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## Digital Imaging and Communications in Medicine (DICOM)

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*Supplement 137: MPEG2 MP@HL Transfer Syntax*

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## Scope and Field of Application

40 This Supplement has been prepared by DICOM Working Group 13 (Visible Light), according to the procedures of the DICOM Committee.

This Supplement describes a new transfer syntax to embed an additional higher level of MPEG2 encoding in DICOM.

45 This additional transfer syntax would typically be used for encoding high definition video sequences, though it is not inherently constrained from encoding other forms of multi-frame pixel data.

This transfer syntax uses MPEG2 lossy compression permitting higher spatial resolution quality, called Main Profile / High Level (MP@HL), typically from 15 to 40 Mbit/s, which means respectively 112 Mbytes and 300 Mbytes per minute of video, and does not exceed 80 Mbit/s.

50 Several different 'levels' and 'profiles' are defined by MPEG and these have a hierarchical relationship. The parameter constraints of a 'higher' level equal or exceed the constraints of 'lower' levels from the same profile, e.g. MPEG2 High Level decoders are able to decode the Main Level bitstreams used in the existing MPEG2 MP@ML transfer syntax in the Visible Light IOD.

### THE EVOLUTION FROM STANDARD DEFINITION TO HIGH DEFINITION

55 The use of high-definition (HD) video sources for video acquisition, both for professional and consumer applications is driving applications in the context of DICOM. The following needs have been identified:

- 60 – Driven by the emergence of HD medical camera products, several manufacturers are offering medical HD MPEG video-recording solutions to those modalities working in the visible light domain. Users have clearly expressed that they want to upgrade their system to HD, mainly to have a better quality of image. Passing from SD to HD makes a very significant progress.
- Targeted modalities include microscopic and endoscopic applications such as Gastro-Enterology, Laparoscopy, Orthopedics, Ophthalmology, ENT, Gynaecology, Bronchoscopy, Pathology, and (Microscopic) Surgery.
- 65 – Visible Light IODs are correct for static images and SD video, although not yet commonly used. An HD MPEG extension can make them attractive for vendors and users in that DICOM provides a consistent solution for both still and compressed motion images for both SD and HD.

The following technical considerations have been taken into consideration in the choice of MPEG2 for HD:

- 70 – MPEG2 is commonly used outside the context of DICOM for both SD and HD video and is supported by a wide range of well-established equipment and applications in networked environments. In particular, tools for editing MPEG2 video are readily available.
- Both users and vendors have expressed the need for an HD DICOM standard as soon as possible in order to avoid possible incompatibility problems, and MPEG2 is an appropriate technology for an immediate solution.
- 75 – Currently available hardware allows for the de-compression of MP@HL in software.
- The standardization of MPEG2 MP@HL for HD does not preclude future consideration of newer encoding technologies based on MPEG4 that would add new features.

80 It should be noted that audio channel(s), for voice or sound-based physiological information, may be interleaved within the video stream using the same audio formats as are currently specified by DICOM for use with MP@ML. No changes are required.

The existing Key Object Selection SOP Class provides a mechanism for referencing individual frames, or multiple frames (such as a video “clip”).

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**Changes to NEMA Standards Publication PS 3.5-2008**

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

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**Part 5: Data Structures and Encoding**

PS 3.5: Add MPEG2 MP@HL IMAGE COMPRESSION in Section 8.

## 8.2.X MPEG2 MP@HL IMAGE COMPRESSION

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MPEG2 Main Profile at High Level (MP@HL) corresponds to what is commonly known as HDTV ('High Definition Television'). DICOM provides a mechanism for supporting the use of MPEG2 MP@HL Image Compression through the Encapsulated Format (see PS 3.3). Annex A defines a Transfer Syntax that references the MPEG2 MP@HL Standard.

105       Note:     MPEG2 compression is inherently lossy. 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 MPEG2 MP@HL are also beyond the scope of this standard.

110     The use of the DICOM Encapsulated Format to support MPEG2 MP@HL compressed pixel data requires that the Data Elements which 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, with some specific exceptions noted here. The Pixel Data characteristics included in the MPEG2  
115     MP@HL bit stream shall be used to decode the compressed data stream.

      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.

120     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.

The requirements are:

- 125       – Planar Configuration (0028,0006) shall be 0  
      Note:     The value of Planar Configuration (0028,0006) is irrelevant since the manner of encoding components is specified in the MPEG2 standard, hence it is set to 0.
- 130       – Samples per Pixel (0028,0002) shall be 3  
      – Photometric Interpretation (0028,0004) shall be YBR\_PARTIAL\_420  
      – Bits Allocated (0028,0100) shall be 8  
      – Bits Stored (0028,0101) shall be 8  
      – High Bit (0028,0102) shall be 7  
      – Pixel Representation (0028,0103) shall be 0  
      – Rows (0028,0010) shall be either 720 or 1080  
135       – Columns (0028,0011) shall be 1280 if Rows is 720, or shall be 1920 if Rows is 1080.  
      – The value of MPEG2 aspect\_ratio\_information shall be 0011 in the encapsulated MPEG2 data stream corresponding to a 'Display Aspect Ratio' (DAR) of 16:9.  
      – The DICOM attribute Pixel Aspect Ratio (0028,0034) shall be absent. This corresponds to a 'Sampling Aspect Ratio' (SAR) of 1:1.  
140       – Cine Rate (0018,0040) and Frame Time (0018,1063) or Frame Time Vector (0018,1065) shall be consistent with the limitations of MP@HL, as specified in Table 8-x below:

**Table 8-x**  
**MPEG2 MP@HL IMAGE TRANSFER SYNTAX FRAME RATE ATTRIBUTES**

<b>Video Type</b>	<b>Spatial resolution layer</b>	<b>Frame Rate (see Note 2)</b>	<b>Frame Time (see Note 3)</b>
30 Hz HD	Single level, Enhancement	30	33.33 ms
25 Hz HD	Single level, Enhancement	25	40.0 ms
60 Hz HD	Single level, Enhancement	60	16.17 ms
50 Hz HD	Single level, Enhancement	50	20.00 ms

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Notes: 1. The requirements on rows and columns are to maximize interoperability between software environments and commonly available hardware MPEG2 encoder/decoder implementations. Should the source picture have a lower value, it should be re-formatted accordingly by scaling and/or pixel padding prior to MPEG2 encoding.

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2. The frame rate of the acquiring camera for '30 Hz HD' MPEG2 may be either 30 or 30/1.001 (approximately 29.97) frames/sec. Similarly, the frame rate in the case of 60 Hz may be either 60 or 60/1.001 (approximately 59.94) frames/sec This may lead to small inconsistencies between the video timebase and real time.

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

4. The value of chroma\_format for this profile and level is defined by MPEG as 4:2:0.

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5. Examples of screen resolutions supported by MPEG2 MP@HL are shown in Table 8-y. Frame rates of 50 Hz and 60 Hz (progressive) at the maximum resolution of 1080 by 1920 are not supported by MP@HL. Interlace at the maximum resolution is supported at a field rate of 50 Hz or 60 Hz, which corresponds to a frame rate of 25 Hz or 30 Hz respectively as described in Table 8-y.

6. An MPEG2 MP@HL decoder is able to decode bitstreams conforming to lower levels. These include the 1080 by 1440 bitstreams of MP@H-14, and the Main Level bitstreams used in the existing MPEG2 MP@ML transfer syntax in the Visible Light IOD.

7. MP@H-14 is not supported by this transfer syntax.

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8. The restriction of DAR to 16:9 is required to ensure interoperability because of limitations in commonly available hardware chipset implementations for MPEG2 MP@HL.

**Table 8-y**  
**Examples of MPEG2 MP@HL screen resolution**

<b>Rows</b>	<b>Columns</b>	<b>Frame rate</b>	<b>Video Type</b>	<b>Progressive or Interlace</b>
1080	1920	25	25 Hz HD	P
1080	1920	29.97, 30	30 Hz HD	P
1080	1920	25	25 Hz HD	I
1080	1920	29.97, 30	30 Hz HD	I
720	1280	25	25 Hz HD	P
720	1280	29.97, 30,	30 Hz HD	P
720	1280	50	50 Hz HD	P
720	1280	59.94, 60	60 Hz HD	P

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One fragment shall contain the whole MPEG2 bit stream.

Note: If a video stream exceeds the maximum length of one fragment (approximately 4 GB), it may be sent as multiple SOP Instances.

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The Basic Offset Table in the Pixel Data (7FE0,0010) shall be empty (present but zero length).

Note: The Basic Offset Table is not used because MPEG2 contains its own mechanism for describing navigation of frames. To enable decoding of only a part of the sequence, MPEG2 manages a header in any group of pictures (GOP) containing a time\_code – a 25-bit integer containing the following: drop\_frame\_flag, time\_code\_hours, time\_code\_minutes, marker\_bit, time\_code\_seconds and time\_code\_pictures.

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Any audio components present within the MPEG2 MP@HL bit stream shall comply with the restrictions as for MPEG2 MP@ML as stated in Section 8.2.5.

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*PS 3.5: Add TRANSFER SYNTAX FOR MPEG2 MP@HL IMAGE COMPRESSION in Section 10.*

## **10.X TRANSFER SYNTAX FOR MPEG2 MP@HL IMAGE COMPRESSION**

One Transfer Syntax is specified for MPEG2 MP@HL Image Compression.

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*PS 3.5: Add MPEG2 MP@HL requirements to Annex A, A.4.5.*

## **Annex A (Normative) Transfer Syntax Specifications**

### **A.4.5 MPEG2 IMAGE COMPRESSION**

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The International Standards Organization ISO/IEC has developed an International Standard, ISO/IEC 13818-2 (~~MPEG2 Part 2~~), ~~for the video compression of generic coding of moving pictures and associated audio information~~ Information Technology - Generic coding of moving pictures and associated audio information: video -- part 2, referred to as "MPEG-2".

A DICOM Transfer Syntax for MPEG2 Image Compression shall be identified by a UID value of **either**:

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- 1.2.840.10008.1.2.4.100 corresponding to the MPEG2 MP@ML option of the ISO/IEC MPEG2 Video standard
- 1.2.840.10008.1.2.4.101 corresponding to the MPEG2 MP@HL option of the ISO/IEC MPEG2 Video standard.

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**Changes to NEMA Standards Publication PS 3.6-2008**

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

**Part 6: Data Dictionary**

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*PS 3.6: Add new UID to Annex A.*

<b>UID Value</b>	<b>UID Name</b>	<b>UID Type</b>	<b>Part</b>
1.2.840.10008.1.2.4.101	MPEG2 Main Profile @ High Level	Transfer Syntax	PS 3.5