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Digital Imaging and Communications in Medicine (DICOM)

Supplement 236: Waveform Presentation State

Prepared by: Working Group 32 Neurophysiology Waveforms

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Document History

2022/06/06	Version 0		Initial version, fragmentary
2022/07/19	Version 1		First draft for wg-32
2022/09/20	Version 5		Draft for wg-06 / First Read
2022/10/14	Version 6		Changes after First Read
2022/11/11	Version 7		Added Cardio Use Case
2022/11/18	Version 8		After Discussion with WG-06
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2023/06/15	Version 15		Prepared for WG-32 (2023-06-15) <ul style="list-style-type: none"> removed separate (Non-Patient-related) Montage object, only explicitly defined montages are required
2023/08/23	Version 16		Changes after meeting with WG-06 (June 2023) <ul style="list-style-type: none"> removed Structured Display IOD and renamed the document Structured Annotation Module Montage Activation Module
2023/08/29	Version 17		Prepared for WG-06 (2023-08-30): <ul style="list-style-type: none"> Presentation State Identification Additional open issues PS3.4 and PS3.6 changes
2023/08/29	Version 18		<ul style="list-style-type: none"> Edits discussed in Meeting with WG-06 (2023-08-30) <ul style="list-style-type: none"> Closed some open issues Move Multiplex Group issues to a separate CP
2024/01/05	Version 19		<ul style="list-style-type: none"> Document cleaned up Re-written Open Issue #2
2024/01/12	Version 20		Changes during and after review with WG-06. <ul style="list-style-type: none"> No authors for individual annotations in the PR – see closed issue #6 No graphics in the Graphic Annotation Module, just text. Also changed the name of the module. Removed ICC Profile Module and added an open issue for it (open issue #6). ?? introduced Common Sop Instance Reference Module Removed amendment of PS3.4 and placed an open

			<p>issue for it (open issue #7)</p> <ul style="list-style-type: none"> • Cleaned up the comments and preserved the discussions in additional closed issues.
2024/03/xx	Version 22		<p>Changes during and after Review with WG-06</p> <ul style="list-style-type: none"> • IOD for Recording PR • changed Module Table overview • Changes in the Waveform Presentation State Relationship Module (also contain the reference to the Waveform Annotations SR) and in the Structured Waveform Annotations Module

Open Issues

1.	<p>Q: Is it sufficient to just create a single Presentation State to store the display settings (montages) for a neurophysiology study during recording? Are there any other situation which also could trigger to store montage settings and so result in more than one Presentation State in one Study?</p>
2.	<p>Q: When annotations are added to waveforms the user often sees the recording using a specific montage. Supplement 239 Waveform Annotations and this supplement define Annotations as always referring to the recording channels in the related waveform objects but it allows to store a recommended montage to show the annotation.</p> <p>Would it be useful if some annotations could choose to refer to the montage channel(s) instead of the recording channel(s)? For the Annotations stored in a separate SR object the definition of this relationship might be complicated.</p>
3.	<p>Q: Shall it be possible to refer to both – images and waveforms - from one PR, e.g. in Angiography or fMRI? Usually the objects are synchronized, but the existing PR objects only allow for referencing images and the new one defined in this supplement only allows for referencing waveform objects.</p>
4.	<p>Q: Besides the storage of montages used in a neurophysiology recording, the proposed PR allows for both: containing simple text annotations and providing display information for annotations stored in a separate Waveform Annotation SR. Are there any scenarios which require annotations in the PR or shall all annotations go to the SR?</p>
5.	<p>Q: This supplement restricts the Presentation State to only refer to SR Documents in the same study. There might be use cases were the annotation SR resides in a different study. Should this be possible in the PR considering, that this results in issues in deciding about which metadata (Study A, Study B) to display?</p>
6.	<p>Q: Is it necessary to include the ICC Profile Module if all color values are defined as CIE Lab values in PCS?</p>
7.	<p>Q: This supplement allows assigning simple text annotations to dedicated waveforms – besides having complex annotations in referenced Waveform Annotation SRs. Presentation states for images support in addition presentation properties like graphical annotations. Are there any use cases which would require such additional properties in the Waveform Presentation State and, if yes, which one?</p>
8.	<p>Q: Within the presentation state object only the temporal coordinates of the annotation and color properties are defined. All other properties are left to the implementation of the viewing software. Would it be necessary to specify further display properties in the presentation</p>

	state and, if yes, which one?
9.	<p>Q: Part 4 of the DICOM standard provides a comprehensive chapter which describes the behavior of applications when they create and assign Presentation States to images (e.g. by a description of the pixel value rendering pipeline).</p> <p><u>The Waveform Presentation State is not intended to fully render the display of waveforms. Therefor no Service Class specific behavior is described in this supplement.</u> Are there any specific requirements for displays to be normative defined for applications assigning waveform presentation states to waveform objects and, if yes, which one?</p>
10.	<p>Q: Waveform Montages introduced in the supplement are fully defined within the Waveform Presentation State object, that uses them. Montages could also be defined and managed externally. Would it be necessary to also standardize such predefined montages and allow to refer to them in the Waveform Presentation state? If yes, this requires separate mechanism to address and access such montage objects.</p>
11.	<p><u>Q: This presentation state object introduces the possibility to assign display properties to waveform annotations coming from separate SR documents. Is it expectable that such annotations come from SR objects with various SOP Classes? If not, the feature could be constraint to only allow Waveform Annotation SR as a source.</u></p>

Commented [SW1]: Reword: we don't do it, because there is nothing to say about how to do it.

Closed Issues

1.	<p>Q: Should annotations also be included in the presentation state object or should annotations be saved separately - e.g. in a separate Structured Report document. If both is applicable: a clear distinction criterion is required: which annotations shall go to the display object, which go to the SR document.</p> <p>A: Annotations expressing clinical information (observations, measurements, ...) should go to a separate object, a DICOM Structured Report object.</p>
2.	<p>Q: What sort of time information is required for display relevant information (when a filter was applied, when the montage was changed)? Relative to the recording (ms or samples)?</p> <p>A: relative to the recording</p>
3.	<p>Q: All IODs in PS3.3 A.33 Softcopy Presentation State Information Object Definitions relate to images, intention is the corrected display of pixel values. PS3.4 N describes how these objects apply to images. If the new Waveform Presentation State IOD is added to A.33, PS3.4 N needs to distinguish between different sorts of Softcopy Presentation State objects. Would it be better to add the new IODs in a separate chapter in PS3.3 (e.g. A.xx Waveform Presentation State Object Definitions)?</p> <p>A: Waveform Presentation State IOD has to go to a separate chapter in PS3.3. Description of Storage of these PRs has to go to a separate section in PS3.4.</p>
4.	<p>Q: Procedure Log is a SR intended to store time stamped events during a procedure (e.g. catheterization lab). Would the Procedure Log IOD fit the requirements as well as the Presentation State IOD? In imaging Presentation State objects are (usually) created after image creation, the neurophysiology the recording use case requires the PR to be created during the recording.</p> <p>A: Use a separate object to store the annotations, but an SR.</p>
5.	<p>Sup222 Microscopy Bulk Simple Annotations Storage introduced the definition of Annotations as separate IEs in MORW and E-R model. Shall the new IODs make use of this IE or choose another wording (not using Annotation) in order to keep the distinction?</p> <p>A: The existing definition is very general and does not contradict its use for waveforms. In</p>

	the new IODs introducing the Annotations for waveforms, the definition could be narrowed.
6.	<p>Q: Presentation State Identification contains date/time, when the PR was created, and coded content descriptor and content creator (optional). Is this sufficient to meet legal and billing requirements or should the authorship be stored for every annotation individually?</p> <p>A: Annotations which require authorship have to be stored in the Annotation SR, unless the authorship of the entire PR is sufficient. There is no authorship for individual annotations in the PR.</p>
7.	<p>Q: How should color and shading be encoded in the Presentation State and in the Structured Display Object?</p> <p>A: CIE Lab values</p>
8.	<p>Q: Is there a general requirement to have a temporal assignment of display settings (filters and montages): When where which settings in place? Or is this information just relevant in conjunctions with annotations: which settings were in place when the observations were made.</p> <p>A: The start time for a montage (offset in seconds to the start of the recording) can be stored.</p>
9.	<p>Q: A montage can combine any type of channels from different object types, not just EEG channels from Routine Scalp EEGs. A mechanism is required that provides the information about what type of object the channels belong to.</p> <p>A: The reference to the original waveform objects contains both, SOP Instance UID and SOP Class UID.</p>
10.	<p>Q: A concrete Presentation State object contains references to concrete SOP Instances - to concrete objects. It must be guaranteed that this reference works for recordings having been split to multiple files due to limitations on file size or recording gaps.</p> <p>A: Multiple Objects can be referenced; Multiplex Groups can span multiple objects.</p>
11.	<p>Q: Should the Presentation State contain timing information? In a sense: for which time range should this display settings be used. How should viewers then behave? Do they switch the display (the filters, montages) when scrolling through the recording?</p> <p>A: The Waveform Presentation State may contain timing information when (relatively to the recording) a montage was onset. It is up to the display implementers how to use this information.</p>
12.	<p>Q: Does the MORW and the E-R model require an extension by introducing a new IE "Waveform Presentation"?</p> <p>A: Yes. Reason is, the current Presentation State IE is image oriented.</p>
13.	<p>Q: Some Modules in the Presentations state allow for (optionally) denoting who added the information (the annotation, the segment of interest). This supplement proposes to use the attribute Operator's Name and to restrict this to persons. Should also be devices/algorithms possible?</p> <p>A: There is no authorship for individual annotations in the PR – see closed issue #6. On the level of the PR itself, a personal authorship can be expressed via the Content Creator Macro in the Presentations State Identification Module or – if the PR is created by a device -</p>

	via the General Equipment Module.
14.	<p>Q: Shall Waveform Presentations States have a separate, new Modality Code?</p> <p>If no, the existing Presentation Series Module can be reused. In this case the description there has to be adapted (the Note talks about images).</p> <p>A: No. The new IOD would differ only with respect to this new Modality Code. The existing Module can be reused.</p>
15.	<p>Q: The Presentation State Relationship Module as currently defined can only be used for images (or CDA). It would require comprehensive changes if it should be used for waveforms as well (e.g. for images, it can refer to a list of frames. For waveforms, it has to refer to a list of channels).</p> <p>There were also discussions about cases, where a presentation state would reference both, image objects and waveform objects (e.g. in angiography or in echocardiography). This is reflected in another open issue.</p> <p>A: Under the assumption that Presentation States refer either to images or to waveforms the decision is to use a separate Module instead of changing the existing.</p>
16.	<p>Q: Shall Annotations in the PR use the existing Attribute "Observation DateTime" to reflect the point in time when the annotation was added?</p> <p>A: No. A new Attribute shall be defined. Observation DateTime is only used in SR context.</p>
17.	<p>Q: What are the conditions to record the display montages during waveform acquisition (recording use case)? What information should be stored and which time precision is required?</p> <p>A: There is always a montage defined. The first has to start at the beginning (beginning of the recording). The start times of the different montages shall be in timely order. Time precision "second" is sufficient.</p>

70

Scope and Field of Application

71 This supplement introduces Service Classes for storage and exchange of presentation information for
 72 DICOM waveform objects by adding a Waveform Presentation State IOD. The Waveform Presentation
 73 State object stores the display montages, i.e. calculative combinations of recorded channels, display filter
 74 settings, and other display properties as well as arbitrary Annotations.

75 This supplement

- 76 • adds a new Waveform Presentation State IE
- 77 • adds [a new SOP Classes](#) to store Waveform Presentation States and the related Modules

78

79

80 In clinical neurophysiology it is important to be able to recreate the presentation of the recorded data as it
 81 was displayed during the recording or during review and reporting. This is important for example when
 82 activity is noted by the operator during recording and that view needs to be recreated post-hoc for review
 83 by a specialist.

84 In cardiology, technicians annotate previously recorded waveforms (e.g. from home monitoring Holter
 85 ECG) and highlights areas of interest. This information is essential input for the cardiologist who reviews
 86 the ECG and finally provides the report.

87 Waveform Objects support limited display information, which has to be provided within the recorded
88 waveform objects. These attributes only cover color and scaling of waveform channels.

89 In neurophysiology a **Montage** defines a list of channels for visualization of the data which is created by a
90 list of original channel sources and the method for their mathematical (linear) recombination. In principle
91 **Montages** could be either predefined and referenced by an object identifier or defined for a specific
92 recording.

93 **Waveform Annotations** are textual or coded markers assigned to a specific timepoint or time range,
94 related to all channels or a selected set of channels. Annotations could be observations as well as
95 measurements.

96 A **Waveform Presentation State Object** provides simple textual annotations, segments of interest,
97 montages including filters, colors, gain, and display scale for a given recording (patient related).

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101

**Changes to NEMA Standards Publications PS3.3
Digital Imaging and Communications in Medicine (DICOM)
Part 3: Information Object Definitions**

102

103

~~Add new IODs a new to Overview Table to PS3.3 A.1.4. Table A.1-x8:~~

Commented [SW2]: The existing Module Overview Table does not really fit ...

104
105

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

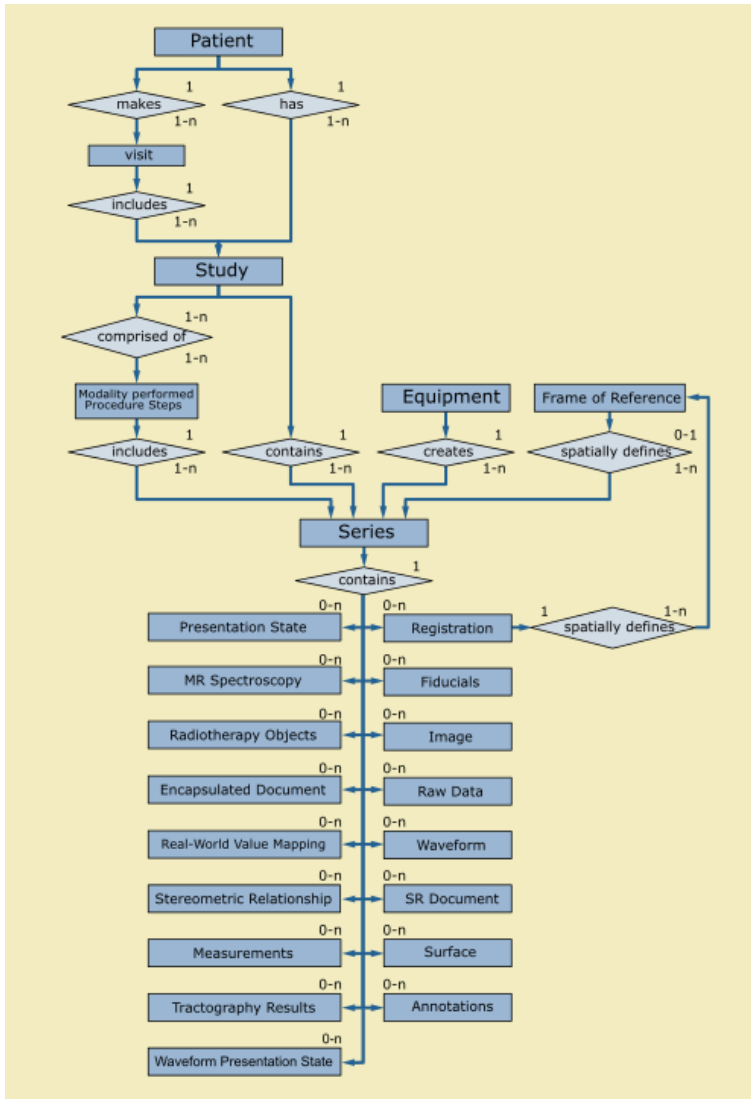
<u>IODs Modules</u>	<u>Waveform Presentation State</u>	<u>Waveform Presentation State For Recording</u>
<u>Patient</u>	<u>M</u>	<u>M</u>
<u>Clinical Trial Subject</u>	<u>U</u>	<u>U</u>
<u>General Study</u>	<u>M</u>	<u>M</u>
<u>Patient Study</u>	<u>U</u>	<u>U</u>
<u>Clinical Trial Study</u>	<u>U</u>	<u>U</u>
<u>General Series</u>	<u>M</u>	<u>M</u>
<u>Clinical Trial Series</u>	<u>U</u>	<u>U</u>
<u>Presn. Series</u>	<u>M</u>	<u>M</u>
<u>Sync.</u>	<u>C</u>	<u>C</u>
<u>General Equip.</u>	<u>M</u>	<u>M</u>
<u>Enhanced General Equip.</u>	<u>M</u>	<u>M</u>
<u>Presn. State Ident.</u>	<u>M</u>	<u>M</u>
<u>Waveform Presn. State Relationship</u>	<u>M</u>	<u>M</u>
<u>Structured Waveform Annotations</u>	<u>U</u>	<u>U</u>
<u>Simple Waveform Annotations</u>	<u>U</u>	<u>U</u>
<u>Displayed Waveform Segments</u>	<u>U</u>	<u>U</u>
<u>Montage Activation</u>	<u>U</u>	<u>M</u>
<u>Waveform Presentation Montage</u>	<u>C</u>	<u>M</u>
<u>SOP Common</u>	<u>M</u>	<u>M</u>

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108

Amend PS3.3 7 DICOM Model of the Real World by adding Waveform Presentation State IE

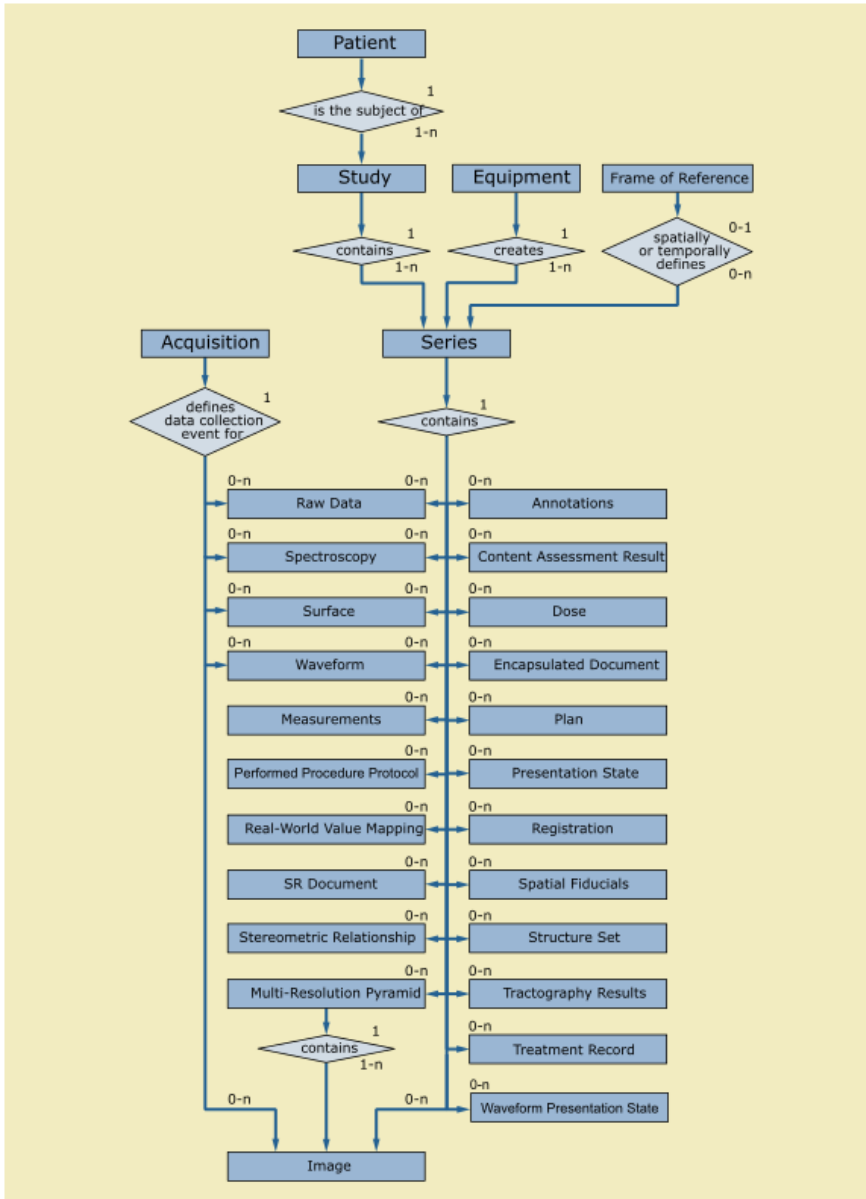


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113 Amend PS3.3 A.1.2 IOD Entity-Relationship Model by adding the Waveform Presentation State IE



114

115 Add the following new content to PS3.3 Section A.1.2.xx ...

116 **A.1.2.nnn Waveform Presentation State IE**

117 The Waveform Presentation State IE defines how referenced waveform objects will be presented.

118 The Waveform Presentation State IE comprises [graphics](#) [simple text](#) annotations, segments of interest, and
 119 montages including filters, colors, gain, and vertical sizes of waveform traces if this information is to be
 120 applied to the referenced waveform(s).

121

122 *Add the following new content to PS3.3 Section A.xx*

123 **A.xx Waveform Presentation [State](#) Information Object Definitions**

124 **A.xx.1 Waveform Presentation State IOD**

125 **A.xx.1.1 Waveform Presentation State IOD Description**

126 The Waveform Presentation State Information Object Definition (IOD) specifies information that may be
 127 used to present (display) waveform objects that are referenced from within the IOD.

128 Note: The Presentation State object allows to store [graphical-and-simple](#) textual annotations, as well as [to](#)
 129 provide display information for annotations stored in a separate Structured Report document. The
 130 policies related to the criteria for where specific annotations should be stored – in the Presentation State
 131 object or in the Structured Report document – are outside the scope of the standard.

132

133 **A.xx.1.2 Waveform Presentation State IOD Entity-Relationship Model**

134 This IOD uses the E-R Model in Section A.1-2, with only the Waveform Presentation State IE below the
 135 Series IE.

136 **A.xx.1.3 Waveform Presentation State IOD Module Table**

137 Table A.xx.1-1 specifies the Modules of the Waveform Presentation State IOD.

138

Table A.xx.1-1. Waveform 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
Frame of Reference	Synchronization	C.7.4.2	C – Required if time synchronization was applied.
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Waveform Presentation State	Presentation State Identification	C.11.10	M
	Waveform Presentation State Relationship	C.xx.hh	M
	Structured Waveform Annotations	C.xx.aa	U
	Simple Waveform Annotations	C.xx.bb	U

	Displayed Waveform Segments	C.xx.cc	U
	Montage Activation	C.xx.dd	C – Required if Concept Name Code Sequence (0040,A043) is present in the top level of the data set with a Code Value (0008,0100) (xxx1-1, DCM, ⁴⁰¹) (i.e. this Presentation State reflects the presentation during recording): May be present otherwise U
	Waveform Presentation Montage	C.xx.ee	C – Required if Montage Activation Module is present.
	SOP Common	C.12.1	M

Commented [SW3]: 2024-03-18: David proposes to make this optional.

139

140 **A.xx.1.4 Waveform Presentation State IOD Constraints**

141 **A.xx.1.4.1 Presentation State Identification**

142 **For Concept Name Code Sequence (0040,A043) DCID xxx1 Waveform Presentation State Purpose shall be used.**

143 **A.xx.2 Waveform Presentation State For Recording IOD**

144 **A.xx.2.1 Waveform Presentation State For Recording IOD Description**

145 The Waveform Presentation State For Recording Information Object Definition (IOD) provides information about the display settings like filters and montages used during recording. It allows to re-create the recording view later during review.

146 Note: The Presentation State object allows to store simple textual annotations, as well as to provide display information for annotations stored in a separate Structured Report document. The policies related to the criteria for where specific annotations should be stored – in the Presentation State object or in the Structured Report document – are outside the scope of the standard.

147

148 **A.xx.2.2 Waveform Presentation State For Recording IOD Entity-Relationship Model**

149 This IOD uses the E-R Model in Section A.1-2, with only the Waveform Presentation State IE below the Series IE.

150 **A.xx.2.3 Waveform Presentation State For Recording IOD Module Table**

151 Table A.xx.2-1 specifies the Modules of the Waveform Presentation State For Recording IOD.

152 **Table A.xx.2-1. Waveform Presentation State For Recording 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
Frame of Reference	Synchronization	C.7.4.2	C – Required if time

			<u>synchronization was applied.</u>
<u>Equipment</u>	<u>General Equipment</u>	<u>C.7.5.1</u>	<u>M</u>
	<u>Enhanced General Equipment</u>	<u>C.7.5.2</u>	<u>M</u>
<u>Waveform Presentation State</u>	<u>Presentation State Identification</u>	<u>C.11.10</u>	<u>M</u>
	<u>Waveform Presentation State Relationship</u>	<u>C.xx.hh</u>	<u>M</u>
	<u>Structured Waveform Annotations</u>	<u>C.xx.aa</u>	<u>U</u>
	<u>Simple Waveform Annotations</u>	<u>C.xx.bb</u>	<u>U</u>
	<u>Displayed Waveform Segments</u>	<u>C.xx.cc</u>	<u>U</u>
	<u>Montage Activation</u>	<u>C.xx.dd</u>	<u>M</u>
	<u>Waveform Presentation Montage</u>	<u>C.xx.ee</u>	<u>M</u>
	<u>SOP Common</u>	<u>C.12.1</u>	<u>M</u>

Commented [SW4]: 2024-03-18: David proposes to make this optional.

160

161

162 Adapt Section PS3.3 Section C.10.10.1 by adding an additional note to indicate, that this attribute is also
 163 used in context of waveform presentations states.

164 Note
 165 This attribute is also used in context of Waveform Presentation States to express the relationship of a
 166 presentation property to selected waveform channels.

168 Adapt Section PS3.3 Section C.11.9 by changing the note to reflect, that a PR could not only apply to
 169 images.

170 Note
 171 This implies that presentation states will be in different Series from the images instances to which they apply,
 172 which will have different values for Modality.

173

174 Add the following new content to PS3.3 Section C.xx

175 **C.xx Waveform Presentation State Modules**

176 **C.xx.hh Waveform Presentation State Relationship Module**

177 Table C.xx.hh-1 specifies the Attributes of the Waveform Presentation State Relationship Module, which
 178 describes the waveforms to which a Waveform Presentation State applies.

179

180 **Table C.xx.hh-1. Waveform Presentation State Relationship Module**

181

Attribute Name	Tag	Type	Attribute Description
Referenced Series Sequence	(0008,1115)	1	Sequence of Items where each Item includes the Attributes of one Series to which the

Attribute Name	Tag	Type	Attribute Description
			Presentation State applies. One or more Items shall be included in this Sequence.
>Series Instance UID	(0020,000E)	1	Unique identifier of a Series that is part of the Study defined by the Study Instance UID (0020,000D) in the enclosing data set. Note The Study Instance UID (0020,000D) value will be that of the Waveform Presentation State.
>Referenced SR Instance Document Sequence	(0008,114A)	1C	The set of Reference Structured Report Documents containing to SR with Waveform Annotations to which the Presentation State applies. These shall be of the Study defined by Study Instance UID (0020,000D) and the Series defined by Series Instance UID (0020,000E) One or more Items shall be included in this Sequence. Required, required if () if Structured Waveform Annotation Sequence (ggga,eee1) is present
>> Include Table 10-11. "SOP Instance Reference Macro Attributes" Include...			
>Referenced Waveform Sequence	(0008,113A)	1	The set of waveforms to which the Presentation State applies. These shall be of the Study defined by Study Instance UID (0020,000D) and the Series defined by Series Instance UID (0020,000E). One or more Items shall be included in this Sequence. The referenced SOP Class shall be the same for all SOP Instances in any each single Item in this Referenced Series Sequence (0008,113A) but may be different for different Items. Note: For example, some Series might represent EEG and some Series might represent ECG.
>>Include Table 10-11. "SOP Instance Reference Macro Attributes"			
>>Referenced Waveform Channels	(0040,A0B0)	1C	Identifies the waveform multiplex group and channel within the referenced Waveform Sequence Instance. Pair of values (M,C). See C.10.10.1.1 Required if the Referenced Waveform SOP Instance contains multiple channels and the reference does not apply to all Channels of all Multiplex Groups.

Commented [S5]: This is ambiguous - it means the Series Instance UID in the current Referenced Series Sequence Item - and not the Series Instance UID of the PR. (same wording is used in C.11.1.1)

Commented [S6]: David / WG-06 meeting 2024-01-10: Keep the same wording as it is used in the <images>PR - if it's ambiguous, it shall be changed consistently in all affected IODs / Modules by a CP.

Commented [S7]: This is ambiguous - it means the Series Instance UID in the current Referenced Series Sequence Item - and not the Series Instance UID of the PR. (same wording is used in C.11.1.1)

Commented [S8]: David / WG-06 meeting 2024-01-10: Keep the same wording as it is used in the <images>PR - if it's ambiguous, it shall be changed consistently in all affected IODs / Modules by a CP.

Commented [S9]: Does this mean: across all series or per series?
Rob, Kevin: per series; but check with David.

Commented [S10]: WG-06 2024-01-10: David agrees that "each" might be more appropriate than "any" → has to be changed for the existing Modules consistently by a CP.

Commented [S11]: Referencing this section is ok. maybe add a second note there to make clear that the same attribute is used also in the waveform PR.

183
184 **C.xx.aa Structured Waveform Annotations Module**

185 This Module defines how a display device applies Waveform Annotations [that are](#) stored in a separate
186 Structured Report document to a waveform. [The Waveform Annotations are defined in position relative to](#)
187 [the waveform time information.](#)

188 **Table C.xx.-aa. Structured Waveform Annotations Module Attributes**
189

Attribute Name	Tag	Type	Attribute Description
Structured Waveform Annotation Sequence	(ggga,eee1)	1	Selects and provides display information for waveform annotations and measurements contained in the referenced SR Document. One or more Items shall be included in this Sequence.
>Series Instance UID	(0020,000E)	4	Unique identifier of a Series that is part of the Study defined by the Study Instance UID (0020,000D) in the enclosing data set. <i>Note</i> The Study Instance UID (0020,000D) value will be that of the Waveform Presentation State.
>Referenced SR Document Sequence	(ggga,eee2)	4	The SR Document which contains the waveform annotations and measurements. The reference to the waveform objects to which the annotations and measurements apply are contained in the SR Document. The Referenced SR Document and the waveform objects referenced in it shall be of the Study defined by Study Instance UID (0020,000D) in the enclosing data set. The Referenced SR Document shall be of the Series defined by Series Instance UID (0020,000E) in this Item of Structured Waveform Annotation Sequence (ggga,eee1). A single Item shall be included in this Sequence.
<i>>>Include Table 10-11 "SOP Instance Reference Macro Attributes"</i>			This references a single SR Document which contains the Annotations. The Instance referenced here has to be contained in the Referenced Instance Sequence (0008,114A) in the Referenced Series Sequence (0008,1115).
>Waveform Annotation Display Selection SQ	(---ggga,---eee2)	3	Selects subsets of Annotations in the referenced SR document for display. If no subset is selected (i.e. this attribute is missing or the sequence is empty) all annotations in the referenced SR are displayed.

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Commented [SW12]: Remove this - Include common Instance Reference Module in the module table of the IOD

Commented [SW13]: Check if an existing attribute could be used instead

Commented [SW14]: Constrain the SOP Class to Waveform Annotation SR ?

Commented [S15R14]: → Open Issue.

Attribute Name	Tag	Type	Attribute Description
			One or more Items may be included in this sequence.
>>Annotation Group Number	(0040,A180)	1G	Identifies the Annotation Group within the Referenced SR Document to which the display information applies. If not present, this display information applies to all annotations in the Referenced SR Document. Required if this display information applies only to a specific Annotation Group.
>>Referenced Montage Index	(ggga,eeec)	3	The recommended viewing montage identified by the Montage Index (ggge,eeee) in the Waveform Montages Sequence (ggge,eeee).
>>Text Color CIE Lab Value	(0070,0241)	3	A default color triplet value used to specify the text color in which it is recommended that the text be rendered on a color display. The units are specified in PCS-Values, and the value is encoded as CIE Lab. See Section C.10.7.1.1.

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190

191 **C.xx.bb. Graphic Simple Waveform Annotations Module**

192 This Module defines Attributes of ~~graphical and~~ textual annotations that shall be made available by a
 193 display device to be applied to a waveform. The ~~graphics and~~ text ~~are is~~ defined in position relative to the
 194 waveform time information.

195 ~~A SimpleA Graphic Waveform- Waveform_A~~ annotation shall be related to a Waveform.

196 **Table C.xx.-bb. Graphic Simple Waveform Annotations Module Attributes**

197

Attribute Name	Tag	Type	Attribute Description
Graphic -Waveform Annotation Sequence	(gggb,eee1)	1	Selects and provides graphical esimpler textual annotations for a group of waveforms or channels within these waveforms. One or more Items shall be included in this Sequence.
>Annotation DateTime	(gggb,eee2)	2	The date and time the annotation was added.
>Referenced Waveform Sequence	(0008,113A)	1C	The Waveform to which this graphic annotation applies. All Waveforms referenced here shall be present in Referenced Waveform Sequence (0008,113A) inside the Referenced Series Sequence (0008,1115) in the top-level data set.

Attribute Name	Tag	Type	Attribute Description
			One or more Items shall be included in this Sequence. Required if the graphic annotation in this Item does not apply to all the waveforms and channels listed in Referenced Waveform Sequence (0008,113A) inside the Referenced Series Sequence (0008,1115) in the top-level data set.
<i>>>Include Table 10-11 "SOP Instance Reference Macro Attributes"</i>			
>>Referenced Waveform Channels	(0040,A0B0)	1	Identifies the waveform multiplex group and channel within the referenced SOP Instance. Pair of values (M,C). See C.10.10.1.1
<i>>Include Table C.xx-a Temporal Range Macro Attributes</i>			Enumerated Values for Temporal Range Type (0040,A130): POINT MULTIPOINT
>Referenced Montage Index	(ggga,eec)	3	The recommended viewing montage identified by the Montage Index (ggge,eeee) in the Waveform Montages Sequence (ggge,eeee).
>Text Object Sequence	(0070,0003)	1C	Describes a text annotation. A single Item shall be included in this Sequence. Required, if Graphic Object Sequence (0070,0009) is not present. May be present otherwise.
>>Unformatted Text Value	(0070,0006)	1	The text to be displayed.
>>Text Color CIELab Value	(0070,0241)	3	A default color triplet value used to specify the text color in which it is recommended that the text be rendered on a color display. The units are specified in PCS-Values, and the value is encoded as CIELab. See Section C.10.7.1.1.
>Graphic Object Sequence	(00070,0009)	1C	Describes a graphic annotation. A single item shall be included in this Sequence. Required, if Text Object Sequence (0070,0003) is not present. May be present otherwise.

Commented [SW16]: Check: is it correct to use 1 here – what if all channels and all multiplex groups are used.

198

199 **C.xx.cc Displayed Waveform Segments Module**

200 This Module defines Attributes required to define Waveform Segments and the properties how to display
201 them. A Waveform Segment is a temporal portion of a waveform ("Segment of Interest").

Table C.xx-cc. Displayed Waveform Segments Module Attributes

Attribute Name	Tag	Type	Attribute Description
Displayed Waveform Segment Sequence	(gggc,eee1)	1	Selects and provides display parameters for segments from a group of waveforms or channels within these waveforms. One or more Items shall be included in this Sequence.
>Segment Definition DateTime	(gggc,eee2)	2	The date and time the segment was defined.
>Referenced Waveform Sequence	(0008,113A)	1C	The Waveforms to which the segment display parameters in this Item apply. All Waveforms referenced here shall be present in Referenced Waveform Sequence (0008,113A) inside the Referenced Series Sequence (0008,1115) in the top-level data set. One or more Items shall be included in this Sequence. Required if the segment display parameters in this Item do not apply to all the waveforms and channels listed in Referenced Waveform Sequence (0008,113A) inside the Referenced Series Sequence (0008,1115) <u>in the top-level data set.</u>
>>Include Table 10-11. "SOP Instance Reference Macro Attributes"			
>>Referenced Waveform Channels	(0040,A0B0)	1	Identifies the waveform multiplex group and channel within the referenced SOP Instances. Pair of values (M,C). See C.10.10.1.1
>Include Table C.xx-a Temporal Range Macro Attributes			Enumerated Values for Temporal Range Type (0040,A130): SEGMENT MULTISEGMENT BEGIN END
>Waveform Display Background CIELab Value	(003A,0231)	1C	A color triplet value recommended for rendering the waveform display background on a color display. The units are specified in PCS-Values, and the value is encoded as CIELab. See Section C.10.7.1.1. At least one of (003A,0231) Waveform Display Background CIELabValue and (003A,0244) Channel Recommended

Attribute Name	Tag	Type	Attribute Description
			Display CIELab Value shall be present.
>Channel Recommended Display CIELab Value	(003A,0244)	1C	A color triplet value recommended for rendering the channel on a color display. The units are specified in PCS-Values, and the value is encoded as CIELab. See Section C.10.7.1.1. At least one of (003A,0231) Waveform Display Background CIELabValue and (003A,0244) Channel Recommended Display CIELab Value shall be present.

204

205 **C.xx.dd Montage Activation Module**

206 This Module defines Attributes recording the timepoints of montage activation.

207

208

Table C.xx-dd. Montage Activation Module Attributes

Attribute Name	Tag	Type	Attribute Description
Montage Activation Sequence	(gggd,eeee)	1	Provides information about when which montage was activated. One or more Items shall be included in this Sequence. The Items shall be ordered by ascending Montage Activation Time Offset (gggd,eeeb) value.
>Referenced Montage Index	(ggga,eeec)	1	The Montage Index (ggge,eeee) of the montage in the Waveform Montages Sequence (ggge,eeee).
>Montage Activation Time Offset	(gggd,eeeb)	1	Time offset in seconds relative to the beginning of the recording. The offset of the first Item shall be 0, i.e. the first montage starts at the beginning of the recording.

209

210 **C.xx.ee Waveform Presentation Montage Module Attributes**

211 This Module contains attributes describing presentation montages of waveform channels.

212

Table C.xx-ee Waveform Presentation Montage Module Attributes

Attribute Name	Tag	Type	Description
Waveform Montages Sequence	(ggge,eeee)	1	Description of Waveform Montages. One or more items are permitted in this sequence.
>Montage Name	(ggge,eeec)	1	The name of the montage.
>Montage Index	(ggge,eeee)	1	The index of the montage within this

			sequence. The value shall start at 1 and increase monotonically by 1. This index will be used to refer to this montage.
>Montage Channels Sequence	(ggge,eeed)	1	Each item in this sequence represents a single channel calculated for presentation. One or more items shall be included in this sequence. Ordering of Items in this Sequence is significant for reference to specific channels.
<i>>>Include Table C.xx.-b. Montage Channel Macro Attributes</i>			
>Waveform Data Display Scale	(003A,0230)	3	The recommended time-based waveform data display scale in units of mm/s (see Section C.10.9.1.8).
>Waveform Display Background CIELab Value	(003A,0231)	3	A color triplet value recommended for rendering the waveform display background on a color display. The units are specified in PCS-Values, and the value is encoded as CIELab. See Section C.10.7.1.1.
>Waveform Presentation Group Sequence	(003A,0240)	3	Sequence of Items, each Item describing a Presentation Group of one or more waveform channels to be displayed together. Note A Presentation Group is conventionally denoted a "display page", and a waveform object may be rendered using several Presentation Groups under user display control. One or more Items are permitted in this Sequence.
>>Presentation Group Number	(003A,0241)	1	A number that identifies the Presentation Group.
>>Channel Display Sequence	(003A,0242)	1	Sequence of Items, each Item describing a channel to be displayed in the Presentation Group. One or more Items shall be included in this Sequence.
>>>Referenced Montage Channel Number	(ggge,eeeb)	1	Number of the montage channel to be displayed in the Presentation group.
>>>Channel Offset	(003A,0218)	3	The offset in seconds from the beginning of the montage channel waveform data to the first sample to be used for presentation. Value may be negative.
>>>Channel Recommended Display CIELab Value	(003A,0244)	1	A color triplet value recommended for rendering the channel on a color display. The units are specified in PCS-Values, and the value is encoded as CIELab. See Section C.10.7.1.1.
>>>Channel Position	(003A,0245)	1	Position of the Channel within the Presentation Group display area (see Section C.10.9.1.9).
>>>Display Shading Flag	(003A,0246)	3	Specifies display area shading between the displayed waveform channel and another line.

			<p>The nature of the shading (e.g., solid, or cross-hatching) is implementation dependent.</p> <p>Enumerated Values:</p> <p>NONE no shading</p> <p>BASELINE shading between the waveform and the channel display baseline (sample value 0 equivalent location)</p> <p>ABSOLUTE shading between the waveform and the channel real world actual value 0 (i.e., taking into account the Channel Baseline (003A,0213) value)</p> <p>DIFFERENCE shading between the waveform and a second waveform in the Presentation Group at the same Channel Position that also has Display Shading Flag (003A,0246) value DIFFERENCE.</p>
>>>Fractional Channel Display Scale	(003A,0247)	1C	<p>Fraction of the Presentation Group vertical display dimension assigned to the unit quantity (least significant bit) of the Channel samples (see Section C.10.9.1.10). Required if Absolute Channel Display Scale (003A,0248) is not present, may be present otherwise.</p>
>>>Absolute Channel Display Scale	(003A,0248)	1C	<p>Nominal vertical display height in mm assigned to the unit quantity (least significant bit) of the Channel samples (see Section C.10.9.1.10). Required if Fractional Channel Display Scale (003A,0247) is not present, may be present otherwise.</p>

213

214

215 **C.xx.ff Montage Channel Macro**

216 This Macro consists of attributes describing a single channel of a waveform montage.

217

Table C.xx-b. Montage Channel Macro Attributes

Attribute Name	Tag	Type	Description
Montage Channel Number	(gggf,0202)	1	The number of the montage channel
Montage Channel Label	(gggf,0203)	1	Text label of the channel, which may be used for display purposes.
Montage Channel Source Sequence	(gggf,0208)	1	A coded descriptor of the waveform channel source. This identifies a single channel in the recorded waveform. Only a single Item shall be included in this Sequence.
<i>>Include Table 8.8-1 "Code Sequence Macro Attributes"</i>			

Source Waveform Sequence	(003A,020A)	1	A Sequence that provides reference to a DICOM Waveform from which this channel was derived. One or more items are permitted in this sequence. If there are multiple Items in this sequence, they have to share the same multiplex group identified by Multiplex Group UID (003A,0310).
<i>Include Table 10-11 "SOP Instance Reference Macro Attributes"</i>			
>Referenced Waveform Channels	(0040,A0B0)	1	Identifies the waveform multiplex group and channel within the referenced SOP Instances. Pair of values (M,C). Only a single channel shall be referenced.
Channel Derivation Description	(003A,020C)	3	Additional description of the channel derivation.
Contributing Channel Sources Sequence	(gggf,0209)	1	A sequence of items each representing a channel contributing to this montage.
>Calculatory Weight	(gggf,020A)	1	The weight of the contribution of this channel. Note: The calculatory weights have to sum to 1.
>Contributing Channel Source Sequence	(gggf,020B)	1	A coded descriptor of the contributing waveform channel source. Only a single Item shall be included in this Sequence.
<i>>>Include Table 8.8-1 "Code Sequence Macro Attributes"</i>			
>Source Waveform Sequence	(003A,020A)	1C	Reference to DICOM Waveform objects from which this channel was derived. One or more items are permitted in this sequence. If there are multiple Items in this sequence, they have to share the same multiplex group identified by Multiplex Group UID (003A,0310).
<i>>>Include Table 10-11 "SOP Instance Reference Macro Attributes"</i>			
>Referenced Waveform Channels	(0040,A0B0)	1	Identifies the waveform multiplex group and channel within the referenced SOP Instance. Pair of Values (M,C) Only a single channel shall be referenced here.
Channel Sensitivity	(003A,0210)	1C	Nominal numeric value of unit quantity of sample. Required if samples represent defined (not arbitrary) units.

Commented [S17]: Is it a necessary or is it a possible limitation, that only channels from the same Multiplex group could contribute to a montage channel?
 * as contributing channels ?
 * same Multiplex group as Montage Channel Source?
 * how to document, if resampling takes place?
 Is there some sort of Sampling frequency for the montage?

Commented [HJ18]: Montages need to be able to include channels from different sources and different multiplexed groups. If the different multiplexed groups have different sampling rates, the software can handle rendering this, I don't think we have to deal with this.

Commented [S19]: Refer to more than one SOP instance, if the recording spans multiple objects (due to splitting)

Commented [S20]: Somewhere has to be explained, if channels from different multiplex groups can be combined, and how this has to be done.

Channel Sensitivity Units Sequence	(003A,0211)	1C	A coded descriptor of the Units of measure for the Channel Sensitivity. Only a single Item shall be included in this Sequence. (see Section C.10.9.1.4.2). Required if Channel Sensitivity (003A,0210) is present.
<i>>Include Table 8.8-1 "Code Sequence Macro Attributes"</i>			
Channel Sensitivity Correction Factor	(003A,0212)	1C	Multiplier to be applied to encoded sample values to match units specified in Channel Sensitivity (003A,0210) (e.g., based on calibration data) (see Section C.10.9.1.4.2). Required if Channel Sensitivity (003A,0210) is present.
Filter Low Frequency Characteristics Sequence	(003A,0318)	1C	The properties of low frequency (high-pass) filters applied to the waveform montage channel. Required if a high-pass filter is used. Shall not be present otherwise
Filter High Frequency Characteristics Sequence	(003A,0219)	1C	The properties of high frequency (low-pass) filters applied to the waveform montage channel. Required if a low-pass filter is used. Shall not be present otherwise
Notch Filter Characteristics Sequence	(003A,0321)	3	The properties of notch filters applied to the waveform montage channel.

218

219 **C.xx.gg Temporal Range Macro**

220 *Ed. Note: This Macro could also replace this set of Attributes in the Waveform Annotation Module C.10.10**

221 This macro contains attributes that define one or more points in time or time ranges in waveforms or
 222 dedicated channels of those waveforms. The waveforms and channels are selected in the enclosing data
 223 set.

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224

Table C.xx-a. Temporal Range Macro Attributes

Attribute Name	Tag	Type	Description
Temporal Range Type	(0040,A130)	1	See section C.xx.gg.g for Enumerated Values
Referenced Sample Positions	(0040,A132)	1C	List of samples within a multiplex group specifying one or more temporal points. Position of first sample is 1. See C.xx.gg.h Required if Referenced Time Offsets

			(0040,A138) and Referenced DateTime (0040,A13A) are not present.
Referenced Time Offsets	(0040,A138)	1C	List of time offsets by number of seconds after start defining one or more temporal Points. Required if Referenced Sample Positions (0040,A132) and Referenced DateTime (0040,A13A) are not present.
Referenced DateTime	(0040,A13A)	1C	List of one or more temporal points by absolute datetime. Required if Referenced Sample Position (0040,A132) and Referenced Time Offsets (0040,A138) are not present.

225

226 **C.xx.gg.g Temporal Range Type**

227 *Ed. Note: This is a rewording of existing C.10.10.1.2. In the current Standard this section only belongs to*
 228 *the Waveform Annotation Module*

229 The Temporal Range Type (0040,A130) Attribute defines the type of temporal extent of a selected region
 230 of waveform data. A temporal point (or instant of time) may be defined by a waveform sample offset (for a
 231 single waveform multiplex group only), time offset, or absolute time.

232 [The value or the values shall be present either as Referenced Sample Positions \(0040, A132\), or as](#)
 233 [Referenced Time Offsets \(0040,A138\), or as Referenced DateTimes \(0040,A13A\).](#)

234
 235 Enumerated Values:

236 **POINT** a single temporal point; a single value shall be present ~~either as a Referenced Sample Position~~
 237 ~~(0040, A132), or as a Referenced Time Offset (0040,A138), or as a Referenced DateTime~~
 238 ~~(0040,A13A).~~

239 **MULTIPOINT** multiple temporal points; multiple values shall be present ~~either as Referenced Sample~~
 240 ~~Positions (0040, A132), or as Referenced Time Offsets (0040,A138), or as Referenced~~
 241 ~~DateTimes (0040,A13A).~~

242 **SEGMENT** a range between two different temporal points; two values shall be present ~~either as~~
 243 ~~Referenced Sample Positions (0040, A132), or as Referenced Time Offsets (0040,A138), or as~~
 244 ~~Referenced DateTimes (0040,A13A).~~

245 **MULTISEGMENT** multiple segments, each denoted by two temporal points ~~either as Referenced Sample~~
 246 ~~Positions (0040, A132), or as Referenced Time Offsets (0040,A138), or as Referenced~~
 247 ~~DateTimes (0040,A13A). An even number of values shall be present, each pair representing one~~
 248 ~~segment.~~

249 **BEGIN** range beginning at one temporal point, and extending beyond the end of the acquired data; a
 250 single value shall be present ~~either as a Referenced Sample Position (0040, A132), or as a~~
 251 ~~Referenced Time Offset (0040,A138), or as a Referenced DateTime (0040,A13A).~~

252 **END** a range beginning before the start of the acquired data, and extending to (and including) the
 253 identified temporal point; a single value shall be present ~~either as a Referenced Sample Position~~
 254 ~~(0040, A132), or as a Referenced Time Offset (0040,A138), or as a Referenced DateTime~~
 255 ~~(0040,A13A).~~

256

257

258 **C.xx.gg.h Referenced Sample Position**

259 *Ed. Note: This is a rewording of existing C.10.10.1.3. In the current Standard this section only belongs to*
 260 *the Waveform Annotation Module*

261 Referenced Sample Positions (0040,A132) may be used only if Referenced Waveform Channels
 262 (0040,A0B0) in the enclosing dataset refers to channels within a single multiplex group. The sample
 263 position is by channel, and applies to all channels specified in Referenced Channels (0040,A0B0) in the
 264 enclosing dataset.

265 **Changes to NEMA Standards Publications PS 3.4**

266 **Digital Imaging and Communications in Medicine (DICOM)**
 267 **Part 4: Service Class Specifications**
 268

269 *Add new SOP Class to PS3.4 Annex B tables*

270 **B.5 Standard SOP classes**

271 The SOP Classes in the Storage Service Class identify the Composite IODs to be stored. Table B.5-1
 272 identifies Standard SOP Classes.

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

SOP Class Name	SOP Class UID	IOD Specification (defined in PS3.3)	Specialization
...			
<u>1.2.840.10008.1.XX1</u>	<u>Waveform Presentation State Storage</u>	<u>Waveform Presentation State IOD</u>	
<u>1.2.840.10008.1.XX2</u>	<u>Waveform Presentation State For Recording Storage</u>	<u>Waveform Presentation State For Recording IOD</u>	

274
 275
 276 *Add the following to PS3.4*

277 **Annex XX Waveform Presentation State Storage SOP Classes (Normative)**

278 ***XX.1 Overview***

279 *The Waveform Presentation State Storage SOP Class extends the functionality of the Waveform*
 280 *Storage Service class defined in Annex B) by the ability to convey an intended presentation state*
 281 *or record an existing presentation state. The SOP Class specifies the information and behavior*
 282 *that may be used to present (display) waveform objects that are referenced from within the SOP*
 283 *Class.*

284 *It includes capabilities for specifying:*

- 285 *a.—textual or graphic annotations*
- 286 *b.—highlighting segments of interest*
- 287 *c.—display of structured annotations provided by a referenced Structured Report object*

288 *d.—waveform presentation montages as a list of channels for visualization of the data*
 289 *created by a list of original channel sources and the method for their mathematical*
 290 *(linear) recombination.*

291
 292 **Todo:**

- 293 • *Describe the workflow, how and when these objects are created*
- 294 • *Describe a display's behavior if a Waveform Presentation State exists in a study.*
- 295 • *describe a display's behavior if more than one Waveform Presentation State exist in a*
 296 *study.*

297
 298

299 **Changes to NEMA Standards Publications PS 3.6**
 300
 301 **Digital Imaging and Communications in Medicine (DICOM)**
 302 **Part 6: Data Dictionary**

303 *Add new Elements to PS3.6 6 Table 6-1. Registry of Data Elements*

304 **Table 6-1. Registry of DICOM Data Elements**

Tag	Name	Keyword	VR	VM	
...					
(ggga,eee1)	Structured Waveform Annotation Sequence	StructuredWaveformAnnotationSequence	SQ	1	
(ggga,eee2)	Referenced SR Document Sequence	ReferencedSRDocumentSequence	SQ	4	
(ggga,eee2)	Waveform Annotation Display Selection SQ	WaveformAnnotationDisplaySelectionSequence	SQ	1	
(ggga,eeec)	Referenced Montage Index	ReferencedMontageIndex	DS	1	
(gggb,eee1)	Graphic Waveform Annotation Sequence	Graphic WaveformAnnotationSequence	SQ	1	
(gggb,eee2)	Annotation DateTime	AnnotationDateTime	DT	1	
(gggb,eee3)	Observer Sequence	Observer Sequence	SQ	4	
(gggc,eee1)	Displayed Waveform Segment Sequence	DisplayedWaveformSegmentSequence	SQ	1	
(gggc,eee2)	Segment Definition DateTime	SegmentDefinitionDateTime	DT	1	
(gggd,eeea)	Montage Activation Sequence	MontageActivationSequence	SQ	1	
(gggd,eeeb)	Montage Activation Time Offset	MontageActivationTimeOffset	DS	1	

(ggge,eeee)	Waveform Montages Sequence	WaveformMontagesSequence	SQ	1	
(ggge,eeeb)	Referenced Montage Channel Number	ReferencedMontageChannelNumber	IS	1	
(ggge,eeec)	Montage Name	MontageName	LO	1	
(ggge,eeee)	Montage Index	MontageIndex	DS	1	
(ggge,eeed)	Montage Channels Sequence	MontageChannelsSequence	SQ	1	
(gggf,0202)	Montage Channel Number	MontageChannelNumber	IS	1	
(gggf,0203))	Montage Channel Label	MontageChannelLabel	SH	1	
(gggf,0208)	Montage Channel Source Sequence	MontageChannelSourceSequence	SQ	1	
(gggf,0209)	Contributing Channel Sources Sequence	ContributingChannelSourcesSequence	SQ	1	
(gggf,020A)	Calulatory Weight	CalulatoryWeight	FL	1	
(gggf,020B)	Contributing Channel Source Sequence	ContributingChannelSource Sequence	SQ	1	
..					

305
306

307 *Add new SOP Classes to PS3.6 Annex A Table A-1:*

308


UID Value	UID Name	UID Keyword	UID Type	Part
...				
<u>1.2.840.10008.1.XX1</u>	<u>Waveform Presentation State Storage</u>	<u>WaveformPresentation StateStorage</u>	<u>SOP Class</u>	<u>PS3.4</u>
<u>1.2.840.10008.1.XX2</u>	<u>Waveform Presentation State For Recording Storage</u>	<u>WaveformPresentation StateForRecordingStorage</u>	<u>SOP Class</u>	<u>PS3.4</u>
...				
...				

309
310

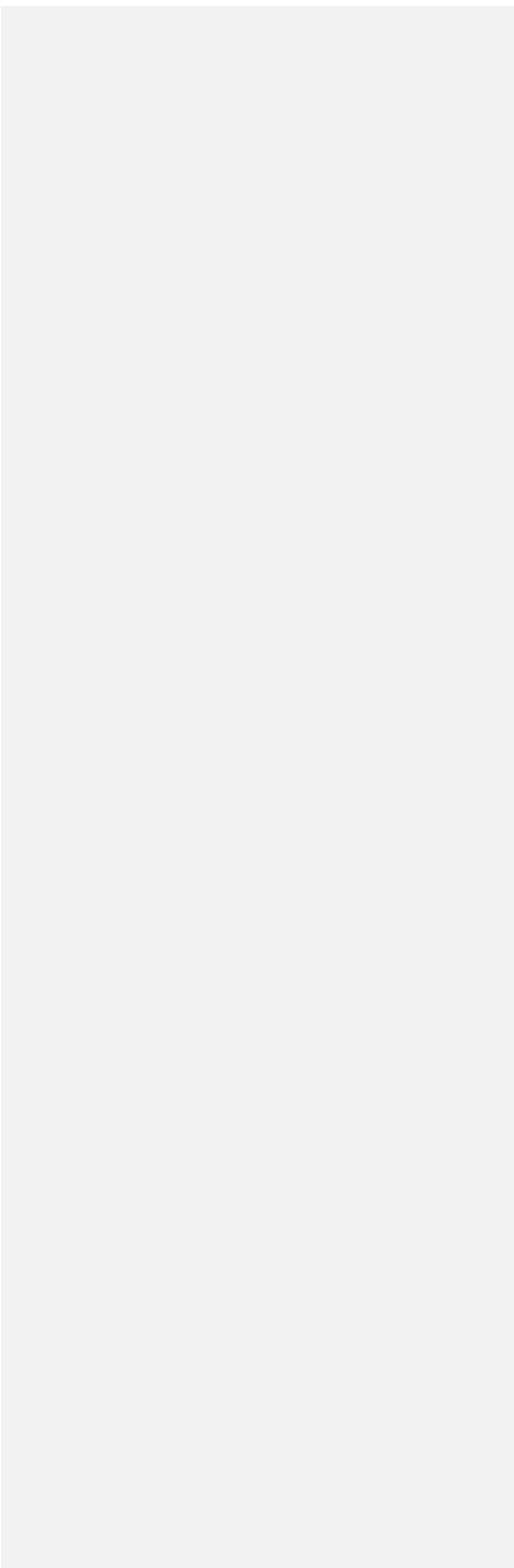
311 *Add new Context Group UID Values to Table A-3:*

312

Context UID	Context Identifier	Context Group Name
...		
<u>1.2.840.10008.6.1.xxx1</u>	<u>CID xxx1</u>	<u>Waveform Presentation State Purpose</u>

313			
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314



315
316
317
318

Changes to NEMA Standards Publications PS3.15
Digital Imaging and Communications in Medicine (DICOM)
Part 15: Security and System Management Profiles

319 Add new Data Elements to PS3.15 Annex E

320 **Table E.1-1. Application Level Confidentiality Profile Attributes**

Attribute Name	Tag	Retd. (from PS3.6)	In Std. Comp. IOD (from PS3.3)	Basic Prof.	Rtn. Safe Priv. Opt.	Rtn. UIDs Opt.	Rtn. Dev. Id. Opt.	Rtn. Inst. Id. Opt.	Rtn. Pat. Chars. Opt.	Rtn. Long. Full Dates Opt.	Rtn. Long. Modif. Dates Opt.	Clean Desc. Opt.	Clean Struct. Cont. Opt.	Clean Graph. Opt.
...														
<u>Annotation DateTime</u>	<u>(gggb.eee2)</u>	<u>N</u>	<u>Y</u>	<u>X/Z</u>						<u>K</u>	<u>C</u>			
<u>Segment Definition DateTime</u>	<u>(gggc.eee2)</u>	<u>N</u>	<u>Y</u>	<u>X/Z</u>						<u>K</u>	<u>C</u>			
...														

321
322

323 **Changes to NEMA Standards Publications PS3.16**
 324
 325 **Digital Imaging and Communications in Medicine (DICOM)**
 326 **Part 16: Content Mapping Resource**

327 *Add new context groups to annex C*

328 **CID-xxx1 Waveform Presentation State Purpose**
 329 **Resources:** HTML | FHIR JSON | FHIR XML | IHE SVS XML
 330 **Keyword:** ~~WaveformPresentationStatePurpose~~
 331 **FHIR Keyword:** ~~dicom-cid-xxx1-WaveformPresentationStatePurpose~~
 332 **Type:** ~~Extensible~~
 333 **Version:** ~~yyymmdd~~
 334 **UID:** ~~1.2.840.10008.6.1.xxx1~~
 335

336 **Table CID-xxx1 Waveform Presentation State Purpose**

Coding Scheme	Code Value	Code Meaning
DCM	xxx1-1	EEG recording presentation

337 **Changes to NEMA Standards Publications PS3.17**
 338
 339 **Digital Imaging and Communications in Medicine (DICOM)**
 340 **Part 17: Explanatory Information**

341 **XXX Neurophysiology Waveform Presentation (Informative)**

342 ~~In this chapter we should point out, what the new DICOM SOP Classes should be used for~~
 343
 344 ~~In clinical neurophysiology it is important to be able to recreate the display of the recorded data as it was~~
 345 ~~displayed during the recording or during review and reporting.~~
 346 ~~In clinical neurophysiology it is important to be able to recreate the presentation of the recorded data as it~~
 347 ~~was displayed during the recording or during review and reporting. This is important for example when~~
 348 ~~activity is noted by the operator during recording and that view needs to be recreated post-hoc for review~~
 349 ~~by a specialist.~~
 350 ~~In cardiology, technicians annotate previously recorded waveforms (e.g. from home monitoring Holter~~
 351 ~~ECG) and highlight areas of interest. This information is essential input for the cardiologist who reviews~~
 352 ~~the ECG and finally provides the report.~~
 353 ~~Waveform Objects support limited display information, which has to be provided within the recorded~~
 354 ~~waveform objects. These attributes only cover color and scaling of waveform channels.~~

Commented [S21]: This section requires more detailed input. Or should it be removed at all ... ?
 2024-03-16: changed text to reflect current specs and use cases from the pptx

355 ~~Montages could be either predefined and referenced by an object identifier or defined for a specific~~
 356 ~~recording. In neurophysiology a Montage defines a list of channels for visualization of the data which is~~
 357 ~~created by a list of original channel sources and the method for their mathematical (linear) recombination.~~
 358 ~~In principle Montages could be either predefined and referenced by an object identifier or defined for a~~
 359 ~~specific recording.~~

360 Waveform Annotations are textual or coded markers assigned to a specific timepoint or time range,
 361 related to all channels or a selected set of channels. Annotations could be observations as well as
 362 measurements.

363 A **Waveform Presentation State Object** stores annotations, filters, and montages used for a given
 364 recording (patient related). A Waveform Presentation State object is stored together with the waveform
 365 study (e.g. a Routine Scalp EEG recording) and can be exchanged between systems.

366
 367 **Use case: Recording**

368 A technician performs an EEG recording. From time to time he changes the filter settings and also the
 369 montages, for example to check the quality of the recording. If abnormalities occur or if external
 370 circumstances change that could be of importance for the evaluation of the recording, the technician adds
 371 an annotation at this point.

372 In addition to the annotations, the recording system also saves the current filter settings and the montage
 373 selected for the display in a waveform presentation state object.

374
 375 **Use case: post hoc Review**

376 A physician acting as a post hoc reviewer looks through a completed EEG recording and marks potential
 377 epileptic patterns. The annotations added by the technician during the recording are shown. The
 378 physician has the option of using the settings for display filters and montage stored in the presentation
 379 state object generated during recording.

380 If he adds annotations, these are stored as well.

381

382 **Use case: Defining a Screen Layout**

383 ~~A physician acting as a post hoc reviewer looks through the data and marks potential epileptic patterns,~~
 384 ~~possibly already annotating morphological/topographical groups. He defines a screen layout by arranging~~
 385 ~~groups of channels from that recording at specific positions with different colors....~~
 386 ~~He then stores the layout in a Waveform Structured Display object as additional object in this study.~~

387

388 **Use case: Electronic Health Record**

389 An epilepsy patient is treated in another organization and the neurologist wants to see the EEGs and
 390 findings of previous epilepsy monitoring recordings (accessible via the patient's health record).

391

392

393 The main use cases that would make use of the new IODs are:

394 1) Neurophysiology:

395 a) Recording: It is required to save the annotations added by the EEG technician during recording
 396 and the display settings used at the time of annotation.

397 b) Post-hoc review: When the doctor views the ~~recording~~recording, he can see the annotations
 398 added during recording. He may want to use the settings stored in the Recording Presentation
 399 State. The doctor marks relevant sections or positions in the EEG and adds a description. From
 400 time to time he may want to change the display parameters and store such settings (unrelated to
 401 time or the annotations).

402 2) Cardiology:

403 a) Home performed Holter ECG: Data acquired by a patient during 24 h / 1 week home ECG
 404 monitoring are viewed by a Holter technician, ~~h~~He annotates the waveforms and highlights areas
 405 of interest.

406 b) The cardiologist reviews the data and may send the data back to the technologist or change the
 407 diagnosis. ~~Finally~~Finally, she signs the report and sends it to the information system.

408 3) Automated waveform analysis: Store observations and measurements as annotations and the
 409 settings used by algorithms in waveform analysis software

410

411 All these use cases require time locked annotations with identification of authorship and situation of
412 annotation ('during acquisition' versus 'post hoc')
413

