

**REPORT OF THE WORKING GROUP ON STANDARDS FOR  
RAW IMAGES OF FINGERPRINTS**



**Customer Service Department  
Reserve Bank of India  
Central Office**

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# Report of the Working Group on Standards for Raw Images of Fingerprints

## 1. Introduction

1.1 The issue of financial inclusion is being presently given paramount importance by Reserve Bank. Information Technology enabled methods are being looked into as effective methods for ensuring financial inclusion of remote and far flung areas. The Committee on Financial Sector Plan for North Eastern Region, set-up by RBI, has suggested that a project plan be prepared for enabling an IT-based Financial Inclusion in the banking system. Accordingly, it was decided to set up an Advisory Group for use of Information Technology for Financial Inclusion which will, inter alia, evolve common/comparable standards for enabling IT based solutions for banking services. The Group would mainly look into the major initiatives undertaken so far for suggesting methods for evolving common/comparable standards for enabling IT based solutions for financial inclusion. The Group shall also look into the issues requiring inter-bank or bank/Regulator inter-face in the IT based solutions.

1.2 The Advisory Group in its second meeting held on March 8, 2007 suggested that a separate Working Group be constituted to deliberate and suggest suitable standards for raw images (fingerprints). Accordingly, a Working Group was constituted with the following as members:

- Prof. U.B. Desai, IIT, Bombay
- Prof. A.N. Rajagopalan, IIT, Madras
- Shri C. Ramnath, CGM (IT), State Bank of India
- Smt. Madhavi Purandhare, AGM, ICICI Bank
- Shri Kaza Sudhakar, CGM, RBI, CSD, Co-opted Member
- Dr A.M. Pedgaonkar, CGM, RBI, DIT – convenor

## 2. Methodology adopted by the Working Group

2.1 The Working Group approached its task by arranging meetings to examine the internal practices in this regard. The Working Group had two meetings on April 27 and May 8, 2007. Further, the vendors of State Bank of India and ICICI Bank, made presentations to the Working Group on their IT-enabled Financial Inclusion initiatives. The Working Group deliberated on ISO/IEC 19594-4 Information Technology – Biometric data interchange formats – Part 4: Finger image data – 2005 – ISO/IEC 19794-4:2005(E).

### **3. ISO/IEC 19594-4 Information Technology – Biometric data interchange formats – Part 4: Finger image data – 2005**

3.1 ISO/IEC 19794 Information technology — Biometric data-interchange formats consists of the following parts:

- ❖ Part 1: Framework
- ❖ Part 2: Finger minutiae data
- ❖ Part 3: Finger pattern spectral data
- ❖ Part 4: Finger image data
- ❖ Part 5: Face image data
- ❖ Part 6: Iris image data
- ❖ Part 7: Signature/sign behavioral data – under preparation
- ❖ Part 8: Finger pattern skeletal data – under preparation

3.2 ISO/IEC 19594-4 Information Technology – Biometric data interchange formats – Part 4: Finger image data standard is intended for those applications requiring the exchange of raw or processed fingerprint images that may not necessarily be limited by the amount of resources required for data storage or transmitting time. It can be used for the exchange of scanned fingerprints containing detailed image pixel information. ISO/IEC 19794-4 can also be used to exchange processed fingerprint image data containing considerably fewer pixels per inch and/or a lesser number of greyscale levels. Use of the captured or processed image can provide interoperability among vendors relying on minutiae-based, pattern-based or other algorithms. As a result, data from the captured finger image offers the developer more freedom in choosing or combining matching algorithm technology. Establishment of an image-based representation of fingerprint information will not rely on pre-established definitions of minutiae, patterns or other types. It will provide implementers with the flexibility to accommodate images captured from dissimilar devices, varying image sizes, resolutions, and different grayscale depths. Use of the fingerprint image will allow each vendor to implement their own algorithms to determine whether two fingerprint records are from the same finger.

3.3 ISO/IEC 19794-4 standard specifies a data record interchange format for storing, recording, and transmitting the information from one or more finger image areas within an ISO/IEC 19785-1 CBEFF data structure. This can be used for the exchange and comparison of finger image data. It defines the content, format, and units of measurement for the exchange of finger image data that may be used in the verification or identification process of a subject. The information consists of a variety of mandatory and optional items, including scanning parameters, compressed or uncompressed images and vendor-specific information. This information is intended for interchange among organizations

that rely on automated devices and systems for identification or verification purposes based on the information from finger image areas. Information compiled and formatted in accordance with ISO/IEC 19794-4 standard can be recorded on machine-readable media or may be transmitted by data communication facilities.

3.4 Systems claiming conformance with ISO/IEC 19794-4 standard shall be capable of encoding and decoding finger image data and the associated parameter data used in the transmitting and/or receiving of fingerprint images as defined by ISO/IEC 19794-4 standard. At a minimum, conformance shall require the ability to capture, exchange, and compare interoperable fingerprint image information.

3.5 ISO/IEC 19794-4 standard do not specify the orientation of the finger, the method of scanning, or the order of scanning used to capture the image. However, each image as presented in accordance with the format standard shall appear to have been captured in an upright position and approximately centered horizontally in the field of view. The recorded image data shall appear to be the result of a scanning of a conventional inked impression of a fingerprint. The scanning sequence (and recorded data) shall appear to have been from left-to-right, progressing from top-to-bottom of the fingerprint.

3.6 Image capture requirements are dependent on various factors including the application, the available amount of raw pixel information to retain or exchange, and targeted performance metrics. As a result of these factors, numeric values for specific image capture parameters will be associated with one of several combinations of image acquisition parameters settings. **The choice of the image acquisition settings level should therefore be commensurate with the system and application requirements.**

3.7 ISO/IEC 19794-4 lists the minimum requirements for selected image acquisition parameters as a function of the image acquisition settings level desired. A tolerance of plus or minus 1% is applicable to the minimum numeric values stated for the scan resolution and dynamic range parameters. It also indicates compliance with established certification procedures. Values for setting levels 40 or 41 are intended for applications requiring the greatest amount of detailed information. Scanners capable of level 30 and 31 performance are currently available and are being deployed for law enforcement purposes. Level 30 or 31 applications primarily include law enforcement agencies. Both level 41 and 31 systems should be certified using these and other requirements contained in Appendix F of the FBI's Electronic Fingerprint Transmission Specification (EFTS/F). The remaining levels are designed for commercial access control and verification systems. The overall quality level of a biometric system will be limited to that level at which all of the minimums are met. Setting levels not listed are reserved for future definition, including indication of compliance with future ISO standards for image capture.

**3.8 The Working Group recommends that the minimum requirements for image acquisition should be the Setting Level 31 as defined in the ISO/IEC 19794-4, which is reproduced below:**

<b>Setting level</b>	<b>Scan resolution pixels/centimeter (ppcm)</b>	<b>Scan resolution pixels/inch (ppi)</b>	<b>Pixel depth (bits)</b>	<b>Dynamic range (gray levels)</b>	<b>Certification</b>
<b>31</b>	<b>197</b>	<b>500</b>	<b>8</b>	<b>200</b>	<b>EFTS/F</b>

Note – Manufacturers generally express the rated scan resolution of their devices in pixels per inch (ppi). The ppcm value is a rounded value of ppi resolution divided by 2.54. Either ppi or ppcm values system may be used, but the two should not be intermixed or re-converted.

3.9 The ISO/IEC 19794-4 standard states that for all quality levels, the finger image shall be represented using square pixels, in which the horizontal and vertical dimensions of the pixels are equal. Any difference between these two dimensions should be within 1%. That is, the ratio of horizontal to vertical pixel dimensions should be between .99 and 1.01.

**3.10 The Working Group recommends that Grayscale finger image data may be stored, recorded, or transmitted in uncompressed – bit packed form.**

**3.11 The Working Group recommends that the image grayscale shall be captured using at least 200 grey levels.**

3.12 Grayscale fingerprint image areas to be captured shall be acquired by an image capture device operating at a specific scanning resolution. As the resolution used in the image capture process is increased, more detailed ridge and structure information for processing becomes available. For minutiae and small feature based algorithms, use of the higher resolution enhances the detection of more closely spaced features that may not be detected using the minimum resolution. **The scan resolution shall be at least 197 ppcm (at least 500 ppi) as given at setting level 31.**

**3.13 The Working Group recommends that the resolution of the image data formatted and recorded for interchange should be the scan resolution of the image.**

3.14 ISO/IEC 19794-4 standard is designed to accommodate both plain (flat) or rolled fingerprint images. Most matching systems perform better if the flat or fleshy part of the finger is centered in the image capture area. Therefore, when capturing a fingerprint image, the center of the fingerprint image area should be located in the approximate center of the image capture area.

3.15 For multiple finger background checking and verification purposes, there are currently fingerprint scanner devices that will acquire images of multiple fingers during a single capture cycle. These devices are capable of capturing the plain impressions from four fingers of either hand during a single scanning. The plain impressions from two thumbs can also be captured at one time. Therefore, with three placements of the fingers on a device's scanning surface all ten fingers from an individual can be acquired in three scans – right four fingers, left four fingers, and two thumbs. For these multi-finger captures, half of the captured fingers should be located to the left of the image center and the other half of the fingers to the right of the image center.

**3.16 The Working Group recommends that the Number of Fingers of which images need to be taken should at least be two fingers, preferably index fingers. Nevertheless, the number may be decided by the banks taking into consideration their business requirements.**

3.17 ISO/IEC 19794-4 standard defines the composition of the finger image record. Each record shall pertain to a single subject and shall contain an image record (consisting of one or more views) for each of one or more fingers, multiple fingers (single image records). The biometric data record specified shall be embedded in a CBEFF-compliant structure in the CBEFF Biometric Data Block (BDB). The CBEFF BDB\_biometric organization shall be assigned by the International Biometric Industry Association (IBIA) to JTC 1 SC 37 shall be used. **The Working Group recommends that each record shall pertain to a single subject and shall contain an image record (consisting of single view) for each of one or more fingers, multiple fingers (single image records).**

3.18 The General Record Header has a capture device ID field (2 byte) which denotes the vendor specific capture device ID. As per ISO/IEC 19794-4 a value of all zeros are acceptable and indicate that the capture device ID is unspecified. It suggest that Application developers may obtain the values for these codes from the vendor. **The Working Group recommends that the values for the capture device Id may preferably be obtained from the vendor and coded in the General Record Header.**

3.19 ISO 19794-4 defines a finger record header. The finger header starts each section of finger data providing information for that view of a single finger image, multi-finger image. For each such image there shall be one finger header record accompanying the view of the image data. The uncompressed image data for that image view shall immediately follow the header portion. Subsequent image views (including the header portion) will be concatenated to the end of the previous image view.

3.20 The finger record header has a 1-byte field for the finger position. The codes for this as well as the maximum size of the recorded image are defined in the ANSI/NIST-ITL 1-2000 standard, "Data Format for the Interchange of Fingerprint, Facial, & Scar Mark & Tattoo (SMT) Information". Codes 0-10 are used for single fingers. Codes 13 and 14 are used for the images containing four fingers from the right hand and left hand respectively. Code 15 is an additional code for accommodating the simultaneous capture of the two thumbs.

3.21 The quality of the overall scanned finger image is to be between 0 and 100 and recorded in one byte. A value of 0 represent the lowest possible quality and the value of 100 shall represent the highest possible quality. The numeric values in this field are to be set in accordance with the general guidelines contained in ANSI/NCITS 358-2002, "BioAPI H-Level Specification Version 1.1". A matcher may use this value to determine its certainty of verification.

3.22 The impression type of the finger image is to be recorded in this one byte field. The codes for this byte are set to be as defined in the ANSI/NIST-ITL 1-2000 standard, "Data Format for the Interchange of Fingerprint, Facial, & Scar Mark & Tattoo (SMT) Information". **The Working Group recommends that Live-scan plain Finger Impression type should be used.**

3.23 **The Working Group recommends that the finger image data field should contain the uncompressed – bit packed grayscale image data formatted and recorded in accordance with the uncompressed – bit packed image compression algorithm as given below (Ref: ISO-IEC 19794-4:2005., item 8.2.14 image compression algorithm)**

Code	Compression algorithm
1	uncompressed – bit packed

3.24 The ISO/IEC 19794-4 Annex A defines the Image quality specifications. These specifications apply to fingerprint scanner systems that supply fingerprint data to the major advanced Automated Fingerprint Identification System (AFIS). Electronic images must be of sufficient quality to allow for:

- conclusive fingerprint comparisons (identification or non-identification decision);
- fingerprint classification;
- automatic feature detection; and
- overall Automated Fingerprint Identification System (AFIS) search reliability.

The fingerprint comparison process requires a high fidelity image without any banding, streaking or other visual defects. Finer detail such as pores and incipient ridges are needed since they can play an important role in the comparison. Additionally, the gray-scale dynamic range must be captured with sufficient depth to support image enhancement and restoration algorithms.

The image quality requirements have associated test procedures to show compliance. These procedures are used in acceptance testing to ensure compliance with the requirements, and in performance capability demonstrations as an indication of capability to perform. Equipment is to be tested to meet the requirements in normal operating modes, e.g., scanners shall not be tested at slower than normal operating speeds to meet modulation transfer function specifications.

3.25 The image quality performance characteristics for a fingerprint scanner require that the scanner capture fingerprints at a minimum resolution in both the detector row and detector column directions (also known as 'along-scan' and 'cross-scan' directions) of 19.69 ppm plus or minus 0.1969 ppm (500 ppi, plus or minus 5 ppi). The final output delivered image from the scanner system shall have a resolution of 19.69 ppm plus or minus 0.1969 ppm (500 ppi, plus or minus 5 ppi), and each pixel shall be gray level quantized to 8 bits. These requirements are described in the ANSI standard: *Data Format for the Interchange of Fingerprint Information*, ANSI/NIST-ITL 1-2000. The Geometric image accuracy, the measured modulation transfer function (MTF), the Signal-to-noise ratio, the Grayscale range of image data, the Grayscale linearity and the Output gray level uniformity should be as defined at ISO/IEC 19794-4 Annex A. **The Working Group recommends that the fingerprint scanner specifications should be as defined in ISO/IEC 19794-4 Annex A for live scan scanner.**

#### 4. Recommendations of the Working Group

4.1 As indicated earlier, the Working Group approached its task by examining the international practices and examining the vendors of SBI and ICICI Bank involved in their IT enabled Financial Inclusion initiatives. The Group felt that if their recommendations were accepted, the same would ensure that the raw images of the fingerprints stored would conform to the international standards and inter-operability.

4.2 Upon deliberations, the Group suggested **the following main minimum standards for adoption:**

4.2.1 **The Working Group recommends that the minimum requirements for image acquisition should be the Setting Level 31 as defined in the ISO/IEC 19794-4, which is reproduced below:**

Setting level	Scan resolution pixels/centimeter (ppcm)	Scan resolution pixels/inch (ppi)	Pixel depth (bits)	Dynamic range (gray levels)	Certification
31	197	500	8	200	EFTS/F

(para 3.8)

4.2.2 The Working Group recommends that Grayscale finger image data may be stored, recorded, or transmitted in uncompressed – bit packed form. (para 3.10)

4.2.3 The Working Group recommends that the image grayscale shall be captured using atleast 200 grey levels. (para 3.11).

4.2.4 The Working Group recommends that the resolution of the image data formatted and recorded for interchange should be the scan resolution of the image. (para 3.13).

4.2.5 The Working Group recommends that the Number of Fingers of which images needs to be taken should atleast be two fingers, preferably index fingers. Nevertheless, the number may decided by the banks taking into consideration their business requirements. (para 3.16).

4.2.6 The Working Group recommends that each record shall pertain to a single subject and shall contain an image record (consisting of single view) for each of one or more fingers, multiple fingers (single image records). (para 3.17).

4.2.7 The Working Group recommends that the values for the capture device Id may preferably be obtained from the vendor and coded in the General Record Header. (para 3.18)

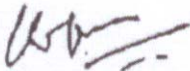
4.2.8 The Working Group recommends that Live-scan plain Finger Impression type should be used. (para 3.22).

4.2.9 The Working Group recommends that finger image data field should contain the uncompressed – bit packed grayscale image data formatted and recorded in accordance with the uncompressed – bit packed image compression algorithm as given below (Ref: ISO/IEC 19794-4:2005., Item 8.2.14 image compression algorithm)

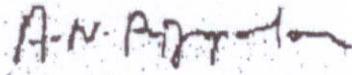
Code	Compression algorithm
1	uncompressed – bit packed

(Para 3.23)

4.2.10 The Working Group recommends that the fingerprint scanner specifications should be as defined in ISO/IEC 19794-4 Annex A for live scan scanner. (para 3.25).



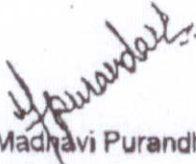
Prof. U.B. Desai  
IIT, Bombay  
(Member)



Prof. A.N. Rajagopalan,  
IIT, Madras  
(Member)



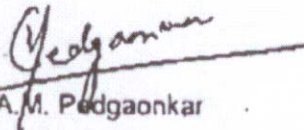
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