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

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*Supplement 196: Segmentation Creation Template*

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20 **DICOM Standards Committee, Working Group 07 Radiotherapy Objects**

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### Change History

Date	Rev	Author	Content
2015-06-18	01	Walter Bosch	Initial Outline
2015-09-27	02	Walter Bosch	Preparation for Work Item presentation
2016-06-01	03	Ulrich Busch	First draft after approval of Workitem and assignment of Supplement number. Format cleaned and updated to match the regular supplement format. Most Headers are renamed along current working title, other text is not updated yet. WG-06 comments are added to the Open Issue list for consideration.

60

### Open Issues and Discussion Points

#	Item
1	Should the ROI Template reference dictionary entries from more than one ROI Dictionary? Should all definitions be required to come from the same ROI Template SOP instance? Allow references to other instances? → DECISION: Retire the ROI Dictionary and condense Dictionary content into Template; add a “Purpose Code” for primary Segmented Property Type Code.
2	How should templates be identified? By template label? By protocol label? By protocol code?
3	What parameters for auto-segmentation other than CT upper/lower limits should be included? Yulong Yan to provide a list of such parameters.
4	Do we need to store both “Anatomic” and “RT Role”-based code sets for segmentation-level and annotation-level IODs, respectively? → These codes have been separated. There is a code pair for each entity. Both should be supported.
5	How should the Clinical Trial context for an ROI Template be identified?
6	What is the role of the Template UID? Does this identify the template class (same for multiple revisions and/or versions), or is this an instance UID?
7	How are template revisions managed? What is the expected behavior for applications receiving updates?
8	2016-06-01 WG-06: A current working title may include Template, when it is sufficiently qualified. Therefore the title 'Segmentation Creation Template' was chosen for the template and the IOD for the time being. The title maybe revised in a later stage if indicated.
9	2016-06-01 WG-06: At a later stage it should be considered, how this IOD maybe made available for outside RT as well. It is certainly of interest in other context as well, and most of the content is pretty generic.
10	2016-06-01 WG-06: As also shortly discussed in WG-07, the terminology ROI maybe replaced by 'Segment', since this is a more generic and modern term.

11	2016-06-01 WG-06: RT Protocol Sequence – this sounds RT-specific, but could be generalized. There are similar constructs in the Standard already, which should be evaluated for use. If we need RT specific information, think of may be using a generic module or construct,along an RT-specific module
12	2016-06-01 WG-06: Indication Code Sequence is similarly also available in the CT protocol, use that one?
13	2016-06-01 WG-06: ROI Segmentation Instruction – may also have a similar concept exists in CT protocol, can that be used?
14	2016-06-01 WG-06: Consider whether it would it be worth to indicate which attributes are important to take from template, and which are not, e.g. it may be ok to change the color, but not the coding.
15	2016-06-01 WG-06: (meta-topic, but added as reminder for Chairs): Inform CT, MR and WG-11 (Display) about the work item
16	2016-06-01 WG-06: Foreword: Start with the essence: Creation of Segmentation,... include details like details, guidance aspects, what elements are segmented etc.)

62

### Closed Issues

#	Item

64 **Things highlighted in yellow** are issues/items in need of review/resolution/attention by reviewers.

**Things highlighted in grey** are just reminders for the editor about editing work that needs to be done.

66

68

## Foreword

70 ((TODO: Start with the essence: Creation of Segmentation,... include details like details, guidance aspects, what elements are segmented etc.))

72 This Supplement to the DICOM Standard defines an ROI Template storage SOP class that describes  
74 desired values for various parameters of image segmentation. Defined Templates are independent of  
76 a specific patient. The objective is enable a radiation oncologist, a therapy department, or a clinical  
78 trial center, to be able to define ROI identification and associated parameters for a variety of  
segmentation situations on one segmentation workstation or treatment planning system, and to  
disseminate those ROI Templates to other systems, independent of the manufacturer. An ROI  
Template SOP instance also be referenced for multiple steps in clinical and clinical trials workflow,  
including prescription, treatment planning, plan analysis, plan review, and automated QA.

80 This document is a Supplement to the DICOM Standard. It is an extension to the following parts of  
the published DICOM Standard:

- 82 Part 2 Conformance
- Part 3 Information Object Definitions
- 84 Part 4 Service Class Specifications
- Part 6 Data Dictionary
- 86 Part 16 Content Mapping Resource
- Part 17 Explanatory Information

88

## Scope and Field of Application

### 90 Introduction

The ROI Template SOP Class addresses details including:

- 92 • ROI Identification and ROI Type
- Segmented Property Type Code and Segmented Property Category Code
- 94 • Instructions for segmentation
- Recommended display color
- 96 A list of ROI identifiers and default values of associated attributes used to populate DICOM RT  
Segment Annotation and segmentation instances including Segmentation, Surface  
98 Segmentation, etc. for a particular clinical context (e.g., Clinical Trial protocol), are collected in  
an ROI Template.
- 100 1. The Template UID identifies an ROI Templates for a particular clinical context from a particular  
publishing source.
- 102 2. The *ROI Presence* value indicates whether the ROI is required for all Protocol patients.
- 104 3. For ROIs that are required conditionally, the *ROI Presence Condition* value provides text  
describing the conditions under which the ROI is required.

## Background

106 The use of anatomical structures and structure sets is fundamental to image based treatment planning  
and delivery but the portability and customization of structure templates does not exist. DICOM  
108 handling of a single structure set associated with an image data set is established. Definition of an ROI  
Template IOD will allow the use of defined templates in building structure sets and other segmentation  
110 instances with established naming conventions. The AAPM, IHE-RO, NRG, ATC, IROC and other  
bodies have promoted and developed uniform tissue names for use in radiation oncology clinical trials.  
112 The expanded use of ROI templates through the development of well defined handling processes  
across platforms and systems is expected to increase productivity across the field of radiation  
114 oncology (virtual simulation, treatment planning and igrt, and image review).

## 116 Use Cases

The primary applications this supplement intends to focus on include:

- 118 • Dissemination of naming conventions for consistent identification of ROIs for image  
segmentation, radiotherapy treatment planning, and radiotherapy plan evaluation.
- 120 • Consistent ROI naming and coding in multi-center clinical trials.
- 122 • Dissemination of Category, Type, Modifier, and Purpose Codes to image segmentation  
applications producing RT Structure Set and RT Segment Annotation instances.
- Support for automated quality assessment of segmentation and radiotherapy treatment plans.

124

126

## Part 2: Conformance

128 In PS 3.2, add new SOP Classes in Table A.1-2

Table A.1-2  
UID VALUES

130

UID Value	UID NAME	Category
...		
1.2.840.10008.5.1.4.1.1.X.1.1	ROI Template Storage	Transfer
...		

132

## Part 3: Information Object Definitions

134

In PS 3.3, add Figure 7-2xx Segmentation Creation Template Storage Information Model as shown

136

138

### 6 DICOM Information Model

...

[Information Model Diagram needed here]

140

142

Figure 7-2xx.

DICOM INFORMATION MODEL – ROI TEMPLATE STORAGE

144

Add new IODs to PS 3.3, Table A.1-1

IODs Modules	ROI Template
General Equipment	M
Enhanced General Equipment	M
SOP Common	M
Clinical Trial Context (Sup 121)	U
ROI Template	M

146

Add the following to PS 3.3, Annex A

148



**A.1 ELEMENTS OF AN INFORMATION OBJECT DEFINITION**

- 150 **A.1.2 IOD Entity-Relationship Model**
- A.1.2.X Segmentation Creation Template IOD**
- 152
- ...
- 154 **A.X Segmentation Creation Template Object Definition**
- A.X.Z Segmentation Creation Template Object Definition**
- 156 **A.X.Z.1 Segmentation Creation Template IOD Description**
- 158 **A.X.Z.2 Segmentation Creation Template Entity-Relationship Model**
- 160 **A.X.Z.3 Segmentation Creation Template IOD Module Table**

**Table A.X1.3.3-1  
ROI Template IOD MODULES**

<b>IE</b>	<b>Module</b>	<b>Reference</b>	<b>Usage</b>
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
SOP Common	SOP Common	C.12.1	M
Clinical Trial	Clinical Trial Context	C.X4.1	U
ROI Template	ROI Template		M

**Add the following to PS 3.3 Annex C**

**C.X1 ROI TEMPLATE MODULES**

This section describes modules specific to the ROI Template IOD

**C.X1.1 ROI Template**

The ROI Template contains a collection of desired segmentation and display values for ROIs associated with a clinical or clinical trials protocol.

**Table C.X1-1 ROI TEMPLATE MODULE ATTRIBUTES**

<b>Attribute Name</b>	<b>Tag</b>	<b>Type</b>	<b>Attribute Description</b>
ROI Template Label		1	Label of this ROI Template
ROI Template Description		1	Extended description of the clinical context in which this ROI Template is to be used.

ROI Template UID		1	Unique Identifier for a ROI Template. The value of this UID is maintained across revisions of this template.
ROI Template Revision		1	Identifier issued by the publisher for this revision of the ROI Template identified by ROI Template UID.
ROI Template Publisher		2	Organization responsible for publishing this ROI Template.
RT Protocol Code Sequence		2	Sequence defining the clinical or clinical trial protocol for which the ROI Template is to be used.
<i>&gt;Include 'Code Sequence Macro' Table 8.8-1</i>		<i>No Baseline CID is defined.</i>	
Indication Code Sequence		2	Sequence containing indication code(s) for which the ROI Template is to be used. Zero or more items shall be included in this sequence.
<i>&gt;Include 'Code Sequence Macro' Table 8.8-1</i>		Baseline CID (I9, I9C, I10, ???)	
ROI Definition Sequence		1	Sequence defining the ROIs for this protocol.
<i>&gt;ROI Definition Index</i>		1	Index for this ROI definition
<i>&gt;ROI Presence</i>		1	Specifies whether the ROI is required to be segmented for all patients for which this template is used. Enumerated values: REQUIRED OPTIONAL CONDITIONAL
<i>&gt;ROI Presence Condition</i>		1C	Description of conditions under which the ROI is required to be segmented for patients on this protocol. Must be present if the value of ROI Presence (????,????) is CONDITIONAL.
<i>&gt;ROI Segmentation Instruction</i>		2C	Segmentation instructions for the ROI, e.g., anatomy to be included and/or excluded. Required if ROI Combination Flag is NO.
<i>&gt;ROI Segmentation Reference URL</i>		3	URL for reference material Required if ROI Combination Flag is NO.
<i>&gt;ROI Combination Flag</i>		1	Indication that this ROI is defined as a combination of other ROIs whose definitions appear in this template. Enumerated values NO YES

>ROI Segmentation Combination Expression		1C	Symbolic expression specifying the combination of ROIs within this template instance as a text string consisting of ROI Identifier values, combination operators and parentheses. See Supp 147 Section C.AA.2.6.1.1 (Needs note describing use. Use ROI Definition Index to identify constituents?) Required if ROI Combination Flag is YES.
>ROI Instance Name		1	Suggested value for ROI Name ( ) and Segment Label ( )
>ROI Instance Description		1	Suggested value for ROI Description ( ) and Segment Description ( )
>ROI Interpreted Type	(3006,00A4)	2	Suggested value for ROI Interpreted Type (3006,00A4) in RT Structure Set.
>ROI Display Color	(3006,002A)	1	RGB triplet color representation for ROI, specified using the range 0-255.
>Recommended Display CIELab Value	(0062,000D)	1	A default triplet value in which it is recommended that segment be rendered on a color display. The units are specified in PCS-Values, and the value is encoded as CIELab. See <a href="#">Section C.10.7.1.1</a> .
>Recommended Display Grayscale Value	(0062,000C)	1	A default single gray unsigned value in which it is recommended that the maximum pixel value in this segment be rendered on a monochrome display. The units are specified in P-Values from a minimum of 0000H (black) up to a maximum of FFFFH (white). Note: The maximum P-Value for this Attribute may be different from the maximum P-Value from the output of the Presentation LUT, which may be less than 16 bits in depth.
>Recommended Presentation Opacity	(0066,000C)	3	Specifies the opacity in which it is recommended that the surface of the ROI be rendered. See C.27.1.1.3.
>Recommended Presentation Type	(0066,000D)	3	Specifies the representation type in which it is recommended that the surface of the ROI be rendered. See C.27.1.1.3.
>Segmented Property Category Code Sequence	(0062,0003)	1	Sequence defining the general category of ROI for radiotherapy purposes. Only a single Item shall be included in this Sequence.
>>Include 'Code Sequence Macro' Table 8.8-1			Defined CID SUP147003

>Segmented Property Type Code Sequence	(0062,000F)	1	Sequence defining the specific property type of ROI for radiotherapy purposes. Only a single Item shall be included in this Sequence. See C.AA.D1.1.2.
>>Include 'Code Sequence Macro' Table 8.8-1			Defined CID is defined in C.AA.D1.1.2.
>>Segmented Property Type Modifier Code Sequence	(0062,0011)	3	Sequence defining the modifier of the property type of this segment. One or more Items are permitted in this Sequence.
>>>Include 'Code Sequence Macro' Table 8.8-1			Defined CID244.
>RT Segment Annotation Category Code Sequence	(30xx,1353)	2	Sequence defining the general category of this segment for radiotherapy purposes. Only a single Item shall be included in this Sequence.
>>Include 'Code Sequence Macro' Table 8.8-1			Defined CID SUP147003 "Radiotherapy Segment Annotation Categories".
>RT Segment Annotation Type Code Sequence	(30xx,1354)	1C	Sequence defining the specific property type of this segment for radiotherapy purposes. Required if RT Segment Annotation Category Code Sequence (30xx,1353) is present and has a value. Only a single Item shall be included in this Sequence. See C.AA.D1.1.2.
>>Include 'Code Sequence Macro' Table 8.8-1			Defined CID is defined in C.AA.D1.1.2.
>Segmented RT Accessory Device Sequence	(30xx,1349)	2	RT Accessory Device, if the ROI represents such a device. Zero or more shall be included in this Sequence. See C.AA.D1.1.3.
>>Include 'Device Model Macro' Table C.AA.2.11-1			
>>Include 'Device Identification Macro' Table C.AA.2.14-1			Defined CID SUP147040.
>>Device Index	(30xx,0112)	1	Index of the Device. The value shall start at 1 and increase monotonically by 1.
>Segment Properties Sequence	(30xx,134B)	3	Segment properties associated with the current segment's interpretation. One or more Items are permitted in this Sequence. See C.AA.D1.1.5.
>>Include 'Content Item Macro' Table 10-2'			Defined TID of Concept Name Code Sequence is TID SUP147003.

>>Segment Properties Modifier Sequence	(30xx,134C)	3	Segment properties modifier for the property. One or more Items are permitted in this Sequence. See C.AA.D1.1.5.
>>>Include 'Content Item Macro' Table 10-2			No Baseline CID is defined.
Purpose of Equivalent Code Sequence	(xxxx,yyy1)	1	Code to be used for Purpose of Equivalent Code Sequence () in the Code Sequence Macro of Codes instantiated from this template.
>>>Include 'Code Sequence Macro' Table 8.8-1			No Baseline CID is defined

174

176

### C.X1.1.1 Mapping of ROI Template Attributes

178 ROI Template attribute values are used to populate instances of RT Segment Annotation and  
segmentation (RT Structure Set, Segmentation, Surface Segmentation, etc.) instances. Mapping  
180 between ROI Template attributes and attributes within the RT Segment Annotation and segmentation  
IODs is shown in table C.X1-2 below.

182

**Table C.X1-2 ROI TEMPLATE ATTRIBUTE MAPPING**

ROI Template Attribute	RT Segment Annotation Attribute	Segmentation/ Surface Seg, ... Attribute	RT Structure Set Attribute
ROI Instance Name		Segment Label ()	ROI Name ()
ROI Instance Description		Segment Description ()	ROI Description ()
ROI Interpreted Type (3006,00A4)			ROI Interpreted Type (3006,00A4)
ROI Display Color (3006,002A)			ROI Display Color (3006,002A)
Recommended Display CIELab Value (0062,000D)		Recommended Display CIELab Value (0062,000D)	
Recommended Display Grayscale Value (0062,000C)		Recommended Display Grayscale Value (0062,000C)	
Recommended Presentation Opacity (0066,000C)		Recommended Presentation Opacity (0066,000C)	
Recommended Presentation Type (0066,000D)		Recommended Presentation Type (0066,000D)	

Segmented Property Category Code Sequence (0062,0003)		Segmented Property Category Code Sequence (0062,0003)	
Segmented Property Type Code Sequence (0062,000F)		Segmented Property Type Code Sequence (0062,000F)	
Segmented Property Type Modifier Code Sequence (0062,0011)		Segmented Property Type Modifier Code Sequence (0062,0011)	
RT Segment Annotation Category Code Sequence (30xx,1353)	RT Segment Annotation Category Code Sequence (30xx,1353)		
RT Segment Annotation Type Code Sequence (30xx,1354)	RT Segment Annotation Type Code Sequence (30xx,1354)		
Segmented RT Accessory Device Sequence (30xx,1349)	Segmented RT Accessory Device Sequence (30xx,1349)		
Segment Properties Sequence (30xx,134B)	Segment Properties Sequence (30xx,134B)		
Segment Properties Modifier Sequence (30xx,134C)	Segment Properties Modifier Sequence (30xx,134C)		

184

## Part 4: Service Class Specifications

186

Add SOP Classes to PS 3.4, Appendix B.5, Table B.5-1

188 **B.5**

### STANDARD SOP CLASSES

Table B.5-1  
Standard SOP Classes

190

SOP Class	SOP Class UID	IOD Specification (defined in PS 3.3)
ROI Template Storage	1.2.840.10008.5.1.4.1.1.X.1.1	
...		

192

Add SOP Classes to PS 3.4, Appendix I, Table I.4-1

**I.4 MEDIA STORAGE SOP CLASSES**

194

**Table I.4-1  
Media Storage Standard SOP Classes**

<b>SOP Class</b>	<b>SOP Class UID</b>	<b>IOD Specification</b>
ROI Template Storage	1.2.840.10008.5.1.4.1.1.X.1.1	IOD defined in PS 3.3
...		

196

198

### Part 6: Data Dictionary

200

Add the following rows to PS 3.6, Section 6

Tag	Name	Keyword	VR	VM
(yym4,m4x2)	Attribute Tag	AttributeTag	AT	1

202

204

206

Add the following rows to PS 3.6, Table A-1

Table A-1  
UID Values

208

UID Value	UID Name	UID Type	Part
1.2.840.10008.5.1.4.1.1.X.1.1	ROI Template Storage	SOP Class	PS 3.4

210

### Part 16: Content Mapping Resource

212

Add the following CIDs to PS 3.16

214

Context ID ???  
ROI Template Categories

216

Type: Extensible      Version: 20yymmdd



Coding Scheme Designator	Code Value	Code Meaning

218

**Add the following rows to PS 3.16, Annex D**

220

DICOM Code Definitions (Coding Scheme Designator "DCM" Coding Scheme Version "01")

Code Value	Code Meaning	Definition	Notes
newcode001			
newcode002			
newcode003			
newcode004			

222

224

## Part 17: Explanatory Information

226

Add the following new Annex to PS 3.17

228

### Annex WW ROI Template Storage Examples (Informative)

230 The following examples are provided to illustrate the usage of various features of the ROI Template  
231 IOD. They do NOT represent recommended practice. In some cases they have been influenced by  
232 published protocols, but the examples here may not fully encode those published protocols and no  
233 attempt has been made to keep them up-to-date.

#### 234 WW.1 CLINICAL TRIAL PROTOCOL

This section includes an ROI Template example based on clinical trial....

236

Table WW-1a ROI Template for Clinical Trial NRG...

238

Attribute	Tag	Value

240