

1	Status	Final Text
2	Date of Last Update	2018/11/11
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6	Submission Date	2018/03/16

7	Correction Number CP-1804	
8	Log Summary: Clarify handling of ICC profiles in WADO-RS for encapsulated images such as JPEG	
9	Name of Standard	
10	PS3.3, PS3.5, PS3.18 2018d	
11	Rationale for Correction:	
12	Color images such as WSI require ICC profiles to be present in the DICOM Attributes but when retrieving them using WADO-RS	
13	services as separate image pixel data or in rendered form, it is not clear whether or not the ICC profile should be included inside the	
14	compressed bitstream, as is supported by JPEG, JPEG 2000, PNG, etc.	
15	Clarify that:	
16	<ul style="list-style-type: none"> for an image/jpeg WADO-RS retrieve rendered transaction, in the absence of a new iccprofile parameter, an ICC profile may or may not be present in the retrieved bitstream. 	
17		
18	<ul style="list-style-type: none"> for an image/jpeg WADO-RS retrieve rendered transaction, in the presence of the new iccprofile parameter, an ICC profile will or will not be present in the retrieved bitstream as specified by the parameter value, and that parameter value can request inclusion of the ICC Profile in the DICOM image or conversion by the origin server to a well-known space. 	
19		
20		
21	<ul style="list-style-type: none"> for an image/jpeg WADO-RS retrieve rendered transaction, i.e., of a JPEG compressed data stream encapsulated in DICOM, an ICC profile may or may not be present in the image in the response, depending on whether or not it was present in the compressed data stream of the stored file; there is no requirement to copy the DICOM Attribute ICC Profile value into APP2 marker segment chunks. 	
22		
23		
24		
25	<ul style="list-style-type: none"> irrespective of WADO, for a JPEG compressed data stream encapsulated in DICOM, if an ICC profile is present in the compressed data stream of a stored file, it shall be identical to the profile in the DICOM Attribute. 	
26		
27	<ul style="list-style-type: none"> irrespective of WADO, for a JPEG-LS or JPEG 2000 compressed data stream encapsulated in DICOM, no ICC profile can be present in the compressed data stream of a stored file due to lack of support in the underlying standard or explicit prohibition of the encoding mechanism by DICOM. 	
28		
29		
30	The list of named ICC profile types in the new iccprofile parameter is intentionally constrained to a small set, to promote interoperability, and allows the user agent to avoid having to retrieve any ICC profile encoded in the image metadata just to determine its type; this does not constrain flexibility since a user agent may still elect to perform its own color management.	
31		
32		
33	Correction Wording:	

Amend DICOM PS3.18 as follows (changes to existing text are bold and **underlined** for additions and ~~struckthrough~~ for removals):

3 Normative References

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3.1 International Organization for Standardization (ISO) and International Electrotechnical Commission (IEC)

[ISO 15076-1] **ISO. 2005. Image technology colour management - Architecture, profile format, and data structure. Also available as ICC.1:2004-10 (Profile version 4.2.0.0), International Color Consortium, available at <http://www.color.org/v4spec.xalter>** .

[ISO 15948] **ISO. 2003. Information technology -- Computer graphics and image processing -- Portable Network Graphics (PNG): Functional specification. A Joint ISO/IEC International Standard and W3C Recommendation. Also available at: <https://www.w3.org/TR/2003/REC-PNG-20031110/>** .

[ISO 22028-2] **ISO. 2013. Photography and graphic technology - Extended colour encodings for digital image storage, manipulation and interchange - Part 2: Reference output medium metric RGB colour image encoding (ROMM RGB)**. http://www.iso.org/iso/catalogue_detail.htm?csnumber=56591 .

3.4 Other References

[Adobe RGB] **Adobe Systems Incorporated. 1998**

~~edition~~**>2005-05</edition>**

Adobe RGB (1998) Color Image Encoding. <http://www.adobe.com/digitalimag/pdfs/AdobeRGB1998.pdf> .

6.1.1.8 DICOM Media Types and Media Types For Bulk Data

This section defines the media types used to represent DICOM Instances and bulk data. It describes:

- The media type and transfer syntax parameter for DICOM ???? Files
- The media types that can be used for the bulk data of single and multi-frame images and video extracted from Instances.
- The syntax of DICOM Media Types including their transfer syntax and character set parameters.
- The query parameter for transfer syntax.
- The meaning of Acceptable Transfer Syntaxes and Selected Transfer Syntax.
- The media types supported by each service.

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Note

1. The compressed bulk data of each part of a multipart payload contains only the compressed bit stream and not the DICOM ???? Encapsulated Sequence or Delimiter Items.
2. For the media type image/jpeg Transfer Syntaxes, the image may or may not include the JFIF marker segment. **The image may or may not include APP2 marker segments with an identifier of "ICC_PROFILE". There is no requirement for the origin server to add a JFIF marker segment nor to copy the value of the ICC Profile (0028,2000) Attribute, if present, into APP2 marker segments in the compressed data stream.** See ????.
3. For the media type image/jp2 and image/jpx Transfer Syntaxes, the image does not include the jp2 marker segment. See ???? and ????.
4. ...

6.5.8 WADO-RS - Retrieve Rendered Transaction

6.5.8.1 Request

6.5.8.1.2 Query Parameters

The origin server shall support all of the **Required** query parameters defined in ~~this section~~ **Table 6.5.8-2**. **An origin server may support Optional query parameters defined in Table 6.5.8-2.** An origin server may define additional parameters. If additional parameters are defined, they shall be documented in the Conformance Statement and in the Retrieve Capabilities response. The origin server shall ignore any unknown parameters.

The following rules pertain to all parameters defined in this section:

1. All parameters are optional for the user agent.
2. All **Required** parameters are required to be supported by the origin server.
3. These parameters only apply to resources that are images and video.
4. Instances that are not images will be rendered in an Acceptable Media Type, if one exists; otherwise, they will not be rendered.
5. The set of transformations specified by the parameters in this section shall be applied to the images as if they were a Presentation State, that is, in the order specified by the applicable image rendering pipeline specified in PS 3.4.

See ???.

Table 6.5.8-2. Retrieve Rendered Query Parameters

Key	Values	Target Resource	Section	Origin Server Support
annotation	"patient" and/or "technique"	All	???	Required
charset	token	All	???	Required
quality	integer	All	???	Required
viewport	vw, vh, [sx, sy, sw, sh]	Non-Presentation States	???	Required
viewport	vw, vh,	Presentation States	???	Required
window	center, width, shape	Non-Presentation States	???	Required
iccprofile	"yes", "no", "srgb", "adobergb", "rommrgb"	Images	6.5.8.1.2.5	Optional

6.5.8.1.2.5 ICC Profile

The "iccprofile" parameter specifies the color characteristics of, and inclusion of an ICC Profile in, the rendered images. It has the following syntax:

```
%s"iccprofile=" 1#( %s"no" / %s"yes" / %s"srgb" / %s"adobergb" / %s"rommrgb" )
```

Where

"no" **indicates that no ICC profile shall be present in the rendered image in the response.**

"yes" **indicates that an ICC profile shall be present in the rendered image in the response, describing its color characteristics, if the Media Type supports embedded ICC Profiles.**

1 **"srgb"** **indicates that an sRGB ICC profile shall be present in the image, if the Media Type supports embedded**
 2 **ICC Profiles, and that the pixels of the rendered image in the response shall be transformed from their**
 3 **original color space and be encoded in the sRGB color space [IEC 61966-2.1].**

4 **"adobergb"** **indicates that an Adobe RGB ICC profile shall be present in the image, if the Media Type supports**
 5 **embedded ICC Profiles, and that the pixels of the rendered image in the response shall be transformed**
 6 **from their original color space and be encoded in the Adobe RGB color space [Adobe RGB].**

7 **"rommrgb"** **indicates that a ROMM RGB ICC profile shall be present in the image, if the Media Type supports**
 8 **embedded ICC Profiles, and that the pixels of the rendered image in the response shall be transformed**
 9 **from their original color space and encoded in the ROMM RGB color space [ISO 22028-2].**

10 **When this parameter is not present:**

- 11 • **an ICC profile may or may not be present in the image in the response;**
- 12 • **the color characteristics of the image in the response may or may not be consistent with any DICOM ICC Profile (0028,2000)**
 13 **Attribute in the metadata.**

14 **The ICC Profile in the image in the response shall be:**

- 15 • **the ICC profile of the color space specified explicitly by the parameter,**
- 16 • **otherwise, the ICC profile encoded in the source DICOM ICC Profile (0028,2000) Attribute, if any, appropriate to the selected**
 17 **frame,**
- 18 • **otherwise, the ICC profile, if any, embedded in the stored compressed representation of the selected frame,**
- 19 • **otherwise, at the discretion of the origin server, the ICC profile of a well-known color space listed in PS 3.3 Section C.11.15.1.2**
 20 **that is appropriate to the type and source of the image.**

21 **If the Media Type does not support embedded ICC Profiles:**

- 22 • **a 400 Bad Request error shall be returned if the parameter value is other than "no"**

23 **Note**

- 24 1. **This parameter allows ICC profile information to be present in the image in the response so that the user agent**
 25 **can make use of it for local color management (e.g., an ICC profile capable browser can apply the profile when**
 26 **displaying the rendered image in the response).**
- 27 2. **This parameter provides a limited mechanism for requesting that the origin server perform some color manage-**
 28 **ment. It provides the names of well-known color spaces for the rendered image in the response. It does not**
 29 **provide a mechanism to supply an arbitrary ICC profile, such as the calibration profile of a display, so it does**
 30 **not absolve the user agent from the need to handle its own color calibration and color management.**
- 31 3. **ICC profiles can theoretically be large relative to the compressed pixel data of a single frame, so the user agent**
 32 **may specify a parameter value of "no", retrieve the DICOM ICC Profile (0028,2000) Attribute value(s) that apply**
 33 **to multiple frames from the metadata, and combine these itself.**
- 34 4. **ICC profiles are embedded in rendered images of Media Type image/jpeg as one or more chunks in APP2**
 35 **marker segments with an identifier of "ICC_PROFILE", as defined in Annex B of [ISO 15076-1].**
- 36 5. **ICC profiles are embedded in rendered images of Media Type image/jp2 either as JP2 Restricted or JPX Full**
 37 **profiles according to [ISO/IEC 15444-1] and [ISO/IEC 15444-2], respectively; rendered images in the response**
 38 **are not subject to the prohibition against inclusion of a JP2 box in JPEG 2000 compressed data streams in**
 39 **DICOM images.**
- 40 6. **ICC profiles are embedded in rendered images of Media Type image/png in an iCCP chunk, as defined in [ISO**
 41 **15948].**

6.5.8.3 Response

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6.5.8.3.1 Status Codes

The response shall include a status code from Table 6.5.8-3, if applicable; otherwise, an appropriate status code shall be used.

Table 6.5.8-3. Common Status Codes

Status Code	Meaning
200 Success	The origin server successfully rendered and is returning representations for the resource.
206 Partial Content	The origin server successfully rendered and is returning representations for part, but not all, of the resource.
<u>400 Bad Request</u>	<u>The origin cannot process the request because of errors in the request headers or parameters.</u>
406 Not Acceptable	The origin server does not support any of the Acceptable Media Types.
413 Payload Too Large	The target resource is too large to be rendered by the origin server.

For reference DICOM PS3.3 unchanged:

2.1 International Organization for Standardization (ISO) and International Electrotechnical Commission (IEC)

[IEC 61966-2.1] IEC. 1999. Ed 1.0. *Multimedia systems and equipment - colour measurement and management - Part 2.1: colour management - Default RGB colour space - sRGB.*

2.6 Other References

[Adobe RGB] Adobe Systems Incorporated. 1998. 2005-05. *Adobe RGB (1998) Color Image Encoding.* <http://www.adobe.com/digitalimag/pdfs/AdobeRGB1998.pdf>.

C.7.6.3 Image Pixel Module

Table C.7-11c. Image Pixel Description Macro Attributes

Attribute Name	Tag	Type	Attribute Description
ICC Profile	(0028,2000)	3	An ICC Profile encoding the transformation of device-dependent color stored pixel values into PCS-Values. See Section C.11.15.1.1. When present, defines the color space of color Pixel Data (7FE0,0010) values, and the output of Palette Color Lookup Table Data (0028,1201-1203). Note The profile applies only to Pixel Data (7FE0,0010) at the same level of the Data Set and not to any icons nested within sequences, which may or may not have their own ICC profile specified.
Color Space	(0028,2002)	3	A label that identifies the well-known color space of the image. Shall be consistent with any ICC Profile (0028,2000) that is also present. See Section C.11.15.1.2.

C.7.6.23 Enhanced Palette Color Lookup Table Module

Table C.7.6.23-1. Enhanced Palette Color Lookup Table Module Attributes

Attribute Name	Tag	Type	Attribute Description
ICC Profile	(0028,2000)	1C	An ICC Profile encoding the transformation of device-dependent color stored pixel values into PCS-Values. See Section C.11.15.1.1 When present, defines the color space of the output of the Enhanced Blending and Display Pipeline. Required if Data Path Assignment (0028,1402) is present and there exists any value other than PRIMARY_PVALUES.
Color Space	(0028,2002)	3	A label that identifies the well-known color space of the image. Shall be consistent with any ICC Profile (0028,2000) that is also present. See Section C.11.15.1.2.

C.8.12.5 Optical Path Module

Table C.8.12.5-1. Optical Path Module Attributes

Attribute Name	Tag	Type	Attribute Description
Optical Path Sequence	(0048,0105)	1	Describes the optical paths used during the acquisition of this image. One or more Items shall be included in this Sequence. See ???
>ICC Profile	(0028,2000)	1C	An ICC Profile encoding the transformation of device-dependent stored pixel values into PCS-Values. See Section C.8.12.5.1.4 Required if Photometric Interpretation (0028,0004) is not MONOCHROME2, or if Palette Color Lookup Table Sequence (0048,0120) is present.
>Color Space	(0028,2002)	3	A label that identifies the well-known color space of the image. Shall be consistent with any ICC Profile (0028,2000) that is also present. See Section C.11.15.1.2.

C.8.12.5.1 Optical Path Attribute Descriptions

C.8.12.5.1.4 ICC Profile

ICC Profile (0028,2000) provides the transform for mapping stored color pixel values into ICC standard color Profile Connection Space (PCS). For MONOCHROME2 pixels that have a preferred color rendering through the Palette Color Lookup Table Sequence (0048,0120), this attribute provides a mapping of that preferred RGB color rendering into PCS. The ICC Profile shall follow the requirements specified in Section C.11.15.1.1.

C.8.32.2 Parametric Map Image Module

Table C.8.32-2. Parametric Map Image Module Attributes

Attribute Name	Tag	Type	Attribute Description
ICC Profile	(0028,2000)	1C	An ICC Profile encoding the transformation of device-dependent color stored pixel values into PCS-Values. When present, defines the color space of the output of the Parametric Map See Section C.11.15.1.1. Required if Pixel Presentation (0008,9205) has a value of COLOR_RANGE.
Color Space	(0028,2002)	3	A label that identifies the well-known color space of the image. Shall be consistent with any ICC Profile (0028,2000) that is also present. See Section C.11.15.1.2.

C.11.15 ICC Profile Module

Table C.11.15-1 contains Attributes that identify and describe an ICC Profile.

Table C.11.15-1. ICC Profile Module Attributes

Attribute Name	Tag	Type	Attribute Description
ICC Profile	(0028,2000)	1	An ICC Profile encoding the transformation of device-dependent color stored pixel values into PCS-Values.
Color Space	(0028,2002)	3	A label that identifies the well-known color space of the image. Shall be consistent with any ICC Profile (0028,2000) that is also present. See Section C.11.15.1.2.

C.11.15.1 Attribute Descriptions

C.11.15.1.1 ICC Profile

ICC Profile (0028,2000) encodes an ICC Input Device Profile that encodes the transformation of device-dependent color stored pixel values into PCS-Values.

Note

- Only Input Device profiles are encoded, since display and output device profiles are not interchanged in DICOM, though they may be used internally within display and output devices, for example when they are calibrated.
- Since the version of the ICC Profile is encoded within the profile itself, no additional version information is encoded in the ICC Profile Module.

The following constraints on the encoding of the ICC Profile shall be observed:

- The profile shall be of the Input Device class, i.e., header bytes 12 through 15, Profile Device/Class Signature, shall be "scnr"
- The color space of the input shall be RGB, i.e., header bytes 16 through 19, Color Space Signature, shall be "RGB", regardless of the Photometric Interpretation of the image pixel data prior to decompression
- PCS shall be CIELab or CIEXYZ, i.e., header bytes 20 through 23, Profile Connection Space, shall be either "Lab" or "XYZ".

Note

1. In the case of a PCS of CIELab, the profile will contain an N-component LUT-based AtoB0Tag, since three-component matrix based transformations are only possible with a PCS of CIEXYZ. A three-component matrix based transformation might be used to define a well-known rather than device-specific profile for such spaces as sRGB.
2. Selection of a PCS of CIELab or CIEXYZ within the ICC profile does not impact the DICOM encoding, since all color management systems support both.

The following constraints on the encoding of the ICC Profile are recommended:

- The Rendering Intent should be Perceptual.

Note

1. The rendering intent specifies how rendering will take place when the ICC Input Profile is linked with another Profile for the purpose of display.
2. A perceptual rendering intent implies that AtoB0Tag and BtoA0Tag tags will be present in the profile. The AtoB0Tag allows mapping from the input values to the PCS. The BtoA0Tag allows mapping from the PCS to the input values, though this is not required for the color rendering pipeline defined in ????.

- All LUTs should be represented as 16 bit values, using tag type lut16Type, for greater precision.
- The chromaticAdaptationTag should be set if the actual illumination source is not D50.

Note

See the discussion of white point in ????.

C.11.15.1.2 Color Space

The Color Space attribute provides a label that identifies the color space by name, when the ICC Profile (0028, 2000) (if present) describes a well-known color space.

Defined Terms:

- SRGB** ICC Profile (0028,2000) defines sRGB color space [IEC 61966-2.1]
- ADOBERGB** ICC Profile (0028,2000) defines Adobe RGB color space [Adobe RGB]
- ROMMRGB** ICC Profile (0028,2000) defines ROMM RGB color space [ISO 22028-2]

C.11.27 MPR Volumetric Presentation State Display Module

Table C.11.27-1. MPR Volumetric Presentation State Display Module Attributes

Attribute Name	Tag	Type	Attribute Description
ICC Profile	(0028,2000)	1C	An ICC Profile encoding the transformation of device-dependent color stored pixel values into PCS-Values. When present, defines the color space of the output of the Volumetric Presentation State. See Section C.11.15.1.1. Required if Pixel Presentation (0008,9205) has a value of TRUE_COLOR.

Attribute Name	Tag	Type	Attribute Description
Color Space	(0028,2002)	1C	A label that identifies the well-known color space of the view. Shall be consistent with the ICC Profile (0028,2000) that is present. Required if Pixel Presentation (0008,9205) has a value of TRUE_COLOR and a standard color space described by one of the Enumerated Values in Section C.11.15.1.2 is used.

C.11.32 Render Display Module

Table C.11.32-1. Render Display Module Attributes

Attribute Name	Tag	Type	Attribute Description
ICC Profile	(0028,2000)	1C	An ICC Profile encoding the transformation of device-dependent color stored pixel values into PCS-Values. When present, defines the color space of the output of the Volumetric Presentation State. See Section C.11.15.1.1. Required if Pixel Presentation (0008,9205) has a value of TRUE_COLOR.
Color Space	(0028,2002)	1C	A label that identifies the well-known color space of the view. Shall be consistent with the ICC Profile (0028,2000) that is present. Required if Pixel Presentation (0008,9205) has a value of TRUE_COLOR and a standard color space described by one of the Enumerated Values in Section C.11.15.1.2 is used.

C.13.3 Basic Film Box Presentation Module

Table C.13-3. Basic Film Box Presentation Module Attributes

Attribute Name	Tag	Attribute Description
ICC Profile	(0028,2000)	An ICC Profile encoding the transformation of device-dependent color stored pixel values into PCS-Values. See Section C.11.15. Note This is an Input Device Profile that describes the characteristics of the pixel data in the film box, not an Output Device Profile that might describe the characteristics of the Print SCP.

Amend DICOM PS3.5 as follows (changes to existing text are bold and underlined for additions and ~~struckthrough~~ for removals):

[ISO/IEC 15444-1] ISO/IEC. 2004. *JPEG 2000 Image Coding System*.

[ISO/IEC 15444-2] ISO/IEC. 2004. *JPEG 2000 Image Coding System: Extensions*.

8.2.1 JPEG Image Compression

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The use of the DICOM Encapsulated Format to support JPEG Compressed Pixel Data requires that the Data Elements that are related to the Pixel Data encoding (e.g., Photometric Interpretation, Samples per Pixel, Planar Configuration, Bits Allocated, Bits Stored, High

Bit, Pixel Representation, Rows, Columns, etc.) shall contain values that are consistent with the characteristics of the compressed data stream.

...

The Pixel Data characteristics included in the JPEG Interchange Format shall be used to decode the compressed data stream.

If APP2 marker segments with an identifier of "ICC_PROFILE" (as defined in Annex B of [ISO 15076-1]) are present in the compressed data stream, their concatenated value shall be identical to the value of ICC Profile (0028,2000) Attribute, if present, excluding padding.

Note

1. These requirements were formerly specified in terms of the "uncompressed pixel data from which the compressed data stream was derived". However, since the form of the "original" uncompressed data stream could vary between different implementations, this requirement is now specified in terms of consistency with what is encapsulated.

When decompressing, should the characteristics explicitly specified in the compressed data stream (e.g., spatial sub-sampling or number of components or planar configuration) be inconsistent with those specified in the DICOM Data Elements, those explicitly specified in the compressed data stream should be used to control the decompression. The DICOM data elements, if inconsistent, can be regarded as suggestions as to the form in which an uncompressed Data Set might be encoded, subject to the general and IOD-specific rules for uncompressed Photometric Interpretation and Planar Configuration, which may require that decompressed data be converted to one of the permitted forms.

2. Those characteristics not explicitly specified in the compressed data stream (e.g., the color space of the compressed components, which is not specified in the JPEG Interchange Format), or implied by the definition of the compression scheme (e.g., always unsigned in JPEG), can therefore be determined from the DICOM Data Element in the enclosing Data Set. For example a Photometric Interpretation of "YBR_FULL_422" would describe the color space that is commonly used to lossy compress images using JPEG. It is unusual to use an RGB color space for lossy compression, since no advantage is taken of correlation between the red, green and blue components (e.g., of luminance), and poor compression is achieved.
3. The JPEG Interchange Format is distinct from the JPEG File Interchange Format (JFIF). The JPEG Interchange Format is defined in ??? section 4.9.1, and refers to the inclusion of decoding tables, as distinct from the "abbreviated format" in which these tables are not sent (and the decoder is assumed to already have them). The JPEG Interchange Format does NOT specify the color space. The JPEG File Interchange Format, not part of the original JPEG standard, but defined in ??? and ???, is often used to store JPEG bit streams in consumer format files, and does include the ability to specify the color space of the components. The JFIF APP0 marker segment is NOT required to be present in DICOM encapsulated JPEG bit streams, and should not be relied upon to recognize the color space. Its presence is not forbidden (unlike the JP2 information for JPEG 2000 Transfer Syntaxes), but it is recommended that it be absent.
4. Should the compression process be incapable of encoding a particular form of pixel data representation (e.g., JPEG cannot encode signed integers, only unsigned integers), then ideally only the appropriate form should be "fed" into the compression process. However, for certain characteristics described in DICOM Data Elements but not explicitly described in the compressed data stream (such as Pixel Representation), then the DICOM Data Element should be considered to describe what has been compressed (e.g., the pixel data really is to be interpreted as signed if Pixel Representation so specifies).
5. DICOM Data Elements should not describe characteristics that are beyond the capability of the compression scheme used. For example, JPEG lossy processes are limited to 12 bits, hence the value of Bits Stored should be 12 or less. Bits Allocated is irrelevant, and is likely to be constrained by the Information Object Definition in ??? to values of 8 or 16. Also, JPEG compressed data streams are always color-by-pixel and should be specified as such (a decoder can essentially ignore this element however as the value for JPEG compressed data is already known).
6. If JPEG Compressed Pixel Data is decompressed and re-encoded in Native (uncompressed) form, then the Data Elements that are related to the Pixel Data encoding are updated accordingly. If color components are converted from YBR_FULL_422 to RGB during decompression and Native re-encoding, the Photometric Interpretation will be changed to RGB in the Data Set with the Native encoding.

8.2.3 JPEG-LS Image Compression

The use of the DICOM Encapsulated Format to support JPEG-LS Compressed Pixel Data requires that the Data Elements that are related to the Pixel Data encoding (e.g., Photometric Interpretation, Samples per Pixel, Planar Configuration, Bits Allocated, Bits Stored, High Bit, Pixel Representation, Rows, Columns, etc.) shall contain values that are consistent with the characteristics of the compressed data stream. The Pixel Data characteristics included in the JPEG-LS Interchange Format shall be used to decode the compressed data stream.

Note

1. See also the notes in Section 8.2.1.
2. No color transformation Photometric Interpretation specific for JPEG-LS is currently defined in DICOM. Annex F of ISO 14495-2 describes a "Sample transformation for inverse colour transform" and a marker segment to encode its parameters, but this is not known to have been implemented. Common practice is to compress the RGB components unconverted, which sacrifices compression performance, and send the Photometric Interpretation as RGB. Though the YBR_RCT Photometric Interpretation and component conversion could theoretically be used, in the absence of DC shifting it results in signed values to be encoded, which are not supported by JPEG-LS.
3. If JPEG-LS Compressed Pixel Data is decompressed and re-encoded in Native (uncompressed) form, then the Data Elements that are related to the Pixel Data encoding are updated accordingly. If color components are converted from any other Photometric Interpretation to RGB during decompression and Native re-encoding, the Photometric Interpretation will be changed to RGB in the Data Set with the Native encoding.
4. The lower limit of 2 on Bits Stored (0028,0101) reflects the minimum JPEG-LS sample precision of 2.

8.2.4 JPEG 2000 Image Compression

The use of the DICOM Encapsulated Format to support JPEG 2000 Compressed Pixel Data requires that the Data Elements that are related to the Pixel Data encoding (e.g., Photometric Interpretation, Samples per Pixel, Planar Configuration, Bits Allocated, Bits Stored, High Bit, Pixel Representation, Rows, Columns, etc.) shall contain values that are consistent with the characteristics of the compressed data stream. The Pixel Data characteristics included in the JPEG 2000 bit stream shall be used to decode the compressed data stream.

When decompressing, should the characteristics explicitly specified in the compressed data stream be inconsistent with those specified in the DICOM Data Elements, those explicitly specified in the compressed data stream should be used to control the decompression. The DICOM data elements, if inconsistent, can be regarded as suggestions as to the form in which an uncompressed Data Set might be encoded, subject to the general and IOD-specific rules for uncompressed Photometric Interpretation and Planar Configuration, which may require that decompressed data be converted to one of the permitted forms.

Note

1. For example, single component may be present, and the Photometric Interpretation (0028,0004) may be MONO-CHROME2.
2. The application of a JPEG 2000 Part 1 reversible multi-component transformation is signaled in the JPEG 2000 bit stream by a value of 1 rather than 0 in the SGcod Multiple component transformation type of the COD marker segment [ISO 15444-1 Table A.17]. No other value of Photometric Interpretation than YBR_RCT or YBR_ICT is permitted when SGcod Multiple component transformation type is 1.

- 1 3. Though it would be unusual, would not take advantage of correlation between the red, green and blue components, and
 2 would not achieve effective compression, a Photometric Interpretation of RGB could be specified as long as no multi-
 3 component transformation [ISO 15444-1 Annex G] was specified by the JPEG 2000 bit stream. Alternative methods of
 4 decorrelation of the color components than those specified in [ISO 15444-1 Annex G] are permitted as defined in PS3.3,
 5 such as a Photometric Interpretation of YBR_FULL; this may be useful when converting existing YBR_FULL Pixel Data
 6 (e.g., in a different Transfer Syntax) without further loss.

7 In either case (Photometric Interpretation of RGB or YBR_FULL), the value of SGcod Multiple component transformation
 8 type would be 0.

9 ??? may constrain the values of Photometric Interpretation for specific IODs.

- 10 4. Despite the application of a multi-component color transformation and its reflection in the Photometric Interpretation at-
 11 tribute, the "color space" remains undefined. There is currently no means of conveying "standard color spaces" either
 12 by fixed values (such as sRGB) or by ICC profiles. Note in particular that the JP2 file header is not sent in the JPEG
 13 2000 bit stream that is encapsulated in DICOM.
- 14 5. If JPEG 2000 Compressed Pixel Data is decompressed and re-encoded in Native (uncompressed) form, then the Data
 15 Elements that are related to the Pixel Data encoding are updated accordingly. If color components are converted from
 16 YBR_ICT or YBR_RCT to RGB during decompression and Native re-encoding, the Photometric Interpretation will be
 17 changed to RGB in the Data Set with the Native encoding.
- 18 6. The upper limit of 40 on Bits Allocated (0028,0100) and 38 on Bits Stored (0028,0101) reflects the maximum JPEG
 19 2000 sample precision of 38 and the DICOM requirement to describe Bits Allocated (0028,0100) as multiples of bytes
 20 (octets).

21 ...

22 A.4.1 JPEG Image Compression

23 ...

24 For all images, including all frames of a multi-frame image, the JPEG Interchange Format shall be used (the table specification shall
 25 be included).

26 **Note**

27 This refers to the ??? "interchange format", not the ??? JPEG File Interchange Format (JFIF).

28 ...

29 A.4.3 JPEG-LS Image Compression

30 ...

31 For all images, including all frames of a multi-frame image, the JPEG-LS Interchange Format shall be used (all parameter specifications
 32 shall be included).

33 A.4.4 JPEG 2000 Image Compression

34 ...

35 For all images, including all frames of a multi-frame image, the JPEG 2000 bit stream specified in [ISO/IEC 15444-1] shall be used.
 36 The optional JP2 file format header shall NOT be included.

37 **Note**

38 The role of the JP2 file format header is fulfilled by the non-pixel data attributes in the DICOM Data Set.