

Integrating the Healthcare Enterprise



5
**IHE Radiation Oncology
Technical Framework Supplement**

10
**Basic RT Objects Interoperability II
(BRTO-II)**

15
Draft for Trial Implementation

20 Date: ~~April 5~~~~November 15~~, 2019~~8~~ (1.11~~0~~)
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25 **Please verify you have the most recent version of this document. See [here](#) for Trial
Implementation and Final Text versions and [here](#) for Public Comment versions.**

Foreword

30 This is a supplement to the IHE Radiation Oncology Technical Framework V1.8. Each supplement undergoes a process of public comment and trial implementation before being incorporated into the volumes of the Technical Frameworks.

This supplement is published on April 22, 2016 public comment. Comments are invited and can be submitted at http://www.ihe.net/Radiation_Oncology_Public_Comments/. In order to be considered in development of the Trial Implementation version of the supplement, comments must be received by May 22, 2016.

This supplement describes changes to the existing technical framework documents.

“Boxed” instructions like the sample below indicate to the Volume Editor how to integrate the relevant section(s) into the relevant Technical Framework volume.

Amend Section X.X by the following:

40 Where the amendment adds text, make the added text **bold underline**. Where the amendment removes text, make the removed text ~~**bold strikethrough**~~. When entire new sections are added, introduce with editor’s instructions to “add new text” or similar, which for readability are not bolded or underlined.

45 General information about IHE can be found at: www.ihe.net.

Information about the IHE Radiation Oncology domain can be found at: ihe.net/IHE_Domains.

Information about the organization of IHE Technical Frameworks and Supplements and the process used to create them can be found at: http://ihe.net/IHE_Process and <http://ihe.net/Profiles>.

50 The current version of the IHE Radiation Oncology Technical Framework can be found at: http://ihe.net/Technical_Frameworks.

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485	3.7.3 Referenced standards.....	40	Formatted	...
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695	7.4.8.2.2.1 Referenced Standards	83	Formatted	...
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Introduction to this Supplement

725 This profile updates the original, basic RT workflow (BRTO) removing several out-of-date restrictions and adding some new features to allow more treatment planning systems to participate (including those for non-traditional linacs and ion machines).

730 The requirement to merge multi-series CT images is removed, the role of the CT Simulation planner is removed, the mandatory import of a CT Sim plan is removed and the mandatory ability to handle a variably spaced dose plane is removed. High resolution contours are added as an optional transaction to handle small structure definitions. The number of contours per structure per slice is now 1000 (up from 100). Decubitus (shoulder resting) planning is added as an optional feature. Ion (particle) beam dose distributions are added to allow for Ion dose display on a dose viewer.

735 History

Date	R.	Author	Change Summary
Sep. 23, 2015	0.1	Sven Siekmann (sven.siekmann@brainlab.com)	Initial Version – Transfer of BRTO to content profile
Oct. 23, 2015	0.2	Sven Siekmann (sven.siekmann@brainlab.com)	<ul style="list-style-type: none"> • Transfer of High-resolution contours CP • Removal of Geometric Planner and RO-6 • Adding DECUBITUS as an option • Added support for RT Ion Plans • Increased contours per slice min requirement
Jan. 27, 2016	0.3	Sven Siekmann (sven.siekmann@brainlab.com)	<ul style="list-style-type: none"> • Added introduction • Added use-case descriptions • Corrected contour image sequence formulation of high-res • Rename high-resolution contours to “off-slice contours” • Make RO-11 optional • Adapted revision numbering from 1.x to 0.x
Jan. 29, 2016	0.4	Sven Siekmann (sven.siekmann@brainlab.com)	<ul style="list-style-type: none"> • Correct Appendix A to chapter 7 • Adapt overview figures • Added General Series Module for Decubitus • Added IOD Table for Geometric Plan
April 22, 2016	1.0	Mary Jungers	Edit and publish for public comment
June 14, 2016	1.1	Sven Siekmann (sven.siekmann@brainlab.com)	<ul style="list-style-type: none"> • Comments PC (Automated Contourer, updated off-slice figures) • Text for Image Orientation Patient (Image Plane module) • Added RT Treatment Record to General Definition section 7.2.2 and 7.2.3 • “Altered option”
September 05, 2016	1.2	Sven Siekmann	<ul style="list-style-type: none"> • Added attributes Content Date (0008,0023) and Content Time (0008,0033) to General Image Module Base Content

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		(sven.siekmann@brainlab.com)	<ul style="list-style-type: none"> Replaced deprecated term AXIAL Renamed “Altered option” to “Reoriented option”
September 29, 2016	1.3	Chris Pauer Christof Schadt	<ul style="list-style-type: none"> Moved Content Date and Time to RT Dose Module as per DICOM CP 1656 Removed General Image Module – No applicability to BRTO-II Added reference to TDIC for General Image Module reference Removed Automated Contourer after changing Structure Set Retrieval transaction of Contourer to optional Add Common Instance Reference to all IOD tables
February 05, 2018	1.5	Sven Siekmann (sven.siekmann@brainlab.com)	<ul style="list-style-type: none"> Added CP-RO-003 (Indicator for Type 3 attributes that shall not be present) Dose Comment (3004,0006) changed to RC+ Proposed text how to display images was removed according to TC decision Added clarification text for Table Top <X> Setup Displacement attributes in Patient Setup Sequence
February	1.6	Sven Siekmann (sven.siekmann@brainlab.com)	<ul style="list-style-type: none"> Corrected reference to “General Image Module Base Content” in TDIC Tissue Heterogeneity Correction O+ → R+ Updated DICOM standard references Corrected Representation of Dose in RO-5 and RO-10. Renamed transaction to RO-BRTO-II-5 and RO-BRTO-II-6
July 16, 2018	1.7	Sven Siekmann (sven.siekmann@brainlab.com)	<ul style="list-style-type: none"> Limit Segmented Property Type Modifier Code Sequence in RT ROI Identification Code Sequence to one item
Aug. 03, 2018	1.8	Sven Siekmann (sven.siekmann@brainlab.com)	<ul style="list-style-type: none"> Corrected X.2 BRTO II Actor OptionsX.2 BRTO II Actor Options Changed Optionality of Archive transactions to R for all transactions Added missing optional transaction RO-11 to X.1-1 for Dosimetric Planner
Oct. 25, 2018	1.9	Sven Siekmann (sven.siekmann@brainlab.com)	<ul style="list-style-type: none"> TC20181018: Added Accession Number to 7.4.1.2.1 TC20181018: Removed Study UID specification for RT Structure Set in message semantics TC20181018: Adapted Study Instance UID note TC20181018: Removed section “Requirement Inheritance” (7.1.3) TC20181018: Adapted table 7.1.2 according to remarks: “X” → “X+” TC20181018: Decision: Type of attributes in General Study Module Base Content (7.4.1.2.1) are RC+ instead of R+
Nov. 15, 2018	1.10	Sven Siekmann (sven.siekmann@brainlab.com)	<ul style="list-style-type: none"> TC20181115: Removed ISOCENTER requirement in 7.4.8.1

Apr. 5, 2019	1.11	Chris Pauer (chris.pauer@sunuclear.com)	<ul style="list-style-type: none"> Clarified Study handling in tandem with TC review at face-to-face meeting.
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Open Issues and Questions

#	Intr. in	Resp.	Description
26	1.7	Sven Siekmann (sven.siekmann@brainlab.com)	<ul style="list-style-type: none"> Adaption in section 7.1.2 and 7.1.4 waiting for PC decision
27	1.9	Sven Siekmann (sven.siekmann@brainlab.com)	<ul style="list-style-type: none"> Dose Displayer without Planner

Closed Issues

740

#	Intr. in	Resp.	Description
1	0.1	Sven Siekmann (sven.siekmann@brainlab.com)	Introduce high-resolution contours for RT Structure Set
2	0.1	Sven Siekmann (sven.siekmann@brainlab.com)	Include DICOM CP 1395, CP 1314 and CP 1398
3	0.1	Sven Siekmann (sven.siekmann@brainlab.com)	Remove Geometric Planner
4	0.1	Sven Siekmann (sven.siekmann@brainlab.com)	Add option for Patient Position Decubitus (HFDR, HFDL, FFDR, FFDL)
5	0.1	Sven Siekmann (sven.siekmann@brainlab.com)	Introduce additional attribute to distinguish between high-res and low res Structure Set? – Discarded. For details see meeting minutes of June 2015 meeting WG-07
6	0.1	Sven Siekmann (sven.siekmann@brainlab.com)	Add RO-2 as optional to Dosimetric Planner in case high-res Structure Set is received, but actor is not capable of handling high-res and consumes these structures as low-res?
10	0.1	Sven Siekmann (sven.siekmann@brainlab.com)	Increased 100 contours per slice min requirement → 1000 contours per slice
12	0.1	Sven Siekmann (sven.siekmann@brainlab.com)	Remove RO-6 (Multi image-series)
13	0.2	Sven Siekmann (sven.siekmann@brainlab.com)	Check „O+*” occurrences for replacement with „-“

#	Intr. in	Resp.	Description
14	0.2	Sven Siekmann (sven.siekmann@brainlab.com)	Add support RT Ion Plan
7	0.1	Sven Siekmann (sven.siekmann@brainlab.com)	Contour image sequence formulation
9	0.1	Sven Siekmann (sven.siekmann@brainlab.com)	Use-case description
11	0.2	Sven Siekmann (sven.siekmann@brainlab.com)	Rename „High-resolution contour“ transactions (Off-Slice contour)
12	0.2	Sven Siekmann (sven.siekmann@brainlab.com)	Introduce optional transaction for DVH display
15	0.3	Sven Siekmann (sven.siekmann@brainlab.com)	Correct Appendix A to chapter 7
16	0.3	Sven Siekmann (sven.siekmann@brainlab.com)	Adapt overview figures
17	1.0	Sven Siekmann (sven.siekmann@brainlab.com)	Text for Image Orientation Patient (Image Plane Module) dictate display requirements not included
19	1.0	Sven Siekmann (sven.siekmann@brainlab.com)	Deprecated term AXIAL used (s. CP 668).
18	1.0	Sven Siekmann (sven.siekmann@brainlab.com)	Naming of actor /options (Automated Contourer, Feet First, Altered, Decubitus)
19	1.4	Sven Siekmann (sven.siekmann@brainlab.com)	CP-RO-003 (Indicator for Type 3 attributes that shall not be present) to 7.1.2
20	1.4	Sven Siekmann (sven.siekmann@brainlab.com)	Dose Comment (3004,0006) should be RC+
21	1.4	Sven Siekmann (sven.siekmann@brainlab.com)	Proposed text how to display images was removed according to TC decision Feb 05,2018
22	1.4	Sven Siekmann (sven.siekmann@brainlab.com)	Added Table Top <X> Setup Displacement clarification text to Patient Setup Sequence
23	1.5	Sven Siekmann (sven.siekmann@brainlab.com)	Tissue Heterogeneity Correction O+ → R+

#	Intr. in	Resp.	Description
24	1.5	Sven Siekmann (sven.siekmann@brainlab.com)	Removed DVH restriction of RO-5 and RO-10 to be in line with RO-BRTO-II-3 and RO-BRTO-II-4. Transaction RO-5 is superseded by RO-BRTO-II-5, transaction RO-10 is superseded by RO-BRTO-II-6.
25	1.6	Sven Siekmann (sven.siekmann@brainlab.com)	TC20180716: Limit Segmented Property Type Modifier Code Sequence in RT ROI Identification Code Sequence to one item
27	1.7	Sven Siekmann (sven.siekmann@brainlab.com)	Corrected X.2 BRTO II Actor Options X.2 BRTO-II Actor Options Changed Optionality of Archive transactions to R for all transactions Added missing optional transaction RO-11 to X.1-1 for Dosimetric Planner
28	1.9	Sven Siekmann (sven.siekmann@brainlab.com)	TC20181115:Removed ISOCENTER requirement in 7.4.8.1

General Introduction

Appendix A – Actor Summary Definitions

Add the following actors to the IHE Technical Frameworks General Introduction list of actors:

No new actors.

745 Appendix B – Transaction Summary Definitions

No new transactions.

Glossary

Add the following glossary terms to the IHE Technical Frameworks General Introduction Glossary:

750 No new glossary terms.

Volume 1 – Profiles

Copyright Licenses

Add the following to the IHE Technical Frameworks General Introduction Copyright section:

NA.

755 Domain-specific additions

NA.

Add Section X

X Basic Radiation Therapy Objects Integration Profile II (BRTO-II)

760 The *Basic Radiation Therapy Objects II* Integration Profile involves the flow of DICOM^{®1} images and treatment planning data, from CT scan through dose display, for 3D conformal, external beam radiation therapy. Detailed plan content for different types of delivery are specified in separate profiles. The emphasis for this integration profile is on reducing ambiguity and facilitating basic interoperability in the exchange of DICOM RT objects.

765 The BRTO II Profile has the following implications:

- All related DICOM objects (CT images, RT Structure Sets, RT Plans, and RT Doses) are required to be in the same frame of reference and have the same Frame of Reference UID.
- The orientation of images, structures, plans, and doses must be consistent, with the exception that head-first/feet-first directions may be altered between scans and treatment delivery.

770 The profile also addresses some capabilities that have been shown to affect interoperability of applications during the Radiation Oncology Treatment Planning Process. The issues addressed include the following:

- Variable Slice Spacing – As above, CT devices may produce image datasets with different slice spacing within a single series. All applications must be able to accept such datasets.

775

- If a Contourer creates an RT Structure Set based on a resampled image set, the Contourer must be able to store the resampled image

- Dose Grid Spacing – Many applications are capable of producing RT Dose objects with different spacing in the X, Y, and Z dimensions. This implies that dose grids are regular inplane, but not

¹ DICOM is the registered trademark of the National Electrical Manufacturers Association for its standards publications relating to digital communications of medical information.

780 guaranteed to have equal row and column spacing. Z-spacing (slice spacing) can be different from the X and Y spacing. This profile requires equidistant Z-spacing for the RT Dose.

X.1 BRTO II Actors, Transactions, and Content Modules

This section defines the actors, transactions, and/or content modules in this profile. General definitions of actors are given in the Technical Frameworks General Introduction Volume 2 at http://www.ihe.net/Technical_Framework/index.cfm.

785 Table X.1-1 lists the transactions for each actor directly involved in the *Basic Radiation Therapy Objects II* Integration Profile. In order to claim support of this Integration Profile, an implementation must perform the required transactions (labeled “R”). A complete list of options defined by this Integration Profile and that implementations may choose to support is listed in X.2.

790

Table X.1-1: Basic RT Objects Integration Profile - Actors and Transactions

Actors	Transactions	Optionality	Section
Archive	Single/Contoured Series Image Retrieval [RO-1]	R	3.Y.1
	Structure Set Storage [RO-2]	R	3.Y.2
	Off-slice Structure Set Storage [RO-BRTO-II-1]	R	3.Y.3
	Dosimetric Plan Storage [RO-4]	R	3.Y.4
	Dose Storage [RO-BRTO-II-5]	R	3.Y.5
	DVH Dose Storage [RO-BRTO-II-3]	R	3.Y.6
	Structure Set Retrieval [RO-7]	R	3.Y.7
	Off-slice Structure Set Retrieval [RO-BRTO-II-2]	R	3.Y.8
	Geometric Plan Retrieval [RO-8]	R	3.Y.9
	Dosimetric Plan Retrieval [RO-9]	R	3.Y.10
	Dose Retrieval [RO-BRTO-II-6]	R	3.Y.11
	DVH Dose Retrieval [RO-BRTO-II-4]	R	3.Y.12
	Resampled/Combined CT Series Storage [RO-11]	R	3.Y.13
Contourer	Single/Contoured Series Image Retrieval [RO-1]	R	3.Y.1
	Structure Set Storage [RO-2]	R	3.Y.2
	Off-slice Structure Set Storage [RO-BRTO-II-1]	O	3.Y.3
	Structure Set Retrieval [RO-7]	O	3.Y.7
	Off-slice Structure Set Retrieval [RO-BRTO-II-2]	O	3.Y.8
	Resampled/Combined CT Series Storage [RO-11]	O	3.Y.13
Dosimetric Planner	Dosimetric Plan Storage [RO-4]	R	3.Y.4
	Dose Storage [RO-BRTO-II-5]	R	3.Y.5
	DVH Dose Storage [RO-BRTO-II-3]	O	3.Y.6
	Structure Set Storage [RO-2]	R	3.Y.2

Commented [CP1]: Do we need the Content Date Content Time for “Derived Secondary”

Actors	Transactions	Optionality	Section
	Off-slice Structure Set Storage [RO-BRTO-II-1]	O	3.Y.3
	Geometric Plan Retrieval [RO-8]	O	3.Y.9
	Structure Set Retrieval [RO-7]	R	3.Y.7
	Off-slice Structure Set Retrieval [RO-BRTO-II-2]	O	3.Y.8
	Single/Contoured Series Image Retrieval [RO-1]	R	3.Y.1
	Resampled/Combined CT Series Storage [RO-11]	O	3.Y.13
Dose Displayer	Dose Retrieval [RO-BRTO-II-6]	R	3.Y.11
	DVH Dose Retrieval [RO-BRTO-II-4]	O	3.Y.12
	Dosimetric Plan Retrieval [RO-9]	R	3.Y.10
	Structure Set Retrieval [RO-7]	R	3.Y.7
	Off-slice Structure Set Retrieval [RO-BRTO-II-2]	O	3.Y.8
	Single/Contoured Series Image Retrieval [RO-1]	R	3.Y.1

795 Figure X.1-1 shows the actors directly involved in the *Basic RT Objects II* Integration Profile and the relevant transactions between them. Other actors that may be indirectly involved due to their participation in *Scheduled Workflow* are not necessarily shown.

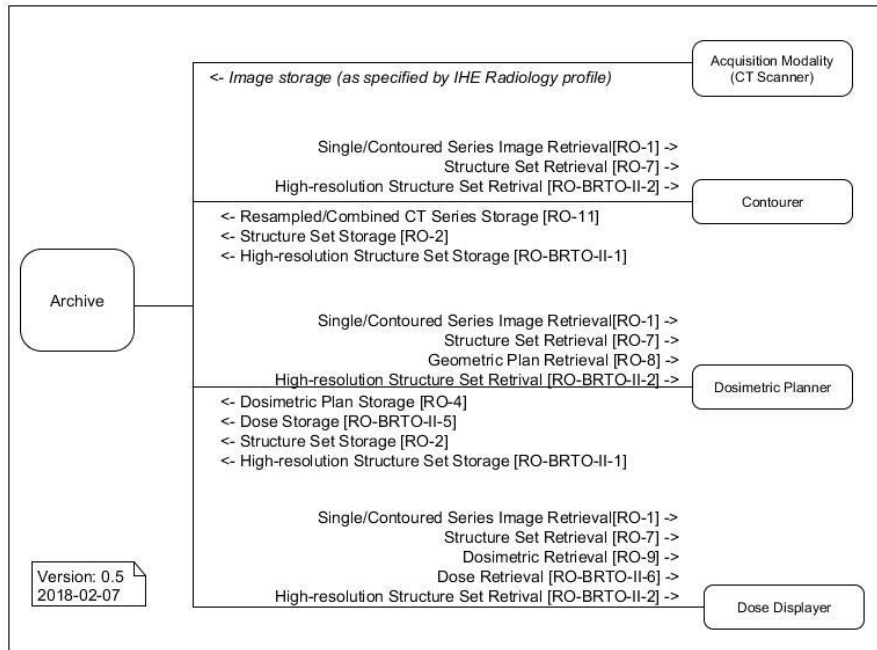


Figure X.1-1: Basic RT Objects Actor Diagram

800 **X.1.1 Actor Descriptions and Actor Profile Requirements**

Most requirements are documented in Transactions (Volume 2) and Content Modules (Volume 3). This section documents any additional requirements on profile’s actors.

805 **Acquisition Modality** – A system that acquires and creates medical images while a patient is present, e.g., a Computed Tomography scanner or Nuclear Medicine camera. A modality may also create other evidence objects such as Grayscale Softcopy Presentation States for the consistent viewing of images or Evidence Documents containing measurements.

Archive – A system that provides long term storage of evidence objects such as images, presentation states, Key Image Notes and Evidence Documents.

810 **Contourer** – A system that consumes one or more CT image series and creates an RT Structure Set. If the Contourer consumes multiple CT image series or has an internal requirement for resampling, it also will generate a single CT image series to which the RT Structure Set maps. A Contourer shall be able to consume CT image series with non-uniform spacing.

Dosimetric Planner – A system that consumes a single CT image series, an RT Structure Set, and a Geometric Plan and creates a Dosimetric Plan and an RT Dose.

815 **Archive (including RT)** – A system that stores the RT SOP Classes in addition to the CT images and is capable of transmitting them.

Dose Displayer – A system that consumes a Dosimetric Plan, a single CT image series, an RT Structure Set, and an RT Dose and displays the dose.

X.2 BRTO II Actor Options

820 Options that may be selected for this Integration Profile are listed in Table X.2-1 along with the IHE Actors to which they apply. Dependencies between options when applicable are specified in notes.

Table X.2-1: Basic RT Objects - Actors and Options

Actor	Options	Vol & Section
Archive	<i>None</i>	- -
Contourer	<i>Feet First, Decubitus</i>	See Vol 3, 7.3.3.2.3
	<i>Off-Slice Structure Set</i>	See Vol 3, 7.3.4.1.1
	<i>Resampled/ Combined CT Storage</i>	See Vol 2, 3.13
Dosimetric Planner	<i>Feet First, Reoriented*, Decubitus</i>	See Vol 3, 7.3.2.2.1(RT Plan)
	<i>Off-Slice Structure Set</i>	See Vol 3, 7.3.4.1.1
	<i>DVH Dose</i>	See Vol 3, 7.3.5.1.1
Dose Displayer	<i>Resampled/ Combined CT Storage</i>	See Vol 2, 3.13
	<i>Off-Slice Structure Set</i>	See Vol 3, 7.3.4.1.1
	<i>DVH Dose</i>	See Vol 3, 7.3.5.1.1

825 *Reoriented: Patient position in treatment setup differs from image patient position. This option is restricted to HFS/HFP/FFS/FFP.

X.3 BRTO II Required Actor Groupings

None.

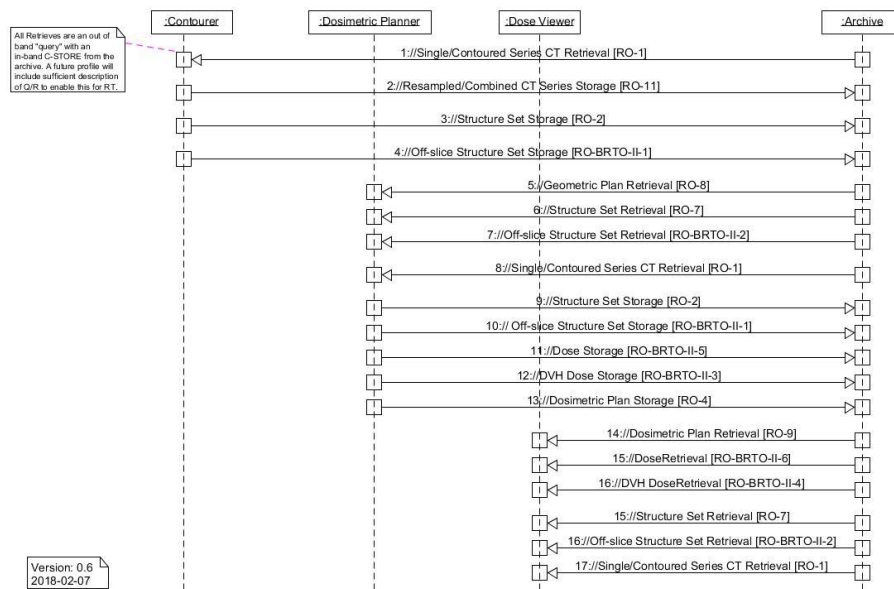
X.4 BRTO II Overview

X.4.1 Concepts

830 *Basic Radiation Therapy Objects II* involves the flow of DICOM images and treatment planning data, from image contouring through dose display, for external beam radiation therapy based on volumetric images. The emphasis for this Integration Profile is on reducing ambiguity and facilitating basic interoperability in the exchange of DICOM RT objects.

835 Structures used within the scope of this profile may be drawn on a CT slice (on-slice contour) or optionally between the CT slices (off-slice contour). Off-slice contouring may be used to represent more detailed structural information. Such information may come from other imaging modalities or from processing CT-derived structures.

X.4.2 Use Cases



840 **Figure X.4.2-1: Basic Process Flow in Basic RT Objects Profile**

X.4.2.1 Use Case #1: Segmentation of Treatment-Relevant Structures

At the beginning of the planning process for a Radiation Therapy, treatment-relevant structures have to be contoured based on an image data set. These structures shall be persisted in an RT Structure Set.
845

X.4.2.1.1 Segmentation of Treatment-Relevant Structures Use Case Description

The user wants to create a structure object containing the target volume(s) and organs at risk relevant for a treatment planning. These objects are contoured on an initial CT image set. When the contouring is finished the structure object will be persisted in an archive.

850 **X.4.2.1.2 Segmentation of Treatment-Relevant Structures Process Flow**

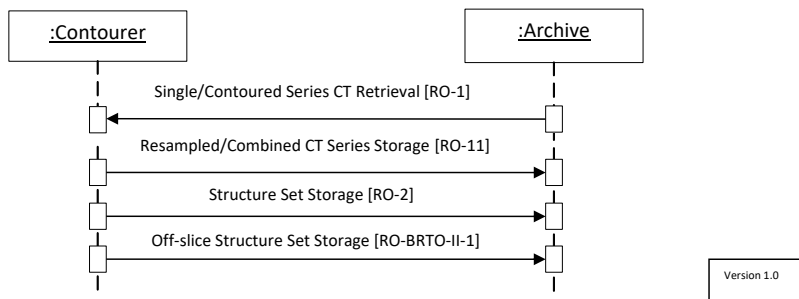


Figure X.4.2.1.2-1: Segmentation of Treatment-Relevant Structures Process Flow in BRTO-II Profile

855 **Pre-conditions:**

The initial image set is available.

Main Flow:

860 The initial image set is retrieved by the contouring system, which sends the RT Structure Set back to the archiving system.

Post-conditions:

The RT Structure Set is archived.

X.4.2.2 Use Case #2: Treatment Planning Based on Segmented Objects

865 Based on the previously contoured structures a treatment planning is performed. As a result an RT Plan and an RT Dose object are persisted, representing the planning result.

X.4.2.2.1 Treatment Planning Based on Segmented Objects Use Case Description

870 The user wants to create a treatment plan for the patient based on previously contoured object definitions. These object definitions and referenced image sets are retrieved by the Treatment Planning System (TPS) acting as a Dosimetric Planner. The user creates an appropriate plan for treatment. The content of such a plan is beyond the scope of this profile. The resulting RT Plan and a corresponding dose distribution shall be saved back to an archive.

Optionally the Dose Volume Histogram (DVH) is saved back to the archive.

X.4.2.2.2 Treatment Planning Based on Segmented Objects Process Flow

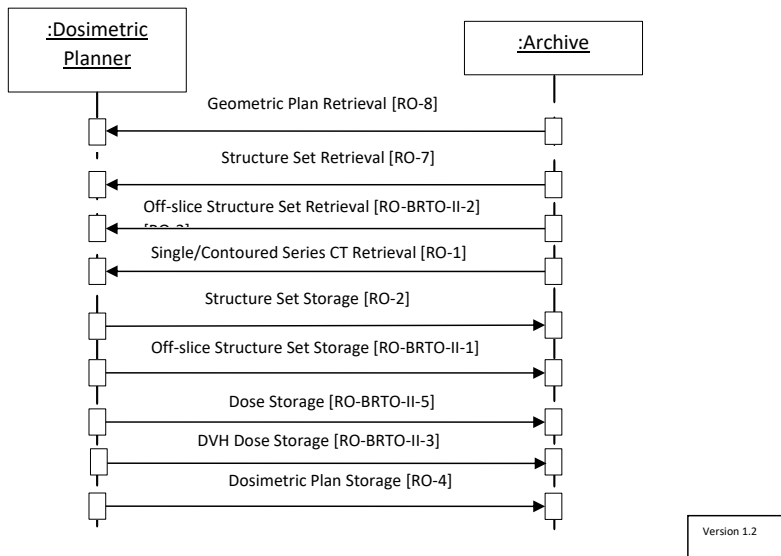


Figure X.4.2.2.2-1: Treatment Planning Based on Segmented Objects Process Flow in BRTO-II Profile

880 **Pre-conditions:**

The initial image set and RT Structure Set are available.

Main Flow:

885 The initial image set(s) and RT Structure Set are retrieved by the Treatment Planning System (TPS). The user creates RT Plan on the TPS and calculates the dose. The TPS send the results sends back to the archiving system.

Post-conditions:

The RT Plan and RT Dose objects are archived.

X.4.2.3 Use Case #3: Dose Display of Treatment Planning Results

The result of previous treatment planning is shown to the user.

890 **X.4.2.3.1 Dose Display of Treatment Planning Results Use Case Description**

The user wants to inspect the result of previous treatment planning. The created object definitions including the dose distribution are retrieved by the Dose Displayer and shown to the user.

Optionally the Dose Volume Histogram (DVH) is imported and displayed.

895 **X.4.2.3.2 Dose Display of Treatment Planning Results Process Flow**

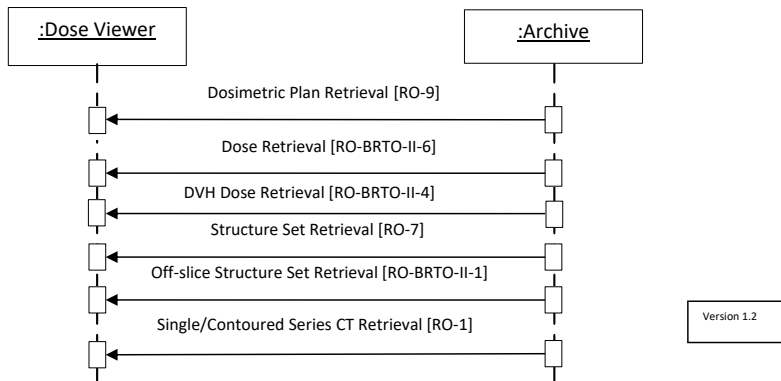


Figure X.4.2.3.2-1: Dose Display of Treatment Planning Results Process Flow in BRTO-II Profile

900

Pre-conditions:

The planning CT image set, RT Structure Set, RT Plan and RT Dose are available.

Main Flow:

905 The planning CT image set, RT Structure Set, RT Plan and RT Dose are retrieved by the Dose Displayer, which shows the given information to the user.

Post-conditions:

None.

X.5 BRTO II Security Considerations

910 There are no explicit security considerations in this profile.

X.6 BRTO II Cross Profile Considerations

Segmentation requirements of this profile are expected to be referenced by other profiles.

Appendices

915 NA

Volume 2 – Transactions

<Reserve a subsequent section number in the current domain Technical Framework Volume 2 (DOM TF-2). Replace the letter “Y” with that section heading number. This number should not change when this supplement is added to the Final Text Technical Framework. In this manner, references should be able to be maintained going forward.>

920

Add Section 3.Y

This section defines each IHE transaction in detail, specifying the standards used, the information transferred, and the conditions under which the transaction is required or optional.

3.1 Single/Contoured Image Series Retrieval [RO-1]

925

This corresponds to transaction RO-1 of the IHE Radiation Oncology Technical Framework. Transaction RO-1 is used by the *Archive*, *Contourer*, *Dosimetric Planner*, and *Dose Displayer* actors.

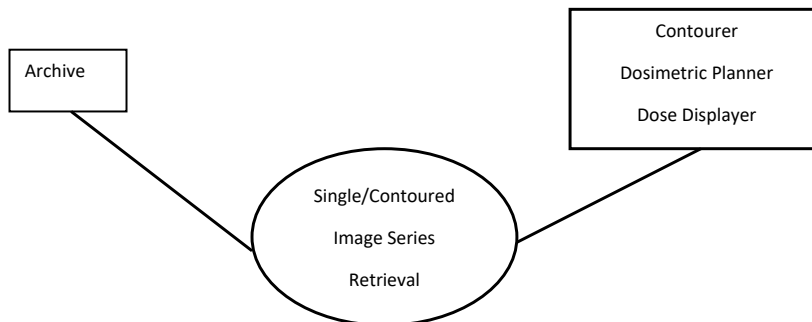
3.1.1 Scope

This transaction is used to send a series of CT-Images from an *Archive* to an application.

930

3.1.2 Use Case Roles

935



Actor: Archive

940

Role: Send CT Series to Contourer, Dosimetric Planner or Dose Displayer

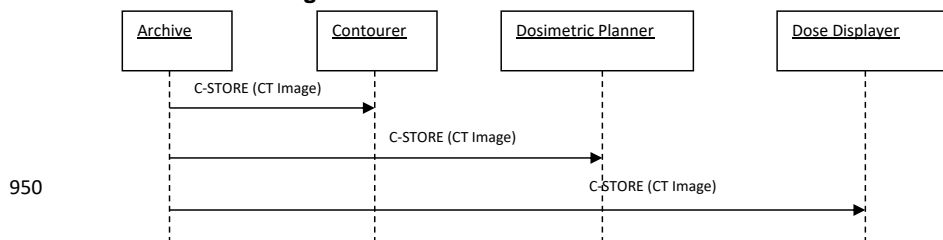
Actor: Contourer, Dosimetric Planner or Dose Displayer

Role: Receives and stores CT Series from Archive

3.1.3 Referenced Standards

DICOM 2018d Edition PS3.4: Storage Service Class.

945 **3.1.4 Interaction Diagram**



950

3.1.4.1 Single/Contoured Image Series Retrieval

3.1.4.1.1 Trigger Events

955 The user of the *Contourer*, in order to generate a set of contours, determines that a certain CT-Series is required, and requests that the *Archive* send the necessary CT-Series to the *Contourer*.

The user of a *Dosimetric Planner*, in order to generate a dosimetric plan and calculate dose, determines that a certain CT Series is required, and requests that the *Archive* send the necessary CT series to the *Dosimetric Planner*.

960 The user of a *Dose Displayer*, in order to view dose, determines that a certain CT Series is required, and requests that the *Archive* send the necessary CT series to the *Dose Displayer*.

The mechanism(s) by which these transfers are initiated is outside the scope of this profile.

3.1.4.1.2 Message Semantics

965 The *Archive* uses the DICOM C-STORE message to transfer the all of the CT Images in the series to the *Contourer*, *Dosimetric Planner* or *Dose Displayer*. The *Archive* is the DICOM Storage SCU and the *Contourer*, *Dosimetric Planner* or *Dose Displayer* is the DICOM Storage SCP.

3.1.4.1.3 Expected Actions

970 The *Contourer* will store all of the CT Images, and will relate the images based on the study, series, and image identification information. These images will then be available to the user of the *Contourer* for use in construction a set of contours which will later be exported as an RT Structure Set (RO-2).

975 The *Dosimetric Planner* will store all of the CT Images, and will relate the images based on the study, series, and image identification information. These images will then be available to the user of the *Dosimetric Planner* for use in construction of a Dosimetric Plan which will later be exported (RO-4). These images will also be involved in the calculation of a related dose, which will be exported later as an RT Dose (RO-BRTO-II-5).

The *Dose Displayer* will store all of the CT Images, and will relate the images based on the study, series, and image identification information. These images will then be available to the user of the *Dose Displayer* for use in construction of a dose display.

980 **3.1.5 Security Considerations**

There are no explicit security considerations.

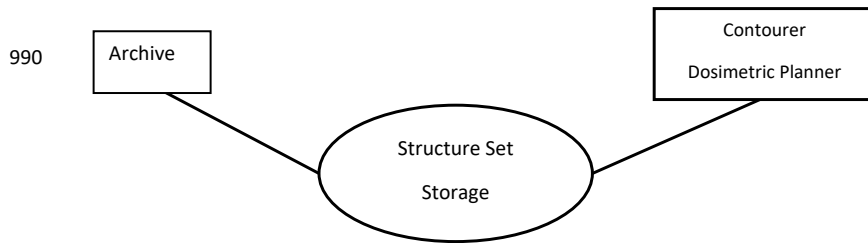
3.2 Structure Set Storage [RO-2]

This corresponds to transaction RO-2 of the IHE Radiation Oncology Technical Framework. Transaction RO-2 is used by the *Archive* and *Contourer* Actors.

985 **3.2.1 Scope**

In the Structure Set Storage Transaction, the *Contourer* stores an RT Structure Set on an *Archive* to make it available.

3.2.2 Use Case Roles



Actor: Contourer, Dosimetric Planner

Role: Sends RT Structure Set to Archive

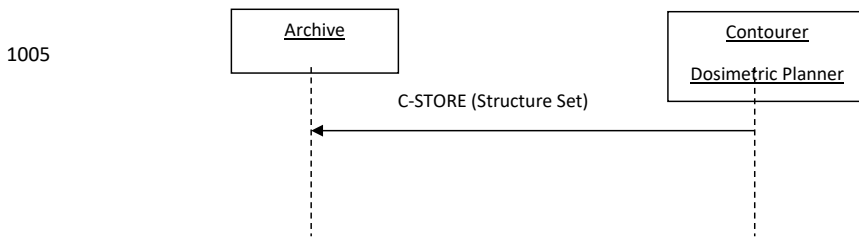
Actor: Archive

Role: Stores RT Structure Set received from Contourer or Dosimetric Planner

1000 **3.2.3 Referenced Standards**

DICOM 2018d Edition PS3.4: Storage Service Class.

3.2.4 Interaction Diagram



1005

3.2.4.1 Structure Set Storage

3.2.4.1.1 Trigger Events

The user of the *Contourer* selects an RT Structure Set to store.

3.2.4.1.2 Message Semantics

1015 The message semantics are defined by the DICOM Storage SOP Class. The *Contourer* or *Dosimetric Planner* is the storage SCU and the *Archive* is the storage SCP.

1020 The Contours in the ROI Contour module are restricted to Geometric Type POINT and CLOSED_PLANAR. ROI contours must correspond to exported image plane locations. If a system does not support unequally-spaced slices, for example, that system is responsible for creating a resampled image set (see RO-11) and creating an RT Structure Set in which the ROI contours reference the resampled image set. Furthermore, absence of an ROI contour on slice(s) between those containing contours of that ROI does not imply the existence of the ROI on the intervening slice(s).

1025 Also refer to chapter 7.3.4.1.1 for an overview of the specific requirements on the DICOM attributes that are included in an RT Structure Set instance. In particular, the RT Structure Set must share a single Frame of Reference UID with the images.

3.2.4.1.3 Expected Actions

Upon receipt of the Structure Set, the *Archive* shall store it. This RT Structure Set is then available for subsequent retrieval (RO-7).

3.2.5 Security Considerations

1030 There are no explicit security considerations.

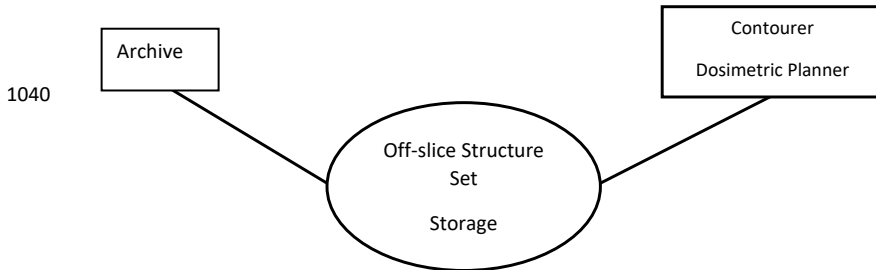
3.3 Off-slice Structure Set Storage [RO-BRTO-II-1]

This corresponds to transaction RO-BRTO-II-1 of the IHE Radiation Oncology Technical Framework. Transaction RO-BRTO-II-1 is used by the *Archive* and *Contourer* Actors.

3.3.1 Scope

1035 In the Off-slice Structure Set Storage Transaction, the *Contourer* stores an RT Structure Set on an *Archive* to make it available.

3.3.2 Use Case Roles



1045 **Actor:** Contourer, Dosimetric Planner

Role: Sends off-slice RT Structure Set to Archive

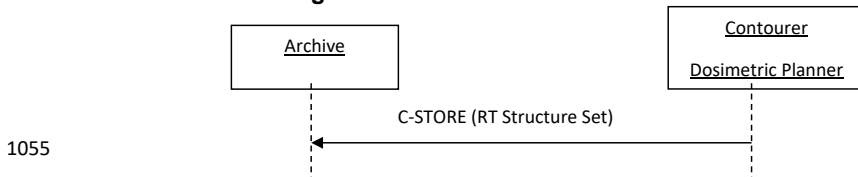
Actor: Archive

Role: Stores off- slice RT Structure Set received from Contourer

3.3.3 Referenced standards

1050 DICOM 2018d Edition PS3.4: Storage Service Class.

3.3.4 Interaction Diagram



3.3.4.1 Structure Set Storage

3.3.4.1.1 Trigger Events

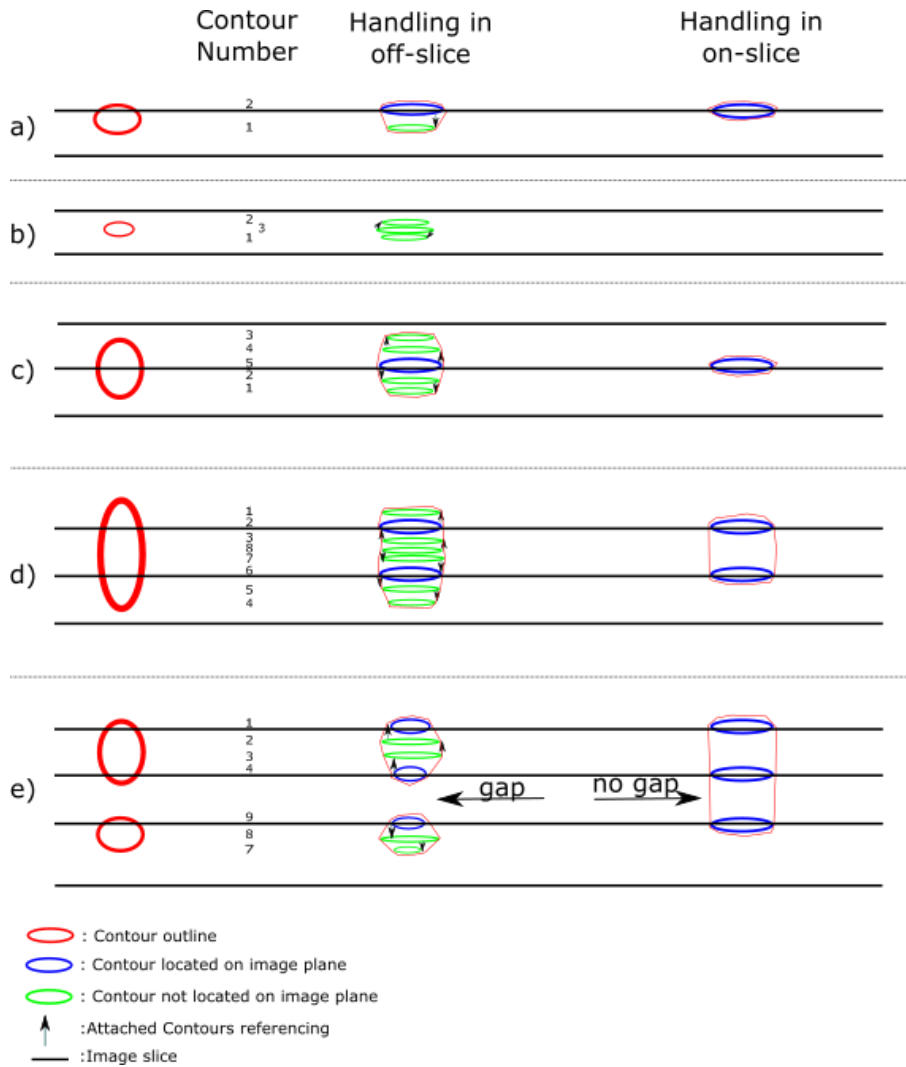
The user of the *Contourer* selects an RT Structure Set to store.

1060

3.3.4.1.2 Message Semantics

The message semantics are defined by the DICOM Storage SOP Class. The *Contourer* or the *Dosimetric Planner* is the storage SCU and the *Archive* is the storage SCP.

- 1065 The Contours in the ROI Contour module are restricted to Geometric Type POINT and CLOSED_PLANAR. If a ROI Contour contains off-slice information, the Contour Number (3006,0048) and the Attached Contours (3006,0049) attributes must be present for all Contour Sequence items (3006,0040) of this ROI. For Contour Sequence items that are not referencing any other Contour Sequence items, the Attached Contours (3006,0049) shall be present but empty. The Attached Contours (3006,0049) shall reference the nearest, directly connected contours with a lower Contour Number (3006,0048).
- 1070 Note that any two non-disjoint contours will be connected by a path on the undirected graph defined by Attached Contour references. If the ROI is intersected by an image plane, there has to be a contour on that plane. All contours shall be parallel to the image plane. The distance between off-slice contours may vary.



1075 **Figure 3.3.4-1 Overview handling in off-slice and on-slice option**

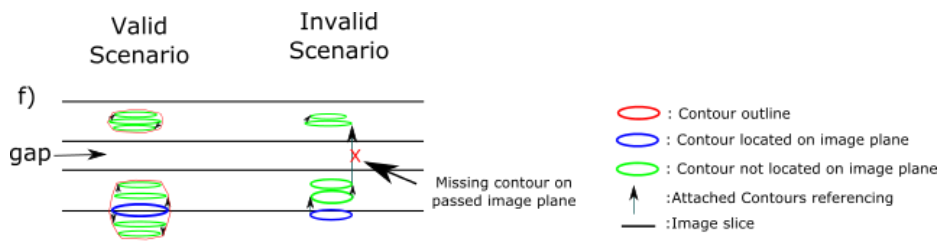


Figure 3.3.4-2 Invalid scenario off-slice contours

1080 Figure 3.3.4-1 shows examples of off-slice contours with and without support of the off-slice option. Examples a) and c) show how to add a small caps to an object by adding an attached contour to the contour on the image slice. Example b) illustrates a very small object between two image slices which will only be shown in applications capable of off-slice handling. Examples c) and d) show that the order of contour number doesn't have to be continuous as long as the requirement of the Attached Contours (3006,0049) is fulfilled. An object having a gap is shown in example e). It can be created in off-slice handling by not connecting the contour with the Contour Number (3006,0048) 9 to the contour with the Contour Number (3006,0048) 4 as shown in example e). In on-slice handling it is not possible to properly encode this gap.

1090 Figure 3.3.4-2 illustrates an invalid scenario in off-slice handling on the right side. Two contours that are not located on image slices shall be connected but the image slices that are intersected between those off-slice contours do not contain a contour definition. To correct this, additional contour definitions have to be done on these two image planes. If the invalid connecting Attached Contour is removed the definition would be correct too, but then it would represent a gap in off-slice handling (left side in example f).

1095 Also refer to chapter 7.3.4.1.1 for an overview of the specific requirements on the DICOM attributes that are included in an RT Structure Set instance and refer to chapter 7.4.8.2.2 for the off-slice specific requirements for the RT ROI Contour Module. In particular, the RT Structure Set must share a single Frame of Reference UID with the images.

3.3.4.1.3 Expected Actions

1100 Upon receipt of the RT Structure Set, the *Archive* shall store it. This RT Structure Set is then available for subsequent retrieval (RO-BRTO-II-2).

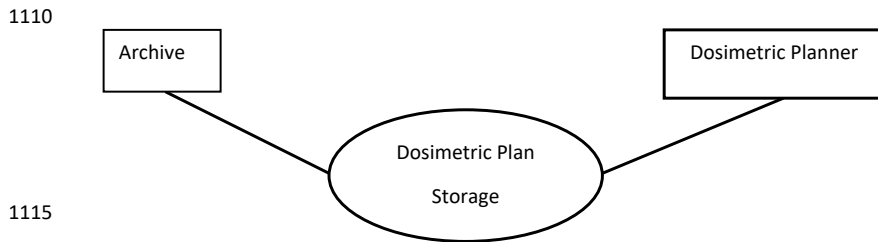
3.4 Dosimetric Plan Storage [RO-4]

This section corresponds to Transaction RO-4 of the IHE-RO Technical Framework. Transaction RO-4 is used by the *Archive* and *Dosimetric Planner* Actors.

1105 **3.4.1 Scope**

In this transaction, the *Dosimetric Planner* sends the plan containing the references to the RT Structure Set to the *Archive*.

3.4.2 Use Case Roles



Actor: Dosimetric Planner

Role: Transmit generated RT Plan to Archive.

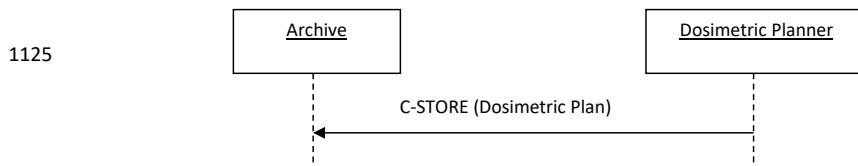
Actor: Archive

1120 **Role:** Accept and store RT Plan from Dosimetric Planner.

3.4.3 Referenced Standards

DICOM 2018d Edition, PS 3.3: RT Modules, PS 3.4: Storage Service Class.

3.4.4 Interaction Diagram



3.4.4.1 Dosimetric Plan Storage

1130 **3.4.4.2 Trigger Events**

The *Dosimetric Planner* transfers the *Dosimetric Plan* to the *Archive*, once the dose calculation is finished.

3.4.4.3 Message Semantics

- 1135 The *Dosimetric Planner* uses the DICOM C-STORE message to transfer the plan. The *Dosimetric Planner* is the DICOM Storage SCU and the *Archive* is the DICOM Storage SCP.
- The *Dosimetric Planner* may create a new series containing the RT Plan or may use an existing series, where previous RT Plan(s) are contained.
- The study where the series of the RT Plan is contained shall be the same study as the one containing the RT Structure Set referenced in the RT Plan.
- 1140 The purpose of the Dosimetric Plan transferred is to convey the reference to the RT Structure Set, which has been used in definition of the plan and which contains the references to the CT Images used for plan calculation. The *Dose Displayer* will use this sequence to retrieve the RT Structure Set and the CT images referenced in the RT Structure Set for display.
- 1145 The IHE-RO extension of the DICOM requirements for the RT General Plan module can be found in 7.4.3.1.1 and for the General Equipment module in 7.4.1.5.1.
- The Dosimetric Plan shall not contain an RT Brachy Application Setup module.
- The Dosimetric Plan may have zero beams, i.e., it may lack an RT Beams module. This is to support teletherapy plans that do not match the traditional isocentric model.
- 1150 Applications should display RT Plan Label, RT Plan Date and RT Plan Time in order to safely identify matching RT Dose and RT Plan pairs.

3.4.5 Security Considerations

There are no explicit security considerations.

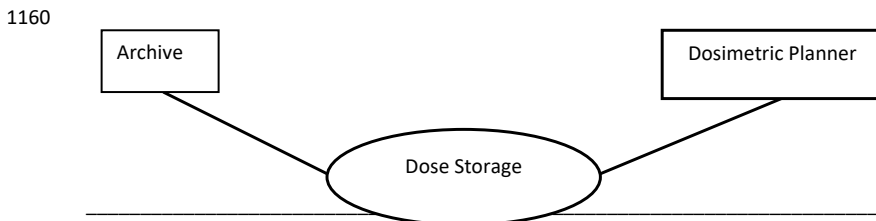
3.5 Dose Storage [RO-BRTO-II-5]

- 1155 This corresponds to RO-BRTO-II-5 of the IHE-RO technical framework. Transaction RO-BRTO-II-5 is used by the *Archive* and *Dosimetric Planner* Actors.

3.5.1 Scope

In the Dose Storage transaction, the *Dose planner* sends the newly created Dose to the *Archive*.

3.5.2 Use Case Roles



1165

Actor: Dosimetric Planner

Role: Transmit generated Dose to the Archive

Actor: Archive

Role: Receives and stores Doses from the Dosimetric Planner

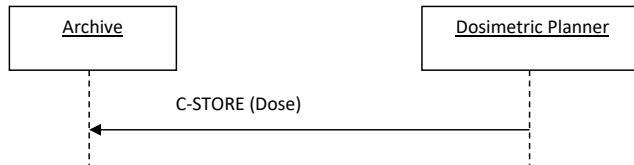
1170

3.5.3 Referenced Standards

DICOM 2018d Edition PS3.4: Storage Service Class.

3.5.4 Interaction Diagram

1175



3.5.4.1 Dose Storage

3.5.4.1.1 Trigger Events

The *Dosimetric Planner* transfers the Dose to the *Archive* within a DICOM association.

1180

3.5.4.1.2 Message Semantics

The *Dosimetric Planner* uses the DICOM C-STORE command to transfer the Dose. The *Dosimetric Planner* is the DICOM Storage SCU and the *Archive* is the DICOM Storage SCP.

Also refer to chapter 7.3.5.1.1 for an overview of Dose specific requirements on the DICOM attributes that are included in an RT Dose object.

1185

3.5.4.1.3 Representation of Dose

This transaction shall support dose represented as a three-dimensional dose array sampled onto transverse image planes in the same DICOM Patient coordinate system Frame of Reference as the diagnostic images used to compute it. The dose image shall be orthogonal with respect to the DICOM patient coordinate system.

1190

Not supported are point doses, projection of dose onto an oblique plane and isodose contours. The dose pixels shall represent absolute physical dose in units of Gray. The value of Dose Units (3004,0002) shall be GY. The value of Pixel Representation (0028,0103) shall be 0; negative dose values shall not be present.

3.5.4.1.4 Expected Actions

1195 The *Archive* will store the received Dose.

The DICOM RT Dose object will be stored such that it can be later retrieved (See RO-BRTO-II-6 Dose Retrieval) in a fashion meeting the requirements defined for a DICOM level 2 SCP (Refer to DICOM PS 3.4 B.4.1).

3.5.5 Security Considerations

1200 There are no explicit security considerations.

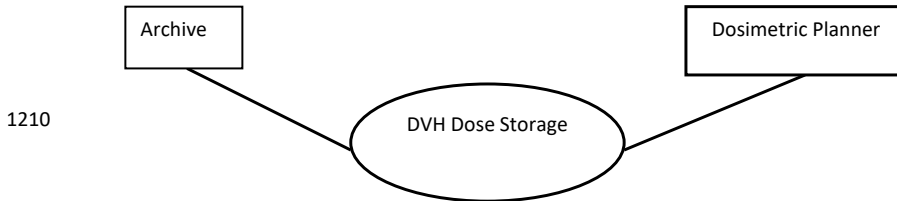
3.6 DVH Dose Storage [RO-BRTO-II-3]

This corresponds to RO-BRTO-II-3 of the IHE-RO technical framework. Transaction RO-BRTO-II-3 is used by the *Archive*, *Dosimetric Planner* and *Dose Displayer* Actors.

3.6.1 Scope

1205 In the DVH Dose Storage transaction, the *Dose Planner* sends the newly created DVH to the *Archive*.

3.6.2 Use Case Roles



Actor: Dosimetric Planner

Role: Transmit generated DVH Dose to the Archive

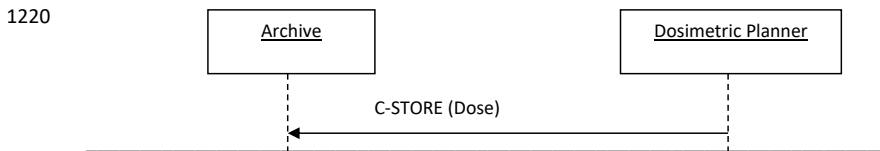
1215 **Actor:** Archive

Role: Receives and stores DVH Doses from the Dosimetric Planner

3.6.3 Referenced Standard

DICOM 2018d Edition PS3.4: Storage Service Class.

3.6.4 Interaction Diagram



3.6.4.1.1 Trigger Events

1225 The *Dosimetric Planner* transfers the DVH Dose to the *Archive* within a DICOM association.

3.6.4.1.2 Message Semantics

The *Dosimetric Planner* uses the DICOM C-STORE command to transfer the DVH Dose. The *Dosimetric Planner* is the DICOM Storage SCU and the *Archive* is the DICOM Storage SCP.

1230 Also refer to chapter 7.3.5.1.1 and 7.4.13.4.1 for an overview of DVH Dose specific requirements on the DICOM attributes that are included in an RT Dose object.

3.6.4.1.3 Expected Actions

The *Archive* will store the received DVH Dose.

1235 The DICOM RT Dose object will be stored such that it can be later retrieved (See RO-BRTO-II-4 DVH Dose Retrieval) in a fashion meeting the requirements defined for a DICOM level 2 SCP (Refer to DICOM PS 3.4 B.4.1). The DVH content may be stored in the same RT Dose instance as the volumetric dose grid, or may be stored in a separate RT Dose instance, containing only the DVH content.

3.6.5 Security Considerations

There are no explicit security considerations.

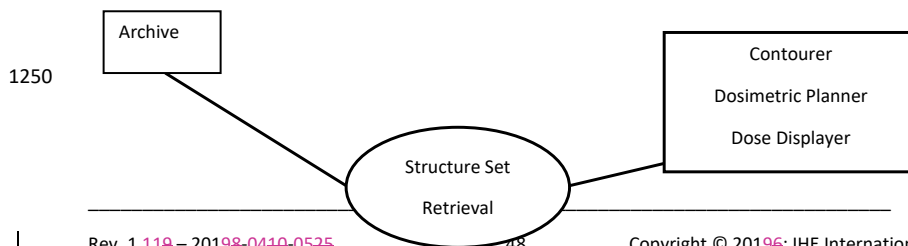
1240 3.7 Structure Set Retrieval [RO-7]

This corresponds to RO-7 of the IHE-RO technical framework. Transaction RO-7 is used by the *Archive*, *Contourer*, *Dosimetric Planner*, and *Dose Displayer* Actors.

3.7.1 Scope

1245 In the Structure Set Retrieval Transaction, the *Archive* stores an RT Structure Set on a *Contourer*, *Dosimetric Planner*, or *Dose Displayer*.

3.7.2 Use Case Roles

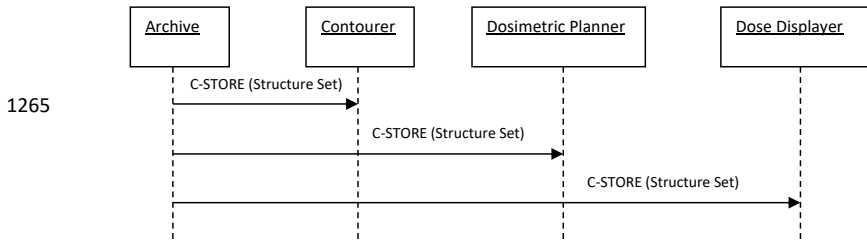


- 1255 **Actor:** Archive
Role: Sends RT Structure Set to Contourer, Dosimetric Planner, or Dose Displayer
Actor: Contourer, Dosimetric Planner, or Dose Displayer
Role: Stores RT Structure Set received from Archive

3.7.3 Referenced standards

- 1260 DICOM 2018d Edition PS3.4: Storage Service Class.

3.7.4 Interaction Diagram



3.7.4.1 Structure Set Retrieval

3.7.4.1.1 Trigger Events

The user of the *Contourer* determines that a new set of contours is to be based upon an existing RT Structure Set and requests that the *Archive* send this Structure Set to the *Contourer*.

The user of the *Dosimetric Planner* determines that a new Dosimetric Plan is to be based upon an existing RT Structure Set and requests that the *Archive* send this RT Structure Set to the *Dosimetric Planner*.

The user of the *Dose Displayer* determines that a dose display is to be based upon an existing Structure Set and requests that the *Archive* send this Structure Set to the *Dose Displayer*.

The mechanism(s) by which these transfers are initiated is outside the scope of this profile.

3.7.4.1.2 Message Semantics

The message semantics are defined by the DICOM Storage SOP Class. The *Contourer*, *Dosimetric Planner*, or *Dose Displayer* is the storage SCP and the *Archive* is the storage SCU.

Also refer to chapter 7.3.4.1.1 for an overview of the specific requirements on the DICOM attributes that are included in an RT Structure Set object.

3.7.4.1.3 Expected Actions

The *Contourer* will store all of the RT Structure Set, and will relate it to images based on the study, series, and image identification information. The contours contained will then be available to the user of the *Contourer* for use in construction a new set of contours which will later be exported as a structure set (RO-2). This new RT Structure Set will have the same Frame of Reference UID and Study Instance UID of the original images and structure set. It may have the same Series Instance UID as the original RT Structure Set.

The *Dosimetric Planner* will store the RT Structure Set, and will relate it to images based on the study, series, and image identification information. These contours contained in this RT Structure Set will then be available to the user of the *Dosimetric Planner* for use in construction

1295 of a Dosimetric Plan which will later be exported (RO-4). These images will also be involved in the calculation of a related dose, which will be exported later as an RT Dose (RO-BRTO-II-5).

The *Dose Displayer* will store the RT Structure Set, and will relate it to images based on the study, series, and image identification information. These contours contained in this RT Structure Set will then be available to the user of the *Dose Displayer* for display in relation to images, doses in the same Frame of Reference.

1300 If the stored RT Structure Set contains off-slice information (RO-BRTO-II-2) and the *Contourer*, *Dosimetric Planner* or *Dose Displayer* does not support this, the consuming actor has to handle it safely.

3.7.5 Security Considerations

There are no explicit security considerations.

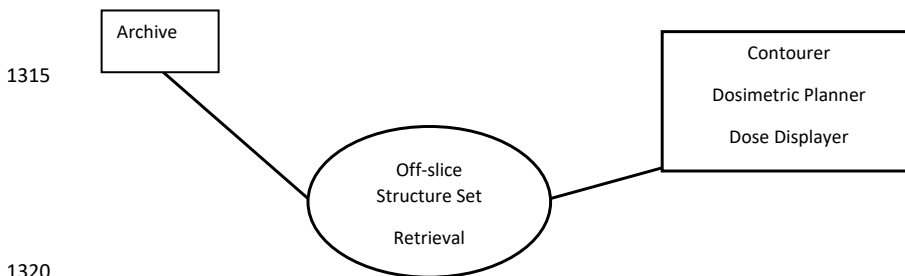
1305 3.8 Off-slice Structure Set Retrieval [RO-BRTO-II-2]

This corresponds to RO-BRTO-II-2 of the IHE-RO Technical Framework. Transaction RO-BRTO-II-2 is used by the *Archive*, *Contourer*, *Dosimetric Planner*, and *Dose Displayer* Actors.

3.8.1 Scope

1310 In the Off-slice Structure Set Retrieval Transaction, the *Archive* stores a Structure Set on a *Contourer*, *Dosimetric Planner*, or *Dose Displayer*.

3.8.2 Use Case Roles



Actor: Archive

Role: Sends off-slice RT Structure Set to Contourer, Dosimetric Planner or Dose Displayer

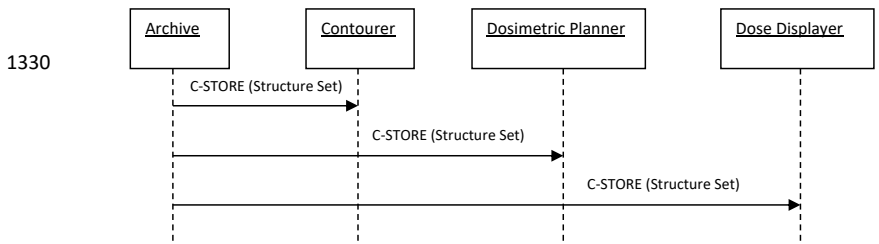
Actor: Contourer, Dosimetric Planner or Dose Displayer

Role: Stores off-slice RT Structure Set received from Archive

1325 **3.8.3 Referenced standards**

DICOM 2018d Edition PS3.4: Storage Service Class.

3.8.4 Interaction Diagram



3.8.4.1 Off-Slice Structure Set Retrieval

3.8.4.1.1 Trigger Events

The user of the *Contourer* determines that a new set off-slice contours is to be based upon an existing Structure Set and requests that the *Archive* send this Structure Set to the *Contourer*.

1340 The user of the *Dosimetric Planner* determines that a new dosimetric plan is to be based upon an existing Structure Set requests that the *Archive* send this Structure Set to the *Dosimetric Planner*.

The user of the *Dose Displayer* determines that a dose display is to be based upon an existing Structure Set and requests that the *Archive* send this Structure Set to the *Dose Displayer*.

1345 The mechanism(s) by which these transfers are initiated is outside the scope of this profile.

3.8.4.1.2 Message Semantics

The message semantics are defined by the DICOM Storage SOP Class. The *Contourer*, *Dosimetric Planner*, or *Dose Displayer* is the storage SCP and the *Archive* is the storage SCU.

1350 Also refer to Sections 7.3.4.1.1 and 7.4.8.2.2 for an overview of the specific requirements on the DICOM attributes that are included in an RT Structure Set instance. Additionally, the attributes mentioned in section 7.4.8.2.2 have to be present according to their requirements.

3.8.4.1.3 Expected Actions

The receiving actor will receive the RT Structure Set, and will relate it to the referenced image instances. Contours not located on image slices will be arranged according to referenced contour

1355 number in the Attached Contours (3006,0049). The contours contained will then be available to the user of the receiving actor.

The off-slice display has to be able to show the additional off-slice features (e.g., gaps).

3.8.5 Security Considerations

There are no explicit security considerations.

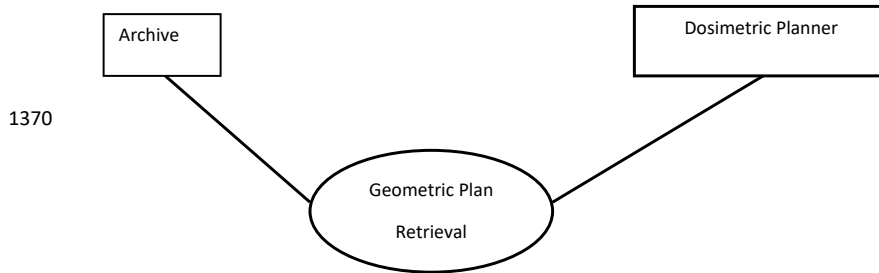
1360 3.9 Geometric Plan Retrieval [RO-8]

This corresponds to RO-8 of the IHE-RO technical framework. Transaction RO-8 is used by the *Archive* and *Dosimetric Planner* Actors.

3.9.1 Scope

1365 In the Geometric Plan Retrieval Transaction, the requested Geometric Plan is transferred from the *Archive* to the *Dosimetric Planner*.

3.9.2 Use Case Roles



1375 **Actor:** Dosimetric Planner

Role: Receives requested Geometric Plan from the Archive

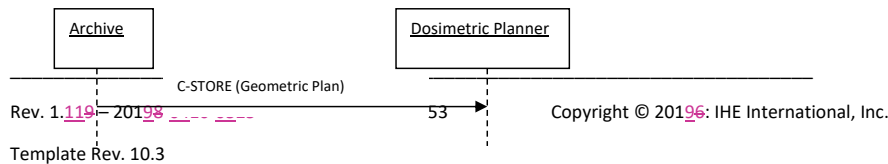
Actor: Archive

Role: Sends requested Geometric Plan instance to the Dosimetric Planner

3.9.3 Referenced standards

1380 DICOM 2018d Edition PS3.4: Storage Service Class.

3.9.4 Interaction Diagram



1385

3.9.4.1 Geometric Plan Retrieval

1390 3.9.4.1.1 Trigger Events

The user of the *Dosimetric Planner* selects a Geometric Plan for completion of the plan and dose calculation.

3.9.4.1.2 Message Semantics

1395 The plan shall be sent from the *Archive* to the *Dosimetric Planner*. Also refer to chapter 7.3.2.2.5 for an overview of Geometric Plan specific requirements on the DICOM attributes that are included in an RT Plan object.

3.9.4.1.3 Expected Actions

1400 The *Archive* shall return the requested Geometric Plan to the *Dosimetric Planner*. The *Dosimetric Planner* shall validate the received Geometric Plan. In cases where the received Geometric Plan is valid, it shall be loaded into the *Dosimetric Planner*. In cases where it is not valid, a warning message shall be displayed to the user, indicating the reason why it is not valid.

3.9.5 Security Considerations

There are no explicit security considerations.

3.10 Dosimetric Plan Retrieval [RO-9]

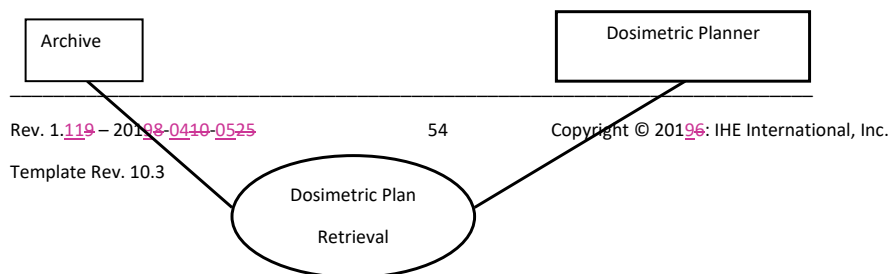
1405 This corresponds to RO-9 of the IHE-RO technical framework. Transaction RO-9 is used by the *Archive* and *Dose Displayer* Actors.

3.10.1 Scope

In this transaction, the *Dose Displayer* retrieves the plan containing the references to the structure set from the *Archive*.

1410

3.10.2 Use Case Roles



1415

1420 **Actor:** Dose Displayer

Role: Accepts plan from Archive.

Actor: Archive

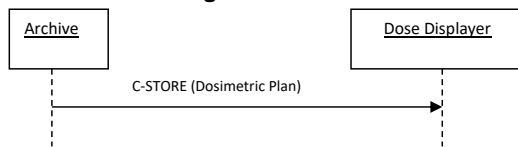
Role: Transmits plan to Dose Viewer.

3.10.3 Referenced Standards

1425 DICOM 2018d Edition, PS 3.3: RT Modules, PS 3.4: Storage Service Class.

3.10.4 Interaction Diagram

1430



3.10.4.1 Dosimetric Plan Retrieval

3.10.4.1.1 Trigger Events

The *Archive* transfers the Dosimetric Plan to the *Dose Displayer*. This action is initiated by the user in advance of the dose viewing session.

1435 **3.10.4.1.2 Message Semantics**

The *Archive* uses the DICOM C-STORE message to transfer the plan. The *Archive* is the DICOM Storage SCU and the *Dose Displayer* is the DICOM Storage SCP.

Also refer to chapter 7.3.2.2.1 and 7.3.2.2.4 for an overview of the RT Plan specific requirements on the DICOM attributes that are included in a Dosimetric Plan.

1440 **3.10.5 Security Considerations**

There are no explicit security considerations.

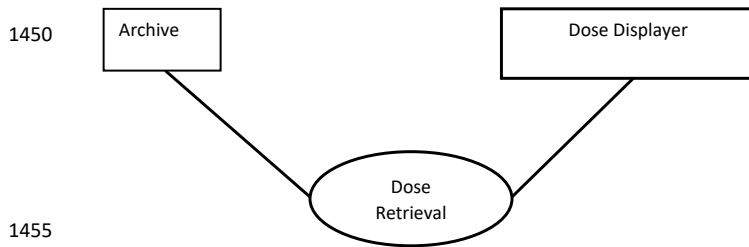
3.11 Dose Retrieval [RO-BRTO-II-6]

This corresponds to RO-BRTO-II-6 of the IHE-RO technical framework. Transaction RO-BRTO-II-6 is used by the *Archive* and *Dose Displayer* Actors.

1445 **3.11.1 Scope**

In the Dose Retrieval Transaction, the requested Dose is transferred from the *Archive* to the *Dose Displayer*.

3.11.2 Use Case Roles



Actor: Dose Displayer

Role: Receives requested Dose from the Archive

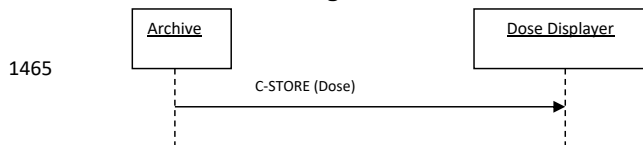
Actor: Archive

Role: Sends requested Dose instance to the Dose Displayer

1460 **3.11.3 Referenced standards**

DICOM 2018d Edition PS3.4: Storage Service Class.

3.11.4 Interaction Diagram



3.11.4.1 Dose Retrieval

3.11.4.1.1 Trigger Events

1470 The user of the *Dose Displayer* selects a Dose for display in the context of a particular CT Image Set and the targets and avoidance structures defined by an RT Structure Set.

3.11.4.1.2 Message Semantics

The *Archive* uses the DICOM C-STORE message to transfer the dose. The *Archive* is the DICOM Storage SCU and the *Dose Displayer* is the DICOM Storage SCP.

1475 Also refer to chapter 7.3.5.1.1 for an overview of Dose specific requirements on the DICOM attributes that are included in an RT Dose object.

3.11.4.1.3 Representation of Dose

1480 This transaction shall support Dose represented as a three-dimensional dose array sampled onto transverse image planes in the same DICOM Patient coordinate system Frame of Reference as the diagnostic images used to compute it. The dose image shall be orthogonal with respect to the DICOM patient coordinate system. The dose planes shall have equidistant spacing with allowed tolerance of 0.01mm.

1485 Not supported are point doses, projection of dose onto an oblique plane and isodose contours. The dose pixels shall represent absolute physical dose in units of Gray. The value of Dose Units (3004,0002) shall be GY. The value of Pixel Representation (0028,0103) shall be 0; negative dose values shall not be present.

3.11.4.1.4 Expected Actions

Upon receiving the request for retrieval, the *Archive* shall return the requested Dose to the *Dose Displayer*.

1490 3.11.5 Security Considerations

There are no explicit security considerations.

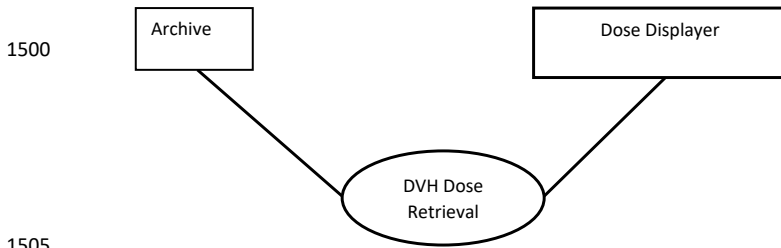
3.12 DVH Dose Retrieval [RO-BRTO-II-4]

In the DVH Dose Retrieval Transaction, the requested DVH Dose is transferred from the *Archive* to the *Dose Displayer*.

1495 3.12.1 Scope

In the DVH Dose Retrieval Transaction, the requested DVH Dose is transferred from the *Archive* to the *Dose Displayer*.

3.12.2 Use Case Roles



Actor: Dose Displayer

Role: Receives requested DVH Dose from the Archive

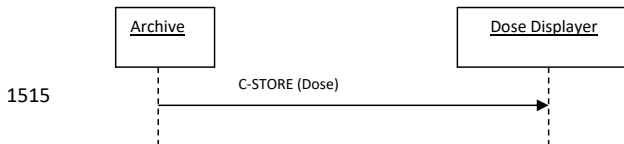
Actor: Archive

Role: Sends requested DVH Dose instance to the Dose Displayer

3.12.3 Referenced standards

DICOM 2018d Edition PS3.4: Storage Service Class.

3.12.4 Interaction Diagram



3.12.4.1 DVH Dose Retrieval

3.12.4.1.1 Trigger Events

1520 The user of the *Dose Displayer* selects a DVH Dose for display in the context of a particular dose distribution defined by itself or another RT Dose and the targets and avoidance structures defined by an RT Structure Set.

3.12.4.1.2 Message Semantics

1525 The *Archive* uses the DICOM C-STORE message to transfer the dose. The *Archive* is the DICOM Storage SCU and the *Dose Displayer* is the DICOM Storage SCP.

Also refer to chapter 7.3.5.1.1 and 7.4.13.4.1 for an overview of DVH Dose specific requirements on the DICOM attributes that are included in an RT Dose object.

The DVH content may be stored in the same RT Dose instance as the volumetric dose grid, or may be stored in a separate RT Dose instance, containing only the DVH content.

1530 **3.12.4.1.4 Expected Actions**

Upon receiving the request for retrieval, the *Archive* shall return the requested DVH Dose to the *Dose Displayer*.

3.12.5 Security Considerations

There are no explicit security considerations.

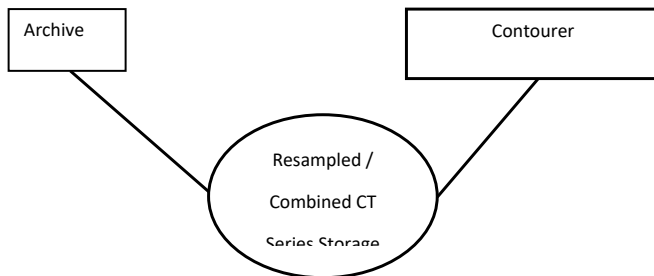
1535 **3.13 Resampled/Combined CT Series Storage[RO-11]**

This corresponds to RO-11 of the IHE-RO technical framework. Transaction RO-11 is used by the *Archive* and *Contourer* Actors.

3.13.1 Scope

1540 In the Resampled/Combined CT Series Storage Transaction, the *Contourer* stores CT Images which have been combined or resampled into a single series on the *Archive*.

3.13.2 Use Case Roles



1545

1550 **Actor:** Contourer

Role: Sends CT Images to the Archive

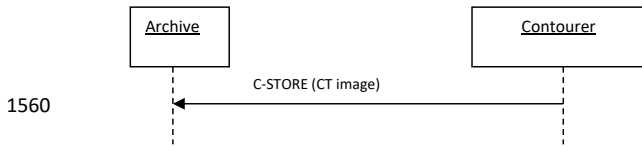
Actor: Archive

Role: Stores CT Images received from Contourer

3.13.3 Referenced standards

1555 DICOM 2018d Edition PS3.4: Storage Service Class.

3.13.4 Interaction Diagram



3.13.4.1 Resampled/Combined CT Series Storage

3.13.4.1.1 Trigger Events

1565 The *Contourer* has constructed a new CT Series. It has either combined CT Images from multiple series or has resampled CT Images from a single series to yield a more desirable slice spacing. The *Contourer* must export a single CT image series including all images on which Structure Set contours are defined. This new series must be stored on the *Archive* to make the images available for subsequent planning or review. This transaction must be performed prior to storage of a structure set (RO-2) which is based upon this new series.

3.13.4.1.2 Message Semantics

1570 The message semantics are defined by the DICOM Storage SOP Class. The *Archive* is the SCP of this service class, and the *Contourer* is the SCU of this service Class.

1575 Also refer to chapter 7.3.3.2.3 for an overview of the specific requirements on the DICOM attributes that are included in a CT Image object. In particular, these CT Images are required to share a study instance UID, and a frame of reference UID, and a series instance UID.

3.13.4.1.3 Expected Actions

Upon receiving the CT Series, the *Archive* will store the images, and will make this series available for subsequent retrieval (RO-1).

3.13.5 Security Considerations

1580 There are no explicit security considerations.

Appendices

No Appendices.

Volume 3 – Content Modules

1585 **5 Namespaces and Vocabularies**

No Namespaces and Vocabularies defined.

6 Content Modules

No Content Modules defined.

7 DICOM Content Definition

1590 **7.1 Conventions**

The conventions of Volume 2, Section 2.2 DICOM Usage Conventions apply unless otherwise stated in the following.

7.1.1 Scope of Requirements

1595 Requirements apply to all profiles which make use of the content definitions by referencing sections of this Volume. However where the uses cases covered by a profile need a different requirements, the profile may specify deviations from the definition here. This allows re-use of content definitions even in cases where only few adaptations are needed. It eliminates the need to duplicate the definitions, when the content requirements are shared in their majority and only a small number of deviations are indicated.

1600 **7.1.2 Requirements Definitions**

Each content module has a list of attributes requirements. In any case, the requirements specified in the referenced DICOM Standard do apply.

1605 Attributes not listed may or may not be present along the definition of the DICOM Standard. The producer may provide such attributes, but the receiver is not required to interpret them. Thus, it is not an error to include more than is asked for, but it is an error to reject a content based on additional attributes present.

Attributes, which may or may not be present by definition in the DICOM Standard, but shall not present under the definition of IHE-RO will be included in the specification with a requirement to be absent.

1610 Attribute requirements are only in effect when the enclosing sequence item is present. For example, a type 1 attribute can be left out of content IF the enclosing sequence is not required and is not present.

1615 IHE and IHE-RO have defined requirements related to the support for and use of attributes in DICOM storage transactions by both Service Class Users (SCUs) and Service Class Providers (SCPs):

IOD Table

M / C / U	As defined in DICOM PS 3.3
R	The Module is defined as Conditional (C) or User Option (U) in DICOM. The Requirement is an IHE extension of the DICOM requirements, and the module shall be present.
RC	The Module is defined as Conditional (C) or User Option (U) in DICOM. The Requirement is an IHE extension of the DICOM requirements, and the module shall be present when the specified conditions apply.

Module Table

O	The attribute or its value is optional, i.e., in DICOM it is Type 2 or 3.
O+*	The attribute is optional, but additional constraints have been added. Note: The specification approach does not force a Type 2 or Type 3 value to become a Type 1 by stating O+.
R	The attribute is required, and is not an IHE extension of the DICOM requirements; i.e., it is already Type 1 in DICOM, but additional constraints are placed by IHE, for example on the value set that may be used for the attribute.
R+	The Requirement is an IHE extension of the DICOM requirements, and the attribute shall be present, i.e., is Type 1, whereas the DICOM requirement may be Type 2 or 3.
RC+	The Requirement is an IHE extension of the DICOM requirements, and the attribute shall be present when the condition is satisfied, i.e., is Type 1C, whereas the DICOM requirement may be Type 2 or 3. If the condition is not fulfilled, the DICOM definitions apply. Note, that this means that the attribute may be present / have a value also in case the condition does not apply.
D	The requirements of DICOM apply unchanged, but the attribute needs to be displayed.
-	No IHE extension of the DICOM requirements is defined. The attribute is listed for better readability or similar purpose.
X+	<u>The attribute information is required to be absent. DICOM Type 2 attributes shall be present with no value. DICOM Type 3 attributes shall be absent.</u>

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7.1.3 Display Requirements

An asterisk (*) appearing on the attribute requirements indicates that the attribute does NOT need to be displayed

7.2 General Definitions

1625 7.2.1 Character Sets

7.2.1.1 Support of Character Sets other than ISO-IR 100

All actors shall support at least the Default Character Set and ISO-IR 100 (Latin-1) in all transactions. Other character sets as specified in Specific Character Set (0008,0005) shall be supported along the specification of the conformance statements of the involved actors.

1630 Especially that means the following:

- It shall be possible for all actors involved in a transaction to use those character sets in their communication which all actors support along their conformance statements.
- When there are no character sets shared across all actors, ISO-RO 100 shall be used.

7.2.2 Transfer of Common Patient Information

1635 *This section will be included in Chapter 7 in the Technical Framework when the other General Sections are moved to Chapter 7 in the TF.*

Attribute (Tag)	CT Image	RT Structure Set	Geometric RT Plan	Dosimetric RT Plan	RT Dose	RT Treatment Record
Patient's Name (0010,0010)	Source	Copy	Copy	Copy	Copy	Copy
Patient ID (0010,0020)	Source	Copy	Copy	Copy	Copy	Copy
Patient's Birth Date (0010,0030)	Source	Copy	Copy	Copy	Copy	Copy
Patient's Sex (0010,0040)	Source	Copy	Copy	Copy	Copy	Copy

7.2.3 Study Handling

1640 *This section will be included in Chapter 7 in the Technical Framework when the other General Sections are moved to Chapter 7 in the TF.*

It is recommended that a new Study is created for the RT Structure Set.

The RT Structure Set may copy the Study IE of the treatment planning image series.

DICOM objects that are created based on this RT Structure Set instance or further derived instances should copy the Study IE of their predecessors.

1645 If changes to Study-related attributes are required in the RT workflow, a new Study IE shall be created.

Attribute (Tag)	CT Image	RT Structure Set	Geometric RT Plan	Dosimetric RT Plan	RT Dose	RT Treatment Record
Study-Instance UID (0020,000D)	Source	New-Source (May-Copy \geq)	Copy	Copy	Copy	Copy
Study-Date (0008,0020)	Source	New-Source (May-Copy \geq)	Copy	Copy	Copy	Copy
Study-Time (0008,0030)	Source	New-Source (May-Copy \geq)	Copy	Copy	Copy	Copy
Referring Physician's Name (0008,0090)	Source	New-Source (May-Copy \geq)	Copy	Copy	Copy	Copy
Study-ID (0020,0010)	Source	New-Source (May-Copy \geq)	Copy	Copy	Copy	Copy
Accession Number (0008,0050)	Source	New-Source (May-Copy \geq)	Copy	Copy	Copy	Copy
Study-Description (0008,1030)	Source	New-Source (May-Copy \geq)	Copy	Copy	Copy	Copy
Frame-of-Reference-UID (0020,0052)	Source	Copy	Copy	Copy	Copy	Copy
Position-Reference-Indicator (0020,1040)	Source	NA	Copy	Copy	Copy	Copy

Note 1: If one copies the Study Instance UID, no study level attributes may be altered.

7.2.4 Frame of Reference Handling

This section will be included in Chapter 7 in the Technical Framework when the other General Sections are moved to Chapter 7 in the TF.

All DICOM objects based on a planning image Set shall copy the Frame of Reference Module values from this image set.

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7.3 IOD Definitions

This section defines each DICOM IOD used in the IHE Radiation Oncology domain in detail, specifying the standards used and the information defined.

7.3.1 Prescription IODs

This section is present only to convey the envisioned section numbering.

7.3.2 Plan IODs

1660 7.3.2.1 Technique Specific RT Plan IODs

7.3.2.1.1 RT Plan IOD for Photon External Beam in Planning State

This section is present only to convey the envisioned section numbering.

7.3.2.1.2 RT Plan IOD for Photon External Beam in Delivery State

This section is present only to convey the envisioned section numbering.

1665 7.3.2.2 RT Plan IOD for General Use

7.3.2.2.1 RT Plan IOD from Dosimetric Planning

7.3.2.2.1.1 Referenced Standards

DICOM 2018d Edition PS 3.3

7.3.2.2.1.2 IOD Definition

IE	Module	Reference	Usage	IHE-RO Usage
Patient	Patient	C.7.1.1	M	M See 7.4.1.1.1
	Clinical Trial Subject	C.7.1.3	U	U
Study	General Study	C.7.2.1	M	M See 7.4.1.2.1
	Patient Study	C.7.2.2	U	U
	Clinical Trial Study	C.7.2.3	U	U
Series	RT Series	C.8.8.1	M	M See 7.4.1.4.1
	Clinical Trial Series	C.7.3.2	U	U
Frame of Reference	Frame of Reference	C.7.4.1	U – See Note.	M See 7.4.1.7.1
Equipment	General Equipment	C.7.5.1	M	M See 7.4.1.5.1
Plan	RT General Plan	C.8.8.9	M	M See 7.4.3.1.1
	RT Prescription	C.8.8.10	U	R See 7.4.3.2.1
	RT Tolerance Tables	C.8.8.11	U	U
	RT Patient Setup	C.8.8.12	U	R See below
	RT Fraction Scheme	C.8.8.13	U	R See 7.4.3.3.3
	RT Beams	C.8.8.14	C - Required if RT Fraction Scheme Module exists and Number of Beams (300A,0080) is greater than zero for one or more fraction groups	R Shall be present
	RT Brachy Application Setups	C.8.8.15	C - Required if RT Fraction Scheme Module exists and Number of Brachy Application Setups (300A,00A0) is greater than zero for one or more fraction groups	N/A
	Approval	C.8.8.16	U	M
	SOP Common	C.12.1	M	M
	Common Instance Reference	C.12.2	U	C – Required if reference information is available

1670

RT Patient Setup Module is defined as follows:

Patient Setup Option	Section
Base Setup	See 7.4.3.4.1
Feet First Setup	See 07.4.3.4.2
Reoriented Setup	See 07.4.3.4.3
Decubitus Setup	See 07.4.3.4.4

1675 **7.3.2.2.2 RT Plan IOD for Dose Composition**

This section is present only to convey the envisioned section numbering.

7.3.2.2.3 RT Plan IOD for Consistent Dose Tracking

This section is present only to convey the envisioned section numbering.

7.3.2.2.4 RT Ion Plan IOD from Dosimetric Planning

1680 **7.3.2.2.4.1 Referenced Standards**

DICOM 2018d Edition PS 3.3

7.3.2.2.4.2 IOD Definition

IE	Module	Reference	Usage	IHE-RO Usage
Patient	Patient	C.7.1.1	M	M See 7.4.1.1.1
	Clinical Trial Subject	C.7.1.3	U	U
Study	General Study	C.7.2.1	M	M See 7.4.1.2.1
	Patient Study	C.7.2.2	U	U
	Clinical Trial Study	C.7.2.3	U	U
Series	RT Series	C.8.8.1	M	M See 7.4.1.4.1
	Clinical Trial Series	C.7.3.2	U	U
Frame of Reference	Frame of Reference	C.7.4.1	U – See Note.	M See 7.4.1.7.1
Equipment	General Equipment	C.7.5.1	M	M See 7.4.1.5.1
Plan	RT General Plan	C.8.8.9	M	M See 7.4.3.1.1
	RT Prescription	C.8.8.10	U	R See 7.4.3.2.1
	RT Ion Tolerance Tables	C.8.8.24	U	U
	RT Patient Setup	C.8.8.12	U	R See below
	RT Fraction Scheme	C.8.8.13	U	R See 7.4.3.3.3
	RT Ion Beams	C.8.8.25	C - Required if RT Fraction Scheme Module exists and Number of Beams (300A.0080) is greater than zero for one or more fraction groups	R Shall be present
	Approval	C.8.8.16	U	M
	SOP Common	C.12.1	M	M
	Common Instance Reference	C.12.2	U	C – Required if reference information is available

RT Patient Setup Module is defined as follows:

Patient Setup Option	Section
Base Setup	See 7.4.3.4.1

Feet First Setup	See 07.4.3.4.2
Reoriented Setup	See 07.4.3.4.3
Decubitus Setup	See 07.4.3.4.4

1685 **7.3.2.2.5 RT Plan IOD from Geometric Planning**

7.3.2.2.5.1 Referenced Standards

DICOM 2018d Edition PS 3.3

7.3.2.2.5.2 Definition

IE	Module	Reference	Usage	IHE-RO Usage
Patient	Patient	C.7.1.1	M	M See 7.4.1.1.1
	Clinical Trial Subject	C.7.1.3	U	U
Study	General Study	C.7.2.1	M	M See 7.4.1.2.1
	Patient Study	C.7.2.2	U	U
	Clinical Trial Study	C.7.2.3	U	U
Series	RT Series	C.8.8.1	M	M See 7.4.1.4.1
	Clinical Trial Series	C.7.3.2	U	U
Frame of Reference	Frame of Reference	C.7.4.1	U – See Note.	M See 7.4.1.7.1
Equipment	General Equipment	C.7.5.1	M	M See 7.4.1.5.1
Plan	RT General Plan	C.8.8.9	M	M See 7.4.3.1.1
	RT Prescription	C.8.8.10	U	U
	RT Tolerance Tables	C.8.8.11	U	U
	RT Patient Setup	C.8.8.12	U	R See below
	RT Fraction Scheme	C.8.8.13	U	U
	RT Beams	C.8.8.14	C - Required if RT Fraction Scheme Module exists and Number of Beams (300A,0080) is greater than zero for one or more fraction groups	R See 7.4.4.4.1 (Can be excluded for zero beams with non-isocentric model)
	RT Brachy Application Setups	C.8.8.15	C - Required if RT Fraction Scheme Module exists and Number of Brachy Application Setups (300A,00A0) is greater than zero for one or more fraction groups	N/A
	Approval	C.8.8.16	U	M
	SOP Common	C.12.1	M	M
	Common Instance Reference	C.12.2	U	C – Required if reference information is available

7.3.3 Image IOD

1690 **7.3.3.1 RT Image**

This section is present only to convey the envisioned section numbering.

7.3.3.2 CT Image

7.3.3.2.1 CT Image in Planning State

This section is present only to convey the envisioned section numbering.

1695 **7.3.3.2.2 CT Image in Delivery State**

This section is present only to convey the envisioned section numbering.

7.3.3.2.3 CT Image for General Use

7.3.3.2.3.1 Referenced Standards

DICOM 2018d Edition PS 3.3

1700 **7.3.3.2.3.2 IOD Definition**

IE	Module	Reference	Usage	IHE-RO Usage
Patient	Patient	C.7.1.1	M	M
	Clinical Trial Subject	C.7.1.3	U	U
Study	General Study	C.7.2.1	M	M
	Patient Study	C.7.2.2	U	U
	Clinical Trial Study	C.7.2.3	U	U
Series	General Series	C.7.3.1	M	M See below
	Clinical Trial Series	C.7.3.2	U	U
Frame of Reference	Frame of Reference	C.7.4.1	M	M
Equipment	General Equipment	C.7.5.1	M	M
Image	General Image	C.7.6.1	M	R
	Image Plane	C.7.6.2	M	R See below
	Image Pixel	C.7.6.3	M	M

IE	Module	Reference	Usage	IHE-RO Usage
	Contrast/Bolus	C.7.6.4	C - Required if contrast media was used in this image	C - Required if contrast media was used in this image
	Device	C.7.6.12	U	U
	Specimen	C.7.6.22	U	U
	CT Image	C.8.2.1	M	M
	Overlay Plane	C.9.2	U	U
	VOI LUT	C.11.2	U	U
	SOP Common	C.12.1	M	M
	Common Instance Reference	C.12.2	U	C – Required if reference information is available

General Series Module is defined as follows:

Image Orientation Option	Section
Base Setup	See 7.4.1.3.1
Feet First Setup	See 7.4.1.3.2
Decubitus Setup	See 7.4.1.3.3

1705 **Image Plane Module is defined as follows:**

Image Orientation Option	Section
Base Setup	See 7.4.6.2.1
Decubitus Setup	See 7.4.6.2.2

7.3.4 RT Structure Set IOD

7.3.4.1 RT Structure Set for General Use

7.3.4.1.1 RT Structure Set for Basic Interoperability

1710 **7.3.4.1.1.1 Referenced Standards**

DICOM 2018d Edition PS 3.3

7.3.4.1.1.2 IOD Definition

IE	Module	Reference	Usage	IHE-RO Usage
Patient	Patient	C.7.1.1	M	M See 7.4.1.1.1
	Clinical Trial Subject	C.7.1.3	U	U
Study	General Study	C.7.2.1	M	M See 7.4.1.2.1
	Patient Study	C.7.2.2	U	U
	Clinical Trial Study	C.7.2.3	U	U
Series	RT Series	C.8.8.1	M	M See 7.4.1.4.1
	Clinical Trial Series	C.7.3.2	U	U
Frame of Reference	Frame of Reference	C.7.4.1	U – See Note.	M See 7.4.1.7.1
Equipment	General Equipment	C.7.5.1	M	M See 7.4.1.5.1
Structure Set	Structure Set	C.8.8.5	M	M See Error! Reference source not found,7-4-8-3-1
	ROI Contour	C.8.8.6	M	R See below
	RT ROI Observation	C.8.8.8	M	M See Error! Reference source not found,7-4-8-1-1
	Approval	C.8.8.16	U	U
	SOP Common	C.12.1	M	M
	Common Instance Reference	C.12.2	U	C – Required if reference information is available

ROI Contour Module is defined as follows:

Contouring Option	Section
On-slice contouring	See 7.4.8.2.1
Off-slice contouring	See 7.4.8.2.2

1715

7.3.5 RT Dose IOD

7.3.5.1 RT Dose IOD for General Use

7.3.5.1.1 RT Dose from Dosimetric Planning

7.3.5.1.1.1 Referenced Standards

1720 DICOM 2018d Edition PS 3.3

7.3.5.1.1.2 IOD Definition

IE	Module	Reference	Usage	IHE-RO Usage
Patient	Patient	C.7.1.1	M	M See 7.4.1.1.1
	Clinical Trial Subject	C.7.1.3	U	U
Study	General Study	C.7.2.1	M	M See 7.4.1.2.1
	Patient Study	C.7.2.2	U	U
	Clinical Trial Study	C.7.2.3	U	U
Series	RT Series	C.8.8.1	M	M See 7.4.1.4.1
	Clinical Trial Series	C.7.3.2	U	U
Frame of Reference	Frame of Reference	C.7.4.1	M	M See 7.4.1.7.1
Equipment	General Equipment	C.7.5.1	M	M See 7.4.1.5.1
Dose	General Image	C.7.6.1	C - Required if dose data contains grid-based doses.	M
	Image Plane	C.7.6.2	C - Required if dose data contains grid-based doses.	R See 7.4.13.1.1
	Image Pixel	C.7.6.3	C - Required if dose data contains grid-based doses.	M
	Multi-Frame	C.7.6.6	C - Required if dose data contains grid-based doses and pixel data is multi-frame data.	R See 7.4.13.2.1
	Overlay Plane	C.9.2	U	U
	Multi-Frame Overlay	C.9.3	U	U
	Modality LUT	C.11.1	U	U
	RT Dose	C.8.8.3	M	M See 7.4.13.3.1

IE	Module	Reference	Usage	IHE-RO Usage
	RT DVH	C.8.8.4	U	RC Required for transactions RO-BRTO-II-3 and RO-BRTO-II-4 See 7.4.13.4.1
	Structure Set	C.8.8.5	C - Required if dose data contains dose points or isodose curves	Outside the scope of this profile.
	ROI Contour	C.8.8.6	C - Required if dose data contains dose points or isodose curves	Outside the scope of this profile.
	RT Dose ROI	C.8.8.7	C - Required if dose data contains dose points or isodose curves	Outside the scope of this profile.
	SOP Common	C.12.1	M	M
	Common Instance Reference	C.12.2	U	C – Required if reference information is available

7.3.6 Treatment Record

This section is present only to convey the envisioned section numbering.

1725

7.4 Module Definitions

This section defines each DICOM Module used in the IHE Radiation Oncology domain in detail, specifying the standards used and the information defined.

7.4.1 General Modules

1730 7.4.1.1 Patient Module

7.4.1.1.1 Patient Module Base Content

7.4.1.1.1.1 Referenced Standards

DICOM 2018d Edition PS 3.3

7.4.1.1.1.2 Module Definition

1735

Attribute	Tag	Type	Attribute Note
Patient's Name	(0010,0010)	R+	IHE requires that this element be present. This element is one of the primary patient identifying elements, and as such, all DICOM objects with the same Study Instance UID, must have the same value in this element. Equipment which creates new series based on other series (i.e., resampled series, new structure sets, plans, etc.) must preserve the value of this element to adhere to this profile.
Patient ID	(0010,0020)	R+	See Patient's Name (0010,0010) See Also RAD TF-2: A.3
Patient's Birth Date	(0010,0030)	O+	See Patient's Name (0010,0010) See Also RAD TF-2: A.3
Patient's Sex	(0010,0040)	O+	See Patient's Name (0010,0010) See Also RAD TF-2: A.3

7.4.1.2 Study Module

7.4.1.2.1 General Study Module Base Content

7.4.1.2.1.1 Referenced Standards

1740 DICOM 2018d Edition PS 3.3

7.4.1.2.1.2 Module Definition

Attribute	Tag	Type	Attribute Note
Study Instance UID	(0020,000D)	RC+*	IHE requires that this value be preserved in the following cases: If a set of images are resampled and re-exported. This new set of images will be a new series. This series will belong to the same study and will have the same study date. This is to facilitate grouping the images in a PACS. <u>All other study level attributes mentioned in this table shall be preserved based on their existence, especially meaning to preserve an empty attribute value.</u> When a plan is constructed from a structure set. The plan will be in the same study, and will have the same study date. IHE requires that this element be present. Equipment which creates new series based on other series (i.e., resampled series, new structure sets, plans, etc.) must preserve the value of this element to adhere to this profile (see 7.2.3).
Study Date	(0008,0020)	RC+	[See Study Instance UID (0020,000D)]
Study Time	(0008,0030)	RC+	[See Study Instance UID (0020,000D)]
Study ID	(0020,0010)	RC+	[See Study Instance UID (0020,000D)]
Accession Number	(0008,0050)	RC+	[See Study Instance UID (0020,000D)]

Attribute	Tag	Type	Attribute Note
Study Description	(0008,1030)	O+	[See Study Instance UID (0020,000D)]

7.4.1.3 General Series Module

7.4.1.3.1 General Series Module Base Content

1745 7.4.1.3.1.1 Referenced Standards

DICOM 2018d Edition PS 3.3

7.4.1.3.1.2 Module Definition

Attribute	Tag	Type	Attribute Note
Series Date	(0008,0021)	RC+	Must be used and preserved, if present. If the producer creates a new series must be defined.
Series Time	(0008,0031)	RC+	Must be used and preserved, if present. If the producer creates a new series must be defined.
Patient Position	(0018,5100)	R+	Shall be one of {HFS, HFP}.

7.4.1.3.2 General Series Module Feet First

1750 7.4.1.3.2.1 Referenced Standards

DICOM 2018d Edition PS 3.3

7.4.1.3.2.2 Module Definition

Attribute	Tag	Type	Attribute Note
Series Date	(0008,0021)	RC+	Must be used and preserved, if present. If the producer creates a new series must be defined.
Series Time	(0008,0031)	RC+	Must be used and preserved, if present. If the producer creates a new series must be defined.
Patient Position	(0018,5100)	R+	Shall be one of {HFS, FFS, HFP, FFP}.

7.4.1.3.3 General Series Module Decubitus

1755 7.4.1.3.3.1 Referenced Standards

DICOM 2018d Edition PS 3.3

7.4.1.3.3.2 Module Definition

Attribute	Tag	Type	Attribute Note
Series Date	(0008,0021)	RC+	Must be used and preserved, if present. If the producer creates a new series must be defined.
Series Time	(0008,0031)	RC+	Must be used and preserved, if present. If the producer creates a new series must be defined.
Patient Position	(0018,5100)	R+	Shall be one of {HFS, FFS, HFP, FFP, HFDL, HFDR, FFDL, FFDL}.

7.4.1.4 RT Series Module

1760 7.4.1.4.1 RT Series Module Base Content

7.4.1.4.1.1 Referenced Standards

DICOM 2018d Edition PS 3.3

7.4.1.4.1.2 Module Definition

Attribute	Tag	Type	Attribute Note
Series Date	(0008,0021)	RC+	Must be used and preserved, if present. If the producer creates a new series must be defined.
Series Time	(0008,0031)	RC+	Must be used and preserved, if present. If the producer creates a new series must be defined.

1765

7.4.1.5 Equipment Module

7.4.1.5.1 General Equipment Module Base Content

7.4.1.5.1.1 Referenced Standards

DICOM 2018d Edition PS 3.3

1770 7.4.1.5.1.2 Module Definition

Attribute	Tag	Type	Attribute Note
Manufacturer	(0008,0070)	R+*	IHE requires that this element be present, and should contain the manufacturer of the equipment creating the image, structure set, plan, or dose. If the equipment is storing and forwarding information, the value of this element shall be preserved. If a new plan is

Attribute	Tag	Type	Attribute Note
			created from a previous plan, the manufacturer of the equipment producing the new plan shall insert their identifier in this element. If a new structure set is created from a previous structure set, the manufacturer of the equipment producing the new structure set shall insert their identifier in this element.
Manufacturer's Model Name	(0008,1090)	R+*	If an application resamples and re-exports a series of CT images, or modifies an instance then this element must be present, and must contain the model name of the equipment doing the resampling.
Software Versions	(0018,1020)	R+*	Must be present.

7.4.1.6 SOP Common Module

7.4.1.6.1 SOP Common Module Base Content

1775 7.4.1.6.1.1 Referenced Standards

DICOM 2018d Edition PS 3.3

7.4.1.6.1.2 Module Definition

Attribute	Tag	Type	Attribute Note
Specific Character Set	(0008,0005)	O+*	See Section 7.2.1
Instance Creation Date	(0008,0012)	R+	Shall be present.
Instance Creation Time	(0008,0013)	R+	Shall be present.

7.4.1.7 Frame of Reference Module

1780 7.4.1.7.1 Frame of Reference Module Base Content

7.4.1.7.1.1 Referenced Standards

DICOM 2018d Edition PS 3.3

7.4.1.7.1.2 Module Definition

Attribute	Tag	Type	Attribute Note
Position Reference Indicator	(0020,1040)	O*	Equipment which creates new series based on other series (i.e., resampled series, new structure sets, plans, etc.) must preserve the value of this element to adhere to this profile.

1785 **7.4.1.8 General Image Module**

7.4.1.8.1 General Image Module Base Content

7.4.1.8.1.1 Referenced Standards

DICOM 2018d Edition PS 3.3

7.4.1.8.1.2 Module Definition

1790 See Treatment Delivery- Image Content (TDIC) Profile, Section 7.4.1.8.1.

7.4.2 Workflow-Related Modules

This section is present only to convey the envisioned section numbering.

7.4.3 General Plan-Related Modules

7.4.3.1 General Plan Module

1795 **7.4.3.1.1 General Plan Module Base Content**

7.4.3.1.1.1 Referenced Standards

DICOM 2018d Edition PS 3.3

7.4.3.1.1.2 Module Definition

Attribute	Tag	Type	Attribute Note
RT Plan Label	(300A,0002)	R+	The label which serves as the identification of the plan for the user.
RT Plan Date	(300A,0006)	R+	The date when the plan was last modified.
RT Plan Time	(300A,0007)	R+	The time when the plan was last modified.
RT Plan Geometry	(300A,000C)	R+*	Shall be PATIENT. This implies that the RT Structure Set exists and is referenced in the General Plan module.

1800 **7.4.3.2 RT Prescription Module**

7.4.3.2.1 RT Prescription Module Base Content

7.4.3.2.1.1 Referenced Standards

DICOM 2018d Edition PS 3.3

7.4.3.2.1.2 Module Definition

1805

Attribute	Tag	Type	Attribute Note
Dose Reference Sequence	(300A,0010)	R+*	
> Dose Reference UID	(300A,0013)	R+*	
> Dose Reference Description	(300A,0016)	R+	

7.4.3.3 RT Fraction Scheme Module

7.4.3.3.1 RT Fraction Scheme Module for Consistent Dose

This section is present only to convey the envisioned section numbering.

7.4.3.3.2 RT Fraction Scheme Module for Delivery

1810 *This section is present only to convey the envisioned section numbering.*

7.4.3.3.3 RT Fraction Scheme Module for Brachy

This section is present only to convey the envisioned section numbering.

7.4.3.3.4 RT Fraction Scheme Module Base Content

7.4.3.3.4.1 Referenced Standards

1815 DICOM 2018d Edition PS 3.3

7.4.3.3.4.2 Module Definition

Attribute	Tag	Type	Attribute Note
Fraction Group Sequence	(300A,0070)	R+*	Shall have only a single item in the sequence
>Number of Brachy Application Setups	(300A,00A0)	R+*	Shall be 0. Brachytherapy is not supported in the BRTO Profile.

7.4.3.4 RT Patient Setup Module

7.4.3.4.1 RT Patient Setup Module Base Content

7.4.3.4.1.1 Referenced Standards

1820 DICOM 2018d Edition PS 3.3

7.4.3.4.1.2 Module Definition

Attribute	Tag	Type	Attribute Note
Patient Setup Sequence	(300A,0180)	R+*	An actor must not rely on the presence of: Fixation Device Sequence Shielding Device Sequence

Attribute	Tag	Type	Attribute Note
			Setup Device Sequence within the Patient Setup Sequence for proper operation.
>Patient Position	(0018,5100)	R+	Shall be one of {HFS, HFP}. In case of multiple Patient Setup items, it shall be the same.
>Setup Technique	(300A,01B0)	R+*	
>Table Top Vertical Setup Displacement	(300A,01D2)	O+*	If present, shall be consistent with Isocenter position. See note below
>Table Top Longitudinal Setup Displacement	(300A,01D4)	O+*	If present, shall be consistent with Isocenter position. See note below
>Table Top Longitudinal Setup Displacement	(300A,01D6)	O+*	If present, shall be consistent with Isocenter position. See note below

Note: All items in the Patient Setup Sequence (300A,0180) shall use the same initial Setup Position.

7.4.3.4.2 RT Patient Setup Module Feet First

7.4.3.4.2.1 Referenced Standards

1825 DICOM 2018d Edition PS 3.3

7.4.3.4.2.2 Module Definition

Attribute	Tag	Type	Attribute Note
Patient Setup Sequence	(300A,0180)	R+*	An actor must not rely on the presence of: Fixation Device Sequence Shielding Device Sequence Setup Device Sequence within the Patient Setup Sequence for proper operation.
>Patient Position	(0018,5100)	R+	Shall be one of {HFS, FFS, HFP, FFP}.
>Setup Technique	(300A,01B0)	R+*	
>Table Top Vertical Setup Displacement	(300A,01D2)	O+*	If present, shall be consistent with Isocenter position. See note below
>Table Top Longitudinal Setup Displacement	(300A,01D4)	O+*	If present, shall be consistent with Isocenter position. See note below
>Table Top Longitudinal Setup Displacement	(300A,01D6)	O+*	If present, shall be consistent with Isocenter position. See note below

Note: All items in the Patient Setup Sequence (300A,0180) shall use the same initial Setup Position.

7.4.3.4.3 RT Patient Setup Module Reoriented

7.4.3.4.3.1 Referenced Standards

1830 DICOM 2018d Edition PS 3.3

7.4.3.4.3.2 Module Definition

Attribute	Tag	Type	Attribute Note
Patient Setup Sequence	(300A,0180)	R+*	An actor must not rely on the presence of: Fixation Device Sequence Shielding Device Sequence Setup Device Sequence within the Patient Setup Sequence for proper operation.
>Patient Position	(0018,5100)	R+	The reoriented Patient Position for treatment shall correspond to the following pairs with respect of the Patient Position during image acquisition: HFS ↔ FFS or HFP ↔ FFP
>Setup Technique	(300A,01B0)	R+*	
>Table Top Vertical Setup Displacement	(300A,01D2)	O+*	If present, shall be consistent with Isocenter position. See note below
>Table Top Longitudinal Setup Displacement	(300A,01D4)	O+*	If present, shall be consistent with Isocenter position. See note below
>Table Top Longitudinal Setup Displacement	(300A,01D6)	O+*	If present, shall be consistent with Isocenter position. See note below

Note: All items in the Patient Setup Sequence (300A,0180) shall use the same initial Setup Position.

7.4.3.4.4 RT Patient Setup Module Decubitus

7.4.3.4.4.1 Referenced Standards

1835 DICOM 2018d Edition PS 3.3

7.4.3.4.4.2 Module Definition

Attribute	Tag	Type	Attribute Note
Patient Setup Sequence	(300A,0180)	R+*	An actor must not rely on the presence of: Fixation Device Sequence Shielding Device Sequence Setup Device Sequence within the Patient Setup Sequence for proper operation.
>Patient Position	(0018,5100)	R+	Shall be one of {HFS, FFS, HFP, FFP, HFDL, HFDR, FFDL, FFDR}.
>Setup Technique	(300A,01B0)	R+*	
>Table Top Vertical Setup Displacement	(300A,01D2)	O+*	If present, shall be consistent with Isocenter position. See note below
>Table Top Longitudinal Setup Displacement	(300A,01D4)	O+*	If present, shall be consistent with Isocenter position. See note below

Attribute	Tag	Type	Attribute Note
>Table Top Longitudinal Setup Displacement	(300A,01D6)	O+*	If present, shall be consistent with Isocenter position. See note below

Note: All items in the Patient Setup Sequence (300A,0180) shall use the same initial Setup Position.

7.4.4 Plan-Related Modules in Planning

7.4.4.1 Specific RT BeamType Specifications

1840 *This section is present only to convey the envisioned section numbering.*

7.4.4.2 General Beam Attribute Specifications

This section is present only to convey the envisioned section numbering.

7.4.4.3 Beam Option Specifications

This section is present only to convey the envisioned section numbering.

1845 7.4.4.4 Other RT Beam Modules

7.4.4.4.1 RT Beams Module for Geometric Planner

7.4.4.4.1.1 Referenced Standards

DICOM 2018d Edition PS 3.3

7.4.4.4.1.2 Module Definition

Attribute	Tag	Type	Attribute Note
Beam Sequence	(300A,00B0)	R+*	An actor must be able to safely handle up to 100 Beam Sequence Items (beams).
>Beam Name	(300A,00C2)	R+	The Beam Name must be unique within the sequence.
>Beam Type	(300A,00C4)	R+*	In the BRTO Profile, for Geometric Plans the value shall be STATIC. Only static beams shall be specified in Geometric Plans. This will allow non-arc-based IMRT (such as Step-and-Shoot or Sliding Window techniques, but not techniques such as fixed aperture arc beams, conformal arc beams, or intensity modulated arc beams. As a result, all beams in Geometric Plans shall consist of exactly two control points.
>Radiation Type	(300A,00C6)	R+*	Any value other than PHOTON is outside the scope of the profile
>High-Dose Technique Type	(300A,00C7)	O+*	Geometric Plans shall not specify this attribute.
>Treatment Machine Name	(300A,00B2)	O+*	An Actor must not rely on the presence of this attribute.

Attribute	Tag	Type	Attribute Note
>Source-Axis Distance	(300A,00B4)	R+*	This attribute is critical for providing information regarding beam divergence.
>Beam Limiting Device Sequence	(300A,00B6)		For the BRTO Profile, shall report at least one set of MLC descriptions or the descriptions of two sets of jaws.
>Referenced Patient Setup Number	(300C,006A)	R+*	
>Number of Wedges	(300A,00D0)	R+*	Geometric Plans are constrained to a value of 0 (i.e., a Geometric Plan must not include a Wedge).
>Number of Compensators	(300A,00E0)	R+*	Geometric Plans are constrained to a value of 0 (i.e., a Geometric Plan must not include a Compensator).
>Number of Boli	(300A,00ED)	R+*	Geometric Plans are constrained to a value of 0 (i.e., a Geometric Plan must not include any Boli).
>Number of Blocks	(300A,00F0)	R+*	All actors shall be able to handle 8 block items, of which no more than one may be an aperture
>Block Sequence	(300A,00F4)		
>>Block Divergence	(300A,00FA)	R+*	Must be present and non-null if Block Sequence is present (i.e., when Number of Blocks is 1 or more), with a value of PRESENT
>>Block Number of Points	(300A,0104)	R+*	The value is constrained to be 3 or more.
>>Block Data	(300A,0106)	R+*	Shall be present and non-null. Limitations on the total number of points are limited only by DICOM limitations on representation with 'explicit VR' in total byte lengths. Systems that limit support of legal sequences shall safely handle receipt of such sequences that exceed their limitations, and document this behavior in their IHE-RO Profile adherence statement.
>Applicator Sequence	(300A,0107)		Not expected in Geometric Plans. However, if present, shall be handled in a safe manner by the receiving system (and document this behavior in their IHE-RO Profile adherence statement). Applications exporting this sequence are outside the scope of the BRTO Profile.
>Final Cumulative Meterset Weight	(300A,010E)	O+*	Shall not be present in a Geometric Plan.
>Number of Control Points	(300A,0110)	R+*	Shall have a value of 2 for Geometric Plans.
>Control Point Sequence	(300A,0111)	R+*	In the BRTO Profile, for Geometric Plans the second control point (sequence item) shall contain only: <ul style="list-style-type: none"> Control Point Index (300A,0112) with a value of 1 Cumulative Meterset Weight (300A,0134) set to NULL.
>>Cumulative Meterset Weight	(300A,0134)	O+*	Shall be NULL for Geometric Plans (in both the first and second control point).
>>Referenced Dose Reference Sequence	(300C,0050)	O+*	Shall not be present for Geometric Plans. Must not be relied upon by actors operating on the object as a Geometric Plan.

Attribute	Tag	Type	Attribute Note
>>Nominal Beam Energy	(300A,0114)	O+*	Actors must not rely on the presence of this attribute to operate correctly. However, if this attribute is present, actors may not ignore the value.
>>Dose Rate Set	(300A,0115)	O+*	Actors must not rely on the presence of this attribute to operate correctly. However, if this attribute is present, actors may not ignore the value.
>>Wedge Position Sequence	(300A,0116)	O+*	Must not be present in a Geometric Plan
>>Beam Limiting Device Position Sequence	(300A,011A)	R+*	Must be present and correspond to those devices defined in the Beam Limiting Device Sequence. It shall be present for a Geometric Plan for Control Point Index 0 only.
>>Gantry Rotation Direction	(300A,011F)	R+*	For a Geometric Plan for Control Point Index 0 only, must have a value of NONE.

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7.4.5 Plan-Related Modules in Delivery

This section is present only to convey the envisioned section numbering.

7.4.6 Image-Related Modules in Planning

7.4.6.1 RT Image Module

1855 *This section is present only to convey the envisioned section numbering.*

7.4.6.2 Image Plane Module

7.4.6.2.1 Image Plane Base Content

7.4.6.2.1.1 Referenced Standards

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1860 **7.4.6.2.1.2 Module Definition**

Attribute	Tag	Type	Attribute Note
Image Orientation (Patient)	(0020,0037)	R+*	This element shall be restricted to TRANSVERSE images only. For a transverse image, direction cosines shall be ($\pm 1, 0, 0, 0, \pm 1, 0$) with an angle tolerance of 0.001 radians (~0.057 degrees)
Slice Thickness	(0018,0050)	-	Shall not be relied on.
Slice Location	(0020,1041)	-	Shall not be relied on.

Attribute	Tag	Type	Attribute Note
Pixel Spacing	(0028,0030)	O+*	For CT, non-isotropic pixels are outside the scope of the profile. For RT Dose, pixel spacing may be non-isotropic.

7.4.6.2.2 Image Plane Decubitus

7.4.6.2.2.1 Referenced Standards

DICOM 2018d Edition PS 3.3

7.4.6.2.2.2 Module Definition

Attribute	Tag	Type	Attribute Note
Image Orientation (Patient)	(0020,0037)	R+*	This element shall be restricted to TRANSVERSE images only. For a transverse image, direction cosines shall be ($\pm 1, 0, 0, 0, \pm 1, 0$) or ($0, \pm 1, 0, \pm 1, 0, 0$), with an angle tolerance of 0.001 radians (~0.057 degrees)
Slice Thickness	(0018,0050)	-	Shall not be relied on.
Slice Location	(0020,1041)	-	Shall not be relied on.
Pixel Spacing	(0028,0030)	O+*	For CT, non-isotropic pixels are outside the scope of the profile. For RT Dose, pixel spacing may be non-isotropic.

1865 7.4.7 Image-Related Modules in Delivery

This section is present only to convey the envisioned section numbering.

7.4.8 Segment-Related Modules

7.4.8.1 RT ROI Observation Module

7.4.8.1.1 RT ROI Observation Module Base Content

1870 7.4.8.1.1.1 Referenced Standards

DICOM 2018d Edition PS 3.3

7.4.8.1.1.2 Module Definition

Attribute	Tag	Type	Attribute Note
RT ROI Observations Sequence	(3006,0080)	R+*	This sequence contains information about an ROI. It references the ROI in Referenced ROI Number which contains a number which must match one of the ROI numbers in one of the elements of the Structure Set ROI Sequence.

Attribute	Tag	Type	Attribute Note
>Referenced ROI Number	(3006,0084)	R+*	Specifies the ROI to which this observation applies. For every item in Structure Set ROI sequence, at least one observation is required, with values in ROI Interpreted Type.
>RT ROI Interpreted Type	(3006,00A4)	R+*	If referenced ROI has associated contours of type CLOSED_PLANAR, the content consumer must accept at minimum the following values: EXTERNAL PTV CTV GTV TREATED_VOLUME IRRAD_VOLUME BOLUS AVOIDANCE ORGAN MARKER CONTRAST_AGENT CAVITY If referenced ROI has associated contours of type POINT, the content consumer must accept at minimum the following values: MARKER REGISTRATION ISOCENTER
> Segmented Property Category Code Sequence	(0062,0003)	-	See Note 1
>> Include 'Code Sequence Macro' Table 8.8-1			
> RT ROI Identification Code Sequence	(3006,0086)	-	See Note 2
>>Segmented Property Type Modifier Code Sequence	(0062,0011)	O+	Not required; Shall contain only one code if present.
>>>Include Table 8.8-1 "Code Sequence Macro Attributes"			Defined CID 244 "Laterality".
>ROI Physical Properties Sequence	(3006,00B0)	O+*	Not required, but shall not be ignored if supplied.
>>ROI Physical Property	(3006,00B2)	R+*	Only relative electron density shall be supported: REL_ELEC_DENSITY

Note 1:This attribute allows preserving information by copying the content of Segmented Property Category Code Sequence (0062,0003) in case a Segmentation object is re-encoded as an RT Structure Set or vice-versa.

Note 2:In case of re-encoding a Segmentation object as an RT Structure Set or vice-versa it is suggested, that the Segmented Property Type Code Sequence (0062,000F) is mapped to RT ROI Identification Code Sequence (3006,0086).

1875

7.4.8.2 RT ROI Contour Module

7.4.8.2.1 RT ROI Contour Module Base Content

7.4.8.2.1.1 Referenced Standards

1880 ~~DICOM 2017e~~ DICOM 2018d Edition PS 3.3

7.4.8.2.1.2 Module Definition

Attribute	Tag	Type	Attribute Note
ROI Contour Sequence	(3006,0039)	R*	
>ROI Display Color	(3006,002A)	-	Not required - no compliant implementation shall rely on this element being present for proper operation. However applications are allowed to be aware of this element and use it to map display colors.
> Recommended Display Grayscale Value	(0062,000C)	-	Not required - no compliant implementation shall rely on this element being present for proper operation. However applications are allowed to be aware of this element and use it to map display colors.
> Recommended Display CIELab Value	(0062,000D)	-	Not required - no compliant implementation shall rely on this element being present for proper operation. However applications are allowed to be aware of this element and use it to map display colors.
>Contour Sequence	(3006,0040)	R+*	Shall be present. Shall contain an item for each contour in the ROI. Compliant implementations shall be able to handle as many as 1000 contours on a single slice. That is, the number of contours in items in all Contour Sequences with the same z-coordinate (and referenced CT image) should be less than or equal to 1000.
>>Contour Image Sequence	(3006,0016)	R+*	Shall be present with a single item. This item is the image upon which this contour should be placed. If the contour type is CLOSED_PLANAR, then the z-coordinates of the contour shall match the z-coordinate of Image Position (Patient) in the image.
>>>Referenced SOP Class UID	(0008,1150)	R+*	Shall be present with a value of '1.2.840.10008.5.1.4.1.1.2'
>>>Referenced SOP Instance UID	(0008,1155)	R*	SOP Instance UID of the image being referenced.
>>>Referenced Frame Number	(0008,1160)	O+*	Shall not be present
>>Contour Geometric Type	(3006,0042)	R+*	Shall be present, with a value of POINT or CLOSED_PLANAR. Conforming implementations must properly interpret this value.
>>Contour Slab Thickness	(3006,0044)	-	Not required - no compliant implementation shall rely on this element being present for proper operation.

Attribute	Tag	Type	Attribute Note
>>Contour Offset Vector	(3006,0045)	O+*	The profile requires that this attribute be zero if present.
>>Number of Contour Points	(3006,0046)	R+*	Required, and must match the actual number of points in Contour Data. Shall not exceed the number for which the Contour Data cannot be encoded when using explicit transfer syntax.
>>Contour Data	(3006,0050)	R+*	Shall be present. If contour type is CLOSED_PLANAR, then all points must have the same z-coordinate. This z-coordinate shall match the z-coordinate in the related CT image within 0.01 mm (contained in the Contour Image sequence in the same item of the ROI Contour Sequence as this data). An implication of this is that the CLOSED_PLANAR contours are transverse.

7.4.8.2.2 RT ROI Contour Module Off-slice

7.4.8.2.2.1 Referenced Standards

DICOM 2018d Edition PS 3.3

1885 7.4.8.2.2.2 Module Definition

Attribute	Tag	Type	Attribute Note
ROI Contour Sequence	(3006,0039)	R*	
>ROI Display Color	(3006,002A)	-	Not required - no compliant implementation shall rely on this element being present for proper operation. However applications are allowed to be aware of this element and use it to map display colors.
> Recommended Display Grayscale Value	(0062,000C)	-	Not required - no compliant implementation shall rely on this element being present for proper operation. However applications are allowed to be aware of this element and use it to map display colors.
> Recommended Display CIELab Value	(0062,000D)	-	Not required - no compliant implementation shall rely on this element being present for proper operation. However applications are allowed to be aware of this element and use it to map display colors.
>Contour Sequence	(3006,0040)	R+*	Shall be present. Shall contain an item for each contour in the ROI. Compliant implementations shall be able to handle as many as 1000 contours on a single slice. That is, the number of contours in items in all Contour Sequences with the same z-coordinate (and referenced CT image) should be less than or equal to 1000.
>> Contour Number	(3006,0048)	R+*	Shall be present if Contour Geometry Type (3006,0042) is CLOSED_PLANAR.
>> Attached Contours	(3006,0049)	RC+*	Shall be present if Contour Geometry Type (3006,0042) is CLOSED_PLANAR and there are other contours referenced. Multiplicity equals the number of contours referenced from this contour (s. 3.3.4.1.2).

Attribute	Tag	Type	Attribute Note
>>Contour Image Sequence	(3006,0016)	RC+*	Shall be present for contours located on image planes. This item is the image upon which this contour should be placed. If the contour type is CLOSED_PLANAR, there shall be contours whose z-coordinates match the z-coordinates of Image Position (Patient) in the image for structures that intersect this image plane.
>>>Referenced SOP Class UID	(0008,1150)	R+*	Shall be present with a value of '1.2.840.10008.5.1.4.1.1.2'
>>>Referenced SOP Instance UID	(0008,1155)	R*	SOP Instance UID of the image being referenced.
>>>Referenced Frame Number	(0008,1160)	O+*	Shall not be present
>>Contour Geometric Type	(3006,0042)	R+*	Shall be present, with a value of POINT or CLOSED_PLANAR. Conforming implementations must properly interpret this value.
>>Contour Slab Thickness	(3006,0044)	-	Not required - no compliant implementation shall rely on this element being present for proper operation.
>>Contour Offset Vector	(3006,0045)	O+*	The profile requires that this attribute be zero if present.
>>Number of Contour Points	(3006,0046)	R+*	Required, and must match the actual number of points in Contour Data. Shall not exceed the number for which the Contour Data cannot be encoded when using explicit transfer syntax.
>>Contour Data	(3006,0050)	R+*	Shall be present. If contour type is CLOSED_PLANAR, then all points must have the same z-coordinate. For every image plane which is referenced in the Structure Set Module () and intersect the ROI, there shall be contours defined the image plane. The z-coordinate of those contours shall match the z-coordinate of the referenced image plane within 0.01 mm (contained in the Contour Image sequence in the same item of the ROI Contour Sequence as this data). An implication of this is that the CLOSED_PLANAR contours are transverse.

7.4.8.3 Structure Set Module

7.4.8.3.1 Structure Set Module Base Content

7.4.8.3.1.1 Referenced Standards

DICOM 2018d Edition PS 3.3

1890 **7.4.8.3.1.2 Module Definition**

Attribute	Tag	Type	Attribute Note
Structure Set Label	(3006,0002)	R+	

Attribute	Tag	Type	Attribute Note
Structure Set Date	(3006,0008)	R+	
Structure Set Time	(3006,0009)	R+	
Referenced Frame of Reference Sequence	(3006,0010)	R+*	This element is required for all 3D RT Structure Sets which are image based. It is to contain a set of references to the entire set of images which comprise the volume from which the Structure Set was constructed, and which is to be used for planning. There should only be one item in this sequence, as a BRTO Profile-based structure is based on a single set of images, which are all in the same frame of reference.
>Frame of Reference UID	(0020,0052)	R+*	This frame of reference UID shall be the same as the frame of reference of the CT series from which the Structure Set was constructed. It will also be the same as the frame of reference of any related RTPLAN's or RTDOSE's.
>RT Referenced Study Sequence	(3006,0012)	R+*	Shall be present and contain the series sequence. Only one item allowed in this sequence.
>>Referenced SOP Instance UID	(0008,1155)	R+*	This Study Instance UID shall be the same as the Study Instance UID of the related CT instances.
>>RT Referenced Series Sequence	(3006,0014)	R+*	Shall be present to contain the Contour Image Sequence. Only one item allowed in this sequence.
>>>Series Instance UID	(0020,000E)	R+*	Shall be present and contain the series to which the set of CT images upon which the structure set is based belong.
>>>Contour Image Sequence	(3006,0016)	R+*	Shall be present. Contains an item for each CT image in the volume upon which the Structure Set is based.
>>>>Referenced SOP Class UID	(0008,1155)	R+*	Shall be present with a value of '1.2.840.10008.5.1.4.1.1.2' This profile is for volumes based on CT Images only
>>>>Referenced Frame Number	(0008,1160)	O+*	Shall not be present
Structure Set ROI Sequence	(3006,0020)	R+*	This sequence shall be present. It defines the ROI's in this Structure Set.
>ROI Number	(3006,0022)	R*	This defines an index to be used for referencing a particular ROI item from other sequences. It is required to be unique within the Structure Set in which it is created. No limitation on values other than uniqueness within sequence.
>Referenced Frame of Reference UID	(3006,0024)	R*	This frame of reference UID shall be the same as the frame of reference UID of the CT series from which the Structure Set was constructed. It will also be the same as the frame of reference of any related RTPLAN or RTDOSE instances.
>ROI Name	(3006,0026)	R+	This is the primary identifier for an ROI (from user perspective). Shall be present and should match UI display. Shall be unique within the Structure Set ROI sequence.
>ROI Description	(3006,0028)	-	Not required - no compliant implementation shall rely on this element being present for proper operation.
>ROI Volume	(3006,002C)	-	Not required - no compliant implementation shall rely on this element being present for proper operation.
>ROI Generation Algorithm	(3006,0036)	R+	Shall be present, with a value of AUTOMATIC, SEMIAUTOMATIC, or MANUAL.

Attribute	Tag	Type	Attribute Note
			This information may be presented to a user, but no semantics for handling a Structure Set is required for this profile. Implementations which create Structure Set instances must provide an appropriate value.

7.4.9 Segment Modules in Delivery

This section is present only to convey the envisioned section numbering.

7.4.10 Registration Modules in Planning

This section is present only to convey the envisioned section numbering.

1895 7.4.11 Treatment Records

This section is present only to convey the envisioned section numbering.

7.4.12 Prescription-Related Modules in Planning

This section is present only to convey the envisioned section numbering.

7.4.13 Dose-Related Modules

1900 7.4.13.1 Image Plane Module

7.4.13.1.1 Image Plane Base Content

7.4.13.1.1.1 Referenced Standards

DICOM 2018d Edition PS 3.3

7.4.13.1.1.2 Module Definition

Attribute	Tag	Type	Attribute Note
Image Orientation (Patient)	(0020,0037)	R+*	This element shall be restricted to TRANSVERSE images only. For a transverse image, direction cosines shall be ($\pm 1, 0, 0, 0, \pm 1, 0$) with an angle tolerance of 0.001 radians (~ 0.057 degrees). The Image Orientation (Patient) shall correspond to the RT Patient Setup of the associated RT Plan (s. 7.3.2.2.1)
Slice Thickness	(0018,0050)	-	Shall not be relied on.
Slice Location	(0020,1041)	-	Shall not be relied on.
Pixel Spacing	(0028,0030)	O+*	For CT, non-isotropic pixels are outside the scope of the profile. For RT Dose, pixel spacing may be non-isotropic.

1905 **7.4.13.2 Multi-Frame Module**

7.4.13.2.1 Multi-Frame Module Base Content

7.4.13.2.1.1 Referenced Standards

DICOM 2018d Edition PS 3.3

7.4.13.2.1.2 Module Definition

Attribute	Tag	Type	Attribute Note
Frame Increment Pointer	(0028,0009)	R+*	Shall have the same value as the Grid Frame Offset Vector (3004,000C).

1910 **7.4.13.3 RT Dose Module**

7.4.13.3.1 RT Dose Module Base Content

7.4.13.3.1.1 Referenced Standards

DICOM 2018d Edition PS 3.3

7.4.13.3.1.2 Module Definition

Attribute	Tag	Type	Attribute Note
Content Date	(0008,0023)	R+	Required
Content Time	(0008,0033)	R+	Required
Samples per Pixel	(0028,0002)	R+*	Shall be present and equal to 1.
Photometric Interpretation	(0028,0004)	R+*	Shall be present and equal to MONOCHROME2 .
Bits Allocated	(0028,0100)	R+*	Shall be present and equal to 16 or 32.
Bits Stored	(0028,0101)	R+*	Shall be equal to Bits Allocated.
High Bit	(0028,0102)	R+*	Shall be one less than Bits Stored.
Pixel Representation	(0028,0103)	R+*	Shall have the value 0 = unsigned integer. Negative dose values shall not be present.
Dose Units	(3004,0002)	R+*	Shall be equal to the enumerated value GY .
Dose Type	(3004,0004)	R+*	Shall be equal to the defined term PHYSICAL or EFFECTIVE .
Dose Comment	(3004,0006)	RC+	Shall be present and not empty if Referenced RT Plan Sequence (300C,0002) is missing and RT Plan Description is present, in which case it should have the same value as RT Plan Description.
Normalization Point	(3004,0008)	-	Shall not be relied on.
Dose Summation Type	(3004,000A)	R+*	Shall have the value PLAN .
Referenced RT Plan Sequence	(300C,0002)	R+*	Shall be present if Dose Summation Type (3004,000A) has the value PLAN .

Attribute	Tag	Type	Attribute Note
Grid Frame Offset Vector	(3004,000C)	R+*	First z coordinate shall be equal to zero. The remaining z coordinates shall be relative to the starting z position in Image Position (Patient) (0020,0032). The difference between neighboring values shall be constant with a tolerance of 0.01mm.
Tissue Heterogeneity Correction	(3004,0014)	R+	Shall be present.

1915 **7.4.13.4 RT DVH Module**

7.4.13.4.1 RT DVH Module Base Content

7.4.13.4.1.1 Referenced Standard

DICOM 2018d Edition PS 3.3

7.4.13.4.1.2 Module Definition

Attribute Name	Tag	Type	Attribute Description
DVH Normalization Point	(3004,0040)	R+*	Shall not be present
DVH Normalization Dose Value	(3004,0042)	R+*	Shall not be present
DVH Sequence	(3004,0050)	-	Sequence of DVHs. One or more Items shall be included in this Sequence.
>DVH Type	(3004,0001)	R+*	Shall be DIFFERENTIAL or CUMULATIVE
>Dose Units	(3004,0002)	R+	Shall be GY.
>Dose Type	(3004,0004)	R+	Shall be either PHYSICAL or EFFECTIVE
>DVH Volume Units	(3004,0054)	R+	Shall be CM3

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Appendices

NA.

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4 National Extensions

1925 NA.