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DICOM Conformance Statement for Accuray CyberKnife® System

Revision G
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DICOM Conformance Statement for The CyberKnife® Stereotactic Radiosurgery/Radiotherapy System

Important Information for CyberKnife® USERS:

The CyberKnife® system currently supports CT, MR, PET, 3DRA image studies with 4 patient positions: HFS (head-first supine), FFS (feet-first supine), HFP (head-first prone), and FFP (feet-first prone) from verified external nodes. Contact Accuray for a complete, current list of external nodes.

DICOM RT Structure Set is the RT object that can be imported from verified external nodes into the CyberKnife® TPS, MultiPlan® and InView® applications. Contact Accuray for a complete, current list of external nodes.

DICOM RT Structure Set and RT Dose are currently the RT objects that can be exported from the CyberKnife® system and MultiPlan®. Exportable DICOM RT Dose information includes a multi-frame volume dose grid, dose volume histograms (DVH), and isodose curves. This RT Dose could be imported to InView® to review the DVH, isodose curves/clouds, and statistical information. Also the dose grid and DVH of RT Dose could be imported to ITC Remote Review Tool [3][4] after pushing to the ITC DICOMPiler software [5] for adding DICOM File Meta Information and Clinical Trial Subject C.7.1.3 module (0012 00xx), and the anonymization.

The CyberKnife® MultiPlan® and InView® are ATC Compliant [4] after version 1.5.1 product release.

The images are sorted by Study Instance UID; all images received with the same Study UID will be grouped into the same case in the CyberKnife® central database. Multiple modalities could be within the same case. Also, note that images received with the same Study Instance UID and modality over different associations will be imported to the CyberKnife® central database just once. So, the user should ensure that a complete image study has been exported to the CyberKnife® before importing that study to the CyberKnife® central database.

Note that image series of the same modality are effectively concatenated into a single series. This allows the user to scan the patient anatomy for a single plan in two or more series. If, however, the user desires to divide the scans for separate treatment plans of different anatomical regions, the user should ensure that the scans have different Study Instance UIDs. After CyberKnife® 4.3.0 patch(TPS 3.6.0 patch) or CyberKnife® Japanese Maintenance 3.4.0.4, the split series feature is provided for users' needs.

Regarding Part 10 file format, we are able to export DICOM part 10 file from our software component in CyberKnife® 5.2.0, but after pushing back to InView® and CyberKnife® databases via CTN_SEND/ CTN_STORAGE/ CTN_ARCHIVE applications, CTN's DICOM server will

trim **DICOM File Meta Information** out because it only supports **Implicit VR Little Endian Transfer Syntax** for now.

The CyberKnife® MultiPlan® and InView® 2.0 do not support those images which have two Image Header (0028,xxxx) for two Pixel Data(7FE0,0010), i.e. two instances of Image Pixel Module, within one silce image file. Note the anomaly is recorded accordingly as bugdb00003404 which is fixed in CyberKnife® 7.2 and MultiPlan® 2.1.

The CyberKnife® system and MultiPlan® support 3D X-Ray rotational angiography(3DRA) in axial and coronal slices of XA modality, whose volumes are routinely generated from rotational angiography sequences, currently for Philips and Siemens machines which are capable of performing high speed rotational acquisition that enables 3D reconstruction. However, the CyberKnife® system does not support 2D X-Ray angiographic projection image. Contact Accuray for the recommended scanning protocol.

Introduction

This document is a DICOM v3.0 [1] Conformance Statement for the CyberKnife® Stereotactic Radiosurgery/Radiotherapy System. It details the DICOM Service Classes and roles supported by this product.
The CyberKnife® represents an entirely new approach to radiosurgery. Incorporating a compact, lightweight linear accelerator mounted on a robotic arm, the CyberKnife provides the surgeon unparalleled flexibility in targeting. Advanced image guidance technology tracks patient and target position during treatment, ensuring accuracy without the use of an invasive head frame. The CyberKnife with DTS (Dynamic Tracking Software) is cleared to provide radiosurgery for lesions anywhere in the body when radiation treatment is indicated. The CyberKnife has often been used to radiosurgically treat otherwise untreatable tumors and malformations. Moreover, this instrument treats tumors at body sites, most of which are unreachable by other stereotactic systems.

This system was developed using MIR DICOM Software CTN v3.0.4 Tool Kit [2] for DICOM v3.0 Services supplied by Electronic Radiology Laboratory, Mallinckrodt Institute of Radiology, Washington University School of Medicine, St. Louis, Missouri USA. For the CyberKnife® MultiPlan® and InView®, DICOM v.3.0 Services was developed using CTN v.3.0.6 Tool Kit [2].

1.1 Applicability

This document is intended to facilitate DICOM data exchange between the CyberKnife® System and diagnostic imaging systems.

1.2 Acronyms/Terminology

3DRA	3 Dimensional X-Ray Rotational Angiography
AE	Application Entity
ATC	Advanced Technology Consortium
CKS	CyberKnife® System
CTN	Central Test Node
DICOM	Digital Imaging and Communication in Medicine
DIMSE	DICOM Message
DVH	Dose-Volume Histogram
FSN	AccuFusion Image Registration Program
IOD	Information Object Definition
ITC	Image-Guided Therapy Center
NEMA	National Electrical Manufacturers Association
MIR	Mallinckrodt Institute of Radiology
MIRIT	Medical Image Review and Import Tool
PDU	Protocol Data Unit
ROI	Region of Interest

RTOG	Radiation Therapy Oncology Group
RSNA	Radiological Society of North America
SCP	Service Class Provider (receiver)
SCU	Service Class User (sender)
SOP	Service Object Pair
SQL	Structured Query Language
TCP/IP	Transmission Control Protocol/Internet Protocol
TPS	Treatment Planning System
UID	Unique Identification
VOI	Volume of Interest

1.3 References

[1] Digital Imaging and Communications in Medicine Standard v3.0.4, National Electrical Manufacturers Association, 2001.

[2] Stephen M. Moore, Conformance Statements for MIR CTN Applications, v2.11.0, Electronic Radiology Laboratory, Mallinckrodt Institute of Radiology, January 7, 2000. (http://wuerlim.wustl.edu/DICOM/ctn-docs/doc_index.html)

[3] ATC File Set Reader DICOM Conformance Statement v. 2.3. (http://itc.wustl.edu/dicom/Conf_Stmts.htm)

[4] ATC Digital Data Submission Procedure (http://atc.wustl.edu/credentialing/data_submit/digital_submit_040818.htm)

[5] ITC DICOMpiler Software (http://itc.wustl.edu/DICOMpiler/index.htm)

2 Implementation Model

The CyberKnife® System uses the CTN application for creation of DICOM Storage Service Class server. The storage service class, CTN_STORAGE/CTN_ARCHIVE Application Entity and CTN_SEND Application Entity, will act respectively in the role of a SCP and a SCU, and facilitates the transfer of a DICOM file between one location and the CKS workstation via a network.

2.1 Application Data Flow Diagram

The CTN_STORAGE server application stores received DICOM files within a standard UNIX directory [2]. The DICOM files may then be imported into the CyberKnife® central database via the MIRIT application.

MIRIT is a CyberKnife® application which provides the capability to review and import DICOM images to the CKS central database.

When MIRIT is invoked, it will scan the directory of files, written by CTN_STORAGE, to determine if individual files may be associated. The association criterion is matching Study UID. If files belong to the same study they will be imported to CKS as a single dataset.

CTN_ARCHIVE server application imports the received DICOM files within SQL database and a DICOM hierarchical directory [2] of the InView® local database and the MultiPlan® cache database.

The CTN_SEND application pushes the DICOM files to the remote AEs, supporting DICOM Storage as SCP. The DICOM files are exported from the CyberKnife® TPS or MultiPlan® and InView® applications, or are stored in the CyberKnife® central database or InView® local database.

CTN_SEND is initiated by the user of the CyberKnife® TPS or MultiPlan® and InView® applications after exporting DICOM RT files.

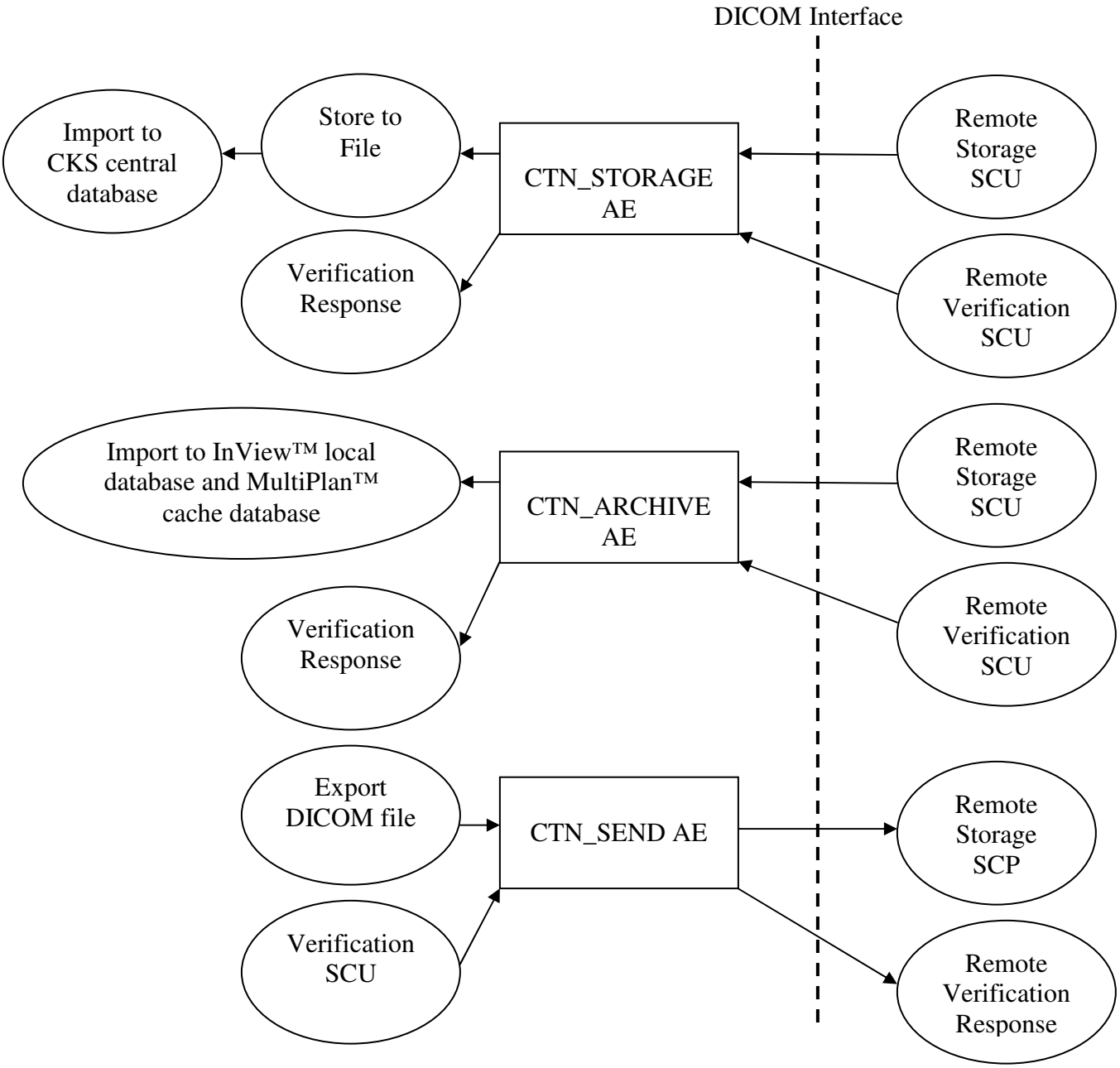

Figure 1: Application Data Flow Diagram

2.2 Functional Definitions of Application Entity

The CTN_STORAGE server application waits until it receives a C-STORE request from a remote SCU. Upon receipt, it saves the received data to a directory with a unique file name. The server handles an association at a time.

CTN_STORAGE is a daemon, started at CKS user login, which runs continuously except for the treatment time.

CTN_ARCHIVE server application waits until it receives a C-STORE request from a remote SCU. Upon receipt, it saves the received data to a DICOM hierarchical directory with a unique file name and inserts the header information to SQL database. The server handles an association at a time.

CTN_ARCHIVE is a service, started right after booting the CyberKnife® MultiPlan® and InView® workstations, which run continuously.

The CTN_SEND application invokes a C-STORE DIMSE service with a SOP instance and then an association will be established with the AE identified by the user. Information objects will be transferred one at a time until there are no more to transfer.

CTN_SEND and CTN_STORAGE/CTN_ARCHIVE serve in the SCU role and the SCP role respectively for SOP classes of the Storage Service Class.

2.3 Sequencing of Real-World Activities

The CyberKnife® has no way of knowing when it has a complete study or what constitutes a complete study. Users should be aware of how many DICOM image files constitute a complete image study before importing to the CKS central database.

3 AE Specifications

3.1 Supported Storage Service Object Pair (SOP) Classes by CyberKnife® System as an SCP

Table 1. Storage SOP Classes Supported by CyberKnife® as an SCP

SOP Class Name	SOP Class UID
Verification SOP Class	1.2.840.10008.1.1
CT Image Storage	1.2.840.10008.5.1.4.1.1.2
MR Image Storage	1.2.840.10008.5.1.4.1.1.4
Positron Emission Tomography Image Storage	1.2.840.10008.5.1.4.1.1.128
RT Dose Storage	1.2.840.10008.5.1.4.1.1.481.2
RT Structure Set Storage	1.2.840.10008.5.1.4.1.1.481.3
Philips Private CX Image Storage	1.3.46.670589.2.4.1.1
X-Ray Angiographic Image Storage	1.2.840.10008.5.1.4.1.1.12.1

3.1.1 Association Establishment Policies

3.1.1.1 General

The default maximum PDU size which can be received by the CTN_STORAGE/CTN_ARCHIVE server is configurable which a default value of 16KB and a maximum value of 32KB.

The CTN_STORAGE server needs at least 150MB free disk space to run.

For configuration information, see the Configuration Section 10.

3.1.1.2 Number of Associations

The number of simultaneous associations which will be accepted by the CTN_STORAGE/CTN_ARCHIVE server are limited only by the kernel parameters of the underlying TCP/IP implementation. The CTN_STORAGE/CTN_ARCHIVE server will spawn a new process/thread for each association request that it receives. Therefore, the CTN_STORAGE/CTN_ARCHIVE server can have multiple simultaneous connections, and there is no inherent limitation on the total number of simultaneous associations which the CTN_STORAGE/CTN_ARCHIVE server can maintain.

The CTN_STORAGE/CTN_ARCHIVE server does limit each external Application Entity to no more than two simultaneous associations.

3.1.1.3 Asynchronous Nature

Not supported.

3.1.1.4 Implementation Identifying Information

Not applicable.

3.1.2 Association Initiation Policy

The CTN_STORAGE/CTN_ARCHIVE AE does not initiate associations.

3.1.3 Association Acceptance Policy

When CTN_STORAGE accepts an association, it will receive supported image SOP Instances and store them on disk. CTN_STORAGE does not limit who may connect to it.

When the CTN_ ARCHIVE accepts an association, it will receive supported image SOP Instances and store them in its database that needs to be configured in CTNControl database. The CTN_ ARCHIVE does not limit who may connect to it.

When Verification SCP accepts an association it responds with a success status.

3.1.3.1 Associated Real-World Activity – Store Request from an External Node

The associated Real-World activity associated with the C-STORE operation is the storage of the image on the disk of the system upon which the CTN_STORAGE/CTN_ARCHIVE server is running. Images are stored by writing the data set of the C-STORE command directory to disk with no further header or interpretation.

The CTN_STORAGE/CTN_ARCHIVE server application responds to remote C-ECHO requests.

The CTN_STORAGE server application will automatically handle request for image storage and store them on receipt of C-STORE requests. The file will be stored in the directory specified at startup of the daemon.

The CTN_ARCHIVE server application updates an image database with patient, study, series and image information after the image is stored to disk.

3.1.3.2 Presentation Context Table

Any of the Presentation Contexts shown in Table 2 is acceptable to the CyberKnife® for receiving and importing information objects.

Table 2. Presentation Contexts for the CyberKnife® System

Presentation Contexts Table			
Abstract Syntax	**Transfer Syntax**	**Role**	**Extended**

SOP Name	UID	Name	UID		Negotiation
Verification	1.2.840.10008.1.1	Implicit VR Little Endian	1.2.840.10008.1.2	SCP	None
CT Image Storage	1.2.840.10008.5.1.4.1.1.2	Implicit VR Little Endian	1.2.840.10008.1.2	SCP	None
MR Image Storage	1.2.840.10008.5.1.4.1.1.4	Implicit VR Little Endian	1.2.840.10008.1.2	SCP	None
Positron Emission Tomography Image Storage	1.2.840.10008.5.1.4.1.1.128	Implicit VR Little Endian	1.2.840.10008.1.2	SCP	None
RT Dose Storage	1.2.840.10008.5.1.4.1.1.481.2	Implicit VR Little Endian	1.2.840.10008.1.2	SCP	None
RT Structure Set Storage	1.2.840.10008.5.1.4.1.1.481.3	Implicit VR Little Endian	1.2.840.10008.1.2	SCP	None
Philips Private CX Image Storage	1.3.46.670589.2.4.1.1	Implicit VR Little Endian	1.2.840.10008.1.2	SCP	None
X-Ray Angiographic Image Storage	1.2.840.10008.5.1.4.1.1.12.1	Implicit VR Little Endian	1.2.840.10008.1.2	SCP	None

3.1.3.2.1 Presentation Context Acceptance Criterion

The CTN_STORAGE/CTN_ARCHIVE server will accept any number of storage SOP classes that are listed in Table 2 above, provided that the requesting application is known to the CTN_ARCHIVE server and has been enabled to store images on the CyberKnife® MultiPlan® and InView® (via a configuration step). The CTN_STORAGE/CTN_ARCHIVE server defines

no limit on the number of presentation contexts accepted. In the event that the CTN_STORAGE/CTN_ARCHIVE server runs out of resources when trying to accept multiple presentation contexts, it will reject the association request.

The CTN_STORAGE/CTN_ARCHIVE server does not check for duplicate presentation contexts and will accept duplicate presentation contexts.

3.1.3.2.2 Transfer Syntax Selection Policies

The CTN_STORAGE/CTN_ARCHIVE server only supports the Implicit VR Little Endian transfer syntax. Any proposed presentation context which includes the Implicit VR Little Endian transfer syntax will be accepted with the Implicit VR Little Endian transfer syntax. Any proposed presentation context that does not include the Implicit VR Little Endian transfer syntax will be rejected.

Note: DICOM Part 10 format is recommended to use one of the DICOM Transfer Syntaxes support explicit Value Representation encoding to facilitate interpretation of File Meta Element Values (See PS 3.5 of the DICOM Standard), such as Explicit VR Little Endian Transfer Syntax(UID=1.2.840.10008.1.2.1).

3.1.3.3 SOP Specific Conformance

3.1.3.4 SOP Specific Conformance to Verification SOP Class

The CTN_STORAGE/CTN_ARCHIVE provides standard conformance to the DICOM Verification Service Class.

3.1.3.5 SOP Specific Conformance to Storage SOP Class

The table shown below lists the Modules that are received and imported by the CKS central database, the InView® local database, and the MultiPlan® cache database. Unlisted Modules are not used by the CyberKnife® system. References in the right column are to DICOM standard, Part 3 (Information Object Definitions).

Module Name	Reference
Patient	C.7.1.1
General Study	C.7.2.1
General Series	C.7.3.1
Frame of Reference	C.7.4.1
General Equipment	C.7.5.1
General Image	C.7.6.1
Image Plane	C.7.6.2
Image Pixel	C.7.6.3
Multi-Frame	C.7.6.6
VOI LUT	C.11.2
SOP Common	C.12.1
CT Image	C.8.2.1

MR Image	C.8.3.1
XA Image	C.8.7.1
PET Image	C.8.9.4

The CTN_STORAGE/CTN_ARCHIVE implements Level 2 (Full) conformance for the Storage SOP Class, but the CyberKnife® system only uses a subset of the attributes as described in the Notes column.

3.1.3.5.1 Patient Module

Attribute Name	Tag	Type	VR	Notes
Patient Name	(0010,0010)	2	PN	Displayed to the user. User can modify the first time an image study for a given patient is imported to the CKS central database. Displayed in InView®.
Patient ID	(0010,0020)	2	LO	Displayed to the user. This attribute is the key identifier in the CKS central database. Displayed in InView®.
Patient Birth Date	(0010,0030)	2	TM	Not used.
Patient Birth Time	(0010,0032)	3	TM	Not used.
Patient Sex	(0010,0040)	2	CS	Not used.

3.1.3.5.2 General Study Module

Attribute Name	Tag	Type	VR	Notes
Study Instance UID	(0020,000D)	1	UI	Displayed to the user. Used to associate multiple images into a single case in the CKS central database. Displayed in InView®.
Study Date	(0008,0020)	2	DA	Displayed in InView®.
Study Time	(0008,0030)	2	TM	Not used.
Referring Physician Name	(0008,0090)	2	PN	Displayed to the user. Can be modified by the user when image is imported to the CKS central database.
Study ID	(0020,0010)	2	SH	Not used.
Accession Number	(0008,0050)	2	SH	Not used.
Study Description	(0008,1030)	3	LO	Displayed in InView®.

3.1.3.5.3 General Series Module

Attribute Name	Tag	Type	VR	Notes
Modality	(0008,0060)	1	CS	Determine special processing required for interpretation of the image data. CKS currently supports 'CT', 'MR', 'PT', 'XA' and 'RTSTRUCT'. InView® additionally supports 'RTDOSE'.
Series Instance UID	(0020,000E)	1	UI	Displayed in InView®.
Series Description	(0008,103E)	3	LO	Displayed in InView®. After MultiPlan® 2.0 and CyberKnife® 7.0, it is used to initialize the CyberKnife respiration phase for GE and SIEMENS 4D CT scanners with the below conversion protocol. • The conversion of GE : Accuray T=0% (full Inhale): 50% T=10% : 60% T=20% : 70% T=30% : 80% T=40% : 90% T=50% (full Exhale): 0% T=60% : 10% T=70% : 20% T=80% : 30% T=90% : 40% T=100%(full Inhale) : 50% • The conversion of SIEMENS: Accuray 0% Exhale (=0% Inhale): 0% 20% Inhale: 10% 40% Inhale: 20% 60% Inhale: 30% 80% Inhale: 40% 100% Inhale (=100% Exhale): 50% 80% Exhale: 60% 60% Exhale: 70% 40% Exhale: 80% 20% Exhale: 90% Validated 4D CT scanners include:

				• GE MEDICAL SYSTEMS, Discovery ST • SIEMENS, Sensation Open
Series Number	(0020,0011)	2	IS	Not used.
Patient Position	(0018,5100)	2C	CS	Determine the orientation of the scan for TPS and FSN rendering. Currently CKS and MultiPlan® support 'HFS', and 'FFS'. However, InView® only supports 'HFS'.

3.1.3.5.4 Frame of Reference Module

Attribute Name	Tag	Type	VR	Notes
Frame of Reference UID	(0020,0052)	1	UI	For CT and MR data, this attribute must be the same for every image in the series.

3.1.3.5.5 General Equipment Module

Attribute Name	Tag	Type	VR	Notes
Manufacturer	(0008,0070)	2	LO	Required for validation in CKS. Validated CT scanners include: • GE MEDICAL SYSTEMS, LightSpeed16, LightSpeed Plus, LightSpeed Pro16, LightSpeed QX/i, LightSpeed Ultra, Discovery LS, HiSpeed, HiSpeed LX\i, HiSpeed QX\i, HiSpeed NX/i • Marconi Medical Systems, PQ5000 (Picker) • Philips, Mx8000, Mx8000 IDT, PQ5000 • SIEMENS, Volume Zoom, SOMATOM

				PLUS 4, Emotion, Emotion Duo, Somatom Sensation 16 • Varian Medical Systems, CTScanner • TOSHIBA, Aquilion Validated MR scanners include: • GE MEDICAL SYSTEMS, GENESIS_SIGNA, SIGNA EXCITE • Philips Medical Systems, Gyroscan Intera (Picker), ACS • SIEMENS, MAGNETOM VISION, Symphony, Harmony Expert • Canon Medical Systems Validated PET scanners include: • GE MEDICAL SYSTEMS, Discovery LS, Discovery QX\i • CPS, 1023/1062/1080 Validated XA scanners include: • Philips Medical Systems, Integris 3D-RA Release2 Validated Workstations include: • Marconi Medical Systems, AcQSim, • VARIAN Medical Systems, Vision 7.1 (Somavision), Vision 7.1/7.2/7.3(Eclipse) • MDS NORDION, TheraplanPlus, Helax-TMS • ADAC, Pinnacle3 • NOMOS CORVUS5.0 • GE AdvantageSim • 3DLine DYART • MIMvista FUSION

				See also Manufacturer Model Name (0008, 1090) for more specific models. InView® uses "Accuray Inc." to check if DICOM RT comes from Accuray.
Pixel Padding Value	(0028,0120)	3	SS	Not used.

3.1.3.5.6 General Image Module

Attribute Name	Tag	Type	VR	Notes
Instance Number	(0020,0013)	2	IS	Not used.

3.1.3.5.7 Image Plane Module

Attribute Name	Tag	Type	VR	Notes
Pixel Spacing	(0028,0030)	1	DS	Physical distance in the patient between the center of each pixel.
Image Orientation (Patient)	(0020,0037)	1	DS	CKS uses this info to reorient image buffer in different patient position (0018, 5100). MultiPlan® and InView® use this info to define the patient coordinate system.
Image Position (Patient)	(0020,0032)	1	DS	CKS uses the value of the X and Y coordinates to recalculate the ROI coordinates of RT Structure Set in TPS. CKS uses the value of the Z coordinate to determine "slice thickness" and "slice number". MultiPlan® and InView® use this info to define the patient coordinate system.
Slice Thickness	(0018,0050)	2	DS	CKS uses to identify "variable slice thickness" errors. Default 10% tolerance can be modified.
Slice Location	(0020,1041)	3	DS	Not used.

3.1.3.5.8 Image Pixel Module

Attribute Name	Tag	Type	VR	Notes
Samples per Pixel	(0028,0002)	1	US	Must be 1.
Photometric Interpretation	(0028,0004)	1	CS	Must be 'MONOCHROME1' or 'MONOCHROME2'
Rows	(0028,0010)	1	US	Number of rows in the image
Columns	(0028,0011)	1	US	Number of columns image
Bits Allocated	(0028,0100)	1	US	Number of bits allocated for each pixel sample.
Bits Stored	(0028,0101)	1	US	Number of bits stored for each pixel sample.
High Bit	(0028,0102)	1	US	Most significant bit for each pixel sample.
Pixel Representation	(0028,0103)	1	US	Data representation of the pixel samples. CKS currently supports both unsigned integer and 2's complement.
Pixel Data	(7FE0,0010)	1	OW	Pixel Data.
Pixel Aspect Ratio	(0028,0034)	1C	IS	Must be 1/1.

3.1.3.5.9 Multi-Frame

Attribute Name	Tag	Type	VR	Notes
Number of Frames	(0028,0008)	1	IS	The number of pixel in Z coordinate for dose volume, 3D dose grid. Required for InView®
Frame Increment Pointer	(0028,0009)	1	AT	

3.1.3.5.10 VOI LUT Module

Attribute Name	Tag	Type	VR	Notes
Window Center	(0028,1050)	3	UI	Not used.
Window Width	(0028,1051)	1C	UI	Not used.

3.1.3.5.11 SOP Common Module

Attribute Name	Tag	Type	VR	Notes
SOP Class UID	(0008,0016)	1	UI	Not used.
SOP Instance UID	(0008,0018)	1	UI	Not used.

3.1.3.5.12 CT Image Module

Attribute Name	Tag	Type	VR	Notes
Image Type	(0008,0008)	1	CS	'ORIGINAL/PRIMARY/AXIAL' or 'ORIGINAL/PRIMARY/LOCALIZER' which indicates scout image in Picker CT scanner. 'DERIVED/SECONDARY' indiciates mixed or fused image from MultiPlan® and InView®.
Samples per Pixel	(0028,0002)	1	US	Value = 1
Photometric Interpretation	(0028,0004)	1	CS	'MONOCHROME1' or 'MONOCHROME2'
Bits Allocated	(0028,0100)	1	US	Value = 16
Bits Stored	(0028,0101)	1	US	Value = 12 to 16
High Bit	(0028,0102)	1	US	Value = 11 to 15
Rescale Intercept	(0028,1052)	1	DS	The value b in relationship between stored value (SV) and Hounsfield (HU). HU = m * SV + b Used to scale data to CT number (CT) via Hounsfield Units in TPS. CT = HU + 1000 = m*SV + b + 1000.
Rescale Slope	(0028,1053)	1	DS	m in the equation specified in Rescale Intercept (0028,1052). Used to scale data to CT number via Hounsfield Units in TPS.
Gantry/Detector Tilt	(0018,1120)	3	DS	If present, Value = zero. Otherwise, CKS does not allow import to the central database.

3.1.3.5.13 MR Image Module

Attribute Name	Tag	Type	VR	Notes
Image Type	(0008,0008)	1	CS	'ORIGINAL/PRIMARY/OTHER' or 'DERIVED/SECONDARY' indiciates mixed or fused image from MultiPlan® and InView®.
Samples per Pixel	(0028,0002)	1	US	Value = 1
Photometric Interpretation	(0028,0004)	1	CS	'MONOCHROME1' or 'MONOCHROME2'
Bits Allocated	(0028,0100)	1	US	Value = 16

3.1.3.5.14 XA Image Module

Attribute Name	Tag	Type	VR	Notes
Image Type	(0008,0008)	1	CS	'DERIVED/SECONDARY' indicates the reconstructed 3DRA image from Philips Integris scanner.
Samples per Pixel	(0028,0002)	1	US	Value = 1
Photometric Interpretation	(0028,0004)	1	CS	'MONOCHROME2'
Bits Allocated	(0028,0100)	1	US	Value = 16

3.1.3.5.15 PET Image Module

Attribute Name	Tag	Type	VR	Notes
Image Type	(0008,0008)	1	CS	'ORIGINAL/PRIMARY' or 'DERIVED/SECONDARY' indiciates mixed or fused image from MultiPlan® and InView®.
Samples per Pixel	(0028,0002)	1	US	Value = 1
Photometric Interpretation	(0028,0004)	1	CS	'MONOCHROME2'
Bits Allocated	(0028,0100)	1	US	Value = 16
Bits Stored	(0028,0101)	1	US	Value = 16
High Bit	(0028,0102)	1	US	Value = 15
Rescale Intercept	(0028,1052)	1	DS	Value = 0 The value b in relationship between stored value (SV) and Hounsfield (HU). HU = m * SV + b Used to scale data to pixel number (PET) via Hounsfield Units in TPS. PET = HU + 1000 = m*SV + b

				+ 1000.
Rescale Slope	(0028,1053)	1	DS	m in the equation specified in Rescale Intercept (0028,1052). Used to scale data to pixel number via Hounsfield Units in TPS.
Frame Reference Time	(0054,1300)	1	DS	Not used
Image Index	(0054,1330)	1	US	Not used

3.1.3.6 SOP Specific Conformance to RT Structure Set Storage SCP

The CTN_STORAGE/CTN_ARCHIVE implements Level 2 (Full) conformance for the Storage SOP Class, but the CyberKnife® system only uses a subset of the attributes described in Section 4.

3.1.3.7 SOP Specific Conformance to RT Dose Storage SCP

The CTN_ARCHIVE implements Level 2 (Full) conformance for the Storage SOP Class, but the CyberKnife® system only uses a subset of the attributes described in Section 6.

3.2 Supported Storage Service Object Pair (SOP) Classes by CyberKnife® System as an SCU

Table 3. Storage SOP Classes Supported by CyberKnife® as an SCU

SOP Class Name	SOP Class UID
Verification SOP Class	1.2.840.10008.1.1
CT Image Storage	1.2.840.10008.5.1.4.1.1.2
MR Image Storage	1.2.840.10008.5.1.4.1.1.4
Positron Emission Tomography Image Storage	1.2.840.10008.5.1.4.1.1.128
RT Dose Storage	1.2.840.10008.5.1.4.1.1.481.2
RT Structure Set Storage	1.2.840.10008.5.1.4.1.1.481.3
X-Ray Angiographic Image Storage	1.2.840.10008.5.1.4.1.1.12.1

3.2.1 Association Establishment Policies

3.2.1.1 General

In TPS application, the CTN_SEND attempts to establish an association when the user chooses the Export DICOM RT menu item and selects a remote node which performs the store operations. The user may select to send the RT Structure Set and RT Dose and CT Image set associated with DICOM RT or any combination of those information objects. The RT Structure Set sent includes all organs contours created for the CT image study and the RT Dose sent includes any combination of dose grid, DVH, and isodose curves.

In InView® application, the CTN_SEND attempts to establish an association when the user chooses the SAVE button of global tool on the right-hand side of user interface and selects a local or remote node which performs the store operations. The user may select to send the fused moving image, mixed image, Volume of Interest (VOI), and original fixed and moving image set. The Volume of Interest which is RT Structure Set includes all organs contours created for the CT image study.

In MultiPlan® application, the CTN_SEND attempts to establish an association when the user chooses the PUSH button of global tool on the right-hand side of user interface and selects a remote node which performs the export operations. The user may select to send the fused moving image, mixed image, Volume of Interest (VOI), RT Dose, and original fixed and moving image set. The Volume of Interest which is RT Structure Set includes all organs contours created for the CT image study and the RT Dose includes any combination of dose grid, DVH, and isodose curves.

The CTN_SEND will keep the association up until the selected information objects have been sent.

The maximum PDU size which can be transmitted by the CTN_SEND is fixed at 16KB.

For configuration information, see Configuration Section 10.

3.2.1.2 Number of Associations

The CyberKnife® system establishes only one simultaneous association at a time.

3.2.1.3 Asynchronous Nature

Not supported.

3.2.1.4 Implementation Identifying Information

The implementation Class UID uniquely defines system. This will be **1.2.840.114358.< DEVICE_SERIAL_ID>**

3.2.2 Association Initiation Policy

3.2.2.1 Associated Real-World Activity – Push Request to an External Node

The CTN_SEND application sends the C-ECHO requests to the remote AE.

The CTN_SEND application will automatically handle request for storage services and transfer them on sending C-STORE requests.

3.2.2.2 Presentation Context Table

Any of the Presentation Contexts shown in Table 4 is acceptable to the CyberKnife® for pushing and exporting information objects.

Table 4. Presentation Contexts for the CyberKnife® System

Presentation Contexts Table					
Abstract Syntax		**Transfer Syntax**		**Role**	**Extended Negotiation**
SOP Name	**UID**	**Name**	**UID**		
Verification	1.2.840.10008.1.1	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	Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None
MR Image Storage	1.2.840.10008.5.1.4.1.1.4	Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None
Positron Emission Tomography Image Storage	1.2.840.10008.5.1.4.1.1.128	Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None
RT Dose Storage	1.2.840.10008.5.1.4.1.1.481.2	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	Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None

X-Ray Angiographic Image Storage	1.2.840.10008.5.1.4.1.1.12.1	Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None

3.2.2.3 SOP Specific Conformance

3.2.2.4 SOP Specific Conformance to Verification SOP Class

The CTN_SEND provides standard conformance to the DICOM Verification Service Class.

3.2.2.5 SOP Specific Conformance to Storage SOP Class

The table shown below lists the Modules that are sent and exported by the CyberKnife® TPS or MultiPlan® and InView® applications. Unlisted Modules are not used by the CyberKnife® system. References in the right column are to DICOM standard, Part 3 (Information Object Definitions).

Module Name	Reference
Patient	C.7.1.1
General Study	C.7.2.1
General Series	C.7.3.1
Frame of Reference	C.7.4.1
General Equipment	C.7.5.1
General Image	C.7.6.1
Image Plane	C.7.6.2
Image Pixel	C.7.6.3
Multi-Frame	C.7.6.6
VOI LUT	C.11.2
SOP Common	C.12.1
CT Image	C.8.2.1
MR Image	C.8.3.1
PET Image	C.8.9.4

The CTN_SEND implements Level 2 (Full) conformance for the Storage SOP Class, but the CyberKnife® system only uses a subset of the attributes as described in the Notes column.

3.2.2.5.1 Patient Module

Attribute Name	Tag	Type	VR	Notes
Patient Name	(0010,0010)	2	PN	Reused from the associated CT Image set for the DICOM RT

				export. Reused from the secondary Image set for the mixed or fused image export.
Patient ID	(0010,0020)	2	LO	Reused from the associated CT Image set for the DICOM RT export. Reused from the secondary Image set for the mixed or fused image export.
Patient Birth Date	(0010,0030)	2	TM	Reused from the associated CT Image set for the DICOM RT export. Reused from the secondary Image set for the mixed or fused image export.
Patient Sex	(0010,0040)	2	CS	Reused from the associated CT Image set for the DICOM RT export. Reused from the secondary Image set for the mixed or fused image export.

3.2.2.5.2 General Study Module

Attribute Name	Tag	Type	VR	Notes
Study Instance UID	(0020,000D)	1	UI	Reused from the associated CT Image set for the DICOM RT export, but for the mixed or fused image export, 1.2.840.<accuray>.<device>.<uid> <accuray>=114358 <device> = value of (0018,1000)
Study Date	(0008,0020)	2	DA	Reused from the associated CT Image set for the DICOM RT export.
Study Time	(0008,0030)	2	TM	Reused from the associated CT Image set for the DICOM RT export.
Referring Physician Name	(0008,0090)	2	PN	Reused from the associated CT Image set for the DICOM RT export.
Study ID	(0020,0010)	2	SH	Reused from the associated CT Image set for the DICOM RT

				export.
Accession Number	(0008,0050)	2	SH	Reused from the associated CT Image set for the DICOM RT export.
Study Description	(0008,1030)	3	LO	Entered by users for the DICOM RT export.

3.2.2.5.3 Frame of Reference Module

Attribute Name	Tag	Type	VR	Notes
Frame of Reference UID	(0020,0052)	1	UI	Reused from the associated CT Image set for export DICOM RT, but for the mixed or fused image export, 1.2.840.<accuray>.<device>.<uid> <accuray>=114358 <device> = value of (0018,1000)

3.2.2.5.4 General Series Module

Attribute Name	Tag	Type	VR	Notes
Modality	(0008,0060)	1	CS	'RTSTRUCT', 'RTDOSE' Reused from the secondary Image set for the mixed or fused image export except for 3DRA which is 'MR'
Series Instance UID	(0020,000E)	1	UI	1.2.840.<accuray>.<device>.<uid> <accuray>=114358 <device> = value of (0018,1000)
Series Description	(0008,103E)	3	LO	Entered by users for the DICOM RT export.
Series Number	(0020,0011)	2	IS	Reused from the associated CT Image set for the DICOM RT export.
Patient Position	(0018,5100)	2C	CS	Reused from the associated CT Image set for the DICOM RT export. Reused from the secondary Image set for the mixed or fused image export.

3.2.2.5.5 General Equipment Module

Attribute Name	Tag	Type	VR	Notes
Manufacturer	(0008,0070)	2	LO	'Accuray Inc.'
Manufacturer's Model	(0008,1090)	3	LO	CyberKnife Version number from the *Version* file.
Device Serial Number	(0018,1000)	3	LO	<device_serial_no> = CyberKnife Site number from the *site_name.dat* datafile.
Software Versions	(0018,1020)	3	LO	TPS or MultiPlan® and InView® Version number

3.2.2.5.6 General Image Module

Attribute Name	Tag	Type	VR	Notes
Instance Number	(0020,0013)	2	IS	Not used.

3.2.2.5.7 Image Plane Module

Attribute Name	Tag	Type	VR	Notes
Pixel Spacing	(0028,0030)	1	DS	Physical distance in the patient between the center of each pixel.
Image Orientation (Patient)	(0020,0037)	1	DS	Reused from the associated CT Image set
Image Position (Patient)	(0020,0032)	1	DS	TPS uses the value of the X and Y coordinates to recalculate the ROI coordinates of RT Structure Set, but MultiPlan® and InView® don't. CKS uses the value of the Z coordinate to determine "slice spacing" and "slice number".
Slice Thickness	(0018,0050)	2	DS	
Slice Location	(0020,1041)	3	DS	Not used.

3.2.2.5.8 Image Pixel Module

Attribute Name	Tag	Type	VR	Notes
Samples per Pixel	(0028,0002)	1	US	Value = 1
Photometric Interpretation	(0028,0004)	1	CS	Value = 'MONOCHROME2'
Rows	(0028,0010)	1	US	Number of rows in the image
Columns	(0028,0011)	1	US	Number of columns in the image
Bits Allocated	(0028,0100)	1	US	Value = 16
Bits Stored	(0028,0101)	1	US	Value = 16
High Bit	(0028,0102)	1	US	Value = 15
Pixel Representation	(0028,0103)	1	US	Value = 0
Pixel Data	(7FE0,0010)	1	OW	Pixel Data.
Pixel Aspect Ratio	(0028,0034)	1C	IS	Not used

3.2.2.5.9 Multi-Frame

Attribute Name	Tag	Type	VR	Notes
Number of Frames	(0028,0008)	1	IS	The number of pixel in Z coordinate for dose volume, 3D dose grid. Required for TPS and MultiPlan MultiPlan®
Frame Increment Pointer	(0028,0009)	1	AT	Value = '3004000c' which referred to Grid Frame Offset Vector(3004, 000C)

3.2.2.5.10 VOI LUT Module

Attribute Name	Tag	Type	VR	Notes
Window Center	(0028,1050)	3	UI	Not used.
Window Width	(0028,1051)	1C	UI	Not used.

3.2.2.5.11 SOP Common Module

Attribute Name	Tag	Type	VR	Notes
SOP Class UID	(0008,0016)	1	UI	RT Dose = "1.2.840.10008.5.1.4.1.1.481.2" RT Structure Set = "1.2.840.10008.5.1.4.1.1.481.3" CT Image ="1.2.840.10008.5.1.4.1.1.2" MR Image ="1.2.840.10008.5.1.4.1.1.4" Positron Emission Tomography ="1.2.840.10008.5.1.4.1.1.128"
SOP Instance UID	(0008,0018)	1	UI	1.2.840.<accuray>.<device>.<uid> <accuray>=114358 <device> = value of (0018,1000)

3.2.2.5.12 CT Image Module

Attribute Name	Tag	Type	VR	Notes
Image Type	(0008,0008)	1	CS	'DERIVED/SECONDARY' indiciates mixed or fused image from MultiPlan® and InView®.
Samples per Pixel	(0028,0002)	1	US	Value = 1
Photometric Interpretation	(0028,0004)	1	CS	'MONOCHROME2'
Bits Allocated	(0028,0100)	1	US	Value = 16
Bits Stored	(0028,0101)	1	US	Value = 12 to 16
High Bit	(0028,0102)	1	US	Value = 11 to 15
Rescale Intercept	(0028,1052)	1	DS	Value = -1000.0 The value b in relationship between stored value (SV) and Hounsfield (HU). HU = m * SV + b Used to scale data to CT number (CT) via Hounsfield Units in TPS. CT = HU + 1000 = m*SV + b + 1000.
Rescale Slope	(0028,1053)	1	DS	Value = 0 m in the equation specified in Rescale Intercept (0028,1052). Used to scale data to CT number via Hounsfield Units in TPS.
Gantry/Detector Tilt	(0018,1120)	3	DS	If present, Value = zero.

				Otherwise, CKS does not allow import to the central database.

3.2.2.5.13 MR Image Module

Attribute Name	Tag	Type	VR	Notes
Image Type	(0008,0008)	1	CS	'DERIVED/SECONDARY' indiciates mixed or fused image from MultiPlan® and InView®.
Samples per Pixel	(0028,0002)	1	US	Value = 1
Photometric Interpretation	(0028,0004)	1	CS	'MONOCHROME2'
Bits Allocated	(0028,0100)	1	US	Value = 16

3.2.2.5.14 PET Image Module

Attribute Name	Tag	Type	VR	Notes
Image Type	(0008,0008)	1	CS	'DERIVED/SECONDARY' indiciates mixed or fused image from MultiPlan® and InView®.
Samples per Pixel	(0028,0002)	1	US	Value = 1
Photometric Interpretation	(0028,0004)	1	CS	'MONOCHROME2'
Bits Allocated	(0028,0100)	1	US	Value = 16
Bits Stored	(0028,0101)	1	US	Value = 16
High Bit	(0028,0102)	1	US	Value = 15
Rescale Intercept	(0028,1052)	1	DS	Value = -1000.0 The value b in relationship between stored value (SV) and Hounsfield (HU). HU = m * SV + b Used to scale data to pixel number (PET) via Hounsfield Units in TPS. PET = HU + 1000 = m*SV + b + 1000.
Rescale Slope	(0028,1053)	1	DS	Value = 0 m in the equation specified in Rescale Intercept (0028,1052). Used to scale data to pixel

				number via Hounsfield Units in TPS.
Frame Reference Time	(0054,1300)	1	DS	Not used
Image Index	(0054,1330)	1	US	Not used

3.2.2.6 SOP Specific Conformance to RT Structure Set Storage SCU

The CTN_SEND implements Level 2 (Full) conformance for the Storage SOP Class, but the CyberKnife® system only uses a subset of the attributes described in Section 5.

3.2.2.7 SOP Specific Conformance to RT Dose Storage SCU

The CTN_SEND implements Level 2 (Full) conformance for the Storage SOP Class, but the CyberKnife® system only uses a subset of the attributes described in Section 7.

3.2.3 Association Acceptance Policy

The CTN_SEND AE does not accept associations.

4 RT Structure Set Information Object Implementation (RT Structure Set Storage SCP)

This section specifies the use of the DICOM RT Structure Set Information Object Definition (IOD) by the Treatment Planning System (TPS), and MultiPlan® and InView® applications.

4.1 RT Stucture Set IOD Implemenation

This section defines the implementation of the RT Structure Set information object by the Treatment Planning System (TPS), and MultiPlan® and InView® applications in the CyberKnife® System. It refers to DICOM v3.0 standard, Part 3 (Information Object Definitions). The TPS and MultiPlan® and InView® applications import and display a RT Structure Set as Regions of Interest (ROI) in the corresponding CT image study via the same Study UID.

4.1.1 Entity Relationship Model

Refer to section A.19.2 in DICOM standard, Part 3(Information Object Definitions) for the E_R Model of the RT Structure Set IOD and a description of each of the entities contained within it.

4.1.2 CyberKnife® Mapping of DICOM Entities

DICOM entities map to CyberKnife® entities in the following manner:

DICOM	CyberKnife®	
	Central Database	**InView® Local Database**
Patient Entity	Patient Entity (set from associated CT Image)	Patient Entity
Study Entity	Case Entity (set from associated CT Image)	Study Entity
Series Entity	Not mapping	Series Entity
Equipment Entity	Not used	Not used
Structure Set	TPS and MultiPlan® geometric information related to defined ROI	InView® geometric information related to defined VOI

4.2 RT Structure Set IOD Module Table

The table in this section describes the mandatory modules to support the RT Structure Set IOD. The Reference column refers to sections in this document.

Entity Name	Module Name	Reference	Usage
Patient	Patient	3.1.3.5.1	M
Study	General Study	3.1.3.5.2	M
	Patient Study	Not used	U
Series	RT Series	3.1.3.5.3	M
Equipment	General Equipment	3.1.3.5.5	M
Structure Set	Structure Set	4.3.1	M
	ROI Contour	4.3.2	M
	RT ROI Observations	4.3.3	M
	Approval	Not used	U
	Audio	Not used	U
	SOP Common	3.1.3.5.10	M

4.3 Information Module Definitions – RT Structure Set

4.3.1 Structure Set Module

The table shown below lists the elements in the Structure Set Module that are read by the TPS ,and MultiPlan® and InView® applications. Unlisted elements are not used by the applications. The Notes column describes special considerations for the usage of each element. Refer to section C.8.8.5 of the DICOM standard, Part 3(Information Object Definitions) for a complete Structure Set Module.

Attribute Name	Tag	Type	VR	Notes
Structure Set Label	(3006,0002)	1	SH	In MultiPlan® and InView®, Value = 'CyRIS<RTSS_VERSION>' which is used to distinguish if RTSS is exported from MultiPlan® and InView® for advanced contouring capability.
Structure Set Date	(3006,0008)	2	DA	Not used.
Structure Set Time	(3006,0009)	2	TM	Not used.
Referenced Frame of Reference Sequence	(3006,0010)	3	SQ	Introduces the sequence describing the frame of reference for the data set. Not used in TPS, and MultiPlan® and InView®.
>Frame of Reference UID	(0020,0052)	1C	UI	Must equal the Frame of Reference UID of the corresponding CT image study.

				Not used in TPS, and MultiPlan® and InView®.
>RT Referenced Study Sequence	(3006,0012)	3	SQ	Not used in TPS, and MultiPlan® and InView®.
Structure Set ROI Sequence	(3006,0020)	3	SQ	Sequence contains items corresponding to organs. Required for TPS, and MultiPlan® and InView®.
>ROI Number	(3006,0022)	1C	IS	ROI number used to make an association with ROI Contour Module and RT ROI Observations Module. Required for TPS, and MultiPlan® and InView®. MultiPlan® and InView® use ROI number to be a unique number which consists of VOI ID as 16-bit MSB and Contour set ID as 16-bit LSB to support the multiple Contour set feature.
>Referenced Frame of Reference UID	(3006,0024)	1C	UI	Equal to the Frame of Reference UID above. Not used in TPS, and MultiPlan® and InView®.
>ROI Name	(3006,0026)	2C	LO	Organ name. Required for TPS, and MultiPlan® and InView®. MultiPlan® and InView® have different ROI Name per Contour set.
>ROI Generation Algorithm	(3006,0036)	2C	CS	'AUTOMATIC', 'SEMIAUTOMATIC', 'MANUAL' depending on the method used to outline the organ. Not used in TPS. MultiPlan® and InView® use 'AUTOMATIC' to set the interpolation flag of the VOI.

4.3.2 ROI Contour Module

The table shown below lists the elements in the ROI Contour Module that are read by the TPS and InView® applications. Unlisted elements are not used by the applications. The Notes

column indicates special considerations for the usage of each element. Refer to section C.8.8.6 in DICOM standard, Part 3(Information Object Definitions) for a complete ROI Contour Module.

Attribute Name	Tag	Type	VR	Notes
ROI Contour Sequence	(3006,0039)	1	SQ	Sequence contains items corresponding to organs. Required for TPS, and MultiPlan® and InView®.
>Referenced ROI Number	(3006,0084)	1	IS	ROI number used to make an association with Structure Set Module and RT ROI Observations Module. Required for TPS, and MultiPlan® and InView®.
> ROI Display Color	(3006,002A)	3	IS	RGB triplet color representation for ROI, specified using the range 0-255. Not used in TPS, but in MultiPlan® and InView®.
>Contour Sequence	(3006,0040)	3	SQ	Sequence contains items corresponding to the contours used to define the ROI (organs). Required for TPS, and MultiPlan® and InView®.
>>Contour Number	(3006,0048)	3	IS	Not used in TPS. MultiPlan® and InView® refer to Contour ID
>>Contour Geometric Type	(3006,0042)	1C	CS	Must be 'CLOSED_PLANAR'. Required for TPS, and MultiPlan® and InView®.
>>Number of Contour Points	(3006,0046)	1C	IS	Number of points in Contour Data (3006, 0050). Required for TPS, and MultiPlan® and InView®.
>>Contour Data	(3006,0050)	1C	DS	Sequence of points stored as (x, y, z) triplets defining a contour in the patient-based coordinate system. Required for TPS, and MultiPlan® and InView®.
>>Contour Image Sequence	(3006,0016)	3	SQ	Sequence contains 1 item corresponding to the image to which the contour applies.

				TPS uses this information first, but if this value doesn't exist, TPS'll use the geometric information of Contour Data (3006,0050) instead. MultiPlan® and InView® always use the geometric information of Contour Data (3006,0050) instead.
>>>Referenced SOP Class UID	(0008,1150)	1C	UI	
>>>Referenced SOP Instance UID	(0008,1155)	1C	UI	

4.3.3 RT ROI Observations Module

The table shown below lists the elements in the RT ROI Observations Module that are read by the TPS and InView® applications. Unlisted elements are not used by the applications. The Notes column indicates special considerations for the usage of each element. Refer to section C.8.8.8 in DICOM standard, Part 3(Information Object Definitions) for a complete RT ROI Observations Module.

Attribute Name	Tag	Type	VR	Notes
ROI Contour Observations Sequence	(3006,0080)	1	SQ	Sequence contains items corresponding to organs. Required for TPS, and MultiPlan® and InView®.
>Observation Number	(3006,0082)	1	IS	Not used in TPS. In MultiPlan® and InView®, it is the same unique number as ROI Number (3006,0022).
>Referenced ROI Number	(3006,0084)	1	IS	ROI number used to make an association with Structure Set Module and ROI Contour Module. Required for TPS, and MultiPlan® and InView®.
>ROI Observation Label	(3006,0085)	3	SH	Not used in TPS. In MultiPlan® and InView®, It refers to ContourSet plane and its value = 'AXIAL', 'SAGITTAL', ' CORONAL'.

>RT Related ROI Sequence	(3006,0030)	3	SQ	Introduces sequence of significantly related ROIs, e.g. CTVs contained within a PTV. Required for MultiPlan® and InView®.
>>Referenced ROI Number	(3006,0084)	1C	IS	ROI number used to make an association with Structure Set Module and RT ROI Observations Module. Required for TPS, and MultiPlan® and InView®.
>>RT ROI Relationship	(3006,0033)	3	CS	Contour Set Geometry Type Value = 'SAME' as Solid Value = 'ENCLOSED' as Cavity
>RT ROI Interpreted Type	(3006,00A4)	2	CS	Type of ROI. Defined terms: EXTERNAL = external patient contour PTV = Planning Target Volume CTV = Clinical Target Volume GTV = Gross Tumor Volume. ORGAN = patient organ Not used in TPS, but in InView®. MultiPlan® and InView® use 'ORGAN' and 'EXTERNAL' as a critical structure, and 'GTV' and 'PTV' as a tumor site to perform the automatic classification.
> ROI Interpreter	(3006,00A6)	2	PN	Name of person performing the interpretation. Not used in TPS and MultiPlan® and InView®.

5 RT Structure Set Information Object Implementation (RT Structure Set Storage SCU)

This section specifies the use of the DICOM RT Structure Set Information Object Definition (IOD) by the Treatment Planning System (TPS) application.

5.1 RT Stucture Set IOD Implemenation

This section defines the implementation of the RT Structure Set information object by the Treatment Planning System (TPS), and MultiPlan® and InView® applications in the CyberKnife® System. It refers to DICOM v3.0 standard, Part 3 (Information Object Definitions). The TPS, and MultiPlan® and InView® applications display and export a RT Structure Set as Regions of Interest (ROI) in the corresponding CT image study via the same Study UID.

5.1.1 Entity Relationship Model

Refer to section A.19.2 in DICOM standard, Part 3(Information Object Definitions) for the E_R Model of the RT Structure Set IOD and a description of each of the entities contained within it.

5.1.2 CyberKnife® Mapping of DICOM Entities

DICOM entities map to CyberKnife® entities in the following manner:

DICOM	CyberKnife®	
	Central Database	**InView® Local Database**
Patient Entity	Patient Entity (set from associated CT Image)	Patient Entity
Study Entity	Case Entity (set from associated CT Image)	Study Entity
Series Entity	Not mapping	Series Entity
Equipment Entity	Not used	Not used
Structure Set	TPS and MultiPlan® geometric information related to defined ROI After MultiPlan® 2.0, geometric information saved as “rtss.dcm” for a deliverable plan.	InView® geometric information related to defined VOI

5.2 RT Structure Set IOD Module Table

The table in this section describes the mandatory modules to support the RT Structure Set IOD. The Reference column refers to sections in this document.

Entity Name	Module Name	Reference	Usage
Patient	Patient	3.2.2.5.1	M
Study	General Study	3.2.2.5.2	M
	Patient Study	Not used	U
Series	RT Series	3.2.2.5.4	M
Equipment	General Equipment	3.2.2.5.5	M
Structure Set	Structure Set	5.3.1	M
	ROI Contour	5.3.2	M
	RT ROI Observations	5.3.3	M
	Approval	Not used	U
	Audio	Not used	U
	SOP Common	3.2.2.5.9	M

5.3 Information Module Definitions – RT Structure Set

5.3.1 Structure Set Module

The table shown below lists the elements in the Structure Set Module that are exported by the TPS, and MultiPlan® and InView® applications. Unlisted elements are not used by the applications. The Notes column indicates special considerations for the usage of each element. Refer to section C.8.8.5 in DICOM standard, Part 3(Information Object Definitions) for a complete Structure Set Module.

Attribute Name	Tag	Type	VR	Notes
Structure Set Label	(3006,0002)	1	SH	In TPS, Value = 'ACCURAY_RTSS' In MultiPlan® and InView®, Value = 'CyRIS<RTSS_VERSION>'
Structure Set Date	(3006,0008)	2	DA	Required for TPS, and MultiPlan® and InView®.
Structure Set Time	(3006,0009)	2	TM	Required for TPS, and MultiPlan® and InView®.
Referenced Frame of Reference Sequence	(3006,0010)	3	SQ	Introduces the sequence describing the frame of reference for the data set.

				Not used in TPS, and MultiPlan® and InView®.
>Frame of Reference UID	(0020,0052)	1C	UI	Must equal the Frame of Reference UID of the corresponding CT image study. Not used in TPS, and MultiPlan® and InView®.
>RT Referenced Study Sequence	(3006,0012)	3	SQ	Not used in TPS and InView®.
Structure Set ROI Sequence	(3006,0020)	3	SQ	Sequence contains items corresponding to organs. Required for TPS, and MultiPlan® and InView®.
>ROI Number	(3006,0022)	1C	IS	ROI number used to make an association with ROI Contour Module and RT ROI Observations Module. Required for TPS, and MultiPlan® and InView®. MultiPlan® and InView® use ROI number to be a unique number which consists of VOI ID as 16-bit MSB and Contour set ID as 16-bit LSB to support the multiple Contour set feature.
>Referenced Frame of Reference UID	(3006,0024)	1C	UI	Equal to the Frame of Reference UID above. Not used in TPS, and MultiPlan® and InView®.
>ROI Name	(3006,0026)	2C	LO	Organ name. Required for TPS, and MultiPlan® and InView®. MultiPlan® and InView® have different ROI Name per Contour set. MultiPlan® uses case insensitive Value = 'SKIN' to determine RT ROI Interpreted Type = 'EXTERNAL' for RTOG compliant.
>ROI Generation Algorithm	(3006,0036)	2C	CS	Required for TPS, and MultiPlan® and InView®. In TPS, Value = 'MANUAL' In MultiPlan® and InView®,

				Value = ‘MANUAL’ or ‘AUTOMATIC’.

5.3.2 ROI Contour Module

The table shown below lists the elements in the ROI Contour Module that are exported by the TPS and InView® applications. Unlisted elements are not used by the applications. The Notes column indicates special considerations for the usage of each element. Refer to section C.8.8.6 in DICOM standard, Part 3(Information Object Definitions) for a complete ROI Contour Module.

Attribute Name	Tag	Type	VR	Notes
ROI Contour Sequence	(3006,0039)	1	SQ	Sequence contains items corresponding to organs. Required for TPS, and MultiPlan® and InView®.
>Referenced ROI Number	(3006,0084)	1	IS	ROI number used to make an association with Structure Set Module and RT ROI Observations Module. Required for TPS, and MultiPlan® and InView®.
> ROI Display Color	(3006,002A)	3	IS	RGB triplet color representation for ROI, specified using the range 0-255. Required for MultiPlan® and InView®.
>Contour Sequence	(3006,0040)	3	SQ	Sequence contains items corresponding to the contours used to define the ROI (organs). Required for TPS, and MultiPlan® and InView®.
>>Contour Number	(3006,0048)	3	IS	Not used in TPS. MultiPlan® and InView® refer to Contour ID
>>Contour Geometric Type	(3006,0042)	1C	CS	Required for TPS, and MultiPlan® and InView®. In TPS , Value = ‘CLOSED_PLANAR’ In MultiPlan® and InView®, Value = ‘CLOSED_PLANAR’ or ‘OPEN_PLANAR’.
>>Number of Contour Points	(3006,0046)	1C	IS	Number of points in Contour Data (3006, 0050).

				Required for TPS, and MultiPlan® and InView®.
>>Contour Data	(3006,0050)	1C	DS	Sequence of points stored as (x, y, z) triplets defining a contour in the patient-based coordinate system. Required for TPS, and MultiPlan® and InView®.
>>Contour Image Sequence	(3006,0016)	3	SQ	Sequence contains 1 item corresponding to the image to which the contour applies. Required for TPS, and MultiPlan® and InView®.
>>>Referenced SOP Class UID	(0008,1150)	1C	UI	Reused from the associated CT Image set. Required for TPS, and MultiPlan® and InView®.
>>>Referenced SOP Instance UID	(0008,1155)	1C	UI	Reused from the associated CT Image set. Required for TPS, and MultiPlan® and InView®, but in InView® sometimes, this value will be blank because the associated image slice is not found.

5.3.3 RT ROI Observations Module

The table shown below lists the elements in the RT ROI Observations Module that are exported by the TPS and InView® applications. Unlisted elements are not used by the applications. The Notes column indicates special considerations for the usage of each element. Refer to section C.8.8.8 in DICOM standard, Part 3(Information Object Definitions) for a complete RT ROI Observations Module.

Attribute Name	Tag	Type	VR	Notes
ROI Contour Observations Sequence	(3006,0080)	1	SQ	Sequence contains items corresponding to organs. Required for TPS, and MultiPlan® and InView®.
>Observation Number	(3006,0082)	1	IS	Not used in TPS. In MultiPlan® and InView®, it is the same unique number as ROI Number (3006,0022).

>Referenced ROI Number	(3006,0084)	1	IS	ROI number used to make an association with Structure Set Module and ROI Contour Module. Required for TPS, and MultiPlan® and InView®.
>ROI Observation Label	(3006,0085)	3	SH	Not used in TPS. In MultiPlan® and InView®, It refers to ContourSet plane and its value = 'AXIAL', 'SAGITTAL', ' CORONAL'.
>RT Related ROI Sequence	(3006,0030)	3	SQ	Introduces sequence of significantly related ROIs, e.g. CTVs contained within a PTV. Required for MultiPlan® and InView®.
>>Referenced ROI Number	(3006,0084)	1C	IS	ROI number used to make an association with Structure Set Module and ROI Contour Module. Required for TPS, and MultiPlan® and InView®.
>>RT ROI Relationship	(3006,0033)	3	CS	Contour Set Geometry Type Value = 'SAME' as Solid Value = 'ENCLOSED' as Cavity
>RT ROI Interpreted Type	(3006,00A4)	2	CS	Type of ROI. In TPS, Value = 'ORGAN' InView® uses 'ORGAN' as a critical structure and 'GTV' and 'PTV' as a tumor site to perform the automatic classification. In MultiPlan®, • Tumor Site = 'GTV' • Critical Site = 'ORGAN' • Skin Type = 'EXTERNAL' for RTOG complaint.
> ROI Interpreter	(3006,00A6)	2	PN	Name of person performing the interpretation. In TPS, Value = 'ADLER'. MultiPlan® and InView® use

				Window login name.

6 RT Dose Information Object Implementation (RT Dose Storage SCP)

This section specifies the use of the DICOM RT Dose Information Object Definition (IOD) by the InView® application.

6.1 RT Dose IOD Implemenation

This section defines the implementation of the RT Dose information object by the InView® application in the CyberKnife® System. It refers to DICOM v3.0 standard, Part 3 (Information Object Definitions). The InView® application displays and imports the 3D dose grid exported from TPS application in the corresponding CT image study via DICOM RT Dose for reviewing plans.

6.1.1 Entity Relationship Model

Refer to section A.18.2 in DICOM standard, Part 3(Information Object Definitions) for the E_R Model of the RT Dose IOD and a description of each of the entities contained within it.

6.1.2 CyberKnife® Mapping of DICOM Entities

DICOM entities map to CyberKnife® entities in the following manner:

DICOM	CyberKnife®	
	Central Database	**InView® Local Database**
Patient Entity	Patient Entity (set from associated CT Image)	Patient Entity
Study Entity	Case Entity (set from associated CT Image)	Study Entity
Series Entity	Not mapping	Series Entity
Equipment Entity	Not used	Not used
RT Dose	Not used	InView® volumetric information related to defined 3D dose grid.

6.2 RT Dose IOD Module Table

The table in this section describes the mandatory modules to support the RT Dose IOD. The Reference column refers to sections in this document.

Entity Name	Module Name	Reference	Usage
Patient	Patient	3.2.2.5.1	M
Study	General Study	3.2.2.5.2	M
	Patient Study	Not used	U
Series	RT Series	3.2.2.5.4	M
Frame of Reference	Frame of Reference	3.2.2.5.3	M
Equipment	General Equipment	3.2.2.5.5	M
Dose	General Image	3.2.2.5.6	C
	Image Plane	3.2.2.5.7	C
	Image Pixel	3.2.2.5.8	C
	Multi-Frame	3.2.2.5.9	C
	RT Dose	6.3.1	M
	RT DVH	6.3.2	U
	Structure Set	6.3.3	C
	ROI Contour	Not used	C
	RT Dose ROI	Not used	C
	Audio	Not used	U
	SOP Common	3.2.2.5.9	M

6.3 Information Module Definitions – RT Dose

6.3.1 RT Dose Module

The table shown below lists the elements in the RT Dose Module that are imported to the InView® application. Unlisted elements are not used by this application. Special considerations in the usage of elements are noted in the Notes column. Refer to section C.8.8.3 in DICOM standard, Part 3(Information Object Definitions) for a complete RT Dose Module.

Attribute Name	Tag	Type	VR	Notes
Dose Units	(3004,0002)	1	CS	Units used to describe dose. Value = 'GY' Required for InView®.
Dose Type	(3004,0004)	1	CS	Type of dose.

				Value = 'PHYSICAL' Required for InView®.
Dose Summation Type	(3004,000A)	1	CS	They of dose summation. Value = 'TOTALHETERO' Required for InView®. For RTOG compliant, if the total dose DVHs refer to an RT Plan which is not provided, Dose Summation Type must be one of the following terms: TOTALHOMO = DVHs computed for total plan dose without heterogeneity correction, or TOTALHETERO = DVHs computed for total plan dose with heterogeneity correction
Dose Grid Scaling	(3004,000E)	1	DS	Scaling factor that when multiplied by the dose grid data found in the Pixel Data(7FE0,0010) attribute of the Image Pixel Module, yields grid doses in the dose units as specified by Dose Units(3004,0002). Required for InView®.

6.3.2 RT DVH Module

The table shown below lists the elements in the RT DVH Module that are imported by the MultiPlan® application. Unlisted elements are not used by this application. Special considerations in the usage of elements are noted in the Notes column. Refer to section C.8.8.4 in DICOM standard, Part 3(Information Object Definitions) for a complete RT DVH Module.

Attribute Name	Tag	Type	VR	Notes
DVH Normalization Point	(3004,0040)	3	DS	Coordinates (x,y,z) of Maximum Dose value in the patient based coordinate system. Required for MultiPlan®. After MultiPlan® 2.0, it is incorporated to 3D dose grid import as a reference point.
DVH Normalization Dose Value	(3004,0042)	3	DS	Maximum dose value. Required for MultiPlan®. After MultiPlan® 2.0, it is incorporated to 3D dose grid import as a reference dose.

6.3.3 Structure Set Module

The table shown below lists the elements in the Structure Set Module that are imported by the MultiPlan® application. Unlisted elements are not used by this application. The Notes column indicates special considerations for the usage of each element. Refer to section C.8.8.5 in DICOM standard, Part 3(Information Object Definitions) for a complete Structure Set Module.

Attribute Name	Tag	Type	VR	Notes
Structure Set Label	(3006,0002)	1	SH	After MultiPlan® 2.0, Value = 'CyRIS<RTDOSE_VERSION>' which is used to distinguish if RTDOSE is exported from MultiPlan® for the normalization of dose distribution and DVH using reference dose an its point as maximum dose and its point.

7 RT Dose Information Object Implementation (RT Dose Storage SCU)

This section specifies the use of the DICOM RT Dose Information Object Definition (IOD) by the Treatment Planning System (TPS) application.

7.1 RT Dose IOD Implemenation

This section defines the implementation of the RT Dose information object by the Treatment Planning System (TPS) and MultiPlan® applications in the CyberKnife® System. It refers to DICOM v3.0 standard, Part 3 (Information Object Definitions). The TPS and MultiPlan® applications display and export a RT Dose as any combination of the 3D dose grid, DVHs, and iosdose curves in the corresponding CT image study via the same Study UID.

7.1.1 Entity Relationship Model

Refer to section A.18.2 in DICOM standard, Part 3(Information Object Definitions) for the E_R Model of the RT Dose IOD and a description of each of the entities contained within it.

7.1.2 CyberKnife® Mapping of DICOM Entities

DICOM entities map to CyberKnife® entities in the following manner:

DICOM	CyberKnife®	
	Central Database	**InView® Local Database**
Patient Entity	Patient Entity (set from associated CT Image)	Patient Entity
Study Entity	Case Entity (set from associated CT Image)	Study Entity
Series Entity	Not mapping	Series Entity
Equipment Entity	Not used	Not used
RT Dose	TPS and MultiPlan® volumetric information related to defined 3D dose grid, statistical information related to the defined DVH and geometric information related to defined isodose curves. After MultiPlan® 2.0, 3D dose grid saved as “rtdose.dcm” for a deliverable plan.	Not used

7.2 RT Dose IOD Module Table

The table in this section describes the mandatory modules to support the RT Dose IOD. The Reference column refers to sections in this document.

Entity Name	Module Name	Reference	Usage
Patient	Patient	3.2.2.5.1	M
Study	General Study	3.2.2.5.2	M
	Patient Study	Not used	U
Series	RT Series	3.2.2.5.4	M
Frame of Reference	Frame of Reference	3.2.2.5.3	M
Equipment	General Equipment	3.2.2.5.5	M
Dose	General Image	3.2.2.5.6	C
	Image Plane	3.2.2.5.7	C
	Image Pixel	3.2.2.5.8	C
	Multi-Frame	3.2.2.5.9	C
	RT Dose	7.3.1	M
	RT DVH	7.3.2	U
	Structure Set	7.3.3	C
	ROI Contour	7.3.4	C
	RT Dose ROI	7.3.5	C
	Audio	Not used	U
	SOP Common	3.2.2.5.9	M

7.3 Information Module Definitions – RT Dose

7.3.1 RT Dose Module

The table shown below lists the elements in the RT Dose Module that are exported by the TPS and MultiPlan® applications. Unlisted elements are not used by this application. Special considerations in the usage of elements are noted in the Notes column. Refer to section C.8.8.3 in DICOM standard, Part 3(Information Object Definitions) for a complete RT Dose Module.

Attribute Name	Tag	Type	VR	Notes
Dose Units	(3004,0002)	1	CS	Units used to describe dose. Value = 'GY' Required for TPS and MultiPlan®.
Dose Type	(3004,0004)	1	CS	Type of dose. Value = 'PHYSICAL'

				Required for TPS and MultiPlan®.
Dose Summation Type	(3004,000A)	1	CS	They of dose summation. Value = 'TOTALHETERO' Required for TPS and MultiPlan®. For RTOG compliant, if the total dose DVHs refer to an RT Plan which is not provided, Dose Summation Type must be one of the following terms: TOTALHOMO = DVHs computed for total plan dose without heterogeneity correction, or TOTALHETERO = DVHs computed for total plan dose with heterogeneity correction
Dose Grid Scaling	(3004,000E)	1	DS	Scaling factor that when multiplied by the dose grid data found in the Pixel Data(7FE0,0010) attribute of the Image Pixel Module, yields grid doses in the dose units as specified by Dose Units(3004,0002). Required for TPS and MultiPlan®.

7.3.2 RT DVH Module

The table shown below lists the elements in the RT DVH Module that are exported by the TPS application. Unlisted elements are not used by this application. Special considerations in the usage of elements are noted in the Notes column. Refer to section C.8.8.4 in DICOM standard, Part 3(Information Object Definitions) for a complete RT DVH Module.

Attribute Name	Tag	Type	VR	Notes
Referenced Structure Set Sequence	(300C,0060)	1	SQ	Introduces sequence of one class/instance pair describing Structure Set containing structures which are used to calculate Dose-Volume Histograms (DVHs). Only a single item shall be permitted in this sequence. Required for TPS and MultiPlan®.
>Referenced SOP Class UID	(0008,1150)	1	UI	Value = '1.2.840.10008.5.1.4.1.1.481.3' Required for TPS and MultiPlan®.
>Referenced SOP Instance UID	(0008,1155)	1	UI	Uniquely identifies the referenced SOP instance which exported by TPS and MultiPlan®. Required for TPS and MultiPlan®.

DVH Normalization Point	(3004,0040)	3	DS	Coordinates (x,y,z) of Maximum Dose value in the patient based coordinate system. Required for TPS and MultiPlan®. After MultiPlan® 2.0, it is incorporated to 3D dose grid export.
DVH Normalization Dose Value	(3004,0042)	3	DS	Maximum dose value. Required for TPS and MultiPlan®. After MultiPlan® 2.0, it is incorporated to 3D dose grid export.
DVH Sequence	(3004,0050)	1	SQ	Introduces sequence of DVHs. One or more items may be included in this sequence. Required for TPS and MultiPlan®.
>DVH Referenced ROI Sequence	(3004,0060)	1	SQ	Introduces sequence of referenced ROIs used to calculate DVH. Required for TPS and MultiPlan®.
>>Referenced ROI Number	(3006,0084)	1	IS	ROI number used to make an association with Structure Set Module and RT DVH Module. Required for TPS and MultiPlan®.
>>DVH ROI Contribution Type	(3004,0062)	1	CS	Value = 'INCLUDED' Required for TPS and MultiPlan®.
>DVH Type	(3004,0001)	1	CS	Value = 'CUMULATIVE' Required for TPS and MultiPlan®.
>Dose Units	(3004,0002)	1	CS	Units used to describe dose. Value = 'RELATIVE' Required for TPS and MultiPlan®.
>Dose Type	(3004,0004)	1	CS	Type of dose. Value = 'PHYSICAL' Required for TPS and MultiPlan®.
>DVH Dose Scaling	(3004,0052)	1	DS	Value = 0.01. Required for TPS and MultiPlan®.
>DVH Volume Units	(3004,0054)	1	CS	Volume axis units. Value = 'CM3', cubic centimeters. Required for TPS and MultiPlan®.
>DVH Number of Bins	(3004,0056)	1	IS	Number of bins n used to store DVH Data(3004, 0058). Value = 100. Required for TPS and MultiPlan®.
>DVH Data	(3004,0058)	1	DS	Required for TPS and MultiPlan®.
>DVH Minimum Dose	(3004,0070)	3	DS	Required for TPS and MultiPlan®.
>DVH	(3004,0072)	3	DS	Required for TPS and MultiPlan®.

Maximum Dose				
>DVH Mean Dose	(3004,0074)	3	DS	Required for TPS and MultiPlan®.

7.3.3 Structure Set Module

The table shown below lists the elements in the Structure Set Module that are exported by the TPS application. Unlisted elements are not used by this application. The Notes column indicates special considerations for the usage of each element. Refer to section C.8.8.5 in DICOM standard, Part 3(Information Object Definitions) for a complete Structure Set Module.

Attribute Name	Tag	Type	VR	Notes
Structure Set Label	(3006,0002)	1	SH	Value = 'CyRIS<RTDOSE_VERSION>'
Structure Set Date	(3006,0008)	2	DA	
Structure Set Time	(3006,0009)	2	TM	
Referenced Frame of Reference Sequence	(3006,0010)	3	SQ	Introduces the sequence describing the frame of reference for the data set. Not used in TPS and MultiPlan®.
>Frame of Reference UID	(0020,0052)	1C	UI	Must equal the Frame of Reference UID of the corresponding CT image study. Reused from the associated CT Image set
>RT Referenced Study Sequence	(3006,0012)	3	SQ	Not used in TPS and MultiPlan®.
Structure Set ROI Sequence	(3006,0020)	3	SQ	Sequence contains items corresponding to organs. Required for TPS.
>ROI Number	(3006,0022)	1C	IS	ROI number used to make an association with ROI Contour Module and RT Dose ROI Module. Required for TPS.
>Referenced Frame of Reference UID	(3006,0024)	1C	UI	Equal to the Frame of Reference UID above. Not used in TPS and MultiPlan®.
>ROI Name	(3006,0026)	2C	LO	The Format of ROI name is

				<view>_Slice<no>_<percent>PCT_<isodose> <view> = {AXIAL, CORONAL,SAGITTAL} <no>= the slice number <percent>= the percentage of dose value <isodose>= the isodose number Required for TPS.
>ROI Generation Algorithm	(3006,0036)	2C	CS	Value = 'AUTOMATIC' Required for TPS.

7.3.4 ROI Contour Module

The table shown below lists the elements in the ROI Contour Module that are exported by the TPS application. Unlisted elements are not used by this application. The Notes column indicates special considerations for the usage of each element. Refer to section C.8.8.6 in DICOM standard, Part 3(Information Object Definitions) for a complete ROI Contour Module.

Attribute Name	Tag	Type	VR	Notes
ROI Contour Sequence	(3006,0039)	1	SQ	Sequence contains items corresponding to organs. Required for TPS.
>Referenced ROI Number	(3006,0084)	1	IS	ROI number used to make an association with Structure Set Module and RT Dose ROI Module. Required for TPS.
>Contour Sequence	(3006,0040)	3	SQ	Sequence contains items corresponding to the contours used to define the ROI (organs). Required for TPS.
>>Contour Number	(3006,0048)	3	IS	
>>Contour Geometric Type	(3006,0042)	1C	CS	In TPS, Value = 'OPEN_PLANAR'. Required for TPS.
>>Number of Contour Points	(3006,0046)	1C	IS	Number of points in Contour Data (3006, 0050). Required for TPS.
>>Contour Data	(3006,0050)	1C	DS	Sequence of points stored as (x, y, z) triplets defining a contour in the patient-based coordinate system. Required for TPS.
>>Contour Image	(3006,0016)	3	SQ	Sequence contains 1 item

Sequence				corresponding to the image to which the contour applies.
>>>Referenced SOP Class UID	(0008,1150)	1C	UI	Reused from the associated CT Image set
>>>Referenced SOP Instance UID	(0008,1155)	1C	UI	Reused from the associated CT Image set

7.3.5 RT Dose ROI Module

The table shown below lists the elements in the RT Dose ROI Module that are exported by the TPS application. Unlisted elements are not used by this application. The Notes column indicates special considerations for the usage of each element. Refer to section C.8.8.7 in DICOM standard, Part 3(Information Object Definitions) for a complete RT Dose ROI Module.

Attribute Name	Tag	Type	VR	Notes
RT Dose ROI Sequence	(3004,0010)	1	SQ	Sequence contains items corresponding to organs. Required for TPS.
>Referenced ROI Number	(3006,0084)	1	IS	ROI number used to make an association with Structure Set Module and ROI Contour Module. Required for TPS.
>Dose Unit	(3004,0002)	1	CS	Value = 'RELATIVE' Required for TPS
>Dose Value	(3004,0012)	1	CS	Required for TPS.

8 Communication Profiles

8.1 Supported Communication Stacks

The CyberKnife® AE supports TCP/IP stack as defined in Part 8 of the DICOM 3.0 standard.

8.2 Network Media Support

The CyberKnife® AE is not concerned about the physical network media, as long as it is based on the TCP/IP stack. The default physical media is 100baseT Ethernet.

9 Extensions, Specializations, Privatizations

Not applicable.

10 Configuration

The CyberKnife® AE DICOM configuration is intended to be performed by Accuray personnel only. The host name mapping to an IP address is defined in the local host table.

The AE title of the CyberKnife® Treatment Workstation is **N1000_STORAGE** and the listening port number is **104**.

The AE title of the MultiPlan® and InView®Workstations is **TPS_<COMPUTERNAME>** and the listening port number is **104**, where **<COMPUTERNAME>** is the computer name from system environment variable. You can look it up the About Dialog of the CyberKnife® MultiPlan® and InView® applications.

For the detailed configuration information, see the Installation Instructions of the CyberKnife® System and the CyberKnife® MultiPlan® and InView® applications.

11 Support for Extended Character Sets

No extended character sets are supported by the CyberKnife® system and the CyberKnife® MultiPlan® and InView® applications. Only Support for DICOM default character set repertoire, i.e. ISO-IR6.