

5

Digital Imaging and Communications in Medicine (DICOM)

Supplement 123: Structured Display

10

15

20 *Prepared by:*

DICOM Standards Committee, Working Groups 22, 11, and 6

1300 N. 17th Street, Suite 1752

Rosslyn, Virginia 22209 USA

25

VERSION: Final Text, October 27, 2008

Pursuant to Work Item 2004-12-C

30

Table of Contents

	Scope and Field of Application	3
	STRUCTURED DISPLAY USE CASES	3
	Dentistry	3
	Ophthalmology	4
35	Cardiology	6
	Radiology	7
	Changes to NEMA Standards Publication PS 3.2-2008	8
	Changes to NEMA Standards Publication PS 3.3-2008	10
	A.33 SOFTCOPY PRESENTATION STATE INFORMATION OBJECT DEFINITIONS.....	12
40	A.33.X Basic Structured Display Information Object Definition	12
	A.33.X.1 Basic Structured Display IOD Description	12
	C.11 LOOK UP TABLES AND PRESENTATION STATES.....	13
	C.11.W Structured Display Module	13
	C.11.X Structured Display Image Box Attribute Descriptions	13
45	C.11.X.1 Structured Display Attribute Descriptions	18
	C.11.X.1.1 Display Environment Spatial Position	18
	C.11.X.1.2 Referenced Image Sequence and Referenced Presentation State Sequence	18
	18	
	C.11.X.1.3 Referenced Instance Sequence.....	19
50	C.11.X.1.4 Referenced Stereometric Instance Sequence	19
	C.11.X.1.5 Type of Synchronization	19
	C.11.Y Structured Display Annotation Module	20
	C.11.Y.1 Structured Display Annotation Attribute Descriptions	21
	C.11.Y.1.1 Unformatted Text Value and Display Environment Spatial Position	21
55	C.23.2 Hanging Protocol Environment Module	23
	C.23.2.1 Hanging Protocol Environment Attribute Descriptions	24
	C.23.2.1.1 Display Environment Spatial Position	24
	Changes to NEMA Standards Publication PS 3.4-2008	26
	B.5 STANDARD SOP CLASSES.....	27
60	B.5.1.x Basic Structured Display.....	27
	I.4 MEDIA STORAGE SOP CLASSES	28
	Changes to NEMA Standards Publication PS 3.6-2008	29
	Changes to NEMA Standards Publication PS 3.11-2008	31
	K.3.1 SOP Classes and Transfer Syntaxes	32
65	Changes to NEMA Standards Publication PS 3.15-2008	33
	C.2 CREATOR RSA DIGITAL SIGNATURE PROFILE.....	34
	C.3 AUTHORIZATION RSA DIGITAL SIGNATURE PROFILE	34

70

Scope and Field of Application

This supplement to the DICOM Standard proposes storage, exchange, query and retrieval of Structured Display objects. The objective is to provide a standard means of encoding the display of multiple images on a screen in a specific spatial relationship and with specified display characteristics (window width / window level, annotation, labeling). This spatial relationship may be based on clinical standards or conventional practice, e.g., intra-oral radiograph mounts, or nuclear cardiac stress test layouts.

It is anticipated that this Structured Display object would complement existing parts of the standard that address display of images, such as Hanging Protocols and Presentation States. Hanging Protocols are intended to provide a general template for display of classes of images according to a user's preference, and as such, intentionally exist outside the usual Patient / Study / Series / Instance hierarchy. The Structured Display object provides a method of encoding a specific layout of specific images in the context of a specific Patient and Study, and hence exists within the Patient / Study / Series / Instance hierarchy.

Presentation States generally specify rendering of individual images and their associated annotation. The Structured Display object is a type of Presentation State that specifies rendering of multiple images on a screen with annotation of the group of images as a set.

The Basic Structured Display Information Object Definition of this Supplement has a scope limited to the display on a single screen. It supports static, cine, and stereo images, and multiple images stacked in a single image box (screen location). It allows synchronized scrolling or playback between two or more image boxes. Displayed images may have Presentation State objects applied to them, e.g., to control window width / window level, display area selection and zoom, rotate / flip, and region of interest annotation. In addition to the image annotations through referenced Presentation State objects, the IOD also supports simple text labels on the screen, e.g., for image box labeling or study identification.

The IOD does not restrict the type of object displayed in an image box. Structured Report, Waveform, or Encapsulated Document SOP Instances may be referenced and, if supported by the receiver, displayed.

STRUCTURED DISPLAY USE CASES

95 Dentistry

Intra-oral radiography typically involves acquisition of multiple images of various parts of the dentition. Many digital radiographic systems offer customized templates that are used for displaying the images in a study on the screen. These templates may also be referred to as mounts or viewsets. The Structured Display Object represents a standard method of encoding and exchanging the layout and intended display of Structured Displays. A structured display object created in this manner could be stored with a study and exchanged with images to allow for complete reproduction of the original exam.

1. A patient visits a General Dentist where a Full Mouth Series Exam with 18 images is acquired. The dentist observes severe bone loss and refers the patient to a Periodontist. The 18 images from the Full Mouth Series along with a Structured Display are copied to a DICOM Interchange CD and sent with the patient to see the specialist. The Periodontist uses the CD to open the exam in his Dental Radiographic Software and consults via phone with the General Dentist. Both are able to observe the same exam showing the images on each user's display using the exact same layout.

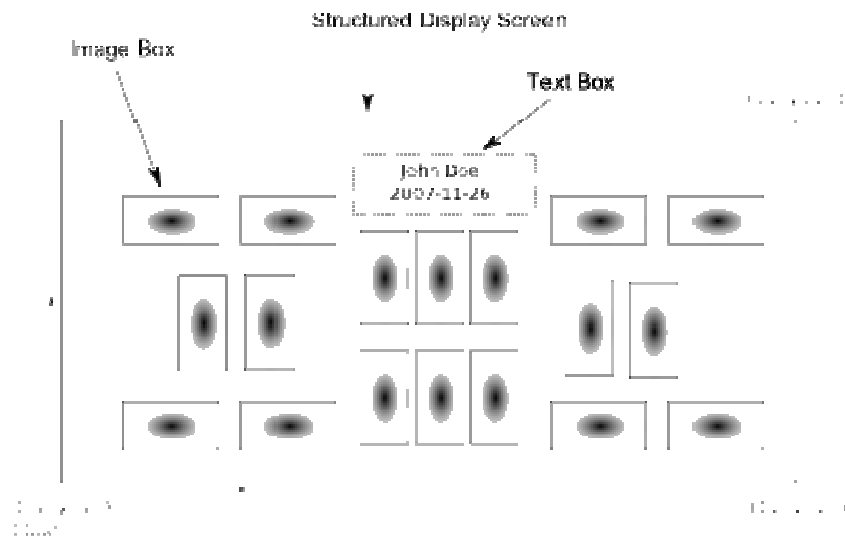
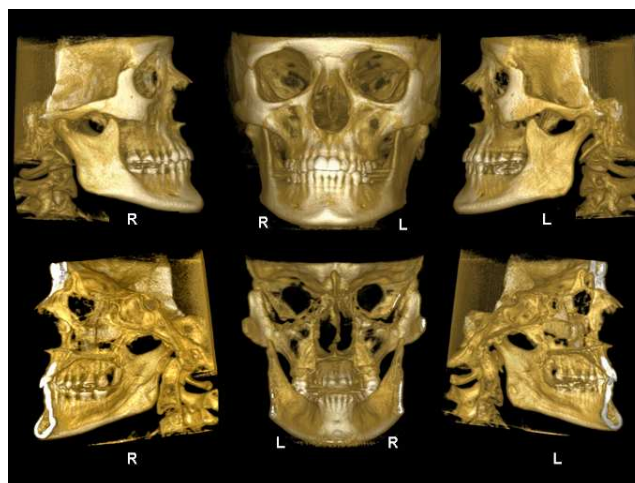


Figure Usecase-1 Intra-oral Full Mouth Series Structured Display

- 110 2. A patient requests cosmetic surgery to enhance their facial appearance. The case requires consultation between an orthodontist in New York and an oral surgeon in California. The cephalometric series of 2D projections constructed from a volumetric CT dataset that is used for the discussion is arranged by a Structured Display for transfer between the two practitioners.



115

Figure Usecase-2 Cephalometric Series Structured Display

Ophthalmology

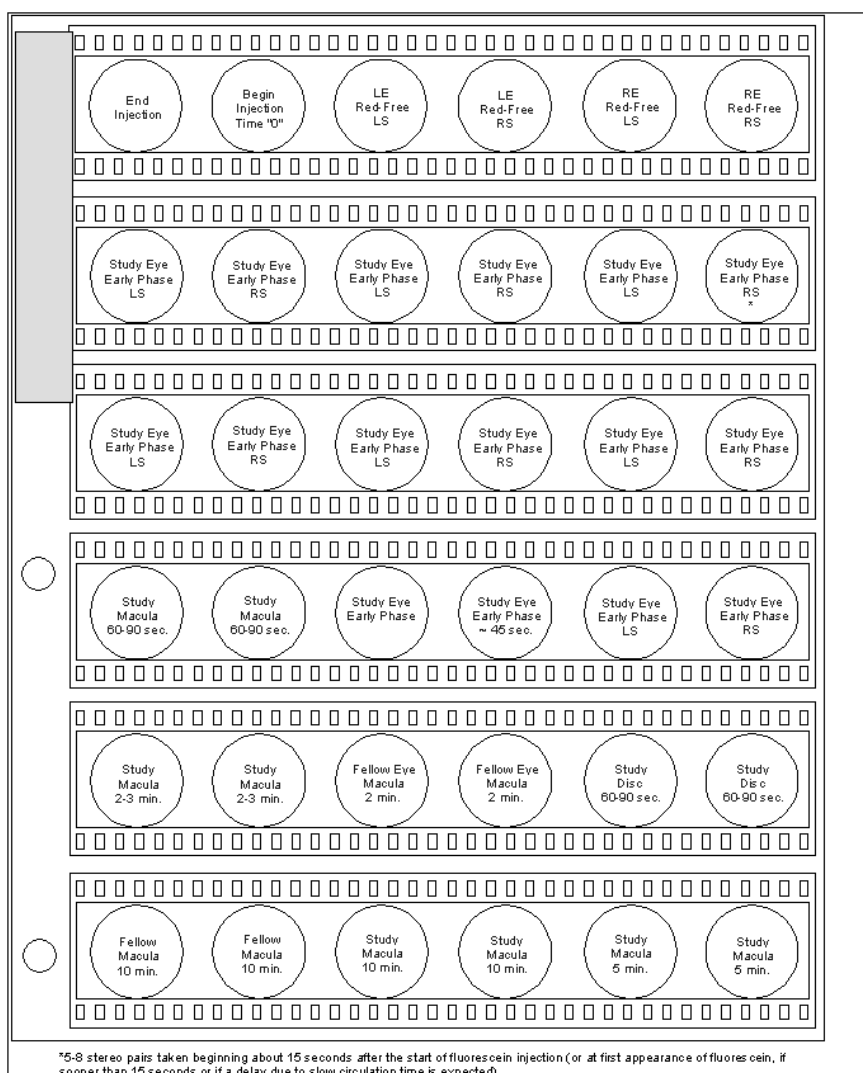
1. A patient in rural Canada visits a general ophthalmologist and is found to have diabetic macular edema. The general ophthalmologist would like to discuss the case with a retina specialist before performing laser surgery. A fluorescein angiogram is done with multiple retinal images taken in a timed series after an intravenous injection. The images along with a Structured Display are shared via a Health Information Exchange with a retina specialist in Calgary, who opens them using his Ophthalmology EMR software and
- 120

consults via phone with the general ophthalmologist. Both physicians view the images in the same layout so the retina specialist can provide accurate guidance for treating the patient.

125

2. A patient in rural Iowa visits his primary care physician for management of diabetes. Three non-mydratic (patient's eyes are not dilated) photographs are taken of the back of each eye, and forwarded electronically along with a Structured Display to an ophthalmologist in Iowa City. The ophthalmologist reads the photos in an agreed upon layout so there is no mistake about what portion of which eye is being viewed. The ophthalmologist is able to tell the primary care physician that his patient does not need to come to Iowa City for face to face ophthalmologic care, but that there is a particular view of the left eye that should be photographed again in 6 months.

130



135

Figure Usecase-3 Ophthalmic Retinal Study Structured Display

3. A patient in rural Minnesota experiences sudden vision loss and goes to a general ophthalmologist, who acquires OCT images and forwards them electronically along with a Structured Display to a retina specialist six travel hours away. The retina specialist is able to view the images in the standard layout that

140 he is comfortable with, and to confirm that the patient has a choroidal neovascular membrane. He determines that it would be worthwhile for the patient to travel for treatment.

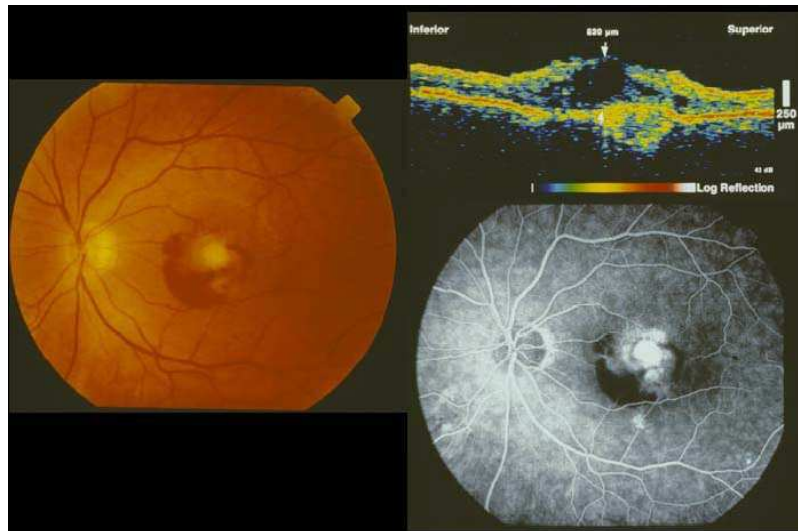


Figure Usecase-4 OCT Retinal Study with Cross Section and Navigation Structured Display

145 **Cardiology**

Cardiac stress testing acquires images in at least two patient states, rest and stress, and typically with several different views of the heart to highlight function of different cardiac anatomic regions. Image review typically involves simultaneous display of the same anatomy at two patient states, or multiple anatomic views at one patient state, or even simultaneous display of multiple anatomic views at multiple states. This applies to all cardiac imaging modalities, including ultrasound, nuclear, and MR. The American College of Cardiology and American Society of Nuclear Medicine have adopted standard display layouts for nuclear cardiology rest-stress studies.

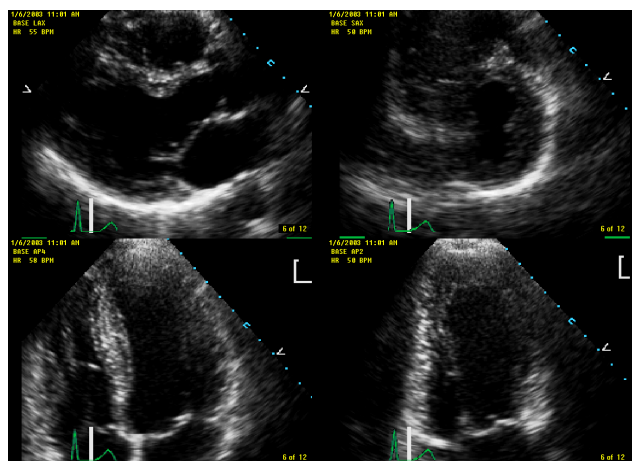


Figure Usecase-5 Stress Echocardiography Structured Display

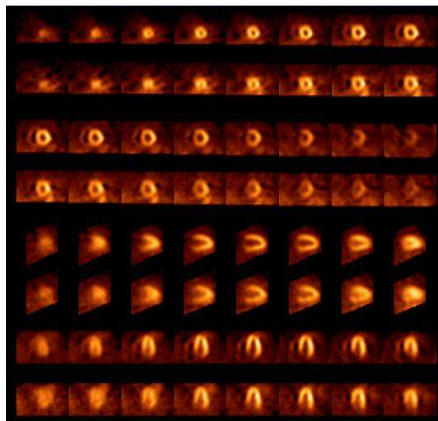


Figure Usecase-6 Stress-Rest Nuclear Cardiology Structured Display

Radiology

160 1. A radiologist on his PACS assembles a screen layout of a stack of CT images of a current lung study, a secondary capture of a 3-D rendering of the CT, and a prior chest radiograph for the patient. He adjusts the window width / window level for the CT images, and zooms and annotates the radiograph to clearly indicate the tumor. He saves a Structured Display object representing that screen layout, including Grayscale Softcopy Presentation State objects for the CT WW/WL and the radiograph zoom and annotation. During the weekly radiology department conference, on an independent (non-PACS) 165 workstation, he accesses the Structured Display object, and the display workstation automatically loads and places the images on the display, and presents them with the recorded WW/WL, zoom settings, and annotations.

170 2. A mammographer reviews a screening exam on a mammo workstation. She wishes to discuss the exam with the patient's general practitioner, who does not have a mammo-specific workstation. She saves a structured display, with presentation states for each image that replicate the display rendered by the mammo workstation (scaling, horizontal and vertical alignment, view and laterality annotation, etc.).

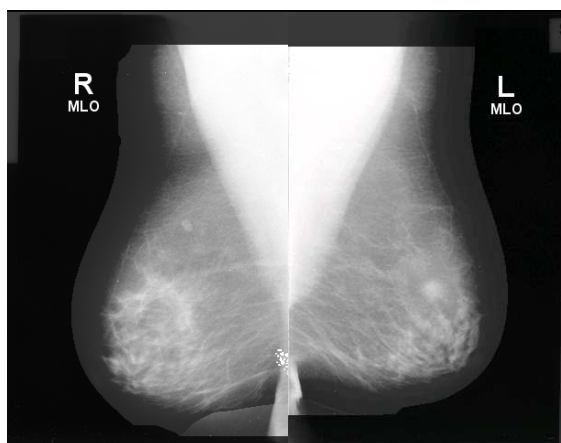


Figure Usecase-7 Mammography Structured Display

Changes to NEMA Standards Publication PS 3.2-2008

Digital Imaging and Communications in Medicine (DICOM)

Part 2: Conformance

Add new SOP Class in Table A.1-2

**Table A.1-2
UID VALUES**

180

UID Value	UID NAME	Category
<u>1.2.840.10008.5.1.4.1.1.131</u>	Basic Structured Display Storage	Transfer

Changes to NEMA Standards Publication PS 3.3-2008

185

Digital Imaging and Communications in Medicine (DICOM)

Part 3: Information Object Definitions

Add new IOD in Table A.1-2

**Table A.1-2
COMPOSITE INFORMATION OBJECT MODULES OVERVIEW – NON-IMAGES**

IODs Modules	<u>Basic</u> <u>Struc</u> <u>Disp</u>
Patient	<u>M</u>
Clinical Trial Subject	<u>U</u>
General Study	<u>M</u>
Patient Study	<u>U</u>
Clinical Trial Study	<u>U</u>
General Series	<u>M</u>
Clinical Trial Series	<u>U</u>
Presentation Series	<u>M</u>
General Equipment	<u>M</u>
Enhanced General Equipment	<u>U</u>
<u>Structured</u> <u>Display</u>	<u>M</u>
<u>Structured</u> <u>Display Image</u> <u>Box</u>	<u>M</u>
<u>Structured</u> <u>Display</u> <u>Annotation</u>	<u>U</u>
Common Instance Reference	<u>M</u>
SOP Common	<u>M</u>

Add section to Annex A

A.33 SOFTCOPY PRESENTATION STATE INFORMATION OBJECT DEFINITIONS

...

A.33.X Basic Structured Display Information Object Definition

195 **A.33.X.1 Basic Structured Display IOD Description**

The Basic Structured Display Information Object Definition (IOD) specifies an instance of a single screen structured display that has been created for a patient. It references specific image or other composite SOP instances from one or more studies for that patient, or for other patients for comparison, arranged in a specific presentation layout. Presentation of images within the structured display may be controlled by 200 referenced Softcopy Presentation State instances. The structured display may include text annotations.

Table A.33.X.1-1 Basic Structured Display IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
	Presentation Series	C.11.9	M
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	U
Presentation State	Structured Display	C.11.W	M
	Structured Display Image Box	C.11.X	M
	Structured Display Annotation	C.11.Y	U
	Common Instance Reference	C.12.2	M
	SOP Common	C.12.1	M

Add new sections to Annex C

205 **C.11 LOOK UP TABLES AND PRESENTATION STATES**

...

C.11.W Structured Display Module

Table C.11.W-1 describes the attributes of the Structured Display Module.

210

**Table C.11.W-1
Structured Display Module Attributes**

Attribute Name	Tag	Type	Attribute Description
<i>Include Content Identification Macro Table 10-12</i>			
Number of Screens	(0072,0100)	1	The number of screens for this Structured Display. If SOP Class UID (0008,0016) equals 1.2.840.10008.5.1.4.1.1.131 (Basic Structured Display), the value shall be 1.
Nominal Screen Definition Sequence	(0072,0102)	1	Sequence of items that describes the set of screens for this Structured Display. The number of items shall equal the value of the Number of Screens (0072,0100) attribute. One or more Items shall be present. Note: The Basic Structured Display IOD limits this Sequence to one Item.
<i>>Include Screen Specifications Macro Table C.23.2-2</i>			
Icon Image Sequence	(0088,0200)	3	This icon image is representative of the structured display. Only a single item shall be present in this sequence.
<i>>Include 'Image Pixel Macro' Table C.7-11b</i>			See C.7.6.1.1.6 for further explanation.
Structured Display Background CIELab Value	(0072,0420)	3	A value in which it is recommended that Structured Display background (i.e., the area outside of Image Boxes) be rendered on a color display. The units are specified in PCS-Values, and the value is encoded as CIELab. See C.10.7.1.1.
Empty Image Box CIELab Value	(0072,0421)	3	A value in which it is recommended that empty Image Boxes be rendered on a color display. The units are specified in PCS-Values, and the value is encoded as CIELab. See C.10.7.1.1.

C.11.X Structured Display Image Box Attribute Descriptions

Table C.11.X-1 describes the attributes of the Structured Display Image Box Module.

Table C.11.X-1
Structured Display Image Box Attributes

Attribute Name	Tag	Type	Attribute Description
Structured Display Image Box Sequence	(0072,0422)	1	The image display boxes defined in the display environment, together with the reference to the image to be displayed in each Image Box. One or more Items shall be present in this sequence.
>Display Environment Spatial Position	(0072,0108)	1	Exactly four dimensionless floating point values, in the range 0.0 to 1.0, indicating the rectangular coordinate position of the Image Box within the Display Environment. Note: For the Basic Structured Display with a single screen, the Display Environment is coextensive with the screen defined in the Nominal Screen Definition Sequence (0072,0102). See Section C.11.X.1.1
>Image Box Number	(0072,0302)	1	An integer that is unique across all Items of the Structured Display Image Box Sequence (0072,0422) that identifies the Image Box.
>Image Box Layout Type	(0072,0304)	1	Type of layout of the Image Box. The types are primarily distinguished by their interaction technique. Defined Terms: STACK: a single rectangle containing a steppable single frame, intended for user-controlled stepping through the image set, usually via continuous device interaction (e.g., mouse scrolling) or by single stepping (mouse or button click). CINE: a single rectangle, intended for video type play back where the user controls are play sequence, rate of play, and direction. SINGLE: a single rectangle, intended for images and objects with no defined methods of interaction. Note: This value may also be used for non-image objects, such as waveforms and SR documents.
>Image Box Overlap Priority	(0072,0320)	3	If this Image Box overlaps in spatial position with others, this attribute indicates the layer of this Image Box in relation to the others. The value shall be a positive integer in the range 1 to 100, where 1 = top and 100 = bottom. If this attribute is not present, then the expected behavior is not defined.

>Display Set Horizontal Justification	(0072,0717)	3	<p>Indicates direction in which to horizontally justify the image within an Image Box that is not the same shape (aspect ratio) as the image.</p> <p>Enumerated Values:</p> <p>LEFT CENTER RIGHT</p> <p>Note: Typically used in mammography display applications in which images from the patient's left and right are displayed "back to back", rather than centered.</p>
>Display Set Vertical Justification	(0072,0718)	3	<p>Indicates direction in which to vertically justify the image within an Image Box that is not the same shape (aspect ratio) as the image.</p> <p>Enumerated Values:</p> <p>TOP CENTER BOTTOM</p>
>Preferred Playback Sequencing	(0018,1244)	1C	<p>Describes the preferred playback sequencing for the Image Box. Overrides any Preferred Playback Sequencing (0018,1244) value in the image objects being displayed.</p> <p>Required if the value of Image Box Layout Type (0072,0304) is CINE.</p> <p>Enumerated Values:</p> <p>0 = Looping (1,2...n,1,2,...n,1,2,...n,...) 1 = Sweeping (1,2,...n,n-1,...2,1,2,...n,...) 2 = Stop (1,2...n)</p>
>Recommended Display Frame Rate	(0008,2144)	1C	<p>Recommended rate at which the frames of a multi-frame image shall be displayed, in frames/second. Shall have a value greater than zero. Overrides any Recommended Display Frame Rate (0008,2144) value in the image objects being displayed.</p> <p>Required if the value of Image Box Layout Type (0072,0304) is CINE and if Cine Relative to Real-Time (0072,0330) is not present.</p>
>Cine Relative to Real-Time	(0072,0330)	1C	<p>A positive dimensionless floating point numeric factor equal to playback rate divided by acquisition rate.</p> <p>Required if the value of Image Box Layout Type (0072,0304) is CINE and if Recommended Display Frame Rate (0008,2144) is not present.</p> <p>Note: The acquisition rate may change within the image object, as specified in Frame Time Vector (0018,1065).</p>

>Initial Cine Run State	(0018,0042)	1C	Defined Terms: STOPPED RUNNING Required if the value of Image Box Layout Type (0072,0304) is CINE.
>Start Trim	(0008,2142)	2C	The frame number of the first frame of the multi-frame image to be displayed in a CINE Image Box. Required if the value of Image Box Layout Type (0072,0304) is CINE.
>Stop Trim	(0008,2143)	2C	The Frame Number of the last frame of the multi-frame image to be displayed in a CINE Image Box. Required if the value of Image Box Layout Type (0072,0304) is CINE.
>Referenced First Frame Sequence	(0072,0427)	2C	Reference to the initial frame in a stack to be displayed in this image box. If value is not present, the first image frame to be displayed is not defined by the Standard. Required if the value of Image Box Layout Type (0072,0304) is STACK. Zero or one Item shall be present.
>>Include 'Image SOP Instance Reference Macro' Table 10-3			
>Referenced Image Sequence	(0008,1140)	2C	Reference to the Image SOP Instances, or frames from multi-frame Image SOP Instances, to be displayed in this Image Box. Required if Referenced Presentation State Sequence (0008,9237), Referenced Stereometric Instance Sequence (0008,1134), and Referenced Instance Sequence (0008,114A) are not present. Zero or more Items shall be present. See C.11.X.1.2.
>>Include 'Image SOP Instance Reference Macro' Table 10-3			Note: The order of frames identified in the Referenced Frame Number (0008,1160) attribute affects ordering in STACK Image Box Layout. See C.11.X.1.2.
>>Referenced Presentation State Sequence	(0008,9237)	1C	Reference to a Softcopy Presentation State SOP Instance to be applied to the referenced image. Only a single Item shall be permitted in this sequence. Required if presentation controls are to be applied to the image or image frame before rendering in the Structured Display.
>>>Include 'SOP Instance Reference Macro' Table 10-11			

>Referenced Presentation State Sequence	(0008,9237)	1C	Reference to a Softcopy Presentation State SOP Instance whose referenced images are to be displayed in the Image Box using the presentation controls of the referenced SOP Instance. Required if Referenced Image Sequence (0008,1140), Referenced Stereometric Instance Sequence (0008,1134), and Referenced Instance Sequence (0008,114A) are not present. A single Item shall be present in this sequence. See C.11.X.1.2.
>>Include 'SOP Instance Reference Macro' Table 10-11			
>Referenced Instance Sequence	(0008,114A)	1C	Reference to a non-image SOP Instance (e.g., waveform, SR, encapsulated document) whose content is to be displayed in the Image Box. Required if Referenced Presentation State Sequence (0008,9237), Referenced Stereometric Instance Sequence (0008,1134), and Referenced Image Sequence (0008,1140) are not present. A single Item shall be present in this sequence. See C.11.X.1.3.
>>Include 'SOP Instance Reference Macro' Table 10-11			
>Referenced Stereometric Instance Sequence	(0008,1134)	1C	Reference to a Stereometric SOP Instance whose referenced images are to be displayed in the Image Box. Required if Referenced Presentation State Sequence (0008,9237), Referenced Instance Sequence (0008,114A), and Referenced Image Sequence (0008,1140) are not present. A single Item shall be present in this sequence. See C.11.X.1.4.
>>Include 'SOP Instance Reference Macro' Table 10-11			
Image Box Synchronization Sequence	(0072,0430)	1C	Description of synchronized display between two or more Image Boxes. Required if synchronized display is specified between Image Boxes. One or more Items shall be present in this sequence.
>Synchronized Image Box List	(0072,0432)	1	Multi-valued list of two or more Image Box Number (0072,0302) values. Indicates that the display of multiple image frames within the specified Image Boxes are synchronized. Referenced Image Boxes shall be of same Image Box Layout Type (0072,0304). An Image Box Number value may appear in only one Image Box Synchronization Sequence (0072,0430) item.

>Type of Synchronization	(0072,0434)	1	Type of synchronization between Image Boxes. Defined Terms: FRAME POSITION TIME PHASE See C.11.X.1.5.
--------------------------	-------------	---	---

C.11.X.1 Structured Display Attribute Descriptions

C.11.X.1.1 Display Environment Spatial Position

220 The Display Environment Spatial Position (0072,0108) specifies the corners of the Image Box relative to the vertical and horizontal dimensions of the Display Environment, specified as Number of Vertical Pixels (0072,0104) and Number of Horizontal Pixels (0072,0106) in the Nominal Screen Definition Sequence (0072,0102).

See also Section C.23.2.1.1.

225 Within the Image Box, the image (or the area of the image selected for display by the associated Presentation State SOP Instance) shall be scaled to fit the display area under the constraint that the aspect ratio of the image is maintained.

In rendering the Image Box, the Application Entity may render display controls (such as cine speed control, or stack position indication) either within or outside the specified Display Environment Spatial Position
230 (0072,0108).

C.11.X.1.2 Referenced Image Sequence and Referenced Presentation State Sequence

Image SOP Instances, or frames from multi-frame SOP Instances, to be displayed in an Image Box may be identified either directly by the Referenced Image Sequence (0008,1140), or indirectly through the Referenced Presentation State Sequence (0008,9237).

235 Referenced Image Sequence is permitted to be zero length, indicating an empty Image Box.

- Note:
1. The recommended display color for an empty Image Box is specified by Empty Image Box CIE Lab Value (0072,0421).
 2. When displaying a standard template such as a dental full mouth series, an empty image box may be used to indicate that the corresponding view was not taken.

240

If images are identified indirectly through the Referenced Presentation State Sequence, all of the image frames identified in the top level Referenced Series Sequence (0008,1115) attribute shall be displayed. For images identified indirectly through a Blending Presentation State SOP Instance, all the image frames for which the Blending Position (0070,0405) value is UNDERLYING shall be displayed, with the relevant
245 SUPERIMPOSED images blended as necessary.

If images are to be displayed, the number of frames referenced for display shall be consistent with the value of Image Box Layout Type (0072,0304). If the value of Image Box Layout Type is SINGLE, only a single frame shall be referenced, either directly or indirectly; if the value is CINE, only a single multi-frame SOP Instance shall be referenced.

250 If the value of Image Box Layout Type is STACK, more than one SOP Instance or frame may be referenced, and the frames constitute a stack to be displayed in the Image Box. For frames identified by the Referenced Image Sequence, the order of stepping through the stack shall be the order of Image SOP Instance references in that Sequence. If multiple frames are selected in Referenced Frame Number

255 (0008,1160), those frames shall be stepped through in the order of their listing in that attribute, within the order of display of their Image SOP Instance.

260 For a stack whose frames are selected indirectly through an Item of the Referenced Presentation State Sequence, the order of stepping through the stack shall be the order of SOP Instance references in the Referenced Series Sequence (0008,1115) of the referenced Presentation State. For a referenced Blending Softcopy Presentation State, this shall be the Referenced Series Sequence within the Blending Sequence (0070,0402) for which the Blending Position (0070,0405) value is UNDERLYING.

- Notes:
- 265 1. Display of images using Blending Softcopy Presentation State must use indirect SOP Instance reference through the Referenced Presentation State Sequence (0008,9237) at the top level of Structured Display Image Box Sequence (0072,0422) Item, and cannot use the Referenced Presentation State Sequence within an item of the Referenced Image Sequence (0008,1140).
 - 270 2. A Blending Presentation State that references a blending of a single underlying frame and a single superimposed frame may be associated with a SINGLE Image Box Layout.
 - 275 3. A reference to a single display frame, either directly through Referenced Image Sequence or indirectly through Referenced Presentation State Sequence, may be associated with either a STACK or a CINE Image Box Layout as a degenerate case.
 - 280 4. There is no requirement for the pixel matrix sizes of the images in the stack, or the image display area as selected by referenced Presentation State SOP Instances, to be identical, nor for the referenced images to be of the same SOP Class.
 - 285 5. Referenced Presentation States are an initial presentation control. The rendering Application Entity might allow a user to interactively enable/disable graphic layers, or change the zoom, rotation, window width / window level, or other presentation controls. Any such Application Entity functionality is beyond the scope of the Standard.

C.11.X.1.3 Referenced Instance Sequence

280 The Referenced Instance Sequence (0008,114A) references a non-Image SOP Instance, e.g., a Structured Report, Waveform, or Encapsulated Document SOP Instance, to be displayed in the image box. For such object references, the value of Image Box Layout Type (0072,0304) shall be SINGLE, even if displaying the object will require scrolling or paging (e.g., a multi-page encapsulated document).

C.11.X.1.4 Referenced Stereometric Instance Sequence

285 The Referenced Stereometric Instance Sequence (0008,1134) references a Stereometric SOP Instance, whose Stereo Pairs Sequence (0022,0020) references image pairs to be displayed in the Image Box. The number of image pairs referenced for display shall be consistent with the value of Image Box Layout Type (0072,0304). If the value of Image Box Layout Type is SINGLE, only a single pair of frames shall be referenced by the Stereo Pairs Sequence in the referenced stereometric instance; if the value is CINE, only a single pair of multi-frame SOP Instances shall be referenced; if the value is STACK, one or more
290 pairs may be referenced constituting a stack to be displayed in the Image Box, and the order of stepping through the stack shall be the order of Items in the Stereo Pairs Sequence. The manner in which a stereo pair is rendered is unspecified.

- Notes:
- 295 1. While the Stereometric IOD allows reference to multiple pairs of multi-frame cine Instances, the CINE Image Box Layout does not support the display of more than one (a "stack" of cines).
 2. Display of stereo pairs typically requires specialized hardware (e.g., polarizing filters and shutter glasses).

C.11.X.1.5 Type of Synchronization

300 Type of Synchronization (0072,0434) specifies the method for synchronizing the display of images in two or more Image Boxes linked through the Synchronized Image Box List (0072,0432).

FRAME: Stepping of frames in one Image Box is synchronized by the stepping of an identical number of frames in the other Image Boxes.

305 POSITION: Stepping of frames in one Image Box is synchronized by the stepping of frames in the other Image Boxes to effect an identical relative positional offset within the patient based coordinate system. This presumes that the referenced images includes Image Position (Patient) (0020,0032) and Image Orientation (Patient) (0020,0037) attributes, and that the stacks have approximately the same orientation relative to the patient based coordinate system.

310 TIME: Playback of frames in one Image Box is synchronized by the playback of frames in the other Image Boxes to effect an identical temporal offset from the original displayed frame. This presumes that the referenced images include Frame Time (0018,1063), Frame Time Vector (0018,1065), or Frame Reference DateTime (0018,9151). It also presumes that if the Image Box Layout Type (0072,0304) is STACK, the frames are referenced in a monotonically increasing time order in the stack.

315 PHASE: Playback of frames in one Image Box is synchronized by the playback of frames in the other Image Boxes to effect an identical phase offset. This presumes that the referenced frames within each referenced Image Box constitute a uniform sampling across a single "cycle", and that relative position within that cycle is synchronized across all the referenced Image Boxes. For Image Boxes with Image Box Layout Type (0072,0304) value CINE, the set of frames to be displayed as one cycle may be specified either using the Referenced Frame Number (0008,1160) attribute within the Referenced Image Sequence (0008,1140), or if that attribute is not present, using the values of attributes Start Trim (0008,2142) and Stop Trim (0008,2143).

325 Notes: 1. PHASE may be used, for instance, to synchronize display of images representing a single cardiac cycle.
2. Synchronization of Image Boxes is an initial presentation control. The rendering Application Entity might allow a user to unlink the synchronization, e.g., to navigate to cine frames before the Start Trim (0008,2142) frame or after the Stop Trim (0008,2143) frame. Any such Application Entity functionality is beyond the scope of the Standard.

330

C.11.Y Structured Display Annotation Module

This Module defines Attributes of text annotation that shall be applied to a Structured Display. The text is defined in position and size relative to the Display Environment.

335 Notes: 1. The text bounding box is specified using the same attribute, Display Environment Spatial Position (0072,0108), that is used for Image Boxes in the Structured Display Module. This attribute uses the coordinates (0.0,0.0) as the bottom left hand corner and (1.0,1.0) as the top right hand corner. In contrast, the image-related text annotations defined in the Graphic Annotation Module in image Presentation State IODs use the attributes Bounding Box Top Left Hand Corner (0070,0010) and Bounding Box Bottom Right Hand Corner (0070,0011), which use the coordinates (0.0,0.0) as the top left
340 hand corner and (1.0,1.0) as the bottom right hand corner.
2. Annotation of regions of interest in images included in the Structured Display, e.g., circling of a feature of interest, may be done with a Presentation State applied to the image in the Structured Display Image Box Sequence (0072,0422) in the Structured Display Image Box Module. This Structured Display
345 Annotation Module provides only for text annotations, typically as used for captions for the Image Boxes or for the Structured Display as a whole.

Table C.11.Y-1 describes the attributes of the Structured Display Annotation Module.

**Table C.11.Y-1
Structured Display Annotation Attributes**

Attribute Name	Tag	Type	Attribute Description
Structured Display Text Box Sequence	(0072,0424)	1	Sequence that describes a text annotation. One or more Items shall be present.

>Unformatted Text Value	(0070,0006)	1	<p>Text data which is unformatted and whose manner of display within the defined bounding box is implementation dependent. See C.11.Y.1.1.</p> <p>The text value may contain spaces, as well as multiple lines separated by either LF, CR, CR LF or LF CR, but otherwise no format control characters (such as horizontal or vertical tab and form feed) shall be present, even if permitted by the Value Representation of ST.</p> <p>The text shall be interpreted as specified by Specific Character Set (0008,0005) if present in the SOP Instance.</p> <p>Note: The text may contain single or multi-byte characters and use code extension techniques as described in PS 3.5 if permitted by the values of Specific Character Set (0008,0005).</p>
>Display Environment Spatial Position	(0072,0108)	1	<p>Exactly four dimensionless floating point values, in the range 0.0 to 1.0, indicating the rectangular coordinate position within the Display Environment of the bounding box in which Unformatted Text Value (0070,0006) is to be displayed.</p> <p>Note: For the Basic Structured Display with a single screen, the Display Environment is coextensive with the screen defined in the Nominal Screen Definition Sequence (0072,0102). See Section C.11.W</p>
>Bounding Box Text Horizontal Justification	(0070,0012)	1	<p>Location of the text relative to the vertical edges of the bounding box. Enumerated Values:</p> <p>LEFT = closest to left edge RIGHT = closest to right edge CENTER = centered</p>
>Graphic Layer Recommended Display CIE Lab Value	(0070,0401)	3	<p>A value in which it is recommended that Unformatted Text Value (0070,0006) be rendered on a color display. The units are specified in PCS-Values, and the value is encoded as CIE Lab. See C.10.7.1.1.</p>

350

C.11.Y.1 Structured Display Annotation Attribute Descriptions

C.11.Y.1.1 Unformatted Text Value and Display Environment Spatial Position

355 The Unformatted Text Value (0070,0006) rendered in Display Environment Spatial Position (0072,0108) need not be confined to the specified bounding box.

- Notes:
1. An implementation may render text outside the confines of the bounding box if necessary to display all the specified text.
 2. Alternatively, an implementation may choose to render the text in a scrolling box, or a link to another fixed or popup window as appropriate.

360

When the text bounding box overlaps an Image Box (from the Structured Display Image Box Module), the text box has a higher display priority (i.e., it is on top of the image box). The background color of the bounding box is undefined.

- 365 Notes: 1. Commonly, the background region of the bounding box around the text will be rendered “transparently”, i.e. the image will be visible, though some implementations may choose to opacity the bounding box behind the text to improve its readability.
2. With a transparent background, for example, an implementation may choose an “exclusive or” style opacification to be sure that the text is discernible over light and dark portions of the image.

370 The size, font, and rotation of the individual rendered text characters are unspecified.

Modify Table C.8-81

**Table C.8-81
MR IMAGE AND SPECTROSCOPY INSTANCE MACRO**

...			
Referenced Grayscale Presentation State Sequence	(0008,9237)	1C	References to Grayscale Presentation State instances acquired in conjunction with this instance. Note: May only be used to reference Presentation States belonging to the acquired data and not to reference Presentation States generated subsequently such as during interpretation. One or more Items may be included in this sequence. Required if Presentation State is generated during acquisition, shall not be present otherwise.
...			

375

Modify Table C.8-114

**Table C.8-114
ENHANCED CT IMAGE MODULE ATTRIBUTES**

Attribute Name	Tag	Type	Attribute Description
...			
Referenced Grayscale Presentation State Sequence	(0008,9237)	1C	References to Grayscale Presentation State instances acquired in conjunction with this instance. Note: May only be used to reference Presentation States belonging to the acquired data and not to reference Presentation States generated subsequently such as during interpretation. One or more Items may be included in this sequence.

380

			Required if Presentation State is generated during acquisition, shall not be present otherwise.
....			

385 **Modify Annex C.23.2 to break out Screen Specifications Macro**

C.23.2 Hanging Protocol Environment Module

Table C.23.2-1 specifies the Attributes that describe and identify the best suited display environment for a Hanging Protocol.

390 Different viewing styles and interactions may be defined depending on a workstation's capabilities. For example, the hanging preferences for viewing a screening mammogram study on a 1Kx1K screen with a 10 second repaint time versus a 2Kx2.5K screen may differ.

- Notes: 1. The term Screen is intended to include all types of display devices (e.g., CRT, LCD, etc.).
2. This information may be used by an application to select a subset of the available screens on which to apply a Hanging Protocol.

395

**Table C.23.2-1
Hanging Protocol Environment Module Attributes**

Attribute Name	Tag	Type	Attribute Description
Number of Screens	(0072,0100)	2	Positive integer indicating the number of screens for which this Hanging Protocol is intended.
Nominal Screen Definition Sequence	(0072,0102)	2	Sequence of zero or more items that describes the set of screens for which this Hanging Protocol is intended.
<u>>Include Screen Specifications Macro Table C.23.2-2</u>			

400

**Table C.23.2-2
Screen Specifications Macro Attributes**

Attribute Name	Tag	Type	Attribute Description
Number of Vertical Pixels	(0072,0104)	1	Positive integer indicating the intended number of rows of the addressable area of the screen in pixels. Note: The goal is not absolute size matching.
Number of Horizontal Pixels	(0072,0106)	1	Positive integer indicating the intended number of columns of the addressable area of the screen in pixels. Note: The goal is not absolute size matching.
Display Environment Spatial Position	(0072,0108)	1	Exactly four unitless dimensionless floating point values indicating the rectangular coordinate position of the screen within the overall bounding box that encompasses all the screens. See C.23.2.1.1.

Screen Minimum Grayscale Bit Depth	(0072,010A)	1C	Positive integer indicating the desired minimum number of grayscale bits per pixel of the screen. Required if Screen Minimum Color Bit Depth (0072,010C) is not present.
Screen Minimum Color Bit Depth	(0072,010C)	1C	Positive integer indicating the desired minimum total number of bits per color channel used to present a pixel. Required if Screen Minimum Grayscale Bit Depth (0072,010A) is not present. Note: A 24-bit color system with 8 bits per color channel (red, green, blue) would have a value of 8.
Application Maximum Repaint Time	(0072,010E)	3	Positive integer indicating the desired maximum time in milliseconds required by the application to repaint the full screen once (i.e., recalculate all pixels and paint them to the screen). Note: This is not the screen refresh time.

C.23.2.1 Hanging Protocol Environment Attribute Descriptions

C.23.2.1.1 Display Environment Spatial Position

405 For the Display Environment Spatial Position (0072,0108) attribute, the lower left corner of the overall bounding box has Cartesian coordinates of (0.0,0.0). The upper right corner has coordinates of (1.0,1.0). The scale of the box is based on the Number of Vertical Pixels (0072,0104) and Number of Horizontal Pixels (0072,0106), not the physical size of the screens that are part of the workstation. The coordinates of each individual screen's box are defined in absolute coordinates relative to the (0,0) and (1,1) range of
410 the overall box. Position of a box is given by a (x1,y1), (x2,y2) pair that identifies the upper left corner and lower right corner if the box is rectangular.

Note: The goal is not absolute position matching of the image boxes rendered on the screens using Hanging Protocol layout information, but that the relative positioning of the image boxes should be consistent
415 between different workstations.

The following figure C.23.2-1 depicts a 1K x 1K screen positioned to the left of a 2K x 2.5K screen. The Display Environment Spatial Position (0072,0108) of the 1K x 1K screen is (0.0,0.4) (0.33,0.0), and the Display Environment Spatial Position (0072,0108) of the 2K x 2.5K screen is (0.33,1.0) (1.0,0.0).

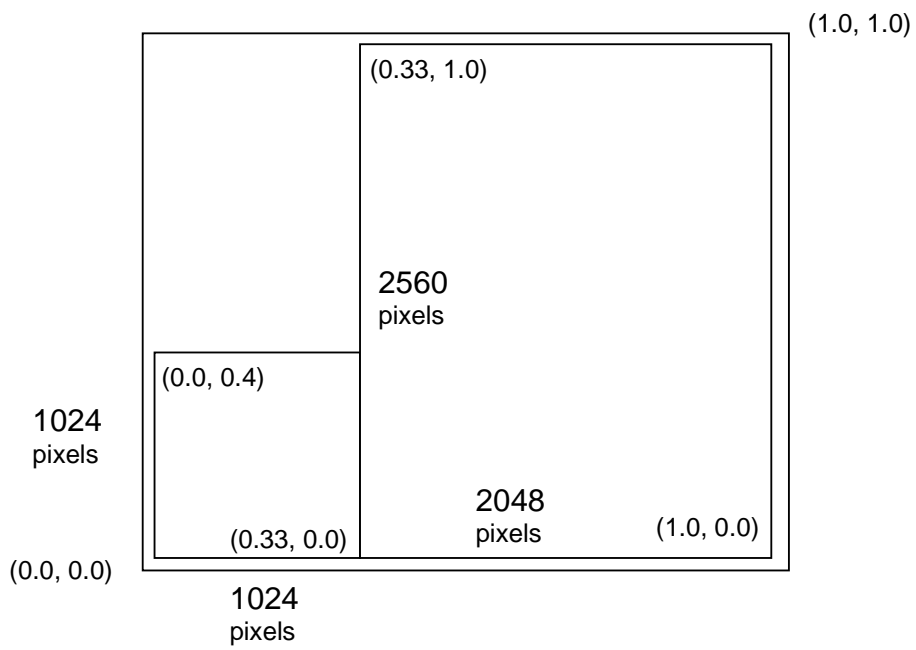


Figure C.23.2-1 Example Hanging Protocol Screen Environment

Changes to NEMA Standards Publication PS 3.4-2008

Digital Imaging and Communications in Medicine (DICOM)

Part 4: Service Class Specifications

425 **Add SOP Classes to Table B.5-1**

B.5 STANDARD SOP CLASSES

**Table B.5-1
Standard SOP Classes**

SOP Class	SOP Class UID	IOD Specification (defined in PS 3.3)
<u>Basic Structured Display Storage</u>	<u>1.2.840.10008.5.1.4.1.1.131</u>	<u>Basic Structured Display IOD</u>

430 **Add new Part 4 section on SOP Class requirements**

B.5.1.x Basic Structured Display

An SCU of the Basic Structured Display Storage SOP Class that creates SOP Instances of the Class shall identify in its Conformance Statement the Composite Storage SOP Classes and Softcopy Presentation State Storage SOP Classes that are also supported by the SCU, and which may be referenced by Basic Structured Display SOP Instances it creates. It shall identify in its Conformance Statement the values it may use in the attributes Image Box Layout Type (0072,0304) and Type of Synchronization (0072,0434).

An SCP of the Basic Structured Display Storage SOP Class, when rendering SOP Instances of the Class, shall preserve the aspect ratio specified by the Nominal Screen Definition Sequence (0072,0102) attributes Number of Vertical Pixels (0072,0104) and Number of Horizontal Pixels (0072,0106) without clipping.

- Notes:
1. The SCP is not required to display using the exact number of vertical and horizontal pixels. The SCP may use as much of its display screen as it desires, while maintaining the Structured Display aspect ratio.
 2. If the display screen has a different aspect ratio, the positioning of the display on the screen is unspecified (centered, left or right justified, top or bottom justified).

An SCP of the Basic Structured Display Storage SOP Class that is capable of rendering SOP Instances of the Class shall identify in its Conformance Statement the Composite Storage SOP Classes and Softcopy Presentation State Storage SOP Classes that are also supported by the SCP, and which will be rendered when referenced by Basic Structured Display SOP Instances for display. It shall specify in its Conformance Statement the user display controls and interactions for the values of Image Box Layout Type (0072,0304) and Type of Synchronization (0072,0434) that it supports. It shall identify in its Conformance Statement its behavior when encountering a referenced Presentation State or other Composite Storage SOP Instance whose display it does not support, or an unsupported value of Image Box Layout Type or Type of Synchronization; such behavior shall include at a minimum a display to the user of the nature of the incompatibility.

Add SOP Classes to Table I.4-1

460 I.4 MEDIA STORAGE SOP CLASSES

Table I.4-1
Media Storage Standard SOP Classes

SOP Class	SOP Class UID	IOD Specification
<u>Basic Structured Display Storage</u>	<u>1.2.840.10008.5.1.4.1.1.131</u>	<u>Basic Structured Display IOD</u>

Changes to NEMA Standards Publication PS 3.6-2008

Digital Imaging and Communications in Medicine (DICOM)

Part 6: Data Dictionary

Add the following rows to Section 6

Tag	Name	VR	VM
(0008,9237)	Referenced Greyscale Presentation State Sequence	SQ	1
<u>(0008,1134)</u>	<u>Referenced Stereometric Instance Sequence</u>	<u>SQ</u>	<u>1</u>
<u>(0018,0042)</u>	<u>Initial Cine Run State</u>	<u>CS</u>	<u>1</u>
<u>(0072,0420)</u>	<u>Structured Display Background CIELab Value</u>	<u>US</u>	<u>3</u>
<u>(0072,0421)</u>	<u>Empty Image Box CIELab Value</u>	<u>US</u>	<u>3</u>
<u>(0072,0422)</u>	<u>Structured Display Image Box Sequence</u>	<u>SQ</u>	<u>1</u>
<u>(0072,0424)</u>	<u>Structured Display Text Box Sequence</u>	<u>SQ</u>	<u>1</u>
<u>(0072,0427)</u>	<u>Referenced First Frame Sequence</u>	<u>SQ</u>	<u>1</u>
<u>(0072,0430)</u>	<u>Image Box Synchronization Sequence</u>	<u>SQ</u>	<u>1</u>
<u>(0072,0432)</u>	<u>Synchronized Image Box List</u>	<u>US</u>	<u>2-n</u>
<u>(0072,0434)</u>	<u>Type of Synchronization</u>	<u>CS</u>	<u>1</u>

470 **Add the following row to Table A-1**

<u>1.2.840.10008.5.1.4.1.1.13</u>	<u>Basic Structured Display Storage</u>	<u>SOP Class</u>	<u>PS 3.4</u>
<u>1</u>			

Changes to NEMA Standards Publication PS 3.11-2008

475

Digital Imaging and Communications in Medicine (DICOM)

Part 11: Media Storage Application Profiles

Item #9: Add to Table K.3-1

K.3.1 SOP Classes and Transfer Syntaxes

480 The Application Profile STD-DEN-CD shall support the SOP Classes and Transfer Syntaxes in the following table.

**Table K.3-1
DENTAL ABSTRACT AND TRANSFER SYNTAXES**

Information Object Definition	SOP Class UID	Transfer Syntax and UID	FSC Requirement	FSR Requirement
Basic Directory	1.2.840.10008.1.3.10	Explicit VR Little Endian Uncompressed 1.2.840.10008.1.2.1	Mandatory	Mandatory
Digital Intra-oral X-Ray Image Storage – For Presentation	1.2.840.10008.5.1.4.1.1.1.3	Explicit VR Little Endian Uncompressed 1.2.840.10008.1.2.1	Optional	Mandatory
Digital X-Ray Image Storage – For Presentation	1.2.840.10008.5.1.4.1.1.1.1	Explicit VR Little Endian Uncompressed 1.2.840.10008.1.2.1	Optional	Mandatory
<u>Basic Structured Display Storage</u>	<u>1.2.840.10008.5.1.4.1.1.1.31</u>	<u>Explicit VR Little Endian Uncompressed</u> <u>1.2.840.10008.1.2.1</u>	<u>Optional</u>	<u>Optional</u>
<u>Grayscale Softcopy Presentation State</u>	<u>1.2.840.10008.5.1.4.1.1.1.1</u>	<u>Explicit VR Little Endian Uncompressed</u> <u>1.2.840.10008.1.2.1</u>	<u>Optional</u>	<u>Optional</u>

Changes to NEMA Standards Publication PS 3.15-2008

Digital Imaging and Communications in Medicine (DICOM)

Part 15: Security and System Management Profiles

Item #10: Add to Section C2 and C3

C.2 CREATOR RSA DIGITAL SIGNATURE PROFILE

...

- 495 a. the SOP Class and Instance UIDs
- b. the SOP Creation Date and Time, if present
- c. the Study and Series Instance UIDs
- d. any attributes of the General Equipment module that are present
- e. any attributes of the Overlay Plane, Curve or Graphic Annotation modules that are present
- 500 f. any attributes of the General Image and Image Pixel modules that are present
- g. any attributes of the SR Document General and SR Document Content modules that are present
- h. any attributes of the Waveform and Waveform Annotation modules that are present
- i. any attributes of the Multi-frame Functional Groups module that are present
- 505 j. any attributes of the Enhanced MR Image module that are present
- k. any attributes of the MR Spectroscopy modules that are present
- l. any attributes of the Raw Data module that are present
- m. any attributes of the Enhanced CT Image module that are present
- n. any attributes of the Enhanced XA/XRF Image module that are present
- 510 o. ...
- p. ...
- q. **any attributes of the Structured Display, Structured Display Annotation, and Structured Display Image Box modules that are present**

515 **C.3 AUTHORIZATION RSA DIGITAL SIGNATURE PROFILE**

...

- a. the SOP Class and Instance UIDs
- b. the Study and Series Instance UIDs
- 520 c. any attributes whose Values are verifiable by the technician or physician (e.g., their Values are displayed to the technician or physician)
- d. any attributes of the Overlay Plane, Curve or Graphic Annotation modules that are present
- e. any attributes of the General Image and Image Pixel modules that are present
- f. any attributes of the SR Document General and SR Document Content modules that are present
- 525 g. any attributes of the Waveform and Waveform Annotation modules that are present
- h. any attributes of the Multi-frame Functional Groups module that are present
- i. any attributes of the Enhanced MR Image module that are present
- j. any attributes of the MR Spectroscopy modules that are present
- k. any attributes of the Raw Data module that are present
- 530 l. any attributes of the Enhanced CT Image module that are present
- m. any attributes of the Enhanced XA/XRF Image module that are present

n. ...

o. ...

p. ...

q. ...

r. **any attributes of the Structured Display, Structured Display Annotation, and Structured Display Image Box modules that are present**

535