

**Digital Imaging and Communications in Medicine (DICOM)**

*Supplement 195:*  
*HEVC/H.265 Transfer Syntax*

*Prepared by:*

**DICOM Standards Committee, WG4/13 HEVC Ad-Hoc group**

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Work Item: 2015-12-A

VERSION: Public Comment

June 1, 2016



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### Open Issues

Number	Date	Item
1	2016-05-31	Does the possibility for streams to span over several fragments without the need for a key frame to be inserted at the beginning of each fragment create any issue?
2	2016-05-31	Does the factorization of audio data encapsulation respect the original intent?

### Closed Issues

Number	Date	Item
1	2016-05-31	No media profile format added
2	2016-05-31	Transfer syntaxes for HEVC Scalable profiles are deferred
3	2016-07-25	Replaced all references to the 2016 version of the standard. Note: The 2016 version is not published by the 25 <sup>th</sup> of July 2016 but is supposed to reached the “published international standard” status by the end of September 2016. A corrigendum should be made to the DICOM standard to reference the latest version of the HEVC standard then.
4	2016-07-25	No reference to HEVC AMD1 added as the AMD1 refers to 3D HEVC which is not used by DICOM at the moment this document is edited.
5	2016-07-25	No reference to HEVC AMD2 added as the AMD2 refers to Screen Content Coding which is not used by DICOM at the moment this document is edited.

## Scope and Field of Application

### 1 INTRODUCTION

This supplement describes two new Transfer Syntaxes to embed High Efficiency Video Coding (HEVC) / H.265 Main Profile / Level 5.1 and Main 10 Profile / Level 5.1 encoded pixel data in DICOM. It does not introduce any new SOP Classes or IODs.

### 2 IMPROVEMENT OF THE 4:2:0 CONTENT COMPRESSION EFFICIENCY

The use of video and still image data in the medical industry has increased and new technologies providing better colors or higher precision are available on the market. Meanwhile, the needs for reduced storage and media exchange cost remains important. To answer the related demand for higher 4:2:0 compression efficiency, this supplement proposes to add the following profiles.

Transfer Syntax HEVC/H.265 Main Profile /Level 5.1 will perform consistent with the [ISO/IEC 23008-2:2015](#) HEVC Main Profile at Level 5.1. This will enable the storage of video files with a resolution of 4096x2160 at 50Hz/60Hz.

Transfer Syntax HEVC/H.265 Main 10 Profile /Level 5.1 will perform consistent with the [ISO/IEC 23008-2:2015](#) HEVC Main 10 Profile at Level 5.1. This will notably enable the storage of video files with a higher dynamic range and a wider gamut space and a resolution of 4096x2160 at 50Hz/60Hz.

### 3 SCOPE OF THE SUPPLEMENT

This proposed supplement includes Addenda to existing Parts of DICOM:

- PS 3.3 Addendum: Information Object Definitions
- PS 3.4 Addendum: Service Class Specifications
- PS 3.5 Addendum: Data Structures and Encoding
- PS 3.6 Addendum: Data Dictionary
- PS 3.17 Addendum: Explanatory Information

### 4 LICENSING ISSUES (ADVISORY NOTE):

HEVC/H.265 has now two associated pools of patents which define royalties to pay for when buying or using HEVC/H.265 codecs:

- MPEG-LA patent pool (<http://www.mpegla.com/main/programs/HEVC/Documents/HEVCweb.pdf>)
- HEVC Advance (<https://www.hevcadvance.com/licensing/#licensing-information>)

While MPEG-LA requires a royalty based on the purchase of equipment, HEVC/H.265 Advance requires companies to pay royalties on the basis of HEVC/H.265 streams they produce which they sell to customers. Interested readers are encouraged to look for further information with the help of specialized professionals.

This Advisory Note is for information only and is not intended to constitute legal advice, and no representation is made about the comprehensiveness of this advisory note.

**Changes to NEMA Standards Publication PS 3.3  
Digital Imaging and Communications in Medicine (DICOM)  
Part 3: Information Object Definitions**

2

4

2 **Add references to Section 2, “International Organization for Standardization (ISO) and International  
4 Electrotechnical Commission (IEC)” to include HEVC/H.265 related information:**

4 **2.1 INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO) AND INTERNATIONAL  
ELECTROTECHNICAL COMMISSION (IEC)**

...

6 [ISO/IEC 14496-22] ISO/IEC. *Information technology - Coding of audio-visual objects - Part 22: Open Font Format.*  
http://www.iso.org/iso/iso\_catalogue/catalogue\_tc/catalogue\_detail.htm?csnumber=52136 .

8 **[ISO/IEC 23008-2:2015] ISO/IEC. *Information technology -- High efficiency coding and media delivery in***  
***heterogeneous environments -- Part 2: High efficiency video coding.*** [http://www.iso.org/iso/](http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_detail.htm?csnumber=67660)  
10 [iso\\_catalogue/catalogue\\_tc/catalogue\\_detail.htm?csnumber=67660](http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_detail.htm?csnumber=67660) .

12 [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://](http://www.color.org/v4spec.xalter)  
www.color.org/v4spec.xalter .

14 ...

16 **Amend “Multi-frame True Color SC Image IOD Content Constraints” to include HEVC/H.265 related  
information:**

18 **A.8.5.4 MULTI-FRAME TRUE COLOR SC IMAGE IOD CONTENT CONSTRAINTS**

The VOI LUT Module shall not be present.

20 In the Image Pixel Module, the following constraints apply:

- Samples per Pixel (0028,0002) shall be 3
- Photometric Interpretation (0028,0004) shall be RGB for uncompressed or lossless compressed transfer syntaxes that do not involve color space transformations, YBR\_ICT for irreversible JPEG 2000 transfer syntaxes, YBR\_RCT for reversible JPEG 2000 transfer syntaxes, YBR\_PARTIAL\_420 for MPEG2\_1\_ and MPEG-4 AVC/H.264\_1, **HEVC/H.265** transfer syntaxes and YBR\_FULL\_422 for other lossy compressed transfer syntaxes

28 **Amend “Enhanced MR Color Image IOD Content Constraints” to include HEVC/H.265 related  
information:**

**A.36.4.3.1 ENHANCED MR COLOR IMAGE IOD CONTENT CONSTRAINTS**

30 The General Image Module, Overlay Plane Module and VOI LUT Module shall not be used in a Standard Extended SOP Class of the Enhanced MR Color Image.

32 Note

34 In order to annotate images, whether during acquisition or subsequently, SOP Instances of the Color Softcopy Presentation State Storage or the Structured Report Storage SOP Classes that reference the image SOP Instance, may be used.

36 No standard mechanism is provided for inclusion of annotations within the image SOP Instance itself, and implementers are discouraged from using private extensions to circumvent this restriction.



- Color Softcopy Presentation State Storage Instances that are generated during acquisition may be referenced from the Image SOP Instance by using the Referenced Presentation State Sequence in the MR Image and Spectroscopy Instance Macro invoked from the Enhanced MR Image Module. See Section C.8.13.2.
- 4 Photometric Interpretation (0028,0004) shall be RGB for uncompressed or lossless compressed transfer syntaxes that do not involve color space transformations, YBR\_ICT for irreversible JPEG2000 transfer syntaxes, YBR\_RCT for reversible JPEG2000 transfer syntaxes, YBR\_PARTIAL\_420 for MPEG2, ~~and~~ MPEG-4 AVC/H.264, HEVC/H.265 transfer syntaxes and YBR\_FULL\_422 for other lossy compressed transfer syntaxes.
- 8 Pixel Presentation (0008,9205) shall be TRUE\_COLOR.

10 **Amend “Lossy Image Compression Method” to include HEVC/H.265 related information:**

#### **C.7.6.1.1.5.1 LOSSY IMAGE COMPRESSION METHOD**

- 12 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.
- 14 Defined Terms for Lossy Image Compression Method (0028,2114):
- |    |                     |                                     |
|----|---------------------|-------------------------------------|
| 16 | <b>ISO_10918_1</b>  | JPEG Lossy Compression              |
| 16 | <b>ISO_14495_1</b>  | JPEG-LS Near-lossless Compression   |
| 16 | <b>ISO_15444_1</b>  | JPEG 2000 Irreversible Compression  |
| 18 | <b>ISO_13818_2</b>  | MPEG2 Compression                   |
| 18 | <b>ISO_14496_10</b> | MPEG-4 AVC/H.264 Compression        |
| 20 | <b>ISO_23008_2</b>  | <u>HEVC/H.265 Lossy Compression</u> |

**Changes to NEMA Standards Publication PS 3.4  
Digital Imaging and Communications in Medicine (DICOM)  
Part 3: Service Class Specifications**

2

4

**Amend “Time Range” to include HEVC/H.265 related information:**

2 **Y.3.2.1.3 TIME RANGE**

4 Time Range (0008,1163) contains the start and end times to be included in the returned object. Times are in seconds, relative to the value of the Content Time (0008,0033) in the parent object.

The range shall include all frames between the specified times including any frames at the specified times.

6 The range may be expanded as a consequence of the format in which the information is stored. Where such expansion occurs, any embedded audio data shall be similarly selected. Under all circumstances, the returned  
8 Composite SOP Instance shall retain the relationship between image and audio data.

Note

10 For MPEG-2, ~~and~~ MPEG-4 AVC/H.264, HEVC/H.265 this would be to the nearest surrounding Key Frames.

For JPEG 2000 Part 2, this would be to nearest surrounding precinct or tile boundary

12 Time Range shall only be used to specify extraction from SOP instances where the times of frames can be ascertained using one or more of the following Attributes:

14 • Frame Time (0018,1063)

• Frame Time Vector (0018,1065)

16 • Frame Reference DateTime (0018,9151) in the Frame Content Sequence (0020,9111)

2

**Changes to NEMA Standards Publication PS 3.5  
Digital Imaging and Communications in Medicine (DICOM)  
Part 5: Data Structures and Encoding**

## SECTION 2 NORMATIVE REFERENCES

2 Add references to section 2 to include HEVC/H.265 related information:

...

4 [ISO/IEC 14496-14] ISO/IEC. 2003. *Information technology - Coding of audio-visual objects - Part 14: MP4 file format.*

6 **[ISO/IEC 23008-2:2015] ISO/IEC. 2015. *High efficiency coding and media delivery in heterogeneous environments -- Part 2: High efficiency video coding***

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

8 ...

## 8 ENCODING OF PIXEL, OVERLAY AND WAVEFORM DATA

### 2 Amend 8.2.7 MPEG-4 AVC/H.264 HiP@Level4.1 Video

#### 8.2.7 MPEG-4 AVC/H.264 HiP@Level4.1 Video Compression

4 The container format for the video bitstream shall be MPEG-2 Transport Stream, a.k.a. MPEG-TS (see [ISO/IEC  
13818-1]) or MPEG-4, a.k.a. MP4 container (see [ISO/IEC 14496-12] and [ISO/IEC 14496-14]). The PTS/DTS of the  
6 transport stream shall be used in the MPEG coding. Any audio components included in the data container shall  
follow the constraints detailed in “8.2.Z Constraints for audio data integration in encapsulated pixel data  
8 objects”. ~~Any audio components present within the bit stream shall be interleaved in either LPCM, AC-3, AAC,  
MP3 or MPEG-1 Layer II audio format and shall comply with the following restrictions:~~

10 ~~Table 8-6. Allowed Audio Formats~~

12 ~~Audio Format MPEG-2 TS Container MP4 Container~~

~~LPCM Allowed~~

14 ~~AC3 Allowed~~

~~AAC Allowed Allowed~~

16 ~~MP3 Allowed Allowed~~

~~MPEG-1 Audio Layer II Allowed Allowed~~

18 ~~• LPCM~~

~~• Maximum bit rate: 4.608 Mbps~~

20 ~~• Sampling frequency: 48, 96 kHz~~

~~• Bits per sample: 16, 20 or 24 bits~~

22 ~~• Number of channels: 2 channels~~

~~Note~~

24 ~~If LPCM is used for Audio components, the container format shall be MPEG-2 TS.~~

~~• AC-3~~

26 ~~• Maximum bit rate: 640kbps~~

~~• Sampling frequency: 48kHz~~

28 ~~• Bits per sample: 16 bits~~

~~• Number of channels: 2 or 5.1 channels~~

**Note**

- 2 ~~1. AC-3 is standardized in [ETSI TS 102 366]~~
- 2 ~~2. If AC-3 is used for Audio components, the container format shall be MPEG-2 TS.~~
- 4 ~~• AAC~~
- 4 ~~• Maximum bit rate: 640kbps~~
- 6 ~~• Sampling frequency: 48kHz~~
- 6 ~~• Bits per sample: 16, 20 or 24 bits~~
- 8 ~~• Number of channels: 2 or 5.1 channels~~

**Note**

- 10 ~~AAC is standardized in Part 7 of the MPEG-2 standard (see [ISO/IEC 13818-7], and Subpart 4 in Part 3 of the MPEG-4 standard (see [ISO/IEC 14496-3]).~~
- 12 ~~• CBR MPEG-1 LAYER III (MP3) Audio Standard~~
- 12 ~~• Maximum bit rate: 320kbps~~
- 14 ~~• Sampling frequency: 32 kHz, 44.1 kHz or 48 kHz for the main channel (the complementary channels can be sampled at the half rate, as defined in the Standard)~~
- 16 ~~• Bits per sample: up to 24 bits~~
- 16 ~~• Number of channels: one main mono or stereo channel, and optionally one or more~~
- 18 ~~complementary channel(s)~~

**Note**

- 20 ~~1. MPEG-1 Layer III is standardized in Part 3 of the MPEG-1 standard (see [ISO/IEC 11172-3]).~~
- 20 ~~2. Although MPEG describes each channel as including up to 5 signals (e.g. for surround effects), it is recommended to limit each of the two channels to 2 signals each one (stereo).~~
- 22 ~~• MPEG-1 LAYER II (MP2)~~
- 24 ~~• Maximum bit rate: 384kbps~~
- 24 ~~• Sampling frequency: 32 kHz, 44.1 kHz or 48 kHz~~
- 26 ~~• Bits per sample: up to 24 bits~~
- 26 ~~• Number of channels: 2~~

28 **Note**

~~MPEG-1 Layer II is standardized in Part 3 of the MPEG-1 standard (see [ISO/IEC 11172-3]).~~

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<b>Amend 8.2.8 MPEG-4 AVC/H.264 HiP@Level4.2 Video Compression</b>
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2 **8.2.8 MPEG-4 AVC/H.264 HiP@Level4.2 Video Compression**

The container format for the video bit stream shall be MPEG-2 Transport Stream, a.k.a. MPEG-TS (see [ISO/IEC 13818-1]) or MPEG-4, a.k.a. MP4 container (see [ISO/IEC 14496-12] and [ISO/IEC 14496-14]). The PTS/DTS of the transport stream shall be used in the MPEG coding. Any audio components included in the data container shall follow the constraints detailed in “8.2.Z Constraints for audio data integration in encapsulated pixel data objects”. ~~Any audio components present within the bit stream shall be interleaved as defined for MPEG-4 AVC/H.264 High Profile Level 4.1 (see Section 8.2.7).~~

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<b>Amend 8.2.9 MPEG-4 AVC/H.264 Stereo HiP@Level4.2 Video Compression</b>
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2 **8.2.9 MPEG-4 AVC/H.264 Stereo HiP@Level4.2 Video Compression**

4 The container format for the video bitstream shall be MPEG-2 Transport Stream, a.k.a. MPEG-TS (see [ISO/IEC  
6 13818-1]) or MPEG-4, a.k.a. MP4 container (see [ISO/IEC 14496-12] and [ISO/IEC 14496-14]). The PTS/DTS of the  
8 transport stream shall be used in the MPEG coding. **Any audio components included in the data container shall  
follow the constraints detailed in “8.2.Z Constraints for audio data integration in encapsulated pixel data  
objects”. Any audio components present within the bit stream shall be interleaved as defined for MPEG-4  
AVC/H.264 High Profile Level 4.1 (see Section 8.2.7).**

10

**Add HEVC/H.265 Main Profile /Level 5.1 Video Compression to Section 8.****2 8.2.X HEVC/H.265 Main Profile /Level 5.1 Video Compression**

4 HEVC/H.265 Main Profile /Level 5.1 Main tier is designed for the compression of 4:2:0 video formats up to 4k at 60  
6 frames per second with a bit depth of 8 bits. DICOM provides a mechanism for supporting the use of HEVC/H.265  
Image Compression through the Encapsulated Format (see PS 3.3). Annex A defines a Transfer Syntax that  
references the HEVC/H.265 Standard.

8 The use of the DICOM Encapsulated Format to support HEVC/H.265 compressed pixel data requires that the Data  
10 Elements that are related to the Pixel Data encoding (e.g., Photometric Interpretation, Samples per Pixel, Planar  
12 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, with some specific exceptions noted here.  
The Pixel Data characteristics included in the HEVC/H.265 bit stream shall be used to decode the compressed data  
stream.

14 Notes: 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.

16 2. When decompressing, should the characteristics explicitly specified in the compressed data stream  
18 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.

20

The requirements are:

- 22 — Planar Configuration (0028,0006) shall be 0
- Samples per Pixel (0028,0002) shall be 3
- 24 — Photometric Interpretation (0028,0004) shall be YBR\_PARTIAL\_420
- Bits Allocated (0028,0100) shall be 8
- 26 — Bits Stored (0028,0101) shall be 8
- High Bit (0028,0102) shall be 7
- 28 — Pixel Representation (0028,0103) shall be 0
- The value of HEVC/H.265 sample aspect\_ratio\_idc shall be 1 in the encapsulated HEVC/H.265 bit stream if  
30 aspect\_ratio\_info\_present\_flag is 1.
- Pixel Aspect Ratio (0028,0034) shall be absent. This corresponds to a 'Sampling Aspect Ratio' (SAR) of 1:1.
- 32 — The values for Rows (0028,0010), Columns (0028,0011), Cine Rate (0018,0040), and Frame Time (0018,1063) or  
Frame Time Vector (0018,1065) shall be compliant with the Main Profile / Level 5.1 of the HEVC/H.265 standard  
34 ([ISO/IEC 23008-2:2015]) and restricted to a square pixel aspect ratio.

36 Notes: 1. The value of Planar Configuration (0028,0006) is irrelevant since the manner of encoding  
components is specified in the HEVC/H.265 standard, hence it is set to 0.

38 2. The limitation on rows and columns are to maximize interoperability between software environments  
and commonly available hardware HEVC/H.265 encoder/decoder implementations. Source pictures that  
40 have a lower value should be re-formatted by scaling and/or pixel padding prior to HEVC/H.265  
encoding.

42 3. The Frame Time (0018,1063) may be calculated from the frame rate of the acquiring camera. A  
frame rate of 29.97 frames per second corresponds to a frame time of 33.367 ms.

44 4. The value of chroma\_format\_idc for this profile and level is equal to 1, indicating the usage of 4:2:0  
content.

The encapsulated pixel data stream may be segmented into more than one fragment.

- Note: The recipient is expected to concatenate the fragments while decoding them. This allows for essentially unlimited length streams; the only limit imposed is the maximum size of frames ( $2^{31}-1$ ).
- 2
  - 4 The container format for the video bitstream shall be MPEG-2 Transport Stream, a.k.a. MPEG-TS (see [ISO/IEC 13818-1]) or MPEG-4, a.k.a. MP4 container (see [ISO/IEC 14496-12] and [ISO/IEC 14496-14]). The PTS/DTS of the
  - 6 transport stream shall be used in the MPEG coding. Any audio components included in the data container shall follow the constraints detailed in “8.2.Z Constraints for audio data integration in encapsulated pixel data objects”.

**Add HEVC/H.265 Main 10 Profile / Level 5.1 video compression to Section 8.****2 8.2.Y HEVC/H.265 Main 10 Profile /Level 5.1 Video Compression**

4 HEVC/H.265 Main 10 Profile /Level 5.1 Main tier is designed for the compression of 4:2:0 video formats up to 4k at 60  
6 frames per second with a bit depth of 10 bits. DICOM provides a mechanism for supporting the use of HEVC/H.265  
Image Compression through the Encapsulated Format (see PS 3.3). Annex A defines a Transfer Syntax that  
references the HEVC/H.265 Standard.

8 The use of the DICOM Encapsulated Format to support HEVC/H.265 compressed pixel data requires that the Data  
10 Elements that are related to the Pixel Data encoding (e.g., Photometric Interpretation, Samples per Pixel, Planar  
12 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, with some specific exceptions noted here.  
The Pixel Data characteristics included in the HEVC/H.265 bit stream shall be used to decode the compressed data  
stream.

14 Notes: 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.

16 2. When decompressing, should the characteristics explicitly specified in the compressed data stream  
18 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.

20

The requirements are:

- 22 — Planar Configuration (0028,0006) shall be 0
- Samples per Pixel (0028,0002) shall be 3
- 24 — Photometric Interpretation (0028,0004) shall be YBR\_PARTIAL\_420
- Bits Allocated (0028,0100) shall be 16
- 26 — Bits Stored (0028,0101) shall be 10
- High Bit (0028,0102) shall be 9
- 28 — Pixel Representation (0028,0103) shall be 0
- The value of HEVC/H.265 sample\_aspect\_ratio\_idc shall be 1 in the encapsulated HEVC/H.265 bit stream if  
30 aspect\_ratio\_info\_present\_flag is 1.
- Pixel Aspect Ratio (0028,0034) shall be absent. This corresponds to a 'Sampling Aspect Ratio' (SAR) of 1:1.
- 32 — The values for Rows (0028,0010), Columns (0028,0011), Cine Rate (0018,0040), and Frame Time (0018,1063) or  
Frame Time Vector (0018,1065) shall be compliant with the Main 10 Profile / Level 5.1 of the HEVC/H.265 standard  
34 ([ISO/IEC 23008-2:2015]) and restricted to a square pixel aspect ratio.

36 Notes: 1. The value of Planar Configuration (0028,0006) is irrelevant since the manner of encoding  
components is specified in the HEVC/H.265 standard, hence it is set to 0.

38 2. The limitation on rows and columns are to maximize interoperability between software environments  
and commonly available hardware HEVC/H.265 encoder/decoder implementations. Source pictures that  
40 have a lower value should be re-formatted by scaling and/or pixel padding prior to HEVC/H.265  
encoding.

42 3. The Frame Time (0018,1063) may be calculated from the frame rate of the acquiring camera. A  
frame rate of 29.97 frames per second corresponds to a frame time of 33.367 ms.

44 4. The value of chroma\_format\_idc for this profile and level is equal to 1, indicating the usage of 4:2:0  
content.

The encapsulated pixel data stream may be segmented into more than one fragment.

- Note: The recipient is expected to concatenate the fragments while decoding them. This allows for essentially unlimited length streams; the only limit imposed is the maximum size of frames (0028,0008) which is  $2^{31}-1$ .
- 2
  - 4 The container format for the video bitstream shall be MPEG-2 Transport Stream, a.k.a. MPEG-TS (see [ISO/IEC 13818-1]) or MPEG-4, a.k.a. MP4 container (see [ISO/IEC 14496-12] and [ISO/IEC 14496-14]). The PTS/DTS of the
  - 6 transport stream shall be used in the MPEG coding. Any audio components included in the data container shall follow the constraints detailed in “8.2.Z Constraints for audio data integration in encapsulated pixel data objects”.

**Add Audio container info Section 8.****2 8.2.Z Constraints for audio data integration in encapsulated pixel data objects**

This section describes the constraints pertaining to the presence of audio data alongside pixel data in DICOM objects.

4 It affects the following pixel data encapsulation transfer syntaxes:

- MPEG-4 AVC/H.264 High Profile / Level 4.1
- 6 — MPEG-4 AVC/H.264 BD-compatible High Profile / Level 4.1
- MPEG-4 AVC/H.264 High Profile / Level 4.2 For 2D Video
- 8 — MPEG-4 AVC/H.264 High Profile / Level 4.2 For 3D Video
- MPEG-4 AVC/H.264 Stereo High Profile / Level 4.2
- 10 — HEVC/H.265 Main Profile / Level 5.1
- HEVC/H.265 Main 10 Profile / Level 5.1

12

14 Any audio components present within a bit stream whose transfer syntax is among those listed above shall be interleaved in either LPCM, AC-3, AAC, MP3 or MPEG-1 Layer II audio format and shall comply with the following restrictions:

16

**Table 8.2.Z-1. Allowed Audio Formats**

Audio Format	MPEG-2 TS	MP4 Container
LPCM	Allowed	-
AC3	Allowed	-
AAC	Allowed	Allowed
MP3	Allowed	Allowed
MPEG-1 Audio Layer II	Allowed	Allowed

18

- LPCM
- 20 — Maximum bit rate: 4.608 Mbps
- Sampling frequency: 48, 96 kHz
- 22 — Bits per sample: 16, 20 or 24 bits
- Number of channels: 2 channels
- 24 — AC-3
- Maximum bit rate: 640kbps
- 26 — Sampling frequency: 48kHz
- Bits per sample: 16 bits
- 28 — Number of channels: 2 or 5.1 channels

Note: AC-3 is standardized in [ETSI TS 102 366]

30 — AAC

- Maximum bit rate: 640kbps
- 32 — Sampling frequency: 48kHz
- Bits per sample: 16, 20 or 24 bits
- 34 — Number of channels: 2 or 5.1 channels

- 2       Note:    AAC is standardized in Part 7 of the MPEG-2 standard (see [ISO/IEC 13818-7], and Subpart 4 in  
3                Part 3 of the MPEG-4 standard (see [ISO/IEC 14496-3]).
- 4    —    CBR MPEG-1 LAYER III (MP3) Audio Standard
  - 5        —    Maximum bit rate: 320kbps
  - 6        —    Sampling frequency: 32 kHz, 44.1 kHz or 48 kHz for the main channel (the complementary channels can be  
7                sampled at the half rate, as defined in the Standard)
  - 8        —    Bits per sample: up to 24 bits
  - 9        —    Number of channels: one main mono or stereo channel, and optionally one or more complementary  
10               channel(s)
- 10   Notes:    1.    MPEG-1 Layer III is standardized in Part 3 of the MPEG-1 standard (see [ISO/IEC 11172-3]).
- 11                2.    Although MPEG describes each channel as including up to 5 signals (e.g. for surround effects),  
12                it is recommended to limit each of the two channels to 2 signals each one (stereo).
- 13   —    MPEG-1 LAYER II (MP2)
  - 14        —    Maximum bit rate: 384kbps
  - 15        —    Sampling frequency: 32 kHz, 44.1 kHz or 48 kHz
  - 16        —    Bits per sample: up to 24 bits
  - 17        —    Number of channels: 2
- 18   Note:    MPEG-1 Layer II is standardized in Part 3 of the MPEG-1 standard (see [ISO/IEC 11172-3]).
- 20



## 2 10 TRANSFER SYNTAX

Add Transfer Syntax for HEVC/H.265 Main Profile / Level 5.1 Image Compression to Section 10.

### 4 10.X Transfer Syntax for HEVC/H.265 Main Profile / Level 5.1 Image Compression

One Transfer Syntax is specified for HEVC/H.265 Main Profile / Level 5.1 Image Compression. Transfer Syntax  
6 HEVC/H.265 Main Profile corresponds to the ISO/IEC 23008-2:2015 HEVC standard's profile and level specifications.

8 Add Transfer Syntax for HEVC/H.265 Main 10 Profile / Level 5.1 Image Compression to Section 10.

### 10.Y Transfer Syntax for HEVC/H.265 Main 10 Profile / Level 5.1 Image Compression

10 One Transfer Syntax is specified for HEVC/H.265 Main 10 Profile / Level 5.1 Image Compression. Transfer Syntax  
12 HEVC/H.265 Main 10 Profile corresponds to the ISO/IEC 23008-2:2015HEVC standard's profile and level  
specifications.

## 14 A TRANSFER SYNTAX SPECIFICATIONS (NORMATIVE)

Add HEVC/H.265 Main Profile / Level 5.1 requirements to Annex A.

### 16 A.4.X HEVC/H.265 Main Profile / Level 5.1 VIDEO COMPRESSION

18 The International Standards Organization ISO/IEC MPEG has developed an International Standard, [ISO/IEC 23008-  
2:2015] (HEVC), for the video compression of generic coding of moving pictures and associated audio information.  
This standard is jointly maintained and has identical technical content as the ISO/IEC 23008-2:2015 HEVC standard.  
20 A DICOM Transfer Syntax for HEVC/H.265 Main Profile / Level 5.1 Image Compression shall be identified by a UID  
value of:  
22 · 1.2.840.10008.1.2.4.AAA corresponding to the HEVC/H.265 Main Profile / Level 5.1 of the ISO/IEC 23008-2:2015  
HEVC Video standard.

24 Add HEVC/H.265 Main 10 Profile / Level 5.1 requirements to Annex A.

### A.4.Y HEVC/H.265 Main 10 Profile / Level 5.1 VIDEO COMPRESSION

26 The International Standards Organization ISO/IEC MPEG has developed an International Standard, [ISO/IEC 23008-  
2:2015] (HEVC), for the video compression of generic coding of moving pictures and associated audio information.  
28 This standard is jointly maintained and has identical technical content as the ISO/IEC 23008-2:2015 HEVC standard.  
A DICOM Transfer Syntax for HEVC/H.265 Main 10 Profile / Level 5.1 Image Compression shall be identified by a UID  
30 value of:  
· 1.2.840.10008.1.2.4.BBB corresponding to the HEVC/H.265 Main 10 Profile / Level 5.1 of the ISO/IEC 23008-  
32 2:2015 HEVC Video standard.

34

2

**Changes to NEMA Standards Publication PS 3.6  
Digital Imaging and Communications in Medicine (DICOM)  
Part 6: Data Dictionary**

**A REGISTRY OF DICOM UNIQUE IDENTIFIERS (UIDS) (NORMATIVE)**

2 **Add new UID to Annex A.**

UID Value	UID Name	UID Type	Part
1.2.840.10008.1.2.4.AAA	HEVC/H.265 Main Profile / Level 5.1	Transfer Syntax	<u>PS3.5</u>
1.2.840.10008.1.2.4.BBB	HEVC/H.265 Main 10 Profile / Level 5.1	Transfer Syntax	<u>PS3.5</u>

4

2

**Changes to NEMA Standards Publication PS 3.17  
Digital Imaging and Communications in Medicine (DICOM)  
Part 6: Explanatory Information**

<b>Amend “Retrieval Based On Report References” to include HEVC/H.265 related information:</b>
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## 2 KK.1.1 RETRIEVAL BASED ON REPORT REFERENCES

4 A referring physician receives radiological diagnostic reports on CT or MRI examinations. These reports contain  
 6 references to specific images. He chooses to review these specific images himself and/or show the patient. The  
 8 references in the report point to particular slices. If the slices are individual images, then they may be obtained  
 10 individually. If the slices are part of an enhanced multi-frame CT/MR object, then retrieval of the whole multi-frame  
 12 object might take too long. The Composite Instance Root Retrieve Service allows retrieval of only the selected frames.

14 The source of the image and frame references in the report could be KOS, CDA, SR, presentation states or other  
 16 sources.

18 Selective retrieval can also be used to retrieve 2 or more arbitrary frames, as may be used for digital subtraction  
 20 (masking), and may be used with any multi-frame objects, including multi-frame ultrasound, XR etc.

22 Features of interest in many long "video" examinations (e.g., endoscopy) are commonly referenced as times from the  
 24 start of the examination. The same benefits of reduced WAN bandwidth use could be obtained by shortening the  
 26 MPEG-2, MPEG-4 AVC/H.264, HEVC/H.265 or JPEG 2000 Part 2 Multi-component based stream prior to  
 28 transmission.

30

<b>Amend “LL.3 Retrieval of Selected Frame Composite Instances From MPEG-2 or MPEG-4 AVC/H.264 Video” to include HEVC/H.265 related information:</b>
--

32

## 20 LL.3 RETRIEVAL OF SELECTED FRAME COMPOSITE INSTANCES FROM MPEG-2, ~~OR~~ MPEG-4 AVC/H.264 OR HEVC/H.265 VIDEO

22 If the image has been stored in MPEG-2, ~~or~~ MPEG-4 AVC/H.264 or HEVC/H.265 format, and if the SCU has  
 24 knowledge independent of DICOM as to which section of a "video" is required for viewing (e.g., perhaps notes from an  
 26 endoscopy) then the SCU can perform the following steps:

28 1. Use known configuration information to identify the available transfer syntaxes.

30 2. If MPEG-2, MPEG-4 AVC/H.264, HEVC/H.265 or JPEG 2000 Part 2 Multi-component transfer syntaxes are  
 32 available, then issue a request to retrieve the required section.

The data received may be slightly longer than that requested, depending on the position of key frames in the data.

34 3. If only other transfer syntaxes are available, then the SCU may need to retrieve most of the object using  
 36 Composite Instance Retrieve Without Bulk Data Retrieve Service to find the frame rate or frame time vector, and  
 38 then calculate a list of frames to retrieve as in the previous sections.

<b>Amend “MM.2.4 MPEG-2 or MPEG-4 AVC/H.264” to include HEVC/H.265 related information:</b>
---

32

## MM.2.4 MPEG-2, ~~OR~~ MPEG-4 AVC/H.264 OR HEVC/H.265

34 Identifying the location of the requested frames within an MPEG-2, ~~or~~ MPEG-4 AVC/H.264 or HEVC/H.265 data  
 36 stream is non-trivial, but if achieved, then little else other than changes to the starting times are likely to be required for  
 38 MPEG-2, ~~or~~ MPEG-4 AVC/H.264 or HEVC/H.265 encoded data, as the use-cases for such encoded data (e.g.,  
 endoscopy) are unlikely to include explicit frame related data. See the note below however for comments on "single-  
 frame" results.

40 An application holding data in MPEG-2, ~~or~~ MPEG-4 AVC/H.264 or HEVC/H.265 format is unlikely to be able to  
 create a range with a frame increment of greater than one (a calculated frame list with a 3<sup>rd</sup> value greater than one),  
 and if such a request is made, it might return a status of AA02: Unable to extract Frames.

2 The approximation feature of the Time Range form of request is especially suitable for data held in MPEG-2, ~~or~~  
MPEG-4 AVC/H.264 or HEVC/H.265 form, as it allows the application to find the nearest surrounding key frames,  
which greatly simplifies editing and improves quality.

4

6 **Amend “MM.2.5 JPEG 2000 Part 2 Multi-Component Transform” to include HEVC/H.265 related information:**

#### **MM.2.5 JPEG 2000 PART 2 MULTI-COMPONENT TRANSFORM**

8 Similar issues exist as for MPEG-2, ~~and~~ MPEG-4 AVC/H.264 and HEVC/H.265 data and similar solutions apply.

10 **Amend “MM.2.8 A "Single Frame" Multi-frame Image” to include HEVC/H.265 related information:**

#### **MM.2.8 A "SINGLE FRAME" MULTI-FRAME IMAGE**

12 The requirement that the newly created image object generated in response to a Frame level retrieve request must be  
14 the same as the SOP class will frequently result in the need to create a single frame instance of an object that is more  
commonly a multi-frame object, but this should not cause any problems with the IOD rules, as all such objects may  
quite legally have Number of Frames = 1.

16 However, a single frame may well cause problems for a transfer syntax based on "video" such as those using MPEG-  
2, ~~or~~ MPEG-4 AVC/H.264 or HEVC/H.265, and therefore the SCU when negotiating a C-GET should consider this  
18 problem, and include one or more transfer syntaxes suitable for holding single or non-contiguous frames where such a  
retrieval request is being made.

20

**Amend “MM.6 Audio” to include HEVC/H.265 related information:**

#### **MM.6 AUDIO**

24 Where the original object is MPEG-2, ~~or~~ MPEG-4 AVC/H.264 or HEVC/H.265 with interleaved audio data in the  
MPEG-2 System, and where the retrieved object is also MPEG-2, ~~or~~ MPEG-4 AVC/H.264 or HEVC/H.265 encoded,  
then audio could normally be preserved and maintain synchronization, but in other cases, the audio may be lost.