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Data Dictionary—Technical Metadata for Digital Still Images

Developed by the
National Information Standards Organization and
AIIM International

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June 1, 2002 – December 31, 2003

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National Information Standards Organization

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Foreword

(This Foreword is not part of NISO Z39.87-2002 / AIIM 20-2002 — *Data Dictionary—Technical Metadata for Digital Still Images*. It is included for information only.)

Cultural institutions and commercial organizations are increasingly engaged in creating libraries of digital still images. A major challenge in making these collections persist is to build systems, defined broadly as "digital repositories," that maintain functionality and quality intrinsic to images. One management strategy, migration, proposes to preserve image data by copying files to new formats at designated intervals.

The premise that underlies migration also informs new concepts of preservation: digital technologies offer the unprecedented opportunity to preserve content without any loss of information from generation to generation. Whether this is possible, and under what conditions, are two of the questions that led the National Information Standards Organization, the Council on Library and Information Resources, and the RLG to sponsor an "Image Metadata Workshop" in April 1999. The goal of the workshop was to launch a collaborative effort to define a set of metadata elements to document technical attributes of digital still images.

The workshop organizers observed that cultural institutions had been focusing primarily on defining descriptive metadata for the purpose of discovery and identification, and that comparatively little work had been done to codify technical attributes of digital images and their production. Workshop participants agreed that technical metadata is necessary to support two fundamental goals: to document image provenance and history (production metadata); and to ensure that image data will be rendered accurately on output (to screen, print, or film). Several participants also observed that ongoing management, or "preservation," of these core functions will require the development of applications to validate, process, refresh, and migrate image data against criteria encoded as technical metadata.

Two overarching goals led NISO and AIIM to develop this data dictionary. The first is to identify the data elements that would be used by applications to control transformations of images against stated metrics (or "anchors") for meaningful quality attributes such as detail, tone, color, and size. The second is to propose elements that would be used by digital repository managers, curators, or imaging specialists to assess the current value (aesthetic or functional) of a given image or collection of images.

The authors of this dictionary are indebted to three working groups that have developed technical metadata specifications for digital still images:

- Digital Imaging Group (DIG), DIG35 Working Group, *Metadata for Digital Images*, Working Draft 2.0 Beta — June 18, 2000
- ISO Technical Committee 42—Photography, ISO/DIS 12234-2, *Photography—Electronic still picture imaging—Removable memory—Part 2: Image data format*—TIFF/EP, WG18/Item 189.2, June 21, 2000
- Adobe Developers Association, *TIFF*, Revision 6.0, Final—June 3, 1992

Although TIFF and TIFF/EP are file format specifications, the TIFF data elements and values (presented as fields with associated file header tags) are used to represent a comprehensive list of metadata used to render and manage image data.

The DIG35 specification distinguishes itself from file format specifications with its stated purpose to facilitate metadata *sharing*.

This proposed national standard is being released as a Draft Standard for Trial Use for the period June 1, 2002 through December 31, 2003. At the end of this review period, the standard will be revised

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Data Dictionary—Technical Metadata for Digital Still Images

1 Purpose and scope

The purpose of this data dictionary is to define a standard set of metadata elements for digital images. Standardizing the information allows users to develop, exchange, and interpret digital image files. The dictionary has been designed to facilitate interoperability between systems, services, and software as well as to support the long-term management of and continuing access to digital image collections.

This data dictionary presents a comprehensive list of technical data elements relevant to the management of digital still images. In this context, "management" refers to the tasks and operations needed to support image quality assessment and image data processing throughout the image life cycle. "Quality assessment" is defined broadly, as it refers both to machine operations and curatorial evaluations. Technical metadata have been identified to "anchor" meaningful attributes of image quality that can be measured objectively, such as detail, tone, color, and size.

This standard frequently refers to images maintained in TIFF (Tagged Image File Format). The TIFF format is a highly flexible and platform-independent format that is supported by numerous image processing applications. The TIFF specification is publicly available to all users. The structure of the header includes a rich set of technical information important for long-term retention such as for colorimetry, calibration, gamut tables, etc. The information is also very useful for remote sensing and multispectral applications. The repeated references to and examples citing the TIFF format within this standard can be extended to other file formats. The technical dictionary indicates the information and metadata all image files should contain as well as additional information related to image production.

1.1 Metadata out of scope

Except for documentation of the systems that were used to create an image, metadata to document provenance, authenticity, or other aspects of image integrity are beyond the scope of this dictionary. Similarly, Intellectual Property and Rights (IPR) metadata, including ownership responsibility, is not covered. Although such metadata may be integral to digital repository development and asset management, other emerging draft standards such as the DOI Namespace initiative address this type of metadata. As stated above, data elements in this dictionary focus upon the object class of digital still images.

2 Application

This standard is intended to facilitate the development of applications to validate, manage, migrate, and otherwise process images of enduring value. Such applications are viewed to be essential components of large-scale digital repositories and digital asset management systems.

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2.1 Audience

Cultural institutions, publishers, rights holders, and other organizations are engaged in digitizing visual materials from historic collections. Therefore, the metadata blocks presented in this document are structured to accommodate practices associated with digital copy photography, such as the use of technical targets, as well as the techniques related to direct digital photography of original scenes.

2.2 Design goals

The design goals of this NISO initiative are to define a metadata set that interoperates with and meets the goal outlined by the DIG35 metadata standard. To that end, the NISO group has adapted the original DIG35 goals as follows:

- **Interchangeable**: The NISO metadata set is based on a sound conceptual model that is both generally applicable to many applications and assured to be consistent over time.
- **Extensible and scalable**: The NISO metadata set enables application developers and hardware manufacturers to utilize additional metadata fields. This allows future needs for metadata to be fulfilled with limited disruption of current solutions.
- **Image file format independent**: The NISO metadata set does not rely on any specific file format and can therefore be supported by many current and future file formats and compression mechanisms.
- **Consistent**: The NISO metadata set works well with existing standards and it is usable in a variety of application domains and user situations.
- **Network-ready**: The NISO metadata set provides seamless integration with a broad variety of systems and services. Integration options include database products and the utilization of XML schemas (the recommended implementation method).

2.3 Implementation guidelines

2.3.1 Metadata encoding

Although recommendations for metadata encoding were deemed beyond the scope of the data dictionary, logical structures have been proposed for several metadata blocks to serve the development of a data model (see sections 6.1.5, 8.1, 8.3, 9.1, and 9.2).

The dictionary authors recommend adopting TIFF/EP's guideline prohibiting default values: "...[for every field] do not allow default values. *All values shall be explicitly stated*. This is done to improve interoperability...." (TIFF/EP, p. 4, emphasis added)

2.3.2 Metadata production

The dictionary assumes that metadata mappings will be essential to automate the collection of technical metadata. Since the design model presumes that NISO-compliant metadata will be stored *outside* the image, applications will need to be developed (or identified) that "harvest" file header data programmatically (see 2.3.3 *Metadata assumptions*). The dictionary implicitly presents the mappings between TIFF's required "Baseline Fields" and selected NISO data elements.

2.3.3 Metadata assumptions

This dictionary adopts the following assumptions articulated in the DIG35 specification:

- General-purpose metadata standards must be "applicable to the broadest possible class of file formats." (DIG35, 3.2.1)
- To facilitate the management (processing) of the widest range of file formats, an image management metadata standard should "*…assume the existence of a file format that contains no header*

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information." (DIG35, 3.2.1, emphasis added) In other words, data that exists in file headers to comply with specifications for a given image format will need to be replicated.

- There should never be any conflicts between the metadata specified in this standard and file header metadata; technical metadata specified in this standard "… *should be considered informational and not be used to decode the image data stored in the associated file*." (DIG35, 3.2.1, emphasis added)
- Regarding metadata conflicts, "... if there is a conflict ... the file header shall always take precedence." (DIG35, 3.2.1)

3 Definitions

This section lists the definitions of terminology used in this standard. Definitions for additional terms related to image processing may be found in ANSI/AIIM TR2-1998—*Glossary of Document Technologies*.

3.1 field:
refers to the entire data element

3.2 tag:
refers only to the ID number of each data element

3.3 image or image data:
refers to a two-dimensional array of pixels

3.4 segments:
the collective term for how image data is stored; individually referred to as either strips or tiles

3.5 processed image:
refers to an image that has had one or more image processing steps applied after scanning (see section 9.1 *Image processing*)

3.6 components:
one or more color elements in each pixel; *component* is preferred over its synonyms *sample* and *channel*

Examples:

- bilevel and grayscale data have one color component per pixel
- RGB color data has three components per pixel

3.7 sampling frequency:
refers to the number and placement of pixels in the image (see section 8.1 *Spatial metrics*)

4 References

The following references contain provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revisions, and parties utilizing this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Acronyms included in brackets at the end of each reference are how the reference is cited in other parts of the text.

ISO 8601:2000, *Data elements and interchange formats—Information interchange—Representation of dates and times*

ISO 12234-2:2001, *Photography—Electronic still picture imaging—Removable memory—Part 2: Image data format—TIFF/EP, (Tag Image File Format / Electronic Photography)*. [TIFF/EP]

Adobe Systems, Inc. *TIFF, Revision 6.0.* Final—June 3, 1992.
<http://partners.adobe.com/asn/developer/pdfs/tn/TIFF6.pdf> [TIFF]

Digital Imaging Group DIG35. *DIG35 Specification: Metadata for Digital Images, Version 1.1, Working Draft*, April 16, 2001, Annexes A, B, and D. [DIG35]

W3C Consortium, *NOTE-datetime—Date and Time Formats*, <http://www.w3.org/TR/NOTE-datetime> [W3C NOTE]

5 Field reference guide

5.1 Documentation

Sections 6 through 9 of this standard define the metadata fields of this data dictionary. Information provided for each field contains the following documentation:

TagName

Definition	*definition in italics*
Type	specification allowable data type(s) (See section 9.2.)
Required	M = mandatory MA = mandatory if applicable R = Recommended O = optional
Repeatable	Y = yes N = no
Values (Examples)	When data type = "enumerated type," values listed are actual values. When data type = "string," examples are provided.
Notes or **Usage Notes**	A comments field, including pointers to related documentation. "Usage Notes" provide additional information about examples.
Use	System Manager (curator, repository manager, imaging expert) User (end user)

5.2 Data types

The following data types are used in this dictionary:

Data Type	Definitions
DateTime	Recorded in compliance with the W3C Note profile, "Representation of dates and times." The W3C Note defines a profile of ISO 8601, the International Standard for the representation of dates and times. This information will most likely be harvested from the file header and not manually input. *Examples:* YYYY-MM-DD HH:MM:SS (with hours 0-24, a space character between the date and time, and a null termination byte) YYYY-MM-DD YYYY-MM YYYY Note: This field should never be changed after it is written in the image

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	capture device.
Enumerated type (restricted to external standard)	a string that may only contain one of a number of values as specified by an existing external standard
Enumerated type (restricted to list)	a string that may only contain one of a number of values listed Note: Such lists can be implemented and regulated on an institutional basis. This allows for quick adoption of new values when technology changes.
Non-negative real	a real number where r >= 0
Positive integer	an integer where i > 0
Real	a real number where r may be < 0
Reference	a single pointer to another object
String	one or more characters

6 Basic image parameters

The items in this section are fundamental to the reconstruction of the digital file as a viewable image on electronically interfaced displays. The standard makes no presumption about the rendered or spatial accuracy of the displayed image, only that a reasonably appearing image can be reconstructed using these elements. Elements for efficient and convenient image display management are provided under section 6.1.5, *Segments.*

6.1 Format

6.1.1 MIMEType

Definition	*designation of the Multipurpose Internet Mail Extensions (MIME) type associated with the image data*
Type	enumerated type (restricted to external standard)
Required	R
Repeatable	N
Values (Examples)	image/gif = GIF image/jpeg = JPEG image/tiff = TIFF image/x-pcd = PCD application/pdf = PDF
Notes	The values listed above represent MIME types for digital still image formats commonly used in library and museum digital reformatting initiatives. The x-convention is used to construct an unofficial type for any image format lacking a formally registered MIME type. See Internet Assigned Numbers Authority for an up-to-date list of formally registered MIME types.
Use	System

6.1.2 ByteOrder

Definition	*designates the byte order in which multi-byte numbers are stored*
Type	enumerated type (restricted to list)
Required	R
Repeatable	N
Values	big_endian

	little_endian
Notes	Virtually all computer architectures are byte addressable. The bytes of a multi-byte data value can be stored in memory in different orders. “Little_endian” means that the low-order byte of the number is stored in memory at the lowest address, and the high-order byte at the highest address. “Big_endian” means that the high-order byte of the number is stored in memory at the lowest address, and the low-order byte at the highest address.
Use	System

6.1.3 Compression

6.1.3.1 CompressionScheme

Definition	*designates the compression scheme used to store the image data*
Type	enumerated type (restricted to list)
Required	M
Repeatable	N
Values	1 = Uncompressed 2 = CCITT 1D 3 = CCITT Group 3 4 = CCITT Group 4 5 = LZW 6 = JPEG 32773 = PackBits (simple byte-oriented run-length scheme)
Usage Notes	Values above are drawn from TIFF (p. 117) though institutions are encouraged to devise a local enumerated list to allow for the addition of new values as technology changes. This data element allows for the designation of subelements in order to record the level of compression applied (see 6.1.3.2 **CompressionLevel**).
Use	System

6.1.3.2 CompressionLevel

Definition	*designates the level of compression used in* 6.1.3.1 **CompressionScheme**
Type	positive integer
Required	MA
Repeatable	N
Values (Examples)	10 30
Use	System

6.1.4 PhotometricInterpretation

6.1.4.1 ColorSpace

Definition	*designates the color space of the decompressed image data*
Type	enumerated type (restricted to external standard)
Required	M
Repeatable	N

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Values	0 = **WhiteIsZero** For bilevel and grayscale images: 0 is imaged as white. 2**BitsPerSample-1 is imaged as black. This is the normal value for Compression=2. 1 = **BlackIsZero** For bilevel and grayscale images: 0 is imaged as black. 2**BitsPerSample-1 is imaged as white. If this value is specified for Compression=2, the image should display and print reversed. 2 = **RGB** In the RGB model, a color is described as a combination of the three primary colors of light (red, green, and blue) in particular concentrations. For each of the three components, 0 represents minimum intensity, and 2**BitsPerSample-1 represents maximum intensity. Thus an RGB value of (0,0,0) represents black, and (255,255,255) represents white, assuming 8-bit components. For **PlanarConfiguration** = 1, the components are stored in the indicated order: first Red, then Green, then Blue. For **PlanarConfiguration** = 2, the **StripOffsets** for the component planes are stored in the indicated order: first the Red component plane **StripOffsets**, then the Green plane **StripOffsets**, then the Blue plane **StripOffsets**. 3 = **Palette color** In this model, a color is described with a single component. The value of the component is used as an index into the red, green, and blue curves in the **ColorMap** field to retrieve an RGB triplet that defines the color. When **PhotometricInterpretation** = 3 is used, **ColorMap** must be present and **SamplesPerPixel** must be 1. 4 = **Transparency Mask** This means that the image is used to define an irregularly shaped region of another image in the same TIFF file. **SamplesPerPixel** and **BitsPerSample** must be 1. PackBits compression is recommended. The 1-bits define the interior of the region; the 0-bits define the exterior of the region. 5 = **CMYK** 6 = **YCbCr** 8 = **CIELab**
Notes	When **PhotometricInterpretation** = 6, TIFF/EP requires use of the following four tags (which are not covered in this specification): 530 **YCbCrSubSampling**, 531 **YCbCrPositioning**, 529, **YCbCrCoefficients**, 532 **ReferenceBlackWhite**. Use the fields defined in sections 6.1.4.3-6.1.4.6 to record these values. See TIFF section 21, *YCbCr Images,* and TIFF/EP Section 5**,** *TIFF/EP Tag definitions,* for additional information regarding TIFF YCbCr (*Class Y*) images.
Use	System (tone, color) Manager (one of the quantitative metrics to evaluate image quality)

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6.1.4.2 ICCProfile

6.1.4.2.1 ProfileName

Definition	*designates the well-defined name of the ICC profile used*
Type	string
Required	MA
Repeatable	N
Values	
Usage Notes	If the ICC profile used is a well-known and well-documented profile, record the information in this data element. If not, record the location of where the profile can be found in the field defined in section 6.1.4.2.2, **ProfileURL**.
Use	System

6.1.4.2.2 ProfileURL

Definition	*designates the URL/URN where the ICC profile is located*
Type	string
Required	MA
Repeatable	N
Values	
Usage Notes	If the ICC profile used is a well-known and well-documented profile, record the information in the field defined in section 6.1.4.2.1 **ProfileName**. If not, record the location of where the profile can be found in this data element**.**
Use	System

6.1.4.3 YCbCrSubSampling

Definition	*designates the subsampling factors used for the chrominance components of a YCbCr image* Note: This tag is mandatory when **PhotometricInterpretation** = 6, and there are no defaults allowed.
Type	enumerated type (restricted to external standard)
Required	MA
Repeatable	N
Values	
Usage Notes	See TIFF, section 21, *YCbCr Images*, and TIFF/EP section 5**,** *TIFF/EP Tag definitions*, for additional information regarding TIFF YCbCr (*Class Y*) images.
Use	System (tone, color) Manager (one of the quantitative metrics to evaluate image quality)

6.1.4.4 YCbCrPositioning

Definition	*designates the positions of subsampled chrominance components relative to luminance samples* Note: This tag is mandatory when **PhotometricInterpretation** = 6, and the value shall equal 2.
Type	enumerated type (restricted to external standard)
Required	MA

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Repeatable	N
Value	2
Usage Notes	See TIFF section 21, *YCbCr Images*, and TIFF/EP section 5, *TIFF/EP Tag definitions*, for additional information regarding TIFF YCbCr (*Class Y*) images.
Use	System (tone, color) Manager (one of the quantitative metrics to evaluate image quality)

6.1.4.5 YCbCrCoefficients

Definition	*encodes the transformation from RGB to YCbCr image data* Note: This tag is mandatory when **PhotometricInterpretation** = 6, and there are no defaults allowed. The transformation is specified as three rational values that represent the coefficients used to compute luminance, Y.
Type	enumerated type (restricted to external standard)
Required	MA
Repeatable	N
Values	
Usage Notes	See TIFF, section 21, *YCbCr Images*, and TIFF/EP section 5, *TIFF/EP Tag definitions***,** for values and additional information regarding TIFF YCbCr (*Class Y*) images.
Use	System (tone, color) Manager (one of the quantitative metrics to evaluate image quality)

6.1.4.6 ReferenceBlackWhite

Definition	*encodes a pair of headroom and footroom image data values for each pixel component* Note: This tag is mandatory when **PhotometricInterpretation** = 6, and there are no defaults allowed.
Type	enumerated type (restricted to external standard)
Required	MA
Repeatable	N
Values	
Usage Notes	See TIFF section 21, *YCbCr Images*, and TIFF/EP section 5, *TIFF/EP Tag definitions*, for values and additional information regarding TIFF YCbCr (*Class Y*) images.
Use	System (tone, color) Manager (one of the quantitative metrics to evaluate image quality)

6.1.5 Segments

Image data is stored using either strips or tiles, which are collectively termed segments (TIFF/EP, 10). TIFF specifies that strip-oriented and tile-oriented fields must not be used in the same file (TIFF, 67).

Figure 1, below, illustrates the logical structure of the **Segments** metadata. Numbers in parentheses refer to the section of the standard where the field is defined.

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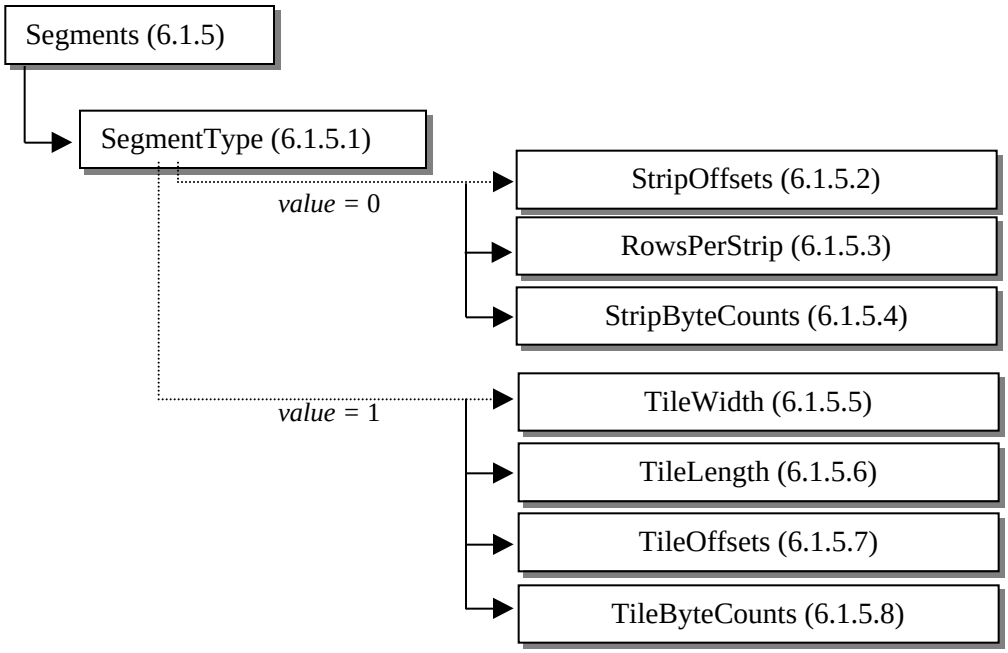

Figure 1 – Logical structure of Segments metadata

6.1.5.1 SegmentType

Definition	*specifies whether image data is stored in strips or tiles*
Type	enumerated type (restricted to list)
Required	M
Repeatable	N
Values	0 = strips 1 = tiles
Usage Notes	When value = 0, fields 6.1.5.5-6.1.5.8 are irrelevant. When value = 1, fields 6.1.5.2-6.1.5.4 are irrelevant.
Use	Manager

6.1.5.2 StripOffsets

Definition	*for each strip, the byte offset of that strip*
Type	positive integer
Required	R (when applicable; see usage note in section 6.1.5.1)
Repeatable	N
Values	
Notes	"The **StripOffsets** field stores the offsets from the start of the image file to the start of each image data strip." (TIFF/EP)
Use	System "This required field is the only way for a reader to find the image data, unless TileOffsets is used." (TIFF, p.40)

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6.1.5.3 RowsPerStrip

Definition	*the number of rows per strip*
Type	positive integer
Required	R (when applicable; see usage note in section 6.1.5.1)
Repeatable	N
Values	
Notes	"RowsPerStrip and ImageLength together tell us the number of strips in the entire image. The equation is:…" (TIFF, p.39)
Use	System

6.1.5.4 StripByteCounts

Definition	*the number of image data bytes stored within each strip after compression*
Type	positive integer
Required	R (when applicable; see usage note in section 6.1.5.1)
Repeatable	N
Values	
Use	System

6.1.5.5 TileWidth

Definition	*the tile width in pixels. This is the number of columns in each tile*
Type	positive integer
Required	R (when applicable; see usage note in section 6.1.5.1)
Repeatable	N
Values	
Use	System

6.1.5.6 TileLength

Definition	*the tile length (height) in pixels, i.e. the number of rows in each tile*
Type	positive integer
Required	R (when applicable; see usage note in section 6.1.5.1)
Repeatable	N
Values	
Use	System

6.1.5.7 TileOffsets

Definition	*for each tile, the byte offset of that tile, as compressed and stored on disk*
Type	positive integer
Required	R (when applicable; see usage note in section 6.1.5.1)
Repeatable	N
Values	
Use	System

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6.1.5.8 TileByteCounts

Definition	*for each tile, the byte offset of that tile, as compressed and stored on disk*
Type	positive integer
Required	R (when applicable; see usage note in section 6.1.5.1)
Repeatable	N
Values	[n] = **TilesPerImage** for **PlanarConfiguration** = 1 = **SamplesPerPixel** * **TilesPerImage** for **PlanarConfiguration** = 2
Notes	For each tile, the number of (compressed) bytes in that tile. See **TileOffsets** for a description of how the byte counts are ordered. No default. See also **TileWidth**, **TileLength**, **TileOffsets**. (TIFF, p.68)
Use	System

6.1.6 PlanarConfiguration

Definition	*designates how the components of each pixel are stored*
Type	enumerated type (restricted to list)
Required	MA (when **SamplesPerPixel** > 1; see section 8.2.2)
Repeatable	N
Values	1 = chunky (pixel interleaved) format 2 = planar format
Notes	"If **SamplesPerPixel** is 1, **PlanarConfiguration** is irrelevant." (TIFF, p.38) See TIFF/EP 5.2.14 for an alternative definition of Planar Configuration that incorporates CFAPattern values.
Use	System

6.2 File

6.2.1 ImageIdentifier

Definition	*a unique identifier*
Type	string
Required	M
Repeatable	N
Values	
Notes	Persistent identifier required at prime object level; optional at all other levels. This identifier must be unique within the local system. To facilitate file sharing or interoperability with other systems, a subelement (see section 6.2.1.1 **ImageIdentifierLocation**) may be added to designate the system or application within which the identifier is unique.
Use	Manager System

6.2.1.1 ImageIdentifierLocation

Definition	*a location qualifier to be used in conjunction with section* 6.2.1 **ImageIdentifier**
Type	string
Required	O
Repeatable	N
Values	

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Notes	Persistent identifier required at prime object level; optional at all other levels. This identifier must be unique within the local system. To facilitate file sharing or interoperability with other systems, **ImageIdentifierLocation** may be added to designate the system or application within which the identifier is unique.
Use	Manager System

6.2.2 FileSize

Definition	*extent of image in number of bytes*
Type	positive integer
Required	M
Repeatable	N
Values (Examples)	618 72839 116126
Usage Notes	The file size must record the number of bytes as provided by the system. Do not attempt to record file sizes in terms of KB, MB, or other notation.
Use	System

6.2.3 Checksum

6.2.3.1 ChecksumMethod

Definition	*type of error detection technique used, i.e. a checksum (or equivalent)*
Type	enumerated type
Required	R
Repeatable	N
Values	
Usage Note	Local repository policies regarding file integrity metadata should govern implementation of this field. The enumerated type values should be defined locally, as should the rule regarding when the checksum is generated: prior to deposit, at the time of deposit, or both. Depending upon local implementation, this field may be used to list the specific type of error detection technique used (e.g., checksum, CRC, MNP, etc.) and the subsequent value would then be recorded in section 6.2.3.1 **ChecksumValue**.
Use	System Manager (to monitor file integrity)

6.2.3.2 ChecksumValue

Definition	*checksum (or equivalent)*
Type	positive integer
Required	R
Repeatable	N
Values	
Usage Note	Linked to section 6.2.3.1 **ChecksumMethod**.
Use	System Manager (to monitor file integrity)

6.2.4 Orientation

Definition	*designates the orientation of the image, with respect to the placement of its rows* (**ImageWidth**) *and columns* (**ImageLength**), *as it was saved to disk*
Type	enumerated type (restricted to external standard)
Required	R
Repeatable	N
Values	1 = normal* 3 = normal rotated 180° 6 = normal rotated cw 90° 8 = normal rotated ccw 90° 9 = unknown
Usage Notes	* "Normal" is defined as follows: when opened, the top (0^{th}) row of pixels corresponds to the visual top of the image and the first (0^{th}) column of pixels on left corresponds to the visual left-hand side of the image. Consult TIFF for additional values referring to mirrored images. (Note that TIFF/EP supports only five values, which are proposed above as the finite list of enumerated type values.) This field is to be used to record only the orientation of the image, *not* the orientation of the source to the device (e.g., camera) used to capture the image.
Use	System

6.2.5 DisplayOrientation

Definition	*designates the orientation in which the image should be presented to a conventional monitor with a 3:2 aspect ratio*
Type	enumerated type (restricted to list)
Required	O
Repeatable	N
Values	0 = portrait 1 = landscape
Notes	This value is important to record when the preferred orientation of the image sent to a 3:2 aspect ratio computer monitor is different from **Orientation**. While **Orientation** refers to the placement of pixels in the digital image file, **DisplayOrientation** refers to the preferred orientation in which to display the content (text, picture, table, etc.) *within* the file. This field will likely become obsolete when "standard" delivery applications, such as web browsers, incorporate an image rotation tool.
Use	System

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6.2.6 TargetedDisplayAR

6.2.6.1 XTargetedDisplayAR

Definition	*unit of X orientation*
Type	positive integer
Required	O
Repeatable	N
Values	
Use	System

6.2.6.2 YTargetedDisplayAR

Definition	*unit of Y orientation*
Type	positive integer
Required	O
Repeatable	N
Values	
Use	System

6.3 PreferredPresentation

Definition	*designation of the device, application, medium, viewing environment (or any combination thereof) to render the image data*
Type	string
Required	O
Repeatable	N
Values	
Usage Notes	For image data that can be defined to have a "best representation," use this free-text field to recommend the "target" device, application, medium, viewing environment (or combination thereof) presumed or proven to be meaningful to image quality. This will be especially important as viewing devices other than the conventional 3:2 monitor become popular. Calculation and automated optimal display from one display Aspect Ratio to another will be possible with the information from section 6.2.5 **DisplayOrientation** and the host of measurements supported within this standard. The Library of Congress's presentation_profile specifies "the program (or equivalent) used to manage the presentation of this primary or intermediate object for users." Standard: ISO 3664 *Viewing conditions for graphic technology and photography*.
Use	Manager User

7 Image creation

This section can best be described as *descriptive* technical metadata. While it provides no quantitative information, per se, it can provide critical information with respect to the logistics and administrative conditions surrounding digital image data capture. Frequently, simple interrogation of these fields offers valuable diagnostics about the image creation step as well as those of subsequent image generations.

This metadata block documents selected, irreversible attributes of the analog-to-digital conversion process that may be used for future quality assessment of the image data. By definition, image creation occurs only once.

See section 9.1 *Image processing* for fields to record digital-to-digital conversion processes.

7.1 SourceType

Definition	*specifies the medium of the analog source material scanned to create a digital still image*
Type	string
Required	R
Repeatable	N
Values (Examples)	daguerreotype reflection print silver gelatin print Acme Bronze 100 chromagenic film 35mm color negative Kodak Royal Gold 100 Emul. 3712011 monograph microfilm
Notes **Usage Notes**	"General or specific physical nature of original item (i.e., still pictorial image)." (LC) *Do not record dimensions of source material in this field.* See **Source_Xdimension** (section 8.1.7) and **Source_Ydimension** (section 8.1.8). When the source of the image data is another digital still image (e.g., a parent high-resolution image used to create a reduced-resolution image), see section 9.1 *Image processing*.
Use	Manager User

7.2 SourceID

Definition	*a unique identifier for a descriptive record of the source of image*
Type	string
Required	O
Repeatable	N
Values (Examples)	RLIN ID OCLC record number Local system control number
Notes	Link to existing data record for the source material.

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Use	Manager System

7.3 ImageProducer

Definition	*identifies the organization-level producer(s) of the image*
Type	string
Required	R
Repeatable	Y
Values (Examples)	Luna Imaging, Inc. JJT, Inc. University of Michigan; Digital Library Production Services Harvard College Library; Digital Imaging Group University of Virginia; William Blake Archive When Repeatable = Y, the following is an example of how to code the information: <ImageProducer> University of Virginia </ImageProducer> <ImageProducer> William Blake Archive </ImageProducer>
Notes	Identifies the organization-level producer of the "file/bitstream, " i.e., the scanned image, transcribed text, audio file, etc.
Use	Manager

7.4 HostComputer

Definition	*computer and/or operating system in use at the time of image creation*
Type	string
Required	R
Repeatable	N
Values	
Notes	The definition for this multi-layered data element can be interpreted narrowly, as in TIFF, or broadly, as in Cedars which states: "This element contains information about the operating environment of the *original digital object at the time of ingest*, including information on relevant hardware and operating systems, together with the software products that would have been required in order to use it." Use the fields defined in sections 7.4.1 **OS** and 7.4.2 **OSVersion** to record specifics about the operating system.
Use	Manager

7.4.1 OS (Operating System)

Definition	*operating system in use at the time of image creation*
Type	string
Required	R
Repeatable	N

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Values (Examples)	Windows Mac Unix Linux
Use	Manager

7.4.2 OSVersion

Definition	*version of the operating system in use at the time of image creation*
Type	string
Required	MA
Repeatable	N
Values (Examples)	2000 (e.g., Windows 2000) NT X (e.g., Mac OS X) V (e.g., Unix System V)
Notes	Must be present if information is present in field 7.4.1 **OS**.
Use	Manager

7.5 DeviceSource

Definition	*classification of device used to create the image data*
Type	string
Required	R
Repeatable	N
Values (Examples)	transmission scanner reflection print scanner digital still camera still from video
Usage Notes	Recommended syntax: Local institutions should create a list of enumerated values for use with this data element in order to regularize information. Doing so on a local level will allow for more rapid expansion of the list to accommodate new technologies. When image processing software is used to generate the image data from a digital source, see section 9.1 *Image processing*.
Use	Manager

7.6 ScanningSystemCapture

7.6.1 ScanningSystemHardware

the scanner manufacturer, model name and/or number used to create the image

7.6.1.1 ScannerManufacturer

Definition	*the manufacturer of the scanner used to create the image*
Type	string
Required	R
Repeatable	N

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Values (Example)	Scitex
Use	Manager

7.6.1.2 ScannerModel

7.6.1.2.1 ScannerModelName

Definition	*the model name of the scanner used to create the image*
Type	string
Required	R
Repeatable	N
Values (Example)	Leaf Volare
Use	Manager

7.6.1.2.2 ScannerModelNumber

Definition	*the model number of the scanner used to create the image*
Type	string
Required	R
Repeatable	N
Values (Example)	
Use	Manager

7.6.1.2.3 ScannerModelSerialNo

Definition	*the serial number of the scanner used to create the image*
Type	string
Required	O
Repeatable	N
Values (Example)	
Use	Manager

7.6.2 ScanningSystemSoftware

7.6.2.1 ScanningSoftware

Definition	*the name of the capture software used to create the image*
Type	string
Required	R
Repeatable	N
Values (Example)	Leaf
Use	Manager

7.6.2.2 ScanningSoftwareVersionNo

Definition	*the version number of the capture software used to create the image*
Type	string
Required	R
Repeatable	N
Values (Example)	4.0 (e.g., Leaf 4.0)
Use	Manager

7.6.3 ScannerCaptureSettings

7.6.3.1 PixelSize

Definition	*specifies the pixel size, in meters, of the scanner*
Type	non-negative real
Required	O
Repeatable	N
Values	
Use	System Manager

7.6.3.2 PhysScanResolution

7.6.3.2.1 XphysScanResolution

Definition	*specifies the physical scanning resolution of the device, in meters, recording the x (width) direction*
Type	non-negative real
Required	O
Repeatable	N
Values	
Usage Note	This is *not* the interpolated resolution of the final output data.
Use	System Manager

7.6.3.2.2 YphysScanResolution

Definition	*specifies the physical scanning resolution of the device, in meters, recording the Y (height) direction*
Type	non-negative real
Required	O
Repeatable	N
Values	
Usage Note	This is *not* the interpolated resolution of the final output data.
Use	System Manager

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7.7 DigitalCameraCapture

7.7.1 DigitalCameraManufacturer

Definition	*the manufacturer of the digital camera used to create the image*
Type	string
Required	R
Repeatable	N
Values (Example)	PhaseOne
Use	Manager

7.7.2 DigitalCameraModel

Definition	*the model of the digital camera used to create the image*
Type	string
Required	R
Repeatable	N
Values (Examples)	H_20 LightPhase
Use	Manager

7.7.3 CameraCaptureSettings

7.7.3.1 FNumber

Definition	*specifies the lens f-number (ratio of lens aperture to focal length) used when the image was captured*
Type	non-negative real
Required	O
Repeatable	N
Values	
Use	System Manager

7.7.3.2 ExposureTime

Definition	*specifies the exposure time used when the image was captured, recorded in seconds*
Type	non-negative real
Required	O
Repeatable	N
Values	
Usage Note	Input may be given as a rational (e.g., 1/125), but systems should store the number as a non-negative real (e.g., 0.008).
Use	System Manager

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7.7.3.3 Brightness

Definition	*specifies the brightness values measured when the image was captured, using APEX values*
Type	non-negative real
Required	O
Repeatable	N
Values	
Usage Note	This value represents the light level at the source (document).
Use	System Manager

7.7.3.4 ExposureBias

Definition	*specifies the actual exposure bias (the amount of under or over-exposure relative to a normal exposure, as determined by the camera's exposure system) used when capturing the image, using APEX units*
Type	non-negative real
Required	O
Repeatable	N
Values	
Use	System Manager

7.7.3.5 SubjectDistance

Definition	*specifies the distance, in meters, between the frontal plane of the camera lens and the subject on which the camera was focused*
Type	non-negative real
Required	O
Repeatable	N
Values (Examples)	<SubjectDistance>5</SubjectDistance> OR <SubjectDistance min=”4.9” max=”5.3”>5</SubjectDistance> OR <SubjectDistance min=”4.9” max=”5.3”/>
Usage Note	May specify a range of values, bounded by minimum and maximum.
Use	System Manager

7.7.3.6 MeteringMode

Definition	*specifies the metering mode (the camera's method of spatially weighting the scene luminance values to determine the sensor exposure) used when capturing the image*
Type	enumerated type (restricted to list)
Required	O
Repeatable	N

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Values	Average Center weighted average Spot Multispot Pattern Partial
Use	System Manager

7.7.3.7 SceneIlluminant

Definition	*specifies the light source that was present when the image was captured*
Type	enumerated type (restricted to external standard)
Required	O
Repeatable	N
Values	Daylight Fluorescent Tungsten Lamp Flash Standard Illuminant A Standard Illuminant B Standard Illuminant C D55 Illuminant D65 Illuminant D75 Illuminant
Usage Note	Values for this data element must be drawn from the list documented in DIG35.
Use	System Manager

7.7.3.8 ColorTemp

Definition	*specifies the actual color temperature value of the scene illuminant in units of Kelvin*
Type	non-negative real
Required	O
Repeatable	N
Values	
Use	System Manager

7.7.3.9 FocalLength

Definition	*specifies the lens focal length in meters used to capture the image*
Type	real
Required	O
Repeatable	N
Values	
Use	System Manager

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7.7.3.10 Flash

Definition	*specifies whether a flash was used in image capture*
Type	enumerated type (restricted to list)
Required	O
Repeatable	N
Values	Yes No
Use	System Manager

7.7.3.11 FlashEnergy

Definition	*specifies the amount of flash energy that was used in Beam Candle Power Seconds (BCPS)*
Type	non-negative real
Required	O
Repeatable	N
Values	
Use	System Manager

7.7.3.12 FlashReturn

Definition	*specifies whether the camera judged that the flash was not effective at the time of exposure*
Type	enumerated type (restricted to list)
Required	O
Repeatable	N
Values	Yes No
Use	System Manager

7.7.3.13 BackLight

Definition	*specifies the lighting conditions at the time of exposure*	
Type	enumerated type (restricted to external standard)	
Required	O	
Repeatable	N	
Values	Front light	"Subject is illuminated from the front side."
	Backlight_1	"The brightness value difference between the subject center and the surrounding area is greater than one full stop (APEX). The frame is exposed for the subject center."
	Backlight_2	"The brightness value difference between the subject center and the surrounding area is greater than one full stop (APEX). The frame is exposed for the surrounding area."

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Usage Note	Values for this data element must be drawn from the list documented in DIG35, B3.2.5 <Back_Light>.
Use	System Manager

7.7.3.14 ExposureIndex

Definition	*specifies the exposure index setting used*
Type	non-negative real
Required	O
Repeatable	N
Values	
Use	System Manager

7.7.3.15 AutoFocus

Definition	*specifies the status of the capture device's focus at the time of capture*	
Type	enumerated list (restricted to external standard)	
Required	O	
Repeatable	N	
Values	Auto Focus Used	"The camera successfully focused on the subject."
	Auto Focus Interrupted	"The image was captured before the camera had successfully focused on the subject."
	Near Focused	"The camera deliberately focused at a distance closer than the subject to allow for the super-imposition of a focused foreground subject."
	Soft Focused	"The camera deliberately did not focus exactly at the subject distance to create a softer image (commonly used in portraits)."
	Manual	"The camera was focused manually."
Usage Note	Values for this data element must be drawn from the list documented in the DIG35, B3.2.5 <Auto Focus Values>.	
Use	System Manager	

7.7.3.16 PrintAspectRatio

specifies the print aspect ratio selected by the user when the picture was taken

7.7.3.16.1 XPrintAspectRatio

Definition	*unit of X ratio*
Type	non-negative real
Required	O
Repeatable	N
Values	

Use	System Manager

7.7.3.16.2 YprintAspectRatio

Definition	*unit of Y ratio*
Type	non-negative real
Required	O
Repeatable	N
Values	
Use	System Manager

7.8 Sensor

Definition	*designates the type of image sensor used in the camera or image capture device*
Type	enumerated type (restricted to external standard)
Required	R
Repeatable	N
Values	undefined MonochromeArea OneChipColorArea TwoChipColorArea ThreeChipColorArea ColorSequentialArea MonochromeLinear ColorTriLinear ColorSequentialLinear
Notes	Enumerated values are drawn from TIFF/EP (pp.25-26) for tag # 37399, *Sensing Methods*.
Use	Manager

7.9 DateTimeCreated

Definition	*Date or DateTime image was created*
Type	DateTime
Required	MA
Repeatable	N
Values	YYYY-MM-DD
Usage Notes	See section 9.1.1 **DateTimeProcessed** for images created by processing image data (i.e., digital-to-digital conversion).
Use	Manager

7.10 Methodology

Definition	*designates the methodology and rationale to digitize an object or collection*
Type	string
Required	O
Repeatable	N

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Values (Examples)	string [free text] [filename or URL] http://lcweb2.loc.gov/ammem/techdocs/digcols.html
Notes	For an example, see Library of Congress, "*Building Digital Collections.*"
Use	Manager User

8 Imaging performance assessment

The operative principle in this section is to *maintain* the attributes of the image inherent to its quality. The title *performance assessment* has both a present and future context: these elements serve as metrics to assess the accuracy of output (today's use) and of preservation techniques, particularly migration (future use).

Sections 8.1 *Spatial metrics* and 8.2 *Energetics* are meant as high-level quantitative measures of imaging performance. Section 8.3 *TargetData* is meant to complement the former by providing low-level benchmarking quantification of the absolute imaging performance of the digital capture process. The information in this latter section should be closely tied to sanctioned imaging performance standards when available. In the absence of such standards, *de-facto* standards are appropriate.

To help in the understanding of this section, Figures 2 and 3 are provided as examples of typical imaging chains. Frequently, confusion exists around image state generations and to which generation the metadata is meant to apply. Often, knowledge at all levels is required. In such cases, repeatable fields for a given element are offered.

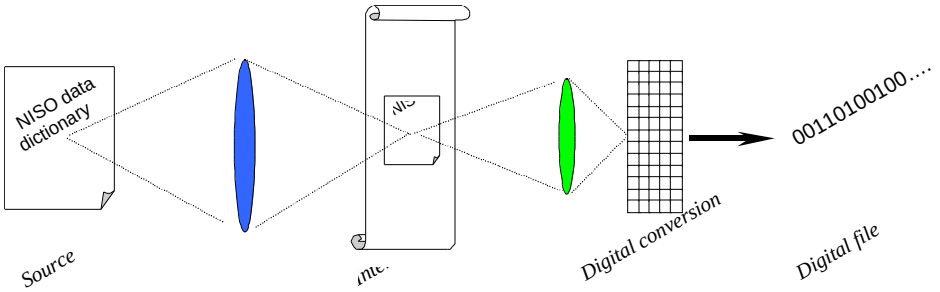

Figure 2 – Digital conversion of Intermediate; indirect conversion of Source

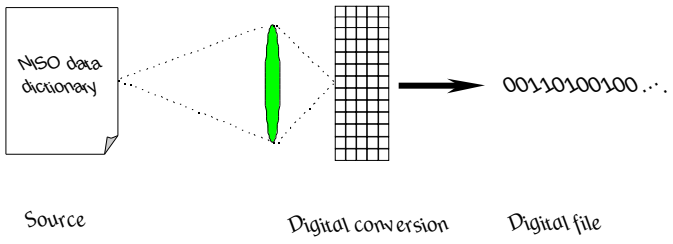

Figure 3 – Direct digital conversion of Source

To a large extent, the image of any source can be linked backed to that source with appropriate capture documentation and benchmarking targets. While the original source characteristics are not unequivocally recoverable, suitably accurate reconstructions of the source can, in principle, occur. The high level metrics of sections 8.1 and 8.2 can provide nominal recovery of the original source characteristics. Detailed imaging performance information in section 8.3, if properly documented, is a reliable thread to more accurate source characteristics.

8.1 Spatial metrics

While it is recognized that digital images can describe three-dimensional objects, this section deals only with the classic 2-dimensional projection of such objects as seen by the imaging device at any given instant in time. The digital image assumes the form of a uniformly sampled rectangular grid of pixels (picture elements) in the "x" (**ImageWidth**) and "y" (**ImageLength**) dimensions. The global photometrics associated with each of these pixels is covered in section 8.2.

Though range or depth data (i.e. "z" dimension) can be digitized with specialized 3-D imaging devices, these are outside the scope of this document.

8.1.1 SamplingFrequencyPlane

Definition	*the reference plane location for which* **XSamplingFrequenc**y *and* **YSamplingFrequency** *are designated*
Type	enumerated type (restricted to list)
Required	M
Repeatable	N
Values	1 = camera/scanner focal plane 2 = object plane 3 = source object plane
Notes	This element is meant to remove the ambiguity with respect to **XSamplingFrequency** and **YSamplingFrequency** for the scanning of film intermediates. It can be used to deduce **Source_Xdimension** or **Source_Ydimension** in conjunction with **ImageWidth** or **ImageLength.** Value = 1 is consistent with DIG35, B.3.2.4, and TIFF/EP, 5.2.9-5.2.10, and is an indication of the physical sensor sampling frequency. It is of limited use without knowledge of the optical magnification between sensor and imaged object. Value = 2 would be most common for direct scanning of source objects. If "object plane" is the same as "source object plane" (see Figure 3), this value is used. Value = 3 is commonly used for film intermediates such as microfilm where **XSamplingFrequency** and **YSamplingFrequency** are often referred to at the source object plane rather than the object film plane (see Figure 2).
Use	System (accurate output of file to print/film [*size*]) Manager (one of the quantitative metrics to evaluate image quality)

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8.1.2 SamplingFrequencyUnit

Definition	*the unit of measurement for* **XSamplingFrequency** *and* **YSamplingFrequency**
Type	enumerated type (restricted to external standard)
Required	M
Repeatable	N
Values	1 = no absolute unit of measurement 2 = inch 3 = centimeter
Usage Notes	From TIFF 296 (*Baseline Required*, p.21-24, 38), and TIFF/EP 296 (5.2.8). Value = 1 used for images that may have a non-square aspect ratio, but no meaningful absolute dimensions. In copy work, should also be used when source measurements are unknown (e.g., when a photo-intermediate such as 35mm negative film is the source). When **SamplingFrequencyUnit** = 2 *and* **Source_Xdimension** is given in inches, the **XSamplingFrequency** may be calculated as follows: **XSamplingFrequency** = **ImageLength**/**Source_Xdimension** When **SamplingFrequencyUnit** = 2 *and* **Source_Ydimension** is given in inches, the **YSamplingFrequency** may be calculated as follows: **YSamplingFrequency** = **ImageWidth**/**Source_Ydimension** The same formulas may be used when **SamplingFrequencyUnit** = 3 and source dimensions are given in centimeters.
Use	System (accurate output of file to print/film [*size*]) Manager (one of the quantitative metrics to evaluate image quality)

8.1.3 XSamplingFrequency

Definition	*specifies the number of pixels per* **SamplingFrequencyUnit** *in the image width*
Type	positive integer
Required	MA (when **SamplingFrequencyUnit** = 2 or 3)
Repeatable	N
Values	
Notes	With fields **YSamplingFrequency** (8.1.4) and **SamplingFrequencyUnit** (8.1.2), **XSamplingFrequency** specifies the dimensions (scale) of the printed image. When **SamplingFrequencyUnit** = 1, the value for this field shall be null.
Use	System (accurate output of file to print/film [*size*]) Manager (one of the quantitative metrics to evaluate image quality)

8.1.4 YSamplingFrequency

Definition	*specifies the number of pixels per* **SamplingFrequencyUnit** *in the image length*
Type	positive integer
Required	MA (when **SamplingFrequencyUnit** = 2 or 3)
Repeatable	N

Values	
Notes	With fields **XSamplingFrequency** (8.1.3) and **SamplingFrequencyUnit** (8.1.5), **YSamplingFrequency** specifies the dimensions (scale) of the printed image.
Use	System (accurate output of file to print/film [*size*]) Manager (one of the quantitative metrics to evaluate image quality)

8.1.5 ImageWidth

Definition	*specifies the width of the digital image, i.e. horizontal or X dimension, in pixels*
Type	positive integer
Required	MA
Repeatable	N
Values	
Notes	The image width may be the shorter or longer dimension of the image, depending upon the orientation of the camera or scanner during image capture. For multiple-resolution image file formats, value shall specify the highest resolution. This value may be used to calculate **XSamplingFrequency** when **Source_Xdimension** is given in inches and **SamplingFrequencyUnit** = 2. Formula to calculate **XSamplingFrequency**: **XSamplingFrequency** = **ImageWidth**/**Source_Xdimension**
Use	System (required field for image viewers [*size*]) Manager (one of the quantitative metrics to evaluate image quality)

8.1.6 ImageLength

Definition	*specifies the length of the digital image, i.e. vertical or Y dimension, in pixels*
Type	positive integer
Required	MA
Repeatable	N
Values	
Notes	The image length may be the shorter or longer dimension of the image, depending upon the orientation of the camera or scanner during image capture. For multiple-resolution image file formats, value shall specify the highest resolution. This field may be used to calculate **YSamplingFrequency** when **Source_Ydimension** is given in inches and **SamplingFrequencyUnit** = 2 Formula to calculate **YSamplingFrequency**: **YSamplingFrequency** = **ImageLength**/**Source_Ydimension**
Use	System (required field for image viewers [*size*]) Manager (one of the quantitative metrics to evaluate image quality)

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8.1.7 Source_Xdimension

Definition	*specifies the width of the scanned object*
Type	non-negative real
Required	O
Repeatable	N
Values (Examples)	7.63 (e.g., 7.63 inches) 32 (e.g., 32 mm)
Usage Notes	The unit of measure (inches, meters, etc.) used must be specified in 8.1.7.1 **Source_XdimensionUnit.** If unknown or impractical to record, the value of **Source_Xdimension** may be deduced. See **SamplingFrequencyPlane** (8.1.1).
Use	System (accurate output of file to print/film [*size*]) Manager (one of the quantitative metrics to evaluate image quality)

8.1.7.1 Source_XdimensionUnit

Definition	*specifies the unit of measure used in 8.1.7* **Source_Xdimension**
Type	string
Required	O
Repeatable	N
Values (Examples)	inches mm
Use	System (accurate output of file to print/film [*size*]) Manager (one of the quantitative metrics to evaluate image quality)

8.1.8 Source_Ydimension

Definition	*specifies the height (i.e., vertical dimension) of the scanned object*
Type	non-negative real
Required	O
Repeatable	N
Values (Examples)	5.29 (e.g., 5.29 inches) 28 (e.g., 28 mm)
Usage Notes	The unit of measure (inches, meters, etc.) used must be specified in 8.1.8.1 **Source_YdimensionUnit.** If unknown or impractical to record, the value of **Source_Ydimension** may be deduced. See **SamplingFrequencyPlane** (8.1.1).
Use	System (accurate output of file to print/film [*size*]) Manager (one of the quantitative metrics to evaluate image quality)

8.1.8.1 Source_YdimensionUnit

Definition	*specifies the unit of measure used in 8.1.8* **Source_Ydimension**
Type	string
Required	O
Repeatable	N

Values (Examples)	inches mm
Use	System (accurate output of file to print/film [*size*]) Manager (one of the quantitative metrics to evaluate image quality)

8.2 Energetics

This section is meant to provide nominal accuracy and precision data on the global energetic response and archiving space of the imaging device and subsequent digital file. The data herein apply to all pixels in the digital image, except as noted. This section is purposely titled *Energetics* to not mislead the user with respect to the visual interpretation of the data contained in the digital image. While interpretative values are provided for each data element, these are considered nominal and not absolute. Only with careful populating of section 8.3 *TargetData* elements can improved data interpretation be realized.

8.2.1 BitsPerSample

Definition	*the number of bits per component for each pixel* Note: This field provides N values depending upon **SamplesPerPixel** present.
Type	enumerated type (restricted to list)
Required	M
Repeatable	N
Values	1 = 1-bit (bitonal) 4 = 4-bit grayscale 8 = 8-bit grayscale or palletizedcolor 8,8,8 = RGB 16,16,16 = TIFF, HDR (high dynamic range) 8,8,8,8 = CMYK
Usage Notes	"Note that this field allows a different number of bits per component for each component corresponding to a pixel. For example, RGB color data could use a different number of bits per component for each of the three color panes. Most RGB files will have the same number of **BitsPerSample** for each component. Even in this case, *the writer must write all three values*." (TIFF, p.29, emphasis added)
Use	System (tone, color) Manager (one of the quantitative metrics to evaluate image quality)

8.2.2 SamplesPerPixel

Definition	*designates the number of color components per pixel*
Type	enumerated type (restricted to external standard)
Required	M
Repeatable	N
Values	1 = when **PhotometricInterpretation** = 0 or 1 3 = when **PhotometricInterpretation** = 2 (RGB)or 6 (YCbCr) 4 = when **PhotometricInterpretation** = 5 (CMYK)
Usage Notes	Values drawn from TIFF (p.39, 69) and TIFF/EP (5.2.19). See also **BitsPerSample** (8.2.1), **PhotometricInterpretation** (6.1.4), and **ExtraSamples** (8.2.3).
Use	System (tone, color) Manager (one of the quantitative metrics to evaluate image quality)

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8.2.3 ExtraSamples

Definition	*specifies that each pixel has* M *extra components whose interpretation is defined by one of the values listed below*
Type	enumerated type (restricted to external standard)
Required	MA
Repeatable	N
Values	0 = unspecified data 1 = associated alpha data (with pre-multiplied color) 2 = unassociated alpha data 3 = range or depth data
Notes	See also: TIFF 338 (*Baseline mandatory if applicable*, p.31). This field must be present if there are extra samples in the image data. When this field is used, **SamplesPerPixel** (8.2.2) has a value greater than **PhotometricInterpretation** (6.1.4) suggests.
Use	System

8.2.4 Colormap

defines a Red-Green-Blue color map (often called a lookup table) for palette-color images

The colormap or lookup table is a series of 4 bytes of information for *each* of the 256 colors. Since the table must be complete in order to allow for color mapping, the four elements comprising **Colormap** will be repeated 256 times (to allow for 0 through 255).

8.2.4.1 Colormap_Reference

Definition	*provides the location of the file containing the color map*
Type	reference
Required	MA (for palettized color images, **PhotometricInterpretation** = 3)
Repeatable	N
Values	[URL]
Usage Notes	As noted in the TIFF definition, **Colormap** is synonymous with color lookup table (CLUT). When **PhotometricInterpretation** = 2, there is no **Colormap**; in other words, there is no **Colormap** in RGB images (TIFF, p.24). The reference data type accommodates the practice of generating a colormap at the beginning of each session. If the color map exists in an external file, it **must** be referenced in this element, otherwise **Colormap** information must be encoded in 8.2.4.2 through 8.2.4.5.
Use	System (tone, color)

8.2.4.2 Colormap_BitCodeValue

Definition	*provides the Bit Code Value or reference point for a particular RGB triplet of the* **Colormap** *(often called a lookup table) for palette-color images*
Type	enumerated type (restricted to external standard)
Required	MA (for palletized color images, **PhotometricInterpretation** = 3)
Repeatable	R

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Values	Possible values are 0-255.
Usage Notes	As noted in the TIFF definition, **Colormap** is synonymous with color lookup table (CLUT). When **PhotometricInterpretation** = 2, there is no **Colormap**; in other words, there is no **Colormap** in RGB images (TIFF, p.24).
Use	System (tone, color)

8.2.4.3 Colormap_RedValue

Definition	*provides the Red Value within a particular RGB triplet of the* **Colormap** *(often called a lookup table) for palette-color images* Note: Particular triplet is referenced in 8.2.4.2 **Colormap_BitCodeValue**.
Type	enumerated type (restricted to external standard)
Required	MA (for palletized color images, **PhotometricInterpretation** = 3)
Repeatable	R
Values	Possible values are 0-255.
Usage Notes	As noted in the TIFF definition, **Colormap** is synonymous with color lookup table (CLUT). When **PhotometricInterpretation** = 2, there is no **Colormap**; in other words, there is no **Colormap** in RGB images (TIFF, p.24).
Use	System (tone, color)

8.2.4.4 Colormap_GreenValue

Definition	*provides the Green Value within a particular RGB triplet of the* **Colormap** *(often called a lookup table) for palette-color images* Note: Particular triplet is reference in 8.2.4.2 **Colormap_BitCodeValue**.
Type	enumerated type (restricted to external standard)
Required	MA (for palletized color images, **PhotometricInterpretation** = 3)
Repeatable	R
Values	Possible values are 0-255.
Usage Notes	As noted in the TIFF definition, **Colormap** is synonymous with color lookup table (CLUT). When **PhotometricInterpretation** = 2, there is no **Colormap**; in other words, there is no **Colormap** in RGB images (TIFF, p.24).
Use	System (tone, color)

8.2.4.5 Colormap_BlueValue

Definition	*provides the Blue Value within a particular RGB triplet of the* **Colormap** *(often called a lookup table) for palette-color images* Note: Particular triplet is reference in 8.2.4.2 **Colormap_BitCodeValue**.
Type	enumerated type (restricted to external standard)
Required	MA (for palletized color images, **PhotometricInterpretation** = 3)
Repeatable	R
Values	Possible values are 0-255.
Usage Notes	As noted in the TIFF definition, **Colormap** is synonymous with color lookup table (CLUT). When **PhotometricInterpretation** = 2, there is no **Colormap**; in other words, there is no **Colormap** in RGB images (TIFF, p.24).

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Use	System (tone, color)

8.2.5 GrayResponseCurve

Definition	*for grayscale data, the optical density of each possible pixel value*
Type	enumerated type (restricted to external standard)
Required	R
Repeatable	N
Values	N = 2******BitsPerSample**
Usage Note	See also: TIFF 290 (*Baseline optional*, p.33) Must be accompanied by **GrayResponseUnit** (8.2.6). (The reference data type accommodates the practice of generating a response curve at the beginning of each session.)
Use	System (objective assessment of optical density)

8.2.6 GrayResponseUnit

Definition	*the precision of the information contained in the* **GrayResponseCurve**
Type	enumerated type (restricted to list)
Required	R
Repeatable	N
Values	1 = Number represents tenths of a unit. 2 = Number represents hundredths of a unit. 3 = Number represents thousandths of a unit. 4 = Number represents ten-thousandths of a unit. 5 = Number represents hundred-thousandths of a unit.
Usage Note	Modifies **GrayResponseCurve** (8.2.5)
Use	System (objective assessment of optical density)

8.2.7 WhitePoint

the white point chromaticity of the effective illumination source of the capture process

White point is comprised of two values: **WhitePoint_Xvalue** and **WhitePoint_Yvalue**. The ordering is white [x], white [y].

8.2.7.1 WhitePoint_Xvalue

Definition	*the X value for the white point chromaticity of the effective illumination source of the capture process*
Type	enumerated type (restricted to list)
Required	O
Repeatable	Y
Values (Example)	3127/10000
Usage Notes	These values specify the 1931 CIE xy chromaticities of the effective illumination (i.e., filter/light source combination) at capture. They *do not* have any relation to location or directional coordinates. For more information about the 1931 CIE standard colorimetric observer, see International Color Consortium.

	The chromaticity of the white point of the image is encoded using the mediaWhitePointTag values within the InterColorProfile tag value." (TIFF/EP 4.5 *Camera Color Space Information*)
Use	System (objective assessment of colorimetry)

8.2.7.2 WhitePoint_Yvalue

Definition	*the Y value for the white point chromaticity of the effective illumination source of the capture process*
Type	enumerated type (restricted to list)
Required	O
Repeatable	Y
Values (Example)	3290/10000
Usage Notes	These values specify the 1931 CIE xy chromaticities of the effective illumination (i.e., filter/light source combination) at capture. They *do not* have any relation to location or directional coordinates. For more information about the 1931 CIE standard colorimetric observer, see International Color Consortium. The chromaticity of the white point of the image is encoded using the mediaWhitePointTag values within the InterColorProfile tag value." (TIFF/EP 4.5 *Camera Color Space Information*)
Use	System (objective assessment of colorimetry)

8.2.8 PrimaryChromaticities

the chromaticities of the primary colors of the imaging process

PrimaryChromaticities is comprised of six values. The ordering is red [x], red [y], green [x], green [y], blue [x], blue [y].

8.2.8.1 PrimaryChromaticities_RedX

Definition	*specifies the Red [x} value for the chromaticities of the primary colors of the imaging process*
Type	enumerated type (restricted to list)
Required	O
Repeatable	Y
Values (Example)	640/1000
Usage Note	These values specify the 1931 CIE xy chromaticities of the capture primaries. The ordering is red [x], red [y], green [x], green [y], blue [x], blue [y]. "The chromaticities of the primaries of the image are encoded using the redColorantTag, greenColorantTag, and blueColorantTag values within the InterColorProfile tag value." (TIFF/EP 4.5 *Camera Color Space Information*)
Use	System (objective assessment of colorimetry)

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8.2.8.2 PrimaryChromaticities_RedY

Definition	*specifies the Red [y} value for the chromaticities of the primary colors of the imaging process*
Type	enumerated type (restricted to list)
Required	O
Repeatable	Y
Values (Example)	330/1000
Usage Note	These values specify the 1931 CIE xy chromaticities of the capture primaries. The ordering is red [x], red [y], green [x], green [y], blue [x], blue [y]. "The chromaticities of the primaries of the image are encoded using the redColorantTag, greenColorantTag, and blueColorantTag values within the InterColorProfile tag value." (TIFF/EP 4.5 *Camera Color Space Information*)
Use	System (objective assessment of colorimetry)

8.2.8.3 PrimaryChromaticities_GreenX

Definition	*specifies the Green [x} value for the chromaticities of the primary colors of the imaging process*
Type	enumerated type (restricted to list)
Required	O
Repeatable	Y
Values (Example)	300/1000
Usage Note	These values specify the 1931 CIE xy chromaticities of the capture primaries. The ordering is red [x], red [y], green [x], green [y], blue [x], blue [y]. "The chromaticities of the primaries of the image are encoded using the redColorantTag, greenColorantTag, and blueColorantTag values within the InterColorProfile tag value." (TIFF/EP 4.5 *Camera Color Space Information*)
Use	System (objective assessment of colorimetry)

8.2.8.4 PrimaryChromaticities_GreenY

Definition	*specifies the Green [y} value for the chromaticities of the primary colors of the imaging process*
Type	enumerated type (restricted to list)
Required	O
Repeatable	Y
Values (Example)	600/1000
Usage Note	These values specify the 1931 CIE xy chromaticities of the capture primaries. The ordering is red [x], red [y], green [x], green [y], blue [x], blue [y]. "The chromaticities of the primaries of the image are encoded using the redColorantTag, greenColorantTag, and blueColorantTag values within the InterColorProfile tag value." (TIFF/EP 4.5 *Camera Color Space Information*)

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Use	System (objective assessment of colorimetry)

8.2.8.5 PrimaryChromaticities_BlueX

Definition	*specifies the Blue [x} value for the chromaticities of the primary colors of the imaging process*
Type	enumerated type (restricted to list)
Required	O
Repeatable	Y
Values (Example)	150/1000
Usage Note	These values specify the 1931 CIE xy chromaticities of the capture primaries. The ordering is red [x], red [y], green [x], green [y], blue [x], blue [y]. "The chromaticities of the primaries of the image are encoded using the redColorantTag, greenColorantTag, and blueColorantTag values within the InterColorProfile tag value." (TIFF/EP 4.5 *Camera Color Space Information*)
Use	System (objective assessment of colorimetry)

8.2.8.6 PrimaryChromaticities_BlueY

Definition	*specifies the Blue [y} value for the chromaticities of the primary colors of the imaging process*
Type	enumerated type (restricted to list)
Required	O
Repeatable	Y
Values (Example)	60/1000
Usage Note	These values specify the 1931 CIE xy chromaticities of the capture primaries. The ordering is red [x], red [y], green [x], green [y], blue [x], blue [y]. "The chromaticities of the primaries of the image are encoded using the redColorantTag, greenColorantTag, and blueColorantTag values within the InterColorProfile tag value." (TIFF/EP 4.5 *Camera Color Space Information*)
Use	System (objective assessment of colorimetry)

8.3 TargetData

Targets are used as concise physical benchmarks for absolute energetic and spatial information about the item of interest at the time of capture. They are, in essence, Rosetta stones for the source. As such, their utility is undisputed whenever corrections or faithful reconstructions of the source document are required.

Depending on workflows and philosophy, targets can be considered as either external or internal to a digital image. Internal targets are part of a digital image by being within the field of view at time of capture. External targets are typically captured session-to-session and usually give temporally sparse information between image captures. For stable capture environments their utility can be equivalent to internal targets. Since they are not part of the digital image itself, their location must be managed in order to maintain a thread to the source.

Figure 4 illustrates the logical structure of the **TargetData**.

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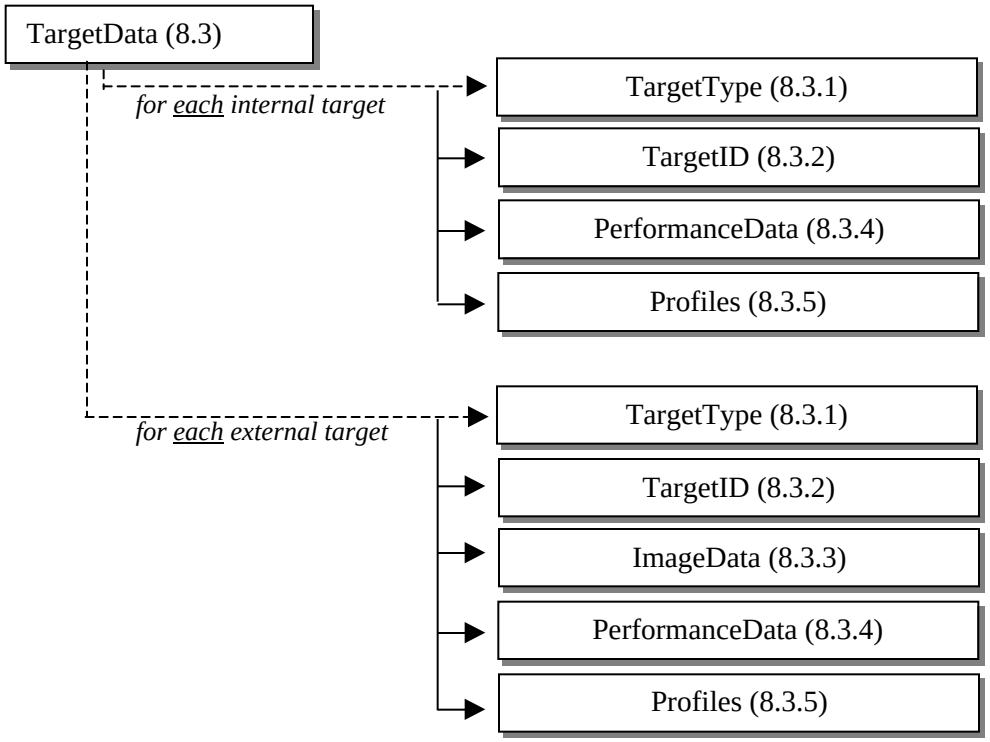

Figure 4 – Logical structure of TargetData

8.3.1 TargetType

Definition	*identifies the targets as either internal or external*
Type	enumerated type (restricted to list)
Required	R
Repeatable	Y
Values	0 = external 1 = internal
Usage Notes	Internal targets are targets which appear within the frame of the digitized item. External targets *do not* appear within the frame with the digitized item and are separate files, usually full frame targets used for calibration purposes. The Count for this field = 1. Each target shall be represented by its own logical metadata block. See diagram of proposed **TargetData** structure (Figure 4). When value = 1, the **ImageData** field shall not be used. See 8.3.3 **ImageData**.
Use	Manager

8.3.2 TargetID

identifies the target manufacturer or organization, name, and version number or media

8.3.2.1 TargetIDManufacturer

Definition	*identifies the manufacturer or organization that created the target*
Type	string
Required	R
Repeatable	Y
Values (Examples)	Gretag-Macbeth Eastman Kodak Applied Image Inc
Usage Notes	The Count for this multi-layered data element = 1. Each target shall be represented by its own logical metadata block. See diagram of proposed **TargetData** structure (Figure 4).
Use	Manager (objective measure of system quality)

8.3.2.2 TargetIDName

Definition	*identifies the name of the target*
Type	string
Required	R
Repeatable	Y
Values (Examples)	ColorChecker Q60 ISO 16067
Usage Notes	The Count for this multi-layered data element = 1. Each target shall be represented by its own logical metadata block. See diagram of proposed **TargetData** structure (Figure 4).
Use	Manager (objective measure of system quality)

8.3.2.3 TargetIDNo

Definition	*identifies the version or number of the target*
Type	string
Required	R
Repeatable	Y
Values (Examples)	ItemXXX Version2
Usage Notes	The Count for this multi-layered data element = 1. Each target shall be represented by its own logical metadata block. See diagram of proposed **TargetData** structure (Figure 4).
Use	Manager (objective measure of system quality)

8.3.2.4 TargetIDMedia

Definition	*identifies the media of the target*
Type	string
Required	MA

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Repeatable	Y
Values (Examples)	Ektachrome Transparency
Usage Notes	The Count for this multi-layered data element = 1. Each target shall be represented by its own logical metadata block. See diagram of proposed **TargetData** structure (Figure 4).
Use	Manager (objective measure of system quality)

8.3.3 ImageData

Definition	*identifies the path where the digital image of the reference target identified in 8.3.2* **TargetID** *is located*
Type	reference
Required	R (applicable only if 8.3.1 **TargetType** = 0)
Repeatable	Y
Values	[Filename] [URN]
Usage Notes	The Count for this field = 1. Each target shall be represented by its own logical metadata block. See diagram of proposed **TargetData** structure (Figure 4).
Use	System (to create **PerformanceData** and/or **Profiles**)

8.3.4 PerformanceData

Definition	*identifies the path of the file that contains the image performance data relative to the target identified in 8.3.2* **TargetID**
Type	reference
Required	O
Repeatable	Y
Values	[filename] [URN]
Usage Notes	**PerformanceData** refers to standards-based characterizations of system performance according to measurements of spatial resolution, OECF, noise, and other attributes important to image quality. Standards: Electronic imaging standards through the International Imaging Industry Association (I3A) provide example uses and reporting formats for proposed ISO performance data characterization. These include, for example, *GrayResponseCurve* (ISO 14524) and *Spatial Resolution Measurement* (ISO 16067).
Use	System Manager (objective measure of quality of **ScanningSystem**)

8.3.5 Profiles

Definition	*identifies the path of the file that contains the ICC color profile or other image management profiles*
Type	reference
Required	O
Repeatable	Y
Values (Examples)	[filename] [URL] or [URN]

Usage Notes	The Count for this field = 1. Each target shall be represented by its own logical metadata block. See diagram of proposed **TargetData** structure (Figure 4).
Use	System (tone/color)

9 Change history

Change History metadata serves the function of documenting processes applied to image data over the life cycle of an image. As defined below, "processes" result either in *editing* or in *transforming* the image.

The *Image creation* metadata block (section 7) is used to document the source, scanning system, and capture settings used to create an image from an analog source. The metadata blocks in Change History are used to document the source, systems, and settings used in all subsequent digital-to-digital operations.

The Change History metadata contains:

- a summary of image processing operations applied to an image and
- previous versions of the technical metadata if image transformation creates a new generation of image.

However:

- The Change History metadata is *not* designed to be used to reverse image-editing operations, though documentation of change history and preservation of essential technical metadata may allow a *simulated* return to original image data.
- The Change History metadata is *not* designed to be used to authenticate an image. Consistent with other metadata blocks in this data dictionary, Change History limits its focus to quality assessment and preservation of *image data* and thus may not be sufficient to meet requirements defined for image integrity and authenticity.

The following assumption and definitions govern the proposed logical structure for Change History:

- Image processing may occur multiple times throughout the life cycle of an image.
- The image life cycle may consist of multiple generations of the image. The logical structure of this standard allows for the *addition* of change history information to the existing metadata.
- Image *transformation* refers to any processing that produces a new generation image (changes to any of the values in section 6.1 *Format* create a new *generation* of the image). In the case of image transformation, section 9.2 *Previous image metadata* is used to track the metadata from the previous generation of the image. See Figure 5 for a visual representation of this.
- All other processes (i.e., those that do *not* create new values in fields listed in section 6.1) are classified as *image editing* and are recorded only in fields listed in section 9.1 *Image processing*.

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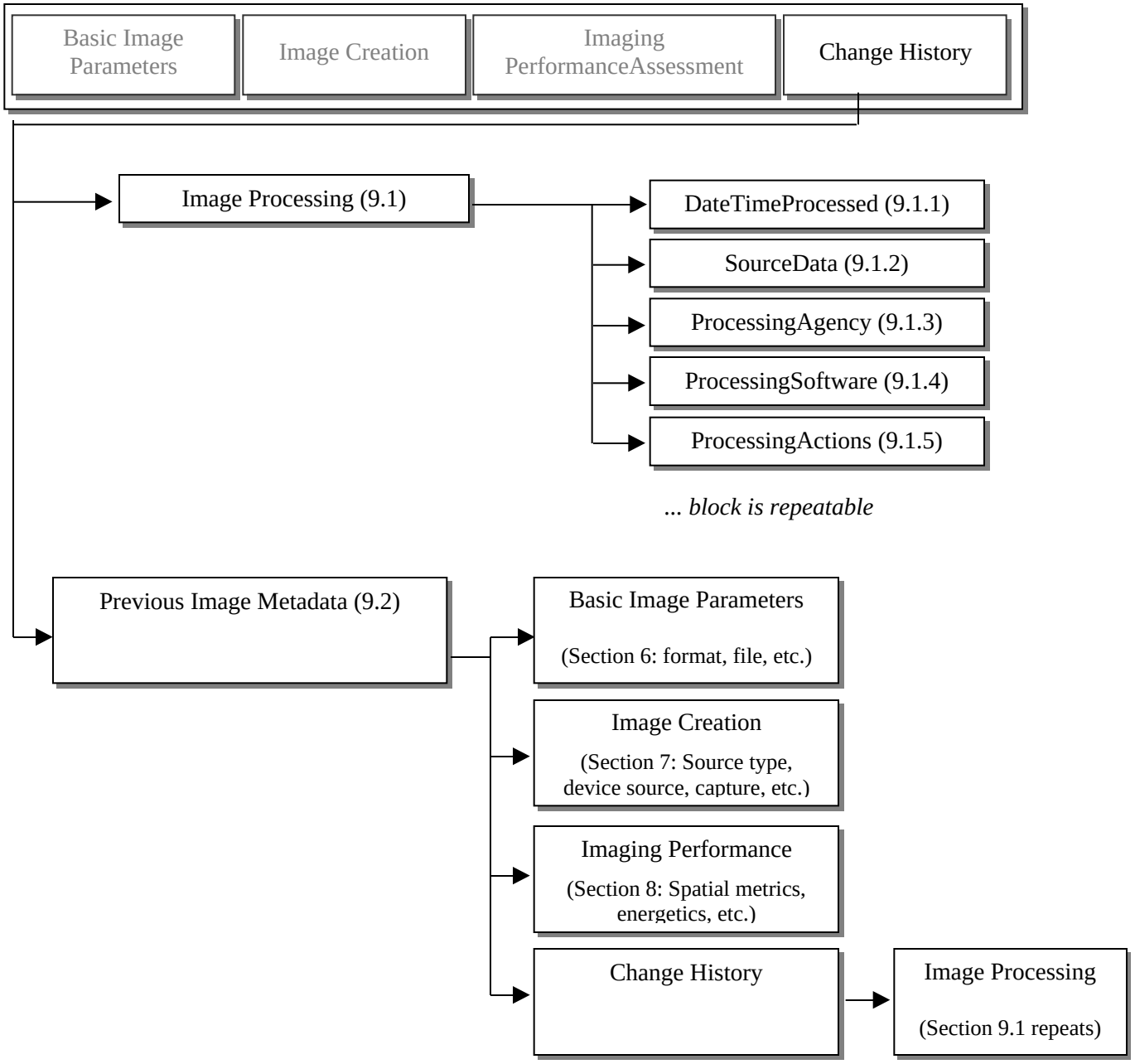

Figure 5 – Logical structure of change history

9.1 Image processing

This metadata block contains a summary of image processing operations (i.e., digital-to-digital conversion processes) that may be used for future quality assessment of the image data.

Note: The fields in sections 9.1.1-9.1.5 define a single metadata block to document a single processing action (e.g., image cropped) *or* a single set of processing actions (e.g., subsampling, application of ICC profile, image transformation).

The logical structure of this metadata block presumes that image processing will occur multiple times (Figure 5). To document a full change history applied to an image, each metadata block should not be overwritten by subsequent processing actions.

9.1.1 DateTimeProcessed

Definition	*Date or DateTime image was processed*
Type	DateTime
Required	MA
Repeatable	N
Values	YYYY-MM-DD
Usage Notes	Use ISO 8601 numeric representations of date and time. If multiple processing steps are recorded together in 9.1.5, the **DateTime** shall refer to the final (i.e., most recent) **ProcessingAction**. The value for this field shall be null for images that receive no processing following image conversion, as documented in section 7 *Image Creation.*
Use	Manager

9.1.2 SourceData

Definition	*specifies either a reference to the source image data (digital file), or a brief description of the file, from which the processed digital image file was created.*
Type	reference or string
Required	MA
Repeatable	N
Values (Examples)	[local filename] [URL] or [URN] or [Name Resolution Service name of file stored in repository] [Photo CD image (location or identifier)]
Usage Notes	The value for this field shall be null for images that receive no processing following image conversion, as documented in section 7 *Image Creation.*
Use	Manager

9.1.3 ProcessingAgency

Definition	*identifies the organization-level producer(s) of the processed image*
Type	string
Required	R
Repeatable	Y

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Values (Examples)	Luna Imaging, Inc. JJT, Inc. University of Michigan Digital Library Production Services Harvard College Library Digital Imaging Group
Use	Manager

9.1.4 ProcessingSoftware

9.1.4.1 ProcessingSoftwareName

Definition	*the name of the image processing software used to edit or transform the image data*
Type	string
Required	R
Repeatable	N
Values (Example)	Adobe Photoshop
Usage Notes	Record version number of software in 9.1.4.2 **ProcessingSoftwareVersion**.
Use	Manager

9.1.4.2 ProcessingSoftwareVersion

Definition	*the version number of the image processing software used to edit or transform the image data*
Type	string
Required	R
Repeatable	Y
Values (Example)	5.5 (e.g., Adobe Photoshop, version 5.5)
Usage Notes	For use with 9.1.4.1 **ProcessingSoftwareName**
Use	Manager

9.1.5 ProcessingActions

Definition	*an ordinal listing of the image processing steps performed by way of* **ProcessingSoftware** *(9.1.4)*
Type	string
Required	R
Repeatable	Y
Values (Examples)	rotate 90° cw transformation (new image generation) ICC profile added
Use	Whenever possible, script or action files should be supplied for this element.

9.2 Previous image metadata

Definition	*documentation of change history and preservation of essential technical metadata to simulate return to original image data*
Type	[retains previous data types]
Required	MA (each time a new generation of the image is created)

Repeatable	Y
Values	TBD. See sample DTD for examples.
Notes	The current information shall not be erased when adding new information to the image history.
Use	Manager User

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Annex A
(informative)

Z39.87 XML schema: MIX

(This Annex is not part of the Draft Standard for Trial Use, Z39.87-2002 / AIIM 20-2002. It is included for information only.)

An XML schema for the technical data elements presented in this standard is available at this URL: <http://www.loc.gov/standards/mix/>.

The schema provides a format for interchange and/or storage of the data specified in NISO Z39.87 / AIIM 20-2002. The schema is in draft status and is referred to as "NISO Metadata for Images in XML (NISO MIX)." MIX is expressed using the XML schema language of the World Wide Web Consortium. MIX is maintained for NISO by the Network Development and MARC Standards Office of the Library of Congress.

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Annex B
(informative)

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