



On-Board Imager 1.4

DICOM Conformance Statement



P/N KC1406D3CS

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Abstract	This document provides information about the DICOM Conformance of the On Board Imager version 1.4 product..	
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1 Conformance Statement Overview

The OBI Application is an application that is used to setup a patient for treatment purposes. To support this function the following DICOM services for receiving and sending diagnostic imaging modalities are supported.

Table 1-1 lists network services supported by OBI 1.4

SOP Classes	User of Service (SCU)	Provider of Service (SCP)
Transfer		
CT Image Storage	Yes	Yes
Spatial Registration Storage	Yes	No
RT Structure Set Storage	Yes	Yes
RT Image Storage	Yes	Yes
RT Plan Storage	No	Yes
Query/Retrieve		
Study Root Query/Retrieve Information Model – FIND	Yes	No
Study Root Query/Retrieve Information Model – MOVE	Yes	No

Table 1-1: Network Services

Table 1-2 lists Media File SOP Classes supported for file based export and import. These SOP classes are only supported when the OBI application is in File mode.

SOP Classes	DICOM Media File Export	DICOM Media File Import
CT Image Storage	Yes	Yes
Spatial Registration Storage	Yes	No
RT Structure Set Storage	Yes	Yes
RT Image Storage	Yes	Yes
RT Plan Storage	No	Yes

Table 1-2: Media File SOP Classes

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2 Table of Contents

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3 Introduction

3.1 Purpose

The definition of the DICOM standard for radiotherapy data started in 1994 and has now reached a productive state. Today, DICOM is the primary choice for exchanging data with an open standard protocol for the majority of vendors and institutions. Varian Medical Systems is committed to this notion and supports the full range of radiotherapy objects for their RV system.

This Conformance Statement is applicable for

OBI Release 1.4.xx

This release is also known by its product name OBI Advanced Imaging. This document contains definitions which are specific for the OBI product. For definitions which are specific for the Treatment application see 2). Otherwise, all definitions of the Varian Server DICOM conformance statement apply as applicable. This conformance statement is entitled 'Varian System Server', see 3), for System 8.

3.2 Audience

- Marketing and Sales
- System Integrators of medical equipment
- Other vendors interfacing using DICOM

3.3 Remarks

The scope of this Conformance Statement is to facilitate communication of the OBI application and other vendor's medical equipment. The Conformance Statement should be read and understood in conjunction with the DICOM standard [1].

The DICOM standard in the current version evolved in 1993 with DICOM 3.0. The definition of the DICOM standard for radiotherapy data started in 1994 and has now reached a mature state. Nowadays DICOM is the primary choice for exchanging data with an open standard protocol for the majority of vendors and institutions. Varian Medical Systems is committed to this notion of standard-based cross-vendor interoperability as well as making use of the DICOM protocol among its own products.

DICOM, by itself, does not guarantee interoperability. However, the Conformance Statement facilitates a first-level validation for interoperability between different applications supporting the same DICOM functionality.

This Conformance Statement is not intended to replace validation with other DICOM equipment to ensure proper exchange of information intended.

Because the DICOM standard is subject to ongoing changes, enhancements and improvements, Varian Medical Systems reserves the right to advance their products by making use of upcoming DICOM features.

3.4 Definitions, Terms and Abbreviations

This section provides the definitions of terms, acronyms and abbreviations that are used throughout the document

AE	Application Entity
DICOM	Digital Imaging and Communications in Medicine
NEMA	National Electrical Manufacturers Association
SCU	Service Class User
SCP	Service Class Provider
SOP	Service Object Pair
UID	Unique Identifier
Management System	DICOM entity from which OBI retrieves structure set data
OBI	Varian's On-Board Imager™ application to provide Image Guided RT features.

3.5 References

- 1) Digital Imaging and Communications in Medicine (DICOM), Parts 1-16 (2004), National Electrical Manufacturers Association (NEMA) Rosslyn, VA, USA
- 2) Treatment Rel. 6.5
DICOM Conformance Statement (P/N 10001678-01)
Varian Medical Systems Inc
Palo Alto, CA, USA
- 3) Varian System Server DICOM Conformance Statement (P/N VA8004D3CS)
Varian Medical Systems International AG
Baden, Switzerland

4 Networking

4.1 Implementation Model

4.1.1 Application Data Flow

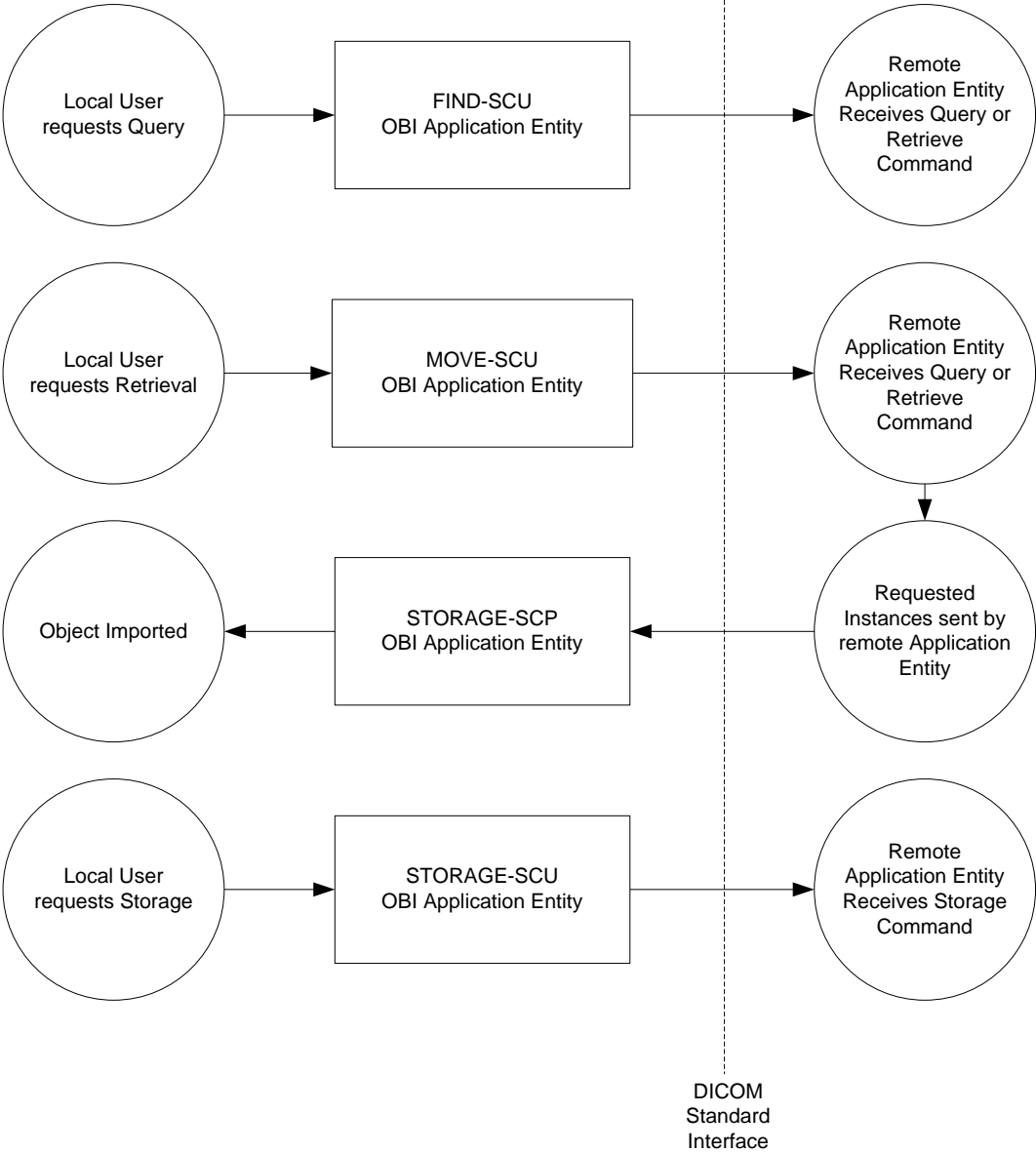


Figure 4-1 Implementation Model

Conceptually the network services may be modeled as the following separate AEs, though in fact all the AEs share a single (configurable) AE Title:

- STORAGE-SCP, receives incoming RT images, CT images, RT Plans and Structure Sets.
- STORAGE-SCU, sends outbound RT images, CT images, Structure Sets and Spatial Registrations.
- FIND-SCU, which queries remote AE's for lists of studies, series and instances.
- MOVE-SCU, which retrieves selected studies, series or instances.
- ECHO-SCU which sends outgoing echo request to Remote Application Entity

4.1.2 Functional Definition of AE's

Note that conceptually the network services may be modeled as the following separate AEs, though in fact all the AEs share a single (configurable) AE Title.

4.1.2.1 OBI Client Storage SCU Application Entity

The Storage SCU Application Entity is invoked when

- A simple 2D, 2D/2D, marker or 3D/3D matching has been performed and Spatial Registrations or Markers must be sent to the Remote AE.
- A 3D/3D matching has been performed and the acquired CT set must be sent to the Remote AE
- Marker Detection has been performed and the markers must be sent to the Remote AE as Structure set linked to the current reference CT image. Each marker is defined as own point set with a single point in it.
- Marker Match has been performed, the markers are stored as curves in the image object and the image object must be sent to the Remote AE.
- When the user saves an acquired image through the UI, the image is then sent to the Remote AE.
- The treatment fraction is closed and all unsaved acquired images and other IODs are sent to the Remote AE.

4.1.2.2 OBI Client FIND SCU, MOVE SCU Application Entity

The Query/Retrieve Application Entity is invoked when

- The patient is loaded in the 4DITC application, and reference images need to be loaded in OBI
- Structure Set and/or CT images must be loaded in order to perform a 3D/3D or marker matching.

4.1.2.3 OBI Client Storage SCP Application Entity

The Storage SCP Application Entity is invoked in order to receive objects requested from a remote Query/Retrieve SCP, such as:

- Reference Images
- Structure Sets
- RT Plan
- Reference CT image set

4.1.3 Sequencing of Real World Activities

CT images are loaded into the OBI application typically after the user switches to marker matching or 3D/3D matching state. OBI invokes a move command for each CT Image related to the structure set represented by the *CT Image Query/Retrieve SCU*. This requires the OBI application to provide the *CT Image Storage SCP*.

When a patient is loaded into the OBI application, it loads each reference image by requesting them from the remote AE.

When a Marker Matching is performed, the Marker Data (Structure Set) is only stored to the remote AE.

When either a Simple 2D, 2D/2D, 3D/3D or marker matching is performed, the Storage SCU entity is invoked and exports the a Spatial Registration to the configured remote AE

When loading from or saving to the Remote Application Entity, the ECHO-SCU entity is typically invoked to ensure that the remote AE is alive and responsive.

The loading of a CT set is described by the following sequence diagram:

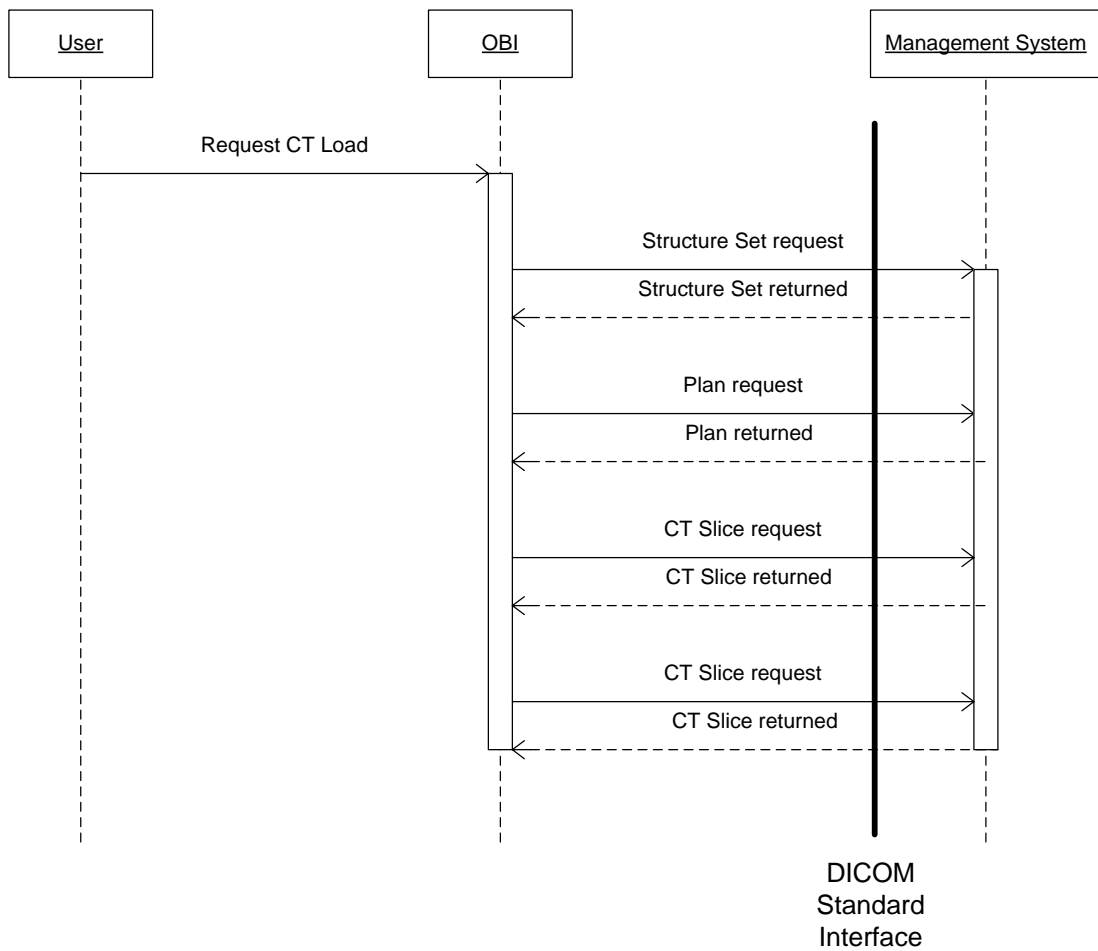


Figure 4-2 Sequence Diagram for CT Set loading

4.2 AE Specifications

4.2.1 OBI Entity Specification

4.2.1.1 SOP Classes

The OBI Entity provides standard conformance to the following DICOM SOP classes.

Abstract Syntax		Transfer Syntax		Role	Extended Negotiation
Name	UID	Name List	UID List		
RT Structure Set Storage	1.2.840.10008.5.1.4.1.1.481.3	DICOM Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None
		DICOM Implicit VR Little Endian	1.2.840.10008.1.2	SCP	None
		DICOM Explicit VR Little Endian	1.2.840.10008.1.2.1	SCP	None
Spatial Registration Storage	1.2.840.10008.5.1.4.1.1.66.1	DICOM Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None
CT Image Storage	1.2.840.10008.5.1.4.1.1.2	DICOM Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None
		DICOM Implicit VR Little Endian	1.2.840.10008.1.2	SCP	None
		DICOM Explicit VR Little Endian	1.2.840.10008.1.2.1	SCP	None
RT Image Storage	1.2.840.10008.5.1.4.1.1.1	DICOM Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None
		DICOM Implicit VR Little Endian	1.2.840.10008.1.2	SCP	None
		DICOM Explicit VR Little Endian	1.2.840.10008.1.2.1	SCP	None
RT Plan Storage	1.2.840.10008.5.1.4.1.1.5	DICOM Implicit VR Little Endian	1.2.840.10008.1.2	SCP	None
		DICOM Explicit VR Little Endian	1.2.840.10008.1.2.1	SCP	None
Study Root Query/Retrieve information model- FIND	1.2.840.10008.5.1.4.1.2.2.1	DICOM Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None
Study Root Query/Retrieve information model- MOVE	1.2.840.10008.5.1.4.1.2.2.2	DICOM Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None

Table 4-1 Supported SCU/SCP SOP Classes for OBI Entity

4.2.1.2 Association Policies

4.2.1.2.1 General

The DICOM standard application context name for DICOM 3.0 is always proposed.

Application Context Name	1.2.840.10008.3.1.1.1
--------------------------	-----------------------

Table 4-2 DICOM Application Context for OBI Client Application Entity

4.2.1.2.2 Number of Associations

The OBI Client Application Entity can initiate (by default) up to three associations at a time. This value is configurable.

Maximum number of simultaneous Associations	no limit
---	----------

Table 4-3 Number of Associations initiated for OBI Client Application Entity

4.2.1.2.3 Asynchronous Nature

OBI Client Application Entity does not support asynchronous communication.

4.2.1.2.4 Implementation Identifying Information

The following implementation class UIDs are used:

Application Entity	Implementation UID
Echo SCU	1.2.246.352.70.2.1.1
Storage SCU	1.2.246.352.70.2.1.3
Storage SCP	1.2.246.352.70.2.1.4
Query/Retrieve SCU	1.2.246.352.70.2.1.5

Table 4-4 Used implementation class UIDs

4.2.1.3 Association Initiation Policy

The OBI Client Application Entity does initiate Associations.

4.2.1.3.1 Activity – Store (STORAGE-SCU)

4.2.1.3.1.1 Description and Sequencing of Activities

When the user performs a Simple 2D, 2D/2D, marker or 3D/3D matching, the match transformation will be stored as a Spatial Registration IOD. The OBI administration tool can be configured to disable the storage of spatial registrations.

When the user performs a marker detection on the reference CT image, the positions of the detected markers will be stored in the Structure Set and linked to the current reference CT image. The OBI administration tool can be configured to disable the storage of the marker data.

When the user performs a marker match, the positions of the matched markers will be stored in the acquired image object as curves. The OBI administration tool can be configured to disable the storage of the marker data. The Curve Dimensions (5002,0005) will be 2, the Number of Points (5002,0010) will be 1, Type of Data (5000,0020) will be POLY, Axis Units (5000,0030) will be PIXL\PIXL, Axis Labels (5000,0040) will be Marker\Marker and Data Value Representation (5000,0103) will be 3.

When the user acquires a verification CT set, each CT Image will be stored. Following isocenters are stored as Points in the Structure Set which is linked to the acquired verification CT set. The values of the RT ROI Interpreted Type (3006,00A4) will be as follows:

- Initial Laser Isocenter (position before acquisition): INITLASERISO

- Acquisition Isocenter (position during acquisition): ACQISOCENTER
- Initial Match Isocenter (position after acquisition): INITMATCHISO

The OBI administration tool can be configured to disable the storage of CT images and isocenters.

The Storage SCU will be invoked and attempts to initiate a new Association. If multiple objects shall be transferred then multiple C-STORE requests will be issued over the Association.

Object Category	SOP Class Name	SOP Class UID
Structure Set	RT Structure Set Storage	1.2.840.10008.5.1.4.1.1.481.3
Spatial Registration	Spatial Registration Storage	1.2.840.10008.5.1.4.1.1.66.1
RT Image	RT Image Storage	1.2.840.10008.5.1.4.1.1.1
CT Image	CT Image Storage	1.2.840.10008.5.1.4.1.1.2

Table 4-5 Object Categories used by OBI Client Storage SCU Application Entity

4.2.1.3.1.2 Proposed Presentation Contexts

OBI Client Storage SCU is capable of proposing the Presentation Contexts shown in the following table.

Presentation Context Table					
Abstract Syntax		Transfer Syntax		Role	Ext. Neg.
Name	UID	Name	UID		
Spatial Registration Storage	1.2.840.10008.5.1.4.1.1.66.1	DICOM Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None
RT Structure Set Storage	1.2.840.10008.5.1.4.1.1.481.3	DICOM Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None
RT Image Storage	1.2.840.10008.5.1.4.1.1.1	DICOM Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None
CT Image Storage	1.2.840.10008.5.1.4.1.1.2	DICOM Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None

Table 4-6 Presentation contexts used by OBI Client Storage SCU Application Entity

4.2.1.3.1.3 SOP Specific Conformance for all Storage SOP Classes

The behavior of OBI Client Storage SCU upon storage is summarized in table below

Service Status	Further Meaning	Error Code	Behavior
Refused	Out of Resources	A7xx	The user is informed that the C-STORE request has failed. Status Comment (0000,0902) is logged and displayed along with additional error information.
Failure	Data Set does not match SOP Class	A9xx	
	Cannot understand	Cxxx	
Warning	Coercion of Data Elements	B000	The SCP has successfully stored the SOP Instance. Because a warning status was received Status Comment (0000,0902) is logged .
	Data Set does not match SOP Class	B007	
	Elements Discarded	B006	
Success	Success	0000	The SCP has successfully stored the SOP Instance. No user feedback is received.
*	*	Any other status code.	Depending on the type of the Error Code it is either handled like a Failure or Warning. However, Error Codes other than listed above in this table should not occur, as they are not defined for C-STORE (see 1), PS 3.4, Table B.2-1).

Table 4-7 OBI Client C-STORE Response Status Handling Behavior

After sending all SOP Instances, either successfully or not, the Association is released using A-RELEASE and the results are presented to the user.

Exception	Behavior
Timeout	The Association is released using A-RELEASE and the whole task of sending SOP Instances is aborted. The user is informed about the timeout and available information about it is logged.
Association aborted by the SCP or network layers	The whole task of sending SOP Instances is aborted.

Table 4-8 OBI Client Storage SCU Communication Failure Behavior

4.2.1.3.1.4 SOP Specific Conformance for RT Structure Set Storage

Detected marker positions will be saved to a new Structure Set. This structure set references the planning CT frame of reference and contains the detected marker positions as they are projected on the planning CT. The modified structure set gets a new UID and the a private referenced structure set sequence (3263,1001) is used to denote the original structure set (with the old UID). This sequence maybe used by the management system to combine the new structure set and the original one to add the markers as detected by OBI.

The ROI Contour Sequence (3006, 0040) shall have the following definitions:

- Contour Geometric type (3006, 0042) = POINT

- Number of Contour Points (3006, 0046) = 1

The ROI observation module shall have the following definitions:

- RT ROI Interpreted Type (3006,00A4) = MARKER.
- Private tag: Marker Subtype (3271,1000) = MARKER

Marker position may be located between slice positions.

Before exporting modified volumetric structures, they get resampled onto the planes of the 3D patient model. The volumetric ROI Contours of an exported RT Structure Set will thus always reference an image slice.

All images used to construct the 3D patient model are referenced in Contour Image Sequence (3006,0016) of RT Structure Set Module, even if they do not have any contours defined on them.

4.2.1.3.1.5 SOP Specific Conformance for Spatial Registration Storage

The spatial registration of the 2D and 2D/2D Match will be used in the following way:

- The Registration Sequence (0070,0308) will include all images (the reference images and the acquired verification RT images) and the Frame of Reference UID of the frame of reference of the reference RT images.
 - The frame of reference module of the spatial registration will belong to the frame of reference of the acquired verification RT images.
 - The transformation matrix type will be RIGID.

The spatial registration of the 3D/3D Match will be used in the following way:

- The Registration Sequence (0070,0308) will include all image slices (the reference CT slices and the acquired verification CT slices) and the Frame of Reference UID of the frame of reference of the reference CT slices.
- The frame of reference module of the spatial registration will belong to the frame of reference of the acquired verification CT image slices.
- The transformation matrix type will be RIGID.

The spatial registration of the Marker Match will be used in the following way:

- The Registration Sequence (0070,0308) will include all image slices (the reference CT slices and the acquired verification RT images) and the Frame of Reference UID of the frame of reference of the reference CT slices.
- The frame of reference module of the spatial registration will belong to the frame of reference of the acquired verification RT images.
- The transformation matrix type will be RIGID.

4.2.1.3.2 Activity – Query/Retrieve (FIND-SCU, MOVE-SCU)

4.2.1.3.2.1 Description and Sequencing of Activities

This function is typically performed by the application after the user switches to marker matching or 3D/3D matching state. At this time an Association is requested.

This application supports Query/Retrieve in the SCU role. The table below shows the supported values for the tag Query/Retrieve Level (0008,0052):

Query/Retrieve Level	Value in (0008,0052)
Composite Object Instance Information	IMAGE

Table 4-9 Supported Query/Retrieve Levels for Query/Retrieve SCU

4.2.1.3.2.2 Proposed Presentation Contexts

Presentation Context Table					
Abstract Syntax		Transfer Syntax		Role	Ext. Neg.
Name	UID	Name	UID		
Study Root Query/Retrieve information model – FIND	1.2.840.10008.5.1.4.1.2.2.1	DICOM Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None
Study Root Query/Retrieve information model – MOVE	1.2.840.10008.5.1.4.1.2.2.2	DICOM Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None

Table 4-10 Proposed Presentation Contexts for OBI Client Q/R SCU Application Entity

4.2.1.3.2.3 SOP Specific Conformance for C-FIND SOP Classes

The behavior of OBI Client Query/Retrieve SCU when encountering status codes in a C-FIND response is summarized in the table below.

Service Status	Further Meaning	Error Code	Behavior
Refused	Out of Resources	A7xx	The object is not found, the user is advised.
Failure	Data Set does not match SOP Class	A9xx	
	Cannot understand	Cxxx	
Cancel	Matching terminated due to Cancel Request	FE00	Cancel is handled like Failure, i.e. the object is not found and the user is advised.
Success	Matching is complete – No final Identifier is supplied	0000	The SCP has completed the match, the user is advised.
*	*	Any other status code.	Handled like failure.

Table 4-11 OBI Client C-FIND Response Status Handling Behavior

No C-CANCEL-FIND requests are ever issued.

Relational-queries are not supported.

Specific Character Set is not supported. It is not included in a query and will be ignored when

present in the response.

Exception	Behavior
Timeout	The user is informed that the operation (C-FIND or C-MOVE) has timed out.
Association aborted by the SCP or network layers	When the Association is aborted during a C-MOVE operation the user is informed.

Table 4-12 OBI Client Q/R C-FIND SCU Communication Failure Behavior

The table below lists the Attributes supported by the C-FIND SCU.

Name	Tag	VR	Type
Query/Retrieve Level	(0008,0052)	CS	R
SOP Instance UID	(0008,0018)	UI	U

Table 4-13 Study Root Request Identifier for OBI Client Q/R C-FIND SCU

The Types of Matching column in the above table should be read as follows:

- S Single Value Matching
- L List of UID Matching
- U Universal Matching
- W Wild Card Matching
- R Range Matching

One or more matching types of the above list may be supported per Attribute.

4.2.1.3.2.4 SOP Specific Conformance for C-MOVE SOP Classes

The behavior of OBI Client Query/Retrieve SCU when encountering status codes in a C-MOVE response is summarized in the following table.

Service Status	Further Meaning	Error Code	Behavior
Refused	Out of Resources – Unable to calculate number of matches	A701	None of the requested SOP Instances could be retrieved. The user will be informed about the failure.
	Out of Resources – Unable to perform sub-operations	A702	
	Move Destination unknown	A801	
Failure	Identifier does not match SOP Class	A900	
	Unable to Process	Cxxx	
Cancel	Sub-operations terminated due to Cancel Indication	FE00	

Service Status	Further Meaning	Error Code	Behavior
Warning	Sub-operations complete – One or more Failures	B000	Some or all SOP Instances have not been transmitted successfully. The user is informed.
Success	Sub-operations complete – No Failures	0000	All SOP Instances have successfully been transmitted.
Pending	Sub-operations are continuing	FF00	Transferring requested SOP Instances is continuing. This message is ignored.
*	*	Any other status code.	Any other status code is handled like Failure.

Table 4-14 OBI Client C-MOVE Response Status Handling Behavior

After having received all requested SOP Instances or when the user aborts the operation the Association is released using A-RELEASE. All events occurring during querying and retrieving SOP Instances are logged. If any log entries are marked with internal category Error they will be shown to the user automatically.

No C-CANCEL-MOVE requests are ever issued.

Exception	Behavior
Timeout	The user is informed that the operation (C-FIND or C-MOVE) has timed out.
Association aborted by the SCP or network layers	When the Association is aborted during a C-MOVE operation the user is informed.

Table 4-15 OBI Client Q/R C-MOVE SCU Communication Failure Behavior

The table below lists the Attributes that will be sent by the C-MOVE SCU.

Name	Tag	VR	Type
Query/Retrieve Level	(0008,0052)	CS	R
SOP Instance UID	(0008,0018)	UI	U

Table 4-16 Study Root Request Identifier for OBI Client Q/R C-MOVE SCU

4.2.1.3.2.5 Supported Operations

This application performs only the operations listed in the table below. This table also shows which of the optional key values (see 1)) are used for a request.

Operation	Target IOD	Key value used for Request
C-FIND	RT Structure Set	SOP Instance UID
C-MOVE	RT Structure Set	SOP Instance UID
C-MOVE	RT Plan	SOP Instance UID
C-FIND	RT Image	SOP Instance UID
C-MOVE	RT Image	SOP Instance UID
C-MOVE	CT Image	SOP Instance UID

Table 4-17 Supported Operations

4.2.1.3.3 Activity – Receive Storage Request

4.2.1.3.3.1 Description and Sequencing of Activities

Received SOP Instances are received and cached on the filesystem, as well as being passed to the application.

4.2.1.3.3.2 General Preconditions

The following precondition for matching shall be fulfilled:

In a valid OBI plan every treatment beam shall contain the same couch translation values (vertical, lateral, longitudinal). It is allowed to have different couch rotation values in the plan

Tolerances for couch values being interpreted as equal are: absolute 2mm for longitudinal, lateral and vertical axes in space.

The plan should contain valid Imaging Device-Specific Acquisition Parameters (300A,00CC) to allow automatic initiation of imaging procedures. However, if no Verification Image Sequence items are present or they do not contain device-specific acquisition parameters as specified above, it is still possible to initiate imaging procedures manually.

OBI differentiates between treatment and setup fields. Treatment fields and setup fields (kV and MV) can be used for OBI use cases.

OBI supports now the “Treatment Delivery Type” (300A,00CE) “SETUP”. This attribute should be the preferred method.

For backwards compatibility, the parameter FieldType in the Extended Interface (3253,1000) can be used to indicate the field type for each beam in the plan as well (please note, that this is a deprecated approach):

```
<ExtendedVAPlanInterface>
  <Beams>
    <Beam>
      <ReferencedBeamNumber>1</ReferencedBeamNumber>
      <BeamExtension>
        <FieldType>SETUP</FieldType>
      </BeamExtension>
    </Beam>
    <Beam>
      <ReferencedBeamNumber>2</ReferencedBeamNumber>
```

```

    <BeamExtension>
      <FieldType>TREATMENT</FieldType>
    </BeamExtension>
  </Beam>
</Beams>
</ExtendedVAPlanInterface>

```

Note that the aforementioned interface is only a portion of the entire interface, which is available in Section C.1.

If a beam is a setup field and planned verification image sequence contains a single item representing a kV image (see definition below), this beam is referred to as a '**kV beam**' in the following.

Tag	Description	T	Convention / Interpretation
Beam Sequence (300A,00B0)	Introduces sequence of treatment beams for current RT Plan. One or more items may be included in this sequence.	1	
>Planned Verification Image Sequence (300A,00CA)	Introduces sequence of planned verification images to be acquired during current beam. One or more items may be included in this sequence. See C.8.8.14.2.	3	Used to plan RT images (kV or MV) to be acquired with this beam.
>>Imaging Device-Specific Acquisition Parameters (300A,00CC)	User-specified device-specific parameters which describe how the imager will acquire the image.	3	<p>This tag is multivalued, values are separated with a backslash character (\).</p> <p>If this tag is missing completely, the planned verification image is interpreted as film.</p> <p>The following values are currently used for portal (MV) imaging:</p> <p>PortImageHighQuality PortImageHighQuality\BeamOff PortImageLowDose PortImageLowDose\BeamOff PortImageIntegrated PortImageContinuous</p> <p>The following values are currently used for kV imaging:</p> <p>KV<ImageType></p> <p>Defined terms for ImageType:</p> <p>Image CBCT</p> <p>Examples: KV\Image KV\CBCT</p>
>Beam Limiting Device Sequence (300A,00B6)	Introduces sequence of beam limiting device (jaw or leaf).	1	For kV beams, this sequence will not be interpreted.

Tag	Description	T	Convention / Interpretation
>Number of Wedges (300A,00D0)	Number of wedges associated with current Beam.	1	For kV beams, this number shall be 0 (no accessories)
>Number of Compensators (300A,00E0)	Number of compensators associated with current Beam.	1	For kV beams, this number shall be 0 (no accessories)
>Number of Boli (300A,00ED)	Number of boli associated with current Beam.	1	For kV beams, this number shall be 0 (no accessories)
>Number of Blocks (300A,00ED)	Number of shielding blocks associated with Beam.	1	For kV beams, this number shall be 0 (no accessories)
>Control Point Sequence (300A,0111)	Introduces sequence of machine configurations describing treatment beam. Two or more items may be included in this sequence. See C.8.8.14.5 and C.8.8.14.6.	1	For kV beams, this sequences shall always include exactly 2 items.
>>Beam Limiting Device Position Sequence (300A,011A)	Introduces sequence of beam limiting device (collimator) jaw or leaf (element) positions. Required for first item of Control Point Sequence, or if Beam Limiting Device changes during Beam. One or more items may be included in this sequence.	1C	For kV beams, this sequence will not be interpreted.
>>Beam Limiting Device Angle (300A,0120)	Beam Limiting Device angle, i.e. orientation of IEC BEAM LIMITING DEVICE coordinate system with respect to IEC GANTRY coordinate system (degrees). Required for first item of Control Point Sequence, or if Beam Limiting Device Angle changes during Beam.	1C	For kV beams, this number shall be 0.0

Tag	Description	T	Convention / Interpretation
>>Beam Limiting Device Rotation Direction (300A,0121)	Direction of Beam Limiting Device Rotation when viewing beam limiting device (collimator) from radiation source, for segment following Control Point. Required for first item of Control Point Sequence, or if Beam Limiting Device Rotation Direction changes during Beam. See C.8.8.14.8. Enumerated Values: CW = clockwise CC = counter-clockwise NONE = no rotation	1C	For kV beams, this value shall be NONE.
>>Gantry Angle (300A,011E)	Gantry angle of radiation source, i.e.orientation of IEC GANTRY coordinate system with respect to IEC FIXED REFERENCE coordinate system (degrees). Required for first item of Control Point Sequence, or if Gantry Angle changes during Beam.	1C	For kV beams, this value specifies the orientation of the kV radiation source with respect to IEC FIXED coordinate system. For MV beams, this value specifies the orientation of the MV radiation source (main gantry) with respect to IEC FIXED coordinate system.
>>Gantry Rotation Direction (300A,011F)	Direction of Gantry Rotation when viewing gantry from isocenter, for segment following Control Point. Required for first item of Control Point Sequence, or if Gantry Rotation Direction changes during Beam. See C.8.8.14.8. Enumerated Values: CW = clockwise CC = counter-clockwise NONE = no rotation	1C	For kV beams, this value shall be NONE.

Table 4-18 Beam Setup kv extensions

When loading reference images in OBI, the (optional) Frame of Reference module in RT Image IODs is ignored. It is always assumed that all reference images of the same plan share a common frame of reference and the internal transformation is computed from the geometric definition of the DICOM RT image module (gantry angle, X-Ray image receptor translation/rotation, etc.).

When saving back on board images to the management system, all images acquired for the same plan and session will share the same frame of reference UID, even if the couch position has been adjusted in between (under the assumption that the patient has not moved on the couch significantly).

4.2.1.3.3.3 Preconditions for RT Images

RT Images, which are used as reference images (for 2D, 2D/2D and Marker Match), must be scaled and contain all geometrical parameters needed to determine the position of the Image in IEC. They must contain a frame of reference UID and the isocenter position in their frame of reference.

The only geometrical parameter, which maybe missing is RT Image Position (3002,0012). If missing, the image is assumed as centered around the z-axis of the Image Receptor system.

4.2.1.3.3.4 Preconditions for 2D Match

Besides the General Preconditions, the following condition shall be fulfilled:

In a valid OBI plan every treatment beam shall contain the same Isocenter Position (300A, 012C). Tolerance for the “same” Isocenter Position is that isocenter positions of any pair of beams within the plan shall deviate less than 1.0 mm.

The plan shall contain at least one valid setup beam configured as a kV or MV image beam or one valid treatment beam configured as a MV image beam.

4.2.1.3.3.5 Preconditions for 2D/2D Match

Besides the General Preconditions, the following condition shall be fulfilled:

In a valid OBI plan every treatment beam shall contain no or the same Isocenter Position (300A, 012C). Tolerance for the “same” Isocenter Position is that isocenter positions of any pair of beams within the plan shall deviate less than 1.0 mm.

The plan shall contain two valid setup beams configured as a kV or MV image beam.

A delta of 90.0 degrees between the gantry/source angles (300A,011E) of the two beams is recommended for an optimal match.

4.2.1.3.3.6 Preconditions for Marker Match

Besides the General Preconditions, the following condition shall be fulfilled:

In a valid OBI plan every treatment beam shall contain the same Isocenter Position (300A, 012C). Tolerance for the “same” Isocenter Position is that isocenter positions of any pair of beams within the plan shall deviate less than 1.0 mm

The plan shall contain two valid setup beams configured as a kV or MV image beam.

A delta of 90.0 degrees between the gantry/source angles (300A,011E) of the two beams is recommended for an optimal match.

To load the slices of the reference CT image OBI loads the plan's structure set, which corresponds to the Referenced RT Structure Set (300C,0060), from the Treatment Management System , and subsequently loads all CT slices referenced in the Contour Image Sequence (3006,0016).

Conditions for CT Slices:

- All CT slices shall have the same Frame of Reference.
- The spacing between CT slices positions in z-direction (DICOM Patient coordinate system) may vary, although it is recommended, that they are equal throughout all slices referenced by the Structure Set.
- The maximal difference in x-direction and in y-direction (DICOM Patient coordinate system) between all CT slices shall be less or equal 0.1 mm.

Conditions for Structure Set (except Structures of Contour Geometric type (3006, 0042) POINT):

- The contour points within a contour shall be positioned on the same contour plane within a maximal Epsilon of 10^{-6} mm in z direction (DICOM Patient coordinate system).
- Structures with contour(s) having contour points that are not positioned on the same contour plane (see point above, i.e. non-transversal structures) are ignored (they are not imported and a corresponding warning message is issued) and the import will continue with the other structures.
- Contour Geometric Type (3006, 0042) has to be either CLOSED_PLANAR or OPEN_PLANAR for all contours of the structure. Structures with mixed contour types are not supported.
- Contour Geometric type (3006, 0042) POINT don't need to fulfill the conditions mentioned above.

Conditions for Marker Point Structures:

- The markers shall be in the structure set referenced by the plan.
- Marker position may be located between slice positions.
- The ROI Contour Sequence (3006, 0040) shall have the following definitions:
 - Contour Geometric type (3006, 0042) = POINT
 - Number of Countour Points (3006, 0046) = 1
- The ROI observation module shall have the following definitions:
 - RT ROI Interpreted Type (3006,00A4) = MARKER.
 - Private tag: Marker Subtype (3271,1000) = MARKER

4.2.1.3.3.7 Preconditions for 3D/3D Match

Besides the General Preconditions, the following condition shall be fulfilled:

In a valid OBI plan every treatment beam shall contain the same Isocenter Position (300A, 012C). Tolerance for the "same" Isocenter Position is that isocenter positions of any pair of beams within the plan shall deviate less than 1.0 mm.

The plan shall contain a valid setup beam. The tag "Beam Type" (300A,00C4) shall have the value "STATIC" configured as a CBCT beam. The tag "Imaging Device Specific Acquisition Parameters" (300A,00CC) shall have the value "KVCBCT".

To load the slices of the reference CT image OBI loads the plan's structure set, which corresponds to the Referenced RT Structure Set (300C,0060), from the Treatment Management System , and subsequently loads all CT slices referenced in the Contour Image Sequence (3006,0016).

Conditions for CT Slices:

- All CT slices shall have the same Frame of Reference.
- The spacing between CT slices positions in z-direction (DICOM Patient coordinate system) may vary, although it is recommended, that they are equal throughout all slices referenced by the Structure Set.
- The maximal difference in x-direction and in y-direction (DICOM Patient coordinate system) between all CT slices shall be less or equal 0.1 mm.

Conditions for Structure Set (except Structures of Contour Geometric type (3006, 0042) POINT):

- The contour points within a contour shall be positioned on the same countour plane within a maximal Epsilon of 10^{-6} in z direction (DICOM Patient coordinate system).
- Structures with contour(s) having contour points that are not positioned on the same contour plane (see point above, i.e. non-transversal structures) are ignored (they are not imported and a corresponding warning message is issued) and the import will continue with the other structures.
- Contour Geometric Type (3006, 0042) has to be either CLOSED_PLANAR or OPEN_PLANAR for all contours of the structure. Structures with mixed contour types are not supported.
- Contour Geometric type (3006, 0042) POINT don't need to fulfill the conditions mentioned above.

4.2.1.3.3.8 Accepted Presentation Contexts

OBI Client Storage SCP Application Entity accepts Presentation Contexts shown in the following table.

Presentation Context Table					
Abstract Syntax		Transfer Syntax		Role	Ext. Neg.
Name	UID	Name	UID		
All Storage SOP Classes in Table 4-1	All Storage SOP Classes in Table 4-1	DICOM Implicit VR Little Endian	1.2.840.10008.1.2	SCP	None
		DICOM Explicit VR Little Endian	1.2.840.10008.1.2.1		

Table 4-19 Acceptable Presentation Contexts for OBI Client Storage SCP Application Entity and Receive Storage Request

4.2.1.3.3.9 SOP Specific Conformance for all Storage SOP Classes**4.2.1.3.3.9.1 Presentation Context Acceptance Criterion**

OBI Client Storage SCP will always accept any Presentation Context for the supported SOP Classes with the supported Transfer Syntaxes. More than one proposed Presentation Context will be accepted for the same Abstract Syntax if the Transfer Syntax is supported, whether or not it is the same as another Presentation Context.

4.2.1.3.3.9.2 Transfer Syntax Selection Policies

If offered a choice of Transfer Syntaxes in a Presentation Context, OBI Client Storage SCP will select the first Transfer Syntax that is listed in the Presentation Context.

OBI Client Storage SCP will accept duplicate Presentation Contexts, that is, if it is offered multiple Presentation Contexts, each of which offers acceptable Transfer Syntaxes, it will accept all Presentation Contexts, applying the same rule for selecting a Transfer Syntax for each as described above.

4.2.1.3.3.9.3 Response Status

OBI Client Storage SCP will behave as described in the Table below when generating the C-STORE response command message.

Service Status	Further Meaning	Error Code	Behavior
Refused	Out of Resources	A700	Failed to receive incoming DICOM Stream. Problem is logged on the SCP side.
	Out of Resources	A7xx	
Failure	Invalid object instance	0117	
	Data Set does not match SOP Class	A9xx	
	Invalid C-STORE request	C000	
Warning	Coercion of Data Elements	B000	
	Data Set does not match SOP Class	B007	
	Elements Discarded	B006	
Success		0000	Instance successfully stored in temporary file.

Table 4-20 Response Status of OBI Client Storage SCP and Receive Storage Request

4.2.1.4 Association Acceptance Policy

The OBI Client Application Entity does accept Associations.

4.3 Network Interfaces

See 3)

4.4 Configuration

4.4.1 AE Title/Presentation Address Mapping

4.4.1.1 Local AE Titles

The local OBI Client Application Entity uses the AE Title and TCP/IP port number configured via the Daemon configuration option in the OBI Admin tool. Note that conceptually the network services have been modeled as separate AEs, though in fact all the AEs share a single (configurable) AE Title.

Application Entity	Default AE Title	Default TCP/IP Port
OBI Client Application Entity	StreamService (configurable)	58051 (configurable)
OBI Client Storage SCU	See above	See above
OBI Client Query/Retrieve SCU	See above	See above

Table 4-21 AE Title Configuration Table

4.4.1.2 Remote AE Title/Presentation Address Mapping

4.4.1.2.1 OBI Client Storage SCU

For the Storage service class SCU, TCP/IP address, called AE title and port number of the destination are configurable as well as the calling AE title used by OBI.

4.4.1.2.2 OBI Client Query/Retrieve SCU

For the OBI Client Query/Retrieve SCU, TCP/IP address, called AE title and port number of the provider are configurable. The calling AE title of the local application, which is also the Move Destination AE title, is configurable too. The local port is the port of the Storage SCP for receiving the data. The Storage SCP will accept only connection requests from the configured remote AE Title and IP Address.

4.4.2 Parameters

The following table shows DICOM relevant configuration parameters. While some of them may be configured directly via a configuration dialog or a configuration application, other values can only be accessed via the Registry or can not be configured at all.

Parameter	Configurable (Yes/No)	Default Value
General Parameters		
Max PDU Receive Size	No	Unlimited
Max PDU Send Size	No	32768 Bytes (32kB)
Time-out waiting for a acceptance or rejection response to an Association request or Association Release request (Application Level Timeout)	Yes	300s

Parameter	Configurable (Yes/No)	Default Value
OBI Client Storage SCU Specific Parameters OBI Client Query/Retrieve SCU Specific Parameters		
Time-out awaiting a Response to a DIMSE Request (Low-Level Timeout)	Yes	300s
Maximum number of simultaneously initiated Associations	No	1

Table 4-22 Configuration Parameters Table

5 Media Interchange

OBI Client Application Entity allows importing and exporting DICOM Media Files. Various import and export filters are available in the OBI Client application to read and create DICOM Media Files. This functionality is only available when the OBI Application is operating in file mode.

The files fully conform to the Part 10 format. However, the Basic Directory IOD as defined in Media Interchange Application Profiles is not present.

6 Support of Character Sets

See Varian System Server DICOM Conformance Statement (3)

7 Security

7.1 Security Profiles

No Security Profiles are supported.

7.2 Association Level Security

7.2.1 OBI Client

Storage SCU does not support Association Level Security.

The Storage SCP instantiated to receive Instances requested by Query/Retrieve SCU checks the following additional values when determining whether to accept Association Open Requests:

- Called AE Title
- Calling AE Title
- IP address of Association Request originator

7.3 Application Level Security

7.3.1 OBI Application

In order to load patient information into the OBI application, the user opens the patient in the 4DITC application, which requires the user identification in the form of a user name and password.

Appendix A Specialization

A.1 IOD Contents

A.1.1 Created SOP Instances

IODs created by the OBI Application Entity are listed in IOD Details.

A.1.2 Usage of Attributes from received IOD's

The OBI Application Entity require all Type 1 Attributes to be present.

A.2 Data Dictionary of Private Attributes

The OBI application does not use any private attributes that are not outlined in this document or 3).

A.3 Coded Terminology and Templates

A.3.1 Context Groups

Information will be published in a future version of this document.

A.3.2 Template Specifications

No standard templates are extended and no private templates are used.

A.3.3 Private Code Definitions

There are no private code definitions.

A.4 Grayscale Image Consistency

Not supported.

A.5 Standard Extended/Specialized/Private SOP Classes

Not Used

A.6 Private Transfer Syntaxes

No private Transfer Syntaxes are used.

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Appendix B IOD Details

B.1 Supported IODs

For better reference with DICOM Standard 1), section titles of the following sub-sections are decorated with section number of DICOM Standard Part 3 where the corresponding IOD Module table can be found.

B.1.1 Computed Tomography Image – A.3.3

IE	Module	Reference	Usage	Presence
Patient	Patient	C.7.1.1	M	
	Clinical Trial Subject	C.7.1.3	U	Not supported
Study	General Study	C.7.2.1	M	
	Patient Study	C.7.2.2	U	Not supported
	Clinical Trial Study	C.7.2.3	U	Not supported
Series	General Series	C.7.3.1	M	
	Clinical Trial Series	C.7.3.2	U	Not supported
Frame of Reference	Frame of Reference	C.7.4.1	M	
Equipment	General Equipment	C.7.5.1	M	
Image	General Image	C.7.6.1	M	
	Image Plane	C.7.6.2	M	
	Image Pixel	C.7.6.3	M	
	Contrast/Bolus	C.7.6.4	C	Not supported
	CT Image	C.8.2.1	M	
	Overlay Plane	C.9.2	U	Not supported
	VOI LUT	C.11.2	U	
	SOP Common	C.12.1	M	

Table 7-1 Computed Tomography Image IOD Modules Support

B.1.2 Spatial Registration – A.39.3

IE	Module	Reference	Usage	Presence
Patient	Patient	C.7.1.1	M	
	Clinical Trial Subject	C.7.1.3	U	Not supported
Study	General Study	C.7.2.1	M	
	Patient Study	C.7.2.2	U	Not supported

IE	Module	Reference	Usage	Presence
	Clinical Trial Study	C.7.2.3	U	Not supported
Series	General Series	C.7.3.1	M	
	Clinical Trial Series	C.7.3.2	U	Not supported
	Spatial Registration Series	C.20.1	M	
Frame of Reference	Frame of Reference	C.7.4.1	M	
Equipment	General Equipment	C.7.5.1	M	
Spatial Registration	Spatial Registration	C.20.2	M	
	Common Instance Reference	C.12.2	M	
	SOP Common	C.12.1	M	

Table 7-2 Spatial Registration Image IOD Modules Support

B.1.3 RT Structure Set – A.19.3

IE	Module	Reference	Usage	Presence
Patient	Patient	C.7.1.1	M	
	Clinical Trial Subject	C.7.1.3	U	Not supported
Study	General Study	C.7.2.1	M	
	Patient Study	C.7.2.2	U	Not supported
	Clinical Trial Study	C.7.2.3	U	Not supported
Series	RT Series	C.8.8.1	M	
	Clinical Trial Series	C.7.3.2	U	Not supported
Equipment	General Equipment	C.7.5.1	M	
Structure Set	Structure Set	C.8.8.5	M	
	ROI Contour	C.8.8.6	M	
	RT ROI Observations	C.8.8.8	M	
	Approval	C.8.8.16	U	Not supported
	SOP Common	C.12.1	M	

Table 7-3 RT Structure Set IOD Modules Support

B.1.4 RT Image – A.17.3

IE	Module	Reference	Usage	Presence
Patient	Patient	C.7.1.1	M	
	Clinical Trial Subject	C.7.1.3	U	Not supported

IE	Module	Reference	Usage	Presence
Study	General Study	C.7.2.1	M	
	Patient Study	C.7.2.2	U	Not supported
	Clinical Trial Study	C.7.2.3	U	Not supported
Series	RT Series	C.8.8.1	M	
	Clinical Trial Series	C.7.3.2	U	Not supported
Frame of Reference	Frame of Reference	C.7.4.1	M	
Equipment	General Equipment	C.7.5.1	M	
Image	General Image	C.7.6.1	M	
	Image Pixel	C.7.6.3	M	
	Contrast/Bolus	C.7.6.4	C	Not supported
	Cine	C.7.6.5	C	Not supported
	Multi Frame	C.7.6.6	C	Not supported
	RT Image	C.8.8.2	M	
	Modality LUT	C.11.1	U	
	VOI LUT	C.11.2	U	
	Approval	C.8.8.16	U	
	Curve (Retired)	C.10.2	U	
	SOP Common	C.12.1	M	
Extended Interface	Extended Interface	N/A	U	Private

Table 7-4 RT Image IOD Modules Support

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Appendix C Extended Interface

The following IODs have private Attributes containing an XML data structure for transporting structured non-DICOM data:

- RT Plan
- CR/CT/MR/SC/RT Image

The following sections specify Attributes containing the XML data and describe the structure of the XML data.

C.1 RT Plan

Node Name	Min occurs	Max occurs	Data Type	Node Description
ExtendedVAPlanInterface	0	1		
> Beams	0	1		
>> Beam	0	Unbounded		
>>> ReferencedBeamNumber	1	1	int	Beam identifier
>>> BeamExtension	1	1		Additional items provided from Vision to expand the features of RT Beams.
>>>> FieldType	1	1	string	TREATMENT or SETUP
>>>> RelatedTreatBeamNumber	0	1	int	Relation from the image beams to the treatment and/or setup beams.
>>>> FieldOrder	1	1	int	Order in which the fields are shown
>>>> GantryRtnExtendedStart	0	1	int	When true, gantry angle position is in the extended range, which means it has an over travel (a Gantry can move most typical 400' and not only 360').
>>>> GantryRtnExtendedStop	0	1	int	When true, gantry angle position is in the extended range, which means it has an over travel (a Gantry can move most typical 400' and not only 360').
>>>> MUSubtraction	0	1	int	MUSubtraction defines whether some MUs have to be subtracted from the related treatment beam to take images in the before phase and/or after phase.
>>>> FieldSetupPhotos	0	1		

Node Name	Min occurs	Max occurs	Data Type	Node Description
>>>> FieldSetupPhoto	0	2		Two setup photos max
>>>>> SetupPhotoNumber	1	1	int	Increasing number of setup photos. The value has to start from 1 and up.
>>>>> SetupPhotoFormat	1	1	string	The format of the pixel information. Supported values are 'JPG' and 'BMP'
>>>>> SetupPhotoPicture	1	1	hex binary	Pixel information of the photo in the corresponding format.
>>>>> PhotoModified	1	1	string	Photo has been modified. PhotoModified may have 'true' or 'false'
>>> CustomAddOns	0	1		
>>>> CustomAddOn	0	4		
>>>>> CustomAddOnType	1	1	string	Three Add On Type to choose from: BLOCK COMPENSATOR TRAY
>>>>> CustomCode	0	1	int	Codes for accessory which may be custom made or factory made (in that case the internal code is equal to the custom code.)
>>>>> ReferencedAddOnNumber	0	1	int	Reference to the identification number of the Block or Compensator.
>>>>> TraySpecification	0	1		In case the CustomAddOn is a tray, it gets reported back through this node
>>>>>> TrayID	1	1	string	User-supplied identifier for tray. Max length is 16 characters.
>>>>>> SourceTrayDistance	0	1	int	The distance from source to slot. This information is needed to distinguish the slot
> ToleranceTables	0	1		
>> ToleranceTable	0	Unbounded		Additional items provided from Vision to expand the features of Tolerance Tables with AutoSetup capabilities
>>> ReferencedToleranceTableNumber	1	1	int	Refers to the tolerance

Node Name	Min occurs	Max occurs	Data Type	Node Description
				table in RT Tolerance Table module
>>> ToleranceTableExtension	1	1		
>>>> GantryRtnSetup	0	1	string	Setup attributes may have following type: Automatic Manual Remote
>>>> CollRtnSetup	0	1	string	
>>>> CollXSetup	0	1	string	
>>>> CollYSetup	0	1	string	
>>>> PatientSupportAngleSetup	0	1	string	
>>>> CouchLngSetup	0	1	string	
>>>> CouchVrtSetup	0	1	string	
>>>> CouchLatSetup	0	1	string	
>>>> TableTopEccentricAngleSetup	0	1	string	
> DoseReferences	0	1		
>> DoseReference	0	Unbounded		
>>> ReferencedDoseReferenceNumber	1	1	int	Reference to the identification number of the Dose Reference (300A,0012) in the RT Prescription module which is a representation of our reference point
>>> DoseReferenceExtension	1	1		Additional items provided from Vision to expand the features of reference points.
>>>> DailyDoseLimit	0	1	decimal	Unit is [Gy]
>>>> SessionDoseLimit	0	1	decimal	Unit is [Gy]
>>>> Breakpoints	0	1		
>>>>> Breakpoint	0	Unbounded		Breakpoint extensions, since DICOM has just one DeliveryWarningDose without a description this is needed.
>>>>>> BreakpointDose	1	1	decimal	Unit is [Gy]

Node Name	Min occurs	Max occurs	Data Type	Node Description
>>>>> BreakpointWarning	1	1	string	Text which describes the breakpoint. Max length is 254 characters

Table 7-5 RT Plan Extended Interface