GE Healthcare

Technical Publications

Direction 5144243-100

Revision 3

AdvantageSim MD

Conformance Statement

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REVISION HISTORY

REV	DATE	REASON FOR CHANGE
A	July 06, 2005	Initial release
0	August 05, 2005	Update for ME
1	February 16, 2006	Updated for M3
2	Jun 25, 2010	Updated accordingly the IHE-RO specification
3.	January 14, 2011	Updated due to review

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Conformance Statement for DICOM

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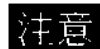

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CONFORMANCE STATEMENT OVERVIEW

Advantage Sim MD is virtual treatment simulation software. It uses CT, PET and MR Image Storage for planning a treatment and as a result it provides RT Plan, RT Structure Set, RT Image and Secondary Capture Image Storage for further processing. Advantage Sim MD does not provide intrinsic implementation of DICOM Network instead uses application interface of its platform called Advantage Workstation.

Table 0.1 provides an overview of the network services supported by <name of product>.

Table 0.1 – NETWORK SERVICES

SOP Classes	User of Service (SCU)	Provider of Service (SCP)
Transfer		
CT Image Storage	No	Yes
MR Image Storage	No	Option*
Positron Emission Tomography Image Storage	No	Option*
Secondary Capture Image Storage	Yes	No
RT Image Storage	Yes	No
RT Structure Set Storage	Yes	Yes
RT Plan Storage	Yes	Yes

Option*: This means that this service can be purchased separately

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SECTION 1 INTRODUCTION

1.1 OVERVIEW

This DICOM Conformance Statement is divided into sections as described below:

SECTION 1, *Introduction*, which describes the overall structure, intent and references for this Conformance Statement.

SECTION 2, *Network Conformance Statement*, which specifies the GEHC equipment compliance to the DICOM requirements for the implementation of networking features.

SECTION 3, *Secondary Capture Information Object Implementation,* which defines the GEHC equipment compliance to DICOM requirements for the implementation of a Secondary Capture information object generated by AdvantageSim.

SECTION 4, *RT Image Information Object Implementation,* which defines the GEHC equipment compliance to DICOM requirements for the implementation of an RT Image information object generated by AdvantageSim.

SECTION 5, *RT Structure Set Information Object Implementation,* which defines the GEHC equipment compliance to DICOM requirements for the implementation of an RT Structure Set information object generated by AdvantageSim, and the requirements for RT Structure Set objects imported into AdvantageSim.

SECTION 6, *RT Plan Information Object Implementation,* which defines the GEHC equipment compliance to DICOM requirements for the implementation of an RT Plan information object generated by AdvantageSim, and the requirements for RT Plan objects imported into AdvantageSim.

SECTION 7, *CT Image Information Object Requirements,* which defines the requirements for CT Images used as input to AdvantageSim.

SECTION 8, MR *Image Information Object Requirements,* which defines the requirements for MR Images used as input to AdvantageSim.

SECTION 9, PE*T Image Information Object Requirements,* which defines the requirements for PET Images used as input to AdvantageSim.

1.2 OVERALL DICOM CONFORMANCE STATEMENT DOCUMENT STRUCTURE

The Documentation Structure of the GEHC DICOM Conformance Statements is shown in the Illustration below.

GEHC DICOM Conformance Statements

@

http://www.ge.com/DICOM

APPLICATION ENTITY SPECIFICATION
(SERVICE CLASSES, INFORMATION OBJECTS, MESSAGE EXCHANGES, ETC.)

Product Implementation:

CT Advantage

MR Advantage

Advantage Sim MD Conformance Statement Direction: 5144243-100

...... Conformance Statement Direction: ......
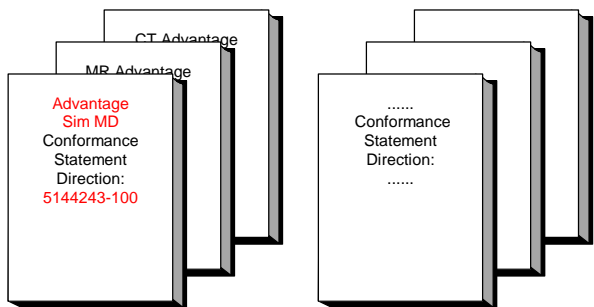
DICOM STANDARD

Standard Specification:

DICOM Part 1

DICOM 2

DICOM 3

DICOM 4

DICOM Part 16
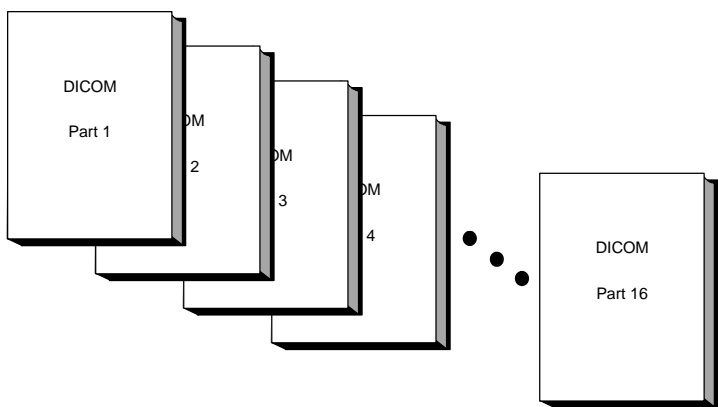
This document specifies the DICOM implementation. It is entitled:

*Advantage Sim MD **7.10***

Conformance Statement for DICOM

Direction **5144243-100**

This DICOM Conformance Statement documents the DICOM Conformance Statement and Technical Specification required to interoperate with the GEHC network interface.

The GEHC Conformance Statement, contained in this document, also specifies the Lower Layer communications which it supports (e.g., TCP/IP). However, the Technical Specifications are defined in the DICOM Part 8 standard.

For more information regarding DICOM, copies of the Standard may be obtained on the Internet at http://medical.nema.org. Comments on the Standard may be addressed to:

DICOM Secretariat

NEMA

1300 N. 17th Street, Suite 1752

Rosslyn, VA 22209

USA

Phone: +1.703.841.3200

1.3 INTENDED AUDIENCE

The reader of this document is concerned with software design and/or system integration issues. It is assumed that the reader of this document is familiar with the DICOM Standard and with the terminology and concepts which are used in that Standard.

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1.4 SCOPE AND FIELD OF APPLICATION

It is the intent of this document to provide an unambiguous specification for GEHC implementations. This specification, called a Conformance Statement, includes a DICOM Conformance Statement and is necessary to ensure proper processing and interpretation of GEHC medical data exchanged using DICOM. The GEHC Conformance Statements are available to the public.

The reader of this DICOM Conformance Statement should be aware that different GEHC devices are capable of using different Information Object Definitions. For example, a GEHC CT Scanner may send images using the CT Information Object, MR Information Object, Secondary Capture Object, etc.

Included in this DICOM Conformance Statement are the Module Definitions which define all data elements used by this GEHC implementation. If the user encounters unspecified private data elements while parsing a GEHC Data Set, the user is well advised to ignore those data elements (per the DICOM standard). Unspecified private data element information is subject to change without notice. If, however, the device is acting as a "full fidelity storage device", it should retain and re-transmit all of the private data elements which are sent by GEHC devices.

1.5 IMPORTANT REMARKS

The use of these DICOM Conformance Statements, in conjunction with the DICOM Standards, is intended to facilitate communication with GE imaging equipment. However, **by itself, it is not sufficient to ensure that inter-operation will be successful**. The **user (or user's agent)** needs to proceed with caution and address at least four issues:

- **Integration** - The integration of any device into an overall system of interconnected devices goes beyond the scope of standards (DICOM v3.0), and of this introduction and associated DICOM Conformance Statements when interoperability with non-GE equipment is desired. The responsibility to analyze the applications requirements and to design a solution that integrates GE imaging equipment with non–GE systems is the **user's** responsibility and should not be underestimated. The **user** is strongly advised to ensure that such an integration analysis is correctly performed.

- **Validation** - Testing the complete range of possible interactions between any GE device and non–GE devices, before the connection is declared operational, should not be overlooked. Therefore, the **user** should ensure that any non–GE provider accepts full responsibility for all validation required for their connection with GE devices. This includes the accuracy of the image data once it has crossed the interface between the GE imaging equipment and the non–GE device and the stability of the image data for the intended applications.

  Such a validation is required before any clinical use (diagnosis and/or treatment) is performed. It applies when images acquired on GE imaging equipment are processed/displayed on a non-GE device, as well as when images acquired on non-GE equipment is processed/displayed on a GE console or workstation.

- **Future Evolution** - GE understands that the DICOM Standard will evolve to meet the user's growing requirements. GE is actively involved in the development of the DICOM Standard. DICOM will incorporate new features and technologies and GE may follow the evolution of the Standard. The GEHC protocol is based on DICOM as specified in each DICOM Conformance Statement. Evolution of the Standard may require changes to devices which have implemented DICOM. **In addition, GE reserves the right to discontinue or make changes to the support of communications features (on its products) described by these DICOM Conformance Statements**. The **user** should ensure that any non–GE provider, which connects with GE devices, also plans for the future evolution of the DICOM Standard. Failure to do so will likely result in the loss of function and/or connectivity as the DICOM Standard changes and GE Products are enhanced to support these changes.

- **Interaction** - It is the sole responsibility of the **non–GE provider** to ensure that communication with the interfaced equipment does not cause degradation of GE imaging equipment performance and/or function.

1.6 REFERENCES

NEMA PS3   Digital Imaging and Communications in Medicine (DICOM) Standard, available free at http://medical.nema.org/

The different supported Advantage Windows platform DICOM conformance statements are described in the following documents:

Document title	Direction
ADVANTAGE WORKSTATION 4.2p Conformance Statement for DICOM V3.0	2381100-100
ADVANTAGE WORKSTATION 4.3 Conformance Statement for DICOM V3.0	5138820-100
ADVANTAGE WORKSTATION 4.4 Conformance Statement for DICOM V3.0	5181424-100

Document title	Direction
ADVANTAGE WORKSTATION 4.5 Conformance Statement for DICOM V3.0	5324648-100
ADVANTAGE WORKSTATION 4.6 Conformance Statement for DICOM V3.0	5404296-100

1.7 DEFINITIONS

Informal definitions are provided for the following terms used in this Conformance Statement. The DICOM Standard is the authoritative source for formal definitons of these terms.

Abstract Syntax – the information agreed to be exchanged between applications, generally equivalent to a Service/Object Pair (SOP) Class. Examples : Verification SOP Class, Modality Worklist Information Model Find SOP Class, Computed Radiography Image Storage SOP Class.

Application Entity (AE) – an end point of a DICOM information exchange, including the DICOM network or media interface software; i.e., the software that sends or receives DICOM information objects or messages. A single device may have multiple Application Entities.

Application Entity Title – the externally known name of an *Application Entity*, used to identify a DICOM application to other DICOM applications on the network.

Application Context – the specification of the type of communication used between *Application Entities*. Example: DICOM network protocol.

Association – a network communication channel set up between *Application Entities*.

Attribute – – a unit of information in an object definition; a data element identified by a *tag*. The information may be a complex data structure (Sequence), itself composed of lower level data elements. Examples: Patient ID (0010,0020), Accession Number (0008,0050), Photometric Interpretation (0028,0004), Procedure Code Sequence (0008,1032).

Information Object Definition (IOD) – the specified set of *Attributes* that comprise a type of data object; does not represent a specific instance of the data object, but rather a class of similar data objects that have the same properties. The *Attributes* may be specified as Mandatory (Type 1), Required but possibly unknown (Type 2), or Optional (Type 3), and there may be conditions associated with the use of an Attribute (Types 1C and 2C). Examples: MR Image IOD, CT Image IOD, Print Job IOD.

Joint Photographic Experts Group (JPEG) – a set of standardized image compression techniques, available for use by DICOM applications.

Media Application Profile – the specification of DICOM information objects and encoding exchanged on removable media (e.g., CDs)

Module – a set of *Attributes* within an *Information Object Definition* that are logically related to each other. Example: Patient Module includes Patient Name, Patient ID, Patient Birth Date, and Patient Sex.

Negotiation – first phase of *Association* establishment that allows *Application Entities* to agree on the types of data to be exchanged and how that data will be encoded.

Presentation Context – the set of DICOM network services used over an *Association*, as negotiated between *Application Entities*; includes *Abstract Syntaxes* and *Transfer Syntaxes*.

Protocol Data Unit (PDU) – a packet (piece) of a DICOM message sent across the network. Devices must specify the maximum size packet they can receive for DICOM messages.

Security Profile – a set of mechanisms, such as encryption, user authentication, or digital signatures, used by an *Application Entity* to ensure confidentiality, integrity, and/or availability of exchanged DICOM data

Service Class Provider (SCP) – role of an *Application Entity* that provides a DICOM network service; typically, a server that performs operations requested by another *Application Entity* (*Service Class User*). Examples: Picture Archiving and Communication System (image storage SCP, and image query/retrieve SCP), Radiology Information System (modality worklist SCP).

Service Class User (SCU) – role of an *Application Entity* that uses a DICOM network service; typically, a client. Examples: imaging modality (image storage SCU, and modality worklist SCU), imaging workstation (image query/retrieve SCU)

Service/Object Pair (SOP) Class – the specification of the network or media transfer (service) of a particular type of data (object); the fundamental unit of DICOM interoperability specification. Examples: Ultrasound Image Storage Service, Basic Grayscale Print Management.

Service/Object Pair (SOP) Instance – an information object; a specific occurrence of information exchanged in a *SOP Class*. Examples: a specific x-ray image.

Tag – a 32-bit identifier for a data element, represented as a pair of four digit hexadecimal numbers, the "group" and the "element". If the "group" number is odd, the tag is for a private (manufacturer-specific) data element. Examples: (0010,0020) [Patient ID], (07FE,0010) [Pixel Data], (0019,0210) [private data element]

Transfer Syntax – the encoding used for exchange of DICOM information objects and messages. Examples: *JPEG* compressed (images), little endian explicit value representation.

Unique Identifier (UID) – a globally unique "dotted decimal" string that identifies a specific object or a class of objects; an ISO-8824 Object Identifier. Examples: Study Instance UID, SOP Class UID, SOP Instance UID.

Value Representation (VR) – the format type of an individual DICOM data element, such as text, an integer, a person's name, or a code. DICOM information objects can be transmitted with either explicit identification of the type of each data element (Explicit VR), or without explicit identification (Implicit VR); with Implicit VR, the receiving application must use a DICOM data dictionary to look up the format of each data element.

1.8 SYMBOLS AND ABBREVIATIONS

AE	Application Entity
CT	Computed Tomography
CS	Conformance Statement
DICOM	Digital Imaging and Communications in Medicine
IHE	Integrating the Healthcare Enterprise
IOD	Information Object Definition
ISO	International Organization for Standards
LUT	Look-up Table
MR	Magnetic Resonance Imaging
NM	Nuclear Medicine
O	Optional (Key Attribute)
OP	Ophthalmic Photography
OSI	Open Systems Interconnection
PACS	Picture Archiving and Communication System
PET	Positron Emission Tomography
PDU	Protocol Data Unit
R	Required (Key Attribute)
RT	Radiotherapy
SC	Secondary Capture
SCP	Service Class Provider
SCU	Service Class User
SOP	Service-Object Pair
SR	Structured Reporting
U	Unique (Key Attribute)
VR	Value Representation

SECTION 2   NETWORK CONFORMANCE STATEMENT

2.1 INTRODUCTION

This section of the conformance statement (CS) specifies the AdvantageSim compliance to DICOM Network Conformance.

AdvantageSim is a radiotherapy virtual simulation application that is installed on the same hardware platform as the base application, Advantage Workstation. This base application is a Networked Medical Imaging Console dedicated to Examination Review and Diagnosis. The workstation uses DICOM services to import acquisition images for possible further analysis or processing, and to export images and radiotherapy data to other vendors. Additionally, radiotherapy data may be imported for further processing by Advantage Workstation or AdvantageSim.

AdvantageSim MD does not have an intrinsic DICOM Network feature. It does not directly invoke the DICOM Server AE. For some detailed information on DICOM features of Advantage Windows, refer to the respective Conformance Statement - *Advantage Workstation where AdvantageSim MD application is running (See 1.6* References).

The application parses the following DICOM objects:

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
Positron Emission Tomography Image Storage	1.2.840.10008.5.1.4.1.1.128
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

The application creates the following DICOM objects:

SOP Class Name	SOP Class UID
Secondary Capture Image Storage	1.2.840.10008.5.1.4.1.1.7
RT Image Information 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

2.2 IMPLEMENTATION MODEL

2.2.1 Application Data Flow Diagram

Refer to the respective Conformance Statement - *Advantage Workstation* where AdvantageSim MD application is running *(See 1.6* References*)*.

2.2.2 Presentation Context Table

Refer to the respective Conformance Statement - Advantage Workstation where AdvantageSim MD application is running *(See 1.6* References*)*.

2.2.3 Real-World Activities

AdvantageSim MD is used to prepare geometric and anatomical data relating to a proposed external beam radiotherapy treatment prior to dosimetry planning. Anatomical volumes can be defined automatically or manually in three dimensions using a set of CT images acquired with the patient in the proposed treatment position.

The **goal of this document** is to give a detailed description of the:

- CT, MR and PET IMAGE DICOM IODs that are required to reconstruct the 3D volumes
- SC IMAGE and RT IMAGE IOD written by the application
- RT STRUCTURE SET and RT PLAN IOD written and read by the application.

2.2.4 Implementation Identifying Information

The Implementation UID for this DICOM Implementation is:

AdvantageSim MD Implementation UID	**1.2.840.113619.6.196**
AdvantageSim MD Implementation Version Name	**ADVSIM70**

2.3 SUPPORT OF EXTENDED CHARACTER SETS

The AdvantageSim MD accepts the ISO_IR 6 (ASCII) and the ISO_IR 100 (Latin alphabet Number 1 supplementary set) character set as SCU and uses ISO_IR 100 as SCP. Multiple characters set are not supported.

SECTION 3   SECONDARY CAPTURE INFORMATION OBJECT IMPLEMENTATION

3.1   INTRODUCTION

This section specifies the use of the DICOM Secondary Capture Image IOD to represent the information included in Secondary Capture images produced by this implementation. Corresponding attributes are conveyed using the module construct.

Note that the implementation described in this section relates to generation of SC Images by the AdvantageSim MD product only. The AdvantageSim MD application does not display SC Images directly, but relies on the Advantage Workstation product for this function. SC Image conformance for Advantage Workstation is described in a related document entitled *Advantage Workstation Conformance Statement (See 1.6* References*)..*

3.2   SC IMAGE IOD IMPLEMENTATION

This section defines the implementation of the SC Image information object in the AdvantageSim MD application. It refers to the DICOM Standard, Part 3 (Information Object Definition).

3.3   SC IMAGE IOD ENTITY-RELATIONSHIP MODEL

ILLUSTRATION **3-1**
SC IMAGE ENTITY RELATIONSHIP DIAGRAM
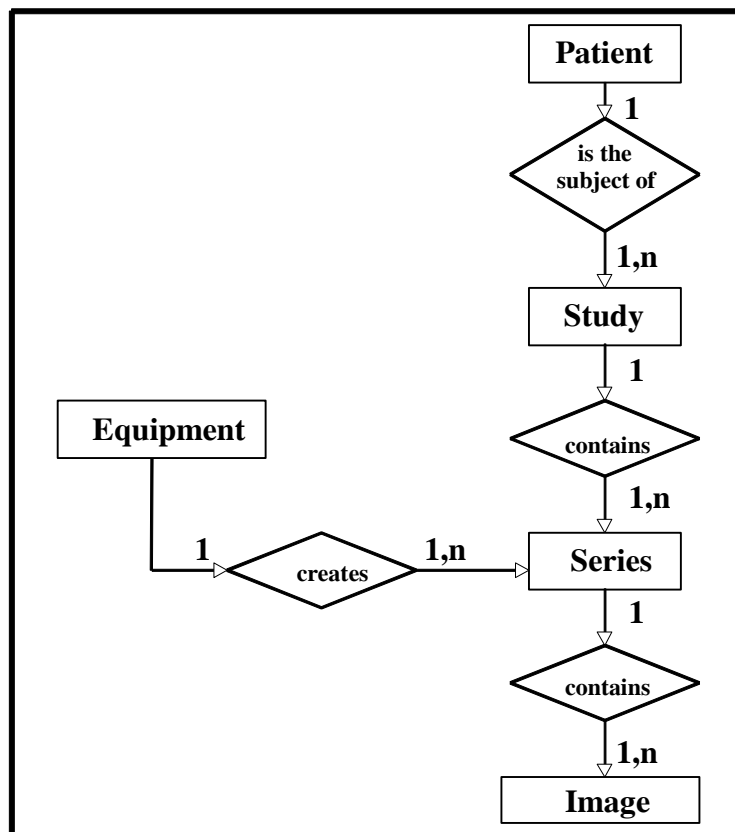
The Entity-Relationship diagram for the SC Image interoperability schema is shown in **ILLUSTRATION** 3-1. In this figure, the following diagrammatic convention is established to represent the information organization:

- 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.

3.3.1 Entities Description

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

3.3.2 AdvantageSim MD Mapping of DICOM entities

DICOM entities map to the AdvantageSim MD entities in the following manner:

DICOM	AdvantageSim MD
Patient Entity	Patient Entity (Advantage Workstation)
Study Entity	Examination Entity (Advantage Workstation)
Series Entity	Series Entity (Advantage Workstation)
Equipment Entity	Workstation on which AdvantageSim MD application is running
Image Entity	Screen save of any AdvantageSim MD image (generated from within application using AdvantageSim MD menu option in main panel). AdvantageSim MD does not directly display SC Images.

3.4 SC IMAGE IOD MODULE TABLE

Within an entity of the DICOM SC Image Information Object Definition, attributes are grouped into related set 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 infer any encoding of information into datasets.

TABLE 3-1 identifies the defined modules within the entities, which comprise the DICOM SC Image Information Object Definition. Modules are identified by Module Name.

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

Note: The elements that are not listed in tables will not be present in generated images.

TABLE 3-1
SC Image Information Object Definition (IOD) Module Table

Entity Name	Module Name	Usage	Reference
Patient	Patient	M	3-5-1-1

Entity Name	Module Name	Usage	Reference
	Clinical Trial Subject	U	Not used
Study	General Study	M	3-5-2-1
	Patient Study	U	not used
	Clinical Trial Study	U	not used
Series	General Series	M	3-5-3-1
	Clinical Trial Series	U	Not used
Equipment	General Equipment	U	3-5-4-1
	SC Equipment	M	3-5-4-2
Image	General Image	M	3-5-5-1
	Image Pixel	M	3-5-5-2
	SC Image	M	3-5-5-3
	Overlay Plane	U	not used
	Modality LUT	U	not used
	VOI LUT	U	not used
	SOP Common	M	3-5-5-4

3.5 INFORMATION MODULE DEFINITIONS

Please refer to DICOM Standard Part 3 (Information Object Definition) for a description of each of the entities and modules contained within the SC Information Object.

3.5.1 Patient Entity Modules

3.5.1.1 Patient Module

Attribute Name	Element Tag	TP	Notes
Patient's Name	(0010,0010)	2	Duplicated from input instances if present in those images, otherwise zero-length
Patient ID	(0010,0020)	2	Duplicated from input instances if present in those images, otherwise zero-length
Issuer of Patient ID	(0010,0021)	3	SCU: Not generated
Issuer of Patient ID Qualifiers Sequence	(0010,0024)	3	SCU: Not generated
Other Patient IDs	(0010,1000)	3	SCU: Not generated
Other Patient IDs Sequence	(0010,1002)	3	SCU: Not generated
Patient's Birth Date	(0010,0030)	2	Duplicated from input instances if present in those images, otherwise zero-length
Patient's Sex	(0010,0040)	2	Duplicated from input instances if present in those images, otherwise zero-length

3.5.2 Study Entity Modules

3.5.2.1 General Study

Attribute Name	Element Tag	TP	Notes
Study Instance UID	(0020,000D)	1	Duplicated from input instances
Study Date	(0008,0020)	2	Duplicated from input instances if present in those images, otherwise zero-length
Study Time	(0008,0030)	2	Duplicated from input instances if present in those images, otherwise zero-length
Referring Physicians' Name	(0008,0090)	2	Zero-length
Study ID	(0020,0010)	2	Duplicated from input instances (must be present in those images - see Section 5)
Accession number	(0008,0050)	2	Duplicated from input instances if present in those images, otherwise zero-length

3.5.3 Series Entity Modules

3.5.3.1 General Series

Attribute Name	Element Tag	TP	Notes
Modality	(0008,0060)	1	'OT'
Series Instance UID	(0020,000E)	1	Created for first image in series, otherwise copied from existing images in series
Series Number	(0020,0011)	2	'100'
Series Description	(0008,103E)	3	'SC Image (AdvantageSim)'
Operators' Name	(0008,1070)	3	Name of the operator is written if not empty

3.5.4 Equipment Entity Modules

3.5.4.1 General Equipment

Attribute Name	Element Tag	TP	Notes
Manufacturer	(0008,0070)	2	'GE MEDICAL SYSTEMS'
Station Name	(0008,1010)	3	<station hostname>
Manufacturer's Model Name	(0008,1090)	3	'Advantage Sim'
Device Serial Number	(0018,1000)	3	<station host ID>
Software Versions	(0018,1020)	3	'7.<subversion>.<build>' (single-valued)

3.5.4.2 SC Equipment

Attribute Name	Element Tag	TP	Notes
Conversion Type	(0008,0064)	1	'WSD'
Modality	(0008,0060)	3	'OT'

Attribute Name	Element Tag	TP	Notes
Secondary Capture Device ID	(0018,1010)	3	<station host ID>
Secondary Capture Device Manufacturer	(0018,1016)	3	'GE MEDICAL SYSTEMS'
Secondary Capture Device Manufacturer's Model Name	(0018,1018)	3	'Advantage Sim'
Secondary Capture Device Software Version	(0018,1019)	3	'7.<subversion>.<build>'

3.5.5 Image Entity Modules

3.5.5.1 General Image

Attribute Name	Element Tag	TP	Notes
Image (Instance) Number	(0020,0013)	2	Generarared number
Patient Orientation	(0020,0020)	2C	Zero-length
Image Date	(0008,0023)	2C	Date when Secondary Capture Image was created.
Image Time	(0008,0033)	2C	Time when Secondary Capture Image was created.
Image Type	(0008,0008)	3	'DERIVED\SECONDARY' (Value 3 and Value 4 not supplied)
Image Comments	(0020,4000)	3	'*Plan_name* (*Plan_date_time*)' where *Plan_name* is the Plan Label of the referenced RT Plan, and *Plan_date_time* is the save date/ time of referenced RT Plan
Burned In Annotation	(0028,0301)	3	'YES'
Lossy Image Compression	(0028,2110)	3	'00'

3.5.5.2 Image Pixel

Attribute Name	Element Tag	TP	Notes
Samples per Pixel	(0028,0002)	1	1
Photometric Interpretation	(0028,0004)	1	'MONOCHROME2'
Rows	(0028,0010)	1	512 (quarter-screen image) or 1024 (full-screen image)
Columns	(0028,0011)	1	512 (quarter-screen image) or 1024 (full-screen image)
Bits Allocated	(0028,0100)	1	8
Bits Stored	(0028,0101)	1	8
High Bit	(0028,0102)	1	7
Pixel Representation	(0028,0103)	1	0000H
Pixel Data	(7FE0,0010)	1	Overlaid data in AdvantageSim MD image display (e.g. on-screen annotations, geometrical structures and beam edges) are converted into monochrome, 'burned in' to the image (i.e. obscure the image pixels) and transmitted as part of Pixel Data

3.5.5.3 SC Image

Attribute Name	Element Tag	TP	Notes
Date of Secondary Capture	(0018,1012)	3	Date when Secondary Capture Image was created.
Time of Secondary Capture	(0018,1014)	3	Time when Secondary Capture Image was created.

3.5.5.4 SOP Common

Attribute Name	Element Tag	TP	Notes
SOP Class UID	(0008,0016)	1	'1.2.840.10008.5.1.4.1.1.7'
SOP Instance UID	(0008,0018)	1	UID root will be '1.2.840.113619.6.196'
Specific Character Set	(0008,0005)	1C	'ISO_IR 100'
Instance Creation Date	(0008,0012)	3	Date when Secondary Capture Image was created.
Instance Creation Time	(0008,0013)	3	Time when Secondary Capture Image was created.
Instance Creator UID	(0008,0014)	3	'1.2.840.113619.6.196'

SECTION 4   RT IMAGE INFORMATION OBJECT IMPLEMENTATION

4.1   INTRODUCTION

This section specifies the use of the DICOM RT Image IOD to represent the information included in images produced by this implementation. Corresponding attributes are conveyed using the module construct.

4.2   RT IMAGE IOD IMPLEMENTATION

This section defines the implementation of the RT Image information object in the AdvantageSim application. It refers to the DICOM Standard, Part 3 (Information Object Definitions). The AdvantageSim MD application does not display RT Images directly, but relies on the Advantage Workstation product for this function.

4.3   RT IMAGE IOD ENTITY-RELATIONSHIP MODEL
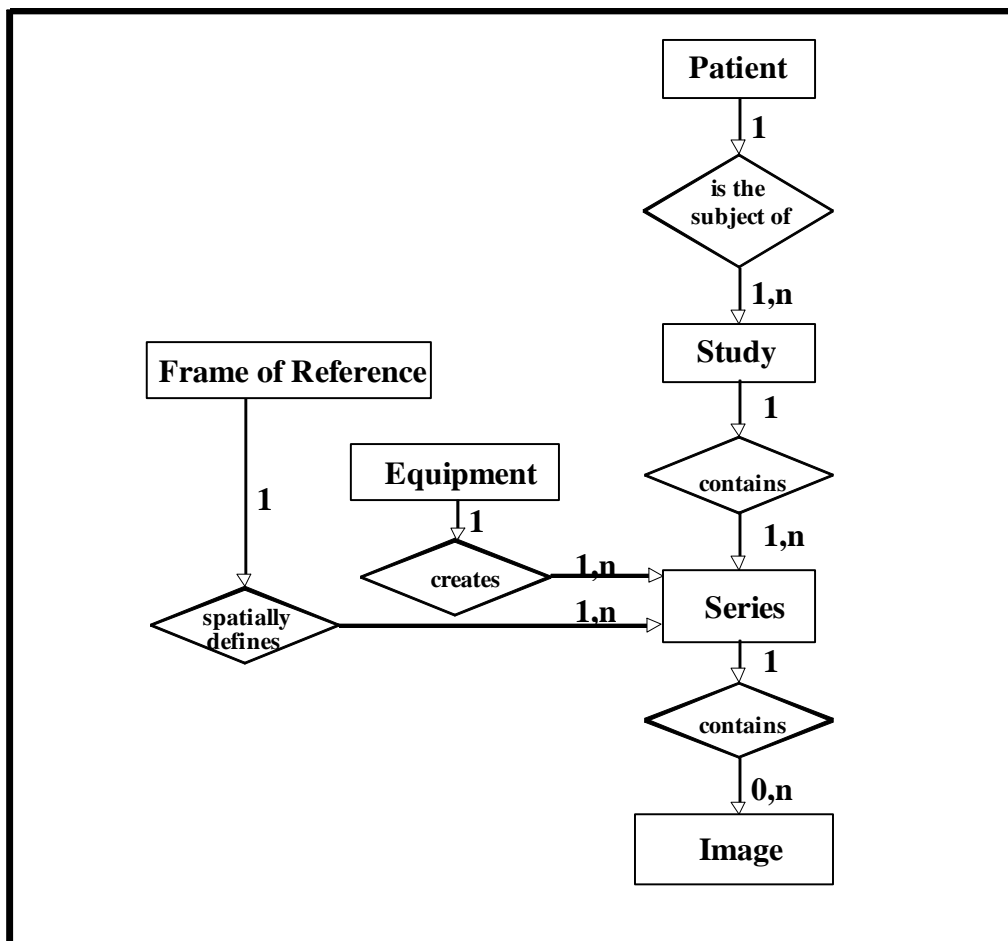
ILLUSTRATION **4-2**
RT IMAGE ENTITY RELATIONSHIP DIAGRAM

The Entity-Relationship diagram for the RT Image interoperability schema is shown in **ILLUSTRATION** 4-2. 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.

4.3.1   Entities Description

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

4.3.2   AdvantageSim Mapping of DICOM entities

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

DICOM	AdvantageSim
Patient Entity	Patient Entity (Advantage Workstation)
Study Entity	Examination Entity (Advantage Workstation)
Series Entity	Series Entity (Advantage Workstation)
Frame of Reference Entity	No mapping
Equipment Entity	Workstation on which AdvantageSim application is running
Image Entity	Screen Save of *DRR (digitally-reconstructed radiograph) image only* (generated from within application using AdvantageSim menu option in main panel). AdvantageSim does not directly display RT Images.

4.4   RT IMAGE IOD MODULE TABLE

Within an entity of the DICOM RT Image Information Object Definition, attributes are grouped into related set 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 infer any encoding of information into datasets.

TABLE 4-2 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 4-2
RT IMAGE INFORMATION OBJECT DEFINITION (IOD) MODULE TABLE

Entity Name	Module Name	Usage	Reference
Patient	Patient	M	4-5-1-1
	Clinical Trial Subject	U	Not used
Study	General Study	M	4-5-2-1

Entity Name	Module Name	Usage	Reference
	Patient Study	U	Not used
	Clinical Trial Study	U	Not used
Series	RT Series	M	4-5-3-1
	Clinical Trial Series	U	Not used
Frame of Reference	Frame of Reference	U	Not used
Equipment	General Equipment	M	4-5-4-1
Image	General Image	M	4-5-5-1
	Image Pixel	M	4-5-5-2
	Contrast/bolus	C	Not used
	Cine	C	Not used
	Multi-Frame	C	Not used
	Device	U	Not used
	RT Image	M	4-5-5-3
	Modality LUT	U	Not used
	VOI LUT	U	Not used
	Approval	U	Not used
	SOP Common	M	4-5-5-4

4.5   INFORMATION MODULE DEFINITIONS

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.

Note: The elements that are not listed in tables will not be present in generated images.

4.5.1   Patient Entity Modules

4.5.1.1   Patient Module

Attribute Name	Element Tag	TP	Notes
Patient's Name	(0010,0010)	2	Duplicated from patient model images if present in those images, otherwise zero-length
Patient ID	(0010,0020)	2	Duplicated from patient model images if present in those images, otherwise zero-length
Issuer of Patient ID	(0010,0021)	3	SCU: Not generated
Issuer of Patient ID Qualifiers Sequence	(0010,0024)	3	SCU: Not generated
Other Patient IDs	(0010,1000)	3	SCU: Not generated
Other Patient IDs Sequence	(0010,1002)	3	SCU: Not generated
Patient's Birth Date	(0010,0030)	2	Duplicated from patient model images if present in those images, otherwise zero-length

Attribute Name	Element Tag	TP	Notes
Patient's Sex	(0010,0040)	2	Duplicated from patient model images if present in those images, otherwise zero-length

4.5.2 Study Entity Modules

4.5.2.1 General Study

Attribute Name	Element Tag	TP	Notes
Study Instance UID	(0020,000D)	1	Duplicated from patient model images
Study Date	(0008,0020)	2	Duplicated from patient model images if present in those images, otherwise zero-length
Study Time	(0008,0030)	2	Duplicated from patient model images if present in those images, otherwise zero-length
Referring Physicians' Name	(0008,0090)	2	Zero-length
Study ID	(0020,0010)	2	Duplicated from patient model images (must be present in those images - see Section 7)
Accession number	(0008,0050)	2	Duplicated from patient model images if present in those images, otherwise zero-length

4.5.3 Series Entity Modules

4.5.3.1 RT Series

Attribute Name	Element Tag	TP	Notes
Modality	(0008,0060)	1	'RTIMAGE'
Series Instance UID	(0020,000E)	1	Created for first image in series, otherwise copied from existing images in series
Series Number	(0020,0011)	2	'101'
Series Description	(0008,103E)	3	'Adv Sim RT Images'
Operator's Name	(0008,1070)	2	SCU: Name of the operator defined at last plan save. SCP: Not used

4.5.4 Equipment Entity Modules

4.5.4.1 General Equipment

Attribute Name	Element Tag	TP	Notes
Manufacturer	(0008,0070)	2	'GE MEDICAL SYSTEMS'
Station Name	(0008,1010)	3	<station hostname>
Manufacturer's Model Name	(0008,1090)	3	'Advantage Sim'
Device Serial Number	(0018,1000)	3	<station host ID>
Software Versions	(0018,1020)	3	'7.<subversion>.<build>' (single-valued)

4.5.5 Image Entity Modules

4.5.5.1 General Image

Attribute Name	Element Tag	TP	Notes
Image (Instance) Number	(0020,0013)	2	Generated number
Patient Orientation	(0020,0020)	2C	Zero-length
Image Date	(0008,0023)	2C	Creation date
Image Time	(0008,0033)	2C	Creation time
Image Comments	(0020,4000)	3	'*Plan_name* (*Plan_date_time*)' where *Plan_name* is the Plan Label of the referenced RT Plan, and *Plan_date_time* is the save date/ time of referenced RT Plan

4.5.5.2 Image Pixel

Attribute Name	Element Tag	TP	Notes
Samples per Pixel	(0028,0002)	1	1
Photometric Interpretation	(0028,0004)	1	'MONOCHROME2'
Rows	(0028,0010)	1	512 (quarter-screen image) or '1024' (full-screen image)
Columns	(0028,0011)	1	512 (quarter-screen image) or '1024' (full-screen image)
Bits Allocated	(0028,0100)	1	8
Bits Stored	(0028,0101)	1	8
High Bit	(0028,0102)	1	7
Pixel Representation	(0028,0103)	1	0000H
Pixel Data	(7FE0,0010)	1	Overlaid data in AdvantageSim image display (e.g. on-screen annotations, geometrical structures and beam edges) are converted into monochrome, 'burned in' to the image (i.e. obscure the image pixels) and transmitted as part of Pixel Data

4.5.5.3 RT Image

Attribute Name	Element Tag	TP	Notes
Samples per Pixel	(0028,0002)	1	1
Photometric Interpretation	(0028,0004)	1	'MONOCHROME2'
RT Image Label	(3002,0002)	1	Name of associated beam in referenced RT Plan
RT Image Name	(3002,0003)	3	'*Plan_name* (*Plan_date_time*)' where *Plan_name* is the Plan Label of the referenced RT Plan, and *Plan_date_time* is the save date/time of referenced RT Plan
Bits Allocated	(0028,0100)	1	8
Bits Stored	(0028,0101)	1	8
High Bit	(0028,0102)	1	7

Attribute Name	Element Tag	TP	Notes
Pixel Representation	(0028,0103)	1	0000H
Image Type	(0008,0008)	1	'DERIVED\SECONDARY\DRR'
Conversion Type	(0008,0064)	2	'WSD'
RT Image Plane	(3002,000C)	1	'NORMAL'
X-Ray Image Receptor Angle	(3002,000E)	2	0
Image Plane Pixel Spacing	(3002,0011)	2	Pixels will always be square
RT Image Position	(3002,0012)	2	First pixel transmitted always has negative x and positive y values (i.e. image viewed from treatment machine gantry with eyes fixed along gantry X axis and top of head towards gantry wall)
Radiation Machine Name	(3002,0020)	2	Name (including suffix) of machine associated with beam in AdvantageSim
Primary Dosimeter Unit	(300A,00B3)	2	Zero-length
Radiation Machine SAD	(3002,0022)	2	Source-axis distance of machine associated with beam in AdvantageSim
RT Image SID	(3002,0026)	2	Equal to SAD of machine associated with beam in AdvantageSim (i.e. image is always projected onto isocenter)
Referenced RT Plan Sequence	(300C,0002)	3	References RT Plan stored immediately before screen save was performed in AdvantageSim. If last saved RT Plan has been subsequently modified in AdvantageSim application, screen save option shall be inhibited.
>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 of beam in referenced RT Plan
Exposure Sequence	(3002,0030)	3	One exposure parameter set is included
>Beam Limiting Device Sequence	(300A,00B6)	3	Sequence will always contain two or three(add-on MLC) items
>>RT Beam Limiting Device Type	(300A, 00B8)	1C	Will be 'X', 'Y', 'ASYMX', 'ASYMY', 'MLCX' or 'MLCY', according to collimator type of machine associated with beam in AdvantageSim
>>Number of Leaf/Jaw Pairs	(300A,00BC)	1C	For 'MLCX' or 'MLCY' collimators, equal to the number of leaf pairs in the MLC collimator jaw of the machine associated with beam in AdvantageSim, for 'X', 'Y', 'ASYMX', 'ASYMY' equals to 1.
>>Leaf Position Boundaries	(300A,00BE)	2C	Provided only for 'MLCX' and 'MLCY' collimators
>>Leaf/Jaw Positions	(300A,011C)	1	Positions of beam limiting device leaf /jaw pairs
>Number of Blocks	(300A,00F0)	1	Number of blocks or cutouts defined for beam in AdvantageSim
>Block Sequence	(300A,00F4)	2C	It is sent if Number Of Blocks is greater than 0. 1-N items may be included.
>> Source to Block Tray Distance	(300A,00F6)	2	Source to Block Tray Distance obtained from machine associated with beam in AdvantageSim

Attribute Name	Element Tag	TP	Notes
>>Block Type	(300A,00F8)	1	'SHIELDING' or 'APERTURE'
>>Block Divergence	(300A,00FA)	2	Zero-length
>>Block Number	(300A,00FC)	1	Blocks will be numbered from 1 to n in order presented in sequence
>>Block Name	(300A,00FE)	3	Name of block or cutout defined in AdvantageSim
>>Material ID	(300A,00E1)	2	Zero-length
>>Block Number of Points	(300A,0104)	2	In AdvantageSim there is no software limit imposed on the number of points in a block shape
>>Block Data	(300A,0106)	2	(x,y) coordinates of block edges
Gantry Angle	(300A,011E)	3	Gantry angle of the associated beam
Beam Limiting Device Angle	(300A,0120)	3	Collimator angle of the associated beam
Patient Support Angle	(300A,0122)	3	Tabel Angle of the associated beam

4.5.5.4   SOP Common

Attribute Name	Element Tag	TP	Notes
SOP Class UID	(0008,0016)	1	'1.2.840.10008.5.1.4.1.1.481.1'
SOP Instance UID	(0008,0018)	1	UID root will be '1.2.840.113619.2.196'
Specific Character Set	(0008,0005)	1C	'ISO_IR 100'
Instance Creation Date	(0008,0012)	3	Creation date
Instance Creation Time	(0008,0013)	3	Creation time
Instance Creator UID	(0008,0014)	3	'1.2.840.113619.6.196'

SECTION 5   RT STRUCTURE SET INFORMATION OBJECT IMPLEMENTATION (AS SCU) AND REQUIREMENTS (AS SCP)

5.1   INTRODUCTION

This section specifies the use of the DICOM RT Structure Set IOD to represent the information included in structure sets produced by this implementation, and also specifies the requirements for the RT Structure Set IOD when being used as input to AdvantageSim. Corresponding attributes are conveyed using the module construct.

AdvantageSim implements the RT Structure Set IOD as a Standard Extended object, containing seven additional elements defined in the Structure Set Module (**see Section 5-5-5-1 of this document**). These attributes are:

- In the Structure Set Module, top level:

  - Couch Removal Status (0249,xxE0), indicating if the treatment couch had been removed by the AdvantageSim software;

  - View Layout (0249,xxE1), storing the arrangement of views;

  - Planar View Windowing (0249,xxE2), the display parameters for the 2D non-DRR views.

  - ·Remove Couch plane's coordinates (0249,xxE6), if the treatment couch had been removed by the AdvantageSim software (See (0249,xxE0)), this value stores the coordinate used for treatment couch removal on Axial view.

- In the Structure Set Module, Structure Set ROI Sequence:

  - ROI Generation Thresholds (0249,xxE3)

  - ROI Bridge Removal Pixels (0249,xxE4), storing the generation parameters for automatically generated structures.

- In the Referenced Frame of Reference Sequence:

  - 3D Model name (0249,xxE5), storing the unique 3D model name assigned for each series.

These attributes are provided for enhanced functionality when reading RT Structure Sets created by the AdvantageSim application itself. They should be ignored by SCP implementations interpreting these objects. These attributes are not required in RT Structure Sets created by SCU implementations for use in AdvantageSim.

5.2   RT STRUCTURE SET IOD IMPLEMENTATION

This section defines the implementation of the RT Structure Set information object in the AdvantageSim application. It refers to the DICOM Standard Part 3 (Information Object Definitions).

In the following tables, notes are provided for when AdvantageSim is acting as a producer of objects (SCU), and a consumer of objects (SCP). Notes in UPPER CASE LETTERS represent restrictions on object contents imposed by AdvantageSim when acting as an SCP (object consumer).

5.3   RT STRUCTURE SET IOD ENTITY-RELATIONSHIP MODEL

ILLUSTRATION **5-3**
RT STRUCTURE SET ENTITY RELATIONSHIP DIAGRAM
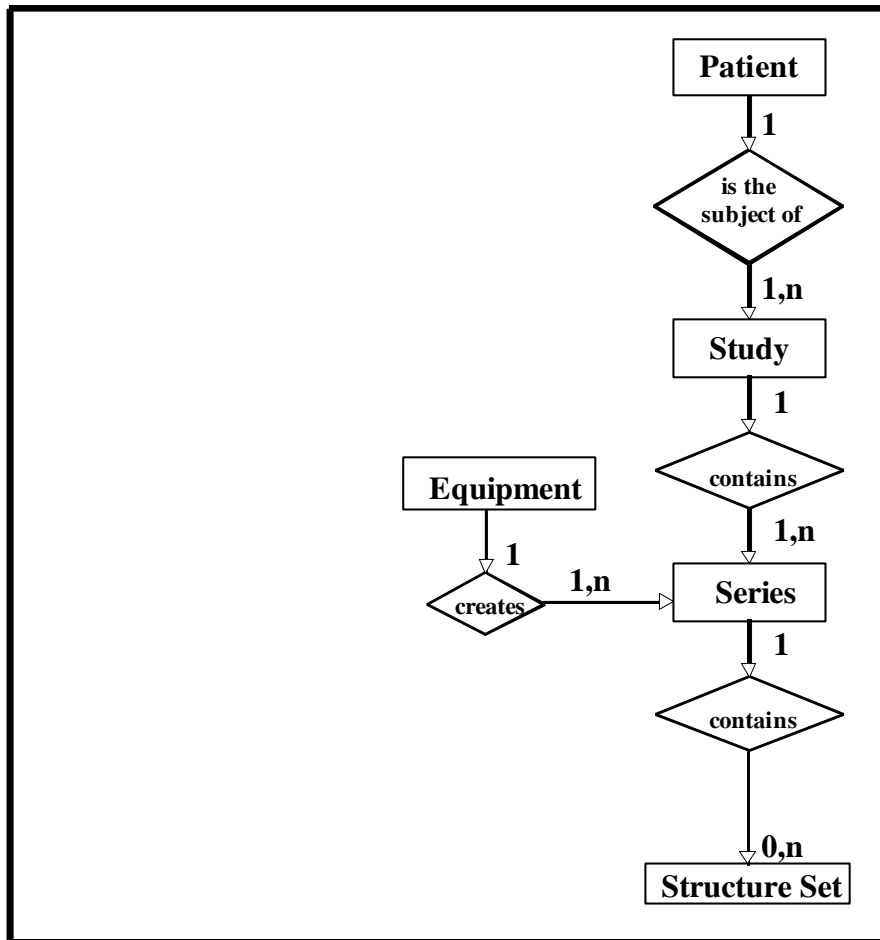
The Entity-Relationship diagram for the RT Structure Set interoperability schema is shown in **ILLUSTRATION** 5-3. In this figure, the following diagrammatic convention is established to represent the information organization:

- 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.

5.3.1 Entities Description

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.

5.3.2 AdvantageSim Mapping of DICOM entities

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

DICOM	AdvantageSim
Patient Entity	Patient Entity (Advantage Workstation)
Study Entity	Examination Entity (Advantage Workstation)
Series Entity	Series Entity (Advantage Workstation)
Equipment Entity	Workstation on which AdvantageSim application is running
Structure Set	AdvantageSim geometric information relating to defined structures and markers

5.4 RT STRUCTURE SET IOD MODULE TABLE

Within an entity of the DICOM RT Structure Set Information Object Definition, attributes are grouped into related set 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 infer any encoding of information into datasets.

TABLE 5-3 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 5-3
RT STRUCTURE SET INFORMATION OBJECT DEFINITION (IOD) MODULE TABLE

Entity Name	Module Name	Usage	Reference
Patient	Patient	M	5-5-1-1
	Clinical Trial Subject	U	Not used
Study	General Study	M	5-5-2-1
	Patient Study	U	Not used
	Clinical Trial Study	U	Not used
Series	RT Series	M	5-5-3-1
	Clinical Trial Series	U	Not used
Equipment	General Equipment	M	5-5-4-1
Structure Set	Structure Set	M	5-5-5-1
	ROI Contour	M	5-5-5-2
	RT ROI Observations	M	5-5-5-3
	Approval	U	Not used
	SOP Common	M	5-5-5-4

5.5 INFORMATION MODULE DEFINITIONS

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

Note: The elements that are not listed in tables will not be present in generated images.

5.5.1 Patient Entity Modules

5.5.1.1 Patient Module

Attribute Name	Element Tag	TP	Notes
Patient's Name	(0010,0010)	2	SCU: Duplicated from patient model images if present in those images, otherwise zero-length SCP: Used for display and database key. NON-NULL VALUE REQUIRED BY ADV SIM FOR SAFE PATIENT IDENTIFICATION
Patient ID	(0010,0020)	2	SCU: Duplicated from patient model images if present in those images, otherwise zero-length SCP: Used for display and database key. NON-NULL VALUE STRONGLY RECOMMENDED FOR SAFE PATIENT IDENTIFICATION
Issuer of Patient ID	(0010,0021)	3	SCU: Not generated SCP: Not used
Issuer of Patient ID Qualifiers Sequence	(0010,0024)	3	SCU: Not generated SCP: Not used
Other Patient IDs	(0010,1000)	3	SCU: Not generated SCP: Not used
Other Patient IDs Sequence	(0010,1002)	3	SCU: Not generated SCP: Not used
Patient's Birth Date	(0010,0030)	2	SCU: Duplicated from patient model images if present in those images, otherwise zero-length SCP: Used for database key if non-null. Use of identical value to that found in acquisition images is recommended
Patient's Sex	(0010,0040)	2	SCU: Duplicated from patient model images if present in those images, otherwise zero-length SCP: Used for database key if non-null. Use of identical value to that found in acquisition images is recommended

5.5.2   Study Entity Modules

5.5.2.1   General Study

Attribute Name	Element Tag	TP	Notes
Study Instance UID	(0020,000D)	1	SCU: Duplicated from patient model images SCP: Not used
Study Date	(0008,0020)	2	SCU: Duplicated from patient model images if present in those images, otherwise zero-length SCP: Not used
Study Time	(0008,0030)	2	SCU: Duplicated from patient model images if present in those images, otherwise zero-length SCP: Not used
Referring Physicians' Name	(0008,0090)	2	SCU: Zero-length SCP: Not used
Study ID	(0020,0010)	2	SCU: Duplicated from patient model images (must be present in those images – see 7.5.2) SCP: Not used
Accession number	(0008,0050)	2	SCU: Duplicated from patient model images if present in those images, otherwise zero-length SCP: Not used

5.5.3   Series Entity Modules

5.5.3.1   RT Series

Attribute Name	Element Tag	TP	Notes
Modality	(0008,0060)	1	SCU: 'RTSTRUCT' SCP: Must be 'RTSTRUCT' (DICOM requirement)
Series Instance UID	(0020,000E)	1	SCU: Created for first image in series, otherwise copied from existing images in series SCP: Not used
Series Number	(0020,0011)	2	SCU: always provided SCP: Used for display if non-null
Series Description	(0008,103E)	3	SCU: 'Adv Sim RT Structure Sets' SCP: Used for display if provided
Operator's Name	(0008,1070)	2	SCU: Name of the operator defined at last plan save. SCP: Not used

5.5.4   Equipment Entity Modules

5.5.4.1   General Equipment

Attribute Name	Element Tag	TP	Notes
Manufacturer	(0008,0070)	2	SCU: 'GE MEDICAL SYSTEMS' SCP: Used to determine system creating object and for display, if non-null (recommended for clear identification of creating system)
Station Name	(0008,1010)	3	SCU: <station hostname> SCP: Not used
Manufacturer's Model Name	(0008,1090)	3	SCU: 'AdvantageSim' SCP: Used to determine system creating object and for display, if provided (recommended for clear identification of creating system)
Device Serial Number	(0018,1000)	3	SCU: <station host ID> SCP: Not used
Software Versions	(0018,1020)	3	SCU: '7.<subversion>.<build>' (single-valued) SCP: Used to determine system creating object and for display, if provided (recommended for clear identification of creating system)

5.5.5   Structure Set Entity Modules

5.5.5.1   Structure Set

Attribute Name	Element Tag	TP	Notes
Structure Set Label	(3006,0002)	1	SCU: Equal to comment entered when saving AdvantageSim Plan, truncated to 16 characters SCP: Used for display and object identification
Structure Set Name	(3006,0004)	3	SCU: Equal to comment entered when saving AdvantageSim Plan (non-truncated) SCP: Used for display and object identification
Instance Number	(0020,0013)	3	SCU: Always provided by AdvantageSim SCP: Used for display if provided
Structure Set Date	(3006,0008)	2	SCU: Date at moment object was saved SCP: Used for display if non-null
Structure Set Time	(3006,0009)	2	SCU: Time at moment object was saved SCP: Used for display if non-null
Couch Removal St (GE private attribute)	(0249,xxE0)	3	SCU: GE private attribute storing whether or not scanner couch has been removed by the AdvantageSim software. Enumerated values: PRESENT, REMOVED. SCP: Used for automatic removal of treatment couch, if present. Not required by AdvantageSim (if absent, user will be asked if treatment couch is to be removed).

Attribute Name	Element Tag	TP	Notes
View Layout (GE private attribute)	(0249,xxE1)	3	SCU: GE private attribute of 4 or 8 values specifying view types of upper left, upper right, lower left, and lower right AdvantageSim views (in that order). Defined terms: "EMPTY", "3D", "AXIAL", "SAGITTAL", "CORONAL", "OBLIQUE", "PROFILE", "CURVED". SCP: Used to initialize view layout. Not required by AdvantageSim (if absent, default AdvantageSim view layout will be used).
Planar View Windowing (GE private attribute)	(0249,xxE2)	3	SCU: GE private attribute (W, L) specifying window width (centered on window level) and window level in Hounsfield Units for planar AdvantageSim views. SCP: Used to set initial W/L after loading RT Structure Set. Not required by AdvantageSim (if absent, default AdvantageSim W/L will be used).
Remove Couch coordinates of the 'plane'	(0249,xxE6)	3	SCU: GE private attribute storing the coordinates of the plane used for couch removal on the Axial view. SCP: Used to remove the treatment couch when loading RT Structure Set. Not required by AdvantageSim (if absent a warning will be displayed to remove the couch manually).
Referenced Frame of Reference Sequence	(3006,0010)	3	SCU: Sequence may contain one or more items, corresponding to the frame of reference of the modality images (CT, MR and PET) SCP: MUST CONTAIN ONE OR MORE ITEMS, EXACTLY ONE OF EACH WHICH MUST BE REFERENCED BY ALL ROIS
>Frame of Reference UID	(0020,0052)	1C	SCU: Duplicated from patient model images if present in those images, otherwise a unique UID will be created by AdvantageSim SCP: FOR THE ITEM REFERENCED BY ROIS, MUST CORRESPOND TO FRAME OF REFERENCE UID (0020,0052) OF ACQUISITION IMAGES
>RT Referenced Study Sequence	(3006,0012)	3	SCU: Sequence can contain one or more items, corresponding to the Studies containing the loaded modality images (CT/MR/PET). SCP: MUST CONTAIN ONE OR MORE ITEMS, EXACTLY ONE OF EACH WHICH MUST BE REFERENCED BY ROIS
>>Referenced SOP Class UID	(0008,1150)	1C	SCU: Always provided SCP: Not used
>>Referenced SOP Instance UID	(0008,1155)	1C	SCU: Always provided SCP: Not used

Attribute Name	Element Tag	TP	Notes
>>RT Referenced Series Sequence	(3006,0014)	1C	SCU: Sequence can contain one or more items, corresponding to the Series containing the loaded modality images (CT/MR/PET) SCP: FOR THE ITEM REFERENCED BY ROIS, MUST CORRESPOND TO CT IMAGE SERIES. AdvantageSim will load all the referenced series from the RT Structure Set.
>>>Series Instance UID	(0020,000E)	1C	SCU: Always provided SCP: Not used
>>>3D Model Name	(0249,xxE5)	3	SCU: Stores the unique name assigned for each series of images loaded in AdvantageSim MD. SCP: Used by AdvantageSim to assign unique names for the loaded series and to identify the series loaded together in a 4D sequence. Unique model name will be generated if it is absent. (Ex. CT1_1, CT1_2, … , CT1_n)
>>>Contour Image Sequence	(3006,0016)	1C	SCU: Sequence will contain all images used for building the corresponding patient model, even if some images, or all have no corresponding contour. SCP: For the RT Referenced Series Sequence item referenced by ROIs, all images will be used to construct the 3D model used as reference, even if they do not contain a contour. All the RT Referenced Series Sequence items will be loaded into AdvantageSim, if they comply with other rules. AT LEAST FIVE IMAGE ITEMS MUST BE PROVIDED. SPACING BETWEEN IMAGES IS STRONGLY RECOMMENDED TO BE LESS THAN 10 MM FOR ADEQUATE 3D MODEL RECONSTRUCTION
>>>>Referenced SOP Class UID	(0008,1150)	1C	SCU: Always equal to CT, MR or PET Image SOP Class SCP: Must be equal to CT, MR or PET Image SOP Class
>>>>Referenced SOP Instance UID	(0008,1155)	1C	SCU: Always provided SCP: Required by AdvantageSim to locate referenced images in AW database. AdvantageSim ME release can identify the referenced images based on the SOP Instance UID only within the same patient.
Structure Set ROI Sequence	(3006,0020)	3	SCU: Always provided unless there have been no structures defined in AdvantageSim, in which case the sequence will be absent. There is no practical limit of the number of items in Advantage Sim MD. SCP: There is no practical limit to the number of items in AdvantageSim. This sequence may also be absent (no structures/markers defined).

Attribute Name	Element Tag	TP	Notes
>ROI Number	(3006,0022)	1	SCU: AdvantageSim will number structures in increasing numeric order, starting from 1, as they are found in the plan SCP: Used to uniquely identify ROI when referenced by ROI Contour and RT ROI Observations Modules (DICOM requirement). Used to uniquely identify AdvantageSim structures and markers if ROI Name is invalid or not supplied
>Referenced Frame of Reference UID	(3006,0024)	1	SCU: Equal to Frame of Reference UID (0020,0052) above SCP: MUST BE EQUAL TO EXACTLY ONE FRAME OF REFERENCE UID (0020,0052) IN REFERENCED FRAME OF REFERENCE SEQUENCE (3006,0010). ALL ROIS MUST REFERENCE THE SAME FRAME OF REFERENCE
>ROI Name	(3006,0026)	2	SCU: Equal to AdvantageSim structure name SCP: Used for AdvantageSim structure or marker name if a valid non-duplicate name, otherwise ROI Number is used to uniquely identify ROI in AdvantageSim
>ROI Generation Algorithm	(3006,0036)	2	SCU: Provided the corresponding structure creation method (MANUAL, SEMIAUTOMATIC and AUTOMATIC) if interoperability option is set otherwise let it empty SCP: Not used
>ROI Generation Thresholds (GE private attribute)	(0249,xxE3)	3	SCU: GE private attribute (H_l, H_u) representing lower and upper Hounsfield Number thresholds used for automatic contouring of this structure. Attribute will be absent if structure was not contoured automatically. SCP: Used to set default structure contouring thresholds for this structure. Not required by AdvantageSim (if absent, default thresholds will be used).
>ROI Bridge Removal Pixels (GE private attribute)	(0249,xxE4)	3	SCU: GE private attribute representing size in pixels of bridges to be removed during automatic contouring. Attribute will be absent if structure was not contoured automatically. Value of zero indicates remove bridges option was not used. SCP: Used to set default structure remove bridges value for this structure. Not required by AdvantageSim (if absent, no bridge removal will be assumed).

5.5.5.2   ROI Contour

Attribute Name	Element Tag	TP	Notes
ROI Contour Sequence	(3006,0039)	1	SCU: Sequence will always contain all the structures defined in the Structure Set Module, in the same sequential order SCP: Multiple contours on slices (bifurcation or multi-part structures), and slices without contours are permitted. Each item corresponds to an ROI defined in the Structure Set ROI Sequence (3006,0020). If none of the structures in the RT Structure Set have defined contours, then ROI Contour Sequence (3006,0039) is zero-length
>Referenced ROI Number	(3006,0084)	1	SCU: Always provided SCP: Must correspond to exactly one ROI Number (3006,0022) in Structure Set ROI Sequence (3006,0020) (DICOM requirement)
>ROI Display Color	(3006,002A)	3	SCU: Contains RGB values corresponding to color used for displaying contour in AdvantageSim application SCP: If RGB values correspond to AdvantageSim color, AdvantageSim color is used otherwise, "nearest" AdvantageSim color is used.
>Contour Sequence	(3006,0040)	3	SCU: Provided if ROI has contours, which have been defined by AdvantageSim, otherwise sequence will not be transmitted SCP: Sequence may be absent if no contours have been defined
>>Contour Number	(3006,0048)	3	SCU: Not used. SCP: Not used.
>>Attached Contours	(3006,0049)	3	SCU: Not used. SCP: Not used.
>>Contour Image Sequence	(3006,0016)	3	SCU: Sequence will always contain exactly one item (referenced CT image) SCP: Sequence can contain one or more items. Contours without a Contour Image Sequence (3006,0016) (i.e. not attached to an acquisition slice) are not used by AdvantageSim.
>>>Referenced SOP Class UID	(0008,1150)	1	SCU: Always provided SCP: Not used
>>>Referenced SOP Instance UID	(0008,1155)	1	SCU: Always provided SCP: Used to locate acquisition image in order to verify consistency of contour z coordinates.

Attribute Name	Element Tag	TP	Notes
>>Contour Geometric Type	(3006,0042)	1	SCU: 'CLOSED_PLANAR' for structures, 'POINT' for markers SCP: Structures with contours other than 'CLOSED_PLANAR' and markers other than 'POINT' will not be used by AdvantageSim
>>Contour Slab Thickness	(3006,0044)	3	SCU: For structures, equal to the sum of the zplus and zminus half thickness in AdvantageSim. Not provided for markers SCP: Not used (slab thickness calculated from acquisition slice)
>>Number of Contour Points	(3006,0046)	1	SCU: In AdvantageSim there is no limit imposed on the number of points in a contour shape SCP: 'CLOSED_PLANAR' CONTOURS MUST HAVE THREE OR MORE POINTS
>>Contour Data	(3006,0050)	1	SCU: Z coordinate of contour data is the Z coordinate of referenced slices. Coordinates are in DICOM coordinate system, not Voxtool RAS coordinate system. Marker positions in AdvantageSim are not restricted to lie on acquisition slices, and therefore their Z coordinate may take any value. SCP: Contour is projected onto voxel plane of AdvantageSim 3D model, which is closest to the Contour Data Z coordinates. THESE Z COORDINATES MUST LIE WITHIN THE SLICE THICKNESS OF THE ACQUISITION SLICE REFERENCED IN THE CONTOUR IMAGE SEQUENCE (3006,0016)

5.5.5.3 RT ROI Observations

Attribute Name	Element Tag	TP	Notes
RT ROI Observations Sequence	(3006,0080)	1	SCU: Sequence can have one or more items and contains all the structures and markers defined in the Structure Set Module, in the same sequential order. There is no limit to the number of items only to the number of structures. If no markers nor structures are defined it is sent as empty. SCP: Each item corresponds to an ROI defined in the Structure Set ROI Sequence (3006,0020). If none of the structures in the RT Structure Set have defined contours, then RT ROI Observations Sequence (3006,0080) is zero-length

Attribute Name	Element Tag	TP	Notes
>Observation Number	(3006,0082)	1	SCU: AdvantageSim will number observations in increasing numeric order, starting from 1 (i.e. Observation Number will correspond to ROI Number) SCP: Not used
>Referenced ROI Number	(3006,0084)	1	SCU: Always provided SCP: Must correspond to exactly one ROI Number (3006,0022) in Structure Set ROI Sequence (3006,0020) (DICOM requirement)
>ROI Observation Label	(3006,0085)	3	SCU: Equal to AdvantageSim structure name, truncated to 16 characters SCP: Not used
>RT ROI Interpreted Type	(3006,00A4)	2	SCU: Supported types are EXTERNAL, PTV, CTV, GTV, AVOIDANCE, ORGAN, CONTRAST_AGENT, CAVITY, and MARKER. Will be zero-length if Structure Type is UNKNOWN in AdvantageSim SCP: ROIs with an Interpreted Type of ISOCENTER will be converted to MARKER. ROIs with an Interpreted Type other than ISOCENTER or those in the above list will be converted to UNKNOWN
>ROI Interpreter	(3006, 00A6)	2	SCU: Zero-length SCP: Not used

5.5.5.4   SOP Common

Attribute Name	Element Tag	TP	Notes
SOP Class UID	(0008,0016)	1	SCU: '1.2.840.10008.5.1.4.1.1.481.3' SCP: Must be equal to '1.2.840.10008.5.1.4.1.1.481.3' (DICOM requirement)
SOP Instance UID	(0008,0018)	1	SCU: UID root will be '1.2.840.113619.2.196' SCP: Used to verify association with RT Plans
Specific Character Set	(0008,0005)	1C	SCU: 'ISO_IR 100' SCP: Specific Character Sets other than 'ISO_IR 100' are not handled explicitly by AdvantageSim
Instance Creation Date	(0008,0012)	3	SCU: Same as Structure Set Date (3006,0008) SCP: Not used
Instance Creation Time	(0008,0013)	3	SCU: Same as Structure Set Time (3006,0009) SCP: Not used
Instance Creator UID	(0008,0014)	3	SCU: '1.2.840.113619.6.196' SCP: If Instance Creator UID corresponds to a version of AdvantageSim, then it is used to prevent loading of old-format RT Structure Sets, otherwise not used

5.6   PRIVATE DATA DICTIONARY FOR RT STRUCTURE SET

Private Creator Identification GEMS_RTEN_01

Attribute Name	Element Tag	VR	VM
Couch Removal Status	(0249,xxE0)	CS	1
View Layout	(0249,xxE1)	CS	4,8
Planar View Windowing	(0249,xxE2)	IS	2
ROI Generation Thresholds	(0249,xxE3)	IS	2
ROI Bridge Removal Pixels	(0249,xxE4)	IS	1
3D Model Name	(0249,xxE5)	CS	1
Remove Couch Coordinate	(0249,xxE6)	CS	1

SECTION 6   RT PLAN INFORMATION OBJECT IMPLEMENTATION (AS SCU) AND REQUIREMENTS (AS SCP)

6.1   INTRODUCTION

This section specifies the use of the DICOM RT Plan IOD to represent the information included in plans produced by this implementation, and also specifies the requirements for the RT Plan IOD when being used as input to AdvantageSim. Corresponding attributes are conveyed using the module construct.

AdvantageSim implements the RT Plan IOD as a Standard Extended object, containing three additional elements defined in the RT General Plan Module (**see Section 6.5.6.1**), one additional element in the RT Patient Setup Module (**see Section 6.5.6.2**), and eight additional elements in the RT Beams module (**see Section 6.5.6.3**). These twelve attributes are:

- In the RT General Plan Module:

    - Macro List (0249,xxF1), storing lists of presets and macros used in the AdvantageSim application;

    - Print Preferences (0249,xxF3), storing the default settings for the AdvantageSim print function;

    - Treatment Device Conventions (0249,xxF4), storing the conventions (IEC-1217 or machine-based) used when displaying beam angles and collimator jaws.

- In the RT Patient Setup Module:

    - Patient Scanned Position (0249,xxF2), storing a copy of the Patient Position (0018,5100) in the acquisition images.

- In the RT Beams Module:

    - Referenced Machine SOP Class UID (0249,xxC0), and Referenced Machine SOP Instance UID (0249,xxC1) of the GE Private DICOM Treatment Machine object used for the beam;

    - Group Name (0249,xx51) and Group Properties (0249,xx52), properties of the AdvantageSim beam group;

    - Associated Markers (0249,xxCA), the list of RT Structure Set markers, which are related to the current beam;

    - Beam Limiting Device Mode (0249,xxF5), the operating mode of the collimator for the current beam.

    - DRR Settings (0249,xxF6), the current DRR settings for the current beam;

- Conformation Algorithm (0249,xxF7), the conformation algorithm used for the current beam.

These attributes are provided for enhanced functionality when reading RT Plans created by the AdvantageSim application itself. They should be ignored by SCP implementations interpreting these objects. These attributes are not required in RT Plans created by SCU implementations for use in AdvantageSim.

6.2   RT PLAN IOD IMPLEMENTATION

This section defines the implementation of the RT Plan information object in the AdvantageSim application. It refers to the DICOM Standard Part 3 (Information Object Definitions).

In the following tables, notes are provided for when AdvantageSim is acting as a producer of objects (SCU), and a consumer of objects (SCP). Notes in UPPER CASE LETTERS represent restrictions on object contents imposed by AdvantageSim when acting as an SCP (object consumer).

6.3   RT PLAN IOD ENTITY-RELATIONSHIP MODEL

ILLUSTRATION **6-4**
RT PLAN ENTITY RELATIONSHIP DIAGRAM
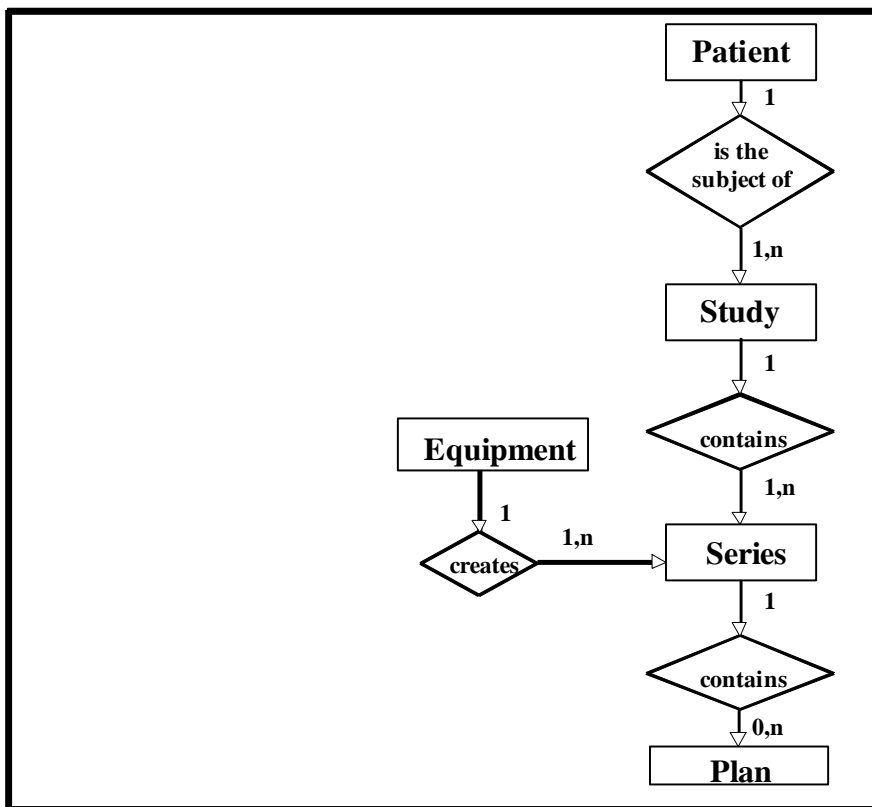
The Entity-Relationship diagram for the RT Plan interoperability schema is shown in **ILLUSTRATION** 6-4. In this figure, the following diagrammatic convention is established to represent the information organization:

- 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.

6.3.1   Entities Description

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

6.3.2   AdvantageSim Mapping of DICOM entities

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

DICOM	AdvantageSim
Patient Entity	Patient Entity (Advantage Workstation)
Study Entity	Examination Entity (Advantage Workstation)
Series Entity	Series Entity (Advantage Workstation)
Equipment Entity	Workstation on which AdvantageSim application is running
Plan Entity	AdvantageSim geometric information related to defined beams

6.4   RT PLAN IOD MODULE TABLE

Within an entity of the DICOM RT Plan Information Object Definition, attributes are grouped into related set 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 infer any encoding of information into datasets.

TABLE 6-4 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 6-4
RT PLAN INFORMATION OBJECT DEFINITION (IOD) MODULE TABLE

Entity Name	Module Name	Usage	Reference
Patient	Patient	M	6-5-1-1
	Clinical Trial Subject	U	Not used
Study	General Study	M	6-5-2-1
	Patient Study	U	Not used
	Clinical Trial Study	U	Not used
Series	RT Series	M	6-5-3-1
	Clinical Trial Series	U	Not used
Equipment	General Equipment	M	6-5-4-1
Frame Of Reference	Frame Of Reference	U	6-5-5-1
Plan	RT General Plan	M	6-5-6-1
	RT Prescription	U	Not used
	RT Tolerance Tables	U	Not used
	RT Patient Setup	U	6-5-6-2

Entity Name	Module Name	Usage	Reference
	RT Fraction Scheme	U	Not used (only treatment simulation information provided)
	RT Beams	C	6-5-6-3
	RT Brachy Application Setups	C	Not used
	Approval	U	6-5-6-5
	SOP Common	M	6-5-6-4

6.5 INFORMATION MODULE DEFINITIONS

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.

Note: The elements that are not listed in tables will not be present in generated images.

6.5.1 Patient Entity Modules

6.5.1.1 Patient Module

Attribute Name	Element Tag	TP	Notes
Patient's Name	(0010,0010)	2	SCU: Duplicated from patient model images SCP: Used for display and database key. NON-NULL VALUE REQUIRED BY ADV SIM FOR SAFE PATIENT IDENTIFICATION
Patient ID	(0010,0020)	2	SCU: Duplicated from patient model images if present in those images, otherwise zero-length SCP: Used for display and database key. NON-NULL VALUE STRONGLY RECOMMENDED FOR SAFE PATIENT IDENTIFICATION
Issuer of Patient ID	(0010,0021)	3	SCU: Not generated SCP: Not used
Issuer of Patient ID Qualifiers Sequence	(0010,0024)	3	SCU: Not generated SCP: Not used
Other Patient IDs	(0010,1000)	3	SCU: Not generated SCP: Not used
Other Patient IDs Sequence	(0010,1002)	3	SCU: Not generated SCP: Not used
Patient's Birth Date	(0010,0030)	2	SCU: Duplicated from patient model images if present in those images, otherwise zero-length SCP: Used for database key if non-null. Use of identical value to that found in acquisition images is recommended

| Patient's Sex | (0010,0040) | 2 | SCU: Duplicated from patient model images if present in those images, otherwise zero-length |
| | | | SCP: Used for database key if non-null. Use of identical value to that found in acquisition images is recommended |

6.5.2   Study Entity Modules

6.5.2.1   General Study

Attribute Name	Element Tag	TP	Notes
Study Instance UID	(0020,000D)	1	SCU: Duplicated from patient model images SCP: Not used
Study Date	(0008,0020)	2	SCU: Duplicated from patient model images if present in those images, otherwise zero-length SCP: Not used
Study Time	(0008,0030)	2	SCU: Duplicated from patient model images if present in those images, otherwise zero-length SCP: Not used
Referring Physicians' Name	(0008,0090)	2	SCU: Zero-length SCP: Not used
Study ID	(0020,0010)	2	SCU: Duplicated from patient model images (must be present in those images: see Section 7) SCP: Not used
Accession number	(0008,0050)	2	SCU: Duplicated from patient model images if present in those images, otherwise zero-length SCP: Not used
Study Description	(0008,1030)	3	SCU: Provided the study description of referenced image only if interoperability option is set SCP: Not used

6.5.3   Series Entity Modules

6.5.3.1   RT Series

Attribute Name	Element Tag	TP	Notes
Modality	(0008,0060)	1	SCU: 'RTPLAN' SCP: Must be 'RTPLAN' (DICOM requirement)
Series Instance UID	(0020,000E)	1	SCU: Created for first image in series, otherwise copied from existing images in series SCP: Not used
Series Number	(0020,0011)	2	SCU: Always provided SCP: Used for display if non-null
Series Description	(0008,103E)	3	SCU: 'Adv Sim RT Plans' SCP: Used for display if provided
Operator's Name	(0008,1070)	2	SCU: Name of the operator defined at last plan save. SCP: Used for display if not empty.

6.5.4 Equipment Entity Modules

6.5.4.1 General Equipment

Attribute Name	Element Tag	TP	Notes
Manufacturer	(0008,0070)	2	SCU: 'GE MEDICAL SYSTEMS' SCP: Used to determine system creating object and for display, if non-null (recommended for clear identification of creating system)
Station Name	(0008,1010)	3	SCU: <station hostname> SCP: Not used
Manufacturer's Model Name	(0008,1090)	3	SCU: 'AdvantageSim' SCP: Used to determine system creating object and for display, if non-null (recommended for clear identification of creating system)
Device Serial Number	(0018,1000)	3	SCU: <station host ID> SCP: Not used
Software Versions	(0018,1020)	3	SCU: '7.<subversion>.<build>' (single-valued) SCP: Used to determine system creating object and for display, if non-null (recommended for clear identification of creating system)

6.5.5 Frame Of Reference Module

6.5.5.1 Frame Of Reference

Attribute Name	Element Tag	TP	Notes
Frame Of Reference UID	(0020,0052)	1	SCU: Provided the frame of reference UID of reference series only if interoperability option set SCP: Not used
Position Reference Indicator	(0020,1040)	2	SCU: Provided as empty only if interoperability option set SCP: Not Used

6.5.6 Plan Entity Modules

6.5.6.1 RT General Plan

Attribute Name	Element Tag	TP	Notes
RT Plan Label	(300A,0002)	1	SCU: Equal to comment entered when saving AdvantageSim Plan, truncated to 16 characters SCP: Used for display and object identification
RT Plan Name	(300A,0003)	3	SCU: Equal to comment entered when saving AdvantageSim Plan (non-truncated) SCP: Used for display and object identification

Attribute Name	Element Tag	TP	Notes
Instance Number	(0020,0013)	3	SCU: Always provided by AdvantageSim
			SCP: Used for display if provided
RT Plan Date	(300A,0006)	2	SCU: Date at moment object was saved
			SCP: Used for display if non-null
RT Plan Time	(300A,0007)	2	SCU: Time at moment object was saved
			SCP: Used for display if non-null
RT Plan Geometry	(300A,000C)	1	SCU: 'PATIENT'
			SCP: if it is 'PATIENT' AdvantageSim will load the RT Plan with the referenced RTSS and series.If it is 'TREATMENT DEVICE', then the RT Structure Set object must be loaded first, then the RT Plan object from Utilities/Load Plan.
Referenced Structure Set Sequence	(300C,0060)	1C	SCU: Sequence will always contain exactly one item, referencing RT Structure Set saved at same time as Plan
			SCP: When RT Plan Geometry is 'PATIENT' AdvantageSim requires an RT Structure Set based on CT data.
			Not used when RT Plan Geometry is 'TREATMENT DEVICE' (Ex. Helax and ADAC RT Plan)
>Referenced SOP Class UID	(0008,1150)	1C	SCU: '1.2.840.10008.5.1.4.1.1.481.3' (RT Structure Set)
			SCP: Must be '1.2.840.10008.5.1.4.1.1.481.3' (RT Structure Set)
>Referenced SOP Instance UID	(0008,1155)	1C	SCU: References RT Structure Set instance associated with current plan. In AdvantageSim RT Structure Set and RT Plan instances are always saved as a pair (even when there are no beams defined)
			SCP: Must be specified referenced RT Structure set upon RT Plan based on
DRR Preset List (GE private attribute)	(0249,xxF0)	3	SCU: Not used
			SCP: Not used.
Macro List (GE private attribute)	(0249,xxF1)	3	SCU: GE private attribute storing list of macros that will be available in the AdvantageSim application.
			SCP: Not required by AdvantageSim. If present, used to initialize macro list. Should not be provided by non-GE implementations.
Print Preferences (GE private attribute)	(0249,xxF3)	3	SCU: GE private attribute storing preferences (defaults) when printing from the AdvantageSim application.
			SCP: Not required by AdvantageSim. If present, used to initialize printing function. Should not be provided by non-GE implementations.

Attribute Name	Element Tag	TP	Notes
Treatment Device Conventions (GE private attribute)	(0249,xxF4)	3	SCU: GE private attribute storing default treatment angle and collimator conventions when plan is loaded into AdvantageSim. Enumerated values: [Frame7] SCP: Not required by AdvantageSim. If present, used to initialize default treatment conventions.

6.5.6.2   RT Patient Setup

Attribute Name	Element Tag	TP	Notes
Patient Setup Sequence	(300A,0180)	1	SCU: Sequence will always contain exactly one item SCP: Sequence may contain one or more items. ALL BEAMS IN BEAM SEQUENCE (300A,00B0) MUST REFERENCE THE SAME PATIENT SETUP NUMBER (300A,0182).
>Patient Setup Number	(300A,0182)	1	SCU: 1 SCP: Used to uniquely identify Patient Setup referenced by beams.
>Patient Position	(0018,5100)	1C	SCU: Patient treatment position in AdvantageSim application. May be different from patient orientation in CT images used to build patient model when patient has been scanned 'FFS' or 'FFP'. In these cases, patient may be 'flipped' to 'HFS' and 'HFP' respectively for simulation, if operator selects this option. SCP: NON-NULL VALUE REQUIRED. PATIENT POSITION MUST BE THE SAME AS PATIENT POSITION DEFINED IN CT IMAGES, EXCEPT THAT 'HFS' IS ALSO PERMITTED FOR 'FFS' CT IMAGES, AND 'HFP' IS PERMITTED FOR 'FFP' CT IMAGES. IF CT IMAGE PATIENT POSITION IS NOT DEFINED (DEFAULTS TO 'HFS'), PATIENT POSITION MUST BE 'HFS' HERE.
>Patient Setup Technique	(300A,01B0)	3	SCU: Provided the user selected setup technique only if interoperability option is set. One of the following enumeration may be included: ISOCENTRIC FIXED_SSD TBI BREAST_BRIDGE SKIN_APPOSITION SCP: not used

Attribute Name	Element Tag	TP	Notes
>Patient Scanned Position (GE private attribute)	(0249, xxF2)	3	SCU: GE private attribute specifying position in which patient was scanned. Strictly equal to value of attribute Patient Position (0018, 5100) in referenced acquisition images. Provided to allow applications reading RT Plan only to correctly transform patient into room coordinate system. SCP: Not required by AdvantageSim. If present, verified as being same as value of Patient Position (0018, 5100) in referenced acquisition images.

6.5.6.3   RT Beams

Attribute Name	Element Tag	TP	Notes
Beam Sequence	(300A,00B0)	1	SCU: Always provided unless no beams have been defined in AdvantageSim, in which case the entire module will be absent SCP: Sequence may be absent, in which case only Patient Setup information will be used
>Beam Number	(300A,00C0)	1	SCU: AdvantageSim will number beams in increasing numeric order, starting from 1, as they are found in the Plan SCP: Used to uniquely identify beams if Beam Name is invalid or not supplied.
>Beam Name	(300A,00C2)	3	SCU: Equal to AdvantageSim beam name SCP: Used for AdvantageSim Beam Name if provided and valid. IF PROVIDED, BEAM NAME (300A,00C2) MUST BE UNIQUE WITHIN BEAM SEQUENCE (300A,00B0). If not provided, Beam Number (300A,00C0) is used to uniquely identify Beam in AdvantageSim.
>Beam Type	(300A,00C4)	1	SCU: 'STATIC' SCP: MUST BE 'STATIC'
>Radiation Type	(300A,00C6)	2	SCU: Zero-length if not defined for current beam, otherwise 'PHOTON' or 'ELECTRON' SCP: MUST BE EITHER ZERO-LENGTH (NO MODALITY DEFINED), 'PHOTON' OR 'ELECTRON'. BLOCKS MUST NOT BE DEFINED FOR BEAMS WITH ZERO-LENGTH RADIATION TYPE.
>Treatment Machine Name	(300A,00B2)	2	SCU: Name of machine associated with beam in AdvantageSim. If treatment machine has not been defined in AdvantageSim for one or more beams, it will not be possible to save the plan. SCP: Used to find treatment machine in AdvantageSim machine database, if GE private attributes Referenced Machine SOP Class UID (0249,xxC0) and Referenced Machine SOP Instance UID (0249,xxC1) are not defined. AdvantageSim uses treatment machine with the same name (converted to lowercase) and the highest-numbered machine suffix. IF ADVANTAGESIM TREATMENT MACHINE DOES NOT EXIST, RT PLAN WILL BE REJECTED.

Attribute Name	Element Tag	TP	Notes
>Referenced Machine SOP Class UID (GE private attribute)	(0249,xxC0)	3	SCU: GE private attribute storing private (GE) SOP Class of treatment machine used to define current beam. Equal to '1.2.840.113619.4.5.251'. SCP: Used for uniquely determining AdvantageSim treatment machine associated with current beam. If this attribute is absent, Treatment Machine Name is used for this purpose.
>Referenced Machine SOP Instance UID (GE private attribute)	(0249,xxC1)	3	SCU: GE private attribute storing SOP Instance of treatment machine used to define current beam. SCP: Used for uniquely determining AdvantageSim treatment machine associated with current beam. If this attribute is absent, Treatment Machine Name is used for this purpose.
>Group Name (GE private attribute)	(0249,xx51)	3	SCU: GE private attribute storing name of AdvantageSim beam group containing current beam. SCP: Used for grouping beams if provided, otherwise placed in a default AdvantageSim beam group, having properties of isocenters unlinked and not equal angles.
>Group Properties (GE private attribute)	(0249,xx52)	3	SCU: GE private attribute storing properties of AdvantageSim beam group containing current beam. One or more values can be included. Defined Terms: EQUAL_ANGLES COMM_ISOCENTER SCP: Used for grouping beams if provided, otherwise placed in a default AdvantageSim beam group. IF DEFINED, PROPERTIES MUST BE THE SAME FOR ALL BEAMS IN THE GROUP.
>Associated Markers (GE private attribute)	(0249,xxCA)	3	SCU: GE private attribute storing ROI Names (3006,0026) of markers in the associated RT Structure Set, which have been defined as relating to the current beam. SCP: Used for associating markers with beams if provided, otherwise all markers are defined as normal (non-associated) markers.
>DRR Settings (GE private attribute)	(0249,xxF6)	3	SCU: GE private attribute storing the DRR settings for the current beam. Format: decimal values separated by '\'. Values: 'DRR state'\'Low Density Mix Coef.'\'Soft Tissue Mix Coef.'\'Bones Mix Coef.'\'Custom Mix Coef.'\'Custom Low Threshold'\'Custom High Threshold'\'Depth Control Center'\'Depth Control Width'. SCP: Used for setting the DRR attributes for the current beam if provided, otherwise default settings used.

Attribute Name	Element Tag	TP	Notes
>Conformation Algorithm (GE private Attribute)	(0249,xxF7)	3	SCU: GE private attribute storing the Conformation Algorithm used for the current beam. Defined Terms: OUTSIDE INSIDE HALF SCP: Used to set the Conformation Algorithm for the current beam if provided, otherwise default (OUTSIDE) is used.
>Source-Axis Distance	(300A,00B4)	3	SCU: Source-axis distance of machine associated with beam in AdvantageSim SCP: MUST BE DEFINED, AND EQUAL TO SOURCE-AXIS DISTANCE SPECIFIED IN CORRESPONDING ADVANTAGESIM TREATMENT MACHINE. The requirement that this attribute be defined has been imposed to provide a check on the coherence of the critical SAD parameter.
>Beam Limiting Device Sequence	(300A,00B6)	1	SCU: Sequence will always contain two or three (add-on MLC) items SCP, NON-MLC COLLIMATORS: SEQUENCE MUST CONTAIN EXACTLY TWO ITEMS. THE COMBINATION OF THE TWO RT BEAM LIMITING DEVICE TYPES (300A,00B8) MUST BE COMPATIBLE WITH THE COLLIMATOR TYPE SPECIFIED IN CORRESPONDING ADVANTAGESIM TREATMENT MACHINE. SCP, MLC COLLIMATORS: AS FOR NON-MLC COLLIMATORS, EXCEPT THAT SEQUENCE MAY CONTAIN TWO OR THREE ITEMS.
>>RT Beam Limiting Device Type	(300A,00B8)	1	SCU: Will be 'X', 'Y', 'ASYMX', 'ASYMY', 'MLCX' or 'MLCY', according to collimator type of machine associated with beam in AdvantageSim SCP: THERE MUST BE TWO ITEMS WHICH REPRESENT MUTUALLY ORTHOGONAL JAWS
>>Number of Leaf/Jaw Pairs	(300A,00BC)	1	SCU: Will be between 1 and 200 SCP: MUST EQUAL NUMBER OF LEAF/JAW PAIRS SPECIFIED IN CORRESPONDING ADVANTAGESIM TREATMENT MACHINE, OR SPECIAL CASE IS ACCEPTED WHEN TYPE IS MLC AND CORRESPONDING TREATMENT MACHINE TYPE IS SYM/ASYM(COMPATIBLE)

Attribute Name	Element Tag	TP	Notes
>>Leaf Position Boundaries	(300A,00BE)	2C	SCU: Provided only for 'MLCX' and 'MLCY' collimators. AdvantageSim supports collimators with unequal leaf widths.
			SCP: NON-NULL VALUE REQUIRED FOR MLCX OR MLCY COLLIMATORS. MUST EQUAL LEAF POSITION BOUNDARIES SPECIFIED IN CORRESPONDING ADVANTAGESIM TREATMENT MACHINE, OR SPECIAL CASE IS ACCEPTED WHEN TYPE IS MLC AND CORRESPONDING TREATMENT MACHINE TYPE IS SYM/ASYM(COMPATIBLE).
>>Beam Limiting Device Mode (GE private attribute)	(0249,xxF5)	3	SCU: GE private attribute storing current "mode" of collimator jaw. Defined terms:
			SYMMETRIC = Functioning as symmetric jaw pair (in the case of MLC's, all leaves on the same jaw have the same position).
			ASYMMETRIC = Functioning as asymmetric jaw pair (in the case of MLC's, all leaves on the same jaw have the same position).
			MLC = Functioning in full multi-leaf mode.
			SCP: Used for setting initial collimator mode, if present. Not required by AdvantageSim (if absent, default collimator mode will be used).
>Referenced Patient Setup Number	(300C,006A)	3	SCU: 1 (i.e. references only patient setup specified in RT Patient Setup module)
			SCP: MUST BE DEFINED, and correspond to Patient Setup Number (300A, 0182) in exactly one item of Patient Setup Sequence (300A, 0180). ALL BEAMS IN BEAM SEQUENCE (300A, 00B0) MUST REFERENCE THE SAME PATIENT SETUP NUMBER (300A, 0182).
>Treatment Delivery Type	(300A,00CE)	3	SCU: 'TREATMENT' SCP: Not used
>Number of Wedges	(300A,00D0)	1	SCU: Equal to number of Wedges defined for beam in AdvantageSim. SCP: Not used
>Wedge Sequence	(300A,00D1)	1C	SCU: Provided if Number of Wedges (300A,00D0) greater than 0. SCP: AdvantageSim displays the orientation of the first wedge. No other wedge attributes are used.
>>Wedge Number	(300A,00D2)	1C	SCU: Identification number of the wedge SCP: USED TO IDENTIFY THE FIRST WEDGE, WHICH WILL BE DISPLAYED.
>>Wedge Type	(300A,00D3)	2C	SCU: sent as empty SCP: Not used

Attribute Name	Element Tag	TP	Notes
>>Wedge ID	(300A,00D4)	3	SCU: Use supplied identifier for the wedge SCP: Not used
>>Wedge Angle	(300A,00D5)	2	SCU: Nominal wedge angle SCP: Not used
>>Wedge Factor	(300A,00D6)	2	SCU: Nominal wedge factor SCP: Not used
>>Wedge Orientation	(300A,00D8)	2	SCU: Wedge Orientation SCP: Used to diplay the wedge orientation on the DRR view of the current beam
>>Source To Wedge Tray Distance	(300A,00DA)	3	SCU: Radiation source to wedge tray attachement edge distance SCP: Not used
>Number of Compensators	(300A,00E0)	1	SCU: 0 SCP: Compensators are ignored by AdvantageSim
>Number of Boli	(300A,00ED)	1	SCU: 0 SCP: Boli are ignored by AdvantageSim
>Number of Blocks	(300A,00F0)	1	SCU: Equal to number of Blocks or Cutouts defined for beam in AdvantageSim SCP: MUST BE ZERO IF RADIATION TYPE (300A,00C6) IS ZERO-LENGTH
>Block Sequence	(300A,00F4)	1C	SCU: Provided if Number of Blocks greater than 0 SCP: AdvantageSim supports both photon blocks and electron blocks (cutouts)
>>Source to Block Tray Distance	(300A,00F6)	2	SCU: Equal to Source to Block Tray Distance of machine associated with beam in AdvantageSim SCP: NON-NULL VALUE REQUIRED. MUST EQUAL SOURCE TO BLOCK TRAY DISTANCE SPECIFIED IN CORRESPONDING ADVANTAGESIM TREATMENT MACHINE
>>Block Type	(300A,00F8)	1	SCU: 'SHIELDING' or 'APERTURE'. 'APERTURE' blocks or cutouts are represented by specifying the internal edge only (i.e. keyhole blocks are not explicitly modeled). SCP: Block Type is displayed in AdvantageSim using block or cutout color on BEV
>>Block Divergence	(300A,00FA)	2	SCU: Zero-length SCP: Not used
>>Block Number	(300A,00FC)	1C	SCU: Blocks will be numbered from 1 to n in order presented in sequence SCP: Used to uniquely identify blocks or cutouts if Block Name is invalid or not supplied

Attribute Name	Element Tag	TP	Notes
>>Block Name	(300A,00FE)	3	SCU: Equal to block name entered in AdvantageSim

SCP: Used for AdvantageSim Block or Cutout Name if provided and valid. IF PROVIDED, BLOCK NAME (300A,00FE) MUST BE UNIQUE WITHIN BLOCK SEQUENCE (300A,00F4). If not provided, Block Number (300A,00FC) is used to uniquely identify block or cutout in AdvantageSim |
| >>Material ID | (300A,00E1) | 2 | SCU: Zero-length

SCP: Not used |
| >>Block Thickness | (300A,0100) | 2C | SCU: Saved in the plan only if the environment variable AWRT_BLOCKTHICK_SEND is set.

SCP: Required if Material ID (300A,00E1) is non-zero length. |
| >>Block Transmission | (300A,0102) | 2C | SCU: Zero-length

SCP: Not used. |
| >>Block Number of Points | (300A,0104) | 2 | SCU: In AdvantageSim there is no software limit imposed on the number of points in a block shape

SCP: NON-NULL VALUE REQUIRED. 3 OR MORE POINTS MUST BE PROVIDED |
| >>Block Data | (300A,0106) | 2 | SCU: In AdvantageSim, last data point does not coincide with first beam point (i.e. shape must be closed by connecting first and last point).

SCP: NON_NULL VALUE REQUIRED. Last data point is connected to first data point (DICOM specification). |
| >Final Cumulative Meterset Weight | (300A,010E) | 2C | SCU: NOT provided if interoperability option is set otherwise with value 100

SCP: Not used |
| >Number of Control Points | (300A,0110) | 1 | SCU: 2 (static beam)

SCP: CAN BE MORE THAN 2 CONTROL POINTS. |
| >Control Point Sequence | (300A,0111) | 1 | SCU: Sequence will contain exactly two items. First item will contain all relevant beam parameters. Second element will contain only the attribute Cumulative Meterset Weight (300A,0134) 100.

SCP: If more than 2 control points are defined in the RT Plan, then AdvantageSim will load only the first control point and the remaining control points will be ignored.

Second control point item is ignored. |
| >>Control Point Index | (300A,0112) | 1C | SCU: 0 for first control point, 1 for second control point

SCP: Not used |

Attribute Name	Element Tag	TP	Notes
>>Cumulative Meterset Weight	(300A,0134)	2C	SCU: Provided as empty if interoperability option is set otherwise with value 0 for first control point, 100 for second control point SCP: Not used
>>Nominal Beam Energy	(300A,0114)	3	SCU: Provided for first control point only if beam energy defined in AdvantageSim, otherwise attribute not provided SCP: IF PROVIDED FOR FIRST CONTROL POINT, MUST EQUAL NOMINAL BEAM ENERGY SPECIFIED FOR THE CURRENT BEAM PARTICLE TYPE IN CORRESPONDING ADVANTAGESIM TREATMENT MACHINE. Not used for second control point.
>>Beam Limiting Device Position Sequence	(300A,011A)	1C	SCU: Provided for first control point only. Sequence will contain exactly two items. SCP: FOR FIRST CONTROL POINT, SEQUENCE ITEMS RESTRICTED BY CONDITIONS DESCRIBED IN BEAM LIMITING DEVICE SEQUENCE (300A,00B6) ATTRIBUTE DESCRIPTION (SEE ABOVE). Not used for second control point.
>>>RT Beam Limiting Device Type	(300A,00B8)	1	SCU: Provided for first control point only. Defined terms: X, Y, ASYMX, ASYMY, MLCX, MLCY SCP: For first control point, must correspond to exactly one of Beam Limiting Device Sequence (300A,00B6) items (DICOM requirement). Not used for second control point.
>>>Leaf/Jaw Positions	(300A,011C)	1	SCU: Provided for first control point only SCP: FOR FIRST CONTROL POINT, LEAF/JAW POSITIONS MUST BE WITHIN JAW LIMITS OF CORRESPONDING JAW SPECIFIED IN CORRESPONDING ADVANTAGESIM TREATMENT MACHINE. Not used for second control point.
>>Gantry Angle	(300A,011E)	1C	SCU: Provided for first control point only SCP: FOR FIRST CONTROL POINT, GANTRY ANGLE MUST BE WITHIN GANTRY ANGLE LIMITS SPECIFIED IN CORRESPONDING ADVANTAGESIM TREATMENT MACHINE. Not used for second control point.
>>Gantry Rotation Direction	(300A,011F)	1C	SCU: Provided (value 'NONE') for first control point only SCP: FOR FIRST CONTROL POINT, MUST BE 'NONE'. Not used for second control point.

Attribute Name	Element Tag	TP	Notes
>>Beam Limiting Device Angle	(300A,0120)	1C	SCU: Provided for first control point only SCP: FOR FIRST CONTROL POINT, BEAM LIMITING DEVICE (COLLIMATOR) ANGLE MUST BE WITHIN COLLIMATOR ANGLE LIMITS SPECIFIED IN CORRESPONDING ADVANTAGESIM TREATMENT MACHINE. Not used for second control point.
>>Beam Limiting Device Rotation Direction	(300A,0121)	1C	SCU: Provided (value 'NONE') for first control point only SCP: FOR FIRST CONTROL POINT, MUST BE 'NONE'. Not used for second control point.
>>Patient Support Angle	(300A,0122)	1C	SCU: Provided for first control point only SCP: FOR FIRST CONTROL POINT, PATIENT SUPPORT (TABLE) ANGLE MUST BE WITHIN TABLE ANGLE LIMITS SPECIFIED IN CORRESPONDING ADVANTAGESIM TREATMENT MACHINE. Not used for second control point.
>>Patient Support Rotation Direction	(300A,0123)	1C	SCU: Provided (value 'NONE') for first control point only SCP: FOR FIRST CONTROL POINT, MUST BE 'NONE'. Not used for second control point.
>>Table Top Eccentric Angle	(300A,0125)	1C	SCU: Provided (value 0) for first control point only (no eccentric rotation possible in AdvantageSim) SCP: FOR FIRST CONTROL POINT, MUST BE 0. Not used for second control point.
>>Table Top Eccentric Rotation Direction	(300A,0126)	1C	SCU: Provided (value 'NONE') for first control point only SCP: FOR FIRST CONTROL POINT, MUST BE 'NONE'. Not used for second control point.
>>Table Top Vertical Position	(300A,0128)	2C	SCU: Provided (zero-length) for first control point only SCP: Not used
>>Table Top Longitudinal Position	(300A,0129)	2C	SCU: Provided (zero-length) for first control point only SCP: Not used
>>Table Top Lateral Position	(300A,012A)	2C	SCU: Provided (zero-length) for first control point only SCP: Not used
>>Isocenter Position	(300A,012C)	2C	SCU: Provided for first control point only SCP: FOR FIRST CONTROL POINT, MUST BE PROVIDED. Not used for second control point.

Attribute Name	Element Tag	TP	Notes
>>Source to Surface Distance	(300A,0130)	3	SCU: Distance from beam origin to first point of patient model encountered along central axis ray. This may not correspond to the true patient surface if the beam passes through the treatment table and the treatment table has not been removed from the patient model. If the central axis ray does not intersect the patient, or intersects through the ends of the patient model, then this attribute will be absent. SCP: AdvantageSim recalculates SSD using isocenter position. If Source to Surface Distance (300A,0130) is provided, and is different from the calculated value, AdvantageSim signals this difference and asks the user if the treatment table needs to be removed from the patient model.

6.5.6.4   SOP Common

Attribute Name	Element Tag	TP	Notes
SOP Class UID	(0008,0016)	1	SCU: '1.2.840.10008.5.1.4.1.1.481.5' SCP: Must be equal to '1.2.840.10008.5.1.4.1.1.481.5' (DICOM requirement)
SOP Instance UID	(0008,0018)	1	SCU: UID root will be '1.2.840.113619.2.196'
Specific Character Set	(0008,0005)	1C	SCU: 'ISO_IR 100' SCP: Specific Character Sets other than 'ISO_IR 100' are not handled explicitly by AdvantageSim
Instance Creation Date	(0008,0012)	3	SCU: Same as Structure Set Date (3006,0008) SCP: Not used
Instance Creation Time	(0008,0013)	3	SCU: Same as Structure Set Time (3006,0009) SCP: Not used
Instance Creator UID	(0008,0014)	3	SCU: '1.2.840.113619.6.196' SCP: Not used
Instance Number	(0020,0013)	3	SCU: generated number SCP: Not used

6.5.6.5   Approval Module

Attribute Name	Element Tag	TP	Notes
Approval Status	(300E,0002)	1	SCU: Provided with value "UNAPPROVED" only if interoperability option set SCP: Not used.

6.6   PRIVATE DATA DICTIONARY FOR RT PLAN

Private Creator Identification GEMS_RTEN_01

Attribute Name	Element Tag	VR	VM
Group Name	(0249,xx51)	SH	1
Group Properties	(0249,xx52)	CS	1-n
Referenced Machine SOP Class UID	(0249,xxC0	UI	1
Referenced Machine SOP Instance UID	(0249,xxC1)	UI	1
Associated Markers	(0249,xxCA)	SH	1-n
DRR Preset List (not used)	(0249,xxF0)	OB	1
Macro List	(0249,xxF1)	OB	1
Patient Scanned Position	(0249,xxF2)	CS	1
Print Preferences	(0249,xxF3)	OB	1
Treatment Device Conventions	(0249,xxF4)	CS	1
Beam Limiting Device Mode	(0249,xxF5)	CS	1
DRR Settings	(0249,xxF6)	DS	1
Conformation Algorithm	(0249,xxF7)	SH	1

SECTION 7 CT IMAGE INFORMATION OBJECT REQUIREMENTS

7.1 INTRODUCTION

This section specifies the requirements for the DICOM CT Image IOD when being used as input to AdvantageSim.

7.2 CT IMAGE IOD IMPLEMENTATION

This section defines how CT Image attributes are used within the AdvantageSim implementation, and whether these attributes are mandatory or optional for the correct operation of AdvantageSim.

7.3 CT IMAGE IOD ENTITY-RELATIONSHIP MODEL
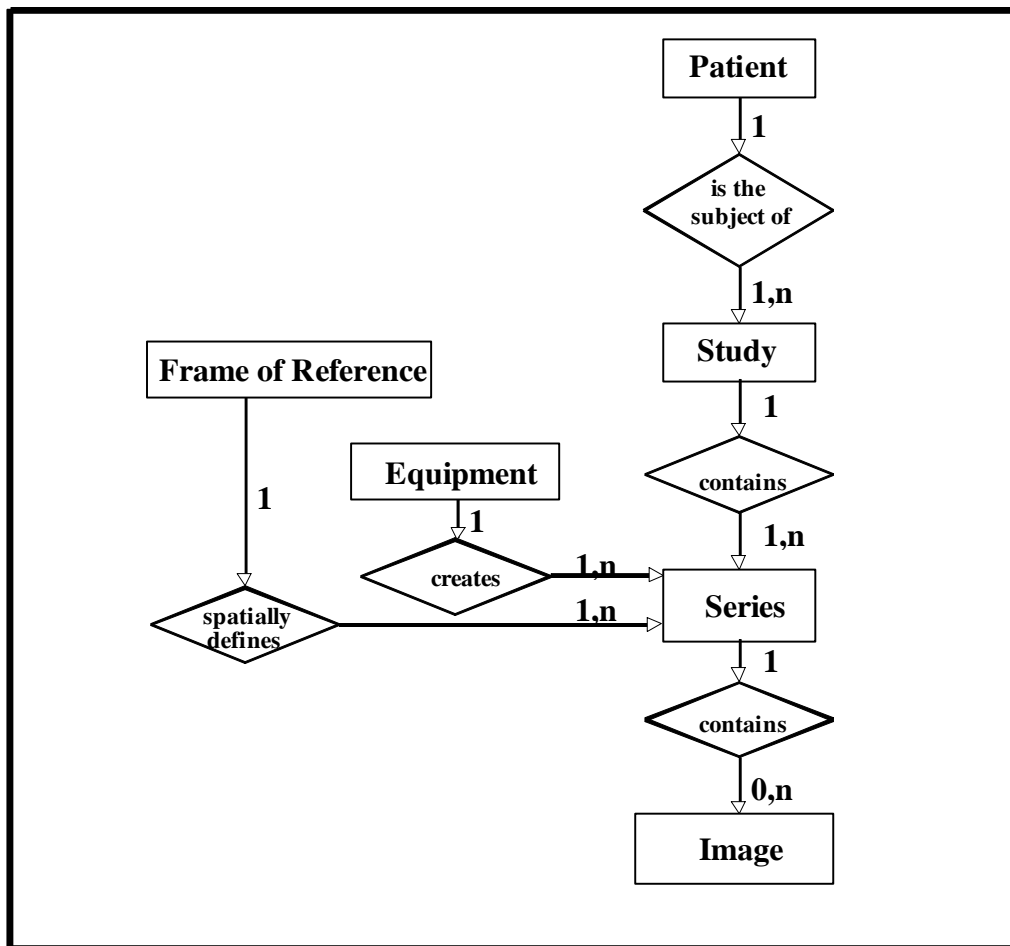
ILLUSTRATION **7-5**
CT IMAGE ENTITY RELATIONSHIP DIAGRAM

The Entity-Relationship diagram for the CT Image interoperability schema is shown in **ILLUSTRATION** 7-5. In this figure, the following diagrammatic convention is established to represent the information organization:

1. each entity is represented by a rectangular box

2. each relationship is represented by a diamond shaped box.

3. 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.

7.3.1 Entities Description

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

7.3.2 AdvantageSim Mapping of DICOM entities

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

DICOM	AdvantageSim
Patient Entity	Patient Entity (Advantage Workstation)
Study Entity	Examination Entity (Advantage Workstation)
Series Entity	Series Entity (Advantage Workstation)
Frame of Reference Entity	None
Equipment Entity	None
Image Entity	Patient model reconstruction on 3D server

7.4   CT IMAGE IOD MODULE TABLE

Within an entity of the DICOM CT Image Information Object Definition, attributes are grouped into a related set 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 infer any encoding of information into datasets.

TABLE 7-5 identifies the defined modules within the entities, which comprise the DICOM CT Image Information Object Definition. Modules are identified by Module Name.

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

TABLE 7-5
CT IMAGE INFORMATION OBJECT DEFINITION (IOD) MODULE TABLE

Entity Name	Module Name	Usage	Reference
Patient	Patient	M	7-5-1-1
	Clinical Trial Subject	U	Not used
Study	General Study	M	7-5-2-1
	Patient Study	U	7-5-2-2
	Clinical Trial Study	U	Not used
Series	General Series	M	7-5-3-1
	Clinical Trial Series	U	Not used
Frame of Reference	Frame of Reference	M	7-5-4-1
Equipment	General Equipment	M	7-5-5-1
Image	General Image	M	7-5-6-1
	Image Plane	M	7-5-6-2
	Image Pixel	M	7-5-6-3
	Contrast/Bolus	C	7-5-6-4
	CT Image	M	7-5-6-5
	Overlay Plane	U	Not used
	VOI LUT	U	Not used
	SOP Common	M	7-5-6-7

7.5   INFORMATION MODULE DEFINITIONS

Please refer to DICOM Standard Part 3 (Information Object Definition) for a description of each of the entities and modules contained within the CT Information Object.

Note: The elements that are not listed in tables will not be present in generated images.

7.5.1   Patient Entity Modules

7.5.1.1   Patient Module

Attribute Name	Element Tag	TP	Notes
Patient's Name	(0010,0010)	2	Used for display if provided. **strongly recommended for safe patient identification**.

Attribute Name	Element Tag	TP	Notes
Patient ID	(0010,0020)	2	Used for display if provided. **strongly recommended for safe patient identification**.
Patient's Birth Date	(0010,0030)	2	Used for display if provided.
Patient's Sex	(0010,0040)	2	Used for display if provided.

7.5.2   Study Entity Modules

7.5.2.1   General Study

Attribute Name	Element Tag	TP	Notes
Study Instance UID	(0020,000D)	1	Used by AdvantageSim for RT object creation.
Study Date	(0008,0020)	2	Used for display if provided.
Study Time	(0008,0030)	2	Used for display if provided.
Referring Physicians' Name	(0008,0090)	2	Used for display if provided.
Study ID	(0020,0010)	2	Used if provided
Accession number	(0008,0050)	2	Used if provided.
Study Description	(0008,1030)	3	Used if provided.
Name of Physician(s) Reading Study	(0008,1060)	3	Used if provided.

7.5.2.2   Patient Study

Attribute Name	Element Tag	TP	Notes
Admitting Diagnoses Description	(0008,1080)	3	Not used.
Patient's Age	(0010,1010)	3	Used by AW if provided.
Patient's Size	(0010,1020)	3	Used by AdvantageSim if provided.
Patient's Weight	(0010,1030)	3	Used by AW if provided.
Additional Patient's History	(0010,21B0)	3	Used by AW if provided.

7.5.3   Series Entity Modules

7.5.3.1   General Series

Attribute Name	Element Tag	TP	Notes
Modality	(0008,0060)	1	Used by AdvantageSim to identify the series modality.
Series Instance UID	(0020,000E)	1	Used by Adv Sim for RT Structure Set creation.
Series Number	(0020,0011)	2	Used if provided
Series Date	(0020,0021)	3	Used by AW if provided.
Series Time	(0020,0031)	3	Used by AW if provided.
Performing Physician's Name	(0008,1050)	3	Used by AW if provided.
Series Description	(0008,103E)	3	Used by AdvantageSim for display purposes.
Operators' Name	(0008,1070)	3	Used by AW if provided.

Attribute Name	Element Tag	TP	Notes
Body Part Examined	(0018,0015)	3	No used
Patient Position	(0018,5100)	3	Used by Adv Sim for patient model reconstruction. If absent, Adv Sim defaults to "HFS" after user confirmation. The defined terms are: HFP = Head First-Prone HFS = Head First-Supine HFDR = Head First-Decubitus Right HFDL = Head First-Decubitus Left FFDR = Feet First-Decubitus Right FFDL = Feet First-Decubitus Left FFP = Feet First-Prone FFS = Feet First-Supine **GE strongly recommends that this attribute be systematically provided.**

7.5.4   Common Frame Of Reference Entity Modules

7.5.4.1   Frame Of Reference

Attribute Name	Element Tag	TP	Notes
Frame of Reference UID	(0020,0052)	1	Used by Adv Sim for RT Structure Set creation.
Position Reference Indicator	(0020,1040)	2	Used by AW if provided.

7.5.5   Equipment Entity Modules

7.5.5.1   General Equipment

Attribute Name	Element Tag	TP	Notes
Manufacturer	(0008,0070)	2	Used by AW if provided.
Institution Name	(0008,0080)	3	Used by AW if provided.
Station Name	(0008,1010)	3	Used by AW if provided.
Manufacturer's Model Name	(0008,1090)	3	Used by AW if provided.
Pixel Padding Value	(0028,0120)	3	Used by AW if provided, defaults to 0 otherwise.

7.5.6   Image Entity Modules

7.5.6.1   General Image

Attribute Name	Element Tag	TP	Notes
Image Number	(0020,0013)	2	Used if provided
Image Date	(0008,0023)	2C	Used by Adv Sim if provided (image time stamp).
Image Time	(0008,0033)	2C	Used by Adv Sim if provided (image time stamp).
Image Type	(0008,0008)	3	See CT Image Module.
Acquisition Number	(0020,0012)	3	Not used.
Acquisition Date	(0008,0022)	3	Used by AW if provided.
Acquisition Time	(0008,0032)	3	Used by AW if provided.

7.5.6.2   Image Plane

Attribute Name	Element Tag	TP	Notes
Pixel Spacing	(0028,0030)	1	Used for patient model reconstruction. PIXELS MUST BE SQUARE (i.e. X and Y values must be equal).
Image Orientation (Patient)	(0020,0037)	1	Used for patient model reconstruction. IMAGES MUST NOT HAVE GANTRY TILT OR SWIVEL (i.e. only one of each (x,y,z) cosine triplet can be non-zero).
Image Position (Patient)	(0020,0032)	1	Used for patient model reconstruction.
Slice Thickness	(0018,0050)	2	Used by AW if provided.
Slice Location	(0020,1041)	3	Not used.

7.5.6.3   Image Pixel

Attribute Name	Element Tag	TP	Notes
Samples per Pixel	(0028,0002)	1	See CT Image Module.
Photometric Interpretation	(0028,0004)	1	See CT Image Module.
Rows	(0028,0010)	1	Used for patient model reconstruction. ROWS AND COLUMNS MUST BE EQUAL.
Columns	(0028,0011)	1	Used for patient model reconstruction. ROWS AND COLUMNS MUST BE EQUAL.
Bits Allocated	(0028,0100)	1	See CT Image Module.
Bits Stored	(0028,0101)	1	See CT Image Module.
High Bit	(0028,0102)	1	See CT Image Module.
Pixel Representation	(0028,0103)	1	Not used, shall be "1".
Pixel Data	(7FE0,0010)	1	Used for patient model reconstruction.
Smallest Image Pixel Value	(0028,0106)	3	Used by AW, defaults to 0 if absent.
Largest Image Pixel Value	(0028,0107)	3	Used by AW, default to 4095 if absent.

7.5.6.4   Contrast/Bolus (not mandatory)

Attribute Name	Element Tag	TP	Notes
Contrast/Bolus Agent	(0018,0020)	1	Used by AW if Contrast/Bolus Module present.
Contrast/Bolus Route	(0018,1040)	1	Used by AW if Contrast/Bolus Module present.

7.5.6.5   CT Image

Attribute Name	Element Tag	TP	Notes
Image Type	(0008,0008)	1	Used for image type identification.
Samples per Pixel	(0028,0002)	1	Not used, shall be 1.
Photometric Interpretation	(0028,0004)	1	Not used, shall be "MONOCHROME2"
Bits Allocated	(0028,0100)	1	Not used, shall be 16.

Attribute Name	Element Tag	TP	Notes
Bits Stored	(0028,0101)	1	Not used, shall be 16.
High Bit	(0028,0102)	1	Not used, shall be 15.
Rescale Intercept	(0028,1052)	1	Used for patient model reconstruction.
Rescale Slope	(0028,1053)	1	Used for patient model reconstruction.
KVP	(0018,0060)	2	Used by AW if provided.
Acquisition Number	(0020,0012)	2	Not used.
Scan Options	(0018,0022)	3	Used by AW if provided.
Data Collection Diameter	(0018,0090)	3	Used by AW if provided.
Reconstruction Diameter	(0018,1100)	3	Not used
Distance Source to Detector	(0018,1110)	3	Not used
Distance Source to Patient	(0018,1111)	3	Not used
Gantry/Detector Tilt	(0018,1120)	3	Used. AdvantageSim rejects images with Gantry Tilt - see Image Orientation (Patient) attribute.
Table Height	(0018,1130)	3	Not used
Rotation Direction	(0018,1140)	3	Not used
Exposure Time	(0018,1150)	3	Used by AW if provided.
X-ray Tube Current	(0018,1151)	3	Used by AW if provided.
Exposure	(0018,1152)	3	Not used
Exposure in As	(0018,1153)	3	Not used
Filter Type	(0018,1160)	3	Not used
Generator Power	(0018,1170)	3	Not used
Focal Spot	(0018,1190)	3	Not used
Convolution Kernel	(0018,1210)	3	Used by AW if provided.

7.5.6.6   SOP Common

Attribute Name	Element Tag	TP	Notes
SOP Class UID	(0008,0016)	1	Used by Adv Sim to confirm image class.
SOP Instance UID	(0008,0018)	1	Used by Adv Sim for image identification.
Specific Character Set	(0008,0005)	1C	AdvantageSim supports the ISO_IR 100 extended character set only.

SECTION 8   MR IMAGE INFORMATION OBJECT REQUIREMENTS

8.1   INTRODUCTION

This section specifies the requirements for the DICOM MR Image IOD when being used as input to AdvantageSim.

8.2   MR IMAGE IOD IMPLEMENTATION

This section defines how MR Image attributes are used within the AdvantageSim implementation, and whether these attributes are mandatory or optional for the correct operation of AdvantageSim.

8.3   MR IMAGE IOD ENTITY-RELATIONSHIP MODEL

ILLUSTRATION 8-6
MR IMAGE ENTITY RELATIONSHIP DIAGRAM
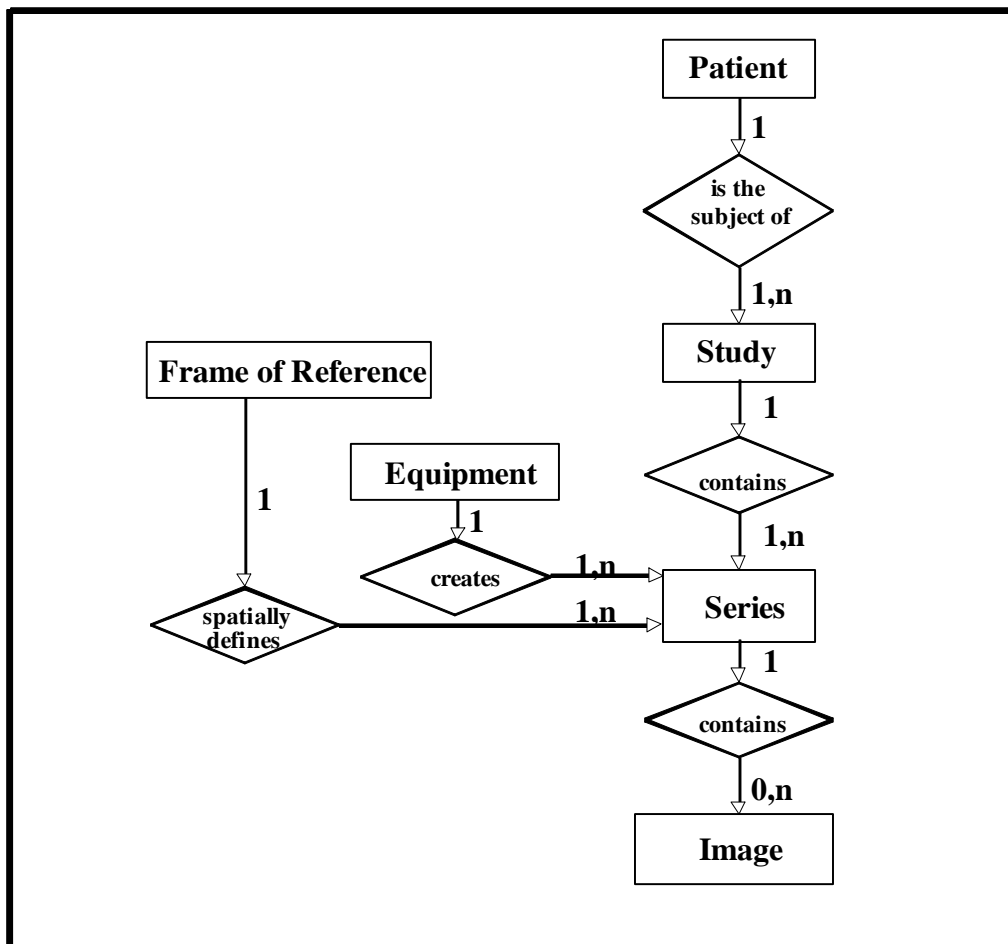
The Entity-Relationship diagram for the MR Image interoperability schema is shown in ILLUSTRATION 8-7. In this figure, the following diagrammatic convention is established to represent the information organization:

     4. each entity is represented by a rectangular box

5. each relationship is represented by a diamond shaped box.

6. 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.

8.3.1 Entities Description

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

8.3.2 AdvantageSim Mapping of DICOM entities

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

DICOM	AdvantageSim
Patient Entity	Patient Entity (Advantage Workstation)
Study Entity	Examination Entity (Advantage Workstation)
Series Entity	Series Entity (Advantage Workstation)
Frame of Reference Entity	None
Equipment Entity	None
Image Entity	Patient model reconstruction on 3D server

8.4 MR IMAGE IOD MODULE TABLE

Within an entity of the DICOM MR Image Information Object Definition, attributes are grouped into a related set 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 infer any encoding of information into datasets.

TABLE 8-6 identifies the defined modules within the entities, which comprise the DICOM MR Image Information Object Definition. Modules are identified by Module Name.

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

TABLE 8-6
MR IMAGE INFORMATION OBJECT DEFINITION (IOD) MODULE TABLE

Entity Name	Module Name	Usage	Reference
Patient	Patient	M	7-5-1-1
	Clinical Trial Subject	U	Not used
Study	General Study	M	7-5-2-1
	Patient Study	U	7-5-2-2
	Clinical Trial Study	U	Not used
Series	General Series	M	7-5-3-1
	Clinical Trial Series	U	Not used
Frame of Reference	Frame of Reference	M	7-5-4-1
Equipment	General Equipment	M	7-5-5-1
Image	General Image	M	7-5-6-1

Entity Name	Module Name	Usage	Reference
	Image Plane	M	7-5-6-2
	Image Pixel	M	7-5-6-3
	Contrast/Bolus	C	7-5-6-4
	MR Image	M	8-5-1-1
	Overlay Plane	U	Not used
	VOI LUT	U	Not used
	SOP Common	M	7-5-6-7

8.5   INFORMATION MODULE DEFINITIONS

Please refer to DICOM Standard Part 3 (Information Object Definition) for a description of each of the entities and modules contained within the MR Information Object. The General Modules that are common are described in the section: SECTION 7 CT IMAGE INFORMATION OBJECT REQUIREMENTS.

Note: The elements that are not listed in tables will not be present in generated images.

8.5.1   Image Entity Modules

8.5.1.1   MR Image

Attribute Name	Element Tag	TP	Notes
Image Type	(0008,0008)	1	Used for image type identification.
Samples per Pixel	(0028,0002)	1	Not used, shall be "1".
Photometric Interpretation	(0028,0004)	1	Not used, shall be "MONOCHROME2".
Bits Allocated	(0028,0100)	1	Not used, shall be 16.
Scanning Sequence	(0018,0020)	1	Used
Sequence Variant	(0018,0021)	1	Used
Scan Options	(0018,0022)	2	Used
MR Acquisition Type	(0018,0023)	2	Used
Repetition Time	(0018,0080)	2C	Used
Echo Time	(0018,0081)	2	Used
Echo Train Length	(0018,0091)	2	Used
Inversion Time	(0018,0082)	2C	Used
Trigger Time	(0018,1060)	2C	Used
Sequence Name	(0018,0024)	3	Not used.
Angio Flag	(0018,0025)	3	Not used.
Number of Averages	(0018,0083)	3	Used by AW if provided.
Imaging Frequency	(0018,0084)	3	Used by AW if provided.
Imaged Nucleus	(0018,0085)	3	Not used.
Echo Number	(0018,0086)	3	Used by AW if provided.
Magnetic Field Strength	(0018,0087)	3	Used by AW if provided.
Spacing Between Slices	(0018,0088)	3	Not used.
Number of Phase Encoding Steps	(0018,0089)	3	Not used.

Attribute Name	Element Tag	TP	Notes
Percent Sampling	(0018,0093)	3	Used by AW if provided.
Percent Phase Field of View	(0018,0094)	3	Not used.
Pixel Bandwidth	(0018,0095)	3	Used by AW if provided.
Nominal Interval	(0018,1062)	3	Not used.
Beat Rejection Flag	(0018,1080)	3	Not used.
Low R-R Value	(0018,1081)	3	Not used.
High R-R Value	(0018,1082)	3	Not used.
Intervals Acquired	(0018,1083)	3	Not used.
Intervals Rejected	(0018,1084)	3	Not used.
PVC Rejection	(0018,1085)	3	Not used.
Skip Beats	(0018,1086)	3	Not used.
Heart Rate	(0018,1088)	3	Not used.
Cardiac Number of Images	(0018,1090)	3	Used by AW if provided.
Trigger Window	(0018,1094)	3	Not used.
Reconstruction Diameter	(0018,1100)	3	Not used.
Receiving Coil Name	(0018,1250)	3	Used by AW if provided.
Transmitting Coil Name	(0018,1251)	3	Not used.
Acquisition Matrix	(0018,1310)	3	Used by AW if provided.
In-plane Phase Encoding Direction	(0018,1312)	3	Not used.
Flip Angle	(0018,1314)	3	Used by AW if provided.
SAR	(0018,1316)	3	Not used.
Variable Flip Angle Flag	(0018,1315)	3	Not used.
dB/dt	(0018,1318)	3	Not used.
Temporal Position Identifier	(0020,0100)	3	Not used.
Number of Temporal Positions	(0020,0105)	3	Not used.
Temporal Resolution	(0020,0110)	3	Not used.

SECTION 9   PET IMAGE INFORMATION OBJECT REQUIREMENTS

9.1   INTRODUCTION

This section specifies the requirements for the DICOM PET Image IOD when being used as input to AdvantageSim.

9.2   PET IMAGE IOD IMPLEMENTATION

This section defines how PET Image attributes are used within the AdvantageSim implementation, and whether these attributes are mandatory or optional for the correct operation of AdvantageSim.

9.3   PET IMAGE IOD ENTITY-RELATIONSHIP MODEL

ILLUSTRATION 9-**7**
PET IMAGE ENTITY RELATIONSHIP DIAGRAM
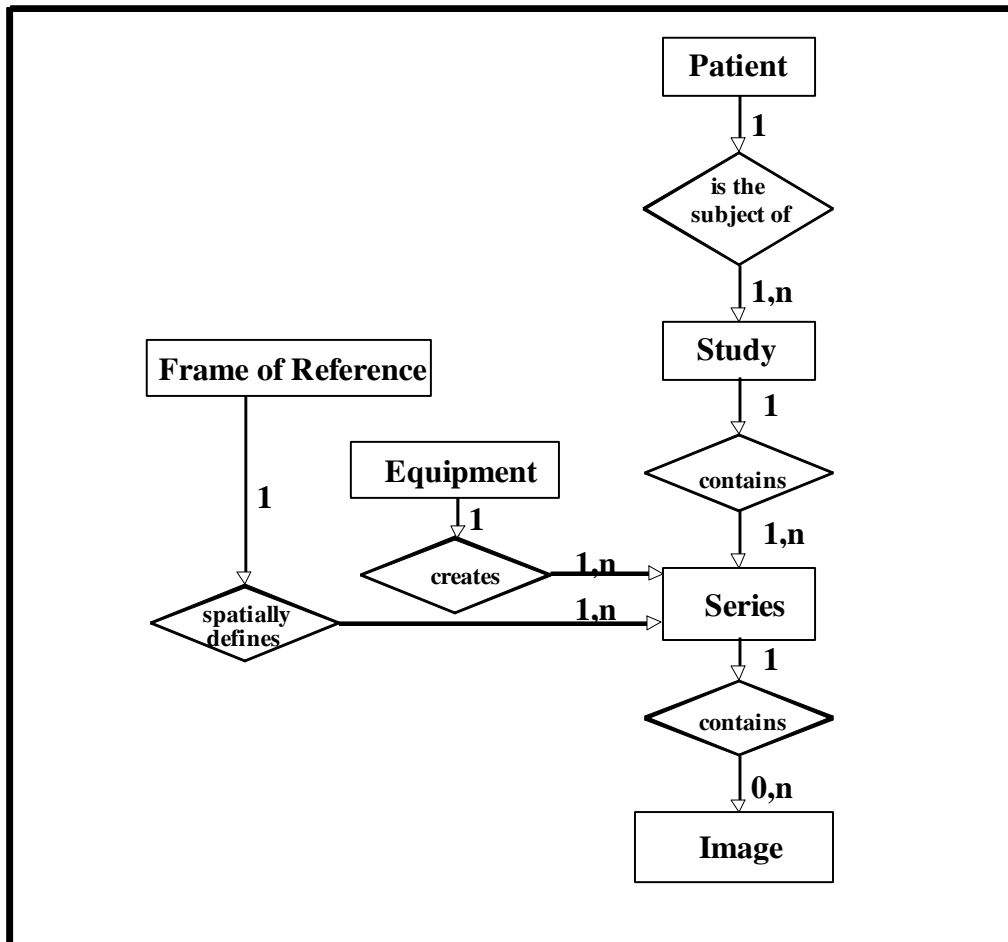
The Entity-Relationship diagram for the PET Image interoperability schema is shown in ILLUSTRATION 9-8. In this figure, the following diagrammatic convention is established to represent the information organization:

7. each entity is represented by a rectangular box

8. each relationship is represented by a diamond shaped box.

9. 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.

9.3.1   Entities Description

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

9.3.2   AdvantageSim Mapping of DICOM entities

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

DICOM	AdvantageSim
Patient Entity	Patient Entity (Advantage Workstation)
Study Entity	Examination Entity (Advantage Workstation)
Series Entity	Series Entity (Advantage Workstation)
Frame of Reference Entity	None
Equipment Entity	None
Image Entity	Patient model reconstruction on 3D server

9.4   PET IMAGE IOD MODULE TABLE

Within an entity of the DICOM PET Image Information Object Definition, attributes are grouped into a related set 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 infer any encoding of information into datasets.

TABLE 9-7 identifies the defined modules within the entities, which comprise the DICOM PET Image Information Object Definition. Modules are identified by Module Name.

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

TABLE 9-7
PET IMAGE INFORMATION OBJECT DEFINITION (IOD) MODULE TABLE

Entity Name	Module Name	Usage	Reference
Patient	Patient	M	7-5-1-1
	Clinical Trial Subject	U	Not used
Study	General Study	M	7-5-2-1
	Patient Study	U	7-5-2-2
	Clinical Trial Study	U	Not used
Series	General Series	M	7-5-3-1
	Clinical Trial Series	U	Not used
	PET Series	M	9-5-1-1
	PET Isotope	M	9-5-1-2
	PET Multi-gated Acquisition	C - Required if Series Type (0054,1000) Value 1 is GATED.	Not used
	NM/PET Patient Orientation	M	Not used
Frame of Reference	Frame of Reference	M	7-5-4-1
Equipment	General Equipment	M	7-5-5-1
Image	General Image	M	7-5-6-1
	Image Plane	M	7-5-6-2
	Image Pixel	M	7-5-6-3
	PET Image	M	9-5-2-1
	Overlay Plane	U	Not used
	VOI LUT	U	Not used
	SOP Common	M	7-5-6-7

9.5 INFORMATION MODULE DEFINITIONS

Please refer to DICOM Standard Part 3 (Information Object Definition) for a description of each of the entities and modules contained within the PET Information Object. The General Modules that are common are described in the section: SECTION 7 CT IMAGE INFORMATION OBJECT REQUIREMENTS.

Note: The elements that are not listed in tables will not be present in generated images.

9.5.1 Series Entity Modules

9.5.1.1 PET Series

Attribute Name	Element Tag	TP	Notes
Series Date	(0008,0021)	1	Used by AW if provided.
Series Time	(0008,0031)	1	Used
Units	(0054,1001)	1	Used
Counts Source	(0054,1002)	1	Not used.
Series Type	(0054,1000)	1	Not used.
Reprojection Method	(0054,1004)	2C	Not used.
Number of R-R Intervals	(0054,0061)	1C	Not used.
Number of Time Slots	(0054,0071)	1C	Used if (0054,1000) Series Type is 'GATED'
Number of Time Slices	(0054,0101)	1C	Not used.
Number of Slices	(0054,0081)	1	Not used.
Corrected Image	(0028,0051)	2	Used
Randoms Correction Method	(0054,1100)	3	Not used.
Attenuation Correction Method	(0054,1101)	3	Not used.
Scatter Correction Method	(0054,1105)	3	Not used.
Decay Correction	(0054,1102)	1	Not used.
Reconstruction Diameter	(0018,1100)	3	Not used.
Convolution Kernel	(0018,1210)	3	Not used.
Reconstruction Method	(0054,1103)	3	Not used.
Detector Lines of Response Used	(0054,1104)	3	Not used.
Acquisition Start Condition	(0018,0073)	3	Not used.
Acquisition Start Condition Data	(0018,0074)	3	Not used.
Acquisition Termination Condition	(0018,0071)	3	Not used.
Acquisition Termination Condition Data	(0018,0075)	3	Not used.
Field of View Shape	(0018,1147)	3	Not used.
Field of View Dimensions	(0018,1149)	3	Not used.
Gantry/Detector Tilt	(0018,1120)	3	Used. AdvantageSim rejects images with Gantry Tilt - see Image Orientation (Patient) attribute.
Gantry/Detector Slew	(0018,1121)	3	Not used.
Type of Detector Motion	(0054,0202)	3	Not used.
Collimator Type	(0018,1181)	2	Not used.
Collimator/Grid Name	(0018,1180)	3	Not used.
Axial Acceptance	(0054,1200)	3	Not used.
Axial Mash	(0054,1201)	3	Not used.
Transverse Mash	(0054,1202)	3	Not used.
Detector Element Size	(0054,1203)	3	Not used.
Coincidence Window Width	(0054,1210)	3	Not used.

Attribute Name	Element Tag	TP	Notes
Energy Window Range Sequence	(0054,0013)	3	Not used.
>Energy Window Lower Limit	(0054,0014)	3	Not used.
>Energy Window Upper Limit	(0054,0015)	3	Not used.
Secondary Counts Type	(0054,1220)	3	Not used.

9.5.1.2 PET Isotope

Attribute Name	Element Tag	TP	Notes
Radiopharmaceutical Information Sequence	(0054,0016)	2	Used
>Radionuclide Code Sequence	(0054,0300)	2	Not used
>>Code Value	(0008,0100)	1C	
>>Code Scheme Designator	(0008,0102)	1C	
>>Code Meaning	(0008,0104)	3	
>Radiopharmaceutical Route	(0018,1070)	3	Not used
>Administration Route Code Sequence	(0054,0302)	3	Not used
>>Code Value	(0008,0100)	1C	
>>Code Scheme Designator	(0008,0102)	1C	
>>Code Meaning	(0008,0104)	3	
>Radiopharmaceutical Volume	(0018,1071)	3	Not used
>Radiopharmaceutical Start Time	(0018,1072)	3	Used
>Radiopharmaceutical Stop Time	(0018,1073)	3	Not used
>Radionuclide Total Dose	(0018,1074)	3	Used
>Radionuclide Half Life	(0018,1075)	3	Used
>Radionuclide Positron Fraction	(0018,1076)	3	Not used
>Radiopharmaceutical Specific Activity	(0018,1077)	3	Not used
>Radiopharmaceutical	(0018,0031)	3	Not used
>Radiopharmaceutical Code Sequence	(0054,0304)	3	Not used
>>Code Value	(0008,0100)	1C	
>>Code Scheme Designator	(0008,0102)	1C	
>>Code Meaning	(0008,0104)	3	
Intervention Drug Information Sequence	(0018,0026)	3	Not used
>Intervention Drug Name	(0018,0034)	3	Not used
>Intervention Drug Code Sequence	(0018,0029)	3	Not used
>>Code Value	(0008,0100)	1C	
>>Code Scheme Designator	(0008,0102)	1C	
>>Code Meaning	(0008,0104)	3	
>Intervention Drug Start Time	(0018,0035)	3	Not used
>Intervention Drug Stop Time	(0018,0027)	3	Not used
>Intervention Drug Dose	(0018,0028)	3	Not used

9.5.2 Image Entity Modules

9.5.2.1 PET Image

Attribute Name	Element Tag	TP	Notes
Image Type	(0008,0008)	1	Used for image type identification.
Samples per Pixel	(0028,0002)	1	Not used, shall be "1".

Attribute Name	Element Tag	TP	Notes
Photometric Interpretation	(0028,0004)	1	Not used, shall be "MONOCHROME2".
Bits Allocated	(0028,0100)	1	Not used, shall be 16.
Bits Stored	(0028,0101)	1	Not used shall be 16
High Bit	(0028,0102)	1	Not used, shall be 15
Rescale Intercept	(0028,1052)	1	Not used (recomputed)
Rescale Slope	(0028,1053)	1	Used
Frame Reference Time	(0054,1300)	1	Not used
Trigger Time	(0018,1060)	1C	Used if (0054,1000) Series Type is 'GATED'
Frame Time	(0018,1063)	1C	Used if (0054,1000) Series Type is 'GATED'
Low R-R Value	(0018,1081)	1C	Not used
High R-R Value	(0018,1082)	1C	Not used
Lossy Image Compression	(0028,2110)	1C	Used by AW if provided. Enumerated values: 00 = Image has NOT been subjected to lossy compression. 01 = Image has been subjected to lossy compression.
Image Index	(0054,1330)	1	Not used.
Acquisition Date	(0008,0022)	2	Used
Acquisition Time	(0008,0032)	2	Used
Actual Frame Duration	(0018,1242)	2	Used if (0054,1000) Series Type is 'GATED'
Nominal Interval	(0018,1062)	3	Not used.
Intervals Acquired	(0018,1083)	3	Used if (0054,1000) Series Type is 'GATED'
Intervals Rejected	(0018,1084)	3	Not used.
Primary (Prompts) Counts Accumulated	(0054,1310)	3	Not used.
Secondary Counts Accumulated	(0054,1311)	3	Not used.
Slice Sensitivity Factor	(0054,1320)	3	Not used.
Decay Factor	(0054,1321)	1C	Not used.
Dose Calibration Factor	(0054,1322)	3	Not used.
Scatter Fraction Factor	(0054,1323)	3	Not used.
Dead Time Factor	(0054,1324)	3	Not used.
Anatomic Region Sequence	(0008,2218)	3	Not used.
>Code Value	(0008,0100)	1C	
>Code Scheme Designator	(0008,0102)	1C	
>Code Meaning	(0008,0104)	1C	
>Anatomic Region Modifier Sequence	(0008,2220)	3	Not used.
>>Code Value	(0008,0100)	1C	
>>Code Scheme Designator	(0008,0102)	1C	
>>Code Meaning	(0008,0104)	1C	
Primary Anatomic Structure Sequence	(0008,2228)	3	Not used.
>Code Value	(0008,0100)	1C	
>Code Scheme Designator	(0008,0102)	1C	
>Code Meaning	(0008,0104)	1C	
>Primary Anatomic Structure Modifier Sequence	(0008,2230)	3	Not used.
>>Code Value	(0008,0100)	1C	
>>Code Scheme Designator	(0008,0102)	1C	
>>Code Meaning	(0008,0104)	1C	

9.6   PRIVATE DATA DICTIONARY FOR PET IMAGES

Private Creator Identification GEMS_PETD_01

Attribute Name	Element Tag	VR	VM
Tracer Name	(0009,xx36)	LO	1
Accum bin duration	(0009,xx78)	SL	1
Measured Time	(0009,xx39)	DT	1
Post injected activity	(0009,xx3C)	FL	1
Scan time	(0009,xx0D)	DT	1
Tracer activity	(0009,xx38)	FL	1
Administered time	(0009,xx3B)	DT	1
Post injected time	(0009,xx3D)	DT	1
Half life	(0009,xx3F)	FL	1

Note

If not all present, the following tags are read, but not used by AdvantageSim:

Acquisition Date, Acquisition Time, Radionuclide Total Dose, Radiopharmaceutical Start Time, Radionuclide Half Life.