ASTRO
Integrating the Healthcare Enterprise

IHE-Radiation Oncology
Technical Framework
Volume 2 - Transactions

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Contents

1 Preface to Volume 2

1.1 Intended Audience

The intended audience of this document is:

- Technical staff of vendors planning to participate in the IHE initiative
- IT departments of healthcare institutions
- Experts involved in standards development
- Anyone interested in the technical aspects of integrating healthcare information systems

1.2 How this Document is Organized

Section 1 is the preface, describing the intended audience, related resources, and organizations and conventions used within this document.

Section 2 provides an overview of the concepts of IHE actors and transactions used in IHE to define the functional components of a distributed healthcare environment.

Section 3 defines transactions in detail, specifying the roles for each actor, the standards employed, the information exchanged, and in some cases, implementation options for the transaction.

Section 4 defines a set of payload bindings with transactions.

Section 5 defines the high level content specifications used for the payloads of the transactions.

Section 6 defines the reusable sections of content payloads.

Section 7 defines the lower level building blocks used in various sections.

1.3 Conventions Used in this Volume

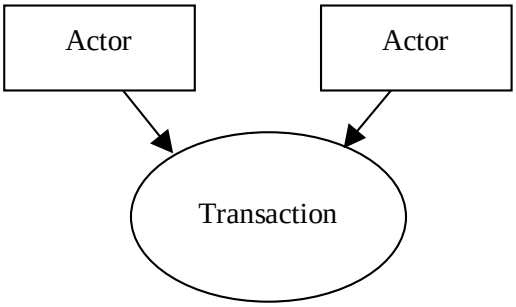
This document has adopted the following conventions for representing the framework concepts and specifying how the standards upon which the IHE Technical Framework is based should be applied.

1.3.1 The Generic IHE Transaction Model

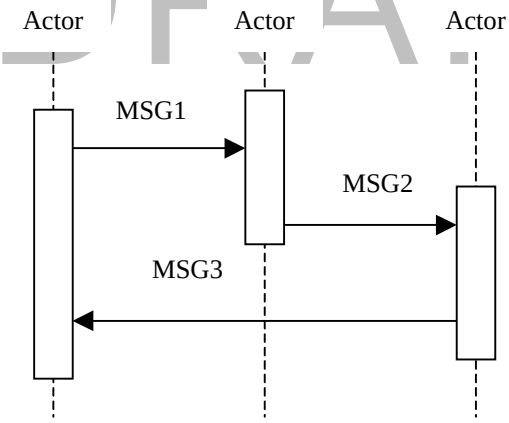
Transaction descriptions are provided in section 4. In each transaction description, the actors, the roles they play, and the transactions between them are presented as use cases.

The generic IHE transaction description includes the following components:

- Scope: a brief description of the transaction.
- Use case roles: textual definitions of the actors and their roles, with a simple diagram relating them, e.g.:



- *Referenced Standards*: the standards (stating the specific parts, chapters or sections thereof) to be used for the transaction.
- *Interaction Diagram*: a graphical depiction of the actors and transactions, with related processing within an actor shown as a rectangle and time progressing downward, similar to:



The interaction diagrams used in the IHE Technical Framework are modeled after those described in Grady Booch, James Rumbaugh, and Ivar Jacobson, *The Unified Modeling Language User Guide*, ISBN 0-201-57168-4. Simple acknowledgment messages are omitted from the diagrams for brevity.

- *Message definitions*: descriptions of each message involved in the transaction, the events that trigger the message, its semantics, and the actions that the message triggers in the receiver.

1.4 Copyright Permissions

1.5 Comments

The IHE sponsors welcome comments on this document and the IHE initiative. They should be directed to the discussion server at http://forums.rsna.org or to:

Robyn Lynn Watson, PhD

Director of Research
American Society for Therapeutic Radiology and Oncology (ASTRO)
8280 Willow Oaks Corporate Drive, Suite 500
Fairfax, VA 22031
ihero@astro.org

2 Introduction

This document, the IHE Radiation Oncology Technical Framework (RO-TF), defines specific implementations of established standards. These are intended to achieve integration goals that promote appropriate exchange of medical information to coordinate the optimal patient care among care providers in different care settings. It is expanded annually, after a period of public review, and maintained regularly through the identification and correction of errata. The latest version of the document is always available via the Internet at http://www.ihe.net/Technical_Framework/index.cfm , where the technical framework volumes specific to the various healthcare domains addressed by IHE may be found.

The IHE Radiation Oncology Technical Framework identifies a subset of the functional components of the healthcare enterprises and health information networks, called IHE actors, and specifies their interactions in terms of a set of coordinated, standards-based transactions.

The other domains within the IHE initiative also produce Technical Frameworks within their respective areas that together form the IHE Technical Framework. Currently, the following IHE Technical Framework(s) are available:

- IHE IT Infrastructure Technical Framework
- IHE Cardiology Technical Framework
- IHE Eye Care Technical Framework
- IHE Laboratory Technical framework
- IHE Radiology Technical Framework
- IHE Patient Care Coordination Technical Framework

Where applicable, references are made to other technical frameworks. For the conventions on referencing other frameworks, see the preface of this volume.

2.1 Relationship to Standards

The IHE Technical Framework identifies functional components of a distributed healthcare environment (referred to as IHE actors), solely from the point of view of their interactions in the healthcare enterprise. At its current level of development, it defines a coordinated set of transactions based on standards (such as HL7, IETF, ASTM, DICOM, ISO, OASIS, etc.) in order to accomplish a particular use case. As the scope of the IHE initiative expands, transactions based on other standards may be included as required.

In some cases, IHE recommends selection of specific options supported by these standards. However, IHE does not introduce technical choices that contradict conformance to these standards. If errors in or extensions to existing standards are

identified, IHE's policy is to report them to the appropriate standards bodies for resolution within their conformance and standards evolution strategy.

IHE is therefore an implementation framework, not a standard. Conformance claims for products must still be made in direct reference to specific standards. In addition, vendors who have implemented IHE integration capabilities in their products may publish IHE Integration Statements to communicate their products' capabilities. Vendors publishing IHE Integration Statements accept full responsibility for their content. By comparing the IHE Integration Statements from different products, a user familiar with the IHE concepts of actors and integration profiles can determine the level of integration between them. See http://www.ihe.net/Resources/upload/ihe_integration_statements.pdf for the format of IHE Integration Statements.

2.2 Relationship to Product Implementations

The IHE actors and transactions described in the IHE Technical Framework are abstractions of the real-world healthcare information system environment. While some of the transactions are traditionally performed by specific product categories (e.g. HIS, Clinical Data Repository, Electronic Health record systems, Radiology Information Systems, Clinical Information Systems or Cardiology Information Systems), the IHE Technical Framework intentionally avoids associating functions or actors with such product categories. For each actor, the IHE Technical Framework defines only those functions associated with integrating information systems. The IHE definition of an actor should therefore not be taken as the complete definition of any product that might implement it, nor should the framework itself be taken to comprehensively describe the architecture of a healthcare information system.

The reason for defining actors and transactions is to provide a basis for defining the interactions among functional components of the healthcare information system environment. In situations where a single physical product implements multiple functions, only the interfaces between the product and external functions in the environment are considered to be significant by the IHE initiative. Therefore, the IHE initiative takes no position as to the relative merits of an integrated environment based on a single, all-encompassing information system versus one based on multiple systems that together achieve the same end.

2.3 Relation of this Volume to the Technical Framework

The IHE Technical Framework is based on actors that interact through transactions.

Actors are information systems or components of information systems that produce, manage, or act on information associated with operational activities in the enterprise.

Transactions are interactions between actors that transfer the required information through standards-based messages.

The implementation of the transactions described in this volume support the specification of Integration Profiles defined in Volume 1. The role and implementation of these transactions require the understanding of the Integration profile they support.

2.4 IHE Usage Conventions (included for reference)

For some DICOM transactions described in this document, IHE has strengthened the requirements on the use of selected Type 2 and Type 3 attributes. These situations are explicitly documented in section 4 and in the appendices.

IHE specifically emphasizes that DICOM Type 2 attributes (for instance, Patient Name, Patient ID) shall be transmitted with zero length if the source system does not possess valid values for such attributes; in other words, the source system shall not assign default values to such attributes. The receiving system must be able to handle zero-length values for such attributes.

IHE has also defined requirements related to the support for and use of matching and return keys in DICOM queries by both Service Class Users (SCUs) and Service Class Providers (SCPs). Matching keys are used to select instances for inclusion in the response by the query SCP to the SCU, whereas return keys only return specific data and are not used for matching.

- Required matching key SCU:

  A key that the Query SCU shall have the ability to offer to its user as a selection criterion. The definition of the means offered to the user of the Query SCU to trigger the sending of a matching key in the Query request is beyond the scope of IHE (e.g. enter a value, select an entry).

- Required matching key SCP:

  An IHE required matching key is processed by the Query SCP just as if it were a DICOM-required matching key. In most cases, IHE-required matching keys are also DICOM-required matching keys.

- Required return key SCU:

  A key that the Query SCU requests from the Query SCP, receives in the query responses, and displays for the user, if required. The definition of the means offered to the user of the Query SCU to request a return key (e.g. by default, check a box) and to make it visible to the user is beyond the scope of IHE.

- Required return key SCP:

  IHE-required return keys specified within DICOM as type 1 or type 2 return keys are processed according to their DICOM type. IHE-required return keys specified within DICOM as type 3 will be processed as if they were type 2.

Query Key Requirement Tables in the framework use the following legend to specify requirements for SCUs and SCPs:

R Required O Optional

The following modifiers are also used:

R+ The requirement is an IHE extension of the DICOM requirements

R* The attribute is not required to be displayed

R+* The Requirement is an IHE extension of the DICOM requirements, but it is NOT required to be displayed

3 IHE Transactions

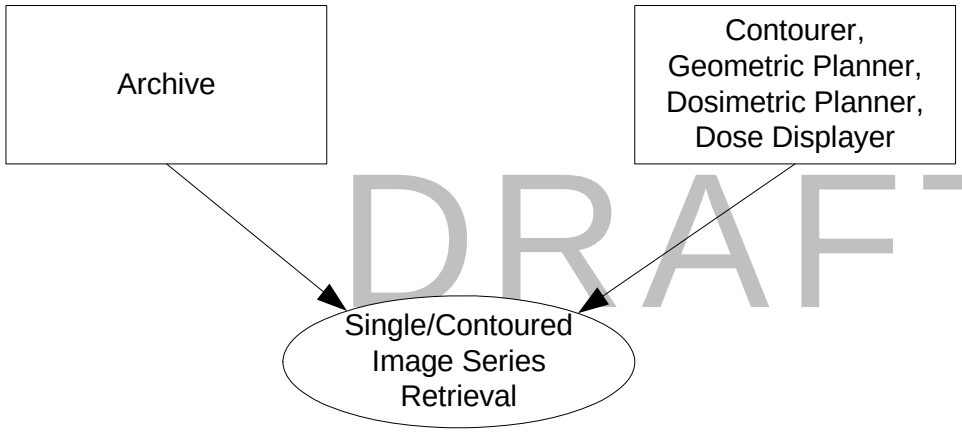
This section defines each IHE transaction in detail, specifying the standards used, and the information transferred.

3.1 RO-1: Single/Contoured Image Series Retrieval

3.1.1 Scope

In the Single/Contoured Image Series Retrieve transaction, the Archive sends a series of CT-Images to the ***Contourer***, ***Geometric Planner***, ***Dosimetric Planner*** or ***Dose Displayer***.

3.1.2 Use Case Roles



Actor: Archive

Role: Transmit CT Series to ***Contourer***, ***Geometric Planner***, ***Dosimetric Planner*** or ***Dose Displayer***

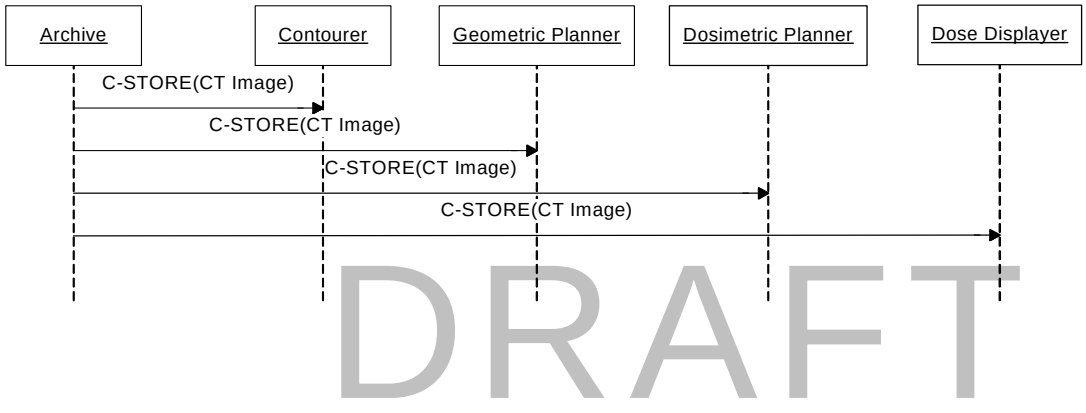
Actor: ***Contourer***, ***Geometric Planner***, ***Dosimetric Planner*** or ***Dose Displayer***

Role: Receives and stores CT Series from Archive

3.1.3 Referenced standards

DICOM 2008 PS3.4: Storage Service Class.

3.1.4 Interaction Diagram



3.1.4.1 Single/Contoured Image Series Retrieval

3.1.4.1.1 Trigger Events

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 ***Geometric Planner***, in order to generate a geometric plan, determines that a certain CT Series is required, and requests that the archive send the necessary CT series to the ***Geometric Planner***.

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***.

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

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

Also refer to appendix A for an overview of specific requirements on the DICOM attributes that are included in a CT Image Object. In particular, all of the CT images involved in this transaction must share a single series instance UID and a single frame of reference UID.

3.1.4.1.3 Expected Actions

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 a structure set (RO-2).

The ***Geometric 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 ***Geometric Planner*** for use in construction of a geometric plan which will later be exported as a ***Geometric Plan*** (RO-3).

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-5).

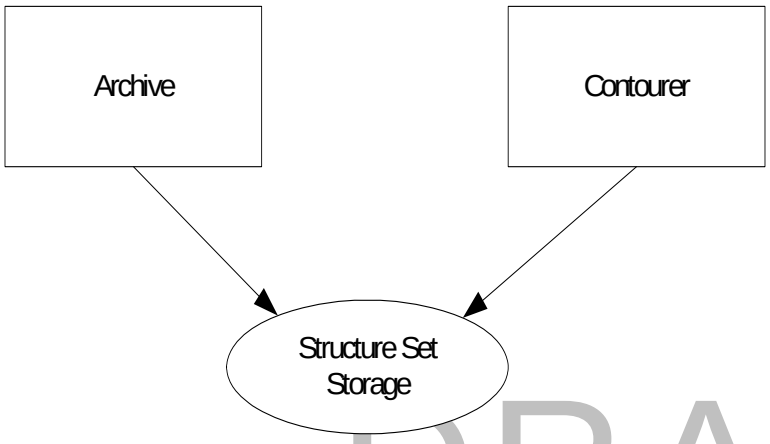
The ***Dose Displayer*** will store all of the CT Images, and will relate the images based on the study, series, and image identification information. These images will then be available to the user of the ***Dose Displayer*** for use in construction of a dose display.

3.2 RO-2: Structure Set Storage

3.2.1 Scope

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

3.2.2 Use Case Roles



Actor: Contourer

Role: Sends Structure Set to Archive

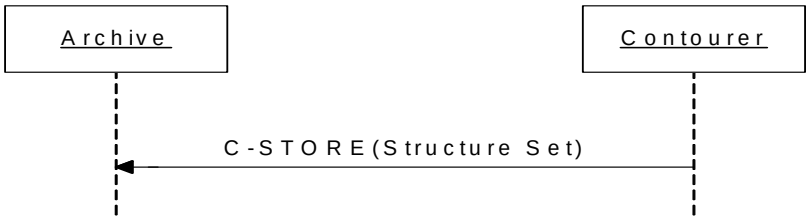
Actor: Archive

Role: Stores Structure Set received from ***Contourer***

3.2.3 Referenced standards

DICOM 2008 PS3.4: Storage Service Class.

3.2.4 Interaction Diagram



3.2.4.1 Structure Set storage

3.2.4.1.1 Trigger Events

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

3.2.4.1.2 Semantics

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

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 a 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).

Also refer to appendix B for an overview of the specific requirements on the DICOM attributes that are included in an RT Structure Set object. In particular, the structure set must share a single frame of reference UID with the images.

3.2.4.1.3 Expected Actions

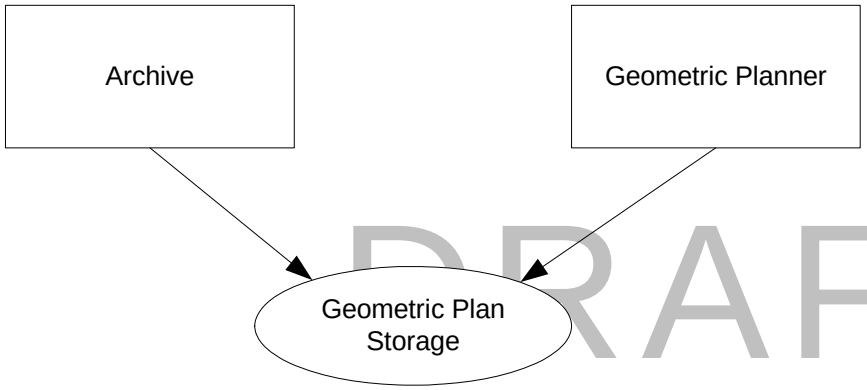
Upon receipt of the Structure Set, the Archive shall store it. This Structure Set is then available for subsequent retrieval (RO-7).

3.3 RO-3: Geometric Plan Storage

3.3.1 Scope

In the ***Geometric Plan*** Storage transaction, the ***Geometric Planner*** sends the newly created ***Geometric Plan*** to the Archive.

3.3.2 Use Case Roles



Actor: Geometric Planner

Role: Transmit generated ***Geometric Plan*** to the Archive

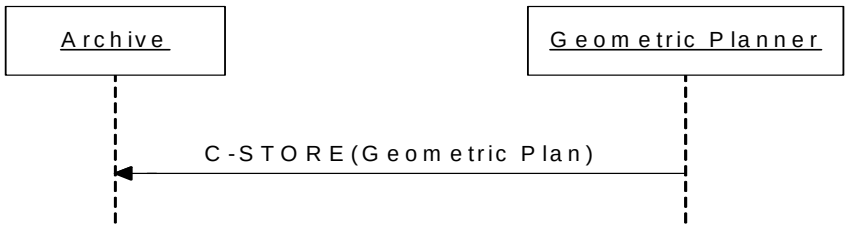
Actor: Archive

Role: Receives and stores Geometric Plans from the ***Geometric Planner***

3.3.3 Referenced standards

DICOM 2008 PS3.4: Storage Service Class.

3.3.4 Interaction Diagram



3.3.4.1 Geometric Plan Storage

3.3.4.1.1 Trigger Events

Upon successful creation of the Geometric Plan, the user of the ***Geometric Planner*** decides to store the Geometric Plan. The ***Geometric Planner*** transfers the ***Geometric Plan*** to the Archive within a DICOM association.

3.3.4.1.2 Message Semantics

The ***Geometric Planner*** uses the DICOM C-STORE message to transfer the Geometric Plan. The ***Geometric Planner*** is the DICOM Storage SCU and the Archive is the DICOM Storage SCP.

Also refer to appendix A for an overview of ***Geometric Plan*** specific requirements on the DICOM attributes that are included in an RT Plan object.

3.3.4.1.3 Expected Actions

The Archive will store the received Geometric Plan.

3.4 RO-4: Dosimetric Plan Storage

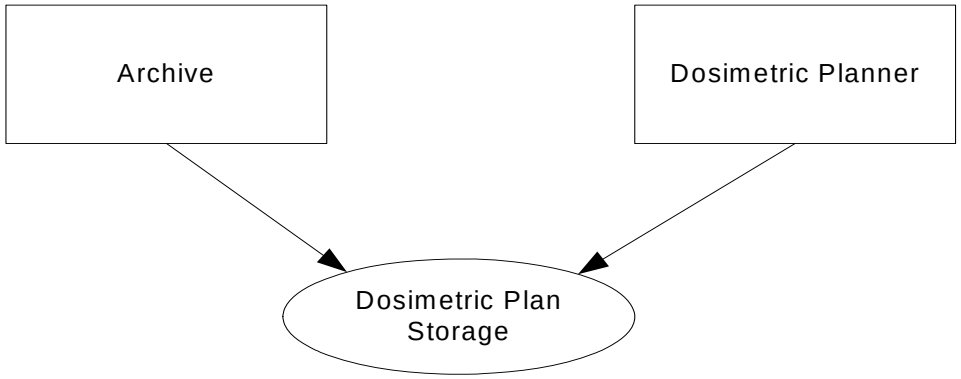
This section corresponds to Transaction RO-4 of the IHE-RO Technical Framework. Transaction RO-4 is used by the Archive and Dosimetric Planner actors.

3.4.1 Scope

In this transaction, the ***Dosimetric Planner*** sends the plan containing the references to the

structure set to the Archive.

3.4.2 Use Case Roles



Actor: ***Dosimetric Planner***

Role: Transmit generated plan to Archive.

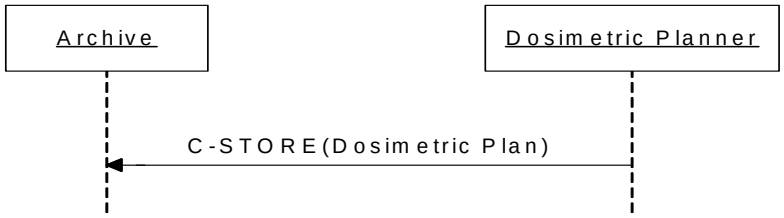
Actor: Archive

Role: Accept and store plan from ***Dosimetric Planner.***

3.4.3 Referenced Standards

DICOM 2008, PS 3.3: RT Modules, PS 3.4: Storage Service Class.

3.4.4 Interaction Diagram



3.4.4.1 Dosimetric Plan Storage

3.4.4.1.1 Trigger Events

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

3.4.4.1.2 Message Semantics

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 plan or may use an existing series, where previous plan(s) are contained.

The study, where the series of the plan is contained, shall be the same study as the one containing the structure set referenced in the plan.

The purpose of the ***Dosimetric Plan*** transferred is to convey the reference to the 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 structure set and the CT images referenced in the structure set for display.

The following table shows the IHE extension of the DICOM requirements for the RT General Plan module.

Table 3.4-1 Required Attributes for RT General Plan Module

Attribute	Tag	Type	Attribute Description

RT Plan Label	(300A,0002)	R+	the user.
RT Plan Date	(300A,0006)	R+	modified.

RT Plan Time	(300A,0007)	R+	modified.
RT Plan Geometry	(300A,000C)	1	Shall be PATIENT. This implies, that the RT Structure Set exists and is referenced in the General Plan module.

The following table shows the IHE extension of the DICOM requirements for the General Equipment module.

Table 3.4-2 Required Attributes for General Equipment Module

Attribute	Tag	Type	Attribute Description

Manufacturer	(0008,0070)	R+	The manufacturer of the ***Dosimetric Planner*** equipment creating the plan shall be provided.
Manufacturer's Model Name	(0008,1090)	R+	The manufacturer's model name of the ***Dosimetric Planner*** equipment creating the plan shall be provided.

Software Versions	(0008,1020)	R+	version of the ***Dosimetric Planner*** equipment creating the plan shall be provided.

On all other attributes of the RT Plan IOD, no IHE extension to the DICOM requirements exists.

The Dosimetric Plan may 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.

Applications should display Plan Label, Date and Time in order to safely identify matching Dose and Plan pairs.

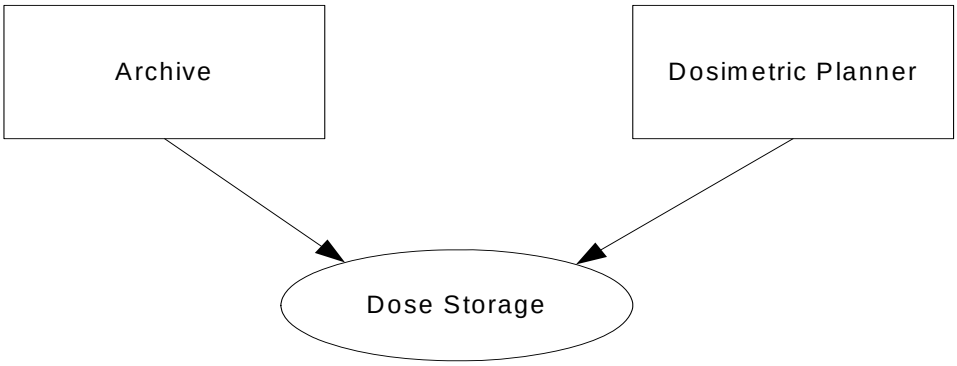
3.5 RO-5: Dose Storage

This section corresponds to RO-5 of the IHE-RO technical framework. Transaction RO-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



Actor: ***Dosimetric Planner***

Role: Transmit generated Dose to the Archive

Actor: Archive

Role: Receives and stores Doses from the ***Dosimetric Planner***

3.5.3 Referenced standards

DICOM 2008 PS3.4: Storage Service Class.

3.5.4 Interaction Diagram

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.

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 appendix A for an overview of Dose specific requirements on the DICOM attributes that are included in an RT Dose object.

3.5.4.1.3 Representation of Dose

This transaction shall support Dose represented as a three-dimensional dose array sampled onto axial 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 value of Image Orientation (Patient) (0020,0037) shall be [±1, 0, 0, 0, ±1, 0].

Not supported are point doses, projection of dose onto an oblique plane, iso-dose contours and dose-volume histograms. 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

The Archive will store the received Dose.

The DICOM RT Dose object will be stored such that it can be later retrieved (See RO-10 Dose Retrieve) in a fashion meeting the requirements defined for a DICOM level 2 SCP (Refer to DICOM PS 3.4 B.4.1).

The DICOM SOP Class UID and Name for the RT Dose object is defined in the table below.

SOP Class UID	SOP Class Name

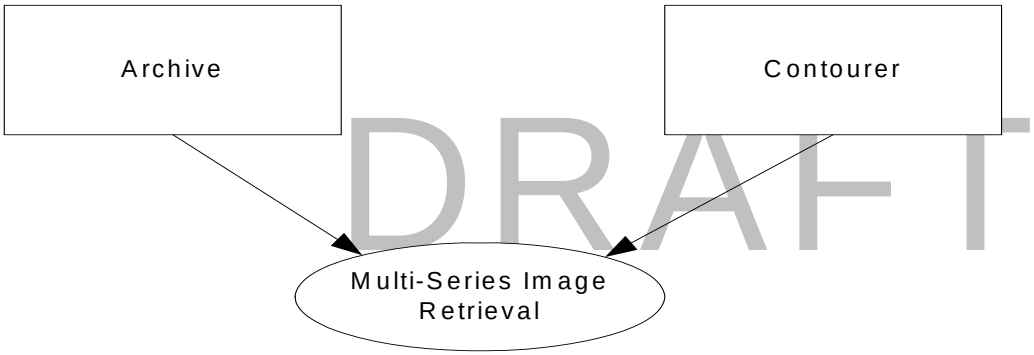
1.2.840.10008.5.1.4.1.1.481.2	RT Dose Storage

3.6 RO-6: Multi-Series Image Retrieve

3.6.1 Scope

In the Multi-Series Image Retrieve Transaction, the Archive stores CT Images from multiple series (but a single study) on a ***Contourer*** to make these Images available for contouring.

3.6.2 Use Case Roles



Actor: Archive

Role: Sends CT Images to the ***Contourer***

Actor: ***Contourer***

Role: Stores CT Images received from Archive

3.6.3 Referenced standards

DICOM 2008 PS3.4: Storage Service Class.

3.6.4 Interaction Diagram

3.6.4.1 Multi-Series Image Retrieve

3.6.4.1.1 Trigger Events

The user of the ***Contourer*** determines that Images from multiple CT Series are to be used in the construction of a single set of contours, and requests that the Archive send these Series to the ***Contourer***.

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

3.6.4.1.2 Message Semantics

The message semantics are defined by the DICOM Storage SOP Class. The Archive is the SCU of this service class, and the ***Contourer*** is the SCP of this service Class.
Also refer to appendix A 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, but not a series instance UID.

3.6.4.1.3 Expected Actions

Upon receiving the multiple CT Series, the ***Contourer*** will resample the Series if necessary, and will combine Images from the various series into a single, new CT Series with a new series instance UID. A Contourer shall be required to support retrieval of multiple (1, 2, or 3) image series. Images in this new series will all share the same study instance UID with the original images. These new images must also share a single frame

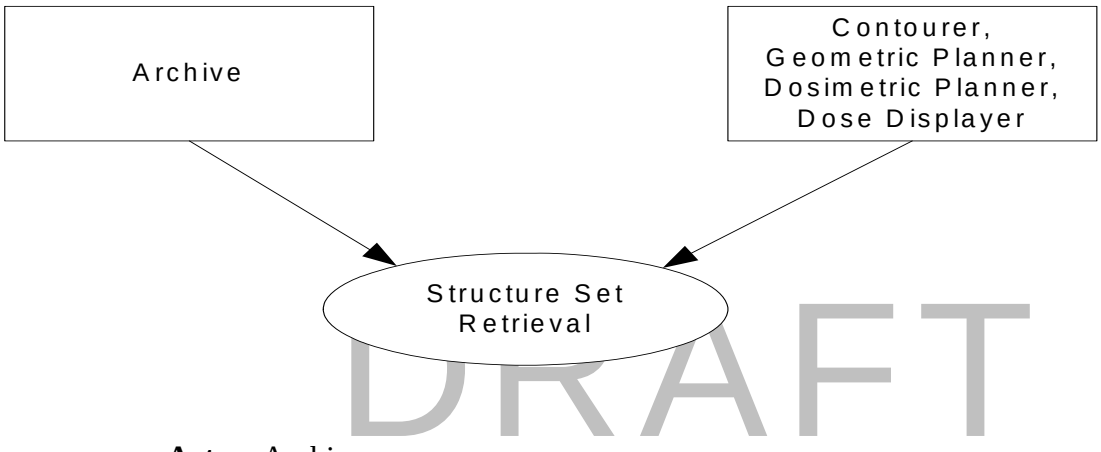
of reference UID with the original images. This new series will be sent back to the archive using the Resampled/Combined CT Series Stored transaction (RO-11).

3.7 RO-7: Structure Set Retrieval

3.7.1 Scope

In the Structure Set Retrieval Transaction, the Archiver stores a Structure Set on a ***Contourer***, ***Geometric Planner***, ***Dosimetric Planner***, or ***Dose Displayer***.

3.7.2 Use Case Roles



Actor: Archive

Role: Sends Structure Set to ***Contourer***, ***Geometric Planner***, ***Dosimetric Planner***, or ***Dose Displayer***

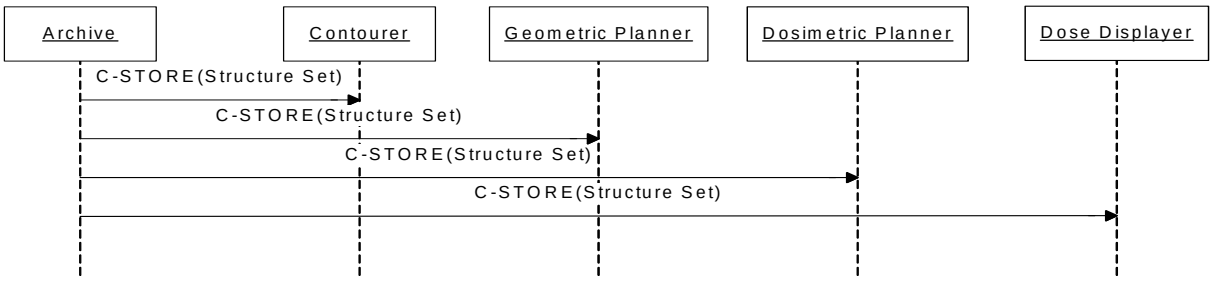
Actor: ***Contourer***, ***Geometric Planner***, ***Dosimetric Planner***, or ***Dose Displayer***

Role: Stores Structure Set received from Archive

3.7.3 Referenced standards

DICOM 2008 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 Structure Set, and requests that the archive send this Structure Set to the ***Contourer***.

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

The user of the ***Dosimetric Planner*** determines that a new dosimetric plan is to be based upon an existing Structure Set, and 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***.

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***, ***Geometric Planner***, ***Dosimetric Planner***, or ***Dose Displayer*** is the storage SCP and the Archive is the storage SCU.

Also refer to appendix B for an overview of the specific requirements on the DICOM attributes that are included in an RT Structure Set object. In particular, the structure set must have the same study instance UID, but a different series instance UID, than the CT series upon which the contours are based.

3.7.4.1.3 Expected Actions

The ***Contourer*** will store all of the 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 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 structure set.

The ***Geometric Planner*** will store the structure set, and will relate it to images based on the study, series, and image identification information. The contours contained in this structure set will then be available to the user of the ***Geometric Planner*** for use in construction of a geometric plan which will later be exported as a ***Geometric Plan*** (RO-3).

The ***Dosimetric Planner*** will store the structure set, and will relate it to images based on the study, series, and image identification information. These contours contained in this structure set 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-5).

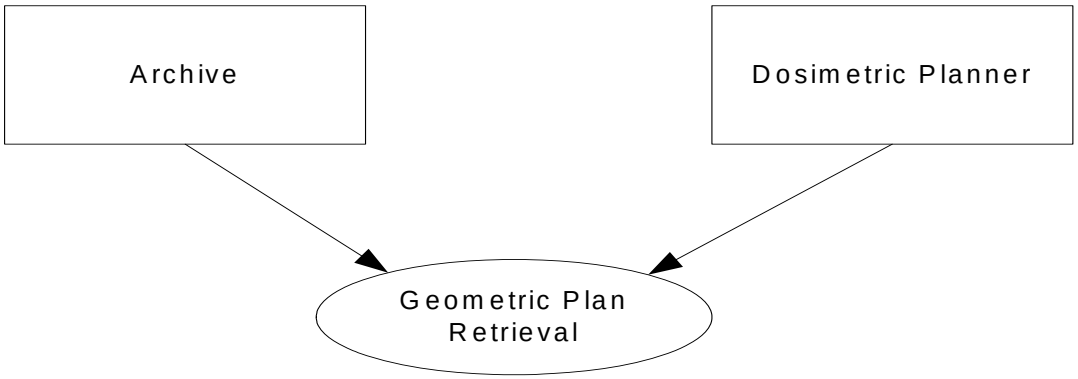
The ***Dose Displayer*** will store the structure set, and will relate it to images based on the study, series, and image identification information. These contours contained in this structure set will then be available to the user of the ***Dose Displayer*** for display in relation to images, doses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

3.8 RO-8: Geometric Plan Retrieve

3.8.1 Scope

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

3.8.2 Use Case Roles



Actor: *Dosimetric Planner*

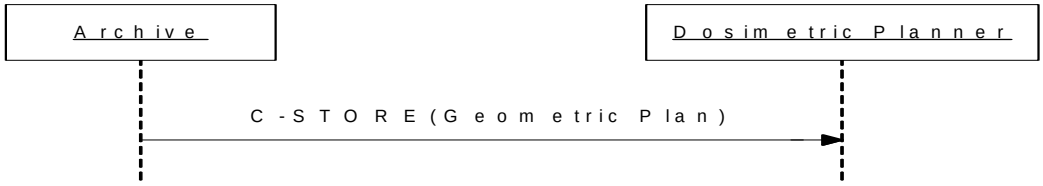
Role: Receives requested ***Geometric Plan*** from the Archive
Actor: Archive

Role: Sends requested ***Geometric Plan*** instance to the ***Dosimetric Planner***

3.8.3 Referenced standards

DICOM 2008 PS3.4: Storage Service Class.

3.8.4 Interaction Diagram



3.8.4.1 Geometric Plan Retrieve

3.8.4.1.1 Trigger Events

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

3.8.4.1.2 Message Semantics

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

3.8.4.1.3 Expected Actions

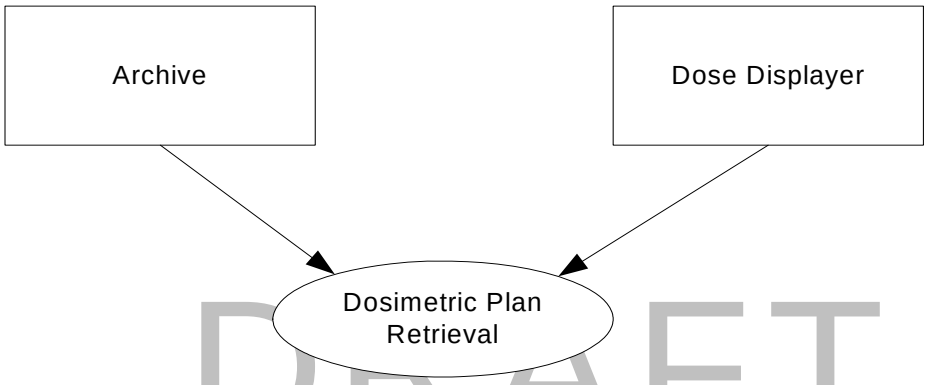
The Archive shall return the requested ***Geometric Plan*** to the ***Dosimetric Planner***. The ***Dosimetric Planner*** shall validate the received Geometric Plan. In case the received ***Geometric Plan*** is valid, it shall be loaded in the ***Dosimetric Planner***; in case it is not valid, a warning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

3.9 RO-9: Dosimetric Plan Retrieve

3.9.1

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

3.9.2 Use Case Roles



Actor: Dose Displayer

Role: Accepts plan from Archive.

Actor: Archive

Role: Transmits plan to Dose Viewer.

3.9.3 Referenced Standards

DICOM 2008, PS 3.3: RT Modules, PS 3.4: Storage Service Class.

3.9.4 3.9.4 Interaction Diagram

3.9.4.1 Dosimetric Plan Retrieve

3.9.4.1.1 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.

3.9.4.1.2 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.

The requirements for the Dosimetric Plan in this transaction are the same as defined in **Error! Reference source not found.**.

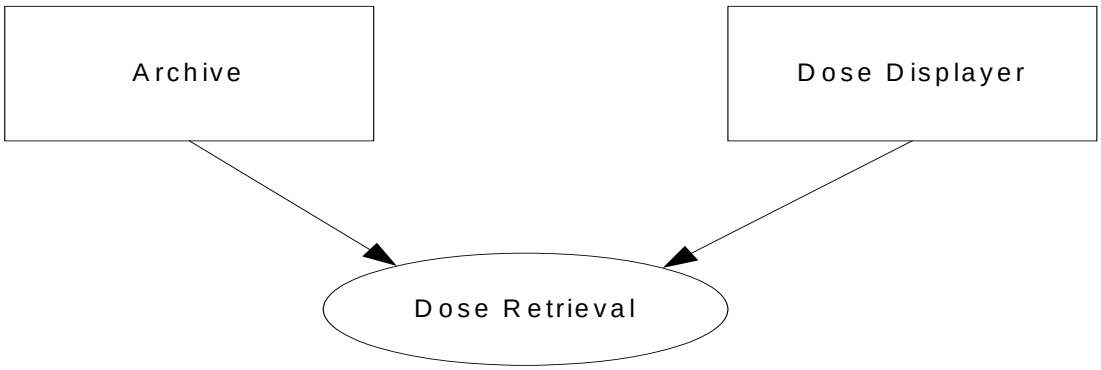
3.10 RO-10: Dose Retrieve

This section corresponds to RO-10 of the IHE-RO technical framework. Transaction RO-10 is used by the Archive and ***Dose Displayer*** actors.

3.10.1 Scope

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

3.10.2 Use Case Roles



Actor: ***Dose Displayer***

Role: Receives requested Dose from the Archive
Actor: Archive

Role: Sends requested Dose instance to the ***Dose Displayer***

3.10.3 Referenced standards

DICOM 2008 PS3.4: Storage Service Class.

3.10.4 Interaction Diagram

3.10.4.1 Dose Retrieve

3.10.4.1.1 Trigger Events

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.

3.10.4.1.2 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.

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

3.10.4.1.3 Representation of Dose

This transaction shall support Dose represented as a three-dimensional dose array sampled onto axial 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 value of Image Orientation (Patient) (0020,0037) shall be [±1, 0, 0, 0, ±1, 0], within an uncertainty of 0.001 Radians. Dose Planes may be irregularly spaced, and they need not correspond to image planes.

Not supported are point doses, projection of dose onto an oblique plane, iso-dose contours and dose-volume histograms. 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.

3.10.4.1.4 Expected Actions

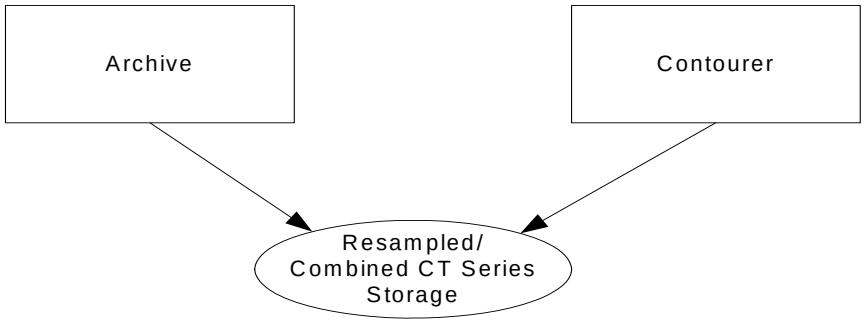
Upon receiving the request for retrieval, the Archive shall return the requested Dose to the ***Dose Displayer***. The ***Dose Displayer*** shall validate the received Dose. If the received Dose is valid, it shall be loaded in the ***Dose Displayer***. If it is not valid, a warning message shall be displayed to the user, indicating the reason why it is not valid.

3.11 RO-11: Resampled/Combined CT Series Storage

3.11.1 Scope

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.

3.11.2 Use Case Roles



Actor: ***Contourer***

Role: Sends CT Images to the Archive

Actor: Archive

Role: Stores CT Images received from ***Contourer***

3.11.3 Referenced standards

DICOM 2008 PS3.4: Storage Service Class.

3.11.4 Interaction Diagram

3.11.4.1 Resampled/Combined CT Series Storage

3.11.4.1.1 Trigger Events

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.

3.11.4.1.2 Message Semantics

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.

Also refer to appendix A 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.

3.11.4.1.3 Expected Actions

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

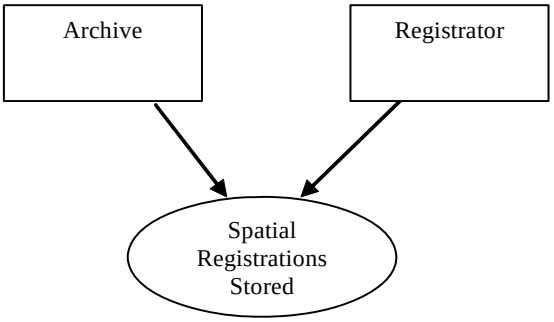
3.12 RO-12: Spatial Registrations Stored

This section corresponds to Transaction RO-12 of the IHE-RO Technical Framework. Transaction RO-12 is used by the **Archive** and **Registrator** actors.

3.12.1 Scope

In the Spatial Registrations Stored transaction, the **Registrator** sends Spatial Registration instances to the **Archive**. Spatial registration objects define how the pixel coordinates of one image data set are transformed to another coordinate system (for example to a coordinate system defined by another image data set thus allowing each dataset to be spatially aligned).

3.12.2 Use Case Roles



Actor: ***Archive***

Role: Accept and store Spatial Registration instances from ***Registrator*** actors.

Actor: ***Registrator***

Role: Transmit Spatial Registration instances to an ***Archive.***

Actor: ***Acquisition Modality***

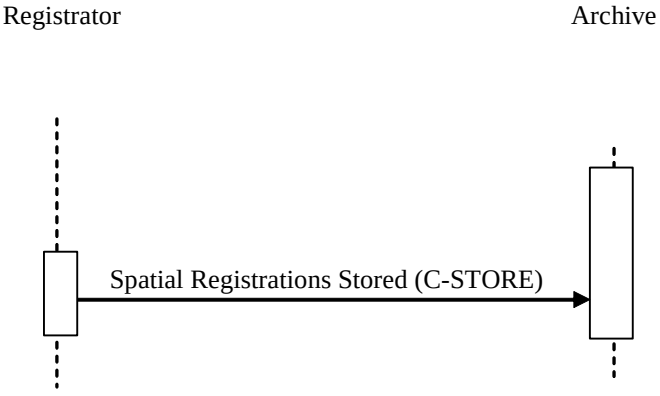
Role: Transmit Spatial Registration instances to an ***Archive.***

3.12.3 Referenced Standard

DICOM 2007 PS 3.4: Storage Service Class

DICOM 2007 PS 3.4: Spatial Registration Storage

3.12.4 Interaction Diagram



3.12.4.1 Spatial Registrations Stored

3.12.4.1.1 Trigger Events

A **Registrator** chooses to transfer one or more Spatial Registration objects to the **Archive**. This may follow creation of the Spatial Registration object as part of a registration process.

3.12.4.1.2 Message Semantics

The **Registrator** uses the DICOM C-STORE message to transfer the Spatial Registration objects. The **Registrator** acts in the role of the DICOM Storage SCU and the **Archive** is the DICOM Storage SCP.

The **Registrator** is responsible for warning the user of mismatched patient demographics within registered series.

The Spatial Registration shall contain two Registration Sequences. Refer to DICOM 2007 PS 3.17 Figure O.4-1 for informative details on the structure of the Registration Sequences.

When registering volumetric datasets with different Frames of Reference, each Registration Sequence shall define the transformation of the corresponding Original Dataset into the Registered Frame of Reference. Typically, one of the Registration Sequences will contain an IDENTITY transform, indicating that the corresponding original dataset established the Registered Frame of Reference. In that case the Frame of Reference of the Spatial Registration object may be the same as the Frame of Reference of that Original Dataset.

When registering more than 2 Frames of Reference each Spatial Registration object shall include a reference to the Registered Frame of Reference UID with an IDENTITY transformation as one of the elements of the Registration Sequence. Each Spatial Registration object shall specify it's Frame of Reference UID attribute to be the same as the Registered Frame of Reference UID.

This profile shall not allow the re-registration of multiple series with the same Frame of Reference. The actor may re-write one or both of the series with new Frames of Reference and perform the registration on the new series. This capability is not required to satisfy this transaction.

A Registration Sequence item shall contain a Frame of Reference and optionally a list of images, indicating that the transformation is applicable to all images within that Frame of Reference. No meaning may be inferred by the actor from the presence of the image references.

Modifying an existing Spatial Registration Object shall result in a new instance with a new instance UID.

The Spatial Registration object shall be stored:

- in the Study to which the Registered Frame of Reference belongs. This Study is identified by the Study UID of the images which establish the Registered Frame of Reference in the Spatial Registration objects as described above.
- in a different series from images.

3.12.4.1.3 Expected Actions

The **Archive** will store the received Spatial Registration objects. The Spatial Registration objects shall be stored such that they can be later retrieved (See 4.58 Utilize Spatial Registrations) in a fashion meeting the requirements defined for a DICOM Level 2 Storage SCP (see DICOM PS 3.4 B.4.1).

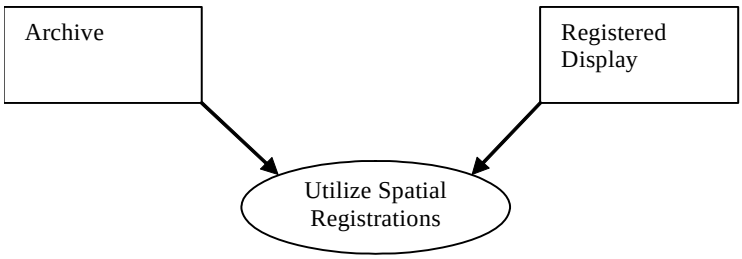
3.13 RO-13: Utilize Spatial Registrations

This section corresponds to Transaction RO-13 of the IHE-RO Technical Framework. Transaction RO-13 is used by the Registered Display and Archive actors.

3.13.1 Scope

A **Registered Display** receives from an **Archive** one or more Spatial Registration objects carrying the transformation information to be applied to two image data sets intended for further processing or fused display.

3.13.2 Use Case Roles



Actor: ***Archive***

Role: Sends images to register to the ***Registered Display*** Actor.

Actor: ***Archive***

Role: Sends requested Spatial Registrations to the ***Registered Display*** Actor.

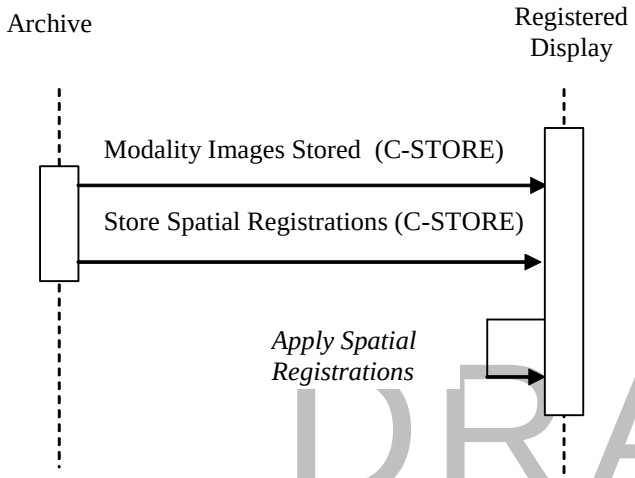
Actor: ***Registered Display***

Role: Receives requested Spatial Registrations from the Archive Actor.

3.13.3 Referenced Standards

DICOM 2007 PS 3.4: Spatial Registration Storage

3.13.4 Interaction Diagram



3.13.4.1 Utilize Spatial Registrations

3.13.4.1.1 Trigger Events

The **Registered Display** receives specific Spatial Registration objects from the **Archive**.

3.13.4.1.2 Message Semantics

The **Archive** uses the DICOM C-STORE message to transfer the Spatial Registration objects. The **Registered Display** is the DICOM Storage SCU and the **Archive** is the DICOM Storage SCP.

It is the responsibility of the **Registered Display** to apply the Spatial Registration as defined in DICOM. Refer to DICOM 2007 PS 3.4, Annex C, for detailed descriptive semantics.

A Registration Sequence item in the Spatial Registration will contain a Frame of Reference and no list of images, in which case the transformation shall be applied to all images within that Frame of Reference;

3.13.4.1.3 Expected Actions

The **Archive** establishes a DICOM association with the **Registered Display**, and uses the DICOM Spatial Registration Storage SOP Class to transfer the requested Spatial Registration objects.

The **Registered Display** shall use the most recently received instances to ensure that the most recent patient data from the Archive is displayed.

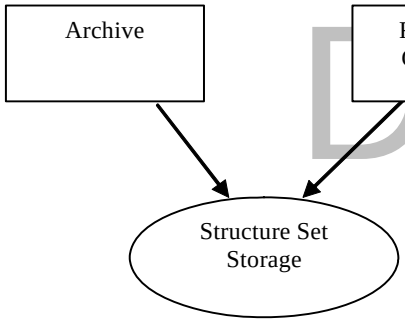
3.14 RO-14: Registered Structure Set Storage

This section corresponds to Transaction RO-14 of the IHE-RO Technical Framework. Transaction RO-14 is used by the **Registered Contourer** and **Archive** actors.

3.14.1 Scope

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

3.14.2 Use Case Roles



Actor: ***Registered Contourer***

Role: Sends Structure Set to ***Archive***

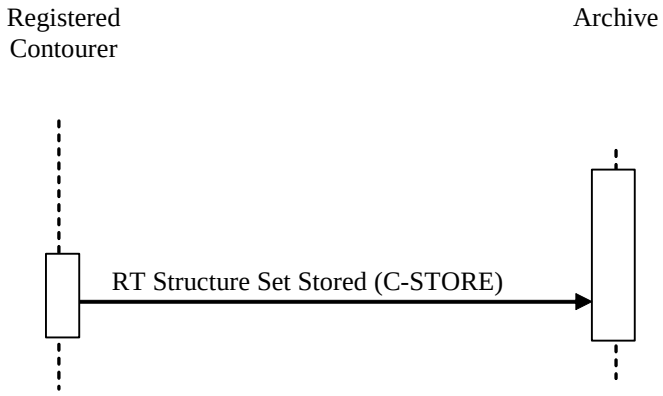
Actor: ***Archive***

Role: Stores Structure Set received from ***Registered Contourer***

3.14.3 Referenced standards

DICOM 2007 PS3.4: Storage Service Class.

3.14.4 Interaction Diagram



3.14.4.1 Registered Structure Set Storage

3.14.4.1.1 Trigger Events

The user of the **Registered Contourer** selects a Structure Set to store.

3.14.4.1.2 Message Semantics

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

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 a structure set in which the ROI contours reference the resampled image set. Absence of an ROI contour on a slice between slices on which contours are defined implies that the ROI does not intersect that slice.

An RT Structure Set object generated by a **Registered Contourer** will reference images from a single series and share the Frame of Reference UID of that series. It is implied that the coordinates in that object will exist in the coordinate system identified by the FoR UID. Finally, contours will exist on the same plane as the referenced image slices.

To make ROI's available to the downstream planning process or to the 2007 Contourer actor, the Registrator actor shall be able not only to transform contours from a source Frame of Reference to the Registered Frame of Refererence, but also to resample the contour to the planes of the images referenced in the RT Structure Set which cooresponds to the Registered Frame of Reference.

The set of contours transmitted in an RT Structure Set must not assume interpolation of contours across image slices. Absence of an ROI contour on a slice between slices on which contours are defined implies that the ROI does not intersect that slice.

Also refer to appendix B for an overview of the specific requirements on the DICOM attributes that are included in an RT Structure Set object. In particular, the structure set must share a single frame of reference UID with the images.

3.14.4.1.3 Expected Actions

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

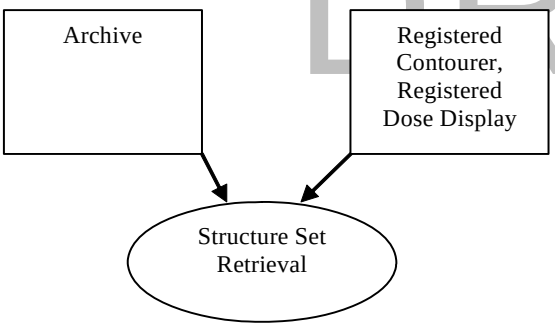
3.15 RO-15: Registered Structure Set Retrieval

This section corresponds to Transaction RO-15 of the IHE-RO Technical Framework. Transaction RO-15 is used by the **Registered Contourer**, **Registered Dose Display**, and **Archive** actors.

3.15.1 Scope

In the Registered Structure Set Retrieval Transaction, the **Archive** stores a Structure Set on a **Registered Contourer** or **Registered Dose Displayer**.

3.15.2 Use Case Roles



Actor*: Archive*

Role: Sends Structure Set to ***Registered Contourer*** or ***Registered Dose Displayer***

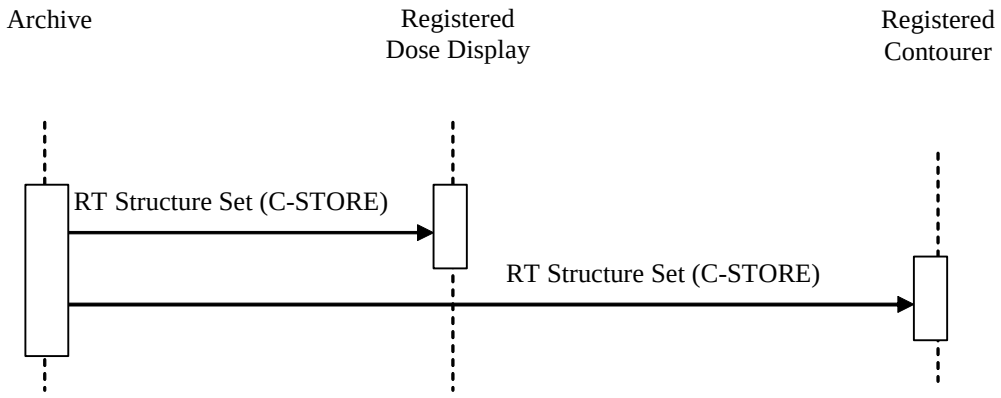
Actor: ***Registered Contourer*** or ***Registered Dose Displayer***

Role: Stores Structure Set received from ***Archive***

3.15.3 Referenced standards

DICOM 2007 PS3.4: Storage Service Class.

3.15.4 Interaction Diagram



3.15.4.1 Registered Structure Set Retrieval

3.15.4.1.1 Trigger Events

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

The user of the **Registered 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 **Registered Dose Displayer**.

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

3.15.4.1.2 Message Semantics

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

Absence of an ROI contour on a slice between slices on which contours are defined implies that the ROI does not intersect that slice.

Also refer to appendix B for an overview of the specific requirements on the DICOM attributes that are included in an RT Structure Set object. In particular, the structure set must have the same study instance UID, but a different series instance UID, than the CT series upon which the contours are based.

3.15.4.1.3 Expected Actions

The **Registered Contourer** will load all of the Structure Set, and will relate it to images based on the Frame of Reference UID. The contours contained will then be available to the user of the **Registered Contourer** for use in construction a new set of contours which will later be exported as a structure set (RO-14: Registered Structure Set Storage). This new structure set will have the same frame of reference UID and study instance UID of the original images and structure set.

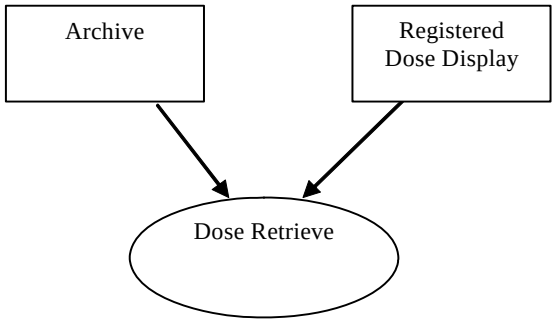
3.16 RO-16: Registered Dose Retrieve

This section corresponds to RO-16 of the IHE-RO technical framework. Transaction RO-16 is used by the **Archive** and **Registered Dose Display** actor.

3.16.1 Scope

In the Registered Dose Retrieve Transaction, the requested Dose is transferred from the **Archive** to the **Registered Dose Display** actor.

3.16.2 Use Case Roles



Actor: ***Registered Dose Display***

Role: Receives requested Dose from the ***Archive***

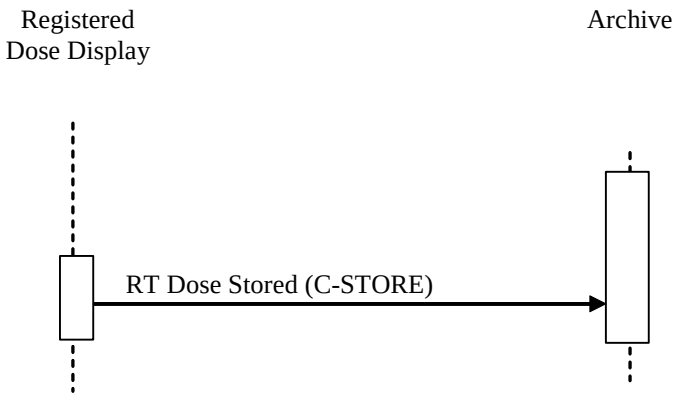
Actor: ***Archive***

Role: Sends requested Dose instance to the ***Registered Dose Display***

3.16.3 Referenced standards

DICOM 2007 PS3.4: Storage Service Class.

3.16.4 Interaction Diagram



3.16.4.1 Registered Dose Retrieve

3.16.4.1.1 Trigger Events

The user of the **Registered Dose Display** 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.

3.16.4.1.2 Message Semantics

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

3.16.4.1.3 Representation of Dose

This transaction shall support Dose represented as a three-dimensional dose array sampled onto axial 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 value of Image Orientation (Patient) (0020,0037) shall be [±1, 0, 0, 0, ±1, 0], within an uncertainty of 0.001 Radians. Dose Planes may be irregularly spaced, and they need not correspond to image planes.

Not supported are point doses, projection of dose onto an oblique plane, iso-dose contours and dose-volume histograms. 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 (0016,0103) shall be 0; negative dose values shall not be present.

3.16.4.1.4 Expected Actions

Upon receiving the request for retrieval, the **Archive** shall return the requested Dose to the **Registered Dose Display**. The **Registered Dose Display** shall validate the received Dose. If the received Dose is valid, it shall be loaded in the **Registered Dose Display**. If it is not valid, a warning message shall be displayed to the user, indicating the reason why it is not valid.

The received Dose will be displayed in the same coordinate system as the image set on which it was computed.

Appendix A Atribute Consistency Between Composite IODs

This appendix is an integral part of the IHE-RO Technical Framework.

The first section provides attribute mappings for the Evidence Creators with additional IHE Requirements based on a number of critical attributes (Type 2 and 3 in DICOM) common to most composite instances (Images, and RT IODs).

- The second section provides additional constraints on the population and use of a number of modules for particular IODs.
- The third section provides additional constraints on the population and use of a number of critical attributes.

A.1 Radiation Oncology Critical Attribute Mapping

The tables below describe requirements, recommendations or explanations on integration-critical attributes for radiation oncology cases. They define which integration-critical attributes need to be equal (copied or generated locally). The 2008 IHE-RO Profile does not include the use of Work List, which precludes its use as the source for the integration-critical attributes. It is anticipated that once Work List is utilized in the IHE-RO Profiles, it will be utilized in favor of the preceding Composite IOD (CT, or RT Structure Set) utilized in the Profile. The purpose in allowing the RT Structure Set to have a differing Study IE is to allow separation of the Study Semantics of a Diagnostic CT from activities that are Oncology related.

For attributes related to clinical trials, it is assumed that the data will be post-processed in to a form suitable for clinical trials after the "complete" set (for the purposes of the clinical trial submission) of a patient's data has been created.

General table structure:

The 1st column denotes the DICOM attributes whose values shall be mapped between the

DICOM objects (equal values in the same table row), including DICOM attribute tag (for clarity).

The 2nd column and following columns define where attribute values come from: all defined attribute values of one table row are equal.

Required mapping of corresponding attributes

Attribute (Tag)	CT IMAGE	RT Structure Set	Geometric RT Plan	Dosimetric RT Plan	RT Dose	Spatial Registration
Patient's Name (0010,0010)	Source	Copy	Copy		Copy	

Attribute (Tag)	CT IMAGE	RT Structure Set	Geometric RT Plan	Dosimetric RT Plan	RT Dose	Spatial Registration
				Copy		Copy
Patient ID (0010,0020)	Source		Copy			

Attribute (Tag)	CT IMAGE	RT Structure Set	Geometric RT Plan	Dosimetric RT Plan	RT Dose	Spatial Registration
		Copy		Copy	Copy	Copy

Attribute (Tag)	CT IMAGE	RT Structure Set	Geometric RT Plan	Dosimetric RT Plan	RT Dose	Spatial Registration
Patient's Birth Date (0010,0030)	Source	Copy	Copy	Copy	Copy	

Attribute (Tag)	CT IMAGE	RT Structure Set	Geometric RT Plan	Dosimetric RT Plan	RT Dose	Spatial Registration
						Copy
's Sex (0010,0040)	Source	Copy	Copy		Copy	

Attribute (Tag)	CT IMAGE	RT Structure Set	Geometric RT Plan	Dosimetric RT Plan	RT Dose	Spatial Registration
				Copy		Copy
Study Instance	Source	New Source	Copy	Copy	Copy	Copy from Base Study

Attribute (Tag)	CT IMAGE	RT Structure Set	Geometric RT Plan	Dosimetric RT Plan	RT Dose	Spatial Registration
UID (0020,000D)		(May Copy *)				Images **

Attribute (Tag)	CT IMAGE	RT Structure Set	Geometric RT Plan	Dosimetric RT Plan	RT Dose	Spatial Registration
Study Date (0008,0020)	Source	New Source (May Copy *)	Copy	Copy	Copy	Copy from Base Study Images **

Attribute (Tag)	CT IMAGE	RT Structure Set	Geometric RT Plan	Dosimetric RT Plan	RT Dose	Spatial Registration
Time (0008,0030)	Source	New Source (May Copy *)	Copy	Copy	Copy	Copy from Base Study Images **

Attribute (Tag)	CT IMAGE	RT Structure Set	Geometric RT Plan	Dosimetric RT Plan	RT Dose	Spatial Registration
Name (0008,0090)	Source	New Source (May Copy *)	Copy	Copy	Copy	Copy from Base Study Images **

Attribute (Tag)	CT IMAGE	RT Structure Set	Geometric RT Plan	Dosimetric RT Plan	RT Dose	Spatial Registration
ID (0020,0010)	Source	New Source (May Copy *)	Copy	Copy	Copy	Copy from Base Study Images **

Attribute (Tag)	CT IMAGE	RT Structure Set	Geometric RT Plan	Dosimetric RT Plan	RT Dose	Spatial Registration
Number (0008,0050)	Source	New Source (May Copy *)	Copy	Copy	Copy	Copy from Base Study Images **

Attribute (Tag)	CT IMAGE	RT Structure Set	Geometric RT Plan	Dosimetric RT Plan	RT Dose	Spatial Registration
Description (0008,1030)	Source	New Source (May Copy *)	Copy	Copy	Copy	

Attribute (Tag)	CT IMAGE	RT Structure Set	Geometric RT Plan	Dosimetric RT Plan	RT Dose	Spatial Registration
Reference UID (0020,0052)	Source	Copy	Copy	Copy	Copy	Copy from

Attribute (Tag)	CT IMAGE	RT Structure Set	Geometric RT Plan	Dosimetric RT Plan	RT Dose	Spatial Registration
						Study Images **
Position Reference Indicator	Source	NA				Copy from

Attribute (Tag)	CT IMAGE	RT Structure Set	Geometric RT Plan	Dosimetric RT Plan	RT Dose	Spatial Registration
(0020,1040)			Copy	Copy	Copy	Base Study Images **

Attribute (Tag)	CT IMAGE	RT Structure Set	Geometric RT Plan	Dosimetric RT Plan	RT Dose	Spatial Registration
						NA

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

** The Base Study Images are identified as the images which establish the Base Frame of Reference of the Spatial Registration objects.

A.2 Radiation Oncology Critical Modules

The tables below describe requirements, recommendations or explanations on integration-critical attributes for radiation oncology cases. They define which integration-critical modules need to be populated for the various RT IODs. The table follows the structure defined in DICOM PS3.3 section A.1.3

RT PLAN IOD MODULES

IE	Module	Reference	Usage	IHE-RO Usage

Patient	Patient	C.7.1.1	M	M

	Clinical Trial Study	C.7.2.3	U	U

Equipment	General Equipment	C.7.5.1	M	M
	RT Fraction Scheme	C.8.8.13	U	U(geometric), M(dosimetric)

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	M (Can be excluded for zero beams with non-isocentricc 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
SOP Common	C.12.1	M	M

RT PLAN IOD MODULES

IE	Module	Reference	Usage	IHE-RO Usage

Patient	Patient	C.7.1.1	M	

	Clinical Trial Subject	C.7.1.3	U	

	Clinical Trial Series	C.7.3.2	U	
	Image Pixel	C.7.6.3	C - Required if dose data contains grid-based doses.	Shall be present

Multi-Frame	C.7.6.6	C - Required if dose data contains grid-based doses and pixel data is multi-frame data.	Shall be present
Overlay Plane	C.9.2	U	
Multi-Frame Overlay	C.9.3		

Frame Overlay		U	
Modality LUT	C.11.1	U	
RT Dose	C.8.8.3	M	

RT DVH	C.8.8.4	U	This module is outside the scope of this profile.

SPATIAL REGISTRATION IOD MODULES

IE	Module	Reference	Usage	IHE-RO Usage

Patient	Patient	C.7.1.1	M	M

Study

	Patient Study	C.7.2.2	U	U

Frame of Reference	Frame of Reference	C.7.4.1	M	M
	SOP Common	C.12.1	M	M

A.3 Radiation Oncology Critical Attributes

The tables below describe requirements, recommendations or explanations on integration-critical attributes for radiation oncology cases.

There are a number of attributes intended to be populated in the original CT

General table structure:

The 1st column denotes the DICOM attributes whose values shall be mapped between the DICOM objects (equal values in the same table row).

The 2nd column denotesThe DICOM attribute tag (for clarity).

The 3rd column defines the IHE-RO criteria for being present and/or displayed. The plus (+) symbol indicates an IHE extension of DICOM, the star (*) symbol indicates the attribute is not required to be displayed. The letter R indicates that the element is required, the letter O that it is optional. An element with type O (with or without the + or * modifiers) is typically called out specifically because some additional constraint has been made on the use of the element. That additional constraint might be that it is to be propagated from an "input object", that it must not be relied upon by an actor using it as input, that it is not to be utilized in output by a particular actor, or that it must be made readily viewable by an actor.

The 4th column provides additional information on the constraints for the attribtue as well as guidance in the use of the attribute.

Patient Module

Attribute	Tag	Type	Attribute Note

Patient's Name	(0010,0010)	R+	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)

Patient's Birth Date	(0010,0030)	O+	See Patient's Name (0010,0010) See Also RAD TF Vol2 A.3
Patient's Sex	(0010,0040)	O+	See Patient's Name (0010,0010) See Also RAD TF Vol2 A.3

General Study Module

Attribute	Tag	Type	Attribute Note

Study Instance UID	(0020,000D)	R+*	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 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. 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.

Study Date	(0008,0020)	R+	[See (0020,000D)]
Study ID	(0020,0010)	R+	[See (0020,000D)]
Study Description	(0008,1030)	O+	[See (0020,000D)]

			(0020,000D)]

GENERAL SERIES MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Note

Series Instance UID	(0020,000E)	R*	Unique identifier of the Series.
Series Description	(0008,103E)	R+	User provided description of the Series

SPATIAL REGISTRATION MODULE ATTRIBUTES

Attribute Name	Tag	Type	

			Attribute Note

>Matrix Registration Sequence	(0070,0309)	1	A sequence that specifies one spatial registration. Exactly one item shall be present

>>Matrix Sequence	(0070,030A)	1	item specifies a transformation. See C.20.2.1.1.
>>>Frame of Reference Transformation Matrix Type	(0070,030C)	1	The only type of Frame of Reference Transformation Matrix (3006,00C6) supported in this profile is RIGID. See C.20.2.1.2

General Equipment Module

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 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 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)		If an application resamples and re-

		R+*	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.

Frame Of Reference Module

Attribute	Tag	Type	Attribute Note
Frame of Reference UID	(0020,0052)	R+*	

			All related DICOM objects (CT images, Structure Sets, Plans, and Doses) are required to be in the same frame of reference and have the same Frame of Reference UID.
Position Reference Indicator	(0020,1040)	O+*	Equipment which creates new series based on other series (i.e. resampled series, new structure sets, plans, etc)

			preserve the value of this element to adhere to this profile.

RT General Plan Module

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 Time	(300A,0007)	R+	The time when the plan was last modified.

RT Patient Setup Module

Attribute	Tag	Type	Attribute Note

Patient Setup Sequence	(300A,0180)	R+*	not rely on the presence of: • Fixation Device Sequence • Shielding Device Sequence • Setup Device Sequence • Table Top Vertical Setup Displacement • Table Top Longitudinal Setup Displacement • Table Top Lateral Setup Displacement within the Patient Setup Sequence for proper operation.
>Patient Position	(0018,5100)	R+	Must be constrained to HFS, FFS, HFP, FFP (Decubitus Left and Decubitus Right Positions shall not be supported)
>Setup Technique	(300A,01B0)	R+*	

RT Fraction Group Module

Attribute	Tag	Type	Attribute Note

Fraction Group Sequence	(300A,0070)	R+*	Must be constrained to contain only 1 item in the sequence

RT BEAMS MODULE (for Geometric Planner)

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+	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. The Beam Name must be unique within the sequence

>Beam Type	(300A,00C4)	R+*	For Geometric Plans the value is constrained to: 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.

>Source-Axis Distance	(300A,00B4)	R+*	This attribute is critical for providing information regarding beam divergence.

>Beam Limiting Device Sequence	(300A,00B6)		For IHE-RO, 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 value are outside the scope of the 2006 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+*	For Geometric Plans the second control point (sequence item) shall contain only: • Control Point Index (300A,0112) with a value of 1 • Cumulative Meterset Weight (300A,0134) set 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.
>>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.

MULTI-FRAME MODULE ATTRIBUTES

Attribute	Tag	Type	Attribute Note

Frame Increment Pointer	(0028,0009)	R+*	or.

RT Dose Module

Attribute	Tag	Type	Attribute Note

Samples per Pixel	(0028,0002)	R+*	Shall be present and equal to 1

Bits Stored	(0028,0101)	R+*	Shall be equal to Bits Allocated

Pixel Representation	(0028,0103)	R+*	Shall have the value 0 = unsigned integer. Negative dose values shall not be present.

Dose Summation Type	(3004,000A)	R+*	Shall have the value **PLAN**.

IMAGE PLANE MODULE ATTRIBUTES

Attribute	Tag	Type	Attribute Note

Image Orientation (Patient)	(0020,0037)	R+*	±1, 0) with an angle tolerance of 0.001 radians (~0.057 degrees)
Slice Thickness	(0018,0050)	O+*	Shall not be relied on.

Slice Location	(0020,1041)	O+*	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

RT Structure Set Module

Attribute	Tag	Type	Attribute Note

Structure Set Label	(3006,0002)	R+	

Structure Set Date	(3006,0008)	R+	

>Frame of Reference UID	(0020,0052)	R+*	This frame of reference UID shall be the same as the frame of reference of the image series from which the RTSTRUCT was constructed.

>>Referenced SOP Instance UID	(0008,1155)	R+*	This Study Instance UID shall be the same as the Study Instance UID of the related image instances.

>>>>Referenced SOP Class UID	(0008,1155)	R+*	Must be present with a value of '1.2.840.10008.5.1.4.1.1.2', '1.2.840.10008.5.1.4.1.1.4' or '1.2.840.10008.5.1.4.1.1.128'
>>>>Referenced Frame Number	(0008,1160)	O+*	Shall not be present

Set ROI Sequence	(3006,0020)	R+	This sequence must be present. It defines the ROI's in this RTSTRUCT

>ROI Number	(3006,0022)	R*	ular ROI item from other sequences. It is required to be unique within the scope of this message. 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 of the image series from which the

	(3006,0026)		
>ROI Description	(3006,0028)	O+*	Not required - no compliant implementation shall rely on this element being present for proper

			Must be present, with a value of AUTOMATIC, SEMIAUTOMATIC, MANUAL, or RESAMPLED. This information may be presented to a user, but no semantics for handling an RTSTRUCT is required for this profile. RESAMPLED indicates that the ROI Contours have been resampled onto a different set of images from those on which the contours were originally created. Implementations which create RTSTRUCT instances must provide an appropriate value.

RT Observations Module

Attribute	Tag	Type	Attribute Note

RT ROI Observations Sequence	(3006,0080)	R+*	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. In particular, an RTSTRUCT must contain an element in this sequence for ISOCENTER.
>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 and ROI Interpreter.
>RT ROI Interpreted Type	(3006,00A4)	O+*	Required if there is not another item in the RT ROI observation sequence with the same Referenced ROI number which has this element populated or the ROI is only utilized

			physical property. If referenced ROI has associated contours of type CLOSED_PLANAR, must be one of: EXTERNAL PTV CTV GTV TREATED_VOLUME IRRAD_VOLUME BOLUS AVOIDANCE ORGAN MARKER CONTRAST_AGENT CAVITY If referenced ROI has associated contours of type POINT, must be one of: MARKER REGISTRATION ISOCENTER

>ROI Physical Properties Sequence	(3006,00B0)	O+*	Not required, but shall not be ignored if supplied.

RT Contour Module

Attribute	Tag	Type	Attribute Note

ROI Contour Sequence	(3006,0039)	R	
>Contour Sequence	(3006,0040)	R+*	Must be present. Must contain an item for each contour in the ROI. Compliant implementations must be able to handle as many as 100 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 100.
>>Contour Image Sequence	(3006,0016)	R+*	Must 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 must match the z-coordinate of Image Position Patient in the image.

>>>Referenced SOP Class UID	(0008,1150)	R+*	Must 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.
>>Contour Slab Thickness	(3006,0044)	O+*	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 be zero if present.

>>Number of Contour Points	0046)	R+*	Contour Data. Shall not exceed the number for which the Contour Data can not be encoded when using explicit transfer syntax.
>>Contour Data	(3006,0050)	R+*	Must be present. If contour type is CLOSED_PLANAR, then all points must have the same z-coordinate. This z-coordinate must 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 axial.

SOP Common Module

Attribute	Tag	Type	

			Attribute Note
SOP Instance UID	(0008,0018)	R+*	If an application alters an Information Object instance, then the new Information Object instance shall be assigned a new UID.

Specific Character Set	(0008,0005)	O+*	Shall be blank or present with value "ISO_IR 100" Only ASCII and ISO_IR 100 are supportedin this profile. Character codes in message will reflect value of this element. IHE-RO has a goal of providing broader multi-language support, potentially using Unicode UTF-8 but not in this profile
Instance Creation Time	(0008,0013)	O+*	Actors must not rely on the presence of

			attribute to operate correctly
Instance Creator UID	(0008,0014)	O+*	this attribute to operate correctly

Instance Number	(0020,0013)	O+*	presence of this attribute to operate correctly

