enrollment directory permissions will be read + write.</p> <p>The function supports post-enrollment, developer-optional, book-keeping operations, statistical processing and data re-ordering for fast in-memory searching. The function will generally be called in a separate process after all the enrollment processes are complete.</p> <p>This function should be tolerant of being called two or more times. Second and third invocations should probably do nothing.</p> <p>This function will be called from a single process/thread. Implementation of this function does not need to be single-threaded (i.e., developers may use multiple threads within this function).</p> |  |       |
| Input Parameters  | configDir  | A read-only directory containing any developer-supplied configuration parameters or run-time data files.   |       |
|                   | enrollmentDir  | The top-level directory in which enrollment data was placed. This variable allows an implementation to locate any private initialization data it elected to place in the directory.  |       |
|                   | edbName  | The name of a single file containing concatenated templates, i.e. the EDB of section 8.1. While the file will have read-write-delete permission, the implementation should only alter the file if it preserves the necessary content, in other files for example.<br>The file may be opened directly. It is not necessary to prepend a directory name. This is a NIST-provided input – implementers shall not internally hard-code or assume any values. |       |
|                   | edbManifestName  | The name of a single file containing the EDB manifest of section 8.1.<br>The file may be opened directly. It is not necessary to prepend a directory name. This is a NIST-provided input – implementers shall not internally hard-code or assume any values.   |       |
|                   | galleryType  | A label from Table 3 specifying the composition of the gallery.  |       |
| Output Parameters | None   |  |       |
| Return Value      | See <a href="#">General Evaluation Specifications</a> document for all valid return code values.   |  |       |

#### 196 9.4.5. Search Initialization

197 The function of Table 9 will be called once prior to one or more calls of the searching function of Table 10 and the gallery  
 198 insert and delete functions of Section 9.4.7. The function might set static internal variables so that the enrollment  
 199 database is available to the subsequent identification searches. This function will be called BEFORE any calls to fork() are  
 200 made.

201 **Table 9 – Identification initialization**

|                  |   |  |       |
|------------------|---|--|-------|
| Prototype        | ReturnStatus initializeIdentification(<br>const string &configDir,<br>const string &enrollmentDir);   |  |       |
|                  |   |  | Input |
|                  |   |  | Input |
| Description      | This function reads whatever content is present in the enrollmentDir, for example a manifest placed there by the finalizeEnrollment() function.<br>This function will be called from a single process/thread. |  |       |
| Input Parameters | configDir   | A read-only directory containing any developer-supplied configuration parameters or run-time data files.   |       |
|                  | enrollmentDir   | The read-only top-level directory in which enrollment data was placed. This directory will contain the gallery files produced from the <b>finalize()</b> function. The enrollment directory will always contain a successfully finalized gallery (i.e. will never be empty). |       |
| Return Value     | See <a href="#">General Evaluation Specifications</a> document for all valid return code values.  |  |       |

#### 202 9.4.6. Search

203 The function of Table 10 compares a proprietary identification template against the enrollment data and returns a  
204 candidate list.

205 **Table 10 – Identification search**

|                   |  |  |        |
|-------------------|--|--|--------|
| Prototype         | ReturnStatus identifyTemplate (  |  |        |
|                   | const std::vector<uint8_t> &idTemplate,  |  | Input  |
|                   | const uint32_t candidateListLength,  |  | Input  |
|                   | std::vector<Candidate> &candidateList,   |  | Output |
|                   | bool &decision);   |  | Output |
| Description       | This function searches a template against the enrollment set, and outputs a list of candidates. The candidateList vector will initially be empty, and the implementation shall populate the vector with candidateListLength entries. |  |        |
| Input Parameters  | idTemplate   | A template from createTemplate(TemplateRole=Search_1N) - If the value returned by that function was non-zero the contents of idTemplate will not be used and this function (i.e. identifyTemplate) will not be called.   |        |
|                   | candidateListLength  | The number of candidates the search should return  |        |
| Output Parameters | candidateList  | A vector containing "candidateListLength " objects of candidates. The datatype is defined in section 8.1.1. Each candidate shall be populated by the implementation. The candidates shall appear in descending order of similarity score - i.e. most similar entries appear first. |        |
|                   | decision   | A best guess at whether there is a mate within the enrollment database. If there was a mate found, this value should be set to true, Otherwise, false. Many such decisions allow a single point to be plotted alongside a DET.   |        |
| Return Value      | See <a href="#">General Evaluation Specifications</a> document for all valid return code values.   |  |        |

206

207 NOTE: Ordinarily the calling application will set the input candidate list length to operationally typical values, say  $0 \leq L \leq$   
208 200, and  $L \ll N$ . We will measure the dependence of search duration on L.

#### 209 9.4.7. Gallery insertion of templates

210 The functions of this section insert a new template into a finalized gallery.

211 **Table 11 – Insertion of template into a gallery**

|                  |   |   |       |
|------------------|---|---|-------|
| Prototype        | ReturnStatus galleryInsertID(   |   |       |
|                  | const std::vector<uint8_t> &templ,  |   | Input |
|                  | const std::string &id);   |   | Input |
| Description      | <p>This function inserts a template with an associated id into an existing finalized gallery. Invocation of this function will always be preceded by a call to initializeIdentification(), which will provide the location of the finalized gallery to be loaded into memory. One or more calls to identifyTemplate() may be made after calling this function.</p> <p>The template ID will not exist in the database already, so a 1:N duplicate search is not necessary.</p> <p>This function will be called from a single process/thread.</p> |   |       |
| Input Parameters | templ   | A template created via createTemplate(TemplateRole=Enrollment_1N) |       |
|                  | id  | An identifier associated with the enrollment template             |       |
| Return Value     | See <a href="#">General Evaluation Specifications</a> document for all valid return code values.  |   |       |

212