Digital Imaging and Communications in Medicine (DICOM)

Supplement 231: Adaptive Dynamic Range GSPS

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Document History

2022/03/07	Version 1	SJN	Initial revision for WG-06 first read
2022/04/04	Public Comment	SJN	Integrate WG-06 input for Public Comment

Open Issues

1.	Should there be a Corresponding Pseudo-Color Softcopy Presentation State? Public comment is sought on this.

Closed Issues

1.	What is an appropriate name for the SOP class presented in this Supplement? **Response:** Adaptive Dynamic Range GSPS
2.	In GSPS, Spatial Transformations apply to all referenced images. Is there interest in including selective and/or multiple spatial transformations (i.e. flip and rotate) in this SOP class? **Response:** There is interest, however, WG-06 prefers to not to include spatial transformations in the scope of this supplement, as selective/multiple spatial transformations are not related to Modality LUT transformations.

Scope and Field of Application

This supplement defines a new SOP Class that relaxes the requirements of the existing GSPS SOP Class for modalities in which the dynamic range varies between images or frames. This SOP class will address handling of Modality LUT in the referenced image(s) and not require the GSPS Modality LUT Module.

The rationale behind this supplement is that PS3.4 N.2.1.1 requires the per image Modality LUT be ignored in the presence of a GSPS object. This is problematic in cases such as PET or MR, in which the dynamic range of the measured values varies between images. This forces the GSPS creator to render a GSPS object for each image.

Modifications to PS3.2

Add SOP Class to PS3.2, Table A.1-2 UID Values

Table A.1-2
UID VALUES

UID Value	UID NAME	Category
…		
1.2.840.10008.5.1.4.1.1.11.x	**Adaptive Dynamic Range Grayscale Softcopy Presentation State Storage**	**Transfer**
…		

Modifications to PS3.3

Add Adaptive Dynamic Range GSPS in PS3.3 Section A.1.4, Table A.1-6

Table A.1-6. Composite Information Object Modules Overview - Presentation States

IODs Modules	Gray Pres State	Col Pres State	Pseudo Col Pres State	Blend Pres State	XA RF Pres State	Planar MPR Vol Pres State	Vol Rend Vol Pres State	Adv Blend Pres State	Adapt Dynamic Range GSPS
Patient	M	M	M	M	M	M	M	M	**M**
Clinical Trial Subject	U	U	U	U	U	U	U	U	**U**
General Study	M	M	M	M	M	M	M	M	**M**
Patient Study	U	U	U	U	U	U	U	U	**U**
Clinical Trial Study	U	U	U	U	U	U	U	U	**U**
General Series	M	M	M	M	M	M	M	M	**M**
Clinical Trial Series	U	U	U	U	U	U	U	U	**U**
Presn. Series	M	M	M	M	M	M	M	M	**M**
Frame of Reference						M	M	M	
General Equip.	M	M	M	M	M	M	M	M	**M**

IODs **Modules**	**Gray Pres State**	**Col Pres State**	**Pseudo Col Pres State**	**Blend Pres State**	**XA RF Pres State**	**Planar MPR Vol Pres State**	**Vol Rend Vol Pres State**	**Adv Blend Pres State**	**Adapt Dynamic Range GSPS**
Enhanced General Equip.					M	M	M	M	**M**
Mask	C		C						**C**
Display Shutter	C	C	C						**C**
Bitmap Display Shutter	C	C	C		C				**C**
Palette Color LUT			M	M					
Overlay Plane	C	C	C		C				**C**
Disp. Area	M	M	M	M	M			U	**M**
Overlay Actvn.	C	C	C		C				**C**
Graphic Annot.	C	C	C	C	C	U	U	U	**C**
Spatial Trans.	C	C	C	C	C			C	**C**
Graphic Layer	C	C	C	C	C	C	C	C	**C**
Graphic Group	U	U	U	U		U	U	U	**C**
Modality LUT	C		C						
Softcopy VOI LUT	C		C		C				**C**
Softcopy Presn. LUT	M				M				**M**
Presn. State Ident.	M	M	M	M	M			M	**M**
Presn. State Reln.	M	M	M		M				**M**
Presn. State Shutter	M	M	M		M				**M**
Presn. State Mask	M		M						**M**
Presn. State Blending				M					

IODs **Modules**	**Gray Pres State**	**Col Pres State**	**Pseudo Col Pres State**	**Blend Pres State**	**XA RF Pres State**	**Planar MPR Vol Pres State**	**Vol Rend Vol Pres State**	**Adv Blend Pres State**	**Adapt Dynamic Range GSPS**
Adv. Presn. State Blending								M	
Adv. Presn. State Display								M	
XA/XRF Presn. State Mask					C				
XA/XRF Presn. State Shutter					C				
XA/XRF Presn. State Presn.					C				
Volumetric Presentation State Identification						M	M		
Volumetric Presentation State Relationship						M	M		
Volume Cropping						C	C		
Presentation View Description						M	M		
Multi-Planar Reconstruction Geometry						M			
Volume Render Geometry							M		
Render Shading							U		

IODs Modules	Gray Pres State	Col Pres State	Pseudo Col Pres State	Blend Pres State	XA RF Pres State	Planar MPR Vol Pres State	Vol Rend Vol Pres State	Adv Blend Pres State	**Adapt Dynamic Range GSPS**
MPR Volumetric Presentation State Display						M			
Render Display							M		
Volumetric Graphic Annotation						U	U		
Presentation Animation						U	U		
ICC Profile		M	M	M				M	
Common Instance Reference						M	M	M	
SOP Common	M	M	M	M	M	M	M	M	**M**

Add the following new section in PS3.3 Annex A.33

A.33.X Adaptive Dynamic Range Grayscale Softcopy Presentation State Information Object Definition

A.33.X.1 Adaptive Dynamic Range Grayscale Softcopy Presentation State IOD Description

The Adaptive Dynamic Range Grayscale Softcopy Presentation State Information Object Definition (IOD) specifies information that may be used to present (display) monochrome images for which the Modality LUT in the referenced Image IODs are intended for presentation control. This IOD supports presentation control for a set of images for which the Modality LUT varies on a frame-by-frame basis.

It includes capabilities from the Grayscale Softcopy Presentation State IOD for specifying:

a. the output grayscale space in P-Values
b. grayscale contrast transformations including VOI LUT
c. selection of the area of the image to display and whether to rotate or flip it
d. image and display relative annotations, including graphics, text and overlays

Note

1. This IOD differs from the Grayscale Softcopy Presentation State IOD, because it supports presentation control for a set of images for which the modality LUT varies on a frame-by-frame basis. See note in Section A.33.1.1.
2. This IOD may only be used to reference monochrome images, i.e. images with a Photometric Interpretation (0028,0004) of MONOCHROME1 or MONOCHROME2. See Section A.33.2 for the

Color Softcopy Presentation State IOD, which allows for referencing color images, e.g. images with a Photometric Interpretation (0028,0004) of RGB.

A.33.X.2 Adaptive Dynamic Range Grayscale Softcopy Presentation State IOD Module Table

Table A.33.X-1 specifies the Modules of the Adaptive Dynamic Range Grayscale Softcopy Presentation State IOD.

Table A.33.X-1. Grayscale Softcopy Presentation State 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	M
Presentation State	Presentation State Identification	C.11.10	M
	Presentation State Relationship	C.11.11	M
	Presentation State Shutter	C.11.12	M
	Presentation State Mask	C.11.13	M
	Mask	C.7.6.10	C - Required if the referenced image(s) are multi-frame and are to be subtracted
	Display Shutter	C.7.6.11	C - Required if a Display Shutter is to be applied to referenced image(s) and the Bitmap Display Shutter Module is not present
	Bitmap Display Shutter	C.7.6.15	C - Required if a Display Shutter is to be applied to referenced image(s) and the Display Shutter Module is not present
	Overlay Plane	C.9.2	C - Required if Overlay is to be applied to referenced image(s) or the Bitmap Display Shutter Module is present.
	Overlay Activation	C.11.7	C - Required if referenced image contains overlay data that is to be displayed or Presentation State Instance contains Overlay data other than Bitmap Shutter
	Displayed Area	C.10.4	M
	Graphic Annotation	C.10.5	C - Required if Graphic Annotations are to be applied to referenced image(s)
	Spatial Transformation	C.10.6	C
	Graphic Layer	C.10.7	C - Required if Graphic Annotations or Overlays or Curves are to be applied to referenced image(s)
	Graphic Group	C.10.11	U

IE	Module	Reference	Usage
	Softcopy VOI LUT	C.11.8	C - Required if a VOI LUT is to be applied to referenced image(s)
	Softcopy Presentation LUT	C.11.6	M
	SOP Common	C.12.1	M

In the Adaptive Dynamic Range Grayscale Softcopy Presentation State IOD, the Presentation Series Module specializes some Attributes of the General Series Module, the Presentation State Mask Module specializes some Attributes of the Mask Module, and the Presentation State Shutter Module specializes some Attributes of the Bitmap Display Shutter Module and Display Shutter Module.

Note

1. Subtraction between different images is not supported.
2. The Mask Module condition implies that it need not be supported by an SCP that supports presentation states only for single-frame image storage SOP Classes, or Instances of multi-frame image Storage SOP Classes that contain only one frame.
3. The Display Shutter may be used to darken image areas that surround important information and exclude extraneous bright areas that increase glare and ambient lighting impairing image interpretation. For example, unexposed areas in a CR image might be obscured using the Display Shutter, rather than permanently replacing image pixels in those areas.
4. This IOD does not support the storage of a multi-frame overlay in the IOD itself, but does support selective activation of multi-frame overlays within the referenced images via the Overlay Activation Module.

Modifications to PS3.4

Add the following to PS3.4 Table B.5-1 Standard SOP Classes

B.5 Standard SOP classes

Table B.5-1. Standard SOP Classes

SOP Class Name	SOP Class UID	IOD Specification (defined in PS 3.3)	Specialization
Adaptive Dynamic Range Grayscale Softcopy Presentation State Storage	1.2.840.10008.5.1.4.1.1.11.x	Adaptive Dynamic Range Grayscale Softcopy Presentation State	

Modify PS3.4 Section B.5.1.8 Enhanced MR Color Image Storage SOP Class as follows

B.5.1.8 Enhanced MR Color Image Storage SOP Class

An SCP of the Enhanced MR Color Image Storage SOP Class shall also support the Color Softcopy Presentation State Storage SOP Class as an SCP**, and optionally the Adaptive Dynamic Range Grayscale Softcopy Presentation State**.

Note

This requirement is present in order to allow the exchange of graphical annotations created by an acquisition device.

Modify PS3.4 Section B.5.1.15 Enhanced PET Image Storage SOP Classes as follows

B.5.1.15 Enhanced PET Image Storage and Legacy Converted Enhanced PET Image Storage SOP Class

An SCP of the Enhanced PET Image Storage or Legacy Converted Enhanced PET Image Storage SOP Class shall also support the Grayscale Softcopy Presentation State Storage SOP Class as an SCP**, and optionally the Adaptive Dynamic Range Grayscale Softcopy Presentation State**.

Note

This requirement is present in order to allow the exchange of graphical annotations created by an acquisition or conversion device.

Modify PS3.4 Section B.5.1.16 Enhanced PET Image Storage SOP Classes as follows

B.5.1.16 Enhanced PET Image Storage SOP Classes

An SCP of the Enhanced PET Image Storage SOP Class shall also support the Grayscale Softcopy Presentation State Storage SOP Class as an SCP**, and optionally the Adaptive Dynamic Range Grayscale Softcopy Presentation State**.

Note

This requirement is present in order to allow the exchange of graphical annotations created by an acquisition device.

Modify PS3.4 Section N.2 Pixel Transformation Sequence

N.2 Pixel Transformation Sequence

The Softcopy Presentation State Storage SOP Classes support a sequence of transformations that completely define the conversion of a stored image into a displayed image.

The sequence of transformations from stored pixel values into P-Values or PCS-Values is explicitly defined in a conceptual model. The actual sequence implemented may differ but must result in the same appearance. Figure N.2-1 describes this sequence of transformations.

Note

1. Even though a Composite Image Storage SOP Class may not include some Modules that are part of the described transformations, the Softcopy Presentation State Storage SOP Classes do include them. For example, the CT Image Storage SOP Class includes Rescale Slope and Intercept in the CT Image Module, but does not include the Modality LUT Module, and hence is restricted to the description of linear transformations. A saved presentation state that refers to a CT Image Storage SOP Instance may include a Modality LUT, and hence may apply a non-linear transformation.

2. For the shutter, annotation and spatial transformations, the order in which they are applied relative to the other transformations should not result in a different appearance. The one exception is when a spatial transformation is applied that involves magnification implemented with interpolation. In this case, whether the interpolation is performed before or after the contrast transformations (such as VOI LUT) may result in a slightly different appearance. It is not considered necessary to constrain this sequence more precisely.

The transformations defined in the Softcopy Presentation State Storage SOP Classes replace those that may be defined in the Referenced Image SOP Instance. If a particular transformation is absent in the Softcopy Presentation State Storage SOP Class, then it shall be assumed to be an identity transformation, and any equivalent transformation, if present, in the Referenced Image SOP Instance shall NOT be used instead.

Values of MONOCHROME1 and MONOCHROME2 for Photometric Interpretation (0028,0004) in the Referenced Image SOP Instance shall be ignored, since their effect is defined by the application of the grayscale presentation state transformations.

Note

These requirements are in order to achieve complete definition of the entire transformation in the Softcopy Presentation State Storage SOP Classes, and not to depend on the content of the Referenced Image SOP Instance, which may change.

The Referenced Image Storage SOP Instance may also contain bit-mapped overlays. The Softcopy Presentation State Storage SOP Classes specify a mechanism for turning these on or off (i.e., displaying them or not).

The presentation related Attributes of the Softcopy Presentation State Storage SOP Classes are immutable. They shall never be modified or updated; only a derived SOP Instance with a new SOP Instance UID may be created to represent a different presentation.

When a Supplemental Palette Color LUT is present in a grayscale Referenced Image Storage SOP Instance:

- The grayscale pipeline in any applicable Grayscale Softcopy Presentation State Storage SOP Instance**, Adaptive Dynamic Range Grayscale Softcopy Presentation State** or Blended Softcopy Presentation State Storage SOP Instance shall be applied only to the range of grayscale stored pixel values, and the presentation state shall not affect the rendering of the indexed color values.
- A Color Softcopy Presentation State Storage SOP Instance shall not be applied.
- A Pseudo-color Softcopy Presentation State Storage SOP Instance may be applied, in which case the Supplemental Palette Color LUT information shall be ignored.
- No mechanism for separately specifying color consistency of the colors in the Supplemental Palette Color LUT is presently defined, only the optional inclusion of an ICC profile in the image instance.

Modify PS3.4 Section N.2.1.1 Modality LUT as follows

N.2.1.1 Modality LUT

The Modality LUT operation applies only to grayscale values.

The Modality LUT transformation transforms the manufacturer dependent pixel values into pixel values that are meaningful for the modality and are manufacturer independent (e.g., Hounsfield number for CT modalities, Optical Density for film digitizers). These may represent physical units or be dimensionless. The Modality LUT in the Presentation State is modality dependent and is analogous to the same Module in an Image.

Note

1. In some cases, such as the CT Image Storage SOP Class, the same conceptual step as the Modality LUT is specified in another form, for example as Rescale Slope and Rescale Intercept Attributes in the CT Image Module, though the Modality LUT Module is not part of the CT Image IOD.
2. Image pixel values with a value of Pixel Padding Value (0028,0120) in the referenced image, or within the range specified by Pixel Padding Value (0028,0120) and Pixel Padding Range Limit (0028,0121) (if present in the referenced image) shall be accounted for prior to entry to the Modality LUT stage. See the definition of Pixel Padding Value in PS3.3. Neither Pixel Padding Value (0028,0120) nor Pixel Padding Range Limit (0028,0121) are encoded in the Presentation State Instance.

In the case of a linear transformation, the Modality LUT is described by the Rescale Slope (0028,1053) and Rescale Intercept (0028,1052). In the case of a non-linear transformation, the Modality LUT is described by the Modality LUT Sequence. The rules for application of the Modality LUT are defined in Section C.11.1 “Modality LUT Module” in PS3.3 .

If the Modality LUT or equivalent Attributes are part of both the Image and the **Grayscale Softcopy** Presentation State, **or the Pseudo-Color Softcopy Presentation State,** then the Presentation State Modality LUT shall be used instead of the Image Modality LUT or equivalent Attributes in the Image. If the Modality LUT is not present in the **Grayscale Softcopy** Presentation State**, or the Pseudo-Color Softcopy Presentation State,** it shall be assumed to be an identity transformation. Any Modality LUT or equivalent Attributes in the Image shall not be used.

The Modality LUT is not present in the Adaptive Dynamic Range Grayscale Softcopy Presentation State by definition. The Modality LUT or equivalent Attributes in the Image shall be used, i.e. do not assume an identity transformation.

Modifications to PS3.6

Add the following UID to PS3.6 Annex A

A Registry of DICOM Unique Identifiers (UIDs) (Normative)

Table A-1. UID Values

UID Value	UID NAME	UID TYPE	Part

1.2.840.10008.5.1.4.1.1.11.x	Adaptive Dynamic Range Grayscale Softcopy Presentation State Storage	SOP Class	PS 3.4

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