TECHNICAL REPORT

ISO/IEC TR 29196

First edition
2015-08-15

Guidance for biometric enrolment

Directives pour l'inscription biométrique

Reference number
ISO/IEC TR 29196:2015(E)

ISO copyright office
Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
copyright@iso.org
www.iso.org

Contents

Page

Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work. In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO and IEC shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT), see the following URL: Foreword – Supplementary information.

The committee responsible for this document is ISO/IEC JTC 1, *Information technology*, Subcommitee SC 37, *Biometrics*.

Introduction

One of the most important contributions to a successful biometric-based recognition system is a consistent enrolment service that generates the biometric data required for subsequent recognition of individuals. Subsequent verifications or identifications will be compared with the biometric data collected at enrolment. If the quality of capture at enrolment is not maintained consistently, the operators of a recognition system which depends on a good enrolment are likely to experience unreliable performance. For those who are enrolled in a verification system, a poor quality enrolment will result in inconvenience should they fail to be recognized. (Readers of this report should note that quality has a specific meaning when applied to biometric systems; a high quality capture is one that results in biometric data that provides good match scores when compared with other high quality images from the same biometric feature.)

By analysing the requirements for a good enrolment from the perspectives of a range of stakeholders, it is possible to derive a set of principles to guide the development of a biometric enrolment policy and the deployment of a service. Where enrolment is outsourced to a third party, it is extremely important to be able to measure quality metrics rather than quantity metrics, since the technical and business objectives of the two organisations (the Relying Party and the Enrolment Authority as defined in this document) may, in general, not be aligned.

Although the recommendations and guidelines in this report are directed in the main at the parties responsible for the enrolment itself and for management of the enrolment service (noting that these two entities may be one and the same), they will also be of value to the designers and developers of enrolment systems.

Guidance for biometric enrolment

1 Scope

This report consolidates information relating to successful, secure and usable implementation of biometric enrolment processes, while indicating areas of uncertainty that organisations proposing to use biometric technologies will need to address during procurement, design, deployment and operation. Much of the information is generic to many types of application e.g. from national scale commercial and government applications, through to closed user group systems for in-house operations, and to consumer applications where convenience rather than security is the primary driver for adoption of biometric technologies.

The report points out the differences in operation relating to specific types of application, e.g. where self-enrolment is more appropriate than attended operation. This report will focus in the main on fixed location enrolments at a number of sites in an organization, where there is an attendant who supports the biometric applicant in effecting a successful enrolment, and where enrolment is a mandatory requirement. In summary, this report consolidates information relating to better practice implementation of biometric enrolment capability in various business contexts including considerations of legislation, policy, process, function (system) and technology.

The report provides guidance as to the collection and storage of biometric enrolment data and the impact on dependent processes of verification and identification. This report will not aim to include material specific to forensic and law enforcement applications.

The recommendations contained in the report are not mandatory.

2 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC 2382-37 and the following apply.

2.1
biometric applicant
individual seeking to be enrolled in a biometric enrolment database

2.2
designers and developers
organization or individuals responsible for the design, development, (and deployment, if applicable) of the enrolment system

2.3
duty officer
individual acting on behalf of either the enrolment authority or operator either present in the vicinity of one or more enrolment stations, or available on line or by telephone, trained to provide advice and guidance to an enrolment officer in case of difficulty

Note 1 to entry: The duty officer may also have a role in determining exception handling routines.

2.4
enrolment authority
organisation (or other entity) with legal and contractual responsibilities for the completion of enrolment processes

2.5
enrolment officer
agent of the operator responsible for the secure and effective enrolment service at one or more enrolment points

2.6
identity provider
entity storing and managing the biometric data obtained directly or indirectly from the biometric enrolment

2.7
operator
organization (or other entity) responsible for delivering the enrolment service on behalf of the enrolment authority

2.8
performance manager
person responsible for managing the enrolment service to ensure it meets its specified enrolment performance criteria

Note 1 to entry: This will typically include actions such as monitoring enrolment performance (quality as well as quantity metrics), applying corrective measures where necessary and reporting enrolment performance achievement to the enrolment authority.

2.9
personal assistant
individual accompanying the biometric applicant at the enrolment session for one or more purposes

Note 1 to entry: Such purposes might include: translation of instructions from the enrolment officer into the native language of the applicant; support for a disabled applicant to enable the applicant to undertake an enrolment successfully; to fulfil a legal requirement such as a parent present at the enrolment of a child.

2.10
relying party
entity operating a biometrically-enabled application for which the enrolment process provides biometric references

2.11
specialist support staff
trained attendant(s) present at the enrolment session on behalf of the enrolment authority or operator to assist with the enrolment of applicants with disabilities, or to fulfil service or legal requirements in respect of gender, religious observance, or age of the applicant

2.12
vendor
entity providing hardware and/or software biometric functionality

3 Abbreviated terms

KPI Key Performance Indicator. A metric quantifying one or more aspects of the successful operation of a process

NFIQ NIST Fingerprint Image Quality

SLA Service Level Agreement. An agreement between a service provider and a customer defining a target level of service, mutual responsibilities of service provider and customer, together with other requirements for the delivery of a service

4 Role of Enrolment in a Biometric System

Given the variety of applications and technologies, it might seem difficult to draw any generalizations about biometric systems. All such systems, however, have many elements in common. Captured biometric samples are acquired from a subject by a sensor. The sensor output is sent to a processor that extracts the distinctive but repeatable measures of the sample (the biometric features), discarding all other components. The resulting features can be stored in the biometric enrolment database as a biometric reference or (in this case) a biometric template. In other cases the sample itself (without feature extraction) may be stored as the reference. A subsequent probe biometric sample can be compared to a specific reference, to many references or to all references already in the database to determine if there is a match. A decision regarding the biometric claim is made based upon the similarities or dissimilarities between the features of the biometric probe and those of the reference or references compared.

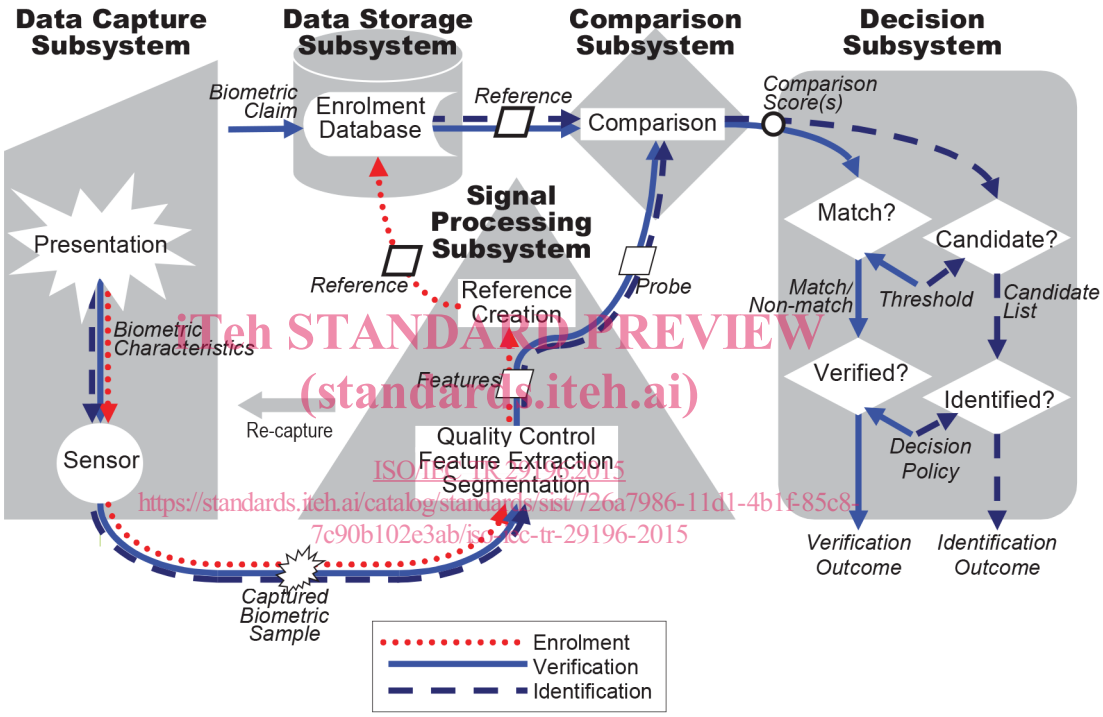

Figure 1 — Components of general biometric system

Figure 1 (which is functional in nature and has no implications for physical location) illustrates the information flow within a general biometric system, showing a general biometric system consisting of data capture, signal processing, data storage, comparison and decision subsystems. This diagram illustrates both enrolment, and the operation of verification and identification systems. The following subclauses describe each of these subsystems in more detail. However, it should be noted that in any implemented system, some of these conceptual components may be absent, or may not have a direct correspondence with a physical or software entity.

The data capture subsystem collects an image or signal of a subject's *biometric characteristics* that they have presented to the *biometric sensor*, and outputs this image/signal as a *captured biometric sample*.

The transmission subsystem (not portrayed in the diagram and not always present or visibly present in a biometric system) will transmit *samples, features, probes* and *references* between different subsystems. The captured biometric sample may be compressed and/or encrypted before transmission, and expanded and/or decrypted before use. A captured biometric sample may be altered in transmission due to noise in the transmission channel as well as losses in the compression/expansion process. Data may be transmitted using standard biometric data interchange formats, and cryptographic techniques

may be used to protect the authenticity, integrity, and confidentiality of stored and transmitted biometric data.

Signal processing may include processes such as:

— *enhancement*, i.e. improving the quality and clarity of the captured biometric sample,

— *segmentation*, i.e. locating the signal of the subject's biometric characteristics within the captured biometric sample,

— *feature extraction,* i.e. deriving the subject's repeatable and distinctive measures from the captured biometric sample, and

— *quality control,* i.e. assessing the suitability of samples, features, references, etc. and possibly affecting other processes, such as returning control to the data capture subsystem to collect further *samples*; or modifying parameters for segmentation, feature extraction, or comparison.

In the case of enrolment, the signal processing subsystem creates a biometric reference. Sometimes the enrolment process requires features from several presentations of the individual's biometric characteristics. Sometimes the reference comprises just the features, in which case the reference may be called a "template". Sometimes the reference comprises just the sample, in which case feature extraction from the reference occurs immediately before comparison.

In the case of verification and identification, the signal processing subsystem creates a biometric probe.

Sequencing and iteration of the above-mentioned processes are determined by the specifics of each system.

References are stored within an *enrolment database* held in the data storage subsystem. Each reference might be associated with some details of the enrolled subject or the enrolment process. It should be noted that prior to being stored in the *enrolment database*, *references* may be reformatted into a biometric data interchange format. *References* may be stored within a biometric capture device, on a portable medium such as a smart card, locally such as on a personal computer or local server, or in a central database.

In the comparison subsystem, *probes* are compared against one or more *references* and *comparison scores* are passed to the decision subsystem. The *comparison scores* indicate the similarities or dissimilarities between the *features* and *reference/s* compared. In some cases, the *features* may take the same form as the stored *reference*. For verification, a single specific claim of subject enrolment would lead to a single *comparison score*. For identification, many or all *references* may be compared with the *features*, and output a *comparison score* for each comparison.

The decision subsystem uses the *comparison scores* generated from one or more attempts to provide the decision *outcome* for a verification or identification transaction.

In the case of verification, the *features* are considered to *match* a compared *reference* when (assuming that higher scores correspond to greater similarity) the *comparison score* exceeds a specified *threshold*. A biometric claim can then be verified on the basis of the *decision policy*, which may allow or require multiple attempts.

In the case of identification, the enrolee reference is a potential *candidate* for the subject when (assuming that higher scores correspond to greater similarity) the *comparison score* exceeds a specified *threshold*, and/or when the *comparison score* is among the highest ranked values generated during comparisons across the entire database. The *decision policy* may allow or require multiple attempts before making an identification decision.

NOTE Conceptually, it is possible to treat multibiometric systems in the same manner as unibiometric systems, by treating the combined captured biometric *samples/references/scores* as if they were a single *sample/reference/score* and allowing the decision subsystem to operate score fusion or decision fusion as and if appropriate. (See also ISO/IEC/TR 24722:2007.)

The administration subsystem (not portrayed in the diagram) governs the overall policy, implementation and usage of the biometric system, in accordance with the relevant legal, jurisdictional and societal constraints and requirements. Illustrative examples include

— providing feedback to the subject during and/or after data capture,

— requesting additional information from the subject,

— storing and formatting of the biometric *references* and/or biometric interchange data,

— providing final arbitration on output from decision and/or scores,

— setting *threshold* values,

— setting biometric system acquisition settings,

— controlling the operational environment and non-biometric data storage,

— providing appropriate safeguards for subject privacy, and

— interacting with the application that utilizes the biometric system.

The biometric system may or may not interface to an external application or system via an Application Programming Interface, a Hardware Interface or a Protocol Interface.

In enrolment, a transaction by a Biometric Capture Subject is processed by the system in order to generate and store an enrolment reference for that individual.

Enrolment typically involves

— sample acquisition,

— sample restoration or enhancement,

— segmentation,

— feature extraction,

— quality checks (which may reject the sample/features as being unsuitable for creating a reference, and require acquisition of further samples),

— reference creation (which may require features from multiple samples), possible conversion into a biometric data interchange format,

— storage,

— test verification or identification attempts to ensure that the resulting enrolment is usable, and

— allowing repeat enrolment attempts, should the initial enrolment be deemed unsatisfactory (dependent on the enrolment policy).

A Biometric Capture Subject can also be required to present additional data specific to the enrolment. This additional data might be a legal name, contact information, credentials, identity documents and the like, although there are some biometric applications that may require no additional data whatsoever to be collected at the time of enrolment beyond the biological and behavioural characteristics.

5 Stakeholders and approaches for enrolment

5.1 Enrolment Stakeholders

The successful operation of a biometric enrolment service depends on the co-operation of a large number of stakeholders as listed in Table 1. (See also Figure 2 below showing that Enrolment Officers

work on behalf of the Operator, which has a relationship with the Enrolment Authority; Personal Assistants support the Biometric Capture Subject of the enrolment).Note that systems may be far simpler than illustrated, for example, the Enrolment Authority may also be the Operator of the service, as well as being the Relying Party in an enterprise access control system.

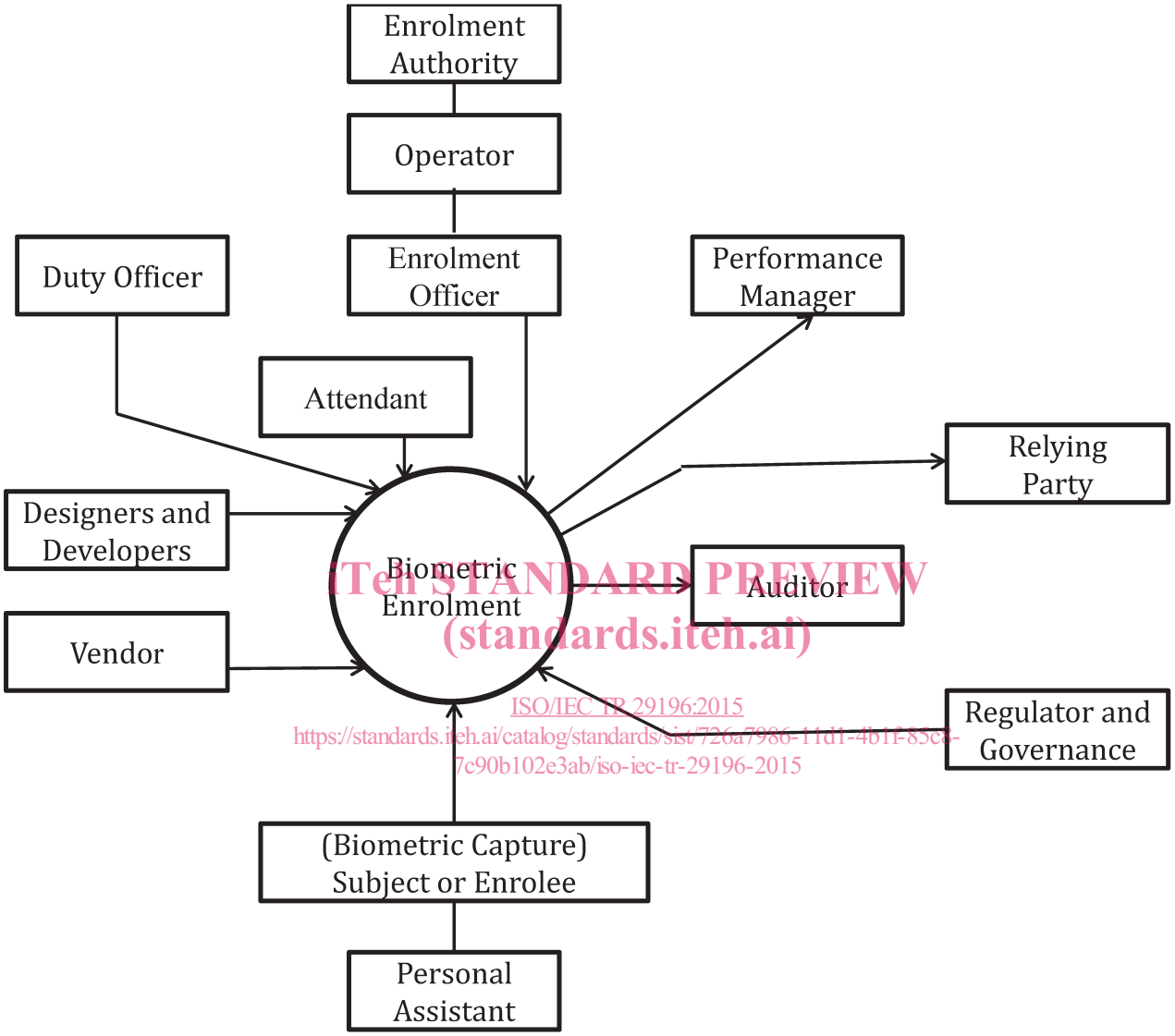

Figure 2 — Stakeholders at Enrolment

Table 1 — Functional Description of Stakeholder roles

Stakeholder	Function description
Enrolment Authority	Responsibility for ensuring the quality of biometric enrolment samples and other KPIs are in accordance with SLA agreements or contractual requirements. Instigating appropriate action if these fall outside the agreed targets. Ensuring compliance with legal requirements. Ensuring that the cultural implications of operating an enrolment service are taken into consideration.

Table 1 *(continued)*

Operator	Organization delivering enrolment service on a day-to-day basis. Responsible to the Enrolment Authority for quality and security of the enrolment service. Taking remedial measures if KPIs, including quality and performance metrics, fall outside the agreed targets.
Performance Manager	Monitoring the performance of the enrolment service. Proposing corrective actions. Reporting back on the results of corrective actions.
Enrolment Officer	Agent of the Operator responsible for the secure and effective enrolment service at one or more enrolment points. Ensures the day-to-day maintenance of equipment used in enrolment. Interfaces with the subjects/Applicants and provides any relevant information to them. Enters any biographical/contextual data (although some of these details may already be pre-populated). Ensures that the quality of the enrolment feature collected by the sensor/camera meets the enrolment standards (usually through requesting the subject to re-enrol if the standard is not achieved). Providing advice and support to the subject to achieve a high standard of enrolment. Notes any exceptional circumstances.
Duty Officer	Provide technical and/or operational advice and guidance to an Enrolment Officer.
Attendant	Assist the Enrolment Officer in obtaining the best available quality biometric sample through following procedures set for subjects with accessibility needs or who have special requirements (in respect of age, gender, religious observance, etc).
The Biometric Capture Subject / Biometric Enrollee, hereafter termed subject and Enrollee respectively	Provide biometric sample to the system.
Personal Assistant	Provide support for the Applicant/Enrollee, e.g. translation of instructions from the Enrolment Officer, support for a disabled Applicant or to fulfil a legal requirement such as a parent present at the enrolment of a child.
Designers and Developers	Designing the enrolment system as part of the enrolment service using systems engineering principles wherever possible. Developing enrolment system, service and process. Specifically developing an interaction protocol for enrolee. Specifically, developing the service for production and distribution of any token used as storage for biometric reference(s), or a pointer to where biometric reference(s) is/are stored.

Table 1 *(continued)*

Vendor	Providing hardware and software. Providing (either directly or through an agent) technical support e.g. for upgrades or rectification of faults, if under contract to do so.
Regulators and other Governance Bodies	Assuring the enrolment process is operated according to laws, regulations, codes of practice, contracts, etc.
Auditor	Audit enrolment protocol.
Identity Provider	Processing the biometric features into references, performing any quality and de-duplication checks and storing references and images.
Relying Party	Using the biometric data obtained from the enrolment service in a biometric recognition service as part of a business-oriented application.

5.2 Enrolment Approaches

Enrolment for biometric services can take the form of many differing approaches depending upon context, complexity, requirements of the Relying Party, etc.

— In-house or outsourced.

— Multiple or single location.

— Fixed, mobile or remote.

— Attended, semi-attended (one enrolment officer overseeing a number of enrolments in parallel) or unattended (e.g. self-enrolment[1)]).

— Mandatory, optional (opt-in), or unaware (e.g. for surveillance/tracking).

— Using a single modality or multiple biometric modalities.

— Designed to provide enrolments for either multiple applications or for a specific application. Enrolment is an expensive part of a biometric service thus in order to reduce costs enrolment may at times be undertaken for multiple Relying Parties, each with differing business, technical and functional requirements. For example the enrolled facial image for a passport may be re-used for a driving licence application. Other enrolment processes may be required to be more specific in design – e.g. access control 'Offline' or 'batch' enrolment where the biometric sample capture process is separate from the enrolment stage, or an integrated credential proofing/acquisition/enrolment process.

— Duration/complexity of the enrolment process, from a simple single modality process (against pre-assigned identity), to a complex process consisting of checks on identity using breeder documents, followed by collection of features relating to multiple modalities and a verification check on the effective operation of the collected features.

Based upon how the system is influenced by the above factors, there will be different requirements and operational guidance.

1) Self-enrolment may be with the active participation of the subject, or can even be acquired with stand-off systems not requiring direct interaction with the subject.

6 Key Stakeholder perspectives

6.1 Summary of key observations

A reproducible biometric enrolment process is a prerequisite for the successful use of biometric recognition in one or more applications at a subsequent time. A poor quality enrolment, e.g. one in which the Biometric Applicant's biometric features have not been collected in line with best practice, will present difficulties when the reference derived from these features is compared with biometric data collected in the context of the application. (Biometric Applicant is termed Applicant hereafter.) For instance, if a thumb is presented and registered in an enrolment for access control, and the Biometric Capture Subject (hereafter termed subject) uses one of the index fingers as instructed by a biometric verification unit at a door, the biometric comparison will fail. The subject will therefore be inconvenienced, in having to use an exception-handling process provided by the Operator of the access control system.

Such problems are likely to occur more often when the Enrolment Authority (and/or operator) for the enrolment service is not the same as that managing the subsequent application that uses biometric recognition (the Relying Party). In this case, the Enrolment Authority bears the costs of ensuring that the quality of enrolments is maintained while the benefits of good quality enrolments accrue to the Relying Party (or Parties). Rather than setting this cost/benefit pivot at the interface between the two organizations, a better strategy is to move it to the enrolment service, incentivizing the Enrolment Authority to deliver high quality enrolments. This will usually entail clear and correct specification of metrics for the enrolment performance in any contracts or agreements between these two organizations.

In setting the requirements for an enrolment service, the Enrolment Authority should take account of the requirements of the Relying Party as well as other stakeholders as listed in Table 1 and represented schematically in 5.1. (When these requirements are not known in full, e.g. because the recognition system of the Relying Party is still under development, designers of enrolment services should take appropriate measures to mitigate any risks.) The SLA between the Enrolment Authority and the Operator of the enrolment service should include KPIs that relate to the business objectives of the Enrolment Authority as well as those of the Relying Party. Requirements should include quantitative performance measures capable of being tested either by the Enrolment Authority or by an independent testing organization during the acceptance phase of the project, as well as periodically afterwards.

The designers and developers of the enrolment system will use the requirements to source suitable vendors of the biometric components, such as the hardware to collect biometric features, software to process these features and assess their quality, and - if required - verification software to check that the enrolment has been completed satisfactorily.

The security of the biometric enrolment process is also an essential aspect of its success. In preparing for a robust process design, all stakeholders are responsible for addressing security requirements, from the design of the logical technical architecture to the functional components, as well as procedures and checks that directly involve interaction with the Applicant and the Subject.

The Enrolment Authority's designers and developers need to address these requirements, as early as possible in the design, such as the ability to check the identity credentials presented by the Applicant and taking measures to counter spoofing attacks. Note that catering to the needs of Applicants with language difficulties and disabilities will also feature in the design but may impact on the security procedures. These aspects of the enrolment process – and any requirements placed by regulators – should be developed into training materials for Enrolment Officers, attendants, duty officers and the Performance Manager.

After completion of the high level design, and prior to deployment, marketing and other awareness-raising activities should be started, so that representatives of the Applicant population, mass media, regulators and special interest groups have time to comment on the proposals for the enrolment service and for changes in the details of the design of the system to be incorporated.