

# **MARCONI**

## **Voxel Q Workstations**

### **4.1.1 Software**

**DICOM Conformance Claim**

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## **INTRODUCTION**

Medical imaging devices claiming conformance to the DICOM standard must indicate in sufficient detail the service classes and information objects, as defined by the standard, to which they conform. This document details the conformance of Marconi Medical Systems, Inc.'s VoxelQ workstations to the DICOM standard, "Radiotherapy Objects" (DICOM-RT). To support DICOM communications, the VoxelQ requires software revision 3.2 or greater as well as the DICOM communications option. Software Revision 3.4 or later is required for support of DICOM-RT. This document does not attempt to detail any other Marconi CT products or other medical imaging devices manufactured by Marconi Medical Systems, Inc.

### **IMPORTANT INFORMATION FOR AcQSim/AcQPlan USERS:**

AcQSim/AcQPlan users with PQ scanners must continue to use the Ethernet-P protocol to receive CT studies in order to maintain compatibility with the Oncology packages. Studies which transfer out (SCU) are allowed to occur via DICOM, but any VQ receiving studies via DICOM will render the study compatible with Radiology packages ONLY.

AcQSim/AcQPlan users with UltraZ or AcQSimCT scanners must use DICOM to receive studies in order to maintain compatibility with the Oncology packages. Studies in (SCP) and out (SCU) of the VQ via DICOM should maintain compatibility with AcQSim/AcQPlan.

All transfers between VQs must continue to occur via Ethernet-P in order to maintain compatibility with AcQSim/AcQPlan.

All DICOM-RT objects currently supported can be transferred out (SCU) to an external (non-VQ) DICOM-RT node. DICOM-RT Plan is currently the only RT object that can be imported from an external node into AcQSim/AcQPlan.

# 1. Implementation Model

This implementation provides for simple transfer of images using the DICOM Storage Service Class. An operator on the VoxelQ may send images to another compliant node. This is done from the main VoxelQ display screen by selecting the "Network" option on the "Study" menu and choosing the desired studies and destination node.

Other compliant nodes may also send images to the VoxelQ using the DICOM Storage Service Class. This can be done anytime the VoxelQ is online. No local operator action is required to accept images.

This implementation provides for query and retrieval of images from compliant DICOM nodes using the DICOM Query/Retrieve Service Class. An operator on the VoxelQ may query a remote node to obtain a list of studies on that node. Similarly, the VoxelQ operator may retrieve these studies from that remote node. This set of operations is initiated from the main VoxelQ display screen by selecting the "Network" option on the "Study" menu and choosing the desired node to query.

## 1.1 Application Data Flow Diagram

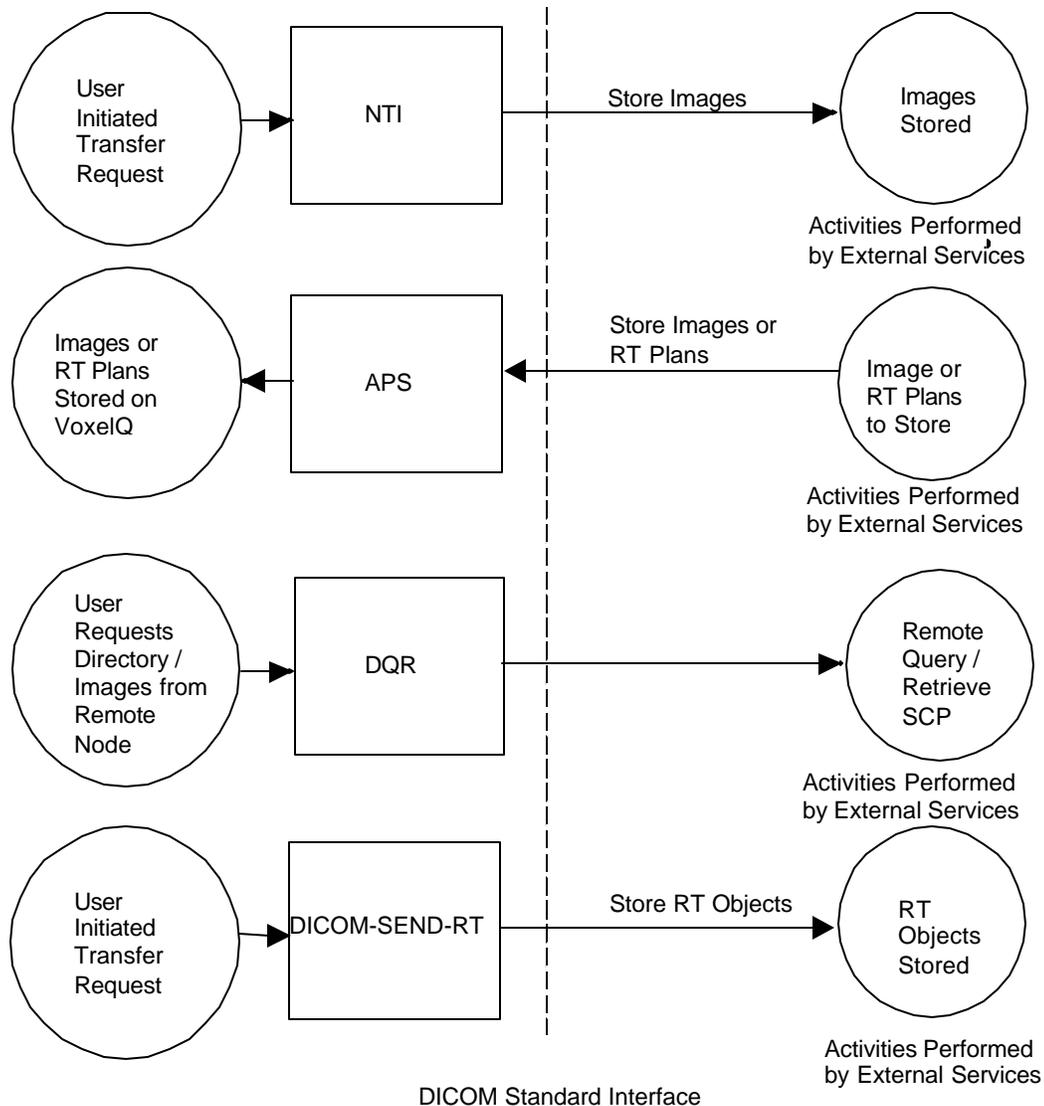
Image data is "pushed" from the VoxelQ when an operator selects a set of studies to transfer. The software package that runs to accomplish the transfer is known as the network transfer user interface (NTI).

Images may be "pulled" to the VoxelQ when the operator selects a remote node to retrieve the images from. The software that runs to support the query and retrieval of images from remote nodes is known as the DICOM Query/Retrieve software (DQR).

Images may be stored on the VoxelQ when a remote node initiates a transfer. The software that runs to support this operation on the VoxelQ is known as ACR-NEMA Provider Services software (APS). The APS software is started at system start-up time. The VoxelQ will accept images from other compliant nodes any time the system is running, subject to the availability of disk, memory, and network resources.

Similarly radiotherapy plans may be stored on the AcQSim system when a remote node initiates a transfer. The ACR-NEMA Provider Services software (APS) supports this operation as well as the storage of diagnostic images. Additional software is provided within AcQSim to allow plans received by the APS software to be associated with existing plans.

Radiotherapy data objects are "pushed" from AcQSim when an operator selects a simulation and chooses the DICOM send option from the connectivity menu. The software package that runs to accomplish the transfer is known as the AcQSim DICOM send user interface (DICOM-RT-SEND).



## 1.2 Functional definitions of AE's

When the NTI or DICOM-RT-SEND software is invoked, 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.

Likewise, when the DQR software is invoked, an association will be established with the AE identified by the user. A Query command will be done to determine the image sets available, and then Move commands will be issued to request the images desired by the operator.

After initialization, the APS software waits for a connection at the presentation address configured for its Application Entity Title. When another node connects, the presentation and application contexts are checked to see if a valid context has

been proposed. If a valid context is proposed and the association is accepted, APS waits for C-Store requests from the remote node. Incoming images are placed on the disk in a VoxelQ format.

## 2. AE Specifications

The application entities NTI, DICOM-RT-SEND and APS support the same DICOM compliance. The NTI and DICOM-RT-SEND are compliant as Storage Service Class Users. The APS is compliant as a Storage Service Class Provider.

### 2.1 NTI Specification

The NTI software provides Standard Conformance to the following DICOM SOP Classes as a Service Class User (SCU):

SOP Class Name	SOP Class UID
Verification	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
Nuclear Medicine Image Storage	1.2.840.10008.5.1.4.1.1.20
Secondary Capture Image Storage	1.2.840.10008.5.1.4.1.1.7
Stand-alone Overlay Storage	1.2.840.10008.5.1.4.1.1.8
Stand-alone Curve Storage	1.2.840.10008.5.1.4.1.1.9

The NTI software never acts in the role of a Service Class Provider (SCP).

#### 2.1.1 Association Establishment Policies

##### 2.1.1.1 General

The NTI software attempts to establish an association when the operator has chosen a set of images to transfer. NTI will keep the association up until either the operator chooses to transfer images to a different node or the operator exits the NTI software. Images are sent one at a time over the open association until all of the images have transferred successfully, the remote node's Service Class Provider software reports an error, or the remote node breaks down the association. The NTI software waits for a response message after each image is sent.

The NTI software does not place any restrictions on the maximum PDU size. If the Service Class Provider for the association does not specify a maximum PDU size, the NTI software sends PDU's of not more than 4096 bytes.

##### 2.1.1.2 Number of Associations

The VoxelQ user interface to the network transfer software allows only one transfer to occur at a time. Therefore, only one association establishment at a time will be attempted.

### 2.1.1.3 Asynchronous Nature

The images are transferred one at a time over the single association. The NTI software waits for a response after each image is sent before sending the next image. Therefore, there is no asynchronous activity in this implementation.

The Asynchronous Operations Window negotiation is not supported.

### 2.1.1.4 Implementation Identifying Information

NTI, DICOM-RT-SEND, DQR, and APS provide a single Implementation Class UID which is "2.16.840.1.113662.2.2".

## 2.1.2 Association Initiation Policy

The NTI software attempts to initiate an association whenever the VoxelQ operator selects a DICOM remote node for transfer or the operator selects studies for transfer. The implementation described here offers only the default transfer syntax.

There are two Real World Activities that cause association establishment. This first occurs when the VQ operator chooses a remote DICOM node and the second occurs when the operator selects studies to send from the study menu.

### 2.1.2.1 VQ operator chooses a remote DICOM node

#### 2.1.2.1.1 Associated Real World Activity

The operator initiates the node selection by making selections from menus on the VoxelQ screen. The operator selects "Study" from the choices at the top of the screen. When the next menu is displayed, the operator selects "Network", and then "Send studies." The operator may then pick a node from the choices provided on the screen.

#### 2.1.2.1.2 Proposed Presentation Contexts

The NTI software will propose all of the following contexts whenever an association establishment is tried. However, objects will only be sent over contexts that have been agreed upon.

Presentation Context Table					
Abstract Syntax		Transfer Syntax		Role	Ext. Neg.
Name	UID	Name List	UID list		
Verification	1.2.840.10008.1.1	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
MR Image Storage	1.2.840.10008.5.1.4.1.1.4	DICOM Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None
Nuclear Medicine Image Storage	1.2.840.10008.5.1.4.1.1.20	DICOM Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None
Secondary Capture Image Storage	1.2.840.10008.5.1.4.1.1.7	DICOM Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None
Stand-alone Overlay Storage	1.2.840.10008.5.1.4.1.1.8	DICOM Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None
Stand-alone Curve Storage	1.2.840.10008.5.1.4.1.1.9	DICOM Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None

#### 2.1.2.1.2.1 SOP Specific conformance

As a result of this Real World Activity, the NTI software will only use the Verification Service Class. It provides standard conformance to the DICOM Verification Class as a Service Class User.

#### 2.1.2.2 VQ operator selects studies to send

##### 2.1.2.2.1 Associated Real World Activity

The operator initiates the image transfers by first selecting the destination node as specified in section 2.1.2.1.1. Then the operator chooses the study or studies to transfer from the directory list on the screen.

##### 2.1.2.2.2 Proposed Presentation Contexts

The NTI software will propose all of the following contexts whenever an association establishment is tried. However, objects will only be sent over contexts that have been agreed upon.

Presentation Context Table					
Abstract Syntax		Transfer Syntax		Role	Ext. Neg.
Name	UID	Name List	UID list		
Verification	1.2.840.10008.1.1	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
MR Image Storage	1.2.840.10008.5.1.4.1.1.4	DICOM Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None

Nuclear Medicine Image Storage	1.2.840.10008.5.1.4.1.1.20	DICOM Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None
Secondary Capture Image Storage	1.2.840.10008.5.1.4.1.1.7	DICOM Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None
Stand-alone Overlay Storage	1.2.840.10008.5.1.4.1.1.8	DICOM Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None
Stand-alone Curve Storage	1.2.840.10008.5.1.4.1.1.9	DICOM Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None

#### 2.1.2.2.2.1 SOP Specific Conformance Statement

The NTI software runs silently as long as successful transfers are occurring. When all of the data which the operator requested has been transferred, the VoxelQ operator is notified via a message on the user console.

When a C-STORE Response with an unsuccessful status is returned to the NTI, the transfer is aborted and the VoxelQ operator is notified via a message on the user console.

**Warning:** C-STORE Response statuses are treated the same as successful statuses.

Extended negotiation is not supported.

Since the VoxelQ may initially receive data from other DICOM nodes, there is not a specific list of optional elements that may be sent. The VoxelQ will send DICOM data exactly as it was received including any invalid SOP instances sent to the VoxelQ from a DICOM Storage SCU.

### 2.1.3 Association Acceptance policy

The NTI software never accepts associations.

## 2.2 APS Specification

The APS software provides Standard Conformance to the following DICOM SOP Classes as a Service Class Provider (SCP):

SOP Class Name	SOP Class UID
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
Nuclear Medicine Image Storage	1.2.840.10008.5.1.4.1.1.20
Secondary Capture Image Storage	1.2.840.10008.5.1.4.1.1.7

Stand-alone Overlay Storage	1.2.840.10008.5.1.4.1.1.8
Stand-alone Curve Storage	1.2.840.10008.5.1.4.1.1.9
RT Plan Storage (AcQSim only)	1.2.840.10008.5.1.4.1.1.481.5

The APS software never acts in the role of a Service Class User (SCU).

## **2.2.1 Association Establishment Policies**

### **2.2.1.1 General**

The APS software is started at system initialization time. After initializing, the APS waits for association requests. When a successful association is made, a new process is spawned to handle requests on the association. This process will receive one request at a time, process it, and send a response before reading the next request from the network. The process will close the association if it has been idle for more than the configured time, or if the Service Class User breaks down the connection.

The APS software does not place any restrictions on the maximum PDU size. If the Service Class User for the association does not specify a maximum PDU size, the APS software sends PDU's of not more than 4096 bytes.

### **2.2.1.2 Number of Associations**

The APS software limits the number of concurrent associations to 20. However, more than 2 associations active concurrently will impact system performance. Other system resource limitations may also impact the maximum number of concurrent associations.

There are no additional restrictions on multiple simultaneous associations with a single AE.

### **2.2.1.3 Asynchronous Nature**

Although there may be concurrent associations, images are processed in a serial fashion. The APS software processes each image in turn and sends a response before processing the next image. Therefore, there is no asynchronous activity in this implementation.

The Asynchronous Operation Window negotiation is not supported.

### **2.2.1.4 Implementation Identifying Information**

NTI, DICOM-RT-SEND, DQR, and APS provide a single Implementation Class UID which is "2.16.840.1.113662.2.2".

## 2.2.2 Association Initiation Policy

The APS software never initiates associations.

## 2.2.3 Association Acceptance Policy

There is only one Real World Activity which causes association establishment. This is when a remote node tries to connect to APS.

### 2.2.3.1 Remote connection to APS

#### 2.2.3.1.1 Associated Real World Activity

The Associated Real World Activity is the attempt by a remote node to store images on the VoxelQ.

#### 2.2.3.1.2 Acceptable presentation contexts.

The table below indicates which presentation contexts will be accepted by the APS software.

Presentation Context Table					
Abstract Syntax		Transfer Syntax		Role	Ext. Neg.
Name	UID	Name List	UID list		
Verification	1.2.840.10008.1.1	DICOM 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	DICOM 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	DICOM Implicit VR Little Endian	1.2.840.10008.1.2	SCP	None
Nuclear Medicine Image Storage	1.2.840.10008.5.1.4.1.1.20	DICOM Implicit VT Little Endian	1.2.840.10008.1.2	SCP	None
Secondary Capture Image Storage	1.2.840.10008.5.1.4.1.1.7	DICOM Implicit VR Little Endian	1.2.840.10008.1.2	SCP	None
Stand-alone Overlay Storage	1.2.840.10008.5.1.4.1.1.8	DICOM Implicit VR Little Endian	1.2.840.10008.1.2	SCP	None
Stand-alone Curve Storage	1.2.840.10008.5.1.4.1.1.9	DICOM Implicit VR Little Endian	1.2.840.10008.1.2	SCP	None
RT Plan Storage (AcQSim only)	1.2.840.10008.5.1.4.1.1.481.5	DICOM Implicit VR Little Endian	1.2.840.10008.1.2	SCP	None

#### 2.2.3.1.2.1 SOP Specific Conformance to Verification SOP Class

APS provides standard conformance to the DICOM Verification Service Class.

#### 2.2.3.1.2.2 SOP Specific Conformance to the Storage SOP Classes

APS conforms to the SOP's of the Storage Service Class at Level 2 (Full). Only minimal checks for data integrity are made during the image transfer. Specifically, the APS software verifies that all required (Type 1) fields are present. When the APS software returns a successful status, the image data has been successfully stored to the disk. When an association is broken down, all of the images which have been successfully received are incorporated into the VoxelQ database. The images are sorted by Study Unique ID; all images with the same study UID received on this association will be grouped into a study on the VoxelQ. Multiple studies may be received over a single association. The images are then available to be viewed at the VoxelQ or transferred to another DICOM node. Note that an error in incorporating an image into the database (such as an incorrect Type 1 element) may result in an image not being available for viewing or transfer even though the C-STORE operation returned a successful status. Also, note that images with the same Study UID received over different associations will be placed in separate studies.

Please note these limitations:

MONOCHROME I images will be accepted without error, but cannot be processed in AcQSim and will not appear in the study list.

Nuclear Medicine studies having either a 0 or no value at all in the field Spacing Between Slices tag (0018,088) will be accepted without error, but cannot be processed in AcQSim and will not appear in the study list.

No data element coercion is performed.

Person Name type fields are not checked for DICOM compliant formatting. The fields are passed through AcQSim as is and no correction is made for fields which were improperly formatted when originally received on AcQSim.

Images are available for viewing on the VoxelQ or transmission to other nodes until they are manually deleted by the VoxelQ operator. Currently, Stand-alone Curves and Stand-alone Overlays cannot be viewed on the VoxelQ. They are maintained with the VoxelQ study to which they belong.

The APS software will return one of the following error statuses when the C-STORE command is not successful.

A700	No resources available. Either memory, disk, or network resources were exhausted.
A902	A required (Type 1 ) field is missing.
A000	Function not supported. A command other than C-Store or C-Echo was received.
A800	The SOP class of the image is not supported. Only SOP classes for which presentation contexts have been established may be sent.

#### 2.2.3.1.3 Presentation Context Acceptance Criteria

APS will always accept any of the Presentation Contexts specified in section 2.2.3.1.2. As many as seven contexts will be accepted per association.

#### 2.2.3.1.4 Transfer Syntax Acceptance Criteria

APS accepts only the DICOM default transfer syntax.

## 2.3 DQR Specification

The DQR software provides Standard Conformance to the following DICOM SOP Classes as a Service Class User (SCU):

SOP Class Name	SOP Class UID
Verification	1.2.840.10008.1.1
Study Root Query/Retrieve Information model FIND	1.2.840.10008.5.1.4.1.2.2.1
Study Root Query/Retrieve Information model MOVE	1.2.840.10008.5.1.4.1.2.2.2

The DQR software never acts in the role of a Service Class Provider (SCP).

### 2.3.1 Association Establishment Policies

#### 2.3.1.1 General

The DQR software attempts to establish an association when the operator wants to choose a set of images to transfer to the local VoxelQ. DQR will keep the association up until either the operator chooses to query a different node or the operator exits the DQR software. Once the association is established, the DQR software will issue C-Find and C-Move requests as needed to satisfy the user's commands.

The DQR software does not place any restrictions on the maximum PDU size. If the Service Class Provider for the association does not specify a maximum PDU size, the DQR software sends PDU's of not more than 4096 bytes.

### **2.3.1.2 Number of Associations**

The VoxelQ user interface to the network transfer software allows only one transfer to occur at a time. Therefore, only one association establishment at a time will be attempted.

### **2.3.1.3 Asynchronous Nature**

The DQR will issue a C-Find command, and wait for its completion before issuing a C-Move command. Only one C-Move command will be outstanding at a time. Therefore, there is no asynchronous activity in this implementation.

The Asynchronous Operations Window negotiation is not supported.

### **2.3.1.4 Implementation Identifying Information**

NTI, DICOM-RT-SEND, DQR, and APS provide a single Implementation Class UID which is "2.16.840.1.113662.2.2".

## **2.3.2 Association Initiation Policy**

The DQR software attempts to initiate an association whenever the VoxelQ operator selects a DICOM remote node or asks for a directory of studies on that node. The implementation described here offers only the default transfer syntax.

There are two Real World Activities that cause association establishment. This first occurs when the VQ operator chooses a remote DICOM node and the second occurs when the operator selects studies to send from the study menu.

### **2.3.2.1 VQ operator chooses a remote DICOM node**

#### **2.3.2.1.1 Associated Real World Activity**

The operator initiates the node selection by making selections from menus on the VoxelQ screen. The operator selects "Study" from the choices at the top of the screen. When the next menu is displayed, the operator selects "Network", and then "Get studies." The operator may then pick a node from the choices provided on the screen.

#### **2.3.2.1.2 Proposed presentation contexts.**

The DQR software will propose all of the following contexts whenever an association establishment is tried. However, objects will only be sent over contexts that have been agreed upon.

Presentation Context Table					
Abstract Syntax		Transfer Syntax		Role	Ext. Neg.
Name	UID	Name List	UID list		
Verification	1.2.840.10008.1.1	DICOM Implicit VR Little Endian	1.2.840.10008.1.2	SCU	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

### 2.3.2.1.2.1 SOP Specific conformance

As a result of this Real World Activity, the DQR software will only use the Verification Service Class. It provides standard conformance to the DICOM Verification Class as a Service Class User.

## 2.3.2.2 VQ operator selects studies to get

### 2.3.2.2.1 Associated Real World Activity

The operator initiates the image transfers by first selecting the destination node as specified in section 2.3.2.1.1. Then the operator chooses selection criteria from the choices on the screen.

### 2.3.2.2.2 Proposed presentation contexts.

The DQR software will propose all of the following contexts whenever an association establishment is tried. However, objects will only be sent over contexts that have been agreed upon.

Presentation Context Table					
Abstract Syntax		Transfer Syntax		Role	Ext. Neg.
Name	UID	Name List	UID list		
Verification	1.2.840.10008.1.1	DICOM Implicit VR Little Endian	1.2.840.10008.1.2	SCU	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

### 2.3.2.2.2.1 SOP Specific Conformance Statement

After issuing the C-Move request, the DQR waits for the resulting status. When all of the data which the operator requested has been transferred, the VoxelQ operator is notified via a message on the user console.

The DICOM 3.0 specifications provides for query-retrieves on three levels: study, series and image levels. These DICOM attributes comprise the keys in a Query Information Object definition (IOD). The following tables specify the fields that the DQR software uses at each level.

#### Study Level Key Attributes:

Attribute Name	Element Tag	Type
Study Date	(0008,0020)	Required
Study Time	(0008,0030)	Required
Accession Number	(0008,0050)	Required
Patient Name	(0010,0010)	Required
Patient ID	(0010,0020)	Required
Study Instance UID	(0020,000D)	UID
Study Number	(0020,0010)	Required
Referring Physician	(0008,1090)	Optional
Study Description	(0008,1030)	Optional
Patient Sex	(0010,0040)	Optional
Patient Age	(0010,1010)	Optional
Patient Weight	(0010,1030)	Optional

#### Series Level Key Attributes:

Attribute Name	Element Tag	Type
Modality	(0008,0060)	Required
Series Instance UID	(0020,000E)	UID
Series Number	(0020,0011)	Required
Series Date	(0008,0020)	Optional
Series Time	(0008,0030)	Optional
Study Description	(0008,1030)	Optional
Series Description	(0008,103e)	Optional
Patient Position	(0018,5100)	Optional
Position Reference Indicator	(0020,1040)	Optional

#### Image Level Key Attributes:

Attribute Name	Element Tag	Type
SOP Instance UID	(0008,0018)	UID
Image Number	(0020,0013)	Required
Image Date	(0008,0023)	Optional

Image Time	(0008,0033)	Optional
Contrast/Bolus Agent	(0018,0010)	Optional
KVP	(0018,0060)	Optional
Exposure Rate	(0018,1151)	Optional
Slice Location	(0020,1041)	Optional

The DQR software may request wild card matching on the patient name field.

The DQR software may request queries be qualified on patient name, patient ID, and study date.

The DQR software will not generate Relational Search queries.

Extended negotiation is not supported.

### 2.3.3 Association Acceptance policy

The DQR software never accepts associations.

## 2.4 DICOM-RT-SEND Specification (AcQSim only)

The DICOM-RT-SEND software provides Standard Conformance to the following DICOM SOP Classes as a Service Class User (SCU):

SOP Class Name	SOP Class UID
RT Image Storage	1.2.840.10008.5.1.4.1.1.481.1
RT Structure Set Storage	1.2.840.10008.5.1.4.1.1.481.3
RT Plan Storage	1.2.840.10008.5.1.4.1.1.481.5

DICOM-RT-SEND software never acts in the role of a Service Class Provider (SCP).

### 2.4.1 Association Establishment Policies

#### 2.4.1.1 General

The DICOM-RT-SEND software attempts to establish an association when the operator, having chosen a simulation, chooses the DICOM send option of the connectivity menu and selects a remote node to which to perform the store operations. The operator may elect to send the RT Image (with or without BEV contours), the RT Structure Set, the RT Plan, or any combination of those information objects. The RT Image sent is the DRR (digitally reconstructed radiograph) or DCR (digitally composited radiograph) displayed at the time the send is performed. The RT Structure Set sent includes all organs contours created for the study. The RT plan sent is the currently active plan. DICOM-RT-SEND

will keep the association up until the selected information objects have been sent. The selected RT Image, RT Structure Set, and the RT Plan are sent in that order over the open association until all have transferred successfully, the remote node's Service Class Provider software reports an error, or the remote node breaks down the association. The DICOM-RT-SEND software waits for a response message after each information object is sent.

The DICOM-RT-SEND software does not place any restrictions on the maximum PDU size. If the Service Class Provider for the association does not specify a maximum PDU size, the DICOM-RT-SEND software sends PDU's of not more than 4096 bytes.

#### **2.4.1.2 Number of Associations**

The AcQSim user interface to the AcQSim DICOM send software allows only one transfer to occur at a time. Therefore, only one association establishment at a time will be attempted.

#### **2.4.1.3 Asynchronous Nature**

The RT Image, RT Structure Set, and RT Plan are transferred one at a time over the single association. The DICOM-RT-SEND software waits for a response after each information object is sent before sending the next object. Therefore, there is no asynchronous activity in this implementation.

The Asynchronous Operations Window negotiation is not supported.

#### **2.4.1.4 Implementation Identifying Information**

NTI, DICOM-RT-SEND, DQR, and APS provide a single Implementation Class UID which is "2.16.840.1.113662.2.2".

### **2.4.2 Association Initiation Policy**

The DICOM-RT-SEND software attempts to initiate an association whenever the operator, having chosen a simulation, chooses the DICOM send option of the connectivity menu and selects a remote node to which to perform the store operations. The implementation described here offers only the default transfer syntax.

There is only one Real World Activity that causes association establishment. This occurs when the AcQSim operator chooses the DICOM send option of the connectivity menu and selects a remote node.

#### **2.4.2.1 VQ operator chooses a remote DICOM node**

#### 2.4.2.1.1 Associated Real World Activity

The operator initiates the node selection by making selections from menus on the AcQSim screen. The operator selects "Study" from the choices at the top of the screen. The operator then selects "Virtual Simulation" or "Verification" from the "Simulation and Planning" panel of AcQSim application menu. The operator then selects "Tools" from the choices at the top of the screen, and "Connectivity" from the menu which then appears. When the Connectivity application menu displays, the operator may then select which information objects to send from the "DICOM-RT" panel. When the operator selects "Send" from the "DICOM-RT" panel, a list of remote nodes configured into the system is displayed. The operator then picks a node from the choices provided on the screen. Since only organs displayed in "outline" mode are transmitted with the RT Image, the operator should take care to display organs of interest using that mode. Graphics not of interest should be turned off, since all displayed graphics are "burned in" to the image before it is sent.

#### 2.4.2.1.2 Proposed Presentation Contexts

The DICOM-RT-SEND software will propose all of the following contexts whenever an association establishment is tried. However, objects will only be sent over contexts that have been agreed upon.

Presentation Context Table					
Abstract Syntax		Transfer Syntax		Role	Ext. Neg.
Name	UID	Name List	UID list		
RT Image Storage	1.2.840.10008.5.1.4.1.1.481.1	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 Plan Storage	1.2.840.10008.5.1.4.1.1.481.5	DICOM Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None

#### 2.4.2.1.2.1 SOP Specific Conformance Statement

The DICOM-RT-SEND software runs silently as long as successful transfers are occurring. When all of the data which the operator requested has been transferred, the AcQSim operator is notified via a message on the user console.

When a C-STORE Response with an unsuccessful status is returned to the NTI, the transfer is aborted and the AcQSim operator is notified via a message on the user console.

**Warning:** C-STORE Response warning statuses are treated the same as failure statuses.

Extended negotiation is not supported.

## **3. Communications Profiles**

### **3.1 Supported Communications Stacks (Parts 8,9)**

Both the APS and NTI software provides DICOM 3.0 TCP/IP network communications support as defined in part 8 of the DICOM 3.0 standard.

### **3.2 TCP/IP Stack**

The TCP/IP protocol stack is supported as implemented in SunOS 4.1.

#### **3.2.1 Physical Media Support**

The following physical media connections are available on the VoxelQ:

- 10 Base T
- 10 Base 2
- 10 Base 5
- 10 Base FOIRL

An AUI connector is provided for maximum flexibility. The connector is located on the rear cover of the VoxelQ.

#### **4. Extensions/Specializations/Privatization**

No extensions, specializations, or privatization are used in this implementation.

See Appendices A and B for a discussion of the use of Curve modules by the VoxelQ and AcQSim.

## 5. Configuration

### 5.1 AE Title/Presentation Address mapping

The destination port and application title are configured for each node using the configuration utilities on the VoxelQ.

### 5.2 Configurable Parameters

Both the port that the APS software listens to and its application title are configurable. They can be changed by the configuration utilities provided on the VoxelQ by configuring the local node as if it were a remote node. The default values are port 104 and protocol "DICOM\_STORAGE". Please note that port numbers 6002, 6938, 6950, and 7020 are used for Marconi CT proprietary protocols and should not be used for the DICOM port.

The APS software will maintain an idle association for a configurable amount of time before disconnecting it. The default is 3600 seconds (1 hour). This value may be changed by editing the file "/usr/sun4.sft/network/etc/transtable" (VoxelQ) or "/usr/sol5.sft/network/etc/transtable" (UltraQ). Modify the line starting with "%MAX\_IDLE\_TIME" to the number of seconds desired. The system must be rebooted for the change to take effect.

Neither the NTI software nor the DICOM-RT-SEND software nor the APS software explicitly specifies a maximum PDU size. Therefore, there is no configuration of this field.

The DICOM option on the VoxelQ must be enabled for the NTI, DICOM-RT-SEND, APS, and DQR software to function. Please consult your Marconi representative for information on how to do this.

All UID's generated by the VoxelQ are based on Marconi's UID root. This root is "2.16.840.1.113662".

The following table shows DICOM and RT DICOM options which may be configured on a connection by connection basis by editing the "CONFIG" parameter in the "netconfig" file located in the startup home directory.

Option	Notes
CADPLAN6.0.0	Configures special naming conventions required to communicate with a Cadplan system version 6.0 or later. When absent (default), no special configuration is performed and standard DICOM is sent.
RTIMAGE_NOBURNTANNOTATIONS	When absent (default), the displayed annotations are "burned in" the pixel data of the RT Image Pixel Module and sent as part of the image. When present, displayed annotations are not "burned in".

RTPLANGEOMETRY_DEVICE	When absent (default), the RT General Plan Module data element Plan Geometry (300A,000C) is 'PATIENT'. When present, RT Plan Geometry is 'TREATMENT_DEVICE'.
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The system must be rebooted in order for changes to “netconfig” to take effect. For information on configuring DICOM connections see the section on network software configuration in the VoxelQ Technical Manual.

Support of Extended Character Sets

The VoxelQ is capable of handling the Latin 1 character set (ISO-IR 100 Latin alphabet No. 1, supplementary set). The VoxelQ will accept, send, and display images that use this character set. The VoxelQ will also accept and send images using other character sets, but data in them may not be displayed correctly. Image datasets obtained on the VoxelQ via DICOM with character sets other than Latin 1 will be sent using the same character set as was received.

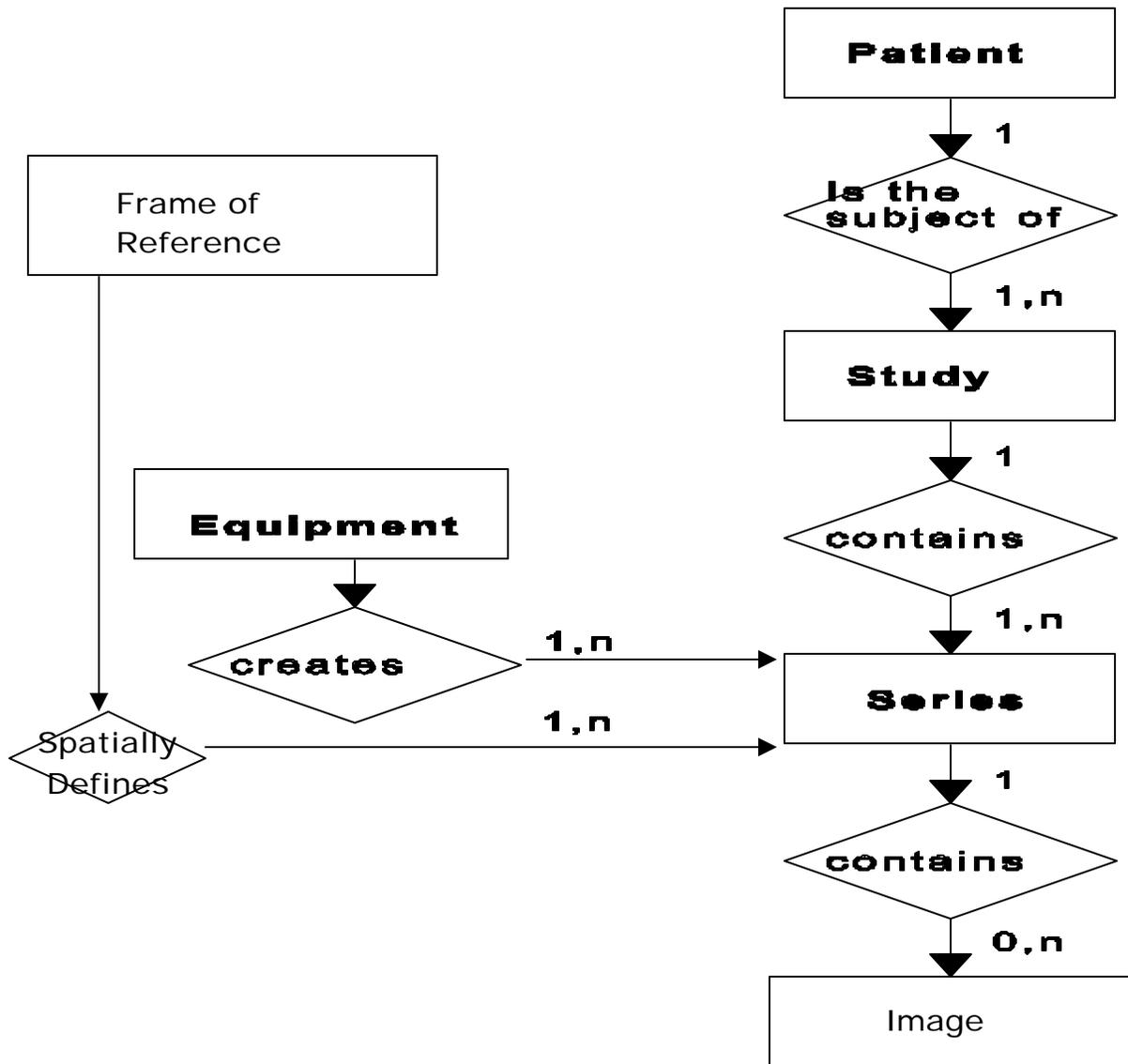
## **6. RT Image Information Object Implementation (RT Image Storage SCU)**

This section specifies the use of the DICOM RT Image Information Object Definition (IOD) by the DICOM-RT-SEND software. The DICOM-RT-SEND software implements a RT Image Storage SCU.

### **6.1 RT Image IOD Implementation**

This section defines the implementation of the RT Image information object by the DICOM-RT-SEND software in the AcQSim application. It refers to DICOM V3.0 Standard, Part 3 (Information Object Definitions). The AcQSim application does not display or support any other operations on the RT Images it creates and transmits.

## 6.2 RT Image IOD Entity – Relationship Model



The entity-relationship diagram for the RT Image interoperability scheme is shown in **Figure 1**. In this figure, the following diagrammatic convention is established to represent the information organization.

- each entity is represented by a rectangular box
- each relationship is represented by a diamond shaped box
- the fact that a relationship exists between two entities is depicted by lines connecting the corresponding entity boxes to the relationship boxes

The relationships are fully defined with the maximum number of possible entities in the relationship shown. See DICOM Part 3 Section 5.1.2 for an explanation of the entity-relationship notation.

### 6.2.1 Entity Descriptions

Refer to DICOM Standard, Part 3 (Information Object Definitions) for a description of each of the entities contained within the RT Image information object.

### 6.2.2 AcQSim Mapping of DICOM Entities

DICOM entities map to AcQSim entities in the following manner:

<b>DICOM</b>	<b>AcQSim</b>
Patient Entity	Patent Entity (VoxelQ Workstation)
Study Entity	Examination Entity (VoxelQ Workstation)
Series Entity	No mapping
Frame of Reference Entity	No mapping
Equipment Entity	Workstation on which AcQSim application is running
Image Entity	Screen Save of DRR (digitally reconstructed radiograph) or DCR (digitally composited radiograph) image only (generated from within the application using the DICOM-RT panel of the AcQSim connectivity menu). AcQSim does not directly store, manipulate, or display RT Images.

### 6.3 RT Image IOD Module Table

Within an entity of the DICOM RT Image Information Object Definition, attributes are grouped into a related set of attributes. A set of related attributes is termed a module.

A modules facilitates the understanding of the semantics concerning the attributes and how the attributes are related with each other. A module grouping does not imply any encoding of information into data sets.

**Table 1** identifies the defined modules within the entities which comprise the DICOM RT Image Information Object Definition. Modules are identified by Module Name.

See DICOM Standard, Part 3 for a complete definition of the entities, modules and attributes.

**Table 1 RT Image Information Object Definition (IOD) Module Table**

Entity Name	Module Name	Usage	Reference
Patient	Patient	M	6.4.1.1
Study	Study	M	6.4.2.1
	Patient Study	U	not used
Series	RT Series	M	6.4.3.1
Frame of Reference	Frame of Reference	U	not used
Equipment	General Equipment	M	6.4.4.1
Image	General Image	M	6.4.5.1
	Image Pixel	M	6.4.5.2
	Contrast/bolus	C	not used
	Cine	C	not used
	Multi-Frame	C	6.4.5.3
	RT Image	M	6.4.5.4
	Modality LUT	U	not used
	VOI LUT	U	not used
	Approval	U	not used
	Curve	U	6.4.5.5
	Audio	U	not used
	SOP Common	M	6.4.5.6

## 6.4 Information Module Definitions – RT Image

Please refer to DICOM Standard, Part 3 (Information Object Definitions) for a description of each of the entities and modules contained within the RT Image Information Object.

### 6.4.1 Patient Entity Modules

#### 6.4.1.1 Patient Module

##### Patient Module Attributes (M)

Attribute Name	Tag	Type	Notes
Patient's Name	(0010,0010)	2	Duplicated from patient study images if present in those images, otherwise zero-length
Patient ID	(0010,0020)	2	Duplicated from patient study images if present in those images, otherwise zero-length
Patient's Birth Date	(0010,0030)	2	Zero-length

Patient's Sex	(0010,0040)	2	Duplicated from patient study images if present and valid in those images, otherwise zero-length
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## 6.4.2 Study Entity Modules

### 6.4.2.1 General Study Module

#### General Study Module Attributes (M)

Attribute Name	Tag	Type	Notes
Study Instance UID	(0020,000D)	1	Duplicated from patient study images
Study Date	(0008,0020)	2	Duplicated from patient study images if present in those images, otherwise zero-length
Study Time	(0008,0030)	2	Duplicated from patient study images if present in those images, otherwise zero-length
Referring Physician's Name	(0008,0090)	2	Duplicated from patient study images if present in those images, otherwise zero-length
Study ID	(0020,0010)	2	Duplicated from patient study images if present in those images, otherwise zero-length
Accession Number	(0008,0050)	2	Duplicated from patient study images if present in those images, otherwise zero-length

## 6.4.3 Series Entity Modules

### 6.4.3.1 RT Series Module

#### RT Series Module Attributes (M)

Attribute Name	Tag	Type	Notes
Modality	(0008,0060)	1	'RTIMAGE'
Series Instance UID	(0020,000E)	1	Created such that all RT Images for a given AcQSim plan fall in the same series
Series Number	(0020,0011)	2	AcQSim RT Plan number

## 6.4.4 Equipment Entity Modules

### 6.4.4.1 General Equipment Module

#### General Equipment Module Attributes (M)

Attribute Name	Tag	Type	Notes
Manufacturer	(0008,0070)	2	'Marconi Medical Systems, Inc.'
Station Name	(0008,1010)	3	Station hostname

Manufacturer's Model Name	(0008,1090)	3	'AcQSim' or 'AcQPlan'
Device Serial Number	(0018,1000)	3	Station host ID
Software Version	(0018,1020)	3	'AcQSim/4.1.x' or 'AcQPlan/4.1.x'

## 6.4.5 Image Entity Modules

### 6.4.5.1 General Image Module

#### General Image Module Attributes (M)

Attribute Name	Tag	Type	Notes
Image Number	(0020,0013)	2	Number of the associated beam in AcQSim RT Plan
Patient Orientation	(0020,0020)	2C	Zero-length
Image Date	(0008,0023)	2C	AcQSim RT Plan edit date
Image Time	(0008,0033)	2C	AcQSim RT Plan edit time

### 6.4.5.2 Image Pixel Module

#### Image Pixel Module Attributes (M)

Attribute Name	Tag	Type	Notes
Samples per Pixel	(0028,0002)	1	1
Photometric Interpretation	(0028,0004)	1	'MONOCHROME2'
Rows	(0028,0010)	1	512
Columns	(0028,0011)	1	512
Bits Allocated	(0028,0100)	1	8 if Bits Stored is 8, otherwise 16
Bits Stored	(0028,0101)	1	8 or 12 depending on configuration (see section 5.2)
High Bit	(0028,0102)	1	Bits Stored – 1
Pixel Representation	(0028,0103)	1	0000H (unsigned integer)
Pixel Data	(7FE0,0010)	1	Overlaid data displayed in AcQSim may be converted to monochrome and "burned in" depending on configuration (see section 5.2)

### 6.4.5.3 Multi-Frame Module

#### Multi-Frame Module Attributes (C)

Attribute Name	Tag	Type	Notes
Number of Frames	(0028,0008)	1	'1'
Frame Increment Pointer	(0028,0009)	1	(0020,0013)

### 6.4.5.4 RT Image Module

## RT Image Module Attributes (M)

Attribute Name	Tag	Type	Notes
RT Image Label	(3002,0002)	1	Name of the associated beam in the AcQSim RT Plan truncated to 16 characters
RT Image Name	(3002,0003)	3	<i>plan_name:beam_name</i> where <i>plan_name</i> is the name of the AcQSim RT Plan and <i>beam_name</i> is the name of the associated beam in the plan
RT Operator Name	(0008,1070)	2	Planner's name
Image Type	(0008,0008)	1	'DERIVED \SECONDARY \DRR'
Conversion Type	(0008,0064)	2	'WSD'
RT Image Plane	(3002,000C)	1	'NORMAL'
Image Receptor Angle	(3002,000E)	1	'0'
Pixel Spacing	(3002,0011)	2	Pixel size
RT Image Position	(3002,0012)	2	Isocenter x,y position
Radiation Machine Name	(3002,0020)	2	Name of treatment machine selected in AcQSim for simulation of associated beam
Primary Dosimeter Unit	(300A,00B3)	2	'MU' or 'MINUTE' (Note 'MINUTE' used for cobalt only)
Radiation Machine SAD	(3002,0022)	2	SAD of the treatment machine selected in AcQSim for simulation of associated beam
RT Image SID	(3002,0026)	2	Equal to Radiation Machine SAD
Referenced RT Plan Sequence	(300C,0002)	3	Sequence contains 1 item
> Referenced SOP Class UID	(0008,1150)	1C	'1.2.840.10008.5.1.4.1.1.481.5' (RT Plan)
> Referenced SOP Instance UID	(0008,1155)	1C	SOP Instance UID of referenced RT Plan
Referenced Beam Number	(300C,0006)	3	Beam number in referenced RT plan
Exposure Sequence	(3002,0030)	3	Sequence contains 1 item
> Beam Limiting Device Sequence	(300A,00B6)	3	Sequence contains 1 or more items depending on the number of collimators defined for the treatment machine selected in AcQSim for simulation of associated beam
>> RT Beam Limiting Device Type	(300A,00B8)	1C	'X', 'Y', 'ASYMX', 'ASYMY', 'MLCX', or 'MLCY'
>> Source to Beam Limiting Device Distance	(300A,00BA)	3	Distance defined for the treatment machine selected in AcQSim for simulation of this beam
>> Number of Leaf/Jaw Pairs	(300A,00BC)	1C	Number of MLC leaves if Beam Limiting Device Type is 'MLCX' or 'MLCY', otherwise 1

Attribute Name	Tag	Type	Notes
>> Leaf Position Boundaries	(300A,00BE)	2C	If Beam Limiting Device Type is 'MLCX' or 'MLCY' of N+1 leaf position boundaries (where N is the Number of Leaf/Jaw Pairs), otherwise not present
>> Leaf/Jaw Positions	(300A,011C)	1C	Stream of 2N positions (where N is the Number of Leaf/Jaw Pairs) giving the position of the collimator jaws or MLC leaves defined in AcQSim for simulation of this beam
> Number of Blocks	(300A,00F0)	1C	Number of shielding blocks defined for associated beam.
> Block Sequence	(300A,00F4)	2C	Sequence contains number of items equal to Number of Blocks and is not present if Number of Blocks is 0
>> Source to Block Tray Distance	(300A,00F6)	2C	Zero-length
>> Block Type	(300A,00F8)	1C	'SHIELDING' or 'APERTURE'
>> Block Divergence	(300A,00FA)	2C	Zero-length
>> Block Number	(300A,00FC)	1C	Block number in the sequence starting at 1
>> Block Name	(300A,00FE)	3	Name of block defined in AcQSim
>> Material ID	(300A,00E1)	2	Zero-length
>> Block Thickness	(300A,0100)	3	Block thickness defined in AcQSim
>> Block Number of Points	(300A,0104)	2C	Number of (x,y) pairs in Block Data (a maximum of 256 supported in AcQSim and 128 in AcQPlan)
>> Block Data	(300A,0106)	2C	Stream of (x,y) pairs containing number of pairs equal to Block Number of Points
Gantry Angle	(300A,011E)	3	Gantry angle defined for the beam
Beam Limiting Device Angle	(300A,0120)	3	Collimator angle defined for the beam

#### 6.4.5.5 Curve Module

Note that the Curve Module is not sent unless the AcQSim operator elects to send BEV contours in the DICOM-RT panel of the Virtual Simulation or Verification Connectivity menu. Graphics not displayed at the time of transmission are not sent.

**NOTE: Only organs displayed in “outline” mode are sent.**

#### Curve Module Attributes (U)

Attribute Name	Tag	Type	Notes
----------------	-----	------	-------

Curve Dimensions	(50xx,0005)	1	2
Number of Points	(50xx,0010)	1	Number of points
Type of Data	(50xx,0020)	1	'POLY'
Data Value Representation	(50xx,0103)	1	0001H (signed short)
Curve Data	(50xx,3000)	1	Array of curve data values containing number of (x,y) pairs equal to Number of Points
Curve Description	(50xx,0022)	3	'Organ: <i>organ_name:color</i> ' for AcQSim organs, 'Axis:Xaxis: <i>color</i> ' or 'Axis:Yaxis: <i>color</i> ' for the coordinate axes, 'Block: <i>block_name:color</i> ' for block outlines, 'MLC:MLC: <i>color</i> ' for MLC outlines, or 'Beam: <i>beam_name:color</i> ' for beam outlines, where " <i>color</i> " is an 8-digit hexadecimal number containing the RGB value of the color used to display the curve. Graphics not displayed will not be sent. Only organs displayed in "outline" mode are sent.
Axis Units	(50xx,0030)	3	'PIXL\PIXL' (pixel units on both x and y axes)

#### 6.4.5.6 SOP Common Module

##### SOP Common Module Attributes (M)

Attribute Name	Tag	Type	Notes
SOP Class UID	(0008,0016)	1	'1.2.840.10008.5.1.4.1.1.481.1' (RT Image Storage)
SOP Instance UID	(0008,0018)	1	Note that identical RT Images transmitted from different AcQSim systems will be assigned different UID's. Note also that editing the associated AcQSim RT Plan will cause a new UID to be created for all RT Images associated with the plan.

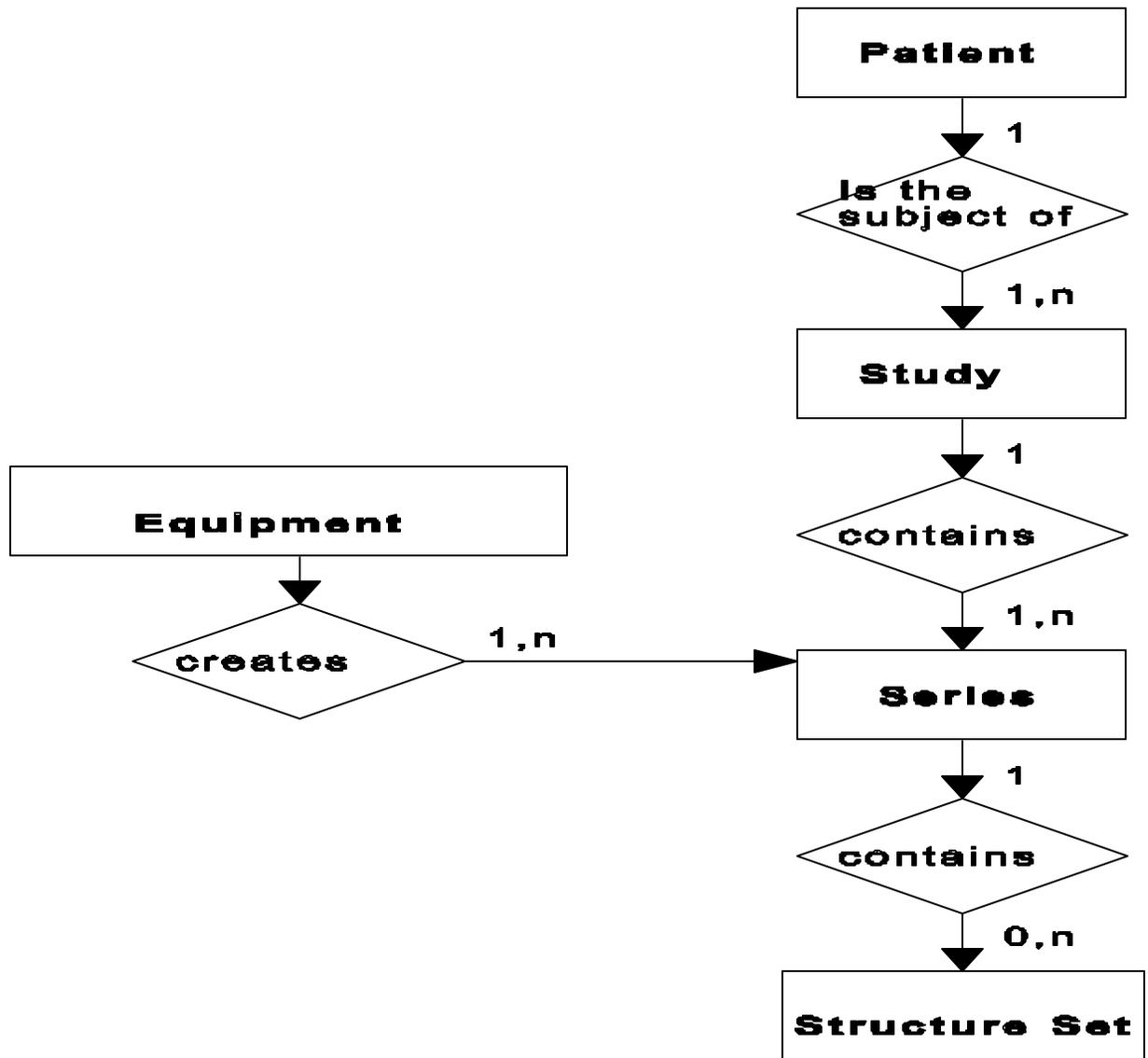
## **7. RT Structure Set Information Object Implementation (RT Structure Set Storage SCU)**

This section specifies the use of the DICOM RT Structure Set Information Object Definition (IOD) by the DICOM-RT-SEND software. The DICOM-RT-SEND software implements a RT Structure Set Storage SCU.

### **7.1 RT Structure Set IOD Implementation**

This section defines the implementation of the RT Structure Set information object by the DICOM-RT-SEND software in the AcQSim application. It refers to DICOM V3.0 Standard, Part 3 (Information Object Definitions). The AcQSim application does not display or support any other operations on the RT Structure Sets it creates and transmits.

## 7.2 RT Structure Set IOD Entity – Relationship Model



The entity-relationship diagram for the Structure Set interoperability scheme is shown in **Figure 2**. In this figure, the following diagrammatic convention is established to represent the information organization.

- each entity is represented by a rectangular box
- each relationship is represented by a diamond shaped box
- the fact that a relationship exists between two entities is depicted by lines connecting the corresponding entity boxes to the relationship boxes

The relationships are fully defined with the maximum number of possible entities in the relationship shown. See DICOM Part 3 Section 5.1.2 for an explanation of the entity-relationship notation.

### 7.2.1 Entity Descriptions

Refer to DICOM Standard, Part 3 (Information Object Definitions) for a description of each of the entities contained within the RT Structure Set information object.

### 7.2.2 AcQSim Mapping of DICOM entities

DICOM entities map to the AcQSim entities in the following manner:

DICOM	AcQSim
Patient Entity	Patient Entity (VoxelQ Workstation)
Study Entity	Examination Entity (VoxelQ Workstation)
Series Entity	No Mapping
Equipment Entity	Workstation on which AcQSim application is running
Structure Set	AcQSim geometric information relating to defined structures and markers

### 7.3 RT Structure Set IOD Module Table

Within an entity of the DICOM RT Structure Set Information Object Definition, attributes are grouped into related sets of attributes. A set of related attributes is termed a module. A module facilitates the understanding of the semantics concerning the attributes and how the attributes are related with each other. A module grouping does not imply any encoding of information into datasets.

**Table 2** identifies the defined modules within the entities which comprise the DICOM RT Structure Set Information Object Definition. Modules are identified by Module Name.

See DICOM Standard, Part 3 for a complete definition of the entities, modules and attributes.

**Table 2 RT Structure Set Information Object Definition (IOD) Module Table**

Entity Name	Module Name	Usage	Reference
Patient	Patient	M	7.4.1.1
Study	Study	M	7.4.2.1
	Patient Study	U	not used
Series	RT Series	M	7.4.3.1
Equipment	General Equipment	M	7.4.4.1
RT Structure Set	Structure Set	M	7.4.5.1
	ROI Contour	M	7.4.5.2
	RT ROI Observations	M	7.4.5.3
	Approval	U	not used
	Audio	U	not used
	SOP Common	M	7.4.5.4

## 7.4 Information Module Definitions – RT Structure Set

Please refer to DICOM Standard, Part 3 (Information Object Definitions) for a description of each of the entities and modules contained with the RT Structure Set Information Object.

### 7.4.1 Patient Entity modules

#### 7.4.1.1 Patient Module

##### Patient Module Attributes (M)

Attribute Name	Tag	Type	Notes
Patient's Name	(0010,0010)	2	Duplicated from patient study images if present in those images, otherwise zero-length
Patient ID	(0010,0020)	2	Duplicated from patient study images if present in those images, otherwise zero-length
Patient's Birth Date	(0010,0030)	2	Zero-length
Patient's Sex	(0010,0040)	2	Duplicated from patient study images if present and valid in those images, otherwise zero-length

## 7.4.2 Study Entity Modules

### 7.4.2.1 General Study Module

#### General Study Module Attributes (M)

Attribute Name	Tag	Type	Notes
Study Instance UID	(0020,000D)	1	Duplicated from patient study images
Study Date	(0008,0020)	2	Duplicated from patient study images if present in those images, otherwise zero-length
Study Time	(0008,0030)	2	Duplicated from patient study images if present in those images, otherwise zero-length
Referring Physician's Name	(0008,0090)	2	Duplicated from patient study images if present in those images, otherwise zero-length
Study ID	(0020,0010)	2	Duplicated from patient study images if present in those images, otherwise zero-length
Accession Number	(0008,0050)	2	Duplicated from patient study images if present in those images, otherwise zero-length

## 7.4.3 Series Entity Modules

### 7.4.3.1 RT Series Module

#### RT Series Module Attributes (M)

Attribute Name	Tag	Type	Notes
Modality	(0008,0060)	1	'RTSTRUCT'
Series Instance UID	(0020,000E)	1	Created such that each Structure Set falls in a series by itself
Series Number	(0020,0011)	2	'1'

## 7.4.4 Equipment Entity Modules

### 7.4.4.1 General Equipment Module

#### General Equipment Module Attributes (M)

Attribute Name	Tag	Type	Notes
Manufacturer	(0008,0070)	2	'Marconi Medical Systems.'
Station Name	(0008,1010)	3	Station hostname
Manufacturer's Model Name	(0008,1090)	3	'AcQSim' or 'AcQPlan'
Device Serial Number	(0018,1000)	3	Station host ID

Software Version	(0018,1020)	3	'AcQSim/4.1.x' or 'AcQPlan/4.1.x'
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## 7.4.5 Structure Set Entity Modules

### 7.4.5.1 Structure Set Module

#### Structure Set Module Attributes (M)

Attribute Name	Tag	Type	Notes
Structure Set Label	(3006,0002)	1	AcQSim RT Plan name truncated to 16 characters
Structure Set Name	(3006,0004)	3	<i>pat_name:pat_id:study_id</i> where <i>pat_name</i> is the Patient's Name (0010,0010), <i>pat_id</i> is the Patient ID (0010,0020), and <i>study_id</i> is the Study ID (0020,0010) from the patient study images
Structure Set Date	(3006,0008)	2	Date organs defined in AcQSim for this patient study were last edited
Structure Set Time	(3006,0009)	2	Time organs defined in AcQSim for this patient study were last edited
Referenced Frame of Reference Sequence	(3006,0010)	3	Sequence contains 1 item
> Frame of Reference UID	(0020,0052)	1C	Duplicated from the Series UID of the patient study images
> RT Referenced Study Sequence	(3006,0012)	3	Sequence contains 1 item
>> Referenced SOP Class UID	(0008,1150)	1C	'1.2.840.10008.3.1.2.3.2' (Study Management)
>> Referenced SOP Instance UID	(0008,1155)	1C	Duplicated from the Study UID of the patient study images
>> RT Referenced Series Sequence	(3006,0014)	1C	Sequence contains 1 item
>>> Series Instance UID	(0020,000E)	1C	Duplicated from the Series UID of the patient study images
>>> Contour Image Sequence	(3006,0016)	1C	Sequence contains one item for each image on which a structure set contour is present
>>>> Referenced SOP Class UID	(0008,1150)	1C	'1.2.840.10008.5.1.4.1.1.481.3' (RT SSET Store)
>>>> Reference SOP Instance UID	(0008,1155)	1C	Duplicated from the Image UID of the patient study images
Structure Set ROI Sequence	(3006,0020)	3	Sequence contains items corresponding to organs defined in AcQSim
> ROI Number	(3006,0022)	3	Structure set (AcQSim organ) number in the sequence starting at 0

> Referenced Frame of Reference UID	(3006,0024)	1C	Equal to the Frame of Reference UID above
> ROI Name	(3006,0026)	2C	AcQSim organ name
> ROI Generation Algorithm	(3006,0036)	2C	'AUTOMATIC', 'SEMIAUTOMATIC', 'MANUAL', or zero-length depending on the AcQSim method used to outline the organ

### 7.4.5.2 ROI Contour Module

#### ROI Contour Module Attributes (M)

Attribute Name	Tag	Type	Notes
ROI Contour Sequence	(3006,0039)	1	Sequence contains items corresponding to organs defined in AcQSim
> Referenced ROI Number	(3006,0084)	1	ROI (AcQSim organ) number in the sequence starting at 0
> Contour Sequence	(3006,0040)	3	Sequence contains items corresponding to the contours used to define the ROI (AcQSim organ)
>> Contour Image Sequence	(3006,0016)	3	Sequence contains 1 item corresponding to the image to which the contour applies
>>> Referenced SOP Class UID	(0008,1150)	1C	'1.2.840.10008.5.1.4.1.1.2' (CT Image Storage)
>>> Referenced SOP Instance UID	(0008,1155)	1C	Duplicated from the Image UID of the patient study images
>> Contour Geometric Type	(3006,0042)	1C	'CLOSED_PLANAR'
>> Number of Contour Points	(3006,0046)	1C	Number of points in Contour Data 92-1024
>> Contour Data	(3006,0050)	1C	Sequence of points stored as (x,y,z) triplets defining a contour in the patient-based coordinate system

### 7.4.5.3 RT ROI Observations Module

#### RT ROI Observations Module Attributes (M)

Attribute Name	Tag	Type	Notes
RT ROI Observations Sequence	(3006,0080)	1	Sequence contains items corresponding to organs defined in AcQSim
> Observation Number	(3006,0082)	1	AcQSim assigns sequential numbers to the observations in the sequence starting at 0
> Referenced ROI Number	(3006,0084)	1	ROI number

> RT ROI Interpreted Type	(3006,00A4)	2	AcQSim uses DICOM-RT terminology in naming and typing organs
> ROI Interpreter	(3006,00A6)	2	Creator of the organ in AcQSim
> ROI Physical Properties Sequence	(3006,00B0)	3	Sequence contains 1 item
>> ROI Physical Property	(3006,00B2)	1C	'REL_MASS_DENSITY'
>> ROI Physical Property Value	(3006,00B4)	1C	AcQSim organ density (in the range '0.0' to '4.095')

#### 7.4.5.4 SOP Common Module

##### SOP Common Module Attributes (M)

Attribute Name	Tag	Type	Notes
SOP Class UID	(0008,0016)	1	'1.2.840.10008.5.1.4.1.1.481.3' (Structure Set Storage)
SOP Instance UID	(0008,0018)	1	Note that identical Structure Sets transmitted from different AcQSim systems will be assigned different UID's. Note also that editing any organ contours will cause a new UID to be created for the Structure Set.

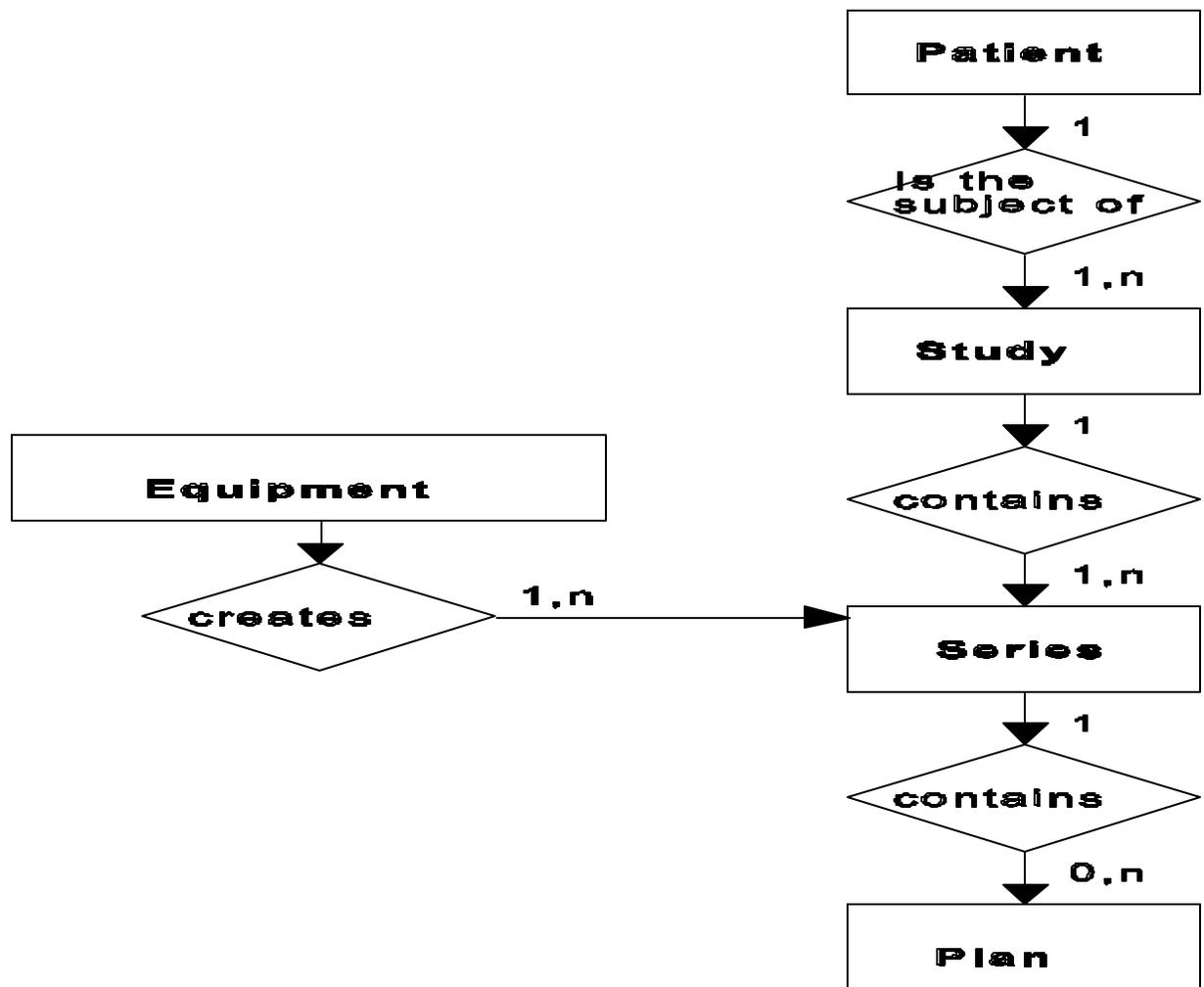
## **8. RT Plan Information Object Implementation (RT Plan Storage SCU)**

This section specifies the use of the DICOM RT Plan Information Object Definition (IOD) by the DICOM-RT-SEND software. The DICOM-RT-SEND software implements a RT Plan Storage SCU.

### **8.1 RT Plan IOD Implementation**

This section defines the implementation of the RT Plan information object by the DICOM-RT-SEND software in the AcQSim application. It refers to DICOM V3.0 Standard, Part 3 (Information Object Definitions). The AcQSim application also implements a RT Plan Storage SCP in order to support import of DICOM RT Plan IODs for verification.

## 8.2 RT Plan IOD Entity – Relationship Model



The entity-relationship diagram for the RT Plan interoperability scheme is shown in **Figure 3**. In this figure, the following diagrammatic convention is established to represent the information organization:

- each entity is represented by a rectangular box
- each relationship is represented by a diamond-shaped box
- the fact that a relationship exists between two entities is depicted by lines connecting the corresponding entity boxes to the relationship boxes

The relationships are fully defined with the maximum number of possible entities in the relationship shown. See DICOM Part 3 Section 5.1.2 for an explanation of the entity-relationship notation.

### 8.2.1 Entity Descriptions

Refer to DICOM Standard, Part 3 (Information Object Definitions) for a description of each of the entities contained within the RT Plan information object.

### 8.2.2 AcQSim Mapping of DICOM entities

DICOM entities map to the AcQSim entities in the following manner:

<b>DICOM</b>	<b>AcQSim</b>
Patient Entity	Patient Entity (AcQSim Workstation)
Study Entity	Examination Entity (AcQSim Workstation)
Series Entity	No mapping
Equipment Entity	Workstation on which AcQSim application is running
Plan Entity	AcQSim geometric information related to defined beams

### 8.3 RT Plan IOD Module Table

Within an entity of the DICOM RT Plan Information Object Definition, attributes are grouped into related sets of attributes. A set of related attributes is termed a module. A module facilitates the understanding of the semantics concerning the attributes and how the attributes are related with each other. A module grouping does not imply any encoding of information into datasets.

**Table 3** identifies the defined modules within the entities which comprise the DICOM RT Plan Information Object Definition. Modules are identified by Module Name.

See DICOM Standard, Part 3 for a complete definition of the entities, modules and attributes.

**Table 3 RT Plan Information Object Definition (IOD) Module Table**

Entity Name	Module Name	Usage	Reference
Patient	Patient	M	8.4.1.1
Study	Study	M	8.4.2.1
	Patient Study	U	not used
Series	RT Series	M	8.4.3.1
Equipment	General Equipment	M	8.4.4.1
Plan	RT General Plan	M	8.4.5.1
	RT Prescription	U	not used
	RT Tolerance Tables	U	not used
	RT Patient Setup	U	not used
	RT Fraction Scheme	U	8.4.5.2
	RT Beams	C	8.4.5.3
	RT Brachy Application Setups	C	not used
	Approval	U	not used
	Audio	U	not used
	SOP Common	M	8.4.5.4

## 8.4 Information Module Definitions – RT Plan

Please refer to DICOM Standard, Part 3 (Information Object Definitions) for a description of each of the entities and modules contained within the RT Plan Information Object.

### 8.4.1 Patient Entity Modules

#### 8.4.1.1 Patient Module

##### Patient Module Attributes (M)

Attribute Name	Tag	Type	Notes
Patient's Name	(0010,0010)	2	Duplicated from patient study images if present in those images, otherwise zero-length
Patient ID	(0010,0020)	2	Duplicated from patient study images if present in those images, otherwise zero-length
Patient's Birth Date	(0010,0030)	2	Zero-length

Attribute Name	Tag	Type	Notes
Patient's Sex	(0010,0040)	2	Duplicated from patient study images if present and valid in those images, otherwise zero-length

## 8.4.2 Study Entity Modules

### 8.4.2.1 General Study Module

#### General Study Module Attributes (M)

Attribute Name	Tag	Type	Notes
Study Instance UID	(0020,000D)	1	Duplicated from patient study images
Study Date	(0008,0020)	2	Duplicated from patient study images if present in those images, otherwise zero-length
Study Time	(0008,0030)	2	Duplicated from patient study images if present in those images, otherwise zero-length
Referring Physician's Name	(0008,0090)	2	Duplicated from patient study images if present in those images, otherwise zero-length
Study ID	(0020,0010)	2	Duplicated from patient study images if present in those images, otherwise zero-length
Accession Number	(0008,0050)	2	Duplicated from patient study images if present in those images, otherwise zero-length

## 8.4.3 Series Entity Modules

### 8.4.3.1 RT Series Module

#### RT Series Module Attributes (M)

Attribute Name	Tag	Type	Notes
Modality	(0008,0060)	1	'RTPLAN'
Series Instance UID	(0020,000E)	1	Created such that each RT Plan falls in a series by itself
Series Number	(0020,0011)	2	'1'

## 8.4.4 Equipment Entity Modules

### 8.4.4.1 General Equipment Module

#### General Equipment Module Attributes (M)

Attribute Name	Tag	Type	Notes
Manufacturer	(0008,0070)	2	'Marconi Medical Systems, Inc.'
Station Name	(0008,1010)	3	Station hostname

Manufacturer's Model Name	(0008,1090)	3	'AcQSim' or 'AcQPlan'
Device Serial Number	(0018,1000)	3	Station host ID
Software Version	(0018,1020)	3	'AcQSim/4.1.x' or 'AcQPlan/4.1.x'

## 8.4.5 Plan Entity Modules

### 8.4.5.1 RT General Plan Module

#### RT General Plan Module Attributes (M)

Attribute Name	Tag	Type	Notes
RT Plan Label	(300A,0002)	1	AcQSim RT Plan name truncated to 16 characters
RT Plan Name	(300A,0003)	3	AcQSim RT Plan name
RT Plan Description	(300A,0004)	3	AcQSim isocenter comment
Operators' Name	(0008,1070)	2	AcQSim planner's name
RT Plan Date	(300A,0006)	2	Date AcQSim RT Plan was last edited
RT Plan Time	(300A,0007)	2	Time AcQSim RT Plan was last edited
RT Plan Geometry	(300A,000C)	1	'PATIENT' or 'TREATMENT_DEVICE' depending on configuration (see Section 5.2)
Referenced Structure Set Sequence	(300C,0060)	1C	Sequence contains 1 item if RT Plan Geometry is 'PATIENT', otherwise not present
> Referenced SOP Class UID	(0008,1150)	1C	'1.2.840.10008.5.1.4.1.1.481.3' (Structure Set Storage)
> Referenced SOP Instance UID	(0008,1155)	1C	SOP Instance UID of Structure Set used in creating this plan

### 8.4.5.2 RT Fraction Scheme Module

#### RT Fraction Scheme Module Attributes (U)

Attribute Name	Tag	Type	Notes
Fraction Group Scheme	(300A,0070)	1	Sequence contains 1 item
> Fraction Group Number	(300A,0071)	1	'1'
> RT Plan Description	(300A,0078)	2	Zero-length
> Number of Beams	(300A,0080)	1	Number of beams in the AcQSim plan
> Referenced Beam Sequence	(300C,0004)	1C	Sequence contains 1 item for each beam in the plan
>> Referenced Beam Number	(300C,0006)	1C	AcQSim beam number

>> Beam Meterset	(300A,0086)	3	Monitor units or minutes (as defined by Primary Dosimeter Unit (300A,00B3) in the RT Beams Module) calculated to deliver the prescribed dose for this beam
> Number of Brachy Application Setups	(300A,00A0)	1	'0'

### 8.4.5.3 RT Beams Module

#### RT Beams Module Attributes (C)

Attribute Name	Tag	Type	Notes
Beam Sequence	(300A,00B0)	1	Sequence contains 1 item for each beam defined in the AcQSim plan
> Beam Number	(300A,00C0)	1	AcQSim beam number
> Beam Name	(300A,00C2)	3	AcQSim beam name
> Beam Type	(300A,00C4)	1	'STATIC' or 'DYNAMIC'
> Radiation Type	(300A,00C6)	2	'PHOTON' or 'ELECTRON'
> Treatment Machine Name	(300A,00B2)	2	Name of treatment machine selected in AcQSim for simulation of this beam truncated to 16 characters
> Manufacturer	(0008,0070)	3	Manufacturer of treatment machine selected in AcQSim
> Manufacturer's Model Name	(0008,1090)	3	Model name of treatment machine selected in AcQSim
> Device Serial Number	(0018,1000)	3	Serial number of treatment machine selected in AcQSim
> Source-Axis Distance	(300A,00B4)	3	SAD of the treatment machine selected in AcQSim for simulation of this beam
> Beam Limiting Device Sequence	(300A,00B6)	1	Sequence contains 1 or more items depending on the number of collimators defined for the treatment machine selected in AcQSim for simulation of associated beam
>> RT Beam Limiting Device Type	(300A,00B8)	1	'X', 'Y', 'ASYMX', 'ASYMY', 'MLCX', or 'MLCY'
>> Source to Beam Limiting Device Distance	(300A,00BA)	3	Distance defined for the treatment machine selected in AcQSim for simulation of this beam
>> Number of Leaf/Jaw Pairs	(300A,00BC)	1	Number of MLC leaves if Beam Limiting Device Type is 'MLCX' or 'MLCY', otherwise 1

Attribute Name	Tag	Type	Notes
>> Leaf Position Boundaries	(300A,00BE)	2C	If Beam Limiting Device Type is 'MLCX' or 'MLCY', a stream of N+1 leaf position boundaries (where N is the Number of Leaf/Jaw Pairs), otherwise not present
> Number of Wedges	(300A,00D0)	1	Number of wedges defined in AcQSim for simulation of this beam
> Wedge Sequence	(300A,00D1)	1C	If Number of Wedges is greater than 0, a sequence containing one item for each wedge, otherwise not present
>> Wedge Number	(300A,00D2)	1C	Wedge number defined in AcQSim
>> Wedge Type	(300A,00D3)	2C	'STANDARD', 'DYNAMIC', or 'MOTORIZED'
>> Wedge ID	(300A,00D4)	3	Wedge Name
>> Wedge Angle	(300A,00D5)	2C	Wedge angle defined in AcQSim
>> Wedge Factor	(300A,00D6)	2C	Wedge factor defined in AcQSim if non-zero, otherwise zero-length
>> Wedge Orientation	(300A,00D8)	2C	Wedge orientation defined in AcQSim (only 0, 90, 180, and 270 are supported)
> Number of Compensators	(300A,00E0)	1	'0'
> Number of Boli	(300A,00ED)	1	Number of boli defined in AcQSim for simulation of this beam (AcQSim currently supports only a single bolus)
> Referenced Bolus Sequence	(300C,00B0)	1C	If Number of Boli is greater than 0, a sequence containing one item for each bolus, otherwise not present
>> Referenced ROI Number	(3006,0084)	1C	The bolus specified by ROI Number (3006,0022) in Structure Set ROI Sequence (3006,0020) in Structure Set Module within Structure Set in Referenced Structure Set Sequence (300C,0060) in RT General Plan Module.
> Number of Blocks	(300A,00F0)	1	Number of blocks defined in AcQSim for simulation of this beam
> Block Sequence	(300A,00F4)	2C	If number of blocks is non-zero, a sequence of items 1 for each block defined in AcQSim, otherwise not present
>> Source to Block Tray Distance	(300A,00F6)	2C	Zero-length
>> Block Type	(300A,00F8)	1C	'SHIELDING' or 'APERTURE'
>> Block Divergence	(300A,00FA)	2C	Zero-length

Attribute Name	Tag	Type	Notes
>> Block Number	(300A,00FC)	1C	Block number in the sequence starting at 1
>> Block Name	(300A,00FE)	3	Block name defined in AcQSim
>> Material ID	(300A,00E1)	2C	Zero-length
>> Block Thickness	(300A,0100)	3	Block thickness defined in AcQSim
>> Block Transmission	(300A,0102)	2C	Block transmission coefficient defined in AcQSim
>> Block Number of Points	(300A,0104)	2C	Number of (x,y) pairs in Block Data (maximum of 256 supported in AcQSim)
>> Block Data	(300A,0106)	2C	Stream of (x,y) pairs containing number of pairs equal to Block Number of Points
> Applicator Sequence	(300A,0107)	3	Sequence of 1 item if an applicator is defined in AcQSim for simulation of this beam, otherwise not present
>> Applicator ID	(300A,0108)	1C	Applicator name defined in AcQSim truncated to 16 characters
>> Applicator Type	(300A,0109)	1C	'ELECTRON_SQUARE', 'ELECTRON_RECT', 'ELECTRON_CIRC', 'ELECTRON_SHORT', 'INTRAOPERATIVE', or 'STEREOTACTIC'
>> Applicator Description	(300A,010A)	3	Applicator name defined in AcQSim
> Final Cumulative Meterset Weight	(300A,010E)	1C	'100.0'
> Number of Control Points	(300A,0110)	1	'2'
> Control Point Sequence	(300A,0111)	1	Sequence of 2 items (Note that at Control Point 1 the sequence item contains only Cumulative Meterset Weight)
>> Control Point Index	(300A,0112)	1	'0' or '1'
>> Cumulative Meterset Weight	(300A,0134)	2	'0.0' at control point 0, '100.0' at control point 1
>> Nominal Beam Energy	(300A,0114)	3	Nominal Beam Energy if present, otherwise not sent
>> Wedge Position Sequence	(300A,0116)	3	Sequence of 1 or more wedge positions for the current control point
>>> Referenced Wedge Number	(300C,00C0)	1C	References wedge described by Wedge Number above
>>> Wedge Position	(300A,0118)	1C	'IN'
>> Beam Limiting Device Position Sequence	(300A,011A)	1C	Sequence contains 1 or more items depending on the number of collimators defined for the treatment machine selected in AcQSim for simulation of this beam

Attribute Name	Tag	Type	Notes
>>> RT Beam Limiting Device Type	(300A,00B8)	1C	'X', 'Y', 'ASYMX', 'ASYMY', 'MLCX', or 'MLCY'
>>> Leaf/Jaw Positions	(300A,011C)	1C	Stream of 2N positions (where N is the Number of Leaf/Jaw Pairs) giving the position of the collimator jaws or MLC leaves defined in AcQSim for simulation of this beam
>> Gantry Angle	(300A,011E)	1C	Gantry angle defined in AcQSim for simulation of this beam
>> Gantry Rotation Direction	(300A,011F)	1C	'NONE'
>> Beam Limiting Device Angle	(300A,0120)	1C	Collimator angle defined in AcQSim for simulation of this beam
>> Beam Limiting Device Rotation Direction	(300A,0121)	1C	'NONE'
>> Patient Support Angle	(300A,0122)	1C	Table angle defined in AcQSim for simulation of this beam
>> Patient Support Rotation Direction	(300A,0123)	1C	'NONE'
>> Table Top Eccentric Angle	(300A,0125)	1C	'0.0'
>> Table Top Eccentric Rotation Direction	(300A,0126)	1C	'NONE'
>> Table Top Vertical Position	(300A,0128)	2C	Zero-length
>> Table Top Longitudinal Position	(300A,0129)	2C	Zero-length
>> Table Top Lateral Position	(300A,012A)	2C	Zero-length
>> Isocenter Position	(300A,012C)	3	(x,y,z) coordinates of the isocenter for this beam

#### 8.4.5.4 SOP Common Module

##### SOP common Module Attributes (M)

Attribute Name	Tag	Type	Notes
SOP Class UID	(0008,0016)	1	'1.2.840.10008.5.1.4.1.1.481.5' (RT Plan Storage)
SOP Instance UID	(0008,0018)	1	Note that identical RT Plans transmitted from different AcQSim systems will be assigned different UID's. Note also that editing the AcQSim RT Plan will cause a new UID to be created for the RT Plan.

## **9. RT Plan Information Object Implementation (RT Plan Storage SCP)**

This section specifies the use of the DICOM RT Plan Information Object Definition (IOD) by the APS software and the AcQSim Verification function. The APS software implements a RT Plan Storage SCP.

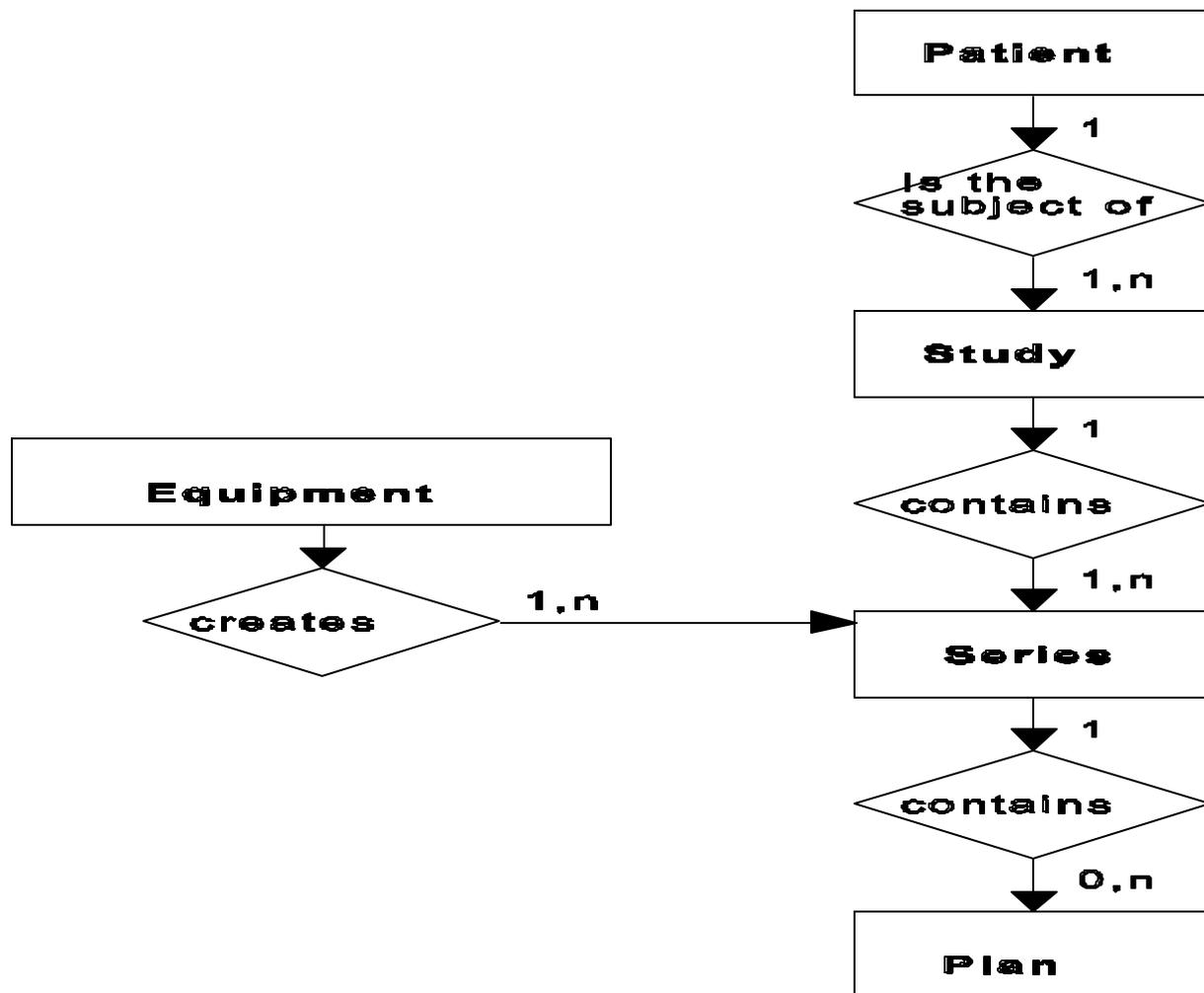
### **9.1 RT Plan IOD Implementation**

This section defines the implementation of the RT Plan information object by the APS software and the AcQSim Verification function. It refers to DICOM V3.0 Standard, Part 3 (Information Object Definitions).

The APS software supports

The AcQSim application also implements a RT Plan Storage SCU in order to support export of DICOM RT Plan IODs.

## 9.2 RT Plan IOD Entity – Relationship Model



The entity-relationship diagram for the RT Plan interoperability scheme is shown in **Figure 4**. The following diagrammatic convention is established to represent the information organization:

- each entity is represented by a rectangular box
- each relationship is represented by a diamond-shaped box
- the fact that a relationship exists between two entities is depicted by lines connecting the corresponding entity boxes to the relationship boxes

The relationships are fully defined with the maximum number of possible entities in the relationship shown. See DICOM Part 3 Section 5.1.2 for an explanation of the entity-relationship notation.

### 9.2.1 Entity Descriptions

Refer to DICOM Standard, Part 3 (Information Object Definitions) for a description of each of the entities contained within the RT Plan information object.

### 9.2.2 AcQSim Mapping of DICOM entities

DICOM entities map to the AcQSim entities in the following manner:

<b>DICOM</b>	<b>AcQSim</b>
Patient Entity	Not used (set from associated plan)
Study Entity	Not used (set from associated plan)
Series Entity	Not used
Equipment Entity	Not used
Plan Entity	AcQSim geometric information related to defined beams

### 9.3 RT Plan IOD Module Table

Within an entity of the DICOM RT Plan Information Object Definition, attributes are grouped into related sets of attributes. A set of related attributes is termed a module. A module facilitates the understanding of the semantics concerning the attributes and how the attributes are related with each other. A module grouping does not imply any encoding of information into datasets.

**Table 4** identifies the defined modules within the entities which comprise the DICOM RT Plan Information Object Definition. Modules are identified by Module Name.

See DICOM Standard, Part 3 for a complete definition of the entities, modules and attributes.

**Table 4 RT Plan Information Object Definition (IOD) Module Table**

Entity Name	Module Name	Usage	Reference
Patient	Patient	M	9.4.1.1
Study	Study	M	9.4.2.1
	Patient Study	U	not used
Series	RT Series	M	9.4.3.1
Equipment	General Equipment	M	9.4.4.1
Plan	RT General Plan	M	9.4.5.1
	RT Prescription	U	not used
	RT Tolerance Tables	U	not used
	RT Patient Setup	U	not used
	RT Fraction Scheme	U	not used
	RT Beams	C	9.4.5.2
	RT Brachy Application Setups	C	not used
	Approval	U	not used
	Audio	U	not used
	SOP Common	M	9.4.5.3

## 9.4 Information Module Definitions – RT Plan

Please refer to DICOM Standard, Part 3 (Information Object Definitions) for a description of each of the entities and modules contained within the RT Plan Information Object.

### 9.4.1 Patient Entity Modules

#### 9.4.1.1 Patient Module

##### Patient Module Attributes (M)

Attribute Name	Tag	Type	Notes
Patient's Name	(0010,0010)	2	Stored as Patient Name in the Plan Header
Patient ID	(0010,0020)	2	Stored as Patient ID in the Plan Header
Patient's Birth Date	(0010,0030)	2	Not Used
Patient's Sex	(0010,0040)	2	Not Used

### 9.4.2 Study Entity Modules

### 9.4.2.1 General Study Module

#### General Study Module Attributes (M)

Attribute Name	Tag	Type	Notes
Study Instance UID	(0020,000D)	1	Compared against the study UID in the dataset
Study Date	(0008,0020)	2	Not used
Study Time	(0008,0030)	2	Not used
Referring Physician's Name	(0008,0090)	2	Not used
Study ID	(0020,0010)	2	Not used
Accession Number	(0008,0050)	2	Not used

### 9.4.3 Series Entity Modules

#### 9.4.3.1 RT Series Module

#### RT Series Module Attributes (M)

Attribute Name	Tag	Type	Notes
Modality	(0008,0060)	1	Field checked to verify value is 'RTPLAN'
Series Instance UID	(0020,000E)	1	Not used
Series Number	(0020,0011)	2	Not used

### 9.4.4 Equipment Entity Modules

#### 9.4.4.1 General Equipment Module

#### General Equipment Module Attributes (M)

Attribute Name	Tag	Type	Notes
Manufacturer	(0008,0070)	2	Stored as Manufacturer
Station Name	(0008,1010)	3	Stored as Station Name
Device Serial Number	(0018,1000)	3	Stored as Device

### 9.4.5 Plan Entity Modules

#### 9.4.5.1 RT General Plan Module

#### RT General Plan Module Attributes (M)

Attribute Name	Tag	Type	Notes
RT Plan Label	(300A,0002)	1	Stored as Plan Info Name
Operators' Name	(0008,1070)	2	Stored as Plan Info Planners_name
RT Plan Date	(300A,0006)	2	Combined with RT Plan Time to form date/time stored in Plan Info Date

RT Plan Time	(300A,0007)	2	Combined with RT Plan Date to form date/time stored in Plan Info Date
RT Plan Geometry	(300A,000C)	1	Sets Patient Geometry flag to True for "Patient" or False for "Treatment Device"
Referenced Structure Set Sequence	(300C,0060)	1C	Sequence contains 1 item if RT Plan Geometry is 'PATIENT', otherwise not present
> Referenced SOP Class UID	(0008,1150)	1C	Not used
> Referenced SOP Instance UID	(0008,1155)	1C	Check to see if this is original

### 9.4.5.2 RT Beams Module

#### RT Beams Module Attributes (U)

Attribute Name	Tag	Type	Notes
Beam Sequence	(300A,00B0)	1	Check to be sure there's at least 1 and not more than 64
> Beam Number	(300A,00C0)	1	Beam number
> Beam Name	(300A,00C2)	3	Beam name
> Beam Type	(300A,00C4)	1	Check to be sure value is 'STATIC'
> Radiation Type	(300A,00C6)	2	Radiation Type
> Treatment Machine Name	(300A,00B2)	2	Treatment Machine Name
> Source-Axis Distance	(300A,00B4)	3	SAD of the treatment machine
> Beam Limiting Device Sequence	(300A,00B6)	1	Must be 1 or more
>> RT Beam Limiting Device Type	(300A,00B8)	1	BLD Type
>> Source to Beam Limiting Device Distance	(300A,00BA)	3	Source to BLD Distance
>> Number of Leaf/Jaw Pairs	(300A,00BC)	1	Number of Leaf/Jaw Pairs
>> Leaf Position Boundaries	(300A,00BE)	2C	If Beam Limiting Device Type is 'MLCX' or 'MLCY', then stored as Leaf Position Boundaries
> Number of Wedges	(300A,00D0)	1	Number of wedges
> Wedge Sequence	(300A,00D1)	1C	Wedge Sequence
>> Wedge Number	(300A,00D2)	1C	Wedge number
>> Wedge Type	(300A,00D3)	2C	Wedge Type
>> Wedge Angle	(300A,00D5)	2C	Wedge angle
>> Wedge Factor	(300A,00D6)	2C	Wedge factor
>> Wedge Orientation	(300A,00D8)	2C	Translated to Left, Right, Front, or Back

Attribute Name	Tag	Type	Notes
> Number of Compensators	(300A,00E0)	1	Number of Compensators
> Number of Boli	(300A,00ED)	1	Number of boli
> Referenced Bolus Sequence	(300C,00B0)	1C	Bolus Sequence
>> Referenced ROI Number	(3006,0084)	1C	ROI number
> Number of Blocks	(300A,00F0)	1	Number of blocks
> Block Sequence	(300A,00F4)	2C	If number of blocks is non-zero, Block Sequence
>> Source to Block Tray Distance	(300A,00F6)	2C	Not Used
>> Block Type	(300A,00F8)	1C	Block Type
>> Block Divergence	(300A,00FA)	2C	Not used
>> Block Number	(300A,00FC)	1C	Block number
>> Block Name	(300A,00FE)	3	Block name
>> Material ID	(300A,00E1)	2C	Not used
>> Block Thickness	(300A,0100)	3	Block thickness
>> Block Transmission	(300A,0102)	2C	Not Used
>> Block Number of Points	(300A,0104)	2C	Number of points
>> Block Data	(300A,0106)	2C	(x,y) pairs
> Applicator Sequence	(300A,0107)	3	Applicator sequence
>> Applicator ID	(300A,0108)	1C	Applicator ID
>> Applicator Type	(300A,0109)	1C	Presently accept only 'ELECTRON_SQUARE', 'ELECTRON_RECT', otherwise error
>> Applicator Description	(300A,010A)	3	Applicator name
> Final Cumulative Meterset Weight	(300A,010E)	1C	Must equal Cumulative Meterset Weight (300A,0134)
> Number of Control Points	(300A,0110)	1	Must equal Control Point Sequence
> Control Point Sequence	(300A,0111)	1	Control Point Sequence
>> Control Point Index	(300A,0112)	1	Control Point Index
>> Cumulative Meterset Weight	(300A,0134)	2	Must equal Final Cumulative Meterset Weight (300A,010E)
>> Wedge Position Sequence	(300A,0116)	3	Wedge Position Sequence
>>> Referenced Wedge Number	(300C,00C0)	1C	Wedge Number
>>> Wedge Position	(300A,0118)	1C	Must be 'IN' or 'OUT'
>> Beam Limiting Device Position Sequence	(300A,011A)	1C	BLD Position Sequence – must be 1 or more
>>> RT Beam Limiting Device Type	(300A,00B8)	1C	BLD type

Attribute Name	Tag	Type	Notes
>>> Leaf/Jaw Positions	(300A,011C)	1C	Leaf/Jaw positions
>> Gantry Angle	(300A,011E)	1C	Gantry Angle
>> Gantry Rotation Direction	(300A,011F)	1C	Must be 'NONE'
>> Beam Limiting Device Angle	(300A,0120)	1C	Collimator angle
>> Beam Limiting Device Rotation Direction	(300A,0121)	1C	Must be 'NONE'
>> Patient Support Angle	(300A,0122)	1C	Table angle
>> Patient Support Rotation Direction	(300A,0123)	1C	Must be 'NONE'
>> Table Top Eccentric Angle	(300A,0125)	1C	Must be '0.0'
>> Table Top Eccentric Rotation Direction	(300A,0126)	1C	Must be 'NONE'
>> Table Top Vertical Position	(300A,0128)	2C	Ignored
>> Table Top Longitudinal Position	(300A,0129)	2C	Ignored
>> Table Top Lateral Position	(300A,012A)	2C	Ignored

## 10. Film Server Specification

The Film Server software provides Standard Conformance to the following DICOM SOP classes as an SCU:

SOP Class Name	SOP Class UID
Basic Grayscale Print Management Meta SOP Class	1.2.840.10008.5.1.1.9
Basic Film Session SOP Class	1.2.840.10008.5.1.1.1
Basic Film Box SOP Class	1.2.840.10008.5.1.1.2
Basic Grayscale Image Box SOP Class	1.2.840.10008.5.1.1.4
Printer SOP Class	1.2.840.10008.5.1.1.16
Basic Color Print Management Meta SOP Class	1.2.840.10008.5.1.1.18
Basic Film Session SOP Class	1.2.840.10008.5.1.1.1
Basic Film Box SOP Class	1.2.840.10008.5.1.1.2
Basic Color Image Box SOP Class	1.2.840.10008.5.1.1.4.1
Printer SOP Class	1.2.840.10008.5.1.1.16

The Film Server software never acts in the role of an SCP.

## **10.1 Association Establishment Policies**

### **10.1.1 General**

The Film Server software attempts to establish an association when it determines that it has the necessary data to print a sheet of film. The film server obtains data when the operator indicates that an image is to be filmed, or when images are being created and the "Auto Film" option is enabled. One or more images may be placed on a film depending on the format selected by the user.

The Film Server software does not place any restrictions on the maximum PDU size. If the Service Class Provider for the association does not specify a maximum PDU size, the Film Server software sends PDU's of s not more than 4096 bytes.

### **10.1.2 Number of Associations**

The number of associations the film server will maintain with a single printer is configurable. The default is one. The maximum number of associations the film server will support is the sum of the number of associations allowed for each configured printer.

### **10.1.3 Asynchronous Nature**

For each sheet of film to be printed, the Film Server creates an association, sets film attributes, prints the film, and releases the association. There is no asynchronous activity. The Asynchronous Operations Window negotiation is not supported.

### **10.1.4 Implementation Identifying information**

The Film Server software will provide a single Implementation Class UID which is 2.16.840.1.113662.2.4.

## **10.2 Association Initiation Policy**

There are two Real World Activities which may cause association establishment. First is when an operator selects a printer, and second is when the operator has indicated to the Film Server software that a sheet of film should be printed. The implementation described here offers only the default transfer syntax (DICOM Implicit VR Little Endian).

### **10.2.1 Printer Selected**

### 10.2.1.1 Associated Real World Activity

When the operator selects a printer for the first time, the film server consults its configuration to determine what level of connection testing should be done. If the configuration indicates a DICOM association should be attempted, the Film Server software will request an association.

### 10.2.1.2 Proposed presentation contexts

The Film Server software will propose Job SOP Class and either Grayscale or Color Meta SOP class based on the type of printer. Only the default transfer syntax (DICOM Implicit VR Little Endian) will be offered.

<b>Presentation Context Table</b>					
Abstract Syntax		Transfer Syntax		Role	Ext. Neg.
Name	UID	Name List	UID List		
Basic Grayscale Print Management Meta SOP Class	1.2.840.10008.5.1.1.9	DICOM Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None
Basic Color Print Management Meta SOP Class	1.2.840.10008.5.1.1.18	DICOM Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None
Print Job SOP Class	1.2.840.10008.5.1.1.14	DICOM Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None

### 10.2.1.3 SOP Specific conformance

As a result of this Real World Activity, the Film Server software will only create, then release the association. It does not exercise any of functionality of the SOP classes and so it provides standard conformance to the service classes it associates with as a Service Class User.

## 10.2.2 Film Sheet to be Printed

### 10.2.2.1 Associated Real World Activity

The Film Server is informed that a sheet of film is to be printed. This may occur because the operator has depressed the "Print" button, or enough images have been selected by the operator for a full sheet of film to be printed.

### 10.2.2.2 Proposed Presentation contexts

The Film Server software will propose Job SOP Class and either Grayscale or

Color Meta SOP class based on the type of printer. Only the default transfer syntax (DICOM Implicit VR Little Endian) will be offered.

<b>Presentation Context Table</b>					
Abstract Syntax		Transfer Syntax		Role	Ext. Neg.
Name	UID	Name List	UID List		
Basic Grayscale Print Management Meta SOP Class	1.2.840.10008.5.1.1.9	DICOM Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None
Basic Color Print Management Meta SOP Class	1.2.840.10008.5.1.1.18	DICOM Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None
Print Job SOP Class	1.2.840.10008.5.1.1.14	DICOM Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None

### 10.2.3 SOP Specific Conformance Statement

The following DIMSE Service Elements and optional attributes are used by the Film Server software:

<b>Basic Film Session SOP Class</b>			
DIMSE Services Used	Optional Attribute Description	Tag	Possible Values
N-CREATE			
	Number of Copies	(2000,0010)	See Note Below
N-SET			
	Number of Copies	(2000,0010)	See Note Below
N-DELETE			
N-ACTION			

<b>Basic Film Box SOP Class</b>			
DIMSE Services Used	Optional Attribute Description	Tag	Possible Values
N-CREATE			
	Magnification Type	(2010,0060)	See Note Below
	Border Density	(2010,0100)	See Note Below
	Trim	(2010,0140)	See Note Below
N-SET			
	Magnification Type	(2010,0060)	See Note Below

	Border Density	(2010,0100)	See Note Below
	Trim	(2010,0140)	See Note Below
N-DELETE			
N-ACTION			

<b>Basic Grayscale Image Box SOP Class</b>			
<b>DIMSE Services Used</b>	<b>Optional Attribute Description</b>	<b>Tag</b>	<b>Possible Values</b>
N-SET			
	Magnification Type	(2010,0060)	See Note Below

<b>Basic Color Image Box SOP Class</b>			
<b>DIMSE Services Used</b>	<b>Optional Attribute Description</b>	<b>Tag</b>	<b>Possible Values</b>
N-SET			
	Magnification Type	(2010,0060)	See Note Below

<b>Print Job SOP Class</b>			
<b>DIMSE Services Used</b>	<b>Optional Attribute Description</b>	<b>Tag</b>	<b>Possible Values</b>
N-EVENT-REPORT			
N-GET			

Basic Film Session SOP Class

Basic Film Box SOP Class

Basic Grayscale Image Box SOP Class

Basic Color Image Box SOP Class

Print Job SOP Class

NOTE: The film server software uses a file to determine what the valid values are for mandatory and optional attributes. A separate file exists for each printer type and is generated by Marconi. The data in the file is based on the conformance statement provided by the manufacturer of the printer.

### **10.3 Association Acceptance Policy**

The Film Server software never accepts associations.

## **11. Communications Profiles**

## **11.1 Supported Communications Stacks (Parts 8,9)**

The following physical media connections are available:

10 Base T, 100 Base T, 10 Base 2, 10 Base 5. An AUI connector is provided for maximum flexibility.

## **12. Extensions/Specializations/Privatization**

No extensions, privatization, or specializations are used in this implementation.

## **13. Configuration**

### **13.1 AE Title/Presentation Address mapping**

The mapping between AE Title and presentation context is done in two files, film\_server.cfg and dicom.cfg.

### **13.2 Configurable Parameters**

The following local parameters are configurable. Please consult your Marconi Service representative for detailed information on using the Service Application. Default values for each field are shown in parentheses.

- Application Title used by the Film Server software (PICKER\_CT\_PRINT\_SCU)
- Connection wait time when connecting to a printer (60 seconds)
- TCP/IP Port used by APS software (104)
- Default connection wait time (60 seconds)
- Port (104)
- Application Title (DICOM\_STORAGE)

Please note: port numbers 6002, 6938, 6950, and 7020 are used for Marconi CT proprietary protocols and should not be used for any of the DICOM ports.

In most cases, the system must be rebooted for configuration changes to take effect.

All UID's generated by the DICOM software are based on Marconi's UID root. This root is 2.16.840.1.113662.

### **13.3 Support of Extended Character Sets**

The VoxelQ will accept, send, and display images which use the Latin 1 character set (ISO-IR 100 Latin alphabet No. 1, supplementary set). The VoxelQ will also accept and send images using other character sets, but data in them may not be displayed correctly.

## Appendix A – VoxelQ Curve Data Modules (Organ Contours)

The data in this group identify organs created as a result of VoxelQ contour definitions. For each organ contour, the NTI software includes a curve module with each image transmitted from the study.

The group number “50xx” specifies a DICOM Repeating Group. This Group is repeated for each curve sent and repeats with even numbers only. For example if three curves are sent, their corresponding DICOM group numbers are 5000, 5002, and 5004.

### Curve Module Attributes

Attribute Name	Tag	Type	Notes
Curve Dimensions	(50xx,0005)	1	2
Number of Points	(50xx,0010)	1	Number of data points defining this curve
Type of Data	(50xx,0020)	1	'ROI'
Data Value Representation	(50xx,0103)	1	0002H (float single)
Curve Data	(50xx,3000)	1	Array of curve data values containing number of (x,y) pairs equal to Number of Points
Curve Description	(50xx,0022)	3	VoxelQ contoured organ name are stored in this field along with the VoxelQ color index for this organ. The organ name may be a maximum of 32 characters. The color index field is a single ASCII-digit number from 1 to 16. The standard DICOM field, '\', separation character separates the fields. Example: 'lung \ 6'. See table A.1 below for the meaning of the color indices.

**Table A.1 – Color Indices**

Color Index	VoxelQ Color Name	RGB Value
1	magenta	(210,0,255)
2	violet	(130,0,255)
3	darkblue	(130,0,255)
4	blue	(0,108,255)
5	lightblue	(0,148,255)
6	aqua	(0,228,255)
7	bluegreen	(0,255,202)
8	green	(0,255,122)
9	lightgreen	(96,255,0)
10	yellowgreen	(176,255,0)
11	yellow	(236,255,0)
12	gold	(255,214,0)
13	rust	(255,154,0)
14	orange	(255,94,0)
15	red	(255,34,0)



## Appendix B – AcQSim AcQPLAN Curve Data Modules (Isocenters)

The data in this group identify AcQSim isocenter points. If an AcQSim plan exists for a study, the NTI software will include a curve group encoding isocenter data with every DICOM image transmitted from the study. If multiple AcQSim plans exist for the selected study the isocenter group is repeated for each plan with the plan name located in the Curve Description field.

The group number “50xx” specifies a DICOM Repeating Group. This Group is repeated for each curve sent and repeats with even numbers only. For example if three curves are sent, their corresponding DICOM groups modules are 5000, 5002, and 5004.

### Curve Module Attributes

Attribute Name	Tag	Type	Notes
Curve Dimensions	(50xx,0005)	1	3
Number of Points	(50xx,0010)	1	Number of isocenter points. This normally will be 2.
Type of Data	(50xx,0020)	1	'ISOCENTER'
Data Value Representation	(50xx,0103)	1	0003H (float double)
Curve Data	(50xx,3000)	1	Isocenter data as an array of (x,y,z) values. The number of values is given by Element 0010 specified above.
Curve Description	(50xx,0022)	3	The AcQSim Plan name is stored in this field.

The current AcQSim specification for Isocenter Data is two Isocenter points of three dimensions each. Two Isocenter points are sent: “Marked” and “Final” in that order. Thus 6 floating double values will be sent in the order shown below.

Example:

marked\_x,  
marked\_y,  
original z location of slice closest to marked Isocenter  
final\_x  
final\_y  
original z location of slice closest to final Isocenter