

Digital Imaging and Communications in Medicine (DICOM)

Supplement 232

JPEG XL Transfer Syntax

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Table of Contents

Document History	3
Open Issues	3
Closed Issues	3
Scope and Field of Application	4
C.7.6.1.1.5.1 Lossy Image Compression Method	4
C.7.6.3.1.2 Photometric Interpretation	Error! Bookmark not defined.
8.2.X JPEG XL Image Compression	6
10.18 Transfer Syntax for a DICOM Default of Lossless and Lossy JPEG XL Compression	8
A.4.12 JPEG XL Image Compression	8
8.7.3.5 Media Type Syntax	20
8.7.4 Rendered Media Types	21
8.7.4 Rendered Media Types	21
8.7.5 Acceptable Media Types	Error! Bookmark not defined.

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	Version 2	WEW	Updated version with WG-04 comments

Open Issues

1.	<p>Should floating point rendered 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.</p> <p>Proposed solution: David Clunie to update this supplement with 32 bit floating point suggestion.</p>
4.	
5.	

Closed Issues

1.	<p>Should JPEG-XL be allowed as a DICOMweb /rendered 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.</p>
2	<p>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.</p>
3	<p>Should rendered images permit JPEG-XL lossless 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.</p>
4	<p>Is it ok to limit the size of each frame to 4 gb for the convenience of limiting each frame to one fragment? Yes.</p>

This simplifies decoding/handling of JPEG XL	
5	Should PALETTE_COLOR be permitted, as JPEG XL supports palette color directly in a way different from the DICOM standard? No Palette color is a specific encoding mostly used internally by RLE. The palette colour 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.

Scope and Field of Application

This supplement covers the addition of the JPEG XL Transfer Syntax to Part 5, not available with other DICOM compression formats.

- JPEG XL has good support for color images, allowing fully defined color spaces to be specified
- Supports multi-frame encoding much more effectively than gif, the only other multiframe rendered format
- JPEG XL has both lossless and lossy modes which can be direct rendered in the browser
- Supports multi-channel encoding

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

Update PS 3.3 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 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]

Note on PS 3.3 Section C.7.6.3.1.2 - although the internal encoding may use XYZ, this is an internal detail of encoding RGB or YBR, so there is no need to include XYZ as a PMI

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, ie lossless. The JPEG XL JPEG Recompression transfer syntax preserves the bits of the JPEG encoding, which is a lossy representation of the original image. The JPEG XL Lossy syntax is a 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 Lossy	1.2.840.1000 8.1.2.4.XX0 1.2.840.1000 8.1.2.4.XX2	1	absent	0 or 1	8,16,24	8-24	7-23

MONOCHROME2 (JPEG Recompression)	JPEG XL JPEG Recompression	1.2.840.1000 8.1.2.4.XX1	1	absent	0 or 1	8	8	7
MONOCHROME2 (single bit)	JPEG XL Lossless	1.2.840.1000 8.1.2.4.XX0	1	absent	0	1	1	0
RGB	JPEG XL Lossless JPEG XL Lossy JPEG XL JPEG Recompression	1.2.840.1000 8.1.2.4.XX0 1.2.840.1000 8.1.2.4.XX2 1.2.840.1000 8.1.2.4.XX1	3	0	0	8,16,2 4	8-24	7-23
YBR_FULL_422	JPEG XL JPEG Recompression	1.2.840.1000 8.1.2.4.XX1	3	0	0	8	8	7

TODO - add table describing the floating point encoding - David Clunie to add this here

Note

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 10.18

10.18 Transfer Syntax for a DICOM Default of Lossless and Lossy JPEG XL Compression

One Transfer Syntax is specified for JPEG XL Lossless Image Compression, and two Transfer Syntaxes are specified for JPEG XL Lossy Image Compression; the second of these is to specify the JPEG XL compression mode allowing for lossless transcoding to baseline JPEG. The JPEG XL Lossless Transfer Syntax shall be supported as a baseline if the JPEG XL Lossy Transfer Syntax is supported.

If a JPEG baseline encoded image is transcoded to JPEG XL, it is suggested to use the JPEG Recompression mode for JPEG to avoid further loss of data, and preserve exact bitwise reconstruction of JPEG.

Add PS3.5 Section A.4.12

A.4.12 JPEG XL Image Compression

The International Standards Organization ISO/IEC has developed an International Standard, [ISO/IEC 18181_1] (JPEG XL), for digital compression and coding of continuous-tone and overlay/monochromatic 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 lossy JPEG XL in the exact JPEG bitstream recompression mode.
3. A Transfer Syntax with a UID of "1.2.840.10008.1.2.4.XX2", which specifies the use of lossy JPEG XL encoding.

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 according to their definitions in PS3.3.

Add PS3.5 Section F.4

F.4 Encapsulated JPEG XL Encoded Images

The International Standards Organization (ISO/IEC) has prepared an International Standard, ISO/IEC 18181 (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-

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	<u>PS3.4</u>
...				

<u>1.2.840.10008.1.XX0</u>	<u>JPEG XL Lossless</u>	<u>JPEGXLLossless</u>	<u>Transfer Syntax</u>	<u>PS3.5</u>
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<u>1.2.840.10008.1.XX1</u>	<u>JPEG XL JPEG Recompression</u>	<u>JPEGXLJPEGRecompression</u>	<u>Transfer Syntax</u>	<u>PS3.5</u>
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<u>1.2.840.10008.1.XX2</u>	<u>JPEG XL Lossy</u>	<u>JPEGXLLossy</u>	<u>Transfer Syntax</u>	<u>PS3.5</u>
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Update PS 3.18 Table 8.7.3-2

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

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
	<u>1.2.840.10008.1.2.4.XX0</u>	<u>JPEG XL Lossless</u>	<u>O</u>

	<u>1.2.840.10008.1.2.4.X X1</u>	JPEG XL JPEG Recompression	<u>O</u>
	<u>1.2.840.10008.1.2.4.X X2</u>	JPEG XL Lossy	<u>O</u>
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
	<u>1.2.840.10008.1.2.4.X X0</u>	JPEG XL Lossless	<u>O</u>
	<u>1.2.840.10008.1.2.4.X X1</u>	JPEG XL JPEG Recompression	<u>O</u>
	<u>1.2.840.10008.1.2.4.X X2</u>	JPEG XL Lossy	<u>O</u>
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

Note

The Transfer Syntaxes used in a DICOM-RTV Metadata Flow are not included, since they are not used to 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 UUIDs 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
	<u>image/jxl</u>	<u>1.2.840.10008.1.2.4.XX0</u>	<u>JPEG XL Lossless</u>	<u>D</u>

		<u>1.2.840.10008.1.2.4.XX1</u>	<u>JPEG XL JPEG Recompression</u>	<u>O</u>
		<u>1.2.840.10008.1.2.4.XX2</u>	<u>JPEG XL Lossy</u>	<u>O</u>
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
	<u>image/jxl</u>	<u>1.2.840.10008.1.2.4.XX0</u>	<u>JPEG XL Lossless</u>	<u>D</u>
		<u>1.2.840.10008.1.2.4.XX1</u>	<u>JPEG XL JPEG Recompression</u>	<u>O</u>

		<u>1.2.840.10008.1.2.4.XX1</u>	<u>JPEG XL Lossy</u>	<u>O</u>
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)	
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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

8.7.4 Rendered Media Types

8.7.4 Rendered Media Types

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

For example, an Instance containing:

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

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

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

Note

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

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

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

Table 8.7.4-1. Rendered Media Types by Resource Category

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

Category	Media Type	UR I	RESTful
	<u>image/jxl</u>	<u>O</u>	<u>O</u>
Multi-frame Image	image/gif	O	O
	<u>image/jxl</u>	<u>O</u>	<u>O</u>
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

Note:

Multi-frame image responses are “animated” gif or JPEG XL responses, and are not the original multi-frame encoding, but are all encoded in a single image response.