ASTRO

Integrating the Healthcare Enterprise

IHE-Radiation Oncology

Technical Framework
Volumes 1-2

2007

Draft for Trial Implementation

August 18, 2007

Comments may be submitted to:

http://forums.rsna.org under the "*IHE*" forum

Select the "*Radiation Oncology Technical Framework*" sub-forum.

Contents

Foreword

Integrating the Healthcare Enterprise (IHE) is an initiative designed to stimulate the integration of the information systems that support modern healthcare institutions. Its fundamental objective is to ensure that in the care of patients all required information for medical decisions is both correct and available to healthcare professionals. The IHE initiative is both a process and a forum for encouraging integration efforts. It defines a technical framework for the implementation of established messaging standards to achieve specific clinical goals. It includes a rigorous testing process for the implementation of this framework. And it organizes educational sessions and exhibits at major meetings of medical professionals to demonstrate the benefits of this framework and encourage its adoption by industry and users.

The approach employed in the IHE initiative is not to define new integration standards, but rather to support the use of existing standards, HL7, DICOM, IETF, and others, as appropriate in their respective domains in an integrated manner, defining configuration choices when necessary. When clarifications or extensions to existing standards are necessary, IHE refers recommendations to the relevant standards bodies.

This initiative has numerous sponsors and supporting organizations in different medical specialty domains and geographical regions. In North America the primary sponsors are the American College of Cardiology (ACC), the Healthcare Information and Management Systems Society (HIMSS) and the Radiological Society of North America (RSNA). IHE Canada has also been formed. IHE Europe (IHE-EUR) is supported by a large coalition of organizations including the European Association of Radiology (EAR) and European Congress of Radiologists (ECR), the Coordination Committee of the Radiological and Electromedical Industries (COCIR), Deutsche Röntgengesellschaft (DRG), the EuroPACS Association, Groupement pour la Modernisation du Système d'Information Hospitalier (GMSIH), Société Francaise de Radiologie (SFR), and Società Italiana di Radiologia Medica (SIRM). In Japan IHE-J is sponsored by the Ministry of Economy, Trade, and Industry (METI); the Ministry of Health, Labor, and Welfare; and MEDIS-DC; cooperating organizations include the Japan Industries Association of Radiological Systems (JIRA), the Japan Association of Healthcare Information Systems Industry (JAHIS), Japan Radiological Society (JRS), Japan Society of Radiological Technology (JSRT), and the Japan Association of Medical Informatics (JAMI). Other organizations representing healthcare professionals are actively involved and others are invited to join in the expansion of the IHE process across disciplinary and geographic boundaries.

The IHE Technical Frameworks for the various domains (Patient Care Coordination, IT Infrastructure, Cardiology, Laboratory, Radiation Oncology, Radiology, etc.) define specific implementations of established standards to achieve integration goals that promote appropriate sharing of medical information to support optimal patient care.

These are expanded annually, after a period of public review, and maintained regularly through the identification and correction of errata. The current version for these Technical Frameworks may be found at www.ihe.net.

The IHE Technical Framework identifies a subset of the functional components of the healthcare enterprise, called IHE Actors, and specifies their interactions in terms of a set of coordinated, standards-based transactions. It describes this body of transactions in progressively greater depth. The volume I 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 provide detailed technical descriptions of each IHE transaction.

1.1 Content of this Document

This profile defines the relevant standards and constraints on those standards in order to implement a specific use case for the transfer of information between systems. This document is organized into 3 volumes as follows:

1.1.1 Volume 1 – Overview

This volume is provided as a high level overview of the profile including descriptions of the use case, the actors involved, the process flow, and dependencies on other standards and IHE profiles. It is of interest to care providers, vendors' management and technical architects and to all users of the profile

1.1.2 Volume 2 – Transactions

This volume is intended as a technical reference for the implementation of specific transactions in the use case including references to the relevant standards, constraints, and interaction diagrams. It is intended for the technical implementers of the profile.

1.1.3 Volume 3 – Document Content

This volume describes additional constraints on documents content such as vocabularies, and metadata passed in the transaction. It is intended for technical implementers of the profile.

An Information Structure Appendix in Volume 3 contains the detailed information models and resulting information structured for medication, allergies and problems. It also contains supporting documentation and examples of document entry structures.

1.2 How to Contact Us

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
robynw@astro.org

Volume 1- Overview

ASTRO

Integrating the Healthcare Enterprise

IHE-RO Technical Framework

2007

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1 Preface to Volume 1

1.1 Intended Audience

The intended audience of this document is:

- Healthcare professionals involved in informatics
- IT departments of healthcare institutions
- Technical staff of vendors participating in the IHE initiative
- Experts involved in standards development
- Those interested in integrating healthcare information systems and workflows

1.2 How this Volume is Organized

Section 2 describes the general nature, purpose and function of the Technical Framework.

Section 3 and the subsequent sections of this volume provide detailed documentation on each integration profile, 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 a summary list of the actors and transactions, detailed discussion of specific issues related to the integration profiles and a glossary of terms and acronyms used.

1.3 Conventions Used in this Document

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 Technical Framework Cross-references

When references are made to another section within a 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 (PCC= Patient Care Coordination, ITI = IT Infrastructure, RAD = Radiology, RO = Radiation Oncology)

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

<section number> is the applicable section number.

For example: RO TF-1: 3.1 refers to Section 3.1 in volume 1 of the IHE Radiation Oncology Technical Framework, ITI TF-2: 4.33 refers to Section 4.33 in volume 2 of the IHE IT Infrastructure Technical Framework.

1.3.2 IHE 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 communicate the required information through standards-based messages.

The diagrams and tables of actors and transactions in subsequent sections indicate which transactions each actor in a given profile must support.

The transactions shown on the diagrams are identified both by their name and the transaction number as defined in RO TF-2 (Volume 2 of the RO Technical framework). The transaction numbers are shown on the diagrams as bracketed numbers prefixed with the specific Technical Framework domain.

In some cases, a profile is dependent on a prerequisite profile in order to function properly and be useful. These dependencies, if any would be found by locating the desired profile in Table 2.6-1 to determine which profile(s) are listed as prerequisites. An actor must implement all required transactions in the prerequisite profiles in addition to those in the desired profile.

1.3.3 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 an overview so the transactions can be seen in the context of an institution's or cross-institutions' 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 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. Transactions are shown as arrows oriented according to the flow of the primary information handled by the transaction and not necessarily the initiator.

1.4 Copyright Permissions

1.5 How to Contact Us

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
mailto:robynw@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/ , 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
- 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 Framework Development and Maintenance

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 or clarifications to the Technical Framework must maintain backward compatibility with previous versions of the framework (except in rare cases for corrections) 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 RO 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 Technical Framework for "Trial Implementation." This version contains both the stable body of the Technical Framework from the preceding cycle and the newly developed supplements. It is this version of the Technical Framework that is used by vendors in developing trial implementation software for the IHE Connectathons.
3. The Committee regularly considers change proposals to the Trial Implementation version of the Technical Framework, including those from implementers who participate in the Connectathon. After resolution of all change proposals received within 60 days of the Connectathon, the Technical Framework version is published as "Final Text".

The Committee as part of the Technical framework maintenance will consider change proposals received after the publication to the "Final Text".

2.4 Radiation Oncology Integration Profiles

IHE Integration Profiles 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, transactions and their content. Actors (listed in 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. Transactions (listed in 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.

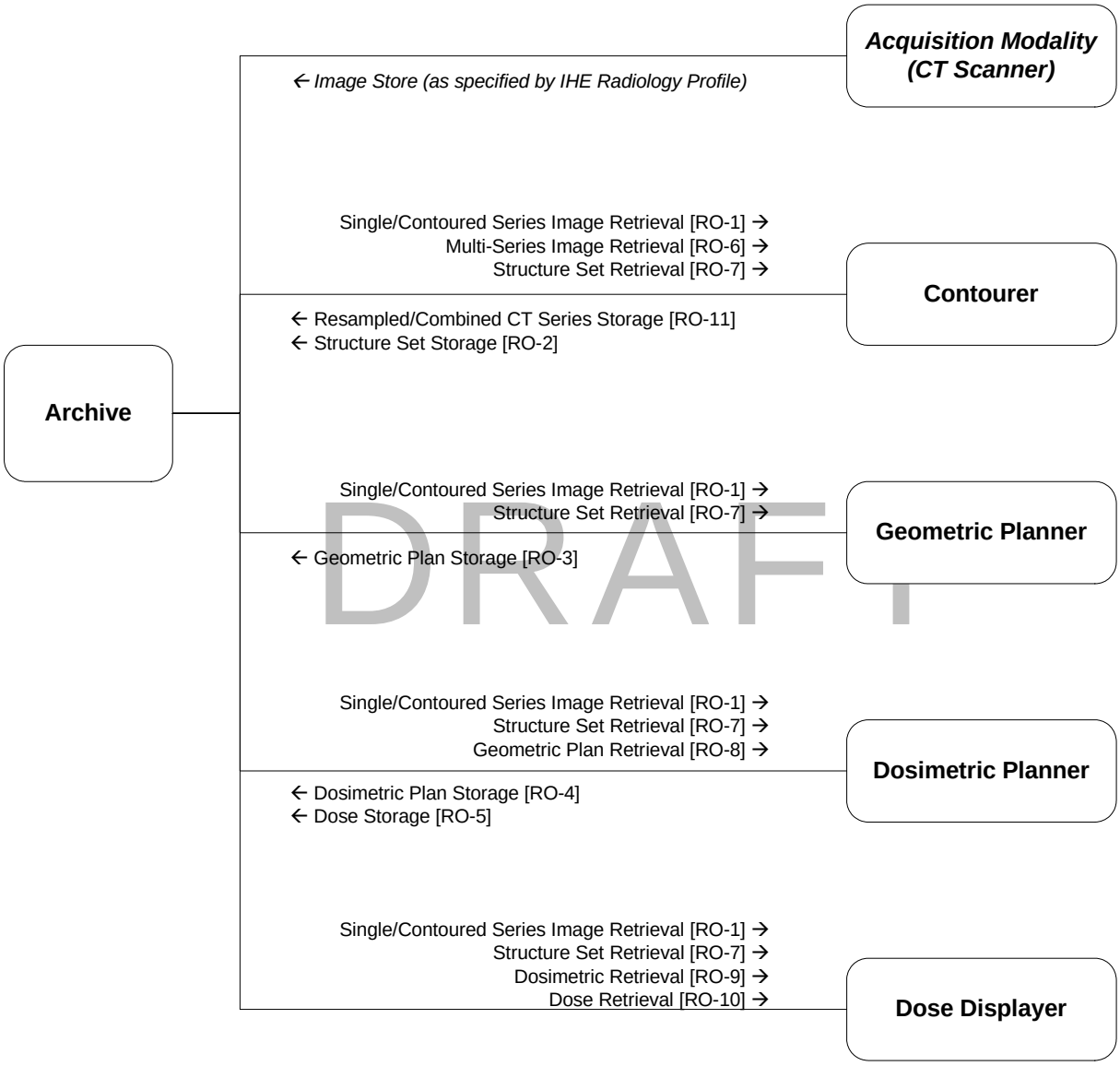


Figure 2.4-1 IHE Radiation Oncology Integration Profiles

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.

2.5 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.

2.6 Product Implementations

Developers have a number of options in implementing IHE actors and transactions in product implementations. The decisions cover three classes of optionality:

- For a system, select which actors it will incorporate (multiple actors per system are acceptable).
- For each actor, select the integration profiles in which it will participate.
- For each actor and profile, select which options will be implemented.

All required transactions must be implemented for the profile to be supported.

Implementers should provide a statement describing which IHE actors, IHE integration profiles and options are incorporated in a given product. The recommended form for such a statement is defined at
http://www.ihe.net/Resources/upload/ihe_integration_statements.pdf .

In general, a product implementation may incorporate any single actor or combination of actors. When two or more actors are grouped together, internal communication between actors is assumed to be sufficient to allow the necessary information flow to support their

functionality. The exact mechanisms of such internal communication are outside the scope of the IHE Technical Framework.

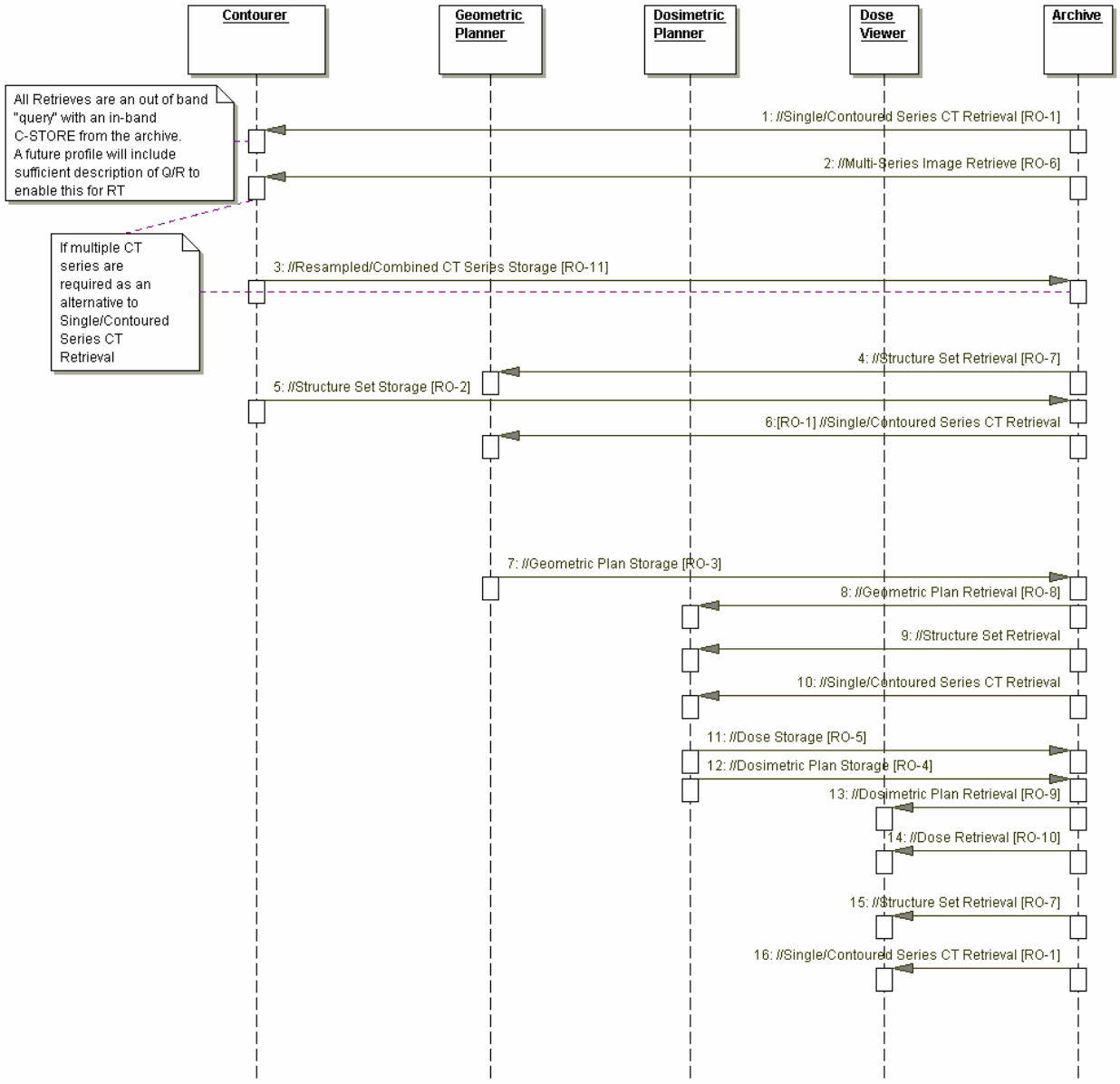
When multiple actors are grouped in a single product implementation, all transactions originating or terminating with each of the supported actors shall be supported (i.e., the IHE transactions shall be offered on an external product interface).

3 RT Objects Integration Profile

3.1 Scope and Purpose

The integration profile for 2007 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.

3.2 RT Object Process Flow



Sequence Diagram

Appendix A: Actors

A.1: 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.
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.

ADT Patient Registration – A system responsible for adding and/or updating patient demographic and encounter information. In particular, it registers a new patient with the Order Placer and Department System.

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

Audit Record Repository – A system unit that receives and collects audit records from multiple systems.

Charge Processor – Receives the posted charges and serves as a component of the financial system. Further definition of this actor is beyond current IHE scope.

Department System Scheduler/Order Filler – A department-based information system (for instance, Radiology or Laboratory) that provides functions related to the management of orders received from external systems or through the department system's user interface. Upon a defined workflow action, makes procedures available for charge posting. The action/event that actually causes charges to post is defined by the actor.

Display – Primary description for this actor can be found in ITI TF-1: Appendix A. The required capabilities for its use within the Radiology Technical Framework add the ability to view "web-viewable" diagnostic and therapeutic imaging information on interchange media.

Enterprise Report Repository – A system that receives Structured Report Export Transactions from the Report Manager and stores them.

Evidence Creator – A system that creates additional evidence objects such as images, presentation states, Key Image Notes, and/or Evidence Documents and transmits them to an Archive. It also makes requests for storage commitment to the Image Manager for the data previously transmitted. It may also retrieve worklist entries for post-processing steps

from the Post-Processing Manager and provide notification of completion of the step, allowing the enterprise to track the status of post-processing work.

External Report Repository Access – A system that performs retrieval of clinical reports containing information generated outside the imaging department and presented as DICOM Structured Reporting Objects.

Image Display – A part of a system that can access imaging evidence objects (images, Presentation States, Key Image Notes, Evidence Documents) through network query/retrieve or reading interchange media and allow the user to view these objects.

Image Manager – A system that provides functions related to safe storage and management of evidence objects. It supplies availability information for those objects to the Department System Scheduler.

Master Patient Index (MPI) – A system that maintains unique enterprise-wide identifiers for patients. Note that this is not supported in the current scope of the IHE Technical Framework

Order Placer – A hospital or enterprise-wide system that generates orders for various departments and distributes those orders to the correct department.

Performed Procedure Step Manager – A system that re-distributes the Modality Performed Procedure Step information from the Acquisition Modality or Evidence Creator to the Department System Scheduler/Order Filler, Image Manager and Report Manager.

Portable Media Creator – This actor assembles the content of the media and writes it to the physical medium.

Portable Media Importer – This actor reads the DICOM information contained on the media, and allows the user to select DICOM instances, reconcile key patient and study attributes, and store these instances. The actor grouped with the Media Importer can then process the instances.

Post-Processing Manager – A system that provides functions related to post-processing worklist management. This involves the ability to schedule post-processing worklist items (scheduled procedure steps), provide worklist items to post-processing worklist clients, and update the status of scheduled and performed procedure steps as received from post-processing worklist clients.

Print Composer – A system that generates DICOM print requests to the Print Server. Print requests include presentation state information in the form of Presentation Look-Up Tables (Presentation LUTs). It may also read the DICOM information contained on interchange media.

Print Server – A system that accepts and processes DICOM print requests as a DICOM Print SCP and performs image rendering on hardcopy media. The system must support pixel rendering according to the DICOM Grayscale Standard Display Function.

Report Creator – A system that generates and transmits draft (and optionally, final) diagnostic reports, presenting them as DICOM Structured Reporting Objects. It may also retrieve worklist entries for reporting steps from the Report Manager and provide notification of completion of the step, allowing the enterprise to track the status of an awaited report.

Report Manager – A system that provides management and short-term storage of DICOM Structured Report objects during the reporting process then distributes text or structured reports to report repositories. It also manages the worklists and status of reporting.

Report Reader – A part of a system that can access reports through network query/retrieve or reading interchange media and allow the user to view reports presented as DICOM Structured Reporting Objects.

Report Repository – A system that provides long-term storage of diagnostic reports and their retrieval as DICOM Structured Reporting Objects.

Secure Node – A system unit that validates the identity of any user and of any other node, and determines whether or not access to the system for this user and information exchange with the other node is allowed. Maintains the correct time and sends audit records to Audit Record Repository.

Time Server – A system unit that knows, maintains and distributes the correct time in the enterprise.

A.2: RT Specific Actors:

Contourer – A system that consumes CT and creates RT Structure Set. If the Contourer consumes multiple series CT or has an internal requirement for resampling, it also will generate a single series CT to which the RT Structure Set maps.

Geometric Planner – A system that consumes (single series) CT and RT Structure Set and creates a Geometric Plan

Dosimetric Planner – A system that consumes (single series) CT, an RT Structure Set, 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, CT, Structure Set and an RT Dose and displays the dose.

The Acquisition Modality (CT) is not included as an RT Specific Actor in the profile, it is assumed that it will have performed its function within the scope of RAD-8 (Modality images stored).

The following table shows which transactions are required to be supported by the actors in the RT Objects Profile (the letter "R" in the Optionality column means the transaction is required. There are no optional transactions in the RT Objects Integration Profile).

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

Actors	Transactions	Optionality	Vol II/III section
	Dosimetric Plan Retrieve [RO-9]	R	3.9
	Structure Set Retrieval [RO-7]	R	3.7
	Single/Contoured Series Image Retrieval [RO-1]	R	3.1

Appendix B: Transactions

B.1: Transaction Descriptions

Transactions are interactions between actors that transfer the required information through standards-based messages. The following are the transactions defined by IHE and referenced throughout the rest of this document.

RO-1: Single/Contoured Image Series Retrieval

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

RO-2: Structure Set Storage

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

RO-3: Geometric Plan Storage

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

RO-4: Dosimetric Plan Storage

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

RO-5: Dose Storage

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

RO-6: Multi-Series Image Retrieve

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.

RO-7: Structure Set Retrieval

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

RO-8: Geometric Plan Retrieve

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

RO-9: Dosimetric Plan Retrieve

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

RO-10: Dose Retrieve

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

RO-11: Resampled/Combined CT Series Storage

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.

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

Integration Profile Transactions

	Profiles
Transactions	**RT Objects**
Single/Contoured Image	X

Transactions	Profiles RT Objects
Series Retrieve	
Structure Set Storage	X
Geometric Plan Storage	X
Dosimetric Plan Storage	X
Dose Storage	X
Multi-Series Image Retrieve	X
Structure Set Retrieve	X
Geometric Plan Retrieve	X
Dosimetric Plan Retrieve	X
Dose Retrieve	X
Resampled/ Combined CT Series Storage	X

Volume 2 - Transactions

ASTRO

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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

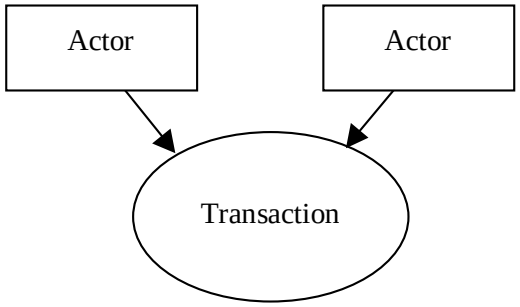
This document has adopted the following conventions for representing the framework concepts and specifying how the standards upon which the IHE Technical Framework is based should be applied.

1.3.1 The Generic IHE Transaction Model

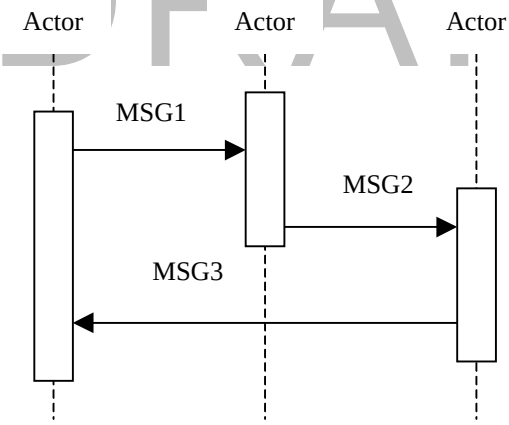
Transaction descriptions are provided in section 4. In each transaction description, the actors, the roles they play, and the transactions between them are presented as use cases.

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 How to Contact Us

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
robynw@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.

3 IHE Transactions

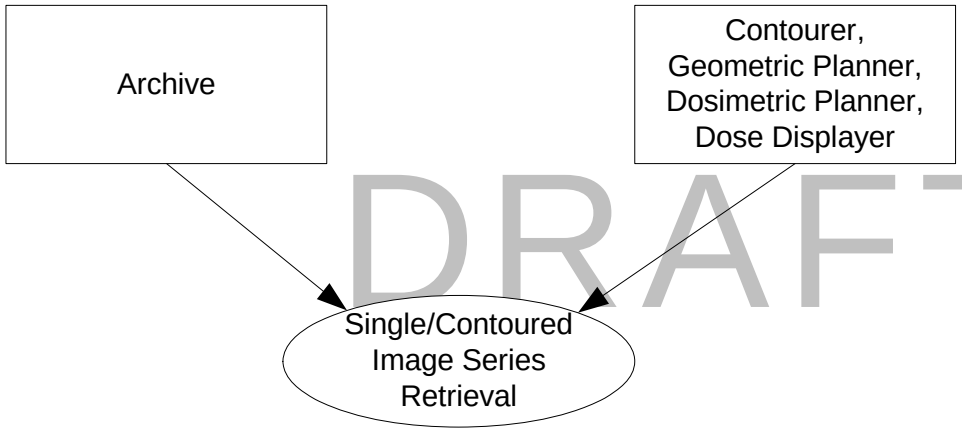
This section defines each IHE transaction in detail, specifying the standards used, and the information transferred.

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***

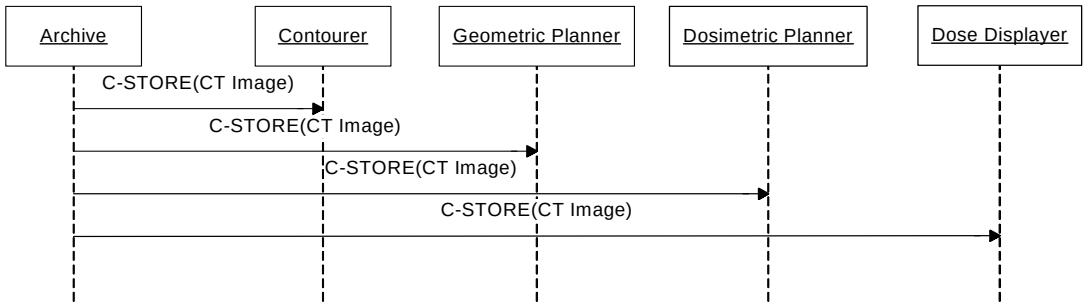
Actor: ***Contourer***, ***Geometric Planner***, ***Dosimetric Planner*** or ***Dose Displayer***

Role: Receives and stores CT Series from Archive

3.1.3 Referenced standards

DICOM 2007 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).

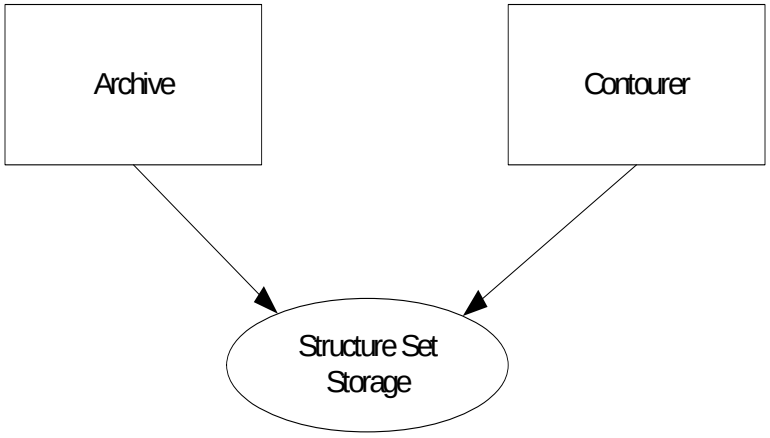
The ***Dose Displayer*** will store all of the CT Images, and will relate the images based on the study, series, and image identification information. These images will then be available to the user of the ***Dose Displayer*** for use in construction of a dose display.

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

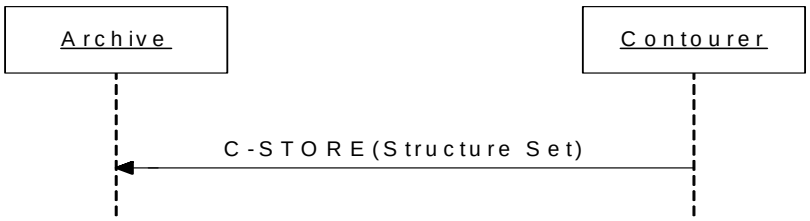
Actor: Archive

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

3.2.3 Referenced standards

DICOM 2007 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 Message 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

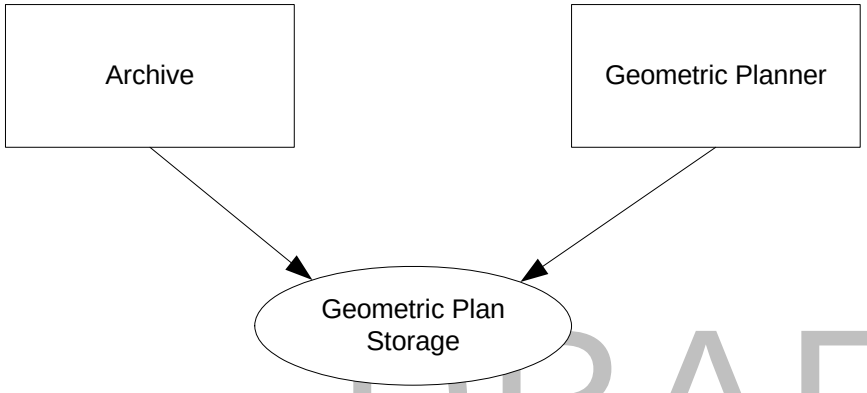
Upon receipt of the Structure Set, the Archive shall store it. This Structure Set is then available for subsequent retrieval (RO-7).

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

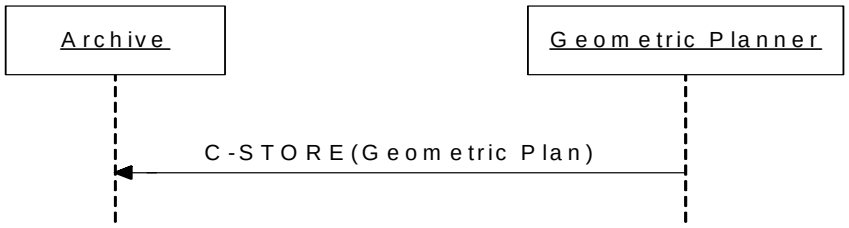
Actor: Archive

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

3.3.3 Referenced standards

DICOM 2007 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.

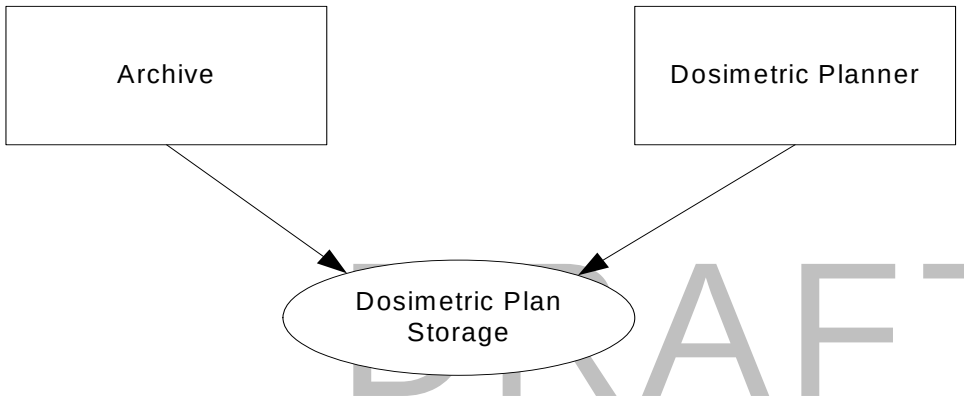
3.4 RO-4: Dosimetric Plan Storage

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.

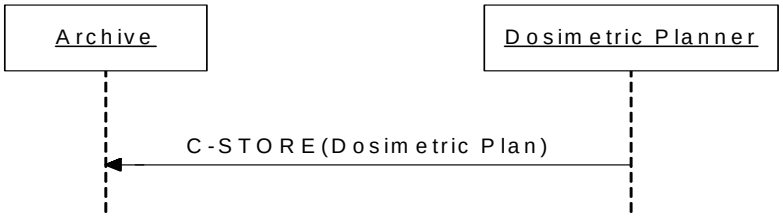
Actor: Archive

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

3.4.3 Referenced Standards

DICOM 2007, 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 XXX Required Attributes for RT General Plan Module

Attribute	Tag	Type	Attribute Description
RT Plan Label	(300A,0002)	R+	The label, which serves as the identification of the plan for the user.
RT Plan Date	(300A,0006)	R+	The date, when the plan was last modified.
RT Plan Time	(300A,0007)	R+	The time, when the plan was last modified.
RT Plan Geometry	(300A,000C)	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 XXX 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+	The software 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.

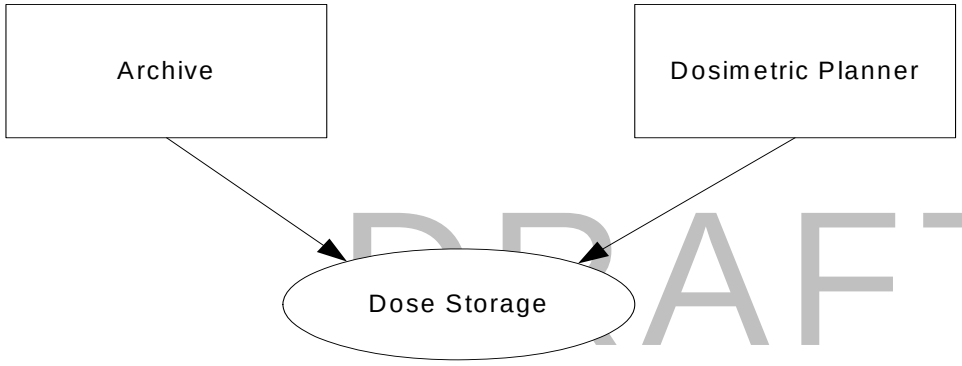
3.5 RO-5: Dose Storage

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 2007 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.

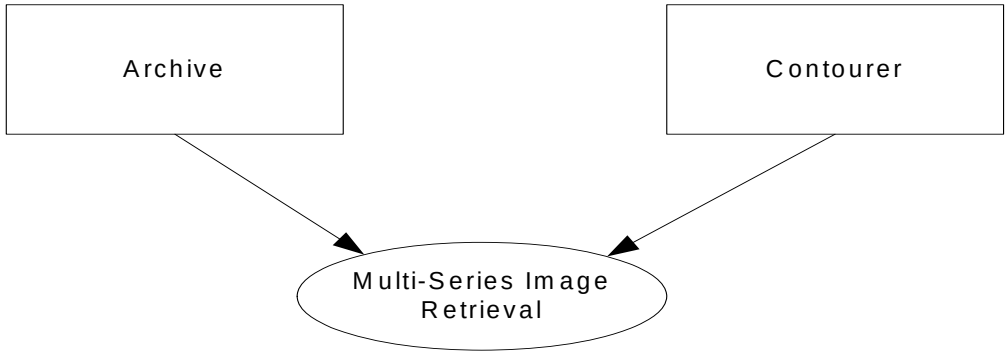
SOP Class UID	SOP Class Name
1.2.840.10008.5.1.4.1.1.481.2	RT Dose Storage

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 2007 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

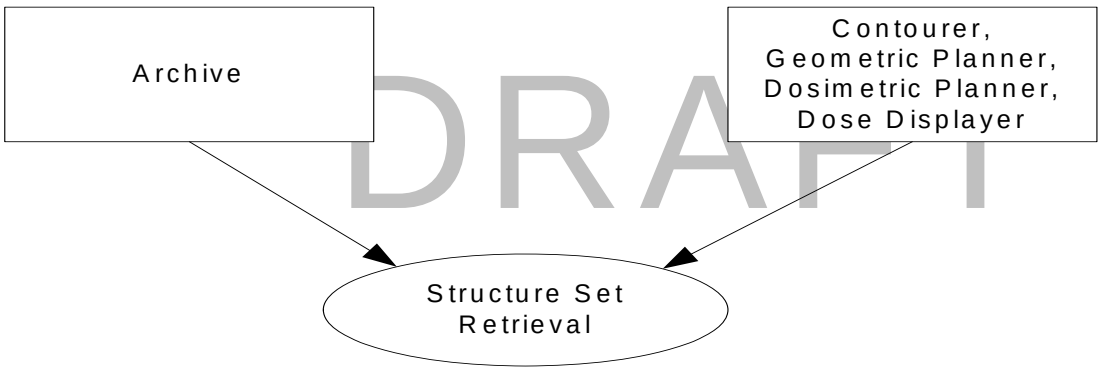
Upon receiving the multiple CT Series, the ***Contourer*** will resample the Series if necessary, and will combine Images from the various series into a single, new CT Series with a new series instance UID. A Contourer shall be required to support retrieval of multiple (1, 2, or 3) image series. Images 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***

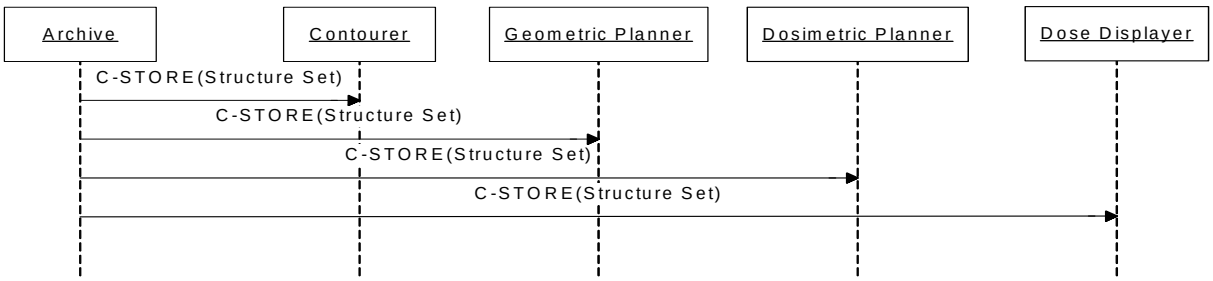
Actor: ***Contourer***, ***Geometric Planner***, ***Dosimetric Planner***, or ***Dose Displayer***

Role: Stores Structure Set received from Archive

3.7.3 Referenced standards

DICOM 2007 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).

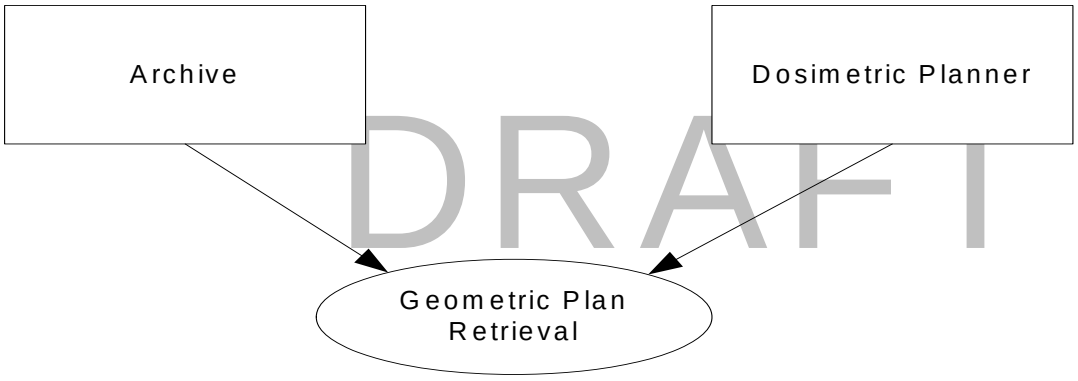
The ***Dose Displayer*** will store the structure set, and will relate it to images based on the study, series, and image identification information. These contours contained in this structure set will then be available to the user of the ***Dose Displayer*** for display in relation to images, doses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

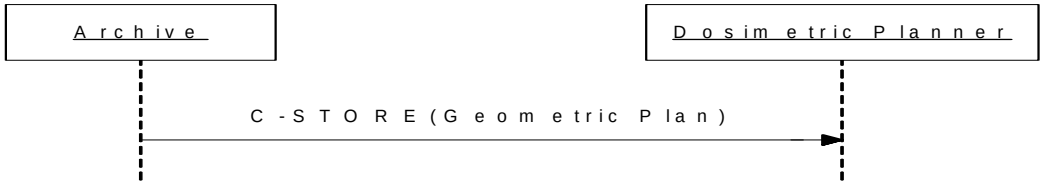
Actor: Archive

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

3.8.3 Referenced standards

DICOM 2007 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

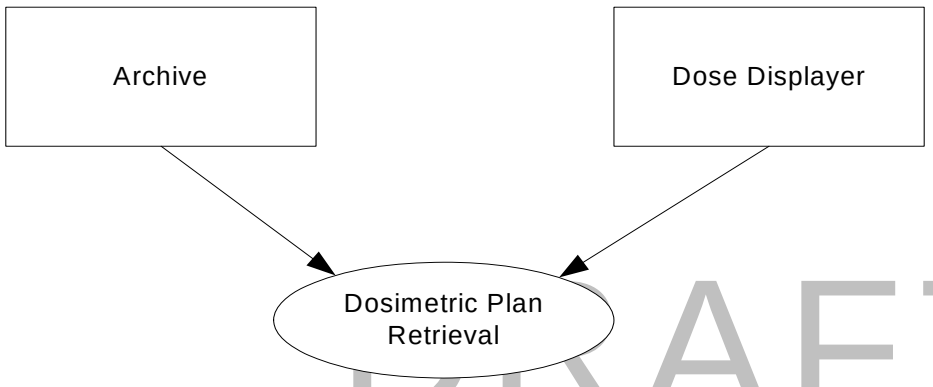
The Archive shall return the requested ***Geometric Plan*** to the ***Dosimetric Planner***. The ***Dosimetric Planner*** shall validate the received Geometric Plan. In case the received ***Geometric Plan*** is valid, it shall be loaded in the ***Dosimetric Planner***; in case it is not valid, a warning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

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 2007, PS 3.3: RT Modules, PS 3.4: Storage Service Class.

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 RO-4: *Dosimetric Plan* Storage.

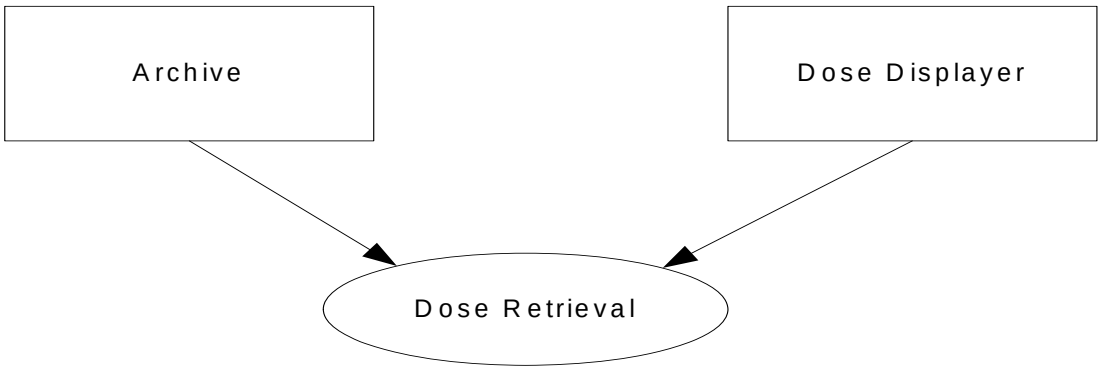
3.10 RO-10: Dose Retrieve

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 2007 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

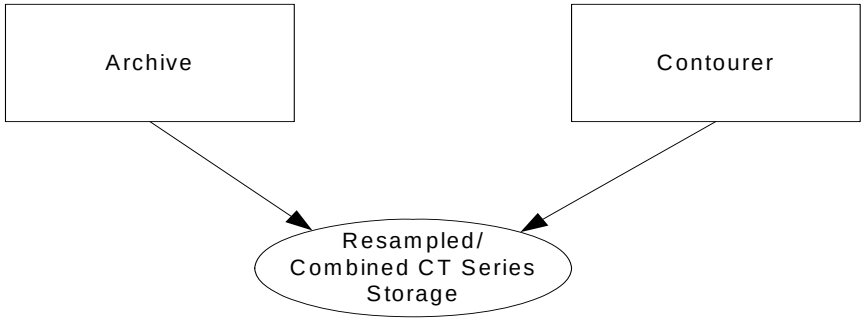
Upon receiving the request for retrieval, the Archive shall return the requested Dose to the ***Dose Displayer***. The ***Dose Displayer*** shall validate the received Dose. If the received Dose is valid, it shall be loaded in the ***Dose Displayer***. If it is not valid, a warning message shall be displayed 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 2007 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).

Appendix A: Attribute 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 2007 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
Patient's Name (0010,0010)	Source	Copy	Copy	Copy	Copy
Patient ID (0010,0020)	Source	Copy	Copy	Copy	Copy
Patient's Birth Date (0010,0030)	Source	Copy	Copy	Copy	Copy
Patient's Sex (0010,0040)	Source	Copy	Copy	Copy	Copy
Study Instance UID (0020,000D)	Source	New Source (May Copy *)	Copy	Copy	Copy
Study Date (0008,0020)	Source	New Source (May Copy *)	Copy	Copy	Copy
Study Time (0008,0030)	Source	New Source (May Copy *)	Copy	Copy	Copy
Referring Physician's Name (0008,0090)	Source	New Source (May Copy *)	Copy	Copy	Copy
Study ID (0020,0010)	Source	New Source (May Copy *)	Copy	Copy	Copy
Accession Number (0008,0050)	Source	New Source (May Copy *)	Copy	Copy	Copy
Study Description (0008,1030)	Source	New Source (May Copy *)	Copy	Copy	Copy
Frame of Reference UID (0020,0052)	Source	Copy	Copy	Copy	Copy
Position Reference Indicator (0020,1040)	Source	NA	Copy	Copy	Copy

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

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 Subject	C.7.1.3	U	U
Study	General Study	C.7.2.1	M	M
	Patient Study	C.7.2.2	U	U
	Clinical Trial Study	C.7.2.3	U	U
Series	RT Series	C.8.8.1	M	M
	Clinical Trial Series	C.7.3.2	U	U
Frame of Reference	Frame of Reference	C.7.4.1	U – See Note.	M
Equipment	General Equipment	C.7.5.1	M	M
Plan	RT General Plan	C.8.8.9	M	M
	RT Prescription	C.8.8.10	U	U(geometric), M(dosimetric)
	RT Tolerance Tables	C.8.8.11	U	U
	RT Patient Setup	C.8.8.12	U	U
	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
	Approval	C.8.8.16	U	M
	Audio	C.10.3	U	U
	SOP Common	C.12.1	M	M

RT Dose IOD Modules

IE	Module	Reference	Usage	IHE-RO Usage
Patient	Patient	C.7.1.1	M	
	Clinical Trial Subject	C.7.1.3	U	
Study	General Study	C.7.2.1	M	
	Patient Study	C.7.2.2	U	
	Clinical Trial Study	C.7.2.3	U	
Series	RT Series	C.8.8.1	M	
	Clinical Trial Series	C.7.3.2	U	
Frame of Reference	Frame of Reference	C.7.4.1	M	
Equipment	General Equipment	C.7.5.1	M	
Dose	General Image	C.7.6.1	C - Required if dose data contains grid-based doses.	Shall be present
	Image Plane	C.7.6.2	C - Required if dose data contains grid-based doses.	Shall be present
	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	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.
	Structure Set	C.8.8.5	C - Required if dose data contains dose points or isodose curves	This module is outside the scope of this profile.
	ROI Contour	C.8.8.6	C - Required if dose data contains dose points or isodose curves	This module is outside the scope of this profile.
	RT Dose ROI	C.8.8.7	C - Required if dose data contains dose points or isodose curves	This module is outside the scope of this profile.
	Audio	C.10.3	U	This module is outside the scope of this profile.
	SOP Common	C.12.1	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+	IHE requires that this element be present. This element is one of the primary patient identifying elements, and as such, all DICOM objects with the same Study Instance UID, must have the same value in this element. Equipment which creates new series based on other series (i.e. resampled series, new structure sets, plans, etc) must preserve the value of this element to adhere to this profile.
Patient ID	(0010,0020)	R+	See Patient's Name (0010,0010)

Attribute	Tag	Type	Attribute Note
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+*	IHE requires that this value be preserved in the following cases: If a set of images are resampled and re-exported. This new set of images will be a new series. This series will belong to the same study and will have the same study date. This is to facilitate grouping the images in a PACS 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 Time	(0008,0030)	R+	[See (0020,000D)]
Study ID	(0020,0010)	R+	[See (0020,000D)]
Study Description	(0008,1030)	O+	[See (0020,000D)]

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)	R+*	If an application resamples and re-exports a series of CT images, or modifies an instance then this element must be present, and must contain the model name of the equipment doing the resampling.

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) must preserve the

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

RT Patient Setup Module

Attribute	Tag	Type	Attribute Note
Patient Setup Sequence	(300A,0180)	R+*	An actor must not rely on the presence of: • Fixation Device Sequence • Shielding Device Sequence • Setup Device Sequence • 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
>Number of Brachy Application Setups	(300A,00A0)	R+*	Must be constrained to a value 0. Brachytherapy is not supported in the 2007 IHE-RO Profiles.

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.

Attribute	Tag	Type	Attribute Note
>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

Attribute	Tag	Type	Attribute Note
			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

Attribute	Tag	Type	Attribute Note
			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+*	Required For RT Dose, Shall be equal to (3004,000C) = Grid Frame Offset Vector.

RT Dose Module

Attribute	Tag	Type	Attribute Note
Samples per Pixel	(0028,0002)	R+*	Shall be present and equal to 1
Photometric Interpretation	(0028,0004)	R+*	Shall be present and equal to **MONOCHROME2**
Bits Allocated	(0028,0100)	R+*	Shall be present and equal to 16 or 32
Bits Stored	(0028,0101)	R+*	Shall be equal to Bits Allocated
High Bit	(0028,0102)	R+*	Shall be one less than Bits Stored

Attribute	Tag	Type	Attribute Note
Pixel Representation	(0028,0103)	R+*	Shall have the value 0 = unsigned integer. Negative dose values shall not be present.
Dose Units	(3004,0002)	R+*	Shall be equal to the enumerated value **GY**
Dose Type	(3004,0004)	R+*	Shall be equal to the defined term **PHYSICAL**
Dose Comment	(3004,0006)	R+	Shall be present and not empty if Referenced RT Plan Sequence (300C,0002) is missing, in which case it should have the same value as RT Plan Description.
Normalization Point	(3004,0008)	O+*	Shall not be relied on.
Dose Summation Type	(3004,000A)	R+*	Shall have the value **PLAN**.
Referenced RT Plan Sequence	(300C,0002)	R	Shall be present if Dose Summation Type (3004,000A) has the value **PLAN**.
>Referenced Fraction Group Sequence	(300C,0020)	R+*	Shall be present if the parent sequence is present, and shall reference a single fraction group within the referenced RT Plan.
Grid Frame Offset Vector	(3004,000C)	R+*	First z coordinate shall be equal to zero. The remaining z coordinates shall be relative to the starting z position in Image Position (Patient) (0020,0032).
Tissue Heterogeneity Correction	(3004,0014)	O+	Shall be present but may be null. The value shall be given if known.

Image Plane Module Attributes

Attribute	Tag	Type	Attribute Note
Image Orientation (Patient)	(0020,0037)	R+*	This element shall be present in every RT Dose IOD. For IHE-RO 2006, this element shall be restricted to AXIAL images only. For an axial image, direction cosines shall be (±1, 0, 0, 0, ±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+*	Shall not be relied on.
Pixel Spacing	(0028,0030)	O+*	For CT, non-isotropic pixels are outside the scope of the profile. For RT Dose, pixel spacing may be non-isotropic

RT Structure Set Module

Attribute	Tag	Type	Attribute Note
Structure Set Label	(3006,0002)	R+	
Structure Set Date	(3006,0008)	R+	
Structure Set Time	(3006,0009)	R+	
Referenced Frame of Reference Sequence	(3006,0010)	R+*	This element is required for all 3D RT Structure Sets which are image based. It is to contain a set of references to the entire set of images which comprise the volume from which the Structure Set was constructed, and which is to be used for planning. There should only be one item in this sequence, as a Structure is only based on a single set of images, which is all in the same frame of reference.
>Frame of Reference UID	(0020,0052)	R+*	This frame of reference UID shall be the same as the frame of reference of the CT series from which the RTSTRUCT was constructed. It will also be the same as the frame of reference of any related RTPLAN's or RTDOSE's.
>RT Referenced Study Sequence	(3006,0012)	R+*	Must be present, to contain series sequence. Only one item allowed in this sequence.
>>RT Referenced Series Sequence	(3006,0014)	R+*	Must be present, to contain Contour Image Sequence. Only one item allowed in this sequence.
>>>Series Instance UID	(0020,000E)	R+*	Must be present, and shall contain the series to which the set of CT images upon which the structure set is based belong.
>>>Contour Image Sequence	(3006,0016)	R+*	Must be present. Contains an item for each CT image in the volume upon which the Structure Set is based.
>>>>Referenced SOP Class UID	(0008,1155)	R+*	Must be present with a value of '1.2.840.10008.5.1.4.1.1.2' This profile is for volumes based on CT Images only
>>>>Referenced Frame Number	(0008,1160)	O+*	Shall not be present
Structure Set ROI Sequence	(3006,0020)	R+	This sequence must be present. It defines the ROI's in this RTSTRUCT

Attribute	Tag	Type	Attribute Note
>ROI Number	(3006,0022)	R*	This defines an index to be used for referencing a particular ROI item from other sequences. It is required to be unique within the 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 CT series from which the RTSTRUCT was constructed. It will also be the same as the frame of reference of any related RTPLAN or RTDOSE instances.
>ROI Name	(3006,0026)	R+	This is the primary identifier for an ROI (from user perspective). Must be present and should match UI display. Must be unique within ROI sequence
>ROI Description	(3006,0028)	O+*	Not required - no compliant implementation shall rely on this element being present for proper operation.
>ROI Volume	(3006,002C)	O+*	Not required - no compliant implementation shall rely on this element being present for proper operation.
>ROI Generation Algorithm	(3006,0036)	R+	Must be present, with a value of AUTOMATIC, SEMIAUTOMATIC, or MANUAL. This information may be presented to a user, but no semantics for handling an RTSTRUCT is required for this profile. 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+*	This sequence contains information about an ROI. It references the ROI in Referenced ROI Number which

Attribute	Tag	Type	Attribute Note
			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 to describe a 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.

Attribute	Tag	Type	Attribute Note
>>ROI Physical Property	(3006,00B2)	R+*	Only relative electron density: REL_ELEC_DENSITY

RT Contour Module

Attribute	Tag	Type	Attribute Note
ROI Contour Sequence	(3006,0039)	R	
>ROI Display Color	(3006,002A)	O+*	Not required - no compliant implementation shall rely on this element being present for proper operation. However applications are allowed to be aware of this element and use it to map display colors.
>Contour Sequence	(3006,0040)	R+*	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.
>>>Referenced Frame Number	(0008,1160)	O+*	Shall not be present
>>Contour Geometric Type	(3006,0042)	R+*	Must be present, with a value of POINT or CLOSED_PLANAR. Conforming implementations must

Attribute	Tag	Type	Attribute Note
			properly interpret this value.
>>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	(3006,0046)	R+*	Required, and must match the actual number of points in Contour Data. Shall not exceed the number for which the Contour Data 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 Date	(0008,0012)	O+*	Actors must not rely on the presence of this attribute to operate correctly
Instance Creation Time	(0008,0013)	O+*	Actors must not rely on the presence of this attribute to operate correctly
Instance Creator UID	(0008,0014)	O+*	Actors must not rely on the presence of this attribute to operate correctly
Instance Number	(0020,0013)	O+*	Actors must not rely on the presence of this attribute to operate correctly