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Digital Imaging and Communications in Medicine (DICOM)

Supplement 236: Waveform Presentation State

Prepared by: Working Group 32 Neurophysiology Waveforms

DICOM Standards Committee, Working Group 6

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71		

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
2023/01/18	Version 9		Prepared for WG-06 (2023-01-18)
2023/01/20	Version 10		Changes during and after WG-06 discussion Jan.2023
2023/03/17	Version 11		Prepared for WG-06 (2023-03-20)
2023/03/24	Version 12		Changes during WG-06 discussion (2023-03-20)
2023/03/24	Version 13		Prepared for WG-32 (2023-03-28)
2023/05/17	Version 14		Prepared for WG-32 (2023-05-17) <ul style="list-style-type: none"> • removed Annotation SR, moved to a separate document
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). • Removed amendment of PS3.4 and placed an open issue for it (open issue #7) • Cleaned up the comments and preserved the

			discussions in additional closed issues.
2024/03/22	Version 22		Changes during and after Review with WG-06 <ul style="list-style-type: none"> reworked Instance References (in the PR Relationship Module) New IOD for Acquisition 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
2024/04/10	Version 23		Prepared for WG-32
2024/05/11	Version 24		Prepared for WG-06 2024-05
2024/05/29	Version 25		Prepared for WG-06 2024-05
2024/05/30	Version 26		Prepared for WG-06 2024-05
2024/05/30	Version 27		Public Comment
2024/08/16	Version 28		public comments, prepared for WG-06 2024-08
2024/08/22	Version 29		Review with WG-06, added new section for changes in PS3.3 F.x
2024/08/23	Version 30		Review with WG-06; prepared for Letter Ballot
2024/10/31	Version 31		LB comments
2024/11/05	Version 32		Discussion with WG-06, LB comments from HOLOGIC Draft final text
2025/01/15	Version 33		Review with WG-06, Draft final text

74

Scope and Field of Application

75 This supplement introduces Service Classes for storage and exchange of presentation information for
76 DICOM waveform objects by adding Waveform Presentation State IODs. The Waveform Presentation
77 State object stores the display montages, i.e. calculative combinations of recorded channels, display filter
78 settings, and other display properties as well as arbitrary Annotations.

79 This supplement

- 80 • adds a new Waveform Presentation State IE
- 81 • adds new SOP Classes to store Waveform Presentation States and the related Modules
- 82 • amends the Basic Directory IOD by adding Waveform Presentation as a new Directory Type

83

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

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

91 Waveform objects support limited display information, which has to be provided within the recorded
92 waveforms. These Attributes only cover color and scaling of waveform channels.

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

95 In neurophysiology a **montage** defines a list of channels for visualization of the data which is created by a
96 list of original channel sources and the method for their mathematical (linear) recombination.

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

99

100
101
102

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

103

104 *Add a new Overview Table to PS3.3 Section A.1.4.:*

105

106 **Table A.1-x. Composite Information Object Modules Overview – Waveform Presentation States**

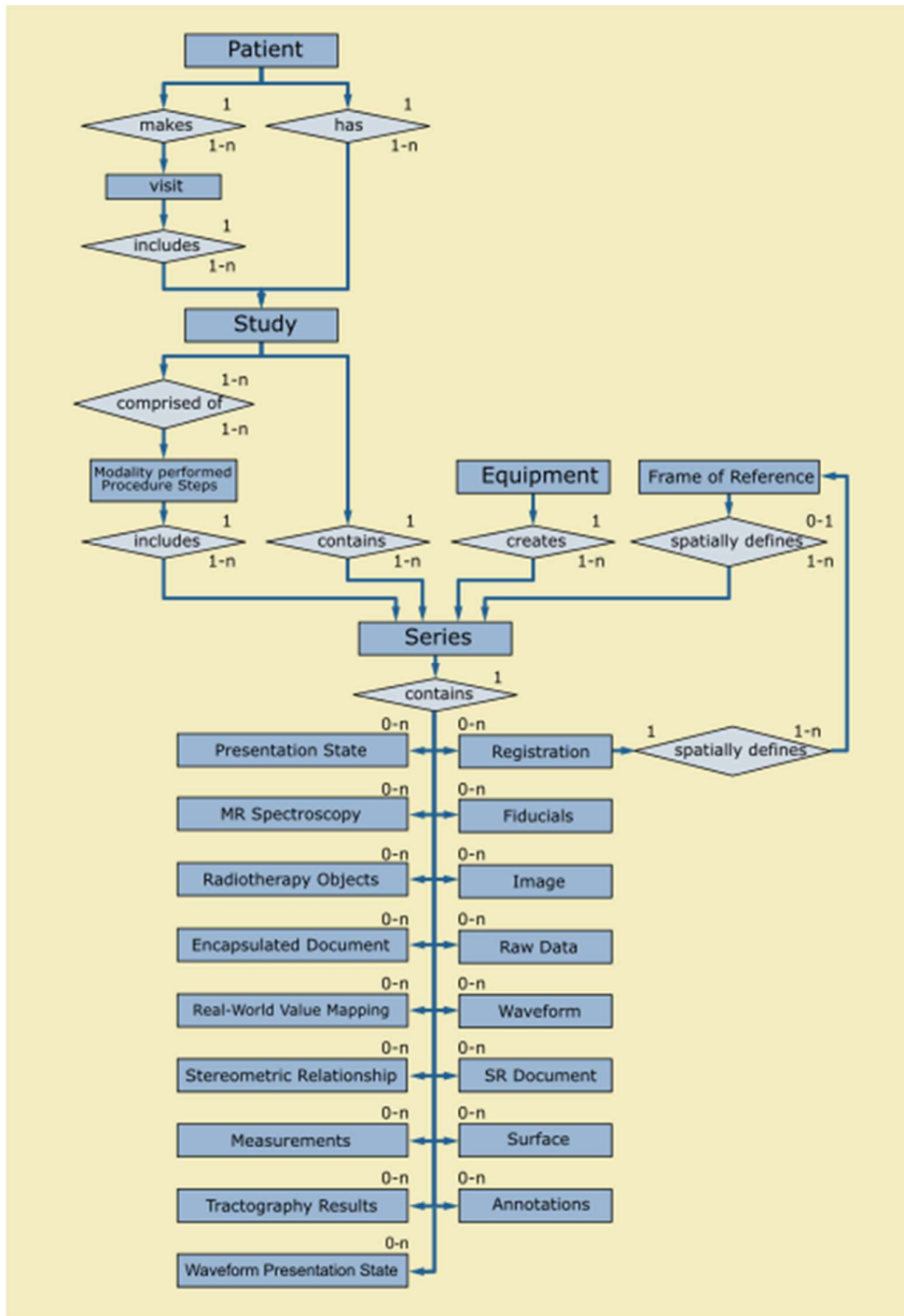
IODs Modules	Waveform Presentation State	Waveform Acquisition Presentation State
Patient	M	M
Clinical Trial Subject	U	U
General Study	M	M
Patient Study	U	U
Clinical Trial Study	U	U
General Series	M	M
Clinical Trial Series	U	U
Presentation Series	M	M
Synchronization	C	C
General Equipment	M	M
Enhanced General Equipment	M	M
Presentation State Identification	M	M
Waveform Presentation State Relationship	M	M
Structured Waveform Annotation	U	U
Textual Waveform Annotation	U	U
Displayed Waveform Segment	U	U
Montage Activation	U	M
Waveform Presentation Montage	C	M
SOP Common	M	M

107

108

109 *Amend PS3.3 Figure 7-1.a DICOM Model of the Real World by adding Waveform Presentation State IE*

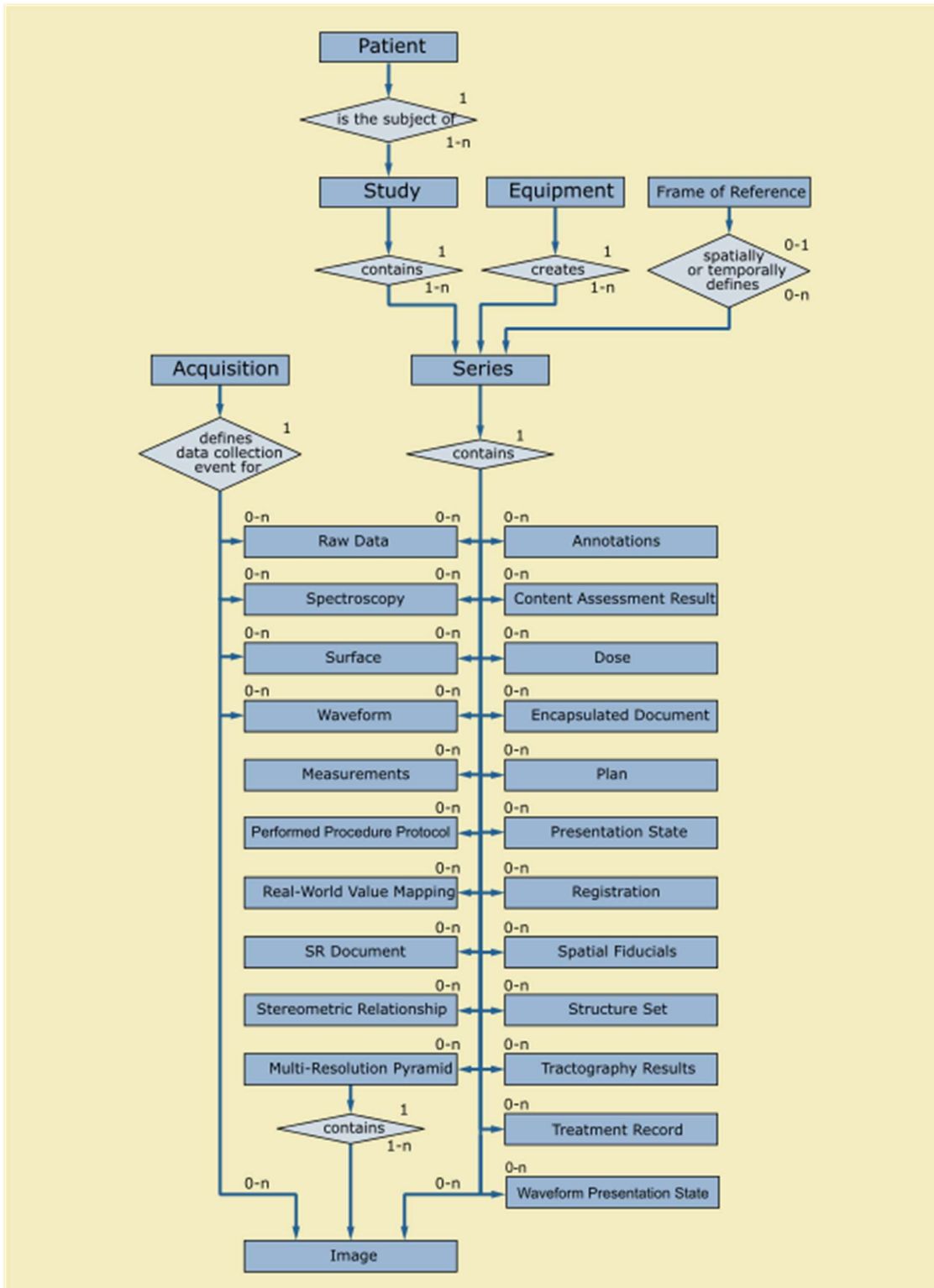
110



111

112

113 Amend PS3.3 Figure A.1-1 DICOM Composite Instance IOD Information Model by adding the Waveform
 114 Presentation State IE



115

116

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

118 **A.1.2.3 Series IE**

119 ...

120 Presentation States shall be grouped into **one or more** Series without Images **or Waveforms** (i.e., in a different
 121 Series from the Series containing the Images **or Waveforms** to which they refer).

122 ...

123 Note

124 **1.** The Series containing Grayscale, Color and Pseudo-Color Softcopy Presentation States and the Series
 125 containing the Images to which they refer are both contained within the same Study, except for Blended
 126 Presentation States, which may refer to images from different Studies.

127 **2. The Series containing the Waveform Presentation State and the Series containing the Waveforms to**
 128 **which they refer are both contained within the same Study.**

129 **3. The Series containing the Waveform Presentation State and the Series containing Waveform**
 130 **Annotation SRs to which they refer are both contained in the same Study but in different Series.**

131

132 Waveforms shall be grouped into Series without Images. A Frame of Reference IE may apply to both
 133 Waveform Series and Image Series.

134 SR Documents shall be grouped into Series without Images.

135

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

137 The Waveform Presentation State IE defines how referenced waveforms will be presented.

138 The Waveform Presentation State IE comprises text annotations, segments of interest, and montages
 139 including filters, colors, gain, and vertical sizes of waveform channels if this information is to be applied to
 140 the referenced waveform(s). It might also contain display information for structured annotations related to
 141 the referenced waveform(s).

142

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

144 **A.xx Waveform Presentation State Information Object Definitions**145 **A.xx.1 Waveform Presentation State IOD**146 **A.xx.1.1 Waveform Presentation State IOD Description**

147 The Waveform Presentation State Information Object Definition (IOD) specifies information that may be
 148 used to present (display) waveforms that are referenced from within the IOD.

149 Note

150 The Waveform Presentation State object allows to store textual annotations, as well as to provide display
 151 information for annotations stored in a separate SR document. The policies related to the criteria for
 152 where specific annotations should be stored – in the Waveform Presentation State object or in the SR
 153 document – are outside the scope of the Standard.

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

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

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

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

159 **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 Annotation	C.xx.aa	U
	Textual Waveform Annotation	C.xx.bb	U
	Displayed Waveform Segment	C.xx.cc	U
	Montage Activation	C.xx.dd	U
	Waveform Presentation Montage	C.xx.ee	C – Required if Montage Activation Module is present.
	SOP Common	C.12.1	M

160

161 Note

162 All Attributes containing color information are defined to contain PCS values, so the ICC Profile Module is not
163 used.

164

165 **A.xx.2 Waveform Acquisition Presentation State IOD**166 **A.xx.2.1 Waveform Acquisition Presentation State IOD Description**167 The Waveform Acquisition Presentation State Information Object Definition (IOD) provides information
168 about the display settings such as filters and montages used during acquisition of the waveform. This
169 allows presentation of the “recording view” later during review of the waveform.

170 Note

171 The Waveform Acquisition Presentation State object allows to store textual annotations, as well as to provide
172 display information for annotations stored in a separate SR document. The policies related to the criteria
173 for where specific annotations should be stored – in the Waveform Acquisition Presentation State object
174 or in the SR document – are outside the scope of the Standard.

175

176 **A.xx.2.2 Waveform Acquisition Presentation State IOD Entity-Relationship Model**177 This IOD uses the E-R Model in Section A.1-2, with only the Waveform Presentation State IE below the
178 Series IE.

179 **A.xx.2.3 Waveform Acquisition Presentation State IOD Module Table**

180 Table A.xx.2-1 specifies the Modules of the Waveform Acquisition Presentation State IOD.

181 **Table A.xx.2-1. Waveform Acquisition 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 Annotation	C.xx.aa	U
	Textual Waveform Annotation	C.xx.bb	U
	Displayed Waveform Segment	C.xx.cc	U
	Montage Activation	C.xx.dd	M
	Waveform Presentation Montage	C.xx.ee	M
	SOP Common	C.12.1	M

182

183 Note

184 All Attributes in this IOD containing color information are defined to contain PCS values, so the ICC Profile
185 Module is not used.

186

187 *Adapt Section PS3.3 Section C.10.10.1.1 by adding an additional note to indicate, that this Attribute is*
188 *also used in context of Waveform Presentation States.*

189 **C.10.10.1.1 Referenced Channels**

190

191

192 Note

193 **1.** As an example, an annotation that applies to the entire first multiplex group and channels 2 and 3 of the third
194 multiplex group would have Referenced Channels value 0001 0000 0003 0002 0003 0003.

195 **2. This Attribute is also used in the context of Waveform Presentation States to express the relationship**
 196 **of a presentation property to selected waveform channels.**
 197

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

200 Note

201 This implies that presentation states will be in different Series from the **images instances** to which they apply,
 202 which will have different values for Modality.
 203

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

205 C.xx Waveform Presentation State Modules

206 C.xx.hh Waveform Presentation State Relationship Module

207 Table C.xx.hh-1 specifies the Attributes of the Waveform Presentation State Relationship Module, which
 208 describe the waveforms to which a Waveform Presentation State applies.

209 Note

210 This module only allows for referencing waveforms and SR documents from a single study. The Presentation
 211 State itself will belong to the same study. Creating annotations that reference waveforms and SR
 212 documents in a different study can be done by creating another Waveform Presentation State in that
 213 other study.
 214

215

216

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

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 Waveform 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 Instance Sequence	(0008,114A)	1C	The set of SR documents containing waveform Annotations to which the Presentation State applies. These SR documents shall be of the Study defined by Study Instance UID (0020,000D) and the Series defined by Series Instance UID (0020,000E) in the enclosing Item. The referenced Instances shall be of SOP Class 1.2.840.10008.5.1.4.1.1.88.77 Waveform Annotation SR Storage. One or more Items shall be included in this Sequence.

Attribute Name	Tag	Type	Attribute Description
			Required if Structured Waveform Annotation Sequence (ggga,eee1) is present.
>> Include Table 10-11 "SOP Instance Reference Macro Attributes"			
>Referenced Waveform Sequence	(0008,113A)	1C	<p>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) in the enclosing Item.</p> <p>One or more Items shall be included in this Sequence.</p> <p>The referenced SOP Class shall be the same for all SOP Instances in a single Item of this Referenced Series Sequence (0008,1115) but may be different for different Items.</p> <p>Notes:</p> <ol style="list-style-type: none"> For example, some Series might represent EEG and some Series might represent ECG. The Waveform Presentation State applies to waveforms that are referenced in annotations in Structured Waveform Annotation Sequence (ggga,eee1), thus those waveforms also need to be included here. <p>Required if Referenced Instance Sequence (0008,114A) is not present.</p>
>>Include Table 10-11 "SOP Instance Reference Macro Attributes"			
>>Referenced Waveform Channels	(0040,A0B0)	1C	<p>Identifies the waveform multiplex group (M) and channel (C) within the referenced waveform SOP Instance using pairs of values (M,C). See Section C.10.10.1.1.</p> <p>Required if the Referenced Waveform SOP Instance contains multiple channels and the reference does not apply to all channels of all multiplex groups.</p>

217

218

219 **C.xx.aa Structured Waveform Annotation Module**

220 This Module defines how a display device applies waveform annotations that are stored in a separate SR
 221 document to a waveform.

222

Table C.xx-aa. Structured Waveform Annotation Module Attributes

Attribute Name	Tag	Type	Attribute Description
Structured Waveform Annotation Sequence	(ggga,eee1)	1	Selects and provides display information for waveform annotations and measurements

Attribute Name	Tag	Type	Attribute Description
			contained in the referenced SR document. One or more Items shall be included in this Sequence.
>Include Table 10-11 "SOP Instance Reference Macro Attributes"			This references an SR document which contains the annotations. The Instance referenced here shall be contained in the Referenced Instance Sequence (0008,114A) in the Referenced Series Sequence (0008,1115).
>Waveform Annotation Display Selection Sequence	(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 document shall be displayed. One or more Items are permitted in this Sequence.
>>Annotation Group Number	(0040,A180)	1	References an annotation group number (130872, DCM, "Waveform Annotation Group Number") defined within the referenced SR document to which the display information applies.
>>Referenced Montage Index	(ggga,eeec)	3	The recommended viewing montage identified by the Montage Index (ggge,eeee) in the Waveform Montage Sequence (ggge,eeee).
>>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.

223

224 **C.xx.bb. Textual Waveform Annotation Module**

225 This Module defines Attributes of textual annotations that shall be made available by a display device to
226 be applied to a waveform. The text is defined in position relative to the waveform time information.

227 A textual waveform Annotation shall be related to a waveform.

228

Table C.xx-bb. Textual Waveform Annotation Module Attributes

Attribute Name	Tag	Type	Attribute Description
Waveform Textual Annotation Sequence	(gggb,eee1)	1	Selects and provides 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)	3	The date and time the annotation was

Attribute Name	Tag	Type	Attribute Description
			added.
>Referenced Waveform Sequence	(0008,113A)	1C	<p>The waveform to which this annotation applies.</p> <p>One or more Items shall be included in this Sequence.</p> <p>Required if the annotation in this Item does not apply to all the waveforms and channels contained in Referenced Waveform Sequence (0008,113A) in the Referenced Series Sequence (0008,1115).</p>
>>Include Table 10-11 "SOP Instance Reference Macro Attributes"			<p>This references waveforms to which the annotation applies.</p> <p>The Instances referenced here shall be contained in the Referenced Waveform Sequence (0008,113A) in the Referenced Series Sequence (0008,1115).</p>
>>Referenced Waveform Channels	(0040,A0B0)	1	Identifies the waveform multiplex group (M) and channels (C) within the referenced SOP Instance using pairs of values (M,C). See Section C.10.10.1.1.
>Include Table C.xx-a "Temporal Range Macro Attributes"			<p>Enumerated Values for Temporal Range Type (0040,A130):</p> <p>POINT</p> <p>MULTIPOINT</p>
>Referenced Montage Index	(ggga,eeec)	3	The recommended viewing montage identified by the Montage Index (ggge,eeee) in the Waveform Montage Sequence (ggge,eeea).
>Text Object Sequence	(0070,0003)	1	Describes a text annotation. A single Item shall be included in this Sequence.
>>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.

230 **C.xx.cc Displayed Waveform Segment Module**

231 This Module defines Attributes required to define waveform segments and the properties how to display
 232 them. A waveform segment is a temporal portion of a waveform (“segment of interest”).

233 **Table C.xx-cc. Displayed Waveform Segment 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)	3	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. 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 contained in Referenced Waveform Sequence (0008,113A) in the Referenced Series Sequence (0008,1115).
>>Include Table 10-11 “SOP Instance Reference Macro Attributes”			This references waveforms to which the segment display parameters in this Item apply. The Instances referenced here shall be contained in the Referenced Waveform Sequence (0008,113A) in the Referenced Series Sequence (0008,1115).
>>Referenced Waveform Channels	(0040,A0B0)	1	Identifies the waveform multiplex group (M) and channels (C) within the referenced SOP Instance using pairs of values (M,C). See Section 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,

Attribute Name	Tag	Type	Attribute Description
			and the value is encoded as CIE Lab. See Section C.10.7.1.1. Required if Channel Recommended Display CIE Lab Value (003A,0244) is not present. May be present otherwise.
>Channel Recommended Display CIE Lab 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 CIE Lab. See Section C.10.7.1.1. Required if Waveform Display Background CIE Lab Value (003A,0231) is not present. May be present otherwise.

234

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

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

237

Table C.xx-dd. Montage Activation Module Attributes

Attribute Name	Tag	Type	Attribute Description
Montage Activation Sequence	(gggd,eeee)	1	Provides information about when a 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 Montage 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.

238

239 **C.xx.ee Waveform Presentation Montage Module**

240 This Module contains Attributes describing presentation montages of waveform channels.

241

Table C.xx-ee Waveform Presentation Montage Module Attributes

Attribute Name	Tag	Type	Description
Waveform Montage Sequence	(ggge,eeee)	1	Description of the waveform montage(s) in the Waveform Presentation State. One or more Items shall be included in this Sequence.

>Montage Name	(ggge,eeec)	3	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 elsewhere to refer to this specific montage Sequence Item.
>Montage Channel Sequence	(ggge,eeed)	1	The channel(s) that comprise this montage. One or more Items shall be included in this Sequence. The order of Items in this Sequence is significant.
<i>>>Include Table C.xx-f "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). Note: This does not prevent applications to change this during display. The value might be used as an initial default setting.
>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 shall be included 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. This is the ordinal number of the Item in the Montage Channel Sequence (ggge,eeed).
>>>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. The nature of the shading (e.g., solid, or cross-hatching) is implementation dependent. Enumerated Values: NONE no shading BASELINE shading between the waveform and the channel display baseline (sample value 0 equivalent location) ABSOLUTE shading between the waveform and the channel real world actual value 0 (i.e., taking into account the Channel Baseline (003A,0213) value) 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.
>>>Fractional Channel Display Scale	(003A,0247)	1C	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.
>>>Absolute Channel Display Scale	(003A,0248)	1C	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.

242

243

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

245 This Macro consists of Attributes describing a single channel of a waveform montage.

246

Table C.xx-f. 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)	3	Text label of the channel, which may be used for display purposes.
Montage Channel Source Code Sequence	(gggf,0208)	1	A coded descriptor of the waveform channel source. This identifies a single channel in the recorded waveform in terms of the lead from which it is collected. Only a single Item shall be included in this Sequence.
>Include Table 8.8-1 "Code Sequence Macro Attributes"			DCID 3001 "ECG Leads" DCID 3004 "Arterial Pulse Waveform" DCID 3005 "Respiration Waveform" DCID 3030 "EEG Leads" DCID 3031 "Lead Location Near or in Muscle" DCID 3032 "Lead Location Near Peripheral Nerve" DCID 3033 "EOG Lead" DCID 3034 "Body Position Waveform"
Source Waveform Sequence	(003A,020A)	1	A Sequence that provides reference to a waveform from which this channel was derived. One or more Items shall be included in this Sequence. If there are multiple Items in this Sequence, they shall share the same multiplex group identified by Multiplex Group UID (003A,0310).
>Include Table 10-11 "SOP Instance Reference Macro Attributes"			
>Referenced Waveform Channels	(0040,A0B0)	1	Identifies the waveform multiplex group (M) and channel (C) within the referenced SOP Instance using a pair of values (M,C). See Section C.10.10.1.1. 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)	2	A Sequence of Items each representing the source of a channel contributing to this montage. Zero or more Items shall be included in this Sequence.
>Channel Weight	(gggf,020A)	1	The relative weight this channel contributes to the montage channel. The weights of all Items in this Sequence shall sum up to 1.

>Channel Source Sequence	(003A,0208)	1	A coded descriptor of the contributing waveform channel source. Only a single Item shall be included in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			DCID 3001 "ECG Leads" DCID 3004 "Arterial Pulse Waveform" DCID 3005 "Respiration Waveform" DCID 3030 "EEG Leads" DCID 3031 "Lead Location Near or in Muscle" DCID 3032 "Lead Location Near Peripheral Nerve" DCID 3033 "EOG Lead" DCID 3034 "Body Position Waveform"
>Source Waveform Sequence	(003A,020A)	1	Reference to waveforms from which this channel was derived. One or more Items shall be included in this Sequence. If there are multiple Items in this Sequence, they shall share the same multiplex group identified by Multiplex Group UID (003A,0310).
>>Include Table 10-11 "SOP Instance Reference Macro Attributes"			
>>Referenced Waveform Channels	(0040,A0B0)	1	Identifies the waveform multiplex group (M) and channel (C) within the referenced SOP Instance using a pair of values (M,C). See Section C.10.10.1.1. Only a single channel shall be referenced here.
Channel Sensitivity	(003A,0210)	1C	Nominal numeric value of unit quantity of sample. See Section C.10.9.1.4.2. Required if samples represent defined (not arbitrary) units.
Channel Sensitivity Units Sequence	(003A,0211)	1C	A coded descriptor of the units of measure for the Channel Sensitivity (003A,0210). See Section C.10.9.1.4.2. Only a single Item shall be included in this Sequence. Required if Channel Sensitivity (003A,0210) is present.
>Include Table 8.8-1 "Code Sequence Macro Attributes"			DCID 82 "Measurement Unit"
Channel Sensitivity Correction Factor	(003A,0212)	1C	Multiplier to be applied to encoded sample values to match units specified in Channel Sensitivity Units Sequence (003A,0211) (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. One or more Items shall be included in this Sequence.
>Include Table C.10.12-1 "Waveform Filter Characteristics Macro Attributes"			
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. One or more Items shall be included in this Sequence.
>Include Table C.10.12-1 "Waveform Filter Characteristics Macro Attributes"			
Notch Filter Characteristics Sequence	(003A,0321)	3	The properties of notch filters applied to the waveform montage channel. One or more Items are permitted in this Sequence.
>Include Table C.10.12-1 "Waveform Filter Characteristics Macro Attributes"			

247

248 **C.xx.gg Temporal Range Macro**249 *Ed. Note: This Macro could also replace this set of Attributes in the Waveform Annotation Module C.10.10*

250 This macro contains Attributes that define one or more points in time or time ranges in waveforms or
 251 dedicated channels of those waveforms. The waveforms and channels are selected in the enclosing data
 252 set.

253

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 Section 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.

254

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

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

258 The Temporal Range Type (0040,A130) Attribute defines the type of temporal extent of ~~the annotated~~
 259 ~~region of interest~~ **a selected region of waveform data**. A temporal point (or instant of time) may be
 260 defined by a waveform sample offset (for a single waveform multiplex group only), time offset, or absolute
 261 time.

262 **The value or the values shall be present either as Referenced Sample Positions (0040, A132), or as**
 263 **Referenced Time Offsets (0040,A138), or as Referenced DateTimes (0040,A13A).**

264

265 Enumerated Values:

266 **POINT** a single temporal point; **a single value shall be present.**267 **MULTIPOINT** multiple temporal points; **multiple values shall be present.**268 **SEGMENT** a range between two **different** temporal points; **two values shall be present.**269 **MULTISEGMENT** multiple segments, each denoted by two temporal points. **An even number of values**
 270 **shall be present, each pair representing one segment.**271 **BEGIN** range beginning at one temporal point, and extending beyond the end of the acquired data; **a**
 272 **single value shall be present.**273 **END** a range beginning before the start of the acquired data, and extending to (and including) the
 274 identified temporal point; **a single value shall be present.**

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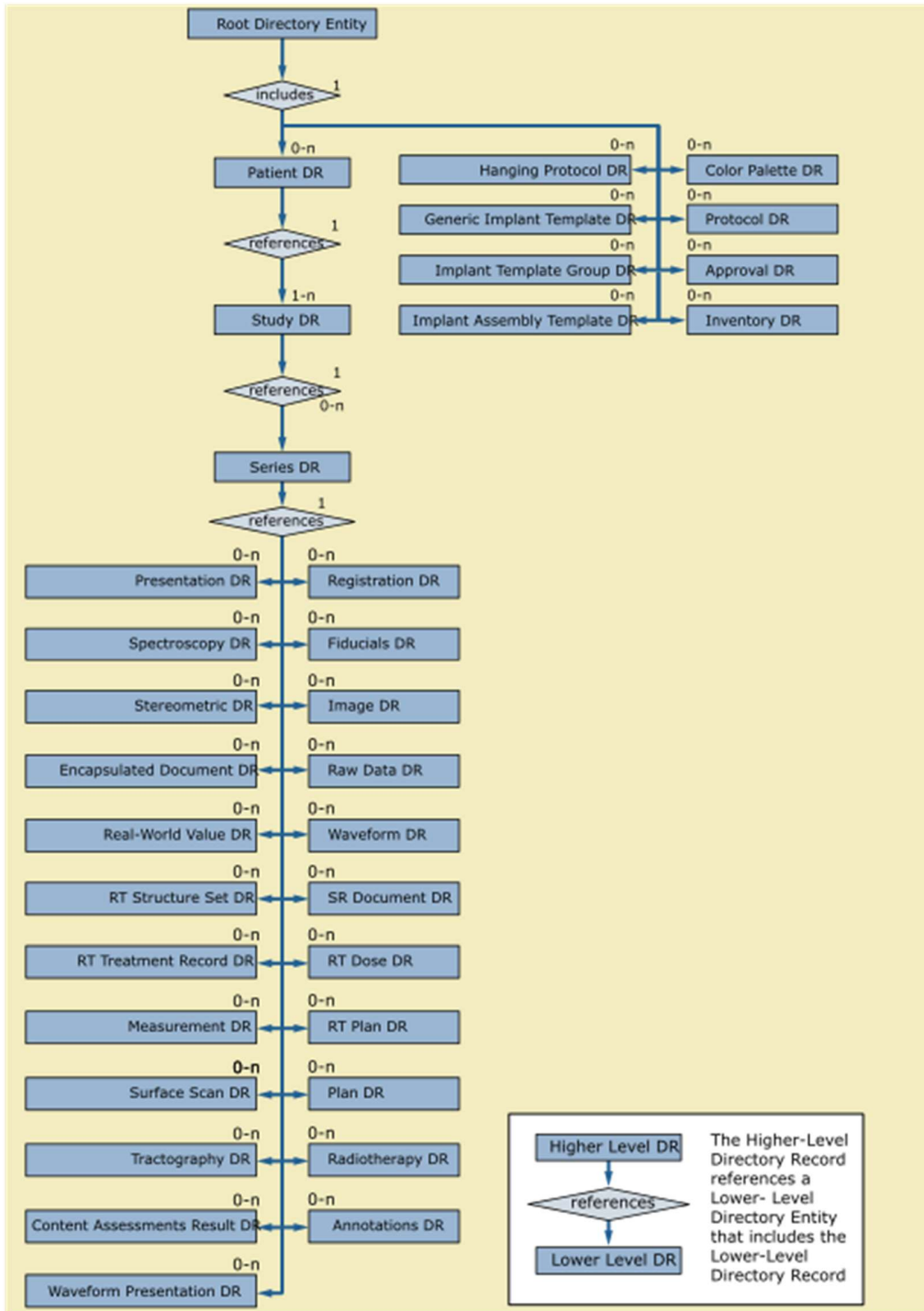
277 **C.xx.gg.h Referenced Sample Position**

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

280 Referenced Sample Positions (0040,A132) may be used only if Referenced Waveform Channels
 281 (0040,A0B0) **in the enclosing dataset** refers to channels within a single multiplex group. The sample
 282 position is by channel, and applies to all channels specified in Referenced Channels (0040,A0B0) **in the**
 283 **enclosing dataset.**

284

285 *Amend Figure F.4.1. Basic Directory IOD Information Model by adding a Waveform Presentation DR*



286

287

288

289 *Add new Enumerated Value for the new Basic Directory Type to F.3-3 PS3 Section F.3*

290

Table F.3-3. Directory Information Module Attributes

Key	Tag	Type	Attribute Description
-----	-----	------	-----------------------

Offset of the First Directory Record of the Root Directory Entity	(0004,1200)	1	Offset of the first byte ...
...			
>Directory Record Type	(0004,1430)	1	Defines as specialized type of Directory Record by reference to its position in the Media Storage Directory Information Model (see Section F.4). Enumerated Values: PATIENT STUDY ... <u>WF PRESENTATION</u> PRIVATE ...
>...			
>Include Record Selection Keys			A number of DICOM Data Elements that contain specific Keys defined for each type of Directory Record (0004,1430) defined in Section F.5.

291

292 Add new Enumerated Value for the new Basic Directory Type to Table F.4-1 Relationship Between
293 Directory Records

294

Table F.4-1. Relationship Between Directory Records

Directory Record Type	Section	Directory Record Types that may be included in the next lower-level directory Entity
...		
SERIES	F.5.3	IMAGE, RT DOSE, RT STRUCTURE SET, RT PLAN, RT TREAT RECORD, PRESENTATION, WAVEFORM, SR DOCUMENT, KEY OBJECT DOC, SPECTROSCOPY, RAW DATA, REGISTRATION, FIDUCIAL, ENCAP DOC, VALUE MAP, STEREOMETRIC, PLAN, MEASUREMENT, SURFACE, TRACT, ASSESSMENT, RADIOTHERAPY, ANNOTATION, <u>WF PRESENTATION</u> , PRIVATE
IMAGE	F.5.4	PRIVATE

...		
<u>WF PRESENTATION</u>	<u>F.5.x</u>	<u>PRIVATE</u>
PRIVATE	F.6.1	PRIVATE, (any of the above as privately defined)

295

296 *Add new Basic Directory Record PS3 Section F.5*297 **F.5.x Waveform Presentation State Directory Record Definition**

298 The Directory Record is based on the specification of Section F.3. It is identified by a Directory Record
 299 Type (0004,1430) of Value "WF PRESENTATION". Table F.5-X lists the set of Keys with their associated
 300 Types for such a Directory Record Type. The description of these Keys may be found in the Modules
 301 related to the Waveform Presentation State IE of Waveform Presentation State IODs. This Directory
 302 Record shall be used to reference a Waveform Presentation State SOP Instance. This Type of Directory
 303 Record may reference a Lower-Level Directory Entity that includes one or more Directory Records as
 304 defined in Table F.4-1

305

306

Table F.5-X. Waveform Presentation Keys

Key	Tag	Type	Attribute Description
Specific Character Set	(0008,0005)	1C	Required if an extended or replacement character set is used in one of the Keys.
Presentation Creation Date	(0070,0082)	1	Date on which the waveform presentation was created. Note This date may be different from the date that the DICOM SOP Instance was created, since the presentation information contained may have been recorded earlier.
Presentation Creation Time	(0070, 0083)	1	Time at which this waveform presentation was created. Note: This time may be different from the time that the DICOM SOP Instance was created, since the presentation information contained may have been recorded earlier.
<i>Include Table 10-12 "Content Identification Macro Attributes"</i>			
Referenced Series Sequence	(0008,1115)	1C	Sequence of Items where each Item includes the Attributes of one Series to which the Waveform Presentation State applies.

			<p>One or more Items shall be included in this Sequence.</p> <p>Required if the IOD of the Waveform Presentation State SOP Instance referenced by this Directory Record includes the Waveform Presentation State Relationship Module.</p>
>Series Instance UID	(0020,000E)	1	<p>Unique identifier of a Series that is part of the Study defined by the Study Instance UID (0020,000D) in the enclosing data set.</p> <p>Note The Study Instance UID (0020,000D) value will be that of the Waveform Presentation State.</p>
>Referenced Instance Sequence	(0008,114A)	1C	<p>The set of SR documents containing waveform Annotations to which the Waveform 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) in the enclosing Item.</p> <p>The referenced Instances shall be of SOP Class 1.2.840.10008.5.1.4.1.1.88.77 Waveform Annotation SR Storage.</p> <p>One or more Items shall be included in this Sequence.</p> <p>Required if Structured Waveform Annotation Sequence (ggga,eee1) is present.</p>
>> <i>Include Table 10-11 "SOP Instance Reference Macro Attributes"</i>			
>Referenced Waveform Sequence	(0008,113A)	1C	<p>The set of waveforms to which the Waveform 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) in the enclosing Item.</p> <p>One or more Items shall be included in this Sequence.</p> <p>The referenced SOP Class shall be the same for all SOP Instances in a single Item of this Referenced Series Sequence (0008,1115) but may be different for different Items.</p> <p>Notes: 1. For example, some Series might represent EEG and some Series</p>

			<p>might represent ECG.</p> <p>2. The Presentation State applies to waveforms that are referenced in annotations in Structured Waveform Annotation Sequence (ggga,eee1), thus those waveforms also need to be included here.</p> <p>Required if Referenced Instance Sequence (0008,114A) is not present.</p>
>>Include Table 10-11 "SOP Instance Reference Macro Attributes"			
Any other Attribute of the Waveform Presentation State IE Modules		3	

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Changes to NEMA Standards Publications PS 3.4
Digital Imaging and Communications in Medicine (DICOM)
Part 4: Service Class Specifications

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

313 **B.5 Standard SOP classes**

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

316 **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 Acquisition Presentation State Storage</u>	<u>Waveform Acquisition Presentation State IOD</u>	

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

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

323

Table 6-1. Registry of DICOM Data Elements

Tag	Name	Keywords	VR	VM	
...					
(ggga,eee1)	Structured Waveform Annotation Sequence	StructuredWaveformAnnotationSequence	SQ	1	
(ggga,eee2)	Waveform Annotation Display Selection Sequence	WaveformAnnotationDisplaySelectionSequence	SQ	1	
(ggga,eeec)	Referenced Montage Index	ReferencedMontageIndex	US	1	
(gggb,eee1)	Waveform Textual Annotation Sequence	WaveformTextualAnnotationSequence	SQ	1	
(gggb,eee2)	Annotation DateTime	AnnotationDateTime	DT	1	
(gggc,eee1)	Displayed Waveform Segment Sequence	DisplayedWaveformSegmentSequence	SQ	1	
(gggc,eee2)	Segment Definition DateTime	SegmentDefinitionDateTime	DT	1	
(gggd,eeee)	Montage Activation Sequence	MontageActivationSequence	SQ	1	
(gggd,eeeb)	Montage Activation Time Offset	MontageActivationTimeOffset	DS	1	
(ggge,eeee)	Waveform Montage Sequence	WaveformMontageSequence	SQ	1	
(ggge,eeeb)	Referenced Montage Channel Number	ReferencedMontageChannelNumber	IS	1	
(ggge,eeec)	Montage Name	MontageName	LT	1	
(ggge,eeed)	Montage Channel Sequence	MontageChannelSequence	SQ	1	
(ggge,eeee)	Montage Index	MontageIndex	US	1	
(gggf,0202)	Montage Channel Number	MontageChannelNumber	IS	1	
(gggf,0203)	Montage Channel Label	MontageChannelLabel	LO	1	
(gggf,0208)	Montage Channel Source Code Sequence	MontageChannelSourceCodeSequence	SQ	1	
(gggf,0209)	Contributing Channel Sources Sequence	ContributingChannelSourcesSequence	SQ	1	
(gggf,020A)	Channel Weight	ChannelWeight	FL	1	
..					

324
325

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

327

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 Acquisition Presentation State Storage</u>	<u>WaveformAcquisitionP resentationStateStorag e</u>	<u>SOP Class</u>	<u>PS3.4</u>
...				

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

337

Add the new Modules from the new IODs to PS3.15 Section C.2 by continuation of the list

338

...

339
340

As a minimum, an implementation shall include the following Attributes in generating the Creator RSA Digital Signature:

341

a. the SOP Class and Instance UIDs

342

b. the SOP Creation Date and Time, if present

343

c. the Study and Series Instance UIDs

344

d.

345

ae. any Attributes of the Waveform Presentation State Relationship Module that are present

346

af. any Attributes of the Structured Waveform Annotation Module that are present

347

ag. any Attributes of the Textual Waveform Annotation Module that are present

348

ah. any Attributes of the Displayed Waveform Segment Module that are present

349

ai. any Attributes of the Montage Activation Module that are present

350

aj. any Attributes of the Waveform Presentation Montage Module that are present

351

Add new Data Elements to PS3.15 Annex E

352

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>			
...														

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Changes to NEMA Standards Publications PS3.17

Digital Imaging and Communications in Medicine (DICOM)

Part 17: Explanatory Information

359 **XXX Waveform Presentation State (Informative)**

360 In clinical neurophysiology it is important to be able to recreate the presentation of the recorded data as it
361 was displayed during the recording or during review and reporting. This allows subsequent reviewers to
362 recreate the display as it was when the recording was made and when an annotation was created, which
363 allows for review of subtle features that may not be obvious in other montages or reference states.

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

367 Waveform objects support limited display information, including only Attributes for color and scaling of
368 waveform channels. This leaves out much information about how waveforms were visualized by the
369 technician who recorded the study, including the mathematical derivation of channels needed for
370 visualization, the ordering of channels on the display screen, and filters used for channel visualization.

371 In neurophysiology, a montage defines the list of channels for visualization of the waveform data which is
372 created from the originally recorded channel sources and it conveys the method for their mathematical
373 (linear) recombination. Montages could be either predefined (for a common list of sources) and
374 referenced by a montage object identifier or defined for each specific recording, because the recording
375 could include a unique list of sources.

376 Waveform Annotations are textual or coded markers assigned to a specific timepoint or time range, related
377 to all channels or a selected set of channels. Annotations could be observations of waveforms, patient
378 stimuli, comments about the recording, as well as measurements.

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

382
383 The Waveform Acquisition Presentation State object is created during the waveform recording in order to
384 persist the montages and filter settings used by the technologist. Over the course of the waveform
385 recording the technologist may use different montages and filter settings and this information is persisted
386 in the Waveform Acquisition Presentation State object.

387
388 The Waveform Presentation State object is created later during review or analysis of the waveform. This
389 persists a description of montages and filter settings associated with created annotations. Subsequent
390 viewers of the recording and the annotations might choose this same view by applying this Presentation
391 State.

392
393

XXX.1 Waveform Presentation State Usage

394 **Use case: Post-hoc Review**

395 A physician acting as a post-hoc reviewer looks through a completed EEG recording and marks potential
396 epileptiform features. The annotations added by the technician during the recording are displayed for
397 anyone reviewing the recording and can provide details useful for the interpreting physician, such as
398 when a patient is moving their body. If the physician adds annotations a Waveform Annotation SR is
399 created. In addition, if triggered by the post-hoc study reviewer, a Waveform Presentation State object is
400 created to store used filter settings and montages.

401

402 **Use case: Electronic Health Record**

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

405 and filter settings used during recording and review may be different between hospitals. So the reviewer
406 may decide to use either the Waveform Acquisition Presentation State object to see directly what the
407 outside EEG staff annotated and which filters and montages were used or may choose to review the data
408 with montage settings as provided in a Waveform Presentation State created by the outside neurologist.
409

410 **Use case: Automated Waveform Analysis**

411 Algorithms may store observations and measurements as annotations in a Waveform Annotation SR
412 object. Additionally, it might be useful to store montages and filter settings used by the algorithm in a
413 Waveform Presentation State object for future reference.

414 **XXX.2 Waveform Acquisition Presentation State Usage**

415 **Use case: Recording**

416 When a technician performs an EEG recording, from time to time, the technician changes the
417 visualization filter settings and montage, in order to check the quality of the source signals and/or to better
418 visualize a potential abnormal signal pattern in the live neurophysiology recording. Based on this
419 information, during the live recording, the technician may adjust the physical parameters of the recording,
420 such as manually adjusting the surface electrode contact with the skin to improve the signal quality. If
421 abnormalities occur or if external circumstances change that could be of importance for the evaluation of
422 the recording, the technician may add an annotation at a particular time point. The Annotations added by
423 the technician during the recording may either be stored in this Waveform Acquisition Presentation State
424 object or in a separate Waveform Annotation SR object.
425

426 **Use case: Quality Control**

427 A neurophysiology technician makes a recording which is of suboptimal quality. The lead technician of the
428 lab reviews the recording with the technician who made the recording using the Waveform Acquisition
429 Presentation State object. They discuss the poor signal quality of certain sources not noticed during the
430 recording. This led to certain physical parameters not being adjusted during the recording, which would
431 have rectified the problem. The reason for that was that the technician used suboptimal filter and/or
432 montage settings. Such suboptimal filter and montage settings can include filter settings with notch filter on
433 which can hide line noise (which can indicate poor impedance) or a montage that does not include relevant
434 sources.
435