Digital Imaging and Communications in Medicine (DICOM)

Supplement 179: Second Generation Radiotherapy –

Part 17

DICOM Standards Committee, Working Group 7, Radiation Therapy
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VERSION: Sup 179 - Revision 01
August 28, 2014

Developed pursuant to DICOM Work Item 2007-06-B

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Foreword

This Supplement in its current state represents the remaining sections of Supplement 147, revision 42, which is being split into several smaller attributes.

Attribute definitions, CID definitions and DICOM Controlled terminology are currently not part of this document, but remain in their entirety in Supplement 147 until it is ready for Public Comment. Then the remaining parts of these chapters will be moved to this document.

This Supplement specifies the additional IODs necessary to support the new Second Generation Radiotherapy IODs and operations.

This document is an extension to the following parts of the published DICOM Standard:

PS 3.17	Explanatory Information

Scope and Field of Application

Introduction

Existing radiotherapy IODs were designed to provide a set of containers for use in communicating radiation therapy data of all types, in a generic and flexible way.

Since the development of the initial IODs, both radiation therapy practice and the DICOM Standard itself have evolved considerably. In particular, workflow management is now a key aspect of DICOM's domain of application, and the introduction of Unified Worklist and Procedure Step (by Supplement 74 in conjunction with Supplement 96) have begun the growth of radiation therapy into workflow management.

This supplement addresses the need for a new generation of IODs and processes required for use in radiation therapy. The general principles under which these IODs and processes have been developed are documented below.

Part 17 Addendum

Add the following to PS3.17:

Annex Z Second Generation RT (Informative)

ZZ.1 INTRODUCTION

This annex provides additional explanations and sample use cases for the 2nd Generation RT IOD's. It is not intended as an exhaustive list of procedure step types that could be undertaken with these objects.

The main clinical purposes of the relationships amongst the important IOD's are shown in the following diagram:

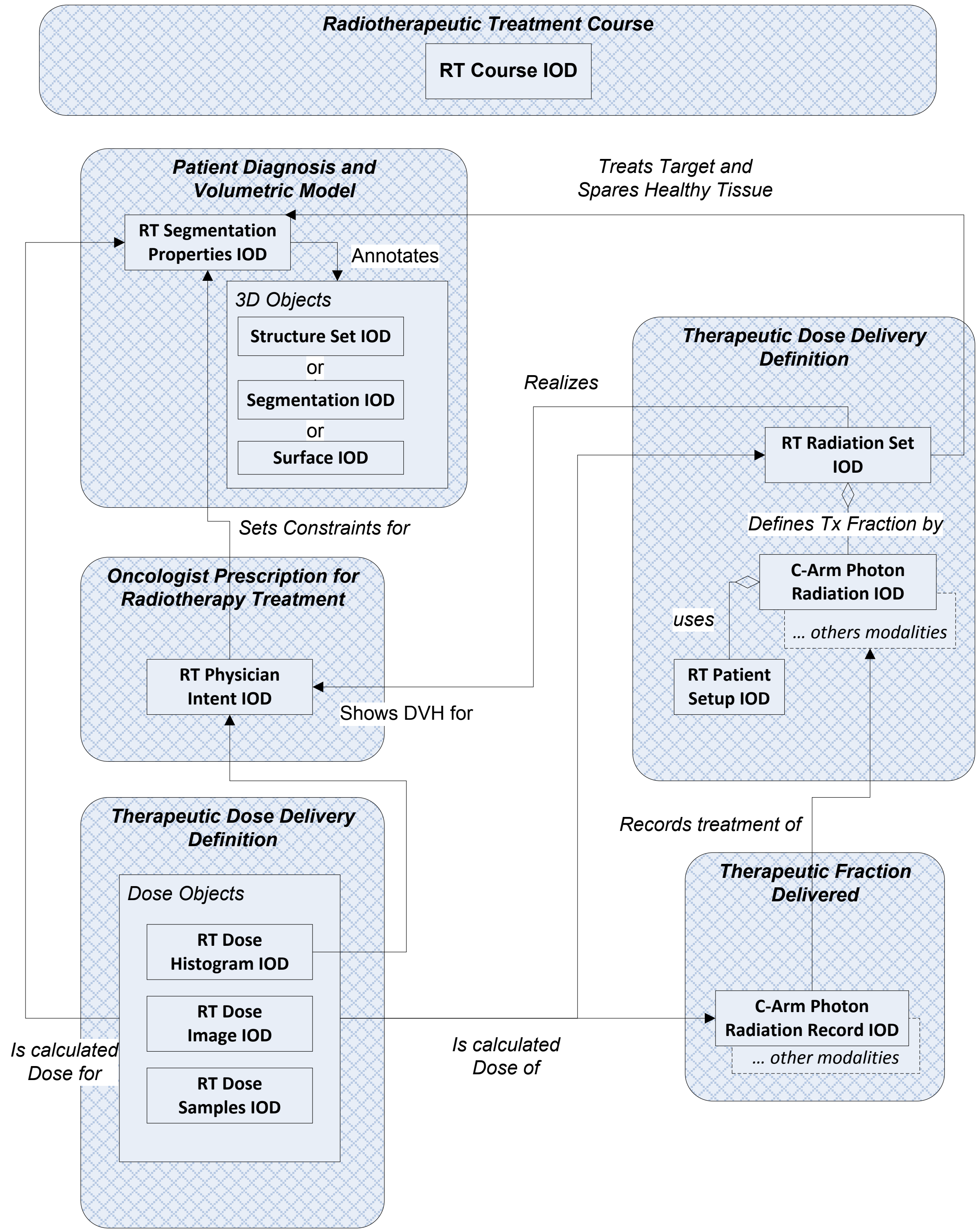

Radiotherapeutic Treatment Course
RT Course IOD
Patient Diagnosis and Volumetric Model
RT Segmentation Properties IOD
Annotates
3D Objects
Structure Set IOD
or
Segmentation IOD
or
Surface IOD
Treats Target and Spares Healthy Tissue
Therapeutic Dose Delivery Definition
Realizes
RT Radiation Set IOD
Defines Tx Fraction by
C-Arm Photon Radiation IOD
uses
… others modalities
RT Patient Setup IOD
Sets Constraints for
Oncologist Prescription for Radiotherapy Treatment
RT Physician Intent IOD
Shows DVH for
Therapeutic Dose Delivery Definition
Dose Objects
RT Dose Histogram IOD
RT Dose Image IOD
RT Dose Samples IOD
Records treatment of
Therapeutic Fraction Delivered
C-Arm Photon Radiation Record IOD
… other modalities
Is calculated Dose for
Is calculated Dose of

Figure ZZ.1-1
Relationship between important IODs

The fundamental relationships between the entities are shown in the following diagram:

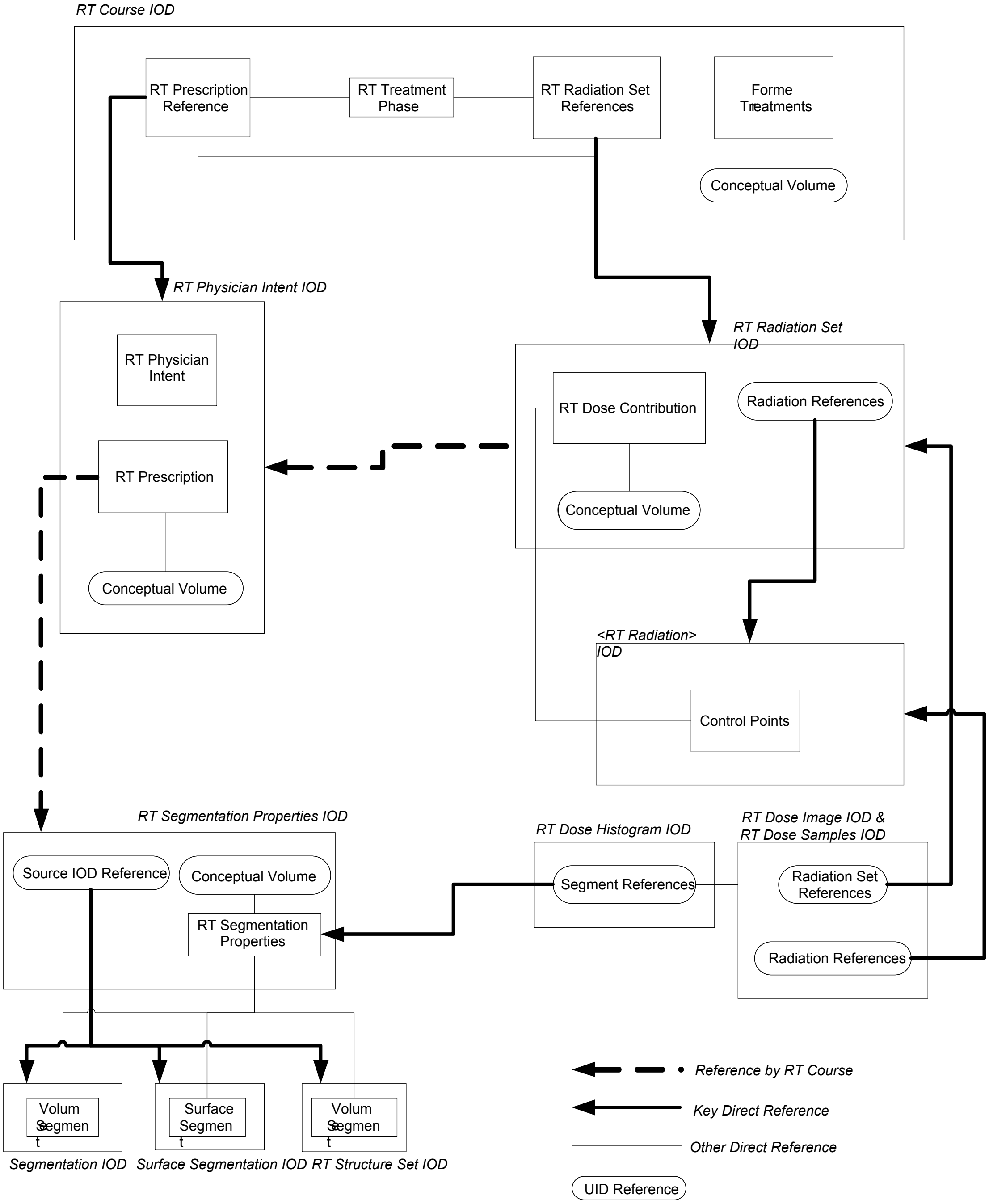


Figure ZZ.1-2
Fundamental Entity Relationships

Note 1: Former Treatments refers to the sequence in the RT Course IOD that documents any radiologically significant delivery to this patient that is not captured in a previous RT Course instance.

ZZ.2 ENTITY DESCRIPTIONS

The following entities are modeled:

ZZ.2.1 RT Course

A top-level entity that describes a given treatment course. All relevant objects are referenced, including acquisition images, registrations, segmentations, physician intent, beam sets, reference and verification imaging and output records. In particular, all information relating to the current approval state of treatment, treatment phases and changes due to adaptation of the therapy are described in this IOD. It describes the overall intended delivery scheme, including fractionation. This consists of one or more phases of treatment (e.g. ‘normal’ and ‘boost’). Each phase is achieved by referencing one or more *RT Radiation Set* instances;multiple sets are required if adaptive therapy is used to achieve the dosimetric objectives of the phase.

RT Course also contains phase-specific fractionation schemes that describe how the beams/catheters are combined to achieve the phase prescription. Note that multiple independent treatment sites will generally be represented by the same conceptual ‘course’ (i.e. chain of RT Course instances) when treated within the same treatment time frame; otherwise they should be represented by different courses. Phases are also modeled within the RT Course. The treatment session summary IOD's in the first generation of RT IOD's are also effectively replaced by RT Course.

The DICOM Standard does not specify how a given radiotherapy course is mapped onto the DICOM IE level hierarchy.To avoid a proliferation of series within a Study, one reasonable approach is to map a course of treatment to a DICOM Study, such that a Study contains all data created by radiotherapy systems for the purpose of addressing a particular course of treatment; however, such a mapping is not mandated.

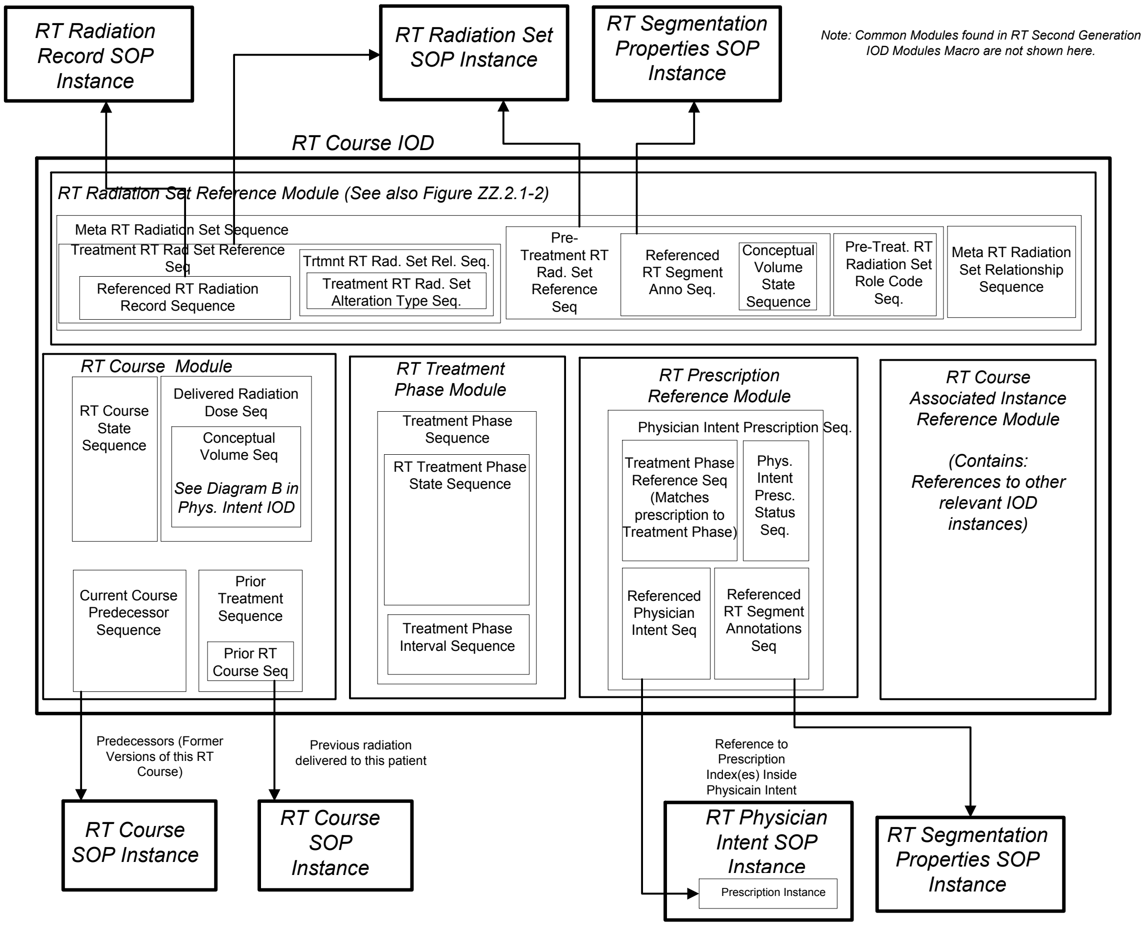


Figure ZZ.2.1-1
RT Course IOD

The following diagram shows the referencing indices used within the RT Course referenceing RT Prescriptions, RT Treatment Phases and RT Radiation Sets.

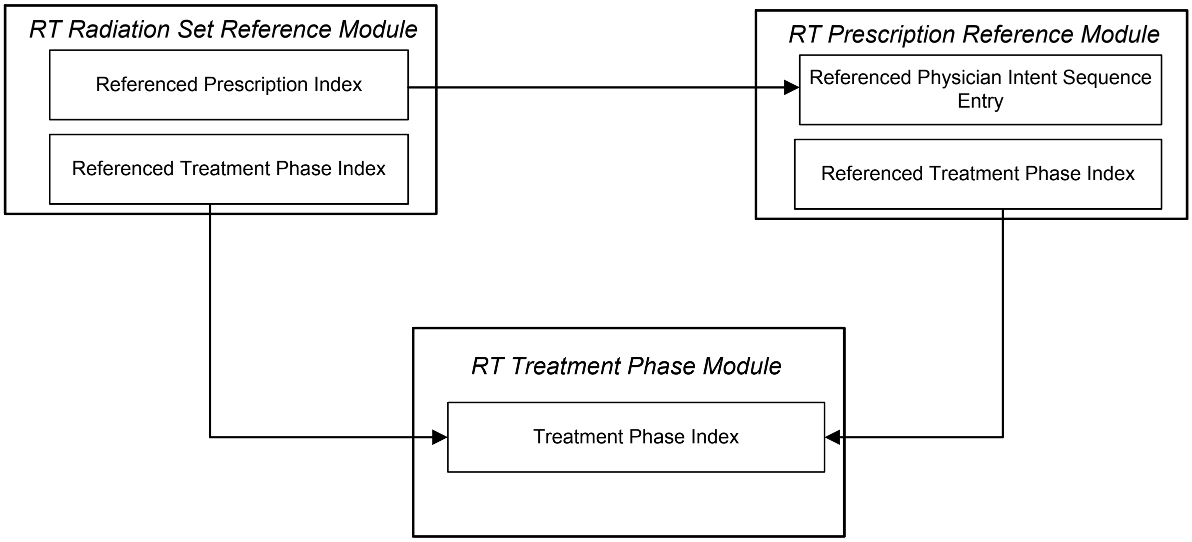


Figure ZZ.2.1-2
Relationships in RT Course IOD using Indexes

ZZ.2.2 RT Physician Intent

Describes how the physician wishes to achieve curative or palliative therapy as inputs to the planning process. The actual planned parameters may differ from the intended parameters described here. Items in the *RT Physician Intent* can include

- use of external therapy or brachytherapy,
- total and fractional dose,
- fractionation scheme,
- treatment sites,
- treatment target volume names,
- constructive solid geometry of targets and critical structures,
- field/MLC margins to be used (in case of 3D Conformal RT),
- dosimetric objectives (dose constraints for targets, organs at risk and normal tissue),
- beam energy,
- use of dose optimization and IMRT,
- use of motion management (e.g. gated treatment, tracking etc.),
- patient setup to be used including immobilization,
- image set(s) used for treatment planning,

- type of image-guided patient setup/treatment delivery (e.g. daily 3D CT, radiographic, fluoroscopic, ultrasound, etc.).
- There is also a location where the physician can enter details of dose from previous treatments.

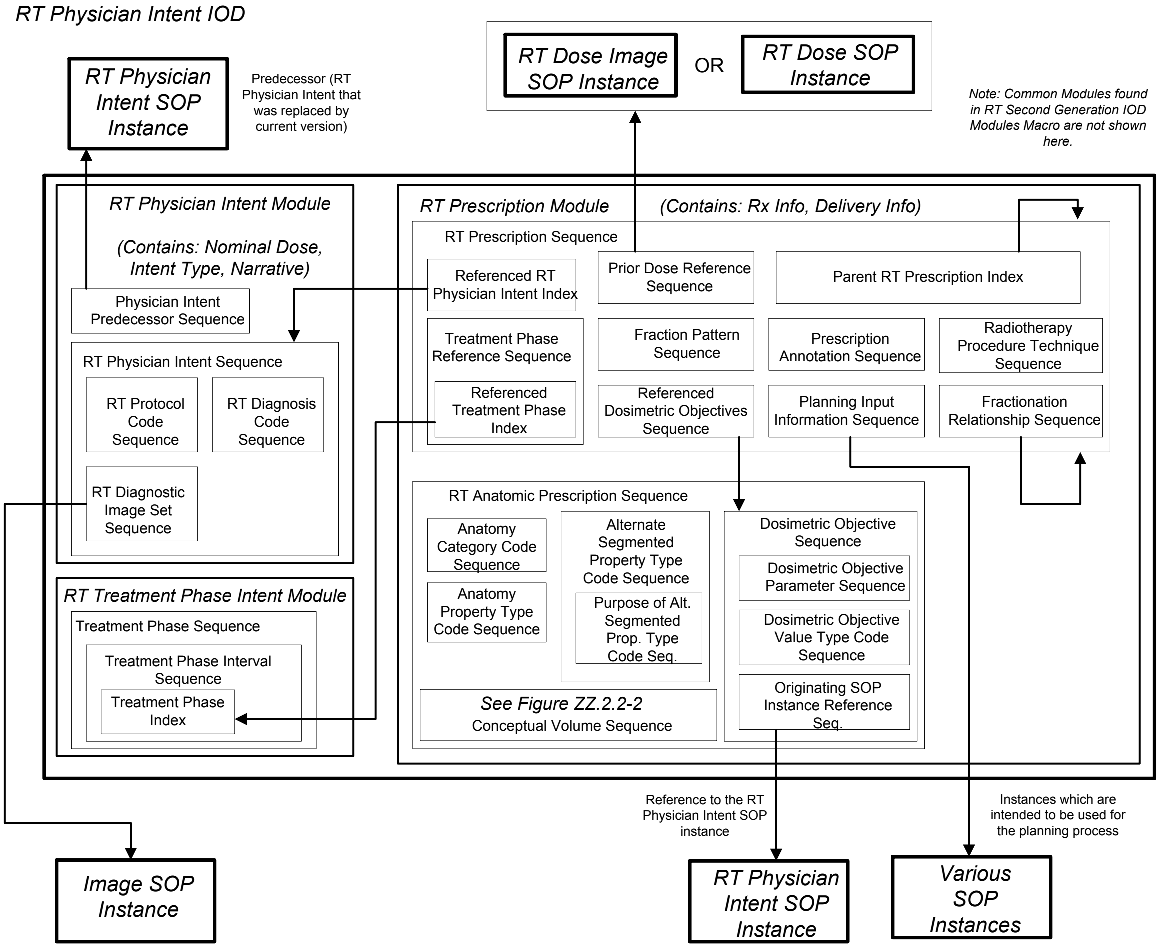
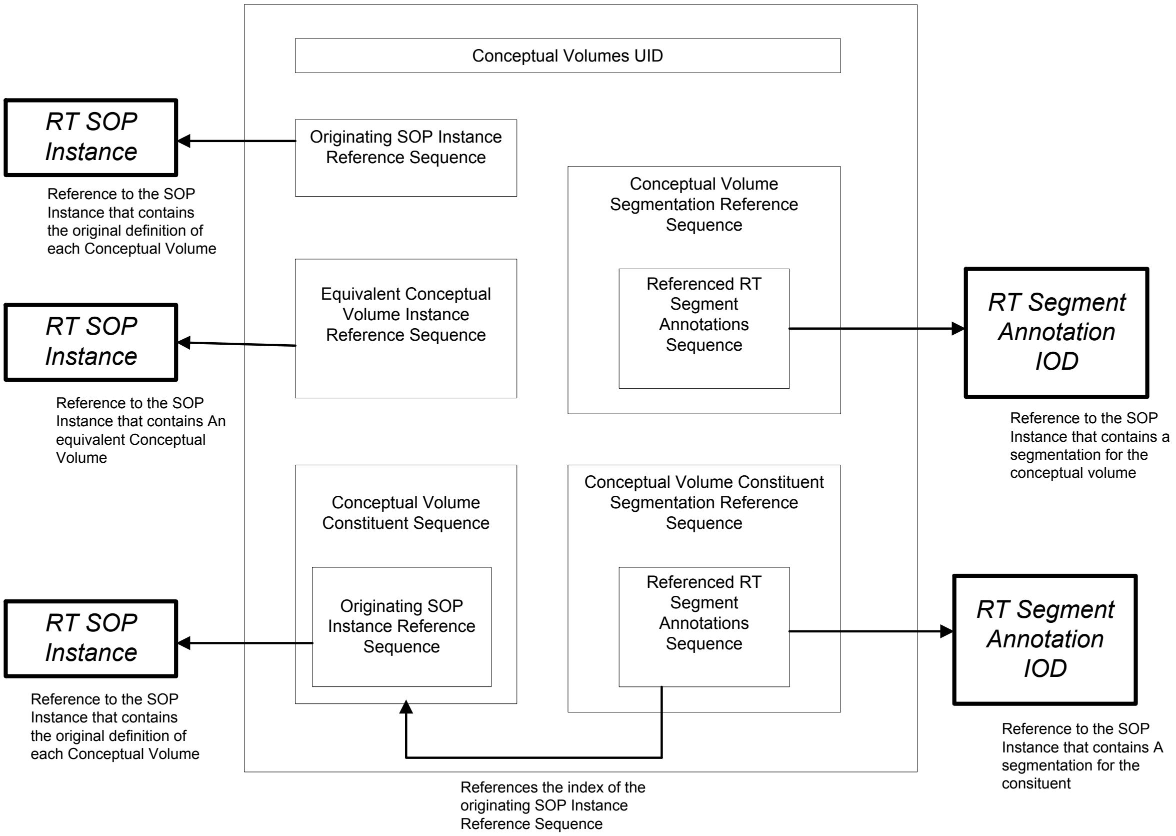


Figure ZZ.2.2-1
Physician Intent IOD

Conceptual Volume



2 **Figure ZZ.2.2-2**
Conceptual Volumes

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ZZ.2.3 RT Segment Annotation

Describes the clinical segmentation types (e.g. clinical target volume, organ at risk, bolus), density overrides, and other RT-specific ROI properties.

Note: Common Modules found in RT Second Generation IOD Modules Macro are not shown here.

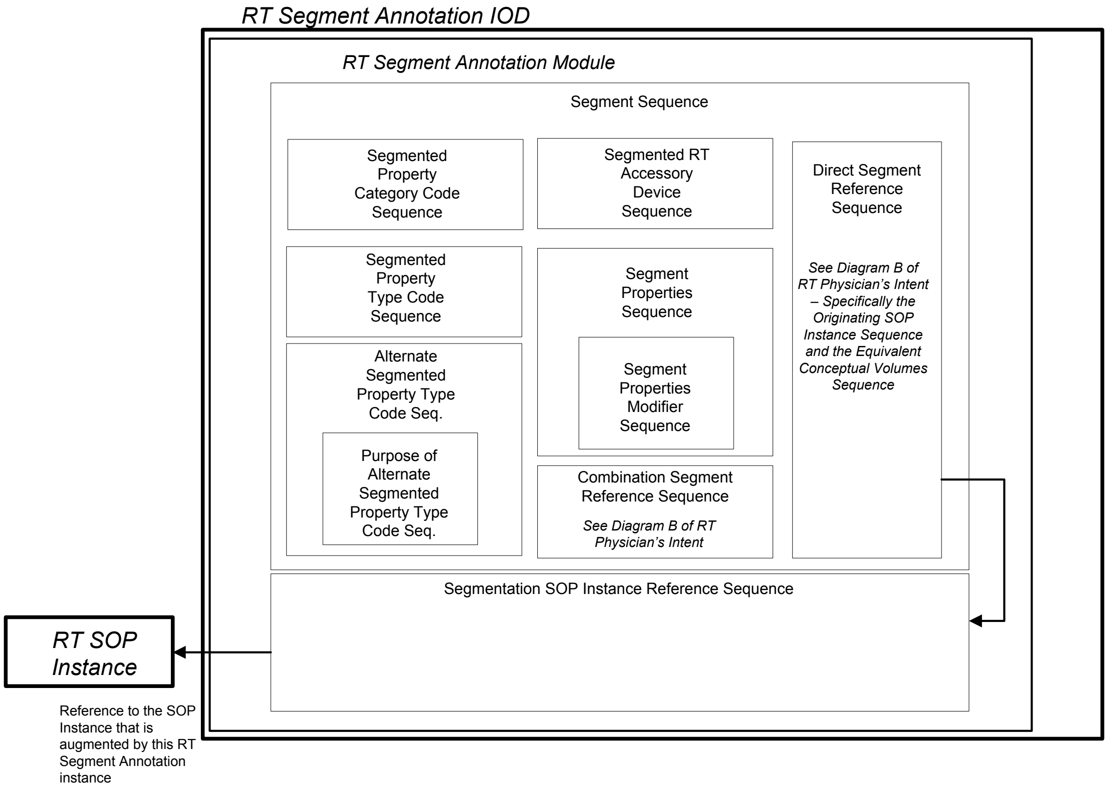


Figure ZZ.2.3-1
RT Segment Annotation IOD

ZZ.2.4 RT Radiation Set

Describes a set of beams and/or catheters being used within a treatment session to help achieve the dosimetric requirements of a given phase. References a set of <*RT Radiation*> SOP Instances. A treatment phase is achieved by delivering one or more *RT Radiation Sets*. One or more new *RT Radiation Sets* may be required each time adaptive therapy is used to maintain a phase prescription.

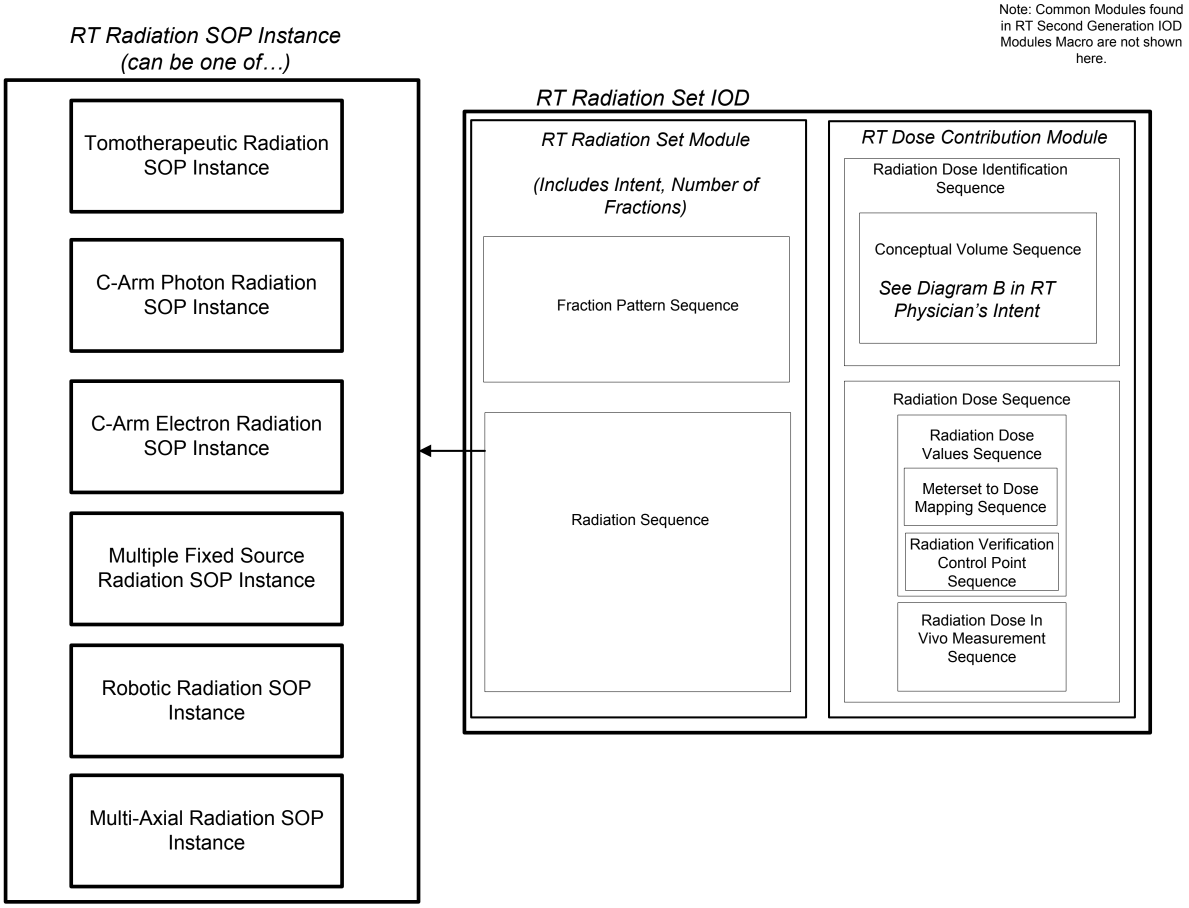


Figure ZZ.2.4-1
RT Radiation Set IOD

A new concept of meta-classes is modeled. Their content is inherent to all members of a such a meta-class and are to be considered as of one type. An example for this is the <RT Radiation> with its multiple technique-specific IOD's, which uses the same pattern of generic modules repesenting the modality-independent clinical data, while including a small set of modality-specifc modules with well-defined purpose, to convey just the delivery-specific data. The notation of such a meta-class is always within <> brackets.

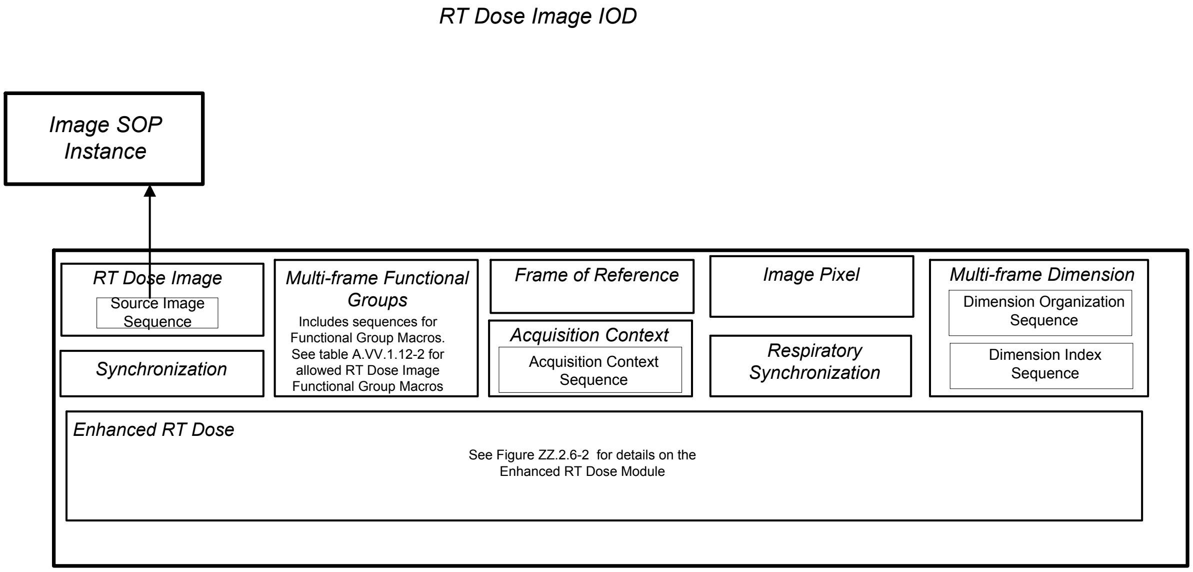
ZZ.2.5 RT Radiation

A conceptual metaclass that represents a means of administering a quantity of radiation generated by a radiation source and is intended to be delivered in a contiguous and indivisible manner (such as a static beam, dynamic arc, helical delivery, step-and-shoot IMRT sequence or catheter). An *<RT Radiation>* description includes a contiguous set of control points.
An *<RT Radiation>* cannot be further subdivided in the DICOM model and is the delivery unit for which dose is reported. If the delivery of an *<RT Radiation>* is interrupted, this is considered to be an error condition and the remaining radiation required to complete the beam will usually need to be computed based upon the planned treatment versus delivered treatment.

An *<RT Radiation>* may be used for the purposes dosimetric verification or therapeutic treatment. Specific IODs that are members of this Meta-SOP Class include *C-Arm Photon Radiation*, *Tomotherapeutic Radiation*, etc.

ZZ.2.6 RT Dose Image

Describes a representation of 3D dose distributions using the multi-frame and functional group paradigms.



Note: Common Modules found in RT Second Generation IOD Modules Macro are not shown here.

Figure ZZ.2.6-1
RT Dose Image IOD

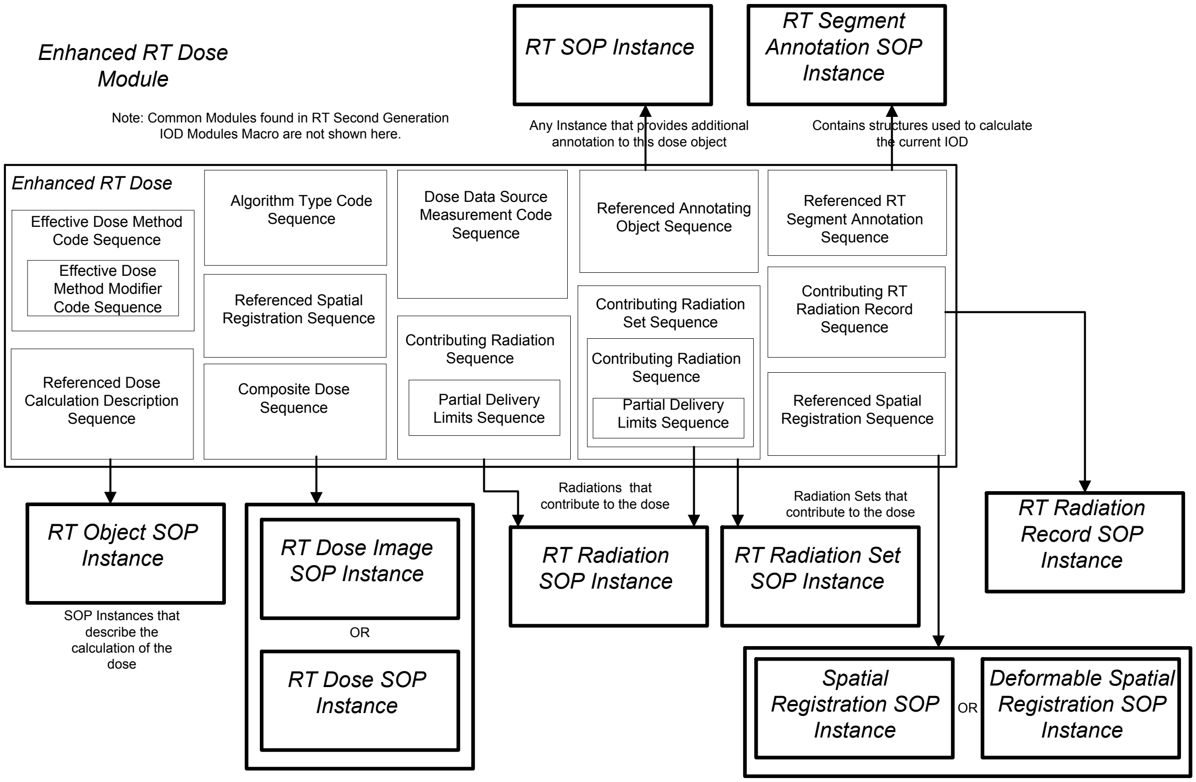


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Figure ZZ.2.6-2
4 Enhanced RT Dose IOD

6 ZZ.2.7 RT Dose Histogram

Describes a representation for dose-volume histogram data.

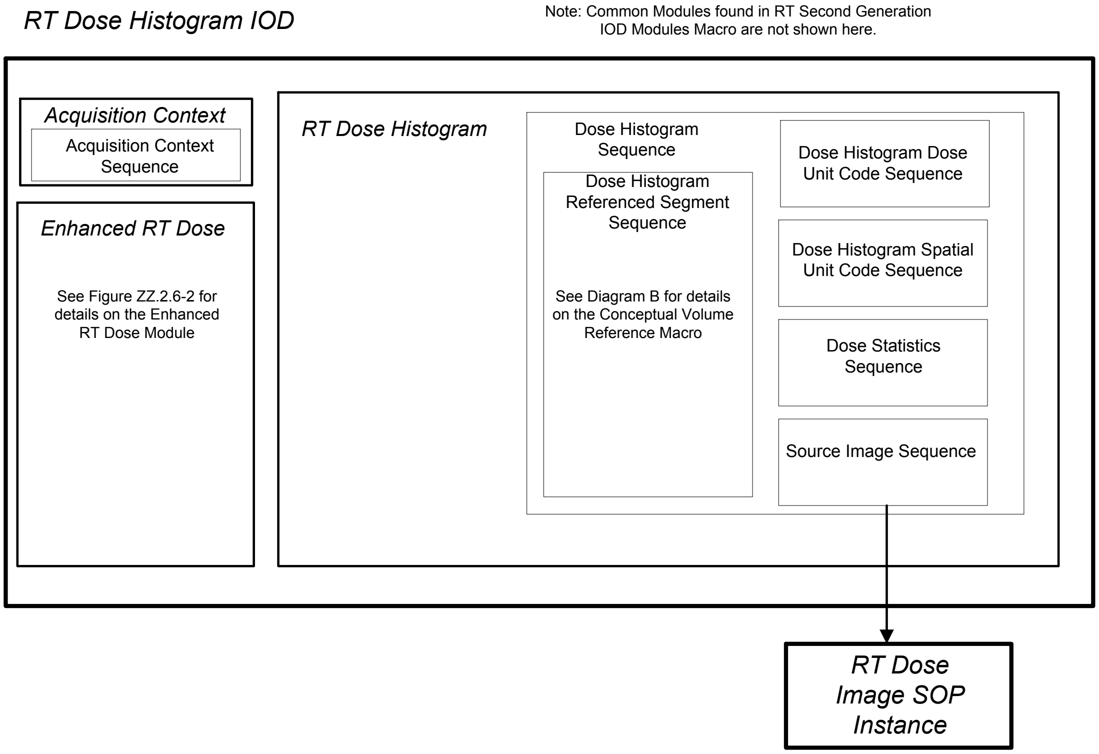

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Figure ZZ.2.7-1
4 **RT Dose Histogram IOD**

6 ZZ.2.8 RT Dose Samples

Describes a representation for dose point data.

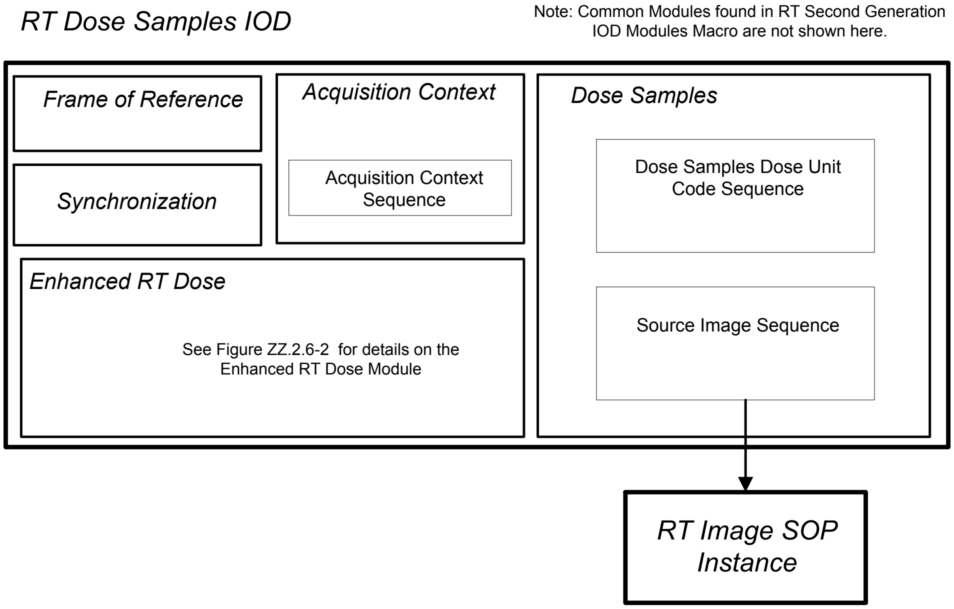

Figure ZZ.2.8-1
RT Dose Samples IOD

ZZ.2.9 RT Radiation Record

A conceptual metaclass representing the parameters of an actual delivery of an *<RT Radiation>*. Specific IODs that are members of this Meta-SOP Class include *C-Arm Photon Radiation, Multi-Axial Radiation*, etc.

ZZ.3 NOTES ON RT COURSE

ZZ.3.1 Introduction

The RT Course IOD is a composite representation of a course of radiation therapy, treating one or more anatomical sites in a coordinated sequence of events over time. It represents the state and history of a single coordinated process at a particular point in time.

The main elements of a treatment course are the specification of the physician's desired treatment approach represented by physician intents, and the realization of this approach through radiation sets organized along the phases of treatments. The RT Course IOD provides a structure to represent the elements of a treatment course, but makes no assumption how the Physician Intents and Treatment Phases are interpreted or implemented. This is usually very specific to a department and a patient. While the RT Course IOD supports quite complex treatment strategies, it can also serve as the container for a simple Physician Intent with one Radiation Set, as it does not suggest any specific approaches.

The RT Course IOD represents the actual state of a treatment and links together the different RT IODs, maintaining their relation and status. It binds together various entities needed in radiotherapy for preparation, execution and review of a radiotherapeutic treatment of a patient. This is accomplished by providing data structures to reference the relevant SOP Instances and indicate their status and progress in the treatment process. These component IODs have been designed to represent smaller units of information as compared with the first-generation DICOM.

With the definition of RT Course, it is possible to render the second-generation RT SOP Instances (representing those entities) stateless. This allows them be stable data containers by isolating the changes in status or relationship with other data, thereby reducing the need to create new instances. In second-generation RT, RT Course factors out the process-related information and separates that information from the content-related information in the referenced SOP Instances.

The RT Course can be used both in a worklist-driven managed environment as well as in an unmanaged Media-file driven environment. It is generally assumed that there is only one RT Course SOP Instance active at a time that serves as the reference for the current treatment definition for a patient. Since this cannot be guaranteed technically, it is the responsibility of the departmental workflow and/or policies and procedures to ensure that there is only one RT Course SOP Instance active at a time. This also applies to other objects in the radiotherapy context such as physician intents, radiation sets etc. See the example use cases below for further explanation.

It is not necessary to keep track of all versions triggered by queries for RT Course objects. A system keeping the RT Course could store historical versions at some point in time when they are clinically of interest (e.g. in between two series of radiation). Those persistent versions are tracked in this sequence for later retrieval. Note however, that for essential information about the whole treatment course, the latest SOP Instance is always sufficient.

ZZ.3.2 Evolution of an RT Course SOP Instance

In a typical case, the RT Course SOP Instance initially contains references to the physician intent(s) for a specific case, references image sets, and segmentation objects used in setting up the physician intent.

Subsequently, an RT Course SOP Instance has the capability to describe the treatment phases throughout the course of treatment. Phases represent the grouped fractions of certain treatment techniques/modalities, such as a photon treatment with a normal radiation phase and a boost phase, or a photon treatment phase followed by a ion treatment phases. A treatment course can have only one phase in the course, multiple phases build a sequence of consecutive periods of treatment within the course.

The RT Course IOD does not place any constraints on how a department or physician partitions the treatment of a patient into physician intents and treatment phases.

When treatment planning starts, an RT Course SOP Instance references RT Radiation Set SOP Instances in different states. It also carries the relations between RT Radiation Set SOP Instances, i.e. whether radiation sets have been derived from other radiation sets, which collections of radiation sets are grouped for dose summation, etc.

There will be a sequence of RT Course SOP Instances over the time of treatment. A change of the content of the treatment course (e.g. changing physician intents, new treatment phases, new radiation sets, changed radiation set status etc.) will be presented in a new RT Course SOP Instance. The most recent RT Course SOP Instance is always complete, i.e. it contains all physician intents, phases, and previous radiation sets of the course, whether they are already treated, in treatment, or planned. Therefore no cumulative logic across historic RT Course SOP Instances is needed. Previous versions referenced in an RT Course SOP Instance do allow tracing of the evolution of the current course definition.

ZZ.3.3 Elements of the RT Course

ZZ.3.3.1. Physician Intent

A Physician Intent is the clinical roadmap of a physician to define the therapeutic goals and strategy to treat the disease. It is a high-level description in accordance with the nomenclatures and policies of the oncology department. The manner in which physician intents are structured and formulated is often very specifically defined in a given department. Therefore the physician intent provides flexibility for department-specific representation. In general, it allows the physician to describe the intended treatment mainly in free text including components like planning and simulation with the nomenclature and detail level as prescribed by the operating procedures in the department.

ZZ.3.3.2. Treatment Phase

Today’s radiotherapy treatments are increasingly complex. To support sequences of various treatments throughout the treatment course the treatment phases support explicit definitions to structure the course into segments. The Treatment Phase provides a means to represent changes in the patient’s radiation sets, by organizing the sequence of sets under treatment.

A radiation set which is currently in treatment will be immutable, while other sets might be in preparation and still undergo changes until approved for treatment. The granularity of radiation sets supports the atomic units of treatment. The RT Course with its phases organizes those units into a structured time-related sequence of intended dose delivery. The arrangement of those radiation sets across time, and their grouping as treatment phases (e.g. a normal treatment and a boost treatment) are supported by the treatment phase sequence.

ZZ.3.3.3. Radiation Sets

The radiation set defines a set of beams which are treated together for one or multiple fractions. The radiation set therefore defines the physical and geometrical parameters of the treatment and indirectly the dose delivered. It is the smallest unit of delivery at one time.

A radiation set therefore describes a series of identical beam collections usually being applied repeatedly. A new treatment series (or another treatment phase, like a boost treatment etc.) is represented by one or more new radiation sets.

Relations between radiation sets are not handled within the radiation set IODs itself, but in the RT Course IOD as follows:

- The relation in respect to time, i.e. how those radiation sets should be treated in series or parallel, is described in the RT Treatment Phase module (describing the treatment phases in relation to each other) and the RT Radiation Set Reference module (describing the radiation sets of a treatment phase in relation to each other) of the RT Course IOD.

- The relation in respect to changes of a radiation set in the course of treatment are described in a specific sequence of the RT Radiation Set Reference module of the RT Course IOD. The use of those relations is restricted to small adaptations of the actual radiation set within the intended series of fractions, keeping the intended treatment technique, beam layout and planned dose distribution. Any change which lies beyond this scope, for example re-planning, is typically handled on a treatment phase level.

Radiation sets may be defined to a greater or lesser extent, depending on the progress of the treatment definition. For the typical stages (Simulation, Planning, Treatment), different radiation sets can be referenced. The final one, the Treatment RT Radiation Set, is intended to be a complete definition, deliverable by a TDS without further change once approved.

ZZ.3.3.4 Clinical State Information

The RT SOP Classes handled in the RT Course exist in various states during the clinical process. Instances may have been just created, may have been reviewed by physicians but not yet approved, or may be finally approved to be ready to use. Those states are not part of the data IOD itself, because their transitions should not necessarily trigger a change of the SOP Instance. States are often set without further changes to the SOP Instance, for example final approval.

The RT Course SOP Class maintains information about the states for most of the SOP Instances it references. It does so by having two types of states:

- Clinical states are used to denote the clinical state in the decision process about the maturity and applicability of a SOP Instance.

- RT Operation State is applicable for objects used to effectively perform the treatment (most prominently the radiation sets) and denotes the current state of the execution.

ZZ.4 NOTES ON SECOND-GENERATION IODS

ZZ.4.1 RT Radiation Set IOD

ZZ.4.1.1 General Notes

The RT Radiation Set represents a fractionation and a set of external beams or brachytherapy radiation configurations which are treated as a collection and always grouped together. Radiation sets are delivered in fractions. Therefore a RT Radiation Set is a collection of <RT Radiation> SOP Instances which define treatments for the same modality. In some cases it is possible for multiple radiations sets to contain the same <RT Radiation> SOP Instance.

By referencing other <RT Radiation> SOP Instances, an RT Radiation Set SOP Instance specifies all physical and geometric information that is needed to define the delivery of the therapeutic dose to the patient.

The methods of defining, verifying and correcting the position of the patient as well as attributes varying within the treatment cycle of a specific radiation set are out of scope for this IOD. An instance of a radiation set remains unchanged across all fractions. A change in the desired treatment normally requires a new radiation set to be created.

ZZ.4.1.2. Fractionation

Fractionation defines the timing of treatments for a radiation set. It defines the number of fractions and the dose for each fraction. It also defines the Radiation Fraction Pattern to be delivered, i.e. daily and/or weekly patterns. Note that the actual schedule of treatments may not completely match the intended scheme (because of holidays, no-shows etc.), but the fractionation provides guidance for the scheduler.

ZZ.4.1.2. Meterset and other parameters resolution

It is strongly recommended that the specified Cumulative Meterset and other machine parameters match the resolution as expected by the Radiation Device to deliver the radiation. If the calculation for Meterset results in a meterset value which is not an exact multiple of the meterset resolution, the result should be rounded to the nearest allowed meterset value.

ZZ.4.2 RT Radiation IODs

ZZ.4.2.1 Control Points

The RT Radiation IODs make use of the Control Point concept as it was introduced within the Beam Sequence (300A,00B0) of the RT Beams Module in first generation RT objects. But due to the different characteristics of Control Points in different treatment devices, concrete definitions of Control Points will be device-specific. Examples are the Tomotherapeutic Control Point Sequence (30xx,1010) or the Multi-Axial Control Point Sequence (30xx,1500). Despite that fact, the base concept is the same for all device-specific Control Points.

For ease of reading, whenever the Control Point concept is referenced within this standard, it is only referenced as "Control Points" without relation to a specific device-related definition.

ZZ.4.2.2 Sub-Control Points

Due to additional requirements of some treatment techniques, a new level below the Control Points is introduced called Sub-Control Point. The base concept is the same for the Control Point level.

ZZ.4.3 RT Segment Annotation IOD

ZZ.4.3.1 Conceptual Volume

The term Conceptual Volume refers to an abstract spatial entity used in radiation therapy (or elsewhere) to identify the region of a patient that is relevant to treatment prescription, treatment planning, plan evaluation, and/or treatment verification.

Generally, a Conceptual Volume is a volume that has a diagnostic or therapeutic purpose. The Conceptual Volume may or may not be specified by a specific segmentation, as defined in a Segmentation, Surface Segmentation, or RT Structure Set SOP Instance. The Conceptual Volume UID ties together instances created at different times and from different imaging modalities. A Conceptual Volume can also be used to reference abstract spatial entities (prior to delineation) for the purpose of prescribing dosimetry constraints for therapy.

ZZ.4.3.2 Segment

The term Segment refers to a delineation of a spatial entity in a Segmentation, Surface Segmentation, or RT Structure Set SOP Instance. A Segment is a realization of a Conceptual Volume and is identified by its Conceptual Volume UID.

ZZ.5 EXAMPLE USE CASES

Four different use cases are illustrated in this section:

- **Using Managed Workflow:** A treatment planning example where workflow is fully managed using a Workflow Manager (e.g. TMS) and the Unified Procedure Step – Pull (UPS-Pull) service class.
- **Using Received RT Course:** A treatment planning example where workflow is managed external to DICOM and the work item is initiated as a result of a transfer from an actor that has performed a previous work item. This corresponds to the case where the RT Course SOP Instance corresponds to an “electronic chart” that is passed from actor to actor, by DICOM Network Storage (“push”) from the previous Performing Device.
- **Using DICOM Media File Set**: A treatment planning example where workflow is managed externally, but transfer occurs using DICOM storage media.
- **Using Archive Query of RT Course**: A treatment planning example where workflow is managed external to DICOM and the work item is retrieved from a central location (the archive). This corresponds to the case where the RT Course SOP Instance corresponds to an “electronic chart” and where the location of the “chart” is constant, but its validity must be managed externally.

ZZ.5.1 Use Case Actors

The following actors are used in the example use cases:

- **User**: A person controlling the performing of the procedure step.
- **Archive**: A database storing SOP Instances (images, plans, structures, dose distributions, etc).
- **Treatment Management System (TMS)**: A suite of applications managing worklists and tracking performance of procedures. This role is commonly fullfilled by an Oncology Information System in the Oncology Department.
- **Virtual Simulation System (VSS):** A workstation performing virtual simulation (localization, segmentation, and beam placement), often as part of a CT Simulation System.

- **Treatment Planning System (TPS):** A workstation performing radiotherapy treatment planning. This includes localization, segmentation, beam placement or optimization, dose calculation, and dose review.
- **Treatment Delivery System (TDS)**: An application performing the treatment delivery specified by the worklist, updating a UPS, and storing treatment records and related SOP instances (such as verification images). Acts as a Performing SCU.
- **Plan Review Station (PRS)**: A workstation performing radiotherapy treatment planning review, displaying and reviewing patient anatomy, beam geometry, and dose distributions.
- **Delivery Review Station (DRS)**: A workstation performing radiotherapy treatment delivery review, displaying and reviewing of patient anatomy, beam geometry, and planned and delivered dose distributions.

ZZ.5.2 Treatment Planning Using Managed Workflow

ZZ.5.2.1 Message Sequencing

Figure ZZ.5.2.2-1 illustrates a message sequence example in the case where a Treatment Planning System (TPS) retrieves a UPS worklist and selects an inverse planning worklist item from a Treatment Management System (TMS). It then retrieves all necessary input objects such as instruction SOP Instances, image sets, Registration SOP Instances, Segmentation SOP Instances, a simulation RT Radiation Set and related <RT Radiation> SOP Instances, and an RT Prescription. The TPS then generates and stores SOP Instances such as a dosimetric RT Radiation Set, RT Dose Image and reference images or image sets to be used for delivery verification. Finally, it updates the procedure step.

ZZ.5.2.2 Transactions and Message Flow

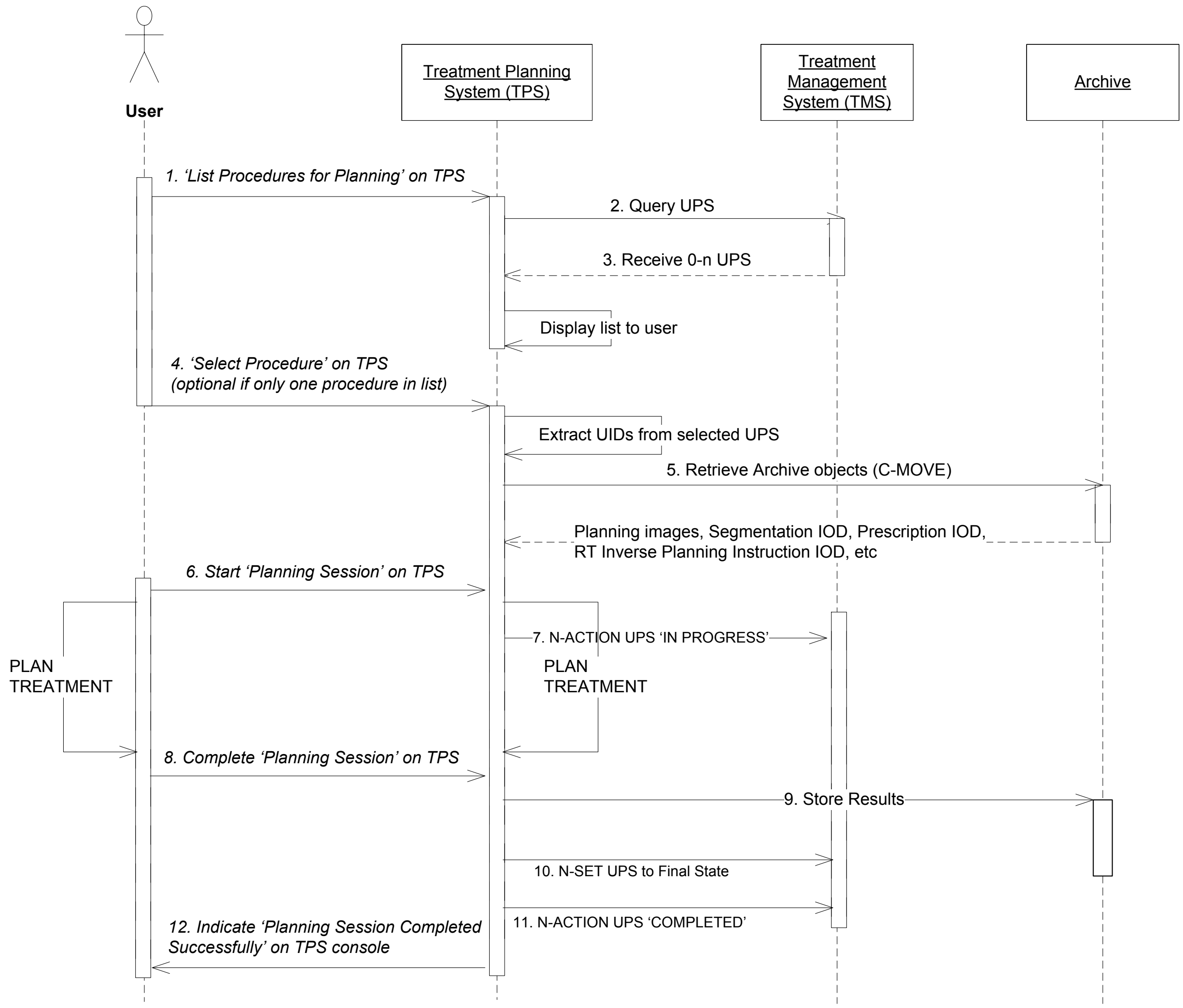

Figure ZZ.5.2.2-1
Treatment Planning Normal Flow - Message Sequence

1. 'List Procedures for Planning' on TPS

   The User requests a of patients requiring treatment planning.

2. Query UPS

   The TPS queries the TMS for Unified Procedure Steps (UPSs) that match its search criteria. For example, all worklist items with a Procedure Step State of 'SCHEDULED' and Workitem Code Sequence containing an item corresponding to 'RT Inverse Planning'. This message is conveyed using the C-FIND request primitive of the Unified Procedure Step - Pull SOP Class.

3. Receive 0-n UPS

The TPS receives the set of Unified Procedure Steps (UPSs) resulting from the Query UPS message. The Receive UPS message is conveyed via one or more C-FIND response primitives of the UPS - Pull SOP Class. Each response with status ‘Pending’ contains the requested attributes of a single UPS. The TMS returns a list of zero or more UPSs containing the planned tasks for the querying device.

4. ‘Select Procedure’ on TPS

The User selects one of the scheduled procedures specified on the TPS. If exactly one UPS was returned from the UPS query described above, then the returned UPS is selected by default.

5. Retrieve Archive Objects

Archive Objects are retrieved by a C-MOVE Request, transmitting the SOP Instances to the TPS. SOP instances locations are fully specified in the Input Information Sequence of the Worklist response.

6. Start ‘Planning Session’ on TPS

The User begins the planning process on the TPS.

7. Set UPS (IN PROGRESS)

As the User begins the planning process, the TPS sets a UPS to have the Procedure Step State of ‘IN PROGRESS’. The SOP Instance UID of the UPS will have been obtained via the returned worklist query response. This message is conveyed using the N-ACTION primitive of the Unified Procedure Step – Pull SOP Class with an action type “UPS Status Change”. This message allows the TMS to update its worklist and permits other Performing Devices to detect that the UPS is being worked on.

8. Complete ‘Planning Session’ on TPS

The User completes the planning process on the TPS.

9. Store Results

When the planning process is complete, the TPS stores the results to the Archive. This would typically be achieved using the Storage and/or Storage Commitment Service Classes. These SOP instances are detailed in Section ZZ.6.

10. Set UPS Progress to Final State

Upon completion of the final beam (although this is not required) the TPS may then update the UPS Progress Information Sequence. The TPS must include references to any results in the Output Information Sequence (results are themselves conveyed by the Store Results step). Any attributes still required for UPS completion must be assigned in this step. This message is conveyed using the N-SET primitive of the Unified Procedure Step - Pull SOP Class.

11. Set UPS (COMPLETED)

The TPS sets the Procedure Step State of the UPS to ‘COMPLETED’ upon completion of the scheduled step and storage of results. This message is conveyed using the N-ACTION primitive of the UPS SOP Class with an action type “Request UPS State Modification”. This message informs the TMS that the UPS is now complete.

12. Indicate ‘Planning Session Completed Successfully’ on TPS

Finally the TPS notifies the User that the requested procedure has completed successfully, and all generated SOP Instances have been stored.

ZZ.5.3 Treatment Planning Using Received RT Course

ZZ.5.3.1 Message Sequencing

Figure ZZ.5.3.2-1 illustrates a message sequence example in the case where a TPS performs a treatment planning operation. The operation is based on an RT Course SOP Instance received from another performing device. In this example the TPS needs to be an RT Course Storage SCP.

This use case supports a special case of the “electronic chart” scenario where an independent system (e.g. a physical patient chart) has been used to determine that the next task is a planning procedure, and the User has identified a suitable workstation for the planning procedure.

ZZ.5.3.2 Transactions and Message Flow

This section describes in detail the interactions illustrated in Figure ZZ.5.3.2-1.

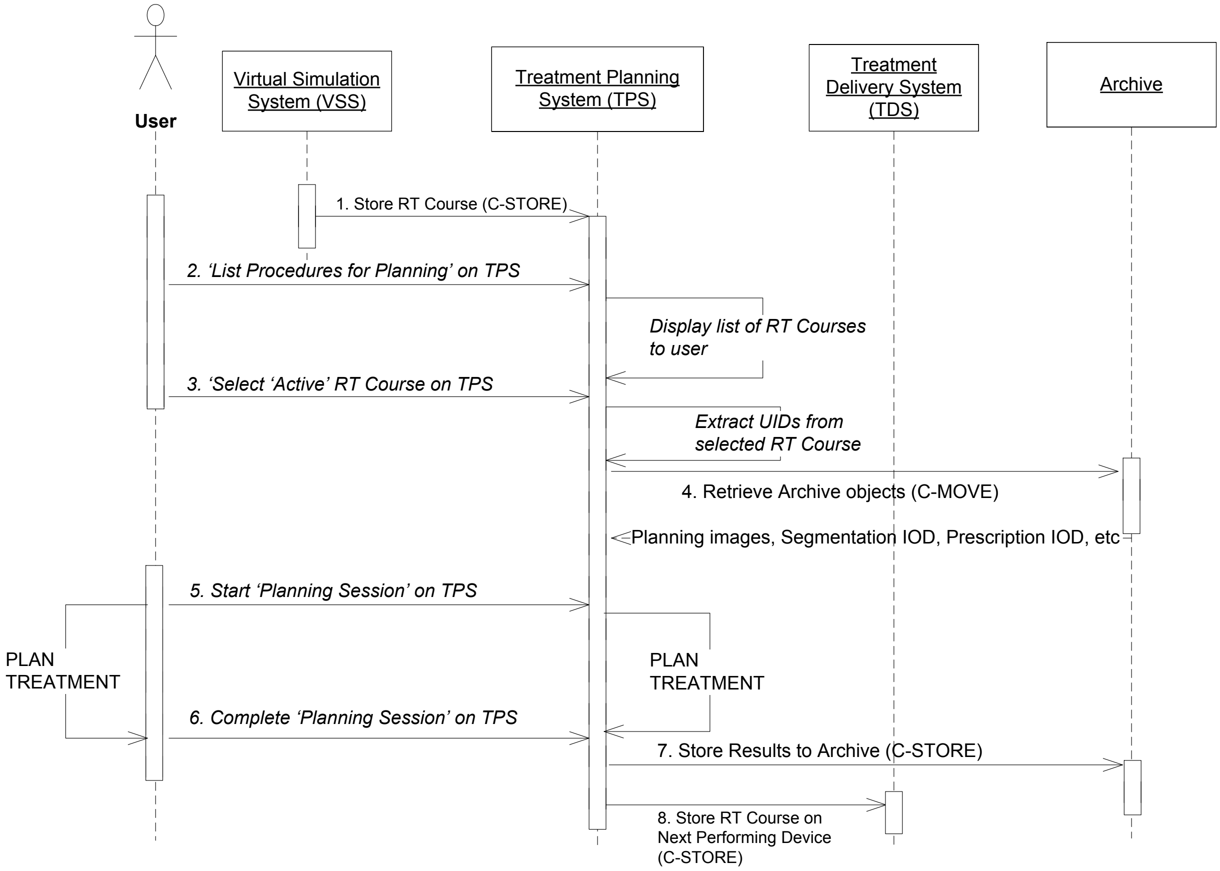

Figure ZZ.5.3.2-1
Treatment Planning Using Received RT Course - Message Sequence

1. Store RT Course to TPS

   The User of another performing device (such as a Virtual Simulation System) initiates a transfer of an RT Course SOP Instance to the TPS. The TPS receives this instance (acting as an RT Course Storage SCP) and stores it locally. Other instances - originating from other devices, or sent at other times - may also have previously been stored.

2. ‘List Procedures for Planning’ on TPS

   The User indicates on the TPS that they want the list of patients requiring treatment planning. The TPS then displays all relevant RT Course SOP Instances that have been stored locally.

3. Select ‘Active’ RT Course on TPS

   The User selects one of the displayed RT Course objects as the active one. The TPS then extracts the required input SOP Instance UIDs from the selected RT Course.

4. Retrieve Archive Objects

   The SOP Instances to be used as input information are transmitted by the Archive to the TPS in response to C-MOVE requests. Typical SOP Instances retrieved are detailed in Section ZZ.4. The TPS knows the location of these SOP instances by virtue of the fully-specified RT Course SOP Instance returned in the previous step.

5. Start ‘Planning Session’ on TPS

   The User begins the planning process on the TPS.

6. Complete ‘Planning Session’ on TPS

   The User completes the planning process on the TPS.

7. Store Results to Archive

   When the planning process is complete, the TPS stores the results to the Archive. This would typically be achieved using the Storage and/or Storage Commitment Service Classes.

8. Store RT Course on Next Performing Device

   The TPS stores a new RT Course SOP Instance on the next performing device, such as a Treatment Delivery System (TDS). It contains the complete history of the treatment course, including the planning step just performed.

ZZ.5.4 Treatment Planning Using DICOM Media

ZZ.5.4.1 Message Sequencing

Figure ZZ.5.4.2-1 illustrates a message sequence example in the case where a TPS performs a treatment planning operation based upon an RT Course SOP Instance that it has received by reading DICOM Media. In this example the TPS needs to be DICOM Media File Set Reader (FSR) for this to occur.

This use case supports a special case of the “electronic chart” scenario where an independent system (e.g. a physical patient chart) is used to track and indicate the procedures to be performed. User has been able to obtain a DICOM Storage Media File Set containing the latest information regarding the treatment course.

As before, the SOP Instances that may be produced and consumed by this procedure are shown in Section ZZ.6.

ZZ.5.4.2 Transactions and Message Flow

This section describes in detail the interactions illustrated in Figure ZZ.5.4.2-1.

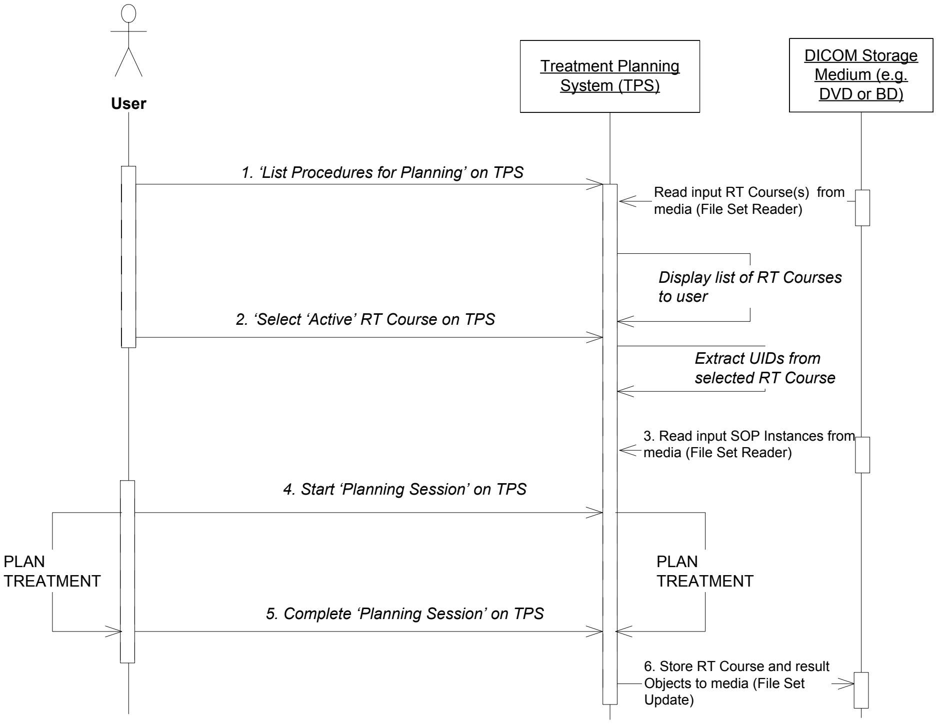

Figure ZZ.5.4.2-1
Treatment Planning Using DICOM Media - Message Sequence

1. ‘List Procedures for Planning’ on TPS

   The User indicates on the TPS that they want a the list of patients requiring treatment planning. The TPS initiates a retrieval of one or more RT Course SOP Instances from a DICOM Medium such as CD-R, DVD or BD. It does this by acting in the role of a DICOM File Set Reader (FSR). The TPS then displays the list to the user.

2. Select ‘Active’ RT Course on TPS

   The User confirms one of the displayed RT Course SOP Instances as the active one. The TPS then extracts the required input SOP Instance UIDs from the selected RT Course.

3. Read Input SOP Instances from Media

   The TPS initiates a retrieval of required input SOP Instances from the DICOM Medium. It does this by acting in the role of a DICOM File Set Reader (FSR). Typical SOP Instances retrieved are detailed in Section ZZ.4. The TPS knows the location of these SOP instances by virtue of the fully-specified RT Course SOP Instance returned in the previous step.

4. Start ‘Planning Session’ on TPS

   The User begins the planning process on the TPS.

5. Complete ‘Planning Session’ on TPS

   The User completes the planning process on the TPS.

6. Store Results to Media

   When the planning process is complete, the TPS stores the results to a DICOM Media File Set. The stored objects include a new RT Course SOP Instance referencing the planning procedure step and any generated SOP Instances. These SOP Instances are detailed in Section ZZ.6.

ZZ.5.5 Treatment Planning Using Archive Query of RT Course

ZZ.5.5.1 Message Sequencing

Figure ZZ.5.5.2-1 illustrates a message sequence example in the case where a TPS performs a treatment planning operation based upon the contents of an RT Course SOP Instance selected from the Archive.

The use case supports a special case of the “electronic chart” scenario where an independent system (e.g. a physical patient chart) is used to track and indicate the procedures to be performed, including the current RT Course SOP Instances retrieved from the Archive.

As before, the SOP Instances that may be consumed and produced by this procedure are shown in Section ZZ.6.

ZZ.5.5.2 Transactions and Message Flow

This section describes in detail the interactions illustrated in Figure ZZ.5.5.2-1.

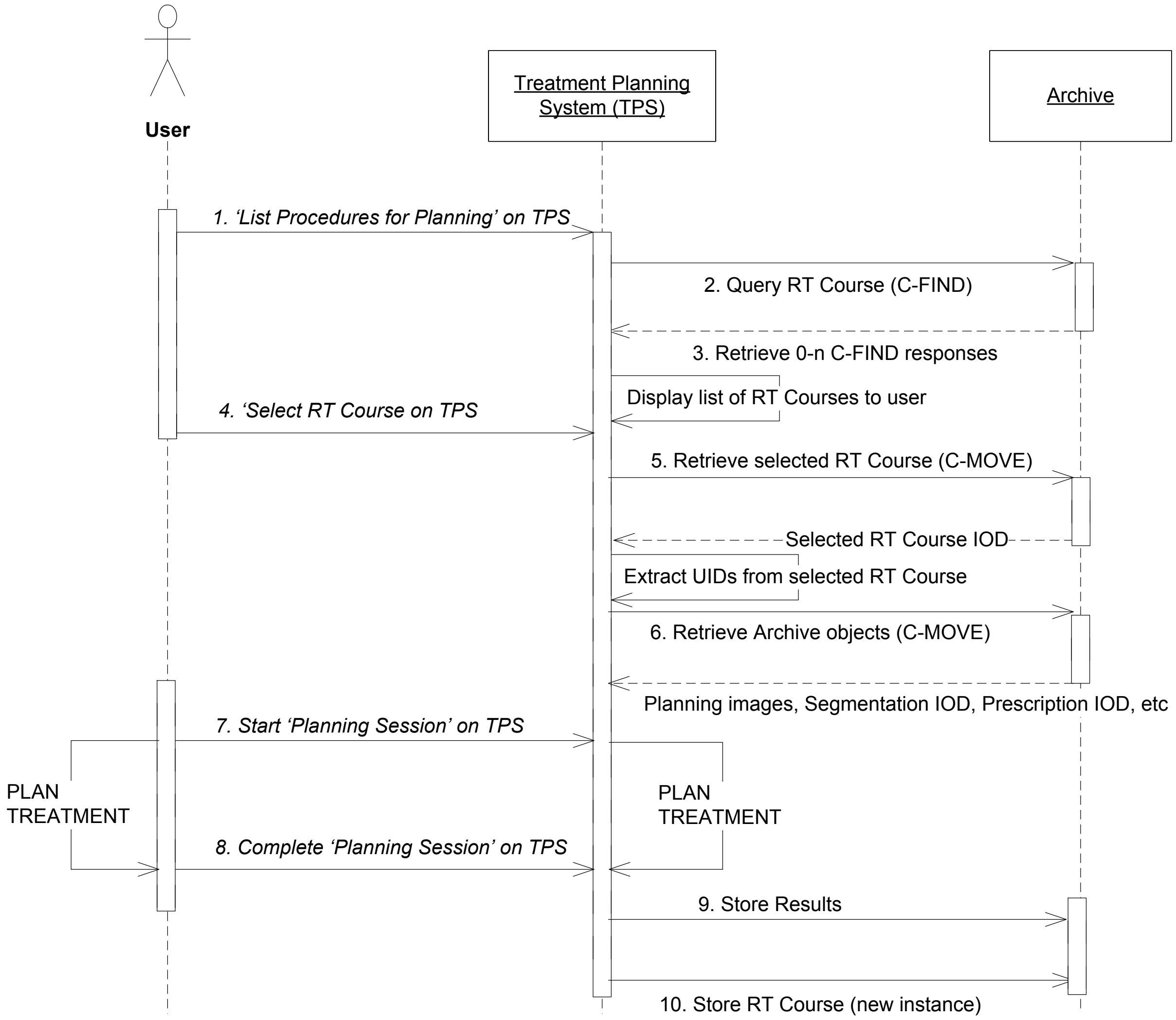

Figure ZZ.5.5.2-1
Treatment Planning Using Archive Query of RT Course - Message Sequence

1. ‘List Procedures for Planning’ on TPS

   The User indicates on the TPS that they want a the list of patients requiring treatment planning.

2. Query RT Course

   The TPS queries the Archive for RT Course SOP Instances that match its search criteria. For example, all RT Courses for a specific patient where the contents of the RT Course indicate that a simulation has already been performed. This message is conveyed using the C-FIND request primitive of the DICOM Query/Retrieve service class.

3. Receive 0-n C-FIND Responses

   The TPS receives the set of results from the Query/Retrieve operation. The result set is conveyed via one or more C-FIND response primitives of the Query/Retrieve SOP Class. The Archive returns a list of zero or more items matching the specified search criteria.

4. ‘Select RT Course’ on TPS

   The User selects one of the returned RT Course SOP Instances on the TPS.

5. Retrieve Selected RT Course

   In response to a C-MOVE Request, the Archive transmits to the TPS the selected RT Course SOP Instance.

6. Retrieve Archive Objects

   Archive Objects are retrieved by a C-MOVE Request, transmitting the SOP Instances to the TPS. SOP Instance locations are fully-specified in the RT Course SOP Instance returned in the previous step.

7. Start ‘Planning Session’ on TPS

   The User begins the planning process on the TPS.

8. Complete ‘Planning Session’ on TPS

   The User completes the planning process on the TPS.

9. Store Results

   When the planning process is complete, the TPS stores the results to the Archive. This would typically be achieved using the Storage and/or Storage Commitment Service Classes. These SOP Instances are detailed in Section ZZ.6.

10. Store RT Course

    The TPS stores a new RT Course SOP Instance on the Archive. It contains the complete history of the treatment course including the planning step just performed and the locations of any objects generated.