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Information technology — Biometric performance testing and reporting —

Part 4: Interoperability performance testing

Technologies de l'information — Essais et rapports de performances biométriques —

Partie 4: Essais de performances d'interopérabilité

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Foreword

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The main task of the joint technical committee is to prepare International Standards. Draft International Standards adopted by the joint technical committee are circulated to national bodies for voting. Publication as an International Standard requires approval by at least 75 % of the national bodies casting a vote.

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ISO/IEC 19795-4 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 37, *Biometrics*.

ISO/IEC 19795 consists of the following parts, under the general title *Information technology — Biometric performance testing and reporting*:

— *Part 1: Principles and framework*

— *Part 2: Testing methodologies for technology and scenario evaluation*

— *Part 3: Modality-specific testing* [Technical Report]

— *Part 4: Interoperability performance testing*

Part 6: Testing methodologies for operational evaluation is under preparation.

Introduction

The multi-part biometric data interchange format standard, ISO/IEC 19794, has been developed to foster interoperable exchange of biometric data. By defining open containers for image, signal and feature data, and constraining some of the properties of the samples, the standards enhance interoperability by requiring implementers to be able to handle a restricted set of all possible biometric samples. Examples of this are the template standards of ISO/IEC 19794-2 and ISO/IEC 19794-8 which embed compact processed data from fingerprint images. Only samples of the same format type (several of which can be defined in the same part of ISO/IEC 19794) are intended to be interchangeable.

One common assertion prior to SC 37's formulation of data interchange standards was that proprietary templates offer greater recognition performance than any likely standard on the grounds that the proprietary instances are the product of processes that embed considerable, private, intellectual property. The question of whether the emerging standards are sufficient then arises: that is, do they code data (feature, image, etc.) representations that allow matching with accuracy comparable to that available from the proprietary solutions?

A second issue, interoperability, arises in those applications where standardized data are generated and matched by different institutions and systems. If a company's feature extraction subsystem processes acquired samples to produce ISO/IEC 19794-x compliant instances, then can other companies' comparison subsystems attain performance comparable with that obtained from the originator's own comparison subsystem? A further question is then whether a third company can successfully recognize enrolment and user samples from two different sources.

This part of ISO/IEC 19795 defines tests to specifically address absolute performance, sufficiency, and interoperability available from biometric data formatted to comply with established standards, particularly those developed in the various parts of ISO/IEC 19794. However, because this part of ISO/IEC 19795 references interchange formats generically, by referencing only their black box generation and use, it also applies to other open standards. One consequence of this approach is that the success of a test is predicated on the correctness and appropriateness of lower-level data elements and values, i.e. conformance to the respective standards. Therefore, the approach here is to require conformance testing as an integral part of the test. This is achieved by referencing formal published conformance tests or profiles of standards. For instance, an interoperability test of the ISO/IEC 19794-5 face format might reference an application profile of its Token image, which in turn might rely on ISO/IEC 15444-1 (JPEG 2000 core coding system).

This part of ISO/IEC 19795 conceives of the following three kinds of tests:

— **online:** a scenario test in which a volunteer population enrols on suppliers' products and subsequently uses suppliers' verification or identification implementations to make genuine and impostor attempts;

— **offline:** a technology test in which an archived corpus of captured samples, not necessarily collected with any intent to simulate the operational conditions of a particular application, is used as input to suppliers' enrolment, verification or identification products to make genuine and impostor attempts;

— **hybrid:** a test in which the sample corpus is collected online under conditions which attempt to simulate the operational conditions of a particular application, and is then processed offline.

In each case, an interoperability test needs to embed multi-supplier generation, exchange, and comparison of samples of the standard interchange format. Online collection from a live population is appropriate when the biometric capture device, and/or the subject interaction with the biometric capture device, is considered to have a material effect on the interoperable performance of the intended application. An offline test is appropriate when a representative corpus of samples is already available (for example passport photographs to be converted into Token instances of ISO/IEC 19794-5). An offline test may be appropriate when the collection of representative data is neither practical nor necessary to determine the interoperable performance of specific subsystems, such as feature extraction and/or comparison.

In all cases, an interoperability test must enrol subjects on one or more products and verify or identify on one or more others. This should involve subjects making transactions as themselves (genuine trials) and as one or more other people (impostor trials). If a large enough population is available, a disjoint impostor population can be used. Since online tests can become onerous on the test population when many products and impostor attempts are needed, hybrid and offline testing allow execution of many zero-effort impostor attempts.

In an interoperability performance test, J generators of standardized biometric data blocks (BDBs) are applied to the samples assembled as part of a hybrid or offline test. By applying K comparison subsystems to the standard BDBs, up to KJ^2 verification or identification trials are conducted, each following ISO/IEC 19795-2. The BDB may be an image or signal, or a standardized template. Optional encodings allowed by the standard interchange format should be fully specified. This might be achieved by normatively referencing one of the ISO/IEC 24713-x profiles. If the format in question is an image, a subsequent internal (usually proprietary) template would be used, but its existence here is subsumed by the notion of a black-box comparison of two instances of the given format.

The test advanced by this part of ISO/IEC 19795 demarcates the generic aspects of interoperability from the meaning associated with each particular biometric format of ISO/IEC 19794-x.

Information technology — Biometric performance testing and reporting —

Part 4: Interoperability performance testing

1 Scope

This part of ISO/IEC 19795 prescribes methods for technology and scenario evaluations of multi-supplier biometric systems that use biometric data conforming to biometric data interchange format standards.

It specifies requirements needed to assess

— performance available from samples formatted according to a standard interchange format (SIF),

— performance available when samples formatted according to a SIF are exchanged,

— performance available from samples formatted according to a SIF, relative to proprietary data formats,

— SIF interoperability, by quantifying cross-product performance relative to single-product performance,

— performance available from multi-sample and multimodal data formatted according to one or more SIFs, and

— performance interoperability of biometric capture devices.

In addition, this part of ISO/IEC 19795

— includes procedures for establishing an interoperable set of implementations,

— defines procedures for testing interoperability with previously established sets of implementations, and

— gives testing procedures for the measurement of interoperable performance.

It does not

— establish a conformance test for biometric data interchange formats, or

— provide test procedures for online data collection.

2 Conformance

An interoperability performance test conforms to this part of ISO/IEC 19795 if it satisfies the requirements specified in Clauses 6, 7, 8 and 9 of this part of ISO/IEC 19795 and the requirements specified in the clauses of ISO/IEC 19795-2 referenced in Table 1.

Table 1 — Conformity with ISO/IEC 19795-2

Structure of ISO/IEC 19795-4 test	ISO/IEC 19795-2 conformance
Online (8.2.1.3)	Clause 7 (Scenario evaluation)
Hybrid (8.2.1.4)	Clause 6 and Clause 7
Offline (8.2.1.2)	Clause 6 (Technology evaluation)

3 Normative references

The following referenced documents are indispensable for the application 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 19795-1, *Information technology — Biometric performance testing and reporting — Part 1: Principles and framework*

ISO/IEC 19795-2, *Information technology — Biometric performance testing and reporting — Part 2: Testing methodologies for technology and scenario evaluation*

4 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC 19795-1, ISO/IEC 19795-2 and the following apply.

4.1
basic interoperability
ability of a supplier's generator to create BDBs that can be processed by other suppliers' comparison subsystems, and the ability of a supplier's comparison subsystem to process BDBs from other suppliers' generators

4.2
biometric capture device
BCD
device that collects a signal from a biometric characteristic and converts it to a biometric sample

NOTE A device can be any piece of hardware, and supporting software and firmware.

4.3
biometric data block
BDB
block of data with a defined format that contains one or more biometric samples or biometric templates

4.4
captured biometric data block
cBDB
block of universally understood, possibly standardized, image or signal data produced by a biometric capture device

NOTE A cBDB is, by definition, an sBDB. It is used in Figures 1 to 5 to indicate the minimal unprocessed output of a biometric capture device.

EXAMPLE Greyscale raster image from a fingerprint scanner.

4.5
comparison subsystem
subsystem capable of comparing standardized or proprietary biometric data blocks

NOTE 1 When a test of an image-level SIF is conducted, a verification comparison subsystem will compare two images (usually by internally producing, then comparing, two proprietary and non-interoperable templates). Because each of the input samples will be used again, it will be more computationally efficient for the proprietary templates to persist within the comparison function. This part of ISO/IEC 19795 ignores the internal operation of each supplier's test software, but a throughput computation may need to break out rates for "first" comparisons and "second" (i.e. already stored template) comparisons.

NOTE 2 The definition should not be construed to exclude systems that legitimately perform more than a single one-to-one comparison in order to verify. Certain cohort normalization techniques, for example, perform additional internal

comparisons intended to improve performance. But such a comparison subsystem remains a black box that accepts two instances to produce a comparison score.

4.6
failure to acquire rate
FTA
proportion of recognition samples for which a generator fails to produce an instance suitable for comparison

NOTE In cases where a single sample is used for each subject, the sample-failure rate is the same as the attempt-failure rate and this definition agrees with, but is a special case of, the definitions given in ISO/IEC 19795-1 and ISO/IEC 19795-2.

4.7
failure to enrol rate
FTE
proportion of enrolment samples for which a generator fails to produce an instance suitable for comparison

NOTE In cases where a single sample is used for each subject, the sample-failure rate is the same as the person-failure rate and this definition agrees with, but is a special case of, the definitions given in ISO/IEC 19795-1 and ISO/IEC 19795-2.

4.8
generator
subsystem capable of producing a standardized or proprietary biometric data block

NOTE 1 Under this definition, a biometric capture device might constitute a generator.

NOTE 2 The subsystem may be implemented in software and/or hardware.

NOTE 3 Referring to ISO/IEC 19785-1 (CBEFF data element specification), a generator would transform a source BDB to a target BDB.

4.9
interoperable performance
performance associated with the use of generator and comparison subsystems from different suppliers

4.10
native performance
performance associated with the use of generator and comparison subsystems from a single supplier

4.11
performance interoperability
measure of the adequacy of interoperable performance

NOTE Performance interoperability expresses the ability of biometric subsystems from different suppliers to generate and compare samples, and to either meet an absolute level of performance or constrain error rates within some relative (i.e. non-absolute) bound.

4.12
proprietary format
PF
format defined in a privately controlled biometric data format specification

4.13
proprietary biometric data block
pBDB
biometric data block conforming to a proprietary format

4.14
proprietary performance
performance associated with the use of proprietary generator/comparison subsystems

4.15
standardized biometric data block
sBDB
block of data with a standard interchange format that contains one or more biometric samples or biometric templates

NOTE This part of ISO/IEC 19795 conceives of a biometric sample as a set of one or more instances of acquired biometric data. This definition therefore includes multi-sample and multimodal data. While none of the parts of ISO/IEC 19794 defines multimodal containers, many of them allow multiple instances. The inclusion of multi-sample and multimodal data is supported by the view of generators and comparison subsystems as black boxes in this part of ISO/IEC 19795.

EXAMPLE 1 An sBDB could be a fingerprint minutiae template conforming to ISO/IEC 19794-2.

EXAMPLE 2 Three ISO/IEC 19794-5 Token face images produced from a person on three separate occasions.

EXAMPLE 3 An ISO/IEC 19794-6 iris image and an ISO/IEC 19794-11 hand geometry image wrapped together in a complex ISO/IEC 19785-1 CBEFF structure.

4.16
standard interchange format
SIF
format defined in a part of ISO/IEC 19794 or in any other publicly available biometric data format specification

4.17
sufficiency
measure of the adequacy of native performance using a standard interchange format

NOTE 1 Sufficiency may be assessed relative to proprietary performance, or against a specified performance level, e.g. "the standard interchange format is sufficient to achieve an EER below 2%" or "the standard interchange format is sufficient to achieve an EER at most 1,5 times that of proprietary performance".

NOTE 2 Sufficiency aims to quantify whether the interchange standard unambiguously embeds sufficient information to attain performance comparable with that available from existing proprietary formats.

NOTE 3 Sufficiency of a standard interchange format is dependent on the intended application. A data interchange format that is sufficient for high quality images, or for a 1% equal error rate, may be insufficient for low quality images, or for a more stringent accuracy requirement. Nevertheless, any finding of a lack of sufficiency does however indicate the SIF was either incapable of marking up the same data as the proprietary instance or, at least, was not exploited to maximum effect.

4.18
supplier
researcher, commercial entity, organization or institution providing a biometric capture device, generator or comparison subsystem

5 Abbreviated terms

For the purposes of this document, the following abbreviations apply.

— API application programming interface
— BCD biometric capture device
— BDB biometric data block
— CBEFF Common Biometric Exchange Formats Framework (i.e. ISO/IEC 19785)
— SIF standardized interchange format
— cBDB captured biometric data block
— sBDB standardized biometric data block

— PF proprietary format
— pBDB proprietary biometric data block
— FAR false accept rate
— FRR false reject rate
— FMR false match rate
— FNMR false non-match rate
— FTA failure to acquire rate
— FTE failure to enrol rate
— FNIR false negative identification rate
— FPIR false positive identification rate
— GFAR generalized false accept rate
— GFRR generalized false reject rate

NOTE 1 In a fingerprint template interoperability test, the reader may find benefit in mentally replacing the sBDB acronym with the term "standard template instance". The term is used here to allow this part of ISO/IEC 19795 to refer generically to standardized signals, images and templates.

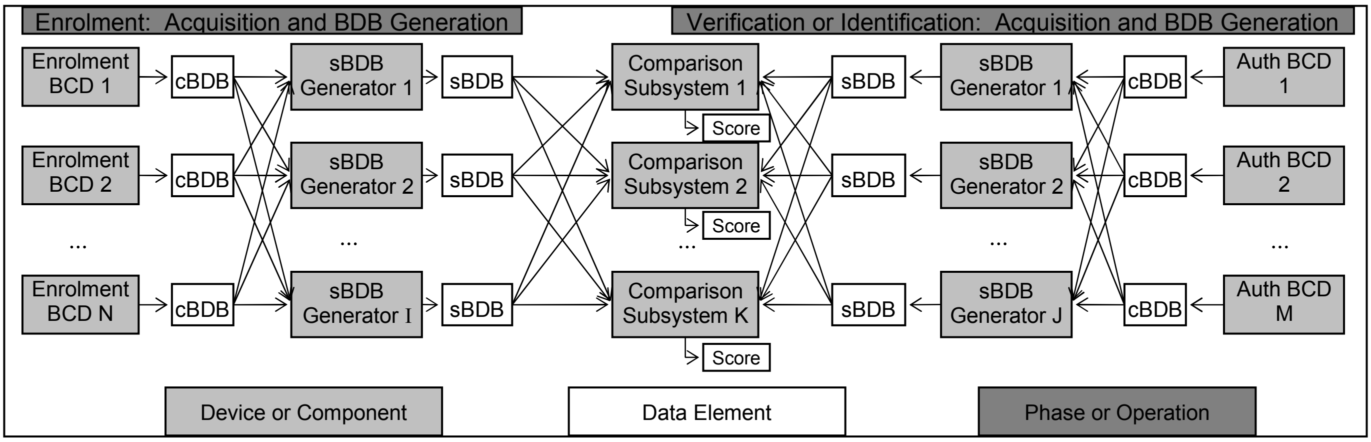
NOTE 2 The quantities FAR, FRR, FMR, FNMR, FTA, FTE, FNIR and FPIR are defined in Clause 4 of ISO/IEC 19795-1:2006. The quantities GFAR and GFRR are also addressed there, in 8.3.4.

6 Goals

6.1 Coverage

The test plan and test report shall document the specific aspects of interoperability that are being investigated. The test report shall include the numbers of suppliers who provided the various components essential to the target interoperability application. A test shall assess sufficiency or interoperability or both. The test plan and test report shall relate its goals to the following overview.

EXAMPLE Six suppliers provided ISO/IEC 19794-5 Token image generators. Each supplier teamed with a supplier of the ISO/IEC 15444 (JPEG 2000) compression format. Four generators employed supplier A's compressor while the other two used supplier B's. In all cases, captured face images were acquired using the biometric capture device from supplier X. These were stored without any compression. Products from the six suppliers were used generate Token instances represented enrolment samples. Comparison subsystems from the same six suppliers were used to compare Token images from each generator with captured images representing authentication samples.



NOTE 1 The sBDB references in this Figure may be replaced by pBDB with the exception that a data format interoperability test will not involve pBDBs in both the enrolment and verification/identification phases. The crossed arrows, which depict interchange, would not be appropriate when pBDBs are generated.

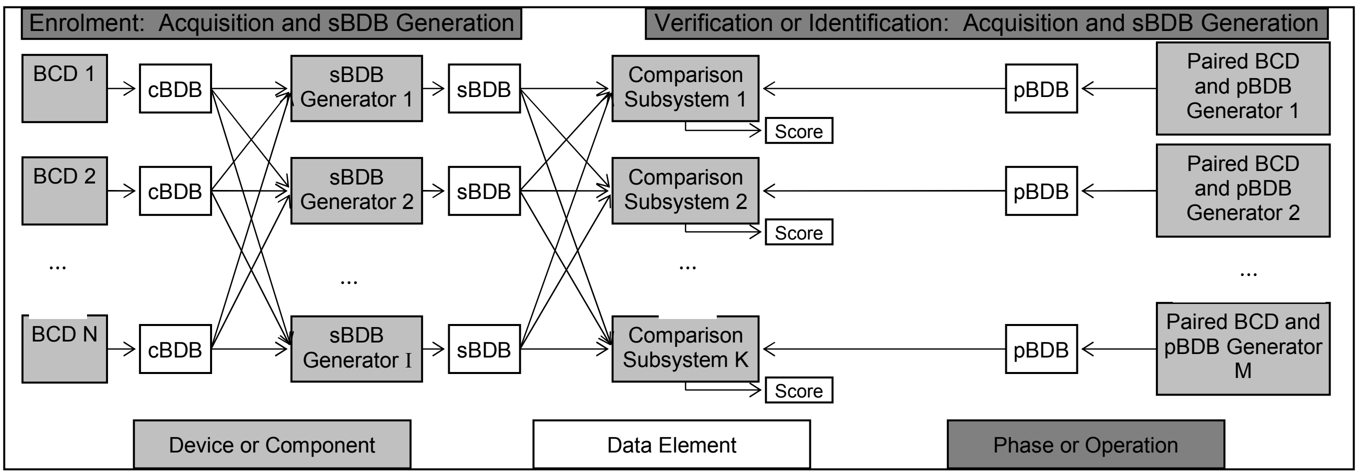
NOTE 2 For identification systems the term "Score" here would more appropriately be replaced by "Candidate List".

NOTE 3 As discussed in clause 7.2.2, each device or component (shown in the mid-grey boxes above, and in the remaining figures) will, in general, have an associated failure-to-process rate.

NOTE 4 This and subsequent figures depict biometric capture devices as generating captured sBDBs (typically unprocessed images) which can be interoperably accepted by all generators. Figure 2 and it's note depict variations on this configuration in which the BCD and the generator are combined with only internal non-standardized data flow.

Figure 1 — General biometric interoperability

Figure 1 depicts the general biometric interoperability problem: different biometric capture devices are used to acquire data that is enrolled in sBDB format by each of I generators for later use in K comparison subsystems. This data is compared with verification or identification data gathered on M biometric capture devices and converted to sBDB form by J generators.



NOTE In some applications, biometric capture devices and generators will be paired. This may arise because there is no need to retain captured samples. A biometric capture device supplier might team with more than one generator supplier, or vice versa. There may be a performance benefit inherent in the BDB generator being tailored to the biometric capture device (rather than having to deal with all possible biometric capture devices).

Figure 2 — Specific interoperability: enrolment BDB is standardized

Some special cases of Figure 1 are described in the following list.

— A common commercial case is depicted in Figure 2: The verification or identification product produces a pBDB which is compared to an enrolled sBDB. Such is the case with an identity credential storing sBDBs for off-card verification (see [1] as an example of such a test).

— The reverse of this situation (a pBDB is enrolled and later compared with a sBDB) is also possible in, for example, a match-on-card application. This is depicted in Figure 3.

— When an offline test is conducted (see, for example, [2]), or when data collection has been done separately, Figure 4 may be appropriate. Note that one but not both of the enrolment and verification BDBs may be pBDBs.

— When the effect of the biometric capture device on performance is of interest (see, for example, [3]) a single BDB generator and comparison subsystem may be appropriate, as shown in Figure 5. Although a biometric capture device interoperability evaluation of this kind does not necessarily involve exchange of sBDBs it is consistent with the definition of performance interoperability in clause 4.12, and is notable because it quantifies biometric capture device performance in terms of recognition error rates rather than its imaging properties.

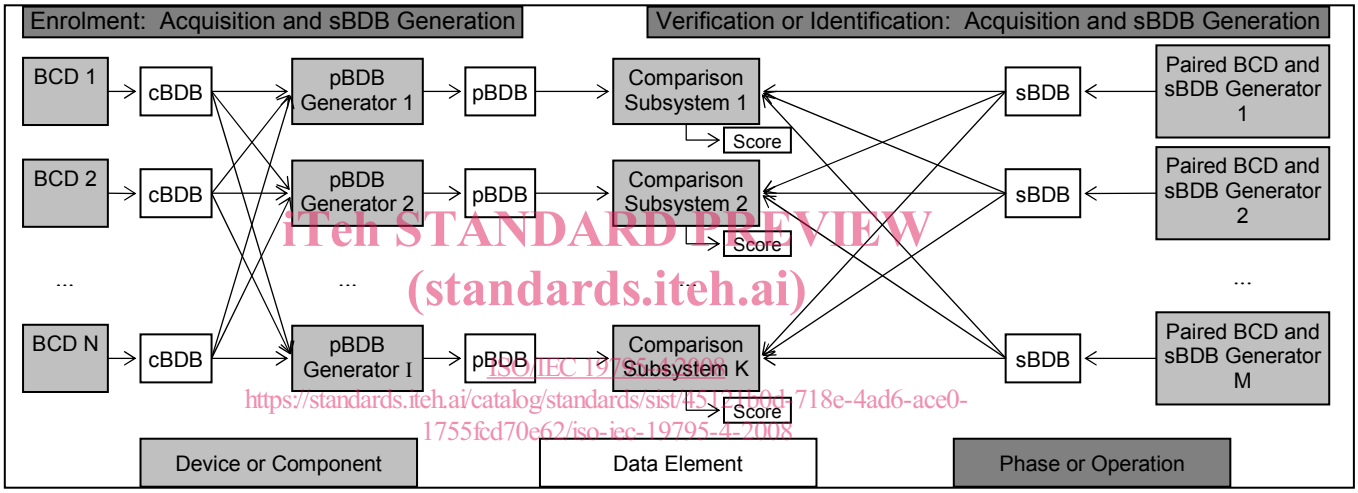
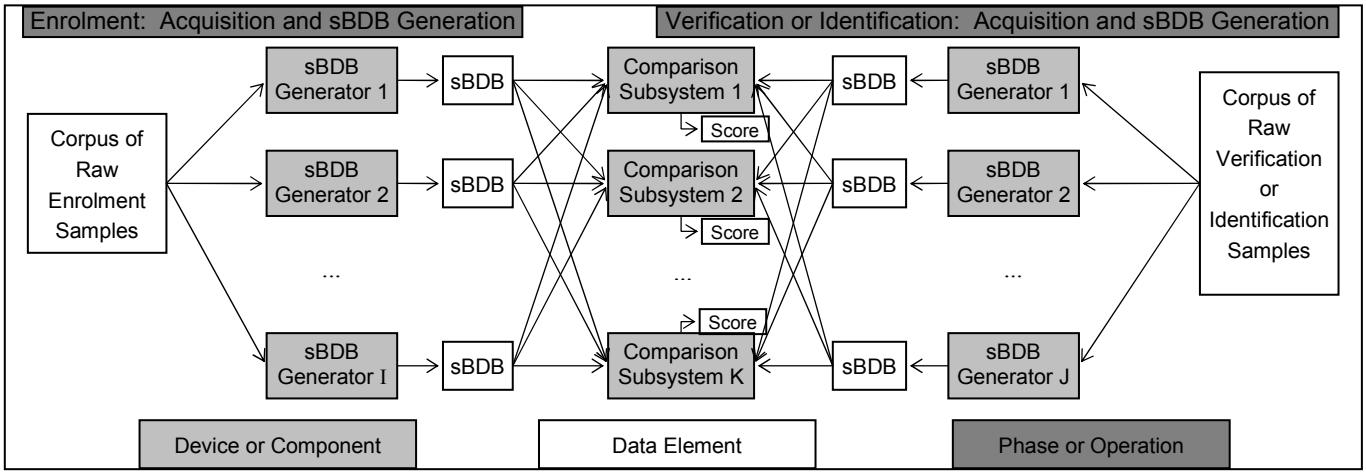


Figure 3 — Specific interoperability: enrolment BDB is proprietary



NOTE 1 The interoperability of capture devices can be tested if the samples from the corpus of captured verification or identification samples stem from a different capture device than the samples in the corpus of captured enrolment samples.

NOTE 2 Either, but not both, of the phases could be mediated by pBDBs here, instead of sBDBs (as in Figure 3). If both phases used pBDBs then this would depict a traditional technology test of the kind standardized in ISO/IEC 19795-2, Clause 6.

Figure 4 — Offline interoperability testing