
**Information technology — Biometric
presentation attack detection —**

**Part 3:
Testing and reporting**

*Technologies de l'information — Détection d'attaque de présentation
en biométrie —*

iTeh STANDARD PREVIEW
Partie 3: Essais et rapports d'essai
(standards.iteh.ai)

[ISO/IEC 30107-3:2017](https://standards.iteh.ai/catalog/standards/sist/757bc955-79b7-4f92-ba6d-b0b887c9840c/iso-iec-30107-3-2017)

<https://standards.iteh.ai/catalog/standards/sist/757bc955-79b7-4f92-ba6d-b0b887c9840c/iso-iec-30107-3-2017>



iTeh STANDARD PREVIEW (standards.iteh.ai)

[ISO/IEC 30107-3:2017](https://standards.iteh.ai/catalog/standards/sist/757bc955-79b7-4f92-ba6d-b0b887c9840c/iso-iec-30107-3-2017)

<https://standards.iteh.ai/catalog/standards/sist/757bc955-79b7-4f92-ba6d-b0b887c9840c/iso-iec-30107-3-2017>



COPYRIGHT PROTECTED DOCUMENT

© ISO/IEC 2017, Published in Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

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	v
Introduction	vi
1 Scope	1
2 Normative references	1
3 Terms and definitions	1
3.1 Attack elements	2
3.2 Metrics	3
4 Abbreviated terms	4
5 Conformance	5
6 Presentation attack detection overview	6
7 Levels of evaluation of PAD mechanisms	6
7.1 Overview	6
7.2 General principles of evaluation of PAD mechanisms	7
7.3 PAD subsystem evaluation	7
7.4 Data capture subsystem evaluation	8
7.5 Full-system evaluation	8
8 Artefact properties	9
8.1 Properties of presentation attack instruments in biometric impostor attacks	9
8.2 Properties of presentation attack instruments in biometric concealer attacks	10
8.3 Properties of synthesized biometric samples with abnormal characteristics	10
9 Considerations in non-conformant capture attempts of biometric characteristics	11
9.1 Methods of presentation	11
9.2 Methods of assessment	11
10 Artefact creation and usage in evaluations of PAD mechanisms	11
10.1 General	11
10.2 Artefact creation and preparation	12
10.3 Artefact usage	13
10.4 Iterative testing to identify effective artefacts	13
11 Process-dependent evaluation factors	13
11.1 Overview	13
11.2 Evaluating the enrolment process	14
11.3 Evaluating the verification process	14
11.4 Evaluating the identification process	14
11.5 Evaluating offline PAD mechanisms	15
12 Evaluation using Common Criteria framework	15
12.1 General	15
12.2 Common Criteria and biometrics	17
12.2.1 Overview	17
12.2.2 General evaluation aspects	17
12.2.3 Error rates in testing	17
12.2.4 PAD evaluation	18
12.2.5 Vulnerability assessment	18
13 Metrics for the evaluation of biometric systems with PAD mechanisms	19
13.1 General	19
13.2 Metrics for PAD subsystem evaluation	20
13.2.1 General	20
13.2.2 Classification metrics	20
13.2.3 Non-response metrics	21
13.2.4 Efficiency metrics	22

13.2.5	Summary.....	22
13.3	Metrics for data capture subsystem evaluation.....	22
13.3.1	General.....	22
13.3.2	Classification metrics.....	22
13.3.3	Non-response and capture metrics.....	22
13.3.4	Efficiency metrics.....	23
13.3.5	Summary.....	23
13.4	Metrics for full-system evaluation.....	23
13.4.1	General.....	23
13.4.2	Accuracy metrics.....	23
13.4.3	Efficiency metrics.....	24
13.4.4	Summary.....	24
Annex A (informative) Classification of attack types.....		25
Annex B (informative) Examples of artefact species used in a PAD subsystem evaluation for fingerprint capture devices.....		31
Bibliography		32

iTeh STANDARD PREVIEW
(standards.iteh.ai)

[ISO/IEC 30107-3:2017](https://standards.iteh.ai/catalog/standards/sist/757bc955-79b7-4f92-ba6d-b0b887c9840c/iso-iec-30107-3-2017)
[https://standards.iteh.ai/catalog/standards/sist/757bc955-79b7-4f92-ba6d-
b0b887c9840c/iso-iec-30107-3-2017](https://standards.iteh.ai/catalog/standards/sist/757bc955-79b7-4f92-ba6d-b0b887c9840c/iso-iec-30107-3-2017)

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 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 the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/IEC JTC 1, Information technology, SC 37, Biometrics.

A list of all parts in the ISO 30107 series can be found on the ISO website.

Introduction

The presentation of an artefact or of human characteristics to a biometric capture subsystem in a fashion intended to interfere with system policy is referred to as a presentation attack. ISO/IEC 30107 (all parts) addresses techniques for the automated detection of presentation attacks. These techniques are called presentation attack detection (PAD) mechanisms.

As is the case for biometric recognition, PAD mechanisms are subject to false positive and false negative errors. False positive errors wrongly categorize bona fide presentations as attack presentations, potentially flagging or inconveniencing legitimate users. False negative errors wrongly categorize presentation attacks (also known as attack presentations) as bona fide presentations, potentially resulting in a security breach.

Therefore, the decision to use a specific implementation of PAD will depend upon the requirements of the application and consideration of the trade-offs with respect to security, evidence strength, and efficiency.

The purpose of this document is as follows:

- to define terms related to biometric presentation attack detection testing and reporting, and
- to specify principles and methods of performance assessment of biometric presentation attack detection, including metrics.

This document is directed at vendors or test labs seeking to conduct evaluations of PAD mechanisms.

Biometric performance testing terminology, practices, and methodologies for statistical analysis have been standardized through ISO and Common Criteria. Metrics such as FAR, FRR, and FTE are widely used to characterize biometric system performance. Biometric performance testing terminology, practices, and methodologies for statistical analysis are only partially applicable to the evaluation of PAD mechanisms due to significant fundamental differences between biometric performance testing concepts and PAD mechanism testing concepts. These differences can be categorized as follows:

a) Statistical significance

Biometric performance testing utilizes a statistically significant number of test subjects representative of the targeted user group. Error rates are not expected to vary significantly when adding more test subjects or using a completely different group. Generally, taking more measurements increases the accuracy of the error rates.

In PAD testing, many biometric modalities can be attacked by a large or indeterminate number of potential presentation attack instrument (PAI) species. In these cases, it is very difficult or even impossible to have a comprehensive model of all possible presentation attack instruments. Hence, it could be impossible to find a representative set of PAI species for the evaluation. Therefore, measured error rates of one set of presentation attack instruments cannot be assumed to be applicable to a different set.

PAI species present a source of systematic variation in a test. Different PAI may have significantly different error rates. Additionally, within any given PAI species, there will be random variation across instances of the PAI series. The number of presentations required for a statistically significant test will scale linearly with the number of PAI species of interest. Within each PAI species, the uncertainty associated with a PAD error rate estimate will depend on the number of artefacts tested and the number of individuals.

EXAMPLE 1 In fingerprint biometrics, many potent artefact materials are known, but any material or material mixture that can present fingerprint features to a biometric sensor is a possible candidate. Since artefact properties such as age, thickness, moisture, temperature, mixture rates, and manufacturing practices can have a significant influence on the output of the PAD mechanism, it is easy to define tens of thousands of PAI species using current materials. Hundreds of thousands of presentations would be needed for a proper statistical analysis – even then, resulting error rates could not be transferred to the next set of new materials.

b) Comparability of test results across systems

In biometric performance testing, application-specific error rates based on the same corpus of biometric samples can be used to compare different biometric systems or different configurations. The meaning of “better” and “worse” is generally understood.

By contrast, when using error rates to benchmark PAD mechanisms, terms such as “better” can be highly dependent on the intended application.

EXAMPLE 2 In a given testing scenario with 10 PAI species (presented 100 times), System₁ detects 90 % of attack presentations and System₂ detects 85 %. System₁ detects all presentations for 9 PAI species but fails to detect all presentations with the 10th PAI species. System₂ detects 85 % of all PAI species. Which is better? In a security analysis, System₁ would be worse than System₂, because revealing the 10th PAI species would orient an attacker such that he could use this method to defeat the capture device all the time. However, if attackers could be prevented from using the 10th PAI species, System₁ would be better than System₂, because individual rates indicate that it is possible to overcome System₂ with all PAI species.

c) Cooperation

Many biometric performance tests address applications such as access control in which subjects are cooperative. Errors due to incorrect operation are an issue of a lack of knowledge, experience or guidance rather than intent. Significant uncooperative behaviour in a group is not part of the underlying “biometric model” and would render the determined error rates almost useless for biometric performance testing.

PAD tests include subjects whose behaviour is not cooperative. Attackers will try to find and exploit any weakness of the biometric system, circumventing or manipulating its intended operation. Presentation attack types, based on the experience and knowledge of the tester, can change the success rates for an attack dramatically. Hence, it can be difficult to define testing procedures that measure error rates in a fashion representative of cooperative behaviour.

d) Automated testing

In biometric performance testing, it is often possible to test comparison algorithms using databases from devices or sensors of similar quality. Performance can be measured in a technology evaluation using previously collected corpuses of samples as specified in ISO/IEC 19795-1.

In PAD testing, data from the biometric sensor (e.g. digitized fingerprint images) may be insufficient to conduct evaluations. Biometric systems with PAD mechanisms often contain additional sensors to detect specific properties of a biometric characteristic. Hence, a database previously collected for a specific biometric system or configuration may not be suitable for another biometric system or configuration. Even slight changes in the hardware or software could make earlier measurements useless. It is generally impractical to store multivariate synchronized PAD signals and replay them in automated testing. Therefore, automated testing is often not an option for testing and evaluating PAD mechanisms.

e) Quality and performance

In biometric performance testing, performance is usually linked directly to biometric data quality. Low-quality samples generally result in higher error rates while a test with only high-quality samples will generally result in lower error rates. Hence, quality metrics are often used to improve performance (dependent on the application).

In PAD testing, even though low biometric quality can cause an artefact to be unsuccessful, there is no reason to assume a certain quality level from artefacts in general. Samples from artefacts can exhibit better quality than samples from human biometric characteristics. Absent a model of attacker skill, it seems valid (at least in a security evaluation) to assume a “worst case” scenario where the attacker always uses the best possible quality. That way, one can at least determine a guaranteed minimal detection rate for the specific test set while reducing the number of necessary tests at the same time. It is then a matter of rating the attack potential of successful artefacts (effort and expertise for the needed quality) in order to assess the security level, as is the practice in Common Criteria evaluations.

Based on the differences a) through e), the following general comments regarding error rates and metrics related to PAD mechanisms can be derived:

- In an evaluation, PAI species are analysed/rated separately.
- Attack presentation classification error rates other than 0 % for a PAI species only prove that the PAI can be successful. A different tester might achieve a higher or lower attack presentation classification error rate. Further, training to identify the relevant material and presentation parameters could increase the attack presentation classification error rate for this PAI species. The experience and knowledge of the tester, as well as the availability of the necessary resources, are significant factors in PAD testing and are taken into account when conducting comparisons or performance analysis.
- Error rates for PAD mechanisms are determined by the specific context of the given PAD mechanism, the set of PAI species, the application, the test approach, and the tester. Error rates for PAD mechanisms are not necessarily comparable across similar tests, and error rates for PAD mechanisms are not necessarily reproducible by different test laboratories.

iTeh STANDARD PREVIEW
(standards.iteh.ai)

[ISO/IEC 30107-3:2017](https://standards.iteh.ai/catalog/standards/sist/757bc955-79b7-4f92-ba6d-b0b887c9840c/iso-iec-30107-3-2017)

<https://standards.iteh.ai/catalog/standards/sist/757bc955-79b7-4f92-ba6d-b0b887c9840c/iso-iec-30107-3-2017>

Information technology — Biometric presentation attack detection —

Part 3: Testing and reporting

1 Scope

This document establishes:

- principles and methods for performance assessment of presentation attack detection mechanisms;
- reporting of testing results from evaluations of presentation attack detection mechanisms;
- a classification of known attack types (in an informative annex).

Outside the scope are:

- standardization of specific PAD mechanisms;
- detailed information about countermeasures (i.e. anti-spoofing techniques), algorithms, or sensors;
- overall system-level security or vulnerability assessment.

The attacks considered in this document take place at the sensor during presentation. Any other attacks are considered outside the scope of this document.

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 2382-37, *Information technology — Vocabulary — Part 37: Biometrics*

ISO/IEC 19795-1:2006, *Information technology — Biometric performance testing and reporting — Part 1: Principles and framework*

ISO/IEC 30107-1:2016, *Information technology — Biometric presentation attack detection — Part 1: Framework*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC 2382-37 and ISO/IEC 30107-1 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 <http://www.iso.org/obp>

3.1 Attack elements

3.1.1

presentation attack

attack presentation

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

Note 1 to entry: An attack presentation might be a single attempt, a multi-attempt transaction, or some other type of interaction with a subsystem.

3.1.2

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.

3.1.3

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

3.1.4

test approach

totality of considerations and factors involved in PAD evaluation

Note 1 to entry: Elements of a test approach are given in [ISO/IEC 30107-3:2017](https://standards.iteh.ai/catalog/standards/sist/757bc955-79b7-4f92-ba6d-b0b887c9840c/iso-iec-30107-3-2017) Clauses 7 to 11.

Note 2 to entry: A test approach refers to all processes, factors, and aspects specified in the course of the evaluation.

3.1.5

item under test

IUT

implementation that is the object of a test assertion or test case

Note 1 to entry: The IUT is the equivalent of TOE in Common Criteria evaluations.

3.1.6

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.

3.1.7**PAI series**

presentation attack instruments based on a common medium and production method and a single biometric characteristic source

EXAMPLE A set of fake fingerprints all made in the same way with the same materials and with the same friction ridge pattern.

Note 1 to entry: Depending on the experimental goals, an evaluation may utilize series from one source or from several. While tests involving several biometric sources may demonstrate generality of a PAI species, they add variation associated with individual human traits.

3.1.8**target of evaluation****TOE**

within Common Criteria, the IT product that is the subject of the evaluation

Note 1 to entry: The TOE is the equivalent of IUT in Common Criteria evaluations.

3.1.9**attack potential**

measure of the capability to attack a TOE given the attacker's knowledge, proficiency, resources and motivation

3.2 Metrics**3.2.1****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

3.2.2**bona fide presentation classification error rate****BPCER**

proportion of bona fide presentations incorrectly classified as presentation attacks in a specific scenario

3.2.3**attack presentation non-response rate****APNRR**

proportion of attack presentations using the same PAI species that cause no response at the PAD subsystem or data capture subsystem

EXAMPLE A fingerprint system may not register or react to the presentation of a PAI due to the PAI's lack of realism.

3.2.4**bona fide presentation non-response rate****BPNRR**

proportion of bona fide presentations that cause no response at the PAD subsystem or data capture subsystem

3.2.5**attack presentation acquisition rate****APAR**

proportion of attack presentations using the same PAI species from which the data capture subsystem acquires a biometric sample of sufficient quality

3.2.6

impostor attack presentation match rate

IAPMR

<full-system evaluation of a verification system> proportion of impostor attack presentations using the same PAI species in which the target reference is matched

3.2.7

concealer attack presentation non-match rate

CAPNMR

<full-system evaluation of a verification system> proportion of concealer attack presentations using the same PAI species in which the reference of the concealer is not matched

3.2.8

impostor attack presentation identification rate

IAPIR

<full-system evaluation of an identification system> proportion of impostor attack presentations using the same PAI species in which the targeted reference identifier is among the identifiers returned or, depending on intended use case, at least one identifier is returned by the system

Note 1 to entry: An attacker might be both an impostor (trying to match an existing non-self enrollee) and a concealer (obscuring his real biometric sample with a PAI).

3.2.9

concealer attack presentation non-identification rate

CAPNIR

<full-system evaluation of an identification system> proportion of concealer presentation attacks using the same PAI species in which the reference identifier of the concealer is not among the identifiers returned or, depending on intended use case, in which no identifiers are returned

Note 1 to entry: In a negative identification system, such as a black-list, the concealer could intend that no identifiers are returned to avoid scrutiny by a human operator.

3.2.10

PAD subsystem processing duration

PS-PD

duration required for the PAD subsystem to classify PAD data

3.2.11

data capture subsystem processing duration

DCS-PD

duration required for the data capture subsystem to acquire a sample, inclusive of PAD subsystem processing duration (if applicable)

3.2.12

full-system processing duration

FS-PD

duration required for the data capture subsystem and comparison subsystem to acquire and process a sample, inclusive of PAD subsystem processing duration (if applicable)

4 Abbreviated terms

The abbreviated terms shown in [Table 1](#) are used in this document.

Table 1 — Abbreviated terms

APCER	Attack Presentation Classification Error Rate
APAR	Attack Presentation Acquisition Rate
APNRR	Attack Presentation Non-Response Rate

Table 1 (continued)

BPCER	Bona Fide Presentation Classification Error Rate
BPNRR	Bona Fide Presentation Non-Response Rate
CCRA	Common Criteria Recognition Arrangement
CAPNIR	Concealer Attack Presentation Non-Identification Rate
CAPNMR	Concealer Attack Presentation Non-Match Rate
DCS-PD	Data Capture Subsystem Processing Duration
EAL	Evaluation Assurance Level
FTA	Failure to Acquire Rate
FTE	Failure to Enrol Rate
FAR	False Accept Rate
FNIR	False Negative Identification Rate
FPIR	False Positive Identification Rate
FRR	False Reject Rate
FSDPP	Fingerprint Spoof Detection Protection Profiles
FS-PD	Full-System Processing Duration
IAPIR	Impostor Attack Presentation Identification Rate
IAPMR	Impostor Attack Presentation Match Rate
IUT	Item Under Test
PS-PD	PAD Subsystem Processing Duration
PAD	Presentation Attack Detection
PAI	Presentation Attack Instrument
PAIS	Presentation Attack Instrument Species
TOE	Target of Evaluation

5 Conformance

To conform to this document, an evaluation of PAD mechanisms shall be planned, executed and reported in accordance with the mandatory requirements as follows:

- [Clause 6](#) to [11.1](#);
- [Clause 13.1](#);
- for evaluations of PAD mechanisms in enrolment, see [11.2](#);
- for evaluations of PAD mechanisms in verification, see [11.3](#);
- for evaluations of PAD mechanisms in positive or negative identification, see [11.4](#);
- for PAD subsystem evaluations, see [13.2](#);
- for data capture subsystem evaluations, see [13.3](#);
- for full-system evaluations of verification systems, see [13.4.2.1](#);
- for full-system evaluations of positive identification systems, see [13.4.2.2](#);
- for full-system evaluations of negative identification systems, see [13.4.2.3](#).