Digital Imaging and Communications in Medicine (DICOM)

Supplement 232

JPEG XL Transfer Syntax

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42 ## Document History

2019/02/21	Version 3	DAC	Updated to reflect conventions in DocBook publishing
2022/01/10	Version 1	WEW	First version of JPEG XL Transfer Syntax supplement
2022/05/02	2	WEW	Updated version with WG-04 comments
2024/01/13	3	WEW	Restarted work to look at JPEG XL encoding again since Safari at least seems to have adopted it and there is other interest

43 ## Open Issues

1.	Should SCP's and DICOMweb origin servers be required to decode to JPEG baseline from the JPEG XL JPEG Recompression Transfer Syntax?
2.	Is the description of lossy compression method and ratio appropriate for the reversible transcoding case to communicate how much loss has accumulated?
3.	For working purposes, we have named the recompression Transfer Syntax "JPEG XL JPEG Recompression". Is there a better/shorter/more descriptive name?

44 ## Closed Issues

1.	For rendered multiframe (NOT transfer syntax) JPEG XL be allowed as a DICOMweb response for multiple frames? **Yes** **The image/gif type is inadequate for acceptable quality, so allowing image/jxl enables much higher quality images to be returned when a multiframe is returned as a single object.**
2	Should rendered images be permitted to have more than 8 bits when rendered with JPEG XL? The availability of HDR monitors is becoming much more common, and these would allow for display of HDR content, so it could be allowed to return HDR rendered images. **Yes** **This should be added as a separate CP.**
3	Should rendered images be allowed to request lossless JPEG XL images? Currently the only lossless format permitted for rendered images is PNG, which is fairly slow to encode/decode. **Yes** **This should be added as a separate CP.**
4	Is it ok to limit the size of each frame to 4 gb for the convenience of limiting each frame to one fragment?

	Yes. **This simplifies decoding/handling of JPEG XL**
5	Should PALETTE_COLOR be permitted using the JPEG XL specific palette handling in a way different from the DICOM standard? **No.** **Palette color is a specific encoding mostly used internally by RLE. The palette color in JPEG XL uses an internal palette, and allows for mixing of palette elements to improve rendering fidelity. This would be very different from DICOM RLE.** **However, generic palette color encoding the same way as other compression methods handle palette color should be permitted**
6	Should floating point content be encoded as JPEG XL lossless? The JPEG XL format allows for 32 bit floating point. However, this is encoded in a separate tag from regular pixel data. That SOP Class allows for both 32 and 64 bit floating point values, so it isn't quite clear how to distinguish between the two for retrieval etc. This requires more consideration if it is desired to be included. **No, not in this supplement.** **Yes, a separate supplement will be added for floating point for several transfer syntaxes as this is a separate application that needs to be addressed by itself.**
7	Should a JPEG XL multiframe "video" transfer syntax be defined, encoded with fragments not matching frames but as a single instance object? Reasoning is that this can produce better encoding capabilities. **No, this would be a separate type of supplement that needs individual approval**

Scope and Field of Application

This supplement adds several JPEG XL Transfer Syntaxes.

- JPEG XL has demonstrated improved compression of color images
- Existing Baseline JPEG images can be transcoded without additional loss to smaller JPEG XL images (particularly useful for WSI)
- Supports multi-frame encoding more effectively than animated gif, the only other multiframe rendered format
- JPEG XL has both lossless and lossy modes that can be natively displayed in some browsers
- Has flexible encoding options (including > 8 bits, single bit)

JPEG XL is also added to the set of rendered formats for DICOMweb.

Update PS3.2 Table N.5-61

59 **Table N.5-61. Supported Rendered Media Types**

Category	Media Type	URI User Agent	URI Origin Server
Single Frame Image	image/jpeg		
	image/gif		
	image/png		
	image/jp2		
	image/jph		
	image/jxl		
Multi-Frame Image	*image/gif*		
	image/jxl		
Video	*video/mpeg*		
	video/mp4		
	video/H265		
Text	text/html		
	text/plain		
	text/xml		
	text/rtf		
	application/pdf		

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62 *Update PS3.2 Table N.5-70*

63 **Table N.5-70. DICOM Compressed Bulkdata Media Types**

Category	Media Type	Transfer Syntax UID	Transfer Syntax Name	User Agent	Origin Server
Single Frame Image	image/jpeg	1.2.840.10008.1.2.4.70	JPEG Lossless, Non-Hierarchical, First-Order Prediction(Process 14 Selection Value 1) :Default Transfer Syntax for Lossless JPEG Image Compression		
		1.2.840.10008.1.2.4.50	*JPEG Baseline (Process 1) :Default Transfer Syntax for Lossy JPEG 8 Bit Image Compression*		
		1.2.840.10008.1.2.4.51	*JPEG Extended (Process 2 & 4) :Default Transfer Syntax for Lossy JPEG 12 Bit Image Compression (Process 4 only)*		
		1.2.840.10008.1.2.4.57	*JPEG Lossless, Non-Hierarchical (Process 14)*		
	image/x-dicom-rle	1.2.840.10008.1.2.5	RLE Lossless		
	image/x-jls	1.2.840.10008.1.2.4.80	JPEG-LS Lossless Image Compression		

		1.2.840.10008.1.2.4.81	*JPEG-LS Lossy (Near-Lossless) Image Compression*		
	image/jp2	1.2.840.10008.1.2.4.90	JPEG 2000 Image Compression (Lossless Only)		
		1.2.840.10008.1.2.4.91	*JPEG 2000 Image Compression*		
	image/jpx	1.2.840.10008.1.2.4.92	JPEG 2000 Part 2 Multi-component Image Compression (Lossless Only)		
		1.2.840.10008.1.2.4.93	*JPEG 2000 Part 2 Multi-component Image Compression*		
	image/jxl	**1.2.840.10008.1.2.4.XX0** **1.2.840.10008.1.2.4.XX2** **1.2.840.10008.1.2.4.XX1**	**JPEG XL Lossless** **JPEG XL Lossy** **JPEG XL JPEG Recompression**		
Multi-frame Image	image/jpeg	1.2.840.10008.1.2.4.70	JPEG Lossless, Non-Hierarchical, First-Order Prediction(Process 14 Selection Value 1) :Default Transfer Syntax for Lossless JPEG Image Compression		

		1.2.840.10008.1.2.4.50	*JPEG Baseline (Process 1) :Default Transfer Syntax for Lossy JPEG 8 Bit Image Compression*		
		1.2.840.10008.1.2.4.51	*JPEG Extended (Process 2 & 4) :Default Transfer Syntax for Lossy JPEG 12 Bit Image Compression (Process 4 only)*		
		1.2.840.10008.1.2.4.57	*JPEG Lossless, Non-Hierarchical (Process 14)*		
	image/x-dicom-rle	1.2.840.10008.1.2.5	RLE Lossless		
	image/x-jls	1.2.840.10008.1.2.4.80	JPEG-LS Lossless Image Compression		
		1.2.840.10008.1.2.4.81	*JPEG-LS Lossy (Near-Lossless) Image Compression*		
	image/jp2	1.2.840.10008.1.2.4.90	JPEG 2000 Image Compression (Lossless Only)		
		1.2.840.10008.1.2.4.91	*JPEG 2000 Image Compression*		

	image/jpx	1.2.840.10008.1.2.4.92	JPEG 2000 Part 2 Multi-component Image Compression (Lossless Only)		
		1.2.840.10008.1.2.4.93	*JPEG 2000 Part 2 Multi-component Image Compression*		
	image/jxl	**1.2.840.10008.1.2.4.XX0** **1.2.840.10008.1.2.4.XX2** **1.2.840.10008.1.2.4.XX1**	**JPEG XL Lossless** **JPEG XL Lossy** **JPEG XL JPEG Recompression**		

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66 *Update PS3.2 Table N.5-71*

67 **Table N.5-71. Rendered Media Types**

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Category	Media Type	User Agent	Origin Server	Transformation
Single Frame Image	image/jpeg			
	image/gif			
	image/png			
	image/jp2			
	image/jph			
	image/jxl			
Multi-Frame Image	*image/gif*			
	image/jxl			
Video	*video/mpeg*			
	video/mp4			
	video/H265			
Text	text/html			
	text/plain			
	text/xml			
	text/rtf			
	application/pdf			

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71 *Update PS3.2 Table N.5-74*

72 **Table N.5-74. Header Fields for Retrieve Transaction - User Agent**

Header Field	Supported Values	Comments
Instance resource		
Accept	*multipart/related; type="application/dicom"; transfer-syntax={uid}*	See in the Overview section Table N.1-1 the supported DICOM SOP Classes / Transfer Syntaxes. Look for "Y" in the "UA" column.
	multipart/related; type="application/octet-stream"	
Metadata resource		
Accept	<<multipart/related; type="application/dicom+xml" multipart/related; type="application/dicom+json">>	
Bulkdata and Pixel Data resource		

Accept	Uncompressed: <<multipart/related; type="application/octet-stream">> Compressed: <<multipart/related; type="{media-type}">> supported {media-type} being <<image/jpeg *image/x-dicom-rle* *image/x-jls* *image/jphc* ***image/jxl*** *image/jp2* *image/jpx* *video/mpeg2* *video/mp4>>*	See details in Section N.5.3.2.1.2.
Rendered Resource		
Accept	<<image/jpeg image/gif image/png *image/jp2* *image/jph* ***image/jxl*** *image/gif* *video/mpeg* *video/mp4* *video/H265* text/html text/plain *text/xml>>*	See details in Section N.5.3.2.1.3.
Thumbnail Resource		

Accept	<<image/jpeg image/gif image/png *image/jp2* *image/jph* ***image/jxl*** *image/gif* *video/mpeg* *video/mp4* *video/H265* text/html text/plain *text/xml*>>	See details in Section N.5.3.2.1.3.
All Resources		
Accept-charset	<<UTF-8 ISO-8859-1 …>>	

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74 *Update PS3.2 Table N.5-77*

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76 **Table N.5-77. Header Fields for Retrieve Transaction - Origin Server**

Header Field	Supported Values	Comments
Instance resource		

Accept	multipart/related; type="application/dicom"; transfer-syntax={uid}	See in the Overview section Table N.1-1 the supported DICOM SOP Classes / Transfer Syntaxes. Look for "Y" in the "OS" column.
	multipart/related; type="application/octet-stream"	
Metadata resource		
Accept	<<multipart/related; type="application/dicom+xml" multipart/related; type="application/dicom+json">>	
Bulkdata and Pixel Data resource		
Accept	Uncompressed: <<multipart/related; type="application/octet-stream">> Compressed: <<multipart/related; type="{media-type}">> supported {media-type} being <<Image/jpeg *image/x-dicom-rle* *image/x-jls* *image/jp2* *image/jphc* ***image/jxl*** *image/jpx* *video/mpeg2* *video/mp4>>*	See details in Section N.5.3.2.1.2.
Rendered Resource		

Accept	<<image/jpeg image/gif image/png *image/jp2* *image/jph* ***image/jxl*** *image/gif* *video/mpeg* *video/mp4* *video/H265* text/html text/plain *text/xml*>>	See details in Section N.5.3.2.1.3.
Thumbnail Resource		
Accept	<<image/jpeg image/gif image/png *image/jp2* *image/jph* ***image/jxl*** *image/gif* *video/mpeg* *video/mp4* *video/H265* text/html text/plain *text/xml*>>	See details in Section N.5.3.2.1.3.
All Resources		

Content-Type	Content-Type returned by the origin server in the response. It contains the media type of the Payload. See Accept for supported Values	
	Accept-charset	*<<UTF-8* *ISO-8859-1* *…>>*

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79 | *Update PS3.2 Table N.5-79* |
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Table N.5-79. Header Fields for Store Transaction - User Agent

Header Field	Supported Values	Comments
Content-Type	multipart/related; type="application/dicom"; transfer-syntax={uid}	See in the Overview section Table N.1-1 the supported DICOM SOP Classes / Transfer syntaxes (look for "Y" in the "UA" column)
	multipart/related; type="application/dicom+xml"; boundary={messageBoundary} multipart/related; type="application/dicom+json"; boundary={messageBoundary}	
	Uncompressed: multipart/related; type="application/octet-stream" *Compressed:* *multipart/related; type="{media-type}"* *supported {media-type} being* *<<Image/jpeg* *image/x-dicom-rle* *image/x-jls* *image/jp2* *image/jphc* ***image/jxl*** *image/jpx* *video/mpeg2* *video/mp4>>*	See details in Section N.5.3.2.1.2.
Content-Length		*[If Content-Encoding is not present]*
Content-Encoding		*[If Content-Length is not present]*

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82 *Update PS3.2 Table N.5-81*

83 **Table N.5-81. Header Fields for Store Transaction - Origin Server**

Header Field	Supported Values	Comments
Content-Type	multipart/related; type="application/dicom"; boundary={messageBoundary} multipart/related; type="application/dicom+xml"; boundary={messageBoundary} multipart/related; type="application/dicom+json"; boundary={messageBoundary} multipart/related; type="application/octet-stream"	See in the Overview section Table N.1-1 the supported DICOM SOP Classes / Transfer syntaxes (look for "Y" in the "OS" column)
	multipart/related; type="application/dicom+xml"; boundary={messageBoundary} multipart/related; type="application/dicom+json"; boundary={messageBoundary}	

	Uncompressed: multipart/related; type="application/octet-stream" *Compressed:* *multipart/related; type="{media-type}"* *supported {media-type} being* *<<Image/jpeg* *image/x-dicom-rle* *image/x-jls* *image/jp2* *image/jphc* ***image/jxl*** *image/jpx* *video/mpeg2* *video/mp4>>*	See details in Section N.5.3.2.1.2.
Content-Length		*[If Content-Encoding is not present.]*

Update PS3.3 Section 2.1

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

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[ISO/IEC 15444-15] ISO/IEC. 2019. JPEG 2000 Image Coding System — Part 15: High-Throughput JPEG 2000.

[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/IEC 18181-1] ISO/IEC. 2022. Information technology - JPEG XL Image Coding System - Part 1 Core Coding System.

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Update PS3.3 C.7.6.1.1.5.1

C.7.6.1.1.5.1 Lossy Image Compression Method

Lossy Image Compression Method (0028,2114) may be multi-valued if successive lossy compression steps have been applied; the value order shall correspond to the values of Lossy Image Compression Ratio (0028,2112), if present.

Defined Terms for Lossy Image Compression Method (0028,2114):

ISO_10918_1

JPEG Lossy Compression [ISO/IEC 10918-1]

ISO_15444_15

JPEG 2000 image coding system — Part 15: High-Throughput JPEG 2000 [ISO/IEC 15444-15]

ISO_18181_1

JPEG XL Lossy Compression [ISO/IEC 18181-1]

ISO_14495_1

JPEG-LS Near-lossless Compression [ISO/IEC 14495-1]

ISO_15444_1

JPEG 2000 Irreversible Compression [ISO/IEC 15444-1]

ISO_13818_2

MPEG2 Compression [ISO/IEC 13818-2]

ISO_14496_10

MPEG-4 AVC/H.264 Compression [ISO/IEC 14496-10]

ISO_23008_2

HEVC/H.265 Lossy Compression [ISO/IEC 23008-2]

Update PS 3.3 Section C.7.6.3.1.2

C.7.6.3.1.2 Photometric Interpretation

The value of Photometric Interpretation (0028,0004) specifies the intended interpretation of the image pixel data.

See PS3.5 for additional restrictions imposed by compressed Transfer Syntaxes.

See Section 8.2.13 in PS3.5 for constraints that apply when using DICOM Real-Time Video.

The following values are defined. Other values are permitted if supported by the Transfer Syntax but the meaning is not defined by this Standard.

Defined Terms:

MONOCHROME1

Pixel data represent a single monochrome image plane. The minimum sample value is intended to be displayed as white after any VOI gray scale transformations have been performed. See PS3.4. This value may be used only when Samples per Pixel (0028,0002) has a value of 1. May be used for pixel data in a Native (uncompressed) or Encapsulated (compressed) format; see Section 8.2 in PS3.5 .

MONOCHROME2

Pixel data represent a single monochrome image plane. The minimum sample value is intended to be displayed as black after any VOI gray scale transformations have been performed. See PS3.4. This value may be used only when Samples per Pixel (0028,0002) has a value of 1. May be used for pixel data in a Native (uncompressed) or Encapsulated (compressed) format; see Section 8.2 in PS3.5 .

PALETTE COLOR

Pixel data describe a color image with a single sample per pixel (single image plane). The pixel value is used as an index into each of the Red, Blue, and Green Palette Color Lookup Tables (0028,1101-1103&1201-1203). This value may be used only when Samples per Pixel (0028,0002) has a value of 1. May be used for pixel data in a Native (uncompressed) or Encapsulated (compressed) format; see Section 8.2 in PS3.5 . When the Photometric Interpretation is Palette Color; Red, Blue, and Green Palette Color Lookup Tables shall be present.

RGB

Pixel data represent a color image described by red, green, and blue image planes. The minimum sample value for each color plane represents minimum intensity of the color. This value may be used only when Samples per Pixel (0028,0002) has a value of 3. Planar Configuration (0028,0006) may be 0 or 1. May be used for pixel data in a Native (uncompressed) or Encapsulated (compressed) format; see Section 8.2 in PS3.5 .

HSV

Retired.

ARGB

Retired.

CMYK

Retired.

XYB

XYB is a long/medium/short wavelength (LMS) based color model inspired by the human visual system, facilitating perceptually uniform quantization. It uses a gamma of 3 for computationally efficient decoding. The exact details of the XYB encoding are defined as part of specific image being encoded in order to optimize image fidelity. Images in XYB transcoded to other Transfer Syntaxes will use RGB or the appropriate equivalent (eg YBR_FULL_422 for JPEG).

Note:

This is the color space used in JPEG XL [ISO 18181-1]

YBR_FULL

Pixel data represent a color image described by one luminance (Y) and two chrominance planes (CB and CR). This photometric interpretation may be used only when Samples per Pixel (0028,0002) has a value of 3. May be used for pixel data in a Native (uncompressed) or Encapsulated (compressed) format; see Section 8.2 in PS3.5 . Planar Configuration (0028,0006) may be 0 or 1.

This Photometric Interpretation is primarily used with RLE compressed bit streams, for which the Planar Configuration (0028,0006) may be 0 or 1; see Section 8.2.2 in PS3.5 and Section G.2 in PS3.5 . When used in the US Image Module, the Planar Configuration (0028,0006) is required to be 1; see Section C.8.5.6.1.16 “Planar Configuration”.

Black is represented by Y equal to zero. The absence of color is represented by both CB and CR values equal to half full scale.

Note

In the case where Bits Allocated (0028,0100) has value of 8 half full scale is 128.

In the case where Bits Allocated (0028,0100) has a value of 8 then the following equations convert between RGB and YCBCR Photometric Interpretation.

Y = + .2990R + .5870G + .1140B

CB= - .1687R - .3313G + .5000B + 128

CR= + .5000R - .4187G - .0813B + 128

Note

The above is based on CCIR Recommendation 601-2 dated 1990.

YBR_FULL_422

The same as YBR_FULL except that the CB and CR values are sampled horizontally at half the Y rate and as a result there are half as many CB and CR values as Y values.

Planar Configuration (0028,0006) shall be 0. May be used for pixel data in a Native (uncompressed) or Encapsulated (compressed) format; see Section 8.2 in PS3.5 .

Note

This Photometric Interpretation is primarily used with JPEG compressed bit streams, but is also occasionally used for pixel data in a Native (uncompressed) format.

Though the chrominance channels are downsampled, there are still nominally three channels, hence Samples per Pixel (0028,0002) has a value of 3, not 2. I.e., for pixel data in a Native (uncompressed) format, the Value Length of Pixel Data (7FE0,0010) is not:

Rows (0028,0010) * Columns (0028,0011) * Number of Frames (0028,0008) * Samples per Pixel (0028,0002) * (⌊(Bits Allocated (0028,0100)-1)/8⌋+1)

padded to an even length, as it would otherwise be, but rather is:

Rows (0028,0010) * Columns (0028,0011) * Number of Frames (0028,0008) * 2 * (⌊(Bits Allocated (0028,0100)-1)/8⌋+1)

padded to an even length.

When used to describe JPEG compressed bit streams, the chrominance sub-sampling in the JPEG bit stream may differ from this description. E.g., though many JPEG codecs produce only horizontally sub-sampled chrominance components (4:2:2), some sub-sample vertically as well (4:2:0). Though inaccurate, the use of YBR_FULL_422 to describe both has proven harmless. For a discussion of the sub-sampling notation, see [Poynton 2008].

Two Y values shall be stored followed by one CB and one CR value. The CB and CR values shall be sampled at the location of the first of the two Y values. For each Row of Pixels, the first CB and CR samples shall be at the location of the first Y sample. The next CB and CR samples shall be at the location of the third Y sample etc.

Note

This subsampling sited on the even luminance pixels is often referred to as cosited sampling. The cositing applies when describing pixel data in a Native (uncompressed) form. When used to describe compressed bit streams, the siting depends on the compression scheme. E.g., for JPEG according to JFIF [ISO/IEC 10918-5], the siting is midway between luminance samples, whereas for MPEG2 [ISO/IEC 13818-2], the sampling is cosited with the even luminance pixels. See also [Poynton 2008].

YBR_PARTIAL_422

Retired. See PS3.3-2017b.

YBR_PARTIAL_420

Pixel data represent a color image described by one luminance (Y) and two chrominance planes (CB and CR).

This photometric interpretation may be used only when Samples per Pixel (0028,0002) has a value of 3. The CB and CR values are sampled horizontally and vertically at half the Y rate and as a result there are four times less CB and CR values than Y values.

Planar Configuration (0028,0006) shall be 0. Shall only be used for pixel data in an Encapsulated (compressed) format; see Section 8.2 in PS3.5 .

Note

This Photometric Interpretation is primarily used with MPEG compressed bit streams. For a discussion of the sub-sampling notation and siting, see [Poynton 2008].

Luminance and chrominance values are represented as follows:

black corresponds to Y = 16;

Y is restricted to 220 levels (i.e., the maximum value is 235);

CB and CR each has a minimum value of 16;

CB and CR are restricted to 225 levels (i.e., the maximum value is 240);

lack of color is represented by CB and CR equal to 128.

In the case where Bits Allocated (0028,0100) has value of 8 then the following equations convert between RGB and YBR_PARTIAL_420 Photometric Interpretation

Y = + .2568R + .5041G + .0979B + 16

CB= - .1482R - .2910G + .4392B + 128

CR= + .4392R - .3678G - .0714B + 128

Note

The above is based on CCIR Recommendation 601-2 dated 1990.

The CB and CR values shall be sampled at the location of the first of the two Y values. For the first Row of Pixels (etc.), the first CB and CR samples shall be at the location of the first Y sample. The next CB and CR samples shall be at the location of the third Y sample etc. The next Rows of Pixels containing CB and CR samples (at the same locations than for the first Row) will be the third etc.

YBR_ICT

Irreversible Color Transformation:

Pixel data represent a color image described by one luminance (Y) and two chrominance planes (CB and CR).

This photometric interpretation may be used only when Samples per Pixel (0028,0002) has a value of 3. Planar Configuration (0028,0006) shall be 0. Shall only be used for pixel data in an Encapsulated (compressed) format; see Section 8.2 in PS3.5 .

Note

This Photometric Interpretation is primarily used with JPEG 2000 compressed bit streams.

Black is represented by Y equal to zero. The absence of color is represented by both CB and CR values equal to zero.

Regardless of the value of Bits Allocated (0028,0100), the following equations convert between RGB and YCBCR Photometric Interpretation.

Y = + .29900R + .58700G + .11400B

CB= - .16875R - .33126G + .50000B

CR= + .50000R - .41869G - .08131B

Note

The above is based on [ISO/IEC 15444-1] (JPEG 2000).

In a JPEG 2000 bit stream, DC level shifting (used if the untransformed components are unsigned) is applied before forward color transformation, and the transformed components may be signed (unlike in JPEG ISO/IEC 10918-1).

In JPEG 2000, spatial down-sampling of the chrominance components, if performed, is signaled in the JPEG 2000 bit stream.

YBR_RCT

Reversible Color Transformation:

Pixel data represent a color image described by one luminance (Y) and two chrominance planes (CB and CR).

This photometric interpretation may be used only when Samples per Pixel (0028,0002) has a value of 3. Planar Configuration (0028,0006) shall be 0. Shall only be used for pixel data in an Encapsulated (compressed) format; see Section 8.2 in PS3.5 .

Note

This Photometric Interpretation is primarily used with JPEG 2000 compressed bit streams.

Black is represented by Y equal to zero. The absence of color is represented by both CB and CR values equal to zero.

Regardless of the value of Bits Allocated (0028,0100), the following equations convert between RGB and YBR_RCT Photometric Interpretation.

$Y = \lfloor (R + 2G + B) / 4 \rfloor$ (Note: $\lfloor \ldots \rfloor$ mean floor)

$CB = B - G$

$CR = R - G$

The following equations convert between YBR_RCT and RGB Photometric Interpretation.

$G = Y - \lfloor (CR + CB) / 4 \rfloor$

R = CR+ G

B = CB+ G

Note

The above is based on [ISO/IEC 15444-1] (JPEG 2000).

In a JPEG 2000 bit stream, DC level shifting (used if the untransformed components are unsigned) is applied before forward color transformation, and the transformed components may be signed (unlike in JPEG ISO/IEC 10918-1).

This photometric interpretation is a reversible approximation to the YUV transformation used in PAL and SECAM.

Update PS3.5 Section 2

2 Normative References

The following standards contain provisions that, through references in this text, constitute provisions of this Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this Standard are encouraged to investigate the possibilities of applying the most recent editions of the standards indicated below.

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[ISO/IEC 15444-9] ISO/IEC. 2005. Information technology - JPEG 2000 image coding system: Interactivity tools, APIs and protocols.

[ISO/IEC 15444-15] ISO/IEC. 2019. Information technology - JPEG 2000 image coding system — Part 15: High-Throughput JPEG 2000

[ISO/IEC 18181-1] ISO/IEC. 2022. Information technology - JPEG XL Image Coding System - Part 1.

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Add PS3.5 Sections 8.2.X (choose X based on insert point)

8.2.X JPEG XL Image Compression

DICOM provides a mechanism for supporting the use of JPEG XL Image Compression through the Encapsulated Format. Annex A defines a number of Transfer Syntaxes that reference the JPEG XL Standard. The JPEG XL Lossless Transfer Syntax provides a compression scheme that preserves the bits of the original image, i.e., lossless. The JPEG XL JPEG Recompression Transfer Syntax preserves the bits of the (lossy) JPEG encoding. The JPEG XL Transfer Syntax is a potentially lossy compression of the original image.

Note

The context where the usage of lossy compression of medical images is clinically acceptable is beyond the scope of the DICOM Standard. The policies associated with the selection of appropriate compression parameters (e.g., compression ratio) for JPEG XL lossy compression are also beyond the scope of this Standard.

The use of the DICOM Encapsulated Format to support JPEG XL 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 XL bit stream shall be used to decode the compressed data stream.

The requirements when using a Standard Photometric Interpretation (i.e., a Defined Term from PS.3. C.7.6.3.1.2) are specified in Table 8.2.4-1. No other Standard Photometric Interpretation values shall be used.

Table 8.2.X-1. Valid Values of Pixel Data Related Attributes for JPEG XL Transfer Syntaxes using Standard Photometric Interpretations

Photometric Interpretation	Transfer Syntax	Transfer Syntax UID	Samples per Pixel	Planar Configuration	Pixel Representation	Bits Allocated	Bits Stored	High Bit
MONOCHROME1 MONOCHROME2	JPEG XL Lossless JPEG XL	1.2.840.10008.1.2.4.XX0 1.2.840.10008.1.2.4.XX2	1	absent	0 or 1	1,8,16,24	1-24	0-23
MONOCHROME2	JPEG XL JPEG Recompression	1.2.840.10008.1.2.4.XX1	1	absent	0	8	8	7

XYB YBR_RCT RGB	JPEG XL Lossless JPEG XL Lossy	1.2.840.10008.1.2.4.XX0 1.2.840.10008.1.2.4.XX2	3	0	0	8,16,24	8-24	7-23
YBR_FULL_422 XYB RGB	JPEG XL JPEG Recompression	1.2.840.10008.1.2.4.XX1	3	0	0	8	8	7

Note

1. These requirements are specified in terms of consistency with what is encapsulated, rather than in terms of the uncompressed pixel data from which the compressed data stream may have been derived.

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.

PS3.3 may constrain the values of Photometric Interpretation for specific IODs.

The JPEG XL bit stream is capable of encoding both signed and unsigned pixel values, hence the value of Pixel Representation (0028,0103) may be either 0 or 1 for monochrome Photometric Interpretations depending on what has been encoded.

The value of Planar Configuration (0028,0006) is irrelevant since the manner of encoding components is specified in the JPEG 2000 standard, hence it shall be set to 0.

Add PS3.5 Sections 10.X

10.X Transfer Syntax for a DICOM Default of Lossless and Lossy JPEG XL Compression

One Transfer Syntax is specified for JPEG XL Lossless Image Compression, one for JPEG XL JPEG Recompression, which allows for transcoding JPEG encoded data without additional loss, and a general JPEG XL Image Compression scheme for any JPEG XL encoded data. Any of these may be negotiated separately and there is no default or baseline specified (other than as described in Section 10.1).

Note:

When a JPEG baseline encoded image is transcoded to JPEG XL, if the JPEG XL JPEG Recompression Transfer Syntax is used rather than the JPEG XL Transfer Syntax, then it is known that the exact bitwise representation of JPEG may be recovered.

Add PS3.5 Section A.4.X

A.4.X JPEG XL Image Compression

The International Standards Organization ISO/IEC has developed an International Standard, [ISO/IEC 18181-1] (JPEG XL) for coding of bi-level, continuous-tone grayscale, or continuous-tone color, or multichannel digital images (see Annex F for further details).

A DICOM Transfer Syntax for JPEG XL Image Compression shall be identified by a UID value, appropriate to its JPEG XL coding process.

Three Transfer Syntaxes are specified for JPEG XL:

1. A Transfer Syntax with a UID of "1.2.840.10008.1.2.4.XX0 ", which specifies the use of the lossless mode of JPEG XL.

2. A Transfer Syntax with a UID of "1.2.840.10008.1.2.4.XX1", which specifies the use of Reversible JPEG transcoding.

3. A Transfer Syntax with a UID of “1.2.840.10008.1.2.4.XX2”, which specifies the use of the lossy, lossless or JPEG recompression mode of JPEG XL

If the SOP Class is a multi-frame object, then each frame shall be encoded separately. Each fragment shall contain encoded data from a single frame.

Note

Encoding each frame in a single fragment limits the total frame size to just under 4 gb.

A JPEG baseline image re-coded to JPEG XL is not a derived image unless the original JPEG image was a derived image, and does not require Derivation Code Sequence (0008,9215) to be added. Lossy Image Compression Ratio (0028,2112) and Lossy Image Compression Method (0028,2114) shall be updated if additional lossy compression is performed.

Add PS3.5 Section F.X

F.X Encapsulated JPEG XL Encoded Images

The International Standards Organization (ISO/IEC) has prepared an International Standard, ISO/IEC 18181-1 (JPEG XL), for the digital compression and coding of continuous-tone still images. This standard is known as the JPEG XL Standard.

A JPEG XL stream allows for bit depths up to 24 bits and up to 8192 components. Components do not need to all be the same type or bit depth. The color space of the image is specified in the JPEG XL encoding.

Inclusion of a JPEG XL coded image in a DICOM message is facilitated by the use of specific Transfer Syntaxes that are defined in Annex A.

Update PS 3.6 Table A- 1

Table A-1. UID Values

UID Value	UID Name	UID Keyword	UID Type	Part
1.2.840.10008.1.1	Verification SOP Class	Verification	SOP Class	PS3.4
...				
1.2.840.10008.1.XX0	**JPEG XL Lossless**	**JPEGXLLossless**	**Transfer Syntax**	**PS3.5**
1.2.840.10008.1.XX1	**JPEG XL JPEG Recompression**	**JPEGXLJPEGRecompression**	**Transfer Syntax**	**PS3.5**
1.2.840.10008.1.XX2	**JPEG XL Lossy**	**JPEGXLLossy**	**Transfer Syntax**	**PS3.5**

Update PS 3.18 Table 8.7.3-2

491 **Table 8.7.3-2. Transfer Syntax UIDs for application/dicom Media Types**

492

Category	Transfer Syntax UID	Transfer Syntax Name	Optionality
Single Frame Image	1.2.840.10008.1.2.1	Explicit VR Little Endian	D
	1.2.840.10008.1.2.4.70	JPEG Lossless, Non-Hierarchical, First-Order Prediction(Process 14 [Selection Value 1]): Default Transfer Syntax for Lossless JPEG Image Compression	O
	1.2.840.10008.1.2.4.50	JPEG Baseline (Process 1): Default Transfer Syntax for Lossy JPEG 8 Bit Image Compression	O
	1.2.840.10008.1.2.4.51	JPEG Extended (Process 2 & 4): Default Transfer Syntax for Lossy JPEG 12 Bit Image Compression (Process 4 only)	O
	1.2.840.10008.1.2.4.57	JPEG Lossless, Non-Hierarchical (Process 14)	O
	1.2.840.10008.1.2.5	RLE Lossless	O
	1.2.840.10008.1.2.4.80	JPEG-LS Lossless Image Compression	O
	1.2.840.10008.1.2.4.81	JPEG-LS Lossy (Near-Lossless) Image Compression	O
	1.2.840.10008.1.2.4.90	JPEG 2000 Image Compression (Lossless Only)	O
	1.2.840.10008.1.2.4.91	JPEG 2000 Image Compression	O
	1.2.840.10008.1.2.4.92	JPEG 2000 Part 2 Multi-component Image Compression (Lossless Only)	O
	1.2.840.10008.1.2.4.93	JPEG 2000 Part 2 Multi-component Image Compression	O
	1.2.840.10008.1.2.4.XX0	**JPEG XL Lossless**	**O**

	1.2.840.10008.1.2.4.XX1	**JPEG XL JPEG Recompression**	**O**
	1.2.840.10008.1.2.4.XX2	**JPEG XL Lossy**	**O**
Multi-frame Image	1.2.840.10008.1.2.1	Explicit VR Little Endian	D
	1.2.840.10008.1.2.4.90	JPEG 2000 Image Compression (Lossless Only)	O
	1.2.840.10008.1.2.4.91	JPEG 2000 Image Compression	O
	1.2.840.10008.1.2.4.92	JPEG 2000 Part 2 Multi-component Image Compression (Lossless Only)	O
	1.2.840.10008.1.2.4.93	JPEG 2000 Part 2 Multi-component Image Compression	O
	1.2.840.10008.1.2.4.XX0	**JPEG XL Lossless**	**O**
	1.2.840.10008.1.2.4.XX1	**JPEG XL JPEG Recompression**	**O**
	1.2.840.10008.1.2.4.XX2	**JPEG XL Lossy**	**O**
Video	1.2.840.10008.1.2.1	Explicit VR Little Endian	D
	1.2.840.10008.1.2.4.100	MPEG2 Main Profile @ Main Level	O
	1.2.840.10008.1.2.4.101	MPEG2 Main Profile @ High Level	O
	1.2.840.10008.1.2.4.102	MPEG-4 AVC/H.264 High Profile / Level 4.1	O
	1.2.840.10008.1.2.4.103	MPEG-4 AVC/H.264 BD-compatible High Profile / Level 4.1	O

	1.2.840.10008.1.2.4.104	MPEG-4 AVC/H.264 High Profile / Level 4.2 For 2D Video	O
	1.2.840.10008.1.2.4.105	MPEG-4 AVC/H.264 High Profile / Level 4.2 For 3D Video	O
	1.2.840.10008.1.2.4.106	MPEG-4 AVC/H.264 Stereo High Profile / Level 4.2	O
	1.2.840.10008.1.2.4.100.1	Fragmentable MPEG2 Main Profile @ Main Level	O
	1.2.840.10008.1.2.4.101.1	Fragmentable MPEG2 Main Profile @ High Level	O
	1.2.840.10008.1.2.4.102.1	Fragmentable MPEG-4 AVC/H.264 High Profile / Level 4.1	O
	1.2.840.10008.1.2.4.103.1	Fragmentable MPEG-4 AVC/H.264 BD-compatible High Profile / Level 4.1	O
	1.2.840.10008.1.2.4.104.1	Fragmentable MPEG-4 AVC/H.264 High Profile / Level 4.2 For 2D Video	O
	1.2.840.10008.1.2.4.105.1	Fragmentable MPEG-4 AVC/H.264 High Profile / Level 4.2 For 3D Video	O
	1.2.840.10008.1.2.4.106.1	Fragmentable MPEG-4 AVC/H.264 Stereo High Profile / Level 4.2	O
	1.2.840.10008.1.2.4.107	HEVC/H.265 Main Profile / Level 5.1	O
	1.2.840.10008.1.2.4.108	HEVC/H.265 Main 10 Profile / Level 5.1	O
Text	1.2.840.10008.1.2.1	Explicit VR Little Endian	D
Other	1.2.840.10008.1.2.1	Explicit VR Little Endian	D

493 Note

494 The Transfer Syntaxes used in a DICOM-RTV Metadata Flow are not included, since they are not used to
495 produce a representation of an Instance encoded in the DICOM File Format.

Update PS 3.18 Table 8.7.3-5

Table 8.7.3-5. Media Types and Transfer Syntax UIDs for Compressed Data in Bulkdata

Resource Category	Media Type	Transfer Syntax UID	Transfer Syntax Name	Optionality
Single Frame Image	image/jpeg	1.2.840.10008.1.2.4.70	JPEG Lossless, Non-Hierarchical, First-Order Prediction(Process 14 [Selection Value 1]) :Default Transfer Syntax for Lossless JPEG Image Compression	D
		1.2.840.10008.1.2.4.50	JPEG Baseline (Process 1) :Default Transfer Syntax for Lossy JPEG 8 Bit Image Compression	O
		1.2.840.10008.1.2.4.51	JPEG Extended (Process 2 & 4) :Default Transfer Syntax for Lossy JPEG 12 Bit Image Compression (Process 4 only)	O

		1.2.840.10008.1.2.4.57	JPEG Lossless, Non-Hierarchical (Process 14)	O
	image/dicom-rle	1.2.840.10008.1.2.5	RLE Lossless	D
	image/jls	1.2.840.10008.1.2.4.80	JPEG-LS Lossless Image Compression	D
		1.2.840.10008.1.2.4.81	JPEG-LS Lossy (Near-Lossless) Image Compression	O
	image/jp2	1.2.840.10008.1.2.4.90	JPEG 2000 Image Compression (Lossless Only)	D
		1.2.840.10008.1.2.4.91	JPEG 2000 Image Compression	O
	image/jpx	1.2.840.10008.1.2.4.92	JPEG 2000 Part 2 Multi-component Image Compression (Lossless Only)	D
		1.2.840.10008.1.2.4.93	JPEG 2000 Part 2 Multi-component Image Compression	O
	image/jxl	**1.2.840.10008.1.2.4.XX0**	**JPEG XL Lossless**	**D**

		1.2.840.10008.1.2.4.XX1	**JPEG XL JPEG Recompression**	**O**
		1.2.840.10008.1.2.4.XX2	**JPEG XL Lossy**	**O**
Multi-frame Image	image/jpeg	1.2.840.10008.1.2.4.70	JPEG Lossless, Non-Hierarchical, First-Order Prediction(Process 14 [Selection Value 1]) :Default Transfer Syntax for Lossless JPEG Image Compression	D
		1.2.840.10008.1.2.4.50	JPEG Baseline (Process 1) :Default Transfer Syntax for Lossy JPEG 8 Bit Image Compression	O
		1.2.840.10008.1.2.4.51	JPEG Extended (Process 2 & 4) :Default Transfer Syntax for Lossy JPEG 12 Bit Image Compression (Process 4 only)	O
		1.2.840.10008.1.2.4.57	JPEG Lossless, Non-Hierarchical (Process 14)	O

	image/dicom-rle	1.2.840.10008.1.2.5	RLE Lossless	D
	image/jls	1.2.840.10008.1.2.4.80	JPEG-LS Lossless Image Compression	D
		1.2.840.10008.1.2.4.81	JPEG-LS Lossy (Near-Lossless) Image Compression	O
	image/jp2	1.2.840.10008.1.2.4.90	JPEG 2000 Image Compression (Lossless Only)	D
		1.2.840.10008.1.2.4.91	JPEG 2000 Image Compression	O
	image/jpx	1.2.840.10008.1.2.4.92	JPEG 2000 Part 2 Multi-component Image Compression (Lossless Only)	D
		1.2.840.10008.1.2.4.93	JPEG 2000 Part 2 Multi-component Image Compression	O
	image/jxl	**1.2.840.10008.1.2.4.XX0**	**JPEG XL Lossless**	**D**
		1.2.840.10008.1.2.4.XX1	**JPEG XL JPEG Recompression**	**O**

		1.2.840.10008.1.2.4.XX1	**JPEG XL Lossy**	**O**
Video	video/mpeg2	1.2.840.10008.1.2.4.100	MPEG2 Main Profile @ Main Level	O
		1.2.840.10008.1.2.4.101	MPEG2 Main Profile @ High Level	D
	video/mp4	1.2.840.10008.1.2.4.102	MPEG-4 AVC/H.264 High Profile / Level 4.1	D
		1.2.840.10008.1.2.4.103	MPEG-4 AVC/H.264 BD-compatible High Profile / Level 4.1	O
		1.2.840.10008.1.2.4.104	MPEG-4 AVC/H.264 High Profile / Level 4.2 For 2D Video	O
		1.2.840.10008.1.2.4.105	MPEG-4 AVC/H.264 High Profile / Level 4.2 For 3D Video	O
		1.2.840.10008.1.2.4.106	MPEG-4 AVC/H.264 Stereo High Profile / Level 4.2	O
Text		N/A (no defined compression transfer syntaxes for Text)		

Other		N/A (no defined compression transfer syntaxes for Other)	

Update PS 3.18 Section 8.7.3.5

8.7.3.5 Media Type Syntax

The syntax of Media Type usage in DICOM is:

dicom-media-type = (dcm-singlepart / dcm-multipart) [dcm-parameters]

Where

dcm-singlepart = dcm-mt-name

dcm-multipart ;see Section 8.7.3.5.1

dcm-parameters = transfer-syntax-mtp ;see Section 8.7.3.5.2

/ charset-mtp;see Section 8.7.3.5.3

dcm-mt-name = dicom / dicom-metadata / bulkdata / pixeldata ;DICOM Media Type name

dicom = "application/dicom"

dicom-metadata = dicom-xml / dicom-json

dicom-xml = "application/dicom+xml"

dicom-json = "application/dicom+json"

bulkdata = octet-stream / pixeldata

octet-stream = "application/octet-stream"

pixeldata = image-pixel / video-pixel

rendered = image-pixel / video-pixel

image-pixel = "image/jpeg" / "image/dicom-rle" / "image/jls" / "image/jp2" / "image/jpx" **/ "image/jxl"**

Update PS 3.18 Section 8.7.4

525 **8.7.4 Rendered Media Types**

526 8.7.4 Rendered Media Types

527 DICOM Instances may be converted by a rendering process into non-DICOM Media Types. This can be
528 useful to display or process them using non-DICOM software, such as browsers.

529

530 For example, an Instance containing:

531 an image could be rendered into the image/jpeg**, image/jxl,** or image/png Rendered Media Types.

532 a multi-frame image in a lossless Transfer Syntax could be rendered into a video/mpeg or video/mp4 **or**
533 **image/jxl** Rendered Media Type.

534 a Structured Report could be rendered into a text/html, text/plain, or application/pdf Rendered Media
535 Type.

536

537 Note

538 Rendered Media Types are usually consumer format media types. Some of the same non-DICOM Media
539 Types are also used as Bulkdata Media Types, that is, for encoding Bulkdata extracted from Encapsulated
540 Pixel Data (used with compressed Transfer Syntaxes), without applying a rendering process. See Section
541 8.7.3.3.

542

543 Rendered images shall contain no more than 8 bits per channel.

544

545 Origin servers shall support rendering Instances of different Resource Categories into Rendered Media
546 Types as specified in Table 8.7.4-1.

547

548 Table 8.7.4-1. Rendered Media Types by Resource Category

Category	Media Type	URI	RESTful
Single Frame Image	image/jpeg	D	D
	image/gif	O	R
	image/png	O	R
	image/jp2	O	O

Category	Media Type	URI	RESTful
	image/jxl	**O**	**O**
Multi-frame Image	image/gif	O	O
	image/jxl	**O**	**O**
Video	video/mpeg	O	O
	video/mp4	O	O
	video/H265	O	O
Text	text/html	D	D
	text/plain	R	R
	text/xml	O	R
	text/rtf	O	O
	application/pdf	O	O

549

550

551