

Registry of USG Recommended Biometric Standards

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NSTC Subcommittee on
Biometrics and Identity Management

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1. Introduction

This *Registry of USG Recommended Biometric Standards* supplements the [NSTC Policy for Enabling the Development, Adoption and Use of Biometric Standards](#), which was developed through a collaborative, interagency process within the Subcommittee on Biometrics and Identity Management and approved by the NSTC Committee on Technology. This Registry is based upon interagency consensus on biometric standards required to enable the interoperability of various Federal biometric applications, and to guide Federal agencies as they develop and implement related biometric programs.

The Biometrics and Identity Management Subcommittee's Standards and Conformity Assessment Working Group (SCA WG) is tasked to develop and update the Registry as necessary. The Subcommittee will continuously review the content of this document, and release updated versions as required to assist agencies in implementing and enforcing the use of biometric standards to meet agency-specific mission needs. The approved version of this document is available on the Federal government's web site for biometric activities at www.biometrics.gov/standards¹.

The maintenance of this Registry is supported by agencies providing appropriate personnel and resources to the Subcommittee's Standards and Conformity Assessment Working Group. Federal agencies identifying issues with this Registry should notify their representatives to the Subcommittee's Standards and Conformity Assessment Working Group.

Two other documents support this Registry and the *NSTC Policy for Enabling the Development, Adoption and Use of Biometric Standards*:

- Supplemental Information in Support of the NSTC Policy for Enabling the Development, Adoption and Use of Biometric Standards;
- Catalog of USG Biometric Product Testing Programs.

In support of specific cross agency biometric data interoperability requirements, this Registry is cited by NATIONAL SECURITY PRESIDENTIAL DIRECTIVE/NSPD - 59/ HOMELAND SECURITY PRESIDENTIAL DIRECTIVE/HSPD - 24, Biometrics for Identification and Screening to Enhance National Security.

For comments or to obtain additional information about this document, send e-mail to standards@biometrics.gov.

2. Scope

This Registry lists recommended biometric standards for USG-wide use. Only standards finalized and approved by a standards developing organization are eligible for analysis by the Subcommittee. Inclusion of a standard in this Registry requires consensus agreement of USG agencies through the Subcommittee's deliberative process. For dated references to standards, only the edition cited applies. For undated references to standards, the latest edition of the referenced standard applies.

These recommendations take into account:

- the differences in how criminal identification and civil biometric authentication systems operate;
- the need to accommodate current implementations as well as new implementations;
- the movement to international versions from national standards;
- it is implied that all amendments and corrigenda are included as part of the recommended biometric standard.

¹ The latest version of this Registry is also available at www.standards.gov/biometrics.

Therefore, along with recommended biometric standards, some high level guidance is often provided with respect to implementation, migration, and grandfathering of existing implementations. Further guidance may be found in the supporting reference documentation.

This Registry is divided into sub-registries of standards or profiles for:

- biometric data collection, storage, and exchange standards;
- biometric transmission profiles;
- biometric identity credentialing profiles;
- biometric technical interface standards;
- biometric conformance testing methodology standards;
- biometric performance testing methodology standards.

Additional biometric standards will be added to this Registry as other standards in the above categories (e.g., other modalities, such as voice) or additional categories (e.g., biometric quality measurement standards) are approved by the standards developing organizations and adopted by the USG for USG-wide use.

This Registry may have supplements intended for use within specific communities of the USG. For information on the status of any such supplements, send email to standards@biometrics.gov.

3. Verbal forms for the expression of provisions

The following terms are used in this document to indicate mandatory, optional, or permissible requirements:

- the terms “shall” and “shall not” indicate requirements strictly to be followed in order to conform to this document and from which no deviation is permitted;
- the terms “should” and “should not” indicate that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others, or that a certain course of action is preferred but not necessarily required, or that (in the negative form) a certain possibility or course of action is deprecated but not prohibited;
- the terms “may” and “need not” indicate a course of action permissible within the limits of this document.

4. Terms and definitions

For the purposes of this document, the following terms and definitions apply. The terms are grouped by conceptual area and are not in alphabetic order.

- **standard** - document, established by consensus and approved by a recognized body, that provides, for common and repeated use, rules, guidelines or characteristics for activities or their results, aimed at the achievement of the optimum degree of order in a given context. [Source: ISO/IEC Guide 2:2004]
- **base standard** - a generic standard containing options that may be profiled for application-specific purposes [Source: ISO/IEC 24713-1:2008]

NOTE 1 Base standards can be used in diverse applications. It may be useful to construct a standardized biometric profile that specifies or restricts values and practices from the options in a base standard. The aim is to achieve interoperability for a specific application.

NOTE 2 Any cited standard must include any amendments, corrigenda and supplements.

- **profile** - conforming subsets or combinations of base standards used to effect specific functions [Source: ISO/IEC 24713-1:2008]

NOTE Profiles define specific values or conditions from the range of options described in the relevant base standards, with the aim of supporting the interchange of data between applications and the interoperability of systems. [Source: ISO/IEC 24713-1:2008]

- **biometric application profile** - conforming subsets or combinations of one or more base standards and/or profiles necessary to accomplish particular function(s) specific to the application and its domain of use. Biometric profiles define specific values or conditions from the range of options described in the relevant base standards and/or profiles, with the aim of supporting the interoperability of systems and the interchange of data between applications. [Source: ISO/IEC 24713-1:2008]

NOTE Specific categories of application profile are:

- **transmission profile** - a profile developed to define sender and receiver requirements for electronic communications between systems.
 - **credentialing profile** - a profile developed to support the requirements of a specific USG personal identity verification system and the sender and receiver specification for electronic communication between systems.
 - *(alternative)* **credentialing profile** - a profile developed to define specific requirements for vetting an entity using biometrically enabled personal identity verification systems.
- **standards developing organization** - an organization that develops and approves consensus standards

NOTE Such organizations may be: accredited, such as ANSI accredited INCITS and ANSI accredited NIST-ITL; or international treaty based, such as ICAO; or international private sector based, such as ISO/IEC; or a consortium, such as RTIC; or a government agency, such as the DoD, DHS, FBI, and NIST.

- **certification** - third-party attestation related to products, processes, systems or persons [Source: ISO/IEC 17000:2004]

NOTE 1 Certification of a management system is sometimes also called registration.

NOTE 2 Certification is applicable to all objects of conformity assessment except for conformity assessment bodies themselves, to which accreditation is applicable.

- **biometric data interchange record (BDIR)** - data package containing biometric data that claims to be in the form prescribed by a base standard

NOTE If the BDIR is encapsulated in a CBEFF record, then the BDIR is also a biometric data block (BDB) as defined in ISO/IEC 19785, but this will not always be the case for BDIRs defined in ISO/IEC 19794.

- **exemplar** - The friction ridge prints of an individual, associated with a known or claimed identity, and deliberately recorded electronically, by ink, or by another medium (also called 'known prints').
- **friction ridge image** - An image of an impression from the palmar surfaces of the hands or fingers, or from the plantar (sole) surfaces of the feet or toes.
- **latent print** - An impression or image of friction ridge skin left on a surface
- **test** - technical operation that consists of the determination of one or more characteristics of a given product, process or service according to a specified procedure [Source: ISO/IEC Guide 2:2004]
- **testing** - action of carrying out one or more tests [Source: ISO/IEC Guide 2:2004]
- **conformance testing** - testing determination of one or more characteristics of an object of conformity assessment, according to a procedure
- **performance testing** - measures the performance characteristics of an implementation such as system error rates, throughput, or responsiveness, sometimes under various conditions
- **sample** - raw data representing a biometric characteristic, which is captured and processed by the biometric system or the digital representation of a biometric characteristic used internally by a biometric system

- **template** - encoded representation of features extracted from a sample suitable for direct comparison
- **sample quality** - measurable properties of a biometric sample associated with its fidelity to its source, and related to the utility, and its expected performance in a verification or identification system or by a forensic examiner
- **signal** - non-image data, possibly multivariate, time series data or spatial data
 - EXAMPLE 1 A speech recording
 - EXAMPLE 2 The (x,y) coordinates and pressure of a pen in an online handwriting recognition system
 - EXAMPLE 3 An electropherogram used in many kinds of DNA typing
- **image** - two or three dimensional spatial data
 - EXAMPLE 1 A two dimensional fingerprint image
 - EXAMPLE 2 A three dimensional face image (i.e. including shape information)
 - EXAMPLE 3 Video of a moving face – not necessarily regularly spaced in time.
- **proprietary image** - image format defined in a privately controlled biometric data format specification
- **proprietary signal** - signal format defined in a privately controlled biometric data format specification
- **proprietary template** - supplier-defined representation of a biometric sample, suitable for matching, usually in an unpublished format
- **basic interoperability** - ability of a generator to create samples that can be processed by other suppliers' comparison subsystems, and the ability of a supplier's comparison subsystem to process input samples from other suppliers' generators [Source: INCITS/ISO/IEC 19795-4:2008 [2009]]
- **scenario evaluation** - the online evaluation of end-to-end system performance in a prototype or simulated application in which samples collected from test subjects are processed in real time. [Source: ISO/IEC 19795-2:2005]
 - NOTE 1 Scenario evaluations are intended for measurement of performance in modeled environments, inclusive of test subject-system interactions. Scenario evaluation assesses biometric technologies in a manner representative of the operational application while maintaining control of performance variables.
 - NOTE 2 The word "online" in the definition refers to human subject involvement.
 - NOTE 3 The term "real time" indicates that the human-system interaction is on the timescale of the operational scenario
- **technology evaluation** - the offline evaluation of one or more algorithms for the same biometric modality using a pre-existing or specially-collected corpus of samples
 - NOTE The concept can be generalized to other biometric components, the key being that the evaluation is deterministic and repeatable. For example, the Appendix F imaging certification tests applied to fingerprint sensors.
- **operational evaluation** - process used to evaluate a biometric system in the targeted operational environment and population
 - NOTE By its nature, it is not a repeatable process. Population, actual environmental conditions, and other factors will vary during operational evaluations.
- **simple object access protocol** - The formal set of conventions governing the format and processing rules of a SOAP message. These conventions include the interactions among SOAP nodes generating and accepting SOAP messages for the purpose of exchanging information along a SOAP message path.
- **class resolution** - The value of resolution (scanning or nominal) used to name (or identify) an acquisition process or image, where the resolution is within a specified tolerance around that value. [Source: ANSI/NIST-ITL 1-2011]

5. Acronyms and abbreviations

ABIS	Automated Biometric Identification System
ANSI	American National Standards Institute
BIAS	Biometric Identity Assurance Services
BIMA	Biometrics Identity Management Agency
BioAPI	Biometric Application Programming Interface
BIR	Biometric Information Record
BSP	Biometric Service Provider
CBEFF	Common Biometric Exchange Formats Framework
DHS	Department of Homeland Security
DoD	Department of Defense
EBTS	Electronic Biometric Transmission Specification
EFTS	Electronic Fingerprint Transmission Specification
FBI	Federal Bureau of Investigation
FIPS	Federal Information Processing Standard
HSPD	Homeland Security Presidential Directive
IAFIS	Integrated Automatic Fingerprint Identification System
ICAO	International Civil Aviation Organization
IDENT	Automatic Biometric Identification System
IEC	International Electrotechnical Commission
INCITS	InterNational Committee for Information Technology Standards
INT-I	INTERPOL Implementation of the ANSI/NIST ITL 1-2000 Standard
ISO	International Organization for Standardization
ITL	Information Technology Laboratory
IXM	IDENT Exchange Messages
MINEX	Minutiae Interoperability Exchange Test
MRTD	Machine Readable Travel Document
NG-ABIS	Next Generation - Automated Biometric Identification System
NGI	Next Generation Identification
NIEM	National Information Exchange Model
NIST	National Institute of Standards and Technology
NSTC	National Science and Technology Council
PIV	Personal Identity Verification
RT	Registered Traveler
RTIC	Registered Traveler Interoperability Consortium
SAP	Subject Acquisition Profile
SMT	Scars, Marks, and Tattoos
SOAP	Simple Object Access Protocol
TWIC	Transportation Worker Identification Credential
TWPDES	Terrorist Watchlist Person Data Exchange Standard
USG	United States Government
US-VISIT	United States Visitor and Immigrant Status Indicator Technology
WSQ	Wavelet Scalar Quantization
XML	Extensible Markup Language

6. Registry concepts and standards nomenclature

The meanings for the headings of the columns in the following tables are as follows:

Validity Period: This column shall be updated periodically as new or improved standards are developed. This may result in the retirement or deprecation of a standard. In such cases, a migration strategy to facilitate backward compatibility may be needed because standardized legacy data may exist in databases or on identity credentials. Agencies engaged in the design of biometrically enabled applications shall adhere to the standards called out below, and shall heed the "validity period" value.

Biometric Data²: This column is organized around the kind of data that is being stored. This derives from the particular biometric modalities chosen for an operation. In some cases, feature based data is stored, and thus the column identifies the captured or processed representation of the sample.

Intended Applicability: The functions of generic biometric applications include: an enrollment phase, and a subsequent identification or verification phase. The enrollment phase embeds capture of an initial sample. The capture may be from a cooperative, non-cooperative or uncooperative subject. Enrollment itself is usually an attended operation. These factors influence the selection of an appropriate data interchange standard because conformance to a standard might be unattainable (e.g., non-cooperative imaging will not always yield a frontal face).

Conceptually a general biometric system³ might execute:

- data capture;
- transmission;
- image or signal processing;
- data storage;
- matching;
- decision;
- administration;
- interface.

Recommended standards: This column enumerates those standards. For data interchange, the intent is that all biometric samples captured, or otherwise instantiated during the validity period, shall be encoded in conformance with the identified standards. For non-data applications, such as performance testing, the intent is that the normative⁴ requirements of the standards are followed. In cases where two or more standards are specified, either or both may be used. In cases where the standards contain high level options or branches, values are mandated as needed.

² This column appears only for the Biometric Data Collection, Storage, and Exchange Standards.

³ This description of biometric systems is expanded upon in ISO/IEC 24713-1:2008, Biometric Profiles for Interoperability and Data Interchange – Part 1: Overview of Biometric Systems and Biometric Profiles

⁴ Standards often contain required content, expressed as *normative* requirements, and recommended content, expressed in *informative* text.

Nomenclature for the ANSI/NIST-ITL Standard: The ANSI/NIST-ITL standard identified in the following sections carries specific nomenclature. Table 1 below explains the fields.

ANSI/NIST-ITL X-YYYY Type ZZ					
ANSI	NIST	ITL	X	YYYY	ZZ
The standard is developed under ANSI approved procedures	The parent standards developing organization	The laboratory at NIST responsible for the standard development	The sequence number for the standard within the calendar year	The year that the standard was published. Development was generally completed a few months prior.	An integer (1-21, 98, 99) indicating specific Type Records of the standard.

Table 1 - ANSI/NIST-ITL Standard Nomenclature

Nomenclature for the INCITS/ISO/IEC Standards: The ISO/IEC standards adopted by INCITS are INCITS/ISO/IEC standards. Such standards identified in the following sections use the nomenclature illustrated in Table 2. The base standard, as originally developed in the international body, is shown in bold. The details of any subsequent US adoption which enclose this are shown in normal type.

INCITS/ISO/IEC 19794-6:2005[2007][R2010]						
INCITS	ISO/IEC	19794	-6	2005	2007	R2010
The name of the body in the U.S. that adopts the international standard	The parent standards developing organization	The ISO/IEC 19794 is a multipart data interchange standard	The dash six denotes Part 6 which in this case standardizes exchange of iris images	The year that the standard was originally published. Development was generally completed a few months prior.	The year the standard was adopted by the US National Body (INCITS).	The year the standard was reaffirmed ⁵ .

Table 2 - INCITS/ISO/IEC Standard Nomenclature

NOTE: For standards that have published amendments they are identified with the following type of syntax: INCITS/ISO/IEC 19784-1:2006/Amd. 1 -2007

7. Biometric data collection, storage, and exchange standards

The biometric standards recommended in Tables 3-8 should be used in all USG applications for which biometric data:

- are exchanged between systems within an agency,
- are exchanged between agencies,
- persist beyond the interaction of a subject with a sensor or system.

The biometric standards listed below primarily cover:

- friction ridge imagery (latent and exemplar images of: fingerprints, palms, and/or plantars)
- friction ridge features,
- face⁶ images,
- iris images,
- DNA,
- scars, marks, tattoos,
- body part images,
- forensic mark ups of samples,
- associated metadata for all of the above.

⁵ Re-affirmation of a standard reflects the decision of the responsible standards developing organization to maintain the availability of a standard without any change of its content. Re-affirmation usually indicates that the standard is technically sufficient for near term applications.

⁶ This document refers to "face recognition" and "face images". Other documents have used the modifier "facial" without any difference in meaning.

Standards for other modalities have been approved by the various standards developing organizations. They are not listed here because the imperative for development of this Registry was ongoing or anticipated multi-agency or USG-wide applications. For parties seeking to collect, store and exchange data from modalities not covered by this Registry, they have the option of using standards approved by national or international standards developing organizations.

It is assumed that parent applications can properly embed or wrap biometric data formatted according to the standards enumerated below (e.g., FBI's EBTS transactions embedding ANSI/NIST-ITL 1-2011 Type 14 fingerprint records). Data records or sets of data records shall not be wrapped in a proprietary wrapper that requires a specific provider's software to decode or encode.

While Tables 3-8 addresses collection, storage and exchange of biometric data, existing transmission profiles such as the FBI's EBTS (see Table 9) might further modify or restrict the recommended standards of Tables 3-8. The shaded cells in all tables indicate the standard is no longer recommended for use.

7.1 Friction ridge imagery

Intended applicability	Biometric data	Validity period	Recommend standard(s)
The electronic exchange of images to be used in the identification or verification process of a subject among criminal justice administrations or organizations that rely on automated identification systems or use other biometric and image data for identification purposes.	Fingerprint, Palm, Plantar Image Data	November 2011 – Present	ANSI/NIST-ITL 1-2011, Type 13, Type 14, Type 15, Type 19
		October 2007 – November 2011	ANSI/NIST-ITL 1-2007 (Traditional Encoding), Type 4, Type 13, Type 14, Type 15
		December 2008 – November 2011	ANSI/NIST-ITL 2-2008 (XML Encoding), Type 4, Type 13, Type 14, Type 15
The interchange among organizations that rely on automated devices and systems for identification or verification purposes based on the information from finger and palm image areas	Finger and Palm Image Data	December 2011 – Present	ISO/IEC 19794-4:2011
The interchange among organizations that rely on automated devices and systems for identification or verification purposes based on the information from finger image areas	Finger Image Data	October 2007 – December 2011	INCITS/ISO/IEC 19794-4:2005[2007]
		October 2007 – July 2012	INCITS 381-2004
		October 2009 – July 2012	INCITS 381-2009

Table 3 - Registry of Friction Ridge Imagery Standards

ANSI/NIST-ITL 1-2011 includes both the Traditional and NIEM-conformant XML encodings. There are no longer separate versions of the standard for each encoding as in ANSI/NIST-ITL 1-2007 and ANSI/NIST-ITL 2-2008.

ANSI/NIST-ITL 1-2011 deprecates the Type-3, -5, and -6 records, but retains the Type-4 record to ensure backward compatibility; *however, new users are encouraged to utilize the Type-14 record to convey fingerprint images*. While the Type-4 record remains the predominant format for transmission of rolled fingerprint information, the Type 14 record is highly recommended because it is:

- used for plain impression transactions including segmentation coordinates;
- supporting use of high resolution images;
- a more flexible format for additional metadata.

NOTE Users should coordinate with receiving agencies to ensure they have the capability to accept Type-14 variable-resolution fingerprint image data.

The variable-resolution image data contained in the Type-13, Type-14, Type-15, and Type 19 records may be in a compressed form. While the records may be used for the exchange of 19.69 ppmm (500 ppi) images, it is strongly recommended that the resolution for fingerprint and palm images be 39.37 ppmm (1000 ppi). When friction ridge images are captured at 39.37 ppmm (1000 ppi) and compressed using JPEG 2000, the compression ratio shall not exceed 15:1. This may be achieved by invoking the JPEG 2000 compressor with a target bit rate greater than or equal to 8/10 bits per pixel. If images scanned at 1000 ppi and compressed using JPEG 2000 are to be converted to images at 500 ppi and compressed using WSQ, then the MITRE procedures [MITRE1000] shall be followed. It should be noted that as the class resolution is increased, more detailed ridge and structure information becomes available in the fingerprint image. However, in all cases the class resolution shall be at least 19.69 ppmm (500 ppi).

When friction ridge images are captured at 19.69 ppmm (500 ppi) and compressed with WSQ, the compression ratio shall not exceed 15:1. This may be achieved by invoking the WSQ compressor with a target bit rate parameter greater than or equal to 8/15 bits per pixel. This compression ratio should be considered as a maximum value and where bandwidth and/or storage permits, lower levels of compression will result in higher quality images, especially where devices with smaller image sensors are used.

Latent friction ridge images shall be acquired with a native resolution of 39.37 ppmm (1000 ppi) or greater.

Latent friction ridge images should be uncompressed; however, if losslessly compressed images shall be stored in conformance to the ISO/IEC 15948 format (PNG). Images shall not be compressed using a lossy compression algorithm. If reduced resolution versions are prepared (e.g., for transmission) the parent high resolution image shall be retained.

While PIV (FIPS 201-1, 2006) requires the use of INCITS 381-2004 for the retention of fingerprint images, the INCITS standard for finger image (INCITS 381-2004) has been withdrawn and is no longer being maintained by the INCITS. As part of the background checking process, FBI requires fingerprints to be formatted according to the ANSI/NIST-ITL standard.

NOTE: ANSI/NIST-ITL 1a-2009 was obviated by the inclusion of Multiple Finger Position Codes in ANSI/NIST-ITL 1-2011, Table 8 Friction ridge position code & recommended image dimensions.

7.2 Friction ridge features

Intended applicability	Biometric data	Validity period	Recommend standard(s)
The electronic exchange of friction ridge feature sets to be used in the identification or verification process of a subject among criminal justice administrations or organizations that rely on automated identification systems.	Friction ridge minutiae data and other features	November 2011 – Present	ANSI/NIST-ITL 1-2011 Type 9
		October 2007 – November 2011	INCITS 378-2004 – or – ANSI/NIST-ITL 1-2007 Type 9, Fields 1-4 and 13-23 – or – ANSI/NIST-ITL 1-2007 Type 9, Fields 1-4 and 126-150
		December 2008 – November 2011	ANSI/NIST-ITL 2-2008 Annex G (XML encoding of INCITS 378-2004) – or – ANSI/NIST-ITL 2-2008 Type 9, per Tables 216a and 216b
Used in a wide range of application areas to include cards where	Fingerprint minutiae	November 2011 – Present	ISO/IEC 19794-2:2011

Intended applicability	Biometric data	Validity period	Recommend standard(s)
automated fingerprint recognition is involved		October 2007 – November 2011	INCITS/ISO/IEC 19794-2:2005[2008], clause 8 compact card format with clause 9 format types 0001, 0003, 0005
		November 2011 – July 2012	INCITS 378-2004
		December 2009 – July 2012	INCITS 378-2009

Table 4 - Registry of Friction Ridge Feature Standards

The primary use of the ANSI/NIST-ITL 1-2011, Type 9 (Minutiae data) record shall be for remote searching of latent prints in criminal justice organizations. New to this version of the standard is the Extended Feature Set (EFS) for latent print markups. There is also a capability to have additional vendor specified feature sets. The ANSI/NIST-ITL 1-2011 allows for both INCITS 378-2004 and INCITS 378-2009 formats. The 2004 version of INCITS 378 had one item for the product identifier. This was clarified and broken into two items in the 2009 version of INCITS 378; the product identifier and the format type. See ANSI/NIST-ITL 1-2011 for additional guidance. If ANSI/NIST-ITL 1-2011 Type 9 is used, vendor blocks (i.e. fields 31 - 125 and 151-175) should not be used.

Identification applications shall use the ISO/IEC 19794-2:2011 standard. This may include proprietary template data in the “vendor-defined extended data” fields. Proprietary template data is non-interoperable but some implementations have shown improved accuracy over standardized data alone [MINEX04]. It is usually usable only if the data is prepared and matched by the products of a single supplier. Reliance on such proprietary data promotes vendor lock-in. To mitigate this risk, the parent images shall be retained. To eliminate this risk, standardized image records should be exchanged. In order to avoid abuse of this allowance of proprietary data, the standardized minutiae data should be required.

In match on-card applications it is recommended to use the core three-byte-per-minutiae format defined in ISO/IEC 19794-2:2011; moreover, the format shall be produced from the ISO/IEC 19794-2:2011 template. See Biometric Specifications for Personal Identity Verification [NIST SP-800-76-1] for additional guidance.

In match-off-card applications none of the ISO/IEC 19794-2:2011 formats shall be used, only INCITS 378-2004. This applies to both the reference and verification templates.

NOTE Although PIV (FIPS 201-1, 2006) requires the use of INCITS 378-2004 for the retention of fingerprint minutiae; the INCITS national standard for finger minutiae has been withdrawn and is no longer being maintained by INCITS. Guidance on minutiae detection and estimation appears in ISO/IEC 19794-2:2011.

7.3 Face images

Intended applicability	Biometric data	Validity period	Recommend standard(s)
The electronic exchange of face image data to be used in the identification or verification process of a subject among criminal justice administrations or organizations that rely on automated identification systems.	2D face images and 3D feature points	November 2011 – Present	ANSI/NIST-ITL 1-2011, Type 10

Intended applicability	Biometric data	Validity period	Recommend standard(s)
Capture and storage (i.e., enrollment or registration processes) for which end-to-end subject capture times above 120 seconds are tolerable	2D Face images	October 2007 – November 2011	ANSI/NIST-ITL 1-2007, Type 10 with subject acquisition profile (SAP) of level 10 or above – or – INCITS/ISO/IEC 19794-5:2005[2007], Full Frontal or Token, with at least 90 pixels between the eyes from all subjects
		December 2008 – November 2011	ANSI/NIST-ITL 2-2008, Type 10 with subject acquisition profile (SAP) of level 10 or above
Non-cooperative or uncooperative capture and storage of images	2D face images	October 2007 – November 2011	ANSI/NIST-ITL 1-2007, Type 10 with subject acquisition profile (SAP) of level 1 or above – or – INCITS/ISO/IEC 19794-5:2005[2007] Basic type only
		December 2008 – November 2011	ANSI/NIST-ITL 2-2008, Type 10 with subject acquisition profile (SAP) of level 1 or above
All other capture, storage or exchange applications	2D face images	October 2007 – November 2011	ANSI/NIST-ITL 1-2007, Type 10 with subject acquisition profile (SAP) of level 1 or above – or – INCITS/ISO/IEC 19794-5:2005[2007], Basic, Full Frontal or Token
		December 2008 – November 2011	ANSI/NIST-ITL 2-2008, Type 10 with subject acquisition profile (SAP) of level 1 or above
Used in a wide range of application areas to include cards where automated face recognition is involved	3D face images	December 2011 - Present	ISO/IEC 19794-5:2011
	2D face images	December 2005 - Present	INCITS/ISO/IEC 19794-5:2005[2007]
		October 2007 – July 2012	INCITS 385-2004
		October 2009 – July 2012	INCITS 385-2009
Capture and storage in Machine Readable Travel Documents	2D face images	October 2007 – Present	ICAO 9303 and Supplement

Table 5 - Registry of Face Image Standards

The ANSI/NIST-ITL 1-2007 and 2-2008, Type 10 record was limited to 2D face images, the new standard now extends to 3D feature points. A subject acquisition profile (SAP) is used to describe a set of characteristics concerning the capture of the biometric sample. The ISO/IEC 19794-5:2011 standard is referenced when describing level 13 and level 14 SAP levels in addition to anthropometric landmarks for 3D feature points. A full listing and descriptions of the SAP can be found in the ANSI/NIST-ITL 1-2011. INCITS/ISO/IEC 19794-5: 2005/Amd 1:2007 [2009] adds an Annex to the base standard as guidance for producing or requiring either conventional printed photographs or digital images of faces that may be used in

applications for passports, visas, or other identification documents and when those images are required to conform to the frontal image types of this standard (INCITS/ISO/IEC 19794-5:2005[2007]).

Conformance to the ANSI/NIST-ITL 1-2007 SAP level 1 and the INCITS/ISO/IEC 19794- 5:2005[2007] "Basic" type allows storage of an arbitrarily poor photograph whose digital, scene, photometric and geometric properties are unlikely to yield acceptable face recognition accuracy. Conformance to the ANSI/NIST-ITL 2-2008 SAP level 1 allows storage of an arbitrarily poor photograph whose digital, scene, photometric and geometric properties are unlikely to yield acceptable face recognition accuracy.

While facial images collected during PIV Registration shall be formatted such that they conform to INCITS 385-2004 this version of the standard has been withdrawn and is no longer being maintained by INCITS.

The ICAO 9303 Supplement is periodic, with revisions affecting the regular issuance of travel document guidance, advice, update, clarification and amplification. The Supplement shall serve as a “bridge” between the formal drafting of Standards and Technical Reports and the needs of the travel document community to have timely and official direction on which to rely. ISO/IEC 19794-5:2005[2007] standard is currently adopted by the International Civil Aviation Organization for e-Passports. Best practices are strongly recommended for the application in the e-passport framework. This ensures that, issuing authorities and/or photographers do not have to change their already-published photo requirements which are based on the existing best practice requirements. The ISO/IEC 19794-5: 2005/Amd 1:2007 [2009] adds an Annex to the base standard as guidance for producing or requiring either conventional printed photographs or digital images of faces that may be used in applications for passports, visas, or other identification documents; when those images are required to conform to the frontal image types of this standard (INCITS/ISO/IEC 19794-5:2005[2007]).

7.4 Scars, Marks and Tattoo

Intended applicability	Biometric data	Validity period	Recommend standard(s)
The electronic exchange of image data from the scars, (needle) marks, and tattoos (SMT) to be used in the identification or verification process of a subject among criminal justice administrations or organizations that rely on automated identification systems.	Scar, (needle) mark, and tattoo information	November 2011 – Present	ANSI/NIST-ITL 1-2011, Type 10

Table 6 - Registry of SMT Standards

Marks, as used in this standard, means needle marks typical of drug use. In some nations the term ‘marks’ denotes what is called ‘latent prints’ within the terminology of this standard.

An SMT image consisting of several parts or sub-images shall use subfields to fully describe the various parts or features found in the total image. The first subfield shall describe the most predominant feature or sub-image contained in the SMT image. Subsequent repeating subfields shall describe additional portions of the image that are not part of the main or central focal point of the image. For example, a tattoo consisting of a man with a snake on the arm being followed by a dog may contain three subfields: one describes the man, a second describing the snake, and a third describing the dog.

7.5 Iris images

Intended applicability	Biometric data	Validity period	Recommend standard(s)
The electronic exchange of iris image data to be used in the identification or verification process of a subject among criminal justice administrations or	Iris images	November 2011 - Present	ANSI/NIST-ITL 1-2011, Type 17
		October 2007 – November 2011	The rectilinear image format of INCITS/ISO/IEC 19794-

Intended applicability	Biometric data	Validity period	Recommend standard(s)
organizations that rely on automated identification systems.			6:2005[2007] – or – ANSI/NIST-ITL 1-2007, Type 17
		December 2008 – November 2011	ANSI/NIST-ITL 2-2008, Type 17
Used in a wide range of application areas to include cards where automated iris recognition is involved.		November 2011 - Present	ISO/IEC 19794-6:2011
Used in a wide range of application areas to include cards where automated iris recognition is involved.		October 2007 – July 2012	INCITS 379-2004

Table 7 - Registry of Iris Image Standards

The ANSI/NIST-ITL 1-2011, Type-17 record was developed to provide a basic level of interoperability and harmonization with the INCITS 379-2004 Iris image interchange format and the ISO/IEC 19794-6:2011 Iris image data interchange format. It also contains optional descriptive data fields and image markup fields. Generic iris images may be exchanged using the mandatory fields of this record type. Images may be monochrome or color with 256 or more intensity levels (gray or per-color component), and vary in size depending on field of view and compression. The recommended formats all store sampled pixel data from rectilinear images. The data shall be encoded as a raw array of intensity values, a raw array of red green blue color values, or as losslessly compressed or lossy-compressed versions thereof. Like face image data, this record type has descriptive characteristics for various subject acquisition profiles which are defined in detail in the ANSI/NIST-ITL 1-2011.

For storage of iris data on-card, off-card, iris capture devices, and the components involved in automated recognition of iris imagery shall conform to the data format specified in 19794-6:2011. In iris recognition, templates are proprietary non-standardized mathematical encodings of information extracted from the formally standardized images that are defined in ISO/IEC 19795-6:2011. The templates are not interoperable therefore organizations retaining only templates are subject to a supplier lock-in hazard.

7.6 DNA

Intended applicability	Biometric data	Validity period	Recommend standard(s)
The electronic exchange of DNA data to be used in the identification or DNA verification process of a subject among criminal justice administrations or organizations that rely on automated identification systems.	DNA	November 2011 - Present	ANSI/NIST-ITL 1-2011, Type 18
The exchange of DNA data for person for only biometric identification or verification technologies that utilize human DNA.		December 2012 - Present	ISO/IEC 19794-14:2012

Table 8 - Registry of DNA Standards

To provide full consideration to privacy, the ANSI/NIST-ITL 1-2011, Type 18 record only uses the non-coding regions of DNA; the regions of the DNA that encode phenotypic information are deliberately avoided. This record type provides a basic level of interoperability with the ISO/IEC 19794-14:2012. The recommended DNA standards should not be used for the exchange of medical and other health related information.

8. Biometric transmission profiles

Biometric transmission profiles identified in Table 9 are intended to provide interoperability. Such profiles specify application-specific criteria onto the base standard. Profiling could consist of establishing definitive values for performance related parameters in the base standard (e.g., resolution, maximum compression) or enumerating values for optional or conditional requirements (e.g., full-frontal face vs. token face in ISO/IEC 19794-5:2011).

Biometric profiles developed for USG applications should address, on a clause-by-clause basis, all normative requirements in base standards, and where appropriate:

- call out values of parameters (e.g., finger number);
- call out normative practice (e.g., encoding of core and delta positions in minutiae records);
- promote informative material to become normative requirements (e.g., maximum face image compression ratios);
- demote normative requirements if compliance would be problematic. Such a step shall be undertaken only after an evidence-based justification can be established and documented. This practice should be undertaken with utmost caution because it breaks conformance to the standard, and may undermine interoperability.

Configurable elements of approved standards should be specified as part of requirements documents; furthermore, configurable elements should be based on operational needs of the implementations.

8.1 Proprietary data

Some of the base standards enumerated in this document include fields for additional proprietary data. A biometric profile should disallow population of these fields because proprietary data is non-interoperable and is likely to be used in preference to standardized data thereby subverting interoperability via vendor lock-in.

USG applications shall not use proprietary image or signal formats when a national or international standard exists for images or signals related to that biometric.

8.2 Proprietary extensions

USG applications should prohibit inclusion of proprietary data in standardized records that contain standardized data. Applications may embed proprietary templates, and achieve interoperability at the image-level.

8.3 Biometric Profiles and Data Models for Large Scale Identification Applications

The biometric transmission profiles of Table 9 are specifications developed by federal and international organizations that permit electronic communication with the specified system. These documents are not base standards but are critical because they define current (“as is”) technical requirements that facilitate interoperability.

The scope of biometric data sharing has expanded to encompass a wider range of operational scenarios that may call for customizable requirements not established in base standards. The biometric transmission profiles recommended above provide an adaptation, constraint, and/or augmentation of the ANSI/NIST-ITL standard to suit the needs of a particular community or an application domain. Since it should be noted that requirements can often change based on real-world events, the use of transmission profiles allows for organizations to more efficiently standardize data without changing the base standard. This flexibility in some instances may cause data to not be fully backwards compatible with legacy devices and vice versa. For example, files provided by systems which originate transactions may not be in a format supported by systems that receive transactions in different versions of the transmission profile are implemented. To ensure the latest requirements and capabilities have been implemented, system integrators are strongly encouraged to coordinate with host organizations prior to implementing recommended biometric transmission profiles. A detailed change log should be included in each biometric transmission profile.

Intended applicability	Validity period	Recommended Transmission Profiles
For sharing biometric and biographical data with the U.S. Government's intelligence community and law enforcement.	December 2009 – Present	TWPDES 3.0
	September 2008 – December 2009	TWPDES 1.2b
For electronically communicating with the Criminal Justice Information Services (CJIS) Division.	December 2011 – Present	FBI EBTS Version 9.3
	January 2012 –Present	FBI EBTS XML Version 3
	May 2011 – December 2011	FBI EBTS Version 9.2
	March 2010 – January 2012	FBI EBTS XML Version 2
	May 2010 – May 2011	FBI EBTS Version 9.1
	November 2009 – May 2010	FBI EBTS Version 9.0
	November 2008 – November 2009	FBI EBTS Version 8.1
	Through October 2007	FBI EFTS Version 7.1
For communicating electronically with and between DoD systems that capture biometric data and repositories of biometric data.	April 2013 – Present	DoD EBTS v3.0; and DoD EBTS IDD v5.0; and DoD EBTS Baseline; Application Profile v1.0; and DoD EBTS IEPD v1.0;
	June 2010 – April 2013	DoD EBTS v2.0
	October 2007 – June 2010	DoD EBTS v1.2
For interfacing with one or more US-VISIT/IDENT messaging services. It describes the IDENT IXM messaging format and the specifications and rules for its use.	October 2012 – Present	IDENT eXchange Messaging (IXM) version 6.0
	June 2010 – October 2012	IDENT eXchange Messaging (IXM) version 5.0
For supplementing the ANSI/NIST-ITL standard for the guidance of members of the International Criminal Police Organization.	June 2010 – Present	Interpol Implementation of ANSI/NIST-ITL 1-2007 (INT-Ib)
	October 2005 – November 2010	Interpol Implementation of ANSI/NIST-ITL 1-2000 (INT-I)

Table 9 - Registry of Biometric Transmission Profiles

8.4 Terrorist Screening Center

The Terrorist Watchlist Person Data Exchange Standard (TWPDES) was developed by the intelligence community to exchange information about terrorists. TWPDES provides a comprehensive XML based standard for exchanging and sharing terrorist-related information with biometric and biographic support in a single package across the entire intelligence and law enforcement communities in the United States and internationally. It incorporates the ANSI/NIST-ITL 2-2008 standard's format for the interchange of biometric information and is NIEM compliant.

TWPDES 3.0, a minor upgrade to TWPDES 1.2b, is NIEM 2.0 compliant and supports all terrorist, screening and watchlisting requirements, and encounter scenarios in the communities. TWPDES 3.0 makes minor technical corrections and contains updated references to external standards including biometric descriptors. One of the goals of TWPDES is to provide not only biographic, but also biometric data for the communication of known and suspected terrorist (KST) information across the intelligence community, law enforcement and international communities, as appropriate. TWPDES 3.0 includes support for biometric identifiers at the person level, support for encounter reporting, including biometrics gathered in an encounter and a more robust watchlisting support. In addition, it is backwards compatible with TWPDES 1.2a and TWPDES 1.2b. The biometric sections of TWPDES 3.0 are compliant with the ANSI/NIST ITL 2-2008 biometric standard as approved on August

12, 2008. Users may constrain the standard to support only the specific requirements in the users' domain. The specification also has built-in extension mechanisms that can be used for inter-agency terrorist-data exchange models. TWPDES 3.0 was approved December 2009 and has been accepted by Office of the Director of National Intelligence (ODNI), DHS, DoD and FBI.

8.5 Federal Bureau of Investigation

Prior to 2007, the Electronic Fingerprint Transmission Specification (EFTS 7.1) in conjunction with the ANSI/NIST-ITL 1-2000 standard was used to support the FBI's IAFIS system. Since then, the IAFIS has been enhanced with additional functionalities including new biometric modalities specified by the Next Generation Identification (NGI). To acknowledge additional processing capabilities and these new biometric modalities, the FBI Electronic Biometric Transmission Specification (EBTS 8.0) was introduced in September 2007. As NGI evolves over time, incremental enhancements are developed and installed. The FBI EBTS is being continually updated to keep pace with these newly installed NGI enhancements. In order to properly interface with the NGI, each revision is fully backward compatible with earlier revisions and with the EFTS. The FBI EBTS's scope continues to be expanded over previous versions to include additional biometric modalities (e.g., palmprint, face, and iris) in recognition of the rapidly developing biometric identification industry. This allows the FBI to move toward a capability that will facilitate multimodal biometric searching of its databases. FBI EBTS 9.3 is the current version being used to interface with NGI. It inherits the basic requirements for logical records set forth in the ANSI/NIST-ITL 1-2011 standard.

8.6 Department of Defense

The DoD Electronic Biometric Transmission Specification (EBTS) was developed by the BIMA Biometrics Standards Working Group as a biometric and contextual data transmission format standard for the exchange of biometric and contextual information within the DoD. The DoD ABIS is an electronic database and an associated set of software applications that support the storage, retrieval, searching and matching of biometric related data collected from persons of national security interest. Due to the mission of the DoD, additional operational requirements beyond those defined in the ANSI/NIST ITL are defined in the DoD standard. The DoD-unique capabilities are defined in the current version of the DoD EBTS.

Following extensive expert review and multiple revisions, the first widely distributed version of the DoD EBTS v1.2 was released by BIMA in November 2006. That document described a set of capabilities that were implemented in the DoD Biometric Enterprise as well as defining future capabilities. DoD EBTS version (v) 1.2 was based on the FBI Electronic Fingerprint Transmission Specification (EFTS) v7.0 and ANSI/NIST-ITL 1-2000. Since the release of DoD EBTS v1.2, a number of events have shaped the release of a new version of the DoD EBTS v2.0:

- As biometric support for various DoD mission activities evolved, so have the requirements for a more flexible standard. As result, the scope of DoD biometric data collection and sharing has expanded to a wider range of operational scenarios through the use of DoD EBTS Application Profiles. This broader set of scenarios necessitated the use of a mechanism to tailor the DoD EBTS to individual applications. This mechanism called "Application Profiles" is an addition to the base DoD EBTS document. It is used to describe customizations for individual operational scenarios that make use of the DoD EBTS.
- Data elements pertaining to biometric data collection and sharing have been defined in a Glossary, an Integrated Data Dictionary, and a Data Model. All of the data elements used in the DoD EBTS v2.0 are defined in the Integrated Data Dictionary v2.2.1.
- The DoD ABIS evolved into the Next Generation ABIS (NG-ABIS), which provides additional functionality such as searching of iris images and face images. Additionally, the DoD EBTS needs to be usable for communications with DoD biometric repositories in addition to DoD ABIS (or NG-ABIS).

DoD Biometrics Identity Management Agency and the DoD Biometrics Standards Working Group released an updated version of DoD EBTS to allow for additional capabilities and modalities. The DoD EBTS v3.0 is based on ANSI/NIST ITL 1-2011; new functionality to DoD EBTS v3.0 adopted from ANSI/NIST-ITL 1-2011 is as follows:

- Type-18 shall be used to exchange DNA and related data
- Type-20 shall contain the source representation(s) from which other Record Types were derived
- Type-21 shall contain an associated context, audio/visual recording or other related data (i.e., pocket litter)
- Type-98 shall contain security information that allows for the assurance of the authenticity and/or integrity of the transaction including such information as binary data hashes, attributes for audit or identification purposes and digital signatures

Additionally, DoD EBTS v3.0 relies on companion documents to be consistently implemented: such as the DoD EBTS Integrated Data Dictionary v5.0 which defines individual data elements, the DoD EBTS Baseline Application Profile which describes mandatory and optional fields for commonly used Types of Transactions (TOT), and Information Exchange Package Documentation for XML implementation.

8.7 Department of Homeland Security

The Automated Biometric Identification System (IDENT) Exchange Messages (IXM) Specification is the transmission profile required for communicating with the US-VISIT IDENT system. The IDENT database was developed in 1994 to support rapid identification of subjects for immigration purposes. Approximately 138 million unique individuals are enrolled in the IDENT database.

IXM is an XML based message exchange format that provides an easy-to-manage, standards based interface to the services offered by US-VISIT. The specification was designed for high volume rapid transaction processing of biometric and biographic data, and leverages existing data standards and data exchange models. IXM v5.0 and earlier versions also supports binary data transmission using existing Web services specifications and technology.

IXM v5.0 and earlier versions of the specification are based on the Global Justice XML Data Model (GJXDM) and the ANSI/NIST-ITL 1-2000 standard.

IXM v6.0 was developed to support additional modalities and services, and is conformant with ANSI/NIST-ITL 1-2011 and NIEM v2.1 design rules. As a NIEM-based version, IXM v6.0 is not backward compatible with prior versions, which are based on the GJXDM data model. However conversion from IXM v5.0 to IXM v6.0 can be accomplished via straightforward syntactic translations using common XML tools. Unlike previous versions, IXM v6.0 does not support the binary coded form of the FBI EBTS as an embedded attachment to IXM messages.

US-VISIT is collaborating with the FBI and DOD to achieve and maintain full interoperability between US VISIT systems, the FBI's IAFIS and the DOD ABIS system. US-VISIT will continue to support legacy transmission profiles as required for other stakeholders.

9. Biometric identity credentialing profiles

Homeland Security Presidential Directive 12 (HSPD - 12), dated August 27, 2004, entitled "Policy for a Common Identification Standard for Federal Employees and Contractors," directed the promulgation of a Federal standard for secure and reliable forms of identification for Federal employees and contractors. It further specified secure and reliable identification that—

- Is issued based on sound criteria for verifying an individual employee's identity

- Is strongly resistant to identity fraud, tampering, counterfeiting, and terrorist exploitation
- Can be rapidly authenticated electronically
- Is issued only by providers whose reliability has been established by an official accreditation process.

The directive stipulates that standards include graduated criteria, from least secure to most secure, to ensure flexibility in selecting the appropriate level of security for each application.

Intended applicability	Validity period	Recommended Credentialing Profiles
Specifies the architecture and technical requirements for a common identification standard for Federal employees and contractors.	October 2007 -- Present	FIPS 201-1, 2006: Personal Identity Verification (PIV) of Federal Employees and Contractors.
Describes technical acquisition and formatting specifications for the biometric credentials of the PIV system, including the PIV Card itself.	October 2007 -- Present	NIST SP-800-76-1, 2007
Fosters a fully-interoperable, vendor-neutral Registered Traveler (RT) program within the United States.	April 2008 -- Present	Registered Traveler Interoperability Consortium Technical Interoperability Specification Version 1.7 April 15, 2008
	March 2008— April 2008	Registered Traveler Interoperability Consortium Technical Interoperability Specification Version 1.6 March 10, 2008
	December 2007 – March 2008	Registered Traveler Interoperability Consortium Technical Interoperability Specification Version 1.5 December 21, 2007
Specifies the behavior at the card interface of the TWIC card application as well as the requirements for TWIC readers, both fixed and portable, to be used with the Transportation Worker Identification Credential (TWIC)	May 2008 - Present	TWIC Reader Hardware and Card Application Specification, Version 1.1.1 May 2008
	October 2007 – May 2008	TWIC Reader Hardware and Card Application Specification, Version 1 September 2007
Specifies the usage of inter-industry commands and data objects related to personal verification through biometric methods	October 2007 - Present	ISO/IEC 7816-11:2004

Table 10 - Registry of Identity Credentialing Profiles

The FIPS 201 standard specifies the architecture and technical requirements for a common identification standard for all US Government employees and contractors. It contains two major sections. Part one describes the requirements for a personal identity verification system that meets the control and security objectives of Homeland Security Presidential Directive 12, including personal identity proofing, registration, and issuance. Part two provides detailed specifications that will support technical interoperability among PIV systems. It describes the card elements, system interfaces, and security controls required to securely store, process, and retrieve identity credentials from the card. The interfaces and data formats of biometric information are specified in NIST Special Publication 800-76-1, Biometric Data Specification for Personal Identity Verification.

The TWIC Reader Hardware and Card Application Specification leverages FIPS 201. For all transportation workers requiring unescorted physical access to national facilities, the TWIC design defines the behavior at the card interface of the TWIC card application as well as the requirements for TWIC card readers to be used with the TWIC. TWICs are tamper-resistant

biometric credentials issued to workers who require unescorted access to secure areas of ports, vessels, outer continental shelf facilities and all credentialed merchant mariners.

Similarly the Registered Traveler Technical Interoperability Specification leveraged the FIPS 201 standard to specify the identify management infrastructure requirements for a fully-interoperable, vendor-neutral RT program within the United States. After TSA’s pilot ended in July 2008, all RT service providers were obligated to follow data security standards to continue offering service. Each service provider's use of data, however, is regulated under its own privacy policy and by its relationship with its customers and sponsoring airport or airline.

The DoD Common Access Card (CAC) is a card about the size of a credit card. It serves as the standard identification for active-duty military personnel, selected reserve, DoD civilian employees, and eligible contractor personnel to enable physical access to buildings and controlled spaces, and enables access to defense computer networks and systems. The Uniformed Services Identification Card is for military retiree or military family members to access military service benefits or privileges.

10. Biometric technical interface standards

The biometric technical interface standards listed in Table 11 shall be used in all USG applications for biometric systems that include “plug and play” capability. This permits agencies to easily, rapidly and seamlessly integrate system components into functioning systems and swap components as needed without losing functionality, such as the ability to achieve data interchange and to protect the biometric data during transmission and storage.

The BioAPI standards (ISO/IEC 19784 series and INCITS 358) support “plug and play” compatibility by specifying how applications communicate with biometric vendor software in a common way independent of the biometric modality. This supports the swapping of products and the incorporation of new products with no application modification.

Intended applicability	Validity period	Recommended Standard(s)				
Establishes the framework for plug and play functionality in client-side capture and verification (e.g., enrollment workstation, kiosk) or server-side verification for one-to-one and multi-biometric applications. This is not applicable for embedded systems.	October 2007 – Present	INCITS/ISO/IEC 19784-1:2006 [2007]				
	October 2007 – November 2010	INCITS 358-2002				
Defines the interface between a biometric service provider (BSP) and a biometric archive function provider (BAFP) for BioAPI.	October 2007 – Present	INCITS/ISO/IEC 19784-2:2007 [2008]				
Specifies a biometric sensor interface for a Biometric Service Provider	December 2011 – Present	INCITS/ISO/IEC 19784-4:2011 [2011]				
Defines a basic structure for standardized biometric information records (BIRs) that consists of three parts, the standard biometric header (SBH), the biometric data block (BDB), and the security block (SB)	October 2007 – Present	INCITS/ISO/IEC 19785-1:2006 [2008]				
Support for additional data elements in 19785-1	October 2010 – Present	INCITS/ISO/IEC 19785-1:2006/Amd 1:2010 [2010]				
Specifies several patron formats that conform to the requirements of ISO/IEC 19785-1	October 2007 – Present	INCITS/ISO/IEC 19785-3:2007 [2008]				
Support for additional data elements in 19785-3	October 2010 – Present	INCITS/ISO/IEC 19785-3:2007/Amd 1:2010 [2010]				
Specifies a common set of data elements necessary to support multiple biometric technologies and to promote	October 2008 – Present	INCITS 398-2008				
		<table border="1"> <thead> <tr> <th>#</th> <th>Name</th> <th>Domain</th> </tr> </thead> <tbody> <tr> <td> </td> <td> </td> <td> </td> </tr> </tbody> </table>	#	Name	Domain	
#	Name	Domain				

Intended applicability	Validity period	Recommended Standard(s)		
interoperability of biometric-based application programs and systems by allowing for biometric data exchange.		1	Patron Format A	General purpose
		2	BioAPI BIR	BioAPI Interfaces
		3	ICAO LDS	e-Passports / MRTDs
		4	PIV	PIV
		5	ANSI/NIST Type 99	Other modalities
		6	Patron Format B	Complex structures
	October 2007 – October 2008	INCITS 398-2005		
Specifies biometric services for identity assurance that are invoked over a services-based framework	December 2011 – Present	INCITS 442-2010		
	December 2008 – December 2011	INCITS 442-2008		
Provides a common, yet flexible, Web services interface that can be used within both closed and open SOA systems.	May 2012 – Present	BIAS SOAP Profile version 1, May 2012		

Table 11 - Registry of Biometric Technical Interfaces

The CBEFF standard (INCITS 398) specifies data structures that support multiple biometric technologies in a common way. CBEFF's data structures, termed Biometric Information Records (BIRs), conform to a CBEFF Patron Format that allows for exchange of biometric data and related metadata (e.g., time stamp, validity period, and creator); moreover, it supports security of biometric data in an open systems environment. While the current recommended CBEFF standard is INCITS 398-2005 for FIPS 201-1, 2006 and ANSI/NIST-ITL 1-2011(Type-99), this standard has been withdrawn and is no longer being maintained by INCITS. Additionally, the FIPS 201 standard states that PIV cards shall adopt certain defined constants from ISO/IEC 19785-3:2007 for on-card matching. NIST has developed the Conformance Test Suite (CTS) for "Patron Format A" data structures specified in INCITS 398-2008 to help users determine whether binary file implementations of BIRs based on this Patron Format conform to the standard. The International Biometrics and Identification Association (IBIA) recognizes both ISO/IEC 19785-1 and INCITS 398-2005 CBEFF versions. It should be noted that INCITS 398-2005 is not backwards compatible with enhanced revisions.

The Biometric Identity Assurance Services (BIAS) standard defines biometric services used for identity assurance that are invoked over a services-based framework. It is intended to provide a generic set of biometric and identity-related functions and associated data definitions to allow remote access to biometric services. The BIAS SOAP Profile is a specific implementation (or binding) of INCITS 442-2010, which defines the requirements for BIAS operations and data elements that can be implemented using any encoding scheme or messaging protocol. The BIAS SOAP Profile defines a conformant implementation. These SOAP-based services enable a software application (requester) to invoke biometric identity assurance operations provided by a local or remote BIAS service provider (responder).

11. Biometric conformance testing methodology standards

Conformance testing methodology standards may specify physical test requirements, logical test requirements (e.g., test assertions, test cases), use of reference data, test reporting formats, and means of testing requirements. Such standards can serve as the basis for the development of test tools (e.g., executable test code, reference data) and reference implementations, which can be used by organizations operating conformance testing programs.

For data interchange standards, the

- **LEVEL 1 TESTING** – in a data interchange standard, a conformance testing methodology that checks field by field and byte by byte conformance with the specification of the BDIR as specified in the standard, both in terms of fields included and the ranges of the values in those fields [ISO/IEC 19794-1:2011]
NOTE This type of testing tests morphological requirements of the base standard.
- **LEVEL 2 TESTING** - conformance testing methodology that tests the internal consistency of the BDIR under test, relating values from one part or field of the BDIR to values from other parts or fields of the BDIR [ISO/IEC 19794-1:2011]
NOTE This type of testing tests syntactic requirements of the base standard.
- **LEVEL 3 TESTING** - conformance testing methodology that tests that a BDIR is a faithful representation of the BDIR subject to the constraints of the parameters in the metadata records [ISO/IEC 19794-1:2011]
NOTE This type of testing tests semantic requirements of the base standard.

The biometric conformance testing methodology standards listed in Table 12 should be considered for all test runs, commissioned or otherwise sponsored by USG agencies.

Intended applicability	Validity period	Recommended Standard(s)
Specifies criteria for ensuring the image quality of fingerprint scanners and printers that input fingerprint images to, or generate fingerprint images from within, the Integrated Automated Fingerprint Identification System (IAFIS).	December 2011 - Present	FBI EBTS Version 9.3, Appendix F
	September 2007 – December 2011	FBI EBTS Version 8.1, Appendix F
Specifies conformance testing of Biometric Service Provider (BSP) implementations claiming conformance to critical requirements specified in INCITS/ISO/IEC 19784-1:2006[2007] (BioAPI 2.0)	October 2007 – Present	INCITS/ISO/IEC 24709-1:2007[2009]
Specifies test assertions for testing conformance of BSPs of all conformance subclasses.	October 2007 – Present	INCITS/ISO/IEC 24709-2:2007[2009]
Defines a number of test assertions written in the assertion language specified in ISO/IEC 24709-1:2007. These assertions enable a user of ISO/IEC 24709-3:2011 (such as a testing laboratory) to test the conformance to ISO/IEC 19784-1 (BioAPI 2.0) of any BioAPI Framework that claims to be a conforming implementation of ISO/IEC 19784-1. Each test assertion specified in ISO/IEC 24709-3:2011 exercises one or more features of an implementation under test.	December 2011 – Present	ISO/IEC 24709-3:2011
Specifies generalized conformance testing methodologies for 1 st Generation 19794 Data interchange records.	December 2009 – Present	INCITS/ISO/IEC 29109-1:2009[2010]
Conformance testing methodology for INCITS/ISO/IEC 19794-5:2005[2007] when using 2D.	December 2010 – Present	ISO/IEC 29109-5:2012
Specifies generalized conformance testing methodologies for 2 nd Generation 19794 Data interchange records.	December 2011 – Present	ISO/IEC 19794-1 AMD 1:2011
Methodology Standard for Biometric Data Interchange Format Standards – Part 1: Generalized Conformance Testing Methodology for INCITS data interchange records	October 2007 – July 2012	INCITS 423.1-2008
Specifies conformance testing of application(s) or service(s) implementations claiming conformance to the INCITS 378-2004 standard.	October 2007 – July 2012	INCITS 423.2-2008
Specifies conformance testing of application(s) or service(s) implementations claiming conformance to the INCITS standard INCITS 398:2008.	December 2011 – Present	INCITS 473-2011

Table 12 - Registry of Conformance Testing Methodologies

While conformance of individual elements of data interchange records to relevant requirements can be determined, no test can be absolutely comprehensive and prove that a given system generating or using biometric data interchange records is

conformant under all possible circumstances, especially when there are optional components of the standard. A well designed conformance test can, however, test all of the most likely sources of problems and ensure that the implementation under test conforms under a reasonable set of circumstances, giving assurance, but not a guarantee, of conformance.

NOTE Conformance testing methodologies for 19794 Data interchange Formats 19794-x of second (2G) generation standards are currently under development. The trend is to merge conformance criteria and methodologies into the base standards.

12. Biometric performance testing methodology standards

The biometric performance testing methodology standards listed in Table 13 should be considered for all tests run, commissioned or otherwise sponsored by USG agencies.

Use of the standards does not restrict testing laboratories from conducting additional activities or using different practices. The standards are therefore suitable for agencies sponsoring tests in experimental or developmental applications.

Intended applicability	Validity period	Recommended Standard(s)
Present the requirements and best scientific practices for conducting technical performance testing	October 2007 – Present	INCITS/ISO/IEC 19795-1:2005[2007]
Defines "technology" and "scenario" evaluations	October 2007 – Present	INCITS/ISO/IEC 19795-2:2007[2009]
Describes the methodologies relating to these modality-dependent variations. It presents and defines methods for determining, given a specific biometric modality, how to develop a technical performance test	October 2007 – Present	ISO/IEC TR 19795-3:2007
Prescribes methods for technology and scenario evaluations of multi-supplier biometric systems that use biometric data conforming to biometric data interchange format standards	December 2008 – Present	INCITS/ISO/IEC 19795-4:2008
Specifies a framework for testing and a grading scheme for reporting the performance of a biometric system suitable for use in access control applications	January 2011 – Present	INCITS/ISO/IEC 19795-5:2011
Specifies metrics and provides guidance on the operational testing for biometric systems	July 2012 – Present	INCITS/ISO/IEC 19795-6:2012
Testing of On-Card biometric comparison algorithms	November 2011 – Present	INCITS/ISO/IEC 19795-7:2011

Table 13 - Registry of Performance Testing Methodologies

Testing a biometric system will involve the collection of input images or signals, which are used for template generation at enrollment and for calculation of matching scores for verification or identification attempts. The images/signals collected can either be used immediately for an online enrollment, verification or identification attempt, or may be stored and used later for offline enrollment, verification or identification.

In a technology evaluation, testing of all algorithms is carried out on a standardized corpus, ideally collected by a “universal” sensor (i.e. a sensor that collects samples equally suitable for all algorithms tested). Performance against this corpus will depend on both the environment and the population in which it is collected. Prior to technology tests example data may be distributed for developmental or tuning purposes. Actual testing needs to be done on data that has not previously been seen by algorithm developers, and is carried out using offline processing of the data. Because the corpus is fixed, the results of technology tests are repeatable.

In a scenario evaluation, testing is carried out on a complete system in an environment that models a real-world target application of interest. Each tested system will have its own acquisition sensor and so will receive slightly different data. Consequently, if multiple systems are being compared, care will be required that data collection across all tested systems is

in the same environment with the same population. Depending on the data storage capabilities of each device, testing might be a combination of offline and online comparisons. Test results will be repeatable only to the extent that the modeled scenario can be carefully controlled.

In an operational evaluation, depending on the data storage capabilities of the operational system, offline testing might not be possible. In general, operational test results will not be repeatable because of unknown and undocumented differences between operational environments. Furthermore, “ground truth” (i.e. who was actually presenting a “good faith” biometric measure) can be difficult to ascertain, particularly if an operational evaluation is performed under unsupervised conditions without an administrator, operator or observer present.

13. References

The Federal Bureau of Investigation (FBI), the Department of Homeland Security (DHS), and the National Institute of Standards and Technology (NIST) have provided funds to purchase single use licenses for fifteen of the copyrighted standards cited in the Registry. These licensed standards are being made available to U.S. Government workers (i.e., U.S. Government employees or U.S. Government contractors) whose names and email addresses have been provided to NIST by their respective U.S. agency. This nomination can be done by one of your agency representatives on the NSTC Subcommittee on Biometrics and Identity Management. If you are not presently included on the NIST listing of eligible recipients, please have your agency submit (or resubmit) your name and email address to NIST so that you can access these standards. If you don't know your agency representatives on the NSTC Subcommittee on Biometrics and Identity Management, please contact us at: incits@nist.gov . For a full listing of the fifteen available standards visit the NIST webpage at: <http://www.nist.gov/itl/incits.cfm>

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7.	DoD EBTS XML IEPD	DoD Electronic Biometric Transmission Specification (EBTS) Information Exchange Package Documentation http://www.biometrics.dod.mil/CurrentInitiatives/Standards/dodebts.aspx
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10.	FIPS 201-1, 2006	Personal Identity Verification for Federal Employees and Contractors http://csrc.nist.gov/publications/fips/fips201-1/FIPS-201-1-chng1.pdf
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12.	ICAO 9303	Part 1 - Machine Readable Passport - Volume 2 Specifications for Electronically Enabled Passports with Biometric Identification Capabilities http://www.icao.int/Security/mrtd/Pages/default.aspx SUPPLEMENT to Doc 9303, Version: Release 8, March 19, 2010
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14.	INCITS 378	INCITS 378-2004 - American National Standard for Information Technology — Finger Minutiae Format for Data Interchange http://webstore.ansi.org/
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17.	INCITS 423.1	INCITS 423.1-2008 - Conformance testing Methodology Standard for Biometric Data Interchange Format Standards – Part 1: Generalized Conformance Testing Methodology http://webstore.ansi.org/
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Table 14 - Reference of Standards