Data Dictionary – Technical Metadata for Digital Still Images Change Summary

Ballot Dates: May 1 – June 15, 2006

This is the second ballot for this standard. A number of comments were received with the first ballot, conducted July 18 – August 26, 2005, that required changes to the standard in order to achieve consensus. The following is a summary of the substantive changes that were made to the standard since the first ballot:

- The purpose and scope (section 1) first paragraph was changed to clarify what types of images are included and excluded.
- The application (section 2) first paragraph was changed to specify the use of systems and software and to add information about the source type.
- ISO 122232 was added to the normative references (section 4).
- The Container description in section 5.2 was expanded to address the relationship of the container's obligation to those of its underlying sub-containers or elements.
- Nine new figures were added to graphically illustrate the container / element "logical structure". The new figures appear in sections 6, 7.1, 7.2, 8.1, 8.2, 8.3, 8.4, 9.1, and 9.2.
- Non-metric measures were abbreviated to be consistent with the metric abbreviations, e.g. "in." instead of "inches".
- The definition of each element was changed to begin with either "a container that" or "a data element that".
- The two elements with the same name "sensor" were changed to distinguish them to: "scannerSensor" and "cameraSensor".
- Appendix B was added with summary lists of containers and elements.
- The following new containers /subcontainers were added:
  7.1.3.2.1 IccProfile, 7.1.3.2.2 LocalProfile, 8.1.3.1 SourceXDimension, 8.1.3.2 SourceYDimension, 8.1.3.3 SourceZDimension, 8.4.4.1 ImageData, 8.4.4.2 GPSData, 9.2.1 BitsPerSample
- The following new elements were added:
  8.4.4.1.3 exposureProgram, 8.4.4.1.4 spectralSensitivity, 8.4.4.1.5 isoSpeedRatings, 8.4.4.1.6 oECF, 8.4.4.1.7 exifVersion, 8.4.4.1.8 flashEnergy, 8.4.4.1.9 backLight, 8.4.4.1.12 maxApertureValue, 8.4.4.1.16 flash, 8.4.4.1.21 sensingMethod, 8.4.4.1.22 cfaPattern, 8.4.4.2.1 through 8.4.4.2.31 various gps related elements, 10.1.5.3 processingOperatingSystemName, 10.1.5.4 processingOperatingSystemVersion
- The following elements had changes to their "type" attribute:
  6.1.1 objectIdentifierType, 6.1.2 objectIdentifierValue, 6.6.4 compressionRatio, 7.2.1.2.2 qualityLayers, 7.2.1.2.3 resolutionLevels, 8.1.2.1 sourceIDType, 8.1.3.1.2 sourceXDimensionUnit, 8.1.3.2.2 sourceYDimensionUnit, 8.1.3.3.2 sourceZDimensionUnit, 8.2.3 captureDevice, 8.4 DigitalCameraCapture, 8.4.4.1.10 brightnessValue, 8.4.4.1.11 exposureBiasValue, 8.4.4.1.18 flashEnergy, 10.1.2 sourceData
- The following containers / elements had changes to their "obligation" attribute:
  6.4.1 formatRegistryName, 6.4.2 formatRegistryKey, 7.1.1 imageWidth, 7.1.2 imageHeight, 7.1.3 PhotometricInterpretation, 7.2.2 MrSID, 7.2.2.1 zoomLevels, 7.2.3.1 djvuFormat,

9.1.1 samplingFrequencyPlane, 9.1.2 samplingFrequencyUnit, 9.2 ImageColorEncoding, 10.1 ImageProcessing

- The following container / elements had changes to their "repeatable" attribute:
  6.1 ObjectIdentifier, 6.1.1 objectIdentifierType, 6.1.2 objectIdentifierValue, 9.2.8.4 primaryChromaticitiesGreenY, 10.1 ImageProcessing
- The following container / elements had changes to their values (examples):
  6.3.1 formatName, 6.6.1 compressionScheme, 7.1.3.2.1.1 iccProfileName, 7.1.3.2.1.2 iccProvileVersion, 7.1.3.2.2.1 localProfileName, 7.1.3.3.1 yCbCrSubSampling, 7.1.3.3.2 yCbCrPositioning, 7.1.3.3.3 yCbCrCoefficients, 7.1.3.4 referenceBlackWhite, 8.1.1 sourceType, 8.1.2.1 sourceIDType, 8.1.2.2, sourceIDValue, 8.1.3.1.2 sourceXDimensionUnit, 8.1.3.2.2 sourceYDimensionUnit, 8.4.4.1.1 fNumber, 8.4.4.1.10 brightnessValue, 8.4.4.1.15 lightSource, 8.4.4.1.17 focalLength, 10.1.1 dateTimeProcessed
- The following container / elements had changes to their "use" attribute:
  6.1.2 objectIdentifierValue, 6.3.1 formatName, 7.1.1 imageWidth, 7.1.2 imageHeight, 8.1.3.1.1 sourceXDimensionValue, 8.1.3.2.1 sourceYDimensionValue, 8.1.3.3.1 sourceZDimensionValue

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Data Dictionary – Technical Metadata for Digital Still Images

Ballot Period: May 1 – June 15, 2006

Abstract: This standard defines a set of metadata elements for raster digital images to enable 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.

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DRAFT STANDARD SUBJECT TO CHANGE

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This standard may be revised or withdrawn at any time. For current information on the status of this standard contact the NISO office or visit the NISO website at:
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Foreword

(This Foreword is not part of ANSI/NISO Z39.87-200X / ANSI/AIIM 20-200X, *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.

Technical Committee AU is indebted to four working groups that have developed technical metadata specifications for digital still images:

- Digital Imaging Group (DIG), DIG35 Working Group. (Developers of *Metadata for Digital Images*, version 1.1, June 18, 2001.)
- ISO Technical Committee 42, Photography. (Developers of ISO 12234-2:2001, *Photography – Electronic still picture imaging – Removable memory – Part 2: TIFF/EP Image data format,* October 25, 2001.)
- Adobe Developers Association. (Developers of *TIFF,* Revision 6.0, Final, June 3, 1992.)
- Preservation Metadata: Implementation Strategies (PREMIS) Working Group. (Developers of the *Data Dictionary for Preservation Metadata*, May 2005.)

They are also indebted to the authors of the original draft data dictionary: Stephen Chapman (Harvard University) and Donald Williams (Eastman Kodak).

The original draft data dictionary relied heavily on the TIFF and TIFF/EP file format specifications for its elements and construction. Over the past two years however, several promising file formats have been developed and released, particularly Joint Photographic Experts Group (JPEG) 2000 and DNG (Digital Negative). This version of Z39.87 should be flexible enough to record information about those formats, but we recommend that the next version be more fully harmonized with their extensive internal metadata schemes.

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[to be added after approval]

Standards Committee AU

Standards Committee AU, responsible for developing this standard, was actually comprised of two different groups: one that developed the Draft Standard for Trial Use (DSFTU), and one that redeveloped this standard following the DSFTU period. Because each group made significant contributions to this standard, both groups are listed below.

At the time the standard was approved, the committee had the following members:

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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 raster images. This standard only applies to still raster (bitmap) images and does not address other image formats such as animated raster, vector, or motion picture. The data documents digital images created through digital photography or scanning, as well as those that have been altered through editing or image transformation (migration).

This data dictionary presents a 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, image data processing, and long-term maintenance 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.

Early versions of this standard frequently referred to images maintained in TIFF (*T*agged *I*mage *F*ile *F*ormat). This final version of the standard has been expanded to allow the documentation of other image file formats. It is important to note that the standard was designed with the bias toward the documentation of master image files. While most of the technical metadata will be available and harvestable from the image file itself, many of the data elements such as image production information are not inherent to the file and will need to be added by the creating institution. Recording these additional data elements adds time and cost and therefore it is understood that it will only be cost-effective to record and maintain the technical metadata for master images. The technical dictionary documents the information and metadata all image files may 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 standards such as the preservation metadata data dictionary developed by the PREMIS working group and 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. Even with this fairly strict definition, there may be some crossover of basic digital object information between this data dictionary and the others such as the PREMIS data dictionary. Because of this, efforts were made early to achieve harmonization across the sets, resulting in this data element set which can stand alone or be used as a part of a broader metadata set like PREMIS.

2 Application

This standard is intended to facilitate the development of applications to validate, manage, migrate, and otherwise process master image files of enduring value. Such applications are viewed to be essential components of large-scale digital repositories and digital asset management systems. The data elements document information to enable systems and software to render the images over time. They are also intended to provide managers information to support quality evaluation of digital images over time, as well as provide users with objective information about the source type of the digital image.

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.

Another distinct audience for this document is capture device and software manufacturers. Data elements enumerated in the data dictionary—especially those designated as mandatory elements – have been vetted by imaging experts and designated as necessary to perform the key functions associated with the long-term management and use of digital images. Capture devices and software applications which can capture, populate, and record the data elements outlined in this data dictionary are likely to be preferred by the cultural heritage community.

2.2 Design Goals

The design goals of this NISO initiative are to define a metadata set that interoperates with and meets the goals outlined by the DIG35 and PREMIS metadata standards. 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 create and 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 is not tied to any specific file format and can therefore document many current and future file formats and compression schemes. It includes data elements common to all image file formats such as pixel dimensions and designates a container where format-specific metadata may be stored without incorporating all format-specific data elements. It acknowledges that format-specific information is critical to long term preservation and will necessarily play a primary role in any preservation strategy. In order to provide the most flexible structure, we have chosen not to repeat all format-specific metadata in this standard, but acknowledge that institutions will likely harvest and store the information using tools that draw directly on each format's published specifications.
- **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 (eXtensible Markup Language) 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 draft data dictionary, the Trial Use Period determined that use of this data dictionary is accomplished primarily through XML encoding. Therefore, the logical structure of the data dictionary takes this into consideration.

The metadata describes the entire file (including header and other information) rather than at the bitstream level. Metadata data elements which are empty (unused for a particular file being documented) may be omitted from the final XML documentation.

The dictionary does not utilize default values. All values should be explicitly stated to improve interoperability.

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 or internal metadata programmatically (see 2.3.3, Metadata Assumptions) as well as allow for recording of additional data elements which are not inherent to the file (or file header) itself.

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 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

Definitions for the elements listed in this standard are included in the individual clauses describing each element.

4 References

This standard references the following documents. When cited in the text of this Standard, the following items are referred to by their standard number or the short name enclosed in brackets at the end of the citation. All standards are subject to revision. When the following documents are superseded by an approved revision, that revision may apply.

Data Dictionary for Preservation Metadata: Final Report of the PREMIS Working Group, Preservation Metadata: Implementation Strategies, May 2005 <http://www.oclc.org/research/projects/pmwg/premis-final.pdf> [PREMIS]

DIG35 Specification: Metadata for Digital Images, version 1.1, June 18, 2001. Available from: <http://www.i3a.org/i_dig35.html> [DIG35]

MIME Media Types, Internet Assigned Numbers Authority (IANA) <http://www.iana.org/assignments/media-types/> [MIME]

ISO 8601:2004, *Data elements and interchange formats – Information interchange – Representation of dates and times*

ISO 12232:1998, *Photography – Electronic still-picture cameras – Determination of ISO speed*

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

ISO 14524:1999, *Photography – Electronic still-picture cameras – Methods for measuring opto-electronic conversion functions (OECFs)*

ISO 16067-1:2003, *Photography – Spatial resolution measurements of electronic scanners for photographic images – Part 1: Scanners for reflective media*

ISO 16067-2:2004, *Photography – Electronic scanners for photographic images – Spatial resolution measurements – Part 2: Film scanners*

ISO/IEC 15444-1:2004, *Information technology – JPEG 2000 image coding system: Core coding system* (Also issued as ITU-T.800)

ISO/IEC 15444-4:2004, *Information technology – JPEG 2000 image coding system: Conformance testing*

Metadata for Images in XML Schema (MIX), Version 0.2 (draft), July 30, 2004. <http://www.loc.gov/standards/mix/> [MIX]

TIFF [Tagged Image File Format], revision 6.0, final, June 3, 1992. Available from: <http://partners.adobe.com/public/developer/tiff/> [TIFF]

W3C NOTE, *Date and Time Formats*, 1998. <http://www.w3.org/TR/NOTE-datetime> [W3C NOTE Datetime]

W3C Recommendation, *XML Schema Part 2: Datatypes*, second edition, 2004. <http://www.w3.org/TR/xmlschema-2/> [XML Datatypes]

5 Element Reference Guide

5.1 Documentation

Sections 6 through 10 of this standard define the metadata elements of this data dictionary. Information provided for each element contains the following documentation:

ElementName

Definition	*definition in italics*
Type	specification allowable data type(s)
Obligation	M = mandatory MA = mandatory if applicable R = recommended O = optional
Repeatable	Y = yes N = no
Values (Examples)	When data type = “enumerated type,” the values listed are actual values. When data type = “string,” examples are provided.
Notes	A comments field, including pointers to related documentation and 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
base64Binary	One of the basic XML Schema data types, base64Binary represents Base64-encoded arbitrary binary data. Recorded in compliance with the *XML Datatypes*. This data type allows the user to embed complex technical metadata like color profiles and color maps within the XML document rather than using a data element to reference their existence at an outside location.
Container	This is a data constraint rather than a data element itself. A Container is a logical grouping or “umbrella” for two or more related data elements or sub-containers. In this data dictionary, data containers carry the strictest level of obligation. No data element or sub-container may have an obligation more strict than its data container.
DateTime	Recorded in compliance with the *W3C NOTE Datetime*. This 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 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
Rational	an integer or a fraction
Real	a real number where r may be < 0
Reference	a single pointer to another object
String	one or more characters

5.3 Element Types and Designations

There are two types of elements used within this data dictionary: data containers and data elements. Data containers are semantic groupings (or "wrappers") of two or more related data elements, containers, or sub-containers. Data elements are the component parts of the data dictionary and are used to record the data specific data values.

Data containers have been used to logically group related data elements (i.e., all data elements related to compression would be grouped within the data container, ***Compression***). In implementation, data containers or sub-containers which are empty—that do not contain any designated values within the related data elements—may be omitted from the XML documentation.

The element types are distinguishable in two ways: through naming convention and through data types. Data container names begin with capital letters (e.g., ***ObjectIdentifier*** and ***FormatDesignation***) and may only carry the data type "Container" (see 5.2 *Data Types*). Data element names begin with lower case letters (e.g., ***objectIdentifierType***, ***objectIdentifierValue***, ***formatName***, or ***fileFormatVersion***) and may carry one of the eleven data types defined in 5.2 *Data Types*.

6 Basic Digital Object Information

Basic Digital Object Information contains a cluster of data elements which apply to all digital object files, not just digital image files. As such, this kind of information may be considered more general preservation metadata, as opposed to technical metadata for images. However because this information is still critically important information about image files, it has been included in this standard.

The data elements in this section have been harmonized with the PREMIS preservation metadata set. When documenting the following mandatory or mandatory if applicable elements in this section, implementation is at the discretion of the institutions. Institutions may opt to record Basic Digital Object Information within the more general administrative metadata about the object or within the grouping of technical image metadata, so long as the information is recorded.

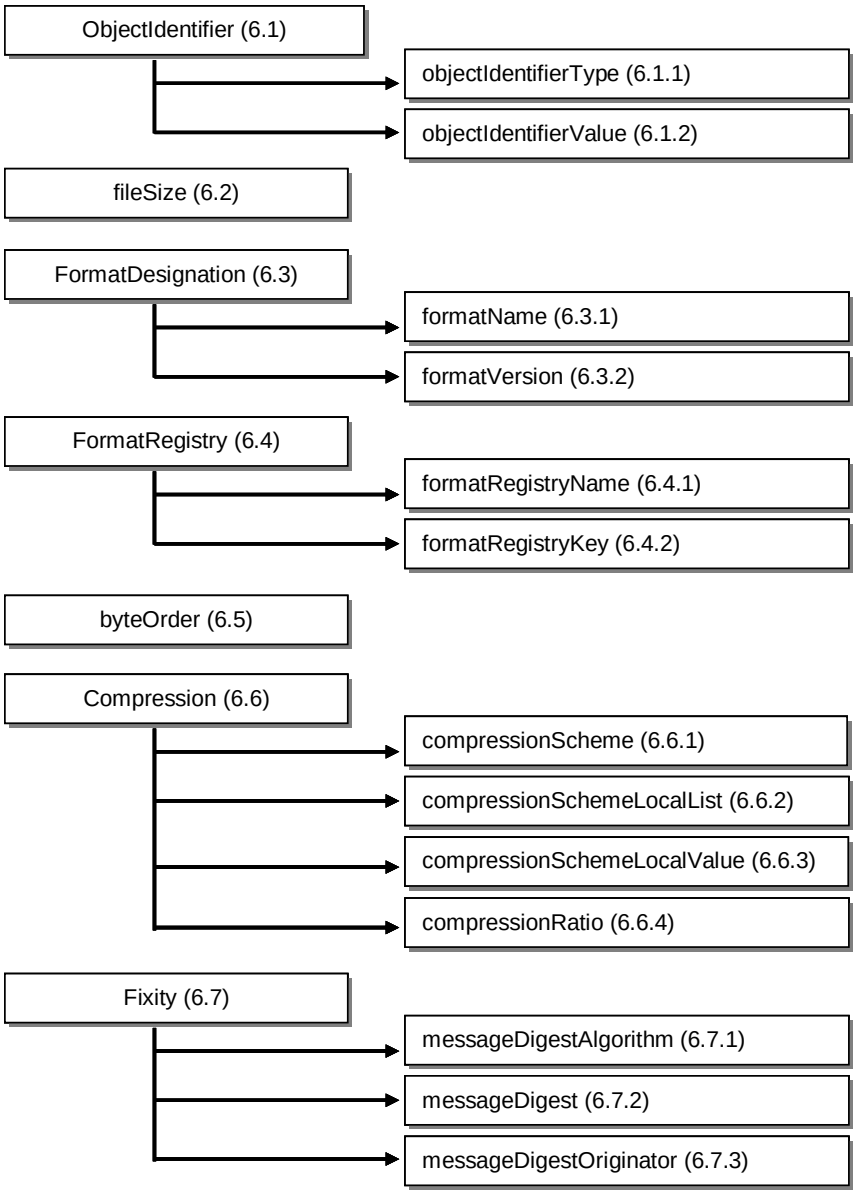

Figure 1: Logical structure of basic digital object information

6.1 ObjectIdentifier

Definition	*a container for a designation used to uniquely identify the object; comprised of two data elements (6.1.1* ***objectIdentifierType*** *and 6.1.2* ***objectIdentifierValue)***
Type	Container
Obligation	M
Repeatable	Y

Notes	Because an image or digital object may have multiple identifiers associated with it (accession number, digital repository URN (Uniform Resource Name), delivery URI (Uniform Resource Identifier), etc.), the ***ObjectIdentifier*** is a repeatable value. To attach the semantic meaning to the identifier, the ***ObjectIdentifier*** must have several sub-elements in order to identify both the system or domain in which it is unique, as well as the value itself. This data container is drawn from the PREMIS data element set.

6.1.1 objectIdentifierType

Definition	*a data element that designates the system or domain in which the identifier is unique; to be used in conjunction with 6.1.2* ***objectIdentifierValue***
Type	string
Obligation	M
Repeatable	N
Values **(Examples)**	[a Content Management System] [a MARC organization code] [a local photograph accession system]
Notes	This identifier must be unique within the local system. In the case where the value itself contains the identifier type (e.g., "oai:lib.uchicago.edu:1"), the identifier type does not need to be explicitly recorded. Similarly, if the institution uses only one type of identifier, the type can be assumed and does not need to be explicitly recorded. This data element is drawn from the PREMIS data element set.
Use	Manager System

6.1.2 objectIdentifierValue

Definition	*a data element that provides the value of the* ***ObjectIdentifier****; related to 6.1.1* ***objectIdentifierType***
Type	string
Obligation	M
Repeatable	N
Values **(Examples)**	CUL2435.67 bl.natlib/news2003.4567 codhawp 00130296 http://photoswest.org/cgi-bin/imager?00130296+C-296
Notes	This data element is drawn from the PREMIS data element set.

Use	Manager System User

6.2 fileSize

Definition	*a data element that designates the size in bytes of the image file*
Type	positive integer
Obligation	M
Repeatable	N
Values **(Examples)**	618 72839 116126
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

6.3 FormatDesignation

Definition	*a container of information identifying the format of the object; comprised of two data elements (6.3.1* ***formatName*** *and 6.3.2* ***formatVersion***)
Type	Container
Obligation	M
Repeatable	N
Notes	Format is the identification of a file by its organization of digital information according to preset specifications. This data container is drawn from the PREMIS data element set. The most specific format (or format profile) should be recorded. That is, if an image is both a valid TIFF and GeoTIFF, it should be identified as a GeoTIFF.

6.3.1 formatName

Definition	*a data element that designates the format name or description of the file format*
Type	string
Obligation	M
Repeatable	N

Values (Examples)	image/jp2 image/geotiff Adobe PDF base64
Notes	This data element is drawn from the PREMIS data element set. Values should be taken from a controlled vocabulary. It is permissible to either list proper format names (e.g., “Adobe PDF”) or MIME types (e.g., “image/tiff” or “image/jp2”)
Use	Manager System User

6.3.2 formatVersion

Definition	*a data element that designates the version of the format named in 6.3.1* ***formatName***
Type	string
Obligation	O
Repeatable	N
Values (Examples)	6.0 1.5 87a 2003
Notes	File formats are formats for encoding information within a file. File format encoding information is documented within specifications so that software and hardware know how to interact with it. Many formats, such as the Tagged Image File Format (TIFF) and Adobe’s Portable Document Format (PDF) have been revised over time to add features, information, etc., yielding multiple specifications of the same file format. Since the way information is encoded in a file changes between one version and the next, it can be important to know what version of the format was used when creating the file. ***formatVersion*** should be recorded if the format is versioned. It can either be a numeric or chronological designation. This data element is drawn from the PREMIS data element set.
Use	Manager System

6.4 FormatRegistry

Definition	*a container of information identifying or giving further information about the format by reference to an entry in a format registry; comprised of two data elements (6.4.1* ***formatRegistryName*** *and 6.4.2* ***formatRegistryKey***)
Type	Container
Obligation	O
Repeatable	N
Notes	As central format registries become available, they will provide an excellent way of referencing detailed format information. Registries currently under development are expected to be network-accessible and are being designed to store detailed specifications on formats and profiles. This data container is drawn from the PREMIS data element set.

6.4.1 formatRegistryName

Definition	*a data element that identifies the referenced format registry*
Type	string
Obligation	O
Repeatable	N
Values (Examples)	FRED: A format registry demonstration, release 0.07 PRONOM, release 3
Notes	This may be a formal name, internally used name, or URI. This data element is drawn from the PREMIS data element set.
Use	Manager System

6.4.2 formatRegistryKey

Definition	*a data element that specifies the unique key used to reference an entry for this format in a format registry*
Type	string
Obligation	O
Repeatable	N
Values (Examples)	info:gdfr/fred/f/tiff TIFF/6.0
Notes	This data element is drawn from the PREMIS data element set.
Use	Manager System

6.5 byteOrder

Definition	*a data element that designates the byte order in which multi-byte numbers are stored*
Type	enumerated type (restricted to list)
Obligation	MA
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

6.6 Compression

Definition	*a container of information detailing which compression was used on the image file or digital object being described; comprised of four data elements (6.6.1* ***compressionScheme****, 6.6.2* ***compressionSchemeLocalList,*** *6.6.3* ***compressionSchemeLocalValue****, and 6.6.4* ***compressionRatio****)*
Type	Container
Obligation	M
Repeatable	Y
Notes	Most single image files will only have one container of compression information. Some image file formats, however, use the Multi-Raster Content Model. JPEG 2000/Part 6 and the DjVu formats (among others) use this model which requires segmentation and compression of different image components, potentially using different codecs on different components of the file. For these file formats, the Compression container is repeatable.

6.6.1 compressionScheme

Definition	*a data element that designates the compression scheme used to store the image data*
Type	string
Obligation	M
Repeatable	N

Values (Examples)	Enumerated in local list Uncompressed CCITT Group 4 LZW JPEG Baseline Sequential JPEG 2000 Lossy JPEG 2000 Lossless JBIG2 Deflate/zlib
Notes	Example values above are drawn from TIFF, JPEG, JPEG 2000, and PDF formats, though institutions are encouraged to devise a local enumerated list to allow for the addition of new values as technology changes. If an institution chooses to devise and utilize a locally enumerated list, the value for this field must be 0 (zero) and the subelement 6.6.2 ***compressionSchemeLocalList*** must be used. This data element allows for the designation of subelements in order to record the compression ratio applied (see 6.6.4 ***compressionRatio***). JPEG 2000 compression schemes (lossless or lossy) are driven by the same algorithm. The note here is of value to repository managers to evaluate image quality and suitability for long-term value.
Use	System Manager

6.6.2 compressionSchemeLocalList

Definition	*a data element that provides the location of the file containing the local enumerated list of compression schemes in use*
Type	reference
Obligation	MA
Repeatable	N
Values	[URL]
Notes	This field must be present if the value in 6.6.1 ***compressionScheme*** is “enumerated in local list”.
Use	System Manager

6.6.3 compressionSchemeLocalValue

Definition	*a data element that identifies the compression scheme utilized from the local list of compression schemes in use*
Type	string

Obligation	MA
Repeatable	N
Notes	This field must be present if the value in 6.6.1 ***compressionScheme*** is "enumerated in local list."
Use	System Manager

6.6.4 compressionRatio

Definition	*a data element that designates the ratio of compressed file size to original file size as a result of the use of 6.6.1* ***compressionScheme***
Type	positive integer
Obligation	O
Repeatable	N
Values **(Examples)**	10 = a 10:1 compression ratio 30 = a 30:1 compression ratio
Notes	For purposes of recording this number, the original file size is assumed to be 1, so only the first half of the ratio (expressing compression) will be recorded.
Use	System Manager

6.7 Fixity

Definition	*a container of information used to verify whether a file has changed or been altered in an undocumented or unauthorized way (often referred to as a "checksum"); comprised of three data elements (6.7.1* ***messageDigestAlgorithm****, 6.7.2* ***messageDigest,*** *and 6.7.3* ***messageDigestOriginator***)
Type	Container
Obligation	M
Repeatable	Y
Notes	This container of data elements is drawn from the PREMIS data element set. Because fixity may be performed multiple times on a digital object, this container of data elements is repeatable, though individual elements within one container are not repeatable.

6.7.1 messageDigestAlgorithm

Definition	*a data element that identifies the specific algorithm used to construct the message digest for the digital object or bitstream*
Type	enumerated type (restricted to list)

Obligation	M
Repeatable	N
Values	Adler-32 CRC32 HAVAL MD5 MNP SHA-1 SHA-256 SHA-384 SHA512 TIGER WHIRLPOOL
Notes	Subsequent values are recorded in sections 6.7.2 ***messageDigest*** and 6.7.3 ***messageDigestOriginator***. Use of enumerated type values is mandatory because they are associated with known algorithms. This data element is drawn from the PREMIS data element set.
Use	System Manager (to monitor file integrity)

6.7.2 messageDigest

Definition	*a data element that specifies the output of 6.7.1* ***messageDigestAlgorithm***
Type	string
Obligation	M
Repeatable	N
Values (Examples)	7c9b35da4f2ebd4 36f1cf88e5a39b3 a257edf4a22be3c
Notes	Linked to section 6.7.1 ***messageDigestAlgorithm*** and 6.7.3 ***messageDigestOriginator***. This data element is drawn from the PREMIS data element set.
Use	System Manager (to monitor file integrity)

6.7.3 messageDigestOriginator

Definition	*a data element that identifies the agent that created the original message digest that is compared in the fixity check*
Type	string
Obligation	O
Repeatable	N
Values **(Examples)**	DRS A0000978
Notes	A preservation repository may ingest files that have had message digests calculated by the submitter; checking these ensures that the file as received is the same as the file sent. The repository may also ingest files that do not have message digests and so must calculate the initial value upon ingest. It can be useful to know who calculated the initial value of the ***messageDigest***. In the examples above, the originator of the ***messageDigest*** could be represented by a string representing the agent (e.g., "DRS") or a pointer to the ingest record (e.g., "A0000978") Linked to section 6.7.1 ***messageDigestAlgorithm*** and section 6.7.2 ***messageDigest***. This data element is drawn from the PREMIS data element set.
Use	System Manager (to monitor file integrity)

7 Basic Image Information

The items in this section are fundamental to the reconstruction of the digital object 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.

7.1 BasicImageCharacteristics

Definition	*a container of information detailing the* ***BasicImageCharacteristics*** *of the digital object; comprised of two data elements (7.1.1* ***imageWidth*** *and 7.1.2* ***imageHeight***) *as well as a container of data elements (7.1.3* ***PhotometricInterpretation***)
Type	Container
Obligation	M
Repeatable	N

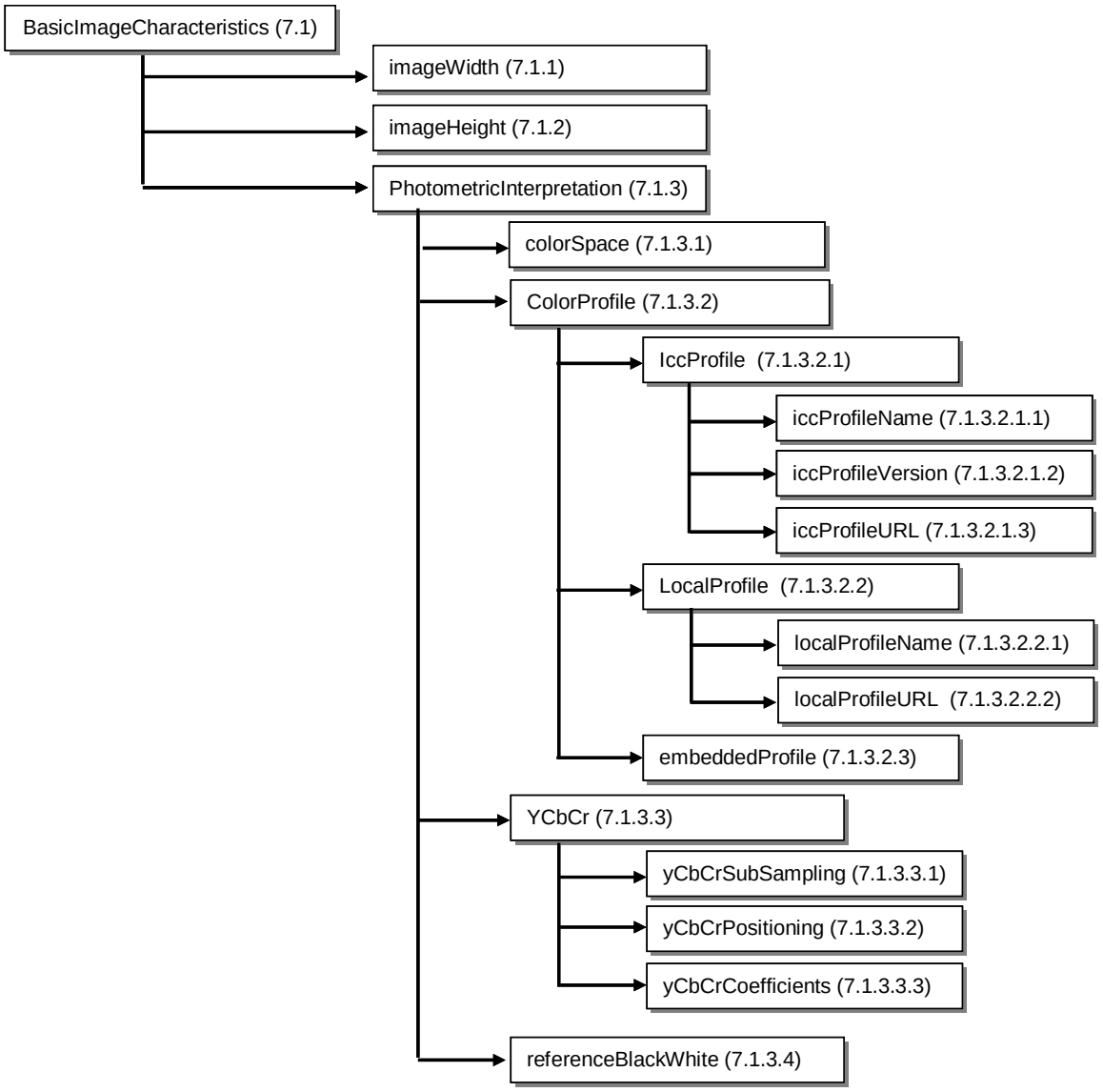

Figure 2: Logical structure of BasicImageCharacteristics

7.1.1 imageWidth

Definition	*a data element that specifies the width of the digital image, i.e. horizontal or X dimension, in pixels*
Type	positive integer
Obligation	M
Repeatable	N
Values **(Examples)**	1330 1600

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 9.1.2.1 ***xSamplingFrequency*** when 8.1.3.1.2 ***sourceXDimensionUnit*** is in inches and 9.1.2 ***samplingFrequencyUnit*** = 2. Formula to calculate ***xSamplingFrequency***: ***xSamplingFrequency*** = ***imageWidth***/***sourceXDimension***
Use	System (required field for image viewers [size]) Manager (one of the quantitative metrics to evaluate image quality) User

7.1.2 imageHeight

Definition	*a data element that specifies the height of the digital image, i.e. vertical or Y dimension, in pixels*
Type	positive integer
Obligation	M
Repeatable	N
Values **(Examples)**	2130 1200
Notes	The image height 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 9.1.2.2 ***ySamplingFrequency*** when 8.1.3.2.2 ***sourceYDimensionUnit*** is in inches and 9.1.2 ***samplingFrequencyUnit*** = 2. Formula to calculate ***ySamplingFrequency***: ***ySamplingFrequency = imageHeight/sourceYDimension***
Use	System (required field for image viewers [size]) Manager (one of the quantitative metrics to evaluate image quality) User

7.1.3 PhotometricInterpretation

Definition	*a container detailing the* ***PhotometricInterpretation*** *information****;*** *comprised of two data elements (7.1.3.1* ***colorSpace*** *and 7.1.3.4* ***referenceBlackWhite***) *and two sub-containers (7.1.3.2* ***ColorProfile*** *and 7.1.3.3* ***YCbCr***)
Type	Container

Obligation	M
Repeatable	N
Notes	Photometric interpretation is the information necessary to properly interpret the pixel values. If sub-containers do not contain any data or are not applicable, they need not be recorded.

7.1.3.1 colorSpace

Definition	*a data element that designates the color model of the decompressed image data*
Type	string
Obligation	M
Repeatable	N
Values (Examples)	WhiteIsZero BlackIsZero RGB PaletteColor TransparencyMask CMYK YCbCr CIELab ICCLab DeviceGray DeviceRGB DeviceCMYK CalGray CalRGB Lab ICCBased Separation sRGB e-sRGB sYCC Indexed Pattern DeviceN YCCK Other (key in appropriate text name)

Notes	Commonly called color spaces, these color models are used to render digital still images. Some color models may be pertinent to certain file types (e.g., TIFF) while others are more device dependent or independent (calibrated) color models. If the color space used is not present, enter text description for the one utilized. ***colorSpace*** recorded here should be a text description. Though element type=string is technically defined as "one or more characters," it is not appropriate to record the numeric encoding for ***colorSpace*** that may come directly from the image file header. Text descriptors should be used to facilitate transparency of information recorded in this element.
Notes	PaletteColor notes: 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 ***colorSpace*** = PaletteColor is used, 9.2.4 ***Colormap*** must be present and 9.2.2 ***samplesPerPixel*** must be 1.
Use	System (tone, color) Manager (one of the quantitative metrics to evaluate image quality)

7.1.3.2 ColorProfile

Definition	*a container of information detailing the color profile associated with the digital image; comprised of two sub-containers (7.1.3.2.1* ***IccProfile*** *and 7.1.3.2.2* ***LocalProfile)****, as well as one data element, 7.1.3.2.3* ***embeddedProfile***
Type	Container
Obligation	MA
Repeatable	N
Notes	The acronym for International Colour Consortium is ICC in all capitals. For consistency in labeling of elements in this standard, the "icc" in the element names of this container is in all lower case with the exception of 7.1.3.2.1 **IccProfile**, a container. If sub-containers do not contain any data or are not applicable, they need not be recorded. ICC profiles should be recorded within the 7.1.3.2.1 **iccProfile** container; local profiles should be recorded within the 7.1.3.2.2 **LocalProfile** container; and embedded profiles are recorded in 7.1.3.2.3 **embeddedProfile.**

7.1.3.2.1 IccProfile

Definition	*a container of information detailing the ICC profile of the digital object; comprised of three data elements (7.1.3.2.1.1* ***iccProfileName,*** *7.1.3.2.1.2* ***iccProfileVersion*** *and 7.1.3.2.1.3* ***iccProfileURL****).*
Type	Container
Obligation	MA
Repeatable	N

Notes	If the ICC profile used is a well-known and well-documented profile, record the **iccProfileName** in 7.1.3.2.1.1 and record the **iccProfileVersion** in 7.1.3.2.1.2. If not, record the location of where the profile can be found in the field defined in section 7.1.3.2.3, **iccProfileURL**.

7.1.3.2.1.1 iccProfileName

Definition	*a data element that designates the well-defined name of the ICC profile used*
Type	string
Obligation	MA
Repeatable	N
Values (Examples)	Adobe RGB Working RGB CIE
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 7.1.3.2.3, ***iccProfileURL***.
Use	System

7.1.3.2.1.2 iccProfileVersion

Definition	*a data element that designates the version of the ICC profile used*
Type	string
Obligation	MA
Repeatable	N
Values (Examples)	1998 [i.e., Adobe RGB (1998)] sRGB IEC61966-2.1 1976 [i.e., CIE 1976]
Notes	If the ICC profile version 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 7.1.3.2.3 ***iccProfileURL***.
Use	System

7.1.3.2.1.3 iccProfileURL

Definition	*a data element that designates the URL/URN where the ICC profile is located*
Type	string
Obligation	MA
Repeatable	N

Values	[URL]
Notes	If the ICC profile used is a well-known and well-documented profile, record the information in the field defined in section 7.1.3.2.1 ***iccProfileName***. If not, record the location of where the profile can be found in this data element.
Use	System

7.1.3.2.2 LocalProfile

Definition	*a container of information detailing the **LocalProfile** of the digital object; comprised of two data elements (7.1.3.2.2.1 **localProfileName and** 7.1.3.2.2.2 **localProfileVersion**).*
Type	Container
Obligation	MA
Repeatable	N
Notes	If an ICC profile is not used, record the name of the local color profile utilized in 7.1.3.2.2.1 ***localProfileName***. Also, record the location of where the profile can be found in the field defined in section 7.1.3.2.2.2 ***localProfileURL***.

7.1.3.2.2.1 localProfileName

Definition	*a data element that designates the name of the local color profile used*
Type	string
Obligation	MA
Repeatable	N
Values (Examples)	Harvard 1234 Michigan ABC
Notes	If an ICC profile is not used, record the name of the local color profile utilized in this data element. Also, record the location of where the profile can be found in the field defined in section 7.1.3.2.2.2 ***localProfileURL***.
Use	System

7.1.3.2.2.2 localProfileURL

Definition	*a data element that designates the URL/URN where the local color profile is located*
Type	string
Obligation	MA
Repeatable	N
Values	[URL]

Notes	If an ICC profile is not used, record the location of where the profile can be found in this data element. Also, record the name of the local color profile utilized in the field defined in section 7.1.3.2.2.1 ***localProfileName***.
Use	System

7.1.3.2.3 embeddedProfile

Definition	*a data element that provides a placeholder to allow institutions to embed the color profile when using the XML (MIX) schema to record data elements*
Type	base64Binary
Obligation	O
Repeatable	N
Values	[Base64-encoded data]
Notes	Some institutions may choose to embed the actual local profile used in addition to or instead of referencing it. This can be done when using the NISO Metadata for Images in XML (MIX) schema, the XML implementation of this data dictionary. (See Appendix A.)
Use	System Manager

7.1.3.3 YCbCr

Definition	*a container of information detailing the YCbCr-related information of the digital object; comprised of three data elements (7.1.3.3.1 **yCbCrSubSampling**, 7.1.3.3.2 **yCbCrPositioning**, and 7.1.3.3.3 **yCbCrCoefficients**)*
Type	Container
Obligation	MA
Repeatable	N
Notes	If container does not contain any data or is not applicable, it need not be recorded.

7.1.3.3.1 yCbCrSubSampling

Definition	*a data element that designates the subsampling factors used for the chrominance components of a YCbCr image*
Type	enumerated type (restricted to external standard)
Obligation	MA
Repeatable	N
Values	Values for this data element must be drawn from the list documented in *TIFF, section 21, YCbCr Images*.
Notes	This tag is mandatory when 7.1.3.1 ***colorSpace*** = YCbCr, and there are no defaults allowed.

Use	System (tone, color) Manager (one of the quantitative metrics to evaluate image quality)

7.1.3.3.2 yCbCrPositioning

Definition	*a data element that designates the positions of subsampled chrominance components relative to luminance samples*
Type	enumerated type (restricted to external standard)
Obligation	MA
Repeatable	N
Values	Values for this data element must be drawn from the list documented in *TIFF, section 21, YCbCr Image*s.
Notes	This tag is mandatory when 7.1.3.1 ***colorSpace*** = YCbCr, and the value shall equal 2.
Use	System (tone, color) Manager (one of the quantitative metrics to evaluate image quality)

7.1.3.3.3 yCbCrCoefficients

Definition	*a data element that encodes the transformation from RGB to YCbCr image data*
Type	enumerated type (restricted to external standard)
Obligation	MA
Repeatable	N
Values	Values for this data element must be drawn from the list documented in *TIFF, section 21, YCbCr Images*.
Notes	This tag is mandatory when 7.1.3.1 ***colorSpace*** = YCbCr, and there are no defaults allowed. The transformation is specified as three rational values that represent the coefficients used to compute luminance, Y.
Use	System (tone, color) Manager (one of the quantitative metrics to evaluate image quality)

7.1.3.4 referenceBlackWhite

Definition	*a data element that encodes a pair of headroom and footroom image data values for each pixel component*
Type	enumerated type (restricted to external standard)
Obligation	MA
Repeatable	N
Values	Values for this data element must be drawn from the list documented in *TIFF, section 21, YCbCr Images*.

Notes	This tag is mandatory when 7.1.3.1 ***colorSpace*** = YCbCr, and there are no defaults allowed.
Use	System (tone, color) Manager (one of the quantitative metrics to evaluate image quality)

7.2 SpecialFormatCharacteristics

Definition	*a container of information detailing **SpecialFormatCharacteristics** of certain digital objects; comprised exclusively of sub-containers which are format-specific*
Type	Container
Obligation	MA
Repeatable	N
Notes	Certain file formats have characteristics that are not common to other image file formats. Information which needs to be documented from these formats should be recorded in data elements in this section, grouped by format. The standard currently recognizes a need for additional information about JPEG 2000, MrSID, and DjVu files. As newer formats emerge, additional format-specific data documentation may be required. This format-specific data should be documented by creating a new container within ***SpecialFormatCharacteristics*** (named for the file format) and populating it with appropriate data elements. If sub-containers do not contain any data or are not applicable, they need not be recorded.

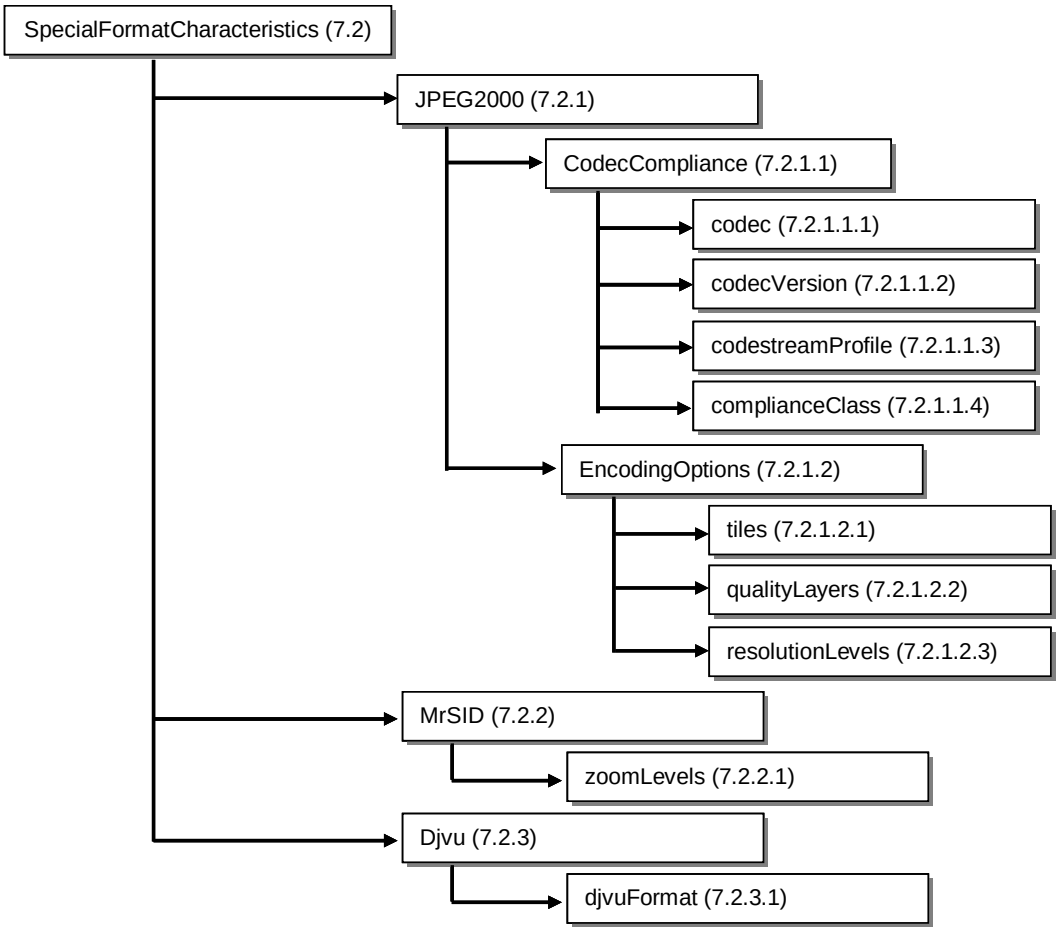

Figure 3: Logical structure of SpecialFormatCharacteristics

7.2.1 JPEG2000

Definition	*a container of information detailing* JPEG 2000 *format-specific data; comprised of two sub-containers of data elements (7.2.1.1* ***CodecCompliance*** *and 7.2.1.2* ***EncodingOptions***)
Type	Container
Obligation	MA
Repeatable	N
Notes	Certain data about JPEG 2000 files have been deemed necessary to document in order to enable accurate rendering and transformations over time. Currently, there are seven elements within this data container, but others could be added at a future date. If other data elements are to be recorded, they would be placed into the ***JPEG2000*** data container. If sub-containers do not contain any data or are not applicable, they need not be recorded.

7.2.1.1 CodecCompliance

Definition	*a container of information detailing JPEG 2000 Codec compliance; comprised of four data elements (7.2.1.1.1* ***codec****, 7.2.1.1.2* ***codecVersion****, 7.2.1.1.3* ***codestreamProfile****, and 7.2.1.1.4* ***complianceClass***)
Type	Container
Obligation	O
Repeatable	N
Notes	7.2.1.1.3 ***codestreamProfile*** and 7.2.1.1.4 ***complianceClass*** together express codec compliance.
Notes	***CodecCompliance*** indicates the level of compliance of a particular codec as defined in ISO/IEC 15444-4. It is usually associated with a particular software application developed by specific companies. Compliance is frequently self-reported by the codec developer.

7.2.1.1.1 codec

Definition	*a data element that designates the specific software implementation of JPEG 2000 compression/decompression methods used to compress the file or codestream*
Type	String
Obligation	O
Repeatable	N
Values **(Examples)**	Kakadu LuraWave.jp2
Use	System

7.2.1.1.2 codecVersion

Definition	*a data element that designates the version of codec used*
Type	String
Obligation	O
Repeatable	N
Values **(Examples)**	3.1 1.11
Notes	Version of the codec named in 7.2.1.1.1 ***codec***.
Use	System Manager

7.2.1.1.3 codestreamProfile

Definition	*a data element that designates the codestream profile of the JPEG 2000 image file*
Type	String
Obligation	O
Repeatable	N
Values	P0 (not allowed to use some of the features of JPEG 2000) P1 (all components must contain low resolution pieces of 128x128 or smaller)
Notes	Profiles define the limits of the codestream syntax parameters. Two profiles are defined in ISO/IEC 15444-1 (ITU-T Rec. T.800) labeled Profile 0 and Profile 1. These Profiles when combined with 7.2.1.1.4 ***complianceClass*** indicate the ability of a specific decoder to operate on a specific codestream. These values are defined in ISO/IEC 15444-4.
Use	System

7.2.1.1.4 complianceClass (cClass)

Definition	*a data element that specifies the largest height, width, and number of components a decoder can decode*
Type	String
Obligation	O
Repeatable	N
Values **(Examples)**	C0 C1 C2
Notes	Decoders may be limited in the size of the output image that they are capable of producing, due to physical display characteristics or memory limitations. Compliance classes indicate the largest height, width, and number of components a decoder can decode.
Use	System

7.2.1.2 EncodingOptions

Definition	*a container of information detailing JPEG 2000 encoding options; comprised of three data elements (7.2.1.2.1* ***tiles****, 7.2.1.2.2* ***qualityLayers****, and 7.2.1.2.3* ***resolutionLevels****)*
Type	Container
Obligation	O
Repeatable	N

7.2.1.2.1 tiles

Definition	*a data element that designates the pixel dimensions (width and height) of the JPEG 2000 tiles used to divide the entire image into a grid for more efficient compression and decompression*
Type	string
Obligation	O
Repeatable	N
Values **(Examples)**	512x512 64x64
Notes	JPEG 2000 images are divided into tiles for more efficient delivery of images. Each tile can be independently decoded, lowering the memory requirements for image decoding. Specified by manager.
Use	Manager System

7.2.1.2.2 qualityLayers

Definition	*a data element that designates the number of quality layers to which each JPEG 2000 image tile has been decomposed*
Type	positive integer
Obligation	MA
Repeatable	N
Values **(Example)**	12
Notes	Quality layers in JPEG 2000 images allow lower quality representations of images to be displayed before the entire image has been decoded. As successive layers are decoded and made available, they contribute data to form higher quality images. Mandatory for JPEG 2000 images (jp2, jpx).
Use	Manager System

7.2.1.2.3 resolutionLevels

Definition	*a data element that designates the number of lower resolution images (levels) to be extracted from the source image*
Type	positive integer
Obligation	MA
Repeatable	N

Values (Example)	6
Notes	Determines the number and size of thumbnail and intermediate size images.
Notes	JPEG 2000 allows one to specify the number of lower resolution images to be extracted from source images. Each resolution level is one-fourth the size of its predecessor. For example, a 1024x768 pixel image with four resolution levels supports the extraction of images at 1024x768, 512x384, 256x192, and 128x96. Mandatory for JPEG 2000 images (jp2, jpx).
Use	Manager System

7.2.2 MrSID

Definition	*a container of information detailing MrSID format-specific data; comprised of one data element (7.2.2.1* ***zoomLevels***)
Type	Container
Obligation	MA
Repeatable	N
Notes	If sub-containers do not contain any data or are not applicable, they need not be recorded.

7.2.2.1 zoomLevels

Definition	*a data element that indicates the number of zoom levels available in the digital image*
Type	positive integer
Obligation	MA
Repeatable	N
Values (Example)	4
Use	System Manager

7.2.3 Djvu

Definition	*a container of information detailing DjVu format-specific data; comprised of one data element* (7.2.3.1 ***djvuFormat***)
Type	Container
Obligation	MA
Repeatable	N

7.2.3.1 djvuFormat

Definition	*a data element that indicates the specific format of the DjVu file*
Type	enumerated (restricted to list)
Obligation	MA
Repeatable	N
Values	indirect bundled
Notes	If the value is "indirect," the index.djvu file must be tracked. The djvu.index file points the browser to the multiple images that make up a single DjVu file.
Use	System Manager

8 Image Capture Metadata

This section can best be described as descriptive technical metadata or administrative metadata. Some of the information may be harvested from the file itself while other information will need to be provided by the institution managing the image capture process.

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 capture occurs only once. 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.

See section 10.1, *ImageProcessing,* for fields to record subsequent digital-to-digital conversion processes.

8.1 SourceInformation

Definition	*a container of information detailing the **SourceInformation** related to the imaged subject; comprised of one data element (8.1.1 **sourceType**) and two data containers (8.1.2 **SourceID** and 8.1.3 **SourceSize**)*
Type	Container
Obligation	R
Repeatable	N
Notes	If sub-containers do not contain any data or are not applicable, they need not be recorded.

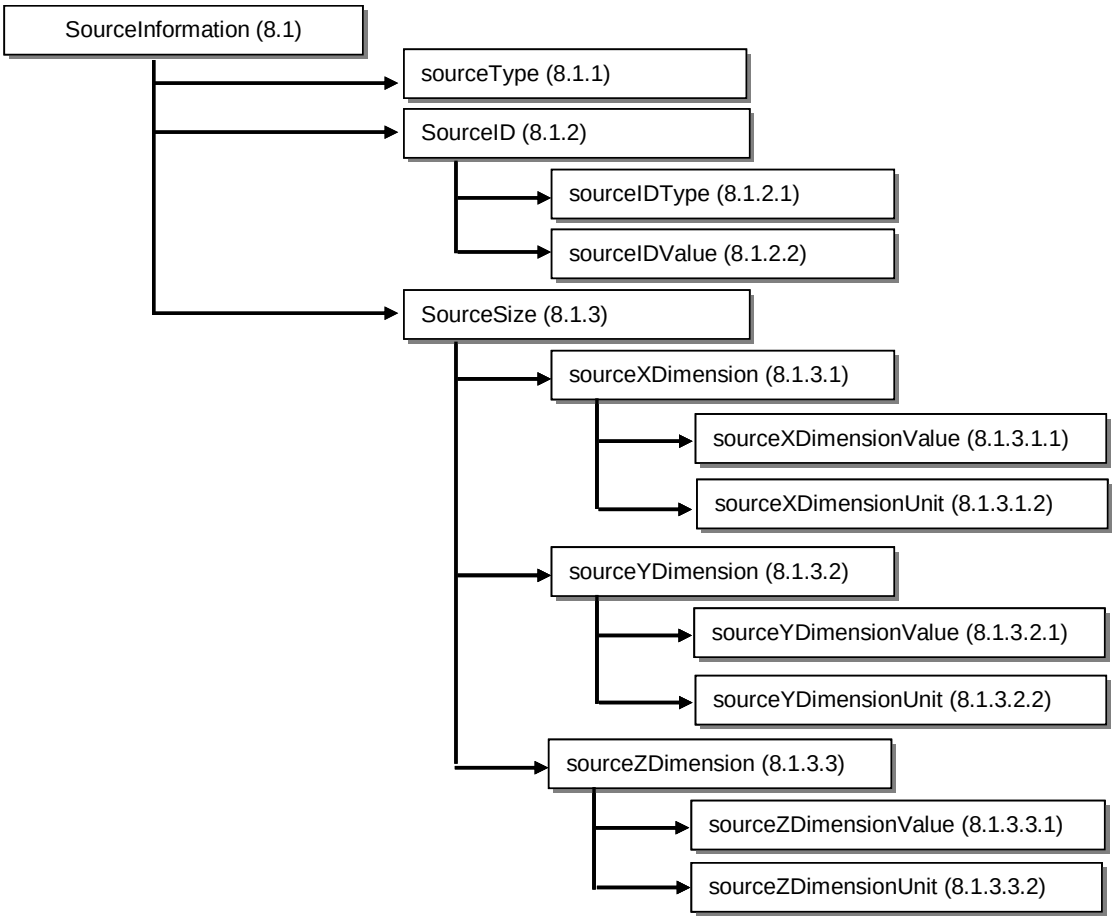

Figure 4: Logical structure of SourceInformation

8.1.1 sourceType

Definition	*a data element that specifies the medium of the analog source material scanned to create a digital still image*
Type	string
Obligation	R
Repeatable	N

Values (Examples)	photograph daguerreotype reflection print gelatin silver print Acme Bronze 100 chromogenic film 35 mm color negative Kodak Royal Gold 100 Emul. 3712011 text document or book microfilm sculpture original scene contact sheet A
Notes	"General or specific physical nature of original item (i.e., still pictorial image)." [MIX] Do not record dimensions of source material in this field. See 8.1.3.1 ***SourceXDimension*** and 8.1.3.2 ***SourceYDimension***. 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 10.1 ***ImageProcessing***.
Use	Manager User

8.1.2 SourceID

Definition	*a container of information detailing the **SourceID** (identifier) of the imaged object; comprised of two data elements (8.1.2.1 **sourceIDType** and 8.1.2.2 **sourceIDValue**)*
Type	Container
Obligation	R
Repeatable	Y
Notes	This identifier must be unique within the local system. Because an image may have multiple identifiers associated with it (accession number, digital repository URN, delivery URI, etc.), the ***SourceID*** container of data elements is repeatable, but individual data elements within a container are not. To attach the semantic meaning to the identifier, the ***SourceID*** may have several sub-elements in order to identify both the system or domain in which it is unique, as well as the value itself. The ***SourceID*** is comprised of the sub-elements ***sourceIDType*** and ***sourceIDValue***. The combination of these sub-elements must be unique.

8.1.2.1 sourceIDType

Definition	*a data element that designates the system or domain in which the identifier is unique; to be used in conjunction with 8.1.2.2* ***sourceIDValue***
Type	string
Obligation	O
Repeatable	N
Values **(Examples)**	[RLG Union Catalog] [OCLCWorldCat] [a local system name] [local photograph accession system name]
Notes	Link to a unique identifier for a descriptive record of the source of image. Container is repeatable. May be multiple descriptive records in various systems.
Use	Manager System

8.1.2.2 sourceIDValue

Definition	*a data element that designates the value of the* ***SourceID***
Type	string
Obligation	O
Repeatable	N
Values **(Examples)**	RLG Union Catalog record number OCLC record number Local system control number
Notes	Link to a unique identifier for a descriptive record of the source of image. Container is repeatable. May be multiple descriptive records in various systems.
Use	Manager System

8.1.3 SourceSize

Definition	*a container of information detailing the* ***SourceSize*** *[dimensions] of the imaged object; comprised of 3 sub-containers (8.1.3.1* ***SourceXDimension***, *8.1.3.2* ***SourceYDimension***, and *8.1.3.3* ***SourceZDimension***)
Type	Container
Obligation	O

Repeatable	N
Notes	If sub-containers do not contain any data or are not applicable, they need not be recorded.

8.1.3.1 SourceXDimension

Definition	*a container of information detailing the **SourceXDimension** (width) of the imaged object; comprised of two data elements (8.1.3.1.1 **sourceXDimensionValue** and 8.1.3.1.2 **sourceXDimensionUnit**)*
Type	Container
Obligation	O
Repeatable	N
Notes	The numerical value is specified in 8.1.3.1.1 ***sourceXDimensionValue.*** The unit of measure (inches, meters, etc.) used must be specified in 8.1.3.1.2 ***sourceXDimensionUnit***.

8.1.3.1.1 sourceXDimensionValue

Definition	*a data element that specifies the width of the imaged object*
Type	non-negative real
Obligation	O
Repeatable	N
Values **(Examples)**	7.63 (e.g., 7.63 in) 32 (e.g., 32 mm)
Notes	If physical dimensions of the source and the dimensions actually imaged differ, record the X dimension of area imaged. For example, if a photographic print measuring 8 inches in the X dimension is imaged in its entirety, the image file's ***sourceXDimensionValue*** would be "8". If the same photographic print is imaged in its entirety with a 1-inch border on all sides, the image file's ***sourceXDimensionValue*** would be "10", because the X dimension of the total area imaged includes the space around the print itself. If a partial detail of a large map is imaged, and the detail measures 6 inches in the X dimension while the map measures 40 inches in the X dimension, the image file's ***sourceXDimensionValue*** would be "6". If a stained glass window is imaged, and the window measures 6 feet in the X dimension, while the church wall in which it is located has a measurement of 300 feet in the X dimension, the image file's ***sourceXDimensionValue*** would be "6". The unit of measure (inches, meters, etc.) used must be specified in 8.1.3.1.2 ***sourceXDimensionUnit***. If unknown or impractical to record, the ***sourceXDimensionValue*** may be deduced. See 9.1.1 ***samplingFrequencyPlane***.

Use	System (accurate output of file to print/film [size]) Manager (one of the quantitative metrics to evaluate image quality) User

8.1.3.1.2 sourceXDimensionUnit

Definition	*a data element that specifies the unit of measure used in 8.1.3.1.1* ***sourceXDimensionValue***
Type	enumerated type, restricted to list
Obligation	O
Repeatable	N
Values **(Examples)**	in. mm
Use	System (accurate output of file to print/film [size]) Manager (one of the quantitative metrics to evaluate image quality)

8.1.3.2 SourceYDimension

Definition	*a container of information detailing the* ***SourceYDimension*** *(height) of the imaged object; comprised of two data elements (8.1.3.2.1* ***sourceYDimensionValue*** *and 8.1.3.2.2* ***sourceYDimensionUnit***)
Type	Container
Obligation	O
Repeatable	N
Notes	This unit of measure may be used to record the height of an object being digitized. The numerical value is specified in 8.1.3.2.1 ***sourceYDimensionValue.*** The unit of measure (inches, meters, etc.) used must be specified in 8.1.3.2.2 ***sourceYDimensionUnit***.

8.1.3.2.1 sourceYDimensionValue

Definition	*a data element that specifies the numerical value that specifies the height (i.e., vertical dimension) of the imaged object*
Type	non-negative real
Obligation	O
Repeatable	N
Values **(Examples)**	5.29 (e.g., 5.29 in.) 28 (e.g., 28 mm)

Notes	If physical dimensions of the source and the dimensions actually imaged differ, record the Y dimension of area imaged. See notes for 8.1.3.1.1 ***sourceXDimensionValue***. The unit of measure (inches, meters, etc.) used must be specified in 8.1.3.2.2 ***sourceYDimensionUnit***. If unknown or impractical to record, the ***sourceYDimensionValue*** may be deduced. See 9.1.1 ***samplingFrequencyPlane***.
Use	System (accurate output of file to print/film [size]) Manager (one of the quantitative metrics to evaluate image quality) User

8.1.3.2.2 sourceYDimensionUnit

Definition	*a data element that specifies the unit of measure used in 8.1.3.2.1* ***sourceYDimensionValue***
Type	enumerated type, restricted to list
Obligation	O
Repeatable	N
Values **(Examples)**	in. mm
Use	System (accurate output of file to print/film [size]) Manager (one of the quantitative metrics to evaluate image quality)

8.1.3.3 SourceZDimension

Definition	*a container of information detailing the* ***SourceZDimension*** *(depth) of the imaged object; comprised of two data elements (8.1.3.3.1* ***sourceZDimensionValue*** *and 8.1.3.3.2* ***sourceZDimensionUnit***)
Type	Container
Obligation	O
Repeatable	N
Notes	This unit of measure may be used to record the depth or thickness of an object being digitized (i.e., the thickness of a bound manuscript, the depth dimension of a sculpture, etc.). The numerical value is specified in 8.1.3.3.1 ***sourceZDimensionValue.*** The unit of measure (inches, meters, etc.) used must be specified in 8.1.3.3.2 ***sourceZDimensionUnit***.

8.1.3.3.1 sourceZDimensionValue

Definition	*a data element that specifies a numerical value that specifies the depth or thickness of the imaged object*
Type	non-negative real
Obligation	O
Repeatable	N
Values **(Examples)**	5.29 (e.g., 5.29 in.) 28 (e.g., 28 mm)
Notes	If physical dimensions of the source and the dimensions actually imaged differ, record the Z dimension of area imaged. See notes for 8.1.3.1.1 ***sourceXDimensionValue***. The unit of measure (inches, meters, etc.) used must be specified in 8.1.3.3.3 ***sourceZDimensionUnit***.
Use	System (accurate output of file to print/film [size]) Manager (one of the quantitative metrics to evaluate image quality) User

8.1.3.3.2 sourceZDimensionUnit

Definition	*a data element that specifies the unit of measure used in 8.1.3.3.1* ***sourceZDimensionValue***
Type	enumerated type, restricted to list
Obligation	O
Repeatable	N
Values **(Examples)**	in. mm
Use	System (accurate output of file to print/film [size]) Manager (one of the quantitative metrics to evaluate image quality)

8.2 GeneralCaptureInformation

Definition	*a container of information detailing the* ***GeneralCaptureInformation*** *of the digital object; comprised of three data elements (8.2.1* ***dateTimeCreated****, 8.2.2* ***imageProducer****, and 8.2.3* ***captureDevice****)*
Type	Container
Obligation	MA
Repeatable	N

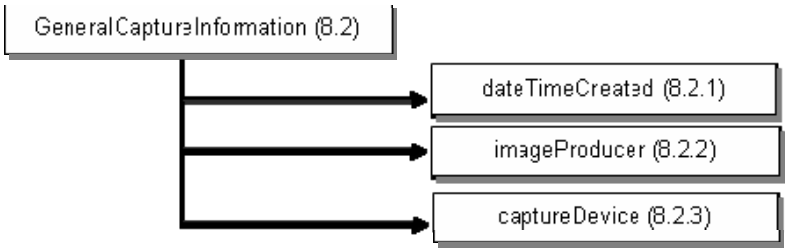

Figure 5: Logical structure of GeneralCaptureInformation

8.2.1 dateTimeCreated

Definition	*a data element that designates the Date or DateTime the image was created*
Type	DateTime
Obligation	MA
Repeatable	N
Values	YYYY-MM-DD (e.g. 2004-07-15) YYYY-MM-DD HH:MM:SS (e.g. 2004-07-15 19:20:00)
Notes	Use ISO 8601 numeric representations of date and time. See section 10.1.1 ***dateTimeProcessed*** for images created by processing image data (i.e., digital-to-digital conversion).
Use	Manager

8.2.2 imageProducer

Definition	*a data element that identifies the organization-level producer(s) of the image*
Type	string
Obligation	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 name of the service provider or production unit responsible for creation of the file/bitstream i.e., the scanned image, transcribed text, audio file, etc.
Use	Manager

8.2.3 captureDevice

Definition	*a data element that designates the classification of device used to create the image data*
Type	enumerated type (restricted to list)
Obligation	O
Repeatable	N
Values **(Examples)**	transmission scanner reflection print scanner digital still camera still from video
Notes	When image processing software is used to generate the image data from a digital source, see section 10.1 ***ImageProcessing***.
Use	Manager

8.3 ScannerCapture

Definition	*a container of information detailing **ScannerCapture** specifics; comprised of three data elements (8.3.1 **scannerManufacturer**, 8.3.3 **maximumOpticalResolution**, and 8.3.4 **scannerSensor**) as well as two sub-containers (8.3.2 **ScannerModel** and 8.3.5 **ScanningSystemSoftware**)*
Type	Container
Obligation	R
Repeatable	N
Notes	If an image is created with a scanner, sub-elements below should be used to specify the scanner settings used when the image was scanned. If sub-containers do not contain any data or are not applicable, they need not be recorded.

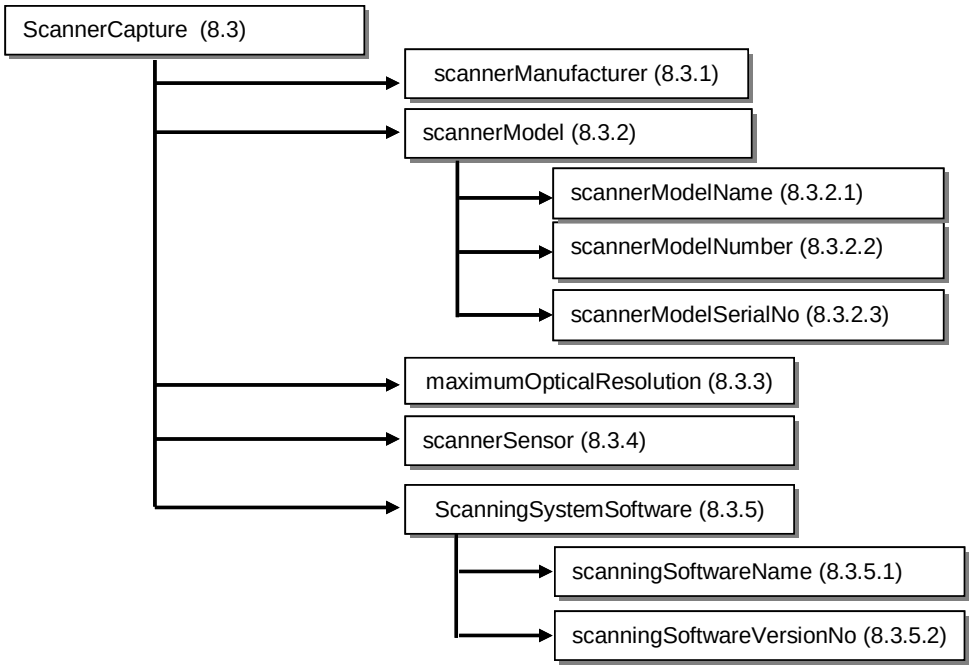

Figure 6: Logical structure of ScannerCapture

8.3.1 scannerManufacturer

Definition	*a data element that identifies the manufacturer of the scanner used to create the image*
Type	string
Obligation	R
Repeatable	N
Values (Examples)	Scitex AGFA-Microtek Creo
Use	Manager

8.3.2 ScannerModel

Definition	*a container of information detailing **ScannerModel** specifics; comprised of three data elements (8.3.2.1 **scannerModelName**, 8.3.2.2 **scannerModelNumber**, and 8.3.2.3 **scannerModelSerialNo**)*
Type	Container
Obligation	R
Repeatable	N

8.3.2.1 scannerModelName

Definition	*a data element that identifies the model name of the scanner used to create the image*
Type	string
Obligation	R
Repeatable	N
Values (Examples)	ArtixScan
Use	Manager

8.3.2.2 scannerModelNumber

Definition	*a data element that identifies the model number of the scanner used to create the image*
Type	string
Obligation	R
Repeatable	N
Values (Example)	2500tf
Use	Manager

8.3.2.3 scannerModelSerialNo

Definition	*a data element that identifies the serial number of the scanner used to create the image*
Type	string
Obligation	O
Repeatable	N
Values (Examples)	TWA02A10811 USC0005103
Use	Manager

8.3.3 maximumOpticalResolution

Definition	*a data element that designates the actual number of photo elements in the scanning sensor (colloquially known as "the maximum optical resolution" for a system)*
Type	string
Obligation	O

Repeatable	N
Values **(Examples)**	400 dpi 3072 x 2048
Notes	For all linear-sensor scanners, use: [any positive integer] dpi. For all area-sensor scanners, use: longer dimension [positive integer] x smaller dimension [positive integer].
Use	Manager

8.3.4 scannerSensor

Definition	*a data element that designates the type of image sensor used in the scanning device*
Type	enumerated type (restricted to external standard)
Obligation	R
Repeatable	N
Values	undefined MonochromeLinear ColorTriLinear ColorSequentialLinear
Notes	Enumerated values are drawn from *TIFF/EP (pp.25-26) for tag # 37399, Sensing Methods*.
Use	Manager

8.3.5 ScanningSystemSoftware

Definition	*a container of information detailing **ScanningSystemSoftware** specifics; comprised of two data elements (8.3.5.1 **scanningSoftwareName** and 8.3.5.2 **scanningSoftwareVersion**)*
Type	Container
Obligation	R
Repeatable	N

8.3.5.1 scanningSoftwareName

Definition	*a data element that identifies the name of the capture software used to create the image*
Type	string
Obligation	R
Repeatable	N

Values (Example)	Leaf
Use	Manager

8.3.5.2 scanningSoftwareVersionNo

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

8.4 DigitalCameraCapture

Definition	*a container of information detailing **DigitalCameraCapture**; comprised of two data elements (8.4.1 **digitalCameraManufacturer** and 8.4.3 **cameraSensor**) as well as two sub-containers (8.4.2 **DigitalCameraModel** and 8.4.4 **CameraCaptureSettings**)*
Type	Container
Obligation	MA
Repeatable	N
Notes	If sub-containers do not contain any data or are not applicable, they need not be recorded.

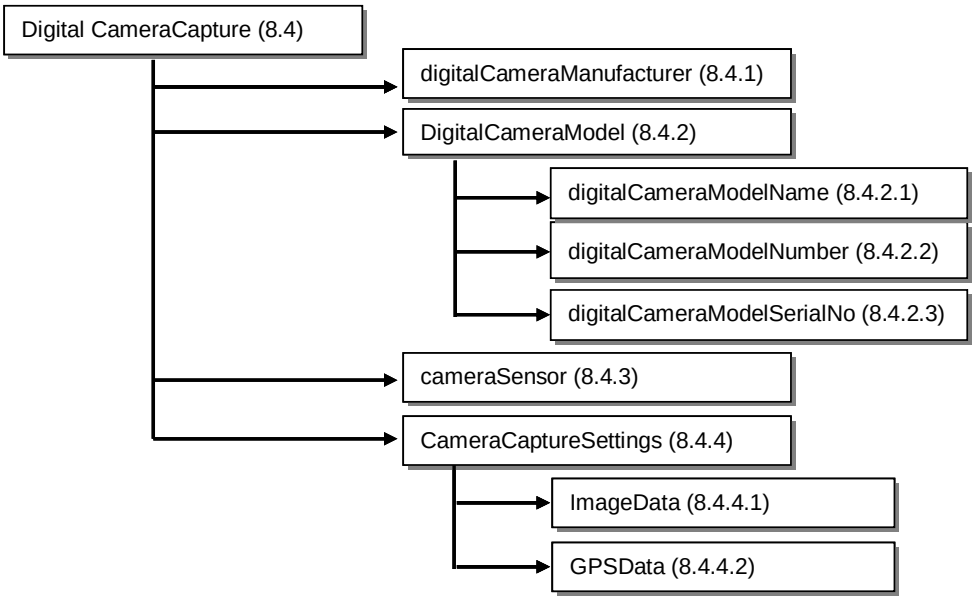

Figure 7: Logical structure of DigitalCameraCapture

8.4.1 digitalCameraManufacturer

Definition	*a data element that identifies the manufacturer of the digital camera used to create the image*
Type	string
Obligation	R
Repeatable	N
Values (Example)	PhaseOne
Use	Manager

8.4.2 DigitalCameraModel

Definition	*a container of information detailing **DigitalCameraModel** specifics; comprised of three data elements (8.4.2.1 **digitalCameraModelName**, 8.4.2.2 **digitalCameraModelNumber**, and 8.4.2.3 **digitalCameraModelSerialNo**)*
Type	Container
Obligation	R
Repeatable	N

8.4.2.1 digitalCameraModelName

Definition	*a data element that identifies the model name of the digital camera used to create the image*
Type	string
Obligation	R
Repeatable	N
Values (Examples)	H_20 LightPhase
Use	Manager

8.4.2.2 digitalCameraModelNumber

Definition	*a data element that identifies the model number of the digital camera used to create the image*
Type	string
Obligation	R
Repeatable	N
Values (Example)	C2520B
Use	Manager

8.4.2.3 digitalCameraModelSerialNo

Definition	*a data element that identifies the serial number of the scanner used to create the image*
Type	string
Obligation	O
Repeatable	N
Values (Example)	30324775
Use	Manager

8.4.3 cameraSensor

Definition	*a data element that designates the type of image sensor used in the camera device*
Type	enumerated type (restricted to external standard)
Obligation	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

8.4.4 CameraCaptureSettings

Definition	*a container of information detailing **CameraCaptureSettings** specifics; comprised of two subcontainers: 8.4.4.1 **ImageData** and 8.4.4.2 **GPSData***
Type	Container
Obligation	O
Repeatable	N
Notes	In most cases, camera capture settings should be able to be extracted from the still image files produced by digital cameras. These data elements have been standardized in EXIF. More specifically, The camera capture settings information in this section has been drawn from **Exchangeable image file format for digital still cameras: Exif Version 2.2.** Within CameraCaptureSettings, the EXIF data has been divided into two parts: ***ImageData*** and ***GPSData***. Tags relating to image data structure, image data characteristics, and picture-taking conditions are found in ***ImageData*** container. EXIF also supporting the recording of Tags related to GPS (global positioning system) information and these optional data elements are contained in the ***GPSData*** container. If sub-containers do not contain any data or are not applicable, they need not be recorded.

8.4.4.1 ImageData

Definition	*a container of information detailing* ***ImageData*** *specifics; comprised of 23 data elements* (8.4.4.1 ***fNumber****, 8.4.4.2* ***exposureTime****, 8.4.4.3* ***exposureProgram****, 8.4.4.4* ***spectralSensitivity****, 8.4.4.5* ***isoSpeedRatings****, 8.4.4.6* ***oECF****, 8.4.4.7* ***exifVersion****, 8.4.4.8* ***shutterSpeedValue****, 8.4.4.9* ***apertureValue****, 8.4.4.10* ***brightnessValue****, 8.4.4.11* ***exposureBiasValue****, 8.4.4.12* ***maxApertureValue****, 8.4.4.13* ***subjectDistance****, 8.4.4.14* ***meteringMode****, 8.4.4.15* ***lightSource****,* 8.4.4.16 ***flash****, 8.4.4.17* ***focalLength****, 8.4.4.18* ***flashEnergy****, 8.4.4.19* ***backLight****, 8.4.4.20* ***exposureIndex****, 8.4.4.21* ***sensingMethod****, 8.4.4.22* ***cfaPattern****,and 8.4.4.23* ***autoFocus****) and one sub-container (8.4.4.24* ***PrintAspectRatio***)
Type	Container
Obligation	O
Repeatable	N
Use	System Manager

8.4.4.1.1 fNumber

Definition	*a data element that specifies the lens f-number (ratio of lens aperture to focal length) used when the image was captured*
Type	non-negative real
Obligation	O
Repeatable	N
Values (Examples)	0.6 1 1.4 2 2.8 4 5.6 7 8
Use	System Manager

8.4.4.1.2 exposureTime

Definition	*a data element that specifies the exposure time used when the image was captured; recorded in seconds*
Type	non-negative real

Obligation	O
Repeatable	N
Values (Example)	0.008
Notes	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

8.4.4.1.3 exposureProgram

Definition	*a data element that indicates the class of the program used by the camera to set exposure when the picture is taken*
Type	enumerated type (restricted to external standard)
Obligation	O
Repeatable	N
Values	0 = Not defined 1 = Manual 2 = Normal program 3 = Aperture priority 4 = Shutter priority 5 = Creative program (biased toward depth of field) 6 = Action program (biased toward fast shutter speed) 7 = Portrait mode (for closeup photos with the background out of focus) 8 = Landscape mode (for landscape photos with the background in focus)
Notes	Values are drawn from the EXIF 2.2 (2002) standard.
Use	Manager User

8.4.4.1.4 spectralSensitivity

Definition	*a data element that indicates the spectral sensitivity of each channel of the camera used*
Type	string
Obligation	O
Repeatable	Y

Values (Examples)	<spectralSensitivity>0.015</spectralSensitivity> <spectralSensitivity>0.030</spectralSensitivity> <spectralSensitivity>0.114</spectralSensitivity> <spectralSensitivity>0.199</spectralSensitivity> <spectralSensitivity>0.297</spectralSensitivity>
Notes	The tag value is an ASCII string. In XML, the data is recorded as a series of repeated elements.
Use	Manager User

8.4.4.1.5 isoSpeedRatings

Definition	*a data element that indicates the ISO Speed and ISO Latitude of the camera or input device as specified in ISO 12232*
Type	integer
Obligation	O
Repeatable	N
Values (Examples)	100 200 400 3200
Notes	Values are drawn from ISO 12232.
Use	Manager User

8.4.4.1.6 oECF

Definition	*a data element that indicates the Opto-Electric Conversion Function (OECF) specified in ISO 14524*
Type	rational
Obligation	O
Repeatable	N
Values	See ISO 14524 for extensive examples.
Notes	OECF is the relationship between the camera optical input and the image values.
Use	Manager User

8.4.4.1.7 exifVersion

Definition	*a data element that specifies the version of the EXIF standard supported*
Type	enumerated type (restricted to external standard)
Obligation	O
Repeatable	N
Values (Examples)	Conformance to this standard is indicated by recording "0220" as 4-byte ASCII.
Notes	Nonexistence of this field is taken to mean nonconformance to any version of the EXIF standard. Values are drawn from the EXIF 2.2 standard.
Use	System Manager User

8.4.4.1.8 shutterSpeedValue

Definition	*a data element that specifies the shutter speed*
Type	rational
Obligation	O
Repeatable	N
Values (Examples)	Full information is available in Annex C of the EXIF 2.2 standard
Notes	The unit is the APEX (Additive System of Photographic Exposure) setting.
Use	Manager User

8.4.4.1.9 apertureValue

Definition	*a data element that specifies the lens aperture*
Type	rational
Obligation	O
Repeatable	N
Values (Examples)	Full information is available in Annex C of the EXIF 2.2 standard
Notes	The unit is an APEX value.
Use	Manager User

8.4.4.1.10 brightnessValue

Definition	*a data element that specifies the brightness values measured when the image was captured, using APEX* (Additive System of Photographic Exposure) *values*
Type	rational
Obligation	O
Repeatable	N
Values (Examples)	-2 -1 0 1 5
Notes	This value represents the light level at the source (document). The expected maximum value is approximately 13.00, corresponding to a picture taken of a snow scene on a sunny day, and the expected minimum value is approximately -3.00, corresponding to a night scene. Ordinarily it is given in the range of -99.99 to 99.99. Unknown shall be indicated.
Use	System Manager

8.4.4.1.11 exposureBiasValue

Definition	*a data element that 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	rational
Obligation	O
Repeatable	N
Values (Examples)	0.0 2.0
Notes	The value is the number of exposure values (stops). For example, -1.00 indicates 1 eV (1 stop) underexposure, or half the normal exposure.
Use	System Manager

8.4.4.1.12 maxApertureValue

Definition	*a data element that indicates the smallest F number of the lens, expressed in APEX values*
Type	rational
Obligation	O
Repeatable	N
Values (Examples)	0.00 3.4 99.00
Notes	Ordinarily it is given in the range of 00.00 to 99.99, but it is not limited to this range.
Use	Manager User

8.4.4.1.13 subjectDistance

Definition	*a data element that 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
Obligation	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”/>
Notes	May specify a range of values, bounded by minimum and maximum.
Use	System Manager

8.4.4.1.14 meteringMode

Definition	*a data element that 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)
Obligation	O
Repeatable	N

Values	Average Center weighted average Spot Multispot Pattern Partial
Notes	Values are drawn from the EXIF 2.2 standard.
Use	System Manager

8.4.4.1.15 lightSource

Definition	*a data element that specifies the light source that was present when the image was captured*
Type	enumerated type (restricted to external standard)
Obligation	O
Repeatable	N
Values	Daylight Fluorescent Tungsten (incandescent light) Flash Fine weather Cloudy weather Shade Daylight fluorescent (D 5700 – 7100K) Day white fluorescent (N 4600 – 5400K) Cool white fluorescent (W 3900 – 4500K) White fluorescent (WW 3200 – 3700K) Standard light A Standard light B Standard lightC D55 D65 D75 D50 ISO studio tungsten other light source unknown

Notes	Enumerated values for this data element are drawn from the list in the EXIF 2.2 standard.
Use	System Manager

8.4.4.1.16 flash

Definition	*a data element that indicates the status of flash when the image was shot*
Type	enumerated type (restricted to external standard)
Obligation	O
Repeatable	N
Values	Flash did not fire. Flash fired. Strobe return light not detected. Strobe return light detected. Flash fired, compulsory flash mode Flash fired, compulsory flash mode, return light not detected Flash fired, compulsory flash mode, return light detected Flash did not fire, compulsory flash mode Flash did not fire, auto mode Flash fired, auto mode Flash fired, auto mode, return light not detected Flash fired, auto mode, return light detected No flash function Flash fired, red-eye reduction mode Flash fired, red-eye reduction mode, return light not detected Flash fired, red-eye reduction mode, return light detected Flash fired, compulsory flash mode, red-eye reduction mode Flash fired, compulsory flash mode, red-eye reduction mode, return light not detected Flash fired, compulsory flash mode, red-eye reduction mode, return light detected Flash fired, auto mode, red-eye reduction mode Flash fired, auto mode, return light not detected, red-eye reduction mode Flash fired, auto mode, return light detected, red-eye reduction mode
Notes	Values for this data element must be drawn from the list in the EXIF 2.2 standard.
Use	System Manager

8.4.4.1.17 focalLength

Definition	*a data element that specifies the lens focal length in meters used to capture the image*
Type	real
Obligation	O
Repeatable	N
Values **(Examples)**	0.120 0.180
Use	System Manager

8.4.4.1.18 flashEnergy

Definition	*a data element that specifies the amount of flash energy that was used in Beam Candle Power Seconds (BCPS)*
Type	rational
Obligation	O
Repeatable	N
Use	System Manager

8.4.4.1.19 backLight

Definition	*a data element that specifies the lighting conditions at the time of exposure*	
Type	enumerated type (restricted to external standard)	
Obligation	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."
Notes	Enumerated values for this data element are drawn from the list documented in DIG35, B3.2.5, *Back_Light*.	
Use	System Manager	

8.4.4.1.20 exposureIndex

Definition	*a data element that specifies the exposure index setting the camera selected*
Type	non-negative real
Obligation	O
Repeatable	N
Values **(Examples)**	7 8 400
Use	System Manager

8.4.4.1.21 sensingMethod

Definition	*a data element that indicates the image sensor type on the camera or input device*
Type	enumerated type (restricted to external standard)
Obligation	O
Repeatable	N
Values	1 = Not defined 2 = One-chip color area sensor 3 = Two-chip color area sensor 4 = Three-chip color area sensor 5 = Color sequential area sensor 7 = Trilinear sensor 8 = Color sequential linear sensor
Notes	Values for this data element must be drawn from the list in the EXIF 2.2 standard.
Use	Manager User

8.4.4.1.22 cfaPattern

Definition	*a data element that indicates the color filter array (CFA) geometric pattern of the image sensor when a one-chip color area sensor is used*
Type	integer
Obligation	O

Repeatable	N
Values	Refer to EXIF 2.2 standard for extensive information.
Notes	CFA Pattern does not apply to all sensing methods.
Use	Manager System

8.4.4.1.23 autoFocus

Definition	*a data element that specifies the status of the capture device's focus at the time of capture*	
Type	enumerated list (restricted to external standard)	
Obligation	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."
Notes	Enumerated values for this data element are drawn from the list documented in the DIG35, B3.2.5, *Auto Focus Values*.	
Use	System Manager	

8.4.4.1.24 PrintAspectRatio

Definition	*a container that specifies the print aspect ratio selected by the user when the picture was taken; comprised of two data elements (8.4.4.1.24* ***xPrintAspectRatio*** *and 8.4.4.1.24.2* ***yPrintAspectRatio****)*
Type	Container
Obligation	O
Repeatable	N

8.4.4.1.24.1 xPrintAspectRatio

Definition	*a data element that specifices the unit of X ratio*
Type	non-negative real

Obligation	O
Repeatable	N
Values (Example)	3
Use	System Manager

8.4.4.1.24.2 yPrintAspectRatio

Definition	*a data element that specifies the unit of Y ratio*
Type	non-negative real
Obligation	O
Repeatable	N
Values (Example)	2
Use	System Manager

8.4.4.2 GPSData

Definition	*a container of information detailing **GPSData** specifics; comprised of 31 data elements (8.4.4.2.1 **gpsVersionID**, 8.4.4.2.2 **gpsLatitudeRef**, 8.4.4.2.3 **gpsLatitude**, 8.4.4.2.4 **gpsLongitudeRef**, 8.4.4.2.5 **gpsLongitude**, 8.4.4.2.6 **gpsAltitudeRef,** 8.4.4.2.7 **gpsAltitude**, 8.4.4.2.8 **gpsTimeStamp**, 8.4.4.2.9 **gpsSatellites**, 8.4.4.2.10 **gpsStatus**, 8.4.4.2.11 **gpsMeasureMode**, 8.4.4.2.12 **gpsDOP**, 8.4.4.2.13 **gpsSpeedRef**, 8.4.4.2.14 **gpsSpeed**, 8.4.4.2.15 **gpsTrackRef**, 8.4.4.2.16 **gpsTrack**, 8.4.4.2.17 **gpsImgDirectionRef**, 8.4.4.2.18 **gpsImgDirection**, 8.4.4.2.19 **gpsMapDatum**, 8.4.4.2.20 **gpsDestLatitudeRef**, 8.4.4.2.21 **gpsDestLatitude**, 8.4.4.2.22 **gpsDestLongitudeRef**, 8.4.4.2.23 **gpsDestLongitude**, 8.4.4.2.24 **gpsDestBearingRef**, 8.4.4.2.25 **gpsDestBearing**, 8.4.4.2.26 **gpsDestDistanceRef**, 8.4.4.2.27 **gpsDestDistance**, 8.4.4.2.28 **gpsProcessingMethod**, 8.4.4.2.29 **gpsAreaInformation**, 8.4.4.2.30 **gpsDateStamp**, and 8.4.4.2.31 **gpsDifferential**)*
Type	Container
Obligation	MA
Repeatable	N
Use	System Manager User

8.4.4.2.1 gpsVersionID

Definition	*a data element that indicates the version of GPS information*
Type	string
Obligation	MA
Repeatable	N
Values	Default = 2.2.0.0 2.2.0.0 = Version 2.2
Notes	The version is given as 2.2.0.0.
Use	System User

8.4.4.2.2 gpsLatitudeRef

Definition	*a data element that indicates whether the latitude is north or south latitude*
Type	enumerated type (restricted to external standard)
Obligation	O
Repeatable	N
Values	N = North latitude S = South latitude
Notes	The ASCII value 'N' indicates north latitude, and 'S' is south latitude. Values are drawn from the EXIF 2.2 standard.
Use	System User

8.4.4.2.3 gpsLatitude

Definition	*a data element that indicates the latitude*
Type	rational
Obligation	O
Repeatable	N
Values **(Example)**	dd/1,mm/1,ss/1
Notes	The latitude is expressed as three rational values giving the degrees, minutes, and seconds, respectively. If latitude is expressed as degrees, minutes and seconds, a typical format would be dd/1,mm/1,ss/1. When degrees and minutes are used and, for example, fractions of minutes are given up to two decimal places, the format would be dd/1,mmmm/100,0/1.
Use	System User

8.4.4.2.4 gpsLongitudeRef

Definition	*a data element that indicates whether the longitude is east or west longitude*
Type	enumerated type (restricted to external standard)
Obligation	O
Repeatable	N
Values	E = East longitude W = West longitude
Notes	ASCII 'E' indicates east longitude, and 'W' is west longitude. Values are drawn from the EXIF 2.2 standard.
Use	System User

8.4.4.2.5 gpsLongitude

Definition	*a data element that indicates the longitude*
Type	rational
Obligation	O
Repeatable	N
Values **(Example)**	ddd/1,mm/1,ss/1
Notes	The longitude is expressed as three rational values giving the degrees, minutes, and seconds, respectively. If longitude is expressed as degrees, minutes and seconds, a typical format would be ddd/1,mm/1,ss/1. When degrees and minutes are used and, for example, fractions of minutes are given up to two decimal places, the format would be ddd/1,mmmm/100,0/1.
Use	System User

8.4.4.2.6 gpsAltitudeRef

Definition	*a data element that indicates the altitude used as the reference altitude*
Type	enumerated type (restricted to external standard)
Obligation	O
Repeatable	N
Values	0 = Sea level 1 = Sea level reference (negative value)

Notes	If the reference is sea level and the altitude is above sea level, 0 is given. If the altitude is below sea level, a value of 1 is given and the altitude is indicated as an absolute value in the gpsAltitude tag. The reference unit is meters. Values are drawn from the EXIF 2.2 standard.
Use	System User

8.4.4.2.7 gpsAltitude

Definition	*a data element that indicates the altitude based on the reference in* ***gpsAltitudeRef***
Type	rational
Obligation	O
Repeatable	N
Values (Examples)	47
Notes	The reference unit is meters.
Use	System User

8.4.4.2.8 gpsTimeStamp

Definition	*a data element that indicates the time as UTC (Coordinated Universal Time)*
Type	string
Obligation	O
Repeatable	N
Notes	***gpsTimeStamp*** is expressed as a string of three rational values giving the hour, minute, and second.
Use	System User

8.4.4.2.9 gpsSatellites

Definition	*a data element that indicates the GPS satellites used for measurements*
Type	string
Obligation	O
Repeatable	N
Notes	This element can be used to describe the number of satellites, their ID number, angle of elevation, azimuth, SNR, and other information in ASCII notation. The format is not specified. If the GPS receiver is incapable of taking measurements, value of the element shall be set to NULL.

Use	System User

8.4.4.2.10 gpsStatus

Definition	*a data element that indicates the status of the GPS receiver when the image is recorded*
Type	enumerated type (restricted to external standard)
Obligation	O
Repeatable	N
Values	A = Measurement in progress V = Measurement Interoperability
Notes	Values are drawn from the EXIF 2.2 standard.
Use	System User

8.4.4.2.11 gpsMeasureMode

Definition	*a data element that indicates the GPS measurement mode*
Type	enumerated type (restricted to external standard)
Obligation	O
Repeatable	N
Values	default = none 2 = 2-dimensional measurement 3 = 3-dimensional measurement
Notes	Values are drawn from the EXIF 2.2 standard.
Use	System User

8.4.4.2.12 gpsDOP

Definition	*a data element that indicates the GPS DOP (data degree of precision)*
Type	rational
Obligation	O
Repeatable	N
Notes	An HDOP value is written during two-dimensional measurement, and PDOP during three-dimensional measurement.
Use	System User

8.4.4.2.13 gpsSpeedRef

Definition	*a data element that indicates the unit used to express the GPS receiver speed of movement*
Type	enumerated type (restricted to external standard)
Obligation	O
Repeatable	N
Values	K = Kilometers per hour M = Miles per hour N = Knots
Notes	Values are drawn from the EXIF 2.2 standard.
Use	System User

8.4.4.2.14 gpsSpeed

Definition	*a data element that indicates the speed of GPS receiver movement*
Type	rational
Obligation	O
Repeatable	N
Use	System User

8.4.4.2.15 gpsTrackRef

Definition	*a data element that indicates the reference for giving the direction of GPS receiver movement*
Type	enumerated type (restricted to external standard)
Obligation	O
Repeatable	N
Values **(Examples)**	T = True direction M = Magnetic direction
Notes	Values are drawn from the EXIF 2.2 standard
Use	System User

8.4.4.2.16 gpsTrack

Definition	*a data element that indicates the direction of GPS receiver movement*
Type	rational
Obligation	O
Repeatable	N
Values (Examples)	The range of values is from 0.00 to 359.99
Use	System User

8.4.4.2.17 gpsImgDirectionRef

Definition	*a data element that indicates the reference for giving the direction of the image when it is captured*
Type	enumerated type (restricted to external standard)
Obligation	O
Repeatable	N
Values	T = True direction M = Magnetic direction
Notes	Values are drawn from the EXIF 2.2 standard.
Use	System User

8.4.4.2.18 gpsImgDirection

Definition	*a data element that indicates the direction of the image when it was captured*
Type	rational
Obligation	O
Repeatable	N
Values (Examples)	The range of values is from 0.00 to 359.99.
Use	System User

8.4.4.2.19 gpsMapDatum

Definition	*a data element that indicates the geodetic survey data used by the GPS receiver*
Type	string
Obligation	MA
Repeatable	N
Values **(Example)**	WGS-84
Notes	If the survey data is restricted to Japan, the value of this tag is "TOKYO" or "WGS-84".
Use	System User

8.4.4.2.20 gpsDestLatitudeRef

Definition	*a data element that indicates whether the latitude of the destination point is north or south latitude*
Type	enumerated type (restricted to external standard)
Obligation	O
Repeatable	N
Values	Default = none N = North latitude S = South latitude
Notes	Values are drawn from the EXIF 2.2 standard.
Use	System User

8.4.4.2.21 gpsDestLatitude

Definition	*a data element that indicates the latitude of the destination point*
Type	string
Obligation	O
Repeatable	N
Values **(Example)**	dd/1,mm/1,ss/1

Notes	The latitude is expressed as a string of three rational values giving the degrees, minutes, and seconds, respectively. If latitude is expressed as degrees, minutes, and seconds, a typical format would be dd/1,mm/1,ss/1. When degrees and minutes are used and, for example, fractions of minutes are given up to two decimal places, the format would be dd/1,mmmm/100,0/1.
Use	System User

8.4.4.2.22 gpsDestLongitudeRef

Definition	*a data element that indicates whether the longitude of the destination point is east or west longitude*
Type	enumerated type (restricted to external standard)
Obligation	O
Repeatable	N
Values	Default = none E = East longitude W = West longitude
Notes	Values are drawn from the EXIF 2.2 standard.
Use	System User

8.4.4.2.23 gpsDestLongitude

Definition	*a data element that indicates the longitude of the destination point*
Type	string
Obligation	O
Repeatable	N
Values **(Example)**	ddd/1,mm/1,ss/1
Notes	The longitude is expressed as a string of three rational values giving the degrees, minutes, and seconds, respectively. If longitude is expressed as degrees, minutes, and seconds, a typical format would be ddd/1,mm/1,ss/1. When degrees and minutes are used and, for example, fractions of minutes are given up to two decimal places, the format would be ddd/1,mmmm/100,0/1.
Use	System User

8.4.4.2.24 gpsDestBearingRef

Definition	*a data element that indicates the reference used for giving the bearing to the destination point*
Type	enumerated type (restricted to external standard)
Obligation	O
Repeatable	N
Values	T = True direction M = Magnetic direction
Notes	Values are drawn from the EXIF 2.2 standard.
Use	System User

8.4.4.2.25 gpsDestBearing

Definition	*a data element that indicates the bearing to the destination point*
Type	rational
Obligation	O
Repeatable	N
Values (Examples)	The range of values is from 0.00 to 359.99.
Use	System User

8.4.4.2.26 gpsDestDistanceRef

Definition	*a data element that indicates the unit used to express the distance to the destination point*
Type	enumerated type (restricted to external standard)
Obligation	O
Repeatable	N
Values	K = Kilometers M = Miles N = Knots
Notes	Values are drawn from the EXIF 2.2 standard.
Use	System User

8.4.4.2.27 gpsDestDistance

Definition	*a data element that indicates the distance to the destination point*
Type	rational
Obligation	O
Repeatable	N
Values **(Examples)**	55 10
Use	System User

8.4.4.2.28 gpsProcessingMethod

Definition	*a data element recording the name of the method used for location finding*
Type	string
Obligation	O
Repeatable	N
Notes	See EXIF 2.2 standard for more information.
Use	System User

8.4.4.2.29 gpsAreaInformation

Definition	*a data element recording the name of the GPS area*
Type	string
Obligation	O
Repeatable	N
Notes	See EXIF 2.2 standard for more information.
Use	System User

8.4.4.2.30 gpsDateStamp

Definition	*a data element recording date and time information relative to UTC (Coordinated Universal Time)*
Type	string
Obligation	O
Repeatable	N

Values **(Examples)**	2006:01:01 2000:12:01
Notes	The format is "YYYY:MM:DD".
Use	System User

8.4.4.2.31 gpsDifferential

Definition	*a data element that indicates whether differential correction is applied to the GPS receiver*
Type	enumerated type (restricted to external standard)
Obligation	O
Repeatable	N
Values	0 = Measurement without differential correction 1 = Differential correction applied
Notes	Values are drawn from the EXIF 2.2 standard.
Use	System User

8.5 orientation

Definition	*a data element that designates the orientation of the image, with respect to the placement of its rows (7.1.1* ***imageWidth****) and columns (7.1.2* ***imageHeight****), as it was saved to disk*
Type	enumerated type (restricted to list)
Obligation	R
Repeatable	N
Values	1 = normal* 2 = normal, image flipped 3 = normal, rotated 180° 4 = normal, image flipped, rotated 180° 5 = normal, image flipped, rotated cw 90° 6 = normal, rotated ccw 90° 7 = normal, image flipped, rotated ccw 90° 8 = normal, rotated cw 90° 9 = unknown NOTE: “cw” = clockwise; “ccw”= counterclockwise

Notes	Values for this field are drawn from terminology from common image processing software. Definitions are as follows: "Normal" is defined as follows: when opened, the top (0th) row of pixels corresponds to the visual top of the image and the first (0th) column of pixels on left corresponds to the visual left-hand side of the image. "Image Flipped" is defined as the mirror image of "normal." (Some software tools call this "image flipped horizontal." This field is to be used to record only the orientation value of the stored image, not the orientation of the source to the device (e.g., camera) at the time of capture, or the correct orientation for rendering the image to a display device.
Use	System

8.6 methodology

Definition	*a data element that designates the methodology and rationale to digitize an object or collection*
Type	string
Obligation	O
Repeatable	N
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

9 Image Assessment Metadata

The operative principle in this section is to maintain the attributes of the image inherent to its quality. The title image 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 9.1 ***SpatialMetrics*** and 9.2 ***ImageColorEncoding*** are meant as high-level quantitative measures of imaging performance. Note that image dimensions and source size, recorded respectively in section 7 *Basic Image Information* and section 8 *Image Capture Metadata*, are also essential data in image assessment. Section 9.3 ***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 8 and 9 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.

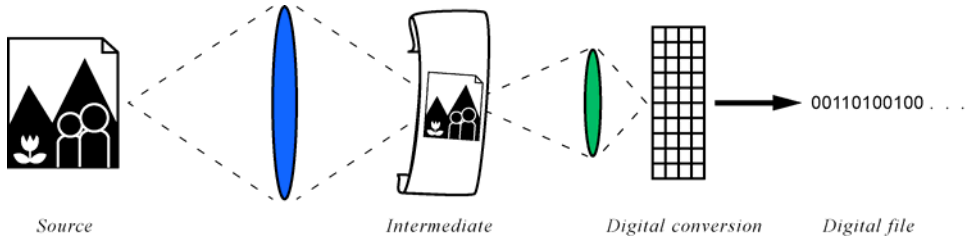

Figure 8: Digital conversion of Intermediate; indirect conversion of Source

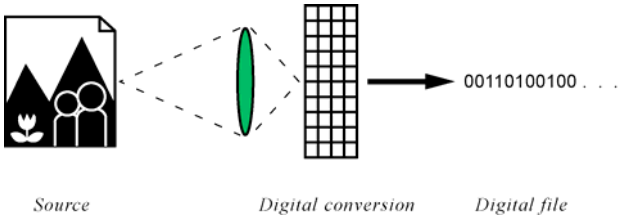

Figure 9: Direct digital conversion of Source

To a large extent, the image of any source can be linked back 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 9.1 and 9.2, along with 7.1.1 ***imageWidth***, 7.1.2 ***imageHeight***, and the elements in container 8.1.3 ***SourceSize*** 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.

9.1 SpatialMetrics

Definition	*a container of information detailing **SpatialMetrics** specifics; comprised of four data elements (9.1.1 **samplingFrequencyPlane**, 9.1.2 **samplingFrequencyUnit**, 9.1.2.1 **xSamplingFrequency**, and 9.1.2.2 **ySamplingFrequency**)*
Type	Container
Obligation	MA
Repeatable	N

Notes	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" (***imageHeight***) 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.

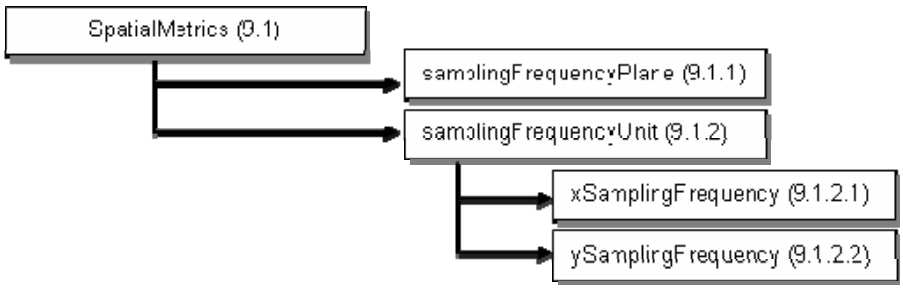

Figure 10: Logical structure of SpatialMetrics

9.1.1 samplingFrequencyPlane

Definition	*a data element that designates the reference plane location for which 9.1.2.1* ***xSamplingFrequency*** *and 9.1.2.2* ***ySamplingFrequency*** *are designated*
Type	enumerated type (restricted to list)
Obligation	MA
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 8.1.3.1 ***sourceXDimension*** or 8.1.3.2 ***sourceYDimension*** in conjunction with 7.1.1 ***imageWidth*** or 7.1.2 ***imageHeight***. Value = 1 is consistent with DIG35, B.3.2.4, 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 9), 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 8).

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

9.1.2 samplingFrequencyUnit

Definition	*a data element that specifies the unit of measurement for 9.1.2.1* ***xSamplingFrequency*** *and 9.1.2.2* ***ySamplingFrequency***
Type	enumerated type (restricted to external standard)
Obligation	MA
Repeatable	N
Values	1 = no absolute unit of measurement 2 = inch 3 = centimeter
Notes	Value = 1 is used for images that may have a non-square aspect ratio, but no meaningful absolute dimensions. In copy work, it should also be used when source measurements are unknown (e.g., when a photo-intermediate such as 35 mm negative film is the source). When ***samplingFrequencyUnit*** = 2 and ***sourceXDimensionValue*** is given in inches, the ***xSamplingFrequency*** may be calculated as follows: ***xSamplingFrequency*** = ***imageHeight***/***sourceXDimensionValue*** When ***samplingFrequencyUnit*** = 2 and ***sourceYDimensionValue*** is given in inches, the ***ySamplingFrequency*** may be calculated as follows: ***ySamplingFrequency*** = ***imageWidth***/***sourceYDimensionValue*** The same formulas may be used when ***samplingFrequencyUnit*** = 3 and source dimensions are given in centimeters. Enumerated values are drawn from DIG35 and the TIFF/EP standards.
Use	System (accurate output of file to print/film [size]) Manager (one of the quantitative metrics to evaluate image quality)

9.1.2.1 xSamplingFrequency

Definition	*a data element that specifies the number of pixels per* ***samplingFrequencyUnit*** *in the image width*
Type	rational
Obligation	MA (when ***samplingFrequencyUnit*** = 2 or 3)
Repeatable	N
Notes	With fields ***ySamplingFrequency*** and ***samplingFrequencyUnit*** , ***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)

9.1.2.2 ySamplingFrequency

Definition	*a data element that specifies the number of pixels per* ***samplingFrequencyUnit*** *in the image length*
Type	rational
Obligation	MA (when ***samplingFrequencyUnit*** = 2 or 3)
Repeatable	N
Notes	With fields ***xSamplingFrequency*** and ***samplingFrequencyUnit***, ***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)

9.2 ImageColorEncoding

Definition	*a container of information detailing* ***ImageColorEncoding*** *specifics; comprised of four data elements (9.2.2* ***samplesPerPixel****, 9.2.3* ***extraSamples****, 9.2.5* ***grayResponseCurve****, and 9.2.6* ***grayResponseUnit****) and four sub-containers (9.2.1* ***BitsPer Sample****, 9.2.4* ***Colormap****, 9.2.7* ***WhitePoint****, and 9.2.8* ***PrimaryChromaticities****)*
Type	Container
Obligation	M
Repeatable	N
Notes	***ImageColorEncoding*** contains information about all color encoding within an image. It is applicable to all images, whether the actual image is full color, grayscale, or black and white. If sub-containers do not contain any data or are not applicable, they need not be recorded.

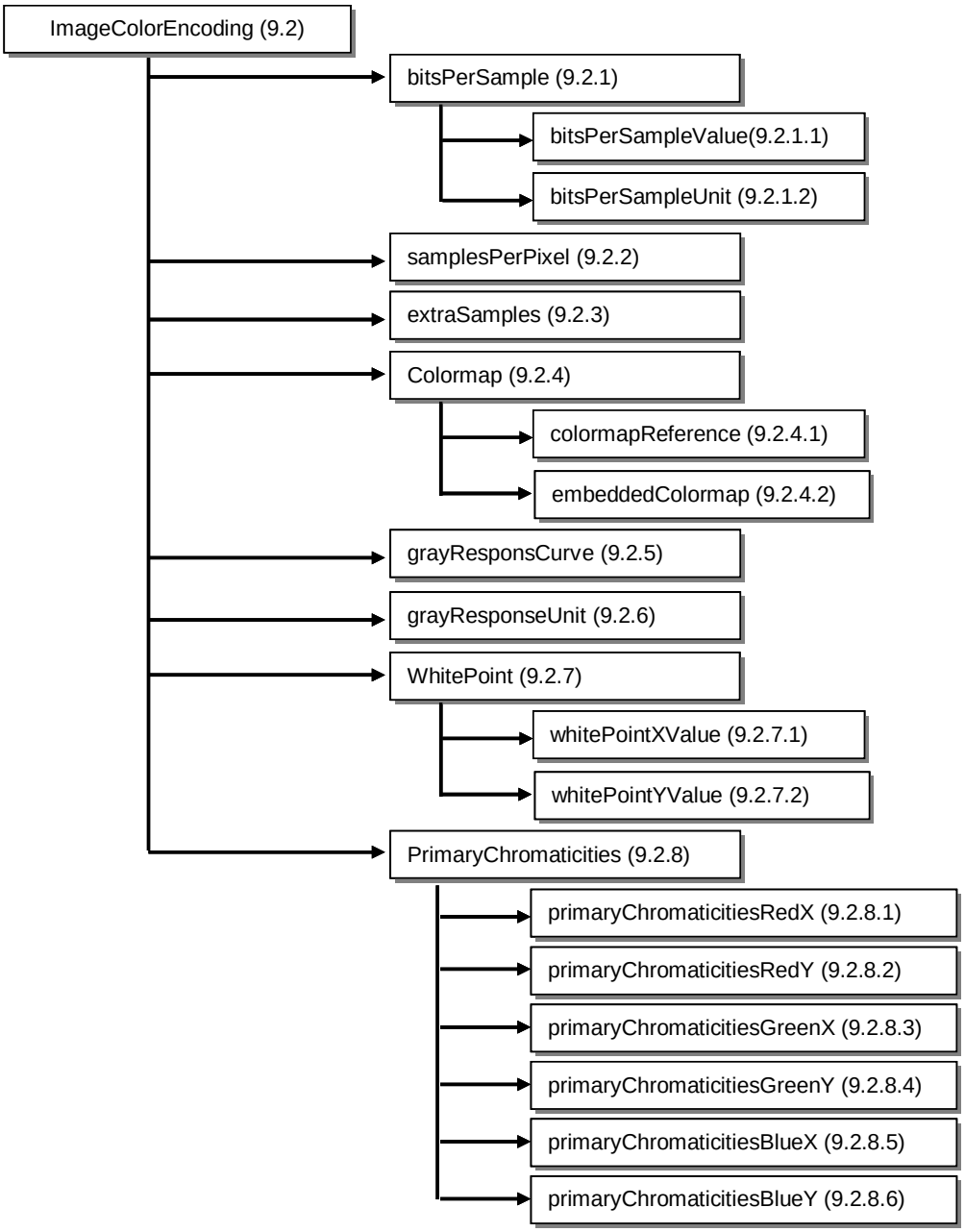

Figure 11: Logical structure of ImageColorEncoding

9.2.1 BitsPerSample

Definition	*a container of information detailing the **BitsPerSample** of the imaged object; comprised of two data elements (9.2.1.1 **bitsPerSampleValue** and 9.2.1.2 **bitsPerSampleUnit**)*
Type	Container
Obligation	M
Repeatable	N

Notes	This container provides N values depending upon 9.2.2 ***samplesPerPixel*** present. This container is used to describe the number of bits for each sample (or channel), expressed in the same order given in 7.1.3.1 ***colorSpace*** and containing the same number of elements as described in 9.2.2 ***samplesPerPixel***. 9.2.1.1 ***bitsPerSampleValue*** may be different for each sample. Some color models, like YCbCr 4:1:1, decimate resolution for some channels; in this case, values must be represented as if each channel has full-resolution with the decimated channels expressed as if they have reduced ***bitsPerSampleValue***; thus, 8-bit YCbCr 4:1:1 is expressed in this field as "8,2,2".
Use	System (tone, color) Manager (one of the quantitative metrics to evaluate image quality)

9.2.1.1 bitsPerSampleValue

Definition	*a data element that designates the number of bits per component for each pixel*
Type	string
Obligation	M
Repeatable	N
Values **(Examples)**	1 4 8 8,8,8 8,2,2 16,16,16 8,8,8,8
Notes	This data element provides N values depending upon 9.2.2 ***samplesPerPixel*** present. This data element is used to describe the number of bits for each sample (or channel), expressed in the same order given in 7.1.3.1 ***colorSpace*** and containing the same number of elements as described in 9.2.3 ***samplesPerPixel***. 9.2.1.1 ***bitsPerSampleValue*** may be different for each sample.
Use	System (tone, color) Manager (one of the quantitative metrics to evaluate image quality)

9.2.1.2 bitsPerSampleUnit

Definition	*a data element that specifies the interpretation of the bits as integer values or floating point values*
Type	enumerated value (restricted to list)
Obligation	M
Repeatable	N
Values	integer floating point
Notes	This field indicates whether each sample should be interpreted as an integer or floating point value. Most traditional image formats use an integer representation; for instance, if a sample is an 8-bit integer, it can represent 256 possible values (0-255). If a sample is a 32-bit floating point number, it can represent a massive range of values, with some variation in the precision of the number, and is commonly and increasingly used in high dynamic range image formats, such as OpenEXR, Cineon, and 32bit float variants of TIFF. This field is important in order to distinguish between quite different formats with similar common names, for instance, 32bit integer TIFF (24bit plus alpha) and 32bit float TIFF.
Use	System (tone, color) Manager (one of the quantitative metrics to evaluate image quality)

9.2.2 samplesPerPixel

Definition	*a data element that designates the number of color components per pixel*
Type	positive integer
Obligation	M
Repeatable	N
Values **(Examples)**	1 3 4
Notes	Examples above reflect those values encountered in imaging encodings commonly in use by the cultural heritage community at the time of writing. Should other encoding be used at a later date, the appropriate number of color components per pixel should be recorded in this field. Related fields: 9.2.1 ***BitsPerSample***, 7.1.3.1 ***colorSpace***, and 9.2.3 ***extraSamples***.
Use	System (tone, color) Manager (one of the quantitative metrics to evaluate image quality)

9.2.3 extraSamples

Definition	*a data element that 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)
Obligation	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	Enumerated values are drawn from DIG35 and the TIFF/EP standards. See also: *TIFF, Tag # 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, 9.2.2 ***samplesPerPixel*** has a value greater than 7.1.3.1 ***colorSpace*** suggests.
Use	System

9.2.4 Colormap

Definition	*a container of information detailing **Colormap** specifics; comprised of two data elements: (9.2.4.1 **colormapReference** and 9.2.4.2 **embeddedColormap**)*
Type	Container
Obligation	MA
Repeatable	N
Notes	A ***Colormap*** defines a Red-Green-Blue colormap (often called a lookup table) for palette-color images. Target data is important for image quality assessment. The colormap or lookup table is a series of 4 bytes of information for each of the 256 colors. Most institutions will choose to record this information via the use of ***colormapReference*** to point to the location of the colormap used. Should an institution wish to enclose or embed the colormap when recording the information in XML, the data element ***embeddedColormap*** should be used to Base64-encode the colormap used into the XML schema. Some institutions will wish to store this technical metadata outside of the file header (perhaps in addition to information stored within header). This practice will differ by institution.

9.2.4.1 colormapReference

Definition	*a data element that provides the location of the file containing the color map*
Type	reference

Obligation	MA (for palettized color images, ***colorSpace*** = PaletteColor)
Repeatable	N
Values	[URL]
Notes	As noted in the TIFF definition, ***Colormap*** is synonymous with color lookup table (CLUT). 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 embedded in 9.2.4.2 .
Use	System (tone, color)

9.2.4.2 embeddedColormap

Definition	*a data element that provides a placeholder to allow institutions to embed the colormap when using the XML (MIX) schema to record data elements*
Type	base64Binary
Obligation	O
Repeatable	N
Values	[Base64-encoded data]
Notes	Some institutions may choose to embed the actual colormap used in addition to or instead of referencing it. This can be done when using the NISO *Metadata for Images in XML* (MIX) schema, the XML implementation of this data dictionary. (See Appendix A.)
Use	System Manager

9.2.5 grayResponseCurve

Definition	*a data element that specifies, for grayscale data, the optical density of each possible pixel value*
Type	enumerated type (restricted to external standard)
Obligation	R
Repeatable	N
Values **(Example)**	N = 2**BitsPerSample
Notes	Enumerated values are drawn from DIG35 and the TIFF/EP standards. See also: *TIFF Tag # 290* (Baseline optional, p.33) Must be accompanied by 9.2.6 ***grayResponseUnit***. (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)

9.2.6 grayResponseUnit

Definition	*a data element that designates the precision of the information contained in 9.2.5* ***grayResponseCurve***
Type	enumerated type (restricted to list)
Obligation	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.
Notes	Modifies 9.2.5 ***grayResponseCurve***.
Use	System (objective assessment of optical density)

9.2.7 WhitePoint

Definition	*a container of information detailing* ***WhitePoint*** *specifics; comprised of two data elements (9.2.7.1* ***whitePointXValue*** *and 9.2.7.2* ***whitePointYValue****)*
Type	Container
Obligation	O
Repeatable	Y
Notes	The ordering is white [x], white [y]. The white point chromaticity of the effective illumination source of the capture process. This container of data elements is repeatable, but individual data elements within container are not. If sub-containers do not contain any data or are not applicable, they need not be recorded.

9.2.7.1 whitePointXValue

Definition	*a data element that specifies the X value for the white point chromaticity of the effective illumination source of the capture process*
Type	enumerated type (restricted to list)
Obligation	O
Repeatable	N
Values (Example)	3127/10000

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.
Use	System (objective assessment of colorimetry)

9.2.7.2 whitePointYValue

Definition	*a data element that specifies the Y value for the white point chromaticity of the effective illumination source of the capture process*
Type	enumerated type (restricted to list)
Obligation	O
Repeatable	N
Values (Example)	3290/10000
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.
Use	System (objective assessment of colorimetry)

9.2.8 PrimaryChromaticities

Definition	*a container of information detailing **PrimaryChromaticities** specifics; comprised of six data elements (9.2.8.1 **primaryChromaticitiesRedX**, 9.2.8.2 **primaryChromaticitiesRedY**, 9.2.8.3 **primaryChromaticitiesGreenX**, 9.2.8.4 **primaryChromaticitiesGreenY**, 9.2.8.5 **primaryChromaticitiesBlueX**, and 9.2.8.6 **primaryChromaticitiesBlueY**)*
Type	Container
Obligation	O
Repeatable	Y
Notes	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].

9.2.8.1 primaryChromaticitiesRedX

Definition	*a data element that specifies the red [x] value for the chromaticities of the primary colors of the imaging process*
Type	enumerated type (restricted to list)
Obligation	O
Repeatable	N

Values (Example)	640/1000
Notes	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].
Use	System (objective assessment of colorimetry)

9.2.8.2 primaryChromaticitiesRedY

Definition	*a data element that specifies the red [y] value for the chromaticities of the primary colors of the imaging process*
Type	enumerated type (restricted to list)
Obligation	O
Repeatable	N
Values (Example)	330/1000
Notes	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].
Use	System (objective assessment of colorimetry)

9.2.8.3 primaryChromaticitiesGreenX

Definition	*a data element that specifies the green [x] value for the chromaticities of the primary colors of the imaging process*
Type	enumerated type (restricted to list)
Obligation	O
Repeatable	N
Values (Example)	300/1000
Notes	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].
Use	System (objective assessment of colorimetry)

9.2.8.4 primaryChromaticitiesGreenY

Definition	*a data element that specifies the green [y] value for the chromaticities of the primary colors of the imaging process*
Type	enumerated type (restricted to list)
Obligation	O
Repeatable	N

Values (Example)	600/1000
Notes	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].
Use	System (objective assessment of colorimetry)

9.2.8.5 primaryChromaticitiesBlueX

Definition	*a data element that specifies the blue [x] value for the chromaticities of the primary colors of the imaging process*
Type	enumerated type (restricted to list)
Obligation	O
Repeatable	N
Values (Example)	150/1000
Notes	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].
Use	System (objective assessment of colorimetry)

9.2.8.6 primaryChromaticitiesBlueY

Definition	*a data element that specifies the blue [y] value for the chromaticities of the primary colors of the imaging process*
Type	enumerated type (restricted to list)
Obligation	O
Repeatable	N
Values (Example)	60/1000
Notes	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].
Use	System (objective assessment of colorimetry)

9.3 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.

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 12 illustrates the logical structure of ***TargetData***.

Definition	*a container of information identifying the information about targets used in the digitization process; comprised of three data elements (9.3.1* ***targetType****, 9.3.3* ***externalTarget****, and 9.3.4* ***performanceData****) and one sub-container (9.3.2* ***TargetID****)*
Type	Container
Obligation	R
Repeatable	N
Notes	If the container does not contain any data or is not applicable, it need not be recorded.

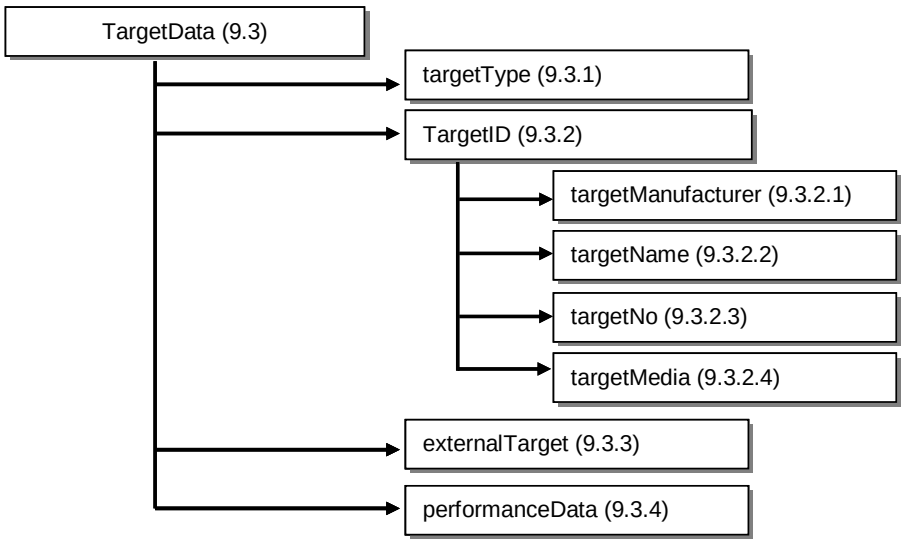

Figure 12: Logical structure of TargetData

9.3.1 targetType

Definition	*a data element that identifies the targets as either internal or external*
Type	enumerated type (restricted to list)
Obligation	R
Repeatable	Y
Values	0 = external 1 = internal

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 12). When value = 1, the ***externalTarget*** field shall not be used. See 9.3.3 ***externalTarget***.
Use	Manager

9.3.2 TargetID

Definition	*a container detailing **TargetID** specifics; comprised of four data elements (9.3.2.1 **targetManufacturer**, 9.3.2.2 **targetName**, 9.3.2.3 **targetNo**, and 9.3.2.4 **targetMedia**)*
Type	Container
Obligation	R
Repeatable	Y
Notes	The container of data elements is repeatable, but individual data elements within the container are not.

9.3.2.1 targetManufacturer

Definition	*a data element that identifies the manufacturer or organization that created the target*
Type	string
Obligation	R
Repeatable	N
Values (Examples)	GretagMacbeth Eastman Kodak Applied Image Inc
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 12).
Use	Manager (objective measure of system quality)

9.3.2.2 targetName

Definition	*a data element that identifies the name of the target*
Type	string
Obligation	R
Repeatable	N

Values (Examples)	ColorChecker Q60 ISO 16067
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 12).
Use	Manager (objective measure of system quality)

9.3.2.3 targetNo

Definition	*a data element that identifies the version or number of the target*
Type	string
Obligation	R
Repeatable	N
Values (Examples)	ItemXXX Version2
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 12).
Use	Manager (objective measure of system quality)

9.3.2.4 targetMedia

Definition	*a data element that identifies the media of the target*
Type	string
Obligation	R
Repeatable	N
Values (Example)	Ektachrome Transparency
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 12).
Use	Manager (objective measure of system quality)

9.3.3 externalTarget

Definition	*a data element that identifies the path where the digital image of the reference target identified in 9.3.2* ***TargetID*** *is located*
Type	reference
Obligation	R (applicable only if 9.3.1 TargetType = 0)

Repeatable	Y
Values	[Filename] [URN]
Notes	Each target shall be represented by its own logical metadata block. See diagram of proposed ***TargetData*** structure (Figure 12).
Use	System (to create ***performanceData*** and/or profiles)

9.3.4 performanceData

Definition	*a data element that identifies the path of the file that contains the image performance data relative to the target identified in 9.3.2* ***TargetID***
Type	reference
Obligation	O
Repeatable	Y
Values	[filename] [URN]
Notes	***performanceData*** refers to standards-based characterizations of system performance according to measurements of spatial resolution, OECF (Opto-Electronic Conversion Function), 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, *Methods for measuring opto-electronic conversion functions (OECFs)* (ISO 14524) and *Spatial resolution measurement* (ISO 16067).
Use	System Manager (objective measure of quality of ***ScannerCapture***)

10 Change History

Change History metadata serves the function of documenting processes applied to image data over the life cycle of an image. These processes consist of either editing or transforming (migrating) the file, depending on where in the life cycle they occur.

The *Image Capture Metadata* block (section 8) 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 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 metadata from earlier generations to be carried

forward within the *Change History* metadata.

- Image transformation refers to any processing that produces a new image. (Changes to any of the values in section 6 *Basic Digital Object Information* (except 6.1 ***ObjectIdentifier***) create a new generation of the image. A new generation would also occur if changes were made to any of the data elements in 7.1 ***BasicImageCharacteristics***.) In the case of image transformation, section 10.2 *Previous Image Metadata* is used to track the metadata from the previous generation of the image. See Figure 13 for a visual representation of this event.

The *Change History* metadata contains:

- a summary of image processing operations applied to an image, and
- previous versions of the technical metadata when image transformation occurs, resulting in a new image.

Initial Image Editing

Any processing that takes place prior to the first time an image file is saved for storage is classified as image editing and is recorded only in fields listed in section 10.1 ***ImageProcessing***. In this context, the fields would be used to record the actions, if any, taken to produce the initial master file, however an individual institution defines it. This metadata is not designed to support reverse image-editing operations, but to describe each of the steps that comprise the standard preparation of masters (e.g. tonal adjustment, color management, sharpening). If the actions are scripted, those scripts could be saved as ***processingActions*** (10.1.6). (For example, for images created in Photoshop® 8.0 (CS) or later, the Photoshop® history file could be saved here.) If an institution saves a "raw" master image, ***ImageProcessing*** metadata would not be present, as the *Image Capture* metadata block would provide all necessary technical metadata about a raw, unprocessed master file.

Subsequent Image Editing and Image Transformation

Any further changes applied to the master or subsequent generations of images will result in a new image with new ***ImageProcessing*** steps being applied to the existing file. This principle can be applied to both the creation of a "service" master as well as to the migration of a file from one format to another for preservation purposes. The existing metadata for the source image can be recorded as a block in the *Previous Image Metadata* section for the newly created image though the expression of the ***ImageProcessing*** steps would differ in each case. For "service" masters generated from an initial master file, institutions may choose to include the *Image Capture* metadata block from the initial master file in the primary metadata record, given the temporal proximity to initial image capture. Metadata documenting subsequent generations of the image will not include *Image Capture* metadata except within the *Previous Image Metadata* section (10.2) of *Change History*.

Change History and Preservation Metadata Requirements

Change History has been designed so that institutions not implementing a more complex set of preservation metadata elements (such as PREMIS) can record preservation actions and maintain some record of provenance through an image's life cycle.

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; and
- 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.

Institutions may decide to retain original image bitstreams and metadata records until the effects of image migration and other preservation actions are better understood.

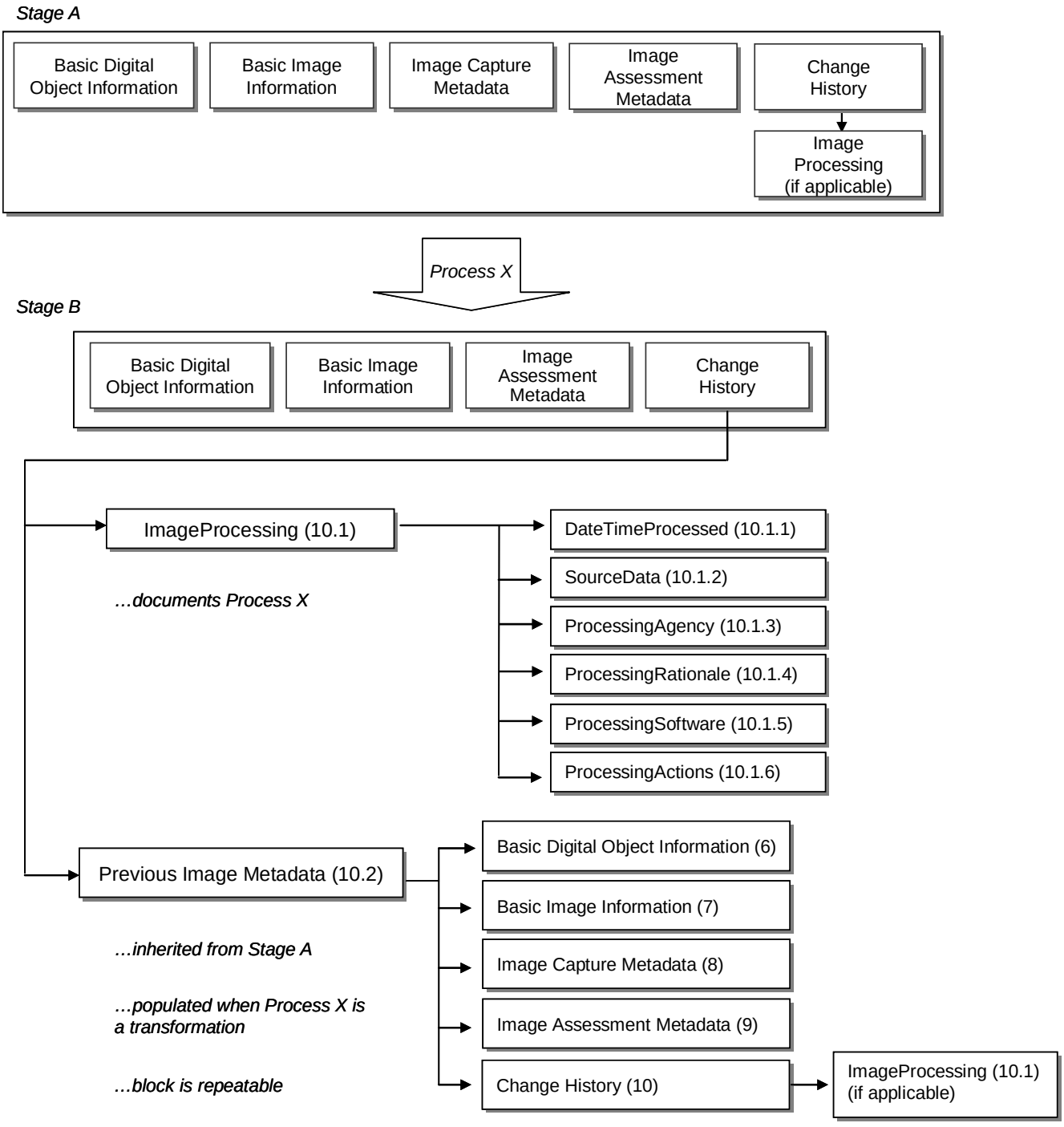

Figure 13: Logical structure of change history for transformed image file

10.1 ImageProcessing

This metadata block contains a summary of image editing or transformation operations that may be used for future quality assessment of the image data or for understanding the provenance of a particular generation of an image file.

A life-cycle management approach presumes that image processing or transformation will occur multiple times as images are preserved over time (see Figure 13). To document a full change history of an image, this metadata section should not be overwritten by subsequent processing or transformation actions but should be preserved along with other technical metadata in the *Previous Image Metadata* section.

NOTE: The fields in sections 10.1.1-10.1.5 can document a single processing action (e.g., image cropped) or a set of processing actions performed in succession (e.g., subsampling, application of ICC profile, image transformation).

Definition	*a container of information identifying the image editing or image transformation related data; comprised of five data elements (10.1.1 **dateTimeProcessed**, 10.1.2 **sourceData**, 10.1.3 **processingAgency**, 10.1.4 **processingRationale**, and 10.1.6 **processingActions**) and one sub-container (10.1.5 **ProcessingSoftware**)*
Type	Container
Obligation	MA
Repeatable	Y
Notes	If the container does not contain any data or is not applicable, it need not be recorded.

10.1.1 dateTimeProcessed

Definition	*a data element that designates the Date or DateTime the image was processed*
Type	DateTime
Obligation	MA
Repeatable	N
Values	YYYY-MM-DD HH:MM:SS YYYY-MM-DD [HH:MM:SS]
Notes	Use ISO 8601 numeric representations of date and time. If multiple processing steps are recorded together in 10.1.5 ***ProcessingSoftware***, the DateTime shall refer to the final (i.e., most recent) ***processingAction*** or time file was saved. The value for this field shall be null for first generation images that receive no processing following image creation, as documented in section 8 (i.e., when a "raw" image is saved).
Use	Manager

10.1.2 sourceData

Definition	*a data element that specifies a reference to the source image data (digitalobject) from which the edited or transformed digital image file was created or an indication that the source was the initial digital capture*
Type	string

Obligation	MA
Repeatable	N
Values **(Examples)**	[local filename] [URL] or [URN] or [Name Resolution Service name of file stored in repository] [Image stored off line on CD or DVD] (location or identifier)] [initial capture]
Notes	In some cases, the image to which ***sourceData*** refers may not be retained. The provenance and history of transformations will be maintained through the Change History metadata. The value for this field shall be null for first generation images that receive no processing following image creation, as documented in section 7.
Use	Manager

10.1.3 processingAgency

Definition	*a data element that identifies the organization-level producer(s) of the processed image*
Type	string
Obligation	R
Repeatable	Y
Values **(Examples)**	Luna Imaging, Inc. JJT, Inc. University of Michigan; Digital Library Production Services Harvard College Library; Digital Imaging Group
Notes	Identifies the name of the service provider or production unit responsible for processing or migrating the file/bitstream.
Use	Manager

10.1.4 processingRationale

Definition	*a data element that provides rationale for image editing decisions or describes trigger event for image migration*
Type	string
Obligation	R
Repeatable	N
Values **(Examples)**	processing actions in 10.1.6 undertaken to best match to source image TIFF to JPEG 2000 transformation undertaken as TIFF format no longer supported
Use	Manager

10.1.5 ProcessingSoftware

Definition	*a container of information detailing the processing software used to edit or transform the image data; comprised of four data elements (10.1.5.1* ***processingSoftwareName,*** *10.15.2* ***processingSoftwareVersion****, 10.1.5.3* ***processingOperatingSystemName****, and 10.1.5.4* ***processingOperatingSystemVersion****).*
Type	Container
Obligation	R
Repeatable	Y
Notes	If sub-containers do not contain any data or are not applicable, they need not be recorded. Container may be repeated, but individual elements within the container may not.

10.1.5.1 processingSoftwareName

Definition	*a data element that identifies the name of the image processing software used to edit or transform the image data*
Type	string
Obligation	R
Repeatable	N
Values (Examples)	Adobe Photoshop ImageMagick Kakadu
Notes	Record version number of software in 10.1.5.2 ***processingSoftwareVersion***.
Use	Manager

10.1.5.2 processingSoftwareVersion

Definition	*a data element that identifies the version number of the image processing software used to edit or transform the image data*
Type	string
Obligation	R
Repeatable	N
Values (Examples)	CS (e.g., Adobe Photoshop, version CS) 5.1.1 (e.g. ImageMagick, version 5.1.1) 4.2.1 (e.g. Kakadu, version 4.2.1)
Notes	For use with 10.1.5.1 ***processingSoftwareName***.
Use	Manager

10.1.5.3 processingOperatingSystemName

Definition	*a data element that identifies the name of the operating system platform on which the 10.1.5* ***ProcessingSoftware*** *application runs*
Type	string
Obligation	R
Repeatable	N
Values (Examples)	Windows (or Win) Macintosh (or Mac) Linux Unix Solaris
Notes	Some image processing systems are written to be OS independent (written in an interpreted language). In these cases (for example, ImageMagick), the operating system used at the time of processing should be recorded. In many cases, system names are abbreviated (WIN for Microsoft Windows or Mac for Macintosh). An institution may use abbreviations within the encoding, but if abbreviations are to be used, the encoding choice must be consistently applied.
Use	Manager System

10.1.5.4 processingOperatingSystemVersion

Definition	*a data element that identifies the version of the operating system platform named in 10.1.5.3* ***processingOperationSystemName***
Type	string
Obligation	R
Repeatable	N
Values (Examples)	32 (for all 32-bit MS Windows platforms) XP (for Windows XP) 2K (for Windows 2000) OS X (for Macintosh)
Use	Manager System

10.1.6 processingActions

Definition	*a data element that designates an ordinal listing of the image processing steps performed by way of 10.1.5* ***ProcessingSoftware***
Type	string

Obligation	R
Repeatable	Y
Values (Examples)	*Editing example:* rotate 90° cw ICC profile added *Transformation example:* Format migration from TIFF 6.0 to lossless JPEG 2000
Notes	Whenever possible, script or action files should be supplied for this element.
Use	Manager

10.2 Previous Image Metadata

Previous image metadata is used to track metadata from any previous generation of the image. Any image processing or transformation events recorded in section 10.1, ***ImageProcessing*** would generate new metadata to be populated in elements within sections 6-9. The previously existing metadata for the source image would be recorded as a block within 10.2, *Previous Image Metadata*. Subsequent generations of metadata would also be recorded as a block within this section.

Definition	*a data element of technical metadata from previous generations of the image file recorded to document provenance and change history and to provide essential metadata that could be used to simulate return to original image data*
Type	[retains previous data types]
Obligation	MA (each time a new generation of the image is created)
Repeatable	Y
Values	See Figure 13.
Notes	The metadata for the source file is recorded as a block in this section. Each subsequent generation's metadata is appended.
Use	Manager User

Appendix A
(informative)
Z39.87 XML schema: MIX

(This Appendix is not part of ANSI/NISO Z39.87-200X (ANSI/AIIM 20-200X), *Data Dictionary – Technical Metadata for Digital Still Images*. 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 ANSI/NISO Z39.87 (ANSI/AIIM 20). 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 by the Network Development and MARC Standards Office of the Library of Congress.

Appendix B
(informative)
Summary of Data Dictionary Elements

(This Appendix is not part of ANSI/NISO Z39.87-200X (ANSI/AIIM 20-200X), *Data Dictionary – Technical Metadata for Digital Still Images*. It is included for information only.)

B.1. Containers

The following table lists all the containers and sub-containers from the Data Dictionary.

NOTE: The following abbreviations are used in the obligation column of this table:
M = mandatory
MA = mandatory if applicable
R = recommended
O = optional

Containers	Obligation	Repeatable	Section Reference
ObjectIdentifier	M	Y	6.1
FormatDesignation	M	N	6.3
FormatRegistry	O	N	6.4
Compression	M	Y	6.6
Fixity	M	Y	6.7
BasicImageCharacteristics	M	N	7.1
PhotometricInterpretation	M	N	7.1.3
ColorProfile	MA	N	7.1.3.2
IccProfile	MA	N	7.1.3.2.1
LocalProfile	MA	N	7.1.3.2.2
YCbCr	MA	N	7.1.3.3
SpecialFormatCharacteristics	MA	N	7.2
JPEG2000	MA	N	7.2.1
CodecCompliance	O	N	7.2.1.1
EncodingOptions	O	N	7.2.1.2
MrSID	MA	N	7.2.2
Djvu	MA	N	7.2.3
SourceInformation	R	N	8.1
SourceID	R	Y	8.1.2
SourceSize	O	N	8.1.3
SourceXDimension	O	N	8.1.3.1

Containers	Obligation	Repeatable	Section Reference
SourceYDimension	O	N	8.1.3.2
SourceZDimension	O	N	8.1.3.3
GeneralCaptureInformation	MA	N	8.2
ScannerCapture	R	N	8.3
ScannerModel	R	N	8.3.2
ScanningSystemSoftware	R	N	8.3.5
DigitalCameraCapture	MA	N	8.4
DigitalCameraModel	R	N	8.4.2
CameraCaptureSettings	O	N	8.4.4
ImageData	O	N	8.4.4.1
PrintAspectRatio	O	N	8.4.4.1.24
GPSData	MA	N	8.4.4.2
SpatialMetrics	MA	N	9.1
ImageColorEncoding	M	N	9.2
BitsPerSample	M	N	9.2.1
Colormap	MA	N	9.2.4
WhitePoint	O	Y	9.2.7
PrimaryChromaticities	O	Y	9.2.8
TargetData	R	N	9.3
TargetID	R	Y	9.3.2
ImageProcessing	MA	Y	10.1
ProcessingSoftware	R	Y	10.1.5
Previous Image Metadata	MA	Y	10.2

B.2. Summary of All Elements

The following table lists all the containers and elements included in the Data Dictionary.

NOTE: The following abbreviations are used in the obligation column of this table:
M = mandatory
MA = mandatory if applicable
R = recommended
O = optional

Element	Type	Obligation	Repeatable	Section Reference
ObjectIdentifier	container	M	Y	6.1
objectIdentifierType	string	M	N	6.1.1
objectIdentifierValue	string	M	N	6.1.2
fileSize	positive integer	M	N	6.2

Element	Type	Obligation	Repeatable	Section Reference
FormatDesignation	container	M	N	6.3
formatName	string	M	N	6.3.1
formatVersion	string	O	N	6.3.2
FormatRegistry	container	O	N	6.4
formatRegistryName	string	O	N	6.4.1
formatRegistryKey	string	O	N	6.4.2
byteOrder	enumerated (list)	MA	N	6.5
Compression	container	M	Y	6.6
compressionScheme	string	M	N	6.6.1
compressionSchemeLocalList	reference	MA	N	6.6.2
compressionSchemLocalValue	string	MA	N	6.6.3
compressionRatio	positive integer	O	N	6.6.4
Fixity	container	M	Y	6.7
messageDigestAlgorithm	enumerated (list)	M	N	6.7.1
messageDigest	string	M	N	6.7.2
messageDigestOriginator	string	O	N	6.7.3
BasicImageCharacteristics	container	M	N	7.1
imageWidth	positive integer	M	N	7.1.1
imageHeight	positive integer	M	N	7.1.2
PhotometricInterpretation	container	M	N	7.1.3
colorSpace	string	M	N	7.1.3.1
ColorProfile	container	MA	N	7.1.3.2
IccProfile	container	MA	N	7.1.3.2.1
iccProfileName	string	MA	N	7.1.3.2.1.1
iccProfileVersion	string	MA	N	7.1.3.2.1.2
iccProfileURL	string	MA	N	7.1.3.2.1.3
LocalProfile	container	MA	N	7.1.3.2.2
localProfileName	string	MA	N	7.1.3.2.2.1
localProfileURL	string	MA	N	7.1.3.2.2.2
embeddedProfile	base64Binary	O	N	7.1.3.2.3
YCbCr	container	MA	N	7.1.3.3
yCbCrSubSampling	enumerated (standard)	MA	N	7.1.3.3.1
yCbCrPositioning	enumerated (standard)	MA	N	7.1.3.3.2
yCbCrCoefficients	enumerated (standard)	MA	N	7.1.3.3.3

Element	Type	Obligation	Repeatable	Section Reference
referenceBlackWhite	enumerated (standard)	MA	N	7.1.3.4
SpecialFormatCharacteristics	container	MA	N	7.2
JPEG2000	container	MA	N	7.2.1
CodecCompliance	container	O	N	7.2.1.1
codec	string	O	N	7.2.1.1.1
codecVersion	string	O	N	7.2.1.1.2
codestreamProfile	string	O	N	7.2.1.1.3
complianceClass (cClass)	string	O	N	7.2.1.1.4
EncodingOptions	container	O	N	7.2.1.2
tiles	string	O	N	7.2.1.2.1
qualityLayers	positive integer	MA	N	7.2.1.2.2
resolutionLevels	positive integer	MA	N	7.2.1.2.3
MrSID	container	MA	N	7.2.2
zoomLevels	positive integer	MA	N	7.2.2.1
Djvu	container	MA	N	7.2.3
djvuFormat	enumerated (list)	MA	N	7.2.3.1
SourceInformation	container	R	N	8.1
sourceType	string	R	N	8.1.1
SourceID	container	R	Y	8.1.2
sourceIDType	string	O	N	8.1.2.1
sourceIDValue	string	O	N	8.1.2.2
SourceSize	container	O	N	8.1.3
SourceXDimension	container	O	N	8.1.3.1
sourceXDimensionValue	non-negative real	O	N	8.1.3.1.1
sourceXDimensionUnit	enumerated (list)	O	N	8.1.3.1.2
SourceYDimension	container	O	N	8.1.3.2
sourceYDimensionValue	non-negative real	O	N	8.1.3.2.1
sourceYDimensionUnit	enumerated (list)	O	N	8.1.3.2.2
SourceZDimension	container	O	N	8.1.3.3
sourceZDimensionValue	non-negative real	O	N	8.1.3.3.1
sourceZDimensionUnit	enumerated (list)	O	N	8.1.3.3.2
GeneralCaptureInformation	container	MA	N	8.2
dateTimeCreated	DateTIme	MA	N	8.2.1
imageProducer	string	R	Y	8.2.2
captureDevice	enumerated (list)	O	N	8.2.3
ScannerCapture	container	MA	N	8.3

Element	Type	Obligation	Repeatable	Section Reference
scannerManufacturer	string	R	N	8.3.1
ScannerModel	container	R	N	8.3.2
scannerModelName	string	R	N	8.3.2.1
scannerModelNumber	string	R	N	8.3.2.2
scannerModelSerialNo	string	O	N	8.3.2.3
maximumOpticalResolution	string	O	N	8.3.3
scannerSensor	enumerated (standard)	R	N	8.3.4
ScanningSystemSoftware	container	R	N	8.3.5
scanningSoftwareName	string	R	N	8.3.5.1
scanningSoftwareVersionNo	string	R	N	8.3.5.2
DigitalCameraCapture	container	MA	N	8.4
digitalCameraManufacturer	string	R	N	8.4.1
DigitalCameraModel	container	R	N	8.4.2
digitalCameraModelName	string	R	N	8.4.2.1
digitalCameraModelNumber	string	R	N	8.4.2.2
digitalCameraModelSerialNo	string	O	N	8.4.2.3
cameraSensor	enumerated (standard)	R	N	8.4.3
CameraCaptureSettings	container	O	N	8.4.4
ImageData	container	O	N	8.4.4.1
fNumber	non-negative real	O	N	8.4.4.1.1
exposureTime	non-negative real	O	N	8.4.4.1.2
exposureProgram	enumerated (standard)	O	N	8.4.4.1.3
spectralSensitivity	string	O	Y	8.4.4.1.4
isoSpeedRatings	integer	O	N	8.4.4.1.5
oECF	rational	O	N	8.4.4.1.6
exifVersion	enumerated (standard)	O	N	8.4.4.1.7
shutterSpeedValue	rational	O	N	8.4.4.1.8
apertureValue	rational	O	N	8.4.4.1.9
brightnessValue	rational	O	N	8.4.4.1.10
exposureBiasValue	rational	O	N	8.4.4.1.11
maxApertureValue	rational	O	N	8.4.4.1.12
subjectDistance	non-negative real	O	N	8.4.4.1.13
meteringMode	enumerated (list)	O	N	8.4.4.1.14

Element	Type	Obligation	Repeatable	Section Reference
lightSource	enumerated (standard)	O	N	8.4.4.1.15
flash	enumerated (standard)	O	N	8.4.4.1.16
focalLength	real	O	N	8.4.4.1.17
flashEnergy	rational	O	N	8.4.4.1.18
backLight	enumerated (standard)	O	N	8.4.4.1.19
exposureIndex	non-negative real	O	N	8.4.4.1.20
sensingMethod	enumerated (standard)	O	N	8.4.4.1.21
cfaPattern	integer	O	N	8.4.4.1.22
autoFocus	enumerated (standard)	O	N	8.4.4.1.23
PrintAspectRatio	container	O	N	8.4.4.1.24
xPrintAspectRatio	non-negative real	O	N	8.4.4.1.24.1
yPrintAspectRatio	non-negative real	O	N	8.4.4.1.24.2
GPSData	container	MA	N	8.4.4.2
gpsVersionID	string	MA	N	8.4.4.2.1
gpsLatitudeRef	enumerated (standard)	O	N	8.4.4.2.2
gpsLatitude	rational	O	N	8.4.4.2.3
gpsLongitudeRef	enumerated (standard)	O	N	8.4.4.2.4
gpsLongitude	rational	O	N	8.4.4.2.5
gpsAltitudeRef	enumerated (standard)	O	N	8.4.4.2.6
gpsAltitude	rational	O	N	8.4.4.2.7
gpsTimeStamp	string	O	N	8.4.4.2.8
gpsSatellites	string	O	N	8.4.4.2.9
gpsStatus	enumerated (standard)	O	N	8.4.4.2.10
gpsMeasureMode	enumerated (standard)	O	N	8.4.4.2.11
gpsDOP	rational	O	N	8.4.4.2.12
gpsSpeedRef	enumerated (standard)	O	N	8.4.4.2.13
gpsSpeed	rational	O	N	8.4.4.2.14
gpsTrackRef	enumerated (standard)	O	N	8.4.4.2.15
gpsTrack	rational	O	N	8.4.4.2.16

Element	Type	Obligation	Repeatable	Section Reference
gpsImgDirectionRef	enumerated (standard)	O	N	8.4.4.2.17
gpsImgDirection	rational	O	N	8.4.4.2.18
gpsMapDatum	string	MA	N	8.4.4.2.19
gpsDestLatitudeRef	enumerated (standard)	O	N	8.4.4.2.20
gpsDestLatitude	string	O	N	8.4.4.2.21
gpsDestLongitudeRef	enumerated (standard)	O	N	8.4.4.2.22
gpsDestLongitude	string	O	N	8.4.4.2.23
gpsDestBearingRef	enumerated (standard)	O	N	8.4.4.2.24
gpsDestBearing	rational	O	N	8.4.4.2.25
gpsDestDistanceRef	enumerated (standard)	O	N	8.4.4.2.26
gpsDestDistance	rational	O	N	8.4.4.2.27
gpsProcessingMethod	string	O	N	8.4.4.2.28
gpsAreaInformation	string	O	N	8.4.4.2.29
gpsDateStamp	string	O	N	8.4.4.2.30
gpsDifferential	enumerated (standard)	O	N	8.4.4.2.31
orientation	enumerated (list)	R	N	8.5
methodology	string	O	N	8.6
SpatialMetrics	container	MA	N	9.1
samplingFrequencyPlane	enumerated (list)	MA	N	9.1.1
samplingFrequencyUnit	enumerated (standard)	MA	N	9.1.2
xSamplingFrequency	rational	MA	N	9.1.2.1
ySamplingFrequency	rational	MA	N	9.1.2.2
ImageColorEncoding	container	M	N	9.2
BitsPerSample	container	M	N	9.2.1
bitsPerSampleValue	string	M	N	9.2.1.1
bitsPerSampleUnit	enumerated (list)	M	N	9.2.1.2
samplesPerPixel	positive integer	M	N	9.2.2
extraSamples	enumerated (list)	MA	N	9.2.3
Colormap	container	MA	N	9.2.4
colormapReference	reference	MA	N	9.2.4.1
embeddedColormap	base64Binary	O	N	9.2.4.2

Element	Type	Obligation	Repeatable	Section Reference
grayResponseCurve	enumerated (standard)	R	N	9.2.5
grayResponseUnit	enumerated (list)	R	N	9.2.6
WhitePoint	container	O	Y	9.2.7
whitePointXValue	enumerated (list)	O	N	9.2.7.1
whitePointYValue	enumerated (list)	O	N	9.2.7.2
PrimaryChromaticities	container	O	Y	9.2.8
primaryChromaticitiesRedX	enumerated (list)	O	N	9.2.8.1
primaryChromaticitiesRedY	enumerated (list)	O	N	9.2.8.2
primaryChromaticitiesGreenX	enumerated (list)	O	N	9.2.8.3
primaryChromaticitiesGreenY	enumerated (list)	O	N	9.2.8.4
primaryChromaticitiesBlueX	enumerated (list)	O	N	9.2.8.5
primaryChromaticitiesBlueY	enumerated (list)	O	N	9.2.8.6
TargetData	container	R	N	9.3
targetType	enumerated (list)	R	Y	9.3.1
TargetID	container	R	Y	9.3.2
targetManufacturer	string	R	N	9.3.2.1
targetName	string	R	N	9.3.2.2
targetNo	string	R	N	9.3.2.3
targetMedia	string	R	N	9.3.2.4
externalTarget	reference	R	Y	9.3.3
performanceData	reference	O	Y	9.3.4
ImageProcessing	container	MA	Y	10.1
dateTimeProcessed	DateTime	MA	N	10.1.1
sourceData	string	MA	N	10.1.2
processingAgency	string	R	Y	10.1.3
processingRationale	string	R	N	10.1.4
ProcessingSoftware	container	R	Y	10.1.5
processingSoftwareName	string	R	N	10.1.5.1
processingSoftwareVersion	string	R	N	10.1.5.2
processingOperatingSystemName	string	R	N	10.1.5.3
processingOperatingSystemVersion	string	R	N	10.1.5.4
processingActions	string	R	Y	10.1.6
Previous Image Metadata	[retains previous data types]	MA	Y	10.2

Appendix C
(informative)
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(This Appendix is not part of ANSI/NISO Z39.87-200X (ANSI/AIIM 20-200X), *Data Dictionary – Technical Metadata for Digital Still Images*. It is included for information only.)

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