Integrating the Healthcare Enterprise

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IHE Radiation Oncology
Technical Framework Supplement

10

Integrated Positioning and Delivery Workflow Profile
(IPDW)

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Draft for Public Comment

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Foreword

This is a supplement to the IHE -RO Technical Framework 1.7. Each supplement undergoes a
process of public comment and trial implementation before being incorporated into the volumes
25   of the Technical Frameworks.

This supplement is published on March 09, 2012 for Public Comment. Comments are invited and
may be submitted at http://www.ihe.net/radiation_oncology/radiationoncologycomments.cfm. In
order to be considered in development of the Trial Implementation version of the supplement
comments must be received by April 08, 2012.

30   This supplement describes changes to the existing technical framework documents and where
indicated amends text by addition (**<u>bold underline</u>**) or removal (**~~bold strikethrough~~**), as well as
addition of new sections introduced by editor's instructions to "add new text" or similar, which
for readability are not bolded or underlined.

"Boxed" instructions like the sample below indicate to the Volume Editor how to integrate the
35   relevant section(s) into the relevant Technical Framework volume:

Replace Section X.X by the following:

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

40   Information about the IHE Radiation Oncology domain can be found at:
http://www.ihe.net/Domains/index.cfm

Information about the structure of IHE Technical Frameworks and Supplements can be found at:
http://www.ihe.net/About/process.cfm and http://www.ihe.net/profiles/index.cfm

The current version of the IHE Technical Framework can be found at:
45   http://www.ihe.net/Technical_Framework/index.cfm

CONTENTS

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Introduction to this Supplement

This supplement adds the Integrated Positioning and Delivery Workflow Profile to the IHE-RO Domain.

200   The Integrated Positioning and Delivery Workflow Profile describes the positioning of a patient prior to treatment delivery. Position monitoring may or may not be invoked during treatment delivery. In this profile, the patient positioning, position monitoring and radiation delivery are managed by a single device.

Open Issues and Questions

205   • The profile makes use of some Patient Positioning Instruction and Result SOPs. Those are currently proposed in the Patient Positioning Supplement developed by DICOM WG 07. However, at this point, the Patient Positioning supplement is not yet in the trial implementation state therefore no SOP Class UIDs are available. It is expected that the Patient Positioning supplement will be available by the time this supplement goes into Trial
210   Implementation. If this schedule does not hold, we will have to revisit this tactic.

Closed Issues

• Include safety configuration.
(See 1. The group discussed error conditions (patient safety issue for TDD with105 local plan storage) involving inconsistencies between (a) TDD local plan and (b) retrieved RT Plan, RT
215   Beams Delivery Instruction, and UPS. Proposed conditions for consistency were developed (see 2-11 below). -> Done in Version 1.6

• We should find a way to define the Object Storage actor in a way, that there is not superfluid semantics included in the annotation of this storage (e.g., whether this is a TMS or an Archive etc.). This storage has the purpose to receive data. The TMS provider should be able
220   to specify, where it wants to have the objects stored.
-> Along May 2011 meeting: provided 2 proposal for objects storage definition: One with one object storage for all objects, and one with configuration for up to 3 object storages.
-> Done in TC Meeting 2011-10

• During TC Meeting 2011-10, we revised the text dealing with local storage and 'stub' plans.
225   Version 1.6 now contains s sketch of this provisions. Final wording for consistency checks has to be worked out.
-> Done in Version 1.7

230 **History**

Nov 12, 2010	1.2	Ulrich Busch (ulrich.busch @varian.com)	Extracted from IHE-RO Profile 3.0 Converted to Supplement
Dec. 23, 2010	1.3	Ulrich Busch (ulrich.busch @varian.com)	Updated actors names along DPDW. Renamed RO-26 from 'UPS Progress Update' to 'UPS Progress Update for Treatment' to indicate the specific scope of this transaction, Added RO-xx 'UPS Progress Update' to introduce progress updates prior and during execution, esp. since 1.3 RO-19: UPS in Progress is now moved to the start of the treatment session (see also below). Items of 2010-06-09 Granada Meeting - Adapt text to registration step and re-positioning steps same as for acquisition step - UPS shall be set IN PROGRESS before dose is delivered for USP which deliver any dose. - Set IN PROGRESS (N-ACTION) is used to LOCK all UPS to be performed by devices within the treatment session ☐ S‹ shall be done for ALL UPS at the beginning of the session. - Set UPS PROGRESS INDICATOR (N-SET) is used to indicate the actual start of the execution of the UPS ☐ <NULL> value to value=0 to indicates start of procedure. - Clarify/correct wording of requirements for Code Value in Scheduled Workitem Code Sequence (0040,4018). - For UPS that must be discontinued (e.g., for unsupported PS, reported with Discontinuation Reason Code "Incorrect Procedure Ordered") the TMS shall not cancel any related procedure steps. The TDD is responsible for managing related UPS, including completion or cancellation of any steps in progress. - UPS that are discontinued due to equipment failure are to be cancelled with Discontinuation Reason Code "Equipment Failure" - Change "Permitted" to "Required" SOP Class support for Performing Device (storage of RT Beams Treatment Record). - If the progress indicator for an acquisition UPS involving dose delivery is >0, then dose reporting object(s) required to satisfy regulatory concerns must be generated and returned to the TMS.
Jan 27, 2011		Ulrich Busch (ulrich.busch @varian.com)	IHE-RO TC Meeting 2011-01-27: - Made Treat step optional, to allow for image-only session - Explain, that support of Conventional / Ion / Brachy modalities have to be declared in IS as a feature support (at least one of this must be supported). - Look for SOP classes Conv / Ion / Brachy - UPS Step: Should contain n of m (N-SET should be blocked, RO-26: UPS Progress Update for Treatment RO-xx: UPS Progress Update)
April 20, 2011	1.4	Ulrich Busch (ulrich.busch @varian.com)	Changes after IHE-RO TC Meeting 2011-01-27: - Completed SOP UIDs - Referenced Standard section updated. The referenced standard is now 2010, because both Supplement 96 and Supplement 74 are final text now, and we decided to go for the final text version for the supplements in work. - Completed table 'Required SOP Class Support for Performing Device

			SCU) in case of radiation exposure' by including the TID 10011 for CT dose reporting (along current REM profile).
			- Removed ((Synchronize text with TDW)) from note in table 'Required Input Sequence Content' of RO-17, because TDW has no corresponding text.
			- Specified in RO-19. That setting the UPS in progress means that the performing device takes ownership. It does not mean, that the activity of these steps has been actually started at this time.
May 5, 2011	1.5	Ulrich Busch (ulrich.busch @varian.com)	Changes during IHE-RO TC Meeting 2011-05-05:
			- Open Issue 'Include safety configuration' added. The provision of TDW should be added here as well.
			- Open Issue on Patient Positioning Instructions and Result IODs added: We need the Patient Positioning Supplement developed by DICOM WG 07 for trial implementation state.
			- Open Issue the Object Storage actor definition added: This actor removes superfluid semantics, and the document must be updated accordingly.
			- PDS result storage for acquisition and registration converted to option.
Sep. 30, 2011		Ulrich Busch (ulrich.busch @varian.com)	Changes following TC Meeting 2011-05-05, to be presented during the Oct 2011 meeting:
			- Update to Object Storage actor where needed.
			- Added provision in RO-20 to require, that consistency checks are to be performed between retrieved and cached objects as in TDW.
Oct. 6, 2011	1.6	Ulrich Busch (ulrich.busch @varian.com)	Changes during IHE-RO TC Meeting 2011-10.06:
			- Decision taken, that we want to include the configuration of multiple AE Titles versus SOP classes. This version contains those definitions now as they have been included during the TC Meeting. Final wordsmithing may be done where needed.
			- Safety considerations: We included Appendix A to include the necessary consistency checks on cached data.
Jan. 06, 2012	1.7 D1	Ulrich Busch (ulrich.busch @varian.com)	Finalization of Profile (Changes prior to IHE-RO TC Meeting 2012-02):
			- Renamed RO-27 UPS Progress Update Steps to RO-27 UPS Progress Update for non-Treatment Steps (as proposed in some earlier meeting), to take a title which is not too generic.
			- Updated all diagrams to comply with final nomenclature
			- Removed actors not present in that profile
			- Updated references to standard and UIDs to final text on UPS items.
			- Cleaned and simplified formatting
			- Checked Appendix A and massaged the text as needed.
Jan. 27, 2012	1.7	Ulrich Busch (ulrich.busch @varian.com)	Second part of finishing profile:
			- Incorporated review findings provided by Johnathon Pauer
			- Incorporated review findings provided by Sue Reilly
			- Some correction in 1.1.4.1.2.1 Matching Keys and Return Keys for Display based on Sue's comments
			- Especially sorted out RO-18 versus RO-20: The first one is about the static objectsm while the second one about 'dynamic' objects – in the same sense as in TDW. Updated Transaction list, Profile and Sequence Diagrams

Feb 7, 2011	1.8	Ulrich Busch (ulrich.busch @varian.com)	Changes during TC Meeting 2012-02, Fort Myers During Meeting: - Reviewed conditions on attributes in Table 3.17 1 Worklist Query for Positioning and Delivery and revised some of them. Added Note 11 for that table - Added provision what the PDS should do in case the status updates fails in RO-19, section 1.3.4.1.3 Expected Actions and RO-25, section 1.9.4.1.3 Expected Actions. After Meeting: - Changed all remaining references to Supp 96 by new references - Fixed sequence Diagram in respect to RO-20 (goes to TMS) - Replaced 'workitem' by 'Procedure Step' wherever the UPS as is meant as a whole - Improved text on failure to update UPS in 1.9.4.1.3 Expected Actions and 1.3.4.1.3 Expected Actions (former wording was from TDW and was not perceived suitable any more)
Feb 17, 2012	1.9	Ulrich Busch (ulrich.busch @varian.com)	After Meeting: - Reworded paragraph on other procedures (last paragraph in section 1.3.4) with the help of Sue's proposal. - Updated footer and some other references
Feb 17, 2012	1.10	Ulrich Busch (ulrich.busch @varian.com)	Editorial Changed to prepare for Public Comment: -
Mar 09, 2012	2.0		Released for public comment

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Volume 1 – Profiles

Add the following bullet to the end of the bullet list in section 1.7

235
- The Integrated Positioning and Delivery Workflow Profile describe the positioning of a patient prior to treatment delivery. Position monitoring may or may not be invoked during treatment delivery. In this profile, the patient positioning, position monitoring and radiation delivery are managed by a single device.

Add the following bullet to the end of the bullet list in section 2.2

240
2.2.X Integrated Positioning and Delivery Workflow Profile

The Integrated Positioning and Delivery Workflow Profile describe the positioning of a patient prior to treatment delivery. Position monitoring may or may not be invoked during treatment delivery. In this profile, the patient positioning, position monitoring and radiation delivery are managed by a single device.

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Add Section 999

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999   Integrated Positioning and Delivery Workflow (IPDW) Profile

The Integrated Positioning and Delivery Workflow Profile describes the positioning of a patient
prior to treatment delivery and the treatment delivery itself. Positionong monitoring may or may
250   not be invoked during treatment delivery. In this profile, the patient positioning, position
monitoring and radiation delivery are managed by a single device. The profile specifies the
transaction based on some well-known procedures.

For positioning, the Positioning and Delivery System (PDS) acquires a set of 2D (planar
projection) or 3D (CT) positioning images or any other positioning indicators (markers, etc.),
255   performs a registration with previously retrieved reference images, and repositions the patient if
necessary.

The PDS then delivers the intended treatment with or without monitoring.

After the intended treatment has been completed or cancelled, the PDS may continue with
another sequence of the above activities, e.g., to treat another target which requires its own
260   positioning / monitoring procedures.

Position acquisition and registration may also occur after all treatments have been delivered in a
session to record the position of the patient at the end of the treatment. Other procedures,
different from the exmaple above, are covered by that profile as well.

265   ## 999.1 IPDW Actors, Transactions, and Content Modules

Figure 999.1-1 IPDW Actor Diagram shows the actors directly involved in the Integrated
Positioning and Delivery Integration Profile and the relevant transactions between them.

RO-17 Worklist Query for Positioning and Delivery
RO-19 UPS in Progress
RO-20: Retrieve Dynamic Treatment Delivery Input Objects
        from Treatment Management System
RO-21 UPS Final Update
RO-25 UPS Completed/Canceled
RO-26 UPS Progress Update for Treatment
RO-27 UPS Progress Update for non-Treatment Steps

Treatment Management System (TMS

Positioning and Delivery System (PDS)

RO-18 Retrieve Workitem Input Objects from Object Storage
RO-22 Store Position Acquisition Results to Object Storage
RO-23 Store Position Registration Results to Object Storage
RO-24 Store Delivery Results to Object Storage

Object Storage

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Figure 999.1-1. IPDW Actor Diagram

Table 999.1-1 lists the transactions for each actor directly involved in the <Profile Acronym>
Profile. In order to claim support of this Profile, an implementation of an actor must perform the
275   required transactions (labeled "R") and may support the optional transactions (labeled "O").
Actor groupings are further described in Section 999.3.

Table 999.1-1. IPDW Profile - Actors and Transactions

Actors	Transactions	Optionality	Section in Vol. 2
Object Storage (OST)	RO-18 Retrieve Workitem Input Objects from Object Storage	R	1.2
	RO-22 Store Position Acquisition Results to Object Storage	R	1.6
	RO-23 Store Position Registration Results to Object Storage	R	1.7
	RO-24 Store Delivery Results to Object Storage	R	1.8
Treatment Management System (TMS)	RO-17 Worklist Query for Positioning and Delivery	R	1.1
	RO-19 UPS in Progress	R	1.3
	RO-20: Retrieve Dynamic Treatment	R	1.4

Actors	Transactions	Optionality	Section in Vol. 2
	Delivery Input Objects from Treatment Management System		
	RO-21 UPS Final Update	R	1.5
	RO-25 UPS Completed/Canceled	R	1.9
	RO-26 UPS Progress Update for Treatment	R	1.10
	RO-27 UPS Progress Update for non-Treatment Steps	R	1.11
Positioning and Delivery System (PDS)	RO-17 Worklist Query for Positioning and Delivery	R	1.1
	RO-18 Retrieve Workitem Input Objects from Object Storage	R	1.2
	RO-19 UPS in Progress	R	1.3
	RO-20: Retrieve Dynamic Treatment Delivery Input Objects from Treatment Management System	R	1.4
	RO-21 UPS Final Update	R	1.5
	RO-22 Store Position Acquisition Results to Object Storage	O	1.6
	RO-23 Store Position Registration Results to Object Storage	O	1.7
	RO-24 Store Delivery Results to Object Storage	R	1.8
	RO-25 UPS Completed/Canceled	R	1.9
	RO-26 UPS Progress Update for Treatment	R	1.10
	RO-27 UPS Progress Update for non-Treatment Steps	R	1.11

999.1.1   Actor Descriptions and Actor Profile Requirements

Normative requirements are typically documented in Volume 2 (Transactions) and Volume 3 (Content Modules). Some Integration Profiles, however, contain requirements which link transactions, data, and/or behavior. Those Profile requirements are documented in this section as normative requirements ("shall").

Profile Preconditions

The Integrated Positioning and Delivery Workflow Profile requires that the Treatment Management System (TMS) has previously received all information needed to effectively respond to queries issued by the Positioning and Delivery System (PDS) that is not generated by the TMS itself. In particular, the TMS must know the SOP Instance UIDs (such as an RT Plan

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290 instance) to be supplied in the Input Information Sequence. The mechanism, by which such information is communicated to the TMS is not covered by the profile. In future profiles, previously executed managed workflow steps may be used to communicate such data.

Treatment Cancellation Prior to Radiation

A UPS for treatment may have been retrieved and set to state IN PROGRESS, but the delivery of
295 radiation may never have begun because the treatment could not be performed for a specific reason.

Cancellation of a Deliver Treatment Procedure Step after radiation has started is fully described by Figure 999.5-1 by taking into account the different final state requirements of RO-21 UPS Final Update and using the CANCELED status in RO-25 UPS Completed/Canceled.

300 However, an Procedure Step for Deliver Treatment may have been retrieved from the TMS and even had its state set to IN PROGRESS, but for whatever reason the radiation was never started. When a cancellation occurs prior to the start of radiation delivery, the process flow may differ as follows:

- If a RO-26 UPS Progress Update for Treatment was issued prior to cancellation, it will have
305 a reported Unified Procedure Step Progress (0040, 4010) (0040,4010) attribute value of 0%.

- The RO-21 Treatment Delivery Final Update transaction will not be required if its Final State conditions (defined in RO-21) have already been met by previous RO-26 UPS Progress Update for Treatment transaction(s).

Treatment Completion

310 An important use case associated with treatment delivery is that of treatment completion following a delivery interruption.

- If the delivery interruption is of a transient nature (e.g., a temporary issue with the delivery machine, or a temporary interruption of the delivery caused by a patient position issue), then the PDS may choose to manage the completion internally, and notify the TMS that the UPS
315 has finally completed normally.

- If the delivery interruption leads to the UPS being moved to the 'CANCELED' state, this requires that a new UPS be scheduled (for example, if the completion requires re-planning, or needs to be performed in a different time slot). The TMS shall then manage the new UPS and specify a Text Value of 'CONTINUATION' in the Scheduled Processing Parameters
320 Sequence when returning a query result (see Volume 2 Table 3.17-2 Note 5) The TMS must also supply the UIDs of the necessary RT Plan, RT Beams Treatment Record, and RT Treatment Summary Record instances that fully specify the nature of the completion.

Profile and Device Capabilities

The capabilities of delivery devices vary considerably in terms of their procedures associated
325 with treatment sessions, specifically for patient positioning and monitoring. Support depends on many factors, like available hardware, licensed features, implemented capabilities and interfaces to external positioning and monitoring devices. Furthermore, these capabilties can change with

an upgrade to the delivery devices, new internal and external application versions etc. . Still the
clinical personnel expects that under this profile it will be possible to schedule these procedures
330   and record their execution for postprocessing, billing and other purposes.

Therefore the collection of procedures, which can be handled by a device, and the combinations
of possible procedures, cannot be specified in this profile in all possble combinations. Often, this
profile may only apply to specific combinations or even a one-vendor only specification.

The scope of this profile therefore does not define all specific procedures which shall be
335   supported. Rather, this profiles defines the use of the unified worklist protocol and the minimum
requirements, which apply to all procedures handled under this profile. The Deliver Treatment
procedure has to be naturally supported by all devices and is specifically required. Some other
well-known procedures are also explicitly specified in such as the Positioning Verification and
Positioning Registration steps with their specific results transactions (RO-22 and RO-23). These
340   are optional because they depend unique capabilities of each device . The reader should note that
the explicitly defined transactions on specific procedures shall be seen as examples for other
procedures not described in this document. Private procedures or use of other standardized
procedures may also be defined in a Positioning and Delivery System vendor's DICOM
Conformance Statement. However, handling of other device-specific procedures should not in
345   anyway contradict the approach as used for well known procedure examples described here.

999.1.1.1   **Object Storage (OST)**

A system that supports retrieval and storage of the output objects by providing the SCP role of the
DICOM Storage Service Class and the SCP role of the DICOM Query/Retrieve Service Class .

350   For retrieval, the UPS Input Information sequence specifies the AE title from which the
performing actor is to retrieve the input objects from. The location from which each class of
objects shall be retrieved from, is defined by and at the discretion of each vendor's TMS
implementation.

For Storage, where each class of objects is to be stored is also defined by and at the discretion of
355   each vendor's TMS implementation. For example, the TMS provider may wish that certain SOP
Classes are sent to its own AE Title, while others (which may or may not be SOP Classes
handled by the TMS) are configured to be sent to another AE Title, perhaps one belonging to an
archival system.

For Storage, the PDS must not only have the capability to configure multiple AE Titles and their
360   corresponding network information, but must also be able to associate an accepted SOP Class list
with each AE Title. While more than one SOP Class may be sent to an single AE Title, each
SOP Class may only be associated with a single AE Title.

365 **999.2 IPDW Actor Options**

Options that may be selected for this Profile are listed in the table 999.2-1 along with the Actors to which they apply. Dependencies between options when applicable are specified in notes.

Table 999.2-1. IPDW - Actors and Options

Actors	Transactions	Volume & Section
Positioning and Delivery System (PDS)	RO-22 Store Position Acquisition Results to Object Storage	3.22
	RO-23 Store Position Registration Results to Object Storage	3.23

370 **999.3 IPDW Actor Required Groupings**

Section not applicable.

999.4 IPDW Document Content Module

999.5 IPDW Overview

999.5.1 Concepts

375 Section not applicable.

999.5.2 Use Case #1:Treatment Delivery Workflow

999.5.2.1 **Treatment Delivery Workflow Use Case Description**

The procedures to be applied for a Treatment Session are retrieved form a Treatment Management System. Position monitoring may or may not be invoked during treatment delivery. 380 In this profile, the patient positioning, position monitoring and radiation delivery are managed by a single device. The device performs the procedures, updates the procedure states and stores the result objects to an object storage.

999.5.2.2 **Treatment Delivery Workflow Process Flow**

The process flow for the Integrated Positioning and Delivery Workflow Profile is shown in 385 Figure 999.5-1.

The workflow annotated in this figure illustrates a representative example of a typical treatment session. In this example, one plan is to be treated after the patient position verification process has been performed. This example therefore comprises 4 Unified Procedures Steps: image acquisition and image registration to determine a correction of the patient position, performing 390 the position correction and treatment. Note that a treatment session may contain more than one plan to treat and various positioning or other steps prior to, in between or after treatment

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delivery. In this sense, the following figure should serve to illustrate a typical workflow, but is not meant to be restrictive in respect to the number and content of steps to be performed within a treatment session.

395
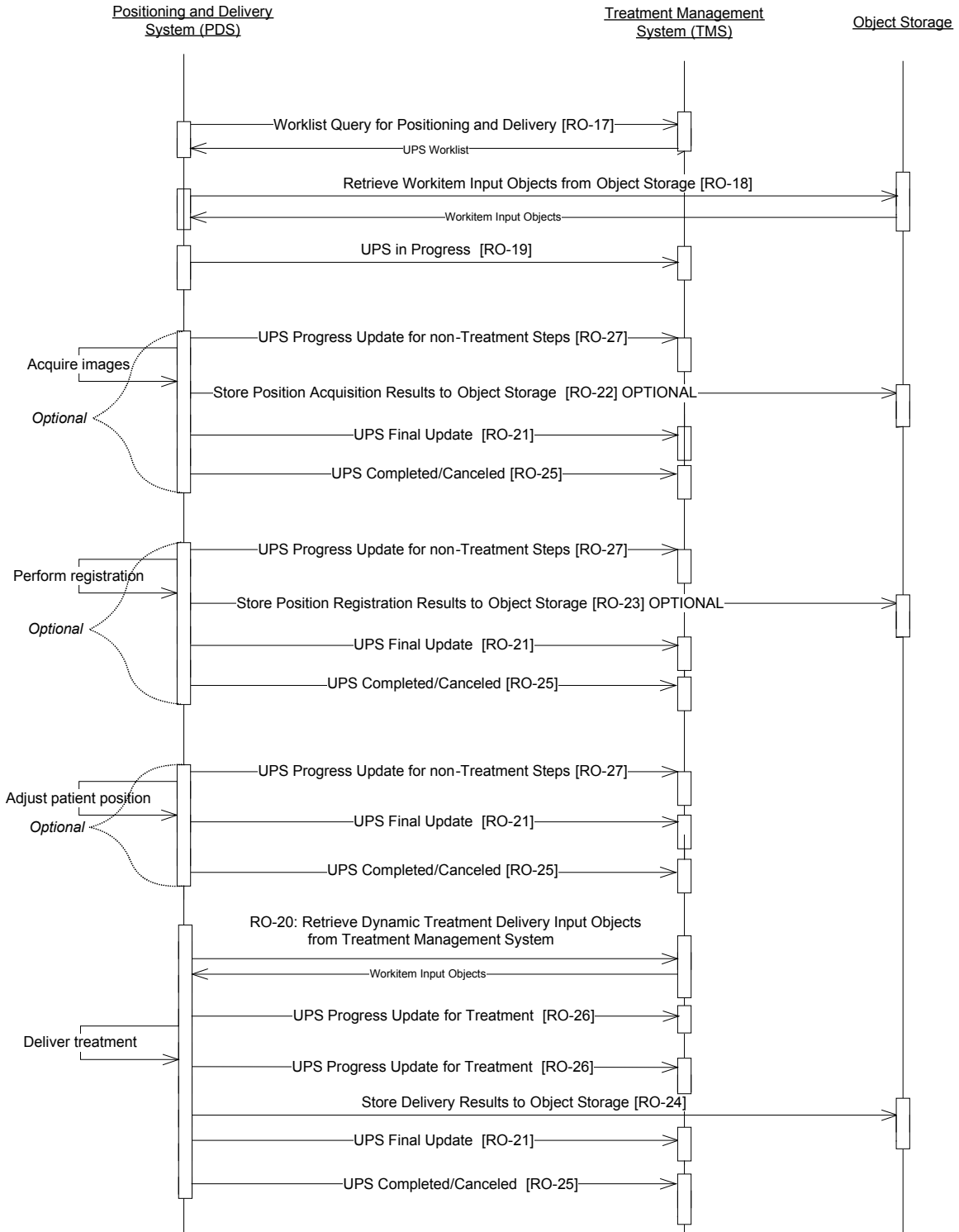
Figure 999.5-1 IHE Integrated Positioning and Delivery Workflow Integration Profile

999.6 IPDW Security Considerations

See Volume 2 - Appendix A.

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999.7 IPDW Cross Profile Considerations

Section not applicable.

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Appendices

Actor Summary Definitions

Add the following terms to the IHE TF General Introduction Namespace list of Actors:

Positioning and Delivery System (PDS)

410   A system that determines and corrects patient position then delivers therapeutic radiation. The PDS fulfils the role of a UPS-Pull 'Pull Performer' SCU as described in DICOM 2011 PS 3.17: Annex GGG, Unified Worklist and Procedure Step – UPS. .

Treatment Management System (TMS)

415   An oncology information system that is responsible for the scheduling of radiotherapy activities (i.e., as a workflow manager). The TMS fulfils the role of a UPS-Pull 'Worklist Manager' SCP as described in DICOM 2011 PS 3.17: Annex GGG, Unified Worklist and Procedure Step – UPS. Note that the TMS actor in other IHE-RO profiles have functionality that is different from that described in this profile.

Object Storage (OST)

420   A system that supports retrival and storage of the output objects by providing the SCP role of the DICOM Storage Service Class and the SCP role of the DICOM Query/Retrieve Service Class .

Transaction Summary Definitions

Add the following terms to the IHE TF General Introduction Namespace list of Transactions:

425   ### RO-17: Worklist Query for Positioning and Delivery

In the Worklist Query for Positioning and Delivery transaction, a PDS requests and receives a set of patient positioning and treatment delivery UPS from a TMS.

RO-18: Retrieve Workitem Input Objects from Object Storage

In the Retrieve Workitem Input Objects from Object Storage transaction, a device PDS requests
430   and receives from the Object Storage all SOP Class Instances required for performing the desired procedure steps returned in a previous query. Each of those SOP Class Instances must have been supplied in the Input Information Sequence of one or more of the previously returned worklist items.

RO-19: UPS in Progress

435   In the UPS in Progress transaction, a device PDS signals to the TMS that responsibility has been taken for the performance of the selected Procedure Step.

RO-20: Retrieve Dynamic Treatment Delivery Input Objects from Treatment Management System

440 In the Retrieve Dynamic Treatment Delivery Input Objects from Treatment Management System transaction, a PDS requests and receives SOP Class instances from the Treatment Management System, in order to support the execution of the requested Procedure Step. Dynamic in the scope of that transaction means, that these requests are of a "transient" nature and are typically generated 'on-the-fly' by the Treatment Management System.

445 ### RO-21: UPS Final Update

In the UPS Final Update transaction, a PDS signals to the TMS any changes in the properties of the Procedure Step that is currently in progress. This transaction occurs prior to the UPS being signaled as completed or canceled.

RO-22: Store Position Acquisition Results to Object Storage

450 In the Store Position Acquisition Results to Object Storage transaction,after a patient position acquisition Procedure Step has been completed by a PDS, the results of the acquisition are stored to the Object Storage. These results may subsequently be referenced in the Output Information Sequence of the corresponding Unified Procedure Step.

RO-23: Store Position Registration Results to Object Storage

455 In the Store Position Registration Results to Object Storage transaction after a patient registration Procedure Step has been completed by a device PDS, the results of the registration operation are stored to the Object Storage. These results may subsequently be referenced in the Output Information Sequence of the corresponding Unified Procedure Step.

RO-24: Store Delivery Results to Object Storage

460 In the Store Position Registration Results to Object Storage transaction, when a treatment delivery Procedure Step has been completed by a PDS, the results of the treatment delivery operation are stored to the Object Storage. These results may subsequently be referenced in the Output Information Sequence of the corresponding Unified Procedure Step.

RO-25: UPS Completed/Canceled

465 In the UPS Completed/Canceled transaction, a PDS signals to the TMS that the selected Procedure Step has either been completed or canceled.

RO-26: UPS Progress Update for Treatment

In the UPS Progress Update for Treatment transaction, a PDS signals to the TMS changes in the progress of the treatment delivery related Procedure Step that is currently in progress.

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RO-27: UPS Progress Update for non-Treatment Steps

In the UPS Progress Update for non-Treatment Steps transaction, a PDS signals to the TMS changes in the progress of a non-treatment delivery related Procedure Step (like an Acquisition, a Registration etc.) that is currently in progress.

475 ## Glossary

Add the following terms to the Glossary:

Volume 2 - Transactions

480 ## 3   Tranactions

> *Add section 3.99 through 3.109 and adjust section numbering as necessary when incorporating in RO TF-2*

3.99 Worklist Query for Positioning and Delivery – RO-17

3.99.1 Scope

485 In the Worklist Query for Positioning and Delivery transaction, a PDS requests and receives a
patient positioning and treatment delivery worklist from a TMS.

3.99.2 Use Case Roles
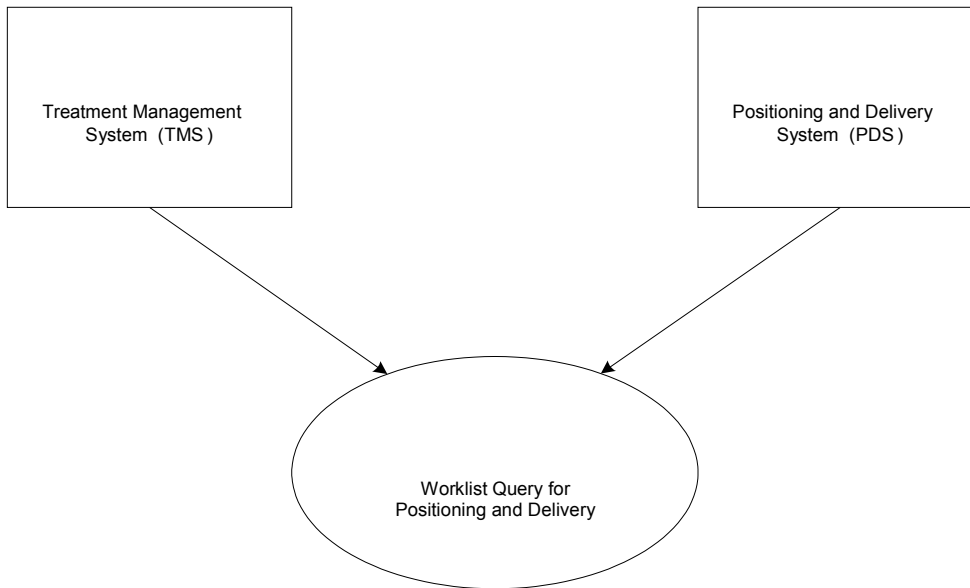
490

Actor:	Treatment Management System (TMS)
Role:	Responds to a worklist query and sends a scheduled patient positioning and delivery worklist to the requesting PDS.
Actor:	Positioning and Delivery System (PDS)
Role:	Queries a TMS and receives a scheduled patient positioning and treatment delivery worklist.

3.99.3 Referenced Standards

DICOM 2011 PS 3.3: RT Modules

DICOM 2011 PS 3.4: Annex CC Unified Procedure Step Service and SOP Classes

3.99.4 Interaction Diagram
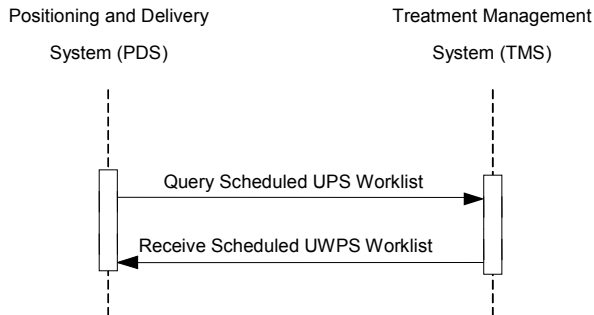
495

3.99.4.1 Query Scheduled UPS Worklist Message

This is the worklist query message sent to the Treatment Management System.

3.99.4.1.1 Trigger Events

The user of the PDS requests that the TMS send a scheduled patient positioning and treatment
500 delivery worklist in order to position the patient and deliver a treatment.

3.99.4.1.2 Message Semantics

The Performing Device uses the C-FIND request of the DICOM Unified Procedure Step – Pull
SOP Class to query the worklist from the TMS. The Performing Device performs the SCU role,
and the TMS performs the SCP role. Note that the UPS-Pull SOP Class is negotiated as the
505 abstract transfer syntax, and used as the Affected SOP Class in the C-FIND request (see DICOM
DICOM 2011 PS 3.4: Annex CC Unified Procedure Step Service and SOP Classes, Section
CC.2.8.1.2.1).

3.99.4.1.2.1 Matching Keys and Return Keys for Display

In the query to the TMS, the PDS (SCU) is required to query for matching on the attributes as
510 shown in Table 3.99.4.1.2.1-1 Worklist Query for Positioning and Delivery. All other potential
query keys may be optionally supplied as described in DICOM 2011, PS 3.4: Annex CC . It is
anticipated that Patient's Name (0010,0010), Patient ID (0010,0020), and Scheduled Station
Name Code Sequence (0040,4025) would be optional matching query key attributes that would
be commonly supplied.

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Table 3.99.4.1.2.1-1 Worklist Query for Positioning and Delivery

Attribute Name	Tag	Query Keys Matching		Query Keys Return	
		SCU	SCP	SCU	SCP
Specific Character Set	(0008,0005)	-	-	O* (Note 10)	R (Note 10)
SOP Class UID	(0008,1016)	-	-	O*	R
SOP Instance UID	(0008,0018)	-	-	R+*	R
Procedure Step State	(0074,1000)	R+* (Note 1)	R	R* (Note 1)	R
Procedure Step Label	(0074,1204)	-	-	R+	R+
Scheduled Station Name Code Sequence	(0040,4025)				
>Code Value	(0008,0100)	R+* (Note 2)	R	R+*	R
>Coding Scheme Designator	(0008,0102)	R+* (Note 3)	R	R+*	R
>Code Meaning	(0008,0104)	-	-	R+	R (Note 4)
Scheduled Procedure Step Start Date and Time	(0040,4005)	R+* (Note 5)	R	R+	R+
Scheduled Workitem Code Sequence	(0040,4018)	(Note 6)	-	R+* (Note 6)	R+
>Code Value	(0008,0100)	-	-	R+*	R+
>Coding Scheme Designator	(0008,0102)	-	-	R+*	R+
>Code Meaning	(0008,0104)	-	-	O	R+
Scheduled Processing Parameters Sequence	(0074,1210)	-	-	R+* (Note 7)	R
Input Information Sequence (Note 11)	(0040,4021)	-	-	R+*	R+ (Note 8)
Study Instance UID	(0020,000D)	-	-	R+*	R+ (Note 9)
Patient's Name	(0010,0010)	O	R	R+	R
Patient ID	(0010,0020)	O	R	R+	R
All other attributes	As described in DICOM Standard 2011, PS3.4. CC 2.5				

Note 1: A Procedure Step State of 'SCHEDULED' shall be supplied.

Note 2: Code Value for the Scheduled Station Name shall contain the string used to definitively match the PDS instance with its representation on the TMS. It is not necessarily human-readable.

520 Note 3: Coding Scheme Designator for the Scheduled Station Name is a private coding scheme, and is not used explicitly in this profile.

Note 4: Coding Meaning for the Scheduled Station Name shall contain the human-readable description of the Station Name, and shall be displayed on the PDS. Note that this attribute is required by IHE-RO in this profile, but is not required in DICOM PS 3.4.

525 Note 5: A 'reasonable' date time range (such as the rest of the current day) shall be supplied to limit the size of the returned result set. If operating in a mode where the patient is selected on the TMS, the TMS is permitted to over-filter the result set based upon this selection and return just the worklist items for the selected fraction.

25

Note 6: Possible value in the Scheduled Workitem Code Sequence (0040,4018) Code Value shall be '121726' (RT Treatment with Internal Verification), and Coding Scheme Designator shall be equal to 'DCM' or equal to any other Scheduled Workitem Code as specified in the conformance statement of the PDS..

530

Note 7: Scheduled Processing Parameters Sequence shall be specified as an empty (null) sequence

Note 8: Input Information Sequence shall contain all the input objects that will ultimately be needed to perform the specified procedure step, and no others. This allows the PDS to determine whether or not the instances are available prior to starting the procedure, and avoids the need for an additional N-GET on the UPS. If the PDS considers that the Input Information Sequence contains inadequate or inconsistent information, then it shall address any such inconsistencies in a safe manner before performing the Requested Procedure.

535

Note 9: Study Instance UID must be supplied by the TMS (SCP) if performance of the procedure step is expected to create composite SOP Instances as output. The supplied Study Instance shall be used by the SCU in creation of such SOP Instances (see transactions Store Position Acquisition Results to, Store Position Registration Results to, and Store Delivery Results to).

540

Note 10: Only ISO-IR 100 (Latin-1) shall be supported.

Note 11: Only the DICOM Retrieval Sequence (0040,E021) in the Referenced Instances and Access Macro shall be used.

In the query to the TMS, the PDS (SCU) is required to query for matching on the attributes shown as "R" or "R+" in the Query Keys Matching SCU column in Table 3.99.4.1.2.1-1

545 Worklist Query for Positioning and Delivery. All other potential query keys may be optionally supplied as described in DICOM PS 3.4. It is anticipated that Patient's Name (0010,0010), Patient ID (0010,0020), and Scheduled Station Name Code Sequence (0040,4025) would be optional matching query key attributes that would be commonly supplied.

In the query to the TMS, the PDS (SCU) is required to accept return keys for display as shown in

550 "Query Keys Return SCU' column of Table 3.99.4.2.1-1 Required Query Keys Returned within the Scheduled Processing Parameters Sequence. All other potential return keys for display may be optionally supplied as described in DICOM Standard 2011, PS 3.4, Section CC.2.5.1.2. The SCU is NOT required to display items marked with an asterisk.

The TMS replies to the query with a set of UPS C-FIND responses containing zero or more

555 scheduled patient positioning worklist items.

3.99.4.1.3   Expected Actions

The TMS retrieves the matching scheduled procedures, and sends the DICOM UPS Worklist to the requesting PDS.

3.99.4.2   Receive Scheduled UPS Worklist Message

560 This is the message that the TMS sends to the PDS as a reply containing DICOM UPS information.

For the Worklist Query for Positioning and Delivery transaction at least one Unified Procedure Step (UPS C-FIND responses in the 'pending' state) shall be returned for each matching treatment session. The set of UPS represents the expected sequence of procedures to be

565 performed in the course of the treatment session. The earliest Scheduled Procedure Step Start Date and Time (0040,4005) of the UPS in a set for a specific Patient represents the expected Start Date and Time of the treatment session, while this value for the following UPS in this set

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26

implies the expected order (the UPS may have been actually returned in an arbitrary order in the query response). However, a user may at any time decide to skip steps or switch the order along
570   clinical needs or preferences.

Input Sequence Specification:

Input sequences shall contain the content specified for each step. Most of the steps require SOP Instance Reference provided in the Input Sequence. The specified location of the SOP Instances shall be an Object Storage..

575   **Output Sequence Specification:**

Output sequences shall contain the content specified for each step, when the steps has been partially or fully executed, i.e., it has a final status of COMPLETED or CANCELED and a Value in Unified Procedure Step Progress (0074,1004) greater than zero. When the step was not performed at all, i.e., it has a final status of CANCELED and a Value in Unified Procedure Step
580   Progress (0074,1004) equal to zero. In this case, the output sequences maybe empty.

3.99.4.2.1   Treat Step

This UPS is requesting actual treatment. This Unified Procedure Step is required if there are no other positioning step(s). This means, that in absence of this step, there are to be other actions scheduled. The typical scenario of such is an image-only session for imaging the patient on a day
585   prior to the day of first treatment.

If more than one RT Plan shall be treated in the treatment session, one UPS per RT Plan treatment shall be present. Each of the steps conform to the specification as follows.

Scheduled Workitem Code Sequence (0040,4018) Code Value shall be equal to '121726' (RT Treatment with Internal Verification), and Coding Scheme Designator shall be equal to 'DCM'.
590   The Input Information Sequence (0040,4021) shall contain reference to a least the following items (additional items may be required for continuation procedures):

1.   The RT Plan SOP or RT Ion Plan SOP Instance to be delivered. Its specified location shall be an Object Storage.

2.   An RT Beams Delivery Instruction SOP Instance. Its specified location shall be the
595   TMS.

3.   In addition, the following values shall be supplied by the SCP for the Scheduled Processing Parameters Sequence:

Table 3.99.4.2.1-1 Required Query Keys Returned within the Scheduled Processing
600   **Parameters Sequence**

Attribute Name	Tag	Query Keys Return
		SCP
Scheduled Processing Parameters Sequence	(0074,1210)	

Attribute Name	Tag	Query Keys Return
		SCP
>Value Type	(0040,A040)	R+* (Note 1)
>Concept Name Code Sequence	(0040,A043)	R+*
>>Code Value	(0008,0100)	R+* (Note 2)
>>Coding Scheme Designator	(0008,0102)	R+* (Note 3)
>>Code Meaning	(0008,0104)	R+* (Note 4)
>Text Value	(0040,A160)	R+ (Note 5)

Note 1: A Value Type of 'TEXT' shall be supplied.

Note 2: Code Value supplied for the Concept Name Code Sequence shall be '2008001'.

Note 3: Coding Scheme Designator supplied for the Concept Name Code Sequence shall be '99IHERO2008'.

Note 4: Code Meaning supplied for the Concept Name Code Sequence shall be 'Treatment Delivery Type'.

605   Note 5: A Text Value of 'CONTINUATION' shall be supplied for scheduled treatment delivery procedures that complete a previously interrupted UPS (that ended in the 'CANCELED" state). Otherwise, a Text Value of 'TREATMENT' shall be supplied.

Table 3.99.4.2.1-2 Required Input Sequence Content

SOP Class Name	SOP Class UID
RT Plan Storage	1.2.840.10008.5.1.4.1.1.481.5
RT Ion Plan Storage	1.2.840.10008.5.1.4.1.1.481.8
RT Beams Delivery Instruction Storage	1.2.840.10008.5.1.4.34.7
RT Brachy Application Setups Delivery Instruction SOP	(reference to draft)
RT Beams Treatment Record Storage (see Note 1)	1.2.840.10008.5.1.4.1.1.481.4
RT Ion Beams Treatment Record Storage (see Note 1)	1.2.840.10008.5.1.4.1.1.481.9
RT Brachy Treatment Record Storage (see Note 1)	1.2.840.10008.5.1.4.1.1.481.6

610   Note 1: The presence of one of either RT Beams Treatment Record Storage, RT Ion Beams Treatment Record Storage or RT Brachy Session Record Storage is required, when the treatment is a continuation of a previously cancelled treatment, i.e., when the Scheduled Processing Parameters Sequence contains the Text Value of 'CONTINUATION'. The set of Treatment Records included shall include all treatment records that are needed for the delivery device to determine how to continue the fraction. The actual SOP class of the records to be
615   provided is determined by the treatment delivery device modality.

Table 3.99.4.2.1-3 Required Output Sequence Content

SOP Class Name	SOP Class UID
RT Beams Treatment Record Storage	1.2.840.10008.5.1.4.1.1.481.4
RT Ion Beams Treatment Record Storage	1.2.840.10008.5.1.4.1.1.481.9

28

RT Brachy Session Record Storage	1.2.840.10008.5.1.4.1.1.481.6

3.99.4.2.2   Non-Treat Steps

620

Non-Treat Steps (typically for positioning) shall be present if no Treat step is available, and may be present otherwise. The presence of these steps depend on the procedures, scheduled by the user on the TMS, to support various kind of positioning and monitoring operations prior to, during and after the treatment(s).

A PDS must be capable of at least one procedure of the type defined in this section.

625

The following list contains a collection of well-known steps for these procedures. While obviously some steps are dependent on others, the sequence of steps is not defined in general. Especially groups of UPS like Acqusition, Registration and Patient Position Adjustment could occur prior to each of several Treat steps, or only prior to one, or even after the Treat step (without Patient Position Adjustment) for after-delivery position verification.

630

635

Note: In a real-life situation, other procedures (e.g., based on device-specific specification in respect to workitem codes, required input sequences etc.) may be needed, when devices support new capabilities. While those steps are out of the scope of this profile, it shall be noted that implementers are strongly advised to follow the same principles as for the well-known steps in the following. This will ensure that new upcoming procedures (being standardized or not) can be supported using the same protocol approach and therefore reduces the implementation effort to support the associated domain logic while allowing re-use of the existing worklist infrastructure on both the TMS and the Performing Device.

A treatment device shall specify the UPS Procedures it supports in its conformance statement. Included in this specification shall also be the following as needed:

- Specific conditions on expected input sequence content

640

- Output sequence content, which will be provided after execution.
- Existing dependencies between UPS (e.g., when a certain procedure is only allowed prior to or after another procedure)

Acquisition Step:

645

When applicable, Scheduled Workitem Code Sequence (0040,4018) Code Value shall be in the set of patient positing acqusition code values (at the time of publication, the values are within 121702-121711) and Coding Scheme Designator shall be 'DCM'. For alternative acqusition modes, private coding scheme designator or future standardized codes may be used.

The Input sequence may initially contain a reference to the instruction to be used for acquisition.

650

Table 3.99.4.2.2-1 Required Input Sequence Content

SOP Class Name	SOP Class UID

SOP Class Name	SOP Class UID
RT Patient Position Setup Reference Acquisition Instruction Storage (Optional)	1.2.840.10008.5.1.4.1.1.481.xx

Other SOP Classes may be present for specific modalities, but are out of the scope of this profile.

For this step, the requirements for output are defined in the separate transaction RO-22.

Registration Step:

655 Scheduled Workitem Code Sequence (0040,4018) Code Value shall be in the range 121712-121721 (registration) and Coding Scheme Designator shall be 'DCM'. For alternative acqusition modes, private coding scheme designator or future standardized codes may be used.

The Input sequence shall initially contain the references to the reference images to be used. After execution, the input sequence shall additionally contain the references to the acquired images
660 being registered against the reference images.

Table 3.99.4.2.2-2 Required Input Sequence Content

SOP Class Name	SOP Class UID
CT Image Storage (Note 1)	1.2.840.10008.5.1.4.1.1.2
RT Image Storage (Note 1)	1.2.840.10008.5.1.4.1.1.481.1
MR Image Storage (Optional)	1.2.840.10008.5.1.4.1.1.4
Positron Emission Tomography Image Storage (Optional)	1.2.840.10008.5.1.4.1.1.128
Registration Instruction Storage (Optional)	1.2.840.10008.5.1.4.1.1.481.xx

Note 1:

- If the Code Value of the preceding Acquisition step is in the range 121707-121708, CT
665 Image Storage references shall be supplied.
- If the Code Value of the preceding Acquisition step is in the range 121702-121706, one or more RT Image SOP Instance references shall be supplied.

Other SOP Classes may be present for specific modalities, but are out of the scope of this profile.

For this step, the requirements for output are defined in the separate transaction RO-23.

670

Patient Position Adjustment Step:

Scheduled Workitem Code Sequence (0040,4018) Code Value shall be equal to '121722' (RT Patient Position Adjustment) and Coding Scheme Designator shall be equal to 'DCM'. For

alternative acqusition modes, private coding scheme designator or future standardized codes may
675   be used.

The Input sequence may initially contain a reference to the instruction to be used for position
correction.

Table 3.99.4.2.2-3 Required Input Sequence Content

SOP Class Name	SOP Class UID
RT Patient Position Correction Instruction Storage (Optional)	1.2.840.10008.5.1.4.1.1.481.xx

Other SOP Classes may be present for specific modalities, but are out of the scope of this profile.

680

Table 3.99.4.2.2-4 Required Output Sequence Content

SOP Class Name	SOP Class UID
RT Patient Position Modification Result Storage	1.2.840.10008.5.1.4.1.1.481.xx

Other SOP Classes may be present for specific modalities, but are out of the scope of this profile.

Patient Position Monitoring Step

685   Scheduled Workitem Code Sequence (0040,4018) Code Value shall be equal to the code, which
will be defined for monitoring in as future version of the DICOM standard, and Coding Scheme
Designator shall be equal to 'DCM'.

Table 3.99.4.2.2-5 Required Input Sequence Content

SOP Class Name	SOP Class UID
RT Patient Position Monitoring Instruction Storage	1.2.840.10008.5.1.4.1.1.481.xx

690   Other SOP Classes may be present for specific modalities, but are out of the scope of this profile.

Table 3.99.4.2.2-6 Required Output Sequence Content

SOP Class Name	SOP Class UID
RT Patient Position Monitoring Result Storage	1.2.840.10008.5.1.4.1.1.481.xx

Other SOP Classes may be present for specific modalities, but are out of the scope of this profile.

695   **Exception Handling on Unsupported Steps**

Due to the dynamic nature of the combinations required to support all activities of a treatment
session, it may happen that a device gets a UPS which contains a procedure which is not
supported by the device. While typially the TMS will configure to the capabilties of a device for

scheduling, this situation may still occur due to mis-configuration by administrative staff or other
reasons. It is therefore important that the receiving device handles this exception explicitly and
does not just silently ignore UPS whose procedures it does not support.

When a performing device gets a UPS, it shall check whether this UPS is supported by the actual
device. If it is not supported the device shall do the following:

It shall indicate to the user that a step was received by the PDS which is unsupported. At least the
following tags out of the Scheduled Workitem Code Sequence (0040,4018) shall be displayed to
provide information about the original intent of this step:

- Code Value (0008,0100)
- Code Meaning (0008,0104)

In the communication with the TMS, it shall indicate to the TMS through the following means: It
shall set the Unified Procedure Step Progress (0074,1004) value to zero. The code value of
Unified Procedure Step Discontinuation Reason Code Sequence (0074,100e) shall be set to
DCM 110502, 'Incorrect procedure ordered' of CID 9300. Immediately afterwards it shall set the
UPS into state CANCELED.

Responsibility to handle dependent UPS

For UPS that must be discontinued (e.g., for unsupported PS, reported with Discontinuation
Reason Code "Incorrect Procedure Ordered") the TMS shall not cancel any related procedure
steps. The PDS is responsible for managing related UPS, including completion or cancellation of
any steps in progress. E.g. is a positioning verification steps could not be performed and
therefore the subsequent registration steps could be be performed, it is the respobsiblitiy of the
PDS to cancel this subsequent step as well.

Exception Handling on Equipment Failure

In the event that the UPS could not be performed on the equipment because the equipment was
not functional, the code value of Unified Procedure Step Discontinuation Reason Code Sequence
(0074,100e) shall be set to DCM 110501, 'Equipment failure' of CID 9300. Immediately
afterwards it shall set the UPS into state CANCELED.

3.99.5 Security Considerations

Section not applicable.

3.100 Retrieve Workitem Input Objects from Object Storage – RO-18

3.100.1 Scope

In the Retrieve Workitem Input Objects from Object Storage transaction, a PDS requests and receives from the Object Storage any SOP Class Instances required for performing desired
735 procedure steps returned by a previous query. Each SOP instance must have been supplied in the Input Information Sequence of one or more of the returned worklist items.

3.100.2 Use Case Roles
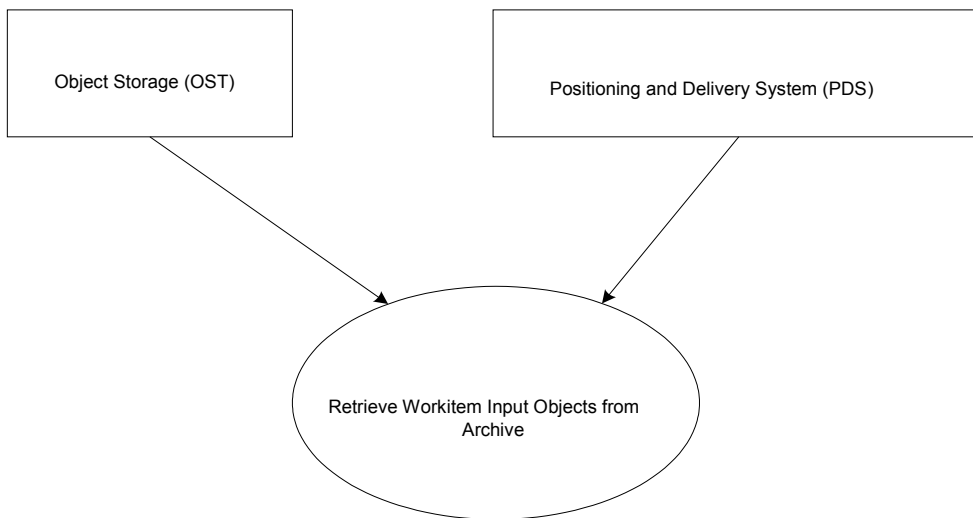
740

Actor:	Object Storage (OST)
Role:	Sends requested DICOM objects to the PDS
Actor:	Positioning and Delivery System (PDS)
Role:	Receives requested DICOM objects from the Object Storage.

3.100.3 Referenced Standards

DICOM 2011 PS 3.3: Information Object Definitions

DICOM 2011 PS 3.4: Storage Service Class

745 DICOM 2011 PS 3.4: Query/Retrieve Service Class

3.100.4 Interaction Diagram

Object Store (OST)   Positioning and Delivery System (PDS)

Retrieve Objects   (C-MOVE)
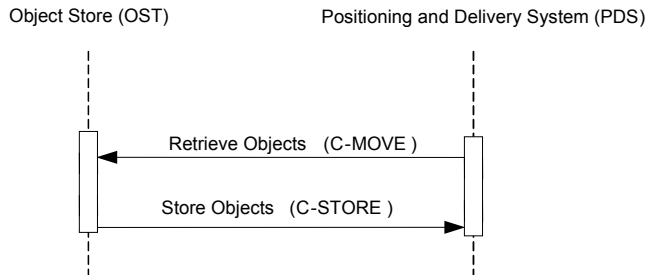
Store Objects   (C-STORE)

3.100.4.1 Retrieve Objects

The Retrieve (Study Root – MOVE) SOP Class shall be supported. Implementations shall support modes of operation in which a single series (e.g., input CT Series) or specific SOP Instances (e.g., an RT Plan) are retrieved from the Object Storage using the Study Root – MOVE SOP Class. Refer to DICOM 2011 PS 3.4, Annex C, for detailed descriptive semantics.

A Performing Device shall be capable of issuing Study-Root C-MOVE for all relevant SOP Instances that are specified in the Input Information Sequence. Other mechanisms for obtaining the data (such as C-STORE or restoring from a DICOM medium) shall not be relied upon to obtain the data. However, if a Performing Device already has access to the input object instances then it is not required to use its C-MOVE capability to obtain those instances again. This would occur either because the objects have been transmitted previously in another operation, or because the requested instance has been created internally.

A Performing Device may receive SOP Instances in the Input Information Sequence for which it determines that it cannot perform the Procedure Step safely. If the Procedure Step is not yet "IN PROGRESS", the resolution is out of the scope of this profile.

If the Procedure Step is already "IN PROGRESS", the Performing Device shall cancel the Procedure Step, providing an explanation in the Reason For Cancellation in the N-ACTION command.

3.100.4.1.1 Trigger Events

In order to position a patient prior to treatment delivery, perform a treatment delivery, or both, the PDS will request one or more of the referenced objects in the Input Information Sequence (0040,4021) of the selected Procedure Step, where the Object Storage is specified as the storage location of that item.

3.100.4.1.2 Message Semantics

The message semantics are defined by the DICOM Query/Retrieve SOP Classes and the DICOM Storage SOP Classes.

A C-MOVE Request from the DICOM Study Root Query/Retrieve Information Model – MOVE SOP Class shall be sent from the Performing Device (SCU) to the Object Storage. The objects that may potentially be required by the Performing Device are specific to the nature and capabilities of the Performing Device. As such, there are no requirements that objects of any specific type be requested. It is assuming that any requested objects have been placed in the Object Storage by means beyond the scope of IHE-RO. Typically C-STORE operations from a Treatment Planning System would have been performed to achieve this goal.

In cases where the Performing Device manages DICOM objects itself, it may well have pre-fetched and processed the required objects. If so, the UIDs supplied in the Input Information Sequence (0040,4021) of the selected Procedure Steps will be sufficient to locate the necessary data, and no retrievals will be necessary (hence the optionality of this transaction in the profiles).

The specific attribute contents of the retrieved objects are also not specified in IHE-RO profiles. It is assumed that the object contents will be specific to the particular combination of Performing Device and Treatment Management System, and are not specified by IHE-RO. However, a participating Object Storage shall support this transaction for at least the objects listed in Table 3.100.4.1.2-1 below.

Table 3.100.4.1.2-1 Required SOP Class Support for Object Storage Actor

SOP Class Name	SOP Class UID
CT Image Storage	1.2.840.10008.5.1.4.1.1.2
RT Structure Set Storage	1.2.840.10008.5.1.4.1.1.481.3
RT Plan Storage (see Note 1)	1.2.840.10008.5.1.4.1.1.481.5
RT Ion Plan Storage (see Note 1)	1.2.840.10008.5.1.4.1.1.481.8
RT Dose Storage	1.2.840.10008.5.1.4.1.1.481.2
RT Beams Treatment Record Storage (see Note 1)	1.2.840.10008.5.1.4.1.1.481.4
RT Ion Beams Treatment Record Storage (see Note 1)	1.2.840.10008.5.1.4.1.1.481.9
RT Brachy Treatment Record Storage (see Note 1)	1.2.840.10008.5.1.4.1.1.481.6
RT Image Storage	1.2.840.10008.5.1.4.1.1.481.1

Note 1: The retrieval of one of RT Beams Treatment Record Storage, RT Ion Beams Treatment Record Storage or RT Brachy Session Record Storage is required when the treatment is a continuation of a previously cancelled treatment, i.e., when the Scheduled Processing Parameters Sequence contains the Text Value of 'CONTINUATION'. The set of Treatment Records included shall include all treatment records that are needed for the delivery device to determine how to continue the fraction. The actual SOP class of the records to be provided is determined by the treatment delivery device modality.

The objects that may potentially be required by the Performing Device are specific to the nature and capabilities of that device. As such, there are no requirements that objects of any specific type be requested. It is assumed that any requested objects have been (or will be) generated by the TMS itself.

In some cases where the Performing Device may have obtained all necessary objects from the Object Storage in a previous step or session, it may not require any additional objects to perform the scheduled procedure (hence the optionality of this transaction).

805   The specific attribute contents of the retrieved objects are also not specified in IHE-RO profiles. It is assumed that the object contents will be specific to the particular combination of Performing Device and TMS, and is not specified by IHE-RO.

3.100.4.1.3   Expected Actions

The Object Storage receives the C-MOVE request, establishes a DICOM association with the
810   requesting actor, and uses the appropriate DICOM Object SOP Classes to transfer the requested objects. The requesting Performing Device is then expected to use the requested objects in the performing of the selected Procedure Steps. This could include displaying overlaid image, structure, and dose information for registration, or using plan information to prepare treatment delivery.

815   In case the RT Plan or RT Ion Plan cannot be represented completely in DICOM, a local storage is needed to represent the full set of parameters to perform treatment delivery. The profile does explicitly allow this option under the condition that is is necessary because of the inablitiy to represent the full set of treatment parameters using DICOM IODs in the existing version of the DICOM standard. In this case the UIDs supplied in the Input Information Sequence (0040,4021)
820   of the selected Procedure Steps will be sufficient to locate the necessary data. The requesting Performing Device is then expected to use the requested objects in performing the selected Procedure Steps.

3.100.5   Security Considerations

In case the full set of parameters to perform treatment delivery is stored locally, the Performing
825   Device is required to perform the consistency checks as specified in Appendix A.

3.101 UPS in Progress – RO-19

3.101.1   Scope

In the UPS in Progress transaction, the PDS signals to the TMS that responsibility has been taken for the performing of the selected Procedure Steps.

830   ### 3.101.2   Use Case Roles
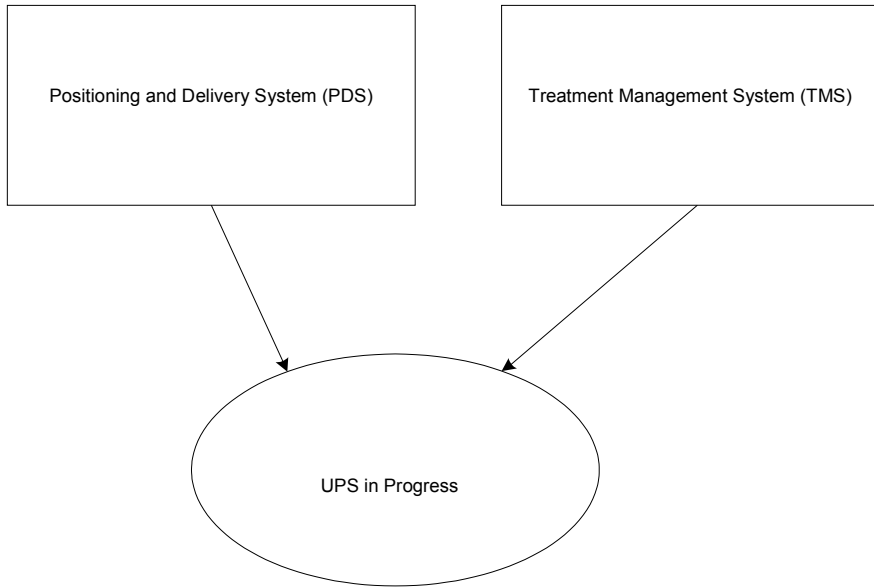
Actor:	Treatment Management System (TMS)
Role:	Responds to a UPS N-ACTION and recognizes the specified Unified Procedure Step as in progress, thereby preventing other Actors from performing the step.
Actor:	Positioning and Delivery System (PDS)
Role:	Signals using UPS N-ACTION that the selected Procedure Step is in progress.

835 **3.101.3 Referenced Standards**

DICOM 2011 PS 3.4: Annex CC Unified Procedure Step Service and SOP Classes

3.101.4 Interaction Diagram
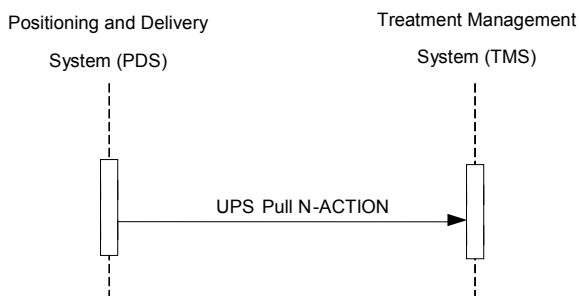
3.101.4.1 **UPS in Progress Message**

840 The Performing Device uses the UPS N-ACTION service to inform the TMS that the specified Unified Procedure Steps have been claimed for execution during the treatment session. This means especially that the device has taken exclusive ownership of those steps. The start of the actual execution will typically occur later in the course of processing the sequence of the Unified Procedure Steps. The actual start of execution will be indicated by the transactions RO-27: UPS

845 Progress Update for non-Treatment Steps or RO-26: UPS Progress Update for Treatment. Note that the UPS-Pull SOP Class is negotiated as the abstract transfer syntax, but the UPS-Push SOP Class is used as the SOP Class of a UPS in all subsequent DIMSE messaging (see DICOM PS 3.4, Section CC.3.1).

3.101.4.1.1 **Trigger Events**

850 The Performing Device has successfully queried and selected a suitable Procedure Step, and has retrieved any necessary Input Information Objects from the Object Storage. All UPS retrieved by the Worklist Query RO-17 for the whole treatment session shall be set to IN PROGRESS using this transaction right before proceeding with the first UPS. This shall ensure that all UPS for the whole session are locked at once for this device exclusively.

855 3.101.4.1.2 **Message Semantics**

The message semantics are defined in DICOM PS 3.4. The value of the Unified Procedure Step State (0074,1000) shall be 'IN PROGRESS'

3.101.4.1.3 **Expected Actions**

The TMS receives the N-ACTION request and sends an N-ACTION response. If the requested

860 Procedure Step is still available for performing, the TMS shall send an N-ACTION response with a Unified Procedure Step State (0074,1000) of 'IN PROGRESS' and a status code of 0000H (success). The TMS shall then be ready to receive UPS N-SET or UPS N-ACTION commands. A unique value for the Transaction UID (0008,1195) shall be supplied by the PDS, and used subsequently by the TMS in authorizing further UPS requests (which must supply the

865 Transaction UID first returned in this transaction).

If the status of one or more of the requested Procedure Steps cannot be set to IN PROGRESS in TMS because the Unified Procedure Step is already IN PROGRESS, or for any other reason, then an N-ACTION response with a status code as described in DICOM PS 3.4, Section CC.2.1.4 shall be returned. Alternatively, the PDS may be unable to set the status to IN

870 PROGRESS for one or more of the Procedure Steps of that transaction, because the communication to the TMS has failed or the response could not be received.

In both cases, the PDS shall issue an N-ACTION request for all the Procedures Steps to request a status change to CANCELLED. The PDS shall inform the user about this condition.

3.101.5 Security Considerations

875 Section not applicable.

3.102 Retrieve Dynamic Treatment Delivery Input Objects from Treatment Management System – RO-20

3.102.1 Scope

880 In the Retrieve Workitem Input Objects from TMS transaction, a PDS requests and receives SOP Class instances from the TMS,in order to support execution of the requested workitem. 'Dynamic' in the scope of this transaction meanse, that these requested instances are of a "transient" nature, typically generated 'on-the-fly' by the TMS.

### 3.102.2 Use Case Roles

885
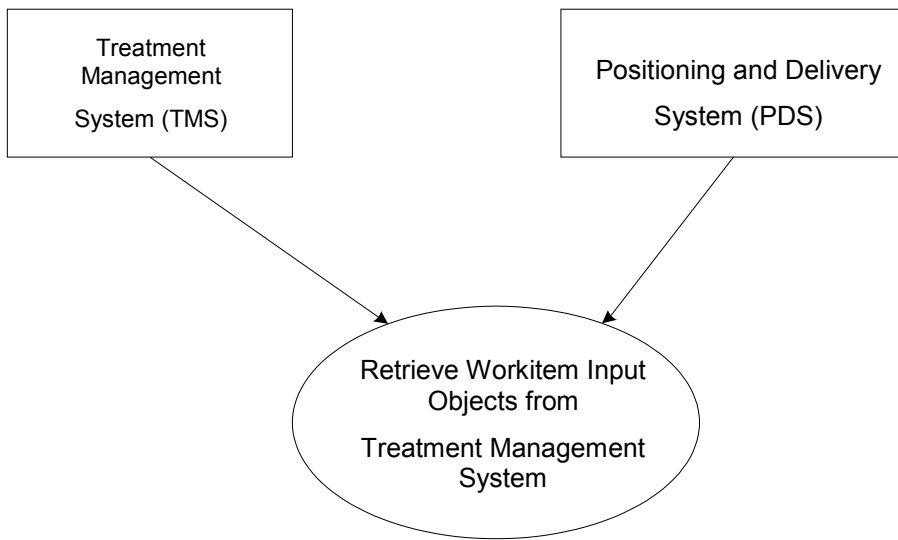
Actor:	Treatment Management System (TMS)
Role:	Sends requested DICOM objects to the PDS.
Actor:	Positioning and Delivery System (PDS)
Role:	Receives requested DICOM objects from the TMS.

3.102.3   Referenced Standards

890   DICOM 2011 PS 3.3: Information Object Definitions

DICOM 2011 PS 3.4: Storage Service Class

DICOM 2011 PS 3.4: Query/Retrieve Service Class

3.102.4   Interaction Diagram
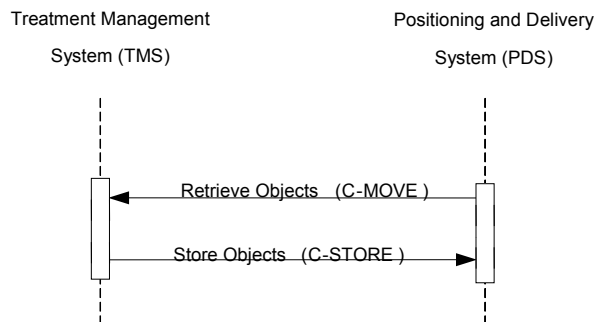
895   3.102.4.1   **Retrieve Objects**

The Retrieve (Study Root – MOVE) SOP Class shall be supported with Series support. Implementations shall support a mode of operation in which specific SOP Instances (rather than entire studies) are retrieved from the TMS using the Study Root – MOVE SOP Class. Refer to DICOM 2011 PS 3.4, Annex C, for detailed descriptive semantics.

900   A Performing Device shall be capable of issuing Study-Root C-MOVE for all relevant SOP Instances that are specified in the Input Information Sequence.

A Performing Device may receive SOP Instances in the Input Information Sequence for which it determines that it cannot perform the Procedure Step safely.

- If the Procedure Step is not yet "IN PROGRESS", the resolution is out of the scope of this
905   profile.
- If the Procedure Step is already "IN PROGRESS", the Performing Device shall cancel the Procedure Step, providing an explanation in the Reason For Cancellation in the N-ACTION command.

3.102.4.1.1 Trigger Events

910   In order to perform a treatment delivery, the PDS requests one or more of the referenced objects in the Input Information Sequence (0040,4021) of the selected Procedure Step, where the TMS is specified as the storage location of that item.

The Performing Device shall not be permitted to perform this transaction on a UPS for which the RT Plan instance supplied in its Input Instance sequence has not previously been obtained using
915   RO-18: Retrieve Workitem Input Objects from Object Storage.

3.102.4.1.2   Message Semantics

The message semantics are defined by the DICOM Query/Retrieve SOP Classes and the DICOM Storage SOP Classes. A C-MOVE Request from the DICOM Study Root Query/Retrieve

920   Information Model – MOVE SOP Class shall be sent from thePDS to the Treatment Management System. The TMS shall be capable of supplying all objects that it originally supplied in the Input Information Sequence (0040,4021) of the UPS as having an AE Title corresponding to the AE Title of the TMS. Note that a specific product implementation could fulfill the roles of both a TMS and an Object Storage, in which case one AE Title could be used

925   to retrieve and store all input and output SOP Instances for the UPS. In the TMS role, only the following SOP Classes may be included in this set:

Table 3.102.4.1.2-1 Potential SOP Class Support for TMS C-MOVE

SOP Class Name	SOP Class UID
RT Beams Delivery Instruction Storage	1.2.840.10008.5.1.4.34.7
RT Treatment Summary Record Storage	1.2.840.10008.5.1.4.1.1.481.7

3.102.4.1.3   Expected Actions

The TMS receives the C-MOVE request, establishes a DICOM association with the requesting

930   Performing Device, and uses the appropriate DICOM SOP Classes to transfer the requested objects. The requesting actor is then expected to use the requested objects in the performing of the selected Procedure Step.
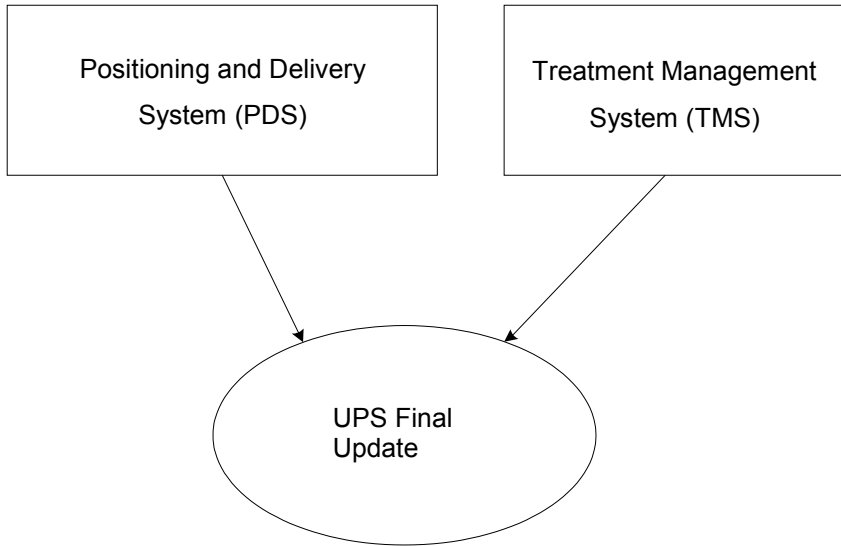
3.102.5   Security Considerations

Section not applicable.

935   # 3.103 UPS Final Update – RO-21

3.103.1   Scope

In the UPS Final Update transaction, a PPS, PDS, or TDD signals to the TMS any changes in the properties of the Procedure Step that is currently in progress prior to the UPS being signaled as completed or canceled.

940   ### 3.103.2   Use Case Roles

Actor:	Treatment Management System (TMS)
Role:	Responds to a UPS N-SET and updates attributes in the specified Unified Procedure Step.
Actor:	Positioning and Delivery System (PDS)
Role:	Signals using UPS N-SET that that certain attributes related to the selected Procedure Step have changed.

945 ### 3.103.3   Referenced Standards

DICOM 2011 PS 3.4: Annex CC Unified Procedure Step Service and SOP Classes

3.103.4   Interaction Diagram
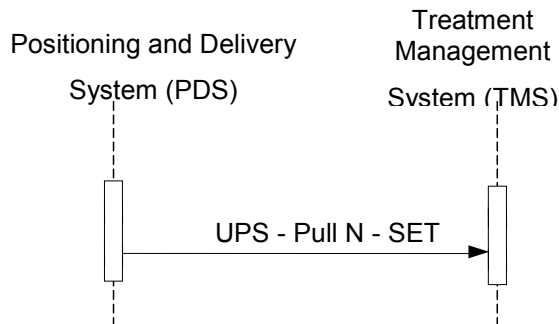
3.103.4.1   **UPS Final Update Message**

950   The Performing Device uses the UPS N-SET service to inform the TMS that certain attributes relating to the specified Unified Procedure Step have changed.

3.103.4.1.1   Trigger Events

The Performing Device is in the process of performing the Procedure Step and wishes to notify the TMS of changes in certain attributes related to the Procedure Step. This may include an

955   update to the completion progress of the Procedure Step.

3.103.4.1.2   Message Semantics

The message semantics are defined in DICOM PS 3.4. Note that the UPS-Pull SOP Class is negotiated as the abstract transfer syntax, but the UPS-Push SOP Class is used as the SOP Class of a UPS in all subsequent DIMSE messaging (see DICOM PS 3.4, Section CC.3.1).

960   Requirement for SCUs using the UPS N-SET command are detailed in Table 3.103.4.1.2-1: UPS N-Set Final State Attribute Requirements. The table contains only those attributes having a Final State requirement of 'R' (required if procedure is COMPLETED or CANCELED) or 'X' (required if procedure is COMPLETED). Of particular note is the last column which indicates the attributes that must be supplied by the SCU in the N-SET command in order to satisfy the

965   Final State requirements. Note that IHE-RO is more restrictive than DICOM PS 3.4 in that a number of attributes are required to be set for all UPS N-SET commands. DICOM PS 3.4 only requires that the attributes have been set by any N-SET or N-ACTION message prior to the procedure step being moved into the COMPLETED or CANCELED state.

970 **Table 3.103.4.1.2-1: UPS N-Set Final State Attribute Requirements**

Attribute Name	Tag	Req. Type N-SET (SCU/SCP)	Final State	IHE-RO Additional Notes/Requirements on SCU
Transaction UID	(0008,1195)	(See DICOM Supp 96 F.X.3.6.3)	R	
SOP Common Information Module				
Specific Character Set	(0008,0005)	1C/1C (Required if extended or replacement character set is used)	Set if required	Only ISO-IR 100 (Latin-1) shall be supported.
SOP Class UID	(0008,0016)	Not allowed	R	Affected SOP Class (0000,0002) is always 'UPS-Push' SOP Class
SOP Instance UID	(0008,0018)	Not allowed.	R	Affected SOP Instance (0000,1000) supplied by C-FIND responses of UPS query
Unified Procedure Step Progress Information Module				
Unified Procedure Step State	(0074,1000)	Not Allowed. Use N-ACTION	R	
Unified Procedure Step Scheduled Procedure Information Module				
Scheduled Procedure Step Priority	(0040,4003)	3/1	R	Supplied implicitly by TMS – not required in N-SET.
Scheduled Procedure Step Modification Date and Time	(0040,4010)	-/1 SCP will use time of SET	R	Supplied implicitly by TMS – not required in N-SET.
Unified Procedure Step Performed Procedure Information Module				
UPS Performed Procedure Sequence	(0040,eee8)	3/2	X	Supplied by this transaction (UPS Final Update) in IHE-RO, if UPS was not 'CANCELED'
>Actual Human Performers Sequence	(0040,4035)	3/1	RC	Shall be provided if known. Not required to be known in IHE-RO.
>>Human Performer Code Sequence	(0040,4009)	3/1	RC	Shall be provided if known. Not required to be known in IHE-RO.
>>Human Performer's Name	(0040,4037)	3/1	RC	Shall be provided if known. Not required to be known in IHE-RO.
>Performed Station Name Code Sequence	(0040,4028)	3/2	R	Supplied by this transaction (UPS Final Update)) in IHE-RO.
>>Code Value	(0008,0100)	1/1		Name of machine performing UPS. Supplied by this transaction (UPS Final Update) in IHE-RO.
>>Coding Scheme Designator	(0008,0102)	1/1		Any private coding scheme designator. Supplied by this transaction (UPS Final Update))

44

Attribute Name	Tag	Req. Type N-SET (SCU/SCP)	Final State	IHE-RO Additional Notes/Requirements on SCU
				in IHE-RO.
>>Code Meaning	(0008,0104)	1/1		Value shall be 'Performed Station Name'. Supplied by this transaction (UPS Final Update)) in IHE-RO.
>Performed Processing Applications Code Sequence	(0040,4007)	3/2	RC	Shall be provided if known. Not required to be known in IHE-RO.
>Performed Procedure Step Start Date	(0040,0244)	3/1	R	Supplied by this transaction (UPS Final Update)) in IHE-RO
>Performed Procedure Step Start Time	(0040,0245)	3/1	R	Supplied by this transaction (UPS Final Update) in IHE-RO
>Performed Workitem Code Sequence	(0040,4019)	3/1	R	Supplied by this transaction (UPS Final Update)) in IHE-RO
>>Code Value	(0008,0100)	1/1		Performed workitem code value. Supplied by this transaction (UPS Final Update)) in IHE-RO.
>>Coding Scheme Designator	(0008,0102)	1/1		Value shall be 'DCM'. Supplied by this transaction (UPS Final Update)) in IHE-RO.
>>Code Meaning	(0008,0104)	1/1		Value shall be consistent with Code Value as described in Supplement 74 PS 3.16 Annex B. Supplied by this transaction (UPS Final Update)) in IHE-RO.
>Performed Procedure Step End Date	(0040,0250)	3/1	X	Supplied by this transaction (UPS Final Update)) in IHE-RO
>Performed Procedure Step End Time	(0040,0251)	3/1	X	Supplied by this transaction (UPS Final Update)) in IHE-RO.
>Output Information Sequence	(0040,4033)	2/2	X	Supplied by this transaction (UPS Final Update) in IHE-RO. May be empty (null) in N-SET if no output objects are created.
>>Study Instance UID	(0020,000D)	1/1	R	Supplied by this transaction (UPS Final Update)) in IHE-RO
>>Referenced Series Sequence	(0008,1115)	1/1	R	Supplied by this transaction (UPS Final Update)) in IHE-RO
>>>Series Instance UID	(0020,000E)	1/1	R	Supplied by this transaction (UPS Final Update)) in IHE-RO
>>>Retrieve AE Title	(0008,0054)	2C/2	RC	Supplied by this transaction (UPS Final Update) for IHE-RO (File Media Set not supported)
>>>Storage Media File-Set ID	(0088,0130)	2C/2	RC	Never supplied for IHE-RO (File Media Set not supported)
>>>Storage Media File-Set UID	(0088,0140)	2C/2	RC	Never supplied for IHE-RO (File Media Set not supported)

45

Attribute Name	Tag	Req. Type N-SET (SCU/SCP)	Final State	IHE-RO Additional Notes/Requirements on SCU
>>>Referenced SOP Sequence	(0008,1199)	1/1	R	Supplied by this transaction (UPS Final Update) in IHE-RO
>>>>Referenced SOP Class UID	(0008,1150)	1/1	R	Supplied by this transaction (UPS Final Update)) in IHE-RO. See transactions Store Position Acquisition Results to, Store Position Registration Results to, Store Delivery Results to for permitted SOP Classes.
>>>>Referenced SOP Instance UID	(0008,1155)	1/1	R	Supplied by this transaction (UPS Final Update) in IHE-RO
>Non-DICOM Output Code Sequence	(0040,4032)	2/2	X	Empty value always supplied by this transaction (UPS Final Update)) in IHE-RO

3.103.4.1.3 Expected Actions

The TMS receives the N-SET request and sends an N-SET response. The Transaction UID (0008,1195) shall always be supplied.

975
- If the requested Procedure Step has been successfully updated, the TMS shall send an N-SET response with a status code of 0000H (success). The Treatment Management System shall then be ready to receive further N-SET or N-ACTION commands.

- If the requested Procedure Step was not successfully updated, the TMS shall send an N-SET response with a failure (non-zero) status code. The TMS shall then be ready to receive further
980 N-SET or N-ACTION commands.

- If the requested Procedure Step cannot be updated because the Unified Procedure Step is not IN PROGRESS, or for any other reason, then an N-SET response with a status code as described in DICOM PS 3.4, Section CC.2.1.4 shall be returned. The TMS shall then remain in the state it was in before the N-SET was received.

985 ### 3.103.5   Security Considerations

Section not applicable.

## 3.104 Store Position Acquisition Results to Object Storage – RO-22

3.104.1   Scope

990 In the Store Position Acquisition Results to Object Storage transaction, when a patient position acquisition Procedure Step has been completed by a PPS or PDS, the results of the acquisition

maybe stored to the Object Storage. These results are subsequently referenced in the Output Information Sequence of the corresponding Unified Procedure Step.

3.104.2 Use Case Roles

995
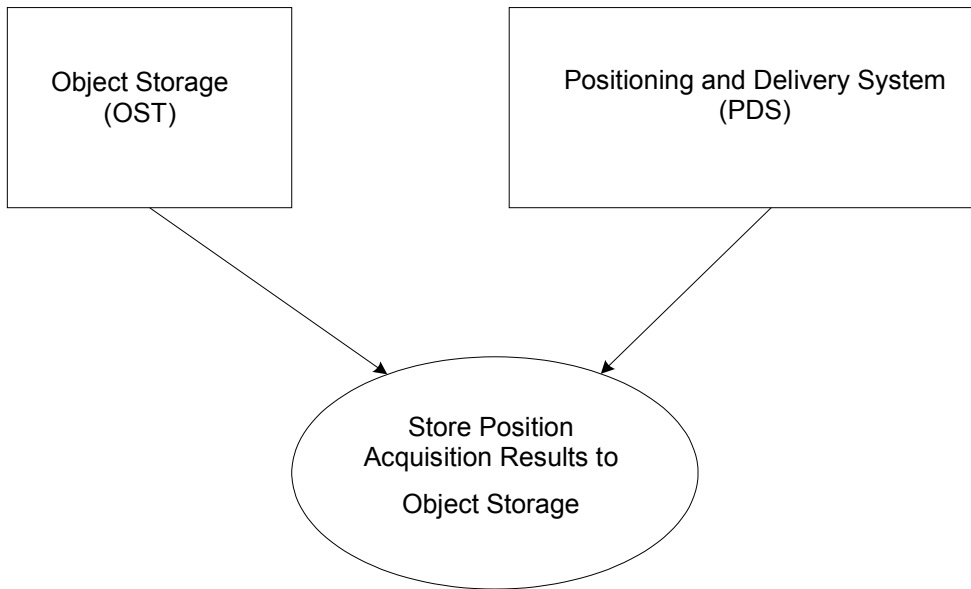
Actor:	Object Storage (OST)
Role:	Responds to a C-STORE request and stores the transmitted objects.
Actor:	Positioning and Delivery System (PDS)
Role:	Stores the output of the position acquisition operation to the Object Storage.

3.104.3 Referenced Standards

1000 DICOM 2011 PS 3.3: Information Object Definitions

DICOM 2011 PS 3.4: Storage Service Class

DICOM 2011 PS 3.16: Content Mapping Resource

3.104.4 Interaction Diagram

Positioning and Delivery
System (PDS)

Object Storage (OST)

C-STORE (Position Acquisition results)
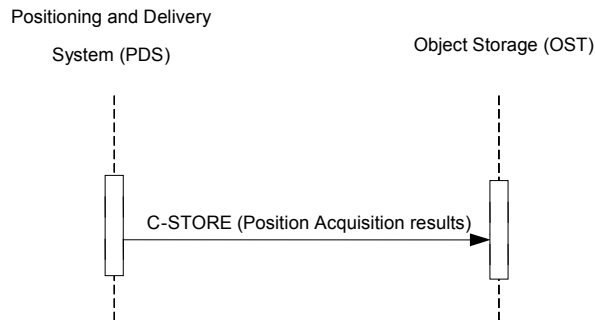
1005 ### 3.104.4.1 Store Objects

The C-STORE Service shall be supported. The DICOM Storage SOP Classes will be supported by the Object Storage as an SCP. Refer to DICOM 2011 PS 3.4, Annex C, for detailed descriptive semantics.

3.104.4.1.1 Trigger Events

1010 The Performing Device has completed a patient position acquisition and wishes to store the generated results of the registration operation.

3.104.4.1.2 Message Semantics

The message semantics are defined by the DICOM Storage SOP Classes. A C-STORE Request shall be sent from the Performing Device to the Object Storage. One or more objects shall be
1015 stored, with one of the SOP Classes denoted in the Table 3.104.4.1.2-1 Permitted SOP Class Support for Performing Device (SCU). The table also denotes the permitted Workitem Code Values in the corresponding UPS for each object type.

Table 3.104.4.1.2-1 Permitted SOP Class Support for Performing Device (SCU)

Workitem Code Value	SOP Class Name	SOP Class UID
121707-121708	CT Image Storage	1.2.840.10008.5.1.4.1.1.2
121702-121706	RT Image Storage	1.2.840.10008.5.1.4.1.1.481.1

1020 Other SOP Classes may be present for specific modalities, but are out of the scope of this profile.

A PDS may choose not to expose the results of the patient position acquisition operation as storage of acquisition objects (typically image sets), since the following treatment delivery is also managed by the same device. For a PPS, the ultimate output of the device is a successful position adjustment, and output of the position acquisition step is not required either. Hence
1025 storage of the position acquisition results (this transaction) is an optional step.

If the progress indicator for an acquisition UPS involving dose delivery is >0 (i.e., the acquisition was started involving radiation) and no treatment record is present for this dose delivered, then dose reporting object(s) required to satisfy regulatory concerns must be generated and returned to the Object Storage.

1030

Table 3.104.4.1.2-2 Required SOP Class Support for Performing Device (SCU) in case of radiation exposure

Workitem Code Value	SOP Class Name	SOP Class UID
121707-121708	X-Ray Radiation Dose SR IOD using: TID 10011 "CT Radiation Dose"	1.2.840.10008.5.1.4.1.1.88.67
121702-121706	X-Ray Radiation Dose SR IOD using: TID 10001 "Projection X-Ray Radiation Dose" TID 10011 "CT Radiation Dose"	1.2.840.10008.5.1.4.1.1.88.67

1035 The specific attribute contents of the generated object are not specified in IHE-RO profiles. It is assumed that the object contents will be specific to the particular combination of Performing Device and Object Storage, and is not specified by IHE-RO.

Any stored objects shall contain the Study Instance UID (0020,000D) supplied by the TMS in the UPS C-FIND response of Transaction Worklist Query for Positioning and Delivery(see Table 3.99.4.1.2.11-1 Worklist Query for Positioning and Delivery). A participating Object Storage 1040 must support this transaction for at least the objects listed in Table 3.104.4.1.2-3 Required SOP Class Support fo Object Storage (SCP).

Table 3.104.4.1.2-3 Required SOP Class Support fo Object Storage (SCP)

SOP Class Name	SOP Class UID
CT Image Storage	1.2.840.10008.5.1.4.1.1.2
RT Image Storage	1.2.840.10008.5.1.4.1.1.481.1

3.104.4.1.3 Expected Actions

1045 The Object Storage receives the C-STORE request, establishes a DICOM association with the requesting actor, and uses the appropriate DICOM Storage SOP Classes to receive the requested objects and store them.

3.104.5   Security Considerations

Section not applicable.

1050

3.105 Store Position Registration Results to Object Storage – RO-23

3.105.1   Scope

In the Store Position Registration Results to Object Storage transaction, when a patient
registration Procedure Step has been completed by a PPS or PDS, the results of the registration
1055   operation maybe stored to the Object Storage. These results are subsequently referenced in the
Output Information Sequence of the corresponding Unified Procedure Step.

3.105.2   Use Case Roles
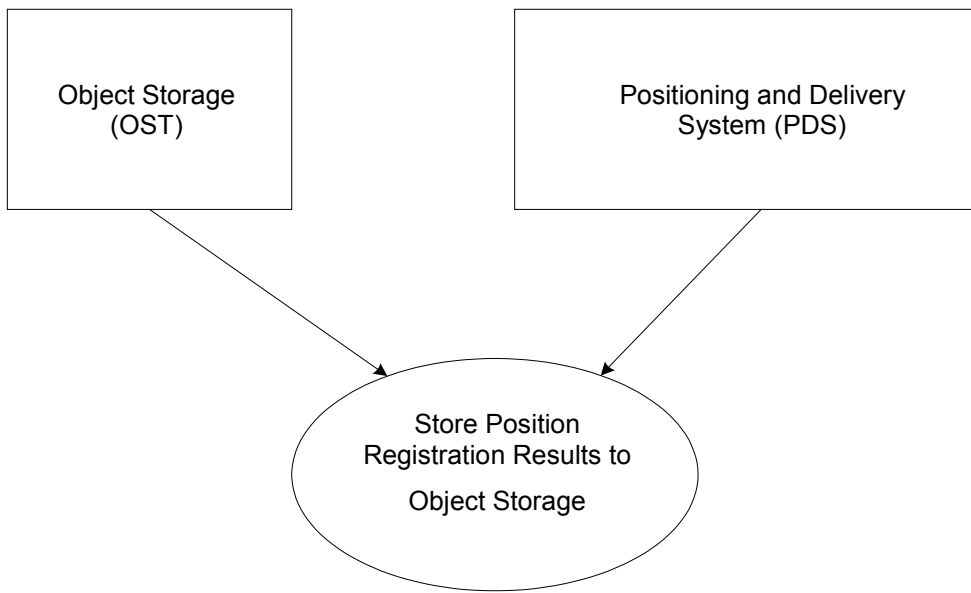
1060

Actor:	Object Storage (OST)
Role:	Responds to a C-STORE request and stores the transmitted objects.
Actor:	Positioning and Delivery System (PDS)
Role:	Stores the output of the positioning registration operation to the Object Storage.

3.105.3 Referenced Standards

DICOM 2011 PS 3.3: Information Object Definitions

DICOM 2011 PS 3.4: Storage Service Class

1065 **3.105.4 Interaction Diagram**
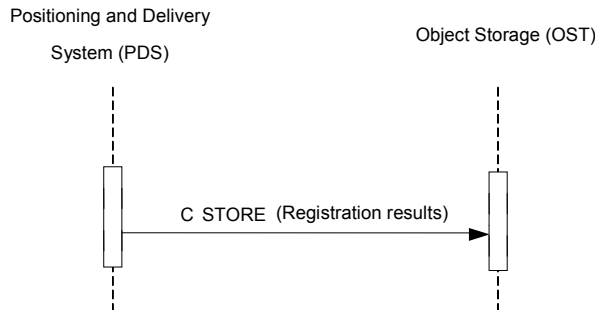
3.105.4.1 Store Objects

The C-STORE Service shall be supported. The DICOM Storage SOP Classes will be supported by the Object Storage as an SCP. Refer to DICOM 2011 PS 3.4, Annex C, for detailed
1070 descriptive semantics.

3.105.4.1.1 Trigger Events

The Performing Device has completed a patient position registration and wishes to store the generated results of the registration operation.

3.105.4.1.2 Message Semantics

1075 The message semantics are defined by the DICOM Storage SOP Classes.

A C-STORE Request shall be sent from the Performing Device to the Object Storage. A single object shall be stored, with one of the SOP Classes denoted in the Table 3.105.4.1.2-1 Permitted SOP Class Support for Performing Device (SCU):

1080 **Table 3.105.4.1.2-1 Permitted SOP Class Support for Performing Device (SCU)**

SOP Class Name	SOP Class UID
Spatial Registration Storage	1.2.840.10008.5.1.4.1.1.66.1
Deformable Spatial Registration Storage	1.2.840.10008.5.1.4.1.1.66.3

Other SOP Classes may be present for specific modalities, but are out of the scope of this profile.

A PDS may choose not to expose the results of the patient registration operation as storage of a registration object, since the following treatment delivery is also managed by the same device. For a PPS, the ultimate output of the device is a successful position adjustment, and output of the

1085 registration step result is not required either. Hence storage of the registration result (this transaction) is an optional step.

The specific attribute contents of the generated object are not specified in IHE-RO profiles. It is assumed that the object contents will be specific to the particular combination of Performing Device and Object Storage, and is not specified by IHE-RO.

1090 Any stored objects shall contain the Study Instance UID (0020,000D) supplied by the TMS in the UPS C-FIND response of Transaction Worklist Query for Positioning and Delivery (see Table 3.99.4.1.2.1-1 Worklist Query for Positioning and Delivery).

A participating Object Storage must support this transaction for at least the objects listed in Table 3.105.4.1.2-2 Required SOP Class Support for Object Storage (SCP).

1095

Table 3.105.4.1.2-2 Required SOP Class Support for Object Storage (SCP)

SOP Class Name	SOP Class UID
Spatial Registration Storage	1.2.840.10008.5.1.4.1.1.66.1
Deformable Spatial Registration Storage	1.2.840.10008.5.1.4.1.1.66.3

3.105.4.1.3 Expected Actions

The Object Storage receives the C-STORE request, establishes a DICOM association with the requesting actor, and uses the appropriate DICOM Storage SOP Class to receive the requested
1100 object and store it.

3.105.5 Security Considerations

Section not applicable.

3.106 Store Delivery Results to Object Storage – RO-24

1105 **3.106.1 Scope**

In the Store Delivery Results to Object Storage transaction, when a treatment delivery Procedure Step has been performed by a PDS or TDD, the results of the treatment delivery operation are stored to the Object Storage. These results may subsequently be referenced in the Output Information Sequence of the corresponding Unified Procedure Step.
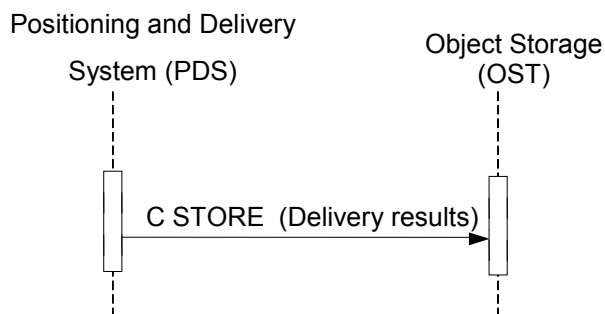
1110 **3.106.2 Use Case Roles**
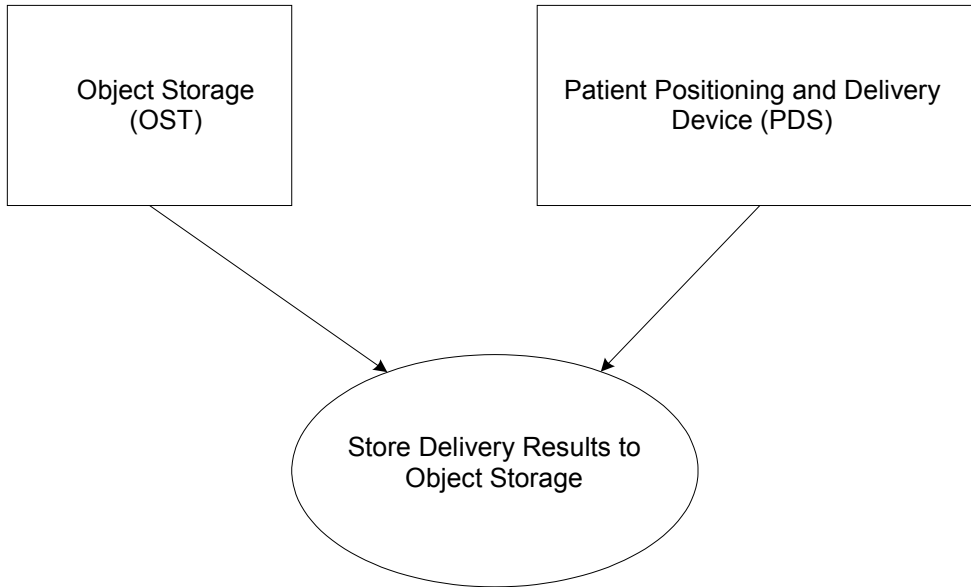
Actor:	Object Storage (OST)
Role:	Responds to a C-STORE request and stores the transmitted objects.
Actor:	Positioning and Delivery System (PDS)
Role:	Stores the output of the treatment delivery operation to the Object Storage.

1115 **3.106.3   Referenced Standards**

DICOM 2011 PS 3.4: Storage Service Class

3.106.4   Interaction Diagram

1120

1150 **3.106.4.1.3 Expected Actions**

The Object Storage receives the C-STORE request, establishes a DICOM association with the requesting actor, and uses the appropriate DICOM Storage SOP Class to receive the requested object and store it.

3.106.5 Security Considerations

1155 Section not applicable.

3.107 UPS Completed/Canceled – RO-25

3.107.1 Scope

In the UPS Completed/Canceled transaction, a PDS signals to the TMS that the selected
1160 Procedure Step has either been completed or canceled.

3.107.2 Use Case Roles
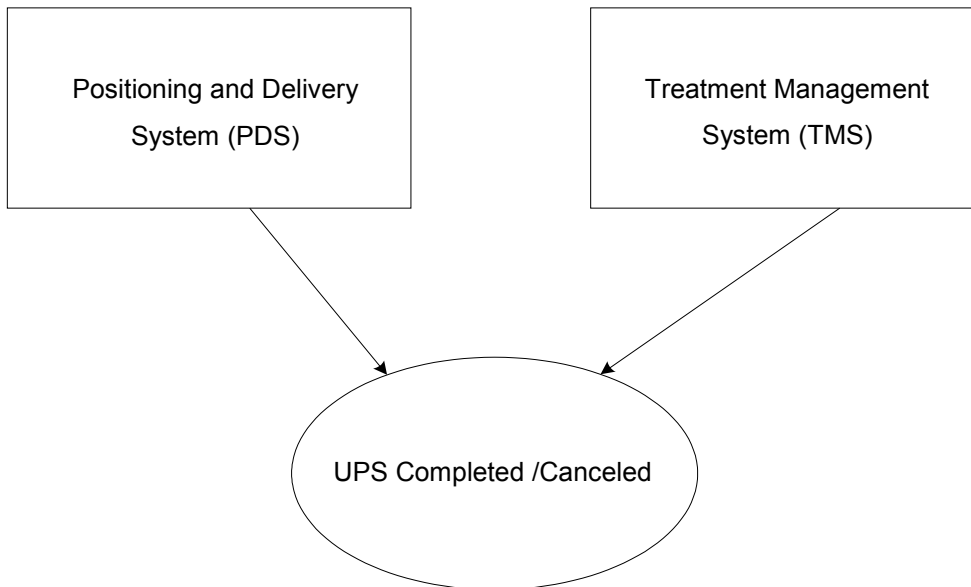
Actor:	Treatment Management System (TMS)
Role:	Responds to a UPS N-ACTION and sets the specified Unified Procedure Step as completed or canceled.
Actor:	Positioning and Delivery System (PDS)

Role:	Signals using UPS N-ACTION that the selected Procedure Step is completed or canceled.

1165

3.107.3   Referenced Standards

DICOM 2011 PS 3.4: Annex CC Unified Procedure Step Service and SOP Classes

3.107.4   Interaction Diagram

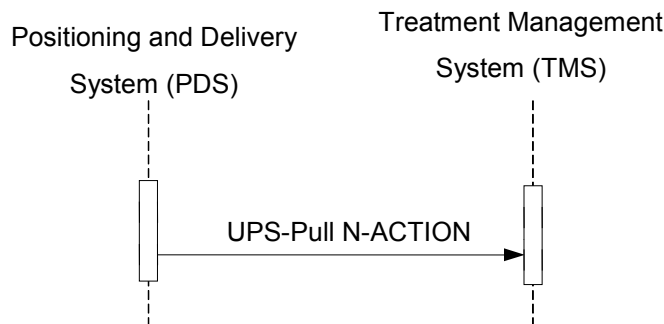1170   3.107.4.1   **UPS Completed/Canceled Message**

The Performing Device uses the UPS N-ACTION service to inform the TMS that the specified Unified Procedure Step has been completed or canceled. Note that the UPS-Pull SOP Class is negotiated as the abstract transfer syntax, but the UPS-Push SOP Class is used as the SOP Class of an UPS in all subsequent DIMSE messaging (see DICOM PS 3.4, Section CC.3.1).

1175   **3.107.4.1.1   Trigger Events**

The Performing Device has successfully completed the Procedure Step, or has not been able to complete the Procedure Step and has determined that processing should be stopped and the Treatment Management System notified.

3.107.4.1.2   Message Semantics

1180   The message semantics are defined in DICOM PS 3.4. The value of the Unified Procedure Step State (0074,1000) shall be 'COMPLETED' or 'CANCELED'.

3.107.4.1.3   Expected Actions

The TMS receives the N-ACTION request and sends an N-ACTION response. The Transaction UID (0008,1195) shall always be supplied.

1185   If the requested Procedure Step has been successfully completed (i.e., the received Unified Procedure Step State (0074,1000) has a value of 'COMPLETED'), the TMS shall send an N-ACTION response echoing a Unified Procedure Step State (0074,1000) of 'COMPLETED', a

Procedure Step Progress of 100%, and a status code of 0000H (success). The Treatment
Management System shall then be ready to receive new worklist queries.

1190 If the requested Procedure Step was not successfully completed (i.e., the received Unified
Procedure Step State (0074,1000) has a value of 'CANCELED'), the TMS shall send an N-
ACTION response echoing a Unified Procedure Step State (0074,1000) of 'CANCELED', a
Procedure Step Progress of between 0% and 100%, and a status code of 0000H (success). The
TMS shall then be ready to receive new worklist queries. The TMS is not required to signal the
1195 cancellation with an N-EVENT-REPORT in this transaction. Note that if the requested
Procedure Step was retrieved and locked, but never started (e.g., the user abandoned delivery, or
the Performing Device determined that the retrieved plan was not deliverable), then Procedure
Step Progress shall be set at 0%.

If the requested Procedure Step cannot be marked as completed or canceled because the Unified
1200 Procedure Step is not IN PROGRESS, or for any other reason, then an N-ACTION response
with a status code as described in DICOM PS 3.4, Section CC.2.1.4 shall be returned. In this
case, the PDS shall display a warning message to the user, that the final state could not be set at
the TMS.

DICOM PS 3.4, Section CC.2.5.1.1 outlines the final state requirements for the UPS N-ACTION
1205 command, i.e., the attributes which must be value before the procedure step is allowed to pass
into the COMPLETED or CANCELED state. The stated requirements for the UPS in Progress
and UPS Final Update transactions ensure that these conditions are met.

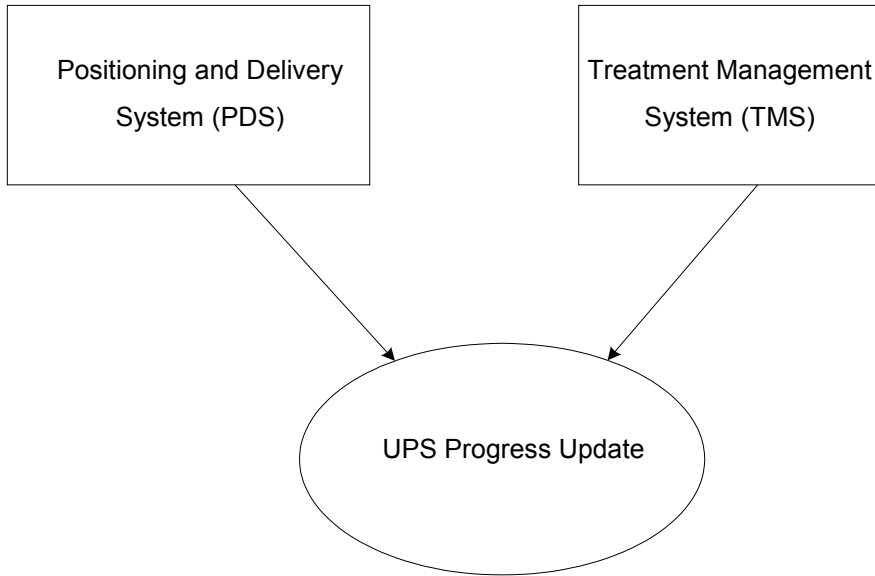### 3.107.5   Security Considerations

Section not applicable.

1210

3.108 UPS Progress Update for Treatment – RO-26

3.108.1   Scope

In the UPS Progress Update transaction, a PDS signals to the TMS any changes in the progress
of the Procedure Step that is currently in progress.

1215 ### 3.108.2   Use Case Roles

Actor:	Treatment Management System (TMS)
Role:	Responds to a UPS N-SET and updates attributes in the specified Unified Procedure Step.
Actor:	Positioning and Delivery System (PDS)
Role:	Signals using UPS N-SET that that progress related to the selected Procedure Step has changed.

1220   ### 3.108.3   Referenced Standards

DICOM 2011 PS 3.4: Annex CC Unified Procedure Step Service and SOP Classes

3.108.4   Interaction Diagram
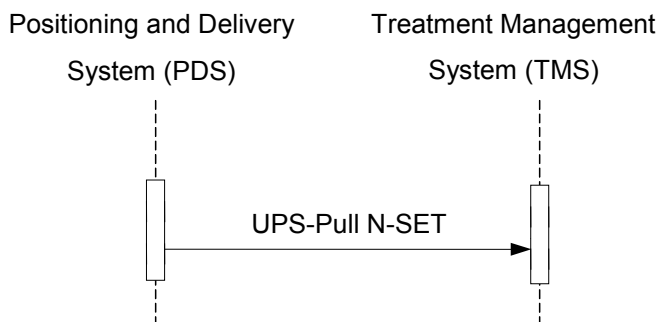
3.108.4.1   **UPS Progress Update Message**

1225   The Performing Device uses the UPS N-SET service to inform the TMS that progress relating to the specified Unified Procedure Step has changed. Note that the UPS-Pull SOP Class is negotiated as the abstract transfer syntax, but the UPS-Push SOP Class is used as the SOP Class of a UPS in all subsequent DIMSE messaging (see DICOM PS 3.4, Section CC.3.1).

3.108.4.1.1   Trigger Events

1230   The Performing Device is in the process of performing the Procedure Step, and wishes to notify the TMS of changes in the progress of the Procedure Step. Specifically, the Performing Device has fetched necessary input data, and notifies the TMS that work is about to start on treatment delivery, indicating such by setting the progress indicator from <NULL> value to value = 0 and indicating the Referenced Beam Number in Progress (see 3.108.4.1.2). This first envocation of
1235   this transaction shall occur prior to delivery of any dose.

During delivery, this transaction may be envoked several times, steadily increasing the value of the progress indicator to any value greater than 0 and less than 100.

The Performing Device has completed or abandoned the work, and indicates progress prior to storing output data (Store Position Acquisition Results to, Store Position Registration Results to,
1240   or Store Delivery Results to).

3.108.4.1.2   Message Semantics

The message semantics are defined in DICOM PS 3.4.

Minimum requirements for SCUs using the UPS N-SET command for this transaction are detailed in Table 3.108.4.1.2-1 UPS N-SET Attribute Requirements for UPS Progress Update
1245   Transaction. Note that at least one of the N-SET commands issued for a given UPS must contain the UPS Performed Procedure Sequence (0074,1216). The Final State requirements for the UPS may be met by this transaction in the case where the UPS is subsequently cancelled prior to radiation delivery, but if not they will ultimately be met by the UPS Final Update transaction (see Section 3.103).
1250

Table 3.108.4.1.2-1 UPS N-SET Attribute Requirements for UPS Progress Update Transaction

Attribute Name	Tag	Type	IHE-RO Additional Requirements on SCU
Transaction UID	(0008,1195)	(See DICOM Standard 2011, Annex CC, Section CC.2.6)	
Unified Procedure Step Progress Information Module			
UPS Progress Information Sequence	(0040,4003)	3	Required by IHE-RO in all instances of this transaction.
>Unified Procedure Step Progress	(0040,4010)	1	
>Unified Procedure Step Discontinuation Reason Code Sequence	(0074,100e)	3	Not required to be supplied for this profile.
Unified Procedure Step Performed Procedure Information Module			
UPS Performed Procedure Sequence	(0074,1216)	1C	Required by IHE-RO in at least one instance of this transaction if Code Value for Scheduled Workitem Code Sequence of UPS is '121726' (RT Treatment with Internal Verification)
>Performed Processing Parameters Sequence	(0074,1212)	3	Required by IHE-RO if UPS Performed Procedure Sequence is provided
>>Value Type	(0040,A040)	1	'TEXT'
>>Concept Name Code Sequence	(0040,A043)	1	
>>>Code Value	(0008,0100)	1	'121700'
>>>Coding Scheme Designator	(0008,0102)	1	'DCM'
>>>Code Meaning	(0008,0104)	1	'Referenced Beam Number in Progress'
>>Text Value	(0040,A160)	1	Integer string equal to the value of Referenced Beam Number (300C,0006)
>Output Information Sequence	(0040,4033)	2	Shall be empty
>Non-DICOM Output Information Sequence	(0040,4032)	2	Shall be empty

3.108.4.1.3   Expected Actions

1255 The TMS receives the N-SET request and sends an N-SET response. The Transaction UID
(0008,1195) shall always be supplied.

- If the requested Procedure Step has been successfully updated, the TMS shall send an N-SET
  response with a status code of 0000H (success). The Treatment Management System shall
  then be ready to receive further N-SET or N-ACTION commands.

1260 - If the requested Procedure Step was not successfully updated, the TMS shall send an N-SET
  response with a failure (non-zero) status code. The TMS shall then be ready to receive further
  N-SET or N-ACTION commands.

- If the requested Procedure Step cannot be updated because the Unified Procedure Step is not
  IN PROGRESS, or for any other reason, then an N-SET response with a status code as
1265 described in DICOM PS 3.4, Section CC.2.1.4 shall be returned. The TMS shall then remain
  in the state it was in before the N-SET was received.

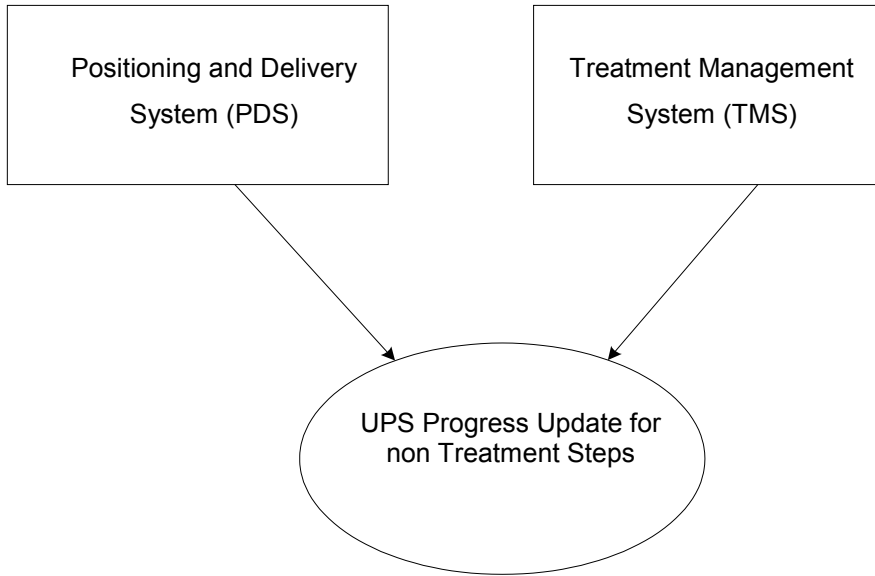### 3.108.5   Security Considerations

Section not applicable.

1270 ## 3.109 UPS Progress Update for non-Treatment Steps – RO-27

3.109.1   Scope

In the UPS Progress Update for non-Treatment Steps transaction, a PDS or TDD signals to the
TMS any changes in the progress of the Procedure Step that is currently in progress.

3.109.2   Use Case Roles

1275

Actor:	Treatment Management System (TMS)
Role:	Responds to a UPS N-SET and updates attributes in the specified Unified Procedure Step.
Actor:	Positioning and Delivery System (PDS)
Role:	Signals using UPS N-SET that that progress related to the selected Procedure Step has changed.

3.109.3   Referenced Standards

1280   DICOM 2011 PS 3.4: Annex CC Unified Procedure Step Service and SOP Classes

3.109.4   Interaction Diagram
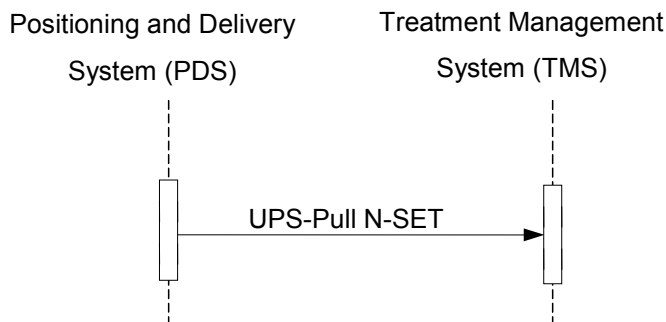
3.109.4.1   **UPS Progress Update Message**

The Performing Device uses the UPS N-SET service to inform the TMS that progress relating to the specified Unified Procedure Step has changed. Note that the UPS-Pull SOP Class is negotiated as the abstract transfer syntax, but the UPS-Push SOP Class is used as the SOP Class of an UPS in all subsequent DIMSE messaging (see DICOM PS 3.4, Section CC.3.1).

3.109.4.1.1   Trigger Events

The Performing Device is in the process of performing the Procedure Step, and wishes to notify the TMS of changes in the progress of the Procedure Step. Specifically, the Performing Device has fetched necessary input data, and notifies the TMS that work is about to start on treatment delivery, indicating such by setting the progress indicator from <NULL> value to value = 0. This first envocation of this transaction shall occur prior to any action requested by the UPS in question.

During performing the action requested by the UPS this transaction may be envoked several times, steadily increasing the value of the progress indicator to any value greater than 0 and less than 100.

The Performing Device has completed or abandoned the work, and indicates progress prior to storing output data (Store Position Acquisition Results to, Store Position Registration Results to, or Store Delivery Results to).

3.109.4.1.2   Message Semantics

The message semantics are defined in DICOM PS 3.4.

Minimum requirements for SCUs using the UPS N-SET command for this transaction are detailed in Table 3.108.4.1.2-1 UPS N-SET Attribute Requirements for UPS Progress Update Transaction. Note that at least one of the N-SET commands issued for a given UPS must contain the UPS Performed Procedure Sequence (0074,1216). The Final State requirements for the UPS may be met by this transaction in the case where the UPS is subsequently cancelled prior to radiation delivery, but if not they will ultimately be met by the UPS Final Update transaction (see Section 3.103).

3.109.4.1.3   Expected Actions

The TMS receives the N-SET request and sends an N-SET response. The Transaction UID (0008,1195) shall always be supplied.

- If the requested Procedure Step has been successfully updated, the TMS shall send an N-SET response with a status code of 0000H (success). The Treatment Management System shall then be ready to receive further N-SET or N-ACTION commands.
- If the requested Procedure Step was not successfully updated, the TMS shall send an N-SET response with a failure (non-zero) status code. The TMS shall then be ready to receive further N-SET or N-ACTION commands.

1320 • If the requested Procedure Step cannot be updated because the Unified Procedure Step is not IN PROGRESS, or for any other reason, then an N-SET response with a status code as described in DICOM PS 3.4, Section CC.2.1.4 shall be returned. The TMS shall then remain in the state it was in before the N-SET was received.

3.109.5 Security Considerations

1325 Section not applicable.

A: Consistency Checks

At a minimum, the consistency checks specified in this appendix shall be performed. Additionally a check based on a specific devcies hazard analysis maybe done during a connectathon. The actual response of the device must correspond to the response specified in the hazard analysis.

Where Patient Name components are mentioned, they must agree in First Name and Last Name only (in default character set). Comparison may be case-insensitive.

In the UPS contained in the C-Find response it is expected that there will be consistency between TMS response and PDS local data in the following elements, but no safety check is required at this point, since no commitment to treat exists:

a. Patient Name

b. Patient ID

c. Patient DOB

d. Patient Sex

e. SOP Instance UID of RT Plan

In the RT Plan instance retrieved from the TMS it is expected that there will be consistency with PDS local data in the following elements:

a. Patient Name

b. Patient ID

c. Patient DOB

d. Patient Sex

e. SOP Instance UID of RT Plan

f. Number of Beams

g. Beam Number for each beam to be treated

h. Beam Meterset for each beam in the Referenced Beam Sequence of the Fraction Group Sequence

i. Referenced Beam Number in the Referenced Beam Sequence of the Fraction Group Sequence

In the RT Beams Delivery Instruction instance retrieved from the TMS it is expected that there will be consistency with PDS local data in the following elements:

a. Patient Name

b. Patient ID

c. Patient DOB

d. Patient Sex

e. SOP Instance UID of RT Plan

f. Referenced Beam Number in the Beam Task Sequence

g. Continuation Start Meterset (if present) for each beam

h. Continuation End Meterset (if present) for each beam

1365   All comparisons of Meterset values in RT Plan and RT Beams Delivery Instruction instances retrieved from the TMS must agree with corresponding PDS local data within clinically meaningful precision (as defined by the PDS).

Meterset values in RT Plan and RT Beams Delivery Instruction instances retrieved from the TMS must satisfy

1370   a. Continuation Start Meterset >= 0

b. Continuation Start Meterset <= Beam Meterset

c. Continuation End Meterset <= Beam Meterset

d. Continuation End Meterset >= Continuation Start Meterset

Inconsistency in Fraction Number is handled at the discretion of the PDS.

1375   In case of inconsistency between RT Plan and RT Beams Delivery Instruction instances retrieved from the TMS and local data, the PDS must either (1) refuse treatment or (2) require user to override in a recorded and auditable manner.

a. Override of Meterset may be recorded in RT Beam Treatment Record, but it is not mandated.

b. Reason for cancellation may be reported in N-Set in UPS Discontinuation Reason Code
1380   Sequence.

The PDS will ensure that the RT Beams Treatment Record instance returned to the TMS is consistent with the RT Plan instance retrieved from the TMS:

a. Patient Name

b. Patient ID

1385   c. Patient DOB

d. Patient Sex

e. SOP Instance UID of RT Plan in Referenced RT Plan Sequence

f. Referenced Beam Number

In case of inconsistency in the elements listed below between the RT Plan instance retrieved
1390   from the TMS and the RT Beams Treatment Record instance returned by the PDS, the TMS will require audited review of the mis-identified record(s):

a. Patient Name

b. Patient ID

c. Patient DOB

1395   d. Patient Sex

e. SOP Instance UID of RT Plan in Referenced RT Plan Sequence

f. Referenced Beam Number

Volume 3 – Content Modules

1400   Volume 3 not applicable.

Volume 4 – National Extensions

Add appropriate Country section

1405 **4.I National Extensions**

Section not applicable.