On-Board Imager 1.3

DICOM conformance statement

VARIAN medical systems | ONCOLOGY SYSTEMS

CE 0086

P/N ***KC1300D3CS***

Product	On-Board Imager 1.3
Identification Number	KC1300D3CS
Document Version	1.3.00
Effective Date	April 27, 2006

Abstract This document provides a DICOM conformance statement for treatment developed by Varian Medical Systems.

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1. Introduction

1.1 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 1.3

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 general DICOM conformance statement apply as applicable. This conformance statement is entiteld 'Vision Release 6.5 DICOM Conformance Statement', see 3).

1.2 Audience

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

1.3 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.

1.4 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) Vision Release 6.5, DICOM Conformance Statement (P/N VA7202D3CS)
Varian Medical Systems International AG
Baden, Switzerland

2. Implementation Model

2.1 Application Data Flow

Two diagrams illustrating the application model for the SCU and the SCP Role during CT Image loading are shown in Figure 1and Figure 2.

The initial function to load a CT image into OBI application is represented by *Structure Set Query/Retrieve SCU*. This function is typically performed by the application after the user switches to marker matching state. OBI provides the *Structure Set Storage SCP*. 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*.

RT Plans and RT Images are loaded by the 4DC application from the Treatment Daemon and read by the On-Board Imager from 4DC. Therefore the conditions applicable to the RT Plan and RT Images needed by On-Board imaging apply to the protocol run between the 4DC application entity and the associated daemon.

2.1.1 Application Data Flow Diagram

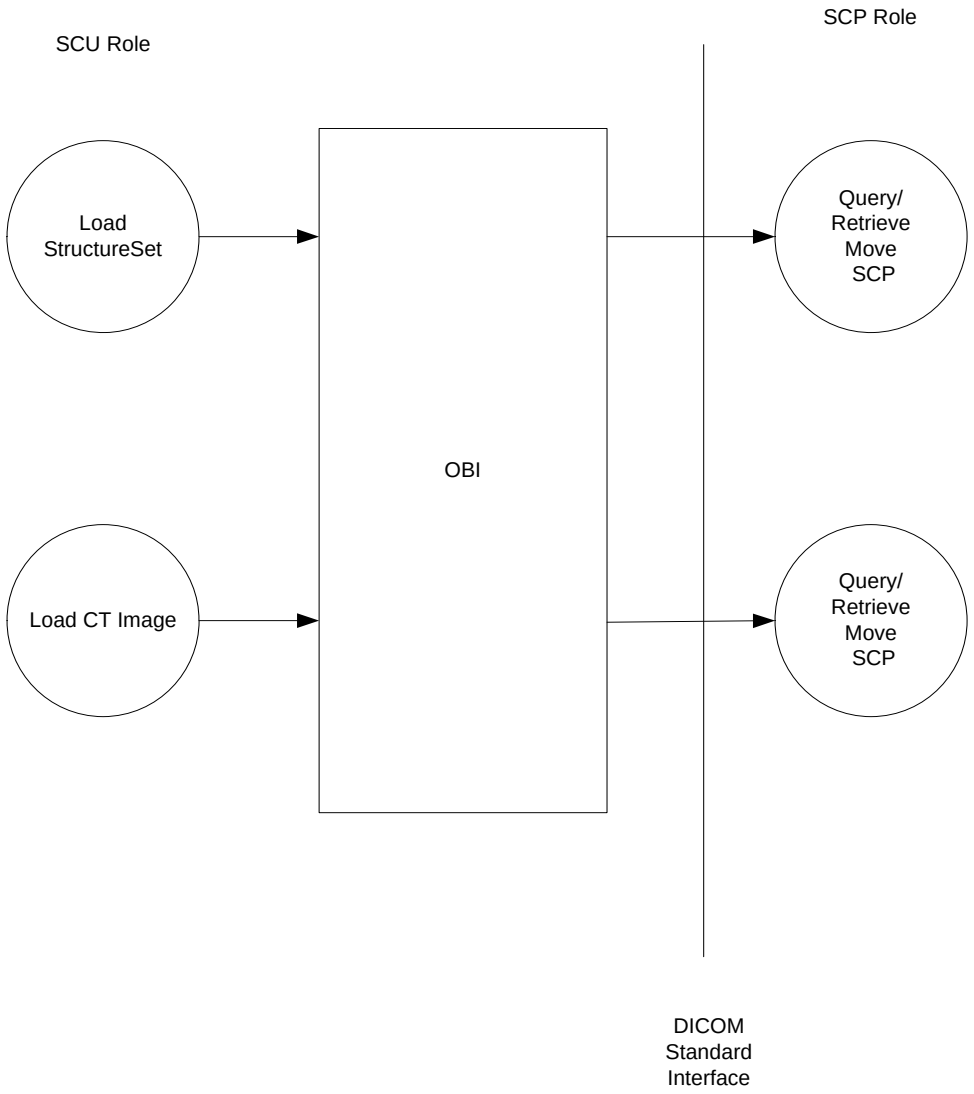

Figure 1: SCU Role Application Data Flow Diagram for Loading CT Image Data

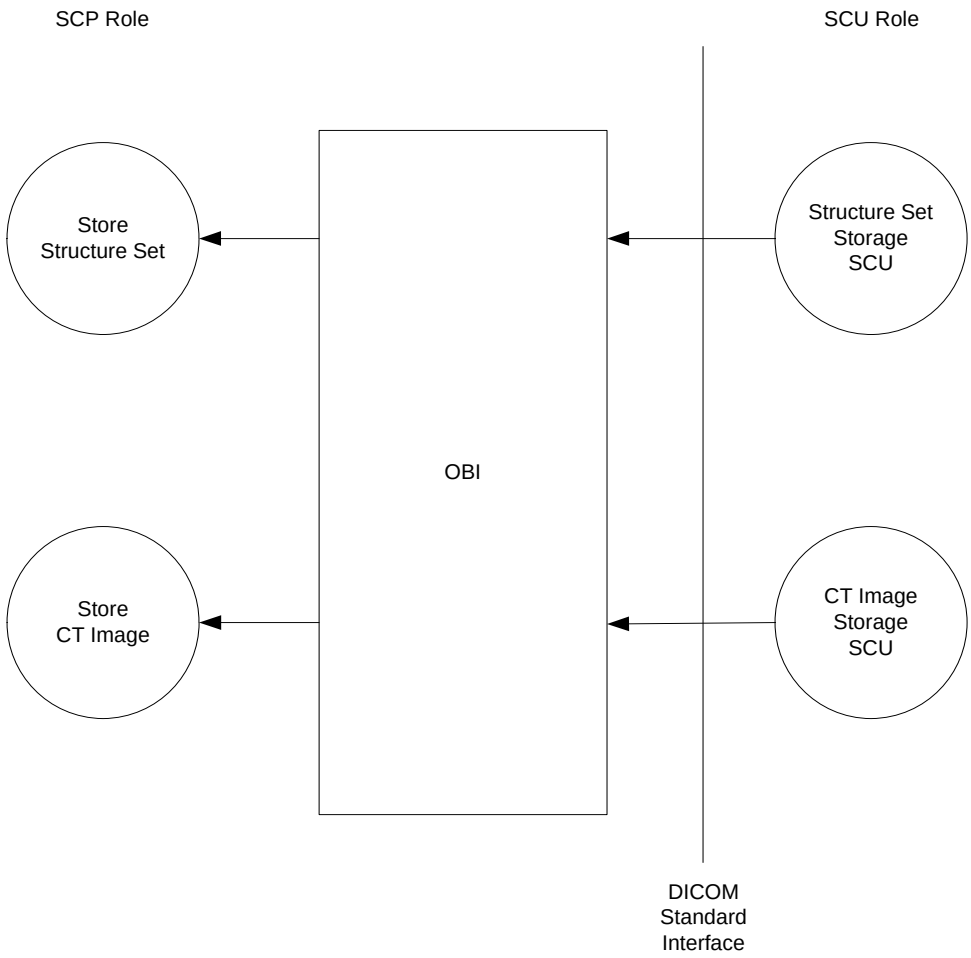

Figure 2: SCP Role Application Data Flow Diagram for Loading CT Image Data

2.2 Functional Definition of AE's

The OBI Entity's main responsibility is to perform a patient setup. Before performing a patient setup OBI loads plan and patient data from Treatment. For further details see 2).

OBI differentiates between treatment and setup fields. Only setup fields (kV and MV) can be used for OBI use cases. The parameter FieldType in the Extended Interface (3253,1000) is used to indicate the field type for each beam in the plan:

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

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

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	This tag is multivalued, values are separated with a backslash character (\). If this tag is missing completely, the planned verification image is interpreted as film. **If the first value is KV, the image shall be acquired with the kV imaging system.** Otherwise, the image shall be acquired with the portal imaging system. Besides this KV flag, this tag may contain arbitrary values relevant for the imaging system, which shall not be interpreted by the Treatment application. The following values are currently used for portal (MV) imaging: PortImageHighQuality PortImageHighQuality\BeamOff PortImageLowDose PortImageLowDose\BeamOff PortImageIntegrated PortImageContinuous The following values are currently used for kV imaging: KV\<ImageType> Defined terms for ImageType: Image CBCT Examples: KV\Image

			KV\CBCT
>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.
>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
>>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:	1C	For kV beams, this value shall be NONE.

	CW = clockwise CC = counter-clockwise NONE = no rotation		
>>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.

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).

2.2.1 General Preconditions

In a valid OBI plan every treatment beam shall contain the same Isocenter Position (300A, 012C) and the same couch values.

Tolerances for couch values being interpreted as equal are: absolute 2mm for longitudinal, lateral, vertical and 1° for rotation axes in space.

The plan should contain valid Imaging Device-Specific Acquisition Parameters (300A,00CC) to allow automatic initiatiation 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.

2.2.2 Preconditions for 2D/2D Match

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.

A beam without Isocenter Position (300A, 012C) will interpreted as ‘same’ (assumed, that all other beams which have isocenters defined have the same isocenter coordinates).

2.2.3 Preconditions for Marker Match

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.

All beams have to specify the Isocenter Position (300A, 012C) and shall contain the same values.

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 Management System using DICOM services. All CT slices shall have the same Frame of Reference. The spacing between CT slices positions in z may vary, although it is recommended, that they are equal throughout all slices referenced by the Structure Set.

2.2.4 Preconditions for 3D/3D Match

The plan shall contain a valid setup beam configured as a CBCT beam. The tag “Imaging Device Specific Acquisition Parameters” (300A,00CC) shall have the value “KV\CBCT”.

All beams have to specify the Isocenter Position (300A, 012C) and shall contain the same values.

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 Management System using DICOM services. All CT slices shall have the same Frame of Reference. The spacing between CT slices positions in z may vary, although it is recommended, that they are equal throughout all slices referenced by the Structure Set.

2.2.5 Preconditions for Marker Save

To activate this feature it is necessary to enable the checkbox “Markers” (Save Objects) in the OBI Administration tool.

2.2.6 Preconditions for Spatial Registration Save

To activate this feature it is necessary to enable the checkbox “Spatial Registration” (Save Objects) in the OBI Administration tool.

2.2.7 Save Markers

The marker positions will be saved as a 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 ROI observation module will 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.

2.2.8 Save Spatial Registration

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

- the Registration Sequence (0070,0308) will include the two reference images, with the frame of reference to whom the registration images belong to (e.g. frame of reference of the CT for DRRs or of the simulation session for simulation images).
- the Registration Sequence (0070,0308) will include the two verification images with the frame of reference issued during the acquisition of the verification images.

The frame of reference module of the spatial registration will belong to the frame of reference of the verification images.

The transformation matrix type will be RIGID.

3. AE Specifications

3.1 OBI Entity Specification

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	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	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 1: Supported SCU/SCP SOP Classes for OBI Entity

3.1.1 Association Establishment Policies

3.1.1.1 General

See details in 3)

3.1.1.2 Number of Associations

See details in 3)

3.1.1.3 Asynchronous Nature

See details in 3)

3.1.1.4 Implementation Identifying Information

The following implementation class UIDs are used:

Application Entity	Implementation UID
Echo SCU	1.2.246.352.70.2.1.1
Echo SCP	1.2.246.352.70.2.1.2
Storage SCP	1.2.246.352.70.2.1.4
Query/Retrieve SCU	1.2.246.352.70.2.1.5

Table 2: Used implementation class UIDs

Appendix A: Study Root Query/Retrieve

This application supportes Query/Retrieve in the SCU role. Table 3 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 3: Supported Query/Retrieve Levels for Query/Retrieve SCU

Supported Keys

Table 4 lists the key used in C-FIND and C-MOVE requests. Only keys listed in this table are sent to the SCP side.

Description	Tag	Type	C-FIND	C-MOVE
Query Level	(0008,0052)	R	✓	✓
SOP Instance UID	(0008,0018)	U	✓	✓
Series Instance UID	(0020,000E)	U		✓

Table 4: Supported Keys for C-FIND and C-MOVE

There are no keys that are expected to be present in a response from the SCP to any of the commands sent by the this application. Not all of the optional keys (Type U) may be sent to the SPC in a request.

Supported Operations

This application performs only the operations listed in Table 5. This table also shows which of the optional key values (see Table 4) 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	CT Image	Series Instance UID

Table 5: Supported Operations