MEMORANDUM

TO: FIPS PUB 201 Draft v1.0 Editors

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RE: Aware, Inc. Comments to FIPS PUB 201 (PIV) Public Draft v1.0

Summary: JPEG2000 should be supported for compression of digital facial biometric images in addition to JPEG.

This memorandum is submitted by Aware, Inc. (www.aware.com/biometrics), a leading vendor and expert in biometrics and image compression software. This memo accompanies a particular comment submitted in an Excel spreadsheet response as requested.

These comments refer specifically to Section 4.4.5.5, where it states "*PIV images shall be compressed using the baseline JPEG compression algorithm using a 30:1 compression ratio.*"

Aware recommends that JPEG2000 compression be supported in addition to JPEG for the following reasons:

1. JPEG2000 is an international ISO standard supported by ANSI/INCITS 385, ISO/IEC 19794-5 FCD, and ICAO LDS standards for compression of biometric face images.
2. JPEG2000 is available from multiple vendors, including Aware, Kakadu, Pegasus, and Luratech. There is a free open source version available called JasPer.
3. JPEG2000 achieves superior compression than JPEG for a given file size; JPEG2000 can compress an image to a file size that is 50-60% of what is required with JPEG for an image of equal quality (as calculated using PSNR).
4. JPEG2000 enables highly accurate compression targeting, achieving within 1% of a desired resulting image size or image quality. This is extremely valuable for the PIV application, given memory constraints.
5. JPEG2000 enables region-of-interest (ROI) encoding, which enables further compression of facial images. This basic functionality is specified in the JPEG2000 standard and is offered by several vendors.

Aware also recommends that maximum compression be guided or specified using a PSNR metric. PSNR is a simple, open mathematical algorithm that provides a measurement of the pixel-to-pixel difference between two images. This technique is described in INCITS M1 Biometric Sample Quality Draft Revision 2, document M1/04-0608, Section 10.

Following is an expanded discussion of some of these points.

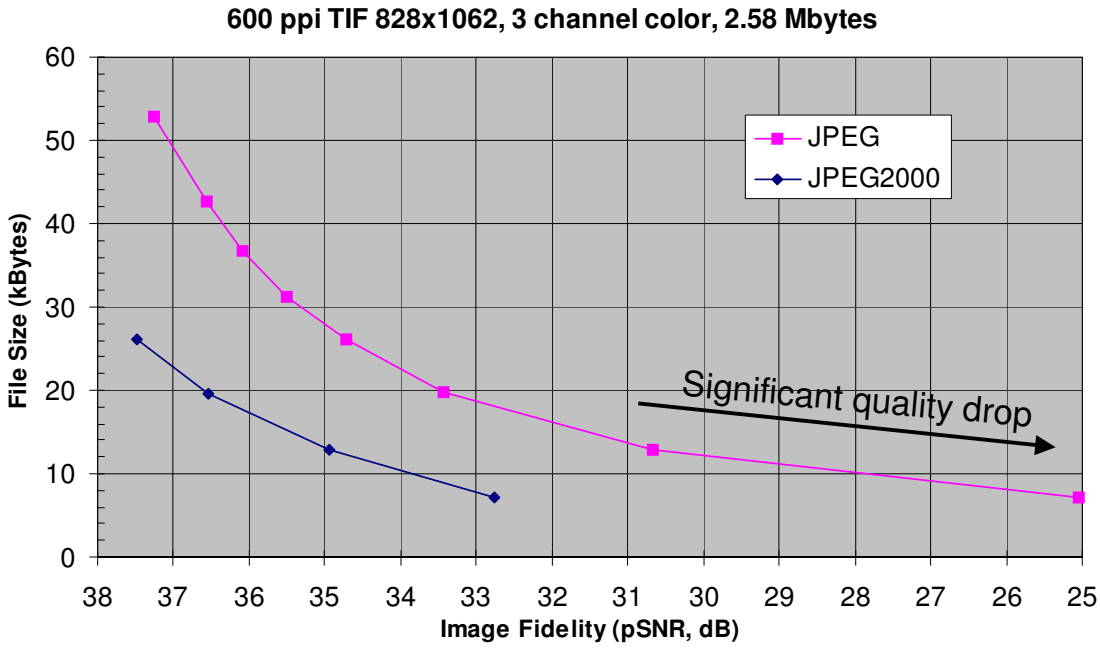
1. Superior compression performance

For large/high-resolution digital facial images, high compression ratios are needed to sufficiently compress so that they may be stored on an ID card along with fingerprints. Very little data has been collected to assess the performance of facial image matching algorithms using images scanned with equipment above 300-ppi resolution. But data shows irrefutably that a) JPEG breaks down and b) JPEG2000 performs significantly better at high compression ratios (on the order of 100:1). This is illustrated in Figure 1.

In order to compress facial images to a size that can be accommodated by a smart card chip along with two fingerprints, it is likely that the desirable facial image size will be on the order of 12-15 Kbytes. But further research is required to assess the relationship between compression and matching performance for large, high-resolution images. Note that the recommended minimum size stated in INCITS 385-2004 section A.2.3.2 is 11 Kbytes (for 300 ppi scanned images only).

Note also that JPEG2000 is an international ISO standard (ISO/IEC 15444) supported by biometrics standards INCITS 385-2004, ISO/IEC 19794-5 draft, and ICAO LDS 1.7.

Figure 1. File size as a function of Image Fidelity using JPEG2000 and JPEG compression for a large sample image



The following example uses a facial image with dimensions 640x480 pixels, as specified in the PIV standard draft. Such an image contains 307,200 pixels, and is 921.6 Kbytes in size uncompressed. The images in Figures 2 and 3 show this image being compressed to 10.3 Kbytes (compression ratio of 88:1) using JPEG2000 (Figure 2); and to 21.0 Kbytes using JPEG (Figure 3). Both result in equal distortion (PSNR=36 dB), but JPEG2000 achieves significantly better compression, and a final file size roughly half of the JPEG image.

Figure 2. 480x640 pixel image compressed to 10.3 kB using JPEG2000. Distortion (PSNR)=36.0 dB.

Figure 3. 480x640 pixel image compressed to 21.0 kB using JPEG. Distortion (PSNR)=36.0 dB

2. JPEG2000 features

JPEG2000 offers several compression features that are particularly valuable for the PIV application:

1. Targeted file size or file quality. Images can be compressed within 2% of target file sizes or image quality. This helps ensure upon registration that an image will be either small enough or of sufficient quality for the application.
2. Versatility and database simplification. JPEG2000 enables the storage of one image file and the subsequent extraction of images of different attributes from that same file for different applications. For example, an agency might store a very high quality JPEG2000 image file in a database. That single file may be the source for facial feature extraction, image file storage on an ID, image printing on an ID, or image viewing in a software application. Only the sub-spatial, sub-quality or sub-resolution portion of the image file needs to be extracted from the master image file for a given application, significantly increasing usability and efficiency.
3. Superior compression. As illustrated, JPEG2000 achieves smaller file sizes for a given quality level than JPEG.
4. Region of interest. Images may be further compressed (or their quality improved) by compressing unneeded areas of the image at a greater ratio than that of the needed areas.