Integrating the Healthcare Enterprise

IHE Radiation Oncology
Technical Framework Supplement

Treatment Delivery Workflow-II
(TDW-II)

Rev. 1.1 – Trial Implementation

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Foreword

This is a supplement to the IHE Radiation Oncology Technical Framework V2.0. Each supplement undergoes a process of public comment and trial implementation before being incorporated into the volumes of the Technical Frameworks.

This supplement is published on February 5, 2021 for trial implementation and may be available for testing at subsequent IHE Connectathons. The supplement may be amended based on the results of testing. Following successful testing it will be incorporated into the Radiation Oncology Technical Framework. Comments are invited and can be submitted at http://www.ihe.net/Radiation_Oncology_Public_Comments.

This supplement describes changes to the existing technical framework documents.

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

Amend Section X.X by the following:

Where the amendment adds text, make the added text **bold underline**. Where the amendment removes text, make the removed text ~~**bold strikethrough**~~. When entire new sections are added, introduce with editor's instructions to "add new text" or similar, which for readability are not bolded or underlined.

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Introduction to this Supplement

This supplement defines the Treatment Delivery Workflow-II (TDW-II) Profile. It adds information to Volumes 1, 2 and 3 of the IHE Radiation Oncology Technical Framework to describe the profile and define the actors and transactions that are present in the profile. The TDW-II Profile is an updated version of the 2010 TDW Profile. This profile uses the final text version of the DICOM Unified Worklist and Procedure Step Service, while TDW used the trial implementation version of DICOM Supplements 74 (RT delivery instructions) and Supplement 96 (Unified Procedure Step). The final text is part of the DICOM Standard since 2011.

In this profile, a single system, a Treatment Delivery Device (TDD), acquires delivery information from a Treatment Management System (TMS) and the Object Storage (OST) and performs a treatment delivery using internal verification (see DICOM Standard 2011 P3.3, A.64). Other optional activities, such as verification image acquisition, registration and patient positioning may be performed by this TDD, but are not explicitly scheduled in this profile.

Open Issues and Questions

None

Closed Issues

#	Intro-duced in	Responsible	Description
1		Ulrich Busch (ulrich.busch@varian.com)	Update of diagram to use new Transaction identifiers. Done in Revision 5.0
2		Ulrich Busch (ulrich.busch@varian.com)	Check references to Section F.X and update them (some reminders are there). Done in Revision 4.0
3		Ulrich Busch (ulrich.busch@varian.com)	Check all table references. Done in Revision 4.0.
4		Ulrich Busch (ulrich.busch@varian.com)	Replace concept code for Scheduled Parameter Sequence by standardized code as requested by an appropriate change proposal of WG-07. Done in Revision 4.0
5		Ulrich Busch (ulrich.busch@varian.com)	Replace Performing Device with TDD. Done in Revision 4.0
6		Ulrich Busch (ulrich.busch@varian.com)	Renumber against new numbering (provided by Bruce). Done in Revision 4.0
7		Ulrich Busch (ulrich.busch@varian.com)	Independent verification that this TDW-II supplement is in adherence with Final versions of Supp 96 & 74/2011 DICOM Standard; identify differences between TDW and TDW-II

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#	Intro-duced in	Responsible	Description
8		Ulrich Busch (ulrich.busch@varian.com)	(Done prior to Revision 4.0) From Uli, BBS:Action item from TC Meeting May 2011: ACTION: (Uli) Post the differences of Supp 96 and 74 between versions used in TDW and FT version. Those changes are as follows: Changes between the frozen draft version of Supplement 96 (fx2) and the second letter ballot version (lb2) were reviewed line-by-line by WG-07. The most important of these changes has been collected by Dave as follows: • The SCU now assigns the Locking UID (formerly Transaction UID), not the SCP, primarily to avoid a small race condition. • The Input Information Sequence has been restructured to specify instance locations fully (see Table 10-3b). • A previous procedure that was replaced (e.g., 'completed' by the current one) can now be encoded (see Table C.X.4-1). • The Beam Number parameter formerly encoded as a Code Sequence must now be encoded in the Procedure Step Progress Description attribute (the code sequence has been deleted). WG-07 discussed this and considered that this information is not important enough in our context to warrant inclusion of a code sequence in the progress module to encode this. • Final state requirements have changed, including addition of a new final state type ('P'). • The Study UID for output instances must be supplied by the SCP, but may be ignored by the SCU (the opposite of the situation in the Frozen Draft). • 'Input Readiness State' has been added, and is required. • Cancelation date/time has been added, and is required. • Date and Time attribute pairs have been changed to single DT attributes. • Some text attributes have been changed to CS.
9		Ulrich Busch (ulrich.busch@varian.com)	TC Meeting January 2013: We deliberately included TDW-RO-XX5 (new: RO-62) to annotate the start of radiation with a progress indication greater than 0. This should ensure, that the Worklist is exploited to ensure indication that the radiation starts. The question is whether we want to keep that concept or make XX5 optional / respectively remove it completed. TC Meeting May 2013: Decision: We want to have at least one progress update > 0 as soon as the TDD has information about that Radiation has started. Done in 5.1 – esp. review changes in [RO-62] TC Meeting October 2013: Reconfirmed.

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#	Intro-duced in	Responsible	Description
10		Ulrich Busch (ulrich.busch@varian.com)	TC Meeting January 2013: What do the requirements on character set in the Match/Return key table mean? Should we make a more general statement about character sets support for the whole profile? Done in 5.1 – added Appendix A. Not sure though yet, if that is the correct place, since in TF it would apply to all transactions, unless otherwise stated. Did not find a good approach in other profiles yet on that issue.
11		Ulrich Busch (ulrich.busch@varian.com)	TC Meeting January 2013: Clarify Storage Actor (TMS or OST). Should be updated along IPDW – just with less optionality, since we only store on SOP Class. Done in 5.1 – esp. review text in 9.1.1.3 Object Storage (OST)
12	5.0	Ulrich Busch (ulrich.busch@varian.com)	TC Meeting May 2013: Clarify, what headers shall be used on Tx Records, when the TDD has a local storage and has inconsistencies with the received data in those header data. Also define in detail which attributes are included in that header definition. Done in 5.1: Added definition to Section 3.63.4.1.2 Message Semantics.
13	6.0	Ulrich Busch (ulrich.busch@varian.com)	3.58.4.1.2.1 Matching Keys and Return Keys for Display: '-' means, that there are no additional requirements. ! This maybe mis-read by some readers. Of course it's required to provide them as empty keys to get the return values. Add an appropriate note.
14	9	Ulrich Busch	For a continuation fraction there is currently no facility in the BDI to declare, that some Beams have been completely treated in a prior fraction. Those beams are just not present. However, it is highly indicated to be able to tell the user, why a beam should not be treated in the current session. Therefore, WG-07 should investigate, whether it is possible to extend the Treatment Delivery Type (300A,00CE) by values of TREATED (and eventually SKIPPED). Include DICOM cp1438 Omitted Beams Sequence In BDI. 2015-09-30 U. Busch: Done in Version 11.
15	10	Chris Pauer	Check Section 9.5 TDW-II Security Considerations if it is still a relevant and effective wording. Eventually it can be improved or straightened. Also check, whether the provision in 3.63.4.1.2 Message Semantics about the following is still needed: In such cases, it is allowed to populate the static objects containing the Treatment Delivery Results with the header data of the locally stored objects, instead of the ones retrieved from the OST. 2015-09-30 U. Busch: Kept it since the conditions where TDW-II is applied did not change in that respect.
17	13	Thomas Schwere	How to communicate medical alerts from TMS to TDD? A container should be provided for passing some free text notes to TDD. Such alerts should go on session level. Proposal is to go with Requested Procedure Comments (0040,1400). TC Meeting Jan 2018: This is not in scope of this profile.

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#	Intro-duced in	Responsible	Description
18	13	Thomas Schwere	Specify behavior for cases where the C-FIND RSP contains UPS other than treatment delivery. 2018-07-25 T. Schwere: Added note in Section 3.58.4.2.3 (version 13).
16	11	Ulrich Busch	Just for confirmation: During the Review, inclusion of the Omitted Beam Task Sequence (300C,0111) in Section 7.4.2.1.1RT Beams Delivery Instruction Base should be reviewed and confirmed. In general, the inclusion was already decided by the TC – see Issue 14. However, the DICOM CP 1438 was not finished at this time, and it was not explicitly decided upon whether it should be mandatory. TC Meeting Aug 2018: Omitted Beam Task Sequence is required (i.e., Type 3 sequence turns into an empty sequence in case no beam is to be omitted).
19	13	Thomas Schwere	From Issue #8: The Beam Number parameter formerly encoded as a Code Sequence must now be encoded in the Procedure Step Progress Description attribute (the code sequence has been deleted). WG-07 discussed this and considered that this information is not important enough in our context to warrant inclusion of a code sequence in the progress module to encode this. The current version of the profile mentions that the beam number should be indicated in the progress update (see Section 3.62.4.1.1). However, the exact specification is currently missing. Question: What was the rationale for introducing this? Is this still needed? TC Meeting Aug 2018: Yes, there is value in providing this to the TMS. As part of ongoing activities in DPDW, the Procedure Step Progress Parameters Sequence (0074,1007) was added to the Unified Procedure Step Progress Information Module in the DICOM Standard. This allows to add any coded procedure-specific progress information and perfectly serves the purpose of specifying the beam in progress. Added appropriate specification in Section 7.5.1.2.1.

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The IHE Technical Framework General Introduction is shared by all of the IHE domain technical frameworks. Each technical framework volume contains links to this document where appropriate.

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Update the following appendices to the General Introduction as indicated below. Note that these are not appendices to this domain's Technical Framework (TF-1, TF-2, TF-3 or TF-4) but rather, they are appendices to the IHE Technical Frameworks General Introduction located here.

Appendix A – Actor Summary Definitions

*Add the following **new or modified** actors to the IHE Technical Frameworks General Introduction Appendix A:*

New (or modified) Actor Name	Description
Treatment Delivery Device	A system that delivers therapeutic radiation to a correctly positioned patient. It can receive and transmit the transactions as documented in this profile.
Treatment Management System	Manages oncology information and is responsible for the scheduling of radiotherapy activities. Consumes beams for use in treatment delivery and manages the treatment in the Radiation Oncology workflow.

Appendix B – Transaction Summary Definitions

*Add the following **new or modified** transactions to the IHE Technical Frameworks General Introduction Appendix B:*

New (or modified) Transaction Name and Number	Definition
Worklist Query for Treatment Delivery [RO-58]	A TDD requests and receives a treatment delivery worklist from a TMS.

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New (or modified) Transaction Name and Number	Definition
Retrieve Static Treatment Delivery Input Instances from OST [RO-59]	A TDD requests and receives from the OST any 'static' SOP Class Instances required in order to perform the desired procedure steps returned by a previous query. Each requested SOP Instance must have been supplied in the Input Information Sequence of one the returned worklist items. These instances are of a persistent nature, specifically the RT Plan input instance.
Treatment Delivery in Progress [RO-60]	A TDD signals to the TMS that responsibility has been taken to perform the selected procedure step by changing its status to IN PROGRESS.
Retrieve Dynamic Treatment Delivery Input Instances from TMS [RO-61]	A TDD requests and receives SOP Class Instances from the TMS to support the execution of the selected procedure step. These requested instances are of a "transient" nature, specifically the RT Beams Delivery Instruction. Note that this transaction shall be present either before or after [RO-60], but not both.
Treatment Delivery Progress Update [RO-62]	A TDD signals to the TMS changes in the progress of the procedure step that is currently in progress. This transaction may occur more than once in this profile, as the delivery status changes.
Store Treatment Delivery Results to OST [RO-63]	When a procedure step has been completed by a TDD, the results of the procedure step are stored to the OST. These results are referenced in the Output Information Sequence of the corresponding Unified Procedure Step.
Treatment Delivery Final Update [RO-64]	A TDD signals to the TMS final changes in the properties of the procedure step that is currently in progress just prior to the UPS being signaled as completed or canceled.
Treatment Delivery Completed/Canceled [RO-65]	A TDD signals to the TMS that the selected procedure step has either been completed or canceled.

Appendix D – Glossary

*Add the following **new or modified glossary** terms to the IHE Technical Frameworks General Introduction Appendix D.*

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New or modified Glossary Term	Definition	Synonyms (if applicable)	Acronym/Abbreviation
Treatment Delivery Device	Device that performs actions promoting patient health or leading to patient cure.		TDD
Treatment Management System	Manages oncology information and is responsible for the scheduling of radiotherapy activities. Consumes beams for use in treatment delivery, and manages the treatment in the Radiation Oncology workflow.		TMS

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New or modified Glossary Term	Definition	Synonyms (if applicable)	Acronym/Abbreviation
Object Storage	System that can receive, retain and serve up DICOM data		OST
Unified Procedure Step	DICOM object that describes the details of a procedure step that has been scheduled, the progress details during performance, and the details of the procedure step actually performed in response.		UPS

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Volume 1 – Profiles

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Add the following to the IHE Technical Frameworks General Introduction Copyright section:

2014 DICOM Standard PS 3.3, 3.4, 3.7

Domain-specific additions

NA

Add Section 9

9 Treatment Delivery Workflow-II (TDW-II) Profile

The Treatment Delivery Workflow-II Integration Profile describes the necessary workflow between a Treatment Management System (TMS) and Treatment Delivery Device (TDD) for treatment delivery. This profile grew out of the Technical Committee's work on the Integrated Positioning and Delivery Workflow (IPDW) Integration Profile, which was found to specify too many required elements for some Treatment Delivery Devices. A number of commercially available delivery machines either do not handle positioning interactions at all or they are not externalized in significant or easily modifiable ways. This profile describes the workflow between the TMS and TDD and when the TDD is largely only concerned with delivery scheduling.

This profile is a workflow profile.

9.1 TDW-II Actors, Transactions, and Content Modules

This section defines the actors, transactions, and/or content modules in this profile. General definitions of actors are given in the Technical Frameworks General Introduction Appendix A at https://www.ihe.net/resources/technical_frameworks.

Figure 9.1-1 shows the actors directly involved in the TDW-II Profile and the relevant transactions between them. If needed for context, other actors that may be indirectly involved due to their participation in other related profiles are shown in dotted lines. Actors which have a mandatory grouping are shown in conjoined boxes.

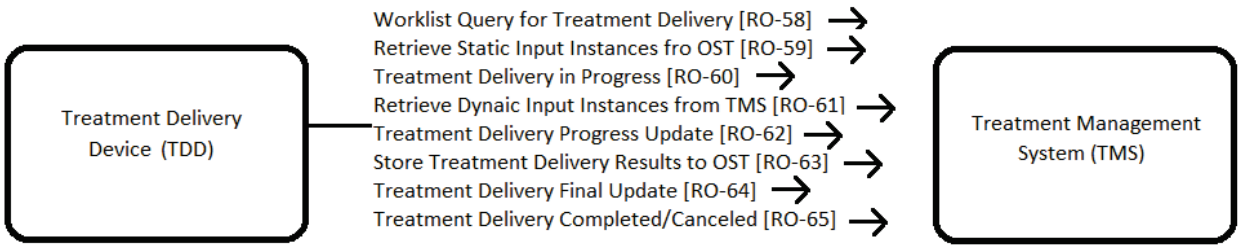

Figure 9.1-1: TDW-II Actor Diagram

Table 9.1-1 lists the transactions for each actor directly involved in the TDW-II Profile. To claim compliance with this profile, an actor shall support all required transactions (labeled "R") and may support the optional transactions (labeled "O").

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Table 9.1-1: TDW-II Profile - Actors and Transactions

Actors	Transactions	Optionality	Reference
Treatment Management System	Worklist Query for Treatment Delivery [RO-58]	R	RO TF-2: 3.58
	Treatment Delivery in Progress [RO-60]	R	RO TF-2: 3.60
	Retrieve Dynamic Treatment Delivery Input Instances from TMS [RO-61]	R	RO TF-2: 3.61
	Treatment Delivery Progress Update [RO-62]	R	RO TF-2: 3.62
	Treatment Delivery Final Update [RO-64]	R	RO TF-2: 3.64
	Treatment Delivery Completed/Canceled [RO-65]	R	RO TF-2: 3.65
Treatment Delivery Device	Worklist Query for Treatment Delivery [RO-58]	R	RO TF-2: 3.58
	Retrieve Static Treatment Delivery Input Instances from OST [RO-59]	R	RO TF-2: 3.59
	Treatment Delivery in Progress [RO-60]	R	RO TF-2: 3.60
	Retrieve Dynamic Treatment Delivery Input Instances from TMS [RO-61]	R	RO TF-2: 3.61
	Treatment Delivery Progress Update [RO-62]	R	RO TF-2: 3.62
	Store Treatment Delivery Results to OST [RO-63]	R	RO TF-2: 3.63
	Treatment Delivery Final Update [RO-64]	R	RO TF-2: 3.64
	Treatment Delivery Completed/Canceled [RO-65]	R	RO TF-2: 3.65
Object Storage	Retrieve Static Treatment Delivery Input Instances from OST [RO-59]	R	RO TF-2: 3.59
	Store Treatment Delivery Results to OST [RO-63]	R	RO TF-2: 3.63

9.1.1 Actor Descriptions and Actor Profile Requirements

Most requirements are documented in Transactions (Volume 2) and Content Modules (Volume 3). This section documents any additional requirements on profile's actors.

9.1.1.1 Treatment Delivery Device (TDD)

A system that delivers therapeutic radiation to a correctly positioned patient. It may perform other functions such as verification image acquisition, registration, and positioning, but is not required to do so. The TDD fulfills the role of a UPS-Pull 'Pull Performer' SCU as described in

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DICOM Standard Part 17 Table GGG.1-1. Note that the TDD actors in other IHE-RO profiles have functionality that is different from that described in this profile.

9.1.1.2 Treatment Management System (TMS)

An information system that manages oncology information and is responsible for the scheduling of radiotherapy activities (i.e., is a workflow manager). The TMS fulfills the role of a UPS-Pull 'Worklist Manager' SCP as described in DICOM Standard 2011 Part 17 Table GGG.1-1. Note that in this profile the system that fulfills the role of the TMS may also fulfill the role of an OST. Note that the TMS actors in other IHE-RO profiles have functionality that is different from that described in this profile.

9.1.1.3 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. 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.

The location, from which the RT Plan/ RT Ion Plan SOP instances and Treatment Record SOP instances shall be retrieved from, is defined by and at the discretion of each vendor's TMS implementation.

The storage, where Treatment Record SOP instances are to be stored, is also defined by and at the discretion of each vendor's TMS implementation.

9.2 TDW-II Actor Options

Options that may be selected for each actor in this profile, if any, are listed in the Table 9.2-1. Dependencies between options when applicable are specified in notes.

Table 9.2-1: Treatment Delivery Workflow - II - Actors and Options

Actor	Option Name	Reference
Treatment Delivery Device	Support of Multiple Targets	RO TF-2: 3.59
Treatment Management System	Support of Multiple Targets	RO TF-2: 3.59
Treatment Management System	Retain Original Treatment Records	RO TF-2: 3.58
Object Storage	Retain Original Treatment Records	RO TF-2: 3.63

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9.3 TDW-II Required Actor Groupings

Not applicable.

9.4 TDW-II Overview

9.4.1 Concepts

The Treatment Delivery Workflow II Integration Profile covers the delivery of a treatment session scheduled in a treatment management system and carried out by a treatment delivery device.

Driven by a worklist on the Treatment Management System (TMS), the Treatment Delivery Device (TDD) delivers the intended treatment. The TDD may optionally perform other unscheduled activities such as verification image acquisition, registration and positioning, but is not required to do so within the scope of this profile.

9.4.2 Use Case #1: Treatment Delivery Workflow

9.4.2.1 Treatment Delivery Workflow Use Case Description

The Treatment Delivery Workflow II Integration Profile describes the necessary workflow between a Treatment Management System (TMS) and Treatment Delivery Device (TDD) for treatment delivery. This profile addresses the use cases for TDDs, which handle imaging and positioning completely internally.

9.4.2.2 Treatment Delivery Workflow Process Flow

The process flow for the Treatment Delivery Workflow-II Integration Profile is shown in Figure 9.4.2.2-1.

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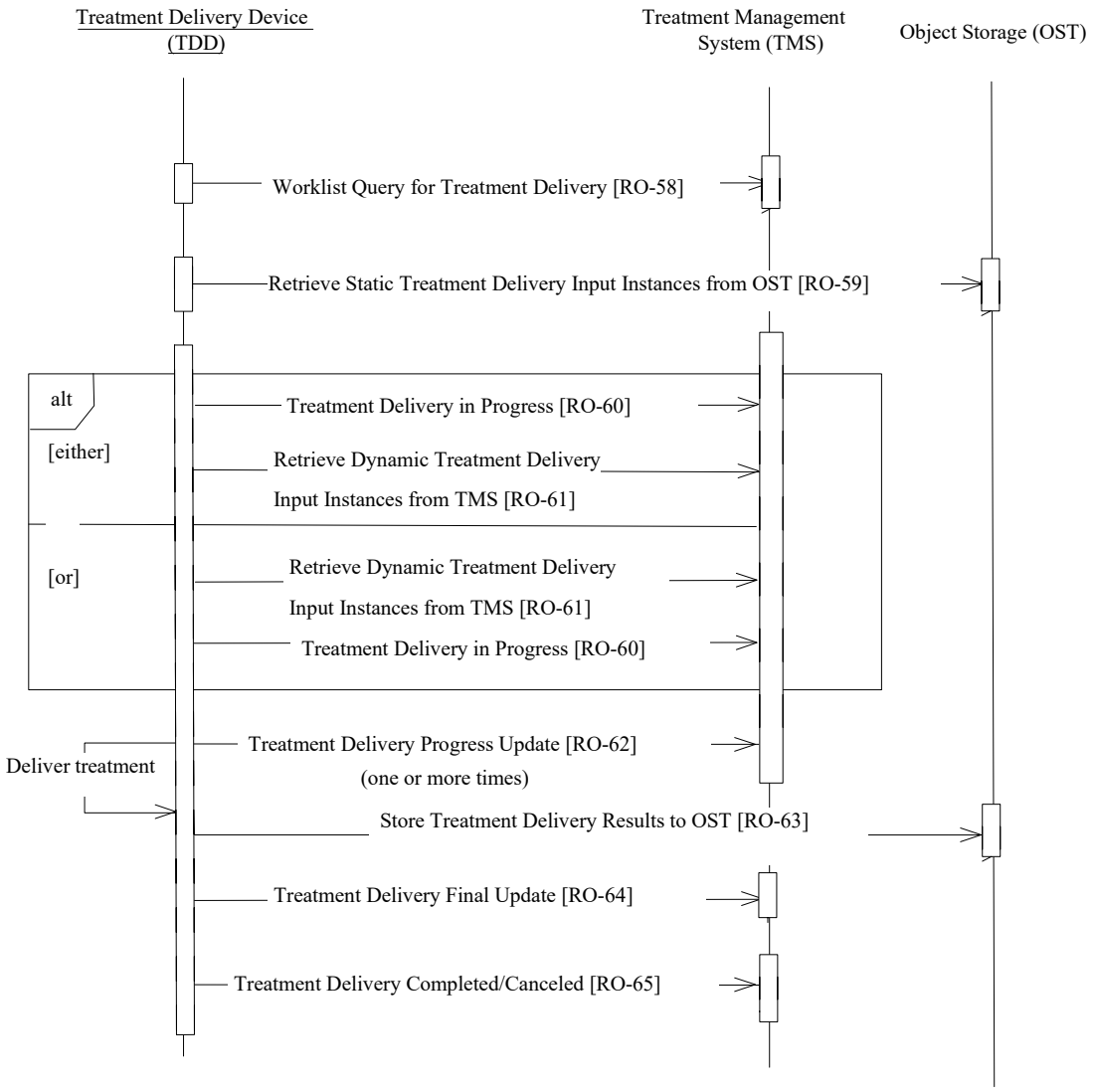

Figure 9.4.2.2-1: Basic Process Flow in TDW-II Profile

In Figure 9.4.2.2-1 above, transactions [RO-60] and [RO-61] may be performed in either order, as decided by the Treatment Delivery Device (TDD). One or the other (but not both) of these options must be taken.

Pre-conditions:

The Treatment Delivery Workflow-II Integration Profile requires that the TMS has previously received all information required (generated externally or internally) to effectively respond to queries issued by the TDD. In particular, the TMS must know the SOP Instance UID of the specific RT Plan/RT Ion Plan to be delivered by the TDD. The OST is required to be in possession of the plan and the records in order to be able to fulfill its role as the repository of

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plans for the TMS. The TMS uses this repository to allow the user to select and schedule the plans to be treated. The TDD shall retrieve that plan from the OST to ensure that the plan treated is consistent with the plan having been scheduled in the TMS. The acquisition of such information by the OST is out of band for this profile.

Main Flow:

The user at the TDD invokes a Worklist Query to request that the TMS sends a scheduled treatment delivery worklist. The TDD gets a list of Patients to be treated, which may have zero or more entries. If the patient to be treated is found, the user selects the patient to be treated.

The TDD delivers the treatment.

Once the treatment delivery is finished (completely or partially), the TDD reports the results of the treatment delivery session to the TMS.

Treatment Cancellation Prior to Radiation:

Cancellation of a treatment delivery during radiation is fully described by Figure 9.4.2.1-1, taking into account the different final state requirements of [RO-64] and the CANCELED status in [RO-65]. However, when a cancellation occurs prior to radiation delivery, the process flow in this case is shown in Figure 9.4.2.1-1. Note from the Figure 9.4.2.2-1 that:

- Any Treatment Delivery Progress Updates [RO-62], if present, issued prior to cancellation will have a reported Procedure Step Progress (0074,1004) of 0% in this scenario.
- The Treatment Delivery Final Update [RO-64] transaction will not be required to be performed if the Final State conditions (described in Table 3.65.2-2in [RO-65]) have already been met by previous [RO-62] transaction(s).

Treatment Completion:

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 patient position issue caused temporary interruption of the delivery), then the TDD may choose to manage the completion internally and notify the TMS that the UPS 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 (e.g., if the completion requires re-planning or needs to be performed in a different time slot). The TMS shall then manage the new UPS, specify a Text Value of ‘CONTINUATION’ in the Scheduled Processing Parameters Sequence when returning a query result, and supply the Start Meterset of the continuation treatment in the Delivery Instruction.

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Post-conditions:

After completion of the treatment delivery, the Treatment Delivery Result objects are stored in the OST and the UPS is updated with the state COMPLETED.

9.5 TDW-II Security Considerations

At a minimum, the consistency checks specified in this appendix shall be performed. Vendors are expected to handle inconsistencies according to their hazard analysis. The relevant hazard analysis information shall be made available upon request to guide testing. This information should be made available to IHE-RO Connectathon Test Manager to facilitate testing of the hazards.

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 TDD local data in the following elements, but no safety check is required at this point, since no commitment to treat exists:

- Patient Name
- Patient ID
- Patient DOB
- Patient Sex
- SOP Instance UID of RT Plan/RT Ion Plan

In the RT Plan instance retrieved from the OST it is expected that there will be consistency with TDD 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/RT Ion 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

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In the RT Beams Delivery Instruction instance retrieved from the TMS it is expected that there will be consistency with TDD 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/RT Ion 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

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

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

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 TDD.

In case of inconsistency between RT Plan/RT Ion Plan and RT Beams Delivery Instruction instances retrieved from the TMS and local data, the TDD 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 Sequence.

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

a. Patient Name
b. Patient ID
c. Patient DOB

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d. Patient Sex

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

f. Referenced Beam Number

In case of inconsistency in the elements listed below between the RT Plan/RT Ion Plan instance retrieved from the OST and the RT Beams Treatment Record/RT Ion Beams Treatment Record instance returned by the TDD, the TMS will require audited review of the misidentified record(s):

a. Patient Name

b. Patient ID

c. Patient DOB

d. Patient Sex

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

f. Referenced Beam Number

9.6 TDW-II Cross Profile Considerations

The profile supports scheduling of treatments and resumptions only, and does not cover transactions within the workflow for other procedures executed during a treatment session like image acquisition, matching and positioning. Those other use cases are handled by the Integrated Positioning and Delivery Workflow (IPDW) Integration Profile.

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Volume 1 Appendices

None

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Volume 2 – Transactions

Add Section 3.58

3.58 Worklist Query for Treatment Delivery [RO-58]

3.58.1 Scope

In the Worklist Query for Treatment Delivery transaction, a TDD requests and receives a treatment delivery worklist from a TMS.

3.58.2 Actor Roles

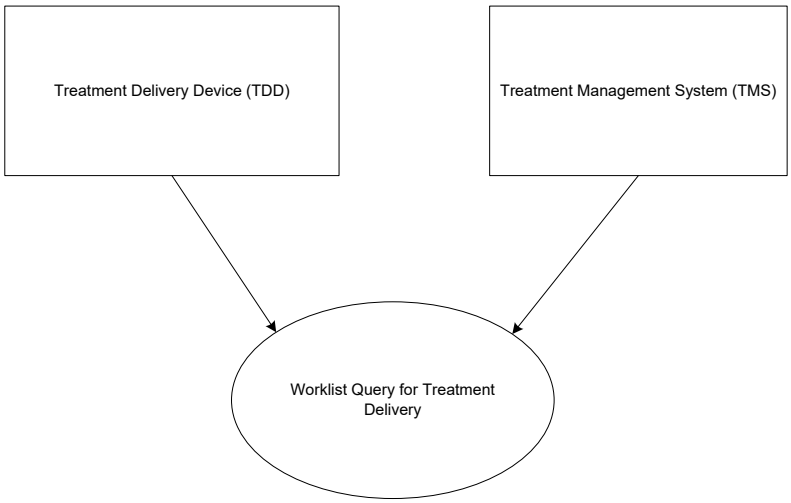

Figure 3.58.2-1: Use Case Diagram

Table 3.58.2-1: Actor Roles

Actor:	Treatment Management System
Role:	Responds to a worklist query and sends the requested scheduled treatment delivery worklist to a TDD.
Actor:	Treatment Delivery Device
Role:	Queries a TMS and receives a scheduled treatment delivery worklist.

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3.58.3 Referenced Standards

DICOM 2015c Edition PS 3.4: Annex CC Unified Procedure Step Service and SOP Classes

3.58.4 Messages

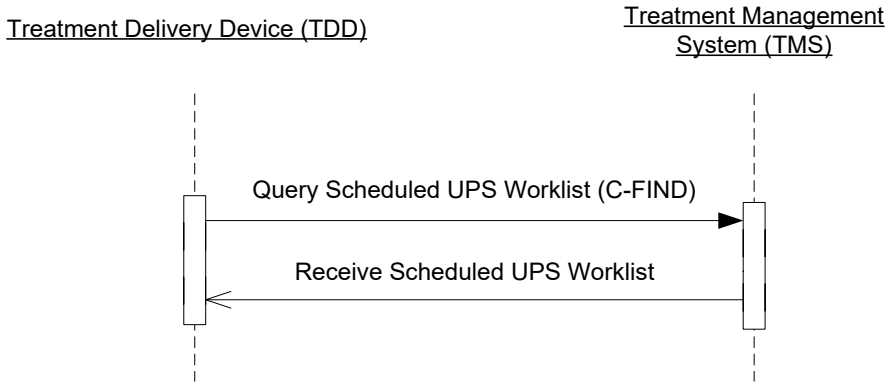

Figure 3.58.4-1: Interaction Diagram

3.58.4.1 Query Scheduled UPS Worklist Message

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

3.58.4.1.1 Trigger Events

The user of the TDD, in order to deliver a treatment, requests that the TMS send a scheduled treatment delivery worklist.

3.58.4.1.2 Message Semantics

The TDD uses the C-FIND request of the DICOM UPS – Pull SOP Class to query the desired worklist on the TMS. The TDD performs the SCU role, and the TMS performs the SCP role. Note that the UPS-Pull SOP Class is negotiated as the abstract transfer syntax, and used as the Affected SOP Class in the C-FIND request (see DICOM Standard P3.4 CC.2.8.1.2.1).

Matching Keys and Return Keys for Display

The TMS replies to the query with a set of zero or more UPS C-FIND RSP containing scheduled treatment delivery worklist items, followed by a C-FIND final response. The content of the scheduled treatment delivery worklist items is defined in Section 7.4.2.2.2.

Matching Key and Return Key requirements are defined in Section 7.5.1.1.1.

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Retain Original Treatment Records Option

The participating TMS shall include in the UPS Input Information Sequence all Treatment Record Instances matching original RT Beams Treatment Record Storage/RT Ion Beams Treatment Record Storage SOP instances which were referenced in the output information sequence received from the TDD for previous deliveries of the corresponding fraction to be continued.

3.58.4.1.3 Expected Actions

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

3.58.4.2 Receive Scheduled UPS Worklist Message

This is the query response message that the Worklist Manager (TMS) sends to the TDD as a reply containing relevant DICOM UPS information.

3.58.4.2.1 Trigger Events

The TDD receives the UPS as requested by the query.

3.58.4.2.2 Message Semantics

For the Worklist Query for Treatment Delivery transaction exactly one Unified Procedure Step (UPS C-FIND RSP in the 'pending' state) shall be returned for each matching treatment session.

Requirements on the Return Key values in the C-FIND RSP are defined in Section 7.4.2.2.2.

3.58.4.2.3 Expected Actions

On reception of the UPS, the TDD will prepare to the execution of the UPS.

Exception Handling for Unexpected UPS

In case the C-FIND RSP contains one or more UPS with Scheduled Workitem Code (0040,4018) other than (121726, DCM, "RT Treatment with Internal Verification") which are unsupported by the TDD, the TDD shall display the unsupported UPS and disable their execution. At least the following tags out of the Scheduled Workitem Code Sequence (0040,4018) shall be displayed to provide information about the requested intent of the appropriate UPS:

- Patient Name
- Patient ID
- Scheduled Station Name code meaning
- Scheduled Workitem Code code meaning

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3.58.5 Security Considerations

See Section 9.5TDW-II Security Considerations

3.59 Retrieve Static Treatment Delivery Input Instances from OST [RO-59]

3.59.1 Scope

In the Retrieve Static Treatment Input Instances from OST transaction, a TDD requests and receives from the OST any ‘static’ SOP Class Instances required for performing the desired Scheduled Treatment Delivery 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.

3.59.2 Actor Roles

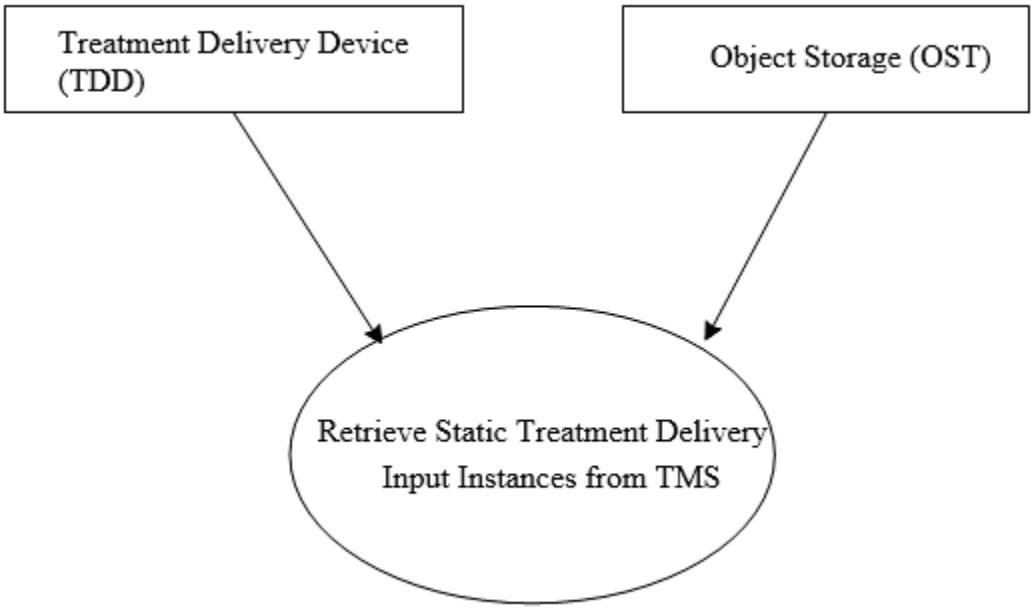

Figure 3.59.2-1: Use Case Diagram

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Table 3.59.2-1: Actor Roles

Actor:	Object Storage
Role:	Sends requested DICOM objects to the TDD
Actor:	Treatment Delivery Device
Role:	Receives requested DICOM objects from the OST

3.59.3 Referenced Standards

DICOM 2015c Edition PS 3.3: RT Modules

DICOM 2015c Edition PS 3.4: Storage Service Class

DICOM 2015c Edition PS 3.4: Query/Retrieve Service Class

3.59.4 Messages

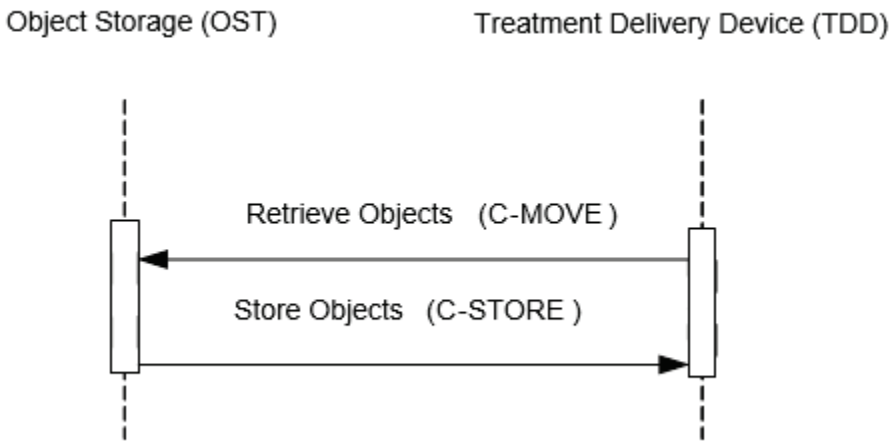

Figure 3.59.4-1: Interaction Diagram

3.59.4.1 Retrieve Objects Message

The Study Root Query/Retrieve Information Model – MOVE SOP Class shall be supported. SCP implementations shall support the instance-level mode of operation in which specific SOP Instances are retrieved from the OST using a Study Root C-MOVE. Refer to DICOM 2014c Edition PS 3.4, Annex C, for detailed descriptive semantics.

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A TDD shall be capable of issuing a Study Root C-MOVE at the instance level for the RT Plan/RT Ion Plan SOP Instance that is specified in the Input Information Sequence. A TDD may also be capable of retrieving other instances, but this is not required. Other mechanisms for obtaining the data (such as an independent C-STORE or restoring from a DICOM medium) shall not be permitted.

A TDD may receive SOP Instances in the Input Information Sequence for which it determines that it cannot perform the Procedure Step safely. In such cases:

- 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 set "IN PROGRESS", the TDD shall cancel the Procedure Step, providing an explanation in the Reason For Cancellation in the N-ACTION command.

3.59.4.1.1 Trigger Events

The TDD, in order to perform a treatment delivery, requests one or more of the referenced objects in the Input Information Sequence (0040,4021) of the selected procedure step, after the Input Readiness State (0040,4041) is set to "READY"

3.59.4.1.2 Message Semantics

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

A C-MOVE Request from the DICOM Study Root Query/Retrieve Information Model – MOVE SOP Class shall be sent from the TDD (SCU) to the OST.

The TDD is required to issue a C-MOVE request for at least one instance of an RT Plan/RT Ion Plan IOD supplied in the Input Information Sequence of one or more returned UPS instances. It may also request other input instances (such as CT data sets, structure sets, dose, etc.), but is not required to do so. It may not request instances that are not supplied in the Input Information Sequence of one or more returned UPS instances.

A participating OST shall support this transaction for at least the RT Plan/RT Ion Plan IOD. Support of other IODs is permitted (e.g., RT Beams Treatment Record Storage/RT Ion Beams Treatment Record Storage SOP instances from previous deliveries).

It is assumed that any requested objects have been placed in the OST by a means outside the scope of this IHE-RO profile. Typically, C-STORE operations from a Treatment Planning System or central Archive would have been performed previously to achieve this goal.

In implementations where the TDD manages DICOM objects itself, it may well have pre-fetched and processed the required objects, in which case the UIDs supplied in the Input Information Sequence (0040,4021) of the selected procedure step would be sufficient to locate the necessary

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data, and no retrievals would be necessary. However, in this profile the RT Plan/RT Ion Plan Instance must be retrieved using C-MOVE.

The OST shall be capable of supplying at least the following SOP Class:

Table 3.59.4.1.2-1: Cross Profile SOP Class Support for OST on C-MOVE Request

SOP Class Name		SOP Class UID	DICOM Content Specification
RT Plan Storage		1.2.840.10008.5.1.4.1.1.481.5	RT Plans shall conform to 7.3.2.1.2 RT Plan IOD for Photon External Beam in Delivery State, when the treatment technique is covered by that specification. It is expected that Plans will conform to 7.3.2.2.3 RT Plan IOD for Consistent Dose Tracking
RT Ion Plan Storage		1.2.840.10008.5.1.4.1.1.481.8	It is expected that Plans will conform to 7.3.2.2.3 RT Ion Plan IOD for Consistent Dose Tracking

The display requirements of 7.3.2.1.2 RT Plan IOD for Photon External Beam in Delivery State are not applicable in this transaction.

Multiple Targets Option

The Plan retrieved from the Object Storage (OST) may include Multiple Targets as defined in Consistent Dose for External Beam (CDEB), when this Option is supported.

3.59.4.1.3 Expected Actions

The OST receives the C-MOVE request, establishes a DICOM association with the requesting actor, and uses the appropriate DICOM Object Storage SOP Classes to transfer the requested objects.

The requesting TDD is then expected to use the requested objects in performing the selected procedure step. In cases where the TDD manages DICOM objects itself, this may be limited to ensuring that the supplied RT Plan/RT Ion Plan instance is consistent with internally stored data.

3.59.5 Security Considerations

See Section 9.5 TDW-II Security Considerations.

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3.60 Treatment Delivery in Progress [RO-60]

3.60.1 Scope

In the Treatment Delivery in Progress transaction, a TDD signals to the TMS that responsibility has been taken for the performing of the selected procedure step.

3.60.2 Actor Roles

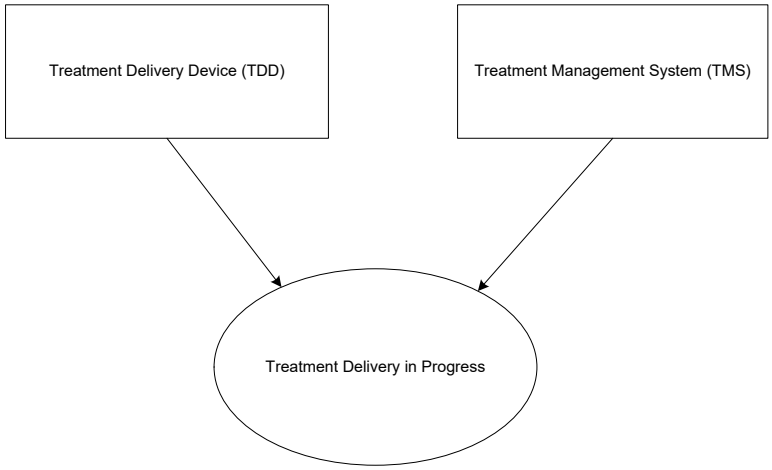

Figure 3.60.2-1: Use Case Diagram

Table 3.60.2-1: Actor Roles

Actor:	Treatment Management System
Role:	Responds to a UPS N-ACTION and recognizes the specified UPS as in progress, thereby preventing any other Actors from performing the step. Receives and saves the Transaction UID as 'Locking UID'
Actor:	Treatment Delivery Device
Role:	Signals using UPS N-ACTION that the selected procedure step is in progress. Generates and sends Transaction UID.

3.60.3 Referenced Standards

DICOM 2015c Edition PS 3.4: Annex CC Unified Procedure Step Service and SOP Classes

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3.60.4 Messages

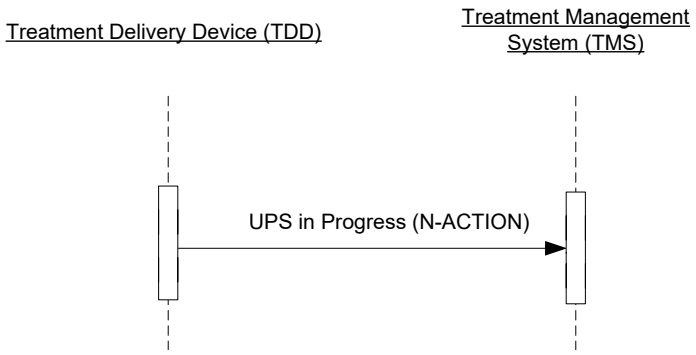

Figure 3.60.4-1: Interaction Diagram

3.60.4.1 UPS in Progress Message

The TDD uses the UPS N-ACTION service to inform the TMS that the specified scheduled Unified Procedure Step has been started and is in progress. Note that the UPS-Pull SOP Class is negotiated as the abstract transfer syntax, but the UPS-Push SOP Class is used as the Requested SOP Class UID of the UID of the UPS in all subsequent DIMSE messaging (see DICOM Standard, P3.4 CC.2.8.1.2.1). The TDD generates and sends a Transaction UID that will be used by the Worklist Manager (TMS) as a 'Locking UID' to prevent other actors from updating the UPS.

3.60.4.1.1 Trigger Events

The TDD has successfully queried and selected a suitable procedure step. It may also have retrieved 'dynamic' input instances using [RO-61] prior to this step.

The TDD 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 [RO-59].

3.60.4.1.2 Message Semantics

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

3.60.4.1.3 Expected Actions

The TDD SCU sends an N-ACTION request to the TMS SCP to change the state of a UPS Instance from 'SCHEDULED' to 'IN PROGRESS'. Included in the N-ACTION request is a SCU generated Transaction UID. This Transaction UID is used in all subsequent DIMSE messaging for that UPS Instance.

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Upon successfully changing the state of a UPS instance to 'IN PROGRESS', the SCP shall record the Transaction UID provided by the SCU in the Transaction UID (0008,1195) of the UPS instance.

Upon successful completion of the N-ACTION request, the SCP shall return, via the N-ACTION response primitive, the N-ACTION Status Code of 0000H (Success). The TMS shall then be ready to receive UPS N-SET or UPS N-ACTION commands.

If the requested procedure step cannot be performed 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 Standard PS 3.4 Table CC.2.1-2 shall be returned. The TMS shall then be capable of accepting further UPS N-ACTION requests or worklist queries.

3.60.5 Security Considerations

Not applicable.

3.61 Retrieve Dynamic Treatment Delivery Input Instances from TMS [RO-61]

3.61.1 Scope

In the Retrieve Dynamic Treatment Input Instances from TMS transaction, the TDD requests and receives SOP Class Instances from the TMS in order to support execution of the requested procedure step. These requested instances are of a "transient" nature, typically generated 'on-the-fly' by the TMS.

3.61.2 Actor Roles

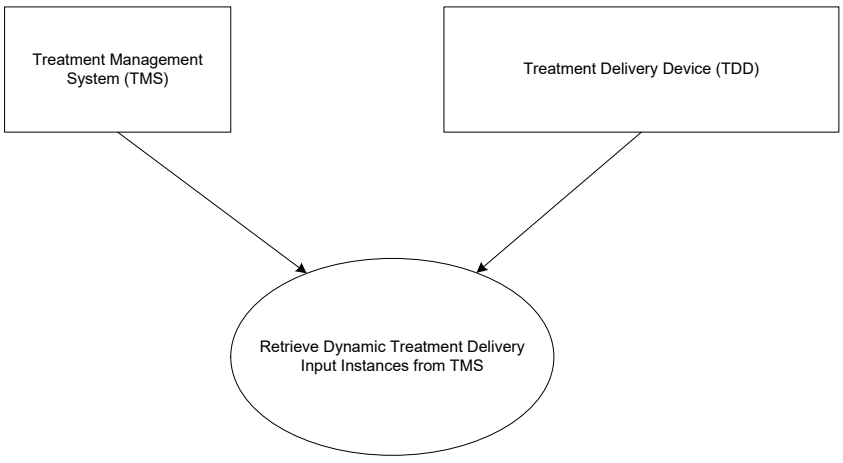

Figure 3.61.2-1: Use Case Diagram

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Table 3.61.2-1: Actor Roles

Actor:	Treatment Management System
Role:	Sends requested DICOM objects to the TDD
Actor:	Treatment Delivery Device
Role:	Retrieves requested DICOM objects from the TMS

3.61.3 Referenced Standards

DICOM 2015c Edition PS 3.3

DICOM 2015c Edition PS 3.4: Storage Service Class

DICOM 2015c Edition PS 3.4: Query/Retrieve Service Class

3.61.4 Messages

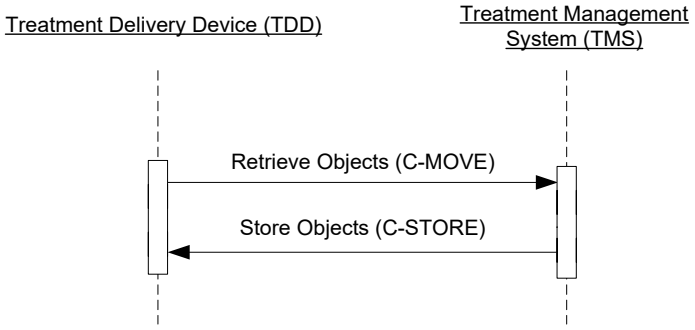

Figure 3.61.4-1: Interaction Diagram

3.61.4.1 Retrieve Objects Message

The Study Root Query/Retrieve Information Model - MOVE SOP Class shall be supported to the Instance-level. Implementations shall support a mode of operation in which specific SOP Instances (rather than entire studies) are retrieved from the TMS using a Study Root C–MOVE. Refer to DICOM 2015c Edition PS 3.4, Annex C, for detailed descriptive semantics.

A TDD SCU shall be capable of issuing Study-Root C-MOVE for the RT Beams Delivery Instruction Storage SOP Instance that is specified in the Input Information Sequence. Other mechanisms for obtaining the data (such as an independent C-STORE or restoring from a DICOM medium) shall not be permitted.

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A TDD may receive SOP Instances in the Input Information Sequence for which it determines that it cannot perform the Procedure Step safely. In such cases:

- 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 TDD shall cancel the Procedure Step, providing an explanation in the Reason For Cancellation in the N-ACTION command.

3.61.4.1.1 Trigger Events

The TDD has successfully queried and selected a suitable procedure step. It may also have set the UPS in progress using [RO-60] prior to this step.

The TDD shall not be permitted to perform this transaction on a UPS for which the RT Plan/RT Ion Plan Instance supplied in its Input Instance Sequence has not previously been obtained using [RO-59].

The TDD shall only perform this transaction after the Input Readiness State (0040,4041) is set to "READY"

3.61.4.1.2 Message Semantics

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

A C-MOVE Request from the DICOM Study Root Query/Retrieve Information Model – MOVE SOP Class, instance-level shall be sent from the TDD (SCU) to the Treatment Management System (SCP).

The TDD is required to issue a C-MOVE request for the instance of the RT Beams Delivery Instruction Storage IOD supplied in the Input Information Sequence of the UPS instance. It may also request other input instances, but is not required to do so. It may not request instances that were not supplied in the Input Information Sequence of the UPS instance.

The TMS shall be capable of supplying at least the following SOP Class:

Table 3.61.4.1.2-1: Required SOP Class Support for TMS on C-MOVE Request

SOP Class Name	SOP Class UID	DICOM Content Specification
RT Beams Delivery Instruction Storage	1.2.840.10008.5.1.4.34.7	See 7.3.9.1.1 RT Beams Delivery Instruction IOD

The TDD shall specify the SOP Class UID of the RT Beams Delivery Instruction Storage in the attributes of the C-MOVE RQ Identifier.

Note: The Affected SOP Class UID of the C-MOVE RQ is always set to the SOP Class of the Study Root Query/Retrieve Information Model. However, to allow a TMS to dynamically determine if the RT Beams Delivery Instruction IOD should be created along TDW or TDW-II, it has to know the requested SOP Class UID. To keep the TMS stateless this

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should not be determined on the negotiated transfer syntax on the initial association for the Worklist Query for Treatment Delivery [RO-58].

3.61.4.1.3 Expected Actions

The TMS receives the C-MOVE request, establishes a DICOM association with the requesting TDD, and uses the appropriate DICOM SOP Classes to transfer the requested object(s).

The requesting actor is then expected to use the requested object(s) in the performing of the selected procedure step.

When the RT Beams Delivery Instruction SOP Instance referenced in the Input Information Sequence of the UPS response will have the value 'CONTINUATION' in the Treatment Delivery Type (300A,00CE) for certain beam(s), the Treatment Delivery Device is expected to treat those beams by resuming the previous partial treatment, observing the Continuation Start Meterset (0074,0120), and Continuation End Meterset (0074,0121).

Beam which have the value 'TREATMENT' in the Treatment Delivery Type (300A,00CE) are expected to be treated completely.

The user shall be informed about the scope of upcoming beam delivery of the beams included in the RT Plan/RT Ion Plan along the information provided in RT Beams Delivery Instruction SOP Instance. If the user decides to treat the plan otherwise, an elevated sign-off shall be required.

The Current Fraction Number (3008,0022) shall be used to display the number of the fraction to be treated and shall be inserted in the treatment records which are created and sent back to the Object Storage.

3.61.5 Security Considerations

See Section 9.5 TDW-II Security Considerations

3.62 Treatment Delivery Progress Update [RO-62]

3.62.1 Scope

In the Treatment Delivery Progress Update transaction, a TDD signals to the TMS any changes in the progress of the procedure step that is currently in progress.

3.62.2 Actor Roles

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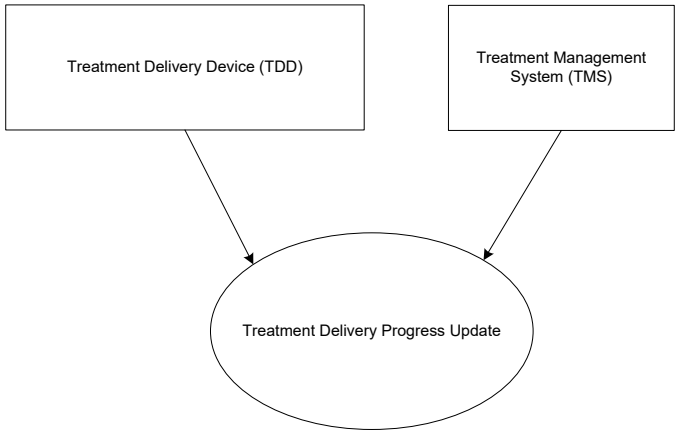

Figure 3.62.2-1: Use Case Diagram

825 **Table 3.62.2-1: Actor Roles**

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

3.62.3 Referenced Standards

DICOM 2015c Edition PS 3.4: Annex CC Unified Procedure Step Service and SOP Classes

3.62.4 Messages

830

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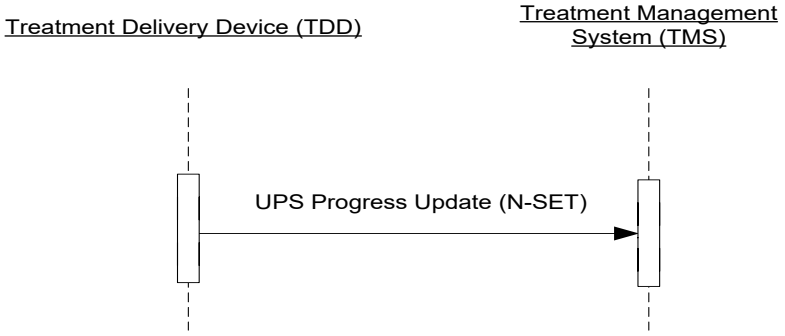

Figure 3.62.4-1: Interaction Diagram

3.62.4.1 UPS Progress Update Message

The TDD 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 Standard, P3.4 CC.2.8.1.2.1).

3.62.4.1.1 Trigger Events

The TDD 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 TDD has fetched necessary input data, and notifies the TMS that work is about to start on treatment delivery by indicating progress of 0% and indicating the Referenced Beam Number in Progress.
- On the first occasion, when the TDD got information, that the treatment machine has started radiating, it shall invoke this transaction indicating progress of between 0% and 100%, and indicating the Referenced Beam Number in Progress.
- During delivery, The TDD may notify the TMS repeatedly, that work has advanced by indicating progress of between 0% and 100%, and indicating the Referenced Beam Number in Progress.

3.62.4.1.2 Message Semantics

The message semantics are defined in the DICOM Standard.

Requirements for SCUs using the UPS N-SET command are defined in Section 7.5.1.1.2. 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 Treatment Delivery Final Update [RO-64].

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The TMS shall then remain in the state it was in before the N-SET was received.

3.62.4.1.3 Expected Actions

The TMS receives the updates and updates its internal state as needed.

3.62.5 Security Considerations

Not applicable.

3.63 Store Treatment Delivery Results to TMS [RO-63]

3.63.1 Scope

In the Store Treatment Delivery Results to TMS transaction, when a treatment delivery procedure step has been performed by a TDD, the results of the treatment delivery operation are stored to the OST. These results shall subsequently be referenced in the Output Information Sequence of the corresponding Unified Procedure Step.

3.63.2 Actor Roles

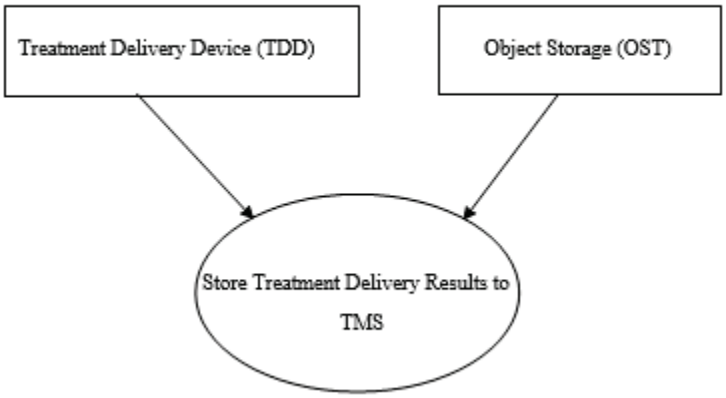

Figure 3.63.2-1: Use Case Diagram

Table 3.63.2-1: Actor Roles

Actor:	Object Storage
Role:	Responds to a C-STORE request and stores the transmitted objects.
Actor:	Treatment Delivery Device

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Role:	Stores the output of the treatment delivery operation to the TMS

3.63.3 Referenced Standards

DICOM 2015c Edition PS 3.4: Storage Service Class

3.63.4 Messages

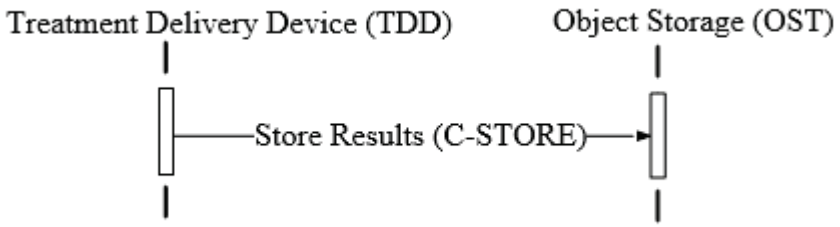

Figure 3.63.4-1: Interaction Diagram

3.63.4.1 Store Results Message

The C-STORE Service shall be supported. The DICOM Object Storage SOP Classes as specified below will be supported by the OST as an SCP. Refer to DICOM 2015c Edition PS 3.4, Annex C, for detailed descriptive semantics.

3.63.4.1.1 Trigger Events

The TDD has completed a treatment delivery and wishes to store the generated results of the delivery operation.

3.63.4.1.2 Message Semantics

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

UPS does not specify the location to which output objects should be stored. Where objects shall be stored is defined by provider of the TMS actor at the discretion of the provider.

In implementations where the TDD maintains a local storage of the RT Plan SOP instances, the Patient Header data may differ from those in the SOP instances retrieved from the OST. In such cases, it is allowed to populate the static objects containing the Treatment Delivery Results with the header data of the locally stored objects, instead of the ones retrieved from the OST.

A participating TDD must support this transaction for the object listed in Table 3.63.4.1.2-1.

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Table 3.63.4.1.2-1: Cross Profile SOP Class Support for TDD (SCU)

SOP Class Name	SOP Class UID	DICOM Content Specification
RT Beams Treatment Record Storage	1.2.840.10008.5.1.4.1.1.481.4	Treatment Records IODs are expected to conform to 7.3.6.2.1 RT Treatment Record IOD for Consistent Dose Tracking.
RT Ion Beams Tx Record	1.2.840.10008.5.1.4.1.1.481.9	Treatment Records IODs are expected to conform to 7.3.6.2.1 RT Treatment Record IOD for Consistent Dose Tracking.

895

A participating OST must support this transaction for the object listed in Table 3.63.4.1.2-2.

Table 3.63.4.1.2-2: Cross Profile SOP Class Support for TMS (SCP)

SOP Class Name	SOP Class UID	DICOM Content Specification
RT Beams Treatment Record Storage	1.2.840.10008.5.1.4.1.1.481.4	Treatment Records IODs are expected to conform to 7.3.6.2.1 RT Treatment Record IOD for Consistent Dose Tracking.
RT Ion Beams Tx Record	1.2.840.10008.5.1.4.1.1.481.9	Treatment Records IODs are expected to conform to 7.3.6.2.1 RT Treatment Record IOD for Consistent Dose Tracking.

Retain Original Treatment Records Option

900 The participating OST shall retain all information from the RT Beams Treatment Record Storage/RT Ion Beams Treatment Record Storage SOP instances received from TDD as described in the description of level 2 SCP conformance Storage Service Class (extended negotiation of the association supported storage level is not required).

3.63.4.1.3 Expected Actions

905 The OST stores the objects received.

The TMS shall retrieve the object content from the OST by any means and present the accumulated dose values to the user allowing to observe the progress of treatments.

3.63.5 Security Considerations

See Section 9.5 TDW-II Security Considerations

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3.64 Treatment Delivery Final Update [RO-64]

3.64.1 Scope

In the Treatment Delivery Final Update transaction, a TDD signals to the TMS any changes in the properties of the procedure step prior to setting the UPS to completed or canceled.3.64.2 Actor Roles

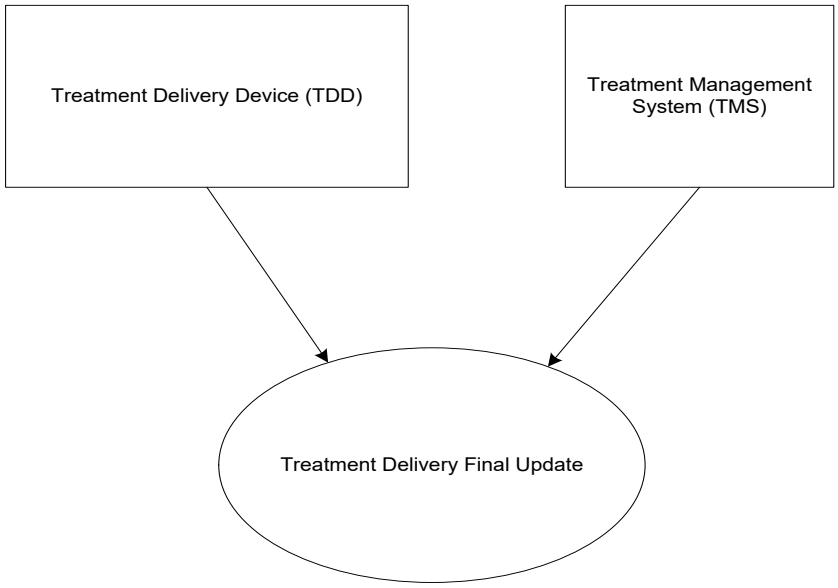

Figure 3.64.2-1: Use Case Diagram

Table 3.64.2-1: Actor Roles

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

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3.64.3 Referenced Standards

DICOM 2015c Edition PS 3.4: Annex CC Unified Procedure Step Service and SOP Classes

3.64.4 Messages

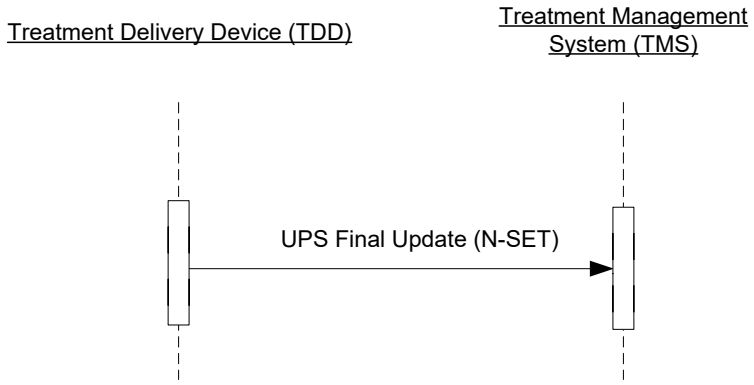

Figure 3.64.4-1: Interaction Diagram

3.64.4.1 UPS Final Update Message

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

3.64.4.1.1 Trigger Events

The TDD has finished the execution of the procedure step.

3.64.4.1.2 Message Semantics

The message semantics are defined in DICOM Standard. 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 Standard, P3.4 CC.2.8.1.2.1).

Requirements for SCUs using the UPS N-SET command are defined in Section 7.5.1.2.3.

3.64.4.1.3 Expected Actions

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

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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.

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 Standard P3.4 Table CC.2.1-2 shall be returned. The TMS shall then remain in the state it was in before the N-SET was received.

3.64.5 Security Considerations

Not applicable.

3.65 Treatment Delivery Completed/Canceled [RO-65]

3.65.1 Scope

In the Treatment Delivery Completed/Canceled transaction, a TDD signals to the TMS that the selected procedure step has either been completed or canceled.

3.65.2 Actor Roles

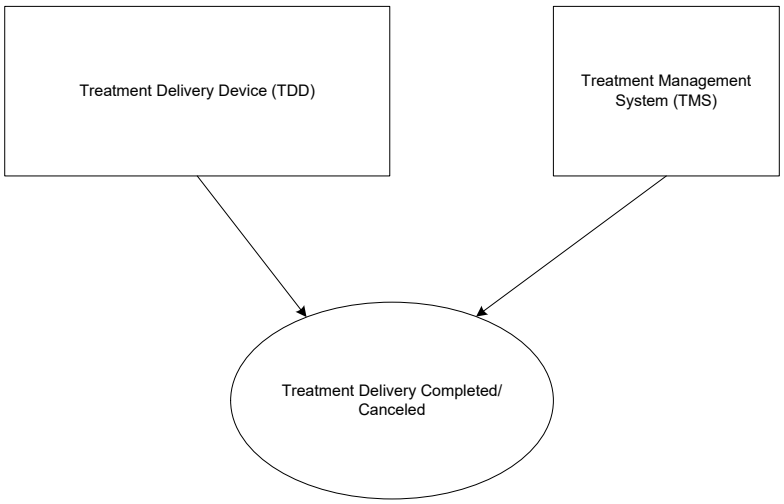

Figure 3.65.2-1: Use Case Diagram

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Table 3.65.2-1: Actor Roles

Actor:	Treatment Management System
Role:	Responds to a UPS N-ACTION and sets the specified Unified Procedure Step as completed or canceled
Actor:	Treatment Delivery Device
Role:	Signals using UPS N-ACTION that the selected procedure step is completed or canceled.

3.65.3 Referenced Standards

DICOM 2015c Edition PS 3.4: Annex CC Unified Procedure Step Service and SOP Classes

3.65.4 Messages

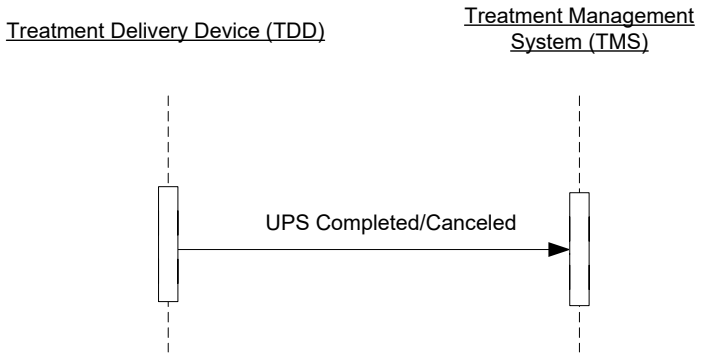

Figure 3.65.4-1: Interaction Diagram

3.65.4.1 UPS Completed/Canceled Message

The TDD 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 Referenced SOP Class UID of an UPS in all subsequent DIMSE messaging (see DICOM Standard, PS 3.4 CC.2.8.1.2.1).

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3.65.4.1.1 Trigger Events

The TDD 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.

3.65.4.1.2 Message Semantics

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

3.65.4.1.3 Expected Actions

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

If the requested procedure step has been successfully completed (i.e., the received Procedure Step State (0074,1000) has a value of 'COMPLETED'), the TMS shall send an N-ACTION response echoing a Procedure Step State (0074,1000) of 'COMPLETED' and a status code of 0000H (success). The Treatment Management System shall then be ready to receive new worklist queries for this TDD.

If the requested procedure step was not successfully completed (i.e., the received Procedure Step State (0074,1000) has a value of 'CANCELED'), the TMS shall send an N-ACTION response echoing a Procedure Step State (0074,1000) of 'CANCELED' 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 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 TDD 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 Procedure Step is not IN PROGRESS, or for any other reason, then an N-ACTION response with a status code as described in DICOM Standard P3.4 Table CC.2.1-shall be returned. The TMS shall then remain in the state it was in before the N-ACTION was received.

DICOM Standard outlines the final state requirements for the UPS N-ACTION command, i.e., the attributes which must be valued before the procedure step can pass into the COMPLETED or CANCELED state. The stated requirements for Treatment Delivery Progress Update [RO-62], Treatment Delivery in Progress [RO-60] and Treatment Delivery Final Update [RO-64] ensure that these conditions are met.

Table 3.65.4.1.3-1 defines how the status of Tx Delivery can be determined based on Procedure Step State and Procedure Step Progress of the UPS (column Output Information Sequence is information only). In any case, determination of what has been actually delivered during the treatment session, requires to check the content of the treatment record(s) as well.

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Table 3.65.4.1.3-1: Status of (therapeutic) Tx Delivery

Procedure Step State (0074,1000)	Procedure Step Progress	Output Information Sequence (see also Section 7.4.2.4.2)	Status of (therapeutic) Tx Delivery
CANCELED	0%	May contain Tx Record(s) with delivered meterset equal 0	No Tx delivered
CANCELED	0% < progress < 100%	Shall contain Tx Record(s) with delivered meterset > 0	Tx partially delivered
COMPLETED	100% (Note 1)	Shall contain Tx Record(s) with delivered meterset > 0	Tx fully delivered as requested

Note 1: Procedure Step State of COMPLETED is a strong enough statement that the intended task of the UPS was performed as expected (independent on the actual Procedure Step Progress). Nevertheless, it's good practice to set the Procedure Step Progress to 100% as part of the Treatment Delivery Final Update [RO-64] transaction.

3.65.5 Security Considerations

Not applicable.

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Volume 2 Appendices

None

Volume 2 Namespace Additions

Not applicable.

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Volume 3 – Content Modules

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7 DICOM Content Definition

7.1 Conventions

See Technical Framework.

7.1.1 Scope of Requirements

See Technical Framework.

7.1.2 Requirements Definitions

See Technical Framework.

7.1.3 Requirement Inheritance

See Technical Framework.

7.1.4 Display Requirements

See Technical Framework.

7.1.5 Service Specification

7.1.5.1 Query Keys

When a Query Key specification contains “R”, “R+” or “R+*”, the SCU is required to query for matching on the attributes. '-' indicates, that there are no additional requirements in respect to the DICOM Standard. Non-empty keys are not allowed to be provided by the SCU.

When a Query Key Return specification contains "R", the SCU must provide the key with a zero length value for Universal Matching, in which case the SCP shall return those attributes in the response.

When the Query Key Return specification contains "O", the SCU may choose to provide such keys for Universal Matching, but the SCP must support matching on this key.

'-' in a cell means, that there are no additional requirements by IHE compared with the DICOM requirements. Implementer shall be aware though, that DICOM requires empty attributes to be present where return values are expected. Therefore '-' must not be read as permitting absence of those attributes in the C-FIND command when such return values shall be present.

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7.2 General Definitions

7.2.1 Character Sets

7.2.1.1 Support of Character Sets other than ISO-IR 100

All actors shall support at least the Default Character Set and ISO-IR 100 (Latin-1) in all transactions. Other character sets shall be supported along the specification of the conformance statements of the involved actors. Especially that means the following:

- It shall be possible for all actors involved in a transaction to use those character sets in their communication which all actors support along their conformance statements.
- When there are no character sets shared across all actors, ISO-RO 100 shall be used.

Where C-FIND is used, the Identifier (Matching Query Keys) may include the Specific Character Set (0008,0005) specifying a character set which is supported by all involved actors. In accordance with the specifications of the DICOM Standard, this attribute is never used for matching, but specifies how other Attributes are encoded in the Request and Response Identifiers.

7.3 IOD Definitions

Add Section 7.3.9

7.3.9 Workflow IOD

7.3.9.1 Delivery Instruction

7.3.9.1.1 RT Beams Delivery Instruction IOD

IE	Module	Reference	Usage	IHE Usage
Patient	Patient	C.7.1.1	M	M See Section 7.4.1.1.1
	Clinical Trial Subject	C.7.1.3	U	U
Study	General Study	C.7.2.1	M	M See Section 7.4.1.2.1
	Patient Study	C.7.2.2	U	U
	Clinical Trial Study	C.7.2.3	U	U
Series	General Series	C.7.3.1	M	M

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IE	Module	Reference	Usage	IHE Usage
	Clinical Trial Series	C.7.3.2	U	U
Equipment	General Equipment	C.7.5.1	M	M See Section 7.4.1.5.1
Plan	RT Beams Delivery Instruction	C.8.8.29	M	M See Section 7.4.2.1.1
	Common Instance Reference	C.12.2	C - Required if not conveyed by a Unified Procedure Step. May be present otherwise.	C
	SOP Common	C.12.1	M	M See Section 7.4.1.6.1

7.4 Module Definitions

7.4.1 General Modules

This section is present only to convey the envisioned section numbering.

7.4.2 Workflow Modules

7.4.2.1 RT Beams Delivery Instruction Module

7.4.2.1.1 RT Beams Delivery Instruction Base

Attribute Name	Tag	Type	Description
Referenced RT Plan Sequence	(300C,0002)	-	Reference to a single RT Plan/RT Ion Plan SOP Instance (whose UID is also supplied in the Input Information Sequence - see PS3.4) containing all the Beams and the Fraction Group referenced in this SOP Instance. Only a single item shall be included in this sequence.
>Include Table 10-11 "SOP Instance Reference Macro Attributes"			
Beam Task Sequence	(0074,1020)	-	Specification of beams to be delivered and/or verified. One or more Items shall be included in this sequence.

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Attribute Name	Tag	Type	Description
>Beam Task Type	(0074,1022)	-	Indication whether beam is to be verified, treated (delivered), or both. Enumerated Values: VERIFY Beam verification only TREAT Beam treatment only VERIFY_AND_TREAT Beam verification and treatment
>Treatment Delivery Type	(300A,00CE)	-	Delivery Type of treatment. Enumerated Values: TREATMENT normal patient treatment CONTINUATION continuation of interrupted treatment (Note 1)
>Primary Dosimeter Unit	(300A,00B3)	D	Measurement unit of machine dosimeter. Enumerated Values: MU Monitor Unit MINUTE minute NP Number of Particles This value shall be the same as in the referenced RT Plan/RT Ion Plan. It applies only to the Continuation Start Meterset (0074,0120) and Continuation End Meterset (0074,0121). Required if Treatment Delivery Type (300A,00CE) is CONTINUATION.
>Continuation Start Meterset	(0074,0120)	D	Meterset within Beam referenced by Referenced Beam Number (300C,0006) at which treatment delivery starts, in units specified by Primary Dosimeter Unit (300A,00B3). Required if Treatment Delivery Type (300A,00CE) is CONTINUATION.
>Continuation End Meterset	(0074,0121)	-	Meterset within Beam referenced by Referenced Beam Number (300C,0006) at which treatment delivery ends, in units specified by Primary Dosimeter Unit (300A,00B3). Required if Treatment Delivery Type (300A,00CE) is CONTINUATION.
>Current Fraction Number	(3008,0022)	R+	The fraction number shall not vary within this sequence.
>Referenced Fraction Group Number	(300C,0022)	-	Indicates which fraction group of the referenced plan is to be treated in the treatment session. Only one Fraction Group shall be specified per Delivery Instruction SOP Instance. Required if the referenced plan has more than one Fraction Group Sequence (300A,0070) item.
>Referenced Beam Number	(300C,0006)	-	Uniquely identifies the Beam that is specified by Beam Number (300A,00C0) within Beam Sequence (300A,00B0) in RT Beams Module of referenced RT Plan/RT Ion Plan.
>Beam Order Index	(0074,1324)	D	If present, should be used if the delivery device allows.

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Attribute Name	Tag	Type	Description
>Autosequence Flag	(0074,1025)	D	If present, should be used if the delivery device allows
>Delivery Verification Image Sequence	(0074,1030)	R+*	There shall be zero items in this sequence
Omitted Beam Task Sequence	(300C,0111)	R+*	Beams not to be delivered and/or verified. Zero or more Items may be present in this sequence.
>Referenced Beam Number	(300C,0006)	R+	Uniquely identifies the Beam that is specified by Beam Number (300A,00C0) within Beam Sequence (300A,00B0) in RT Beams Module of referenced RT Plan/RT Ion Plan.
>Reason for Omission	(300C,0112)	R+	Reason why the referenced beam is not to be delivered and/or verified: Defined Terms: ALREADY_TREATED The beam has been already treated in an earlier treatment session
>Reason for Omission Description	(300C,0113)	-	Description of reason for omission.

Note 1: Treatment Delivery Type (300A,00CE) shall have the value 'CONTINUATION' for beam(s) which have been partially delivered. Beams which have not yet been delivered at all during the execution of the previous UPS shall have the value 'TREATMENT'. Note that no beam in the Beam Delivery instruction will have the value 'CONTINUATION' in the case, when some beams have been delivered completely, but the other beams of the plans have not yet been started at all during the execution of the previous UPS. In this case all the latter beams will be included in the Beam Task Sequence with the value 'TREATMENT'.

7.4.2.2 Unified Procedure Step Scheduled Procedure Information Module

The following sections specify the information required in the Unified Procedure Step Scheduled Procedure Information when creating a UPS instance (either internally or using the N-CREATE service) prior exposing it. The first section specifies general requirements applying to any UPS whereas the subsequent sections specify requirements along the intended action (i.e., Scheduled Workitem Code) of the UPS.

7.4.2.2.1 UPS Scheduled Procedure Information Base

Attribute	Tag	Type	Attribute Note
Scheduled Station Name Code Sequence	(0040,4025)	R*	
>Code Value	(0008,0100)	R+*	Code Value for the Scheduled Station Name shall contain the string used to definitively match the performing device instance with its representation on the TMS. It is not necessarily human-readable.

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Attribute	Tag	Type	Attribute Note
>Coding Scheme Designator	(0008,0102)	O+*	Coding Scheme Designator for the Scheduled Station Name is a private coding scheme, and is not used explicitly in the IHE-RO profiles.
>Code Meaning	(0008,0104)	R	Code Meaning for the Scheduled Station Name shall contain the human-readable description of the Station Name.
Scheduled Workitem Code Sequence	(0040,4018)	R+	When applicable the code shall use one of the following CIDs: CID 9241 Radiotherapy General Workitem Definition CID 9242 Radiotherapy Acquisition Workitem Definition CID 9243 Radiotherapy Registration Workitem Definition For other procedures, private coding scheme designator or future standardized codes may be used. See subsequent sections for use case specific workitem codes. Displayed value shall clearly state the intent of the workitem, but does not have to match the specific meaning text.
>Code Value	(0008,0100)	R*	
>Coding Scheme Designator	(0008,0102)	R*	
>Code Meaning	(0008,0104)	R	
Scheduled Processing Parameters Sequence	(0074,1210)	RC+*	Required if the performing of the UPS requires additional processing parameters. See subsequent sections for use case specific processing parameters.
Input Information Sequence	(0040,4021)	RC+*	Required if the performing of the UPS requires additional input information. See subsequent sections for use case specific input information.
Study Instance UID	(0020,000D)	R+*	Study Instance UID must be supplied by the 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.
All other attributes	As described in DICOM Standard		

7.4.2.2.2 UPS Scheduled Procedure Information for 'Treatment Delivery'

In addition to the requirements of Section 7.4.2.2.1 the following shall apply:

- The code in the Scheduled Workitem Code Sequence (0040,4018) shall be equal to (121726, DCM, "RT Treatment with Internal Verification").

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- The Input Information Sequence (0040,4021) shall contain references to a least the following items (additional items may be supplied for other reasons, but are out of scope for this profile):

Table 7.4.2.2.2-1: Input Information Sequence Items for Treatment Delivery

SOP Class Name	SOP Class UID	Retrieve Location
RT Plan Storage or RT Ion Plan Storage	1.2.840.10008.5.1.4.1.1.481.5 1.2.840.10008.5.1.4.1.1.481.8	Object Storage
RT Beams Delivery Instruction Storage	1.2.840.10008.5.1.4.34.7	TMS
RT Beams Treatment Record Storage or RT Ion Beams Treatment Record Storage (See Note 1)	1.2.840.10008.5.1.4.1.1.481.4 1.2.840.10008.5.1.4.1.1.481.9	Object Storage

Note 1: The presence of a Treatment Record is required, when the treatment is a continuation of a previously interrupted treatment, i.e., when 'Treatment Delivery Type' in the Scheduled Processing Parameters Sequence contains the value of 'CONTINUATION'. The set of Treatment Records included shall include all treatment records that are needed for the delivery device to exactly determine how to continue the fraction. To ensure interoperability with delivery devices requiring all treatment records previously sent for a specific fraction and all attributes of the original treatment records, supporting the Retain Original Treatment Records Option shall be mandatory.

- The Scheduled Processing Parameters Sequence shall include the following:

Table 7.4.2.2.2-2: Scheduled Processing Parameters Sequence Items

	NL	VT	Concept Name	VM	Req Type	Condition	Value Set Constraint
1		TEXT	(121740, DCM, "Treatment Delivery Type")	1	M		TREATMENT CONTINUATION
2		TEXT	(2018001, 99IHERO2018, "Plan Label")	1	M		
3		NUMERIC	(2018002, 99IHERO2018, "Current Fraction Number")	1	M		
4		NUMERIC	(2018003, 99IHERO2018, "Number of Fractions Planned")	1	M		

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Content Item Descriptions

Row 1	This parameter indicates whether the treatment to be delivered is a complete fraction or a continuation of previous incompletely treated fraction. A Text Value of 'CONTINUATION' shall be supplied if the delivery completes a previously interrupted treatment delivery UPS (that ended in the 'CANCELED' state). Otherwise, a Text Value of 'TREATMENT' shall be supplied.
Row 2	Shall be set to the label of the RT Plan/RT Ion Plan to be delivered. This corresponds to the RT Plan Label (300A,0002) of the referenced plan. The requirement as specified in the RT General Plan module applies here as well (see 7.4.3.1.1.2). This allows the delivery device to display the plan label upon receiving the C-FIND RSP without requiring retrieving the plan instance.
Row 3	Shall be set to the index of the fraction to be delivered. Corresponds to Current Fraction Number (3008,0022) in the referenced RT Beams Delivery Instruction IOD. The requirement as specified in the RT Beams Delivery Instruction Base module applies here as well (see 7.4.2.1.1). This allows the delivery device to display the fraction information upon receiving the C-FIND RSP without requiring retrieving the delivery instruction instance.
Row 4	Shall be set to the total number of fractions prescribed for the plan. This corresponds to Number of Fractions Planned (300A,0078) of the referenced plan. This allows the delivery device to display the fraction information upon receiving the C-FIND RSP without requiring retrieving the delivery instruction instance.

If more than one RT Plan/RT Ion Plan shall be treated in the treatment session, one UPS per plan treatment shall be present/scheduled.

7.4.2.3 Unified Procedure Step Relationship Module

7.4.2.3.1 UPS Relationship Base

Attribute	Tag	Type	Attribute Note
Patient's Name	(0010,0010)	R+	
Patient ID	(0010,0020)	R+	
All other attributes	As described in DICOM Standard		

7.4.2.4 Unified Procedure Step Performed Procedure Information Module

The UPS Performed Procedure Information Module is provided by the performer of the UPS in the IHE-RO Final Update transaction using the UPS N-SET command. Therefore, the Type specification for the UPS attributes correspond to the final state requirements of the UPS. The specification only contains those attributes having a Final State requirement of 'R' (required if procedure is COMPLETED or CANCELED) or 'X' (required if procedure is CANCELED).

The SCU shall provide at least one item in the Performed Workitem Code Sequence (0040,4019). Other items may be sent as well representing other unscheduled activities performed by the SCU, but those may be ignored by the SCP.

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The first section specifies general requirements applying to any type of UPS whereas the subsequent sections specify requirements along the intended action of the UPS (i.e., Scheduled/Performed Workitem Code) of the UPS.

7.4.2.4.1 UPS Performed Procedure Information Base

Attribute	Tag	Type	Attribute Note
UPS Performed Procedure Sequence	(0074,1216)	R*	Supplied by the UPS final update transaction in IHE-RO if UPS is not CANCELED. May be supplied otherwise.
>Actual Human Performers Sequence	(0040,4035)	RC*	Shall be provided if known. Not required to be known in IHE-RO
>>Human Performer Code Sequence	(0040,4009)	RC*	Shall be provided if known. Not required to be known in IHE-RO.
>>Human Performer's Name	(0040,4037)	RC	Shall be provided if known. Not required to be known in IHE-RO.
>Performed Station Name Code Sequence	(0040,4028)	R*	Supplied by the UPS final update transaction in IHE-RO.
>>Code Value	(0008,0100)	R	Name of machine performing UPS. Supplied by the UPS final update transaction in IHE-RO.
>>Coding Scheme Designator	(0008,0102)	R*	Any private coding scheme designator. Supplied by the UPS final update transaction in IHE-RO.
>>Code Meaning	(0008,0104)	R*	Value shall be 'Performed Station Name'. Supplied by the UPS final update transaction in IHE-RO.
>Performed Procedure Step Start DateTime	(0040,4050)	R	Supplied by the UPS final update transaction in IHE-RO.
>Performed Workitem Code Sequence	(0040,4019)	R*	The code of the performed workitem. Supplied by the UPS final update transaction in IHE-RO. See also Scheduled Workitem Code Sequence (0040,4018) and subsequent sections for use case specific workitem codes.
>>Code Value	(0008,0100)	R*	
>>Coding Scheme Designator	(0008,0102)	R*	
>>Code Meaning	(0008,0104)	R	
>Performed Procedure Step End DateTime	(0040,4051)	R*	Supplied by the UPS final update transaction in IHE-RO.
>Output Information Sequence	(0040,4033)	R*	Supplied by the UPS final update transaction in IHE-RO. May be empty (null) if no output objects are created as a result of performing the UPS.
>>Type of Instances	(0040,E020)	R*	Value shall be 'DICOM'.
>>Study Instance UID	(0020,000D	R*	Supplied by the UPS final update transaction in IHE-RO.
>>Series Instance UID	(0020,000E	R*	Supplied by the UPS final update transaction in IHE-RO.

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Attribute	Tag	Type	Attribute Note
>>Referenced SOP Sequence	(0008,1199)	R*	Supplied by the UPS final update transaction in IHE-RO.
>>>Referenced SOP Class UID	(0008,1150)	R*	Supplied by the UPS final update transaction in IHE-RO.
>>>Referenced SOP Instance UID	(0008,1155)	R*	Supplied by the UPS final update transaction in IHE-RO.
>>>HL7 Instance Identifier	(0040,E001)	RC+	Shall not be used in IHE -RO.
>>>Referenced Frame Number	(0008,1160	RC+	Shall not be used in IHE -RO.
>>>Referenced Segment Number	(0062,000B	RC+	Shall not be used in IHE -RO.
>>DICOM Retrieval Sequence	(0040,E021)	R	Supplied by the UPS final update transaction in IHE-RO.
>>>Retrieve AE Title	(0008,0054)	R	Supplied by the UPS final update transaction in IHE-RO.
>>DICOM Media Retrieval Sequence	(0040,E022)	RC+	Shall not be used in IHE -RO.
>>WADO Retrieval Sequence	(0040,E023)	RC+	Shall not be used in IHE -RO.
>>XDS Retrieval Sequence	(0040,E024)	RC+	Shall not be used in IHE -RO.
>>WADO-RS Retrieval Sequence	(0040,E025)	RC+	Shall not be used in IHE -RO.
All other attributes	As described in DICOM Standard		

7.4.2.4.2 UPS Performed Procedure Information for 'Treatment Delivery'

In addition to the requirements of Section 7.4.2.4.1, the following applies:

- The code of the required item in the Performed Workitem Code Sequence (0040,4019) shall be set to (121726, DCM, "RT Treatment with Internal Verification").
- The Output Information Sequence (0040,4021) shall contain references to at least the following items (additional items may be supplied for other reasons, but are out of scope for this profile):

Table 7.4.2.4.2-1: Output Information Sequence Items for Treatment Delivery

SOP Class Name	SOP Class UID	Retrieve Location
RT Beams Treatment Record Storage or RT Ion Beams Treatment Record Storage (See Note 1)	1.2.840.10008.5.1.4.1.1.481.4 1.2.840.10008.5.1.4.1.1.481.9	Object Storage

Note 1: Required if any therapeutic treatment was delivered to the patient while performing this UPS. May be present otherwise for example to record execution of patient setup imaging.

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7.5 Service Definitions

7.5.1 Unified Worklist and Procedure Step

7.5.1.1 General Requirements

7.5.1.1.1 C-FIND Requirements

In a C-FIND query the Worklist Client (SCU) is required to query for return on the attributes as shown in the 'Query Keys Return' SCU column in Table 7.5.1.1.1-1 Worklist Query. The Worklist Manager (SCP) is required to return the values for these keys. All other potential return keys may be optionally supplied as described in DICOM Standard.

Table 7.5.1.1.1-1: Worklist Query

Attribute Name	Tag	Query Keys Matching		Query Keys Return	
		SCU	SCP	SCU	SCP
Specific Character Set	(0008,0005)	-	-	O* (Note 4)	R (Note 4)
SOP Class UID	(0008,1016)	-	-	O*	R
SOP Instance UID	(0008,0018)	-	-	R+*	R
Procedure Step State	(0074,1000)	R+* (Note 1)	R*	R*	R*
Scheduled Station Name Code Sequence	(0040,4025)	R* (Note 6)	R*	R*	R*
>Code Value	(0008,0100)	R+* (Note 2)	R	R+*	R
>Coding Scheme Designator	(0008,0102)	O+*	R	R+*	R
>Code Meaning	(0008,0104)	-	-	R+	R
Study Instance UID	(0020,000D)	-	-	R+*	R+
Patient's Name	(0010,0010)	R+ (Note 5)	R	R+	R+
Patient ID	(0010,0020)	R+ (Note 5)	R	R+	R+
All other attributes	As described in DICOM Standard				

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 performing device instance with its representation on the TMS. It is not necessarily human-readable.

Note 3: 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 SCP, the SCP is permitted to over-filter the result set based upon this selection and return just the worklist items for the selected fraction.

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Note 4: See Section 7.2.1.1.

Note 5: Shall be empty.

Note 6: Code Meaning (0008,0104) of the Scheduled Station Name Code Sequence (0040,4025) shall be displayed on the performing device.

Note 7: Scheduled Workitem Code Sequence shall be specified as an empty (null) sequence. The Return Key of this sequence is specified in the use case specific sections for C-FIND.

Note 8: Scheduled Processing Parameters Sequence shall be specified as an empty (null) sequence. The Return Key of this sequence is specified in the use case specific sections for C-FIND.

Note 9: Input Information Sequence shall be specified as an empty (null) sequence. The Return Key of the 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 performing device to determine if the instances are available prior to starting the procedure, and avoids the need for an additional N-GET on the UPS. If the performing device 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.

7.5.1.1.2 N-SET Progress Update Requirements

In the Treatment Delivery Progress Update transaction, the performer of the UPS (SCU) uses the UPS N-SET to inform the TMS about any changes in the progress of the UPS.

The minimum requirements for SCUs using the UPS N-SET command are detailed in Table 7.5.1.1.2-1.

Table 7.5.1.1.2-1 UPS N-SET Progress Update Requirements

Attribute Name	Tag	Type	IHE-RO Additional Requirements on SCU
Unified Procedure Step Progress Information Module			
Procedure Step Progress Information Sequence	(0074,1002)	R+*	
>Procedure Step Progress	(0074,1004)	R+*	
Unified Procedure Step Performed Procedure Information Module			
UPS Performed Procedure Sequence	(0074,1216)	R+*	
>Output Information Sequence	(0040,4033)	R+*	Shall be empty

7.5.1.1.3 N-SET Final Update Requirements

In the Final Update transaction, the performer of the UPS (SCU) uses the UPS N-SET to inform the TMS about any changes in the properties of the UPS prior to setting the UPS to completed or canceled.

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The minimum requirements for SCUs using the UPS N-SET command are detailed in 7.4.2.4. Note that IHE-RO is more restrictive than DICOM Standard requiring several attributes to be set for all UPS N-SET commands. DICOM Standard 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.

7.5.1.1.4 Object Retrieval

The UPS Input Information Sequence specifies AE title(s), Retrieve AE Title (0008,0054), from which input objects are to be retrieved. Storage location(s) are defined by the provider of the TMS actor, at the discretion of this provider. Configuration of AE Titles for object retrieval is communicated out of band.

7.5.1.2 Unified Worklist and Procedure Step for 'Treatment Delivery'

7.5.1.2.1 N-SET Progress Update Requirements for 'Treatment Delivery'

In addition to the requirements in Section 7.5.1.1.2 N-SET Progress Update Requirements, the beam that is being in progress shall be indicated as follows:

Table 7.5.1.2.1-1 UPS N-SET Progress Update Requirements for 'Treatment Delivery'

Attribute Name	Tag	Type	IHE-RO Additional Requirements on SCU
Unified Procedure Step Progress Information Module			
Procedure Step Progress Information Sequence	(0074,1002)	R+*	
>Procedure Step Progress Parameters Sequence	(0074,1007)	R+*	See Table 7.5.1.2.1-2.

Table 7.5.1.2.1-2: Procedure Step Progress Parameters Sequence Items

	NL	VT	Concept Name	VM	Req Type	Condition	Value Set Constraint
1		NUM	(2018004, 99IHERO2018, "Referenced Beam Number")	1	M		

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Volume 3 Appendices

None

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