

Performance Without Conformance? Value of Level 1, 2 and 3 Conformance

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Conformance to Biometric Standards

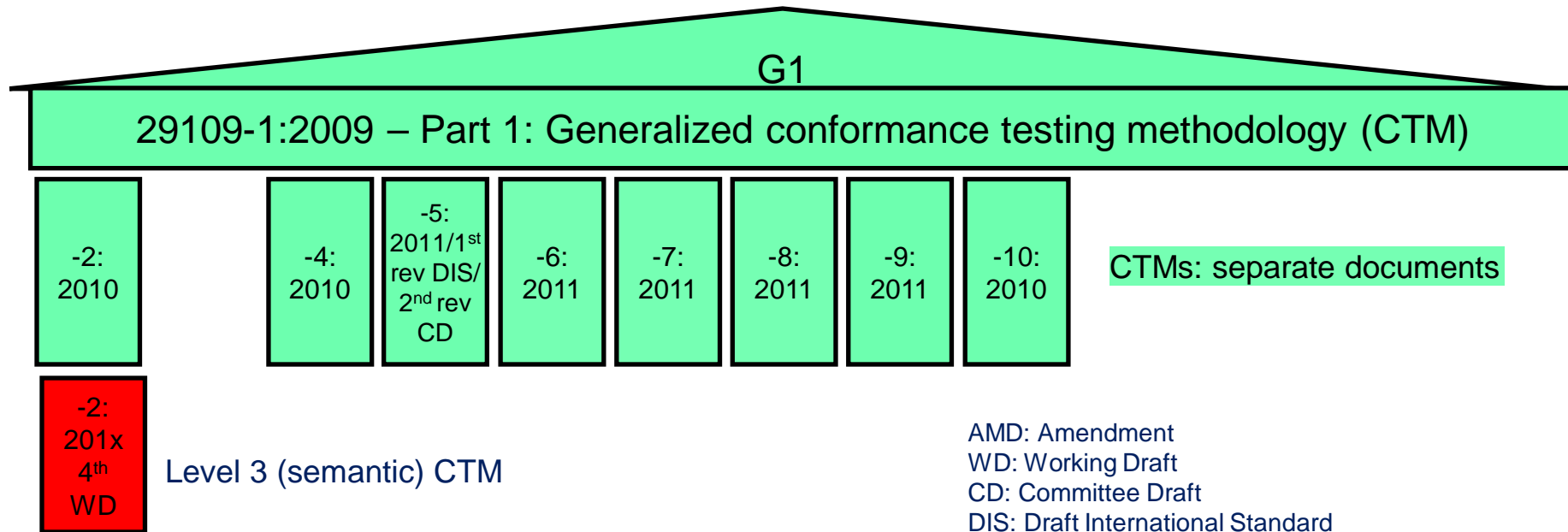
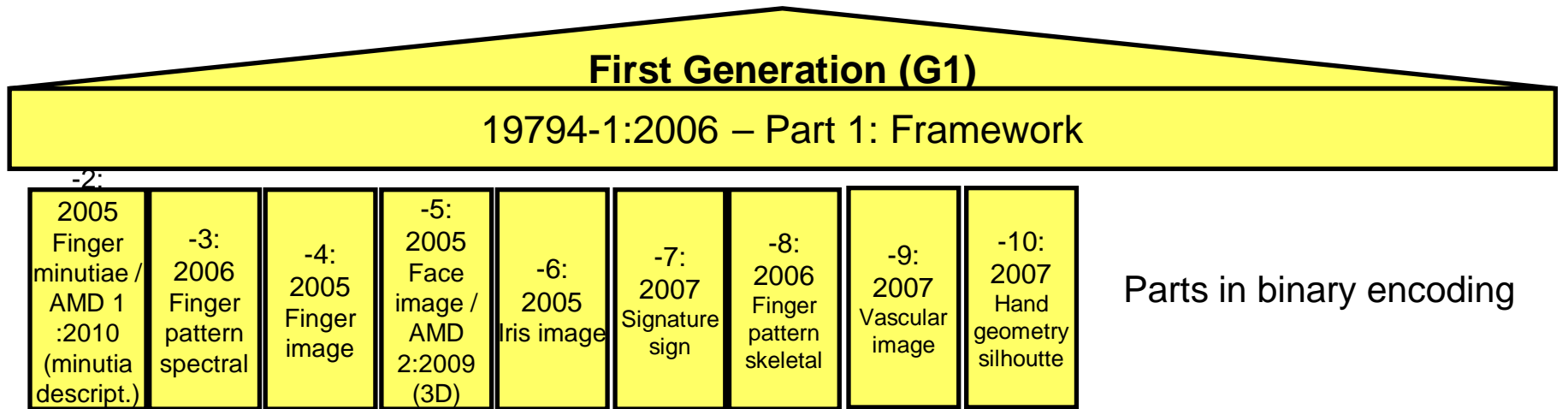
- The existence of biometric standards alone is not enough to demonstrate that products meet the technical requirements specified in the standards.
- Conformance testing:
 - Captures the technical description of a specification and measures whether an implementation faithfully implements the specification.
 - Supports increasing levels of confidence in product quality and increases the probability of successful interoperability and data interchange.

Conformance to Biometric Standards

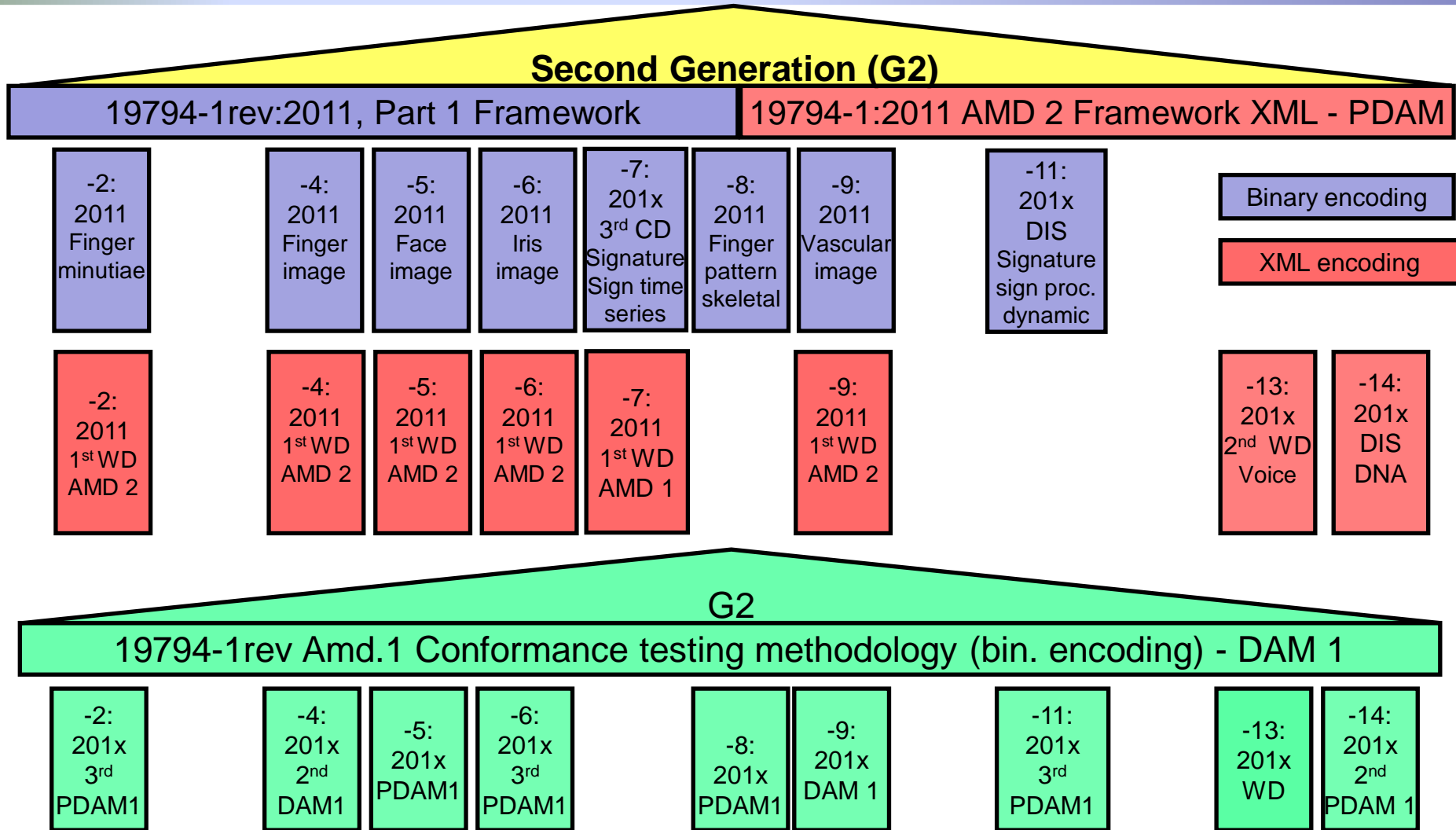
- Can the lack of conformance to biometric standards (data interchange formats in this discussion) also seriously influence operational access to the biometric data and/or deter the system from achieving the expected performance?
- Conformance testing plays the role of the canary in the coal mine warning on possible issues related with the expected level of performance.



ISO/IEC JTC 1 SC 37 Biometric Data interchange Formats and Related Conformance Testing Methodology Standards



ISO/IEC JTC 1 SC 37 Biometric Data interchange Formats and Related Conformance Testing Methodology Standards



WD: Working Draft / CD: Committee Draft / DIS: Draft International Standard / FDIS: Final Draft International Standard
PDAM: Proposed Draft Amendment / DAM: Draft Amendment

Hierarchy of Conformance Tests for Biometric Data Interchange Formats

- Conformance Testing Methodology standards include:
 - Summary of the conformance test requirements in the data format standard that indicates what level of conformance testing is applicable to each requirement.
 - Three levels of conformance testing are defined:
 - *Level 1 conformance testing (L1)*
 - *Level 2 conformance testing (L2)*
 - *Level 3 conformance testing (L3)*
 - Conformance test assertions to be tested for the corresponding requirements.

Conformance Test Suites (CTSs) Designed to Test Implementation of Biometric Data Interchange Format Standards

Standards developed by JTC1/SC37

ISO/IEC 19794-x – 1G

ISO/IEC 19794-x rev – 2G

Base Standard

-2:
2005
Finger
minutiae

-4:
2005
Finger
image

-5:
2005
Face
image

-2rev:
2011
Finger
minutiae

-4rev:
2011
Finger
image

-5rev:
2011
Face
image

-6rev:
2011
Iris
image

-13:
20xx
WD
Voice

-14:
20xx
5th CD
DNA

CTS Planned, Under Dev., or Developed



Under Dev.

Under Dev.

Under Dev.



Planned

Planned

CTS Installer version released



CTS source Code version released



CTS for standard Profile (PIV) – Installer version

On-card
Beta



Off-card
Beta



Level 1 (L1) Conformance Testing

- L1 testing checks field by field and byte by byte conformance with the standard, both in terms of ranges, values and, as required, cardinality.
- Most values are used to determine which L2/L3 tests to run.
- If no L1 processing is performed, L2 tests (and in some cases) L3 tests may not be performed.

L1 Testing – 2G Finger Minutiae Data Format (19794-2:2011) - Error Example & Possible Impact

General Header

- Format Identifier
- Version Number
- Length of Record
- Number of Finger Representations
- Device Certification Block Flag

- The standard defines a field for Finger Position (e.g., left index finger, right index and middle ring).
- Allowed values are: 0 - 10, 13 - 15, and 40 - 50.
- If the value in the field would be 51, a decision statement would have no L2 tests to perform for 51.
- Any use of the record / further tests based on finger position may be jeopardized by this error.

Representation

- Representation Length
- Capture Date and Time
- Capture Device Technology Identifier, Capture Device Vendor Identifier, Capture Device Type Identifier
- Quality and Certification Blocks
- **Finger Position (51)**
- Representation Number
- Image Spatial Sample Rate (horiz and vert)
- Impression Type
- Size of Scanned Image in X-Dir and in Y-Dir
- Minutiae Field Length
- Ridge Ending Type
- Number of Minutiae
- Minutia Type
- Minutia X, Minutia Y and Angle ϕ
- Minutia Quality
- Extended Data Block Length
- Extended Data Area Type Code
- Extended Data Area Length
- Extended data

Level 2 (L2) Conformance Testing

- L2 conformance testing checks the internal consistency of a data format implementation under test (IUT), relating values from one part of the IUT to values from other parts of the IUT.
- L2 tests involve interactions between multiple values from different parts of the IUT and sometimes are derived from implicit assumptions that are not explicitly stated in a standard.
- L2 tests require more complex validation than L1 tests.
- Example: Length (e.g., Record, Representation, Extended Data Area). Length errors can create havoc in L1, L2 and L3 testing and record parsing/processing.

L2 Testing – 2G Iris Data Format (19794-6:2011)

Error Example & Possible Impact

General Header

- Format Identifier
- Version Number
- Record Length
- Number of Representations
- Certification Flag
- **Number of Eyes Represented = 0**
(laterality is unknown)

- Inconsistency between the Number of Eyes Represented and the Eye Label field in the representation.
- The General Header specifies that the Number of Eyes Represented is 0; meaning the record should ONLY contain representations where the Eye Label = 0 (Undefined).
- A DB query to select a specific subset of records may disregard this record. Do you need it?

Representation

- Representation Length
- Capture Date and Time
- Capture Device Technology Identifier
- Quality Block
- Representation Number
- **Eye Label = 1**
(**SUBJECT_EYE_LABEL_RIGHT = 1**)
- Image Type
- Image Format
- Iris Image Property Bit
- Image Width
- Image Height
- Bit Depth
- Range
- Roll Angle of Eye
- Roll Angle Uncertainty
- Iris Center Smallest X
- Iris Center Largest X
- Iris Center Smallest Y
- Iris Center Largest Y
- Iris Diameter Smallest
- Iris Diameter Largest
- Image Data Length
- **Iris Image Data (Right eye)**

L2 Testing - 2G Finger Image Data Format (19794-4:2011)

– Possible Impact Due to Unexpected Extended Data

General Header

- Format Identifier
- Version Number
- Record Length
- Number of Finger/Palm Representations
- Certification Flag
- Number of Distinct Finger/Palm Positions

- Example assumes that the system is designed to handle records that are not expected to have any representation with extended data so it assumes the length of the image to be: Representation Length – Length of **(Representation Header)**
- The “Length of the image” could be incorrect:
- How robust the record/image processing is?
- Is the image detected using “magic bytes”?
- Is the image processed correctly?
- Was L2 testing performed to detect possible errors/inconsistencies?

Representation

- **Representation Length = 2000**
- Capture Date and Time
- Capture Device Technology Identifier
- Capture Device Vendor Identifier
- Capture Device Type Identifier
- Quality Block
- Certification Block
- Finger/Palm position
- Representation Number
- Scale Units
- Scan Spatial Sampling Rate (horiz)
- Scan Spatial Sampling Rate (vert)
- Image Spatial Sampling Rate (horiz)
- Image Spatial Sampling Rate (vert)
- Bit Depth
- Image Compression Algorithm
- Impression Type
- Horizontal Line Length
- Vertical Line Length
- **Image Data Length = 1500**
- Image (**compressed**)

Extended Data

L2 Testing – 2G Iris Data Format (19794-6:2011)

Image Format Specified vs. Iris Image Data Format

General Header

- Format Identifier
- Version Number
- Record Length
- Number of Representations
- Certification Flag
- Number of Eyes Represented

- The Image Format field was erroneously filled out as 0x0A_{Hex}, specifying that the image is a JPEG2000 format; however the image inserted is a PNG image (Image Format of 0x0E_{Hex}).
- If the system uses the Image Format field as directions on how to parse the Image Data, once attempting to parse the PNG as a JPEG2000, it finds it “incompatible” and may not use the record.
- Was L2 testing performed to detect this inconsistency?

Representation

- Representation Length
- Capture Date and Time
- Capture Device Technology Identifier
- Quality Block
- Representation Number
- Eye Label
- Image Type
- **Image Format = 0x0A_{Hex} (JPEG2000)**
- Iris Image Property Bit
- Image Width
- Image Height
- Bit Depth
- Range
- Roll Angle of Eye
- Roll Angle Uncertainty
- Iris Center Smallest X
- Iris Center Largest X
- Iris Center Smallest Y
- Iris Center Largest Y
- Iris Diameter Smallest
- Iris Diameter Largest
- Image Data Length
- **Iris Image Data = PNG Image**

Level 3 (L3) Conformance Testing (Semantic)

- L3 conformance testing checks if the biometric data implementation is a faithful representation of the input biometric data record or “parent biometric data” and ensures requirements are satisfied that are not merely “L1 & L2” requirements.
- The input biometric data record may be (e.g.):
 - An image
 - Raw sensor output such as a time series of data points from a digitization tablet.
- For some requirements in a standard, L3 testing might be significantly difficult or even impossible to test.

“L3” Standard Requirements/Error – Examples

- 19794-4 :2011 (finger image data format):
 - “Each record shall pertain to a single subject.”
 - Incorrectly labeled fingerprint (labeling a Right thumb as a Right index finger).
- 19794-5:2005 (face image data format):
 - Pose Angle: “The (3 multi-byte) Pose Angle field (BY, BP, BR) shall represent the estimate or measure pose of the subject in the image.”
- 19794-2 (finger minutiae format)
 - See detailed discussion in: “*The Benefit of Ground Truth Data to Semantic Conformance Testing of Fingerprint Minutia Encoding*”, Dr. Christoph BuschFraunhofer IGD / Hochschule Darmstadt, Germany
http://biometrics.nist.gov/cs_links/ibpc2010/pdfs/Busch_Christoph_IBPC2010-gtm-100224.pdf

L3 Testing – 2G Iris Data Format (19794-6:2011)

Error Example & Possible Impact

General Header

- Format Identifier
- Version Number
- Record Length
- Number of Representations
- Certification Flag
- **Number of Eyes Represented = 1**
(left or right eye is known to be present)

- Discrepancy between Eye Label indicating that the representation is on a right eye and the iris image data (which is of a left eye).
- Is there an impact on recognition performance?

Representation

- Representation Length
- Capture Date and Time
- Capture Device Technology Identifier
- Quality Block
- Representation Number
- **Eye Label = 1**
(**SUBJECT_EYE_LABEL_RIGHT = 1**)
- Image Type
- **Image Format (Raw, JPEG2000, PNG)**
- Iris Image Property Bit
- Image Width
- Image Height
- Bit Depth
- Range
- Roll Angle of Eye
- Roll Angle Uncertainty
- Iris Center Smallest X
- Iris Center Largest X
- Iris Center Smallest Y
- Iris Center Largest Y
- Iris Diameter Smallest
- Iris Diameter Largest
- Image Data Length
- **Iris Image Data (Left eye)**

Conclusions on Conformance Testing

- Conformance testing plays the role of the canary in the coal mine: lack of conformance to the required standard(s) can, in many cases, jeopardize the expected recognition performance or prevent access to the data (as well as impact the overall operational performance).
- Implementers may handle non-conformant records in different ways during processing.
- All levels of conformance testing are important and necessary. Whenever possible, in addition to L1 and L2 tests, L3 tests should be performed.
- More research on L3 testing procedures is necessary.

Contact

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Background slides:

- [Role of ISO/IEC SC 37 on biometric data formats](#)
- [Role of NIST/ITL in support of these standards](#)
- [ANSI/NIST-ITL 1-2011 Implementation Conformance Error Example and NIST/ITL Conformance Test Tools Roadmap](#)
- [Additional Conclusions](#)

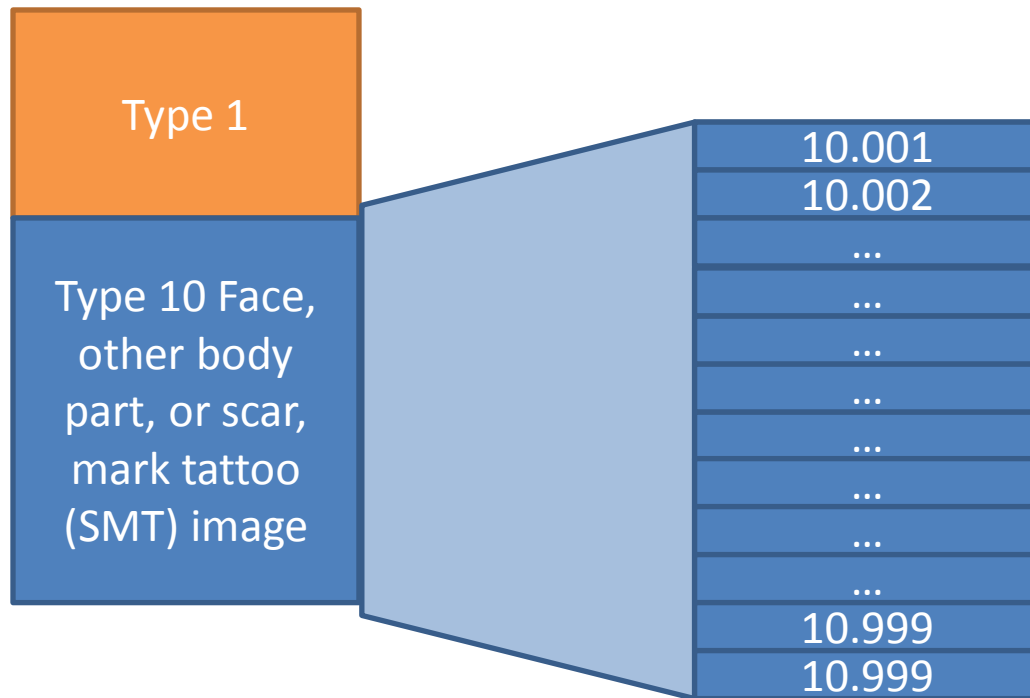
ISO/IEC JTC 1/SC 37 (SC 37)

- Scope:
 - *“Standardization of generic biometric technologies pertaining to human beings to support interoperability and data interchange among applications and systems. Generic human biometric standards include: common file frameworks; biometric application programming interfaces; biometric data interchange formats; related biometric profiles; application of evaluation criteria to biometric technologies; methodologies for performance testing and reporting and cross jurisdictional and societal aspects.*
 - SC 37, in particular, is responsible for the development of biometric data interchange format standards and the associated conformance testing methodologies (CTMs) for these biometric data formats.

NIST/ITL's Support for Conformance Testing

- NIST/ITL participates in the development of biometric (CTM) standards and other conformity assessment efforts.
- It also develops Conformance Test Architectures and Test Suites designed to test implementations of:
 - International (SC 37) biometric data interchange formats
 - ANSI/NIST-ITL Standards (developed with NIST/ITL's leadership), focus on Law Enforcement, Military, Intelligence, Border Management and Homeland Security applications.

Error Example - Multiple Tagged Image Fields in an ANSI/NIST-ITL 1-2011 Implementation



10.999 contains the biometric data associated with the Record.

- There are two Fields 10.999 in the Type 10 Record.
- There should not be more than one field 10.999.
- To process the image:
 - Would you access the last field of the Record or
 - Would you scan the Records until you find a 999 Field and stop (since there is supposed to be only one)?
- Is the biometric data contains in the 10.999 the same?
- Which Field is supposed to be used in matching?
- The advantage of performing L2 / L3 tests before matching is apparent.

Conformance Test Suites Designed to Test Implementations of ANSI/NIST-ITL (AN-20XX) Standards

Base Standard	<div>ANSI/NIST-ITL 1-2007</div> <div>Target: CTA/CTS for selected Record Types: 1 (Transaction information), 4 (High-resolution grayscale fingerprint image), 10 (Facial and SMT image), 13 (Variable-resolution latent image), 14 (Variable-resolution fingerprint image), and 17 (Iris image)</div>	<div>ANSI/NIST-ITL 1-2011</div> <div>Target: CTA/CTS for Data Conventions, Information Associated with several Record Types, and selected Record Types: 1, 4, 10, 13, 14, 15 (Variable-resolution palm print image record), 17, and Traditional Encoding</div>
CTS Planned, Under Dev., or Developed	<div>V. 0.5👍</div> <div>Other Record Types?</div>	<div>Required Conformance Test Architecture Changes From Previous Version Made</div>
CTS Installer version released	<div>V. 0.5👍</div> <div>Evaluating need</div>	<div>Code under development</div>
CTS source Code version released	<div>👍</div> <div>Evaluating need</div>	<div>Under consideration</div>
CTS for Profiles of the AN-20xx Standards	<div>Evaluating users' needs</div>	<div>Evaluating users' needs</div>

Additional Conclusions

- For many applications, suppliers declaration of conformance may be acceptable since other approaches to conformance testing (e.g. testing by third-party accredited labs) tend to be more expensive.
- However, the public availability of conformance test tools may help end-users interested in requiring conformance to biometric standards gain a higher level of confidence in products.
- These test tools, can also support product developers interested in using the same testing tools available to end-users and can also benefit testing labs interested in offering this type of service to developers and end-users.