Action Plan Background: TIFF 6.0
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Release Date: 1/31/2003

Change History:
11/04/2003 Added section 1.12. Edited sections 4.1 and 6 to reflect additional information about Tiff profiles. Edited sections 3.8 and 5 to emphasize the fact that Tiff files can contain multiple images and the implications of this.
08/20/20004 Added sections 1.14 (Specification Requirements) and 2.2 (Internal Technical Metadata)

Preface: The TIFF 6.0 specification distinguishes between 'Baseline TIFF' and 'TIFF extensions'. The specification encourages all applications that purport to read TIFF 6.0 to support all features of Baseline TIFF. TIFF 6.0 images that use one or more of the TIFF extensions may not be supported by all TIFF readers. Throughout this document assume that the information applies to Baseline TIFF unless the information is followed by [TIFF extension].

1 General Description

1.1 Format Name: TIFF (Tag Image File Format)

1.2 Version: 6.0

1.3 MIME media type name: image

1.4 MIME subtype: tiff

1.5 Short Description: A tag-based raster image file format

1.6 Common Extensions: .tiff, .tif (recommended by specification)

1.7 Color depth: Bi-tonal to 24-bit

1.8 Color Space: Bi-level, Grayscale, Palette, RGB, CMYK [TIFF extension], YCbCr [TIFF extension], CIE L*a*b [TIFF extension]

1.9 Compression: Varies, can be any of: LZW [TIFF extension], JPEG [TIFF extension], PackBits (Run-length Encoding) (for black and white TIFF images), raw uncompressed, modified Huffman (for black and white TIFF images), and CCITT (Huffman) Group III & IV [TIFF extension] (for black and white TIFF images)

1.10 Progressive Display: Possible when using LZW [TIFF extension] or JPEG [TIFF extension] compression

1.11 Animation: No

1.12 Byte Order: Can be either little- or big-endian.

1.13 Magic number(s) or equivalent:
II (little-endian): 0x4949 0x2A00
MM (big-endian): 0x4D4D 0x002A

1.14 Specification Requirements
Tiff 6.0 Requirements:
- Start with the 8-byte image file header (see page 13 of [Adobe 1992])
- Contain at least one image file directory (IFD)
- Each IFD must have at least one entry
- The entries in each IFD must sorted in ascending order according to their tag numbers
- Only one NUL is allowed between strings within a field of type ASCII
- Can use field types not described in the specification
- Can have more than one IFD (and therefore image) in the file
- No data should be referenced from more than one place (Tiff readers and editors are not required to detect this condition and handle it properly)
- All strip offsets must reference valid locations
- May contain data types not described in the specification

The Tiff 6.0 specification describes additional requirements for the following profiles.
Bilevel Baseline Image Requirements:

Tag name	***Value***
ImageWidth	
ImageHeight	
Compression	1, 2 or 32773
PhotometricInterpretation	0 or 1
StripOffsets	
RowsPerStrip	
StripByteCounts	
XResolution	
YResolution	
ResolutionUnit	1, 2 or 3

Grayscale Baseline Image Requirements:

Tag name	*Value*
ImageWidth	
ImageHeight	
BitsPerSample	4 or 8
Compression	1 or 32773
PhotometricInterpretation	0 or 1
StripOffsets	
RowsPerStrip	
StripByteCounts	
XResolution	
YResolution	
ResolutionUnit	1, 2 or 3

Palette-Color Baseline Image Requirements:

Tag name	*Value*
ImageWidth	
ImageHeight	
BitsPerSample	4 or 8
Compression	1 or 32773
PhotometricInterpretation	3
StripOffsets	
RowsPerStrip	
StripByteCounts	
XResolution	
YResolution	
ResolutionUnit	1, 2 or 3
ColorMap	

RGB Full Color Baseline Image Requirements:

Tag name	*Value*
ImageWidth	
ImageHeight	
BitsPerSample	8,8,8
Compression	1 or 32773
PhotometricInterpretation	2
StripOffsets	

Tag name	*Value*
RowsPerStrip	
StripByteCounts	
XResolution	
YResolution	
ResolutionUnit	1, 2 or 3

2 Contents and Features

2.1 Essential and Distinguishing Characteristics

Can describe bi-level, grayscale, palette-color, and full-color image data in several color spaces. Supports numerous compression schemes, is largely hardware and software independent, and supports the inclusion of private or special-purpose information. It's capable of embedding multiple images within a single file so it can act as a wrapper for a document with multiple images or a single image with multiple alpha channels. Capable of encoding non-image textual information which can be used for metadata. The compression scheme can be lossy or lossless, depending on which compression algorithm is used. Maximum file size is capped at 4GB (2^32-1). Images can be tiled [TIFF extension] or in strips.

2.2 Internal Technical Metadata

Technical metadata element (G = general file metadata, GI = general image metadata, F = format-specific metadata)	*Obligation (R = required by spec., S= Information given by spec., O = Optional but described in spec., X = described by publication external to spec., DR = Derivable information from required metadata, DO = derivable information from optional metadata)*
Byte order [G]	R
Specification version [G]	DR
Compatible profiles per image [G]	DR
Software [G]	O
Date time [G]	O
Copyright [G]	O
Compression per image [GI]	S (can be optionally overridden in file)
Image length (height) [GI]	O
Image width [GI]	O
Bits per Sample (bits per component) [GI]	S (can be optionally overridden in file)
Color space [GI]	R
ICC color profile [GI]	X

Technical metadata element (G = general file metadata, GI = general image metadata, F = format-specific metadata)	***Obligation (R = required by spec., S= Information given by spec., O = Optional but described in spec., X = described by publication external to spec., DR = Derivable information from required metadata, DO = derivable information from optional metadata)***
Threshholding (technique used to convert from gray to black and white pixels) [GI]	S (can be optionally overridden in file)
Cell width [GI]	O
Cell height [GI]	O
Orientation [GI]	S (can be optionally overridden in file)
Samples per pixel (number of components per pixel) [GI]	S (can be optionally overridden in file)
Minimum sample value (Min. component value) [GI]	S (can be optionally overridden in file)
Maximum sample value (Max. component value) [GI]	S (can be optionally overridden in file)
Resolution - vertical [GI]	O
Resolution - horizontal [GI]	O
Gray response unit (gray response curve precision) [GI]	S (can be optionally overridden in file)
Gray response curve (optical density of each possible pixel value for grayscale data) [GI]	O
Resolution unit [GI]	S (can be optionally overridden in file)
Predictor (pre-compression encoding algorithm) [GI]	O
White point [GI]	O
Primary chromaticities [GI]	O
Color map (Palette table) [GI]	O
Halftone hints [GI]	O
Ink set (for separated color images) [GI]	O
Ink names (for separated color images)[GI]	O
Number of inks (for separated color images) [GI]	O
Dot range (for separated color images) [GI]	O
Target printer (for separated color images) [GI]	O
Extra samples (non-color components description) [GI]	S (can be optionally overridden in file)
JPEG compression parameters [GI]	O
YCbCr color parameters [GI]	O
Reference Black White [GI]	O
Image type (purpose or role of image within file) [GI]	S (can be optionally overridden in file)
Fill order (bit order within a byte) [F]	S (can be optionally overridden in file)
Rows per strip [F]	S (can be optionally overridden in file)
Strip byte counts (strip sizes) [F]	O

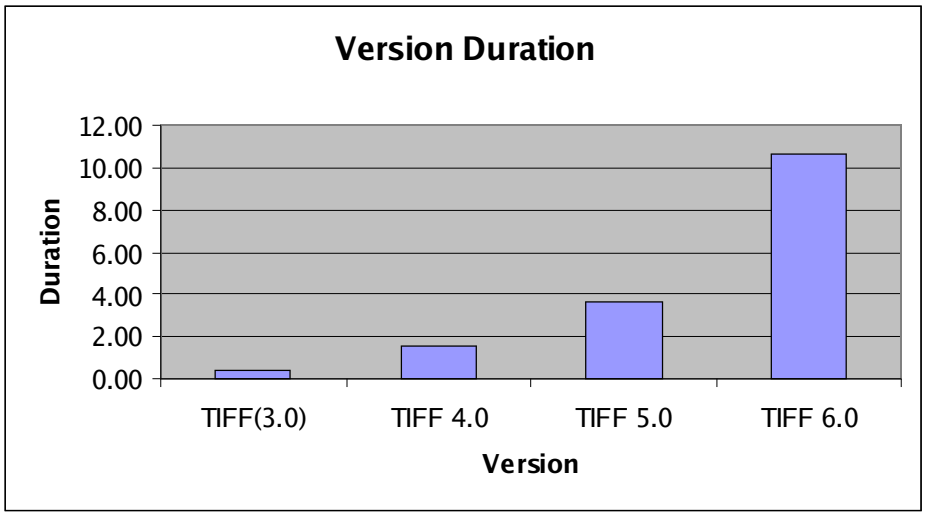
Technical metadata element (G = general file metadata, GI = general image metadata, F = format-specific metadata)	*Obligation (R = required by spec., S= Information given by spec., O = Optional but described in spec., X = described by publication external to spec., DR = Derivable information from required metadata, DO = derivable information from optional metadata)*
Planar configuration (component storage method) [F]	S (can be optionally overridden in file)
Free offsets [F]	O
Free byte counts [F]	O
T4Options [F]	O
T6 options [F]	O
Transfer function [F]	O
Transfer range [F]	O
Tile width [F]	O
Tile length [F]	O
Tile byte counts (tile sizes) [F]	O
Sample format [F]	O
S Min Sample Value [F]	O
S Max Sample Value [F]	O
Number of rows [F]	DO
Number of tiles [F]	DO
Storage segment (rows or tiles) [F]	DO

3 Usefulness

3.1 Version Duration: 10 years, 8 months and continuing

3.2 History of Prior Versions Duration:

- First version: Fall 1986: TIFF (no revision number – should have been TIFF 3.0 because there were two earlier major draft releases) by Aldus Corporation and Microsoft
- Second version: April 1987: TIFF 4.0 (minor enhancements)
- Third version: October 1988: TIFF 5.0 (added support for palette color images and LZW compression)
- Fourth and current version: June 3, 1992: TIFF 6.0



3.3 Expected Newer Versions:
According to graphics newsgroup archives, Adobe developers wrote a TIFF 7.0 draft specification in 1997. An Adobe developer claimed that the new specification added enhancements but was backwards-compatible with TIFF 6.0. The specification was never released to the public. It is rumored that Adobe thought that the TIFF specification, which they had inherited from Aldus, was in direct competition with a product they developed - PDF. Lawrence et. al (2002), attempted to contact the Adobe team regarding the TIFF 7.0 status. He notes that "the TIFF 7.0 development group seems to be determined not to release any information regarding their work". From these details it is questionable whether or not a newer version of TIFF will ever be released by Adobe.

3.4 Existence of Publicly Available Complete Specifications: Available for free download at: http://partners.adobe.com/asn/developer/pdfs/tn/TIFF6.pdf

3.5 Specifications-controlling Body:
TIFF was developed by Aldus and Microsoft Corp, and the specification was owned by Aldus, which in turn merged with Adobe Systems, Incorporated. Adobe Systems now holds the Copyright for the TIFF specification. TIFF is a trademark, formerly registered to Aldus, and which is now claimed (though not yet registered) by Adobe Systems, Inc.

3.6 Related Legal Issues:
A TIFF image may optionally use LZW compression, which is the subject of United States patent number 4,558,302 owned by the Unisys Corporation. This U.S. patent is scheduled to expire on June 20, 2003. There remains uncertainty as to the legal uses of LZW after the expiration. Unisys will still hold foreign LZW patents and the US patent could theoretically be extended if Unisys added extensions to the original patent. In addition, other US companies may also hold LZW patents. These issues could make it less likely for future applications to support the decoding and encoding of LZW-compressed images.

3.7 Application and Platform Support: TIFFs are software and hardware independent. They are supported by the majority of scanners and most image viewing and editing software. They are not supported natively by WWW browsers, but can be viewed using plug-ins and helper applications. Because TIFF is a flexible specification, not all of its features are supported by TIFF readers.

3.8 Limitations: Not natively supported by WWW browsers; can not store vector graphics. TIFF uses 4-byte integer file offsets to store image data, with the consequence that a TIFF file cannot have more than 4 Gigabytes of raster data. However, this is 4G of compressed data, and so if the compression ratio is high enough, theoretically a TIFF image could be much larger (in fact, 2**32-1 pixels square). Its versatile nature can be problematic, with issues such as large strip sizes (a contiguous portion of the image) overflowing memory allocation, support for both big-endian and little-endian byte ordering, and the capability of storing multiple images within the file.

3.9 Perceived Popularity: TIFF files are widely used in the areas of archiving, scanning, faxing, prepress, remote sensing and multispectral applications.

4 Related Formats

4.1 Specification Variations:

The Tiff 6.0 specification describes four different baseline profiles: bi-level, grayscale, RGB and palette. It also describes the following non-baseline or extension profiles: CCITT Group 3 and 4, LZW, tiled tiffs, CMYK, YCbCr, CIEL*a*b*, and JPEG.

There are many other Tiff profiles described in separate specifications by organizations or companies other than Adobe. They tend to be compatible with the Tiff 6.0 specification and add tags to support more functionality. These profiles include Class F (for fax images), GeoTIFF (for geographic images), Tiff/EP (for digital cameras), Tiff/IT (for prepress images), and Exif (for digital cameras). Other Tiff profiles are not completely compatible with the Tiff 6.0 specification, such as RichTIFF.

5 Summary and Conclusions

Many factors make TIFF 6.0 a stable format. The TIFF 6.0 specification has been around for a relatively long time - 10.66 years. TIFF files can be used as general purpose image archival formats, supporting many compression schemes, color spaces and color depths. The specification is complete and made freely downloadable on the WWW by Adobe. Historically, the revised

TIFF specifications have been backwards-compatible, so it is likely that if the TIFF 7.0 specification is ever published it will be backwards-compatible with TIFF 6.0.

Some TIFF 6.0 features may be problematic for archival purposes. For the reasons discussed in (3.6 Legal Issues), LZW compression should be avoided, at least until Unisys' US patent expires. Additionally, the features that are not part of Baseline TIFF (e.g. advanced color spaces and compression algorithms) are less likely to be widely supported by applications. However, some of these extensions, like the CIE L*a*b color space, have merits such as device-independence that may make them more widely acceptable in the future. The fact that Tiff files can contain multiple images, each with different compression algorithms, color spaces, etc. means that the ability to assign technical metadata to individual images within a file should be supported by archives.

6 References

[Adobe 1992] Adobe Developers Association, "TIFF Revision 6.0", Adobe Systems Incorporated, Final - June 3, 1992. (http://partners.adobe.com/asn/developer/pdfs/tn/TIFF6.pdf)

Campbell, Joe. “The Spirit of Tiff Class F”, Tiff-F Revised Specifications, Cygnet Technologies, Berkeley, CA; April 29, 1990.

Lawrence, Gregory W., William R. Kehoe; Oya Y. Rieger; William H. Walters and Anne R. Kenney. "Risk Management of Digital Information: A File Format Investigation", Council on Library and Information Resources, June 2000.
(http://www.clir.org/pubs/reports/pub93/contents.html)

Libtiff Mailing List, (www.remotesensing.org)

Ritter, Niles; and Mike Ruth. “GeoTIFF Format Specification: GeoTIFF Revision 1.0”, Specification Version 1.8.1, GeoTIFF Working Group, October 31, 1995.

Technical Standardization Committee on AV & IT Storage Systems and Equipment, “Exchangeable image file format for digital cameras: Exif Version 2.2”, JEITA CP-3451, April 2002.

White, W.T. “'Solo ' Image File Format: RichTIFF and its replacement by 'Solo' JFIF”, Coatsworth Communications, Inc., Brampton, Ontario, Canada; October 14, 1998.