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Information security — Criteria and methodology for security evaluation of biometric systems —

Part 1:
Framework

Sécurité de l'information — Critères et méthodologie pour l'évaluation de la sécurité des systèmes biométriques — Partie 1: Cadre

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Foreword

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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).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 27, *Information security, cybersecurity and privacy protection*.

A list of all parts in the ISO/IEC 19989 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Biometric systems can be vulnerable to presentation attacks where attackers attempt to subvert the system security policy by presenting their natural biometric characteristics or artefacts holding copied or faked characteristics. Presentation attacks can occur during enrolment or identification/ verification events. Techniques designed to detect presentation artefacts are generally different from those to counter attacks where natural characteristics are used. Defence against presentation attacks with natural characteristics typically relies on the ability of a biometric system to discriminate between genuine enrolees and attackers based on the differences between their natural biometric characteristics. This ability is characterized by the biometric recognition performance of the system. Biometric recognition performance and presentation attack detection have a bearing on the security of biometric systems. Hence, the evaluation of these aspects of performance from a security viewpoint will become important considerations for the procurement of biometric products and systems.

Biometric products and systems share many of the properties of other IT products and systems which are amenable to security evaluation using the ISO/IEC 15408 series and ISO/IEC 18045 in the standard way. However, biometric systems embody certain functionality that needs specialized evaluation criteria and methodology which is not addressed by the ISO/IEC 15408 series and ISO/IEC 18045. Mainly these relate to the evaluation of biometric recognition and presentation attack detection. These are the functions addressed in the ISO/IEC 19989 series.

ISO/IEC 19792 describes these biometric-specific aspects and specifies principles to be considered during the security evaluation of biometric systems. However, it does not specify the concrete criteria and methodology that are needed for security evaluation based on the ISO/IEC 15408 series.

The ISO/IEC 19989 series provides a bridge between the evaluation principles for biometric products and systems defined in ISO/IEC 19792 and the criteria and methodology requirements for security evaluation based on the ISO/IEC 15408 series. The ISO/IEC 19989 series supplements the ISO/IEC 15408 series and ISO/IEC 18045 by providing extended security functional components together with supplementary activities related to these requirements. The extensions to the requirements and supplementary activities found in the ISO/IEC 15408 series and ISO/IEC 18045 relate to the evaluation of biometric recognition and presentation attack detection which are particular to biometric systems.

This document consists of the introduction of the general framework for the security evaluation of biometric systems, including extended security functional components, and supplementary methodology and evaluation activities for the evaluator. The detailed recommendations are developed for biometric recognition aspects in ISO/IEC 19989-2 and for presentation attack detection aspects in ISO/IEC 19989-3.

In this document, the term "user" is used to mean the term "capture subject" used in biometrics.

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Part 1: Framework

1 Scope

For security evaluation of biometric recognition performance and presentation attack detection for biometric verification systems and biometric identification systemsthis document specifies:

— extended security functional components to SFR Classes in ISO/IEC 15408-2;

— supplementary activities to methodology specified in ISO/IEC 18045 for SAR Classes of ISO/IEC 15408-3.

This document introduces the general framework for the security evaluation of biometric systems, including extended security functional components, and supplementary activities to methodology, which is additional evaluation activities and guidance/recommendations for an evaluator to handle those activities. The supplementary evaluation activities are developed in this document while the detailed recommendations are developed in ISO/IEC 19989-2 (for biometric recognition aspects) and in ISO/IEC 19989-3 (for presentation attack detection aspects). This document is applicable only to TOEs for single biometric characteristic type. However, the selection of a characteristic from multiple characteristics in SFRs is allowed.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC 2382:2008, *Information technology — Vocabulary*

ISO/IEC 2382-37:2017, *Information technology — Vocabulary— Part 37: Biometrics*

ISO/IEC 15408-1:2009, *Information technology — Security techniques — Evaluation criteria for IT security — Part 1: Introduction and general model*

ISO/IEC 15408-2:2008, *Information technology — Security techniques — Evaluation criteria for IT security — Part 2: Security functional components*

ISO/IEC 15408-3:2008, *Information technology — Security techniques — Evaluation criteria for IT security — Part 3: Security assurance*

ISO/IEC 18045:2008, *Information technology — Security techniques — Methodology for IT security evaluation*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC 2382:2008, ISO/IEC 2382-37:2017, ISO/IEC 15408-1:2009, ISO/IEC 18045:2008, and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at https://www.iso.org/obp

3.1
attack presentation classification error rate
APCER
proportion of attack presentations using the same PAI species incorrectly classified as bona fide presentations in a specific scenario

[SOURCE: ISO/IEC 30107-3:2017, 3.2.1]

3.2
attack type
element and characteristic of a presentation attack, including PAI species, concealer or impostor attack, degree of supervision, and method of interaction with the capture device

[SOURCE: ISO/IEC 30107-3:2017, 3.1.3]

3.3
bona fide presentation
interaction of the biometric capture subject and the biometric data capture subsystem in the fashion intended by the policy of the biometric system

Note 1 to entry: Bona fide is analogous to normal or routine, when referring to a bona fide presentation.

Note 2 to entry: Bona fide presentations can include those in which the user has a low level of training or skill. Bona fide presentations encompass the totality of good-faith presentations to a biometric data capture subsystem.

[SOURCE: ISO/IEC 30107-3:2017, 3.1.2]

3.4
bona fide presentation classification error rate
BPCER
proportion of bona fide presentations incorrectly classified as presentation attacks in a specific scenario

[SOURCE: ISO/IEC 30107-3:2017, 3.2.2]

3.5
PAI species
class of presentation attack instruments created using a common production method and based on different biometric characteristics

EXAMPLE 1   A set of fake fingerprints all made in the same way with the same materials but with different friction ridge patterns would constitute a PAI species.

EXAMPLE 2   A specific type of alteration made to the fingerprints of several data capture subjects would constitute a PAI species.

Note 1 to entry: The term "recipe" is often used to refer to how to make a PAI species.

Note 2 to entry: Presentation attack instruments of the same species may have different success rates due to variability in the production process.

[SOURCE: ISO/IEC 30107-3:2017, 3.1.6]

3.6
penetration testing
testing used in vulnerability analysis for vulnerability assessment, trying to defeat vulnerabilities of the TOE based on the information about the TOE gathered during the relevant evaluation activities

Note 1 to entry: In the ISO/IEC 15408 series, this term is used without definition.

3.7
presentation attack
presentation to the biometric data capture subsystem with the goal of interfering with the operation of the biometric system

Note 1 to entry: Presentation attack can be implemented through a number of methods, e.g. artefact, mutilations, replay, etc.

Note 2 to entry: Presentation attacks may have a number of goals, e.g. impersonation or not being recognized.

Note 3 to entry: Biometric systems may not be able to differentiate between biometric presentation attacks with the goal of interfering with the systems operation and non-conformant presentations.

[SOURCE: ISO/IEC 30107-1:2016, 3.5]

3.8
presentation attack detection
PAD
automated determination of a presentation attack

Note 1 to entry: PAD cannot infer the subject's intent. In fact it may be impossible to derive that difference from the data capture process or acquired sample.

[SOURCE: ISO/IEC 30107-1:2016, 3.6]

3.9
presentation attack instrument
PAI
biometric characteristic or object used in a presentation attack

Note 1 to entry: The set of PAI includes artefacts but would also include lifeless biometric characteristics (i.e. stemming from dead bodies) or altered biometric characteristics (e.g. altered fingerprints) that are used in an attack.

[SOURCE: ISO/IEC 30107-1:2016, 3.7]

Note 2 to entry: Examples of altered biometric characteristics are mutilation, surgical switching of fingerprints between hands and/or toes (See Table 1 in 5.2 of ISO/IEC 30107-1:2016).

4 Symbols and abbreviated terms

APCER   attack presentation classification error rate

BPCER   bona fide presentation classification error rate

IT   information technology

FAR   false acceptance rate

FAU   SFR class of audit

     NOTE   The class name is defined in ISO/IEC 15408-2. Here, F of FAU stands for functional requirement, AU for audit. The class name is defined in this way in the ISO/IEC 15408 series. For details, see Annex A.

FMR   false match rate

FNIR   false-negative identification-error rate

FNMR   false non-match rate

FPIR   false-positive identification-error rate

FPT   SFR class of protection of the TSF

             NOTE   See NOTE to FAU.

FRR   false rejection rate

FTAR   failure-to-acquire rate

FTER   failure-to-enrol rate

PAD   presentation attack detection

PAI   presentation attack instrument

PP   protection profile

SAR   security assurance requirement

SFR   security functional requirement

ST   security target

TOE   target of evaluation

TSF   TOE security functionality

TSFI   TSF interface

5 General remarks

In addition to the requirements and recommendations provided in Clause 7 and Clause 8, those in ISO/IEC 15408-2 shall be applied.

In addition to the requirements and recommendations provided in Clause 9 to Clause 15, those in ISO/IEC 15408-3 and ISO/IEC 18045 shall be applied.

Annex D provides background information on supplementary activities for PAD evaluation.

The definition of authentication can be found in ISO/IEC 2382.

The definitions of biometric (adjective), biometric capture, assurance, biometric capture device, biometric characteristic, biometric concealer, biometric enrolee, biometric enrolment, biometric enrolment database, biometric feature, biometric identification, biometric impostor, biometric presentation, biometric recognition, biometrics, biometric reference, biometric sample, biometric system, biometric verification, comparison, enrol, failure-to-acquire rate, failure-to-enrol rate, alse match rate, false-negative identification-error rate, false non-match rate, false-positive identification-error rate, identify, match (noun) and threshold (noun) can be found in ISO/IEC 2382-37.

NOTE 1   In this document, the expression "capture device" is sometimes used instead of "biometric capture device".

NOTE 2   In this document, the expression "concealer" is sometimes used instead of "biometric concealer".

NOTE 3   In this document, the expression "impostor" is sometimes used instead of "biometric impostor".

The definitions of administrator, assignment, assurance, attack potential, class, component, confirm, delivery, describe, determine, developer, development, element, ensure, evaluation, extension, family, guidance documentation, identity, interaction, interface, life-cycle, object, operation ⟨on a component of ISO/IEC 15408⟩, operation, operational environment, potential vulnerability, Protection Profile, Protection Profile evaluation, security requirement, Security Target, ST evaluation, subject, target of evaluation, TOE security functionality, TSF data, TSF interface, TSF self-protection, verify and vulnerability can be found in ISO/IEC 15408-1.

NOTE 4   The second "operation" is related to the AGD class.

The definitions of action, activity, check, examine, methodology, report, scheme, sub-activity and work unit can be found in ISO/IEC 18045.

6   Vulnerabilities in biometric systems and security evaluation

6.1   Categorization of common vulnerabilities of biometric systems

In ISO/IEC 19792:2009, 8.3, common vulnerabilities of biometric systems are categorized into the following ten factors:

a)   performance limitations;

b)   artefact of biometric characteristics;

c)   modification of biometric characteristics;

d)   difficulty of concealing biometric characteristics;

e)   similarity due to blood relationship;

f)   special biometric characteristics;

g)   synthesized wolf biometric samples;

h)   hostile environment;

i)   procedural vulnerabilities around the enrolment process; and

j)   leakage and alteration of biometric data.

NOTE 1   All of the factors listed above are not vulnerabilities of biometric systems but each is related to them. In this document, the vulnerabilities of the factors or those related to factors, and their relations to security evaluation are considered.

Figure 1 shows the relationship between the vulnerability factors described in ISO/IEC 19792 and the types of evaluation described in this document.
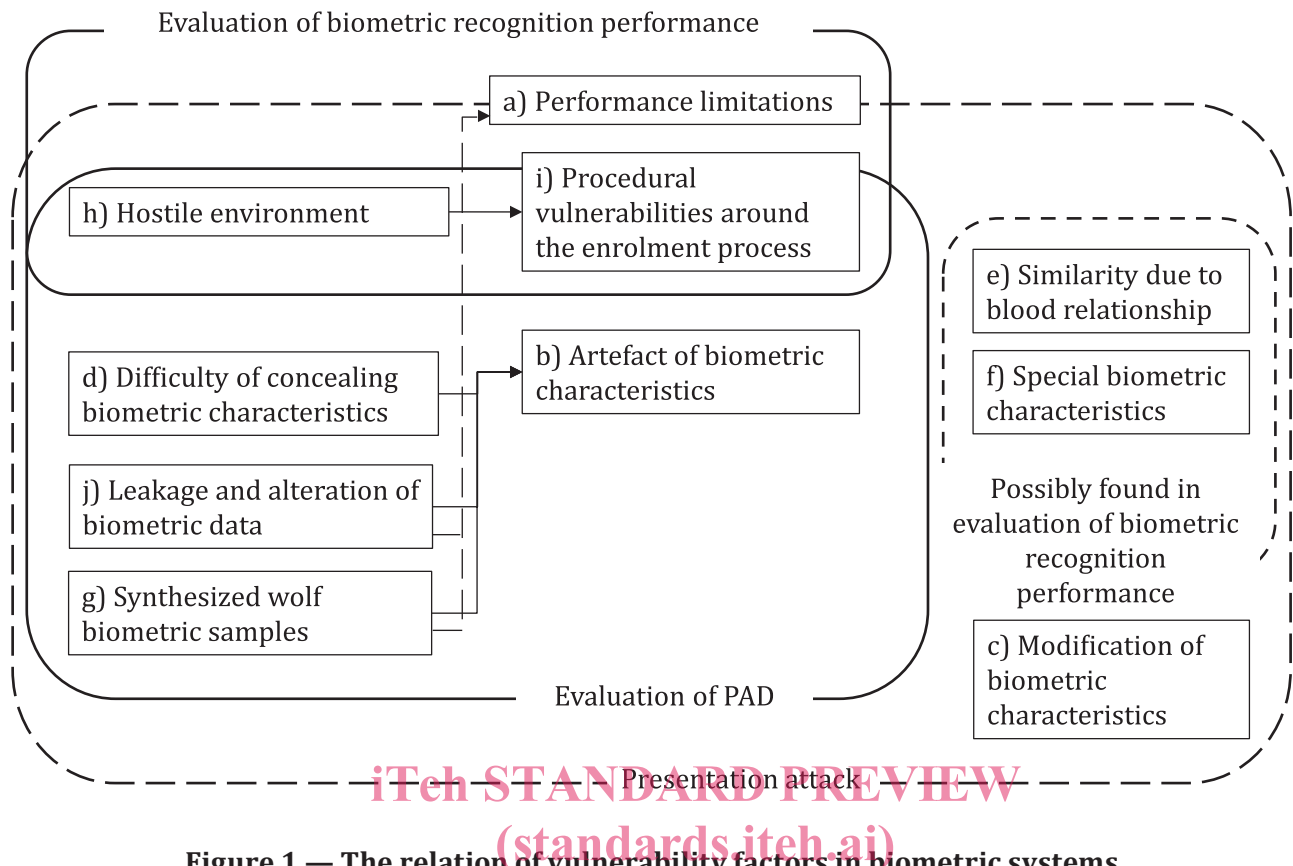
Figure 1 — The relation of vulnerability factors in biometric systems

Factor j) is important as related to the protection of TSF-data/used data (see ISO/IEC 19792). In this document, however, factor j) is considered only from the standpoint of its exploitation by attackers to facilitate the construction of PAIs or mounting attacks related to biometric recognition performance. The evaluation of measures to protect biometric data from leakage or alteration is not addressed here.

Factor a), inherent in all biometric systems, can lead to false acceptances and false rejections, and is addressed in the biometric recognition performance evaluation. However, it can be also considered in relation to the zero-effort attack (presentation from impostor attempts under the policy of the intended use following the TOE guidance documentation). Thus, the biometric recognition performance evaluation and the PAD evaluation interrelate to each other. This factor is relevant to enrolment, verification, and identification.

Other factors are relevant to presentation attacks. However, factors e) and f) are out of scope for a PAD evaluation. Factor f) relates to individuals who have unusual natural biometric characteristics that make them more than usually liable to generate an apparent match against those of other people. However, such individuals are likely to be very difficult to find for the purpose of testing during an evaluation. They can be accidentally found as the result of the evaluation of biometric recognition performance. For factor e), it is difficult to collect such samples for the security evaluation. Outlier subjects giving rise to abnormally high biometric recognition performance can be encountered during biometric recognition performance testing. This can reveal a potential vulnerability in the TOE and relevant information should be used to inform the AVA evaluation activity.

Factor c) may be seen as a means of presentation attack that would exploit recognition weaknesses such as those revealed with a) and f) but thus to be considered in the vulnerability analysis phase. However, it requires extra elements beyond the scope of the objective evaluation. For example, surgery to embed the biometric characteristic of another person requires a sacrifice by the test subject and mimicry requires special skills to be developed by them.

Therefore, factors b), d), g), h), and i) are the factors to be evaluated in ISO/IEC 15408 evaluation for PAD. Factor i) needs to be considered only in enrolment. Factors b), g), and h) are relevant to

enrolment, verification, and identification, but note that factor i) is influenced by factor h) as described in ISO/IEC 19792. A hostile environment can cause an enrolment of poor-quality biometric references that can later be compared to similarly poor quality biometric samples (see ISO/IEC 19792:2009, 8.3.9 and 8.3.10 for further information). Note that factors h) and i) are to be evaluated in ISO/IEC 15408 evaluation for biometric recognition performance. Factor d) refers to the fact that many biometric characteristics are not hidden and Hence, are potentially vulnerable to capture and recording for use in the construction of PAIs to make presentation attacks (e.g. latent fingerprint images, photographs of faces, recordings of voices). Hence, it shall be taken into account when calculating the attack potential of an attack (see F.1). Factor g) should also be considered in biometric recognition performance evaluation, as wolf samples can be exploited by an attack on the system elsewhere than on the data capture subsystem (e.g. via logical injection of a sample during the recognition process). This is related to the vulnerability analysis tasks in ISO/IEC 19989-2.

NOTE 2   Factor g) is indirectly related to factor f). Factor f) can be regarded as a naturally occurring variant of factor g) so that evaluation of the resistance of a TOE to synthesied wolf samples can provide an insight into the potential vulnerability to naturally occurring special biometric characteristics.

An attacker can have a variety of objectives: A biometric impostor would try to be recognized as a biometric enrolee other than themselves. A biometric concealer would try to avoid being matched to their own biometric reference.
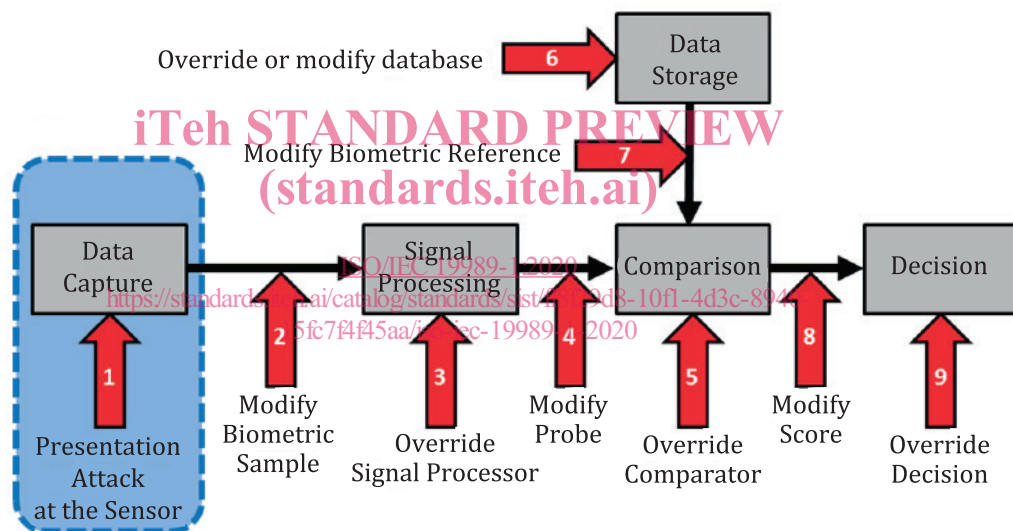

Figure 2 — Examples of points of attack in a biometric system (from ISO/IEC 30107-1)

Figure 2 illustrates generic attacks against a biometric system. Among these attacks, the attack indicated with arrow 1 is a presentation attack and those indicated with arrows 2 and 4 mark places where attacks can be made against captured biometric sample data and relate to biometric recognition performance. Points of attack 2 and 4 are considered in ISO/IEC 19989-2 only when the attack scenario is related to exploiting specific behaviour of biometric recognition performance (for example algorithm weaknesses). The other aspects are covered by generic IT security evaluation approaches and are not specific to the security evaluation of a biometric system. As a summary, the objectives of ISO/IEC 19989-2 and ISO/IEC 19989-3 are the following.

For ATE, ISO/IEC 19989-2 deals with the testing of biometric recognition performance in order to evaluate presentations from impostor attempts under the policy of the intended use following the TOE guidance documentation.

ISO/IEC 19989-3 deals with the testing of presentation attack detection mechanism.

For AVA, ISO/IEC 19989-2 is for all vulnerabilities that are biometric-specific (i.e. related to some extent to biometric recognition performances), excluding those with presentation at the capture subsystem