Integrating the Healthcare Enterprise

IHE Radiation Oncology (RO) Technical Framework

Volume 1
IHE RO TF-1
Profiles

Revision 1.8 - Final Text

June 26, 2014

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CONTENTS

1 Introduction

Integrating the Healthcare Enterprise® (IHE) is an initiative designed to advance the integration of the health information systems. Its fundamental objective is to ensure that in the care of patients all required information for medical decisions is available to authorized healthcare professionals.

IHE is both a process and a forum for encouraging integration efforts. It defines technical frameworks for the implementation of established standards to achieve specific clinical goals. It includes a rigorous testing process for systems implementing this framework. And it organizes educational sessions and exhibits at major meetings of medical professionals to demonstrate the benefits of these frameworks and encourage their adoption by developers and users of health information systems.

IHE International, the organization overseeing development of the IHE Technical Frameworks is sponsored by the Healthcare Information and Management Systems Society (HIMSS) and the Radiological Society of North America (RSNA). The following organizations are responsible for sponsoring development activities in their respective domains:

- Anatomic Pathology – Association pour le Developpement de l'Informatique en Anatomie et Cytologie Pathologique (ADICAP)/ Groupement pour la Modernisation du Système d'Information Hospitalier (GMSIH)
- Cardiology – American College of Cardiology
- Dental – American Dental Association
- Eye Care – Academy of American Ophthalmologists
- IT Infrastructure –HIMSS
- Laboratory –GMSIH/ Société Française d'Informatique de Laboratoire (SFIL)
- Patient Care Coordination –American College of Physicians (ACP)/HIMSS
- Patient Care Devices –American College of Clinical Engineering (ACCE)/HIMSS
- Pharmacy – European Association of Hospital Pharmacists (EAHP)/Dutch National IT Institute for Healthcare (NICTIZ)/Phast
- Quality, Research and Public Health –American Heart Association, HIMSS, RSNA
- Radiation Oncology –American Society for Radiation Oncology (ASTRO)
- Radiology – RSNA
  - Mammography – American College of Radiology (ACR)/RSNA
  - Nuclear Medicine –Society of Nuclear Medicine

Other organizations representing healthcare professionals are invited to join in the expansion of the IHE process across disciplinary and geographic boundaries.

1.1 Overview of Technical Framework

The IHE Technical Frameworks are expanded annually, after a period of public review, and maintained regularly through the identification and correction of errata. The IHE Radiation Oncology Technical Framework is maintained by the IHE Radiation Oncology Technical Committee. The current version specifies the IHE transactions defined and implemented as of the date of publication. The latest version of the document is always available at http://www.ihe.net/Technical_Frameworks.

The IHE Technical Framework identifies functional components of health information systems, called IHE Actors, and specifies their interactions as coordinated, standards-based transactions. The present volume provides a high-level view of IHE functionality, showing the transactions organized into functional units called Integration Profiles that highlight their capacity to address specific clinical needs. The subsequent volumes, 2 and 3, provide detailed technical descriptions of each IHE transaction including the clinical problem it is intended to address and the IHE Actors and transactions it comprises.

The appendices following the main body of the document provide detailed discussion of specific issues related to the integration profiles and a glossary of terms and acronyms used.

Where applicable in these volumes, references are made to Technical Frameworks of other IHE domains. For the conventions used to reference Technical Frameworks from other domains, see Section 1.6.4 in this volume.

1.2 Audience

The intended audience of this document is:

- Technical staff of vendors participating 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

1.3 Relationship to Standards

IHE does not define standards, but rather facilitates the use of existing standards — including HL7, W3C, Web Services, DICOM and others, as appropriate — in an integrated manner by specifying detailed implementations of these standards. When clarifications or extensions to standards are necessary, IHE refers recommendations to the relevant standards bodies. Vendors who have implemented IHE integration capabilities can use an IHE Integration Statement to describe the conformance of their product to the Actors and Profiles in the IHE Technical Framework. See RAD TF-1: Appendix D for the format of such IHE Integration Statements. IHE encourages implementers to ensure that products implemented in accordance with the IHE Technical Framework also meet the full requirements of the standards underlying IHE. Standards conformance claims should be made in direct reference to the specific standard in question.

1.4 Relationship to Real-world Architectures

The IHE Actors and transactions described in the IHE Technical Frameworks are abstractions of real-world health information systems. The IHE Technical Framework intentionally avoids associating functions or actors with specific product categories. For each actor, the IHE Technical Framework defines only those functions associated with their interactions with other health 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 health information system.

IHE 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.

1.5 Reserved

1.6 Conventions

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.

1.6.1 Actor and Transaction Diagrams and Tables

Each integration profile is a representation of a real-world capability that is supported by a set of actors that interact through transactions. Actors are information systems or components of information systems that produce, manage, or act on categories of information required by operational activities in the enterprise. Transactions are interactions between actors that transfer the required information through standards-based messages. The tables of actors and transactions starting with section 3 indicate which transactions each actor in a given profile must support. The convention used in these diagrams is that the arrow indicating the direction for the transaction points from the initiator of the transaction to the destination. In some cases, a profile is dependent on a pre-requisite profile in order to function properly and be useful. For example, Presentation of Grouped Procedures depends on both Scheduled Workflow and Consistent Presentation of Images being implemented as pre-requisites. These dependencies can be found by locating the desired profile in Table 2.1-1 and seeing which profiles are listed as required pre-requisites. An actor must implement all required transactions in the pre-requisite profiles in addition to those in the desired profile. In some cases, the pre-requisite is that the actor selects any one of a given set of profiles to satisfy the pre-requisite. For example, Post-processing depends on any one of the content profiles being supported.

1.6.2 Process Flow Diagrams

The descriptions of integration profiles that follow include Process Flow Diagrams that illustrate how the profile functions as a sequence of transactions between relevant actors. These diagrams are intended to provide a “big picture” so the transactions can be seen in the context of the overall workflow. Certain transactions and activities not defined in detail by IHE are shown in these diagrams in italics to provide additional context on where the relevant IHE transactions fit

into the broader scheme of healthcare information systems. These diagrams are not intended to present the only possible scenario. Often other actor groupings are possible, and complementary transactions from other profiles may be interspersed. In some cases the sequence of transactions may be flexible. Where this is the case there will generally be a note pointing out the possibility of variations.

The convention used in these diagrams is that the arrow on the line for the transaction points from the initiator of the transaction to the destination.

1.6.3 Normative versus informative contents of the Technical Framework

Most parts of the Technical Framework describe required or optional characteristics of Integration Profiles, Actors and Transactions: these are normative. For a better understanding of the text, there also exist illustrating parts in the Technical Framework that are informative and non-normative.

According to IETF RFC 2119, certain words indicate whether a specific content of the Technical Framework is normative: either required (e.g., “must”, “required”, “shall”) or optional (e.g., “may”, “recommended”). Informative content does not contain these key words.

1.6.4 Technical Framework Referencing

When references are made to a section within the same Technical Framework volume, a section number is used by itself. When references are made to other volumes or to a Technical Framework in another domain, the following format is used:

<domain designator> TF-<volume number>: <section number>, where

<domain designator> is a short designator for the IHE domain (ITI = IT Infrastructure, RO = Radiation Oncology)

<volume number> is the applicable volume within the given Technical Framework (e.g., 1, 2, 3), and

<section number> is the applicable section number.

For example: ITI TF-1: 3.1 refers to section 3.1 in volume 1 of the IHE IT Infrastructure Technical Framework, RAD TF-3: 4.33 refers to section 4.33 in volume 3 of the IHE Radiology Technical Framework.

When references are made to specific transactions (transaction numbers) the following format is used:

<domain designator>-<transaction number>

For example RAD-4 refers to transaction number 4 (Procedure Scheduled) in the Radiology Technical Framework.

1.7 History of Annual Changes

- 2007: Initiated the IHE Radiation Oncology Technical Frameworks with the *Basic Radiation Therapy Objects* Integration Profile (BRTO).

- 2011: Updated the front matter sections of Volumes 1 and 2 of the IHE Radiation Oncology Technical Frameworks to be consistent with newly released domain-wide sections.
- 2014: Updated Volumes 1 and 2 of the IHE Radiation Oncology Technical Frameworks to include approved 2013 change proposals and technical frameworks formatting changes.

1.8 Comments

ASTRO welcomes comments on this document and the IHE-RO initiative. They should be submitted at http://www.ihe.net/Radiation_Oncology_Public_Comments or to:

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1.9 Copyright Permission

1.10 IHE Technical Framework Development and Maintenance Process

The IHE Radiation Oncology Technical Framework is continuously maintained and expanded on an annual basis by the IHE Radiation Oncology Technical Committee. The development and maintenance process of the Framework follows a number of principles to ensure stability of the specification so that both vendors and users may use it reliably in specifying, developing and acquiring systems with IHE integration capabilities.

The first of these principles is that any extensions, clarifications and corrections to the Technical Framework must maintain backward compatibility with previous versions of the framework in order to maintain interoperability with systems that have implemented IHE Actors and Integration Profiles defined there.

The IHE Radiation Oncology Technical Framework is developed and re-published annually following a three-step process:

1. The Radiation Oncology Technical Committee develops supplements to the current stable version of the Technical Framework to support new functionality identified by the IHE Strategic and Planning Committees and issues them for public comment.

2. The Committee addresses all comments received during the public comment period and publishes an updated version of the Supplement for "Trial Implementation". It is this version of the supplement used by vendors in developing trial implementation software for the annual Radiation Oncology Connectathon.
3. The Committee regularly considers change proposals to the trial implementation version of a supplement, including those from implementers who participate in the Connectathon. After resolution of all change proposals received, the supplement is approved for Final Text and added to the current Technical Framework at its next revision.

2 Radiation Oncology Integration Profiles

IHE Radiation Oncology Integration Profiles (Figure 2-1), offer a common language that healthcare professionals and vendors can use to discuss integration needs of healthcare enterprises and the integration capabilities of information systems in precise terms. Integration Profiles specify implementations of standards that are designed to meet identified clinical needs. They enable users and vendors to state which IHE capabilities they require or provide, by reference to the detailed specifications of the IHE Radiation Oncology Technical Framework.

Integration profiles are defined in terms of IHE Actors and transactions. Actors (see RO TF-1: Appendix A) are information systems or components of information systems that produce, manage, or act on information associated with clinical and operational activities in the enterprise. Transactions (see RO TF-1: Appendix B) are interactions between actors that communicate the required information through standards-based messages.

Vendor products support an Integration Profile by implementing the appropriate actor(s) and transactions. A given product may implement more than one actor and more than one integration profile.

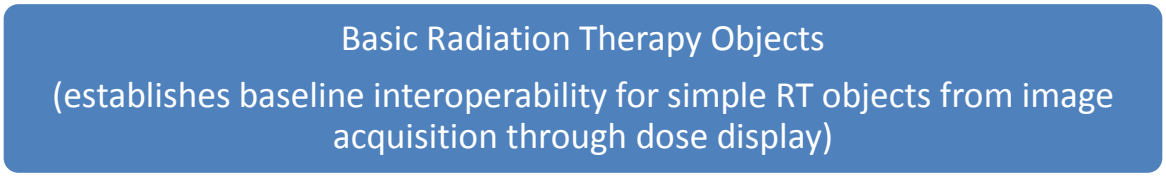

Figure 2-1: IHE Radiation Oncology Integration Profiles

2.1 Dependencies among Integration Profiles

Dependencies among IHE Integration Profiles exist when implementation of one integration profile is a prerequisite for achieving the functionality defined in another integration profile. Figure 2-1 provides a graphical view of the dependencies among IHE Radiation Oncology Integration Profiles and between IHE RO Integration Profiles and Integration Profiles from other domains (such as Radiology). The arrows in the figure point from a given integration profile to the integration profile(s) upon which it depends. Table 2.1-1 defines these dependencies in tabular form.

Some dependencies require that an actor supporting one profile be grouped with one or more actors supporting other integration profiles. For example (see the ITI TF), Enterprise User *Authentication (EUA) requires that different actors be grouped with the Time Client Actor that* participates in the Consistent Time (CT) Integration Profile. The dependency exists because EUA Actors must refer to consistent time in order to function properly.

Table 2.1-1: Integration Profiles Dependencies

Integration Profile	Depends on	Dependency Type	Purpose
Basic Radiation Therapy Objects	*Scheduled Workflow*	*Acquisition Modality Image Storage (RAD-8)*	*CT Images will be stored in the archive in accordance with the referenced transaction*

To support a dependent profile, an actor must implement all required transactions in the prerequisite profiles in addition to those in the dependent profile. In some cases, the prerequisite is that the actor selects any one of a given set of profiles.

2.2 Integration Profiles Overview

In this document, each IHE Integration Profile is defined by:

- The IHE actors involved
- The specific set of IHE transactions exchanged by each IHE actor.

These requirements are presented in the form of a table of transactions required for each actor supporting the Integration Profile. Actors supporting multiple Integration Profiles are required to support all the required transactions of each Integration Profile supported. When an Integration Profile depends upon another Integration Profile, the transactions required for the dependent Integration Profile have not been included in the table.

Note that IHE Integration Profiles are not statements of conformance to standards, and IHE is not a certifying body. Users should continue to request that vendors provide statements of their conformance to standards issued by relevant standards bodies, such as HL7 and DICOM. Standards conformance is a prerequisite for vendors adopting IHE Integration Profiles.

Also note that there are critical requirements for any successful integration project that IHE cannot address. Successfully integrating systems still requires a project plan that minimizes disruptions and describes fail-safe strategies, specific and mutually understood performance expectations, well-defined user interface requirements, clearly identified systems limitations, detailed cost objectives, plans for maintenance and support, etc.

2.2.1 This section is reserved.

2.2.2 This section is reserved.

2.2.3 Basic Radiation Therapy Objects (BRTO)

Basic Radiation Therapy Objects involves the flow of DICOM images and treatment planning data, from CT scan through dose display, for 3D conformal, external beam radiation therapy. The emphasis for this first Integration Profile is on reducing ambiguity and facilitating basic interoperability in the exchange of DICOM RT objects.

3 Basic Radiation Therapy Objects Integration Profile (BRTO)

The *Basic Radiation Therapy Objects* Integration Profile involves the flow of DICOM images and treatment planning data, from CT scan through dose display, for 3D conformal, external beam radiation therapy. The emphasis for this first Integration Profile is on reducing ambiguity and facilitating basic interoperability in the exchange of DICOM RT objects.

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:

- Multiple Image Series – In some cases, CT devices will produce multiple image series for use in a single treatment plan; for example, an overall scan at 5 mm spacing and a second series at 3 mm spacing in the target volume area. Systems acting as Contourers in this profile must be able to accept such image datasets. It is required to coalesce and re-sample such series into a single series (which must be exported for other systems to reference) within this profile.
- 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, though resampling of image and structure set data (and export of these data) is acceptable.
- 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 guaranteed to have equal row and column spacing. Z-spacing (slice spacing) can be different from the X and Y spacing and can also be irregular. Applications reading RT Dose objects must be able to handle such spacing.

3.1 Actors / Transactions

Table 3.1-1 lists the transactions for each actor directly involved in the *Basic Radiation Therapy Objects* 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 IHE RO TF-1: 3.2.

Table 3.1-1: Basic RT Objects Integration Profile - Actors and Transactions

Actors	Transactions	Optionality	Section
Archive	Single/Contoured Series Image Retrieval [RO-1]	R	RO TF-2: 3.1
	Structure Set Storage [RO-2]	R	RO TF-2: 3.2
	Geometric Plan Storage [RO-3]	R	RO TF-2: 3.3
	Dosimetric Plan Storage [RO-4]	R	RO TF-2: 3.4
	Dose Storage [RO-5]	R	RO TF-2: 3.5
	Multi-Series Image Retrieval [RO-6]	R	RO TF-2: 3.6
	Structure Set Retrieval [RO-7]	R	RO TF-2: 3.7

Actors	Transactions	Optionality	Section
	Geometric Plan Retrieval [RO-8]	R	RO TF-2: 3.8
	Dosimetric Plan Retrieval [RO-9]	R	RO TF-2: 3.9
	Dose Retrieval [RO-10]	R	RO TF-2: 3.10
	Resampled/Combined CT Series Storage [RO-11]	R	RO TF-2: 3.11
Contourer	Single/Contoured Series Image Retrieval [RO-1]	R	RO TF-2: 3.1
	Structure Set Storage [RO-2]	R	RO TF-2: 3.2
	Multi-Series Image Retrieval [RO-6]	R	RO TF-2: 3.6
	Structure Set Retrieval [RO-7]	R	RO TF-2: 3.7
	Resampled/Combined CT Series Storage [RO-11]	R	RO TF-2: 3.11
Geometric Planner	Geometric Plan Storage [RO-3]	R	RO TF-2: 3.3
	Structure Set Retrieval [RO-7]	R	RO TF-2: 3.7
	Single/Contoured Series Image Retrieval [RO-1]	R	RO TF-2: 3.1
Dosimetric Planner	Dosimetric Plan Storage [RO-4]	R	RO TF-2: 3.4
	Dose Storage [RO-5]	R	RO TF-2: 3.5
	Geometric Plan Retrieval [RO-8]	R	RO TF-2: 3.8
	Structure Set Retrieval [RO-7]	R	RO TF-2: 3.7
	Single/Contoured Series Image Retrieval [RO-1]	R	RO TF-2: 3.1
Dose Displayer	Dose Retrieval [RO-10]	R	RO TF-2: 3.10
	Dosimetric Plan Retrieval [RO-9]	R	RO TF-2: 3.9
	Structure Set Retrieval [RO-7]	R	RO TF-2: 3.7
	Single/Contoured Series Image Retrieval [RO-1]	R	RO TF-2: 3.1

Figure 3.1-1 shows the actors directly involved in the *Basic RT Objects* 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.

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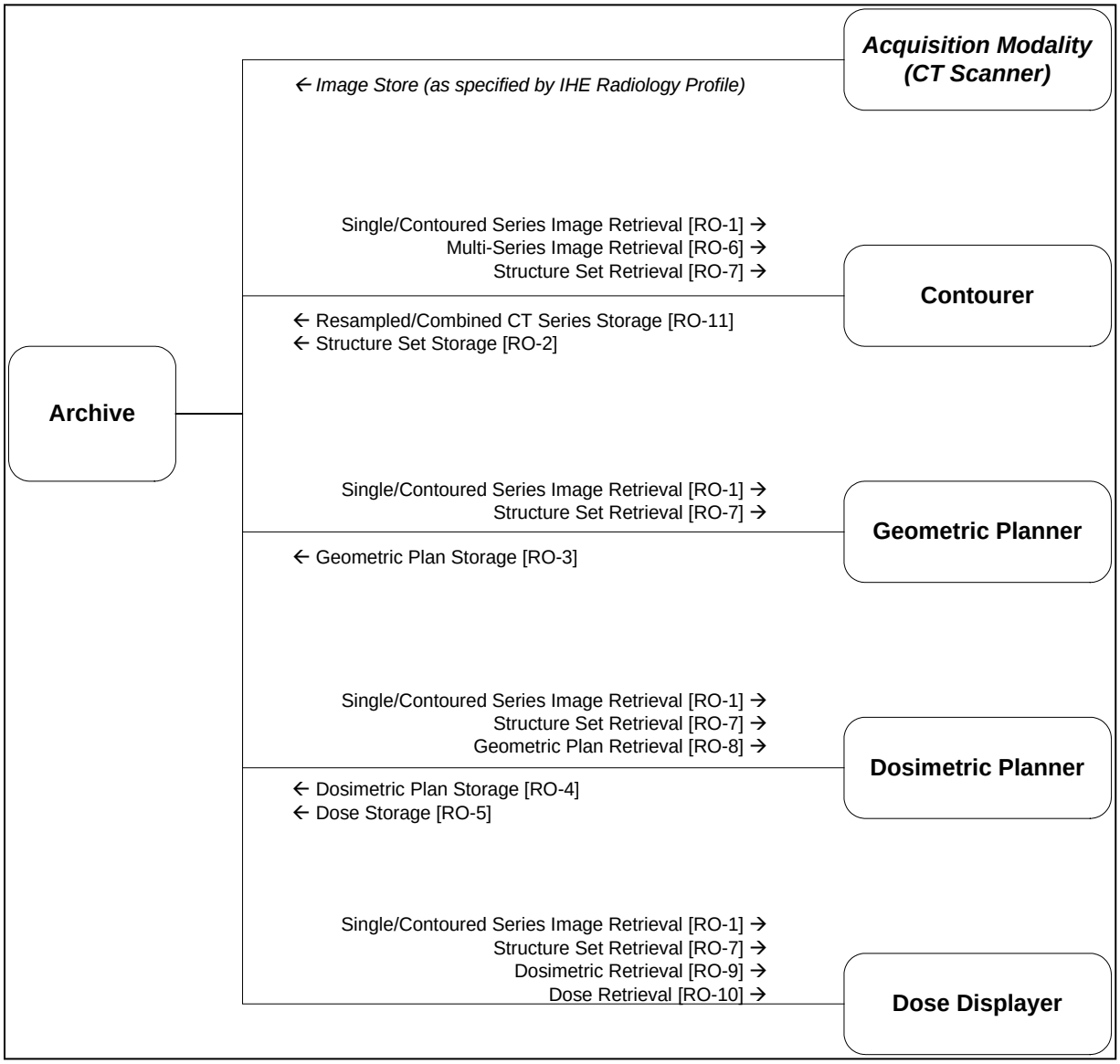

Figure 3.1-1: Basic RT Objects Actor Diagram

3.2 Basic RT Objects Integration Profile Options

Options that may be selected for this Integration Profile are listed in Table 3.2-1 along with the IHE Actors to which they apply. Dependencies between options when applicable are specified in notes.

Table 3.2-1: Basic RT Objects - Actors and Options

Actor	Options	Volume & Section
Archive	*None*	- -
Contourer	*None*	- -

Actor	Options	Volume & Section
Geometric Planner	*None*	- -
Dosimetric Planner	*None*	- -
Dose Displayer	*None*	- -

3.3 Basic RT Objects Process Flow

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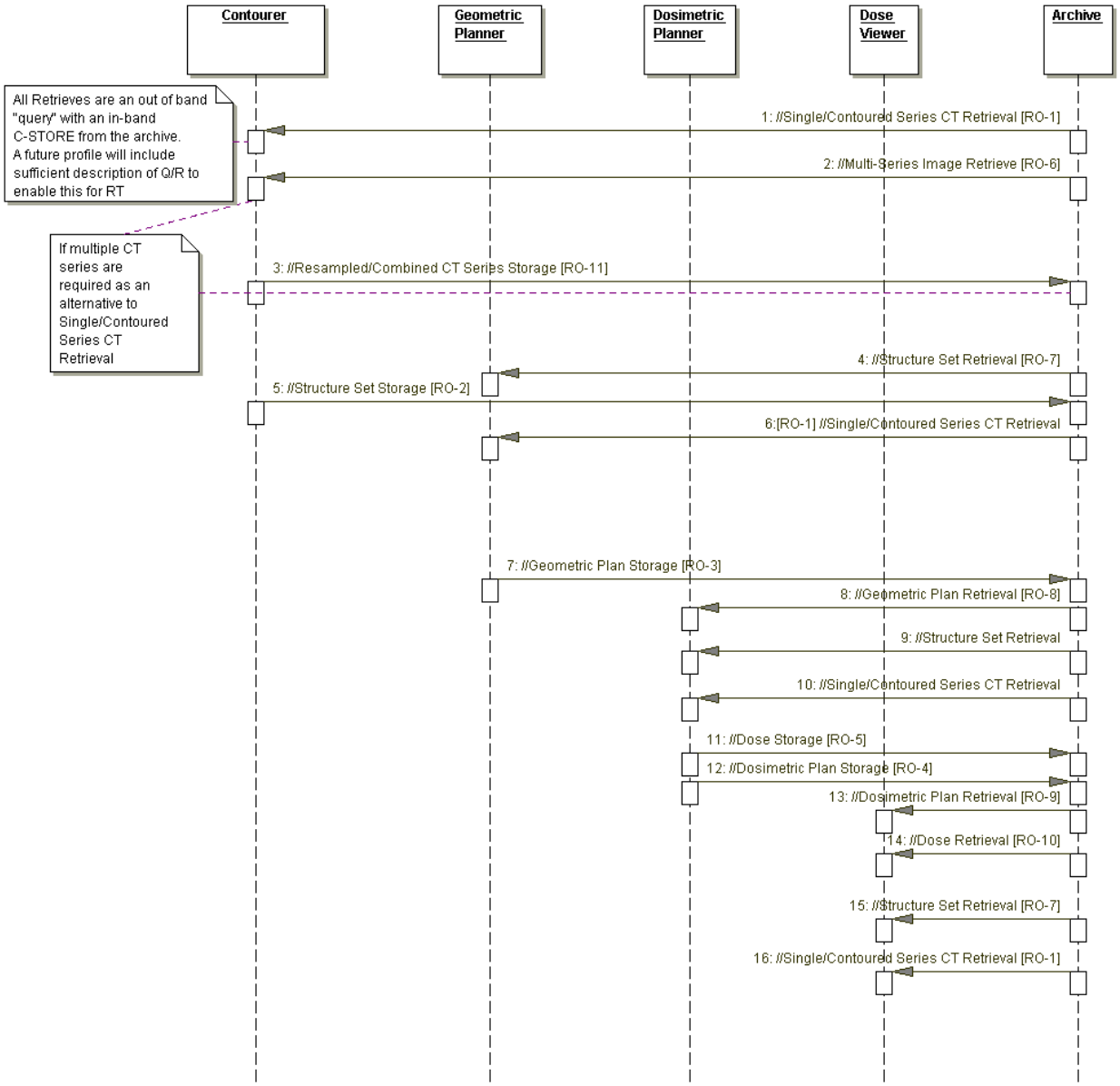

Figure 3.3-1: Basic Process Flow in Basic RT Objects Profile

3.4 Basic RT Objects Security Considerations

There are no explicit security considerations in this profile.

Appendices

Appendix A – Actor Descriptions

Actors are information systems or components of information systems that produce, manage, or act on information associated with operational activities in the enterprise. The following are definitions of actors used in the IHE Radiation Oncology Integration Profiles:

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.

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.

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

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.

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.

The following table shows which actors are used in which Integration Profiles.

Table A-1: Integration Profile Actors

Integration Profile Actor	BRTO
Acquisition Modality	X
Archive	X
Contourer	X
Geometric Planner	X
Dosimetric Planner	X
Dose Displayer	X

Appendix B – Transactions

Transactions are interactions between actors that transfer the required information through standards-based messages. The following are brief descriptions of the transactions defined by IHE Radiation Oncology.

1. **Single/Contoured Image Series Retrieval**: The *Archive* stores a series of CT images to the *Contourer*, *Geometric Planner*, *Dosimetric Planner*, or *Dose Displayer*.
2. **Structure Set Storage**: The *Contourer* stores an RT Structure Set to the *Archive*. The RT Structure Set shall reference only a single CT image series.
3. **Geometric Plan Storage**: The *Geometric Planner* stores a newly created Geometric Plan to the *Archive*.
4. **Dosimetric Plan Storage**: The *Dosimetric Planner* stores a Dosimetric Plan containing references to the RT Structure Set to the *Archive*. A Dosimetric Plan, as defined in the BRTO Profile, is not meant to be consumed by another *Dosimetric Planner* or a Treatment Management System.
5. **Dose Storage**: The *Dosimetric Planner* stores a newly created RT Dose to the *Archive*.
6. **Multi-Series Image Retrieval**: The *Archive* stores CT images from multiple series (but a single study) to a *Contourer* to make these images available for contouring.
7. **Structure Set Retrieval**: The *Archive* stores an RT Structure Set on a *Contourer*, *Geometric Planner*, *Dosimetric Planner*, or *Dose Displayer*.
8. **Geometric Plan Retrieval**: The *Archive* stores a Geometric Plan to a *Dosimetric Planner*.
9. **Dosimetric Plan Retrieval**: The *Archive* stores a Dosimetric Plan containing the references to the RT Structure Set to the *Dose Displayer*.
10. **Dose Retrieval**: The *Archive* stores an RT Dose to the *Dose Displayer*.
11. **Resampled/Combined CT Series Storage**: The *Contourer* stores CT images which have been combined or resampled into a single series to the *Archive*.

The following table shows which transactions are used in which Integration Profiles.

Table B-1: Integration Profile Transactions

Integration Profile Transaction	BRTO
Single/Contoured Image Series Retrieval	X
Structure Set Storage	X
Geometric Plan Storage	X
Dosimetric Plan Storage	X
Dose Storage	X
Multi-Series Image Retrieval	X

Integration Profile Transaction	BRTO
Structure Set Retrieval	X
Geometric Plan Retrieval	X
Dosimetric Plan Retrieval	X
Dose Retrieval	X
Resampled/ Combined CT Series Storage	X

Glossary

Dosimetric Plan: an RT Plan object containing sufficient information to dosimetrically define a radiation therapy treatment. The Dosimetric Plan shall contain references to RT Structure Set and RT Dose objects. A Dosimetric Plan shall contain a Fraction Group Sequence (300A,0070) containing a single sequence item. Each beam in the Referenced Beam Sequence (300C,0004) shall have its Beam Meterset (300A,0086) defined.

Geometric Plan: an RT Plan object containing a subset of information defining a radiation therapy treatment. The Geometric Plan shall contain a reference to an RT Structure Set. Further definition of a Geometric Plan can be found by review of the appendices of RO TF-2. A Geometric Plan is conceptually the state of an RT Plan object that might be stored by a CT-Simulation application (i.e., a Geometric Planner).

